APPENDIX 1

Metro Region Species List:

Purpose and Limitations

The purpose of Metro's Species List is threefold:

1. To identify fish and wildlife species occurring in the Metro region.
2. To identify the relative importance of various types of habitat to fish and wildlife species.
3. To provide a biologically meaningful way in which to describe the biodiversity of the Metro region.

THE LIST IS NOT A STATEMENT OF POLICY. In keeping with Metro's Streamside Vision Statement, the focus of the list is on native fish and wildlife species whose historic ranges include the metropolitan area and whose habitats are or can be provided for in urban habitats. Urban habitats may never be conducive to significant populations of some species, such as black bear and cougar. Further analysis and Metro Council deliberation will help determine (to the extent possible) the type, amount, and location of fish and wildlife habitats that should be protected and/or restored. For example, landowner incentives will be developed for conservation purposes.

This list contains:

1. All known native vertebrate species that currently exist within the Metro region (the final version will include a map of area involved) for at least a portion of the year and could be found in the region through diligent search by a knowledgeable person. Vagrant species (those that do not typically occur every year) are not included on this list.
2. Extirpated (locally extinct) native vertebrate species known to have inhabited the region in the past.
3. Nonnative vertebrate species with established breeding populations in the region.

The species list is based on the opinion of more than two dozen local wildlife experts. The Oregon Natural Heritage Program (ORNHP), Endangered Species Act (ESA), and Oregon Department of Fish and Wildlife (ODFW) status categories were obtained from ORNHP's February, 2001 *Rare, Threatened and Endangered Plants and Animals of Oregon* publication. Habitat associations were obtained from Johnson and O'Neil's new book, *Wildlife Habitats and Relationships in Oregon and Washington.* The taxonomic standards for common and scientific names for birds is based on the American Ornithological Union Check-list. We are also developing a separate aquatic and terrestrial invertebrate list, but this will not be as comprehensive in scope as the vertebrate species list.

For questions or comments regarding this list, please contact Lori Hennings at Metro (503/797-1726).

Metro Region Species List:
Key to Notations

* Indicates species that are non-native (also known as alien or introduced) to Metro region.

( ) Parentheses indicate a species that was historically present but was extirpated from the Metro region within approximately the last century.

1 **Code** (type of animal)
A = Amphibians
B = Birds
F = Fish
M = Mammals
R = Reptiles

2 **Migratory Status** (indicates trend for the majority of a given species in the Metro region):
A = Anadromous (fish; lives in the ocean, spawns in fresh water)
C = Catadromous (fish; lives in fresh water, spawns in the ocean)
M = Migrates through area without stopping for long time periods
N = Neotropical migratory species (birds; majority of individuals breeding in the Metro region migrate south of U.S./Mexico border for winter)
R = Permanent resident (lives in the area year-round)
S = Short-distance migrant (from elevational to regional migration, e.g., across several states)
W = Winters in the Metro region

3 **Federal Status** is based on current Endangered Species Act listings. **E** = Endangered, **T** = Threatened. Endangered taxa are those which are in danger of becoming extinct within the foreseeable future throughout all or a significant portion of their range. Threatened taxa are those likely to become endangered within the foreseeable future.
LE = Listed Endangered. Taxa listed by the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS) as Endangered under the Endangered Species Act (ESA), or by the Departments of Agriculture (ODA) and Fish and Wildlife (ODFW) of the state of Oregon under the Endangered Species Act of 1987 (OESA).
LT = Listed Threatened. Taxa listed by the USFWS, NMFS, ODA, or ODFW as Threatened.
PE = Proposed Endangered. Taxa proposed by the USFWS or NMFS to be listed as Endangered under the ESA or by ODFW or ODA under the OESA.
PT = Proposed Threatened. Taxa proposed by the USFWS or NMFS to be listed as Threatened under the ESA or by ODFW or ODA under the OESA.

C = Candidate taxa for which NMFS or USFWS have sufficient information to support a proposal to list under the ESA, or which is a candidate for listing by the ODA under the OESA.
SoC = Species of Concern. Former C2 candidates which need additional information in order to propose as Threatened or Endangered under the ESA. These are species which USFWS is reviewing for consideration as Candidates for listing under the ESA.

4 **ODFW Status** (state status) is based on current Oregon Department of Fish and Wildlife "Oregon Sensitive Species List," 2001. See Federal Status (above) for definitions of LT and LE.
SC (Critical) = Species for which listing as threatened or endangered is pending; or those for which listing as threatened or endangered may be appropriate if immediate conservation actions are not taken. Also considered critical are some peripheral species which are at risk throughout their range, and some disjunct populations.
SV (Vulnerable) = Species for which listing as threatened or endangered is not believed to be imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring. In some cases the population is sustainable, and protective measures are being implemented; in others, the population may be declining and improved protective measures are needed to maintain sustainable populations over time.
SP (Peripheral or Naturally Rare) = Peripheral species refer to those whose Oregon populations are on the edge of their range. Naturally rare species are those which had low population numbers historically in Oregon because of naturally limiting factors. Maintaining the status quo for the habitats and populations of these species is a minimum requirement. Disjunct populations of several species which occur in Oregon should not be confused with peripheral.
SU (Undetermined Status): Animals in this category are species for which status is unclear. They may be susceptible to population decline of sufficient magnitude that they could qualify for endangered, threatened, critical or vulnerable status, but scientific study will be required before a judgement can be made.

5 **ORNHP Rank (ABI – Natural Heritage Network Ranks):** ORNHP participates in an international system for ranking rare, threatened and endangered species throughout the world. The system was developed by The Nature Conservancy and is maintained by The Association for Biodiversity Information (ABI) in cooperation with Heritage Programs or Conservation Data Centers (CDCs) in all 50 states, in 4 Canadian provinces, and in 13 Latin American countries. The ranking is a 1-5 scale, primarily based on the number of known occurrences, but also including threats, sensitivity, area occupied, and other biological factors. On Metro's Species List the first ranking (**rank**/rank) is the Global Rank and begins with a "G". If the taxon has a trinomial (a subspecies, variety or recognized race), this is followed by a "T" rank indicator. A "Q" at the end of this ranking indicates the taxon has taxonomic questions. The second ranking (rank/**rank**) is the State Rank and begins with the letter "S". The ranks are summarized below.

1 = Critically imperiled because of extreme rarity or because it is somehow especially vulnerable to extinction or extirpation, typically with 5 or fewer occurrences.
2 = Imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6-20 occurrences.
3 = Rare, uncommon or threatened, but not immediately imperiled, typically with 21-100 occurrences.
4 = Not rare and apparently secure, but with cause for long-term concern, usually more than 100 occurrences.
5 = Demonstrably widespread, abundant, and secure.
H = Historical Occurrence, formerly part of the native biota with the implied expectation that it may be rediscovered.
X = Presumed extirpated or extinct.
U = Unknown rank.
? = Not yet ranked, or assigned rank is uncertain.

6 **ORNHP List** is based on Oregon Natural Heritage Program data.
List 1 contains taxa that are threatened with extinction or presumed to be extinct throughout their entire range.
List 2 contains taxa that are threatened with extirpation or presumed to be extirpated from the state of Oregon. These are often peripheral or disjunct species which are of concern when considering species diversity within Oregon's borders. They can be very significant when protecting the genetic diversity of a taxon. ORNHP regards extreme rarity as a significant threat and has included species which are very rare in Oregon on this list.
List 3 contains species for which more information is needed before status can be determined, but which may be threatened or endangered in Oregon or throughout their range.
List 4 contains taxa which are of conservation concern but are not currently threatened or endangered. This includes taxa which are very rare but are currently secure, as well as taxa which are declining in numbers or habitat but are still too common to be proposed as threatened or endangered. While these taxa currently may not need the same active management attention as threatened or endangered taxa, they do require continued monitoring.

7 **Riparian Association** indicates use of any of the 4 water-based habitats. Single "X" in any habitat type (upland or water-associated) indicates general association; "XX" indicates close association, as per Johnson and O'Neil 2001.

8 **Habitat Types** based on Johnson and O'Neil (2001). These habitats are described more fully within the text of the upland and riparian chapters.
WLCH = Westside Lowlands Conifer-Hardwood Forest
WODF = Westside Oak and Dry Douglas-fir Forest and Woodlands
WEGR = Westside Grasslands
AGPA = Agriculture, Pasture and Mixed Environs

URBN = Urban and Mixed Environs
WATR = Open Water - Lakes, Rivers, Streams
HWET = Herbaceous Wetlands
RWET = Westside Riparian-Wetlands

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Appendix 1. Species list and habitat associations for species normally occurring within the Metro region. Study area is the Metro jurisdictional boundary plus 1 mile buffer, plus UGB study areas.

Code[1]	Common Name	Genus/Species	Migratory Status[2]	Federal Status[3]	ODFW Status[4]	ORNHP Rank[5]	ORNHP List[6]	Riparian Assn.[7]	Habitat Type[8] WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
F	River Lamprey	*Lampetra ayresi*	A	SoC	None	G4/S4	4	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Western Brook Lamprey	*Lampetra richardsoni*	A	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Pacific Lamprey	*Lampetra tridentata*	A	SoC	SV	G5/S3	2	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	White Sturgeon	*Acipenser transmontanus*	A	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	American Shad*	*Alosa sapidissima*	A	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chiselmouth	*Acrocheilus alutaceus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Goldfish*	*Carassius auratus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Common Carp*	*Cyprinus carpio*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Peamouth Chub	*Mylocheilus caurinus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
(F)	(Oregon Chub - extirpated from Metro area)	*Oregonichthys crameri*	R	LE	SC	G2/S2	1	(XX)	(XX)	(XX)	N/A	N/A	N/A	N/A	N/A	N/A
F	Northern Pikeminnow (Squawfish)	*Ptychocheilus oregonensis*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Longnose Dace	*Rhynichthys cataractae*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Leopard Dace	*Rhynichthys falcatus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Speckled Dace	*Rhynichthys osculus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Redside Shiner	*Richardsonius balteatus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Largescale Sucker	*Catostomus macrocheilus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Brown Bullhead*	*Ameiurus nebulosus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	N/A	N/A	N/A	N/A	N/A	N/A
F	Eulachon (Columbia River Smelt)	*Thaleichthys pacificus*	A	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Coastal Cutthroat Trout, SW WA/Col. R. ESU	*Oncorhynchus clarki clarki*	A	PT	SC	G4T2Q/S2	2	XX	XX	X	N/A	N/A	N/A	N/A	N/A	N/A
F	Coastal Cutthroat Trout, Upper Will. R. ESU	*Oncorhynchus clarki clarki*	A	SoC	None	G4T?Q/S3?	4	XX	XX	X	N/A	N/A	N/A	N/A	N/A	N/A
F	Chum Salmon, Columbia River ESU	*Oncorhynchus keta*	A	LT	SC	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Coho Salmon, Oregon Coast ESU	*Oncorhynchus kisutch*	A	LT	SC	G4T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Coho Salmon, Lower Columbia R./Southwest Washington ESU	*Oncorhynchus kisutch*	A	C	LE	G4T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Rainbow Trout (resident populations)	*Oncorhynchus mykiss*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead (anadromous Rainbow Trout), Oregon Coast ESU	*Oncorhynchus mykiss*	A	C	SV	G5T2T3Q/S2S3	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead, Lower Columbia River ESU	*Oncorhynchus mykiss*	A	LT	SC	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead, Upper Willamette River ESU, winter run	*Oncorhynchus mykiss*	A	LT	SC	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead, Middle Columbia River ESU	*Oncorhynchus mykiss*	A	LT	SC/SV	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead, Snake River Basin ESU	*Oncorhynchus mykiss*	A	LT	SV	G5T2T3Q/S2S3	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Steelhead, Upper Columbia River ESU	*Oncorhynchus mykiss*	A	LE	None	G5T2Q/SU	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Sockeye Salmon, Snake River ESU	*Oncorhynchus nerka*	A	LE	None	G5T1Q/SX	1 - ex	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chinook Salmon, Lower Columbia R. ESU	*Oncorhynchus tshawytscha*	A	LT	SC	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chinook Salmon, Upper Will. R spring run	*Oncorhynchus tshawytscha*	A	LT	None	G5T2Q/S2	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chinook Salmon, Snake River Fall-run ESU	*Oncorhynchus tshawytscha*	A	LT	LT	G5T1Q/S1	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chinook Salmon, Snake River Spr/Sum.run	*Oncorhynchus tshawytscha*	A	LT	LT	G5T1Q/S1	1	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Chinook Salmon, Upper Col. R. Spring-run	*Oncorhynchus tshawytscha*	A	LE	None	G5T1Q/SU	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Mountain Whitefish	*Prosopium williamsoni*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Sand Roller	*Percopsis transmontanus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Mosquitofish*	*Gambusia affinis*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	N/A	N/A	N/A	N/A	N/A	N/A

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Code[1]	Common Name	Genus/Species	Migratory Status[2]	Federal Status[3]	ODFW Status[4]	ORNHP Rank[5]	ORNHP List[6]	Riparian Assn.[7]	Habitat Type[8] WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
F	Three-spined Stickleback	*Gasterosteus aculeatus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Prickly Sculpin	*Cottus asper*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Reticulate Sculpin	*Cottus perplexus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Green Sunfish*	*Lepomis cyanellus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Pumpkinseed Sunfish*	*Lepomis gibbosus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Warmouth*	*Lepomis gulosus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Bluegill*	*Lepomis macrochirus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Smallmouth Bass*	*Micropterus dolomieu*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Largemouth Bass*	*Micropterus salmoides*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	X	N/A	N/A	N/A	N/A	N/A	N/A
F*	White Crappie*	*Pomoxis annularis*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Black Crappie*	*Pomoxis nigromaculatus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F*	Yellow Perch*	*Perca flavescens*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	X	N/A	N/A	N/A	N/A	N/A	N/A
F*	Walleye*	*Stizostedion vitreum vitreum*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
F	Starry Flounder	*Platichthys stellatus*	R	None	None	None	None	XX	XX	?	N/A	N/A	N/A	N/A	N/A	N/A
A	Northwestern Salamander	*Ambystoma gracile*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
A	Long-toed Salamander	*Ambystoma macrodactylum*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
A	Pacific Giant Salamander	*Dicamptodon tenebrosus*	R	None	None	None	None	XX			XX	X	X	X		X
A	Cope's Giant Salamander	*Dicamptodon copei*	R	None	SU	G3/S2	2	XX	X		XX	X				
A	Columbia Torrent Salamander	*Rhyacotriton kezeri*	R	None	SC	G3/S3	2	XX			XX	X				
A	Cascade Torrent Salamander	*Rhyacotriton cascadae*	R	None	SV	G3/S3	2	XX			XX	X				
A	Rough-skinned Newt	*Taricha granulosa*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
A	Dunn's Salamander	*Plethodon dunni*	R	None	None	None	None	X			X	X	X			X
A	Western Red-backed Salamander	*Plethodon vehiculum*	R	None	None	None	None	X			X	X	X			X
A	Ensatina	*Ensatina eschscholtzii*	R	None	None	None	None	X			X	XX	X	X	X	X
A	Clouded Salamander	*Aneides ferreus*	R	None	SU	G3/S3	3					X	X		X	X
A	Oregon Slender Salamander	*Batrachoseps wrighti*	R	SoC	SU	G4/S3	1	X			X	X				
A	Western Toad	*Bufo boreas*	R	None	SV	G4/S4	4	XX	XX	XX	XX	X	X	X	X	X
A	Tailed Frog	*Ascaphus truei*	R	SoC	SV	G4/S3	2	XX			XX	X				
A	Pacific Chorus Frog (tree frog)	*Hyla regilla*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
A	Northern Red-legged Frog	*Rana aurora aurora*	R	SoC	SV/SU	G4T4/S3	2	XX	XX	XX	XX	XX	X	X	X	X
(A)	(Oregon Spotted Frog - extirpated)	*Rana pretiosa*	R	C	SC	G2G3/S2	1	(XX)	(XX)	(XX)	(XX)	(X)	(X)	(X)	(X)	
A*	Bullfrog*	*Rana catesbeiana*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	XX	X	X	X	X	X
R*	Common Snapping Turtle*	*Chelydra serpentina*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	X				X	X
R	Painted Turtle	*Chrysemys picta*	R	None	SC	G5/S2	2	XX	XX	XX	X		X		X	X
R	Northwestern Pond Turtle	*Clemmys marmorata marmorata*	R	SoC	SC	G3T3/S2	1	XX	XX	XX	XX	X	XX	X	X	X
R*	Red-eared Slider*	*Trachemys scripta elegans*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	X				X	X
R	Northern Alligator Lizard	*Elgaria coerulea*	R	None	None	None	None	X			X	X	X	X		X
R	Southern Alligator Lizard	*Elgaria multicarinata*	R	None	None	None	None	X			X	X	X	X	X	X
R	Western Fence Lizard	*Sceloporus occidentalis*	R	None	None	None	None					X	X	X	X	X

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			Migratory	Federal	ODFW	ORNHP	ORNHP	Riparian	Habitat Type[8]							
Code[1]	Common Name	Genus/Species	Status[2]	Status[3]	Status[4]	Rank[5]	List[6]	Assn.[7]	WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
R	Western Skink	*Eumeces skiltonianus*	R	None	None	None	None					X	X	X	X	X
R	Rubber Boa	*Charina bottae*	R	None	None	None	None	X			X	X		X	X	X
R	Racer	*Coluber constrictor*	R	None	None	None	None						X	X	X	X
R	Sharptail Snake	*Contia tenuis*	R	None	SV	G5/S3	4	X			X	X	X	X	X	X
R	Ringneck Snake	*Diadophis punctatus*	R	None	None	None	None	X			X	X	X	X	X	X
R	Gopher Snake	*Pituophis catenifer*	R	None	None	None	None						X	X	X	X
R	Western Terrestrial Garter Snake	*Thamnophis elegans*	R	None	None	None	None	X		X	X		X	X	X	X
R	Northwestern Garter Snake	*Thamnophis ordinoides*	R	None	None	None	None	X			X	X	X	X	X	X
R	Common Garter Snake	*Thamnophis sirtalis*	R	None	None	None	None	XX		XX	XX	X	X	X	X	X
B	Red-throated Loon	*Gavia stellata*	W / M	None	None	None	None	XX			XX					
B	Pacific Loon	*Gavia pacifica*	W / M	None	None	None	None	XX			XX					
B	Common Loon	*Gavia immer*	W / M	None	None	None	None	XX	X	XX						
B	Pied-billed Grebe	*Podilymbus podiceps*	S / N	None	None	None	None	XX	X	XX	X					
B	Horned Grebe	*Podiceps auritus*	W / M	None	SP	G5/S2B, S5N	2	XX	XX	XX						
B	Eared Grebe	*Podiceps nigricollis*	W	None	None	None	None	XX	XX	XX						
B	Western Grebe	*Aechmophorus occidentalis*	W	None	None	None	None	XX	XX	XX						
B	Clark's Grebe	*Aechmophorus clarkii*	W / M	None	None	None	None	XX	XX	XX						
B	Doubled-crested Cormorant	*Phalacrocorax auritus*	R / S	None	None	None	None	XX	XX	X	X					X
B	American Bittern	*Botaurus lentiginosus*	S / N	None	None	None	None	XX		XX					X	
B	Great Blue Heron	*Ardea herodias*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	XX	X
B	Great Egret	*Ardea alba*	W / M	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
B	Green Heron	*Butorides virescens*	N / S	None	None	None	None	XX	X	XX	XX					
B	Black-crowned Night Heron	*Nycticorax nycticorax*	S	None	None	None	None	XX	XX	XX	X					
(B)	(California Condor - extirpated)	*(Gymnogyps californianus)*	R	LE	None	G1SX	1-ex	(X)			(X)			(X)		
B	Turkey Vulture	*Cathartes aura*	N	None	None	None	None	X		X	X	X	X	X	X	X
B	Greater White-fronted Goose	*Anser albifrons*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Snow Goose	*Chen caerulescens*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Ross's Goose	*Chen rossii*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Canada Goose	*Branta canadensis*	VARIABLE	None	None	None	None	XX	XX	XX	X				XX	
B	Dusky Canada Goose	*Branta canadensis occidentalis*	W / M	None	None	G5T2T3/ S2N	4	XX	XX	XX	X				XX	
B	Aleutian Canada Goose (wintering)	*Branta canadensis leucopareia*	W / M	LT	LE	G5T3/S2N	1	XX	XX	XX	X				XX	
B	Trumpeter Swan	*Cygnus buccinator*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Tundra Swan	*Cygnus columbianus*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Wood Duck	*Aix sponsa*	S	None	None	None	None	XX	XX	X	XX	X			X	
B	Gadwall	*Anas strepera*	W / M	None	None	None	None	XX	XX	XX				X	X	
B	Mallard	*Anas platyrhynchos*	R	None	None	None	None	XX	X	XX	XX				X	X
B	Eurasian Wigeon	*Anas penelope*	W / M	None	None	None	None	XX	XX	X					X	

Appendix 1. Species list and habitat associations for species normally occurring within the Metro region. Study area is the Metro jurisdictional boundary plus 1 mile buffer, plus UGB study areas.

Code[1]	Common Name	Genus/Species	Migratory Status[2]	Federal Status[3]	ODFW Status[4]	ORNHP Rank[5]	ORNHP List[6]	Riparian Assn.[7]	Habitat Type[8] WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
B	American Wigeon	*Anas americana*	W / M	None	None	None	None	XX	X	XX	X				XX	
B	Blue-winged Teal	*Anas discors*	W / M	None	None	None	None	XX	X	XX				X	XX	
B	Cinnamon Teal	*Anas cyanoptera*	N	None	None	None	None	XX	X	XX				X	XX	
B	Northern Shoveler	*Anas clypeata*	W / M	None	None	None	None	XX	XX	XX				X	X	
B	Northern Pintail	*Anas acuta*	W / M	None	None	None	None	XX	XX	XX					X	
B	Green-winged Teal	*Anas crecca*	S	None	None	None	None	XX	X	XX	X			X	X	
B	Canvasback	*Aythya valisineria*	W / M	None	None	None	None	XX	XX	XX						
B	Redhead	*Aythya americana*	W / M	None	None	None	None	XX	XX	XX						
B	Ring-necked Duck	*Aythya collaris*	W / M	None	None	None	None	XX	X	X	XX					
B	Greater Scaup	*Aythya marila*	W / M	None	None	None	None	XX	XX							
B	Lesser Scaup	*Aythya affinis*	W / M	None	None	None	None	XX	XX	XX						
B	Surf Scoter	*Melanitta perspicillata*	W / M	None	None	None	None	X	X							
B	Harlequin Duck	*Histrionicus histrionicus*	W / M	SoC	SU	G4/S2B, S3N	2	XX	XX		XX					
B	Bufflehead	*Bucephala albeola*	W / M	None	SU	G5/S2B,S5N	4	XX	XX	XX	X					
B	Common Goldeneye	*Bucephala clangula*	M	None	None	None	None	XX	XX	X						
B	Barrow's Goldeneye	*Bucephala islandica*	W / M	None	SU	G5/S3B,S3N	4	XX	XX	X						
B	Hooded Merganser	*Lophodytes cucullatus*	W / M	None	None	None	None	XX	XX	X	XX	XX				
B	Common Merganser	*Mergus merganser*	W / M	None	None	None	None	XX	XX		XX	XX				
B	Red-breasted Merganser	*Mergus serrator*	W / M	None	None	None	None	X	X							
B	Ruddy Duck	*Oxyura jamaicensis*	W / M	None	None	None	None	XX	XX	XX						
B	Osprey	*Pandion haliaetus*	N	None	None	None	None	XX	XX		X	X	X		X	X
B	White-tailed Kite (appears to be undergoing range expansion)	*Elanus leucurus*	W / M	None	None	G5/S1B, S3N	2	X			X	X		X	XX	
B	Bald Eagle[a]	*Haliaeetus leucocephalus*	S	LT[a]	LT	G4/S3B, S4N	2	XX	XX	X	X	X	X	X	X	X
B	Northern Harrier	*Circus cyaneus*	N	None	None	None	None	X		X	X			X	X	X
B	Sharp-shinned Hawk	*Accipiter striatus*	N	None	None	None	None	X		X		X	X	X	X	X
B	Cooper's Hawk	*Accipiter cooperii*	S	None	None	None	None	X		X	X	X	X	X	X	X
B	Northern Goshawk	*Accipiter gentilis*	W / M	SoC	SC	G5/S3	2	X		X	X	X	X			
B	Red-shouldered Hawk (appears to be undergoing range expansion)	*Buteo lineatus*	?	None	None	None	None	X			X	X			X	
B	Red-tailed Hawk	*Buteo jamaicensis*	S / N	None	None	None	None	X		X	X	X	X	X	XX	X
B	Rough-legged Hawk	*Buteo lagopus*	W / M	None	None	None	None	X		X	X	X	X	X	X	X
B	American Kestrel	*Falco sparverius*	S	None	None	None	None	X		X	X	X	X	X	X	X
B	Merlin	*Falco columbarius*	W / M	None	None	G5/S1B	2	X	X	X	X	X	X	X	X	X
B	American Peregrine Falcon	*Falco peregrinus anatum*	N	None	LE	G4T3/S1B	2	X	X	X	X	X	X	X	X	X
B*	Ring-necked Pheasant*	*Phasianus colchicus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	X		X	X	X	X	XX	XX	X
B	Ruffed Grouse	*Bonasa umbellus*	R	None	None	None	None	XX			XX	XX	X		X	
B	Blue Grouse	*Dendragapus obscurus*	R	None	None	None	None	X			X	XX	X			

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			Migratory	Federal	ODFW	ORNHP	ORNHP	Riparian	Habitat Type[8]							
Code[1]	Common Name	Genus/Species	Status[2]	Status[3]	Status[4]	Rank[5]	List[6]	Assn.[7]	WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
B*	Wild Turkey*	*Meleagris gallopavo*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	X			X	X	X	X	X	X
(B)	(Mountain Quail - extirpated)	*Oreortyx pictus*	R / S	SoC	SU	G5/S4?	4	(X)			(X)	(X)	(X)		(X)	(X)
B	California Quail	*Callipepla californica*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Virginia Rail	*Rallus limicola*	R / S	None	None	None	None	XX		XX					X	
B	Sora	*Porzana carolina*	S / N	None	None	None	None	XX		XX					X	
B	American Coot	*Fulica americana*	R / S	None	None	None	None	XX	XX	XX					X	X
B	Lesser Sandhill Crane	*Grus canadensis*	W / M	None	None	None	None	XX		XX					XX	
B	Black-bellied Plover	*Pluvialis squatarola*	M	None	None	None	None	X	X						XX	
B	American Golden-plover	*Pluvialis dominica*	W / M	None	None	None	None	X	X						XX	
B	Semipalmated Plover	*Charadrius semipalmatus*	M	None	None	None	None	XX	XX						X	
B	Killdeer	*Charadrius vociferus*	S / N	None	None	None	None	X		X	X	X	X	X	XX	X
B	Greater Yellowlegs	*Tringa melanoleuca*	W / M	None	None	None	None	XX	XX	XX	X			X	X	
B	Lesser Yellowlegs	*Tringa flavipes*	W / M	None	None	None	None	XX	XX	XX	X			X	X	
B	Solitary Sandpiper	*Tringa solitaria*	W / M	None	None	None	None	XX	XX	XX	XX			X	X	
B	Spotted Sandpiper	*Actitis macularia*	N	None	None	None	None	XX	X	X	XX				X	
B	Semipalmated Sandpiper	*Calidris pusilla*	W / M	None	None	None	None	XX	XX							
B	Western Sandpiper	*Calidris mauri*	W / M	None	None	None	None	XX	XX	XX					X	
B	Least Sandpiper	*Calidris minutilla*	W / M	None	None	None	None	XX	X	XX					X	
B	Baird's Sandpiper	*Calidris bairdii*	W / M	None	None	None	None	XX	X	XX					X	
B	Pectoral Sandpiper	*Calidris melanotos*	W / M	None	None	None	None	XX	X	XX					X	
B	Dunlin	*Calidris alpina*	W / M	None	None	None	None	XX	XX	XX					XX	
B	Short-billed Dowitcher	*Limnodromus griseus*	W / M	None	None	None	None	X		X					X	
B	Long-billed Dowitcher	*Limnodromus scolopaceus*	W / M	None	None	None	None	XX	X	XX					XX	
B	Common Snipe	*Gallinago gallinago*	S / N	None	None	None	None	XX		XX				X	XX	
B	Wilson's Phalarope	*Phalaropus tricolor*	W / M	None	None	None	None	XX	X	X						
B	Red-necked Phalarope	*Phalaropus lobatus*	W / M	None	None	None	None	X	X							
B	Bonaparte's Gull	*Larus philadelphia*	M / W	None	None	None	None	XX	X						X	X
B	Mew Gull	*Larus canus*	W / M	None	None	None	None	XX	XX						X	X
B	Ring-billed Gull	*Larus delawarensis*	W / M	None	None	None	None	XX	XX	X					X	X
B	California Gull	*Larus californicus*	S	None	None	None	None	XX	XX	X					X	X
B	Herring Gull	*Larus agentatus*	W / M	None	None	None	None	XX	XX	X					X	X
B	Thayer's Gull	*Larus thayeri*	W / M	None	None	None	None	XX	XX	X					X	X
B	Western Gull	*Larus occidentalis*	R / S	None	None	None	None	X	X							XX
B	Glaucous Gull	*Larus hyperboreus*	W / M	None	None	None	None	XX	XX	X						X
B	Glaucous-winged Gull	*Larus glaucescens*	W / M	None	None	None	None	XX	X							XX
B	Caspian Tern	*Sterna caspia*	N	None	None	None	None	XX	XX	XX						
B	Forster's Tern	*Sterna forsteri*	M	None	None	None	None	XX	XX	XX						

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B	Common Tern	*Sterna hirundo*	W / M	None	None	None	None	X	X							
B*	Rock Dove*	*Columba livia*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien							X	XX	XX
B	Band-tailed Pigeon	*Columba fasciata*	S	SoC	None	G5/S4	4	XX			XX	XX	XX		X	X
B	Mourning Dove	*Zenaida macroura*	S	None	None	None	None	XX			XX	X	X	X	XX	X
B	Barn Owl	*Tyto alba*	R / S	None	None	None	None	X		X	X		X	X	XX	X
B	Western Screech-Owl	*Otus kennicottii*	R	None	None	None	None	X		X	X	X	X		X	X
B	Great Horned Owl	*Bubo virginianus*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Northern Pygmy-Owl	*Glaucidium gnoma*	R	None	SC	G5/S4?	4	X		X	X	XX	X		X	X
(B)	(Northern Spotted Owl - extirpated from Metro region)	*(Strix occidentalis caurina)*	(S)	LT	LT	G3T3S3	1					(XX)	(X)			
B	Barred Owl	*Strix varia*	R	None	None	None	None	X			X	XX	X			X
B	Long-eared Owl	*Asio otus*	W / M	None	None	None	None	X		X		X	X	X	X	
B	Short-eared Owl	*Asio flammeus*	W / M	None	None	None	None	XX		XX				X	XX	
B	Northern Saw-whet Owl	*Aegolius acadicus*	R / S	None	None	None	None	X			X	XX	XX		X	X
B	Common Nighthawk (nearly extirpated)	*Chordeiles minor*	N	None	SC	G5/S5	4	X	X	X	X	X	X	X	X	X
B	Vaux's Swift	*Chaetura vauxi*	N	None	None	None	None	XX	XX	X	X	X	X	X		X
B	Anna's Hummingbird	*Calypte anna*	R	None	None	None	None	X			X	XX	X			X
B	Rufous Hummingbird	*Selasphorus rufus*	N	None	None	None	None	X		X	X	X	X	X	X	X
B	Belted Kingfisher	*Ceryle alcyon*	S	None	None	None	None	XX	XX		XX					
B	Lewis's Woodpecker (extirpated as breeding species)	*Melanerpes lewis*	W / M	SoC	SC	G5/S3B, S3N	4	X			X		XX	X	X	X
B	Acorn Woodpecker	*Melanerpes formicivorus*	R	SoC	None	G5/S3?	4						XX	X		X
B	Red-breasted Sapsucker	*Sphyrapicus ruber*	S	None	None	None	None	X			X	X	X	X	X	X
B	Downy Woodpecker	*Picoides pubescens*	R	None	None	None	None	XX			XX	X	X		X	X
B	Hairy Woodpecker	*Picoides villosus*	R	None	None	None	None	X			X	X	X	X	X	X
B	Northern Flicker	*Colaptes auratus*	R	None	None	None	None	X			X	X	X	X	X	X
B	Pileated Woodpecker	*Dryocopus pileatus*	R	None	SV	G5/S4?	4	X			X	X	X		X	X
B*	Monk Parakeet*	*Myiopsitta monachus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX			XX		X		X	XX
(B)	(Yellow-billed Cuckoo; extirpated)	*Coccyzus americanus*	N	SoC	SC	G5/S1B	2	(XX)			(XX)					
B	Olive-sided Flycatcher	*Contopus cooperi (= borealis)*	N	SoC	SV	G5/S4	4	X			X	XX				
B	Western Wood-Pewee	*Contopus sordidulus*	N	None	None	None	None	X			X	X	X		X	X
B	Willow Flycatcher (western OR race)	*Empidonax traillii brewsteri*	N	None	SV	G5TU/S1B	4	XX			XX	X	X		X	X
B	Hammond's Flycatcher	*Empidonax hammondii*	N	None	None	None	None					X	X			
B	Dusky Flycatcher	*Empidonax oberholseri*	M	None	None	None	None	X			X	X	X			
B	Pacific-slope Flycatcher	*Empidonax dificilus*	N	None	None	None	None	X			X	XX	X			
B	Say's Phoebe	*Sayornis saya*	N	None	None	None	None							X	X	X
B	Western Kingbird	*Tyrannus verticalis*	N	None	None	None	None						X	X	X	X
B	Northern Shrike	*Lanius excubitor*	W / M	None	None	None	None	X		X				X	XX	

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Code[1]	Common Name	Genus/Species	Status[2]	Status[3]	Status[4]	Rank[5]	List[6]	Assn.[7]	WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
B	Cassin's Vireo	*Vireo cassinii*	N	None	None	None	None					X	XX			X
B	Hutton's Vireo	*Vireo huttoni*	R / S	None	None	None	None	X			X	X	XX		X	X
B	Warbling Vireo	*Vireo gilvus*	N	None	None	None	None	XX			XX	XX	X		X	X
B	Red-eyed Vireo	*Vireo olivaceus*	N	None	None	None	None	XX			XX	X				
B	Steller's Jay	*Cyanocitta stelleri*	R	None	None	None	None	X			X	X	X		X	X
B	Western Scrub-Jay	*Aphelocoma californica*	R	None	None	None	None	X			X	X	XX	X	X	X
B	Gray Jay	*Perisoreus canadensis*	R	None	None	None	None	X			X	X	X			X
B	American Crow	*Corvus brachyrhynchos*	R	None	None	None	None	X		X	X	X	X	X	XX	XX
B	Common Raven	*Corvus corax*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Streaked Horned Lark	*Eremophila alpestris strigata*	S	SoC	SC	G5T2/S2?	2							XX	X	X
B	Purple Martin	*Progne subis*	N	SoC	SC	G5/S3B	2	XX	XX	X	X	X	X	X		X
B	Tree Swallow	*Tachycineta bicolor*	N	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
B	Violet-green Swallow	*Tachycineta thalassina*	N	None	None	None	None	X	X	X	X	X	X	X	X	X
B	Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	N	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
B	Cliff Swallow	*Petrochelidon pyrrhonota*	N	None	None	None	None	XX	XX	X	XX	X	X	X	X	X
B	Barn Swallow	*Hirundo rustica*	N	None	None	None	None	XX	XX	XX	XX	X	X	X	XX	X
B	Black-capped Chickadee	*Poecile atricapilla*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Mountain Chickadee	*Poecile gambeli*	W / M	None	None	None	None	X			X	X	X			X
B	Chestnut-backed Chickadee	*Poecile rufescens*	R	None	None	None	None	X			X	X	X		X	X
B	Bushtit	*Psaltriparus minimus*	R	None	None	None	None	X			X	X	X		X	X
B	Red-breasted Nuthatch	*Sitta canadensis*	R	None	None	None	None	X			X	X	X		X	X
B	White-breasted Nuthatch	*Sitta carolinensis*	R	None	None	None	None	X			X		X	X	X	X
B	Brown Creeper	*Certhia americana*	R	None	None	None	None	X			X	X	X	X	X	X
B	Bewick's Wren	*Thryomanes bewickii*	R	None	None	None	None	X		X	X	X	X		X	X
B	House Wren	*Troglodytes aedon*	N	None	None	None	None	X			X	X	X	X	X	X
B	Winter Wren	*Troglodytes troglodytes*	R	None	None	None	None	X			X	X	X			X
B	Marsh Wren	*Cistothorus palustris*	N	None	None	None	None	XX		XX						
B	American Dipper	*Cinclus mexicanus*	R / S	None	None	None	None	XX	XX	X	XX					
B	Golden-crowned Kinglet	*Regulus satrapa*	R	None	None	None	None	X			X	XX	X			X
B	Ruby-crowned Kinglet	*Regulus calendula*	W / M	None	None	None	None	X		X	X	X	X	X	X	X
B	Western Bluebird	*Sialia mexicana*	S	None	SV	G5/S4B, S4N	4					XX	XX	X	X	X
B	Townsend's Solitaire	*Myadestes townsendi*	W / M	None	None	None	None	X			X	X	X		X	X
B	Swainson's Thrush	*Catharus ustulatus*	N	None	None	None	None	X			X	X	X		X	X
B	Hermit Thrush	*Catharus guttatus*	S	None	None	None	None	X			X	X	X		X	X
B	American Robin	*Turdus migratorius*	S	None	None	None	None	X		X	X	X	X	X	X	X
B	Varied Thrush	*Ixoreus naevius*	W / M	None	None	None	None					XX	X		X	X
B*	European Starling*	*Sturnus vulgaris*	R / S	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX		X	XX	X	X	X	X	XX

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Code[1]	Common Name	Genus/Species	Status[2]	Status[3]	Status[4]	Rank[5]	List[6]	Assn.[7]	WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
B	American Pipit	*Anthus rubescens*	W / M	None	None	None	None	X		X				X	XX	
B	Cedar Waxwing	*Bombycilla cedrorum*	S	None	None	None	None	X		X	X	X	X		X	X
B	Orange-crowned Warbler	*Vermivora celata*	N	None	None	None	None	X			X	X	X	X	X	X
B	Nashville Warbler	*Vermivora ruficapilla*	N	None	None	None	None	X			X	X	X		X	
B	Yellow Warbler	*Dendroica petechia*	N	None	None	None	None	XX			XX					
B	Yellow-rumped Warbler	*Dendroica coronata*	S	None	None	None	None	X		X	X	X	X		X	X
B	Black-throated Gray Warbler	*Dendroica nigrescens*	N	None	None	None	None	XX			XX	XX	XX		X	X
B	Townsend's Warbler	*Dendroica townsendi*	S / N	None	None	None	None	X			X	X	X		X	X
B	Hermit Warbler	*Dendroica occidentalis*	N	None	None	None	None	X			X	XX	X			
B	MacGillivray's Warbler	*Oporornis tolmiei*	N	None	None	None	None	X			X	X	X		X	
B	Common Yellowthroat	*Geothlypis trichas*	N	None	None	None	None	XX		XX	XX	X	X	X		X
B	Wilson's Warbler	*Wilsonia pusilla*	N	None	None	None	None	XX			XX	XX	X		X	X
B	Yellow-breasted Chat	*Icteria virens*	N	SoC	SC	G5/S4?	4	XX			XX	X	X		X	
B	Western Tanager	*Piranga ludoviciana*	N	None	None	None	None	X			X	XX	XX			X
B	Spotted Towhee	*Pipilo maculatus*	R	None	None	None	None	X			X	X	XX		X	X
B	Chipping Sparrow	*Spizella passerina*	N	None	None	None	None	X			X	X	X	X	X	X
B	Oregon Vesper Sparrow	*Pooecetes gramineus affinis*	S / N	SoC	SC	G5T3/S2B, S2N	2							XX	XX	
B	Savannah Sparrow	*Passerculus sandwichensis*	S / N	None	None	None	None	X		X	X			XX	XX	X
B	Fox Sparrow	*Passerella iliaca*	W / M	None	None	None	None	X			X	X	X		X	X
B	Song Sparrow	*Melospiza melodia*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Lincoln's Sparrow	*Melospiza lincolnii*	S / N	None	None	None	None	XX		XX	XX	X			X	
B	Swamp Sparrow	*Melospiza georgiana*	W / M	None	None	None	None	XX		XX	XX				X	
B	White-throated Sparrow	*Zonotrichia albicollis*	W / M	None	None	None	None								X	X
B	Harris's Sparrow	*Zonotrichia querula*	W / M	None	None	None	None								X	X
B	White-crowned Sparrow	*Zonotrichia leucophrys*	S	None	None	None	None	X		X	X	X	X	X	X	X
B	Golden-crowned Sparrow	*Zonotrichia atricapilla*	R	None	None	None	None	X		X	X	X	X	X	X	X
B	Dark-eyed Junco	*Junco hyemalis*	S	None	None	None	None	X			X	X	X		X	X
B	Black-headed Grosbeak	*Pheucticus melanocephalus*	N	None	None	None	None	X			X	X	X		X	X
B	Lazuli Bunting	*Passerina amoena*	N	None	None	None	None	X			X	X	X	X	XX	X
B	Red-winged Blackbird	*Agelaius phoeniceus*	S	None	None	None	None	XX		XX	X			X	X	X
B	Tricolored Blackbird	*Agelaius tricolor*	S	SoC	SP	G3/S2B	2	XX		XX					X	
B	Western Meadowlark (extirpated as breeding species)	*Sturnella neglecta*	W / M	None	SC	G5/S5	4	X		X				XX	XX	
B	Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	N	None	None	None	None	XX		XX					X	
B	Brewer's Blackbird	*Euphagus cyanocephalus*	S	None	None	None	None	X		X	X		X	X	XX	X
B	Brown-headed Cowbird	*Molothrus ater*	S / N	None	None	None	None	X		X	X	X	X	X	XX	X
B	Bullock's Oriole	*Icterus bullockii*	N	None	None	None	None	XX			XX		XX		X	X

Appendix 1. Species list and habitat associations for species normally occurring within the Metro region. Study area is the Metro jurisdictional boundary plus 1 mile buffer, plus UGB study areas.

			Migratory	Federal	ODFW	ORNHP	ORNHP	Riparian	Habitat Type[8]							
Code[1]	Common Name	Genus/Species	Status[2]	Status[3]	Status[4]	Rank[5]	List[6]	Assn.[7]	WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
B	Purple Finch	*Carpodacus purpureus*	S	None	None	None	None	XX			XX	X	XX		X	X
B	House Finch	*Carpodacus mexicanus*	R	None	None	None	None	X		X	X	X	X	X	XX	XX
B	Red Crossbill	*Loxia curvirostra*	R / S	None	None	None	None	X			X	X	X			X
B	Pine Siskin	*Carduelis pinus*	S	None	None	None	None	X		X	X	X	X		X	X
B	Lesser Goldfinch	*Carduelis psaltria*	S	None	None	None	None	XX			XX	X	XX	X	X	X
B	American Goldfinch	*Carduelis tristis*	S	None	None	None	None	X		X	X	X	X	X	X	X
B	Evening Grosbeak	*Coccothraustes vespertinus*	W / M	None	None	None	None	X			X	X	X			X
B*	House Sparrow*	*Passer domesticus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien								XX	XX
M*	Virginia Opossum*	*Didelphis virginiana*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	X			X	X	X	X	XX	XX
M	Vagrant Shrew	*Sorex vagrans*	R	None	None	None	None	X		X	X	X	X	X	X	X
M	Pacific Water Shrew	*Sorex bendirii*	R	None	None	None	None	XX		X	XX	X	X			
M	Water Shrew	*Sorex palustris*	R	None	None	None	None	XX			XX	X				
M	Trowbridge's Shrew	*Sorex trowbridgii*	R	None	None	None	None	X			X	XX	X		X	X
M	Shrew-mole	*Neurotrichus gibbsii*	R	None	None	None	None	X		X	X	XX	X		X	X
M	Townsend's Mole	*Scapanus townsendii*	R	None	None	None	None	X		X	X	X	X	X	X	X
M	Coast Mole	*Scapanus orarius*	R	None	None	None	None	X			X	XX	X	X	X	X
M	Yuma Myotis	*Myotis yumanensis*	R / S	SoC	None	G5/S3	4	XX	XX	XX	XX	X	X	X	X	X
M	Little Brown Myotis	*Myotis lucifugus*	R / S	None	None	None	None	X	X	X	X	X	X	X	X	X
M	Long-legged Myotis	*Myotis volans*	R / S	SoC	SU	G5/S3	4	X	X	X	X	XX	X	X	X	X
M	Fringed Myotis	*Myotis thysanodes*	R / S	SoC	SV	G4G5/S2?	2	X	X	X	X	X	X		X	X
M	Long-eared Myotis	*Myotis evotis*	R / S	SoC	SU	G5/S3	4	X	X	X	X	X	X	X	X	X
M	Silver-haired Bat	*Lasionycteris noctivagans*	L	SoC	SU	G5/S4?	4	X	X	X	X	XX	X	X	X	X
M	Big Brown Bat	*Eptesicus fuscus*	R / S	None	None	None	None	X	X	X	X	X	XX	X	XX	XX
M	Hoary Bat	*Lasiuris cinereus*	L	None	None	G5/S4?	4	X	X	X	X	X	X	X	X	X
M	Pacific Western Big-eared Bat	*Corynorhinus townsendii townsendii*	R / S	SoC	SC	G4T3T4/S2?	2	XX	XX	X	X	X	X	X	X	X
M	Brush Rabbit	*Sylvilagus bachmani*	R	None	None	None	None	X			X	X	X	X	X	X
M*	Eastern Cottontail*	*Sylvilagus floridanus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	X			X				X	X
M	Mountain Beaver	*Aplodontia rufa*	R	None	None	None	None	XX			XX	XX				
M	Townsend's Chipmunk	*Tamias townsendii*	R	None	None	None	None	X			X	XX	X			X
M	California Ground Squirrel	*Spermophilus beecheyi*	R	None	None	None	None					X	X	X	X	X
M*	Eastern Fox Squirrel*	*Sciurus niger*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien							XX	XX	XX
M*	Eastern Gray Squirrel*	*Sciurus carolinensis*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien						XX		X	XX
M	Western Gray Squirrel	*Sciurus griseus*	R	None	SU	G5/S4?	3					X	XX		X	X
M	Douglas' Squirrel	*Tamiasciurus douglasii*	R	None	None	None	None		XX	XX	X					
M	Northern Flying Squirrel	*Glaucomys sabrinus*	R	None	None	None	None	X			X	XX	XX			X
(M)	(Western pocket gopher)	*(Thomomys mazama)*	(R)	None	None	None	None					(XX)	(XX)	(X)	(X)	(X)
M	Camas Pocket Gopher	*Thomomys bulbivorus*	R	SoC	None	G3G4/S3 S4	3							XX	XX	X

Appendix 1. Species list and habitat associations for species normally occurring within the Metro region. Study area is the Metro jurisdictional boundary plus 1 mile buffer, plus UGB study areas.

Code[1]	Common Name	Genus/Species	Migratory Status[2]	Federal Status[3]	ODFW Status[4]	ORNHP Rank[5]	ORNHP List[6]	Riparian Assn.[7]	Habitat Type[8] WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
M	American Beaver	*Castor canadensis*	R	None	None	None	None	XX	XX	XX	XX	X	X		X	X
M	Deer Mouse	*Peromyscus maniculatus*	R	None	None	None	None	XX		XX	XX	XX	XX	XX	XX	XX
M	Bushy-tailed Woodrat	*Neotoma cinerea*	R	None	None	None	None	X			X	XX	XX		XX	X
M	Western Red-backed Vole	*Clethrionomys californicus*	R	None	None	None	None	X			X	X				
M	Heather Vole	*Phenacomys intermedius*	R	None	None	None	None	X			X		X			
M	White-footed Vole	*Arborimus (= Phenacomys) albipes*	R	SoC	SU	G3G4/S3	4	XX			XX	XX				
M	Red Tree Vole	*Arborimus (= Phenacomys) longicaudus*	R	SoC	None	G3G4/S3S4	3	X			X	XX	XX			
M	Gray-tailed Vole	*Microtus canicaudus*	R	None	None	None	None							XX	XX	
M	Townsend's Vole	*Microtus townsendii*	R	None	None	None	None	XX		XX	X	X	X	X	X	
M	Long-tailed Vole	*Microtus longicaudus*	R	None	None	None	None	XX		XX	XX	X	X	X	X	
M	Creeping Vole	*Microtus oregoni*	R	None	None	None	None	X			X	X	X	X	X	X
M	Water Vole	*Microtus richardsoni*	R	None	None	None	None	X			X	X				
M	Common Muskrat	*Ondatra zibethicus*	R	None	None	None	None	XX	XX	XX	XX				X	X
M*	Black Rat*	*Rattus rattus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien								X	XX
M*	Norway Rat*	*Rattus norvegicus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien								X	XX
M*	House Mouse*	*Mus musculus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien								XX	XX
M	Pacific Jumping Mouse	*Zapus trinotatus*	R	None	None	None	None	XX		X	XX	X	X		X	
M	Common Porcupine	*Erethizon dorsatum*	R	None	None	None	None	XX		X	XX	XX	XX		X	X
M*	Nutria*	*Myocastor coypus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	XX	XX	XX	XX				X	X
M	Coyote	*Canis latrans*	R	None	None	None	None	X		X	X	X	X	X	X	X
M	Red Fox	*Vulpes vulpes*	R	None	None	None	None	X			X	X	X	XX	X	X
M	Gray Fox	*Urocyon cinereoargenteus*	R	None	None	None	None	X			X	XX	X	X	X	
(M)	(Gray Wolf - extirpated)	*(Canis lupus)*	S	None	None	None	None	(X)			(X)	(X)	(X)	(X)		
M	Black Bear	*Ursus americanus*	S	None	None	None	None	X		X	X	X	X	X	X	X
(M)	(Grizzly Bear)	*(Ursus arctos)*	(R)	LT	None	G4/SX	2-ex	(X)			(X)	(X)		(X)		
M	Common Raccoon	*Procyon lotor*	R	None	None	None	None	XX	X	XX	XX	X	X	X	XX	XX
M	Ermine	*Mustela erminea*	R	None	None	None	None	X			X	X	X	X	X	
M	Long-tailed Weasel	*Mustela frenata*	R	None	None	None	None	X		X	X	X	X	X	X	X
M	Mink	*Mustela vison*	R	None	None	None	None	XX	XX	XX	XX	X	X	X	X	X
M	Striped Skunk	*Mephitis mephitis*	R	None	None	None	None	X		X	X	X	X	X	X	X
M	Western Spotted Skunk	*Spilogale gracilis*	R	None	None	None	None	X			X	X	X	X	X	X
M	Northern River Otter	*Lontra canadensis*	R	None	None	None	None	XX	XX	XX	XX					X
M	Mountain Lion (Cougar)	*Puma concolor*	S	None	None	None	None	X		X	X	X	X		X	X
M	Bobcat	*Lynx rufus*	S	None	None	None	None	X		X	X	X	X	X	X	X
M*	Domestic Cat (feral)*	*Felis domesticus*	R	N/A - alien	N/A - alien	N/A - alien	N/A - alien	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
M	California Sea Lion	*Zalophus californianus*	S	None	None	None	None	XX	XX							

Appendix 1. Species list and habitat associations for species normally occurring within the Metro region. Study area is the Metro jurisdictional boundary plus 1 mile buffer, plus UGB study areas.

Code[1]	Common Name	Genus/Species	Migratory Status[2]	Federal Status[3]	ODFW Status[4]	ORNHP Rank[5]	ORNHP List[6]	Riparian Assn.[7]	Habitat Type[8] WATR	HWET	RWET	WLCH	WODF	WEGR	AGPA	URBN
M	Roosevelt Elk	*Cervus elaphus roosevelti*	S	None	None	None	None	X		X	X	X	X	X	X	X
(M)	(Columbian White-tailed Deer)	*(Odocoileus virginiana leucurus)*	(R)	LE	SV	G5T2QS2	1	(X)		(X)	(X)	(X)	(XX)	(X)	(X)	(X)
M	Mule Deer	*Odocoileus hemionus*	R	None	None	None	None	X		X	X	X	X	X	X	X

[a] Bald eagle is currently proposed for de-listing at the federal level.

I:\gm\long_range_planning\Goal 5\Goal 5 report revision\Science Review\Current Chapters & appxs\Appx 1 Species list - Verts.doc

Appendix 2. Review of key findings of urban stream studies examining the relationship of urbanization on stream quality.

Reference	Location	Biological Parameter	Key Finding
Benke, Willeke, Parrish and Stites 1981	Atlanta	Aquatic insects	Negative relationship between number of insect species and urbanization in 21 streams
Black and Veatch 1994	Maryland	Fish/insects	Fish, insect and habitat scores were all ranked as poor in 5 subwatersheds that were greater than 30% TIA
Booth 1991	Seattle, WA	Fish habitat / channel stability	Channel stability and fish habitat quality declined rapidly after 10% TIA
Booth et al. 1996	Washington	Aquatic habitat	There is a decrease in the quantity of large woody debris found in urban streams at around 10% TIA
Couch et al. 1997	Atlanta, Georgia	Fish, habitat	As watershed population density increased, there was a negative impact on urban fish and habitat
Crawford & Lenat 1989	North Carolina	Aquatic insects and fish	A comparison of three stream types found urban streams had lowest diversity and richness
Galli 1991	Maryland	Stream temperature (aquatic habitat)	Stream temperature increased directly with subwatershed impervious cover
Galli 1994	Maryland	Brown trout	Abundance and recruitment of brown trout declined sharply at 10-15% TIA
Garie and McIntosh 1986	New Jersey	Aquatic insects	Drop in insect taxa from 13 to 4 noted in urban streams
Hicks and Larson 1997	Connecticut	Aquatic insects	A significant decline in various indicators of wetland aquatic macroinvertebrate community health was observed as TIA increased to levels of 8-9%
Horner et al. 1996	Puget Sound, Washington	Insects, fish, water quality, riparian zone	Steepest decline of biological functioning after 6% TIA. There was a steady decline, with approximately 50% of initial biotic integrity at 45% TIA
Jones and Clark 1987	Northern Virginia	Aquatic insects	Urban streams had sharply lower diversity of aquatic insects when human population density exceeded 4 persons/acre (estimated 10-25% TIA)
Jones et al. 1996	Northern Virginia	Aquatic insects and fish	Unable to show improvements at 8 sites downstream of BMPs as compared to reference conditions
Klein 1979	Maryland	Aquatic insects/fish	Macroinvertebrate and fish diversity declines rapidly after 10% TIA
Limburg and Schmidt 1990	New York	Fish spawning	Resident and anadromous fish eggs and larvae declined sharply in 16 tributary streams greater than 10% TIA
Luchetti and Fuersteburg 1993	Seattle	Fish	Marked shift from less tolerant coho salmon to more tolerant cutthroat trout populations noted at 10-15% TIA at 9 sites
MacRae 1996	British Columbia	Stream channel stability (aquatic habitat)	Urban stream channels often enlarge their cross-sectional area by a factor of 2 to 5. Enlargement begins at relatively low levels of TIA.
Maxted and Shaver 1996	Delaware	Aquatic insects and habitat	No significant differences in biological and physical metrics for 8 BMP sites versus 31 sites without BMPs (with varying TIA)
May et al. 1997	Washington	Insects, fish, water quality, riparian zone	Physical and biological stream indicators declined most rapidly during the initial phase of the urbanization process as the TIA exceeded the 5-10% range
MWCOG 1992	Washington, D.C.	Aquatic insects and fish	There was a significant decline in the diversity of aquatic insects and fish at 10% TIA
Pedersen and Perkins 1986	Seattle	Aquatic insects	Macroinvertebrate community shifted to chironomid, oligochaetes and amphipod species tolerant of unstable conditions.

Appendix 2 (continued)

Reference	Location	Biological Parameter	Key Finding
Pedersen and Perkins 1986	Seattle	Aquatic insects	Macroinvertebrate community shifted to chironomid, oligochaetes and amphipod species tolerant of unstable conditions.
Richards et al. 1993	Minnesota	Aquatic insects	As watershed development levels increased, the macroinvertebrate community diversity decreased
Schueler and Galli 1992	Maryland	Fish	Fish diversity declined sharply with increasing TIA; loss in diversity began at 10-12% TIA
Schueler and Galli 1992	Maryland	Aquatic insects	Insect diversity metrics in 24 subwatersheds shifted from good to poor over 15% TIA
Shaver, Maxted, Curtis and Carter 1995	Delaware	Aquatic insects	Insect diversity at 19 stream sites dropped sharply at 8 to 15% TIA.
Shaver, Maxted, Curtis and Carter 1995	Delaware	Habitat quality	Strong relationship between insect diversity and habitat quality; majority of 53 urban streams had poor habitat
Steedman 1988	Ontario	Aquatic Insects	Strong negative relationship between biotic integrity and increasing urban land use/riparian condition at 209 stream sites. Degradation begins at about 10% TIA
Steward 1983	Seattle	Salmon	Marked reduction in coho salmon population noted at 10-15% TIA at 9 sites
Taylor 1993	Seattle	Wetland plants / amphibians	Mean annual water fluctuation was inversely correlated to plant and amphibian density in urban wetlands. Sharp declines noted over 10% TIA
Taylor et al. 1995	Washington	Wetland water quality	There is a significant increase in water level fluctuation, conductivity, fecal coliform bacteria, and total phosphorus in urban wetlands as TIA exceeds 3.5%
Trimble 1997	California	Sediment loads (aquatic habitat)	About 2/3 of sediment delivered into urban streams comes from channel erosion
U.S. EPA 1983	National	Water quality / pollutant concentration	Annual phosphorus, nitrogen, and metal loads increased in direct proportion with increasing TIA
Weaver 1991	Virginia	Fish	As watershed development increased to about 10%, fish communities simplified to more habitat and trophic generalists
Yoder 1991	Ohio	Aquatic insects / fish	100% of 40 urban sites sampled had fair to very poor index of biotic integrity scores

Sources: Schueler 1994, Caraco et al. 1998

SOCIETY FOR ECOLOGICAL RESTORATION

APPENDIX 3.

Guidelines for Developing and Managing Ecological Restoration Projects

Andre Clewell[1], John Rieger[2], and John Munro[3]

June 24, 2000

The following guidelines are suggested for conceiving, organizing, conducting, and assessing ecological restoration projects. Adherence to these guidelines will reduce errors of omission and commission that compromise project quality. The guidelines are applicable to any ecosystem, terrestrial or aquatic. They are useful in any context – public works projects, stewardship programs, mitigation projects, private land initiatives, etc. The guidelines are generic and were developed as essential background for managers, policy makers, and the interested public as well as for professional and volunteer restoration practitioners. Design issues and the details for planning and implementing restoration projects lie beyond the scope of these guidelines. We leave such complexities to the authors of manuals and the presenters of workshops who address these topics.

The mission of every ecological restoration project is to reestablish a functional ecosystem of a designated type that contains sufficient biodiversity to continue its maturation by natural processes and to evolve over longer time spans in response to changing environmental conditions. The two attributes of biodiversity that are most readily attained by restoration are species richness and community structure. The restoration ecologist must assure adequate species composition and species abundance to allow the development of suitable community structure and to initiate characteristic ecosystem processes. Concomitantly, the restorationist must provide appropriate physical conditions to sustain these species.

If restoration cannot be fully achieved, then the project should be re-designed as *rehabilitation*, which we define as any ecologically beneficial treatment short of full restoration. Management actions that cause ecological damage do not qualify as restoration. Unfortunately, *restoration* is applied inappropriately to projects that sacrifice biodiversity and impair ecological functions to accomplish single-species management or to attain economic objectives. Continued indiscriminate use will cause *ecological restoration* to lose its meaning as a creditable conservation strategy. Restoration projects can accommodate particular species and can satisfy economic objectives as long as ecosystem integrity is not compromised.

Once a project site is restored, it may require periodic management, as do many other natural areas, to maintain ecosystem health in response to continuing human-mediated impacts. These guidelines do not address post-project management specifically, although some of the guidelines are readily adaptable for that purpose.

The project guidelines are numbered for convenience; they do not necessarily have to be initiated in numerical order. We recommend that a narrative be written in response to the issues raised in each guideline. Collectively, these narratives will comprise a comprehensive guidance document for planning and executing the project.

CONCEPTUAL PLANNING

Conceptual planning identifies the reasons why restoration is needed and the general strategy for conducting it. Conceptual planning is conducted when restoration appears to be a feasible option but before a decision has been made to exercise that option. The written conceptual plan captures the essence and character of the potential restoration.

1. Identify the project site location and its boundaries. Project boundaries are delineated, preferably on a large-scale aerial photograph and also on soil and topographic maps that show the watershed and other aspects of the surrounding landscape.

2. Identify ownership. The name and address of the landowner is given. If an organization or institution owns or manages the land, the names and titles of key personnel are listed. The auspices under which the project will be conducted are noted – public works, mitigation, etc.

3. Identify the need for restoration. Tell what happened at the site that warrants restoration. State the intended benefits of restoration.

4. Identify the kind of ecosystem to be restored and the type of restoration project. The ecosystem to be restored is designated along with any particular habitats and plant or animal communities of that ecosystem that are targeted for restoration. The type of restoration is selected from the following list of five options. It is important to make this initial distinction to avoid misunderstandings later. Restoration projects at diverse project sites may include more than one of these options:

1) *Repair of a damaged ecosystem.* This option attempts to return a site to its historic or preexisting condition. Commonly a few minor aspects of the preexisting ecosystem cannot be fully restored. These should be identified and accepted as exceptions. Restoration work takes place at the same site where damage occurred. Such restoration has been termed *in-kind* (the historic type of ecosystem is restored) and *onsite* (restoration occurs at the same location where the historic ecosystem was damaged). Restoration with respect to the following four options is not necessarily *on-site*, and some are not *in-kind.*

2) *Creation of a new ecosystem of the same kind to replace one that was entirely removed.* The term *creation* signifies that the restored ecosystem must be entirely reconstructed on a site denuded of its vegetation (terrestrial systems) or its benthos (aquatic systems). Creations are commonly conducted on surface mined lands and in brownfields (severely damaged urban and industrial lands).

3) *Creation of another kind of regional ecosystem to replace one which was removed from a landscape that became irreversibly altered.* This option is important for restoring natural areas in an urban context where, for example, original hydrologic conditions cannot be restored.

4) *Creation of a replacement ecosystem where an altered environment can no longer support any previously occurring type of regional ecosystem.* The replacement ecosystem may consist of novel combinations of indigenous species that are assembled to suit novel site conditions as, for example, at a retired solid waste disposal site.

5) *Creation of a replacement ecosystem, because no reference system exists to serve as a model for restoration.* This option is relevant in densely populated regions of Eurasia, where many centuries of land use have obliterated all remnants of original ecosystems.

5. Identify restoration goals, if any, that pertain to social and cultural values. Goals are the ideals that a restoration project attempts to achieve. Goals relating to social and cultural values may be prescribed as long as they are congruent with the primary goal of reestablishing a functional ecosystem that contains sufficient biodiversity to continue its maturation by natural processes and to evolve over longer time spans in response to changing environmental conditions. Social values are largely economic. They may consist of the production of goods such as timber, forage, and fisheries at restored sites. Or they may comprise natural services including the protection of recharge areas and potable water supplies, detention of floodwaters, attenuation of erosion and sedimentation, noise reduction, immobilization of contaminants, transformation of excess nutrients, generation of pollinators for crops, generation of predators of crop pests, and provision of recreational opportunities and consequent tourism. They can also conserve germ plasm of economic species and serve as refugia for wildlife and for rare species. Cultural values include aesthetic amenities and the revival of historical environments as aspects of preserving cultural heritage. If the goal is to restore a fixed cultural landscape, then the project may have to be re-designated as rehabilitation.

6. Identify physical site conditions in need of repair. Some examples of conditions that are amenable to restoration are improvements in water quality, removal of structures to reestablish a more natural hydrologic regime, and improvements to the soil in terms of compaction, organic matter content, and nutrient content.

7. Identify stressors in need of regulation or re-initiation. Stressors are re-occurring external conditions that maintain the integrity of an ecosystem by discouraging the establishment of competitive species that cannot tolerate particular stress events. Examples are fires, anoxia caused by flooding or prolonged hydroperiods, periodic drought, salinity shocks associated with tides and coastal aerosols, freezing temperatures, and unstable substrates caused by water, wind or gravity as on beaches, dunes, and flood plains.

8. Identify biotic interventions that are needed. Some characteristic species of plants and animals may require reintroduction or their existing populations need to be augmented. Nuisance species and exotic species may require removal or control. Mycorrhizal fungi, N-fixing bacteria, and other microbial species may need to be introduced.

9. Identify landscape restrictions, present and future. The biota at a project site is affected by off-site conditions, particularly land usage. Restoration should not be attempted in landscapes that can no longer support the kind of ecosystem designated for restoration or which will likely be compromised later by the effects of land usage offsite. To the extent possible, future threats to the integrity of the restored ecosystem should be minimized by mechanisms such as zoning or binding commitments from neighboring landowners.

Some aquatic ecosystem restoration depends entirely on improving the watershed, and all restoration work is accomplished offsite. Examples of impacts from offsite include water pollution, turbidity, and agricultural runoff. The hydrologic regime in any project site can be altered offsite by dams, drainage projects, diversions of runoff caused by highways and other public works, and by the impervious surfaces characteristic of developed land. Water tables are lowered by transpiration from trees and are raised, sometimes dramatically, by timber harvest. Fire frequency is reduced by intentional suppression and by landscape fragmentation that interrupts the cover of flammable vegetation. Exotic species colonization onsite is commonly traced to infestations offsite. The presence or abundance of birds and other mobile animals depends on the health of other ecosystems in the landscape upon which they partially depend.

10. Identify project-funding sources. Potential external funding sources should be listed if internal funding is inadequate.

11. Identify labor sources and equipment needs. New personnel may have to be hired, volunteers invited, and other labor contracted. The availability of special equipment must be determined.

12. Identify biotic resource needs. Biotic resources include seeds, other plant propagules, nursery-grown planting stocks, and animals for establishment at the project site.

13. Identify the need for securing permits required by government agencies. Dredge and fill permits may be required for tasks involving rivers and wetlands. Other permits may be applicable for the protection of endangered species, historic sites, etc.

14. Identify permit specifications, deed restrictions, and other legal constraints. If restoration is being conducted as mitigation, compliance with permit specifications must be incorporated into the restoration plan or re-negotiated. Restrictive covenants and zoning regulations may preclude certain restoration activities. Legal restrictions on ingress and egress could prevent some restoration tasks from being accomplished. If the restoration is being placed under conservation easement, the timing of the easement must be satisfied.

15. Identify project duration. Short-term restoration projects are generally more costly than longer-term projects. The longer the project, the more the practitioner can rely on natural processes and volunteer labor to accomplish specific restoration objectives that are identified below in Guideline #27. In accelerated restoration programs such as mitigation projects, costly interventions must substitute for these natural processes.

16. Identify strategies for long-term protection and management. Restoration is futile without reasonable assurance that the project site will be protected and properly managed into the indefinite future. Protection could be secured with conservation easements or the legal transfer of the property to a public resource agency or non-governmental organization.

PRELIMINARY TASKS

Preliminary tasks are those upon which project planning depends. These tasks form the foundation for well-conceived restoration designs and programs. Preliminary tasks are fulfilled after conceptual planning results in the decision to proceed with the restoration project.

17. Appoint a restoration ecologist who is responsible for technical aspects of restoration. Restoration projects are complex, require the coordination of diverse activities, and demand numerous decisions owing in part to the stochastic nature of ecological processes. For these reasons, leadership should be vested in an individual who maintains overview of the entire project and who has the authority to act quickly and decisively. The restoration ecologist may delegate specific tasks but retains the ultimate responsibility for the attainment of objectives. Nonetheless, restoration responsibilities are sometimes divided according to the organizational charts of larger corporations and government bureaus. Pluralistic leadership augments the potential for errors in project design and implementation. In mitigation projects, agency personnel become silent co-partners with the restoration ecologist when they mandate particular restoration activities as permit specifications. This practice reduces the restoration ecologist's capacity for flexibility and innovation, including the prompt implementation of adaptive management actions. The preparation of a written guidance document, based upon responses to these guidelines, will help promote the judicious execution of the restoration project in cases of pluralistic leadership and in negotiating permit specifications with government agencies.

18. Appoint the restoration team. The team includes the restoration ecologist, the project manager, other technical personnel who may contribute to the project, and anyone else whose input will critically affect the project. It is essential that the responsibilities of each individual are clearly assigned and that each person be given concomitant authority. The restoration ecologist and the project manager should maintain open lines of communication. If restoration is one component of a larger project, the restoration ecologist should enjoy equal status with other project planners to prevent actions that could compromise restoration quality or inflate costs.

19. Prepare a budget to accommodate the completion of preliminary tasks. Time and resources as well as funding need to be allocated for these tasks.

20. Document existing project site conditions and describe the biota. Project evaluation depends in part upon being able to contrast the project site before and after restoration. Properly labeled and archived photographs are fundamental. Camera locations should be recorded, so that before and after photos can be compared. Videotapes, aerial photographs, and oblique aerial photos from a low-flying aircraft are helpful. Soils and other physical site conditions should be described. To the extent possible, species composition should be listed and species abundance estimated. The structure of all component communities should be described in sufficient detail to permit objective means of evaluating the performance of projects subsequent to their implementation.

21. Document the project site history that led to the need for restoration. The years in which impacts occurred should be recorded. Historical aerial photos are helpful. Disturbance features should be photographed.

22. Conduct pre-project monitoring as needed. Sometimes it is useful or requisite to obtain baseline measurements on such parameters as water quality and groundwater levels for a year or more prior to initial project installation. If so, these measurements will continue after the project begins as part of the monitoring program.

23. Gather baseline ecological information and conceptualize a reference ecosystem from it upon which the restoration will be modeled and evaluated. The kind of ecosystem that has been selected for restoration must be described in sufficient detail to develop restoration objectives and to serve as a comparison for evaluating the completed restoration project. Documentation of the pre-project site conditions (Guideline #20) may contribute substantially to the reference. Generally, no one site contains the range of variability that is representative of the ecosystem designated for restoration. Therefore, the reference system should be conceptualized from the collective attributes of several sites. These attributes should include both the biotic and abiotic (physical) components. They should include seral (developmental) descriptions, because a comparison between an ecologically young restoration site and a mature reference system requires assumptions that are difficult to substantiate. The description of the reference system can be the citation of existing documents, a report of baseline ecological studies conducted by the restoration team, or a combination thereof.

24. Gather pertinent autecological information for key species. The restoration ecologist should have access to whatever knowledge is available regarding the recruitment, maintenance, and reproduction of key species. If necessary, trials and tests can be conducted by the restoration team prior to project installation.

25. Conduct investigations as needed to assess the effectiveness of restoration methods. Novel and unusual restoration methods may require testing prior to their implementation at the project site.

26. Decide if ecosystem goals are realistic or if they need modification. On the basis of information gained from carrying out the aforementioned guidelines, the project team should conduct a feasibility study to determine if the type of restoration (Guideline #4) and the original project goals (Guideline #5) were realistic. If not, modifications should be proposed.

27. Prepare a list of objectives designed to achieve restoration goals. Objectives are the specific activities to be undertaken for the satisfaction of project goals. The restoration ecologist should list all objectives needed to achieve each project goal. Objectives may be executed directly through the establishment of project features or passively through suitable project design. In either case, objectives are explicit, measurable, and have a designated time element. Objectives can cover a wide array of specific actions. They may be hydrological, e.g., the filling of a drainage ditch to improve sheet flow; pedological, e.g., the amendment of organic matter to improve soil texture; or biological, e.g., the prompt removal of a particular exotic species that threatens ecosystem integrity. Other objectives may pertain to re-introducing fire according to a specific prescription, removing an abandoned road, or establishing a windbreak. Certain objectives may require actions that take place offsite to improve conditions onsite. Some restoration projects can be accomplished with one or few objectives. For example, perhaps all that is needed is to install culverts beneath a road to improve drainage, assuming the vegetation can recover passively.

28. Secure permits required by regulatory and zoning authorities. These are the permits identified in guidelines #13 and #14.

29. Establish liaison with other interested governmental agencies. Potential interested agencies should be notified of the project. Later, site tours can be conducted for agency personnel and progress reports dispatched to them. This networking could expedite assistance, should it become needed.

30. Establish liaison with the public and publicize the project. Local residents automatically become stakeholders in the restoration. They need to know how the restored ecosystem can benefit them personally. For example, the restoration may attract ecotourism that will benefit local businesses, or it may serve as an environmental education venue for local schools. If residents favor the restoration, they will protect it and vest it with their political support. If they dislike the restoration, they may vandalize or otherwise disrespect it.

31. Arrange for public participation in project planning and implementation. The restoration team should make every effort to involve local residents or other interested members of the public to participate in project planning and installation. By doing so, the participants develop a feeling of ownership, and they will be more likely to assume a stewardship role for the completed project. Volunteer labor by local residents or by ecotourists may reduce overall project costs. However, such labor requires coordination, special supervision, and additional liability insurance.

32. Install roads and other infrastructure needed to facilitate project implementation. The degree to which infrastructure is provided should be weighed against the costs of down time caused by its absence and against considerations of safety and opportunities for public relations tours.

33. Engage and train personnel who will supervise and conduct project installation tasks. Project personnel who lack restoration experience or knowledge of particular methods will benefit from attending workshops and conferences that provide background information. Otherwise, the restoration ecologist should provide training.

INSTALLATION PLANNING

Installation plans describe how the project will be implemented, i.e., project design. The care and thoroughness with which installation planning is conducted will be reflected by how aptly project objectives are realized.

34. Describe the interventions that will be implemented to attain each objective. The restoration ecologist should identify all actions and treatments needed to accomplish each objective listed in Guideline #27. Detailed instructions are prepared for implementing each of these interventions. Concomitantly, the needs for labor, equipment, supplies, and biotic stocks are identified.

Restoration projects should be designed to reduce the need for mid-course corrections that inflate costs and cause delays. Special care should be given to describing site preparation activities, i.e., those interventions that precede the introduction of biotic resources. Once biotic resources are introduced, it may become exceedingly difficult to repair dysfunctional aspects of the physical environment.

Some interventions can be accomplished concurrently and others must be done in sequence. The need for sequencing should be clearly identified. Some restoration activities require follow-up activities or continuing periodic maintenance following installation. These tasks are predictable and can be written into the implementation plans under their respective objectives. Examples of maintenance tasks include the repair of erosion on freshly graded land and the removal of competitive weeds and vines from around young plantings.

35 State how much of the restoration can be accomplished passively. Restoration tasks initiate or accelerate natural processes. Nearly all manifestations of restoration are accomplished by these processes and not by the direct artifice of the restorationist. For example, a small quantity of plants may be introduced as nursery stock with the expectation that these plants will propagate and increase substantially in density. Many restoration projects make no provision for introducing species of animals. The assumption is that, 'if we build it, they will come.' The restoration plan should acknowledge those aspects that are expected to develop passively, i.e., without intervention. If passive restoration is not realized, then additional interventions must be prescribed (see Guideline #47).

36. Prepare performance standards and monitoring protocols to measure the attainment of each objective. A performance standard (also called a design_criterion) provides evidence on whether or not an objective has been attained. This evidence is gathered by monitoring in accord with a prescribed protocol or methodology. Performance standards require careful selection for their power to measure the completion of an objective. Monitoring tells the restoration ecologist to what degree a given objective has been attained. It is essential that performance standards and monitoring protocols be selected prior to any project installation activity. Otherwise, the objectivity of the performance standard will be compromised by the initial results of installation. Monitoring protocols must be geared specifically to performance standards. Other information is extraneous and inflates project costs. Monitoring protocols should be designed so that data are readily gathered, thereby reducing monitoring costs. They should be empirical to facilitate their objective interpretation.

37. Schedule the tasks needed to fulfill each objective. Scheduling can be complex. Planted nursery stock may have to be contract-grown months or longer in advance of planting and must be delivered in prime condition. Older, root-bound stocks are generally worthless. If direct seeding is prescribed, seed collecting sites will have to be identified. The seed must be collected when ripe, possibly stored, and perhaps pre-treated. Site preparation for terrestrial systems cannot be scheduled when conditions are unsuitable. For example, soil manipulations cannot be accomplished if flooding is likely, and prescribed burning must be planned and conducted in accordance with applicable fire codes. The availability of labor and equipment can further complicate scheduling. Workdays may have to be shortened for safety during especially hot weather and in lightening storms. Wet weather may cause equipment to bog down. Schedules should reflect these eventualities.

Most objectives are implemented within the first or second year of installation. Some objectives may have to be delayed. For example, the re-introduction of plants and animals with specialized habitat requirements may have to be postponed several years until habitat conditions become suitable.

38. Procure equipment, supplies, and biotic resources. Care should be taken to assure that regional ecotypes of biotic resources are obtained to increase the chances for genetic fitness and to prevent needless and harmful introductions of non-indigenous ecotypes and species.

39. Prepare a budget for installation tasks, maintenance events, and contingencies. Budgeting for planned objectives is obvious. However, budgeting for unknown contingencies is just as important. No restoration project has ever been accomplished exactly as it was planned. Restoration is a multivariate undertaking, and it is impossible to account for all eventualities. Examples of contingencies are severe weather events, depredations of deer and other herbivores on a freshly planted site, colonization by invasive species, vandalism, and unanticipated events elsewhere in the landscape that impact the project site. The need to conduct at least some remediation is a near certainty. Generally, the cost of remediation increases in relation to the time it takes to respond after its need is discovered. For these reasons, contingency funds should be available on short notice.

INSTALLATION TASKS

Project installation fulfills installation plans. If planning was thorough and supervision adequate, installation will generally proceed smoothly and within budget.

40. Mark boundaries and secure the project area. The project site should be staked or marked conspicuously in the field. Fencing and fire lanes should be installed as needed. This guideline is sometimes ignored until it results in a contingency, such as a neighbor's cattle escaping into a freshly planted project site.

41. Install monitoring features. Permanent transect lines, staff gauges, piezometer wells, etc., need to be installed and marked.

42. Implement restoration objectives. Restoration tasks were identified in Guideline #34. The restoration ecologist must supervise project installation or delegate supervision to project team members. Responsibility for proper implementation should not be entrusted to subcontractors, volunteers, and labors crews who are doing the work. The cost of retrofitting exceeds the cost of appropriate supervision.

POST-INSTALLATION TASKS

The attainment of objectives may depend as much on follow-up activities as it does to the care given to initial installation activities. The importance of post-installation work cannot be overemphasized.

43. Protect the project site against vandals and herbivory. Project sites attract dirt bike riders, feral swine, deer, geese, nutria, etc. Beaver can destroy a newly planted site by plugging streams and culverts. Appropriate preventive actions should be taken.

44. Perform post-implementation maintenance. Conduct maintenance activities that were described in Guideline #34.

45. Reconnoiter the project site regularly to identify needs for mid-course corrections. The restoration ecologist needs to inspect the project site frequently, particularly during the first year or two following an intervention, to schedule maintenance as needed and to react promptly to contingencies.

46. Perform monitoring as required to document the attainment of performance standards. Measurements of water levels and certain water quality parameters are generally conducted on a regular schedule. Otherwise, monitoring should not be required until monitoring data will be meaningful for decision-making. Monitoring and the reporting of monitoring data are expensive. Regular reconnaissance (Guideline #45) negates the need for frequent monitoring.

47. Implement adaptive management procedures as needed. Adaptive management as a restoration strategy is essential, because what happens at one stage in restoration dictates what needs to happen next. A restoration plan must contain built-in flexibility. If reconnaissance or monitoring reveal that objectives are not being met, then alternative interventions may have to be attempted. The project manager should realize that restoration objectives may never be realized for reasons that lie beyond the control of the restoration ecologist. If so, then new goals (Guideline #5) and objectives (Guideline #27) may have to be adopted if a functional ecosystem is to be returned to the project site.

EVALUATION

The installation of a project does not guarantee that its objectives will be attained or its goals achieved. Restoration differs from most civil engineering projects for which the results are more predictable. Restored ecosystems are dynamic and require evaluation within the context of an indefinite temporal dimension.

48. Assess monitoring data to determine if performance standards are being met. If performance standards are not being met within a reasonable period of time, refer to Guideline #47.

49. Describe aspects of the restored ecosystem that are not covered by monitoring data. This description should commence when project work has been essentially completed. The description should compliment the documentation that was conducted prior to the initiation of restoration activities (Guideline #20) to allow before and after comparisons.

50. Determine if project goals were met, including those for social and cultural values. Based on monitoring data and other documentation (Guidelines #46, #49), evaluate the restoration with respect to its project goals. These will include the primary goal to restore a functional ecosystem that emulates the reference ecosystem at a comparable ecological age (Guideline #4). They will also include any secondary goals with respect to social and cultural values (Guideline #5).

51. Publish an account of the restoration project and otherwise publicize it. Publicity and documentation should be incorporated into every restoration project for the following reasons: Published accountings are fundamental for instituting the long-term protection and stewardship of a completed project site. Policy makers and the public need to be appraised of the fiscal and resource costs, so that future restoration projects can be planned and budgeted appropriately. Restoration ecologists improve their craft by becoming familiar with how restoration objectives were accomplished.

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Appendix 4.

Selected restoration activities and potential indicators of the effects of management activities, based on ecosystem function. Please read the Restoration chapter and take note of cautionary advice regarding planning and implementing restoration activities in an urban setting, particularly instream modifications.

Function or Value	Selected Potential Restoration Activities	Some Potential Indicators of Management Activity Effects
Water quality (sediment filtering, nutrient/pollutant filtering, erosion control and stream bank stability)	• Increase riparian and upland vegetation (especially woody vegetation) in watershed • Vegetative filter strips (VFS) • Control sediment inputs through BMPs and regulatory measures • Promote development of healthy soils through native plant communities (increases soil retention and filtering capacity) • Limit development and impervious surfaces near stream • Remove or modify sewer outfalls • Artificial wetlands (bioswales and water detention structures) • Public education to keep toxins out of storm drains • Reduce or eliminate industrial discharges • Promote alternatives to pesticides and chemical fertilizers • Promote passage of more water through wetlands and undeveloped floodplains • Retain/increase springs, seeps and wetlands • Increase late summer flows	• Benthic index of biological integrity (B-IBI) (Booth 1991; Spence et al. 1996; Karr and Chu 2000; Booth et al. 2001) • Piezometers or small wells to test groundwater and hyporheic water quality (Fernald et al. 2000) • Water quality tests such as temperature, sediment/turbidity, pH, dissolved oxygen, conductivity, nitrogen and phosphorus, herbicides/pesticides, suspended/floating matter, trash loading, odor, and chemical contamination (National Marine Fisheries Service 1996; Spence et al. 1996; FIRSWG 1998; Hollenback and Ory 1999) • Percent catchment in various types of vegetation and wetland cover (Spence et al. 1996) • Total impervious area, effective impervious area, or road density and location (National Marine Fisheries Service 1996; Schueler 1994; May et al. 1997b) • Intergravel dissolved oxygen in sites where fine particulate organic matter is present (Spence et al. 1996)
Microclimate and shade	• Terrestrial: reduce microclimatic edge effects by addressing size, shape of habitat patches • Aquatic: provide vegetative shade over stream • Terrestrial and aquatic: increase forest width	• Terrestrial: measures of air temperature, relative humidity, soil moisture and temperature, solar radiation, and wind speed (Spence et al. 1996; Saunders et al. 1999; Gehlhausen et al. 2000; Laurance et al. 2000) • Aquatic: water temperature (Budd et al. 1987; Beschta et al. 1988)
Sources of stream flow and flood storage (hydrology)	• Reduce impervious surfaces in watershed • Remove or modify sewer outfalls • Add riparian and upland vegetation; increase riparian forest width • Reconnect streams to floodplain • Retain/increase springs, seeps and wetlands (sources of cold water) • Allow channel meanders • Limit development near stream • Control water inputs artificially to mimic natural conditions • Protect natural and create new detention ponds to detain increased peak runoff • Groundwater recharge (increases late summer flows) • Dam removal/modification to more closely mimic natural flow regime	• B-IBI (urban land cover correlates equally well in Pacific Northwest with B-IBI at subbasin, riparian, and local scales) (Booth 1991; Spence et al. 1996; Karr and Chu 2000; Booth et al. 2001) • Hydrographs (historic vs present) and stream gauges (Brookes 1987; Hollenbach & Ory 1999) • Annual and interannual streamflow patterns such as T_{qmean}, $T_{0.5}$ yr and CV_{AMF}, quality and timing of peak and low flows (Spence et al. 1996; Booth et al. 2001) • Channel scour (Spence et al. 1996) • Discharge (Spence et al. 1996) • Width/depth ratio, streambank condition, floodplain

Function or Value	Selected Potential Restoration Activities	Some Potential Indicators of Management Activity Effects
	• Reintroduce/allow beaver (increases water storage) • Increase late summer flows	connectivity, change in peak/base flows, increase in drainage network (National Marine Fisheries Service 1996)
Organic materials	• Increase native vegetation, particularly in riparian areas (although note that small mammals and amphibians require woody debris, thus this should also be addressed in uplands) • In riparian areas, increase conifer:hardwood ratio (large wood from coniferous trees lasts longer instream) • Increase stream connectivity with and ecological integrity of floodplain (floodplain delivers organic materials to stream and riparian areas during flood events) • Addition of fish carcasses to stream	• Measure woody debris and leaf litter or retention time of same (relatively straightforward; Webster and Meyer 1997) • Measure instream nutrient retention time, nutrient spiraling, nutrient cycling (relatively complex; Allan 1995; Cederholm et al. 2000; Cederholm et al. 2001) • GIS: measure forest width and conifer:hardwood ratio or amount and types of vegetative cover (Schueler 1994; Xiang 1996)
Channel dynamics	• Reconnect isolated habitats (instream and terrestrial) • Use a variety of methods (TIA reduction, forest canopy increase, sediment control) to modify flow and sediment regimes to resemble undisturbed conditions • Reduce stream crossings • Control sediment inputs • Remove or modify fish passage barriers • Road removal or alteration • Structural additions (large wood, boulders) • Bank stabilization (vegetation plantings, gabion structures, etc.) • Fencing to avoid livestock grazing • Rest-rotation or grazing strategy • Conifer conversion • Dam removal/modification • Addition of large wood, boulders	• Benthic index of biological integrity (Spence et al. 1996; Karr and Chu 2000; Booth et al. 2001) • Fish-IBI (Regier et al. 1989) • Fraction of bed sediment below a threshold size (measures potentially lethal reductions in permeability allowing flow of oxygenated water to substrate) (Booth et al. 2001) • Cross section and bankfull channel boundary measurements, flood stage surveys, width-to-depth ratios, rates of bank or bed erosion (FIRSWG 1998; Prichard 1998) • Relative Bed Stability Index (Olsen et al. 1997, from Booth et al. 2001) • Riparian forest width measures (Spence et al. 1996) • Channel sinuosity measures (Spence et al. 1996) • Connectivity measures (aerial photography or fragmentation program such as FRAGSTATS) (FIRSWG 1998; FRAGSTATS available at http://www.umass.edu/landeco/research/fragstats/fragstats.html)
Habitat and connectivity	• Reconnect isolated habitats • Consider habitat patch size and shape • Increase native canopy and shrub cover • Control invasive and nonnative plants • Add water sources for wildlife • Plant food resources for wildlife • Manage to increase instream and terrestrial large woody debris • Introduce controlled fire regime to mimic natural disturbances • Improve fish passage	• Bird and wildlife use (FIRSWG 1998) • Large woody debris, instream and terrestrial (Beschta 1979; Dooley and Paulson 1988; FIRSWG 1988; Booth et al. 1997) • Riparian-dependent birds (Spence et al. 1996; Bureau of Land Management 2001) • Aerial photography (FIRSWG 1998) • B-IBI (Booth 1991; Spence et al. 1996; Karr and Chu 2000; Booth et al. 2001) • Sensitive fish (e.g., salmonids) (Spence et al. 1996) • Presence of area-sensitive species (needing large habitat patches) (Keller et al. 1993; Hodges and Krementz 1996; Wenger 1999) • Instream habitat elements: substrate, large woody debris,

Function or Value	Selected Potential Restoration Activities	Some Potential Indicators of Management Activity Effects
		pool frequency and quality, off-channel habitat, and refugia; % road crossings with inadequate culverts, % unscreened diversions, % impassable dams, frequency of off-channel habitats and LWD in riparian zone (National Marine Fisheries Service 1996; Spence et al. 1996) • Terrestrial habitat elements: percent vegetative cover, species density, size and age class distribution, planting survival and reproductive vigor (FIRSWG 1998) • Physical barriers such as culverts (National Marine Fisheries Service 1996) • Nonnative species (Spence et al. 1996) • % riparian zone within 100 m with natural riparian woody plants (Spence et al. 1996) • Beaver sign (Spence et al. 1996)
Reducing human disturbance	• Reduce edge effects • Reduce road effects • Limit trails (especially paved) in large habitat patches for Neotropical migratory birds, which are disturbance-sensitive • Reduce nonnative species through direct removal and/or habitat manipulations • Preserve endangered habitats and habitats critical to endangered species	• Presence, abundance, diversity of sensitive species, or sensitive species index such as B-IBI or Neotropical migratory breeding bird surveys (Spence et al. 1996; Karr and Chu 2000; Booth et al. 2001; Moore et al. 1993; Friesen et al. 1995; Nilon et al. 1995; Theobald et al. 1997; Mancke and Gavin 2000; Hennings 2001; Hennings and Edge 2003) • Bird nesting success studies and studies on associated predators (Small and Hunter 1988; Marzluff et al. 1998; Heske et al. 2001) • Vegetation surveys (Hennings 2001; Hennings and Edge 2003; Roni et al. 2002) • Recreational use surveys (FIRSWG 1998)

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METRO
People places • open spaces
Clean air and clean water do not stop at city limits or county lines. Neither does the need for jobs, a thriving economy, and good transportation choices for people and businesses in our region. Voters have asked Metro to help with the challenges that cross those lines and affect the 24 cities and three counties in the Portland metropolitan area.

A regional approach simply makes sense when it comes to protecting open space, caring for parks, planning for the best use of land, managing garbage disposal, and increasing recycling. Metro oversees world-class facilities such as the Oregon Zoo, which contributes to conservation and education, and the Oregon Convention Center, which benefits the region's economy.

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CHAPTER 1: INTRODUCTION

Purpose and Objectives

Metro's authority to plan for fish and wildlife habitat protection in the region derives from State Land Use Planning Goal 5: Natural Resources, Scenic and Historic Areas, and Open Spaces. The Goal 5 administrative rule (OAR 660-023) recognizes Metro's unique planning role and gives Metro the option to develop a functional plan to protect regionally significant fish and wildlife habitat[1] (OAR 660-023-080(3)). In 1996 the Metro Council voted to recognize the regional significance of fish and wildlife habitat and include protection in the functional plan.

In October 2000, the Metropolitan Policy Advisory Committee (MPAC) approved a vision for fish and wildlife habitat protection for the region, which was adopted by the Metro Council.

> The overall goal is to conserve, protect and restore a continuous ecologically viable streamside corridor system, from the streams' headwaters to their confluence with others streams and rivers, and with their floodplains in a manner that is integrated with the surrounding urban landscape. This system will be achieved through conservation, protection and appropriate restoration of streamside corridors through time. (Metro 2000)

In achieving the overall goal, the vision statement emphasizes the importance of balancing several goals, including livable communities and a strong economy with protection and enhancement of fish and wildlife habitat. Integrating the needs of people with the needs of fish and wildlife in an urban environment is not an easy task. There is debate on the value of protecting habitat in urban and developing areas, considering the difficulty many species have cohabiting with humans and the economic value of developable land in urban areas. Metro's policies have consistently placed a high level of importance on the protection of the natural environment as a means of maintaining the high quality of life citizens of this region expect.

The general economic, social, environmental, and energy (ESEE) tradeoffs of allowing, limiting, and prohibiting conflicting uses in fish and wildlife habitat areas are described in this report. The next step of Metro's planning process is to identify the specific ESEE tradeoffs of several program options, after which the Metro Council will make a decision to allow, limit, or prohibit conflicting uses in fish and wildlife habitat areas.

Description of the Goal 5 ESEE process

The Goal 5 process follows three steps. The first step is to identify regionally significant fish and wildlife habitat, which Metro completed in 2002. The economic, social, environment and energy (ESEE) analysis is the second step. Metro is now completing the first phase of a regional ESEE analysis. Metro will next apply the tradeoffs identified in the first phase of the analysis to several options for protection to evaluate where and how to protect fish and wildlife habitat. This will provide the Metro Council the information they need to make a decision about where development should be allowed, limited, or prohibited. The third step is to develop a program to

[1] In this report, when we use the term "fish and wildlife habitat" we are referring to "regionally significant fish and wildlife habitat" as identified in Metro's Goal 5 Inventory.

protect significant fish and wildlife habitat. After Metro adoption, local cities and counties will have 2-4 years to comply with the regional fish and wildlife habitat protection program.

Oregon State Planning Goal 5 requires an analysis of the economic, social, environmental, and energy (ESEE) consequences that could result from a decision to allow, limit, or prohibit conflicting uses in fish and wildlife habitat. The rule requires that this analysis be completed before actions are taken to protect or not protect any regionally identified fish and wildlife habitat. Specifically, the rule requires the following steps:

1. Identify conflicting uses;
2. Determine the impact area;
3. Analyze the ESEE consequences; and
4. Develop a program to achieve Goal 5.

First, governments must identify conflicting uses that exist, or could occur, with regard to significant Goal 5 resource sites (fish and wildlife habitat). A conflicting use is a land use or activity that may negatively impact fish and wildlife habitat. Second, the rule requires a determination of the impact area, representing the extent to which land uses or activities in areas adjacent to habitat could negatively impact the habitat. The impact area identifies the geographic limits within which to conduct the ESEE analysis for significant fish and wildlife habitat. Third, the ESEE consequences analysis considers the impact of a decision to either fully protect fish and wildlife habitat, fully allow conflicting uses, or limit the conflicting uses. Jurisdictions that choose to limit conflicting uses must do so in a way that "protects the resource to the desired extent." The standards identified by the state for completing the ESEE analysis are procedural rather than substantive. Findings must show that the steps of the ESEE analysis are met, but OAR 660-23-040 states that: "[t]he ESEE analysis need not be lengthy or complex, but should enable reviewers to gain a clear understanding of the conflicts and consequences to be expected."

Regional policies guide Metro's ESEE analysis

Metro's role in identifying fish and wildlife habitat protection measures and incentives within its boundary has been established with adoption of the *Regional Urban Growth Goals and Objectives (RUGGOs), Region 2040 Growth Concept* and the *Urban Growth Management Functional Plan.* Fish and wildlife habitat, by their very nature, cross jurisdictional boundaries and require management through regional, watershed-wide protection strategies. Metro has a role in working with local jurisdictions to determine the protection of these important habitats, just as it determines parking standards, transportation networks and land use densities for the region. Through extensive public involvement, the Metro Council has identified the need to balance natural resource protection with urban development while the region grows.

The Metro Council has adopted several policies following the direction of citizens that influence the ESEE consequences analysis. These policies provide the framework for protecting natural resources while managing urban growth in the region. Fish and wildlife habitat play a key role in maintaining the livability of the Metro region. Table 1-1 below summarizes key regional policies guiding Metro's work.[2]

[2] More extensive descriptions of these policies may be found in *Appendix A.*

Table 1-1. Regional policies guiding habitat protection efforts.

Policy	Description and relevance to habitat protection
Metro Charter *1992*	Required Metro to address issues of regional significance, such as land use and transportation planning as well as regional parks and open spaces. Identified the protection of natural systems – floodplains, rivers, streams, and wetlands – as a cornerstone for regional policies.
Greenspaces Master Plan *1992*	Articulated the vision for a cooperative, interconnected system of parks, natural areas, trails, and green ways for fish, wildlife and people. Recommended tools to protect greenspaces, such as acquisition, education and restoration. In 1995, voters passed a bond measure directing Metro to purchase regionally significant natural areas. Since then, more than 8,000 acres of natural areas have been acquired for permanent protection.
Future Vision Report *1995*	A key document in guiding land use management for the protection of fish and wildlife habitat. While not a regulatory document, it has greatly influenced the content of Metro's regional plans. States that the region should manage watersheds to protect, restore and maintain the integrity of streams, wetlands and floodplains, and their multiple biological, physical and social values. Identifies the need for restored ecosystems protected from future degradation.
Metro 2040 Growth Concept *1994*	Describes the preferred form of growth and development for the region, including how much the UGB should ultimately be expanded, ranges of density within the boundary, and which areas should be protected as open space. Basic philosophy is to preserve access to nature and build better communities.
Regional Urban Growth Goals and Objectives (RUGGO's) *1995*	Identifies goals and planning activities for the Metro region. Two objectives relate to water resources, and a third relates to wildlife habitat: Objective 12, Watershed Management and Regional Water Quality and Objective 13, Urban Water Supply; Objective 15, Natural Areas, Parks, Fish and Wildlife Habitat calls for an open space system capable of sustaining or enhancing native wildlife and plants.
Regional Framework Plan *1998*	Sets out the land-use, transportation, parks, water resources, natural hazards and related policy directives for the region's future. Three chapters address fish and wildlife habitat: Chapter 3: protection of lands outside the UGB for natural resource, future urban or other uses; Chapter 6: parks, open spaces and recreational facilities; and Chapter 7: water sources and storage.
Stream and Floodplain Protection Plan (Title 3) *1998*	Adopted by Metro as part of the Urban Growth Management Functional Plan, it establishes regional performance standards to address water quality and floodplain management. Recommends actions for the protection of fish and wildlife habitat. The completed sections of Title 3 meet the requirements for Statewide Planning Goal 6 (water quality) and Goal 7 (flood management).

As shown in the table above, Title 3 of Metro's Urban Growth Management Functional Plan addresses water quality, flood management, and fish and wildlife habitat conservation. Section 5(C) of Title 3 describes the steps that Metro must follow in order to establish a program to protect fish and wildlife habitat. These steps, shown below, relate to the process outlined in the state's Goal 5 administrative rule.

1) Establish criteria to define and identify regionally significant fish and wildlife habitat areas.
2) Adopt a map of regionally significant fish and wildlife areas after (a) examining existing Goal 5 data, reports and regulations from cities and counties, and (b) holding public hearings.
3) Identify inadequate or inconsistent data and protection in existing Goal 5 data, reports, and regulations on fish and wildlife habitat.
4) Complete Goal 5 economic, social, environmental, and energy (ESEE) analyses for mapped regionally significant fish and wildlife habitat areas only for those areas where inadequate or inconsistent data or protection has been identified.

5) Establish performance standards for protection of regionally significant fish and wildlife habitat that must be met by the plans' implementing ordinances of cities and counties.

Steps 1 and 2, establishing an inventory of regionally significant fish and wildlife habitat, have been completed and were adopted by the Metro Council in 2002.[3] Step 3 requires Metro to conduct an analysis of local jurisdictions' existing Goal 5 programs to determine inadequacy or inconsistency of these programs across the region. Metro's *Local Plan Analysis* satisfies the requirement (step 3) by providing a thorough analysis of local Goal 5 city and county programs (Metro 2002a). The analysis concludes that there are many inconsistencies and inadequacies in fish and wildlife habitat protection in the Metro region. Step 4 is the economic, social, environmental, and energy (ESEE) analysis. A region-wide analysis must be conducted that considers the economic, social, environmental, and energy consequences of allowing, limiting, or prohibiting conflicting uses before a program can be developed (Step 5).

Metro's approach to the analysis

Goal 5 has previously been completed by city or county governments, focusing on the natural resources (or other Goal 5 resources) that fall within their specific jurisdictions. However, Metro was given the ability to choose to protect Goal 5 resources at a regional level in the state administrative rule. Streams and rivers, forests and meadows, and the fish and wildlife that inhabit them do not acknowledge jurisdictional boundaries. The economy of the region also functions at a larger scale than just one city or county. Just as it makes sense to plan for transportation needs across the Portland metropolitan region (Metro region), consideration of the protection of fish and wildlife habitat at a larger scale allows for greater understanding of the connections between habitats and the functions of the ecosystem as a whole. Now the task at hand is to weigh the economic, social, environmental, and energy (ESEE) consequences of protecting fish and wildlife habitat within the Metro region. Many issues are similar to those encountered at a city or county; however, some are different such as Metro's ability to add land to the urban growth boundary (UGB) to prevent a net loss of buildable land due to fish and wildlife protection.[4]

Metro's approach for conducting a region-wide ESEE consequences analysis focuses on achieving the goals of the 2040 Growth Concept. The goals in the Growth Concept, the Future Vision, the Regional Framework Plan (implemented through the Urban Growth Management Functional Plan) and Metro's Vision Statement for Protecting Fish and Wildlife Habitat all specify that the region should manage growth while protecting the natural environment, maintaining a high quality of life, and providing affordable housing options.

Development of the 2040 Growth Concept included the balancing of goals in some ways similar to an ESEE analysis. Citizens and policymakers chose to increase density in centers and along major transportation routes (e.g., light rail, main streets) to minimize sprawl and avoid the addition of more land to the urban growth boundary. Green corridors and protection along streams and rivers was identified as a critical component of maintaining a high quality of life in a densely populated region. Transportation plays a critical role in the overall concept: without

[3] See Metro's *Riparian corridor and wildlife habitat inventories* (Metro 2002d) and *Technical Report for Goal 5* (Metro 2002c).
[4] This topic is discussed in more detail at the end of this chapter.

efficient public transit as well as opportunities to walk, bike or drive from home to shops, jobs, and recreation the compact communities envisioned would not function. Metro's current efforts to protect fish and wildlife habitat help further the goals in the 2040 Growth Concept.

Metro has taken a regional approach to the ESEE analysis, considering the overall tradeoffs of protecting or not protecting fish and wildlife habitat. The analysis is general and contains qualitative and, where possible, quantitative, descriptions of tradeoffs. The conflicting use and economic analyses contain specific acreage figures but at a regional scale. Additional analysis will be conducted in the next step of the planning process in the evaluation of the tradeoffs of several program options. Frequently, a consequence could fall in more than one ESEE category. For example, flooding has negative economic consequences (cost to repair damaged structures), social consequences (families lose irreplaceable items like photos), environmental consequences (changes to the stream system), and energy consequences (energy used to repair buildings). Many consequences cross categories and Metro staff used professional judgement to determine which category was most effective for describing the consequences.

This ESEE analysis does not result in a final decision to allow, limit, or prohibit conflicting uses in fish and wildlife habitat. The analysis describes the tradeoffs in a general fashion to help the Metro Council evaluate program options during the next step of the planning process. The Metro Council will complete the ESEE by making allow, limit, or prohibit decisions for fish and wildlife habitat.

Local Goal 5 programs

Most of the local jurisdictions in the Metro region have adopted Goal 5 programs that have been acknowledged by Oregon's Department of Land Conservation and Development as being in compliance with the state rule. Some of these programs were developed prior to Goal 5 rule revisions in 1996, while a few have been done more recently. The rule requires local jurisdictions to balance the need to protect natural resources against other state goals such as housing (Goal 10) and transportation (Goal 12) while providing ample opportunity for citizen involvement (Goal 1). Thus, the state rule allows local jurisdictions' Goal 5 programs to be in compliance with state law while being inconsistent with each other. However, Metro's code required an analysis of the consistency of local fish and wildlife protection prior to conducting a regional ESEE analysis and a regional protection program.

Metro staff conducted an analysis of local Goal 5 programs beginning in 1999 and culminating in a report to the Metro Council (Metro 2002a). The analysis demonstrated that there are many inconsistencies and inadequacies in fish and wildlife protection in the Metro region. An important reason for the inconsistency in local protection is that the Goal 5 rule does not set a specific standard, rather it lays out a process for jurisdictions to follow. The process described by state law allows jurisdictions to choose which resources to protect and the level of protection received after balancing the consequences of protection with the economic, social, and energy needs within the jurisdiction. Most jurisdictions choose to "limit" conflicting uses in fish and wildlife habitat areas, the Goal 5 rule defines this choice as "conflicting uses should be allowed in a limited way that protects the resource to the desired extent." This language gives local governments wide discretion in designing protection programs.

Metro's Regional Urban Growth Goals and Objectives (RUGGOs) and the Vision Statement emphasize the importance of protecting fish and wildlife habitat and recognize the need to provide a more consistent level of protection throughout the region. Metro's ESEE analysis identifies the tradeoffs of allowing, limiting, or prohibiting development consistently across the region.

Federal and state habitat protection policies

There are many policies that focus attention on the protection of fish and wildlife habitat. This section provides a brief overview of the key federal and state policies that set requirements for jurisdictions and agencies for fish and wildlife habitat protection.[5] While Metro is not required by law to address most of the policies described in Table 1-2 on the following page, a regional fish and wildlife habitat protection plan will help to meet the goals described by many of the federal and state policies.[6]

The federal Endangered Species Act and the Clean Water Act most specifically relate to Metro's current efforts to protect fish and wildlife habitat. NOAA Fisheries is currently developing recovery plans for listed salmon species. Metro's inventory of regionally significant fish and wildlife habitat has identified habitat upon which listed salmon depend for some part of their life histories. Coordinating Metro's program with NOAA Fisheries recovery plan as it is developed will not only assist in long-term recovery of the species, but also with local compliance with the ESA.

The Oregon Department of Environmental Quality (DEQ) is required by the federal Clean Water Act to maintain a list of steam segments that do not meet water quality standards, called the 303(d) list (DEQ 2003a). Many of the region's streams are 303(d) listed as water-quality impaired due to elevated temperatures.[7] Once a stream or river segment is 303(d) listed, the DEQ is responsible for developing water quality standards that protect beneficial uses of rivers, streams and lakes. These standards, called Total Maximum Daily Load (TMDL) determinations, are specific to 303(d) listed segments of rivers and streams and the problems identified in those segments, but are developed using a comprehensive approach that considers a larger geographic area, such as a watershed (DEQ 2003).

TMDLs outline how much pollution a water body can receive and still not violate water quality standards. Once TMDL standards are established, the state monitors water quality and reviews available data and information to determine if these standards are being met and water is protected. A stream or river segment can be "de-listed," or removed from the 303(d) water quality limited list, when TMDL determinations are made, or when new data indicates the

[5] Additional descriptions of these policies may be found in *Appendix A*.

[6] Metro must address activities on land owned by Metro, such as the take provisions of the ESA, local standards adopted to comply with the CWA, and state wetland laws.

[7] Appendix B includes two tables showing the DEQ's 1998 and 2002 303(d) listings of water quality limited water bodies in the Metro region (courtesy Don Yon, Oregon DEQ, 2003). Note that the 1998 list is substantially longer than the 2002 list. This does not mean that the water quality has improved; stream reaches that were on the 1998 list, but not on the 2002 list, typically indicate that a TMDL was developed, not that the particular pollution problem was solved.

waterbody meets water quality standards. The 303(d) listing identifies the problem(s); TMDLs provide a plan to improve water quality and meet federal clean water standards.

Metro's Stream and Floodplain Protection Plan (Title 3), described earlier, addresses water quality. However, many streams in the region still suffer from degraded water quality, and more recent science calls for greater protections than were in place when Title 3 was developed. Current efforts to improve water quality for fish habitat will also help to meet the federal standards in the Clean Water Act.

Table 1-2. Federal and state policies guiding fish and wildlife habitat protection.

Policy	Description
Federal policies	
Endangered Species Act (ESA)	The purpose of the ESA is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." Requires federal agencies to identify critical habitat for endangered and threatened species, create a recovery plan for those species and in some circumstances issue regulations that provide for the conservation of such species. Above all, the act prohibits any individual, group of individuals, states, cities and counties from "taking" a listed species.[1] Twelve species of salmon and steelhead are listed as either threatened or endangered in the Columbia River and Willamette River Basins.
Clean Water Act (CWA)	Sets a national goal to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." In Oregon, the CWA is implemented by the DEQ with review and approval by the U.S. EPA. The DEQ has the responsibility for protecting the beneficial uses of rivers, streams and lakes of the state. Beneficial uses include drinking water, cold water fisheries, industrial water supply, recreation and agricultural uses.
Northwest Power Act	Requires the Bonneville Power Administration to implement a Fish and Wildlife Program that mitigates for the degradation to both fish and wildlife habitat caused by the Columbia Hydropower System. Complying with the Fish and Wildlife Program is achieved primarily through subbasin plans developed with oversight from the Northwest Power Planning Council.
Magnuson-Stevens Fishery Conservation and Management Act	Requires federal agencies to consult with NOAA Fisheries on activities that may adversely affect essential fish habitat (EFH). Defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The Pacific Fishery Management Council identified EFH for pacific coast salmon. Those areas generally include "waters and substrate necessary for salmon production needed to support a long-term sustainable salmon fishery and ... a healthy ecosystem."
State policies	
Oregon Plan for Salmon and Watersheds	The mission of the Oregon Plan is "to restore our native fish populations – and the aquatic systems that support them – to productive and sustainable levels that will provide substantial environmental, cultural and economic benefits." Initiated to address restoration of coastal coho salmon, the Oregon Legislature later incorporated other related efforts into one overarching framework. Designed to restore the healthy function of Oregon's natural aquatic systems.
Native Fish Conservation Policy	The purpose of the policy is: "to ensure the conservation and recovery of native fish in Oregon." Focuses on "naturally produced native fish" which are those fish species that "reproduce and complete their full life cycle in natural habitats." The reason for this focus on naturally produced fish is that those "native fish are the primary basis for Endangered Species Act de-listing decisions and the foundation for long-term sustainability of native species and hatchery programs."
Oregon Endangered Species Act	Intended to manage the listed "species and their habitats so that the status of the species improves to a point where listing is no longer necessary." Species are listed when they are: (1) native, and (2) in danger of extinction throughout any significant portion of its range (endangered) or (3) likely to become an endangered species within the foreseeable future throughout any significant portion of its range (threatened).
Oregon Wetland Regulatory Program	The Oregon Division of State Lands (DSL) administers Oregon's removal/fill law. Using similar definitions as the federal government, DSL determines wetland boundaries and water bodies that meet the definition of "waters of the state." A permit is required for fill or removal equal to or exceeding 50 cubic yards or more of material in any waters of the state at one location.
Essential Indigenous Anadromous Salmonid Habitat	In an effort to identify and protect essential habitat for salmon and trout, the Oregon Legislature in 1993 required DSL to identify essential indigenous anadromous salmon habitat. DSL has defined such habitat as: "habitat that is necessary to prevent the depletion of indigenous anadromous salmonid species during their life history stages of spawning and rearing."

[1]The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.
Acronyms: DEQ: Department of Environmental Quality; EPA: Environmental Protection Agency; NOAA: National Oceanic and Atmospheric Administration.

Public opinion on habitat protection

In a national survey on biodiversity, respondents strongly agreed (69 percent) with the statement "[w]e have a personal responsibility to the earth to protect all plant and animal life"; and strongly agreed (71 percent) with the statement "[n]ature provides me with inspiration and peace of mind." (Belden, Russonello & Stewart, 2002). Residents of the Metro region are known for placing a high value on the natural environment, which some believe adds to a high quality of life. Many people move to the region to take advantage of the close proximity to hiking, biking, boating and other outdoor activities. Residents also enjoy access to nature in the city: hiking in Forest Park, boating on the Willamette, birding at Smith and Bybee Lakes. Residents of the region have emphasized the protection and restoration of parks and open spaces through public surveys over the last several years. Metro has been particularly interested in public opinion regarding the protection of fish and wildlife habitat in recent years.

Several opinion surveys were conducted in 2001, including a May 2001 Davis and Hibbits phone survey commissioned by Metro, an October 2001 Moore Information survey sponsored by KGW-TV and the Portland Tribune, and an informal "SurveyPoint" poll available by phone and on Metro's website. Results from all three studies demonstrated that Metro residents place great value on protecting natural resources and maintaining the region's quality of life. In 2002 Davis, Hibbitts, & McCaig conducted a survey for Clean Water Services in Washington County that showed a mix of values related to healthy streams. The general public and streamside property owners rated clean drinking water, clean rivers and streams, and open space for fish and wildlife habitat as being "most important"; but rated healthy fish populations in local streams and adequate water in streams for fish and wildlife as being "least important". This contradiction is especially interesting since clean rivers and streams locally are a requirement for healthy fish populations regionally.

Metro held "Coffee Talks" from September 2001 through January 2002, a series of 93 small group dialogues in various locales throughout the urban region. Discussions focused on the urban growth boundary, fish and wildlife habitat protection, and transportation. The Coffee Talks were advertised via local radio, television, and newspapers. In addition, approximately 90,000 citizens received an October 2001 "Let's Talk" about fish and wildlife newsletter, including some 45,000 property owners with land in the inventory. An important component of these talks involved whether the public thought it was important to protect fish and wildlife habitat in the urban region and if so, how this should be accomplished. This public feedback was distributed to Metro staff and Councilors for consideration in the planning process. One important outcome of this process was indication of strong public support for Metro's efforts to maintain and enhance natural habitat areas.

In March 2002, Metro held a regional conference and five localized workshops to garner public opinion and participation entitled "Let's Talk" (Metro 2002b). Metro undertook a major notification process to encourage attendance to these activities, including the fall 2001 Natural Resource Protection mailing of nearly 90,000 to property owners and interested parties; press releases to major and local newspapers; partnership with KGW, a major local television station; and follow-up calls to neighborhood associations, business interests and other parties to encourage participation. About 1,000 people attended the conference and workshops. The results confirm the importance of natural resource protection to the area's citizens, and interest in several strategies for natural resource protection emerged – perhaps most notably, financial incentives for protection as well as disincentives for failing to protect these resources.

Overview of Metro's fish and wildlife habitat inventory

Metro has the authority pursuant to Oregon Administrative Rule chapter 660, division 23, to identify "regional resources." A regional resource is defined by the Goal 5 rule as "a site containing a significant Goal 5 resource, including but not limited to a riparian corridor, wetland, or open space, which is identified as a regional resource on a map adopted by Metro ordinance." Metro's Goal 5 work addresses the following Goal 5 resources: riparian corridors, associated wetlands, and wildlife habitat. This report uses the term "regional resource" or "resource" interchangeably with "riparian corridors and upland wildlife habitat," or simply "fish and wildlife habitat." A regional approach to inventorying fish and wildlife habitat requires a consistent level of data and analysis across the entire Metro region. Metro's fish and wildlife habitat inventory is based on the best available information that can be applied consistently at a regional scale.

Metro completed its inventory of fish and wildlife habitat in 2002. Metro took an ecological functions approach to define the riparian corridor and identify upland wildlife habitat, based on its extensive scientific literature review (Metro 2002c). This approach combines geographic information system (GIS) mapping technology, scientific recommendations, and fieldwork for an inventory that encompasses the entire Metro region. The methodology assigns values to fish and wildlife habitat features that allows comparison of their cumulative importance. Below is a short overview of the current state of fish and wildlife habitat in the region, followed by a description of the inventory methodology.

State of the region's fish and wildlife habitat

Habitat loss, alteration, and significant increases in the amount of impervious land cover characterize the Metro region. More than one-fourth of all surface streams (about 400 miles) have been removed or piped underground, and many of the remaining stream miles suffer from degraded water quality, fragmentation, and simplification (loss of structural and functional diversity) of riparian corridors for fish and wildlife. Ninety-six percent of the land in the Willamette basin under 500 feet in elevation is privately owned and has been converted to agricultural or urban use (Willamette Urban Watershed Network 2000). A recent study of tree cover in the Willamette/Lower Columbia Region found a reduction in tree canopy cover from 46 percent in 1972 to 24 percent at present (American Forests 2001). Average tree cover in the region's urban areas is only 12 percent, down from nearly 21 percent in 1972. Eleven percent of the Metro region's natural areas[8] were lost between 1989-1999, with accompanying adverse effects on watershed hydrology and wildlife habitat.

Below are some examples of changes in our region's fish and wildlife habitat over time. The Metro region has experienced substantial vegetation loss, harming wildlife and habitat. For example:

[8] Identified by Metro's Parks and Greenspaces Department, includes undeveloped areas providing fish and wildlife habitat value.

- There has been a ***43 percent decline in forest cover*** from levels prior to substantial urbanization (i.e., 1850's), with very serious repercussions for wildlife and hydrology. Forest composition has also changed due to loss of old growth forests and white oak woodlands. The species depending on these habitats are disappearing (Metro 2002c).
- ***Current riparian/wetland forest is only 17 percent of historic levels.*** Riparian wildlife habitat has more closely associated species (64, excluding fish) than any other terrestrial habitat type, including 11 species at risk in Oregon and/or nationally, with at least two more species now lost from this region (Metro 2002c).
- Of all habitat types in the Metro region, the greatest change in vegetation type has been the ***near-complete loss of grassland and oak savanna***; current estimates are that less than one percent of the historic extent still exists in small, scattered patches. ***Grassland bird species are declining precipitously*** in the Metro area, with several species lost and more that will disappear from the region if trends continue.[9]
- ***Agriculture and urban land uses comprise 55 percent*** of the land area in the region. Urban land cover is overtaking agricultural lands in the Metro region, with important hydrologic and wildlife repercussions.[10]

The riparian corridors and wildlife habitat that remain in our region, especially those providing a high ecological functional value, are scarce and diminishing as more land is urbanized.

Riparian corridors

As described in Metro's Technical Report for Goal 5 (science review; Metro 2002c), the riparian corridor refers to the land and vegetation adjacent to waterbodies such as streams, rivers, wetlands and lakes that are influenced by perennial or intermittent water. According to the scientific literature reviewed, riparian corridors provide important ecological benefits for fish and wildlife including:

1. Microclimate and shade
2. Streamflow moderation and water storage
3. Bank stabilization, sediment and pollution control
4. Large wood and channel dynamics
5. Organic matter input

The ecological functions listed above provide the basis for Metro's delineation of riparian corridors. In the spring of 2001, Metro launched an effort to map the ecological functions of riparian corridors and the specific landscape features that are associated with these functions. Features include stands of trees, woody vegetation, meadows, wetlands, steep slopes, and flood areas that are located along the region's streams and rivers. Based on the scientific literature, Metro identified areas where landscape features make a substantial, or "primary," contribution to providing an ecological function to the stream. Areas identified as "primary" receive a score of

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[9] See Table 8 in Metro's *Riparian Corridor and Wildlife Habitat Inventories*, Metro 2002d.

[10] Agricultural lands are more water-permeable than urban lands, and are used by grassland species as "surrogate" grassland habitat.

six points. Landscape features that fall within the outer part of the range described in the scientific literature provide riparian function to a lesser degree and are said to serve a "secondary function" and receive one point. All areas that provide function to the stream are thus mapped and receive a score.

The scores are additive for any given landscape feature and reflect relative ecological function at any given point on the map. For example, a location on the map could contribute significantly to all five functions listed above and receive a score of 30 (five primary functions times six points each). Another location may receive primary scores for three functions (three primary functions times six points) plus secondary functions for up to two other functions (18 points for primary functions, plus two points for secondary functions). Still another location may receive only a single point for one secondary function (for example, developed floodplains). ***The Metro Council determined that all areas receiving a score for providing riparian ecological function are regionally significant.***

Wildlife habitat

The Goal 5 rule defines wildlife habitat as

> ...[A]n area upon which wildlife depend in order to meet their requirements for food, water, shelter, and reproduction. Examples include wildlife migration corridors, big game winter range, and nesting and roosting sites. (OAR 660-023-0110(1)(b)).

The rule does not provide specific guidance on how to identify significant wildlife habitats other than referring to the standard inventory process (OAR 660-23-030) and minimum consultation requirements outlined in OAR 660-23-110. The Goal 5 rule allows a jurisdiction flexibility in defining the area for which a significance determination must be made.

Metro's approach to identifying the region's important wildlife habitats was based on a combination of: (1) best available scientific literature; (2) GIS modeling; (3) field studies to address the Goal 5 rule to determine the location, quantity and quality of potential wildlife habitat, as well as the adequacy of that information; and (4) local expertise to identify locations of sensitive species and habitats (Habitats of Concern). The model assigns values to wildlife habitat features that allow comparison of their cumulative importance to the regional wildlife habitat network. In early 2001, Metro mapped wildlife habitat based on specific features associated with these characteristics. Features include stands of trees, woody vegetation, meadows, and wetlands located within the region. The wildlife model is based on four criteria:

1. habitat patch size (minimum patch size of 2 acres unless a Habitat of Concern),
2. proximity to water sources,
3. proximity to other natural areas, and
4. forest interior habitat.

In brief, larger habitat patches are more valuable to native wildlife than smaller patches because more species are retained over time, and species sensitive to human disturbance still have a place to live. Rounder patches are better than long, narrow patches to reduce negative edge effects. Water within or near habitat patches is important so animals can drink. Connectivity to other natural area patches is key to maintaining biodiversity; sometimes local populations become extinct and connectivity provides the means for reintroducing that species, as well as maintaining the genetic diversity important to the long-term health of a population.

Metro's model accounts for edge effects and habitat quality, as verified by scientific fieldwork conducted in 2001. The habitat attributes positively associated with increasing scores[11] in Metro's GIS model include:

- More downed wood and logs
- More food resources
- A wider variety of food resources
- Food availability over longer periods
- Fewer non-native trees
- Fewer non-native shrubs
- Fewer non-native herbs
- Increased structural diversity
- More wildlife cover available throughout the year
- More nesting and den sites (snags, root wads, rocky crevices, etc.)
- Less human disturbance onsite or nearby
- Better wildlife diversity onsite
- More year-round availability of water
- Healthier stream channel morphology
- More vegetative cover near water sources
- More types of water resources (streams, wetlands, etc.)

Each habitat patch was ranked and assigned a score for each of the model criteria, relative to other habitat patches. Sites were subsequently separated into three classes, of up to three possible points, for each criterion. The scores are additive for any given habitat patch and reflect relative wildlife habitat value for each of the habitat patches identified on the map. In addition to the wildlife habitat model, Metro worked with local experts and agency staff to identify "Habitats of Concern." Habitats of Concern are those sites known to be critical for sensitive species or to be scarce and declining in the Metro region. ***The Metro Council determined that all areas receiving a score of two or greater are regionally significant, plus sites identified as a Habitat of Concern.***

Fish and habitat classification

Metro's inventories of fish and wildlife habitat provide a wealth of information on the relative ecological value of specific sites across the region. The inventory methodology distinguished between habitat function with as much precision as possible to make an informed decision on regional significance. The upland wildlife habitat was evaluated separately from the riparian wildlife habitat areas. However, a method of classifying the fish and wildlife habitat together becomes useful in the ESEE to facilitate distinguishing the tradeoffs of protecting or not

[11] Statistically significant results of simple linear regression. For more detailed statistical findings, see Metro's *Riparian corridors and wildlife habitat inventory* (Metro 2002c).

protecting the habitat areas and, later, in the protection program. For the ESEE analysis, Metro classified fish and wildlife habitat based on the ecological function scores into six classes, under two main categories: riparian/wildlife and upland wildlife. Each class covers a geographically discrete portion of the inventory, and may include riparian and/or wildlife functions and also may be a Habitat of Concern. Class I riparian/wildlife and Class A upland wildlife are the highest value. More description of the classification system may be found in the *Conflicting Uses* chapter.

Definition of allow, limit, prohibit

In Metro's ESEE analysis the consequences of allowing, limiting, or prohibiting identified conflicting uses on fish and wildlife habitat are described. The Goal 5 rule requires that a program be developed that is based on and supported by the ESEE analysis, and that describes the degree of protection intended for the fish and wildlife habitat. Although the ESEE consequences analysis is described in terms of "allow, limit, or prohibit," the Goal 5 program may be some combination of the three scenarios, such as "strictly limit" (between prohibit and limit), "limit," or "moderately limit" (between limit and allow).

Allow a conflicting use

According to the Goal 5 rule, "a local government may decide that the conflicting use should be allowed fully, notwithstanding the possible impacts on the resource site." The Goal 5 rule also requires that the ESEE analysis "demonstrate that the conflicting use is of sufficient importance relative to the resource site, and must indicate why measures to protect the resource to some extent should not be provided." [660-23-040 (5)(a)] For example, the economic and social benefits of allowing an industrial use may outweigh the environmental and energy benefits of protecting the fish and wildlife habitat because of the additional jobs and increased tax base the development may create.

A decision to allow the conflicting use does not necessarily preclude habitat protection. All development in a fish and wildlife habitat area would be subject to existing local, state, and federal government regulations. For example, Title 3 (water quality) setbacks are required for new development along streams. In addition, incentives and/or educational materials could be developed to encourage stewardship and other voluntary protection measures.

Limit conflicting use

According to the Goal 5 rule, "a local government may decide that both the resource site and the conflicting uses are important compared to each other, and, based on the ESEE analysis, the conflicting uses should be allowed in a limited way that protects the resource site to a desired extent." [660-23-404(5)(b)]

A program to limit a conflicting use can be designed to allow some level of development with certain restrictions to protect the fish and wildlife habitat to the maximum extent possible. For example, the disturbance area may be limited in size ("x" number of square feet) and location (as far from the water feature as possible). Design standards may also be required to lessen the impact on the habitat (e.g., tree retention, cluster development, impervious surface reduction, etc.). In addition, mitigation standards may be required to replace lost habitat functions (e.g., plant native vegetation).

Prohibit a conflicting use

A Goal 5 resource (i.e., fish and wildlife habitat) would receive the highest level of protection with a decision to prohibit conflicting uses. According to the Goal 5 rule, "a local government may decide that a significant resource site is of such importance compared to the conflicting uses, and the ESEE consequences of allowing the conflicting uses are so detrimental to the resource, that the conflicting uses should be prohibited." [660-23-404(5)(c)] For example, development may be prohibited within a highly valuable riparian corridor with intact vegetation. Some development, however, may be allowed if all economic use of a property is lost through full protection. This could occur when a parcel of otherwise developable land is located fully within a riparian corridor.

Impact of ESEE decision on the UGB

A decision to limit or prohibit conflicting uses in fish and wildlife habitat areas could impact the amount of buildable land available to meet the jobs and housing needs of the Metro region within the UGB. If land for employment and housing were protected, then the Metro Council is required to consider either increasing densities or changing design type designations in other parts of the region. If the 20-year demand for growth still cannot be met, the Metro Council has the authority to expand the UGB to meet regional needs. At the regional level, expanding the UGB has the potential to mitigate the negative consequences on jobs and housing of limiting or prohibiting development. However, not all uses are "substitutable" or able to be relocated from one part of the region to another. For example, it is easier to relocate housing than water-dependent industrial uses. Expanding the UGB to allow for protection of fish and wildlife habitat may be one method to minimize clashes with conflicting uses. However, such a decision may increase expenditures associated with extending infrastructure, vehicle miles traveled, and other development related expenses.

Organization of this report

This ESEE analysis describes the tradeoffs associated with allowing, limiting, or prohibiting conflicting uses in fish and wildlife habitat areas. The goals are to follow the steps outlined in the Goal 5 rule and to provide sufficient information for the Metro Council to evaluate program options for the protection of fish and wildlife habitat.

The second chapter, *Impact Areas*, identifies the area within which conflicting uses adversely affect the fish and wildlife habitat. Chapter three, *Conflicting Uses*, describes the land uses and activities that negatively impact fish and wildlife habitat, including a substantial amount of data related to the inventory, fish and wildlife habitat classification, and acreage figures for types of conflicting uses.

Chapters four through seven *(Economic Consequences, Social Consequences, Environmental Consequences,* and *Energy Consequences)* contain Metro's analysis of the ESEE consequences for the region.

Chapter eight, *Summary and Conclusions*, highlights the main ESEE tradeoffs and the implications for the next step of Metro's planning process in the development of a fish and wildlife habitat protection plan.

CHAPTER 2: IMPACT AREAS

Introduction

One step of the economic, social, environmental, and energy (ESEE) analysis is to identify "impact areas." The ESEE analysis is conducted for both the resource area (in this case, regionally significant riparian corridors and wildlife habitat) and the impact area. Under the Goal 5 rule, Metro may develop a program that applies to both the regionally significant fish and wildlife habitat and the impact area.

Definition of the impact area

Under the Goal 5 rule, Metro must identify an impact area for all regionally significant fish and wildlife habitat:

> *Local governments shall determine an impact area for each significant resource site. The impact area shall be drawn to include only the area in which allowed uses could adversely affect the identified resource. The impact area defines the geographic limits within which to conduct an ESEE analysis for the identified significant resource. (OAR 660-23-040(3))*

Simply put, the impact area defines an area where allowed land uses or activities could harm the fish and wildlife habitat. The impact area may be larger than the identified significant fish and wildlife habitat or it may be as small as the fish and wildlife habitat itself. For example, impact areas for riparian corridors could encompass lands outside the corridor that contribute to riparian function. Development near streams and wetlands removes vegetation that would otherwise contribute to riparian function by providing shade, sedimentation control, and water storage. Developed areas near streams and wetlands can be included within impact areas because they are sources of run-off from impervious surfaces, human disturbance, noise, lighting, toxins, fertilizers and pesticides. Each of these influences may adversely affect riparian areas and wildlife habitat.

The Goal 5 rule allows substantial discretion in determining the impact area for fish and wildlife habitats. Recent court decisions dictate that the size and extent of the impact area can be quite large, so long as there are reasons to support the impact area decision.[12] For example, the extent of an impact area could include the entire watershed.

As documented in Metro's science paper, the effects of urbanization on the functions and values of fish and wildlife habitat are pervasive.[13] A compelling case can be made for identifying the entire watershed as an impact area based on the cumulative effects of urbanization, such as road density, impervious surfaces and altered hydrology, vegetation loss and alteration, and species depletion. However, doing so may necessitate an ESEE analysis for the entire watershed, which significantly encumbers the Goal 5 planning process. Stormwater management through watershed planning may be more realistic for addressing these larger, more pervasive effects of

[12] Sanders v. Yamhill County, 34 Or LUBA 782 (1998).
[13] Metro's Technical Report for Goal 5, August, 2002, pages 33-50.

urbanization on the function of fish and wildlife habitats.[14] Metro's current work plan calls for addressing regional stormwater issues following completion of the fish and wildlife program.

Local examples[15]

Local jurisdictions complying with the Goal 5 rule have used a variety of means to determine impact areas, with approaches ranging from simple to complex. In the simplest approach the impact area and the fish and wildlife habitat area can be the same, and some local jurisdictions have selected that option. For example, the city of Fairview, city of St. Helens, and Deschutes County consider the impact area to be the same as the habitat area. Note that Fairview, under the old Goal 5 rule, stated, "the Fairview impact area could reasonably be the entire City." However, Fairview did not identify a specific impact area outside of the habitat area, as it would serve "no useful purpose."

Some jurisdictions utilize setbacks to define impact areas. For example, the city of Wilsonville chose to implement a 25-foot impact area in addition to the habitat area "because it was protective of the resource, provided a reasonable review of development, and allowed a buffer area for the storm sewer system."

Other jurisdictions assign impact areas that vary based on fish and wildlife habitat. For example, Lake Oswego uses the impact area to refer to "the area where development siting standards are recommended to mitigate identified adverse impacts." The City's definition of the impact area varies based on the habitat type (e.g., 30-foot impact area on each side of a Class 1 stream, with different impact areas for other types of stream). The impact area width ranges from 25-30 feet (in which no new structures may be built), but there is an additional 10-foot construction setback. However, upon development and drawing of the final plat, the 30-foot setback outer line then becomes the hard-and-fast line and everything within becomes the protection area. For upland tree groves there are no impact areas.

In Tualatin, the impact area also varies based on the habitat type. The impact area for wetlands includes the wetland plus a 25-foot setback surrounding the wetland. Some upland wildlife habitat within 50 feet of certain wetlands plus any adjacent steeply sloped areas are also included in the impact area. Open space areas do not include any additional land as an impact area, and for forested habitat sites the impact area extends to the edge of the canopy. These examples are a sampling of the broad range of choices available for designating impact areas.

Metro's approach

Metro's riparian corridor inventory covers a substantial portion of the landscape and describes the features that provide function to the riparian corridor. Areas that received a score of one to 30 are identified as regionally significant habitat. The wildlife habitat inventory excludes substantial low-structure vegetation, most forested habitat patches less than two acres, and habitat patches scoring less than two in the model (approximately 2,070 acres in the 2-20 acre size range). The potential impacts of adjacent land use on wildlife habitat are important.

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[14] Stormwater management and watershed planning are identified in Metro's Regional Growth Goals and Objectives, the Regional Framework Plan, and Title 3 as issues of regional concern.
[15] See Metro's *Local Plan Analysis* (Metro 2002) for more information.

However, the advantages of additional impact areas may be higher for vulnerable riparian areas (within 150 feet of a water feature) than for upland wildlife habitat. Therefore, a larger impact area for riparian areas close to water features has been identified than for wildlife habitat and riparian resources further than 150 feet from water.

Riparian impact areas beyond the existing inventory include the areas adjacent to the most vulnerable resources such as streams, wetlands and lakes with little or no riparian vegetation. All land uses in a watershed impact the streams within it, but Metro's scientific literature review indicates that the area providing the most important ecological functions to the stream generally falls within 150 feet. Therefore the ***riparian impact area*** has been defined as the area within 150 feet of a stream, wetland or lake that otherwise is not included in the inventory. Developed floodplains that are included in the inventory do not have an additional impact area. The ***vegetation impact area*** is defined as 25 feet around all remaining resources to protect the tree root zone area and low-structure vegetation. Using this method to identify the impact area adds 16,323 acres to the inventory of regionally significant fish and wildlife habitat to be analyzed for ESEE consequences.

There are many ways to determine impact areas under the Goal 5 rule. Metro's impact area focuses primarily on two aspects of the Goal 5 fish and wildlife habitat inventories: primary functional criteria for streams and waterbodies, and tree root-zone protection. This impact area protects the vulnerability of the fish and wildlife habitat. An ecologically appropriate impact area designation also helps Metro and its partners identify key restoration areas.

Riparian corridor impact area

Aquatic resources such as streams, wetlands and lakes may be strongly influenced by adjacent land use, and their degradation may cause cascading negative effects downstream. For example, an eroding streambank has negative consequences for instream habitat both onsite and downstream. This is particularly true when there is little or no existing vegetation nearby. When these conditions exist, streams, rivers, and wetlands are unlikely to receive the benefits of any Goal 5 program without additional impact areas. These water resources are likely to be in close proximity to developed areas where runoff, sediments, excess nutrients and pollutants can make their way directly to the water without the moderating influences provided by vegetation. These resources may be the areas most adversely impacted by adjacent land uses and practices.

While all land uses in a watershed impact the water bodies within it, the scientific literature review shows that the area providing primary function to the stream generally falls within 150 feet[16]. Adjacent land use has the strongest influence on waterways within the 150-foot zone, where the majority of primary ecological functions are either being provided, or would be if the area were not developed. Areas with secondary ecological functions may extend substantially further than 150 feet from the stream. These resources likely play lesser, but cumulatively important, roles in regional stream health and an argument can be made for impact areas on existing secondary resources. However, basing impact areas on secondary functions *that should*

[16] To review the literature on recommended widths, see Table 7 in *Metro's Technical Report for Goal 5*, July 2002; for GIS mapping descriptions for the two inventories, see Tables 4 and 5 in *Metro's Riparian Corridor and Wildlife Habitat Inventories*, August 2002.

exist but don't would be difficult to model and would necessitate inclusion of the entire watershed as the impact area. These data support Metro's impact area for riparian areas of 150 feet from the water body.

Tree root zone protection

In the case of wildlife habitat, adverse edge effects are an important driver of ecological value and are incorporated into Metro's wildlife habitat model via habitat patch size and habitat interior. Edge effects are a function of human influences occurring at or near a forest or wetland edge; therefore it could be argued that impact areas are already accounted for in wildlife habitat patches. For example, a habitat patch narrower than 400 feet contains virtually no interior habitat. Therefore, human influences such as disturbance and nonnative species may be relatively pervasive; impact areas may serve no purpose in such cases. However, tree root zone compaction could theoretically result in a gradual shrinking of forested habitat over time due to tree damage around the edges of the habitat.

Tree root protection is important because root damage affects the entire tree. Soil compaction above the roots is a key culprit. The drip-line is the full area beneath the tree canopy. Certified arborists state that the root zone of a tree typically extends at least one-and-a-half to two times the distance of the drip-line; some experts indicate root spread may extend as far as two to three times the distance of the drip-line (Appleton et al. 2000; Ryan et al. 2002). A Metro GIS survey of trees in our region indicates that the drip-line for relatively mature trees is about 65 feet. Therefore, Metro's impact area for root zone protection is 25 feet.[17]

A 25-foot impact area is also appropriate for addressing non-forested habitat areas. Low structure vegetation can be quite fragile and vulnerable to disturbances such as trampling, motorized and non-motorized traffic, grazing, etc. Physical disturbance in herbaceous habitats often leads to nonnative or invasive species proliferation (Alberta Riparian Habitat Management Program). This is an issue in for both native herbaceous habitats and agricultural lands, where noxious weeds may rapidly spread and can cause severe crop losses resulting in economic hardship.

Summary

A 150-foot riparian impact area and 25-foot vegetation impact area will:

- Provide all fish and wildlife habitat with an impact area (except developed floodplains).
- Provide the most sensitive fish and wildlife habitat with wider impact areas.
- Provide impact areas to address tree root zones.
- Allow the potential to address areas that are already degraded, but where negative inputs may strongly influence onsite and downstream water quality and key wildlife habitat (such as wetlands).
- Meet the requirements of the Goal 5 rule.

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[17] Take the drip line times the recommended distance: 65 x 1.75 = 113.75. Subtract out the drip line: 113.75 – 65 ft = 48.75. Divide by two to get the radius for a 1-sided impact area: 48.75 / 2 = 24.4 ft.

CHAPTER 3: CONFLICTING USES

Introduction

A key step in the economic, social, environmental, and energy (ESEE) analysis is to identify conflicting uses that "exist, or could occur" within regionally significant fish and wildlife habitat and identified impact areas. A conflicting use is a "land use, or other activity reasonably and customarily subject to land use regulations, that could adversely affect a significant Goal 5 resource" (OAR 660-23-010(1)). Identifying conflicting uses is important in order to focus the ESEE consequences analysis on various land uses and related disturbance activities that may negatively impact fish and wildlife habitat.

The following sections describe:

- Metro's method for identifying conflicting uses from a regional perspective,
- the relationship of generalized regional zones to Metro's fish and wildlife habitat inventory,
- the relationship of the 2040 design type hierarchy to Metro's fish and wildlife habitat inventory,
- the relationship of impact areas to generalized regional zones, and
- conflicting uses by Metro's generalized regional zones.

The consequences of allowing, limiting or prohibiting the conflicting use are covered in each of the ESEE analyses, discussed in the following chapters.

Identifying Conflicting Uses

The Goal 5 rule directs local governments to identify conflicting uses in their ESEE analysis by examining "land uses allowed outright or conditionally within the zones applied to the resource site and impact area" (OAR 660-23-040(2)). The Goal 5 rule does not, however, address how conflicting uses should be identified for a regional ESEE analysis.

Metro has taken a regional approach in identifying conflicting uses. Metro is responsible for developing regional policies for managing growth, protecting natural resources, directing regional investment in a mix of transportation options, as well as other policies. Metro does not, however, have zoning authority. Instead, local governments are responsible for implementing regional policy using their comprehensive planning and zoning authority. Consequently, Metro is relying on its compilation of local jurisdictions' zoning codes to provide the framework for identifying conflicting uses (Metro's regional zones and generalized regional zones), as described in the next section. In addition, Metro's 2040 Growth Concept is also described to address conflicting uses that "could occur" over time.

Regional zones and generalized regional zones

Metro's Data Resource Center (DRC) developed "regional zones" and "generalized regional zones" as a GIS data layer to perform regionwide analyses. These regional zones are based on a compilation of local government zoning designations. Each local jurisdiction has a unique array of zoning categories, with literally hundreds of zoning codes that regulate land use in the 24 cities and three counties within Metro's jurisdiction. Although zoning categories are similar among jurisdictions, the actual permitted uses and density requirements often vary. Metro compiled local city and county zoning codes and assigned them to one of 26 regional zones as shown in Table 3-1 below. Table 3-1 also shows the generalized regional zones into which the 26 regional zones are further aggregated. Local jurisdictions had an opportunity to review the compilation and assignments, and corrections were made based on their comments.

Table 3-1. Regional zones & generalized regional zones.

Regional zones	Generalized regional zones
SFR1 Single Family 1 – detached housing with minimum lot sizes from 20,000 square feet and over.	***SFR Single-family Residential***
SFR2 Single Family 2 – detached housing with minimum lot sizes ranging from 12,000 to 20,000 square feet.	
SFR3 Single Family 3 – detached housing with minimum lot sizes ranging from 8,500 to 12,000 square feet.	
SFR4 Single Family 4 – detached housing with minimum lot sizes from 6,500 to 8,500 square feet.	
SFR5 Single Family 5 – detached housing with minimum lot sizes ranging from 5,500 to 6,500 square feet.	
SFR6 Single Family 6 – detached housing with minimum lot sizes from 4,000 to 5,500 square feet.	
SFR7 Single Family 7 – detached housing with minimum lot sizes up to 4,000 square feet.	
MFR1 Multi-family 1 – housing and/or duplex, townhouse and attached single-family structures allowed outright. Maximum net allowable densities range from 2 to 25 units per acre, with height limits usually set at 2 1/2 to 3 stories.	***MFR Multi-family Residential***
MFR2 Multi-family 2 – housing accommodating densities ranging from 25 to 50 units per acre. Buildings may exceed three stories in height.	
MFR3 Multi-family 3 – housing accommodating densities ranging from 50 to 100 units per acre.	
MFR4 Multi-family 4 – housing accommodating densities greater than 100 units per acre. This is the densest of the multi-family zones and would require greater use of vertical space and buildings with multiple stories.	

Note: Local jurisdictions are the ultimate source for actual zoning of any given property.

Table 3-1 (cont.). Regional Zones & Generalized Regional Zones

Regional Zones (cont.)	Generalized Regional Zones (cont.)
MUC1 Mixed Used Center 1 – combines residential and employment uses in town centers, main streets and corridors.	***MUC*** ***Mixed Use Centers***
MUC2 Mixed Use Center 2 – combines residential and employment uses in light rail station areas and regional centers.	
MUC3 Mixed Use Center 3 – combines residential and employment uses in central city locations. Mixed use is weighted toward residential development.	
CN Neighborhood Commercial – small scale commercial districts permitting retail and service activities such as grocery stores and laundromats supporting the local residential community. Floor space and/or lot size is usually limited from 5,000 to 10,000 square feet.	***COM*** ***Commercial***
CG General Commercial – larger scale commercial districts, often with a more regional orientation for providing services. Businesses offering a wide variety of goods and services are permitted and include highway and strip commercial zones.	
CC Central Commercial – allows a full range of commercial activities typically associated with central business districts. More restrictive than general commercial in the case of large lot and highway oriented uses, but usually allows multi-story development.	
CO Office Commercial – districts accommodating a range of business, professional and medical office facilities, typically as a buffer between residential areas and more intensive uses.	
PF Public Facilities – generally provides for community services such as schools, churches, government offices, hospitals, libraries, correctional facilities, public parks, public recreation facilities and public utilities.	
IL Light Industrial – districts permitting warehousing and light processing and fabrication activities. May allow some commercial activities.	***IND*** ***Industrial***
IH Heavy Industrial – districts permitting light industrial and more intensive industrial activities such as bottling, limited chemical processing, heavy manufacturing and similar uses.	
IMU Mixed Use Industrial – districts accommodating a mix of light manufacturing, office and retail uses.	
IA Industrial Area – districts designated exclusively for manufacturing, industrial, warehouse and distribution related operations.	
FF Agriculture or Forestry – activities suited to commercial scale agricultural production, typically with lot sizes of 30 acres or more.	***RUR*** ***Rural***
RRFU Rural or Future Urban – residential uses permitted on rural lands or areas designated for future urban development with minimum lot sizes of one acre or more.	
POS Parks and Open Space – preservation of public and private open and natural areas.	***POS*** ***Parks and Open Space***

Note: Local jurisdictions are the ultimate source for actual zoning of any given property.

Metro's 26 regional zones provide a clear representation of general land uses allowed outright over the regional landscape. The general zones do not, however, represent land uses allowed conditionally within zones because these vary among local jurisdictions and are not explicitly captured in the regional zones. Disturbance activities associated with conditional uses will be considered in the *Conflicting Uses by Generalized Regional Zones* section.

According to the Goal 5 rule, the ESEE analysis "may address each of the identified conflicting uses, or it may address a group of similar conflicting uses" (OAR 660-23-040(5)). The 26 regional zones are further aggregated into seven major land use categories (generalized regional zones, see Table 3-1): single-family residential, multi-family residential, mixed use, commercial, industrial, rural, and parks and open space. These seven generalized regional zones represent a group of similar conflicting uses and are used in the ESEE analysis for identifying the consequences of allowing, limiting, or prohibiting conflicting uses within fish and wildlife habitat.

Metro's 2040 Growth Concept

Metro's 2040 Growth Concept helps to identify where conflicting uses are likely to occur over time. The 2040 Growth Concept map[18] shows the general location of the 2040 design types inside the urban growth boundary (UGB), as well as several outside the UGB, but inside Metro's jurisdiction. Areas outside the UGB are primarily designated as rural reserves. In December 2002, the Metro Council approved a major expansion of the UGB. The decision brings approximately 18,880 acres into the boundary. These areas have been held at a rural level of development and do not yet have urban zoning. These areas will be the focus of detailed concept planning based on the 2040 Growth Concept principles and land uses will intensify in these areas over time.

Metro's 2040 Growth Concept (adopted in 1995) defines the form of regional growth and development for the Metro region. The concept encourages land use and transportation policies that will allow the Metro area cities and counties to manage growth, protect natural resources, and make improvements to facilities and infrastructure while maintaining the region's quality of life. The concept reflects important values identified by the people who live in this region: access to nature, protection of farmland and natural areas, safe and stable neighborhoods, a diversity of housing types, transportation choices, and a healthy economy.

The concept provides an expression of the region's goals through land use and identifies various design types as the "building blocks" of the regional strategy for managing growth. The centerpiece of the 2040 Growth Concept is the development of centers – compact, mixed-used areas inside the UGB with employment, housing, retail, and cultural and recreational activities, and a pedestrian-friendly environment with access to a variety of transportation choices.

The success of the 2040 Growth Concept depends in large part on the implementation of regional transportation priorities. The Regional Transportation Plan (RTP) groups the 2040 design types into a hierarchy based on transportation investment priority. This hierarchical scheme also helps

[18] To view the 2040 Growth Concept map online: http://www.metro-region.org/library_docs/land_use/concept.pdf

to focus economic development priorities (see *Economic Consequences* chapter) in areas that are most important to achieving the goals of the 2040 Growth Concept. For the purposes of Metro's Goal 5 ESEE analysis, a modified grouping of the 2040 design types is proposed as follows:

Primary land use components

The central city, regional centers, industrial areas, and intermodal facilities are centerpieces of the 2040 Growth Concept. Implementation of the Growth Concept is largely dependent on the success of these primary components:

- *Central City.* Downtown Portland serves as the region's major regional center and also functions as a hub for cultural activities and employment for the entire metropolitan area.

- *Regional Centers.* Regional centers are located throughout the region and serve large market areas outside the central city (e.g., Hillsboro, Gresham). They are intended to become the focus of compact development, redevelopment, and high-quality transit service.

- *Industrial Areas (non-water dependent).* The region's economy depends on a strong base of industry. The Growth Concept identifies areas to be devoted to this use. For purposes of Goal 5, industrial areas have been further divided into non-water dependent and water dependent. Industrial areas that are not water dependent typically demand proximity to high quality transportation and access to an employee base.

- *Industrial Areas (water dependent).* The metropolitan area developed as a city based on a prime location at the confluence of the Columbia and Willamette Rivers. The Portland Harbor consists of several marine terminals that provide access to cities throughout the Pacific Rim, as well as access to the rest of the United States with rail and highway service. Several industrial properties are located on the harbor adjacent to this transportation network.

- *Intermodal transportation facilities.* The region's continued strength as a national and international distribution center is dependent on the provision of adequate intermodal facilities. These facilities include marine terminals, freight facilities for trucking, airports and railroads.

Secondary land use components

- *Town Centers.* Town centers include compact development and a relatively high level of transit service, but they are meant to be smaller and less dense than regional centers. Town centers provide local shopping, employment, and cultural and recreational opportunities within a local market area (e.g., Forest Grove, Milwaukie).

- *Main Streets.* Main streets are similar to town centers but on a smaller scale. Main streets typically serve the immediate neighborhood and sometimes have a traditional commercial identity that may draw visitors from other parts of the region.

- *Station Communities.* Station communities are areas of development centered around light rail or high-capacity transit stations. These areas include mixed-use, compact development and provide a mix of transportation options such as light rail, bus, bicycling, walking and auto.

Tertiary design type components

- *Inner Neighborhoods.* These areas include primarily residential development and are accessible to employment. Inner neighborhoods generally have better access to jobs and shopping than outer neighborhoods and lot sizes are typically smaller.

- *Outer Neighborhoods.* These areas are farther away from large employment centers and have larger lot sizes and thus lower densities than inner neighborhoods.

- *Employment centers.* Employment centers are designated to receive various types of employment and may include residential development that serves the needs of employees.

- *Corridors.* Corridors are major streets that serve as key transportation routes for people and goods. Corridors are not intended to be as dense as centers, but provide a mix of uses such as higher density residential, office, commercial, and retail.

Other

- *Parks and Open Spaces.* Parks and open space include recreational parks, streams and trail corridors, wetlands, floodplains and other natural areas. These areas play a key role in maintaining the quality of life citizens of the region enjoy. Access to both recreational parks and natural areas has been identified as a high priority by residents. These areas are unlikely to provide opportunities for residential, commercial, or industrial development.

- *Rural.* Rural lands outside the urban growth boundary.

The 26 regional zones and seven generalized regional zones, together with the 2040 Growth Concept described in this section, allow for a regional picture of both existing and potential future conflicting uses. The next section describes the relationship of the seven generalized regional zones with Metro's Goal 5 fish and wildlife habitat inventory.

Relationship of generalized regional zones and 2040 design types to Metro's Goal 5 inventory of regionally significant fish and wildlife habitat

This section takes a closer look at where conflicting uses and Goal 5 fish and wildlife habitat overlap. Metro's Goal 5 inventory of regionally significant fish and wildlife habitat is analyzed in the following ways: geographical boundaries (i.e., UGB, Metro's jurisdiction); development status (i.e., developed and vacant); generalized regional zones and development status; generalized regional zones, fish and wildlife habitat classification and development status; and 2040 design types hierarchy and fish and wildlife classification. In addition, impact areas are summarized by generalized regional zones and development status. This information provides context in the ESEE analysis by quantifying the extent (i.e., acreage) to which fish and wildlife habitat may be impacted by allowing, limiting, or prohibiting the conflicting uses.

Distribution of land within the UGB and Metro's jurisdictional boundary

Figure 3-1 below shows the urban growth boundary and Metro's jurisdictional boundary (before December 2002). The land area within Metro's jurisdiction is comprised of approximately 227,540 acres within the UGB and 53,120 outside the UGB for a total of over 280,660 acres (not including water features), or about 438 square miles. The 2002 UGB expansion areas (hatched areas on map) include approximately 18,800 acres, most of which are inside Metro's jurisdiction (over 3,100 acres are currently outside Metro's jurisdiction). The gray area on the map represents regionally significant fish and wildlife habitat.

Figure 3-1. Metro's fish and wildlife habitat inventory, UGB, jurisdictional boundary & expansion areas.

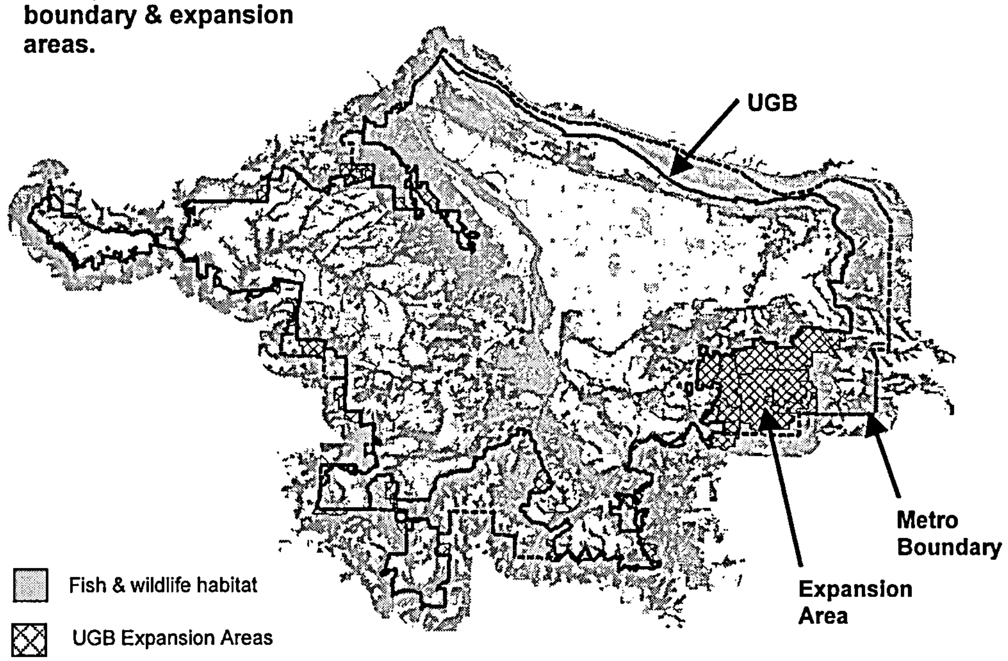


Table 3-2 disaggregates non-habitat and habitat lands into three geographical areas: inside the UGB, UGB expansion areas, and the remaining areas in Metro's jurisdiction outside of the UGB. The total acreage shown in the table includes approximately 3,100 acres in the expansion areas that are currently outside Metro's jurisdiction. Approximately 81,700 acres of fish and wildlife habitat are within, or will be within, Metro's jurisdictional boundary (almost 29 percent of the total land area). Within the UGB, 24 percent of the total land area is fish and wildlife habitat (53,671 acres). UGB expansion areas include over 8,200 acres of fish and wildlife habitat (44 percent of the expansion area). Fifty-three percent of the remaining areas in Metro's jurisdiction outside the UGB (19,794 acres) are fish and wildlife habitat.

Two-thirds (66 percent) of the total fish and wildlife acres are within the UGB. The other third (28,026 acres) is located in the expansion areas and the remaining areas in Metro's jurisdiction outside the UGB.

Table 3-2. Fish and wildlife habitat by Metro's jurisdictional status.

Geographical Area	Total Acres* (Non-habitat and habitat)	Fish and wildlife habitat		
		Habitat Acres	*% of Geog. Area*	*% of Total Habitat*
Inside UGB (before Dec. 2002)	227,539	53,671	24%	66%
UGB Expansion Areas (Dec. 2002)**	18,799	8,232	44%	10%
Remaining areas in Metro's jurisdiction outside UGB	37,404	19,794	53%	24%
Total Acreage	283,742	81,697	29%	100%

Source: Metro's Regional Land Information System (RLIS) data base
*Water areas removed (~8,000 acres of habitat)
**UGB expansion areas include approximately 3,100 acres that are currently outside Metro's jurisdiction

Distribution of land by development status

In this section, both non-habitat and habitat lands are broken out by development status (developed and vacant) within the three geographical areas (see Table 3-3). A description of each development status follows to provide a better understanding of Table 3-3.

Developed refers to land that has improvements and specific land uses. There are two subsets within the developed category: urban and parks. *Urban*, as used in this report, refers to land developed in accordance with the specific zoning (e.g., single-family residential, commercial, industrial, etc.).

Parks refer to Metro's inventory of public and private parks and open space, golf courses, cemeteries, trails, and other uses. Parks are categorized as developed land because they are generally not available for urban development in Metro's analysis of buildable lands within the UGB.

Vacant refers to land that has no buildings, improvements or identifiable land use. Metro's vacant lands inventory also includes vacant portions of developed tax lots that are 1/2 acre

(20,000 square feet) or greater. The vacant category also has two subsets: constrained and buildable.

Constrained land consists of environmentally sensitive land – Title 3 Water Quality and Flood Management Areas (i.e., river and stream corridors, wetlands, floodplains, steep slopes 25 percent or greater adjacent to water features); land in public ownership (that otherwise would be buildable); already platted single-family lots; and buffers on major utility lines (50-75 feet). Title 3 areas alone are used to calculate constrained land outside the UGB. Constrained land is not necessarily unbuildable. For example, from 1998 to 2000, 363 acres (seven percent) of undeveloped Title 3 vegetated corridors were developed and 568 acres (9 percent) of floodplains were developed (Metro 2003).

Buildable land is what remains after subtracting out vacant constrained land from total vacant acres. Vacant, buildable land provides the basis for estimating the region's 20-year land supply for dwelling units and employment inside the UGB.

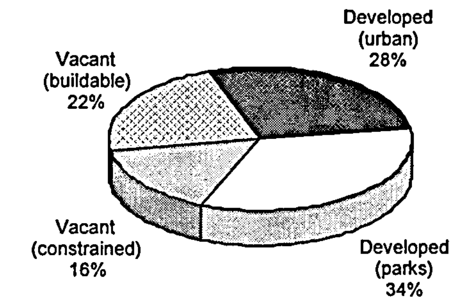
Forty-four percent of the total vacant, buildable acres (both non-habitat and habitat land) in Table 3-3 are classified as fish and wildlife habitat (28,355 acres/64,178 acres). Approximately 41 percent of the total vacant buildable acres within the UGB is fish and wildlife habitat (11,923 acres/29,146 acres). Outside the UGB, 47 percent of the total vacant buildable acres (16,431 acres/35,031 acres) is fish and wildlife habitat.

Table 3-3. Non-habitat and habitat lands by development status.

Geographical Area	Non-habitat acres				Fish and wildlife habitat acres				Total Acres
	Developed		Vacant		Developed		Vacant		
	Urban	*Parks*	*Constr.*	*Buildable*	*Urban*	*Parks*	*Constr.*	*Buildable*	
Inside UGB (before 12/02)	143,263	9,216	4,166	17,223	15,041	18,258	8,449	11,923	227,539
UGB Expansion Areas (12/02)	3,791	377	0	6,399	1,262	716	552	5,703	18,799
Remaining areas in Metro's jurisdiction	4,701	708	0	12,201	2,161	5,028	1,877	10,728	37,404
Total Acreage	151,754	10,301	4,166	35,823	18,464	24,001	10,878	28,355	283,742

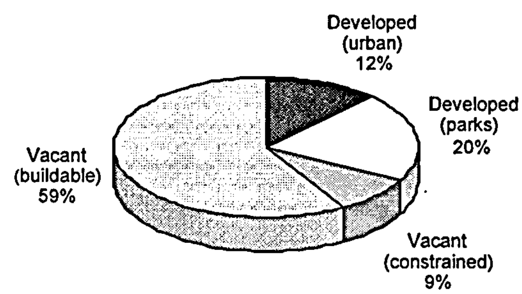
Figures 3-2 and 3-3 show the proportion of fish and wildlife habitat by development status inside the UGB and outside the UGB in expansion areas and Metro's jurisdiction (based on Table 3-3). Thirty-eight percent of the fish and wildlife habitat inside the UGB is vacant (buildable plus constrained); 62 percent is considered developed (urban plus parks). Within the expansion areas and remaining areas in Metro's jurisdiction, 32 percent of the land is developed and 68 percent is vacant.

Figure 3-2. Fish and wildlife habitat by development status inside UGB.



Developed land is included in the Goal 5 fish and wildlife habitat inventory for several reasons. First, developed areas along streams that lack significant vegetation are mapped with a 50-foot default area to recognize essential riparian function. Second, vegetated portions of developed lots are included in the Goal 5 inventory where they contribute riparian function and/or wildlife habitat value. For example, dense forest canopies over developed subdivisions are included in the inventory where the canopy meets the applicable mapping criteria (Metro 2002d).

Figure 3-3. Fish and wildlife habitat by development status in expansion areas & remaining areas in Metro's jurisdiction.



The development status of fish and wildlife habitat provides some insight into the vulnerability of the habitat to potential adverse impacts from conflicting uses. The least vulnerable fish and wildlife habitat is that in park status; however, protection is not guaranteed. For example, a park may be developed for recreational uses (e.g., ball fields) rather than left in a natural state. Fish and wildlife habitat classified as developed (urban) is less vulnerable than those that are vacant. Changes often occur, however, on developed land. For example, a lot may be subdivided, expansion of existing facilities may occur, or management practices may change (e.g., tree cutting). Vacant, constrained fish and wildlife habitat, as pointed out above, may also be developed but less intensively in many cases. Vacant, buildable fish and wildlife habitat is the most vulnerable to adverse impacts.

Distribution of fish and wildlife habitat by generalized regional zones and development status

This section presents regionally significant fish and wildlife habitat by generalized regional zones and development status (Tables 3-4 and 3-5) within the UGB (before December 2002), and in UGB expansion areas and the remaining areas in Metro's jurisdiction.

The largest proportion of fish and wildlife habitat is zoned for single-family residential development (46 percent). Nearly 27 percent of single-family zoned habitat land (6,687 acres) is considered buildable, which also represents the largest proportion of total buildable habitat land (56 percent).

The parks and open spaces (POS) category contains the next highest proportion of fish and wildlife habitat (20 percent). However, the POS category significantly under-represents the amount of land actually used as parks in the region because many local jurisdictions do not have a separate zone for parks and open space. Instead, parks are allowed outright or conditionally in all or most zones. In such cases, parks and open space generally retain the underlying zoning. To address this issue, parks are identified separately under the "developed" land category in the tables below. For example, there are over 5,500 acres of parks (based on Metro's parks and open space inventory) that are zoned single-family residential.

Fourteen percent of fish and wildlife habitat is zoned for industrial use (7,721 acres); of that, 23 percent is considered buildable (1,761 acres). Although only seven percent of fish and wildlife habitat is zoned for rural uses inside the UGB, over half of it is buildable and represents the second highest proportion (17 percent) of total buildable habitat land.

Table 3-4. Total fish and wildlife habitat by generalized regional zones inside UGB.*

Generalized Regional Zones	Fish and wildlife habitat acres					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	9,300	5,557	3,277	6,687	24,821	46%
MFR	975	704	462	470	2,610	5%
MUC	406	100	266	512	1,284	2%
COMM	649	1,144	451	429	2,672	5%
IND	2,620	972	2,368	1,761	7,721	14%
RUR	380	193	1,261	2,015	3,923	7%
POS	483	9,577	359	48	10,468	20%
NO ZONE**	155	11	5	1	172	0%
TOTAL	*14,968*	*18,258*	*8,449*	*11,923*	*53,671*	*100%*

*Before December 2002
**Some habitat areas within the UGB (0.3%) have no zoning designation.

Most of the fish and wildlife habitat in UGB expansion areas and the remaining areas in Metro's jurisdiction has rural zoning (89 percent; Table 3-5). Sixty-three percent of rural habitat land is considered buildable (15,772 acres).

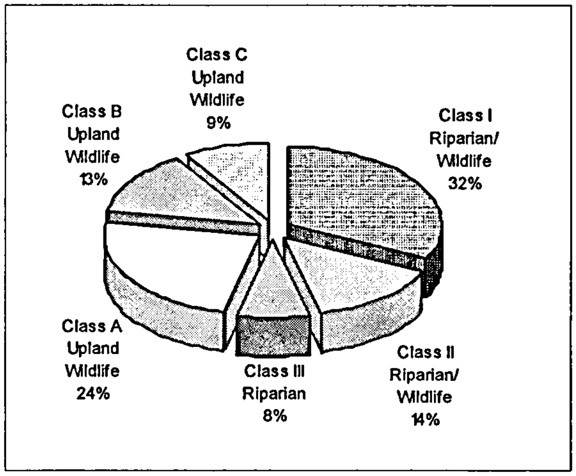
Table 3-5. Total fish and wildlife habitat acres by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Fish and wildlife habitat acres					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	163	231	16	460	871	3%
RUR	2,860	3,982	2,356	15,772	24,969	89%
POS	324	1,521	43	109	1,997	7%
MFR, MUC, COM, IND	77	9	13	90	189	1%
TOTAL	*3,423*	*5,743*	*2,429*	*16,431*	*28,026*	*100%*

Distribution of fish and wildlife habitat by classification and generalized regional zones

In this section, Metro's fish and wildlife habitat inventory is divided into six classifications, each representing discreet areas on the landscape: Class I, II and III riparian/wildlife corridors, and Class A, B, and C upland wildlife habitat. Metro has created these classifications as a tool to distinguish higher value habitat from lower value habitat. This information can then be used for analyzing conflicting uses and ESEE consequences, and for developing a Goal 5 program. Figures 3-4 and 3-5 show the breakdown of regionally significant fish and wildlife habitat by classification (53,671 habitat acres in UGB; 28,026 habitat acres outside UGB). The following sections describe these classifications and present tables that show each fish and wildlife habitat classification by generalized regional zone.

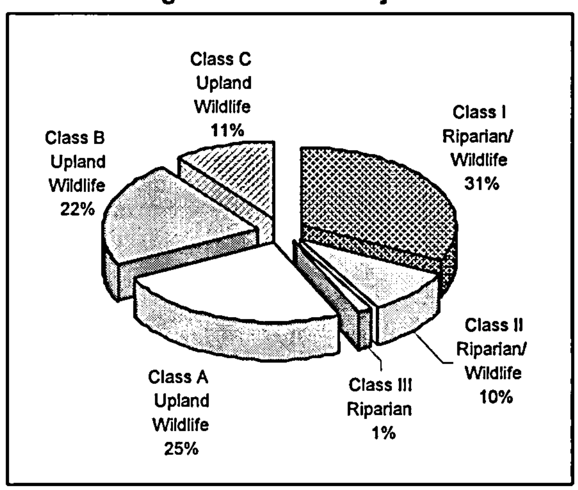
Figure 3-4. Fish and wildlife habitat by classification within the UGB.



Class I riparian/wildlife corridors

Class I riparian/wildlife corridors is the largest classification, representing 32 percent of total fish and wildlife habitat inside the UGB and 31 percent outside the UGB. These areas are predominantly high value riparian corridors that provide three to five primary functions (scoring 18-30 points in the riparian model). The primary functions include: 1) microclimate and shade; 2) streamflow moderation and water storage; 3) bank stabilization, sediment and pollution control; 4) large wood and channel dynamics; and 5) organic material sources. Class I riparian corridors include rivers, streams, stream-associated wetlands, undeveloped floodplains,

Figure 3-5. Fish and wildlife habitat by classification in UGB expansion areas & remaining areas in Metro's jurisdiction.



forest canopy within 100 feet of a stream, and forest canopy within 200 feet of streams with adjacent steep slopes.

Wildlife habitat is also included in high value riparian/wildlife corridors. For example, an area providing riparian function may also have habitat value in the wildlife model. Habitats of Concern are unique or unusually important wildlife habitat areas and are considered high value habitat. Where Habitats of Concern coincide with any riparian/wildlife corridor, the area of overlap is elevated to a Class I riparian/wildlife corridor.

Table 3-6 shows that single-family residential, rural, and industrial development contain the largest concentration of Class I riparian/wildlife corridors (40 percent, 18 percent, and 17 percent, respectively) and the largest portion of buildable land (42 percent, 33 percent, and 14 percent, respectively) inside the UGB. Outside the UGB (Table 3-7), 80 percent of Class I riparian/wildlife corridors is zoned rural and 18 percent is in parks and open space. Forty percent of rural zoned Class I riparian/wildlife corridors inside the UGB is considered buildable. Overall (i.e., inside and outside the UGB), only seven percent of all buildable land (non-habitat and habitat) is Class I riparian/wildlife corridors.[19]

Table 3-6. Class I riparian/wildlife corridors by generalized regional zones inside UGB.

Generalized Regional Zones	Class I Riparian/Wildlife Corridors					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	1,661	2,414	1,868	942	6,886	40%
MFR	206	377	296	71	949	6%
MUC	74	57	194	97	423	2%
COMM	104	607	242	84	1,036	6%
IND	427	713	1,441	326	2,907	17%
RUR	113	85	922	739	1,858	18%
POS	111	2,812	246	9	3,176	11%
NO ZONE*	38	8	3	0	50	0%
TOTAL	*2,734*	*7,073*	*5,212*	*2,267*	*17,285*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-7. Class I riparian/wildlife corridors by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class I Riparian/Wildlife Corridors					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	24	41	16	74	155	2%
RUR	571	2,635	1,867	2,098	7,172	80%
POS	288	1,288	37	18	1,631	18%
MFR, MUC, COM, IND	15	7	11	17	50	1%
TOTAL	*898*	*3,971*	*1,931*	*2,207*	*9,008*	*100%*

Class II riparian/wildlife corridors

Class II riparian/wildlife corridors comprise 14 percent of total fish and wildlife habitat inside the UGB and ten percent outside the UGB (see Figures 3-4 and 3-5). These areas are medium value riparian/wildlife corridors that provide one to two primary functional values (scoring six to

[19] (2,267 acres + 2,207 acres)/64,178 total buildable acres = 6.97%

17 points in the riparian model) or a combination of one primary function and one or more secondary functions. Wildlife habitat is included in these areas where it coincides with the medium value riparian habitat. Class II riparian/wildlife corridors include rivers, streams, 50-foot area along developed stream segments, forest canopy or low structure vegetation within 200 feet of streams, and portions of undeveloped floodplains extending beyond 300 feet of streams. Class II riparian/wildlife corridors are elevated to Class I when they contain Habitats of Concern.

Forty-four percent of fish and wildlife habitat inside the UGB is zoned single-family residential; 22 percent is industrial (Table 3-8). Outside the UGB (Table 3-9), 95 percent of the habitat is zoned rural. Only about five percent[20] of the total vacant buildable land (non-habitat and habitat land) is classified as Class II riparian/wildlife corridors.

Table 3-8. Class II riparian/wildlife corridors by generalized regional zones inside UGB.

Generalized Regional Zones	Class II Riparian/Wildlife Corridor					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	1,385	666	527	708	3,285	44%
MFR	207	78	75	62	422	6%
MUC	64	17	45	100	226	3%
COMM	134	250	137	75	596	8%
IND	448	114	684	378	1,623	22%
RUR	88	23	269	186	566	8%
POS	64	571	41	13	689	9%
NO ZONE*	42	2	2	0	47	1%
TOTAL	*2,432*	*1,721*	*1,780*	*1,521*	*7,454*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-9. Class II riparian/wildlife corridors by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class II Riparian/Wildlife Corridors					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	15	14	1	42	71	3%
RUR	348	214	438	1,568	2,569	95%
POS	14	8	1	6	29	1%
MFR, MUC, COM, IND	21	1	1	9	32	1%
TOTAL	*398*	*237*	*442*	*1,625*	*2,702*	*100%*

Class III riparian/wildlife corridors

Class III riparian corridors comprise eight percent of total fish and wildlife habitat inside the UGB and one percent outside the UGB (see Figures 3-4 and 3-5). These are low value areas that have riparian value only (located outside of wildlife habitat areas) such as developed floodplains and smaller forest canopies that are disassociated from streams (less than 20 acres). Thirty-seven percent of Class III riparian/wildlife corridors inside the UGB are single-family residential; another 37 percent is industrial (Table 3-10). Overall, most of Class III areas are developed (84 percent), typically in floodplains. Class III riparian corridors outside the UGB are predominantly rural land (90 percent) and mostly buildable (58 percent; Table 3-11). These are probably undeveloped forest canopies of less than 20 acres.

[20] (1,521 acres + 1,625 acres)/64,178 acres = 4.9%

Table 3-10. Class III riparian/wildlife corridors by generalized regional zones inside UGB.

Generalized Regional Zones	Class III Riparian Corridors					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	1,186	84	55	174	1,499	37%
MFR	245	5	7	35	293	7%
MUC	183	0	2	23	209	5%
COMM	272	16	4	25	318	8%
IND	1,389	16	31	59	1,496	37%
RUR	45	5	2	46	98	2%
POS	115	33	3	2	153	4%
NO ZONE *	29	0	0	0	29	0%
TOTAL	*3,464*	*161*	*104*	*364*	*4,094*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-11. Class III riparian/wildlife corridors by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class III Riparian Corridors					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	13	1	0	7	21	6%
RUR	116	10	1	203	330	90%
POS	8	0	0	0	8	2%
MFR, MUC, COM, IND	6	0	1	2	9	2%
TOTAL	*142*	*11*	*2*	*212*	*368*	*100%*

Class A upland wildlife habitat

Class A upland wildlife habitat comprises 24 percent of the fish and wildlife habitat inside the UGB and 25 percent outside the UGB (see Figures 3-4 and 3-5). These are high value wildlife habitat areas scoring seven to nine points in the wildlife model. Examples include upland portions of large forest patches and large contiguous patches such as Forest Park. This category may also contain areas providing secondary functions for riparian corridors and Habitats of Concern located outside of riparian/wildlife corridors.

Within the UGB, forty-five percent of Class A upland wildlife habitat is zoned as single-family residential and 44 percent is parks and open space (Table 3-12). Seventy-seven percent of buildable land located within Class A upland wildlife habitat is zoned single-family zoning. Ninety percent of Class A wildlife habitat in UGB expansion areas and the remaining areas in Metro's jurisdiction is zoned for rural uses (Table 3-13), and most of this acreage is buildable (72 percent).

Table 3-12. Class A upland wildlife habitat by generalized regional zones inside UGB.

Generalized Regional Zones	Class A Upland Wildlife Habitat					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	1,677	1,285	286	2,486	5,734	45%
MFR	85	129	42	94	350	3%
MUC	17	23	9	112	161	1%
COMM	29	53	21	49	152	1%
IND	80	98	47	238	462	4%
RUR	45	27	10	234	316	2%
POS	94	5,557	43	7	5,700	44%
NO ZONE*	4	0	0	0	4	0%
TOTAL	*2,031*	*7,171*	*457*	*3,219*	*12,879*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-13. Class A upland wildlife habitat by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class A Upland Wildlife Habitat					
	Developed Acres		Vacant Acres		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	34	175	0	191	400	6%
RUR	615	862	34	4,682	6,193	90%
POS	10	209	2	35	256	4%
MFR, MUC, COM, IND	7	0	0	23	30	0%
TOTAL	*666*	*1,246*	*36*	*4,931*	*6,879*	*100%*

Class B upland wildlife habitat

Class B upland wildlife habitat makes up 13 percent of the fish and wildlife habitat inside the UGB and 22 percent outside the UGB (see Figures 3-4 and 3-5). These are medium value upland wildlife habitat areas scoring four to six points in the wildlife model. These areas include upland portions of medium sized forest patches with low structure connector patches along streams and rivers. This habitat category may also contain areas providing secondary functions for riparian corridors. Within the UGB, seventy-two percent of Class B upland wildlife habitat is zoned single-family residential; a large portion (68 percent) is developed, parks, and constrained land (Table 3-14). Outside the UGB, 96 percent of the habitat is zoned for rural uses. Eighty-three percent of these rural zoned lands are buildable (Table 3-15).

Table 3-14. Class B upland wildlife habitat by generalized regional zones inside UGB.

Generalized Regional Zones	Class B Upland Wildlife Habitat					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	2,339	794	409	1,657	5,199	72%
MFR	119	47	23	95	284	4%
MUC	23	0	9	111	143	2%
COMM	50	128	15	76	269	4%
IND	58	5	25	262	350	5%
RUR	89	28	29	419	565	8%
POS	52	298	27	2	378	5%
NO ZONE*	17	0	0	0	17	0%
TOTAL	*2,747*	*1,299*	*537*	*2,622*	*7,205*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-15. Class B upland wildlife habitat by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class B Upland Wildlife Habitat					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	54	0	0	93	147	2%
RUR	805	171	12	4,869	5,856	96%
POS	5	16	3	47	71	1%
MFR, MUC, COM, IND	12	0	0	28	41	1%
TOTAL	*876*	*187*	*15*	*5,037*	*6,115*	*100%*

Class C upland wildlife habitat

Class C upland wildlife habitat represents nine percent of the fish and wildlife habitat inside the UGB and 11 percent outside the UGB (see Figures 3-4 and 3-5). These are less valuable upland wildlife habitat areas scoring two to three points in the wildlife habitat model. They include forest patches and smaller connector patches along streams and rivers. This category may also contain areas providing secondary functions for riparian corridors.

Within the UGB, single-family zoning is applied to 47 percent of Class C wildlife habitat. Industrial and rural zoning are applied to 19 percent and 11 percent, respectively (Table 3-16). Over 40 percent of the total land in this habitat category is buildable inside the UGB. Almost all of the land outside the UGB (96 percent; Table 3-17) is zoned rural, 82 percent of which is buildable.

Table 3-16. Class C upland wildlife habitat by generalized regional zones inside UGB.

Generalized Regional Zones	Class C Upland Wildlife Habitat					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	1,052	314	132	721	2,219	47%
MFR	113	69	18	113	313	7%
MUC	44	2	6	70	122	3%
COMM	59	90	32	120	301	6%
IND	218	26	142	498	884	19%
RUR	73	25	29	393	520	11%
POS	48	308	1	16	372	8%
NO ZONE*	26	0	0	0	26	
TOTAL	*1,633*	*834*	*360*	*1,929*	*4,756*	*100%*

*Some habitat areas within the UGB (0.3%) have no zoning designation.

Table 3-17. Class C upland wildlife habitat by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Class C Upland Wildlife Habitat					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	21	1	0	54	76	3%
RUR	406	89	4	2,350	2,849	96%
POS	0	0	0	2	2	0%
MFR, MUC, COM, IND	15	1	0	12	28	1%
TOTAL	442	91	4	2,418	2,955	*100%*

Relationship of Metro's fish and wildlife habitat inventory to the 2040 Design Type Hierarchy

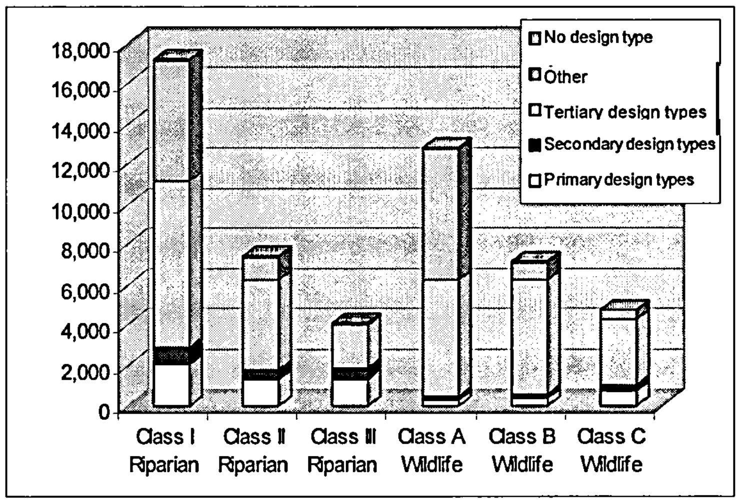
This section examines the relationship of Metro's fish and wildlife habitat inventory to the 2040 design type hierarchy described in the first section. Table 3-18 shows that over half of the fish and wildlife habitat (55 percent) falls into the tertiary design type category (i.e., inner and outer neighborhoods, employment centers, corridors); 28 percent is other design types (i.e., parks and open space, rural); and 11 percent is primary design types (city center, regional centers, industrial centers, intermodal transportation facilities). Only 14 percent of buildable fish and wildlife habitat coincides with primary design types, whereas 79 percent is in the tertiary design type category. This information is not included for the area outside the UGB because design types are not applied for the most part. Where they are applied, the location of the design types is very general.

Table 3-18. Fish and wildlife habitat acreage by 2040 design type hierarchy and development status inside the UGB.

2040 Design Type Hierarchy	Development Status					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
Primary design types	2,205	66	2,082	1,712	6,064	11%
Secondary design types	1,070	212	525	762	2,570	5%
Tertiary design types	11,460	3,038	5,685	9,384	29,568	55%
Other design types	271	14,818	92	6	15,187	28%
No design types	34	123	65	59	282	1%
Total	*15,041*	*18,258*	*8,449*	*11,923*	*53,671*	*100%*

Figure 3-6 shows the distribution of fish and wildlife habitat classes by 2040 design type hierarchy.[21] For example, most of Class I riparian/ wildlife corridors (14,350 acres; 83 percent) falls within the tertiary design type and other design type categories; almost all of Class A upland wildlife (12,305 acres; 96 percent) coincides with these two categories.

Figure 3-6. Distribution of fish and wildlife habitat classes by 2040 design type priority inside UGB.



Impact Areas

Impact areas, as described in the previous section, define an area where allowed land uses or activities could harm the fish and wildlife habitat. Development activities near streams and wetlands often remove vegetation that would otherwise contribute to riparian function by providing shade, sedimentation control, and water storage. Developed areas also contribute runoff from impervious surfaces, human disturbance, noise, lighting, toxins, fertilizers and pesticides; each of these influences may adversely affect riparian areas and wildlife habitat. Tables 3-19 and 3-20 break out impact area acreage by generalized regional zones and development status. Over 13,300 acres are included as impact areas inside the UGB and 82 percent are developed. Over half of the impact area inside the UGB is zoned for single-family use; 19 percent is industrial zoned land. Impact areas outside the UGB (3,000 acres) are primarily zoned for rural uses (92 percent). Fifty-nine percent of the impact area outside the UGB is considered buildable.

[21] Figure 3-6 does not reflect design types adopted through the Pleasant Valley Concept Plan.

Table 3-19. Impact areas by generalized regional zones inside UGB.

Generalized Regional Zones	Impact Areas					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	5,833	400	254	634	7,121	53%
MFR	903	67	39	92	1,101	8%
MUC	309	15	32	103	459	3%
COMM	645	159	33	89	926	7%
IND	1,625	86	251	585	2,547	19%
RUR	205	20	53	263	541	4%
POS	139	397	8	8	552	4%
NO ZONE*	70	0	0	0	70	1%
TOTAL	*9,729*	*1,144*	*670*	*1,774*	*13,317*	*100%*

*Some habitat areas within the UGB (.3%) have no zoning designation.

Table 3-20. Impact areas by generalized regional zones in expansion areas and remaining areas in Metro's jurisdiction.

Generalized Regional Zones	Impact Areas					
	Developed		Vacant		Total	
	Urban	*Park*	*Constrained*	*Buildable*	*Dev. & Vac*	*% of Total*
SFR	59	1	0	43	103	3%
RUR	932	105	0	1,722	2,759	92%
POS	53	4	0	4	61	2%
MFR, MUC, COM, IND	65	0	0	18	83	3%
TOTAL	1,109	110	0	1,787	3,006	100%

The next section describes the activities that occur within each zone that may conflict with regionally significant fish and wildlife habitat.

Conflicting Uses by Metro's Generalized Regional Zones

The seven generalized regional zones provide the framework for identifying conflicting uses at a regional scale and the potential consequences, or impacts, to regionally significant fish and wildlife habitat. These generalized regional zones, by themselves, are not conflicting uses. It is the development activities and other disturbances (e.g., clearing land, adding impervious surfaces, replacing natural vegetation with non-native vegetation, etc.) permitted by the local zoning that potentially conflict with fish and wildlife habitat. These activities can generate negative impacts on natural vegetation and soil, the hydrologic and erosional processes in a watershed, and the physical characteristics of fish and wildlife habitat.

This section describes some of the common disturbance activities associated with land uses that are allowed outright or conditionally within Metro's generalized regional zones and that conflict with fish and wildlife habitat. The consequences, or impacts, to regionally significant fish and wildlife habitat are described in each of the ESEE analyses that follow this section.

According to the Goal 5 rule, a local government, following the standard ESEE process, complies with the rule if it identifies "at least the following activities as conflicting uses in riparian corridors:

(a) The permanent alteration of the riparian corridor by placement of structures or impervious surfaces, except for:
  (A) Water-dependent or water-related uses; and
  (B) Replacement of existing structures with structures in the same location that do not disturb additional riparian surface area; and

(b) Removal of vegetation in the riparian area, except:
  (A) As necessary for restoration activities, such as replacement of vegetation with native riparian species;
  (B) As necessary for the development of water-related or water-dependent uses; and
  (C) On lands designated for agricultural or forest use outside UGBs." (OAR 660-23-090(7))

Past land use practices, and perhaps to a lesser degree current land use practices, can negatively impact fish and wildlife habitat. Some of the common disturbance activities are listed in Table 3-21. Among the most obvious disturbances are the removal of vegetation and the placement of structures and impervious surfaces. Removal of vegetation from streambanks, floodplains, and upland wildlife areas fundamentally alters the stream hydrology resulting in many adverse effects (e.g., increased erosion, sedimentation, increased flooding, loss of habitat, etc.). Increased levels of impervious surfaces reduce groundwater infiltration, increase stormwater runoff, and degrade water quality (see *Environmental Consequences* chapter).

Disturbance activities occur in all regional zones; however, the degree to which these disturbances occur depends on the intensity of the land use (e.g., single-family residential vs. mixed use center), and the form and layout of the development (cluster development vs. evenly distributed development). The remainder of this section describes the disturbance activities in each of following generalized regional zones.

- Single family residential
- Multi-family residential
- Mixed Use Centers
- Commercial
- Industrial
- Rural
- Parks and Open Space

Single family residential (SFR 1-7)

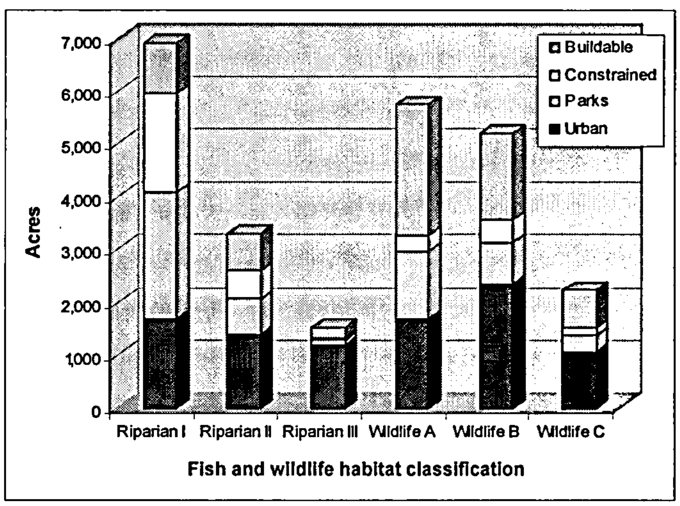
Single-family residential (SFR 1-7) generally allows detached and attached housing on lot sizes up to 20,000 square feet. Conditional uses that often occur in single-family residential zones include: residential recreational centers, churches, schools, daycare facilities, nursing homes, retail sales and service, basic utilities, parks and open areas, etc.

The largest portion of Metro's Goal 5 fish and wildlife habitat inventory– 46 percent – is zoned for single-family residential uses (24,821 acres; see Table 3). Figure 3-7 shows the distribution of SFR fish and wildlife habitat by classification and development status. Over 50 percent of SFR habitat land is classified as high value riparian/wildlife corridors and upland wildlife habitat (12,620 acres); 44 percent of it is vacant (17 percent constrained; 27 percent buildable). Twenty-one percent of SFR habitat land is classified as Class B upland wildlife habitat; 13 percent is

Table 3-21. Common disturbance activities.

- Clearing vegetation and removing native soils
- Grading, excavation, filling, hauling, and soil compaction
- Adding impervious surfaces by constructing buildings, sidewalks, driveways, parking areas and roads
- Modifying streams such as channelizing, piping, widening, deepening, straightening and armoring streambanks to confine flows, increase capacity for flood control, and stabilize streambanks
- Installing utility connections such as sewers and stormwater pipes; septic tanks (in rural areas); building sewer pump stations and water towers
- Building stormwater control structures
- Constructing roads, stream crossings (e.g., bridges), installing culverts
- Landscaping with non-native vegetation (e.g., establishment of lawns, addition of non-native landscape features – trees, shrubs, groundcover, etc.)
- Introducing non-native fish and wildlife species
- Using fertilizers, pesticides and herbicides
- Building fences and other wildlife barriers
- Using toxins in households and businesses
- Generating runoff from household and business activities
- Other (pets, lights, noise, litter, garbage, etc.)

Figure 3-7. Distribution of SFR zoned habitat land by classification and development status in UGB.



riparian/wildlife II. Overall, the developed/vacant status of SFR habitat land is 60/40 percent (respectively). Twenty-seven percent of the vacant land is buildable. Outside the UGB in expansion areas and remaining areas in Metro's jurisdiction, only three percent of fish and wildlife habitat is currently zoned for single-family residential. UGB expansion areas, which are predominantly zoned for rural uses, will eventually be upzoned to accommodate single-family residential development as well as a mix of other uses (e.g., multi-family, commercial, industrial, etc.).

Common development activities that occur in areas zoned for single-family residential include: preparing the site by clearing vegetation and grading; installing utility connections (e.g., stormwater pipes; sewer pipes); building roads and sidewalks; creating stormwater detention facilities; and constructing dwelling units, garages, accessory buildings, driveways, and parking areas. Past development practices included piping or modifying streams (e.g., channelizing, deepening, widening) and filling wetlands. These activities are now widely regulated and are less likely to occur.

Other disturbance activities occurring in SFR land that potentially impact fish and wildlife habitat include: landscaping with non-native vegetation (e.g., lawn, ornamental plants, etc.); applying pesticides, herbicides, and fungicides; building fences and other wildlife barriers; generating runoff; using household toxins; allowing pets to roam freely; generating noise, and using outdoor lighting.

As described earlier, the removal of natural vegetation and the placement of structures and impervious surfaces are the most prevalent disturbances in nearly all zones. Some land uses may require more site preparation (e.g., vegetation removal, grading, etc.) and more impervious surface coverage (e.g., buildings, parking, etc.) than others. For example, a two-acre parcel developed as a single-family subdivision may add less impervious surfaces than an industrial development that requires a large percentage of total land area to accommodate manufacturing, warehousing and transportation facilities. Within SFR zones, however, vegetation removal and impervious surface coverage are highly variable, depending on development practices. For example, some communities may not require that trees and native vegetation be conserved during the development process. Residential streets may be designed to be wider than necessary for serving small volumes of traffic. Development practices that incorporate natural resources into the design (e.g., cluster design) and reduce overall imperviousness (e.g., narrow street design, shared parking) are likely to have less impact on fish and wildlife habitat.

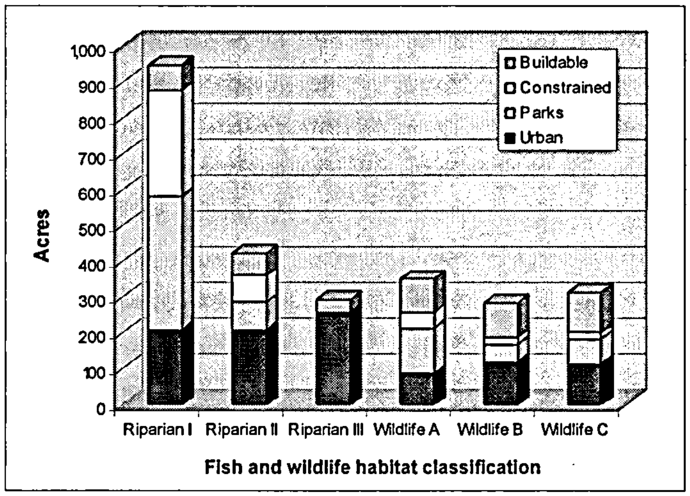
Multi-family residential (MFR 1-4)

Multi-family residential (MFR1-4) includes land for apartment complexes, duplexes, garden apartments, rowhouses, townhouses, condominiums, and other attached single-family structures. These range in densities from two to 25 units per acre with height limits usually set at 2-1/2 to 3 stories (MFR1) to densities greater than 100 units and multiple stories (MFR4). Some mixed-use and neighborhood-scale commercial uses may be allowed under certain circumstances. Conditional uses may include churches, governmental facilities, utility structures, schools, residential recreational centers, group living facilities, etc.

Five percent of the Goal 5 fish and wildlife habitat inventory is zoned as MFR (2,610 acres; see Table 3-4). Figure 3-8 shows the distribution of MFR land by habitat classification and development status. Half of the MFR zoned habitat is classified as high value riparian/wildlife corridors and upland wildlife habitat (1,299 acres). Overall, the total developed/vacant status of MFR habitat is 64/36 percent respectively. Most of the buildable land is found in the three upland wildlife categories.

Development activities that occur in areas zoned for multi-family residential are similar to those found in single-family residential areas. Vegetation is removed, impervious surfaces are added, household activities are similar. Multi-family development may add more impervious surface than single-family residential to accommodate for parking. However, in many cases multi-family residential construction can clear less land area to construct the dwelling units than a typical single-family subdivision. Certain disturbance activities may be more common in single-family than in multi-family residential uses. For example, pesticide, herbicide and fertilizer use may be greater in single-family developments with landscaped yards.

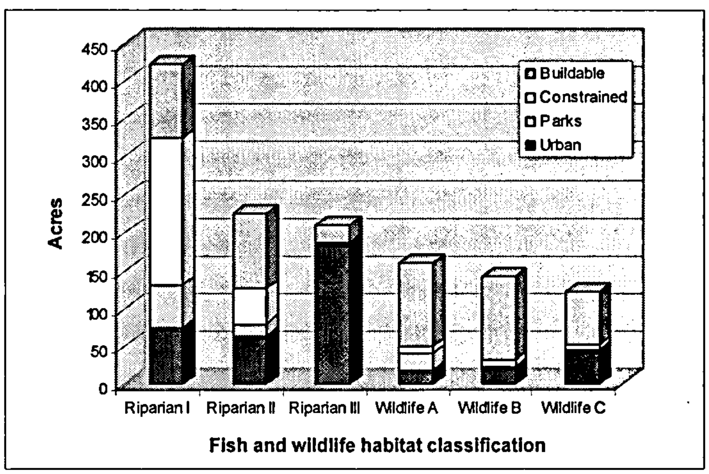
Figure 3-8. Distribution of MFR zoned habitat land by classification and development status in UGB.



Mixed use centers (MUC)

Mixed use centers (MUC) include residential along with commercial uses in town centers, main streets, corridors, light rail station areas, regional centers and the central city. Development types generally permitted include moderate-density to high-density multi-family residential uses, attached single-family dwellings, locally-oriented commercial, retail, services, office uses, community service, and daycare. Mixed-use centers have a strong pedestrian and transit orientation.

Figure 3-9. Distribution of MUC zoned habitat land by classification and development status in UGB.



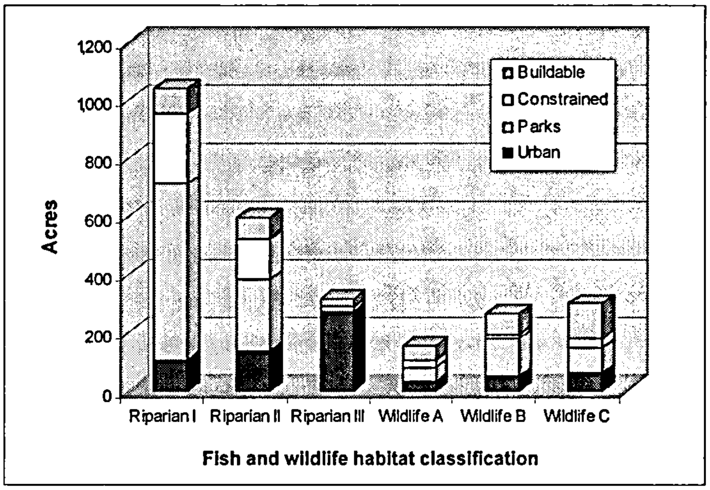
Only two percent of fish and wildlife habitat is zoned for mixed use (1,284 acres; see Table 3-4). Figure 3-9 shows the distribution of MUC land by habitat classification and development status. Fifty-one percent of habitat zoned for mixed use is Class I and II riparian/wildlife corridors (649 acres); 33 percent is upland wildlife habitat (426 acres); and 16 percent is Class III riparian (210 acres). About 40 percent of MUC zoned habitat is buildable.

Similar development activities to those described in the SFR and MFR sections occur in mixed-use centers: vegetation is cleared, impervious surfaces are added. A higher level of imperviousness may occur in these areas as a result of parking requirements and road networks. Other disturbance activities may be different from residential uses. For example, the use of pesticides and herbicides is likely to be less significant in mixed-use centers. The design of mixed-use centers determines the severity of impacts on the fish and wildlife habitat.

Commercial (COM)

Commercial (COM) districts are similar to mixed use zoning in that they tend to be closer to central urban areas or related corridors of commercial activity. Commercial uses include a wide range and scale of retail and service businesses, office, and civic uses in a concentrated area. Public facilities (PF) such as schools, churches, government offices, hospitals, libraries, correctional facilities, public recreation facilities, and public utilities are also included in this category. Conditional uses typically allowed in commercial areas include group living facilities (e.g., nursing homes, boarding houses), churches, schools, jails and related facilities, basic utilities, radio transmission facilities, transit park and rides, rail lines and utility corridors, etc.

Figure 3-10. Distribution of COM zoned habitat land by classification and development status in UGB.



Five percent of fish and wildlife habitat is zoned for commercial development (2,672 acres; see Table 3-4). Figure 3-10 shows the distribution of commercial land by habitat classification and development status. Thirty-nine percent of the land is classified as high value riparian/wildlife corridors; only eight percent of that is buildable. Upland wildlife habitat comprises only a small potion (nine percent) of commercial land. The developed/vacant status of COM habitat land is 67/33 percent (respectively).

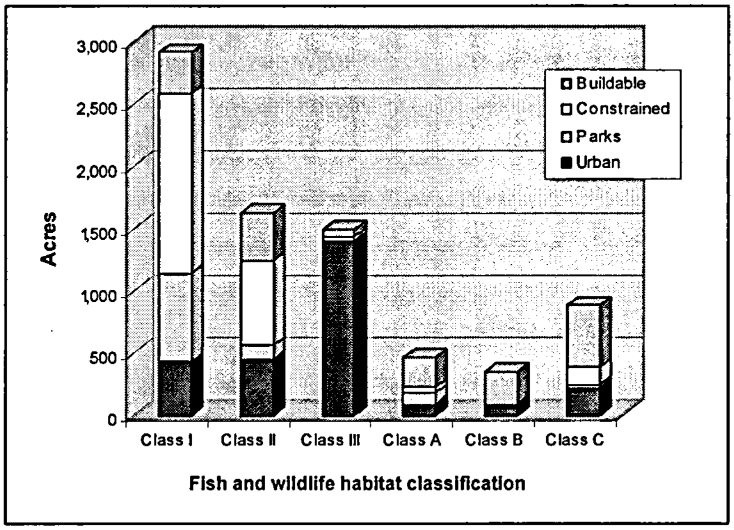
The disturbance activities related to commercial uses are similar to those described for SFR and MFR uses; however, in many cases these activities are more intense. Clearing and grading are usually more extensive for commercial development. Roads and parking lots are important features of commercial development to allow for customer access and visitation. Additional traffic around commercial areas creates more pollutants on roadways, which are eventually washed into streams and rivers. In addition, increased traffic creates hazards to wildlife when moving from one habitat area to another. Large parking lots result in more impervious surfaces than are typically required for residential uses and mixed use areas.

Some of the disturbance activities are less of an issue in commercial development than in residential areas. For example, application of fertilizers, pesticides and herbicides may be reduced, unless the commercial development incorporates extensive landscaping. Impacts to the fish and wildlife habitat from domestic pets are also less relevant in commercial development.

Industrial (IND)

Industrial zones allow a variety of industrial uses from light manufacturing (e.g., fabrication) to heavy manufacturing (e.g., chemical processing) to mixed use industrial (e.g., a mix of light manufacturing, office and retail uses). Supporting commercial services such as restaurants and banks may be allowed outright, depending on the zone, or permitted with limitations. Conditional uses may include junkyards and wrecking yards, basic utilities, commercial recreation facilities, and waste related services.

Figure 3-11. Distribution of IND zoned habitat land by classification and development status in UGB.



Industrial zoned land represents a fairly significant portion of the Goal 5 fish and wildlife habitat inventory – 14 percent (7,721 acres; see Table 3-4). Industrial land tends to be large, flat parcels that may intersect with fish and wildlife habitat in lower density areas of the region, often bordering rivers, streams or wetlands. This fact is apparent from Figure 3-11; over 2,900 acres, or 38 percent of industrially zoned habitat, is high value riparian/wildlife corridors. Over sixty percent of Class I is considered vacant, most of which is constrained land. The developed/vacant status of total IND habitat land is 47/53 percent (respectively).

Disturbance activities in industrial development are similar to those found in residential and commercial areas, but to a greater degree depending on the intensity of the industrial activity (e.g., light industrial vs. heavy industrial). Industrial development is typically land intensive, meaning it requires a large percentage of total land area to accommodate manufacturing, warehousing, transportation facilities, etc. Site preparation for industrial development frequently requires complete site clearing and grading. Past development practices retained few, if any, natural resources on the site and the entire site was covered with impervious surfaces. Current regulations require that impervious surfaces be set back from water features, and that riparian areas be planted with native vegetation.

Some industrial uses require a substantial amount of water for use in manufacturing processes (e.g., cooling equipment) that is later released to the rivers at an increased temperature. This process impacts instream habitat for fish and other aquatic species. Industrial areas may contribute high quantities of heavy metals and other toxic materials. In addition, the use, storage, and transport of hazardous materials often occurs in industrial uses.

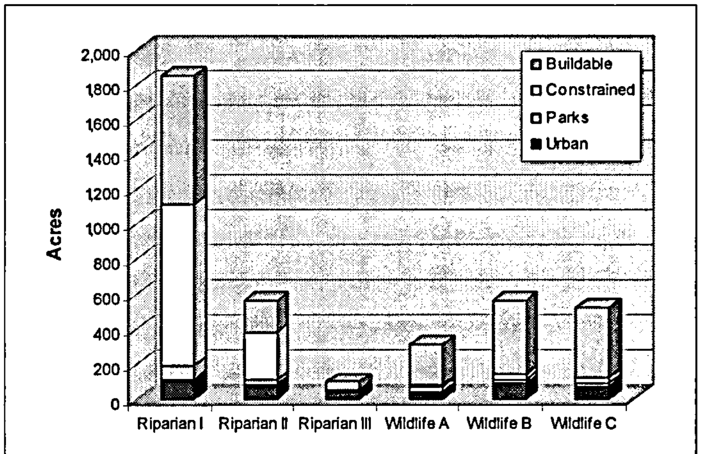
Mining typically occurs on industrially-zoned land. In the Metro region, mining is focused on aggregate resources (naturally occurring concentrations of stone, rock, sand and other materials used for urban development and road building). Aggregate resources are regulated as Goal 5 resources. Instream and off-channel mining of aggregate resources has direct and significant negative impacts on the aquatic ecosystem. Extraction of sand and gravel from within a stream channel may change the way in which water and sediment move through a stream system and altering stream characteristics (e.g., channel morphology and substrate, channel stability, etc.). Off-channel mining practices often include construction of berms and dikes to prevent flood flows from spilling into excavation areas. These structures can prevent the natural lateral migration of the stream.

Marine terminals, freight facilities for trucking, airports and railroad mostly occur in industrial zoned areas. These land uses have similar disturbance activities as land intensive industrial uses. Airports have the additional impact of noise and light. The Goal 5 rule exempts water-dependent or water-related uses, which are generally located in industrially zoned areas, from being identified as conflicting uses. (OAR 660-23-090(7)) However, activities related to these uses have detrimental impacts on instream aquatic habitat.

Rural (RUR)

The rural generalized zoning category includes RRFU (Rural Residential and Future Urban) and FF (Agricultural and Forestry). Rural residential lands provide the opportunity for single-family housing on lots of one acre or more in a rural or semi-rural environment. This designation also includes areas set aside for future urban development. Some of the local zones that fall into the RRFU category also allow agriculture, horticulture, greenhouses, nurseries, timber growing, and raising of livestock and animals.

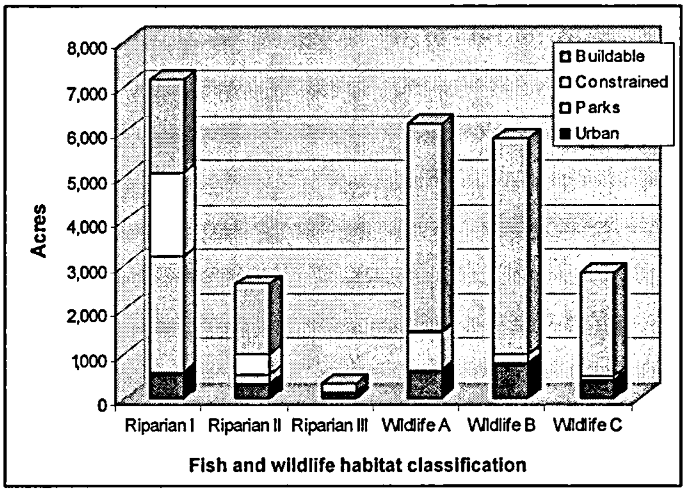
Figure 3-12. Distribution of RUR habitat land by classification and development status in UGB.



Fourteen percent of the fish and wildlife habitat inside the UGB (before December 2002) is zoned for rural use (7,721 acres; see Table 3-4). Not surprisingly, fish and wildlife habitat zoned for rural uses is a much higher proportion (89 percent) in UGB expansion areas and the remaining areas within Metro's jurisdiction (24,969 acres; see Table 3-5). Figure 3-12 shows that most of the rural zoned habitat land within the UGB is Class I and Class II riparian/wildlife corridors (62 percent). Over half (51 percent) the total habitat land zoned for rural uses inside the UGB is considered buildable.

Figure 3-13 shows the distribution of rural fish and wildlife habitat in UGB expansion areas and the remaining areas in Metro's jurisdiction. Fifty-four percent of habitat zoned for rural uses is high value Class I riparian/wildlife corridors and Class A upland wildlife habitat; more than half of that is buildable. Over 8,200 acres of the 18,800 acres in UGB expansion areas (44 percent) are significant fish and wildlife habitat. These areas will eventually be upzoned from rural zoning to accommodate urban development.

Figure 3-13. Distribution of RUR habitat land by classification and development status outside UGB.



Rural disturbance activities are similar to single-family and multi-family residential, except that there is typically less impervious surface. The larger lots generally spread out the impact of development and produce less stormwater runoff. However, the use of pesticides, herbicides and fertilizers may be greater in rural developments where agricultural uses are allowed. In addition, grazing of livestock can cause soil erosion, soil compaction, deterioration of water quality, and simplification of native vegetation diversity.

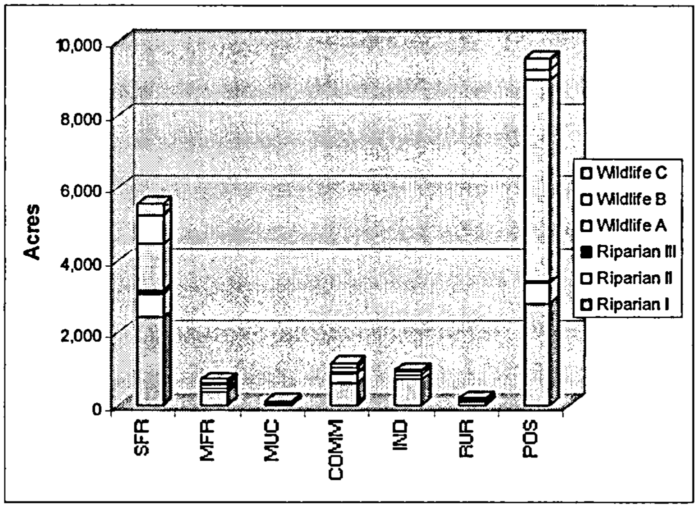
Agricultural uses and forestry, suitable to commercial scale production (typically with lot sizes of 30 acres or more), are allowed in the FF (Agriculture or Forestry) regional zone. Commercial farm and forest uses can involve extensive removal of native vegetation and habitat and are considered a conflicting use within the UGB. However, the Goal 5 rule exempts identifying agricultural and forest use outside the UGB as conflicting uses. (OAR 660-23-090(7)) Clearing vegetation, plowing fields, exposing bare soils and other farming and forestry practices (e.g., use of harvesting equipment) can heavily impact fish and wildlife habitat (e.g., soil erosion, soil compaction, etc.).

Parks and open space (POS)

Twenty percent of the Goal 5 fish and wildlife habitat inventory (10,470 acres; see Table 3-4) is actually zoned as parks and open space. An additional 8,680 acres are included in Metro's parks and open spaces inventory, but are zoned something other than POS. Parks and open space are allowed outright or conditionally in all of the generalized regional zones, although to varying degrees, and often retain the underlying zoning. Metro excludes parks and open space from the buildable land supply for estimating the region's 20-year land supply for dwelling units and employment inside the UGB.

Figure 3-14 shows park acreage by generalized zones and habitat classification. The largest number of park acres occurs in POS and SFR zoning.

Figure 3-14. Parks and open space by generalized regional zones and habitat classification.



The disturbance activities associated with parks and open space vary depending on the intensity of use. Many developed parks provide ball fields, tennis courts, picnic areas, recreational trails, maintenance facilities, parking lots, and other amenities. Disturbance activities in parks create impacts that are similar to those described for residential uses; however, generally a smaller percentage of land is covered by impervious surfaces. Maintenance practices used in many parks are similar to residential landscaping practices and can negatively impact habitat. Off-leash dog use in some of these parks impacts water quality.

Undeveloped open space, on the other hand, has the least amount of disturbance activities. These areas provide important wildlife habitat. Publicly owned open space provides recreational opportunities for people and a connection to nature and exposure to wildlife. Human activities such as hiking and biking, however, can negatively impact the fish and wildlife habitat.

Summary

Metro identified conflicting uses from a regional perspective by examining generalized regional zones (Metro's compilation of local jurisdictions' zones) and by considering Metro's 2040 Growth Concept. The conflicting use chapter analyzed Metro's Goal 5 fish and wildlife habitat inventory (e.g., habitat class, development status) and its distribution among generalized regional zones, 2040 design type priorities, and impact areas. Disturbance activities that are likely to occur within the generalized regional zones are also described. Some key points from this chapter include:

Figure 3-15. Total acreage in Metro's jurisdiction.

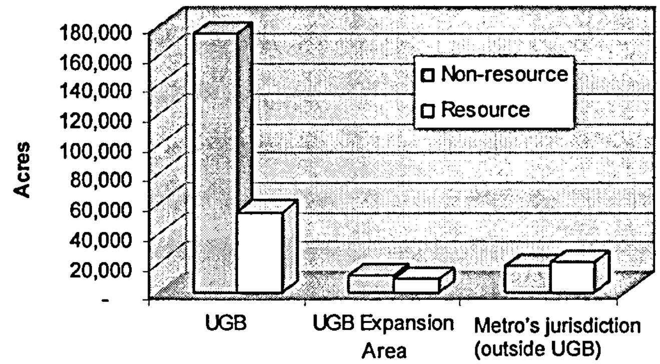
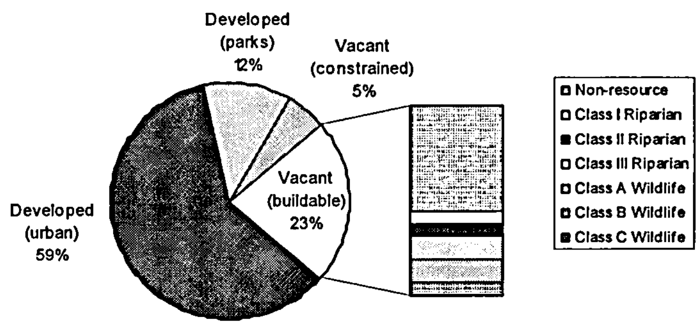


Figure 3-16. Percentage of total acreage in Metro's jurisdiction by development status.



- Metro's jurisdiction is comprised of approximately 280,660 acres, or about 438 square miles (not including water features). Figure 3-15 shows a comparison of non-habitat land with habitat land in three geographical areas: the UGB (pre-December 2002), UGB expansion areas (December 2002), and the remaining areas in Metro's jurisdiction outside the UGB (see Figure 3-1 map).
- About 29 percent of the total acreage in the three geographical areas represented in Figure 3-15 is regionally significant fish and wildlife habitat (81,700 acres).
- Approximately two-thirds of fish and wildlife habitat are within the UGB.
- Twenty-three percent of the total land area (both non-habitat and habitat) is vacant buildable land (64,175 acres). Almost half of the vacant buildable land in Metro's jurisdiction is fish and wildlife habitat (see Figure 3-16).
- Twenty-eight percent of vacant fish and wildlife habitat is already constrained by existing environmental regulations.
- The highest quality riparian/wildlife corridors (Class I) comprise about seven percent of the total supply of buildable land, while the highest quality upland wildlife (Class A) is 13 percent of the total supply of buildable land.

- The generalized regional zones, by themselves, are not conflicting uses. It is the development activities and other disturbances (e.g., clearing vegetation; adding impervious surfaces such roads, sidewalks, buildings and parking lots; landscaping with non-native vegetation; use of chemicals and contaminants) that generate negative impacts to fish and wildlife habitat.
- Forty-seven percent of fish and wildlife habitat is zoned single-family residential; over half is classified as high value riparian/wildlife and upland wildlife.
- Twenty percent of the fish and wildlife habitat is zoned for parks and open space. However, 34 percent of the fish and wildlife habitat is used as a park or open space.
- Fourteen percent of fish and wildlife habitat is zoned for industrial use. Of this amount, 44 percent overlaps with high value habitat, and over half is vacant.
- Metro has identified approximately 16, 300 acres as impact areas; over half are zoned single-family residential; 19 percent are zoned industrial; 82 percent is developed.
- 2040 design types are prioritized into four categories: primary land use components, secondary land use components, tertiary land use components, and other. Over half of the fish and wildlife habitat overlap with tertiary land use components (i.e., inner and outer neighborhoods, employment centers, corridors); 28 percent of the habitat is other design types (i.e., parks and open space, rural), 11 percent is in a primary category (i.e., central city, regional centers, industrial areas, intermodal transportation facilities); and five percent is secondary land uses (i.e., town centers, main streets, and station communities).

Figure 3-17. Distribution of habitat classification by generalized regional zones inside the UGB.

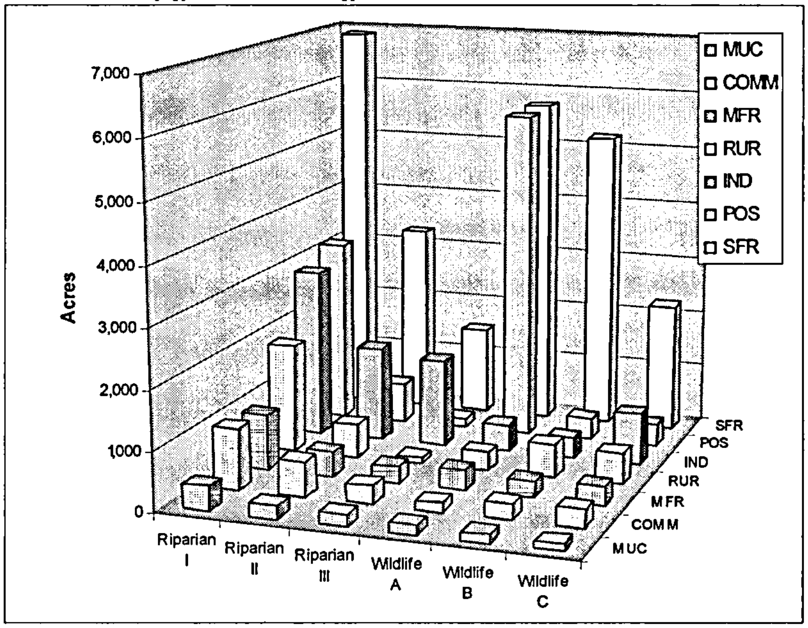
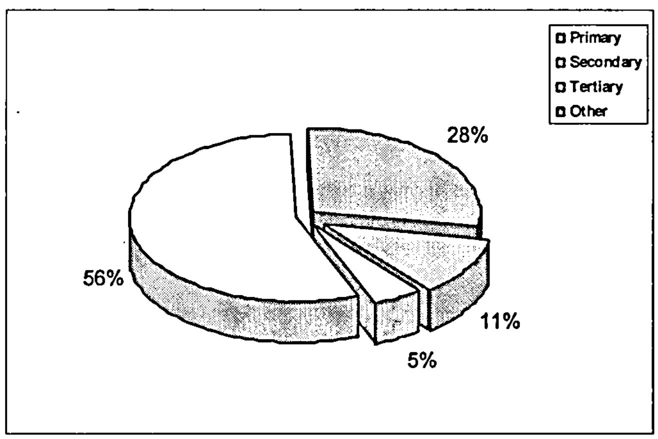


Figure 3-18. Percentage of fish and wildlife habitat by 2040 design type hierarchy.



The next four chapters consider the ESEE consequences of allowing, limiting, or prohibiting conflicting uses in fish and wildlife habitat areas.

CHAPTER 4: ECONOMIC CONSEQUENCES

Introduction

This chapter focuses on the economic consequences of protecting or not protecting fish and wildlife habitat. The competition between developing fish and wildlife habitat and protecting the ecosystem services provided by these areas lies at the heart of economic analysis. Metro contracted with ECONorthwest, a well-respected economic consulting firm, to provide insights into this competition and identify supporting information for the economic analysis. ECONorthwest conducted a review of the relevant literature[22] that focused on the factors that influence the market value for developable land and the economic value of ecosystem services provided by fish and wildlife habitat.

This chapter begins by providing an overview of the region's economy and the economic principles guiding the analysis. It then briefly outlines the major analytical tasks involved. The remainder of the chapter summarizes ECONorthwest's analysis[23] and describes the tradeoffs of protecting or not protecting fish and wildlife habitat by addressing the following questions:

- How is land ranked based on the economic importance for development?
- How is land ranked based on the economic importance for ecosystem services?
- What are the interactions between development value and ecosystem services value of fish and wildlife habitat?
- What are the potential economic consequences of allowing, limiting or prohibiting conflicting uses?

Background and context

Metro region's economy

The economic structure of the region's economy has shifted over time from one driven by resource industries (timber, agriculture, and metals) to more knowledge-based and service-oriented industries. This restructuring has occurred as productivity, labor trends and capital investments have re-shaped the national economy over the last half century and forced regional economies like the Portland area to adapt in order to prosper. And indeed the Portland area has prospered – witnessed by its above-average population and job growth over the last several decades.

Early on, cities on the West Coast emerged because of proximity to trade routes and abundant natural resources of which residents could take advantage. This region was blessed with plentiful rainfall and rich soil for agriculture in the Willamette Valley and plentiful trees for harvesting logs for homes and industry. Portland's proximity at the confluence of two great rivers provided cheap and convenient access/connections for farm goods and supplies to and

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[22] See Appendix C: *Final Draft Literature Review for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest 2003)

[23] See Appendix C: *Final Report for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest 2004).

from various sea and inland trade routes. Portland became a major seaport and transportation hub for West Coast trade.

Agriculture in the northern Willamette Valley has changed over time as farm production has become more competitive nationwide. Farms that once produced foodstuffs for the Portland area no longer are the dominant agricultural industry. Today instead, the major agricultural producers are nursery growers and grass seed farming.

With the onset of World War II, the region's economy shifted to producing goods for the war effort. Ship building and ancillary manufacturing arose to briefly become a key industry during the 1940's. Since then, ship building has declined. However, the transportation equipment industry remains a significant industry in the region, but the components of this industry have shifted away from ship building to the production of rail cars (Gunderson), aircraft parts manufacturing (Boeing) and heavy diesel truck production (Freightliner).

After construction of the Bonneville Dam and other dams along the Columbia River, metals manufacturing and fabrication (particularly aluminum) became an important component of the regional economy. The dams provided an opportunity to create jobs and generate cheap and plentiful electricity for residents in the region. The enormous surplus of electricity attracted Reynolds Aluminum and others to locate aluminum smelting plants in and around the region. As the aluminum industry matured, the Northwest aluminum industry's competitive advantage steadily waned. A combination of higher electricity prices, diminished electrical supplies, and global competition has forced most of the region's aluminum smelters out of business. The metal industry in the region has evolved into a secondary industry that mostly handles recycling of scrap metals.

Before the 1980's regional recession, timber products (logging and paper) were engines of growth for the State and metropolitan area economies. This is no longer the situation. Continued concerns over logging of old growth forests and associated decline of species have led to restricted harvest levels on federal forest lands. In addition, competition from Canadian sources and southeast U.S. producers has increased over time. Continued productivity enhancements in the industry also add to the long-term employment declines in this industry. As a result, the forest products industry is a smaller part of the regional economy.

As the region's traditional resource industries came under increased competitive pressures, the metropolitan area experienced the emergence of a new industry – the so-called high-tech industry. High-tech had its nascent beginning in 1946 with Techtronix and 30 years later with Intel. The high-tech industry really came into prominence in the 1990's as Intel and other multi-national firms from Asia invested over $10 billion in the area alone. The high-tech sector, popularly known as Silicon Forest, which is largely concentrated in Hillsboro, with smaller "clusters" in Tualatin and Gresham, is not monolithic but is comprised of different companies specializing in various fields of expertise. The region's specialties in the high-tech field include semi-conductors, electro-scientific instruments, printer and parts manufacturing, and visual projection devices.

The transport of goods and services has always been an important component of the metropolitan economy. The Port of Portland continues to be a key economic component to this region's economic health. The factors that made Portland a key location for commerce are still here today and may be even stronger today than before. International travel and the trading of goods and services overseas is much greater today. The regional economy is much more globally bound, so the infrastructure and technology to move goods and people overseas and around the country are very important to the growth and prosperity of the region.

As the region's basic or traded sectors grow and attract new businesses and the people who work for these companies, the region has experienced a multi-fold increase in services and retail. Every city has needs and these needs are provided by the numerous entrepreneurs who everyday provide the goods and services residents living in the city demand. As the region's population grows, so have the number of shopkeepers. Like all metropolitan areas in the U.S., there has been an evolution in how goods and services are supplied to consumers. One example is the rapid growth of Mega-stores and regional malls that did not exist half a century ago.

As described above, the region's economy has shifted over time from resource-based industries to more knowledge-based and service-oriented industries. This transition has added complexity to the region's economy and competition for natural resources. The following section briefly describes the economic principles upon which this analysis is based.

Economic principles

The following six economic principles help define the approach to the analysis of economic tradeoffs of developing lands that contain significant riparian and/or wildlife habitat or protecting this habitat and the associated ecosystem services that benefit society.

1. *Market prices for land can be used as a measure of development value.* Property markets for developable land meet most of the criteria for a well-functioning market. Many sellers and buyers participate in the market, there is free entry to and exit from the market, and buyers and sellers have access to information on the attributes of land that provide development value. For these reasons, market prices for land provide a good measure of development value. Participants in a market can measure or rank the development potential or importance of properties based on property value.
2. *Ecosystem services have economic value.* Ecosystem services are the benefits to society of well-functioning ecosystems such as riparian areas that mitigate flooding, help filter toxins and sediment from surface runoff and provide recreational and other amenity values. Society also benefits from wildlife habitat that helps support populations of species with commercial, recreational, and cultural value.
3. *Property markets may capture some, but not all, of the values of ecosystem services.* Property markets can provide information on the value of some ecosystem services, such as the value associated with proximity or access to recreational resources or scenic vistas. Property values typically do not reflect the value of other ecosystem services, such as water quality or wildlife habitat services.
4. *Property markets may not capture public policy or planning goals.* Just as property markets fail to reflect the full value to society of ecosystem services, these markets may also fail to capture the value of public policy or planning goals that affect land use. For example, properties with the highest market value may not necessarily be the most

important lands from a public policy perspective. Specific to this project, the hierarchy of design types as described by the 2040 Growth Concept emphasizes certain land use types in certain locations. Public policy consideration drives the design of the hierarchy, not market prices. As a result, the 2040 Growth Concept may emphasize the importance of a relatively low valued land use, such as industrial development, in an area that, if left to property markets, would develop into a higher valued use, such as a residential development.

5. *There is competition for the fish and wildlife habitat resources at issue in this study.* In the past, discussions of the competition for natural resources focused on the tradeoffs of developing or using a resource and the associated jobs created or supported versus protecting the resource for its intrinsic or non-use value. This is the 'jobs vs. the environment' argument. Such an approach assumed two competing demands for a resource: 1) that protecting the environment would not generate or support jobs, and 2) that development use would not generate negative impacts beyond affecting non-use values.

   Today, the competition for resources is more complex with more demands on a finite amount of natural resources. The dynamics of the competition extend far beyond a choice of jobs or the environment. A distinction can be made between demands on the resource that have use and non-use values. The range of demands with use values include commercial use of the resource, the ecosystem services provided by the resources, the impacts of the resources and development values on location decisions of retirees, workers and businesses and other quality-of-life impacts and options to use the resources in the future.[24] Demands with non-use values include the intrinsic value of the resources.
6. *A static analysis likely will fail to inform stakeholders or decision makers adequately of the economic tradeoffs.* A static analysis is similar to taking a snapshot of analytical conditions. This approach assumes no changes in factors that could influence the outcome of a decision to develop or to protect resources. An alternative approach that considers how changes or adjustments affect the economic analysis will likely provide a more complete description of the economic tradeoffs than ignoring these adjustments. In this case, dynamic adjustments may include expanding the urban growth boundary (UGB) and the substitutability of land within the UGB. Such a dynamic approach also considers the likely restoration efforts that can help mitigate the negative impacts of development on regionally significant fish and wildlife habitat. A dynamic approach that considers likely changes, adjustments, or possible mitigation efforts will provide decision makers with a more complete view of the likely economic impacts than will a static approach.

Framework for the economic analysis

The framework for the economic analysis consists of four major analytical tasks, briefly described below.

[24] See Appendix C, *Final Draft Literature Review for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest, 2003), for more information on the competing demands for natural resources.

- *Rank fish and wildlife habitat based on the economic importance for development (development value).* In this analytical task, a method was developed to rank the relative importance of land for development using three criteria: land value, employment and 2040 design types.

- *Describe economic value of ecosystem services provided by fish and wildlife habitat.* In this task, the economic value of ecosystem services is described based on ECONorthwest's economic literature review. Metro's ranking of fish and wildlife habitat for ecological function serves as a proxy for the economic value of ecosystem services.

- *Compare the ranking of economic importance for development (development value) with Metro's ranking of ecological value for fish and wildlife habitat.* This comparison provides information on the amount and distribution of significant interactions between development use and habitat protection.

- *Describe the economic consequences of allowing, limiting, or prohibiting development of regionally significant fish and wildlife habitat.* In this task, reference is made back to the previous tasks that describe the context for the analysis of economic tradeoffs. Economic factors (e.g., land value, employment, 2040 design types and value of ecosystem services) are described that may be affected by a Goal 5 decision.

How is land ranked based on the economic importance for development?

Not all land has the same economic importance for development, just as not all fish and wildlife habitat have the same ecological value. For example, land zoned for parks has less economic importance compared to land zoned for industrial uses. This analysis ranks land based on economic importance for development, or "development value." This approach helps weigh the economic consequences of protecting or not protecting fish and wildlife habitat.

Development value of land can be ranked in many ways. Methods include ranking land based on property value, distance from city center, the amount of vehicle and pedestrian traffic that passes by, or local economic development priorities that target specific economic sectors or land uses. Developing an exhaustive list of methods and applying them to the lands that contain fish and wildlife habitat goes beyond the scope of this analysis. Instead, this analysis focuses on a three measures that provide a general understanding of the development values: land value, employment potential associated with development (employment density) and 2040 Growth Concept planning goals.

Property markets provide a good measure of a property's development value because factors that affect a parcel's development potential (i.e., location and use) are typically widely known and easily measured.[25] The location factors that influence property values include availability of

[25] See Appendix C, *Final Draft Literature Review for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest, 2003), for more information.

urban infrastructure services, transportation access, and zoning and other regulations. Use factors include a property's amenities, physical terrain and lot size and shape.

The second measure for describing the importance of land for development is the employment potential associated with development. Land values and employment potential describe current conditions. For insights into relative importance for development in the future, a third measure is used that ranks land using Metro's 2040 Growth Concept planning goals described by the 2040 design types.[26] The following sections describe these three measures.

Rank lands based on land value

Market prices reflect a parcel's location and use factors. Distribution of land value was modeled based on local tax assessor data and mapped using GIS. County assessors' data on value (compiled by Metro) is a reasonable proxy for market value for purposes of identifying a range of property values from high to low. "Reasonable proxy" means that there is a relatively high correlation between values in the assessor's data and market values. That is, a high value in the assessor's database will also have a high market value. Given the limitations on assessed value from Measures 5 and 50, it is expected that assessed values will be less than market values. However, this data is used to describe a range of property values from high to low, not as a measure of market value for any one property.

The data on land value was used for ranking lands, not the value of land plus improvements. Land value reflects the expected value of land in the best uses supported by the market and allowed by public policy. Including the value of improvements would bias the analysis against undeveloped land. Property without improvements would likely be constrained to the lower end of the range of values if the range included the value of improvements.

The database of assessed values excludes land uses that do not pay property taxes, such as public schools and some hospitals, and underestimates the value of other land uses that pay limited property taxes, such as low-income housing. Land value reflects the amenity values associated with fish and wildlife habitat, but likely does not capture the value of other ecosystem services such as those associated with water quality and flood management.

Map 1 shows the distribution of land value across the Metro region. Land value is divided into "low," "medium" and "high" values. Habitat lands with assessed values equal to or greater than $8.00 per square foot have high development value. Habitat lands with assessed values greater than $4.50 and less than $8.00 have medium development value. Habitat lands with assessed value below $4.50 per square foot have low development value.[27] Values are expressed as mean dollars per square foot. Map 1 shows that the highest values are centered on the city of Portland and surrounding concentrations of population and commercial activity. Areas of medium value surround the high valued areas and include areas of suburban population and commercial concentrations. Low values are found in the remaining outlying areas.

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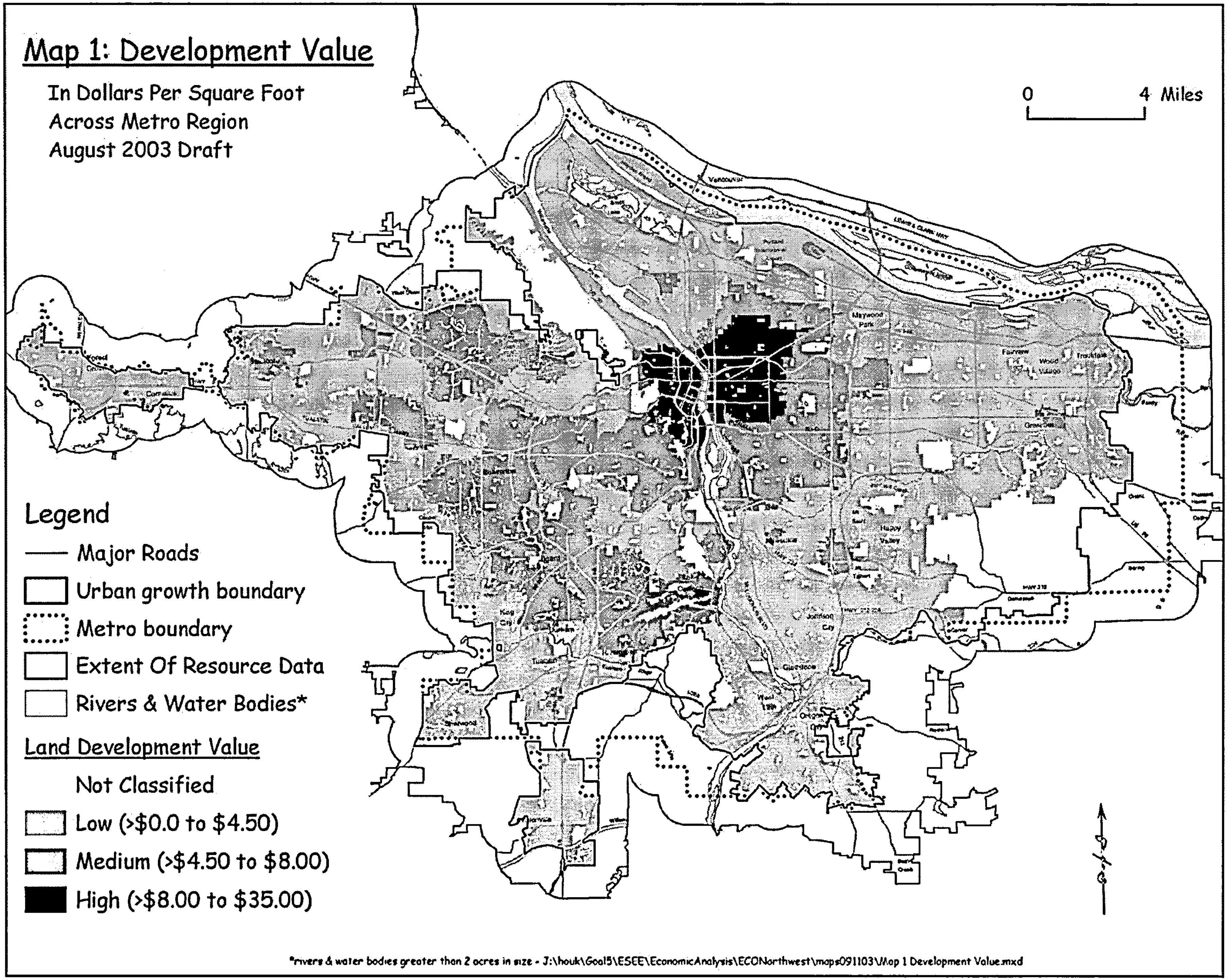
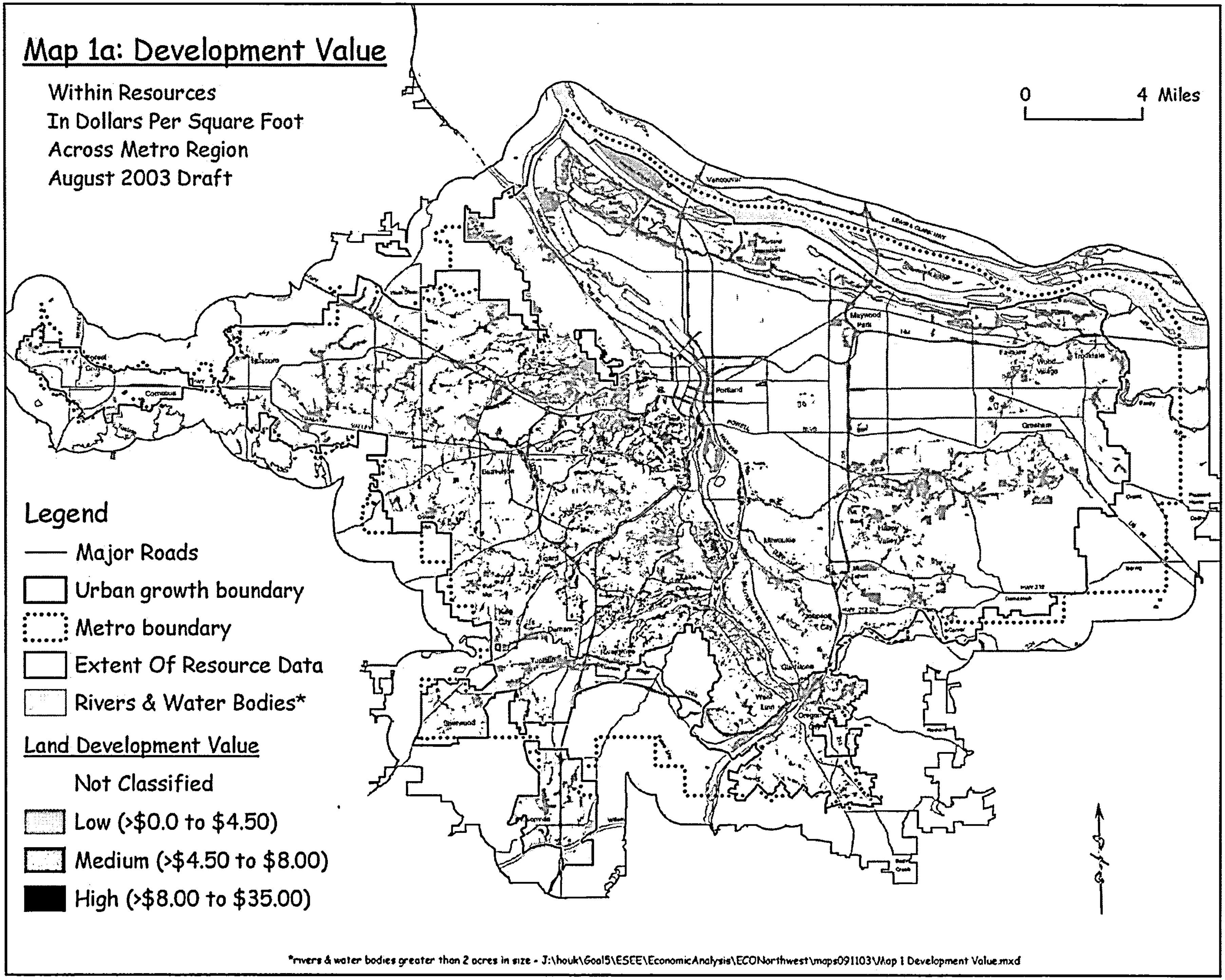
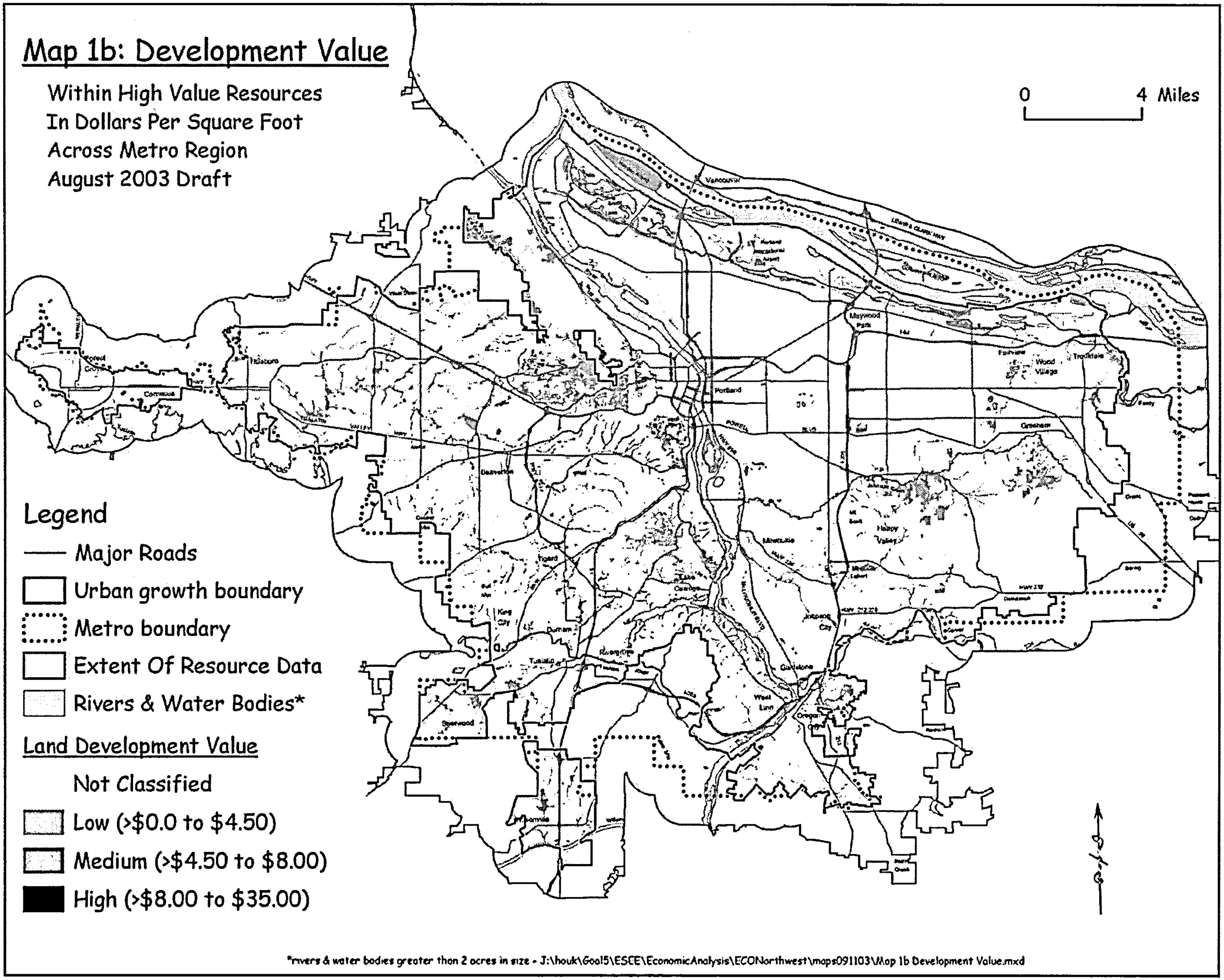
[26] See Conflicting Use chapter for description of 2040 design types.

[27] See Appendix C, *Final Report for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest 2004), for more information

Map 1a depicts the distribution of land values for the subset of lands in Metro's jurisdiction that contain fish and wildlife habitat. The large majority of these acres fall in the outlying or low category. Map 1b shows only those habitat lands that are ranked high for the quality of fish and wildlife habitat characteristics. Another way of describing the lands shown in Map 1b is that they represent the development value of lands that contain the most significant fish and wildlife habitat


Map 1: Development Value
In Dollars Per Square Foot
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
Land Development Value
Not Classified
Low (>$0.0 to $4.50)
Medium (>$4.50 to $8.00)
High (>$8.00 to $35.00)
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 1 Development Value.mxd


Map 1a: Development Value
Within Resources
In Dollars Per Square Foot
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
Land Development Value
Not Classified
Low (>$0.0 to $4.50)
Medium (>$4.50 to $8.00)
High (>$8.00 to $35.00)
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 1 Development Value.mxd


Map 1b: Development Value
Within High Value Resources
In Dollars Per Square Foot
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
Land Development Value
Not Classified
Low (>$0.0 to $4.50)
Medium (>$4.50 to $8.00)
High (>$8.00 to $35.00)
Portland
Vancouver
Gresham
Beaverton
Tigard
Milwaukie
Happy Valley
Hillsboro
Tualatin
Sherwood
Wilsonville
Gladstone
West Linn
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 1b Development Value.mxd

Rank lands based on employment potential

Employment potential associated with development is a way of ranking economic importance of land. The more employees that land can support, the more valuable it is for development. Employment density was modeled as employees per gross acre across the Metro region (using State 202 employment data[28]) and mapped using GIS. Jobs were assigned to vacant or undeveloped land based on jobs in surrounding areas with similar zoning.

Employment density was divided into "low," "medium" and "high" employment. Habitat lands with employment density equal to or greater than 16 jobs per acre have high development value. Habitat lands with employment density greater than four and less than 16 jobs per acre have medium development value. Habitat lands with employment density of four jobs per acre or less have low development value.[29]

The methodology for assigning jobs to vacant land and for defining three categories of employment density assumes that jobs are tied to a specific location and cannot move to other locations in the Metro region. This assumption is certainly not strictly correct; in some instances it may not be even approximately correct. To the extent that land uses that support these jobs can move elsewhere in the UGB, or be directed elsewhere in the future, these alternatives will help mitigate potential negative employment impacts of limit and prohibit decisions.

The measure of employment density does not capture the relative importance of residential development; however, ranking land based on land value, as described in the previous section, provides a measure of the relative development value of residential areas. Another limitation of this analysis is that it does not distinguish among jobs that are more "important" and those that are less "important" to the region's economy.

Map 2 shows the distribution of lands ranked by employment density. The low, medium and high categories in Map 2 correspond to the break points described above. Compared with the distribution of development values as described by land value (see Map 1), lands that support employment occupy a smaller subset of Metro's jurisdiction. That is because Map 2 excludes lands that do not support employment, primarily residential and park lands. Map 2 shows that lands that support employment predominate in the Portland city center and along transportation routes.

Map 2a depicts the distribution of employment density for the subset of lands in Metro's jurisdiction that contains significant fish and wildlife habitat. The large majority of these lands fall in the outlying or low category.

Map 2b shows the subset of lands from Map 2a that are ranked high for the quality of fish and upland wildlife habitat characteristics. Map 2b shows the employment density for lands that contain the most significant fish and wildlife habitat. Policy decisions that protect the most significant habitat would have the greatest impact on these lands.

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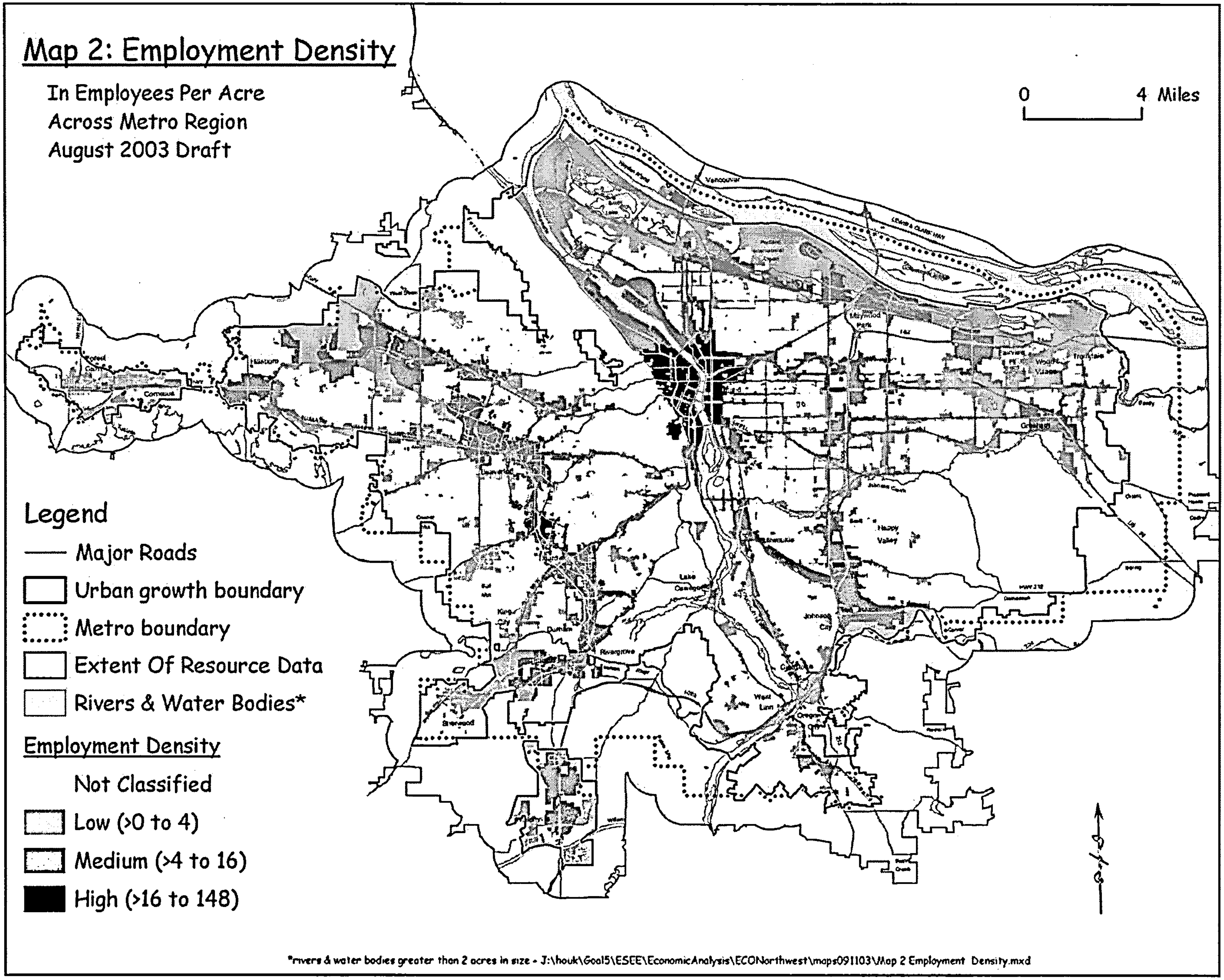
[28] 2002 employment data for the metropolitan region are from the Oregon Department of Revenue (referred to as the Employment Security, 202 tapes).

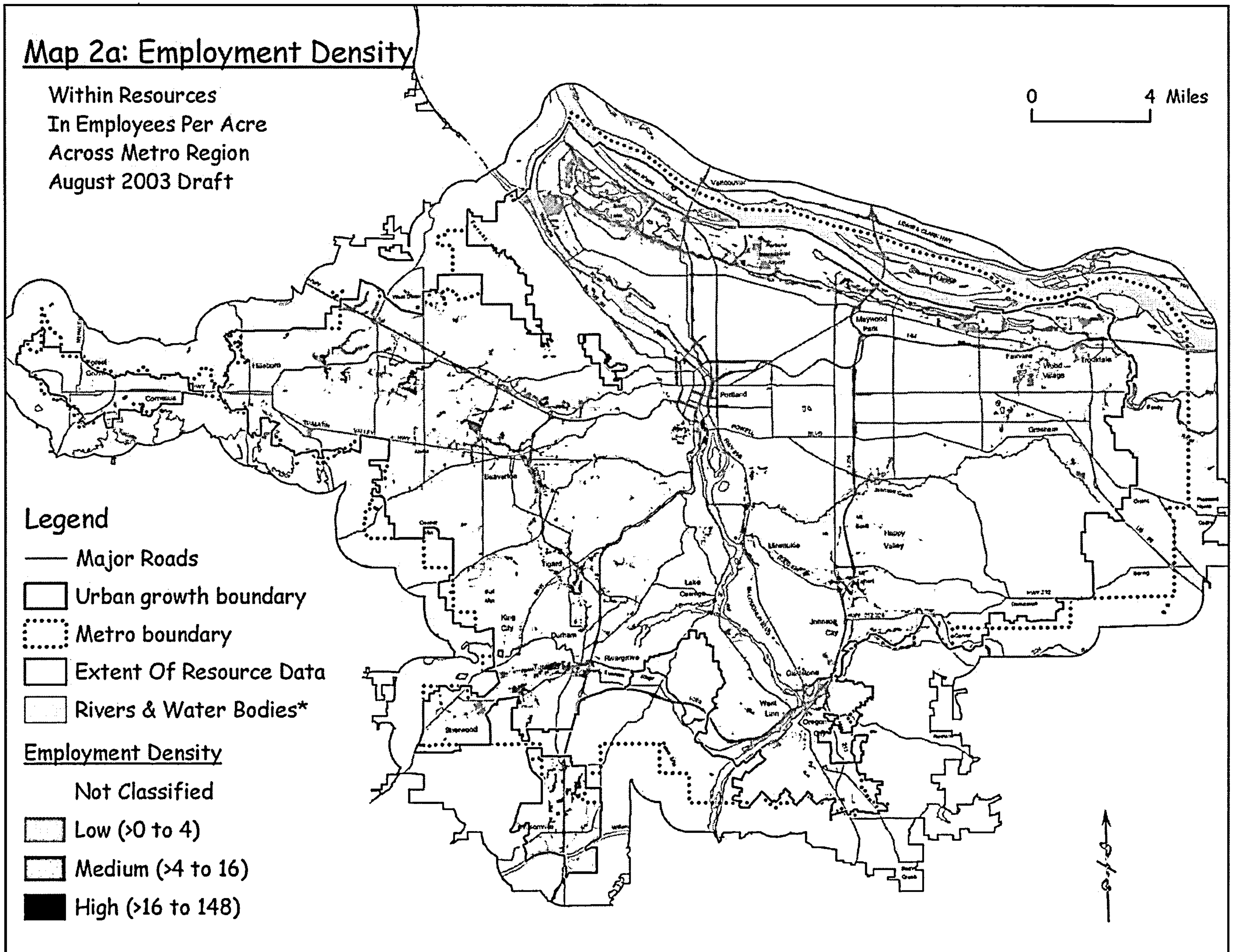
[29] See Appendix C: *Final Report for the Economic Portion of Metro's Goal 5 ESEE Analysis* (ECONorthwest 2004).



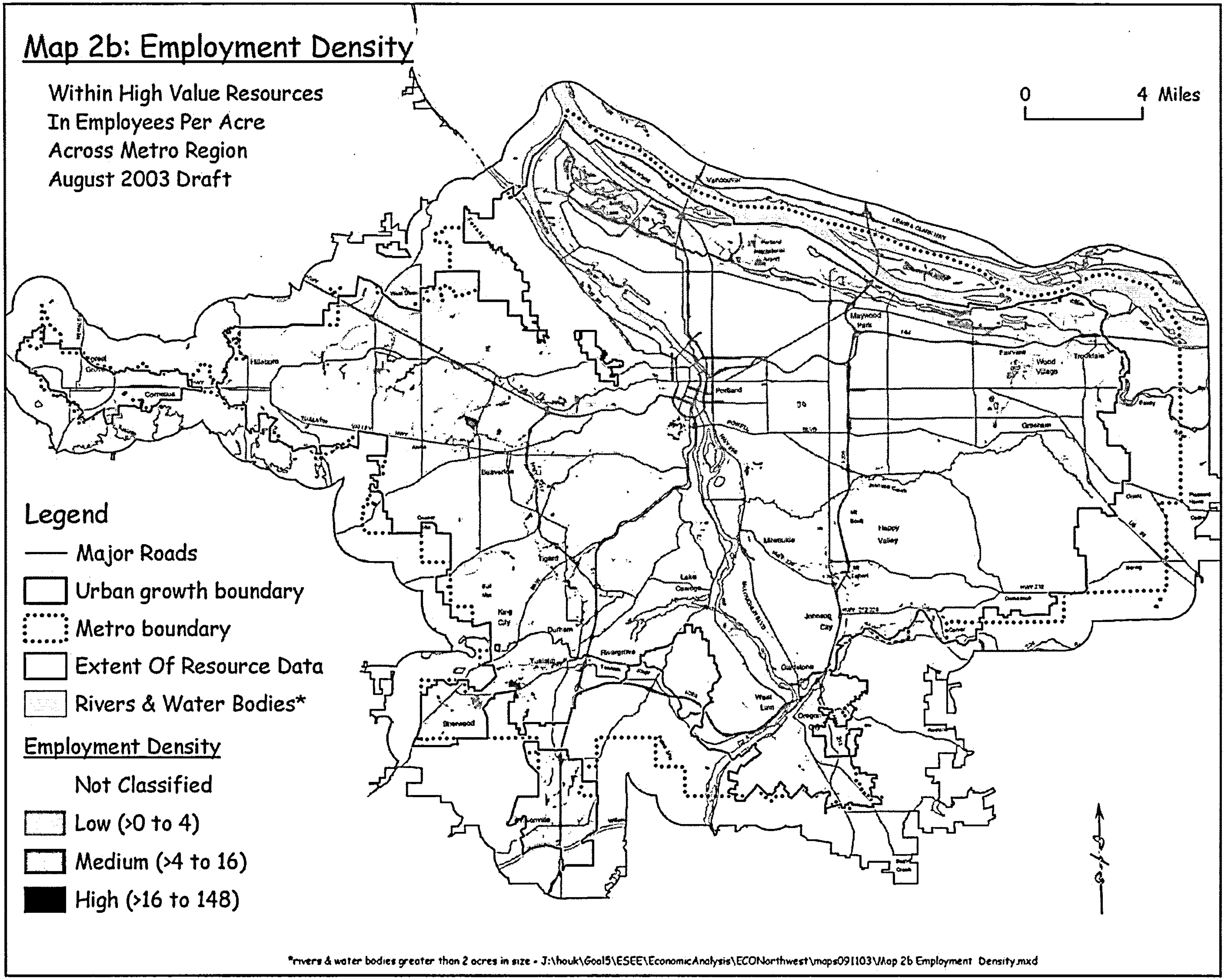
Map 2: Employment Density
In Employees Per Acre
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
Employment Density
Not Classified
Low (>0 to 4)
Medium (>4 to 16)
High (>16 to 148)
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 2 Employment Density.mxd

Map 2a: Employment Density

Within Resources
In Employees Per Acre
Across Metro Region
August 2003 Draft



*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 2a Employment Density.mxd


Map 2b: Employment Density
Within High Value Resources
In Employees Per Acre
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
Employment Density
Not Classified
Low (>0 to 4)
Medium (>4 to 16)
High (>16 to 148)
Vancouver
Portland
Hillsboro
Beaverton
Tigard
Gresham
Milwaukie
Happy Valley
Tualatin
Sherwood
Gladstone
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 2b Employment Density.mxd

Rank lands based on 2040 design types

Land value and employment density provide snapshot views of current conditions. For insights into future development patterns and associated economic importance of land, the 2040 design type hierarchy was used. As described in the *Conflicting Use* chapter, the success of the 2040 Growth Concept depends in large part on the implementation of regional transportation priorities. The Regional Transportation Plan (RTP) groups the 2040 design types into a hierarchy based on transportation investment priority. This hierarchy also helps to focus economic development priorities in areas that are most important to achieving the goals of the 2040 Growth Concept. For the purposes of this economic analysis, a modified grouping of the 2040 design types was used as follows:

- *Primary land use components* – central city, regional centers, industrial areas, and intermodal facilities
- *Secondary land use components* – town centers, main streets, station communities
- *Tertiary land use components* – inner and outer neighborhoods, employment centers, corridors, future urban lands
- *Other land use components* – parks and open space, rural lands

In general, land values and employment densities are expected to be higher for primary components and decrease moving from primary to secondary to tertiary and finally to other land use components.

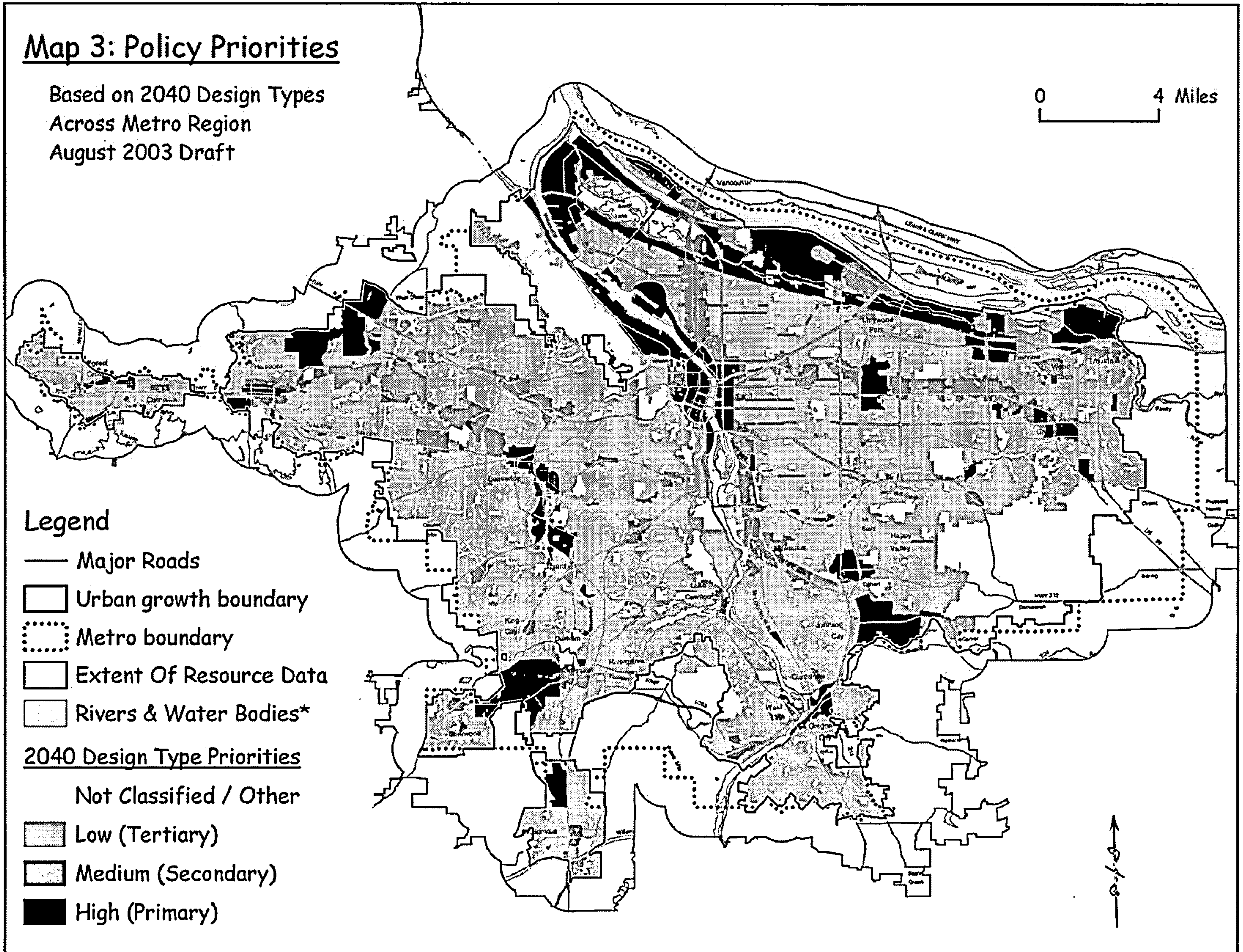
Maps 3, 3a, and 3b show the distribution of the four categories of 2040 design types. Map 3a shows the subset of lands in Map 3 that contain significant Goal 5 fish and wildlife habitat. Metro's Goal 5 decision will affect these lands. Map 3b shows the subset of lands in Map 3a that support the most significant Goal 5 fish and wildlife habitat.

Comparing Maps 1, 2, and 3 show that primary design types are distributed across more of Metro's jurisdiction than are areas of high land value or employment density, which are concentrated mostly in the downtown Portland area. This is especially true along the Columbia River and the Willamette River outside of downtown Portland. These industrial areas have low land values and employment densities for the most part, but have a primary design type designation. One interpretation of this difference is that the design types reflect public policies to support or enhance the industrial areas along the rivers for future development. Even though these areas have low land values and employment densities relative to the Portland city center, public policy considerations dictate that these industrial lands should be emphasized or enhanced for reasons other than land value or employment density.

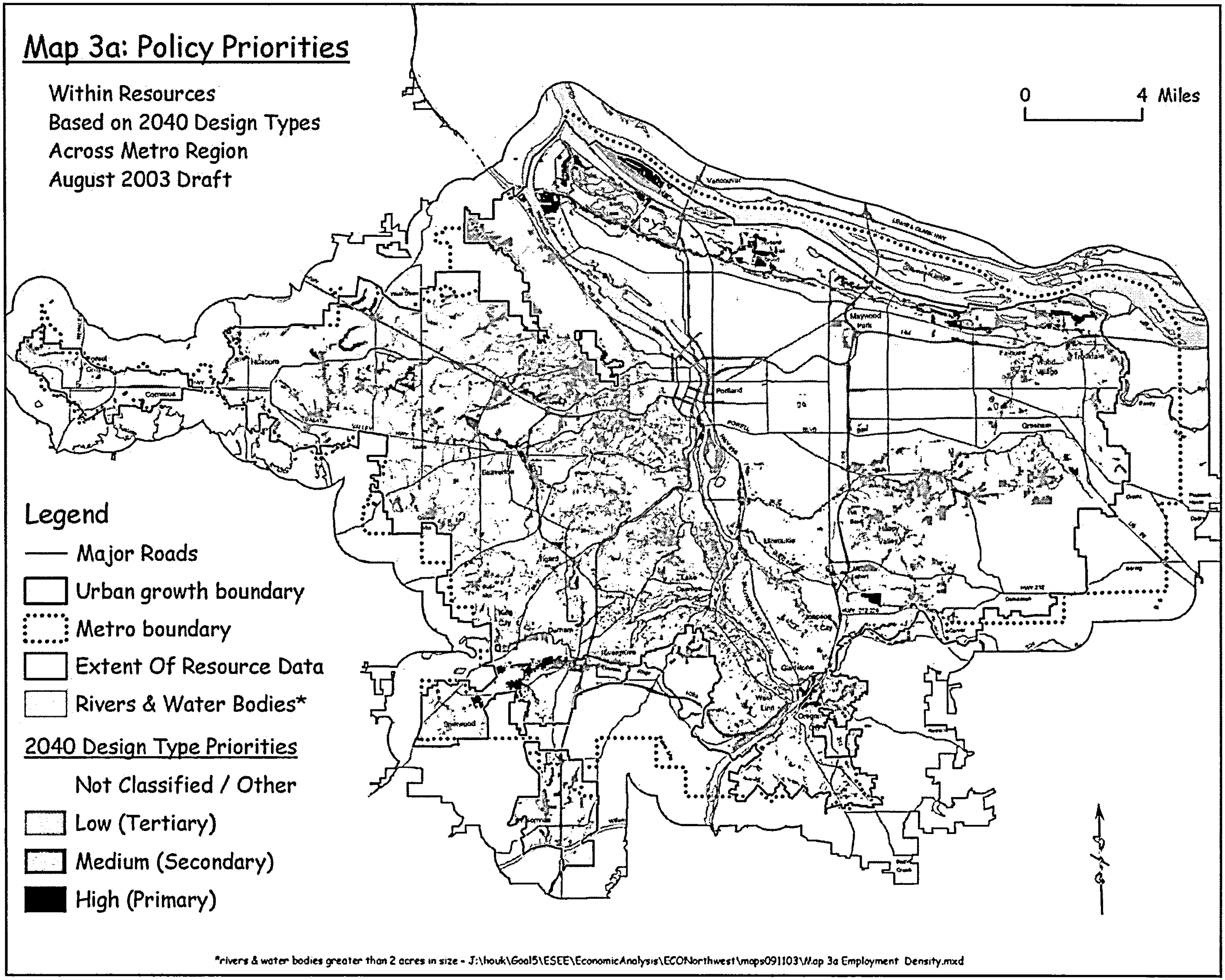
The preceding paragraph describes differences in distribution among the three measures of development value. There are also similarities. For example, just as most lands in Metro's jurisdiction rank low for land value and employment density, most lands also rank in the tertiary or other design type. Another similarity is that, with the exception of lands along the rivers, the distribution of lands with high and medium employment density has a pattern similar to the distribution of lands ranked primary and secondary design types.

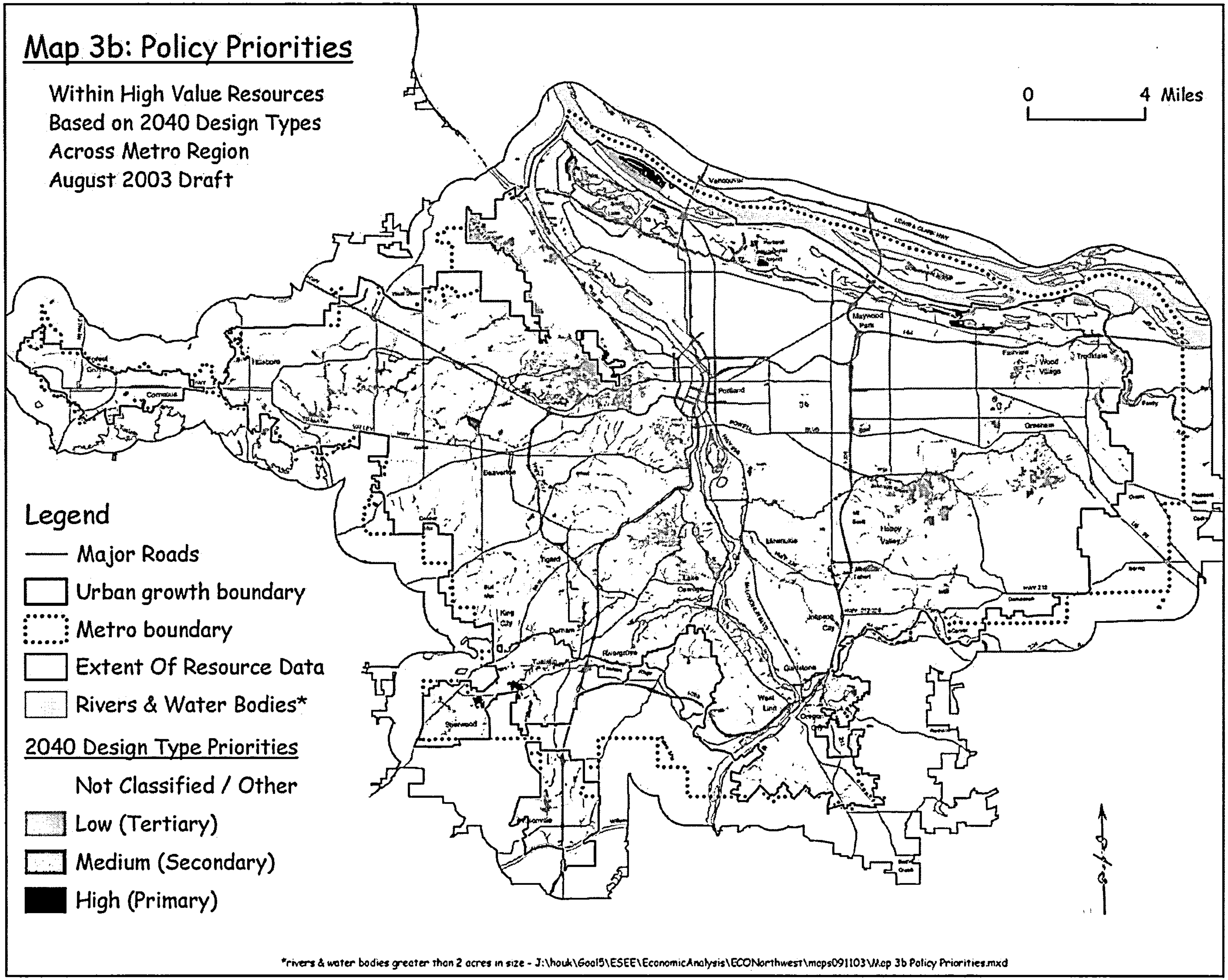
Map 3: Policy Priorities

Based on 2040 Design Types
Across Metro Region
August 2003 Draft



*rivers & water bodies greater than 2 acres in size - **These names could change in the future - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps\Map 3 Policy Priorities.mxd


Map 3a: Policy Priorities
Within Resources
Based on 2040 Design Types
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
2040 Design Type Priorities
Not Classified / Other
Low (Tertiary)
Medium (Secondary)
High (Primary)
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 3a Employment Density.mxd


Map 3b: Policy Priorities
Within High Value Resources
Based on 2040 Design Types
Across Metro Region
August 2003 Draft
0 4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
2040 Design Type Priorities
Not Classified / Other
Low (Tertiary)
Medium (Secondary)
High (Primary)
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 3b Policy Priorities.mxd

Limitations of the ranking methods

Land value

This method excludes land uses exempt from property taxes or underestimates the economic importance of lands that pay taxes at a diminished rate. Lands exempt from tax assessments—for example, schools, universities, and some hospitals—do not appear in the data base or analysis for this measure of economic importance. This method also underestimates the economic importance of lands with restricted or diminished tax assessments—for example, low-income housing, urban-renewal areas, and other land uses that benefit from public policies that subsidize tax payments. The analysis includes these lands in the ranking, but the rankings may not reflect these parcels' full value.

Employment density

This analysis calculates the average employment density across all land uses in a given GIS map unit. This method may underestimate or overestimate the employment density for some individual parcels. For example, the employment density for a GIS map unit that includes residential areas surrounding a university or hospital may underestimate the employment ranking for these facilities because of the relatively low employment densities found in the residential areas. The opposite is also true. Because the method calculates the average employment density per map unit, properties with lower-than-average densities will be represented by an average measure for the entire map unit that overestimates the employment density for these parcels.

Employment density does not distinguish between "more" important or "less" important jobs as described by employment income or employment multipliers. Employment density provides stakeholders and decisionmakers with employment information that exceeds the requirements for a Goal 5 ESEE analysis. Also, Metro uses employment density when addressing other land use issues that have employment consequences.[30] Finally, the 2040 design types capture to some degree the economic importance of land as described by employment multipliers.

2040 design types

The 2040 design types exclude certain land uses or underestimate the relative importance of a given land use. For example, several educational institutions are not located in designated design type areas. In other cases, what some consider a regionally significant land use, such as a regional medical center, is included in a lower level design type.

The land uses of concern—those for which the three methods used in the economic analysis either exclude or underestimate their economic importance—fall predominantly into four general categories: 1) transportation, 2) utilities, 3) education, and 4) health care. The following subsection briefly describes the relative economic importance of these land uses.

Transportation facilities and utilities: To stay competitive, cities must have modern and efficient physical infrastructure, including roads, bridges, water and sewer systems, airport and cargo facilities, energy systems and telecommunications. The economic literature shows a correlation between economic growth and transportation facilities and utility services. Well-functioning and efficient physical infrastructure helps promote improvements in productivity.

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[30] See the Metro report, *Technical Report: 1999 Employment Density Study*, April 6, 1999, revised May 5, 1999.

The quality of, and access to, transportation facilities and utilities can also directly influence production costs.

Education: The economic literature distinguishes between the economic importance of primary and secondary education, from college, university and post-graduate studies. Many high-skilled or knowledge-based workers can choose where they want to live, they can apply their skills to a variety of industries or have the ability to telecommute. Because they can pick and choose their locations, they choose those with quality amenities, including good elementary and secondary schools.

Given the current high demand for skilled labor, economic growth and development depends in part on access to a critical mass of employable persons with the necessary training and education. An educated workforce has become the primary location factor for growing companies. The most competitive cities recognize that businesses must locate near or have access to knowledge centers. Among the most important knowledge-based organizations are colleges and universities that provide trained personnel and research capacities. Companies also depend on training and continuing education facilities that help them become and remain learning organizations.

Increasing evidence suggests that promoting innovation, creativity, flexibility and adaptability will be essential to keeping U.S. cities economically vital and internationally competitive. Innovation is particularly important in industries that require an educated workforce. High-tech companies need to have access to new ideas typically associated with a university or research institute.

Medical services: Medical services contribute to a region's economic growth and development in a number of ways. In many municipalities, hospitals and medical clinics are among the largest employers. For example, in the Portland area, OHSU is the region's top employer. Medical schools and research facilities provide important education related services that help support the growth and development of knowledge-based businesses. The availability of high quality and diverse medical services also contributes to a region's quality of life, which helps attract and retain high skilled, and highly educated workers.

How is land ranked based on the economic importance for ecosystem services?

Ecosystem services are the beneficial outcomes, for the natural environment or people, that result from ecosystem functions. Overlap exists between the ecological functions of riparian corridors and upland wildlife habitat and the ecosystem services that benefit society and have economic value (see Table 4-1). For example, the ecosystem function of tree canopy and foliage shading streams helps reduce air and water temperatures, which may benefit society by reducing cooling demands in summer and by protecting species such as salmon that have recreational, commercial and intrinsic value. The ecosystem functions of streamflow moderation and water storage help moderate flooding, which benefits society by reducing flood damage and flood management costs. The ecosystem functions of bank stabilization and sediment and pollution control may help reduce landslides and maintain water quality, which benefits society through avoided costs to filter and treat water. Wildlife habitat may benefit society by supporting species with commercial and recreational value. Riparian corridors and wildlife habitat provide amenity benefits such as scenic views and open space.

Table 4-1: Ecological functions, wildlife characteristics and related ecosystem services that benefit society.

Ecological Functions (Riparian)	Ecosystem Services
Microclimate shade and cooling	Moderating summer temperatures, which reduces energy demand for cooling.
Stream flow moderation and improved water storage	Reduced flood damage and flood-management costs.
Bank stabilization and sediment and pollution control	Improved water quality. Reduced demand for water filtration and treatment. Reduced landslides and related damage and clean-up costs.
Large woody debris and channel dynamics	Reduced flood damage and flood-management costs.
Well-functioning riparian areas in general	Amenity and intrinsic values associated with riparian areas.
Ecological Functions (Wildlife Characteristics)	
Habitats of concern and habitats for unique and sensitive species	Increased population of salmon and associated increase in commercial, recreational, spiritual and intrinsic value.
Well-functioning wildlife habitats in general	Amenity and intrinsic values associated with wildlife habitat.

Source: ECONorthwest 2003.

Describing the value of ecosystem services is more challenging than describing the value of development related attributes. No single measure of the economic value of ecosystem services captures the complete value of all services provided by riparian corridors and upland wildlife habitat. ECONorthwest's literature review[31] describes various studies (e.g., hedonic analysis, replacement cost, avoided cost, travel cost, contingent valuation, benefit-transfer) that provide information and perspectives on the value of ecosystem services. The review also reports values for a range of ecosystem services (e.g., flood management, water quality, habitat that supports salmon, amenity and intrinsic values) as described in academic literature and other sources.

During the inventory process, regionally significant riparian corridors and upland wildlife habitat were determined based primary and/or secondary ecological services they provide. ECONorthwest concluded in their literature review that Metro's inventory and ranking of riparian corridors and upland wildlife habitat provide a basis from which to identify the ecosystem services provided by this habitat that have value to society. Even though the inventory ranking did not focus on the economic value of these habitats, it provides insights into the relative economic importance. That is, resources that ranked high (for ecological functions) provide more of the type of ecosystem services that society values than do areas that ranked low.

For the ESEE analysis, riparian corridors and upland wildlife habitat were divided into six classifications (three riparian, three wildlife), each representing discreet areas on the landscape

[31] Appendix C: *Final Draft Literature Review for the Economic Portion of Metro's Goal 5 ESEE Analysis* (October 2004).

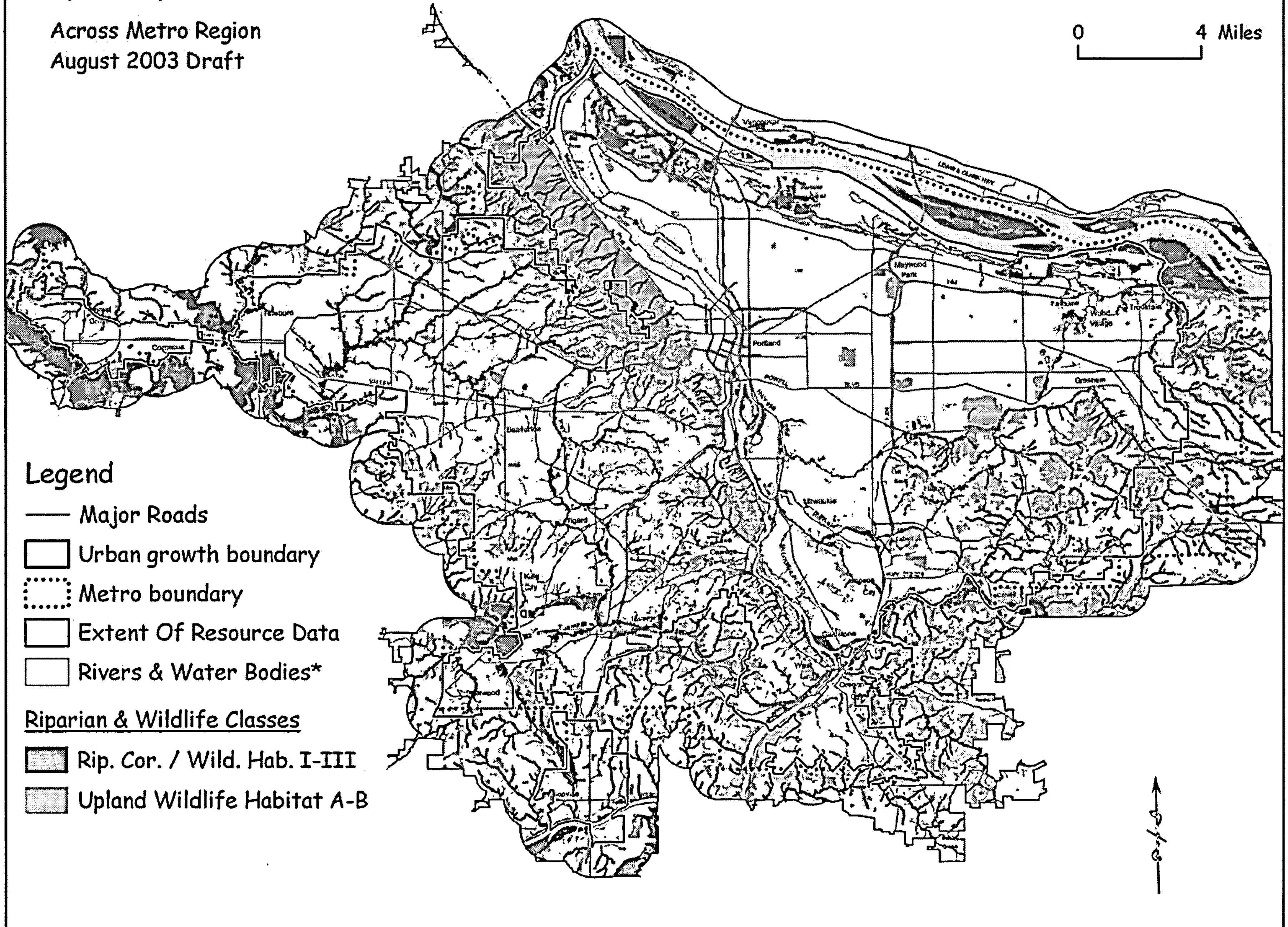
(see description in the *Conflicting Use* chapter). This was done to distinguish higher value habitat from lower value habitat for consideration of allow, limit and prohibit consequences. This analysis assumes that areas that provide more of the ecological functions and wildlife characteristics provide more ecosystem services and value to society than do areas that provide fewer functions and characteristics. It also assumes that actions that enhance or protect ecosystem services will have positive economic consequences, and actions that degrade these services will have negative economic consequences, specific to these services. For purposes of this analysis, the six classifications have been grouped into three categories: high value, medium value and low value (see Table 4-2).

Table 4-2. Ranking for economic importance for ecosystem services.

High Value Habitat	Medium Value Habitat	Low Value Habitat
Class I riparian/wildlife corridors	Class II riparian/wildlife corridors	Class III riparian corridors
Class A upland wildlife habitat	Class B upland wildlife habitat	Class C upland wildlife

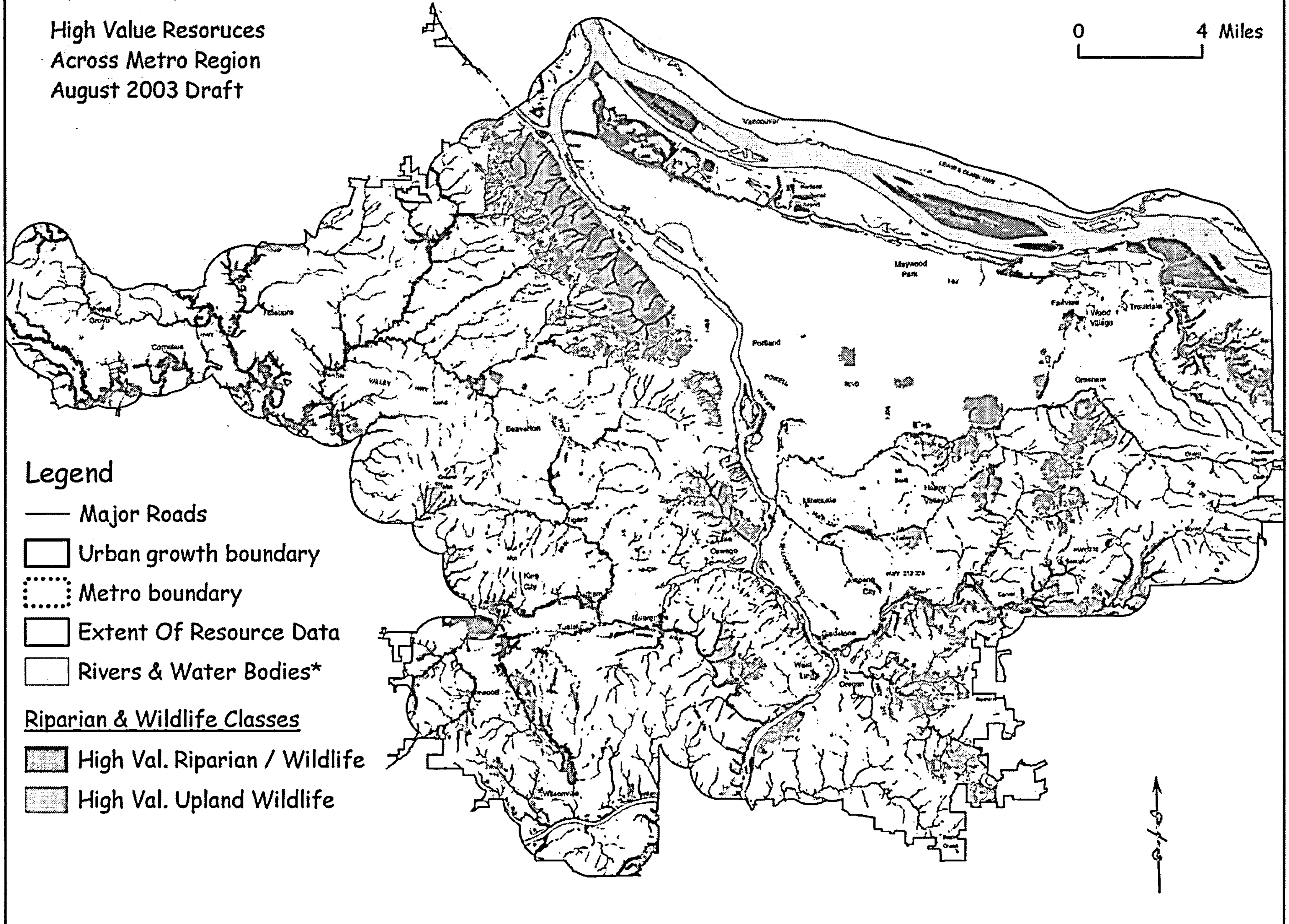
Map 4 shows the distribution of the riparian and wildlife habitat classes across Metro's jurisdiction. The map shows that with one notable exception, the area between the Willamette and Columbia rivers, fish and wildlife areas cover much of Metro's jurisdiction. The areas with little or no fish or wildlife habitat are historically the most intensely developed areas. Map 4a shows the distribution of the highest valued habitat lands: Class I riparian/wildlife corridors and Class A upland wildlife habitat.

Map 4: Riparian & Wildlife Classes



*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 4 Riparian & Wildlife Classes.mxd

Map 4a: Riparian & Wildlife Classes



*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 4a Riparian and Wildlife.mxd

What are the interactions between development value and ecosystem services value of fish and wildlife habitat?

The *Conflicting Use* chapter described lands within the UGB, in UGB expansion areas and the remaining areas within Metro's jurisdiction (outside the UGB) in various ways. This section relies on that data and other data generated from this economic analysis to provide insight on the amount and distribution of significant interactions between development use and habitat protection. This information is relevant because the economic consequences of allowing, limiting, or prohibiting development differs by development value and ecosystem services value.

To provide background for this analysis, this section begins by recapping information from the *Conflicting Use* chapter on the development status of fish and wildlife habitat, and the potential conflicts based on generalized regional zones. It then presents data and analysis on the economic interactions between development value (land value, employment density, 2040 design types) and habitat type (Class I-III riparian corridors, Class A-C upland wildlife).

Development status of fish and wildlife habitat and impact areas

The development status is relevant to the economic analysis because it can influence the type, amount and timing of the economic consequences of allow, limit and prohibit decisions. Of the four development categories shown in Table 4-3 below, lands in the developed/park status would be least affected by Metro's Goal 5 decisions. To the extent that lands in this development status includes private lands such as golf courses, these uses may be affected in some way by Goal 5 decisions, but any impact will be more limited compared with potential impacts to land in developed urban uses.

Table 4-3: Fish and wildlife habitat by development status and as a percentage of total lands in the development status in the UGB (2002).

Development Status	% of Fish & Wildlife Habitat	% of Total in Development Status
Developed (parks)	34%	66%
Developed (urban)	28%	10%
Vacant (constrained)	16%	67%
Vacant (buildable)	22%	41%
Total	100%	(not applicable)

Development on lands in the vacant constrained status is already affected more by Title 3 (Water Quality and Flood Management) and other regulations. Goal 5 decisions may have impacts on these lands; however, it will be to a lesser degree than on vacant land unconstrained by Title 3 or other regulations. Goal 5 decisions may affect lands in the developed/urban status in the future if the properties are redeveloped or existing uses expand to cover more of the property. Lands in the vacant buildable status may be most immediately affected by Goal 5 decisions.

Table 4-3 also shows habitat lands as a percentage of total lands (both fish and wildlife habitat and non-fish and wildlife habitat) in development categories in the UGB. For example, 34 percent of fish and wildlife habitat are in the developed/parks category and they account for approximately 66 percent of the total developed/parks in the UGB. Developed/urban lands account for 28 percent of fish and wildlife habitat, but these lands represent just 10 percent of total developed/urban acres in the UGB. Vacant constrained lands contain 16 percent of the fish and wildlife habitat, representing 67 percent of total vacant constrained acres in the UGB. Twenty-two percent of fish and wildlife habitat is vacant buildable, and these lands account for a significant percentage (41 percent) of the total vacant buildable acres in the UGB.

Figure 4-1: Development status of impact areas.

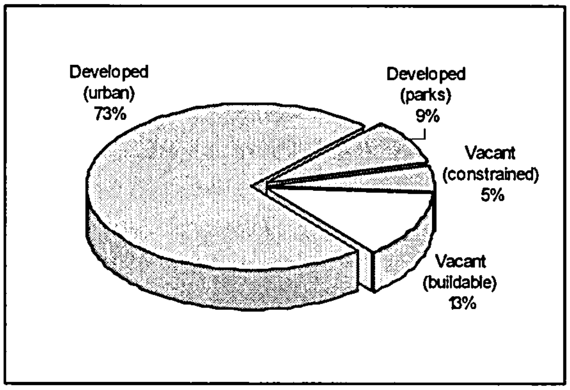
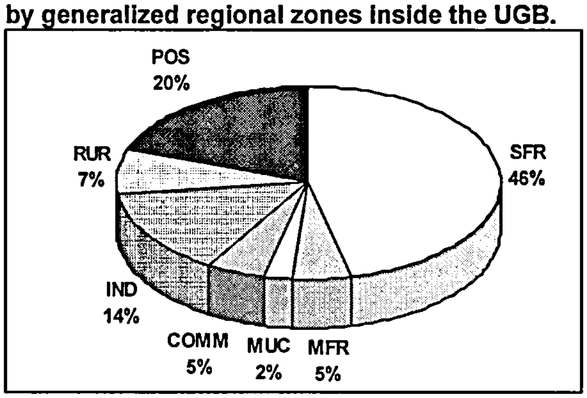


Figure 4-1 shows that most impact areas (see Chapter 2: *Impact Areas* for definition) are developed as urban. The distribution of development values for impact areas follow the distributions of land value, employment density and 2040 design types described earlier for lands containing fish and wildlife habitat. Most impact areas are characterized by low land value or employment density, or design types that have low land value and employment.

Fish and wildlife habitat by generalized regional zones

As Figure 4-2 shows, approximately 46 percent of the fish and wildlife habitat occur on lands zoned as single-family residential. Other zones with a significant percentage of fish and wildlife habitat are parks and open space (20 percent) and industrial (14 percent). Together, these three zones account for 80 percent of the fish and wildlife habitat.

Figure 4-2: Percentage of fish & wildlife habitat by generalized regional zones inside the UGB.



Lands outside the UGB and within Metro's jurisdiction are primarily zoned rural residential, and agricultural and forestry lands. Relative to the Portland City center, these lands have low land value and employment density. These lands have not yet been categorized by 2040 design types.

Fish and wildlife habitat classifications

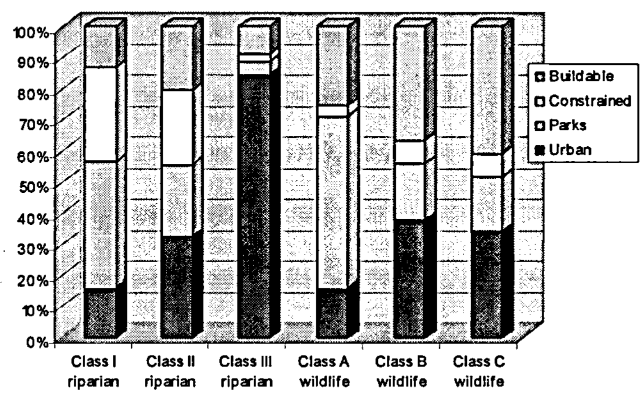
Fish and wildlife habitat classifications are defined in the *Conflicting Use* chapter. Table 4-4 shows the percentage of fish and wildlife habitat in each classification. Notice that the percentage declines from Class I to Class III and from Class A to Class C. Fifty-six percent of the inventory lands is in high value riparian/wildlife corridors (Class I) and upland wildlife habitat (Class A). Twenty-seven percent of the inventory land is medium value (Class II/B) and the remainder (17 percent) is low value fish and wildlife habitat.

Table 4-4: Percentage of fish and wildlife habitat by habitat classifications.

Fish and wildlife habitat classification	Percent of total fish & wildlife habitat
Riparian/wildlife Class I	32%
Riparian/wildlife Class II	14%
Riparian Class III	8%
Upland Wildlife Class A	24%
Upland Wildlife Class B	13%
Upland Wildlife Class C	9%
Total	100%

Figure 4-3 shows that, in general, the percentage of land in a given habitat type (i.e., riparian/wildlife corridors, upland wildlife habitat) that is developed as urban increases moving from high value (Class I/A) habitat to low value habitat (Class III/C). For example, 16 percent of Class I riparian/ wildlife corridors is developed as urban, whereas 85 percent of Class III is developed as urban. These results are consistent with the map of significant fish and wildlife habitat (Map 4), which shows very few significant resources in areas with the longest history of more intensive urban development.

Figure 4-3: Fish and wildlife habitat classification by development status.



Much of the Class I/A land is in parks and opens space: 41 percent of Class I lands and 56 percent of Class A lands. This percentage drops significantly when moving to Class II/B, 23 percent and 18 percent, respectively.

The greatest percentage of vacant constrained land falls in Class I and II riparian/wildlife corridors (30 percent and 24 percent, respectively). This makes sense because many of these areas are located in floodplains. In the vacant buildable status, a higher percentage of habitat lands is upland wildlife habitat compared to riparian/wildlife corridors.

Development value

Development value, or the economic importance of land for development, is measured by land value, employment value, and 2040 design type hierarchy. The following analysis describes the interaction between individual measures of development value and fish and wildlife habitat.

Land value

Table 4-5 below demonstrates that the percentage of fish and wildlife habitat classifications with no land value (as determined by tax assessors)[32] declines from Class I riparian/wildlife and Class A upland wildlife habitat to Class III riparian and Class C upland wildlife. The percentage of lands with low and medium land value increases across these same classes of riparian and upland wildlife habitat. None of the lands in Class I and only three percent of lands in Class III have high land value. One percent of land in the remaining classes are categorized as having high land value.

Map 1a shows the overlap of the three classes of land value on fish and wildlife habitat. Map 1b shows the overlap on high valued habitat lands (Class I/A) only. These maps illustrate the distribution of land value described in Table 4-5. Comparing Map 1a with Map 4 (Riparian and Wildlife Classes) shows that a significant portion of the lands that contains fish and wildlife habitat does not support development value as measured using land value. Map 1b shows that a relatively small percentage of the fish and wildlife habitat that support land value are ranked high valued habitat (Class I/A).

Table 4-5: Percentage of fish and wildlife habitat by land value.

Land Value	Riparian/ Wildlife I	Riparian/ Wildlife II	Riparian III	Upland Wildlife A	Upland Wildlife B	Upland Wildlife C
% of habitat with no land value (as determined by tax assessor)	43%	25%	7%	57%	19%	19%
% of habitat with **low** land value	48%	61%	69%	38%	59%	62%
% of habitat with **medium** land value	9%	14%	22%	4%	22%	18%
% of habitat with **high** land value	0%	1%	3%	1%	1%	1%
Total	100%	100%	100%	100%	100%	100%

Employment Value

Table 4-6 lists the percentage of fish and wildlife habitat classifications that does not support employment and, the percentage categorized as having low, medium, and high employment density, relative to the Portland city center.[33] The table shows that much of the fish and wildlife habitat is zoned for uses that does not support significant amounts of employment. For example,

[32] Excludes a measure of the land value of public institutions, such as parks and schools, and public infrastructure such as roads, sewer and water services.

[33] See the full table of interactions in the Appendix for the number of acres by zoning type ranked low, medium and high employment density.

83 percent of Class I riparian/wildlife corridors and 95 percent of Class A upland wildlife habitat are zoned for single-family residential, multi-family residential, rural, and parks and open space. Of the acres in zonings that support employment, such as industrial, commercial and mixed use, 11 percent of Class I lands and three percent of Class A lands are categorized as having low employment density relative to the Portland city center.

In general, the percentage of lands that does not support employment declines from Class I/A to Class III/C. However, the percentage of lands with low employment value increases from Class I/A to Class III/C. Two out of the six classes of significant fish and wildlife habitat, Class II and III, have lands designated as high employment value. However, these lands represent a very small percentage, one and two percent respectively, of the total lands in these classes.

Table 4-6: Percentage of fish and wildlife habitat by employment density value.

Employment Density	Riparian/ Wildlife I	Riparian/ Wildlife II	Riparian III	Upland Wildlife A	Upland Wildlife B	Upland Wildlife C
% of habitat that does not support employment	83%	72%	51%	95%	91%	75%
% of habitat supporting **low** employment	11%	18%	30%	3%	5%	18%
% of habitat supporting **medium** employment	6%	9%	17%	2%	4%	7%
% of habitat supporting **high** employment	0%	1%	2%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%

Map 2a shows the overlap of the three classes of employment density on all classes of fish and wildlife habitat. Map 2b shows the overlap of the three classes of employment density on high valued habitat (Class I/A) only. These maps illustrate the distributions shown in Table 4-6. Maps 2a, employment density, and Map 4, fish and wildlife habitat inventory, illustrate that much of the inventory is zoned parks and open space or residential, which are not considered employment generating uses. Also, of the habitat lands that do support employment, very little of these lands support high employment densities. Map 2b shows the same trends but for high valued habitat lands (Class I/A) only. Comparing Map 1a with Map 2a shows that more of the fish and wildlife habitat lands support development value as measured by land value compared with development value measured by employment density.

2040 design types

Table 4-7 shows the distribution of fish and wildlife habitat classifications by the 2040 design type hierarchy. This distribution differs from the trends described for land value and employment density. In general, more of the fish and wildlife habitat have high economic value from a policy perspective than from a land value or employment generation perspective. Map 3a shows the overlap of the three design type priorities on all classes of fish and wildlife habitat. Map 3b shows the same overlap but for high valued habitat lands (Class I/A) only. As with land value and employment, much of the fish and wildlife habitat does not support development values as measured by 2040 design types (see Map 3a compared with Map 4). Map 3b and Map 4 show that, relative to the total distribution of fish and wildlife habitat, the overlap of high valued habitat with primary 2040 design types covers a small area.

Table 4-7: Percentage of fish and wildlife habitat by 2040 design type hierarchy.

2040 Design Type Hierarchy	Riparian/ Wildlife I	Riparian/ Wildlife II	Riparian III	Upland Wildlife A	Upland Wildlife B	Upland Wildlife C
% Other design types that do not support development value	35%	15%	2%	52%	13%	10%
% Tertiary (low)	48%	60%	52%	44%	79%	68%
% Secondary (medium)	5%	6%	13%	2%	3%	7%
% Primary (high)	12%	18%	33%	2%	5%	15%
Total	100%	100%	100%	100%	100%	100%

Comparing Table 4-7 with Tables 4-5 and 4-6 illustrates that more fish and wildlife habitat have development value when ranking these lands using design types than rankings based on land value or employment. However, a significant percentage of lands still falls in the low valued development category (tertiary). Except for Classes A and B (upland wildlife habitat), which have a relatively small percentage of land in the high category (primary), the other classes have a significantly larger percentage of land in the high category, relative to land value and employment measures. As illustrated in the next table (Table 4-8), much of this high valued land is zoned for industrial use.

Single-family residential, parks and open space, and industrial generalized regional zones account for 80 percent of significant fish and wildlife acres (see Figure 4-4). Cross referencing the number of habitat acres for these zoning types with primary, secondary, tertiary and other 2040 design types illustrates interactions between habitat land and future land use as described by the design types. Table 4-8 shows the major interactions.

Table 4-8: Interactions between fish and wildlife habitat by zoning and 2040 design types hierarchy in the UGB (2002).

Generalized Regional Zones	% of Fish & Wildlife Habitat Classified as Tertiary & Other	% of Fish & Wildlife Habitat Classified as Primary
Single-family residential	98%	1%
Parks and open space	98%	0.3%
Industrial	33%	60%

Source: Data analysis by Metro staff and ECONorthwest.

Ninety-eight percent of fish and wildlife habitat acres zoned as single-family residential and parks and open space is classified as tertiary or other design types, but only 33 percent of industrial acres is classified by these design types. In contrast, sixty percent of fish and wildlife habitat acres in industrial zoning is classified as a primary 2040 design type, with one percent or less of single-family and parks and open space acres in the primary design type.

As illustrated in Tables 4-5 and 4-6, estimating development value using land value or employment found that the large majority of fish and wildlife habitat acres either do not support development value or have a low value, relative to acres in the Portland city center. Estimating development value using 2040 design types has similar results for land in single-family or parks and open space zoning but not for acres in industrial zoning, as noted above. To the extent that 2040 design types describe future development patterns in the UGB, it appears that the future interactions between high development values and significant fish and wildlife habitat will occur mostly on land zoned for industrial use.

Combined measures

The analysis above describes the interaction between *individual* measures of development value, for example, land value, employment, 2040 design types, and fish and wildlife habitat. The following analysis describes the interactions between the *combined* measures of development values and significant fish and wildlife habitat.

As described above, the development value of acres containing significant habitat was ranked based on high, medium, and low land values and employment density. For these same acres development value is also described using primary, secondary, tertiary and other 2040 design types. The "other" design type includes parks, open space, and rural lands, which are expected to have a low development value.

Table 4-9 describes the interactions between the combined measures of development value and fish and wildlife habitat for the three zoning types, single-family residential, parks and open space and industrial, which account for 80 percent of the acres of significant habitat. The second column in Table 4-9 lists the percentage of habitat acres that fall into the "other" design type. The percent of habitat acres that score low on all three measures of development value is listed in the third column. The fourth column lists the percentage of habitat acres that score at least one medium value and no high values. The percentage of habitat acres that scored high on at least one measure of development value is shown in the fifth column.

Table 4-9: Interactions fish and wildlife habitat by zoning and combined measures of development value in the UGB (2002).

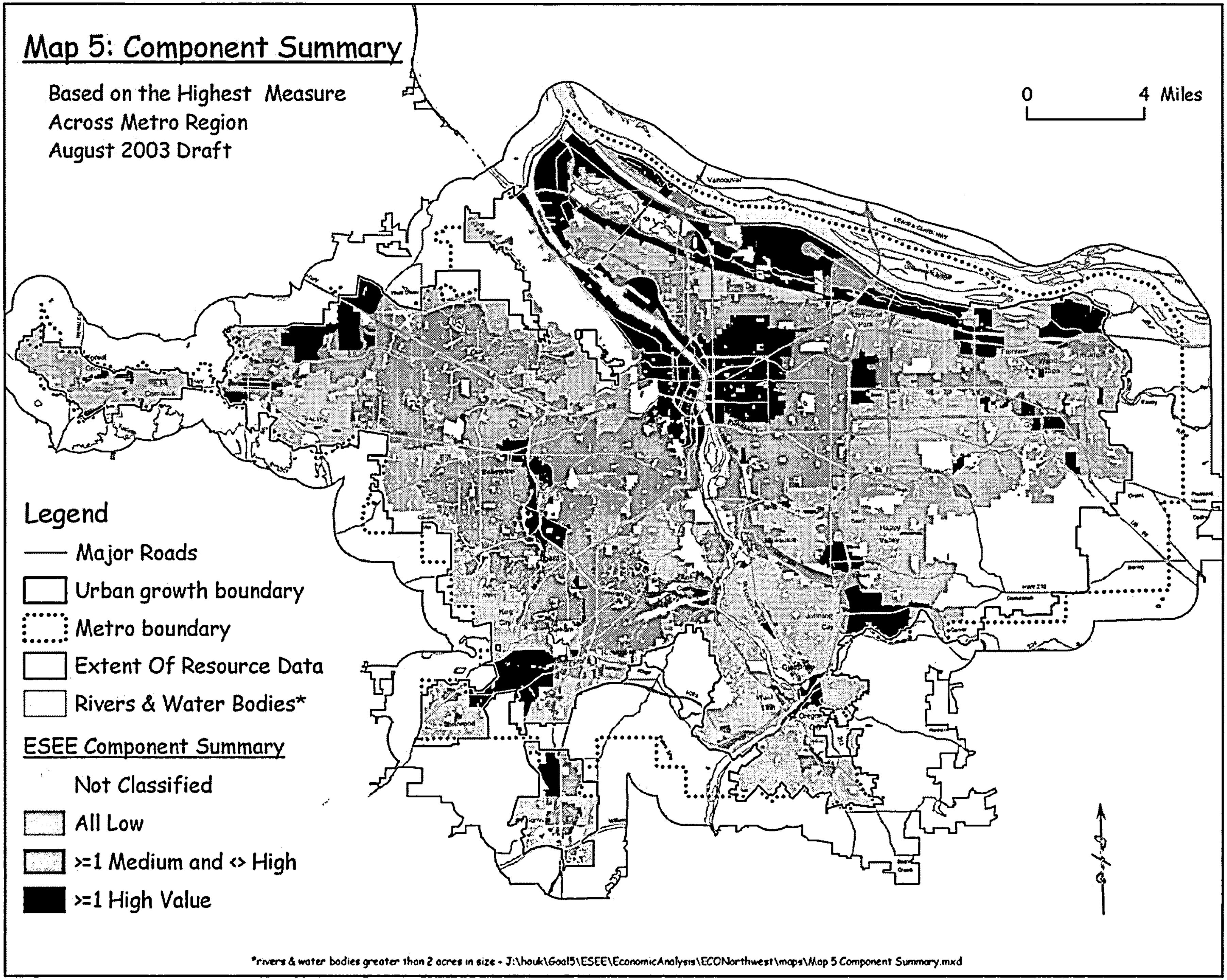
Generalized Regional Zones	% of Habitat Acres Classified as "Other" Design Type	% of Habitat Acres with All Low Measures	% Habitat Acres with at Least One Medium Measure, No High Measures	% of Habitat Acres with at Least One High Measure
Single-family Residential	17%	61%	21%	2%
Parks and Open Space	81%	17%	2%	0.3%
Industrial	10%	14%	15%	61%

Source: Data analysis by Metro staff and ECONorthwest.

Similar to the results illustrated in Table 4-8, Table 4-9 shows how interactions for industrial lands differ from interactions for single-family or parks and open space. For example, approximately 17 percent of fish and wildlife habitat in single-family zoning is in the "other" design type; 61 percent scored low on all three measures of development value. For parks and open space the percentage of habitat acres in these two categories is even higher, approximately 98 percent. In contrast, for habitat acres in industrial zoning, approximately 24 percent is in these two low categories, with approximately 61 percent of the industrial acres scoring high on at least one measure of development value. As noted in Table 4-7, most of these acres scored high on the 2040 design type measure of development value. A very small percentage of habitat acres in single-family or parks and open space scored high on any of the measures of development value.

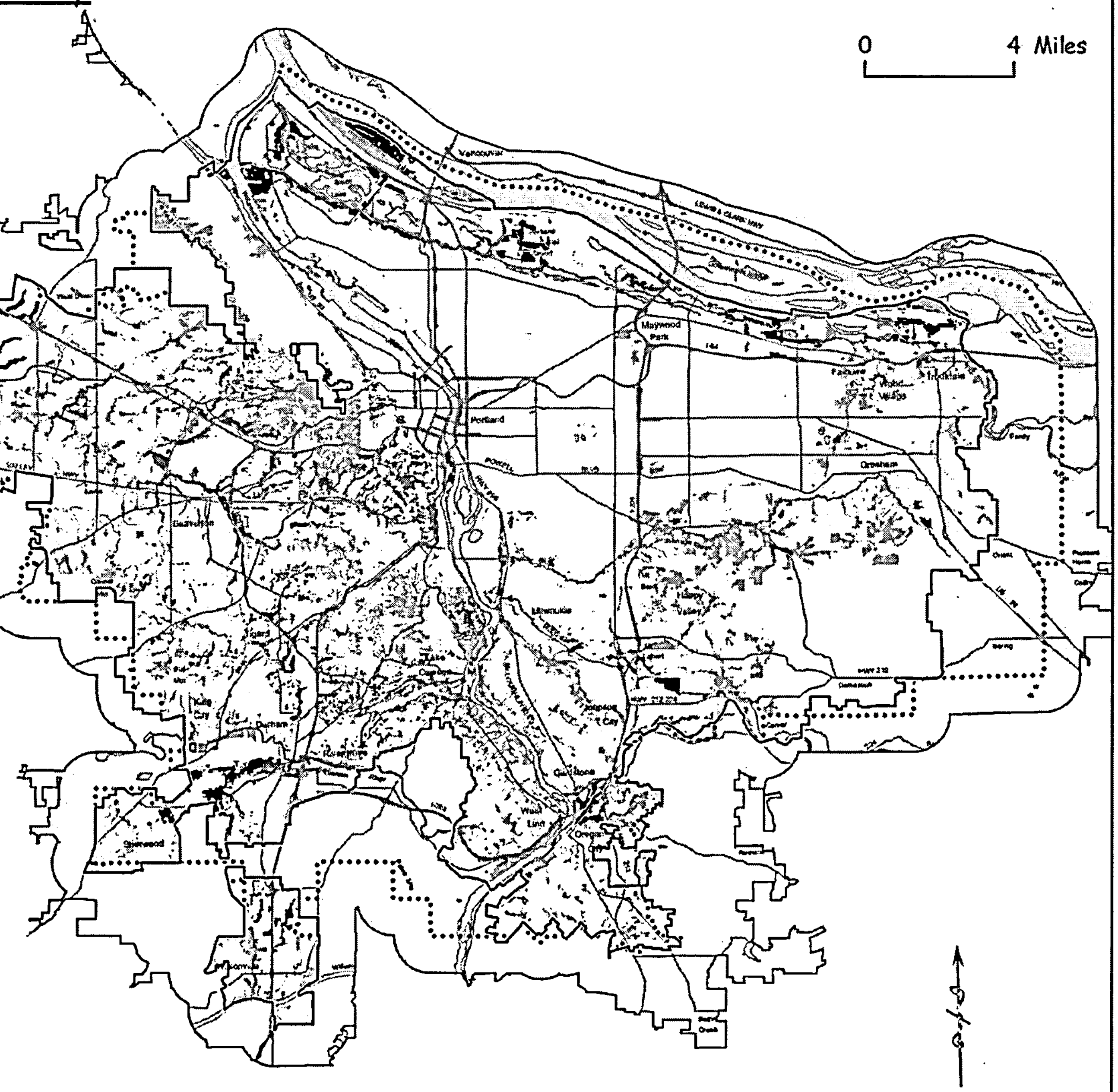
Maps 5, 5a and 5b show the distribution of the three combined measures: areas that scored low on all three measures of development value, areas that scored medium on at least one measure without scoring high on any measures, and areas that scored high on at least one measure. Map 5a shows the overlap of the combined measures on all habitat lands and Map 5b shows the overlap of combined measures on high valued habitat lands (Class I/A) only.

Comparing Map 5 with Maps 1 (Land Value), 2 (Employment Density) and 3 (2040 Design Type Hierarchy) illustrates that areas outside the Portland city center that ranked high on at least one measure ranked high on the 2040 design types. Map 5a shows this same distribution for lands that overlap with significant fish and wildlife habitat. As shown on Map 5b much of the high value fish and wildlife habitat lands overlap with lands that scored low on all three measures of development value. However, for a significant portion of this map there is an overlap of high valued habitat with areas that scored high on at least one measure of development value. In most cases these lands scored high on 2040 design types and are zoned industrial.


Map 5: Component Summary
Based on the Highest Measure
Across Metro Region
August 2003 Draft
0
4 Miles
Legend
Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*
ESEE Component Summary
Not Classified
All Low
>=1 Medium and <> High
>=1 High Value
*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps\Map 5 Component Summary.mxd

Map 5a: Component Summary

Within Resources
Based on the Highest Measure
Across Metro Region
August 2003 Draft



Legend

- Major Roads
- Urban growth boundary
- Metro boundary
- Extent Of Resource Data
- Rivers & Water Bodies*

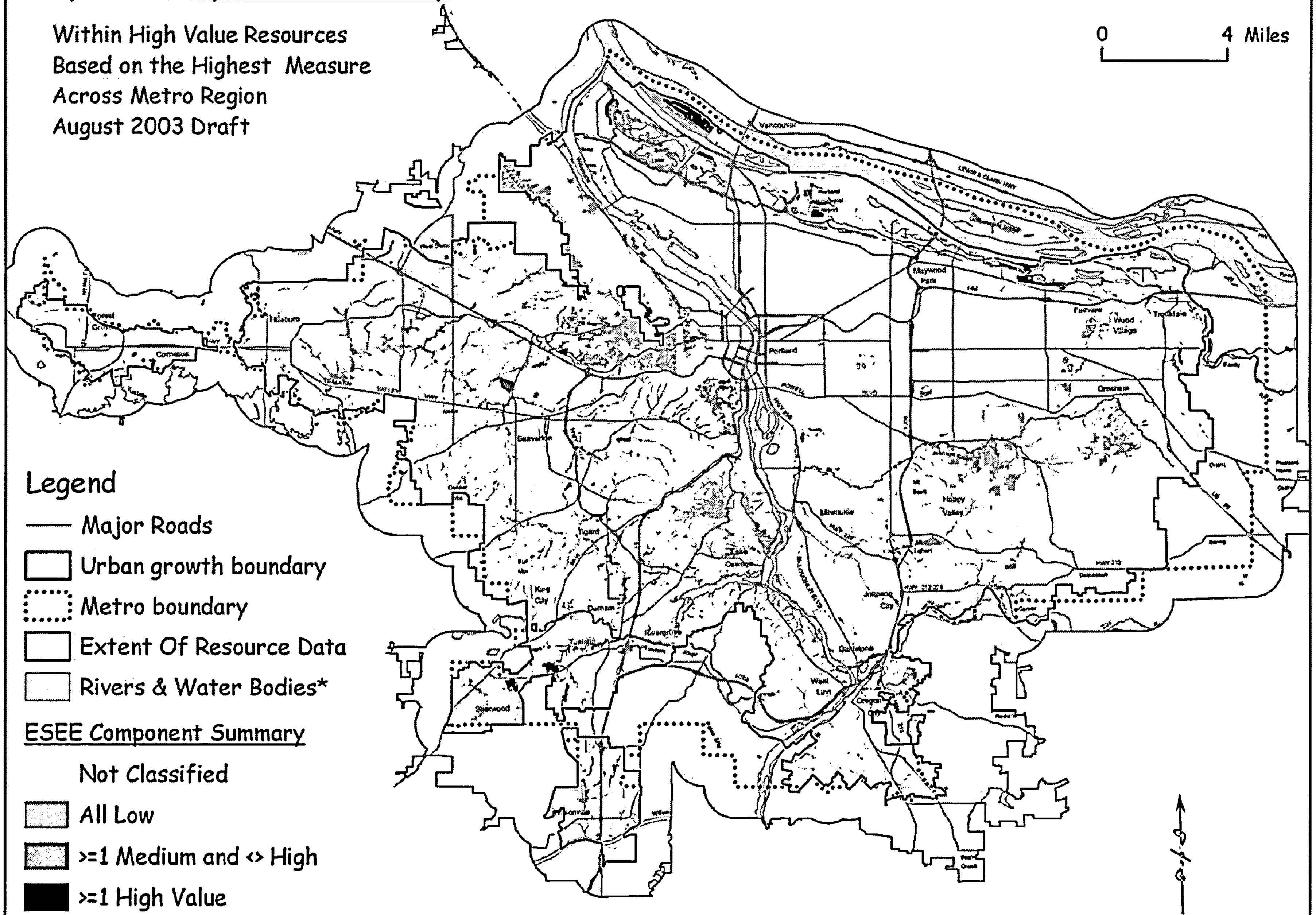
ESEE Component Summary

- Not Classified
- All Low
- >=1 Medium and <> High
- >=1 High Value

*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps091103\Map 5a Employment Density.mxd

Map 5b: Component Summary

Within High Value Resources
Based on the Highest Measure
Across Metro Region
August 2003 Draft



Legend

— Major Roads
Urban growth boundary
Metro boundary
Extent Of Resource Data
Rivers & Water Bodies*

ESEE Component Summary

Not Classified
All Low
>=1 Medium and <> High
>=1 High Value

*rivers & water bodies greater than 2 acres in size - J:\houk\Goal5\ESEE\EconomicAnalysis\ECONorthwest\maps\Map 5b Component Summary.mxd

Summary of interactions

- *Land value, zoning and habitat:* The zoning for a majority of fish and wildlife habitat lands, approximately 64 percent, support development value. The remainder fall into POS zoning or contain water bodies. Of the lands with development value, most fall into the low land value category.
- *Employment, zoning and habitat:* Approximately 78 percent of the fish and wildlife lands do not support employment. These lands are zoned SFR, MFR, RUR and POS. Of the lands that do support employment, most fall into the low employment category.
- *2040 design type and habitat:* The distribution of fish and wildlife habitat lands by 2040 design types differs from the distributions described above for land value and employment. In general, categorizing lands using 2040 design types yields a distribution with a greater percentage of the lands having development value, and for the lands that have development value, more of the lands rank in the higher-valued design types.
- *2040 design type, zoning, and habitat:* Three generalized regional zones, SFR, POS and IND, account for 80 percent of the habitat acres. Ninety-eight percent of the fish and wildlife habitat lands zoned SFR and POS fall into the lowest design type[34]. In contrast, 33 percent of the lands zoned IND fall in the lowest design type and 60 percent is ranked in the primary, or highest, design type.
- *Land value, employment, 2040 design type, zoning and habitat:* Focusing on fish and wildlife habitat lands zoned SFR, POS and IND, approximately 98 percent of POS lands, and approximately 78 percent of SFR lands ranked in the lowest category for all three measures of development value (land value, employment and 2040 design type). In contrast, 25 percent of lands zoned IND ranked in the lowest categories for all three measures of development value. Over 60 percent of IND lands ranked in the highest category for at least one measure.
- *Goal 5 allow, limit, prohibit impacts:* The large majority of Goal 5 allow, limit and prohibit decisions will impact lands zoned SFR, POS and IND. Impacts on lands zoned SFR and POS will have little or no employment impacts and will affect lands ranked low on the land-value scale. The majority of impacts on lands zoned IND will affect lands ranked high on at least one measure of development value.

The fact that Goal 5 decisions would primarily affect acres with lower land values and employment densities does not mean that limit or prohibit decisions on these acres would generate trivial economic consequences. The low category for these development values are relative to land values and employment densities found in the Portland city center and do not represent an absolute measure of land value or employment. The actual impacts of limit or prohibit decisions on property values or employment will depend on the specifics of the decision, the details of the Goal 5 program that implements the decision, actions that may mitigate any negative impacts, and specifics of the individual parcels affected.

[34] This includes lands in the tertiary design type, and lands in the "other" design type that includes parks, open space and rural reserves.

What are the potential economic consequences of allowing, limiting or prohibiting conflicting uses?

This section describes the economic consequences of decisions to allow, limit, or prohibit land uses that conflict with significant fish and wildlife habitat. Four categories of economic consequences of Goal 5 decisions are considered in this analysis:

- The changes in the values of the goods and services citizens receive are referred to as *economic values*. The economic values at issue in this analysis include the impact of Goal 5 decisions on property values (location and site factors) and the values of ecosystem goods and services provided by riparian and wildlife areas (e.g., flood management, water quality, habitat that supports salmon, amenity and intrinsic values).
- The changes in the level of economic activities within the local economy such as the impact on the level of local employment and income, changes in tax payments and transportation impacts are referred to as *economic impacts*.
- The changes in the development patterns over the coming decades are outlined by the *2040 design types.*
- The changes in the distributions of costs and benefits within the economy, especially changes affecting groups of special concern, such as property owners that shoulder a disproportionate amount of the negative consequences of a policy decision, are referred to as *economic equity*. Equity tradeoffs in this analysis include tradeoffs by type of land use, as described by zoning type, and the geographic distribution of economic tradeoffs.

The sections that follow describe: 1) the baseline for the analysis of economic tradeoffs, 2) the potential economic consequences based on the four categories listed above, 3) the summary of economic consequences of allow, limit or prohibit decisions and 4) the factors that influence economic consequences.

Baseline for the analysis of economic tradeoffs

The existing, non-Goal 5, regulatory protection of fish and wildlife habitat provides the baseline for the analysis of economic tradeoffs of Goal 5 allow, limit and prohibit decisions. An allow decision will permit developing significant habitat to the limits allowed by existing, non-Goal 5 protection measures. Goal 5 limit or prohibit decisions provide a marginal *increase* in protection above and beyond existing protection measures.

For lands in Metro's jurisdiction, Title 3 of the Urban Growth Management Function Plan (Title 3) describes existing protection measures and is the baseline against which the Goal 5 management decisions will be measured. Title 3 regulates development that affects water quality, flood management and fish and wildlife conservation.

Because Title 3 implements statewide land-use goals, it affects lands in all the local jurisdictions within Metro's jurisdiction. Local jurisdictions, however, may adopt protection measures that exceed Title 3 regulations. The economic tradeoffs of Goal 5 allow, limit and prohibit decisions in these jurisdictions will differ from the tradeoffs in jurisdictions where Title 3 represents the baseline protection in the following ways:

- Allow decisions will overestimate the negative impacts of development on Goal 5 fish and wildlife habitat and associated ecosystem services. An allow decision will also overestimate the benefits on development values.
- Limit and prohibit decisions will overestimate the benefits of habitat protection and will overestimate the negative impacts on development values.

Potential economic consequences

This section describes potential economic consequences by the four economic factors – economic values, economic impacts, 2040 design types and economic equity – and how Goal 5 decisions may impact these factors.

Economic Values

Property values in development – the factors that affect the development value for land fall into two general categories: location factors and use factors.
Location factors include:

- Availability and quality of public infrastructure, for example, roads, sewer, water and electric. Land-use decisions that hinder or make more difficult the provision of infrastructure services may negatively impact the values of the affected properties.
- Access to the site. Actions that limit or impede access to a site may negatively impact the site's property value.
- Agglomerative economies associated with the location. Decisions that promote or allow the development of agglomerative economies, such as clustering of commercial or industrial developments, will help maintain or enhance development values of these activities. Decisions that inhibit the development of such agglomerative economies may have the opposite effect.
- Existing zoning or other land-use regulations. Zoning and other regulations can have positive and negative impacts on a property's value. For example, waterfront properties zoned for industrial use might have higher property values if they were zoned residential. In another example, a residential zoning may protect property values by excluding incompatible land uses (e.g., a gas station).

Use factors include:

- Amenities of the site, for example, views, access to parks, water and other open spaces. Actions that protect or enhance a location's amenities, may also protect or enhance the impact that amenities have on property values.
- Physical terrain, for example, hilly or flat. Grading hills and other changes to a parcel's physical terrain may increase the parcel's usability and development value. Actions that limit grading hills or other changes to a parcel's physical terrain may negatively impact the parcel's property value.
- Lot size, shape and buildable area. Actions that limit a parcel's usable area may negatively impact the parcel's development value. Impacts from limiting a parcel's usable area will likely be the most common way that limit or prohibit decisions could influence development values.

Values of ecosystem services – Chapter 6 of the report describes the environmental consequences of allow, limit and prohibit decisions on fish and wildlife habitat and on the associated ecological functions and wildlife characteristics. As described in literature review (see Appendix C), the ecological functions of fish and wildlife provide ecosystem services that benefit society. Actions that protect or enhance these services will also protect and enhance their value. Actions that degrade ecosystem services will have the opposite effect. As services degrade, society either does without the service, restores the degraded habitat or replaces some lost or degraded services by building engineered projects (e.g., upgrading a water-treatment plant that provides clean water).

Ecosystem services include:

- Flood management. Fish and wildlife habitat help mitigate flooding by moderating flow intensities and absorbing runoff. Actions that reduce flood management services may increase flooding of area homes and businesses, and increase flood related damages and government expenditures for flood clean up and mitigation.
- Water quality. Fish and wildlife habitat help control soil erosion and landslides that cause sedimentation. Habitat areas also help filter toxins and sediment from surface runoff before they enter streams and other water bodies. Degrading these services may increase the flow of sediment and contaminants into area waters. Degraded water quality may increase filtration costs for businesses and municipalities. Increased concentrations of toxins and sedimentation may also increase the costs of projects mandated by regulatory agencies to bring water quality into compliance with federal and state water-quality laws (e.g., the Clean Water Act).
- Moderating water and air temperatures. Vegetation in fish and wildlife habitats provides shade that helps reduce air temperatures and the "heat island effect" in summer. Moderating air temperatures in summer helps reduce electricity costs associated with air conditioning. Actions that remove this vegetation may increase summer air temperatures and cooling costs.
- Stormwater services. Fish and wildlife habitats absorb rainfall that otherwise would flow into stormwater systems. Replacing these habitats with impervious surfaces will increase stormwater flows and management costs. These costs can be substantial.
- Salmon habitat. Fish and wildlife habitat support salmon populations and related commercial, recreational and cultural values. Actions that protect salmon habitats also help protect these values. Actions that degrade habitats may have the opposite effect.
- Amenities. Fish and wildlife habitat provide view, open space, and water-related amenities and associated amenity values for properties in proximity to habitat. Actions that protect these amenities also protect the contribution this habitat make toward property values. Actions that degrade the habitat have the opposite effect.
- Recreation. Fish and wildlife habitat support recreation activities including wildlife viewing, fishing and activities associated with parks and open space. Degrading these habitats may also degrade recreation related ecosystem services.
- Intrinsic and option values. Intrinsic values are the values people find inherent in a habitat or species for itself, rather from the use or consumption of the habitat. These values represent the amounts residents or society would pay to protect a habitat, or expect in payment to degrade the habitat. Option values represent the value of protecting a habitat or species for future use or enjoyment. Actions that degrade fish and wildlife habitat also degrade the intrinsic and option values associated with the habitat. Such decisions also increase the risks of an irreversible outcome, for example, extinction of a salmon species, which may have negative economic consequences in the future.

- Carbon sequestration. Chapter 7 describes the energy consequences of allow, limit and prohibit decisions on fish and wildlife habitat, including the carbon-sequestration benefits of trees and other vegetation. Removing the vegetation negatively impacts the sequestration benefits and associated economic value.

To the extent that fish and wildlife habitat provide multiple ecosystem service, the true or full values of services at risk from actions that degrade habitat are the cumulative values of the affected services.

Economic Impacts

Employment – for lands that support employment, e.g., commercial, industrial and mixed use, the factors that influence land value also influence employment. For example, actions that affect access to a site or a property's developable area will also likely affect the employment potential of the site. In general, however, Goal 5 decisions will impact land values more than employment (or income) for the following reasons:

- A large percentage of the fish and wildlife habitat are zoned for land uses that do not support employment. Of the remaining lands, many have low employment densities relative to densities in the Portland city center.
- A portion of the lands containing habitat zoned commercial or industrial have previously been developed and currently support employment. Goal 5 decisions will not affect this employment. A Goal 5 decision on these lands may affect future employment through redevelopment of properties.

Actions that protect or degrade fish and wildlife habitat may impact jobs that depend on these habitats. For example, protecting salmon habitat may help support jobs that depend on commercial and recreational salmon harvests. In this example, many of the jobs associated with salmon harvests may be located outside Metro's service area.

Income – income tradeoffs of protecting or degrading fish and wildlife habitat will follow employment tradeoffs

Property taxes – impacts of protecting or degrading fish and wildlife habitat will follow impacts on property values. This is especially true for lands zoned commercial and industrial that have not yet been developed. Limiting development on these lands may negatively impact property values and associated property taxes. Limiting development may have the opposite effect on property values and associated tax payments for residential property surrounding or adjacent to properties currently undeveloped. Protecting fish and wildlife habitat on these lands may have a beneficial impact in property taxes, especially over the long term.

Payroll taxes – the payroll tax tradeoffs of protecting or degrading fish and wildlife habitat will follow employment and income tradeoffs.

Business taxes – the business tax tradeoffs of protecting or degrading fish and wildlife habitat will follow the tradeoffs for property value, employment and income for lands zoned commercial, industrial and mixed use.

Transportation costs – transportation costs increase with the number of vehicle miles traveled (VMT). Planning guidelines that address transportation costs, such as the 2040 design types, promote more compact development that limits VMT and transportation costs. Actions that push development out towards the UGB or beyond will increase VMT and transportation costs relative to actions that promote more compact development.

2040 Design Types

The 2040 Growth Concept outlines the Portland metropolitan region's plan to accommodate expected population growth over the coming decades, while addressing housing, transportation, open space and employment needs. The 2040 design types represent land-use categories (e.g., central city, main streets, neighborhoods, rural reserves/open space) that embody the Growth Concept's transportation, housing and other land-use goals. The 2040 Growth Concept anticipates expected population growth while:

- Maintaining access to nature.
- Protecting wildlife habitat.
- Promoting efficient use of land.
- Supporting a vibrant economy.
- Providing transportation options.
- Promoting development along transportation corridors.
- Minimizing sprawl and VMT.

Activities that protect or degrade fish and wildlife habitat may have mixed impacts on the 2040 Growth Concept's goals and associated design types. Protecting and maintaining access to these habitats supports the growth concept and design types' emphasis on habitat protection. However, if protecting habitat displaces development to the extent that it promotes sprawl, expanding the UGB and the number of VMT, protection actions may inhibit or limit the design types. Alternatively, developing habitat may limit UGB expansion and associated consequences, but may also conflict with the growth concept's goals that address habitat protection and access to natural areas.

The growth concept's goals regarding development density and transportation considerations may mitigate the impacts of habitat protection on sprawl. Increasing the efficiency of land use by promoting higher development densities along transportation corridors complements the habitat protection goals by accommodating, to some extent, land uses that might otherwise be displaced to outside the UGB.

Economic Equity

Geographic distribution of impacts – in general, locations within Metro's jurisdiction that have been developed more intensely over longer periods of time have the least amount of fish and wildlife habitat. As a result, Goal 5 protection measures will have limited or no negative impacts on development in these locations.

Distribution of impacts by land use – approximately 80 percent of the lands containing fish and wildlife habitat fall into three generalized regional zones: single-family residential (SFR), parks and open space (POS), and industrial (IND). Potential economic tradeoffs associated with Goal 5 protection will fall primarily on lands in these zoning categories. As a group, lands in other zoning categories will experience limited Goal 5 economic tradeoffs.

Distribution of impacts by Goal 5 treatment – Goal 5 treatments will affect the distribution of positive and negative economic tradeoffs. Allow treatments do not increase habitat protection beyond Title 3 or local regulatory measures and place no additional restrictions on land use and development. Developers and property owners will enjoy most, if not all, of the benefits. Habitat-associated ecosystem services and those that benefit from the habitat and services will suffer most, if not all, of the negative economic tradeoffs. Results for prohibit treatments will have the opposite effect. Development interests will suffer most, if not all, of the restrictions. Habitat, ecosystem services, and those who benefits from the habitat and services will experience most, if not all, of the benefits. Limit treatments offer the most equitable distribution of tradeoffs because they generate positive and negative tradeoffs for development and resource interests.

Summary of economic consequences

Summarized below are some of the economic consequences of allowing, limiting or prohibiting conflicting uses.

Allow conflicting uses

Allowing conflicting uses means no additional protection of Goal 5 fish and wildlife beyond the baseline protection provided by Title 3, or by local protection measures that exceed Title 3 guidelines.

- No impediments to development or negative impacts on the development value of land.
- Development-related employment, income and taxes will be unaffected by Goal 5.
- No Goal-5 related increase in VMT, transportation costs or UGB expansion.
- Amenity-related property values and associated property taxes for undeveloped lands zoned SFR and RUR that are adjacent to Goal 5 habitat lands may be less for this scenario relative to limit and prohibit scenarios.
- Flood mitigation services will decline, flood damage and clean-up costs may increase.
- Erosion and sedimentation will increase, as will concentration of toxins in streams and other water bodies. Water-quality expenditures (e.g., for filtration and treatment) by businesses and municipalities may increase. Municipal expenditures that address water-quality regulations (e.g., the federal Clean Water Act) may increase.
- Summer temperatures and the urban "heat island effect" may increase with an associated increase in cooling costs.
- Developing fish and wildlife habitat will increase the amount of impervious surfaces, which will increase stormwater flows and treatment costs.
- Development that negatively impacts salmon habitat may affect commercial, recreational and cultural harvests. Municipal expenditures that address habitat regulations (e.g., Endangered Species Act) may increase.

- Degrading fish and wildlife habitat may negatively affect recreational opportunities and values that depend on these habitats.
- Negative impacts on intrinsic values for fish and wildlife habitat.
- Developing fish and wildlife habitat now or in the near-term precludes developing them in the future or protecting them for future generations. This reduces the option values associated with the habitats.
- Carbon sequestration and air-pollution removal will decline with an associated decline in air quality and related values of air-quality services.
- Businesses that rely on fish and wildlife habitat and associated ecosystem services may experience a decline in sales, employment and income relative to the limit or prohibit scenarios. Employment and business-related tax payments may also decline.
- Allowing conflicting uses will negatively affect the 2040 Growth Concept and design types that emphasize protecting habitat and maintaining access to habitat.
- The large majority, if not all, of the negative economic tradeoffs of this option affect fish and wildlife habitat, associated ecosystem services and economic factors (e.g., jobs, incomes and values, that depend on these habitats). Development interests suffer little or no negative economic tradeoffs.

Limit conflicting uses

Limiting conflicting uses strikes a balance between completely developing the Goal 5 fish and wildlife habitat and protecting them. This alternative provides opportunities including: developing lands in ways that minimize negative environmental and economic tradeoffs; supporting the development goals embodied by the 2040 design types; and protecting the most important habitats.

- Will generate a mix of positive and negative economic tradeoffs for development interests and for the habitats and associated ecosystem services. Developing habitat will generate positive impacts on development values, employment, income and tax payments. However, these impacts will be less than for the allow scenario. The habitat will likely suffer some degradation, but not to the extent generated under the allow scenario.
- The consequences for the 2040 design types will be mixed. Protecting fish and wildlife habitat to a greater extent, compared with the allow scenario, may increase VMT if protecting habitat displaces development and pushes it out toward the UGB or beyond. This may also increase the next UGB expansion and transportation costs. However, protecting habitat is consistent with the planning goals reflected in the design types.
- Will generate a more equitable distribution of positive and negative economic tradeoffs, compared with either the allow or prohibit scenarios. Development interests and habitat will both experience positive and negative economic tradeoffs.

Prohibit conflicting uses

Prohibiting conflicting uses will prevent development actions that conflict with, or degrade, fish and wildlife habitat. This scenario emphasizes habitat protection. Protection measures will exceed the baseline protection provided by Title 3, or by local protection measures that exceed Title 3 guidelines.

- Amenity-related property values and associated property taxes for lands zoned SFR and RUR that are adjacent to fish and wildlife habitat may be greater for this scenario relative to limit and allow scenarios.
- This alternative will provide the greatest amount of flood mitigation services and value.
- Erosion and sedimentation will be less than limit or allow alternatives, as will concentration of toxins in streams and other water bodies. Water quality expenditures (e.g., for filtration and treatment) by businesses and municipalities may be the least under this alternative. Municipal expenditures that address water quality regulations (e.g., the federal Clean Water Act) may decline, especially over the long term.
- This alternative will have the greatest mitigating effect on summer temperatures, the urban "heat island effect," and associated cooling costs.
- Prohibiting development in fish and wildlife habitat will generate the least amount of impervious surfaces, and will generate the least amount of stormwater flows and treatment costs.
- This scenario will protect the greatest amount of salmon habitat and may positively affect commercial, recreational and cultural harvests. Municipal expenditures that address habitat regulations (e.g., Endangered Species Act) may decline, especially over the long term.
- This alternative will preserve the greatest amount of recreational opportunities and the associated recreational values.
- The intrinsic and options values for the fish and wildlife habitat will be preserved.
- Maintaining the greatest amount of vegetation will maximize carbon sequestration, air pollutant removal and the related values of air quality services.
- This alternative will provide the greatest support to businesses that rely on fish and wildlife habitat and associated ecosystem services.
- Prohibiting conflicting uses will support the aspects of the 2040 Growth Concept and design types that emphasize protecting habitat and maintaining access to habitat.
- This alternative will have the greatest negative impact on the development value of land.
- Development related employment, income and tax payments will also suffer the greatest under this alternative.
- Aspects of the 2040 design types that minimize VMT and sprawl will be negatively impacted if protection measures displace development within the UGB.
- The large majority, if not all, of the negative economic tradeoffs of this alternative affect development interests. The economic values and activities supported by fish and wildlife habitat suffer little or no negative economic tradeoffs, relative to allow and limit alternatives.

Factors that influence economic consequences

The description of economic tradeoffs in the previous section assumes no reaction by stakeholders and decision makers that would impact the economic tradeoffs. This static approach ignores, for example, the possibility that restoring fish and wildlife habitat may mitigate some of the negative economic tradeoffs of development on these habitats. A more dynamic view of economic tradeoffs considers alternatives that could help mitigate negative tradeoffs and enhance positive tradeoffs. This section describes a number of these dynamic factors.

Substitutability of land uses
Moving proposed land uses that conflict with fish and wildlife habitat to alternative locations may mitigate negative economic tradeoffs for both the land use and habitat. The previously conflicting land use can take place without impacting habitat. Substituting a non-conflicting or less conflicting land use in the habitat area will protect, to some extent, the property's development value. Such a move will also protect, to some extent, the quality and quantity of the property's fish and wildlife habitat.

The feasibility of substituting land uses depends on the types of land uses at issue and the availability of suitable sites outside habitat areas. The more specific or unique the development requirements, the less likely the development can take place elsewhere. For example, water-dependent industrial development must take place in specific locations—relatively large lots with water access. This limits the extent to which the land use can avoid conflicting with habitat by moving elsewhere. By comparison, residential land uses have relatively few development specific requirements and take place throughout Metro's jurisdiction.

Expanding the Urban Growth Boundary
Protecting fish and wildlife habitat may reduce the amount of developable land within the UGB. If this is the case, expanding the UGB could mitigate this loss while protecting fish and wildlife habitat within the existing UGB. However, expanding the UGB may promote sprawl and negative sprawl-related impacts including increased VMT and transportation costs, and possibly minimizing the effectiveness of the 2040 design types.

Encourage development practices that minimize conflicts with fish and wildlife habitat
Encouraging development practices that minimize conflicts with resources may help mitigate negative economic tradeoffs for both development and the resources. These practices include low-impact development projects that minimize impervious surfaces and manage stormwater in ways that more closely mimic natural systems. Cluster developments for residential lands is another example. This type of development localizes housing sites and associated land-use activities (e.g., roads) while avoiding developing fish and wildlife habitat. In another example property owners may sell future development rights while retaining ownership without restrictions on existing land uses.

Restoring degraded fish and wildlife habitat
Restoring already-degraded fish and wildlife habitat could offset a portion of the negative impact of new development on habitat elsewhere. In some cases, restoration opportunities may lie outside the existing UGB or Metro's jurisdiction.

Economic consequences by generalized regional zone

Below is a brief description of the economic consequences by the seven generalized regional zones (matrices describing the consequences may be found in (See Appendix D):

- **Single-family residential (SFR):** Lands zoned SFR account for almost half, 46 percent, of Goal 5 fish and wildlife habitat. Protection actions on these lands will primarily affect property values and related tax payments with little or no direct impacts on employment and income. Since SFR developments typically retain more vegetation and tree cover than other types of development, this land use will conflict less with habitat and retain more ecosystem services and associated economic values than other development uses. Encouraging low impact developments and cluster development patterns may help mitigate negative economic tradeoffs for development and resources.

- **Multi-family residential (MFR):** MFR lands account for approximately five percent of Goal 5 fish and wildlife habitat. Economic tradeoffs will be similar to SFR lands except that MFR development typically retains less vegetation cover and fewer ecosystem services and associated values.
- **Commercial (COM):** Approximately five percent of Goal 5 fish and wildlife habitat are on lands zoned COM. Habitat protection actions may negatively affect property values, employment, income and related tax payments. COM developments involve extensive landscape modifications that negatively affect ecosystem services and the economic values of services. These negative impacts are comparable to, or greater than, the degradation of ecosystem services and values associated with MFR developments.
- **Industrial (IND):** IND lands account for approximately 15 percent of lands containing Goal 5 fish and wildlife. Economic tradeoffs will be similar in type and extent to tradeoffs for COM lands.
- **Mixed-use centers (MUC):** Approximately three percent of Goal 5 fish and wildlife habitat are on lands zoned MUC. Economic tradeoffs will be similar to developments on lands zoned MFR and COM. Limiting MUC developments will have mixed impacts on 2040 design types and the underlying 2040 Growth Concept. Protecting fish and wildlife habitat supports the Growth Concept's goals of maintaining access to nature and protecting habitat. Limiting MUC developments, however, may negatively impact the design type's emphasis on promoting more efficient land use and minimizing sprawl and VMT.
- **Rural residential (RUR):** RUR lands account for approximately seven percent of Goal 5 fish and wildlife habitat. Economic tradeoffs of developing RUR lands will be similar to SFR except less intensive given the more dispersed nature of RUR developments.
- **Parks and Open Space (POS):** Approximately 20 percent of the Goal 5 fish and wildlife habitat are on lands zoned POS. Protection measures may limit recreation activities that require facilities (e.g., ball fields and golf courses, and related infrastructure such as parking lots). This limitation may negatively impact property values for private parklands more than parks on public lands. Park and open space land uses may be the least intrusive on habitats and associated ecosystem services and economic values.

Summary Points

This section lists the summary points from the analysis of economic consequences.

- Fish and wildlife habitat lands were ranked for their economic importance for development or development value using three measures: land value, employment density and 2040 design type hierarchy.
- Fish and wildlife habitat lands provide ecological functions (e.g., bank stabilization, streamflow moderation, shade, etc.) that also provide ecosystem services (e.g., reduce flood damage, improve water quality). Ecosystem services have economic value. The analysis assumes that habitat that ranked high (for ecological functions) provide more of the type of ecosystem services that society values than do areas that ranked low.
- The Goal 5 programs may protect services such as flood management, water quality, amenity, and salmon-habitat values across a broad area that may affect residents throughout

the UGB and downstream from the UGB. Protecting these ecosystem services may also reduce municipal expenditures to provide these same services, especially over the long term.

- Prohibiting development protects habitat and associated values, but will limit development related economic benefits.
- Limiting development preserves some level of development and habitat values.
- Protecting fish and wildlife habitat within the existing UGB preserves habitat in close proximity to current population distributions but increases the probability of expanding the UGB sooner or to a greater extent than otherwise would be the case if protection measures displace developable land.
- Protecting habitat on the urban fringe protects development interests close in, but reduces access to habitat and associated ecosystem services for the majority of the population within the existing UGB.
- The details of the program options applied at the parcel level will dictate the type and extent of positive and negative economic tradeoffs for Goal 5 habitat protection measures.
- The fact that Goal 5 decisions would primarily affect land with lower property values and employment density does not mean economic consequences of limit or prohibit decisions would be trivial. The low category of land value and employment is relative to values and employment in the Portland city center. The cumulative property value or number of employees affected may be significant depending on the type of decision, the details of the Goal 5 program that implements the decision, actions that may mitigate the negative impact (e.g., expanding the UGB), and specifics of the individual parcels affected.
- Goal 5 programs that include fish and wildlife habitat restoration activities may mitigate the need to implement more severe limit decisions. That is, a program that includes habitat restoration may result in more allow or limit decisions, compared with a program that excludes habitat restoration. However, restoration plans should be developed in the context that restoring degraded habitat may be more expensive, and in the end provide fewer or lower quality ecosystem services, compared with protecting high quality habitat.

CHAPTER 5: SOCIAL CONSEQUENCES

Introduction

This chapter focuses on the social consequences of protecting or not protecting fish and wildlife habitat. Areas providing fish and wildlife habitat provide many important social benefits. However, protecting these areas places a burden on property owners. In this chapter the social benefits and burdens of protecting or not protecting fish and wildlife habitat are described by addressing the following questions:

- What do fish and wildlife habitat contribute to our cultural heritage and sense of place?
- How does protecting fish and wildlife habitat affect our health?
- What educational values are provided by fish and wildlife habitat?
- How does protecting fish and wildlife habitat affect public safety?
- What are the social impacts of protecting fish and wildlife habitat on the land supply?
- How does protecting fish and wildlife habitat affect property rights (private and public)?
- What fish and wildlife habitat will we leave for future generations to enjoy?
- What are the potential social consequences of allowing, limiting, or prohibiting conflicting uses as they relate to Metro's generalized zones?

Metro's fish and wildlife habitat protection efforts are being conducted under State Land Use Planning Goal 5. Land use planning is largely a negotiated social and political process that involves people, their communities, and their governments in decision making. Thus, the social issues include not only those related to land use plans specifically but also those of democracy, participation, and community process. Planning is a public social process representing multiple needs and values. The overall planning context and the importance of social participation are discussed in the section below.

Framework for the social analysis

Citizens have indicated the importance of protecting the air and water, endangered species and natural areas. Federal,[35] state, regional, and local policies reflect these choices. Publicly supported programs (e.g., Metro's Parks and Greenspaces program) exemplify the value placed on natural resources. Over 40 local groups (largely volunteers) focus their work on preserving and restoring streams and rivers, including watershed councils and conservation groups, land trusts, friends groups, specific stream groups, and the Willamette restoration initiative.[36] The public interest and outreach programs sponsored by parks and recreation programs and non-profit organizations provide opportunities for social gatherings, education, recreation, and conservation activities.

The value placed on ecosystem health by citizens in the region highlights the importance of conserving fish and wildlife habitat. The long-term, less tangible benefit of ecosystem health (intrinsic value of habitat) exists along with short-term amenity benefits to property owners and

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[35] Endangered Species Act, Clean Water Act, etc. See *Introduction* chapter and *Appendix A* of ESEE report for more detail on policies that protect fish and wildlife habitat.
[36] See Metro's *Riparian Corridor and Wildlife Habitat Inventories* (Metro 2002d) for more information.

others. Some of the social benefits that arise from a healthy ecosystem are clean water, improved salmon and other wildlife habitat, biodiversity of plant and animal species, relief from urban stress, flood mitigation, educational and recreational opportunities, and neighborhood amenities.

In this analysis we consider the possible impacts of protecting or not protecting fish and wildlife habitat on human needs and social values. This analysis does not undertake a survey of people's values; however, it does point to a range of relevant and acknowledged values that bear on the protection of fish and wildlife habitat. Some of the relevant values considered in the analysis are ecological, economic, health, educational, aesthetic, and sense of place or regional identity. A range of values is associated with these issues, and sometimes they conflict with each other.

Linking human needs and comprehensive planning

The existing and planned functions[37] of the Metro region serve the needs of individuals, organizations and communities. These functions cover a range of security and welfare needs as well as the need for freedom and identity. Oregon's comprehensive planning goals parallel the diversity of social organization that supports human development. The planning goals address an array of concerns such as farms, industry, water quality, historic preservation, citizen involvement and urbanization. Land use policies specifically address such social functions as land for housing and employment, location of public facilities, and provision of recreation and natural areas.

Metro's 2040 Growth Concept was designed to help the Metro region continue to grow in a way that maintains a high quality of life. This includes livable neighborhoods, good transportation options, a strong economy, a vibrant culture, and access to nature while retaining aspects of the local character that provide continuity with the past and make this region unique.

Natural resources are one touchstone of this region's uniqueness. Without the proximity of forests, rivers, scenic mountain views, and farmland valleys, the region's natural and cultural identity would be diminished. Oregon's planning goals recognize that the land use planning program needs to preserve significant fish and wildlife habitat. This recognition of natural resource protection is a form of valuation that society places on nature to meet a variety of general needs and desires related to resource dependency, urbanization, and enjoyment of life.

Social participation and public legitimacy

This analysis focuses on the tradeoffs of protecting or not protecting fish and wildlife habitat from a social point of view. However, a key social consideration of any protection program is a well-designed and transparent public outreach and involvement process. Without plentiful opportunities for meaningful public comment, a program (regulatory or voluntary) is unlikely to succeed, and with good public involvement the success of implementation is more likely. It is important to identify the range of opinions of those who have a stake in the development of potential policies to protect fish and wildlife habitat.

Natural resource protection engenders strong stakeholder claims. The value placed on natural resources differs among individuals and stakeholder groups, and the natural resources in question

[37] For example, housing, schools, roads and transportation, industrial zones, and parks.

are not always equally distributed. Some people view natural resources as public or common goods, while others view them as private property. Citizens have given the government the responsibility for overseeing the management and allocation of public resources while also protecting private property rights.

Regulations to protect natural resources require a degree of social agreement for acceptance and cooperation to be effective. According to Uphoff and Langholz (1998), three key elements must be in place for natural resource protection to be effective: (1) a legal/coercive element, (2) an economic/profit motive element, and (3) a cultural/social acceptance element. Without social approval it may be impossible to prevent motivations of monetary self-interest or to counter illegal activity intended to circumvent laws protecting common goods. Social processes that uphold legitimacy and participation in decision making are thus essential for long-term public policy support and successful implementation.

It is important to respect the right of citizens to participate in identifying key issues of interest and concern. Without an adequate level of citizen involvement and direction, a program may be less likely to be accepted and runs the risk of being viewed as too technical or bureaucratic (Lane 2001, Brechin et al. 2002). The disproportionate influence of "powerful interests" can be ameliorated with open planning processes. Public resource management and allocation is political and involves the values of a broad range of people. Broad citizen involvement allows for a transparent process, develops trust, and leads to negotiated agreements that build locally acceptable commitments (Creighton 1983).

Citizen involvement is formalized in Oregon's land use planning system as Statewide Planning Goal 1. When stakeholders are provided with an opportunity to participate, programs are more likely to be successful. People and communities may see their interests in protecting the region's fish and wildlife habitats differently and may thus express different priorities in terms of their immediate needs and values. But, from a social perspective, this process of participation and opportunity for citizen involvement in the planning process is central. It is important that citizen involvement be a key aspect of program development and that the issues raised in the analysis below be considered.

What do fish and wildlife habitat contribute to our cultural heritage and sense of place?

Fish and wildlife habitat once covered the entire Metro region. "Historical evidence indicates that at the time of the Oregon Trail migration, the majority of the Portland region was in a continuous canopy" (Poracsky 2000). People have been drawn to the Willamette Valley and the confluence with the Columbia River for centuries because of the abundant natural resources available to provide a good quality of life. Lewis and Clark missed the mouth of the Willamette River twice as they explored the Columbia River, due to the forested islands screening it from view. After they were told by Native Americans of the river's existence they went back to explore and were duly impressed (Riddle 2000). Wildlife were abundant: "[Lewis and Clark] camped across the river from the island and in their journals bemoaned being kept awake by the 'horid' noise of the geese, ducks, and swans" (Matrazzo 2000). Just a few decades later the rivers were completely changed:

> River traffic was crowded with ferries carrying passengers back and forth to the east and west banks, and river steamers taking sightseers on excursions up the Willamette to the "Niagara of the West," up the Columbia to the Gorge, or downriver to the ocean. (Riddle 2000)

Today the remnants of habitat provide residents with a sense of regional identity and preserve some of the fish and wildlife species that have so shaped the development of this region.

Cultural heritage

Nature and wildlife are part of our region's unique identity. Residents of this region consistently say that contact with nature is important, and they value the natural biological diversity that is part of the Willamette Valley.[38] Robin Cody (2000), co-author of the book *Wild in the City: A guide to Portland's natural areas* (Houck and Cody 2000), states: "Although Portlanders are now a fully urbanized people, the rivers still make us who we are. Never too deeply buried in the urban ethos is an imaginative truth, that not so long ago we emerged to a riverside clearing, the sons and daughters of pioneers, self-selected for rugged individuality."

As Oregonians, state symbols are part of the cultural identity of residents in the Portland metropolitan region. The Western Meadowlark was selected as Oregon's state bird by schoolchildren in 1927 (Marshall et al. 2003). It is currently a state-listed Species of Concern, and has been nearly extirpated from the Portland metropolitan region due to loss of native grasslands (a Habitat of Concern here) and development encroachment. However, some birds still winter over in the region, and bird-watchers often seek them out in areas such as the agricultural lands around the Tualatin River. The state fish, Chinook salmon, has five runs in or near this region, and all five are federally listed as Threatened or Endangered. Loss of these species and their habitats implies an irreplaceable cultural loss.

Fish and wildlife play key roles, currently and historically, in Native American religion and culture. Levi Holt, former commissioner of the Columbia River Inter-Tribal Fish Commission (CRITFC), comments:

> The tribes always treated water as a medicine because it nourished the life of the earth, flushing poisons out of humans, other creatures and the land. We knew that to be productive, water must be kept pure. When water is kept cold and clean, it takes care of salmon. (Hollenbach and Ory 1999)

The CRITFC (2002) states that "without salmon returning to our rivers and streams, we would cease to be Indian people." CRITFC holds fundraisers each year, and so far the Spirit of the Salmon Fund has raised over $1.5 million for the commission and its member tribes to spend on salmon recovery activities. The federal government also has treaty obligations that ensure the availability of Chinook salmon and steelhead trout for tribal fishing (*U.S. v. Washington* 1974).

This identification with nature and wildlife by the majority of the region's residents is reflected in many ways. For example, the 100-year-old Audubon Society of Portland is older than the

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[38] May 2001 Davis and Hibbits phone survey commissioned by Metro, an October 2001 Moore Information survey sponsored by KGW-TV and the Portland Tribune, and an informal "SurveyPoint" poll available by phone and on Metro's website in 2001.

national Audubon Society and is the largest chapter in the country, with over 10,000 members and 1,000 volunteers. Each year thousands of residents flock to the Wild Arts Festival to buy wildlife art and meet the authors of wildlife-related books; salmon and birds are probably the most common art themes in this area. Metro's annual Salmon Festival takes place at Oxbow Regional Park, located in the scenic Sandy River Gorge eight miles east of Gresham. Native Chinook salmon have migrated for thousands of years from the Pacific Ocean to the Sandy River and may be viewed spawning at the park during the festival and throughout October. Nature and wildlife are prominent subjects in the Portland Art Museum and in art galleries throughout the region.

Residents of the region also care specifically about at-risk wildlife and habitats. For example, in a 1997 poll conducted by the *Oregonian*, the decline of the region's salmon topped the list of residents' environmental worries (Brinckman 1997). The underlying reason was that salmon represent the Northwest's heritage and serve as a gauge of water quality and environmental health. Residents frequent rare habitats such as the oak woodland/wetlands complex in Oaks Bottom and river islands such as Sauvie Island. Such places harbor unique plant and wildlife communities and represent native habitats that were once common here, which makes them especially valuable to the region.

In 1999, Metro surveyed a diverse group of stakeholders, whose consensus on the most appropriate criteria for defining regionally significant fish and wildlife habitat included the presence of threatened, endangered, state sensitive, or state-listed species (Metro 1999a). Declining species most often depend on sensitive or declining habitats, such as riparian, Oregon white oak, undeveloped hilltops and river islands, or native grasslands. Loss of these species and the habitats they depend on is irreversible. In 2002, Metro conducted a public outreach effort in which over 2,400 residents participated (Metro 2002b). Environmental protection was identified as one of the three key issues deserving greater emphasis.

Contact with nature and the rich diversity of species and habitats native to this region are important parts of the region's cultural heritage; to the extent that these habitats are lost, so is a part of our culture, heritage, and natural history.

Sense of place and neighborhood character

The relation of people to place and land is an essential experience. Humans have been sensitized over millions of years by their co-evolution with the landscapes and species on the planet. The experience people have growing up is influenced by the climate, seasons, terrain, vegetation, and local animals. Home or neighborhood terrain, playgrounds, backyards, local parks, and scenic views, as well as the urban experiences of work, leisure, and travel in the region all influence the sense of place people feel, including their level of attachment to particular places.

The Metro region is well defined by its landscape: major rivers, hills, trees, the rainy season and summer heat. It includes views of Mt. Hood and Mt. St. Helens. The region is defined by the many streams and rivers, including the Willamette River running through the urban core, the Tualatin in the west and the Clackamas in the east, and the Columbia River leading to the Pacific Ocean. Forest Park provides opportunities for hiking in the city as well as defining our views of downtown Portland – skyscrapers framed against the forest and hills. This region is unique:

"Few cities in the nation can boast putting oceans, mountains, fresh strawberries, spawning salmon, and spectacular waterfalls in the same sentence, much less in the same day" (Seltzer 2000).

Bioregionalism is a landscape term expressing a reciprocal interaction of people and place, nature and society. Respect for place becomes a key feedback response for promoting the quality of life that people seek (Bethold-Bond 2000). Our regional identity includes the urban landscape that spans the river harbors, downtown Portland, and the cities and towns with a mix of new and old structures, known neighborhood features, gathering places, workplaces, city parks, museums, restaurants and stores. People are socially connected to the entirety of the built and natural environment, through street trees, gardens, walks, bicycle rides, and automobile trips. People have a regional identity in addition to other place-based identities (e.g., a neighborhood or watershed).

Historical perspectives on the changing Oregon landscape, the people who settled here, and the treatment of the environment, explain some of the region's uniqueness as well as common responses to life and development issues. In Terence O'Donnell's (1988) history of the 10,000 years of settlement since the "land came to rest and humans arrived to live from it," the people that chose to come to Oregon are described as being of modest ambition, respectable folks, self-sufficient and independent, seeking some measure of retreat and quiet.

> To delineate with any exactitude the character of either a person or a place is a futile exercise. Nonetheless, and perhaps as this and impressionistic history of Portland suggests, certain traits have appeared again and again in the town's expression of itself. There is the value placed on nature, a rather curious value for a city to embrace. One observer has commented that Portlanders are 'reluctant to face the facts of urban life, only its amenities'." (O'Donnell & Vaughn 1984)

A counter-perspective to immigrant sensibilities or attachment to place is reflected in an account of the utility of the land and the realities of capital and markets. Many people moved to Oregon to profit from the abundant natural resources. For many years it seemed there was no end to the board feet to be logged from the forests and the number of salmon caught from the rivers.

> Nearly a century and a half of American settlement has produced a regional landscape which has grown increasingly less distinctive and progressively less stable.... Northwesterners have frequently acted as if the natural world exists largely as something to buy and sell and as if the regional ecology were infinitely malleable. (White 1983)

These perspectives on the value of natural resources represent the conflicting values placed on natural resources and the changing views over time.

Scenic values

Trees, open space, and streams define the visual appeal of the Portland metropolitan region. Tree-covered hills blanket the cities and towns; removal of large sections of the canopy would change the visual appeal residents of the region enjoy. Fish and wildlife habitat can provide scenic value regardless of the degree of physical accessibility. People can enjoy a view of a stream, open space, or forest even if they are not able to explore it. However, people's perceptions of what makes up a "scenic" view may differ. Some consider densely vegetated hillsides to be attractive, while others are attracted to open, park-like land. Most fish and wildlife habitat value is derived from the more densely vegetated areas. There are also economic values placed on scenic views, as described in the *Economic Consequences* chapter of this report.

Natural resources buffer land uses from each other

Fish and wildlife habitat can help to buffer incompatible land uses from each other. Open space, tree canopy, and streams provide physical, noise, and visual buffering that can separate land uses and reduce off-site impacts. Trees not only help to control noise pollution but add the soothing sounds of wind rustling through leaves and branches. A U.S. Department of Agriculture publication reports that a 100-foot wide and 45-foot tall patch of trees can reduce noise levels by 50 percent (U.S. Department of Agriculture 1998). For example, a residential area buffered from industrial uses by a forest or stream will be more desirable than a residential area without the buffer.

How does protecting fish and wildlife habitat affect our health?

Health is a social issue. It encompasses both physical and mental well being. Fish and wildlife habitat provide benefits that affect both our physical and mental health. According to the Academy of Leisure Sciences (2002), recreation and leisure activities may be one of the best methods of curbing rising medical costs. Recreation contributes to healthy living, and healthy people need less medical care. People have long recognized the value of nature in contributing to our mental and physical well being. In fact, the ancient Egyptians created gardens to restore the spirit.

Recreational opportunities

Land use planning is tied to environmental quality and to recreational and leisure activity, both of which have a direct effect on people's health. Air and water quality is one aspect of this, along with opportunities for physical exercise through recreation and mental health benefits derived from proximity to nature. Recreation helps to fuel the human spirit, strengthen the physical self, and create a series of connections to others, community, and the environment that are as necessary to life as air and water.

Psychologists Sachs and Segal (1994) found that activities such as a walk in the woods gives a boost to the immune system that lasts two or three days. Exercise helps people live longer. Several studies have shown that middle-aged adults who exercise live on average about two years longer (Nieman 1998). Aside from improved cardiopulmonary benefits and quality of life, researchers have found that exercise had a beneficial effect on the happiness of cancer survivors: those exercising reported 19 additional hours of happiness per week than those not exercising (Courneya et al. 2003).

Natural areas provide tangible value in urban environments for people and communities. Natural resources, open space, parks, greenways, and trail systems are described generally as amenities in an urban area. The region's natural resource amenities include a mix of local parks and natural scenery, plus access to wilderness destinations within a two-hour drive. Hiking in Portland's Washington Park, driving to the scenic Columbia Gorge, weekend camping visits to the Cascades or the Oregon Coast, and boating on the Willamette River are some examples of recreation opportunities in the region. People enjoy walking and spending time in their neighborhoods and backyards in livable communities. Many people move to the Metro region specifically for the abundance of recreational opportunities located in and near the urban area.

The Metropolitan Greenspaces Master Plan, adopted by the Metro Council in 1992, describes a vision for a unique regional system of parks, natural areas, greenways, and trails for fish, wildlife and people. The plan identifies 57 urban natural areas and 34 trail and greenway corridors that define green infrastructure for the Metro region. In 1995 voters approved a bond measure ($135 million) to purchase sites identified in the plan. Local park providers, schools, businesses, and citizen groups are implementing the plan through a combination of open space acquisition, land-use standards, incentives, and stewardship.

Residents and local governments are working with Metro to ensure that people have access to nature close to home as well as efficient ways to get to work, school, or shopping. When originally conceived 100 years ago, the regional trail system was going to be 40 miles long, circling the city of Portland. The Metro area has grown substantially since then. The Metropolitan Greenspaces Master Plan expanded the concept to 25 cities and four counties within the Portland/Vancouver metropolitan region. Today, plans call for an 800-mile network of land trails, water trails, and greenways. Nearly 30 percent of the land-based trails are complete. Recreation and access to nature are important values to citizens of this region.

Recreational activities help to keep people well. While protecting fish and wildlife habitat on private land does not provide most residents of the region with direct recreational opportunities, it does contribute to overall ecosystem health. A healthy ecosystem means continued presence of fish in streams and birds and other wildlife in natural areas. Many citizens have moved to this region for the opportunity to engage in fishing, canoeing, sea kayaking, and other activities on the region's streams and rivers. Birdwatching is a popular pastime, especially visits to Smith and Bybee Lakes and Sauvie Island.

Impact of sprawl

A healthy urban environment is typified by neighborhood amenities such as access to nature (in the form of parks or openspace views) and pedestrian-scale development that provides both aesthetic and functional value. The modern predominance of door-to-door automobile trips, congestion, stresses, and pollution detracts from our health and enjoyment of city living. An article on integrative medicine identifies the "biopsychosocial interface" of the built environment, implicating urban planning and public policy in the process:

> While the trend toward increasing urban sprawl has impacts on land use, transportation, and economic and social development, less attention has been paid, until recently, to the fact that the way that our communities are designed can also have serious health consequences. (Horowitz 2002)

Horowitz describes the common health threats of auto-dependent urban sprawl as respiratory problems from air pollution, toxicity in air and water supplies, various stress factors, lack of physical exercise or activity, obesity, and impaired access to nature. Urban and suburban sprawl can isolate people socially. Urban stress also arises from noise, crime, litter, or blight in neighborhood settings. However, increased density does not always have a positive impact on health. For instance, densely settled areas may allow for faster transmittal of communicable diseases. Not all neighborhoods face these issues, and social inequities between income groups and neighborhoods are well known and linked to health and environmental justice issues.

Environmental quality

Having intact natural systems helps keep the air and water clean in urban areas. Urbanization contributes to poor air quality and higher levels of industrial pollutants and results in other adverse effects such as high summer "heat island" temperatures.[39] Polluted air and water can cause many physical ailments such as asthma and bronchitis, allergies, and gastrointestinal problems. Poor air quality can prevent children from playing outside on summer days and can prevent adults from exercising outdoors or commuting by foot or bicycle. Retaining natural areas in the region helps to mitigate the negative impacts of development on human health.

Fish and wildlife depend on clean air and water to thrive. Fish are especially sensitive to poor water quality, such as that caused by the presence of toxins and other chemicals. Some people depend on fishing as a supplementary food source, and eating contaminated fish can negatively affect their health. Negative impacts include increased cancer risk and other health effects such as immunological, reproductive, developmental or nervous system disorders (U.S. Environmental Protection Agency 2002). Native Americans in the Columbia Basin eat fish at rates six to 11 times the national average and thus may be at a higher risk for negative impacts (U.S. Environmental Protection Agency 2002). Toxic fish are of particular concern for pregnant women and young children. Therefore, protecting fish and wildlife habitat may help keep those who eat fish from the region's rivers healthy.

Mental health and stress

The sight of natural areas enhances our mental health. Edward O. Wilson (1986) described this in his "biophilia hypothesis," which posits that human beings are attracted to nature because they are inextricably linked to the natural world and emotionally dependent on it. In discussing related research, the Trust for Public Lands (1994) points to information in over 100 studies describing the benefits of stress reduction from "experiences in wilderness and urban nature areas." Dr. Roger Ulrich of Texas A&M's Center for Health Systems and Design supports this research. He is cited in popular health literature regarding his studies on the positive response patients exhibit when exposed to natural environments:

> "...[J]ust looking at certain types of everyday nature is quickly effective in producing a mild, open-eyed relaxation response... Anger and fear also both diminish to the point of measurable improvement." (Ulrich quoted in British United Provident Association [BUPA] 2002)

Ulrich has found that passive scenic values reduce stress, lower blood pressure, and enhance medical recovery (Ulrich et al. 1991). Anytime people have a chance to look out a window at greenspace, or to be outdoors, they experience some benefit associated with a connection to nature, all other factors being equal (BUPA 2002, Baker 2002). Even pictures of nature can positively affect hospital patients. A study in a Swedish hospital found that heart surgery

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[39] See *Energy Consequences* chapter for more discussion on Urban Heat Island effects.

patients viewing a landscape with trees and water "experienced less anxiety, and required fewer strong pain doses, than control groups assigned no pictures" (Ulrich et al. 1993).

Nature and spiritual values

Spiritual values are associated with a deeper reverence for nature and the outdoors. Beyond the benefits of exercise or stress relief, spirituality binds human beings and nature in a larger whole. Some people feel their closest connection with religion or the spiritual world when in the woods or by a river. Over the past few centuries the rise of science and rationalism provided humankind the opportunity to exert more control over nature and distanced people from their spiritual connections to nature (Rockefeller 1992). Most people today live in urban environments, with many children growing up not learning how the natural environment functions and supports our well being.

Many religions reflect beliefs of a larger mutual arising of knowing, meaning, and sense between people, nature and cosmos. Respect for the land, a morality of caring that extends to the type of utility we place on nature, is evident in Western spiritual traditions. On the other hand, another school of thought focuses on the "man over nature" model that focuses on the utilitarian value of animals and ecosystems (Rockefeller 1992). Lately many of the major religious organizations, such as the World Council of Churches, the U.S. Conference of Catholic Bishops, and the National Religious Partnership for the Environment have actively supported environmental protection policies and describe the connection between faith and the ecological health of the planet (Schueller 2001). For example, the Catholic Bishops of the Northwest issued a letter on caring for the Columbia River watershed, spurred by the economic and ecological conflicts evident in the region (Columbia River Pastoral Letter Project 2000). The letter described "...a vision that promotes justice for people and stewardship of creation."

Native American culture and spirituality is based on an appreciation of the natural world, as described by Margaret Saluskin of the Yakama Tribe below.

> Salmon was presented to me and my family through our religion as our brother. The same with the deer. And our sisters are the roots and berries. And you would treat them as such. Their life to you is just as valuable as another person would be. (Hollenbach and Ory 1999).

Spiritual awareness of the importance of nature has led to the philosophy and teaching of ethics, as expressed by such inspirational leaders as John Muir, Aldo Leopold, and Henry David Thoreau (Rockefeller 1992). It has also given rise to new philosophies, such as deep ecology, and to religions that view nature as sacred, such as paganism and Gaia (goddess)-based religions. Deep ecology is a philosophy based on the sacred relationship with Earth and all beings, an international movement for a viable future, a path for self-realization, and a compass for daily action (Drengson 1999). Nature provides inspiration and the chance for people from many religions and viewpoints to explore and enjoy their spirituality.

What educational values are provided by fish and wildlife habitat?

The existence of healthy ecosystems and fish and wildlife species enhances educational values and promotes recreation opportunities such as wildlife viewing, nature painting, and photography. Healthy ecosystems also provide "living laboratories" for active educational programs from volunteer monitoring to formal scientific research. While these values and opportunities are realized mostly on public lands, private open space and natural resources also contribute substantially to maintaining healthy ecosystems and habitat for fish and wildlife species. These activities are not limited to public lands, as some private lands are dedicated to wildlife sanctuaries and environmental education facilities. In addition, roads and adjacent public parks afford viewing opportunities on adjacent private lands.

Nearby natural areas provide important educational opportunities

The importance of a variety of accessible natural areas for educational programs is evidenced by the wide array of non-formal education providers[40] and formal education providers[41] in the region. These entities provide programs for children and adults to learn about the environment, natural and cultural history, fish and wildlife species and their habitats, social studies, and civics.

Natural areas can provide a focal point for teaching people about how government works and how they can be involved in improving their neighborhood, city, or region. This public participation improves community understanding of environmental, social, and political issues.

Park districts such as Metro Parks and Greenspaces, Portland Public Parks, Tualatin Hills Parks and Recreation District, and North Clackamas County Parks District host hundreds of outdoor activities and environmental education programs, involving thousands of youth and adults on an annual basis. Metro's Parks and Greenspaces department developed a map depicting the locations of all the nature centers and environmental learning centers in the region. Non-profit groups such as the Audubon Society of Portland, Friends of Trees, and SOLV have extensive education and volunteer programs aimed at restoring fish and wildlife habitats and increasing people's awareness of the habitats and species within the region.

Natural areas provide opportunities for interdisciplinary education

More and more schools are recognizing the value of natural areas and the environment as an effective focus for integrated, interdisciplinary studies in all areas – social studies, arts, science, and mathematics. This model, *using the environment as an integrated context for learning* (EIC), has been shown to improve critical thinking skills, achievement in standardized tests and improved student attitudes about learning and civility toward others (Leiberman and Hoody 1998).

Public school districts, such as Portland Public Schools and North Clackamas School District, provide magnet schools focused on environmental learning. These schools fully incorporate public open spaces in their curriculum, providing an integrated context for all subject areas. Public and private schools also have "adopted" natural areas adjacent to or near the school grounds as a project-based approach to the overall curriculum. Happy Valley Environmental School, for example, uses the city-owned wetlands in this way and has helped build walkways

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[40] For example, Tualatin Hills Nature Park, Jackson Bottom Wetlands Preserve, Tryon Creek State Park.
[41] For example, public and private schools, community colleges, universities, professional training institutes.

and restore native vegetation. Three Rivers Charter School in the Wilsonville-West Linn School District uses its grounds and adjacent lands to integrate all subjects.

Publicly owned open space and natural areas provide the bulk of recreation and educational opportunities within the region. However, private lands and wildlife sanctuaries, such as the 112-acre Audubon Society of Portland campus and the OES March/Montclair wetlands complex, also make a substantial contribution to the region's environmental education and recreation opportunities. Corporate parks, with associated natural areas, provide passive and active recreational opportunities for workers while enhancing the overall workplace environment.

How does protecting fish and wildlife habitat affect public safety?

Land that provides functional fish and wildlife habitat is often located on steep slopes and on floodplains in the urban area, since those lands pose more difficulties to develop. Protecting vegetative cover in these areas may reduce public safety hazards like landslides and floods. However, negative impacts of protecting or increasing trees and vegetative cover include possible increased risk of wildfires and increased numbers of undesirable species. Fish and wildlife habitat may also have an impact on reducing crime and violence.

Flooding and landslides

Trees and vegetative cover provide slope stability, prevent stream bank erosion, and allow for permeable soils to absorb and hold floodwaters, while conserving fish and wildlife habitat. Any conservation and restoration of habitat lands would likewise help with the prevention of natural and environmental hazards such as landslides, flooding, stormwater runoff, and erosion. The costs to property owners and insurance companies from landslides, flooding, and erosion can be significant if development is not carefully engineered; even then downstream properties may be affected by vegetative clearance or surface runoff. Thus, habitat conservation provides social benefits to property owners and communities that are located in higher risk locations.

Goal 7 of the Statewide Planning Goals requires local governments to reduce risk from natural hazards. The rule states that "local governments shall adopt comprehensive plans (inventories, policies and implementing measures) to reduce risk to people and property from natural hazards." Approximately 28 percent of the vacant, buildable land in Metro's inventory is environmentally constrained. The fish and wildlife inventory represents ecosystem functions and biodiversity in the region, and environmental constraints represent hazards and safety protection (e.g., floods, landslides, and water quality). This convergence of functions illustrates multiple benefits from habitat protection – preventing natural hazards and protecting fish and wildlife habitat. It also demonstrates that much of the remaining fish and wildlife habitat is located in the more difficult to develop areas.

Wildfires and windstorms

Besides flooding and landslides, wildfires are another type of natural hazard. Urban wildfires are risks for property owners associated with dry trees, brush, and vegetation in close proximity to built structures that in drought conditions or hot summer weather. Managing fish and wildlife habitat to encourage native vegetative cover while also managing for any fire hazard is a balancing act. The risks would be less in cool, moist riparian areas than the drier upland habitats. Spatial buffering could minimize risks to people and structures. Trees intermingled with houses, businesses, roads, and utility lines can pose hazards in windstorms as well.

Nuisance species

Preserving fish and wildlife habitat could allow nuisance species to continue to live in proximity to people. However, several species have adapted to live in the most urban environments and are likely to stay, such as raccoons and opossums. Wetlands and areas of standing water allow mosquitoes to breed and may contribute to diseases such as the West Nile virus. However, if wetlands are healthy the natural ecosystem controls mosquito populations (Scheirer 1994, Ladd and Frankenberger 2003).

Crime and violent behavior

The presence of trees and grass can lower the incidence of aggression and violent behavior, as was found by Bill Sullivan and Francis Kuo in a study of residents of public housing in Chicago (Kuo and Sullivan 2001a). Greenery reduces mental fatigue, which allows for more positive interactions between people. Neighborhood green areas can also increase community ties and support networks (Kuo et al. 1998). Additionally, tree canopy (as opposed to dense shrubs) in urban areas may actually reduce crime (Kuo and Sullivan 2001b). The study found that, compared with apartment buildings that had little or no vegetation, buildings with high levels of greenery had 52 percent fewer total crimes, including 48 percent fewer property crimes and 56 percent fewer violent crimes.

What are the social impacts of protecting fish and wildlife habitat on the land supply?

The urban land supply is a representative social issue because it relates to people's basic needs for housing, jobs and urban services. A constriction of the existing land supply could negatively affect the social needs these lands serve (e.g., housing and employment). An urban growth boundary (UGB) expansion could offset the impacts, but the urbanizing rural land spreads the development pattern further towards the periphery of the region. This could increase travel times[42] and congestion and could encroach further on fish and wildlife habitat in rural areas.

Metro's fish and wildlife habitat inventory covers developed, vacant, and buildable land. (See *Conflicting Use* chapter for more information.) If there are changes to the regional land supply, the Goal 5 rule allows governments to meet competing needs by compensating for reductions in the buildable land inventory. The rule states that a government shall:

> (a) Amend its urban growth boundary to provide additional buildable lands sufficient to compensate for the loss of buildable lands caused by application of Goal 5;
> (b) Redesignate other land [inside the UGB] to replace identified land needs... (OAR 660-23-070(1)).

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[42] Please see this report's *Energy Consequences Analysis* chapter for more description of the impacts of urbanizing rural land.

One of Metro's key tasks is the identification of buildable land, which defines where new development can occur. The buildable land supply influences housing availability and affordability, employment, and manufacturing locations. It also influences transportation system planning and general accessibility, along with public facility siting (e.g., cultural centers, schools, utility, and maintenance facilities). Land supply also affects public capital expenditures as urban services are spread out over larger areas.

Vacant land, redevelopable land, and infill sites provide the basis for housing and employment growth in the region. All vacant land is not considered *buildable*. Some of it is environmentally constrained (Title 3 lands in floodplains and adjacent steep slopes), and some is in public ownership and serves other needs (e.g., schools, parks, utility easements). The buildable land inventory is reviewed periodically to ensure that there is an adequate 20-year supply to meet forecasted housing and employment demand.[43]

Whether protection of fish and wildlife habitat will constrain buildable lands will not be determined until a program option is chosen. The Goal 5 rule allows for a range of approaches to conflicting uses: development may continue, be limited in some manner, or be prohibited in certain areas. Consistent with Metro's existing policies to protect water quality and floodplains, the assumption is that habitat protection may restrict design and management on some lands but will not prevent all development in order to prevent regulatory takings. Potential social impacts of constraining the land supply are described below.

Housing opportunities and affordability

Residential zones make up the largest component of buildable land in the fish and wildlife habitat inventory. Approximately 60 percent of the vacant, buildable habitat within the urban growth boundary is zoned residential,[44] and of that 66 percent is not environmentally constrained. Thus, the residential buildable land supply appears to be the most sensitive to possible impacts of fish and wildlife habitat protection.

The types of housing opportunities available may change depending on habitat protection. Rather than reduce the number of housing units allowed on a lot, regulations may allow for the same units in a denser configuration, such as rowhouses, condominiums, or apartments. Clustering units on smaller lots in a subdivision may allow fish and wildlife habitat to be preserved. These potential changes have social impacts. Many people who might choose to purchase or rent a single-family home with a large yard will not view these other housing options as equivalent. The location of the housing is important as well. Housing opportunities closer to existing employment, shopping, and entertainment will not be replaced by residentially zoned land in areas on the urban fringe.

Housing affordability may be affected if protecting fish and wildlife habitat results in changes to the land supply. Some studies have shown that maintaining an urban growth boundary and limiting the supply of buildable land increase the cost of housing (Staley and Mildner 1999). Further limits to the land supply may cause a commensurate increase in housing costs. However,

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[43] Buildable lands are described in December 1999 Update to the Technical Appendix to the Urban Growth Report.
[44] SFR: 56%, MFR: 4%

another recent study found that market demand, not land constraints or growth management policies, is the primary determinant of housing prices (Nelson et. al 2002). In some instances denser housing is more affordable than large-lot single-family homes, so that policies supporting increased density may result in lower housing costs. Housing developed on the periphery of the region may or may not be affordable, depending on the costs involved in bringing urban services to new areas. Limiting or prohibiting conflicting uses could have a negative impact on housing affordability but may not, depending on the type of development allowed and other market forces.

Impacts on quantity and nature of employment opportunities

Employment opportunities typically occur on land that is zoned for commercial, industrial, or institutional uses. Vacant land zoned for commercial, industrial, or mixed-use development makes up 28 percent of the land within the fish and wildlife habitat inventory, and almost half is not environmentally constrained. Development of these uses on land containing fish and wildlife habitat can sometimes occur in such a way that some or most of the habitat functional value is retained.

The location of these lands is an important factor in determining the social impact of allowing, limiting, or prohibiting use in these areas. Metro is able to add land to the UGB if employment capacities are reduced due to habitat protection. However, it is important to consider the social impacts of adding employment land on the urban fringe. Will job opportunities located in newly developed areas be equivalent to lost opportunities located near existing concentrations of housing? Residents choosing to work in locations further from their homes will incur additional travel expenses as well as a reduction in quality of life due to more time spent commuting and away from home. Additionally, the types of jobs may be different, as a company that might choose to locate in an existing commercial or industrial area may not choose to move to a new location.

How does protecting fish and wildlife habitat affect property rights (private and public)?

Metro's Goal 5 fish and wildlife habitat inventory covers both public and private land. Habitat coincides with residential, commercial, and industrial property as well as with public land such as parks, greenspaces, schools, and public facilities. Property ownership and land use regulations are sensitive issues that are central to habitat protection. Property is subject to law and review by people and social institutions concerned with the use of land. Changes to property use are negotiated in this public-private dynamic.

Natural resource stewardship exacerbates the question of government oversight because ecosystems cross property lines and jurisdictional boundaries. Ecosystem continuity is one criterion for successful environmental stewardship, and this larger view tends to reside with public sector planning and oversight. Government has a responsibility to uphold the public trust, including the protection of valued public resources, once identified and agreed upon.

Property owners have many concerns about regulations limiting development on their land. People purchase a property with the expectation of a certain use; thus regulatory certainty is an important factor. A change in regulations affecting land development and use could have an economic impact, but there is also a social aspect relating to individuals' perceptions of their rights and roles in our society. Restrictions on the use of property can also contribute to feelings of political alienation and may cause people to invest in property or businesses elsewhere.

Americans have a history of strong individual property rights

Property is considered by many to be one of the basic institutions of human society, similar to family and religion. In America the rights that come along with owning a piece of property have been especially revered. Many people believe that individual property owners should determine the most appropriate and beneficial use of their property. These beliefs date back to frontier times in America, when land was conquered and tamed.

The legal concept of property consists of a number of rights that are guaranteed by the government (Sargent et. al 1991). A common idiomatic description of property rights is the reference to a "bundle of sticks," where each stick represents rights the owner has in regard to the land. Some sticks are reserved by the government, such as the right to tax and the right to control the type of private use on the land (Meyer 2001). Conferred rights depend on public oversight and responsibilities associated with land ownership. The benefits, agreements, and responsibilities tied to property are varied and are negotiated over time by law and public policy. There are also informal cultural aspects of property such as status conferred by property, how property is kept, and related social conduct by property owners.

Land ownership issues are complex because individuals have expectations of what they can do with their land while society at large has expectations of how land should be managed.[45] Environmental conservation and natural resource scarcity are two examples of how common issues affect both public and private property interests. Natural resource protection, for the sake of the public good, has become a factor in the debate about land use and resource management, which involves multiple types of property and uses. However, many residents of the region consider unregulated ownership of property (or as few regulations as possible) to be important. Thus, if Metro were to implement regulations to limit or prohibit conflicting uses in identified fish and wildlife habitat, such limitations on the activities of a private property owner would have a social impact on those property owners and other citizens who feel strongly about the rights of private property owners to use their property as they see fit, unfettered by government regulation.

Takings

The "Takings Clause" of the Fifth Amendment to the U.S. Constitution provides that private property shall not be taken for public use without just compensation. This clause was part of the U.S. Constitution as initially ratified, and it represents a bedrock principle of American law. Article I, section 18 of the Oregon Constitution contains a similar requirement. Not many people

[45] Property rights are a function of what others are willing to acknowledge. A property owner's actions are limited by the expectations and rights of other people, as formally sanctioned and sustained in law (Meyer 2001).

would disagree that if the government physically takes private property and puts it to public use, to build a road, for example, the landowner should be justly compensated for the value of the property that was taken. This is normally done through a condemnation procedure. A more difficult question arises, however, when the government does not physically confiscate property but rather regulates how private citizens may use their property. The U.S. Supreme Court has issued numerous decisions interpreting and refining the meaning of the federal Takings Clause in the context of such alleged "regulatory takings."[46] Such jurisprudence makes it clear that the meaning of the Takings Clause in the context of regulatory takings is still vigorously and passionately debated.

In 2000, this issue was put before the people of Oregon in the form of Ballot Measure 7. Measure 7 asked if property owners should be compensated for any decrease in the market value of their property caused by the imposition of new governmental regulations. The measure passed, but the Oregon Supreme Court later overturned the measure on procedural grounds (it had not been adopted as required by the Oregon Constitution). A recent report by the City Club of Portland on ballot Measure 7 (from the 2000 election) addressed regulatory takings. The report suggests that compensation to property owners is reasonable at a certain agreed-upon threshold of regulatory appropriation, as it relates to existing allowed uses (not anticipated or speculative uses). The report suggests government is accountable for its regulatory impacts and should estimate these impacts and make exceptions when unfair burdens exist (City Club of Portland 2002).

Thus, in summary, it is clear that people have strong feelings about the takings issue; feelings that go beyond concern about a loss in the economic value of property. There are people who believe, for example, that the *Dolan v. City of Tigard* decision should be interpreted to require the government to compensate any landowner whose ability to develop their property is at all limited by a government regulation. Others legally dispute that interpretation, and a legal recitation of the interpretation of Supreme Court cases is inappropriate in this analysis. The point of raising this issue is that it goes to the question of individual rights in our society and the relationship between individuals and government. Some who believe that more compensation should be provided when the government regulates the use of private property might feel alienated from government when courts have ruled that certain regulations do not constitute compensable takings. Put another way, if regulations are imposed that may decrease property owners' freedom to use their property as they wish, some will believe that the government has "taken" their property, regardless of whether a court would find that such an action was a constitutional "taking" for which they should be compensated.

If the Metro Council chooses to limit or prohibit conflicting uses on some fish and wildlife habitat, a program to protect these areas will be developed in such a way that a legal taking does not occur, similar to current regulations to protect water quality and prevent flooding (Title 3). However, many landowners believe that additional regulations require compensation, and that a regulatory program should also include incentives.

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[46] See, e.g., *Agins v. Tiburon, Nollan v. California Coastal Commission, Dolan v. City of Tigard, Penn Central Transp. Co. v. New York City, Lucas v. South Carolina Coastal Council,* and *Palazzolo v. Rhode Island*; see also *Dodd v. Hood River County* (9th Circuit decision).

Personal financial security

Real property is one of the largest economic investments many people make and is an important and sensitive social issue. Property represents issues of security, income, housing, and employment opportunity. The ability to use land as it is zoned implies a social and economic purpose or right – perhaps described as certainty or security. Private investment in property is tied to a potential income stream or return on investment, which usually results from a combination of local plans and development conditions, general market conditions, upkeep, and improvements. Investors in property seek clarity about the regulatory framework. Regulations that result in reductions to property value may affect people's ability to draw on the equity in their homes to fund retirement, education, and other activities. Thus, limiting or prohibiting conflicting uses, if it results in reduced property values, can have a negative social impact.

At the same time, because property overlaps with and can affect natural resource systems – land, water, air, ecosystems – property is also tied to common goods which are needed and valued by society at large as well as by individuals. The impact of natural areas on quality of life, property values, and regional attractiveness is an economic consideration as well. For example, local studies (Lutzenhiser and Netusil 2001, Bolitzer and Netusil 2000) have shown that proximity to some types of natural areas actually increase property values, thus preservation of these habitats could positively impact nearby property owners. Private individuals and firms can capture the value of location, such as nearby parks, open space or schools, or good accessibility to services or transportation infrastructure. This results in higher demand and higher dollar valuation of these properties. On the other hand, public parks, schools, highways, and other perceived amenities capture individual or commercial value by the usage, time, and willingness of people to pay for them. Negative impacts such as congestion, noise, nuisance, crime, pollution, or diminished natural features can affect adjacent property values as well as the community.

Distribution of benefits and burdens

When a community makes habitat allocation decisions, social equity issues and questions of policy fairness may arise. There are several social equity considerations. Who may be affected if fish and wildlife habitat identified in the inventory is protected? Who benefits, and who is burdened by a habitat protection program? If some property owners are burdened, is the benefit gained commensurate with the burdens on property owners? The affected parties could include individual property owners, families, and businesses as well as other entities such as public agencies, non-profits, and community organizations.

Fish and wildlife habitat is fixed in location at a given point in time; therefore, the distribution of the assets and liabilities resulting from the habitat is inherently uneven. Uneven distribution of the habitat is not in itself an inequity, since these natural assets were not publicly allocated in the past and cannot be reallocated at present. The habitat exists in nature, is partially attributable to historic development trends, and is a feature of the landscape today. If Metro were to develop a plan to restore or acquire fish and wildlife habitat and thus invest publicly in conserving these areas, then social equity concerns might arise. Currently, distributive concerns are minimized because of the fixed character of the habitat and the lack of funds to develop restoration or acquisition programs targeted to the fish and wildlife habitat inventory.

Public access to many of the fish and wildlife habitat inventory sites identified by Metro is limited, and public benefits are more indirect than direct. Indirect public benefits are derived from the value of maintaining biodiversity in the region and from general environmental health and water quality improvements. The more direct benefits of being located near fish and wildlife habitat accrue to those nearby. While streams and rivers are a public resource, streamside property owners benefit more from actions taken to protect and enhance stream health. Those same property owners may "pay" for their location with the increased risk of flooding and sometimes additional regulations to maintain the public values of the habitat. Amenity values[47] that benefit property owners may be considered as offsets against burdens these same owners may face in shouldering the responsibility of conserving these resources.

Fish and wildlife habitat can add value to property (Bolitzer and Netusil 2000) and is related to the demand for these locations. On the other hand, if the fish and wildlife habitat substantially hinders development of the property or acts as a nuisance, then there are inequities to consider. If the benefits and burdens are relatively equal, then some of the equity issues may be neutral.

The property owners most affected by a decision to limit or prohibit conflicting uses are single-family residential (46 percent), followed by industrial land (14 percent). However, developed land is likely to be less affected than vacant land.[48] All residents of the region will benefit from the retention of fish and wildlife habitat, even though public access may be unavailable on all but publicly owned land. The benefits arising from protecting fish and wildlife habitat have been described throughout this social analysis. Thus, the burden may fall disproportionately on one group of property owners to provide the benefit for the common good. A protection program that includes incentives and carefully considers the impact of regulations may reduce the burden on the selected property owners.

Public property rights

Ownership of property is defined as an aggregate of rights that are guaranteed and protected by the government. However, the government retains some rights in trust for the people. For example, environmental quality and fish and wildlife habitat are not owned by anyone. They are public resources that the government can act to preserve, which is the concept of the public trust doctrine.

For example, the public has a right to clean air and water. Landowner actions on private land affect the quality of both air and water. Therefore, government regulations at the federal level have been developed to protect public rights through the Clean Air Act and the Clean Water Act. Similarly, fish and wildlife are important natural resources that typically cross legal boundaries, moving from one property to another. An individual does not own the wildlife that inhabits or crosses his or her land (*Geer v. Connecticut* 1896). If society has identified specific species of fish or wildlife as important to protect, through the Endangered Species Act or other means, then a government has the responsibility to act to maintain the species in trust for the people.

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[47] See *Economic Consequences Analysis* for more description of amenity values.

[48] Developed land: single family, 37 percent; industrial, 34 percent. See *Conflicting Uses* chapter for more data.

In law, the public trust doctrine serves as a foundation of the public's right for common use and access of public resources (although this doctrine has traditionally been restricted to the interpretation of navigable waterways and tidelands). The public trust doctrine can theoretically be applied to all public trust resources. Private individuals do not own public trust resources. The Oregon beaches are one example of a public trust resource. The Oregon legislature affirmed the public's right to access or use of a common area (the beach) on Oregon's coast (between low tide and the line of vegetation defined in ORS 390.770) even if privately owned. This is not so much about a right of public access as about the responsibility to preserve the associated public value (availability of that experience) inherent to this unique coastal environment (Oregon Department of Land Conservation and Development 2003a, "Beach Bill"). Access is not required to protect a public trust resource. Protecting air and water quality or wildlife, while affecting private property rights, does not require providing public access to private land.

Controversy and legal conflicts are likely regarding the differences in public trust assertions and private right claims when these concepts overlap in policy making, such as with developing a program to protect regionally significant fish and wildlife habitat. Establishing the value of these habitats from both a public and private perspective is important in identifying the social concerns of protecting fish and wildlife habitat.

What fish and wildlife habitat will we leave for future generations to enjoy in the Metro region?

Sustainable development and other social movements by local, national and international groups have fostered a new urgency in planning and development. Interdisciplinary thinking seeks to reconcile natural resources, human needs, social responsibility, and ethics. Preserving biodiversity has an intrinsic value as well as a potential future value with regard to science, health, cultural heritage, and the economy. The overarching message of social-environmental policy is human interdependence with the natural world. Resource scarcity and environmental degradation temper production and consumption patterns around the world. This new social awareness leads to shifts in how growth and development occur, from the workplace to people's backyards.

Social values that support society's interdependence with nature, as opposed to control over nature, indicate an awareness of the biophysical limits of the environment. While everyone does not adhere to sustainable development's goal of a moral obligation to preserve the natural world, some see this as recognition of deeper social values that extend to future generations. The U.S. Conference of Catholic Bishops (USCCB) states that

> ...[W]e simply cannot leave this problem for the children of tomorrow. As stewards of their heritage, we have an obligation to respect their dignity and to pass on their natural inheritance, so that their lives are protected and, if possible, made better than our own. (USCCB 2001)

Resource dependency is a defining characteristic of living systems. An essential challenge for modern development is how to design and manage for humanity's interdependence with nature. This is not just an ecological, engineering, or market question; it is also increasingly a social and policy issue. Attention to human-induced environmental problems has emerged as a result of our increased population, resource scarcity, waste generation and the combined effects on health and long-term survival. In urban metropolitan areas these effects can be seen with growth: more people, more pollution, and a scarcity of open space (Donnelley 1998, Lange 2003, Lazaroff 2003, McClure 2003).

Intergenerational equity

How do people manage for environmental stability, health, and the integrity of the planet's ecosystem for future generations? The interdependency of people and nature is a reciprocal relationship. Feedback or awareness is key to the stability of the ecosystem. Sustainable development embraces this idea. It has captured the common sense notion of moderation, of realizing that biophysical limits exist and exercising caution with resources that may not be easily replenished. This current awareness extends to monitoring the most basic ecosystem attributes, such as climate conditions, air, water and soil quality, and species diversity.

Originally written 30 years ago, the Oregon Statewide Planning goals repeatedly cite "carrying capacity"[49] when assessing development and impacts on the environment. The following two phrases are repeated as considerations in nine planning guidelines (for natural resources, air and water quality, natural hazards, recreation, economic development, housing, public facilities, transportation, and urbanization):

> Plans ... should consider as a major determinant the carrying capacity of the air, land and water resources of the planning area. The land conservation and development actions provided by such plans should not exceed the carrying capacity of such resources. (Oregon Department of Land Conservation and Development 2003b)

These are general parameters of evaluation and specific application of this principle is often hard to estimate. As more attention is paid to sustainability, renewed attention to what carrying capacity means becomes relevant. A decision to limit or prohibit conflicting uses in fish and wildlife habitat areas meets the social goal of retaining natural resources for future generations to enjoy.

What are the potential social consequences of allowing, limiting, or prohibiting conflicting uses?

The Goal 5 process requires local governments to make a decision to allow, limit, or prohibit conflicting uses to protect fish and wildlife habitat based on balancing the consequences of the four ESEE factors. A description of what it might mean to allow, limit, or prohibit conflicting uses is described in the Chapter 3, *Conflicting Uses*. The social consequences analysis is limited by the hypothetical context of policy changes. In general, the social considerations as they relate to specific property development are focused on people's rights and interests in effecting policy and on the value people place on the long-term existence of fish and wildlife habitat. Below is a general description of the social impacts of allowing, limiting or prohibiting conflicting uses, a

[49] *Carrying capacity* as defined by DLCD: Level of use which can be accommodated and continued without irreversible impairment of natural resources productivity, the ecosystem and the quality of air, land and water resources.

summary of the differences of the consequences by regional zone, and the key points learned from the social analysis. Several matrices relating the social impacts to Metro's generalized regional zones may be found in Appendix D.

Potential social consequences

Allow conflicting uses

A decision to allow conflicting uses in fish and wildlife habitat areas would have positive and negative social consequences. Property owners would not be concerned about impacts to property rights, there would be no takings issues, and the burden of protecting fish and wildlife habitat would be equally distributed. For residential land in particular, there might not be a change in personal financial security or the right to maintain and develop land within the existing regulatory framework. There would be no change in the number or type of housing options, and housing affordability might not be affected. Industrial landowners could continue to develop using land intensive practices. Employment opportunities under current zoning might not change. Additionally, less fish and wildlife habitat might mean a decreased risk of urban wildfires and nuisance species.

However, a decision to allow conflicting uses would have several negative impacts. The fish and wildlife habitat that forms a major portion of our cultural heritage, sense of place, and regional identity might be eroded and possibly lost. The salmon that are so important to Native American culture and the heritage of the Pacific Northwest would stand less of a chance of surviving. Some property owners might be concerned that property values would diminish due to potential loss of nearby natural areas. Public health could suffer due to poor air and water quality, fewer recreational opportunities, reduction in opportunities for mentally restorative nature visits, and possibly higher levels of aggression and violence. Opportunities for children and adults to learn about the environment specifically and to integrate environmental learning with traditional subjects to form a cohesive approach would be lost. Loss of tree canopy and vegetation could increase the risk of floods and landslides. Fewer companies might locate to this region if the quality of life and outdoor recreation are negatively affected. An allow decision would not provide for intergenerational equity, since people today would not be saving fish and wildlife habitat for future generations to enjoy.

Limit conflicting uses

A decision to limit conflicting uses in fish and wildlife habitat areas would be a compromise, attempting to minimize the negative social impacts of either allowing or prohibiting conflicting uses. If development occurred with minimal impact to the fish and wildlife habitat, social values could be maintained while reducing the effect on property owners. This type of approach could maintain housing and employment options while preserving as much habitat as possible. Some or most of our cultural heritage, neighborhood character, sense of place, and scenic values would be preserved. Negative impacts on public health could be reduced, and most educational opportunities could be retained. Benefits such as stress reduction, decrease in aggression and violent behavior, and positive impacts on mental health might not be lost. Salmon would be provided with more of a chance to recover and impacts on Native American culture and regional identity would be lessened. Risk of floods and landslides would be reduced, and there would be more intergenerational equity. However, an increase in habitat could result in more urban wildfires and nuisance species. Regulations limiting conflicting uses might not be equitably distributed among property owners, and there may be impacts on property rights as well as takings concerns.

Prohibit conflicting uses

A decision to prohibit conflicting uses in fish and wildlife habitat areas would preserve all of the important social values and public benefits provided by habitat described above. However, such regulations would result in an unequal distribution of burden among property owners, with a negative impact on property rights. Takings concerns would likely become an issue. While property owners with existing homes might not be affected, vacant land might not be allowed to develop in the same way as currently allowed. Housing and employment options might be reduced, with a resulting need to increase densities or expand the urban growth boundary. More land would be needed to meet housing and employment demand if conflicting uses were prohibited on additional land within the urban growth boundary.

Social consequences by generalized regional zone

Most of the social consequences are similar across zones (matrices describing the consequences may be found in Appendix D); the differences are identified below.

- **Single-family residential (SFR):** For single-family uses, a decision to allow could maintain personal financial security (equity) if property values are not affected. A limit or prohibit decision might reduce options for large lot homes if they are allowed under current zoning. However, in some instances larger lots could reduce the impact on fish and wildlife habitat and could be allowed under a limit decision, depending on the type of program.
- **Multi-family residential (MFR):** A limit or prohibit decision may reduce opportunities to develop at high densities in fish and wildlife habitat areas. This could affect property owners by reducing the number of units that could be built on a specific property, reducing development potential. However, a program could be designed to minimize the impact by allowing clustered development or transferring density.
- **Mixed-use centers (MUC):** An allow decision would have no impact on current 2040 densities or development in centers, supporting the achievement of the 2040 Growth Concept. A limit or prohibit decision may impact achievement of the 2040 Growth Concept by curtailing growth in centers, depending on the type of program implemented.
- **Commercial (COM) & Industrial (IND):** For commercial and industrial land the most important social consequence of a limit or prohibit decision is the potential to impact job creation and the location of future jobs.
- **Rural (RUR):** In rural areas the focus is on the future opportunities for housing and employment that could be minimized when the land is urbanized.
- **Parks and open space (POS):** An allow decision would maintain or increase opportunities for active recreation, while a decision to limit or prohibit could reduce opportunities for active recreation, depending on the program.

Summary points

- Protection of fish and wildlife habitat preserves many important social values. These include our cultural heritage, regional identity, sense of place, and neighborhood character. Property owners may also benefit from the retention of fish and wildlife habitat through increased property values. Opportunities for education abound in areas with healthy fish and wildlife habitat.

- The distribution of the regulatory burden on property owners to protect fish and wildlife habitat for the general public benefit is a critical social concern. Private property rights are a fundamental cornerstone of American life, and additional regulations reducing development rights may be seen as an attack on personal financial security as well as a possible taking. However, there are public rights to clean air and water, as well as healthy fish and wildlife, which serve as a counterbalance to this view.
- Fish and wildlife habitat provide positive benefits to public health and safety, but there are some negative effects. There are many obvious benefits of recreation, as well as the mental health and stress relief found in nature. Additionally, minimizing the incidence of flooding and erosion contributes to public safety. However, increased forest canopy and vegetation could lead to wildfire risks and potential damage from windstorms.
- People today have a responsibility to provide future generations with some of the same benefits that current residents enjoy. Sustainable development practices allow for development to occur today while maintaining a certain amount of intergenerational equity.

CHAPTER 6: ENVIRONMENTAL CONSEQUENCES

Introduction

Urban areas are, by their nature, heavily impacted by human activities. In turn, humans are part of the ecosystem in which they live, and human welfare ultimately depends in part on the vital services, such as shade, fresh air and clean water, provided by natural resources. The urban growth boundary (UGB) designates a limit to physical expansion of the urban area; to contain the negative ecological effects associated with urban sprawl and to protect valuable forest and agricultural lands. The UGB is effective at this: current aerial photographs clearly show that more natural resources and farmland remain outside the UGB than within it.

What are the consequences to regionally significant fish and wildlife habitat of allowing, limiting, or prohibiting land uses that conflict with habitat functions? Full protection of remaining fish and wildlife habitat will preserve existing habitat functions. Fully allowing conflicting uses in fish and wildlife habitat will reduce or remove existing ecological functions, with associated negative impacts on fish, wildlife and people. However, consequences for the broadest category – limiting conflicting uses within fish and wildlife habitat – depend on the definition of limit. Limiting conflicting uses implies that some limited amount of development or other conflicting use(s) will occur in conflict with fish and wildlife habitat areas. The consequences depend on the extent and type of land use and the habitat's ecological importance in the regional system, influenced by the program selected in the next phase of the Goal 5 process. Figure 6-1 provides a general illustration of the potential environmental consequences of this decision process; actual consequences depend on the program selected and its implementation effectiveness.

Figure 6-1. Range of potential consequences of prohibiting, limiting, and allowing conflicting uses within fish and wildlife habitat.

Prohibit	*Limit*	*Allow*
• Preserve existing ecological functions	• Existing ecological functions impaired	• Existing ecological functions greatly impaired
• More native plants and animals	• Some increase in non-native species invasions	• Greatly increased non-native species invasions
• More biodiversity	• Some biodiversity loss	• Substantial biodiversity loss
• Retain existing stream network	• Some streams will be lost, but less than allow	• Substantial stream loss continues
• Good restoration potential	• Good restoration potential	• Poor restoration potential
• Flood frequency, magnitude maintained as is possible	• Flooding increased compared to prohibit	• Flooding substantially increased
• Soil loss continues at current level	• Increased soil loss, sedimentation	• Very damaging soil loss, sedimentation
• Possibly retain salmon	• Salmon decline further	• Probable salmon loss
• Possible environmental threat due to greater UGB expansions	• Possible environmental threat due to greater UGB expansions, but to a lesser degree than Prohibit	• Decreased need for future UGB expansions, reducing environmental threats to areas outside the UGB

This chapter addresses the following questions:

- What are the functions and values of the region's fish and wildlife habitat?
- What impacts do conflicting uses have on the region's fish, wildlife, and their habitats?
- What are the potential environmental consequences to fish and wildlife habitat of allowing, limiting, or prohibiting uses that conflict with habitat function?

What are the functions and values of the region's fish and wildlife habitat?

To assess the consequences of allowing, limiting or prohibiting conflicting uses on fish and wildlife habitat, it is important to first identify the ecological characteristics of healthy ecosystems. Metro's science paper characterized the attributes of healthy watersheds and functional values of fish and wildlife habitat (Metro 2002c), as summarized below:

Key ecological attributes that characterize a healthy watershed

- Vegetated uplands dominated by native plant cover.
- Continuous stream corridors, including headwater areas, with healthy, fully functioning riparian corridors. The fewer the disruptions within the riparian corridor, the better.
- Floodplains connected with stream and river channels.
- Relatively unaltered hydrologic regimes.[50]
- Intact hyporheic zones.[51]
- Clean water at temperatures suitable to support native wildlife.
- Natural (or ecologically sustainable) input rates of solar radiation, sediments, organic matter, and nutrients that support healthy, productive and diverse fish and wildlife populations.
- Lateral, longitudinal and vertical connections between ecosystem components.
- Natural (or ecologically sustainable) rates of landscape disturbances.
- Good air quality.[52]
- Healthy, uncompacted soils.
- Diverse biological communities.

Key functions and values of fish and wildlife habitat

- Key habitat functions in riparian corridors can be assigned to five main categories: microclimate and shade; streamflow moderation and water storage; bank stabilization and pollution control; large wood and channel dynamics; and organic material sources.
- Native vegetation plays a critical role in the longitudinal and lateral connectivity of the riparian corridor for fish and wildlife.
- Native vegetation supports more species of native wildlife than non-native vegetation.
- Downed wood and snags (or large woody debris), frequently found in natural ecosystems but often lacking in disturbed environments, are crucial to providing high quality habitat in both

[50] That is, natural drainage systems that route and deliver water in quantities and at rates similar to natural conditions.
[51] Retention of the natural intermixing of ground- and stream water.
[52] See Chapter 7, *Energy Consequences* for further discussion of air quality.

aquatic and terrestrial ecosystems. Large wood also influences natural channel dynamics.

- Conservation of the majority of water areas – wetlands, streams, groundwater, and near surface water areas (hyporheic zone) – is essential to ecosystem health.
- Appropriate buffers to retain key riparian corridor functions should be based on site-specific conditions.
- Upland habitat is important for many wildlife species. The guidelines in developing a conservation plan for upland habitat are: large habitat patches are better than small patches; small patches of unique habitat are worth saving; connectivity to other patches is important; and connectivity or proximity to water resources is valuable.
- Declining and unique habitats are vital to regional biodiversity, and should receive high conservation priority status.
- Habitat fragmentation is detrimental to both wildlife and habitat; buffers and surrounding land use play an important role in maintaining the functions of remaining habitat.
- Tree canopy provides important wildlife habitat and helps maintain air and water quality.

Metro's science paper (Metro 2002c) identifies the fish and wildlife species regularly supported by the region's existing wildlife habitat.

What impacts do conflicting uses have on the region's fish, wildlife, and their habitats?

In water and on land, urban environments share similar ecological problems worldwide, including habitat loss, habitat damage and alteration, modified hydrology, non-native species, and human disturbance. Impacts with negative consequences to fish and wildlife habitat are both site-specific and ultimately, cumulative. For example, stream problems due to pollution may come from either point-source[53] or non-point source polluters.[54] Cumulative impacts provide a way to consider the combined influence of one type of action by many individuals.

Metro's role is to assess and address the cumulative impacts of development and other uses that conflict with fish and wildlife habitat at the regional level. The scientific literature and Metro's fieldwork (Frady et al. 2003) state that certain types of site-specific impacts tend to be associated with certain development types.[55]

In urban areas, cumulative impacts are pervasive and cause great environmental harm. It is often difficult to separate one cumulative impact category from another because they overlap and combine for harmful effects. For example, vegetation loss and increased impervious surfaces combine to alter natural hydrologic regimes. During rainstorms, these impacts cause too much water to enter the streams, too quickly. The result is damaged streambanks and streambeds with increased erosion; erosion adds sediments to the stream, and so forth. Problems such as these quickly become widespread in all urban areas. For the purposes of this analysis it is useful to cluster the primary consequences into eight general categories. Table 6-1 below lists each environmental consequence category and cross-references it with the conflicting uses identified

[53] Industrial or municipal wastewater discharge into a stream or river.
[54] All landowners using pesticides or all non-natural stormwater discharges within a watershed.
[55] This is discussed in more detail in the *Conflicting Use* chapter.

in the *Conflicting Uses* chapter. Following Table 6-1, each environmental consequence category is described more fully and the types of impacts associated with that category identified.[56]

Table 6-1. Cross-reference of the major environmental consequences categories and the conflicting uses associated with each category.

Potential consequences to fish and wildlife habitat	Disturbance Activities (conflicting uses)																
	Vegetative clearing	Grading, filling, soil compaction	Installation of impervious surfaces; runoff	Stream modification	Installation and maintenance of utilities	Stormwater piping, water control structures	Road construction, bridges, culverts	Landscaping, introduction of exotic plant species	Introduction of non-native fish and wildlife species	Herbicides, pesticides, fertilizer use	Installation of fences and other wildlife barriers	Introduction of toxics, heavy metals, pollutants	Water useage	Livestock grazing	Trail construction, maintenance and use	Allowing pets, livestock in natural resource areas	Human disturbance (e.g. light, noise)
Altered hydrology, physical stream damage, increased flooding	■	■	■	■	■	■	■	□	□	□		□	■	■	□	□	
Degraded water quality	■	■	■	■	■	■	■	■	□	■		■	■	■	■	■	
Loss/degradation of riparian or upland habitat	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Habitat fragmentation	■	■	■	■	■	■	■	■	□	□	■		□	■	□	□	■
Altered microclimate	■	■	■	■	■	■	■	□		□			■	■	□		■
Reduced woody debris and organic materials	■	□	■	■	■	■	■	■		□			□	■	□		
Erosion, sedimentation and soil loss	■	■	■	■	■	■	■	□		□			□	■	■	□	
Reduced biodiversity; non-native species invasions	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

■ Conflicting use has potential for direct impact.
□ Conflicting use has potential for impacts, but at a reduced level or through indirect means.

Altered hydrology, physical stream damage, increased flooding

This category is listed first because it is an overarching issue in urban ecology. Activities typically associated with urbanization, especially vegetation removal, installation of impervious surfaces, and stormwater control (Table 6-1), fundamentally alter the patterns of rainwater delivery to streams and other waterbodies: too much water hits the stream too quickly. The result is physical damage to streams and an increase in flooding. Many adverse effects are documented due to hydrologic alterations, and some of these are listed in Table 6-2. Impaired

[56] For more in-depth discussions of these issues and relevant literature citations, see *Metro's Technical Report for Goal 5* (Metro 2002c).

water quality, addressed as a separate environmental consequence category, is also associated with altered hydrology, as are many other urban effects (see Table 6-1 above).

In the Metro region, much of the rainfall naturally seeps into the soil and makes its way to the stream only after much slowing and interception by soils, rocks, plants, and roots. Streams and the animals living there are adapted to these patterns; when the patterns change substantially, streams can no longer support some of these species, such as salmon and certain insects critical to instream food webs (McCarron et al. 1997; May and Horner 2000).

Development activities remove vegetation, add impervious surfaces, and often include intentional widening, deepening, straightening, and sometimes armoring streambanks to confine flows and increase a stream's capacity for localized flood control (although in fact, this practice increases flooding by altering the hydrology). These activities result in moving water more quickly downstream, disconnecting the stream from its floodplain and groundwater sources, degrading riparian habitat, and creating bigger floods and more problems downstream. To illustrate this concept, Figure 6-2 compares two hydrographs, a type of graph that charts the timing of runoff and peak flood stage. The "Q after" line shows a taller flood peak that occurs sooner, with more water being discharged via the stream than under natural conditions (Q before).

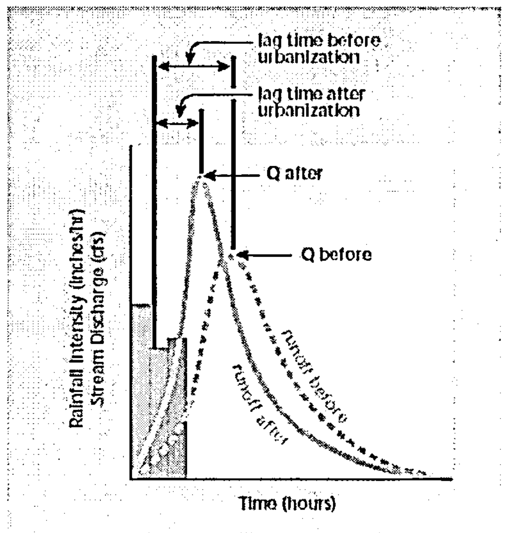

Figure 6-2. A comparison of hydrographs before and after urbanization.
(Source: FIRSWG 1988)

Altered hydrology damages stream channels and streambanks. Fast-moving, high-volume water quickly erodes away streambanks, incises (downcuts) stream channels, and increases sediment loads in the water and streambed. Stream channels widen and straighten, and are often intentionally modified in these ways, to accommodate increased stormwater velocity and volume due to altered hydrology. Large woody debris, ponds, pools, riffles, streambanks, and sandbars are simplified or washed away. The stream's substrate – that is, the particles making up the bottom of the streambed – tend to change from larger rocks to finer particles such as clay and silt; fine substrates are tightly packed, with little room for oxygen pockets or macroinvertebrates. Salmon need larger substrates for spawning, and they also need macroinvertebrates for food. These changes result in a loss of stream complexity and fish and wildlife habitat and degraded water quality downstream due to increased fine sediments in the channel and in the water column.

Altered hydrology causes increased flooding by affecting the frequency, duration and magnitude of flood events, and reducing water infiltration and storage (Booth and Jackson 1997). The frequency is altered in that more floods occur per year. Flood duration and severity tend to be increased. These flood characteristics are typically measured using a hydrograph; Figure 6-2 shows an example of the changes in flood patterns that occur with urbanization. The hydrograph's peak is taller and occurs sooner (a bigger flood that quickly overwhelms water storage) and the shape of the peak is narrower (the water is not retained on the land to replenish groundwater and keep summer streams running).

Altered hydrology complicates restoration efforts in an urban setting. Restoration has some limited ability to counteract these negative effects, but may be rendered ineffective if larger-scale issues such as stormwater, canopy cover, and imperviousness are not addressed. For example, placing large wood in a stream usually helps under more natural conditions, but if the stream is too flashy from altered hydrology it may wash away the wood and continue to widen, deepen, and damage the stream.

Table 6-2. Environmental consequences of altered hydrology, physical stream damage and increased flooding.

• Degraded riparian habitat, ecological function loss • Decreased channel sinuosity (results in higher water velocity, increased discharge, increased flooding) • Stream channel scouring, armoring, and changes in channel width and depth • Streambank erosion and destabilization • Downstream sedimentation and erosion • Loss of riparian vegetation due to erosion, downcutting, disconnection with groundwater • Loss of stream shading; higher water temperatures • Altered microclimate • Loss of riparian buffer filtration capacity • Loss of hyporheic zone, groundwater • Loss of large woody debris, instream complexity • Loss of pool/riffle complexes and decreased streambed substrate size harms native fish and invertebrates • Loss of ecosystem services provided by healthy watersheds: clean water, nutrient cycling, human food (salmon), water storage, flood abatement, summertime inflow/recharge of cool, clean water to streams, etc. • Loss of critical food web components (macroinvertebrates, salmon, organic materials) • Loss of sand bars, shorebird, and waterfowl habitat • Loss of habitat heterogeneity; reduced instream and riparian structural and functional diversity • Loss of native soil and native soil invertebrates • Native aquatic and land-dwelling wildlife decline due to cumulative instream and terrestrial habitat degradation • Reduced biodiversity

Degraded water quality

Urban areas are where human population densities are highest. Humans are the primary source of pollutants and excess nutrients, thus urbanized watersheds typically have elevated pollution levels and impaired water quality. However, many factors contribute to pollution, and some of these factors can be controlled or mitigated. Table 6-3 highlights some of the environmental consequences of degraded water quality.

Excess pollutants, increased temperatures, or excess sediments may degrade water quality. Sediments are addressed in a separate consequences category below (Erosion, sedimentation and soil loss). Pollution can destroy food webs within stream systems. Pollution includes excess fertilizers, pesticides and herbicides, heavy metals, and other toxins. Impervious surfaces collect and concentrate pollutants from different land use activities and deliver these materials to streams during storms, preventing percolation and natural filtering by soil and vegetation. Data collected in the Pacific Northwest suggest that pollution from urban areas is harming salmon, birds and some mammals such as river otters (Lower Columbia River Estuary Program [LCREP] 1999; McCarthy and Gale 1999). Human health is also an issue; eating fish and crayfish from polluted waters can cause serious illness.[57] For example, fish in the Columbia Slough contain PCBs and pesticides; these chemicals may effect human development, reproduction, and immune systems, and may increase the probability of contracting cancer (City of Portland 2003).

[57] See *Social Consequences* chapter for further discussion of public health issues.

Development type influences the pollutants entering stream systems. For example, *E. coli* derives primarily from residential areas (pets, leaking septic tanks, etc.), entering through runoff, stormwater and groundwater; this bacterium is an indicator of fecal pollution from warm-blooded animals (Oregon Department of Environmental Quality 1998). Sediments derive most frequently from industrial and residential streets; construction and agriculture are other major sediment sources.

Phosphorus derives from fertilizer applied to residential lawns, industrial streets, and residential streets, in that order, but also sometimes from natural geological sources and from air deposition (Don Yon, Oregon DEQ, personal communication 2003); elevated phosphorus levels are a common problem in our area. Excess nitrogen is typically associated with agricultural lands, but residential fertilizers are another source. Some of these nutrients are needed in waterways, but excess amounts cause unnaturally increased nutrients, leading to low-oxygen water conditions and other water quality problems.

Heavy metals in excess amounts are toxic to humans, fish and other wildlife. Heavy metals are often contributed by cars and trucks; brake pads, oil and tire wear are major sources (Engberg 1995; Baldwin et al. 2003). Copper is emerging as a major problem for salmon, and in urban areas derives primarily from brake pads (Baldwin et al. 2003). Industrial lands are also a source of heavy metals through both point- and nonpoint-sources, but residential roofs also contribute substantial amounts of copper and zinc.

Pesticides, from both the present and the past (e.g., DDT), are present in many of the region's streams. More pounds of pesticides per acre are applied in urban areas than agricultural areas (Stinson and Bromley 1991). Recent research suggests that pesticides at low levels have an additive harmful effect on stream-dwelling wildlife (Munn and Gilliom 2001). Pesticides harm fish and wildlife through a variety of means, including direct mortality, decreased reproductive capacity, loss of salmon navigation and defense abilities, and loss of macroinvertebrates, a key salmon food source.

Table 6-3. Environmental consequences of degraded water quality.

- Hazardous materials, toxics in waterways and on land
- Groundwater and well water contamination
- Toxic pesticide residuals may remain in soils, plants, groundwater, and surface water for decades
- Human toxicity, direct and indirect (drinking contaminated water, eating contaminated fish)
- Heavy metal contamination harms salmon
- Pesticides entering waterways kill or harm aquatic organisms; unintended kills to non-target organisms
- Loss of pollution-intolerant species; increase in tolerant generalist species, which out-compete sensitive species
- Toxin bioaccumulation; decrease in reproductive success (e.g., Bald Eagles, Osprey, salmon, otters)
- Pollution-associated chemical changes, growth impediments
- Decreased stream and wetland water quality; feeds into larger streams, rivers and degrades downstream quality
- Increased nutrients in streams and wetlands; excess algal growth, low oxygen conditions harm aquatic organisms
- Decrease in life-sustaining capacity of air, water, and land
- Impaired salmon olfactory responses and homing behavior
- E. coli, other bacterial contamination; human health risk
- Water temperature increases result in lower dissolved oxygen; harms temperature-sensitive aquatic organisms (e.g., salmon, macroinvertebrates)
- Reduced biodiversity

Other chemicals found in streams, soil and groundwater create a variety of health problems for humans, fish and wildlife. Oil and other hydrocarbons, PAHs (polycyclic aromatic hydrocarbons), PCBs, dioxins and furans, pesticides, and metals are the most toxic to fish and wildlife, based on both Lower Columbia River and Willamette River studies by DEQ, and these are also most prevalent in the region's waterways (Don Yon, personal communication 2003). These chemicals typically derive from vehicular use and industrial and residential uses, through both point- and nonpoint-sources.

Physical and chemical pollution is not the only important water quality issue; temperature is a key water quality issue in the Metro region (see *Appendix B*). Water temperature is an important indicator of a watershed's vitality because of its controlling influence on the metabolism, development and activity of aquatic organisms (Naiman et al. 1992). Cold water holds more oxygen; cold, well-oxygenated water is needed by many aquatic species. Increased water temperatures may have profound effects on aquatic species, such as salmon, that can tolerate only a limited temperature range natural to Pacific Northwest streams. Air temperature and riparian vegetation play key roles in maintaining lower water temperatures.[58]

Riparian vegetation helps keep stream and river water cool (Budd et al. 1987). Riparian vegetation is more effective in providing shade and moderating stream temperature in smaller streams. Shade also cools shallow groundwater that feeds the stream during dry summer periods. Although shading on larger rivers may have little influence on water temperature, overhanging riparian vegetation along the banks creates cooler microhabitat for fish and aquatic organisms, and shade from smaller tributaries supply cooler water to large rivers (Palone and Todd 1997). Removing vegetation, especially trees and shrubs, results in warmer stream and river water.

As described in Chapter 1, the Oregon DEQ is required by the federal Clean Water Act to maintain a list of steam segments that do not meet water quality standards, called the 303(d) list. Many of the region's stream reaches are 303(d) listed as water-quality impaired due to elevated temperatures (Appendix B). Elevated temperatures are typically due to a combination of riparian forest removal and an increase in pavement and other impervious surfaces, where water flowing across these heat-gathering surfaces is warmed. Fish and other aquatic wildlife are adapted to the naturally cool water conditions in the Metro region, and warmer water harms these animals.

Loss/degradation of fish and wildlife habitat

Vegetation loss through a variety of means harms fish and wildlife and their habitats. Habitat loss has been identified a key factor in the decline of biodiversity worldwide (Kerr and Currie 1995). Within this category, many actions contribute to cumulative impacts. The Metro region, once composed of vast forested expanses, now has only about 12 percent forest canopy cover remaining according to one recent report (American Forests 2001). Substantial losses (25 percent or more) of surface streams reduces riparian habitat, a vitally important habitat type to the region's wildlife (Metro 1999b). Table 6-4 highlights some of the environmental consequences of habitat loss and degradation.

However, substantially more forest canopy cover exists outside the UGB than within it, attesting

[58] See Chapter 7 *Energy Consequences* for more information.

to the success of the UGB in controlling some negative impacts due to urbanization at the macro scale. In addition, many areas within the Metro region are currently undergoing restoration and tree-planting activities that provide widespread benefits to fish, wildlife, and people through improvements to the environment. If this environmentally promising trend continues and accelerates, the region could potentially see ecological improvement over time, perhaps even with increased human population and development.

Wildlife habitat is directly lost through development and other land use activities that remove trees and other vegetation. Habitat is degraded through a variety of activities, from site-specific to regional spatial scales. For example, at the site level, construction of a single-family residential home typically involves clearing vegetation, resulting in habitat loss. Lawns and other non-native vegetation replace native forests, resulting in a shift in plant species, leading to a shift in wildlife species. This is often to the detriment of native species and those species that rely on specific native habitat types such as grasslands, coniferous forests, or Oregon white oak habitat. During site preparation, soils are moved and compacted, altering soil profiles, fungus and microorganisms important to the success of native plant communities.

Table 6-4. Environmental consequences of fish and wildlife habitat loss and degradation.

- Altered watershed hydrology
- Increased flooding
- Erosion and soil loss throughout the watershed
- Increased downstream sedimentation and erosion
- Increased water velocity: stream incision, bank damage, loss of pool/riffle complexes, decreased substrate size
- Soil compaction; reduced water infiltration and storage
- Loss of fish and wildlife habitat
- Loss of habitat connectivity; fragmentation
- Reduction of structural and functional habitat diversity
- Shift in vegetation types or dominant plant species
- Shift to deciduous tree cover, with changes in wildlife, nutrient cycles, and reduced water storage capacity
- Increased adverse edge effects such as predation
- Increased edge-associated non-native species
- Loss of native vegetation in herbaceous, shrub, tree layers
- Loss of large woody debris and its sources
- Loss of native soil and native invertebrates
- Native aquatic wildlife declines due to cumulative instream and terrestrial habitat degradation
- Loss of stream shading
- Increased air temperatures (see Energy section, Urban Heat Island effect)
- Increased water temperatures
- Altered microclimate (warmer, drier air and soils)
- Loss of ecosystem services provided by plants (toxin and CO_2 uptake; O_2 release; water and carbon storage)
- Loss of riparian buffer pollution, sediment filtration capacity
- Loss of at-risk habitats
- Reduced biodiversity

At a larger spatial scale, the effects of changes in vegetative cover can be observed through long-term species trends. For example, at-risk habitats in this region include riparian forests and grasslands, with substantial regional losses documented. Trends over the past three decades for many bird species that specialize in these habitats show precipitous declines.[59]

All other consequence categories interact with this consequence category. For example, altered hydrology results in the loss and degradation of aquatic/riparian areas; so do degraded water quality, habitat fragmentation, altered microclimate, loss of large wood, and erosion and soil

[59] For some examples of species declining in the Metro region, see Table 6 in *Metro's Technical Report for Goal 5* (Metro 2002c).

loss. This is because wildlife depends on natural resources to live, and natural resources rely to some degree on wildlife as well. For example, plants need insects for fertilization; plants provide insects with food and a place to live, hide, and reproduce. Nearly all bird species feed their young insects. Birds disperse the plant seeds pollinated by the insects, and also do some pollinating themselves (for example, hummingbirds).

Habitat fragmentation

As discussed above, large-scale vegetation loss impacts wildlife. What habitat remains typically becomes fragmented, with increased consequences to wildlife and habitat due to negative edge effects and loss of connectivity between habitats. Habitat fragmentation has been identified as a key factor in the decline of biodiversity worldwide (Kerr and Currie 1995). Table 6-5 highlights some of the environmental consequences of habitat fragmentation.

Fragmentation reduces or eliminates the structural and functional diversity of fish and wildlife habitat; it also alters microclimate, discussed below. The predominance of non-native species is a key problem accompanying habitat fragmentation, primarily due to adverse edge effects.[60]

Edge effects are the negative consequences to plant and wildlife communities due to positioning near the edge of a habitat patch. Edge effects include increased predation of birds and bird nests by native and non-native predators; increased non-native plant and animal species; simplified forest structure; and increased human disturbances (physical, light and noise) associated with activities near the edge of the patch (Soulé 1991; Lidicker and Koenig 1996; Bolger et al. 1997; Hennings and Edge 2003). Habitat fragmentation increases edge habitat, and edge effects.

Table 6-5. Environmental consequences of wildlife habitat fragmentation.

- Small remnant patches of habitat not connected to other natural vegetation
- Adverse edge effects due to non-native or invasive plants and animals
- Increased wildlife disturbance and mortality due to pets, humans and predators moving along patch edges
- Increased nest predation
- Degraded habitat quality due to reduction in invertebrate abundance and quality
- Loss of connectivity between habitat patches
- Gradual loss of species richness over time in disconnected habitat patches
- Loss of population gene flow and genetic diversity
- "Edge" species benefit, while forest-interior or area-sensitive species decline or are lost
- Impassable barriers and mortality to wildlife (e.g., roads)
- Increases in roads and pathways (major disturbance and invasive species vectors)
- Vegetation trampling, soil compaction and tree root zone disturbance; increased tree wind-throw and death
- Loss of/harm to those species relying on a specific habitat type to meet their life-history needs
- Loss of/harm to disturbance-sensitive wildlife species (e.g., Neotropical migratory songbirds, bats, shorebirds)
- Noise/light pollution require fish and wildlife habitat quality
- Reduced biodiversity

Fragmentation and habitat isolation is also a problem because some wildlife species, such as amphibians, have small home ranges and cannot travel as freely as birds and mammals (Corn and Bury 1989; Richter and Azous 1995). Once a species disappears from a habitat patch, there may

[60] Non-native species are discussed further under the section below entitled "Reduced biodiversity and non-native species invasions."

be no way for more individuals of that species to move back in and repopulate the patch, causing regional species losses over time. All types of development can cause habitat loss and fragmentation, and fragmentation occurs in all types of habitat – streams, wetlands, riparian, and upland wildlife habitats. When large-scale habitat loss occurs, an ecosystem can no longer support as much wildlife as it once did (Wilcox and Murphy 1985; Bolger et al. 1997).

It is possible to reduce the adverse effects of fragmentation by planning the size, shape, and connectivity of remaining natural areas (Soulé 1991) and Metro built these important characteristics into the wildlife habitat model.[61]

In areas with extensive habitat loss typical of urban areas, it is important to plan for larger habitat patches and connectivity among patches wherever possible. Narrow habitat patches such as those along developed streams are critical to migratory wildlife such as Neotropical migratory birds, known to be at risk in the Metro area (Hennings and Edge 2003). Neotropical migrants are bird species that breed in the Metro region, but migrate south of the U.S./Mexico border to overwinter.[62] A system that contains large and medium sized habitat patches, connected by narrower corridors and nearby smaller patches is desirable.

The amount of human disturbance to wildlife is related to habitat fragmentation. Human disturbance can occur anywhere in urban areas, but within wildlife habitat patches these disturbances are typically concentrated in or near edge habitats. Road, noise, lights, and human activity[63] can all have detrimental effects on fish and wildlife and their habitats.

Noise can disrupt wildlife movement by distracting animals or by causing them to move away from the noise source, which can affect migration, breeding and nesting habits, as well as effectively reducing available habitat. Road noise is an emerging issue for birds, who rely on song to communicate and defend their breeding territories (Reijnen et al. 1995). Road noise may be a key to Neotropical migratory songbird loss in our urban area, where the number of species and individuals is reduced with increasing road density (Hennings and Edge 2003).

Night lighting, which frequently occurs near habitat edges, can alter the life cycles of plants and animals. For example, Moore et al. (2000) found that night lighting caused some wetland algae-grazing invertebrate species to forage deeper in the water; this could cause algal blooms at the water's surface, which can degrade water quality through low dissolved oxygen levels and toxicity. While lighting effects on fish of our area have not been studied, river-dwelling seatrout in Scotland are exposed to greater predation under night lighting (Contor and Griffith 1995). Terrestrial invertebrates (Frank 1988), amphibians (Buchanan 1993), birds (Frey 1993) and mammals (Rydell and Baagoe 1996) are also affected by night lighting.

Large buildings that remain lit overnight are known to attract migrating birds, which are injured or killed when they hit the buildings (Trapp 1998; Manville 2000). The magnitude of kills may

[61] See *Introduction* chapter for a brief description of Metro's wildlife habitat model. Metro's *Riparian corridor and Wildlife Habitat Inventories* contain a complete description (Metro 2002c).
[62] Typical examples include some of the more colorful species such as most warblers, Rufous Hummingbirds and Western Tanagers.
[63] For example, hiking on trails, children playing in streams.

depend on siting, height, lighting, and cross-sectional area of the obstacle, as well as weather conditions (Weir 1976). Night lighting also affects wildlife habitat itself. Many plant species depend on light and dark cycle lengths to direct their growth and reproduction, thus changing light duration may interfere with germination, flowering, and growth (Campbell 1990; Edwards and El-Kassaby 1996; Environmental Building News 1998).

The mere presence of humans has been shown to be detrimental to some wildlife species. Repeated human disturbance such as approaching large mammals can cause loss of unborn young (Phillips and Alldredge 2000). Bird biologists recognize that repeatedly approaching a bird's nest may cause the parents to abandon eggs or young (Bowman and Stehn 2003). Human disturbance causes energetically costly defensive behavior in animals; for example, bats are particularly sensitive to human disturbance, especially during breeding or hibernation (LaRoe et al. 1995; Tuttle 1997; Montana Chapter, The Wildlife Society 1999). Other negative effects from humans disturbing natural environments include vegetation trampling, tree root zone disturbance, and soil compaction, which reduces water infiltration and capacity for soil to support plants and invertebrates) (Cole and Trull 1992; Cole 1995; Whitecotton et al. 2000).

Altered microclimate

Riparian areas have a unique microclimate differentiated from upland habitat by a diversity of vegetation, leading to complex structure in the forest canopy, which impacts the amount of light, heat, and wind that penetrates the area. Moist soils help to keep temperatures lower than in surrounding areas as well. Stream channel width and riparian area topography influence microclimate extent (Brosofske et al. 1997; Pollock and Kennard 1998). Table 6-6 highlights some of the environmental consequences of altered microclimate.

Table 6-6. Environmental consequences of altered microclimate.

- Decrease in soil and air moisture
- Increase in soil, air, and water temperatures, with particularly harmful effects to amphibians
- Wider temperature variability in soils and air
- Decrease in soil's carrying capacity for microorganisms (macroinvertebrates, beneficial bacteria and fungi)
- Decrease in soil's ability to support plants, with corresponding habitat loss/degradation and reduction in ecosystem's ability to support wildlife
- Reduction in organic materials and large wood; altered food web, degraded fish and wildlife habitat (especially invertebrates, fish, amphibians, small mammals and snag-dependent species)
- Decrease in terrestrial food sources: leaves and other organic matter, macroinvertebrates
- Decreased stream shading, increased water temperatures
- Shallow groundwater temperature increases due to shading loss and soil warming
- Increased wind causes wind-throw, damaging or killing trees, especially near edges
- Wind-throw causes reduction in patch size and increased edge effects and fragmentation
- Wind-throw exposes soils to erosion
- Altered plant, fish and wildlife communities
- Reduced biodiversity

The microclimate of riparian areas is generally more moist and mild (cooler in summer and warmer in winter) than the surrounding area (Knutson and Naef 1997). This creates diverse habitat characteristics that are desirable to many species, particularly for amphibians year-round and for large mammals during hot, dry summers and severe winters (Knutson and Naef 1997). Widespread microclimate alterations change plant and animal communities, due in part to the edge effects engendered by habitat fragmentation (Saunders et al. 1999; Gehlhausen et al. 2000; Laurance et al. 2000). Forest edges tend to have elevated air temperatures, reduced humidity, and are exposed to more wind than forest interior habitats (Saunders et al. 1999; Gehlhausen et al. 2000; Laurance et al. 2000). In urban areas, this effect is compounded by the urban heat island effect.[64]

Amphibians may be the group most sensitive to microclimate changes and have suffered worldwide declines over the past 20 years, with particularly significant declines in the Pacific Northwest (LaRoe et al. 1995; Richter and Ostergaard 1999; Semlitsch 2000). Unlike other species groups, amphibian skin and eggs are not wind- or waterproof, and exposure to temperature and wind increases may be lethal.

Microclimate includes wind effects. An important consideration with forested riparian buffers is the ability of the forest to withstand the force of high winds (Broderson 1973; Steimblums et al. 1984). For example, in northwest Washington, windthrow (uprooting of trees or tree trunk breakage from wind) averaged 33 percent in riparian forest buffers within one to three years after clearcut harvest of adjacent timber (Grizzel and Wolff 1998). In a review of several studies, Pollock and Kennard (1998) determined that wider forest buffers protected trees from windthrow much more effectively than narrow forests. Thus, microclimate effects also relate to habitat loss and degradation, as well as several other consequence categories.

Shade is an important microclimatic function of riparian vegetation that influences water temperature (discussed in the Degraded Water Quality section above). Riparian vegetation creates an instream microclimate that maintains relatively constant water temperatures; when a riparian forest is removed, the monthly mean maximum temperature along smaller streams may increase 7-8° C (Budd et al. 1987). Water temperature is one of the most crucial environmental factors influencing salmon and other aquatic species.

Reduced woody debris and organic materials

Large woody debris (LWD), such as branches, logs, snags, uprooted trees, and root wads, is an important component of aquatic habitats in the Pacific Northwest, both as a structural element and as cover from predators or protection from high streamflows (Adams 1994; Prichard et al. 1998). Organic matter, such as leaves, twigs, and pine needles, help form the foundation of food webs both in aquatic habitats and on land. When riparian vegetation is removed, the source of large wood and organic matter is removed, with resulting harm to fish and wildlife habitat. Table 6-7

Table 6-7. Environmental consequences of reduced woody debris and organic material.

- Loss of stream and channel complexity (pool-riffle sequences, river island formation)
- Changes in channel bottom topography and substrate
- Increased water velocity in streams and rivers
- Changes in sediment and nutrient storage, transport, and cycling; decreased nutrient retention time
- Increased erosion rates and sedimentation
- Loss of important base components of food web
- Reduced carrying capacity of environment (fewer individuals can be supported when food is reduced)
- Loss of important macroinvertebrate, fish, amphibian, bat and small mammal, and bird refugia and habitat
- Potential loss of wildlife species depending on large wood and snags
- Decreased carbon storage (see Energy section)
- Loss of organic components that make up healthy soil; decreased beneficial bacteria, fungi and soil invertebrates
- Decreased rate of new soil production
- Decreased ability for soil to support plants and animals
- Reduced biodiversity

[64] See *Energy Consequences* chapter.

highlights some of the environmental consequences of reduced woody debris and organic materials.

Large woody debris is a key aquatic habitat structure. As sediment, large woody debris and other organic materials are transported and deposited throughout a watershed, channel characteristics and aquatic and terrestrial habitats are formed. Large woody debris is important because it influences the routing and storage of water and sediments, as well as the development of channel bottom topography, including the formation and distribution of pools (Beschta 1979; Booth et al. 1997).

In addition, LWD helps dissipate energy generated from streamflow, slowing erosion and sediment transport rate and retaining organic debris, making it available to organisms living there (Naiman et al. 1992). Large woody debris is also an important source of aquatic cover and acts as a surface for biological activity by aquatic organisms (Gregory et al. 1991; Naiman et al. 1992).

Large woody debris is often intentionally removed from waterways; for example, between 1867 and 1912, 55 miles of the Willamette River above Albany, Oregon were improved for navigation by removing an average 61 snags per kilometer (Sedell et al. 1990). Large wood may also be removed from streams in an attempt to reduce flooding. In urban streams of the Pacific Northwest, large wood is significantly depleted through washout, downcutting, and direct removal (Booth et al. 1997). In the Puget Sound region, the amount of large woody debris in the channel decreases with increased development (May et al. 1997).

The removal of riparian vegetation also results in loss of terrestrial LWD critical to soil health and wildlife habitat (Maser and Trappe 1984). Large woody debris, both standing (snags) and fallen, is an important source of foraging, cover and nest sites for birds, mammals, reptiles, and amphibians. LWD provides nesting habitat for cavity-nesting birds such as woodpeckers, chickadees, nuthatches and wrens. Woody debris has also been shown to be a key habitat element for amphibians (Bury et al. 1991; Welsh and Lind 1991; Butts and McComb 2000) and small mammals (McComb et al. 1993; Butts and McComb 2000; Wilson and Carey 2000).

Beyond the structural importance of LWD, other, smaller organic debris provides carbon, the basic fuel for aquatic and terrestrial food webs (Allan 1995). Smaller pieces of organic litter (e.g., leaves, needles and twigs) and terrestrial insects, important food sources for aquatic species, enter the stream primarily by direct leaf or debris fall (Spence et al. 1996). Benthic, or stream-bottom, invertebrates rely on a supply of organic litter to maintain healthy communities. Removing riparian vegetation also removes the primary source of these materials, reducing the stream's habitat value to fish and wildlife (Brown and Krygier 1970). In addition, when flow rates increase and channels are simplified, the retention time of organic debris in the system is decreased because it quickly washes downstream (Webster and Meyer 1997). Thus urbanized streams tend to contain less food than undisturbed watersheds.

Erosion, sedimentation and soil loss

Increased erosion and sedimentation results from:

- vegetation removal,
- hydrologic alterations (increased water velocity increases erosion),
- roads and other impervious surfaces, and
- construction.

Upon delivery to streams, these sediments are either suspended in water (creating increased turbidity) or deposited on the streambed (creating sediment build-up and embeddedness), where they can alter sediment transport processes, initiate channel instability and lead to in- and near-stream habitat degradation. Erosion removes topsoil; it takes many years for nature to build only a few inches of good topsoil. Healthy soils are vital in the establishment and nourishment of plants and provide habitat for countless organisms. Construction activities also compact soil, reducing the overall watershed infiltration rate and storage capacity. Table 6-8 highlights some of the environmental consequences of erosion, sedimentation and soil loss.

Table 6-8. Environmental consequences of erosion, sedimentation and soil loss.

• Soil loss; it takes centuries to build a few inches of good soil. Hydric (water-retaining) soil is especially detrimental. • Stream banks damaged • Stream bed substrates altered, size reduced (salmon and many macroinvertebrates need larger substrate; fish, amphibians, birds, other animals need macroinvertebrates) • Sediment buildup in stream channels and subsequent loss of channel topography (infilling of pools and loss of biodiversity in aquatic habitats) • Water quality impairments; increased sedimentation in downstream streams and wetlands • Increased sedimentation in estaries due to feeder stream sediment loads • Loss of soil's ability to support vegetation, with accompanying habitat loss and degradation • Vegetation is damaged or washed away when soils are eroded; fish and wildlife habitat loss and degradation • Vegetation loss leads to increased runoff, leading to further erosion • Loss of organic matter critical to fish and wildlife food webs and habitat • Toxics bind to sediments, enter streams and wetlands • Salmon reduction and loss • Large amounts of land with recently disturbed soils suitable for weedy, invasive species • Increased water turbidity and/or changes in water chemistry, with negative fish and wildlife consequences • Reduced biodiversity

Vegetation holds soils in place and captures excess sediments as they wash through during rainstorms (Gregory et al. 1991; Knutson and Naef 1997; Naiman and Decamps 1997). Riparian vegetation removal is especially harmful because it disturbs existing soils, allows sediments from the disturbed area to wash into stream, and removes the last remaining filter between the stream and the land. However, removal of vegetation in upland areas, especially in steeply sloped terrain, also contributes to a higher rate of soil erosion and can result in significant consequences such as landslides, flooding, channel erosion and destruction of aquatic habitat.

Landslides are downslope movement, under gravity, of masses of soil and rock material.[65] In an urban setting, improper drainage most often induces disastrous sliding (Oregon DOGAMI 2003). Landslides and debris flows (rapidly moving landslides that typically move long distances) are natural processes, triggered or accelerated by these factors:

- Intense or prolonged rainfall, or rapid snow melt, causing sharp changes in groundwater levels
- Undercutting of a slope or cliff by erosion or evacuation
- Shocks or vibrations from earthquakes or construction.
- Vegetation removal by fires, timber harvesting, or land clearing.
- Placing fill (weight) on steep slopes
- A combination of these factors

Salmon and other aquatic species need clear water with low concentrations of suspended sediments in the water column (turbidity) and cool water. High turbidity clogs fish gills and can hamper migration. However, deposited sediments generally have a greater impact on aquatic species than suspended sediments because they alter macroinvertebrate communities (salmon food supply) and ruins spawning habitat. Salmon, salamanders and many aquatic insects need relatively sediment-free gravel beds with suitable gravel in which to reproduce.

Roads and other impervious surfaces contribute substantially to erosion and soil loss. Road networks contribute more sediments to streams than any other land management activity, from both surface erosion and landslides (Jones et al. 2000; Gucinski et al. 2001). Not only do these features substantially increase sedimentation in their own right, but they also reduce the capacity of soil to support vegetation and store water. In addition, many toxic substances bind to soil particles and enter waterways via eroded soil; for example, DDT, banned decades ago but still present in soils, washes into streams and wetlands in this manner.

Activities such as grading, filling, hauling and agriculture cause significant erosion and transport of fine sediments to the stream (Trimble 1997; Wood and Armitage 1997). Each year in the U.S. an estimated 80 million tons of sediment are washed from construction sites into water bodies (Goldman et al. 1986). Soil quality is typically degraded along urban stream corridors where development activities include removal of natural riparian vegetation, grading, compaction of soil, and placement of fill that is dissimilar from native topsoil.

Reduced biodiversity, non-native species introductions, and landscaping

As described in the *Introduction* chapter, our area's natural resources have changed dramatically in terms of quantity and quality with human encroachment. Altered plant and animal communities are a hallmark of urban ecosystems. Non-native plant and animal invasions, proliferation of generalist species and loss of specialists (those relying on a specific habitat type or feature) are prevalent. Non-native species are associated with the majority of at-risk species declines worldwide due to competition for resources and outright predation (Wilcove et al. 1998;

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[65] As defined by the Oregon Department of Geology and Mineral Industries (DOGAMI; Oregon DOGAMI 2003). Landslide hazard areas have been mapped by DOGAMI and are available on their website www.oregongeology.com/landslide/landslidehome.htm.

Pimentel et al. 2000). Table 6-9 highlights some of the environmental consequences of reduced biodiversity and non-native species invasions.

Manicured lawns and landscaping often replace natural vegetation along stream corridors in developed areas throughout watersheds, and this impacts wildlife communities. By replacing the naturally complex mix of vegetation with lawns, structural complexity is reduced. Structurally complex vegetation supports more native species than simple vegetation (Hennings and Edge 2003). In addition, simplified, non-native habitats favor non-native wildlife species because the non-native species that have established populations are habitat generalists, or species that can survive in a wide variety of circumstances. Native generalists also benefit from habitat simplification, to the detriment of native species with more specific habitat requirements.

Table 6-9. Environmental consequences of reduced biodiversity, non-native species introductions, and landscaping.

- Restricted pool of pollinators and seed dispersers
- Reduced native wildlife gene pools can lead to decreased survival rates
- Human-enhanced dispersal of some species (weeds, rodent pests, starlings, English Sparrows, pigeons)
- Potential reduction, loss of species that control pest species (e.g., woodpeckers control carpenter ants)
- Increased competition for food and habitat resources
- Non-native species invasions; reductions in native fish and wildlife populations; extirpations; species extinctions
- Urbanization often benefits species with small home ranges and high reproductive rates
- Generalists that can thrive in a variety of habitats and situations displace more sensitive habitat specialists
- Loss of balance between predator-prey populations
- Increase in small mammal abundance for certain species; small mammals eat bird eggs
- Simplification and large-scale alteration of plant and animal communities
- Non-native plant invasions reduce functional and structural diversity of wildlife habitat
- Loss of food resources for native wildlife species (native insects and birds prefer native plants)
- Local native species extinctions due to increased competition and predation
- Numerous sources for continuous non-native re-invasions
- Introduction of diseases and parasites to which native organisms are not adapted
- Financial harm to crops and agriculture due to pests
- Wildlife predation by cats, dogs, and other human-introduced predators
- Reduced biodiversity

In the Metro region, non-native birds such as European Starlings, non-native amphibians such as bullfrogs, and non-native fish tend to out-compete or directly kill native species.[66] Non-native plants are an issue because they favor non-native wildlife species. In the Metro region, non-native birds and plants are linked to edge effects.[67]

Domestic animals can have strong impacts on wildlife communities. Domestic animals include livestock, but in urban areas the primary species impacting wildlife are domestic cats and dogs, which kill wildlife and disrupt native wildlife behavior. For example, barking dogs scare wildlife, increasing stress levels and reducing

[66] For example, starlings made up 17 percent of riparian birds surveyed along 54 riparian study sites in the greater Metro region (Hennings 2001); the narrower the forest, the more starlings – sometimes more than half of all breeding birds present.
[67] Discussed in the Fragmentation section above; non-native plants, shrubs, and birds decline with distance to the edge of a forest patch.

their ability to forage and nest.[68] As most pet owners realize, cats kill animals even when they have ample food provided. In addition, dogs and cats can contribute to stream degradation by contributing fecal coliform and disturbing streambanks and vegetation.

Wildlife barriers (including habitat fragmentation) also reduce biological diversity. Development practices such as installing stream crossings[69] and piping and culverting streams destroy habitat and create impassable fish barriers that block entire stream reaches to migratory fish species and isolate remaining species, putting these populations at risk of reduced genetic diversity and/or extinction. Habitat fragmentation creates wildlife barriers by creating space between habitat patches across which some species cannot travel.

What are the potential environmental consequences to fish and wildlife habitat of allowing, limiting, or prohibiting uses that conflict with natural resource function?

All major consequences occur in each zoning type, but the severity depends on prevalent conflicting uses. For example, more imperviousness results in more severe hydrologic alterations; more pesticide use results in increased water quality impairment. More traffic translates to increased human disturbance to wildlife. The consequences also depend on the percent of fish and wildlife habitat falling within each zoning type. For example, single-family residential contains about half of all habitat; consequences may be strong due to amount of land cover. On the other hand, commercial contains only five percent of all habitat; thus potential consequences are reduced because commercial uses do not cover much land. This section includes a summary of the potential environmental tradeoffs of allowing, limiting, or prohibiting conflicting uses. Most of the environmental consequences are similar in all regional zones, the differences are described below. Appendix D contains several matrices that summarize the environmental consequences of a decision to allow, limit, or prohibit by generalized regional zones. Finally, the key points learned from the environmental consequences analysis are highlighted at the end of the chapter.

Summary of potential environmental tradeoffs

The analysis of environmental consequences is general in nature to account for variability within zoning types, and also because consequences depend on the program selected. Environmental consequences can also vary depending on the scale through which they are viewed; for example, at the site level, high-density housing is associated with fairly high levels of imperviousness, but on a larger scale this zoning type reduces the amount of roads and land needed to accommodate housing. Below are some general consequences associated with allow, limit, and prohibit decisions.

Allow conflicting uses

- Extensive loss of ecological functions in riparian areas, especially for Class I riparian corridors

[68] About a third of U.S. households have cats; each year in the U.S. cats kill an unknown, but undeniably large number of wild animals (The Wildlife Society 2002).
[69] For example, roads, sewers, and pipelines.

- Likely to harm salmon
- Degraded water quality
- Extensive loss of valuable wildlife habitat and functional values (size, interior habitat, connectivity, proximity to water)
- Loss of Habitats of Concern
- Continued loss of native species and at-risk species; reduction in migratory songbirds
- Education opportunities
- Reduced need for UGB expansion; protects habitat outside UGB from urban encroachment

Limit conflicting uses

- Depends on type of program: results may range from minimal protection to near-full protection of ecological functions
- Strong potential for restoration, mitigation, and education activities to offset negative impacts
- Implementation of BMPs (best management practices) and low impact development standards could reduce negative impacts
- Less harm to native species and fewer nonnative species invasions than Allow
- Intrusion in some habitat areas will reduce the quality of other habitats, especially if connector habitat is fragmented and interior habitat reduced
- May require UGB expansion, depending on program

Prohibit conflicting uses

- Retention of some of the region's most critical ecological functions and best remaining wildlife habitats
- Most likely to support salmon conservation, retains important aquatic habitat
- Prevents further habitat fragmentation; preserves restoration opportunities
- Minimizes hydrologic alterations, reduces flooding, and preserves water quality
- Provides key breeding habitat for migratory songbirds, aquatic species, habitat interior species, and other native species
- Preserves Habitats of Concern
- May require substantial expansion of the UGB

Environmental consequences by generalized regional zone

The disturbance activities, or conflicting uses, associated with each of Metro's generalized regional zones were described in Chapter 3, *Conflicting Uses.* Disturbance activities (conflicting uses) were cross-referenced with potential consequences to regionally significant fish and wildlife habitat in Table 6-1 at the beginning of this chapter. Many of the negative environmental impacts due to conflicting uses relate to the levels of imperviousness and the amounts of natural land cover associated with those conflicting uses. There are trends in imperviousness and natural land cover associated with Metro's generalized regional zones. These trends are useful in fostering discussion about land use impacts. Table 6-10 lists these general trends, providing a foundation for the consequences discussion.

Table 6-10. Relative levels of imperviousness and natural landcover typically associated with generalized zoning land-use types.*

Generalized regional zone	Typical onsite imperviousness[1]	Typical infrastructure requirements[2]	Typical natural landcover[1]
Commercial	High	Moderate to high	Low
Industrial	High	Variable	Low
Mixed use	Moderate to high	Lower per person	Low
High-density multi-family	Moderate to high	Lower per person	Low to moderate
Medium/low density multi-family	Moderate onsite	Moderate per person	Low to moderate
High density single family	Moderate onsite	Moderate per person	Low to moderate
Medium/low density single family	Low to moderate	Higher per person	Moderate to high
Rural	Low	Higher per person	High
Agricultural	Low	Variable	High
Open space	Low	Low	High

*These general estimates are provided to facilitate discussion.
[1]Relative to other land use types; per unit area.
[2]Infrastructure refers to roads and parking, sewers and stormwater piping, power transmission, etc. needed to support the land use.

Most of the environmental consequences are similar across zones (matrices describing the consequences may be found in Appendix D); the differences are identified below.

- **Single-family residential (SFR):** tends to retain more trees and vegetation, reducing negative impacts. Stormwater piping and imperviousness is a strong factor due to the extent of single family zoning; altered hydrology is a primary consequence. Landscaping, pesticide and fertilizer use, and pets tend to degrade habitat and water quality. Potential to retain existing vegetation and add new vegetation, as well as stormwater solutions such as Low Impact Development, could have positive implications for stormwater runoff and hydrology.
- **Multi-family residential (MFR):** density decreases overall infrastructure and road requirements, but increases onsite imperviousness and vegetation loss. Multi-family residential tends to create more human disturbance because human densities are higher. In general, negative environmental consequences are stronger at the site level compared to less dense forms of housing, but reduced at a larger scale due to compactness and efficiency of form.
- **Commercial (COM):** high onsite imperviousness; increased traffic and human disturbance. Consequences similar to industrial development, but commercial development is more consistently associated with certain disturbances, including installation and maintenance of utilities, stormwater-related modifications, and road construction. Not as strongly associated with toxics, heavy metals and other pollutants as industrial development, although transportation-related toxics are an issue due to heavy traffic and parking requirements.
- **Industrial (IND):** high onsite imperviousness; tends to have low amounts of vegetation; use of toxic chemicals may increase negative impacts to fish and wildlife. Consequences weighted toward altered hydrology, degraded water quality, habitat loss, and alterations to biological communities, including reduced biodiversity. Institutional uses are similar to industrial, except that they are not strongly associated with toxics and can sometimes have more natural land cover.
- **Mixed-use centers (MUC):** may decrease VMT which reduces water quality impacts at the regional scale, but onsite imperviousness and noise and light disturbances may be high. May

include a variety of land uses, therefore conflicting uses and consequences vary. Can offer efficient land use and reduce the amount of land needed, because development types can meet specific local needs. Can provide shared parking and greater efficiency in parking lot layout, thereby reducing imperviousness and the stormwater runoff associated with paved areas.

- **Rural residential (RUR):** Less severe hydrologic alterations compared to areas with more pavement and less vegetation. More roads and other infrastructure required per dwelling unit. Agriculture (not regulated by Metro) may increase pesticides, nutrient inputs, and seasonal disturbances, but also can provide grassland and connector habitat. Leaky septic systems can degrade water quality. Livestock grazing harms riparian areas, compacts soil, and degrades water quality. Human disturbance reduced compared to higher density housing types.
- **Parks and open space (POS):** active parks increase human disturbance and tend to remove natural landcover; landscaping in such parks may degrade water quality and wildlife habitat. In more natural areas parks provide important habitat, connectivity, and improved water qualityIn some jurisdictions (e.g., Portland), other uses such as rail lines, utility corridors, broadcast facilities, mining, agriculture, and institutional uses are allowed, with corresponding consequences.

Summary points

- Tree canopy is invaluable to the functionality of both fish and wildlife habitat habitat. It is important both near streams and throughout the watershed, as affirmed by local studies (Frady et al. 2003). Tree canopy provides habitat, absorbs pollution and excess nutrients, and slows and retains stormwater, reducing hydrologic alterations.
- Hydrologic changes have far-reaching negative consequences. Reducing or mitigating imperviousness and stormwater impacts will be important to address these consequences.
- Consequences to fish habitat depend on habitat value. For example, loss of high-value (Class I) riparian corridors, which retain three to five primary functions, would have a stronger ecological impact than Class II or Class III riparian corridors, which contain two or no primary ecological functions, respectively. Loss of high-value riparian corridors would also result in loss of high-value wildlife habitat, because Class I riparian corridors include some high-value wildlife habitat (including Habitats of Concern) where high value inventory areas overlap. For example, many Class I riparian corridors include bottomland hardwood forest and wetlands in a floodplain setting; this type of area is critical to riparian function and also provides a unique and declining habitat type.
- Consequences to wildlife habitat also depend on habitat value, but with different implications than fish habitat. Because connectivity is important to wildlife, the loss of any component in the system may reduce the value of nearby wildlife habitat patches. For example, preserving two Class A wildlife habitat patches – the largest patches with good water resources and connectivity to other patches, or Habitats of Concern – will be most valuable to wildlife if between-patch connectivity is retained; the connecting patches are typically Class B or C wildlife habitat. If only Class A wildlife habitat is preserved, its value will be reduced due to loss of nearby Class B and C patches. On the other hand, smaller habitat patches tend to have lower quality habitat due to edge effects and reduced interior habitat.
- Homes surrounded by trees can provide very important wildlife habitat. For example, local

studies indicate that resident native birds are most diverse in developed areas with plenty of forest canopy (Hennings and Edge 2003). Single-family residential accounts for a large proportion of fish and wildlife lands, therefore retaining tree canopy within this zoning type is desirable. This would allow some conflicting uses to occur while retaining important natural resources, with important implications for limiting future UGB expansions. Clustered housing is one way to reduce forest canopy loss.

CHAPTER 7: ENERGY CONSEQUENCES

Introduction

Urbanization leads to concentrated areas of energy use, with important implications for fish and wildlife habitat. In turn, fish and wildlife habitat influence energy use. Within the UGB the issue is not whether, but *how* to urbanize, and the extent to which fish and wildlife habitat should be protected. The nature of these relationships can affect energy use and efficiency within the UGB, as well as the boundary's size and shape.

The energy consequences analysis of allowing, limiting or prohibiting conflicting uses in fish and wildlife habitat areas addresses the following questions, from a regional perspective:

- What is energy, and how is it used?
- What are the environmental consequences of energy use?
- How does regional planning relate to energy use?
- What are the energy consequences of allowing, limiting, or prohibiting conflicting uses in or near fish and wildlife habitat?

What is energy, and how is it used?

Energy can be broadly defined as the capability of a system to do work. In the electric power industry, energy is more narrowly defined as the mathematical product of real power and time (Public Power Council 2003). For the purposes of this document, energy is the fossil fuel, hydroelectric, or other resource providing the energy to do work, such as driving, creating roads and buildings, and heating and cooling.

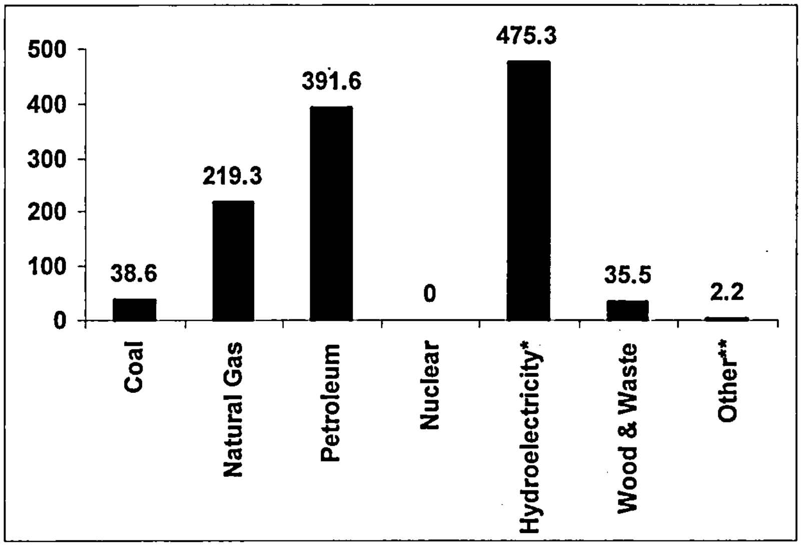
According to the U.S. Department of Energy, Oregonians' primary energy sources are fossil fuels (petroleum products and natural gas) and electricity (Figure 7-1). The proportion of Oregon's energy derived from fossil fuels has risen substantially, whereas the proportion of electricity has held steady since 1980, at about 20 percent (Oregon Office of Energy 2002). Regional planning influences fossil fuel use more than electricity use, because the spatial arrangement of urban infrastructure systems strongly influence fossil fuel use. The factors influencing electricity use tend to be more site-specific.

Fossil fuels

Oregon's fossil fuel use has nearly tripled in the past 40 years. This is due primarily to motor vehicle use, which relies chiefly on petroleum products although interest in alternative fuels is growing. By 1999, petroleum products accounted for nearly half of the energy used in the state (Oregon Office of Energy 2002).

Natural gas is another important fossil fuel resource for industry, electricity generation, residential, and commercial uses, in that order. Natural gas use per capita increased 63 percent between 1990 and 1999, rising to 24 percent of total energy use in the state.

Figure 7-1. Types of energy consumed by Oregonians, 1999 (in trillions of BTUs).



* May include pumped storage and net imports of electricity generated from this resource.
** Geothermal, wind, photovoltaic, and solar.
Source: U.S. Department of Energy, http://www.eia.doe.gov/emeu/sep/or/frame.html

Electricity

Electricity is another important energy source in the region. Portland General Electric (PGE) is the state's largest utility, providing electricity to more than 730,000 customers in Portland, Salem and nearby communities (Hemmingway et al. 2002). The energy sources for PGE's electricity include PGE's hydropower (10 percent), coal (25 percent), gas/oil (26 percent) and purchases on the market which include Mid-Columbia hydropower, wind and other renewable energy sources (39 percent) (PGE 2002). Pacific Power serves another 68,000 customers in the Metro region. Eighty percent of Pacific Power's generation is from thermal plants (Pacificorp 2003).

It takes energy to produce and deliver energy to gas stations, homes, businesses and industry. Of the major energy sources, electricity takes the most energy, on average, for production and delivery to the site (U.S. Department of Energy 1999). However, that depends on how electricity is produced (e.g., via hydropower or fossil fuels). For example, for every unit of fossil fuel-generated electricity produced, it costs three fossil fuel energy units to produce and deliver it to the site, whereas hydropower takes substantially less production and delivery energy (U.S. Department of Energy 1999). Coal is the most energy-intensive source of electricity. Hydropower is a renewable resource, as discussed next, but the region's capacity for generating hydropower is limited.

Renewable energy sources

The Oregon Office of Energy defines renewable energy as energy from any source that can be maintained in a constant supply over time (Oregon Office of Energy 2003). Renewable energy sources represent the most promising future energy supplies because they may be sustainable over the long term; the supply of fossil fuels is limited and therefore non-renewable and non-sustainable. Hydropower (flowing water) is the prevalent renewable energy source used in the Metro region, but alternative sources such as wind and sun power could be further developed. Table 7-1 shows the five predominant renewable energy sources: hydropower, biomass, wind, the sun (solar), and heat from inside the earth (geothermal).

Table 7-1. Types of and uses for renewable sources of energy.

Source of energy	Description	Used for heat?	Used for Electricity?	Used for Vehicle fuel?
Water (hydro-electric)	Like the wind, flowing water is a product of the earth's climate and geography. Snowmelt and runoff from precipitation at higher elevations flow toward sea level in streams and rivers. In an earlier era, water wheels used the power of flowing water to turn grinding stones and to run mechanical equipment. Modern hydro-turbines use water power to generate electricity.		Yes	(electric cars are used, but not on a widespread basis)
Biomass	"Biomass" describes all plants, trees and organic matter on the earth. Biomass is a source of renewable energy because the natural process of photosynthesis constantly produces new organic matter in the growth of trees and plants. Photosynthesis stores the sun's energy in organic matter. That energy is released when biomass is used to make heat, electricity or liquid fuels.	Yes	Yes	Yes
Wind	The wind blows because of natural conditions of climate and geography. Historically, wind power was used to supply mechanical energy, for example to pump water, grind grain or sail a boat. Today, wind power is primarily a source of electricity.		Yes	
Solar	The sun is a constant natural source of heat and light. Sunlight can be converted to electricity. Solar energy is energy that comes directly from the sun.	Yes	Yes	
Geothermal	Heat from deep within the earth is called "geothermal energy." In some locations, geothermal energy is close enough to the surface that, by drilling a well to reach the heat source, the energy can be extracted and used for heating buildings and other purposes. Where the temperatures are hot enough, geothermal energy can be used to generate electricity.	Yes	Yes	

Source: Oregon Department of Energy 2003.

All renewable energy sources can be used to produce electricity. Solar energy and geothermal energy can supply both electricity and heat. Biomass can supply all three forms of useful energy.

Energy cost and availability

Energy cost and availability are important factors influencing the prevailing types of energy used. The Oregon Office of Energy calculated source-specific potential electricity generation and estimated wholesale costs for a variety of renewable energy types (Table 7-2, in order of least to most expensive).

Table 7-2. Potential generation and estimated wholesale costs for renewable energy resources available in the Pacific Northwest.

Renewable energy resource	Cost (cents per kilowatt-hour)	Region-Wide Potential for Generation (average megawatts)
Hydroelectric	1.1 to 7.0	170
Chemical recovery boilers (used to recycle chemicals, reduce wastewater discharges, and recover energy from pulp wood industry)	2.6	195
Natural gas (can be manufactured rather than extracted; for example, methane from livestock manure)	2.7	7,400
Industrial cogeneration (consumes fuel, usually natural gas, to produce both heat and electricity; captures and uses energy that otherwise would be wasted)	2.7 to 6.4	4,600
Landfill gas	3.1	94
Wood residue	4.3 to 5.4	300
Geothermal	5.2 to 6.5	390 to 1,070
Wind	5.3 to 8.1	700+
Forest biomass	5.5 to 6.6	300 to 1,000
Solar thermal	8.6	-----
Solar photovoltaic (large-scale)	19.4	-----
Solar photovoltaic (small-scale)	21.5 to 23.6	-----

Source: Oregon Office of Energy 2003.

As Table 7-2 shows, hydroelectric power is the cheapest renewable source of electricity in the region, but not necessarily the source with the most energy potential nor the most environmentally sound option. As with any source of energy, there are environmental costs associated with hydroelectric power, including harm to salmon habitat. Some sources such as wind and solar power may be less environmentally harmful, and prices may drop as the technology develops. The environmental consequences of energy use are discussed next.

What are the environmental consequences of energy use?

Energy use can impact the environment in some major and specific ways, and natural resources mitigate these consequences and influence energy use. Therefore, energy consequences are often environmental, but environmental consequences lead to changes in energy use. Some environmental consequences relating directly to energy use include:

- Increased air temperatures
- Increased water temperatures
- Reduced air quality
- Habitat loss and degradation due to infrastructure (transportation and energy)
- Negative effects from hydropower and dams

Increased air temperatures

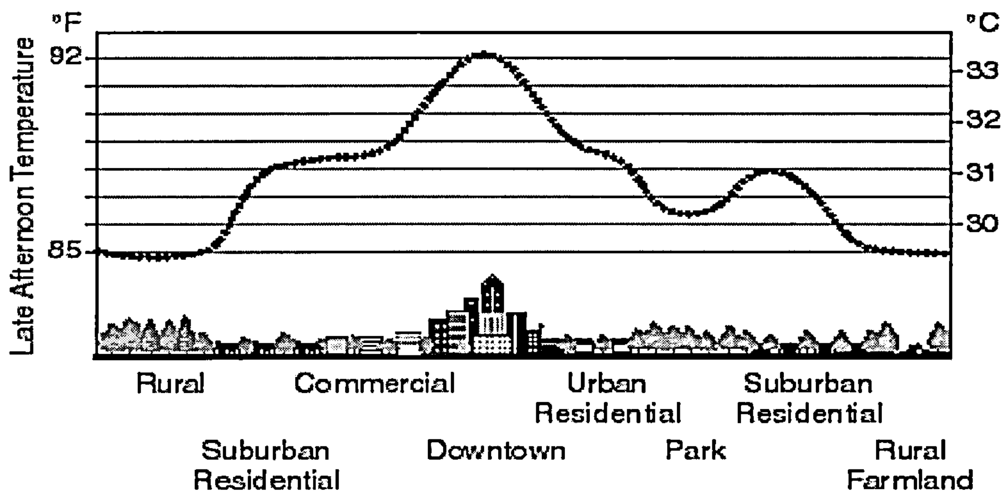
Vegetation helps cool the air, whereas pavement, buildings, and combustion processes such as motor vehicle engines tend to warm the air. This warming may occur both locally (the urban heat island effect) and globally (global warming). Air temperature also influences water temperature and quality, as discussed in the next category.

Air temperature influences energy use; for example, in cities with populations of more than 100,000, peak utility cooling demand increases 1.5 percent to 2 percent for every degree Fahrenheit the temperature rises (U.S. Department of Energy 1999). This increases energy demand and alters forest microclimates by increasing water, soil and air temperature and reducing soil and air humidity.[70]

Urban heat island effect

Cities are warmer than other areas, a phenomenon called the "Urban Heat Island effect" (Figure 7-2; U.S. Department of Energy 1993). The urban heat island effect is not limited to downtown areas, but is also influenced by suburban developments; it is a temperature gradient, increasingly warm from rural to urban areas. The average temperature difference along this gradient varies regionally, with differences in temperature from rural to urban areas ranging from 2° to 8° F (U.S. Department of Energy 1993).

Figure 7-2. Sketch of a typical Urban Heat Island profile (reproduced with permission from Morris 2003).



Plants help reduce the urban heat island effect by cooling the air through several mechanisms. In well-vegetated areas, a substantial portion of solar energy that hits plants is used for plant metabolism (U.S. Department of Energy 1993). Plants provide shade, which keeps other surfaces from storing the sun's heat energy. Plants also use moisture for temperature control; as temperatures rise, excess water is released from leaves it cools the surrounding air.

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70 See *Environmental Consequences* chapter for further discussion on microclimate.

Impervious surfaces, especially dark surfaces with low reflectivity, collect and efficiently store the sun's energy as heat, as well as displacing vegetation. The heat energy is released at night, creating areas of warm air. Several hot days in a row can compound this effect, because as the urban or suburban area fails to cool at night, temperatures rise on each successive hot day; ambient air temperature can differ between an urban heat island and a vegetated area by 2-10° F. On a hot day, the air above a paved area may be 25° F hotter than the air in a nearby forest. The U.S. Department of Energy (1993) states that one of the simplest and cheapest strategies for countering the urban heat island effect is to increase the number of trees and other plants.

Global warming

Carbon dioxide in the air is a key contributor to global warming, or the "greenhouse effect" (Rubin et al. 1992). Carbon is stored in trees and other plants, but is released through combustion processes and vegetation removal (Northwest Environment Watch 2003). Although debate continues, most scientists now agree that increasing greenhouse gas emissions from human activities are altering the world's atmosphere, primarily due to the burning of fossil fuels and land use changes such as deforestation (Oregon Progress Board 2000; Price and Root 2001).

In Oregon, electricity production generates 44 percent of the carbon dioxide (CO_2) emissions, and transportation fuels contribute another 35 percent; natural gas contributes 14 percent (Oregon Progress Board 2000). Trees absorb and trap atmospheric CO_2, storing the carbon in solid form for long periods of time (Krieger 2001; Price and Glick 2002). Trees also reduce atmospheric CO_2 by reducing demand for heating and air conditioning (McPherson et al. 2002).

Global warming is expected to change the planet's climate by altering the exchange of water among the oceans, atmosphere, and land; this is expected to shift regional temperatures and patterns of rainfall (Price and Glick 2002). To illustrate, the annual average global temperature has increased by one degree Fahrenheit over the past century; increases have been slightly higher in the Pacific Northwest, at 1.5° F (Price and Root 2001; Northwest Environment Watch 2003). Scientists anticipate that the Pacific Northwest will experience warmer, wetter winters and warmer, drier summers, with an average increase of 4.5°F by 2050 (Snover et al. 1998).

Global climate change is also likely to influence terrestrial wildlife, such as bird communities (Price 2000; Price and Root 2001). Species' distribution ranges are likely to move northward, and for many species that are already vulnerable, the risk of extinction will increase with global warming (Gitay et al. 2002). For example, Neotropical migratory birds, known to be at-risk in the urban Metro area (Hennings and Edge 2003), are predicted to change in species composition by 32 percent, with a 16 percent net decrease in species richness over the next 75-100 years (Price and Root 2001).

Increased water temperatures

Air temperature strongly influences water temperature. Water temperature is an important indicator of a watershed's vitality because of its controlling influence on the metabolism, development and activity of aquatic organisms (Naiman et al. 1992). Temperature and precipitation are the primary variables that determine the annual water cycle in the Pacific Northwest (Climate Impacts Group, University of Washington 2003). Increased water temperature is a common reason for Metro-area streams appearing on DEQ's 303(d) list of water quality impaired streams, as discussed in the *Environmental Consequences* chapter.

Increased water temperatures reduce the amount of oxygen the water can hold and change the water's chemistry (Pauley et al. 1989). As a result, energy impacts that cause an upward shift in air temperatures result in impaired water quality. This has negative impacts on wildlife living in and near the stream, such as macroinvertebrates, fish and amphibians (Tevis 1966; Pearson and Kramer 1972; Merritt et al. 1982).

Eaton and Scheller (1996) estimated that temperature increases from a doubling of atmospheric carbon dioxide is likely to reduce habitat for cold and cool water fish by approximately 50 percent. Rathert et al. (1999) identified annual air temperature range as a key environmental variable predicting the number of native fish species present in Oregon streams. According to Tyedmers and Ward (2001), the direct impacts to fisheries of water temperature increases due to predicted global warming include the following:

- Rising water temperatures (streams fed by deep groundwater or with riparian shading will be less affected)
- Altered hydrologic regimes (more winter flooding; dryer summers; decreased water supply due to loss of snow pack; shift in some streams from perennial to ephemeral)
- Changes in aquatic productivity (loss of cold-water fish and the macroinvertebrates on which they depend for food; increase in nonnative warm-water species)

Reduced air quality

Although an environmental issue, air pollution is directly related to urban energy use. Vehicular traffic, industry, and heating and cooling are energy-consuming activities that produce air pollutants as products of combustion. Air pollution is also directly related to vegetation; trees and plants clean the air (McPherson et al. 2002).

Air quality is measured and reported in a variety of ways, but Oregon DEQ collects and houses most state and local air quality data. Oregon DEQ uses an Air Pollution Index (API) to integrate carbon monoxide, particulates, ozone, nitrogen oxides, sulfur dioxide, and other pollutants into a single air quality index value (Oregon Department of Environmental Quality 2003b).[71] Figure 7-3 (on page XX) shows the Metro region's major sources of air pollution.

Air temperature is a major factor relating to air pollution. Higher air temperatures accelerate the chemical reactions leading to high ozone concentrations and other pollutants. While ozone high in the earth's atmosphere protects humans from the harmful effect of ultraviolet radiation, it is a pollutant near the earth's surface. Unacceptable levels of smog-forming ozone and other pollutants are frequently reached at 94° F and above, compounding the heat island problem by creating a heat-trapping cloud of pollution over urban areas (McPherson et al. 2002).

Most air pollution is caused by individual actions such as driving cars; using woodstoves, gas-powered lawn mowers and motorboats, paints and aerosol products like hairspray and air

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[71] Air quality indices are reported daily via DEQ's website (http://www.deq.state.or.us).

fresheners; and outdoor burning. The Oregon DEQ estimates that industry contributes less than 10 percent of air pollution problems in the state; by far, the largest single source of air pollution is gas-powered vehicles (Oregon Department of Environmental Quality 2001), and this is what can be influenced most at the regional scale.

Habitat loss and degradation due to infrastructure (transportation and energy)

Motor vehicle transportation is the single biggest outlay of energy in the region, and also creates the largest proportion of infrastructure needed to support urban areas. Transportation infrastructure such as road networks requires substantial energy outlays, removes habitat, and negatively impacts wildlife and the environment.[72] Wildlife mortality due to roads is well known. Infrastructure relating directly to the transmission of energy, such as power line corridors and pipelines, may also remove or fragment fish and wildlife habitat, as well as providing corridors for the transmission of undesirable seed sources.[73]

Negative effects from hydropower and dams

Hydropower is associated with both positive and negative environmental impacts: on the one hand, hydropower is one of the cleanest sources of electricity available on a large scale because it harnesses the movement of water for energy rather than burning fossil fuels. On the other hand, dams affect fish and wildlife and their habitats. Although dams provide many societal benefits including power generation, water storage, flood control, agricultural irrigation, and recreation, they influence watershed functions in fundamental ways (FISRWG 1998). Ecological problems associated with dams include erratic water volume and velocity (altered hydrology), increased streambank erosion, loss and fragmentation of riparian habitat, altered water chemistry, altered instream habitat, and blocked fish and instream wildlife passage.

All salmon and steelhead in the Columbia Basin are affected to some degree by damming activities (Federal Caucus 2000). Fish bypass systems and mitigation strategies are now required as part of Federal Energy Regulatory Commission licensing (Portland General Electric 2003).[74] Recognizing the impacts of energy production on wildlife, regional energy providers such as PGE now offer voluntary "salmon power" or "green power" energy sources, designed to provide more wildlife- and environment-friendly energy at slightly higher short-term costs.

More than 85 percent of the inland waterways within the continental United States are now artificially controlled through dams (National Research Council [NRC] 1992), including all major Metro area rivers. The Columbia and Snake River systems are protected areas, closed to further hydropower development (Oregon Office of Energy 2003). Some of the Metro region's electricity derives from these sources. Reducing the risk to salmon populations in these river systems may require changes in the management of existing hydroelectric plants. These measures may reduce overall generating capacity, although further development of alternative renewable energy sources could help offset the capacity loss.

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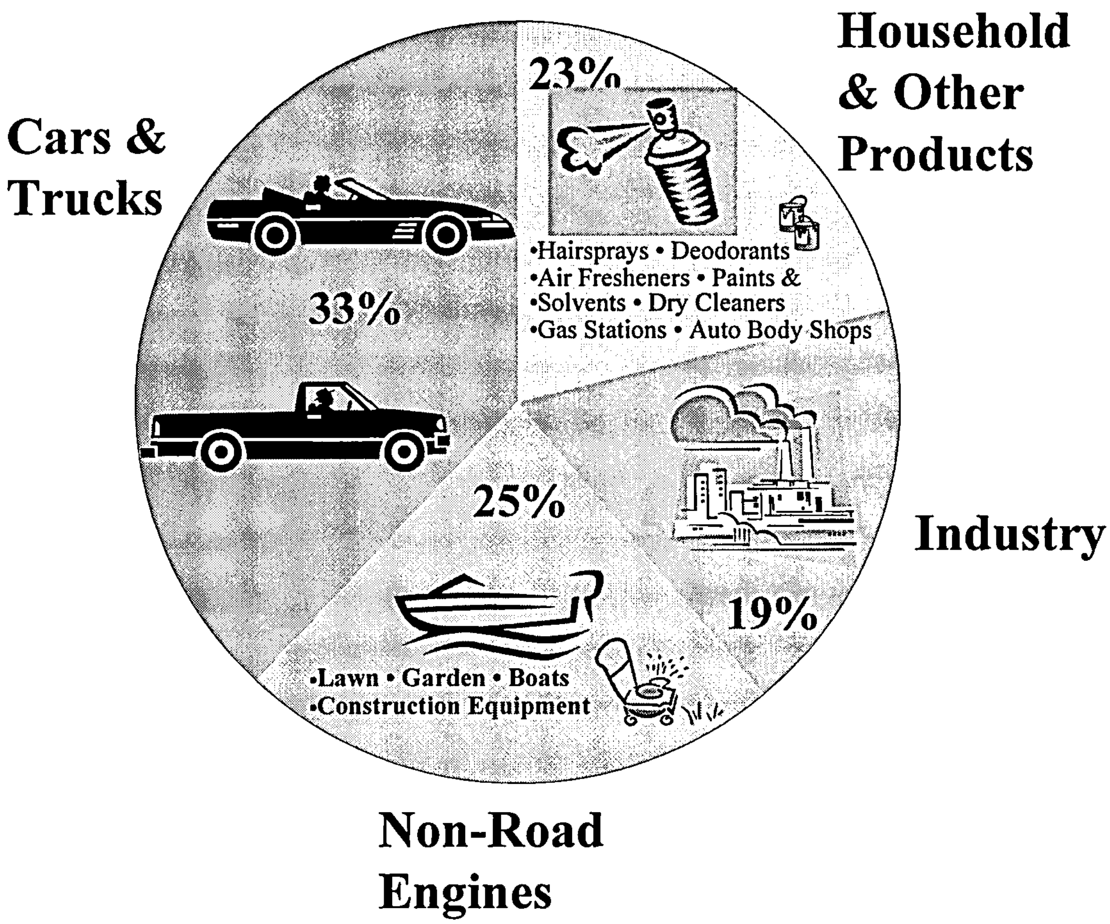
[72] See *Environmental Consequences* chapter for further discussion.
[73] Infrastructure is discussed further in the Regional Planning section of this chapter.
[74] The Idaho National Engineering Laboratory administers a federally funded program to develop hydroelectric turbines that will cause less harm to fish (Oregon Office of Energy 2003).

Figure 7-3. Portland/Vancouver metropolitan area airshed ozone* sources, 2001.



* Volatile Organic Compounds and Nitrogen Oxides

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How does regional planning relate to energy use?

At the regional scale, energy use is most strongly influenced by the extent and physical arrangement of transportation networks, the built environment, and green infrastructure. These factors are related, and changes in one affect the others and overall energy use patterns. All three factors influence air and water temperature and quality, thus influencing fish and wildlife habitat.

The 2040 Growth Concept and the UGB are important tools for reducing energy use because they define the extent of the urban region and guide the physical arrangement of the built environment and corresponding transportation network. Keeping development inside the UGB protects farm and forest lands from sprawl and reduces vehicle miles traveled (VMT). The 2040 Growth Concept sets forth and implements policies that encourage efficient land use and a balanced transportation system, and guides the physical arrangement of urban centers and the transportation network.

The region's 2040 Growth Concept calls for:

- A compact urban form, including efficient land use that can accommodate a variety of needed zoning types;
- A well-planned transportation system that includes vehicular travel, mass transit, and alternative transportation modes such as bicycling and walking; and
- Protection of natural areas.

The importance of these factors to the region's energy use is discussed below.

Importance of a compact urban form and zoning types

A compact urban form conserves energy by reducing transportation-related energy output and infrastructure needs, and also reduces the spatial extent of vegetation loss and the urban heat island effect.

As the population of an area increases transportation needs increase, and sometimes the number of miles a citizen needs to travel (VMT) also increases. At present, most vehicles are powered by fossil fuels; therefore increased VMT results in increased fossil fuel use. The amount of VMT increase depends on where and how far citizens must drive to meet their daily needs, as well as whether alternative modes of transportation are available.

In the Metro region from 1989 through 1999, about 46 square miles of land were developed, with most construction resulting from development within existing urban and suburban areas in keeping with the region's goals to contain urban sprawl (Northwest Environment Watch 2002a, 2002b). The Metro region's rate of high-density growth (more than 12 people per acre) nearly doubled that of Seattle over the past decade; the region's population increased by about 470,000 during that period.

These statistics indicate two things about the Metro region: first, with more people moving into the area, more city or suburban areas and related infrastructure must be built or expanded, which takes energy and materials.[75] Second, because population density is increasing within the UGB, the infrastructure requirements are reduced compared to the much larger infrastructure investments needed to support development in rural areas. Compact urban forms are more energy and resource efficient than "sprawled" cities.

Transportation and other infrastructure relates to energy because it:

- requires energy to install and maintain;
- can cause loss of trees and natural areas, with resulting energy implications including air temperature and quality and the need to repair damaged stream systems; and
- creates impervious surfaces, with resulting transportation, energy-related air and water quality, and maintenance and repair issues.

Compact urban forms reduce infrastructure requirements. During the 2040 Growth Concept development process Metro modeled water, sewer and stormwater infrastructure requirements under three regional development scenarios (Metro 1994a, b). The option with the most compact urban form incurred the lowest costs for water and sanitary sewer service, although stormwater costs were indistinguishable among the concepts.

There are hidden energy and ecological expenses involved with installing and maintaining infrastructure systems. Stream equilibrium is disturbed when roads, sewer or stormwater pipes are located in stream corridors and under streams, resulting in disturbances that require energy and materials to restore. For example, energy is required to address sediments generated through construction that clog wetlands and stormwater systems; exotic plant invasions; stream channel damage; flood protection and repair, etc.

Substantial dollars in the region are already being invested in restoration. For example, the Metropolitan Greenspaces Program, funded by the U.S. Fish and Wildlife Service and administered in partnership with Metro Regional Parks and Greenspaces, funded 279 restoration and environmental education products totaling more nearly $2.4 million from 1991-2002. With total local matching funds of nearly $7.4 million, the Portland/Vancouver region has spent nearly $9.8 million on restoration through this program alone.

Zoning type influences energy use. Table 7-3 shows the results of a survey Metro conducted to examine the VMT issue. The results indicate that areas combining good transit options (trains and buses) and mixed-use zoning tend to have the lowest VMT, as well as the fewest cars or trucks per household. Mixed-use urban centers are higher density centers of employment and housing that are well served by transit to form compact areas of retail, cultural, and recreational activities in a pedestrian-friendly environment. Mixed-use centers are energy-efficient because they provide efficient access to goods and services and enhance multi-modal transportation. Higher density residential housing is more energy-efficient than low densities due to increased VMT and infrastructure requirements. All zoning types are needed, but a compact urban form can help reduce energy requirements for each.

[75] Materials also require energy for manufacture and transport.

Table 7-3. Metro Travel Behavior Survey Results for Multnomah County (all trip purposes, all income groups).

	Mode Share					Vehicle Miles per Capita	Auto Ownership per Household
Land Use Type	% Auto	% Walk	% Transit	% Bike	% Other		
Good Transit/Mixed Use	58.1%	27.0%	11.5%	1.9%	1.5%	9.8	0.9
Good Transit Only	74.4%	15.2%	7.9%	1.4%	1.1%	13.3	1.5
Remainder of Multnomah County	81.5%	9.7%	3.5%	1.6%	3.7%	17.3	1.7
Remainder of Region	87.3%	6.1%	1.2%	0.8%	4.6%	21.8	1.9

Source: Metro 1994 Travel Behavior Survey

Importance of a balanced transportation system

Fossil fuel use is second only to hydroelectric power in regional energy consumption. A large proportion of the region's infrastructure, including roads, parking areas and driveways, supports transportation. Transportation infrastructure creation and maintenance require energy, and so do the vehicles using that infrastructure. However, mass transit and the availability of alternative transportation modes reduce energy consumption and related environmental consequences by reducing VMT, fossil fuel use, and infrastructure needs.

Gasoline use is the principal cause of urban air pollution in the Pacific Northwest, creates the region's largest source of greenhouse gas emissions, and is one of the region's most expensive imports (Northwest Environment Watch 2002a). Overall gas consumption in the Pacific Northwest grew 21 percent from 1993-2002, about in step with the rate of population growth. Oregon consumes 17 percent more gas than it did a decade ago.

Although overall gas consumption also grew in Oregon recent decades, per capita gas consumption in the state actually dropped by about one percent over the last decade; the average Oregonian used 8.5 gallons of gas per week in 2002 (Northwest Environment Watch 2002b). Per capita consumption was expected to drop more substantially with the significant trends in fuel efficiency seen during the 1980s, but Oregonians bought more trucks and sport utility vehicles (SUVs) in the 1990s. SUVs and minivans typically consume about one-fourth more gasoline per mile than cars. Therefore, the expected improvements in per capita fuel use and air quality failed to materialize (Northwest Environment Watch 2002a).

VMT, the number of trips made, driving speed, and driving patterns impact fossil fuel use (Girling et al. 2000). These variables are influenced by the accessibility of uses, and the attractiveness of routes to pedestrian, bicycle, and transit modes of travel. In general, research agrees that higher densities, appropriate mixes of land uses, well designed circulation networks, transit options, and attractive pedestrian and bicycle routes can be associated with less motor vehicle travel.

Importance of "green infrastructure"

As discussed above, trees and other vegetation reduce energy demand and help moderate the air temperature increases and air pollution associated with energy use. Fish and wildlife habitat that provides ecosystem services and that are considered important or necessary to support cities and suburbs, can be considered a type of infrastructure: "green infrastructure." Recognition and protection of green infrastructure, both inside and outside the urban growth boundary, are reflected in Metro's 2040 Growth Concept.

Aside from positive environmental and aesthetic effects, green infrastructure can provide access to alternative transportation modes such as walking and bicycling – for example, the Fanno Creek Greenway and Springwater Corridor trail systems provide non-motorized transportation access to many of the region's citizens.

However, protection of fish and wildlife habitat can also increase energy use by increasing VMT. For example, too many avoided stream crossings may result in the need to drive further around fish and wildlife habitat, increasing VMT. Similarly, utilities such as sewer and water lines may need to be rerouted, requiring energy and materials. Extensive natural areas protection could result in larger UGB expansions.

Those policies that allow the region to maintain a compact urban form and reduce VMT, while at the same time interspersing green infrastructure into and around the built environment, will reduce regional energy demands and the environmental impacts associated with energy use.

What are the energy consequences of allowing, limiting, or prohibiting conflicting uses in or near fish and wildlife habitat?

The analysis of energy consequences is general in nature and deals primarily with the implications of tree and vegetation loss and extent of the urban area. Metro avoided focusing on site-specific energy issues such as household appliance use, because other issues are more relevant to energy use at the regional scale. Below is a general description of the energy impacts of allowing, limiting or prohibiting conflicting uses, a summary of the differences of the consequences by regional zone, and the key points learned from the energy analysis. Several matrices relating the energy impacts to Metro's generalized regional zones may be found in Appendix D.

Potential energy consequences

Below are some general consequences associated with allow, limit, and prohibit decisions:

Allow conflicting uses

- Compact urban form reduces transportation energy use
- Less vegetation available to conserve energy and mitigate air quality, air and water temperatures

Limit conflicting uses

- Potential to find middle ground, maximizing vegetation and compact urban form
- Most likely to support Region 2040 Growth Concept***Prohibit conflicting uses***

- Potential need for UGB expansions, increased transportation infrastructure, more energy used
- Maximizes retention of forest canopy and vegetation, maximizing vegetation energy benefits

Energy consequences by generalized regional zone

Most of the energy consequences are similar across zones (matrices describing the consequences may be found in Appendix D); the differences are identified below.

- **Single-family residential (SFR):** tends to retain more trees and vegetation than other zoning types, reducing negative air quality and temperature impacts. However, tends to require more infrastructure and creates the need for greater travel distances. In this regard, low-density housing is the most energy inefficient use of all housing types. Clustered housing can reduce this negative consequence.
- **Multi-family residential (MFR):** density decreases overall infrastructure and road requirements, reducing energy use due to reduced transportation and infrastructure needs.
- **Commercial (COM):** high onsite imperviousness, including parking needs, and relatively low tree and vegetation cover can increase temperatures and air pollution consequences.
- **Industrial (IND):** high onsite imperviousness and relatively low amounts of vegetation can increase temperatures and air pollution. Tends to have fewer parking needs than COM.
- **Mixed-use centers (MUC):** this land use is energy efficient because it decreases VMT and overall infrastructure requirements. Can offer efficient land use and reduce the amount of land needed, because development types can meet specific local needs. Can provide shared parking and greater efficiency in parking lot layout, thereby reducing imperviousness and negative energy consequences associated with temperature regulation.
- **Rural residential (RUR):** more roads and other infrastructure required per dwelling unit. Higher VMT due to distances residents need to travel to meet their daily needs. However, tends to retain forest canopy and other vegetation, helping to regulate air and water temperatures and improve air quality.
- **Parks and open space (POS):** varies by the intensity of development within the park. Some parks are very natural, contributing to positive temperature regulation and air quality effects. Other parks, such as those with buildings, parking areas and paved boat landings, may increase negative energy effects related to temperature regulation and air quality.

Summary points

- A compact urban form conserves energy by reducing infrastructure and Vehicle Miles Traveled (VMT), and also conserves fish and wildlife habitat outside UGB.
- Trees and other vegetation are a key variable mitigating negative energy impacts. Plants clean and cool air and water, and also reduce air conditioning demand.
- Transportation infrastructure creation and maintenance require energy, whereas transit and alternative transportation modes reduce energy consumption. Program solutions that reduce infrastructure needs and support alternative modes of transportation are likely to reduce overall energy use.
- At the regional scale, fossil fuel use for transportation constitutes a key use of energy and contributes to warming of air and water, as well as air pollution. Reducing vehicle miles traveled, and the infrastructure required to support such travel, is an important variable in reducing energy use. Clustered housing and MUC and MFR zoning types provide three potential ways to reduce VMT and infrastructure needs.

- Protection of fish and wildlife habitat can increase energy use by increasing VMT, because drivers must travel around the protected areas. However, trees and other vegetation also help mitigate negative energy effects. A strong energy solution would include a balance between compact urban form and retention of green infrastructure within the urban area.

CHAPTER 8: SUMMARY AND CONCLUSIONS

Introduction

Integrating the needs of people with the needs of fish and wildlife in an urban environment is not an easy task. There is debate on the value of protecting habitat in urban and developing areas, considering the difficulty many species have cohabiting with humans and the economic value of developable land in urban areas. However, a large body of evidence, both local and nationwide, indicates that people living in urban areas value fish and wildlife habitat. In addition, properties located adjacent to fish and wildlife habitat can have higher economic and social value.

In keeping with these values, Metro's policies have consistently placed a high level of importance on the protection of the natural environment as a means of maintaining the high quality of life citizens of this region expect. The general economic, social, environmental, and energy tradeoffs of allowing, limiting, and prohibiting conflicting uses are summarized in this chapter. The next step of Metro's planning process is to identify the specific ESEE tradeoffs of several program options, after which the Metro Council will make a decision to allow, limit, or prohibit conflicting uses in fish and wildlife habitat areas.

Tradeoffs of allowing, limiting or prohibiting conflicting uses

The Goal 5 rule describes a process in which the economic, social, environmental, and energy consequences of allowing, limiting, and prohibiting conflicting uses are balanced with the need to preserve fish and wildlife habitat. These tradeoffs are described below by fish and wildlife habitat classification and then the differences by general regional zone are highlighted. Metro considers the tradeoffs from a regional perspective. Some of the tradeoffs are different when considering local priorities and concerns, for example from a regional perspective conflicting uses could be relocated or intensified in one area to account for fish and wildlife habitat protection in another. This solution may not address the needs of a city to provide jobs or housing within its jurisdiction, or to protect locally significant fish and wildlife habitat.

Fish and wildlife habitat class

The consequences of allowing conflicting uses vary by habitat class, with negative impacts greater when conflicting uses are allowed in high value fish and wildlife habitat areas. Impacts on undeveloped land would likely be greater than on developed land, depending on the type of program implemented. However, developed land may be impacted when redevelopment activities occur. Here we focus on the impacts to undeveloped land.

Class I riparian/wildlife corridors and Class A upland wildlife

Allow

The tradeoffs of an allow decision would be substantially greater in Class I riparian/wildlife corridors and Class A upland wildlife habitats than in habitat areas with less functional value. There would not be many positive consequences of allowing conflicting uses in these high quality habitat areas. Only seven percent of the unconstrained, buildable land[76] within the

[76] Unconstrained land has no current environmental regulations; buildable land includes vacant lots and portions of developed lots over a certain size. See *Conflicting Uses* chapter for more detailed definitions.

UGB[77] falls within Class I riparian/wildlife, if more vacant land fell within these areas the tradeoffs would be higher. Less than one-fifth of Class I land is zoned for uses which support employment[78] and none is of high employment value,[79] limiting economic benefits of an allow decision. The largest portion (42 percent) of buildable land in Class I riparian/wildlife is zoned for single family use, so a decision to allow would minimize additional property owner concerns about further regulations on their land. Class A wildlife contains about eight percent of unconstrained, buildable land within the UGB, and of that land 77 percent is zoned for single family use. Single family is likely to retain more natural land cover than other zoning types, providing some wildlife habitat and connectivity within the UGB. Only five percent of Class A wildlife is zoned for uses which support employment, and none is ranked as high employment value.

The negative impacts of an allow decision are particularly striking when considering the environmental consequences. Many primary ecological functions and habitat characteristics would be lost, key habitat for sensitive and endangered species would be fragmented and degraded, and nonnative species would likely be introduced. The loss of trees and vegetation would also lead to higher air temperatures and increased energy demand for temperature regulation. The negative economic impacts of an allow decision in these healthy habitat areas would include the loss of ecosystem services, potential increase in municipal expenditures on water quality and flood control, and a high risk of foregoing future ecosystem benefits. The social impact of losing these high value habitat would be greater than lower value areas, since these places are critical to preserving cultural heritage and protecting public health. A decision to allow would negatively impact the salmon that are so important to Native American culture; and the heritage and economy of the Pacific Northwest may face an irreversible loss through habitat loss and degradation.

Prohibit

A decision to prohibit conflicting uses in Class I riparian/wildlife corridors and Class A upland wildlife would result in the most positive environmental consequences. The amount of buildable land impacted would be fifteen percent of the total buildable land in the UGB, which would reduce competition between habitat conservation and development of these high value habitats (Class I and Class A habitat). Preserving the high value habitats would minimize negative environmental consequences but would focus protection efforts on owners of buildable single family land, especially in upland habitat areas. A decision to prohibit would reduce air temperatures but may increase infrastructure needs and commute distances by preventing road development in high value habitats. Some of the negative economic development impacts of a prohibit decision may be mitigated by the value of ecosystem services provided by high quality habitat. The key social tradeoff is between preserving the public social values of habitat while impacting private property rights. A decision to prohibit conflicting uses in these areas would likely require additional density elsewhere in the UGB or an expansion of the UGB to provide sufficient buildable land.

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[77] The UGB prior to December 2002.

[78] Land zoned for employment includes mixed-use, commercial, and industrial zones, and does not include parks.

[79] Employment density is based on employees per acre. See Appendix C.

Limit

A decision to limit conflicting uses in Class I riparian/wildlife corridors and Class A upland wildlife habitat would allow some habitat preservation while mitigating the negative economic, social and energy consequences. The impact of limiting development would depend on the type of program implemented, and the results may range from minimal to almost complete protection of ecological functions. Using best management practices and low impact development standards to mitigate the impacts of development could reduce negative environmental, social, energy and economic consequences. Retention of existing habitat would be much cheaper than restoring it later, and also would require less energy.

Class II riparian/wildlife corridors and Class B upland wildlife

Allow

The tradeoffs of allowing conflicting uses in Class II riparian/wildlife would not be as great as in Class I riparian/wildlife corridors but still have a substantial negative impact on ecological function. However, the potential for losing existing ecological functions is reduced because fewer functions are present. A decision to allow may also result in the loss of restoration opportunities to regain ecological functions. The loss of Class II riparian/wildlife corridors would remove existing water quality filtration capacity and other ecological functions, with resulting negative impacts on ecosystem services, social values, and energy use. It also would have a negative environmental impact on Class I riparian/wildlife corridors by removing areas that contribute both primary and secondary function to the streams and water bodies. Class II riparian/wildlife corridors contains about four percent of the unconstrained buildable land within the UGB; thus allowing development in these areas does not have a significant economic benefit. Most of that buildable land is zoned for single family (47 percent), followed by industrial land (25 percent). The positive social and economic benefits of development would accrue to private landowners with an allow decision, while the public benefits would be diminished. Approximately 28 percent of land in Class II riparian/wildlife corridors supports employment, but only one percent is classified as high employment value.

A decision to allow development in Class B upland wildlife would result in the loss of connectivity between habitat patches as well as extensive loss of migratory stopover habitats and movement corridors. This would impact the value of the Class A upland wildlife areas by reducing connectivity among them, with consequent negative social and economic impacts. Class B upland wildlife contains a little over six percent of the buildable land in the UGB. Over 63 percent of that land is zoned for single family use, followed by rural (16 percent) and industrial (10 percent). Single family uses often retain more habitat value if trees and vegetation are preserved, which would reduce the negative environmental, social and energy consequences of a decision to allow development. Only nine percent of Class B upland wildlife land supports employment, and none is classified as of high employment value.

Prohibit

Prohibiting conflicting uses in Class II riparian/wildlife corridors and Class B upland wildlife would result in a number of positive environmental consequences but at the expense of affecting a large number of residential property owners. Preservation of Class II riparian/wildlife corridors and Class B upland wildlife would increase the quality of Class I riparian/wildlife corridors and Class A upland wildlife, maintaining riparian ecological functions and habitat connectivity. A decision to prohibit may result in the need to increase density within the UGB or to expand the boundary. It also would retain restoration opportunities where ecological functions could be regained by increasing tree canopy or removing nonnative plants.

Limit

The tradeoffs of preserving Class II riparian/wildlife corridors and Class B upland wildlife may be addressed by mitigating the negative consequences with a limit decision. The impact of limiting development would depend on the type of program implemented. Using best management practices and low impact development standards to mitigate the impacts of development could reduce negative environmental, social, energy and economic consequences. Retention of existing habitat would be much cheaper than restoring it later, and also would require less energy. These habitat types that are not currently high quality may benefit from limited development if tied to restoration and mitigation.

Class III riparian/wildlife corridors; Class C upland wildlife

Allow

The tradeoffs of allowing conflicting uses in Class III riparian/wildlife corridors and Class C upland wildlife would not be as great as in the higher value habitat areas. Class III riparian/wildlife corridors include smaller forest patches and developed floodplains. The developed floodplains currently provide little ecological value but may provide opportunities for restoration in the future. Isolated smaller forest patches provide some environmental and energy benefits. These areas make up less than one percent of the buildable land in the UGB. Forty-eight percent of that land is zoned for single family, development of which could retain some of the forest canopy. Forty-nine percent of Class III riparian/wildlife corridors is zoned for uses which support employment, but only two percent is classified as high employment value.

Class C upland wildlife patches are of reduced quality compared to A and B upland wildlife and these isolated patches may be associated with increased wildlife mortality on roads. However, Class C upland wildlife patches may provide important habitat for specific wildlife species as well as connectivity along riparian corridors. Class C upland wildlife comprises only about five percent of the buildable land within the UGB, most of which is zoned for single family (37 percent) and industrial (26 percent). Only 25 percent of Class C upland wildlife land is zoned for uses which support employment, and none is classified as high employment value.

Prohibit

The ecological benefits of prohibiting development in Class III riparian/wildlife corridors and Class C upland wildlife would not be commensurate with the negative economic, social and energy consequences for the property owners in these areas. However, the impact on buildable land would be minimal, reducing the regional impact of preserving these areas.

Limit

A decision to limit conflicting uses in Class III riparian/wildlife corridors and Class C upland wildlife could preserve some habitat value while mitigating the negative consequences of protection. Class III riparian/wildlife corridors and Class C upland wildlife could provide important sites for restoration, improving the overall habitat quality for all habitat classes.

Impact areas
Allow, Limit, Prohibit
The negative consequences of allowing conflicting uses in impact areas would be substantially less for all four ESEE factors than in higher value fish and wildlife habitat categories. Impact areas provide little existing ecological function, so the environmental benefit of limiting or prohibiting conflicting uses is low. However, these areas provide important opportunities for landowner education, stewardship and restoration. With redevelopment a limit decision that directs the use of low impact development standards and best management practices could help the overall ecosystem to regain ecological function over time.

Regional zones

Most of the impacts of allowing conflicting uses would be the same across regional zones and are described in Table 8-1; the differences are described below.

Single family residential (SFR)
For single-family uses, the tradeoffs include many of the most sensitive social issues. Single-family zoning comprises the largest portion (46 percent) of the fish and wildlife habitat inventory, and includes 23 percent of the total unconstrained buildable land within the UGB. A decision to allow conflicting uses minimizes additional restrictions on the development potential of land, reducing possible impacts on personal financial security and regulatory or perceptual takings. Allowing conflicting uses on vacant land may impact established neighborhoods, changing neighborhood character and impacting property owners. With a limit decision, single family uses provide opportunities to balance the competing needs of habitat protection and property development rights. These lands often retain trees and vegetation and also provide opportunities for stewardship and landowner education. However, residential uses may increase offsite roads and infrastructure. Prohibiting conflicting uses completely would adversely affect a large number of residential property owners, but would retain habitat and neighborhood character.

Multi-family residential (MFR)
The most important tradeoff to consider in a decision to allow, limit, or prohibit development on land zoned for multi-family is the impact on capacity within the UGB. However, land zoned for multi-family accounts for only five percent of the total fish and wildlife habitat inventory and only one and a half percent of the total unconstrained buildable land within the UGB. Thus, limiting or prohibiting conflicting uses on multi-family land would have a minimal impact on housing capacity. Multi-family development tends to have fewer infrastructure requirements per dwelling unit as compared to single family, reducing the cost of development (economic and energy) but increasing vegetation loss and impervious surfaces. With a limit decision, this zoning type allows for substantial preservation of the habitat along with development if low impact development standards are applied in conjunction with best management practices.

Mixed-use centers (MUC)
A key tradeoff to consider for mixed-use centers is their importance in supporting the 2040 Growth Concept and providing housing and employment capacity within the UGB. Mixed-use centers comprise only two percent of the fish and wildlife habitat inventory, and almost two percent of the total unconstrained buildable land in the UGB. Mixed-use centers allow residents

the opportunity to live near their work, which tends to reduce vehicle miles traveled and the related negative water quality impacts and energy use. Less time spent commuting also allows people time to spend with family, on hobbies or recreational activities. However, the increased levels of impervious surfaces and tree loss add to the urban heat island effect and contribute to global warming. Mixed-use centers may provide some opportunity for habitat preservation along with development, depending on the type of program implemented.

Commercial (COM)
For commercial uses the most important tradeoff to consider is the impact on employment and shopping opportunities. Commercially zoned land accounts for five percent of the fish and wildlife habitat inventory, and only one and a half percent of the total unconstrained buildable land in the UGB. Allowing conflicting uses in commercially zoned areas reduces employment impacts specific to development use and does not affect related income and income tax revenue to municipalities. However, similar to mixed-use centers, the increased levels of on-site impervious surfaces have negative environmental and energy impacts. Commercial land uses tend to be more land extensive than single family or multi-family uses, thus reducing the ability to preserve ecological function while allowing development. However, some ecological functions could be retained with a limit decision by requiring low impact development and best management practices.

Industrial (IND)
Industrial uses provide employment and an income base for the region, a critical tradeoff to consider when protecting fish and wildlife habitat. Land zoned for industrial use comprises 14 percent of the fish and wildlife habitat inventory, but only six percent of the total unconstrained buildable land in the UGB. Additionally, most of the habitat land zoned for industrial use is classified as having a low employment density, minimizing the economic development impacts of a limit or prohibit decision. Industrial development tends to be very land extensive, maximizing vegetation loss; increased toxins may be present. Instituting low impact development standards and best management practices with a limit decision may preserve some of the ecological functions while reducing negative economic impacts.

Rural (RUR)
An important tradeoff to consider in rural areas is the impact of allowing conflicting uses on the regional identity and preservation of land for development in the future. Rural areas serve as visual greenbelts and also maintain land in agricultural uses near the UGB. Rural zoning comprises seven percent of the fish and wildlife habitat inventory and seven percent of the total unconstrained buildable land in the UGB. Outside of the UGB but within Metro's jurisdiction, rural residential is the predominate use. Rural uses provide important connector habitat, but allowing conflicting uses in rural areas can have negative environmental effects such as livestock degradation of riparian areas and water quality impacts of leaky septic tanks. A limit decision would provide opportunities to preserve habitat while allowing some development to occur.

Parks and open space (POS)
A key consideration for parks and open space uses is the need for active recreation facilities versus using public land to preserve habitat for the public benefit. Land in use as parks and open space makes up 20 percent of the fish and wildlife habitat inventory, but provides a negligible

amount of unconstrained buildable land. Publicly owned lands offer the main opportunity to preserve habitat for the public benefit without negatively impacting private property owners.

Key points

Following completion of the ESEE analysis, Metro staff will develop alternatives for implementing programs to protect regionally significant fish and wildlife habitat. These alternatives will be analyzed based on the ESEE tradeoffs identified above, and will be evaluated using criteria developed from the key points described below. This section identifies some of the implications from the analysis that may be relevant to developing and evaluating Goal 5 alternatives.

Economic

1. **Fish and wildlife habitat and the ecosystem services they provide have economic value.** Decisions that protect or enhance ecosystem services have a positive effect on the economy. In some cases it is more cost effective to protect fish and wildlife habitat than it is to undertake restoration or build engineered structures to provide for flood control, water quality, and other ecosystem services.
2. **Development status of fish and wildlife habitat moderates the types, intensity, and distribution of economic consequences.**
    - Most fish and wildlife habitat is in park status, developed with existing uses, or constrained by existing regulatory programs protecting streams, wetlands, floodplains, and steep slopes near streams (34 percent of the habitat is in park status, 22 percent is developed, and 16 percent is vacant constrained). The majority of high value fish and wildlife habitat (71 percent of Class I riparian/wildlife and 59 percent of Class A upland wildlife areas) is already in parks/open space or constrained.
    - While fish and wildlife habitat comprises 41 percent of the unconstrained buildable land supply within the 2002 UGB, the highest value habitat comprises 20 percent of the region's buildable land supply. This reduces the competition between conservation and development of high value fish and wildlife habitat.
    - The degree to which development is limited within fish and wildlife habitat, especially vacant buildable lands, will directly affect the need for compensatory actions such as increasing densities within the UGB and expanding the UGB.
    - Single-family lands deserve special attention given that they account for a large proportion of fish and wildlife habitat (46 percent). How these lands are treated in protection programs will influence the development value and habitat value of these lands.
    - Conflicts are highest on the 14 percent of fish and wildlife habitat lands in industrial zoning. About 61 percent of these lands scored high for at least one measure of development value. How conflicts are resolved in these areas have implications on employment and potentially the need to expand the UGB.
3. **A majority of fish and wildlife habitat occurs outside areas of intensive urban development.** Economic consequences of decisions to limit or prohibit conflicting uses on these lands will affect economic activities with low land value and employment density, relative to the Portland city center. However, these decisions will have a more significant impact on land values than on employment.

- A majority of high value fish and wildlife habitat (83 percent of Class I riparian/wildlife and 95 percent of Class A upland wildlife) is not zoned to support employment, and land that does support employment is mostly of low employment value (no land in these categories is of high employment value).
- Moderate and low value fish and wildlife habitat supports more employment compared to high value habitat, but most employment values remain low.
- A significant proportion of fish and wildlife habitat occurs in areas that have some development value, but compared to the Portland city center, the development values are low.

4. **Limit and prohibit decisions would affect primarily 2040 design types with lower expected levels of urbanization (i.e., inner and outer neighborhoods).** However, these areas cover a majority of the urban landscape, so the decisions would impact a large number of property owners.
5. **The fact that limit or prohibit decisions would affect land with lower property values and employment density does not mean that the regional consequences of such decisions would be trivial.** The cumulative property value or employment affected could be significant depending on the details of the regional program and the nature of mitigating actions (such as increasing densities within centers or expanding the UGB)
6. **Decisions that result in protection of fish and wildlife habitat may reduce the future costs to municipalities of complying with environmental regulations such as the federal Endangered Species Act and the federal Clean Water Act.** Likewise, degrading fish and wildlife habitat increases the likelihood that future municipal expenditure to comply with environmental laws will increase.
7. **Relocation of conflicting uses within the current UGB, or expanding the UGB, has the potential to mitigate the adverse effects of limit and prohibit decisions on land value and employment.** However, expanding the UGB may increase expenditures associated with vehicle miles traveled, extending or expanding infrastructure, and other urban growth expenditures. At the local scale, relocating conflicting uses to another jurisdiction or expansion of the UGB may not mitigate adverse effects unless the expansion occurs nearby.

Social

1. **Protection of fish and wildlife habitat preserves many important social values.** These include our cultural heritage, regional identity, sense of place, and neighborhood character. Property owners may also benefit from the retention of fish and wildlife habitat through increased property values. Opportunities for education abound in areas with healthy fish and wildlife habitat.
2. **The distribution of the regulatory burden on property owners to protect fish and wildlife habitat for the general public benefit is a critical social concern.** Private property rights are a fundamental cornerstone of American life, and additional regulations reducing development rights may be seen as an attack on personal financial security as well as a possible taking. However, there are public rights to clean air and water, as well as healthy fish and wildlife, which serve as a counterbalance to this view.
3. **Fish and wildlife habitat provide positive benefits to public health and safety, but there are some negative effects.** There are many obvious benefits of recreation, as well as the mental health and stress relief found in nature. Additionally, minimizing the incidence of

flooding and erosion contributes to public safety. However, increased forest canopy and vegetation could lead to wildfire risks and potential damage from windstorms.

4. **People today have a responsibility to provide future generations with some of the same benefits that current residents enjoy.** Sustainable development practices allow for development to occur today while maintaining a certain amount of intergenerational equity.

Environmental

1. **Trees are invaluable to the health of fish and wildlife habitat.** It is important both near streams and throughout the watershed, as affirmed by local studies. Trees provide habitat, absorb pollution and excess nutrients, and slow and retain stormwater, reducing hydrologic alterations.
2. **Hydrologic changes have far-reaching negative consequences.** Reducing or mitigating impervious surfaces and stormwater impacts is necessary to mimic natural water flow patterns.
3. **Consequences to fish habitat depend on habitat value.** For example, loss of high-value Class I riparian/wildlife habitat would have a stronger ecological impact than Class II or Class III habitat. Loss of high-value riparian habitat would also result in loss of high-value wildlife habitat, because Class I riparian/wildlife habitat include some high-value wildlife habitat (including Habitats of Concern).
4. **Consequences to wildlife habitat also depend on habitat value, but with different implications than fish habitat.** Because connectivity is important to wildlife, the loss of any component in the system may reduce the value of nearby wildlife habitat patches. For example, preserving two Class A upland wildlife habitat patches will be most valuable to wildlife if connectivity is retained, and the connecting patches are typically Class B or C upland wildlife. If only Class A upland wildlife is preserved, its value will be reduced due to the loss of nearby Class B and C upland wildlife.
5. **Homes surrounded by trees can provide important wildlife habitat.** Resident native birds are most diverse in developed areas with plenty of forest canopy. A limit decision provides opportunities to preserve important fish and wildlife habitat while allowing for some conflicting uses, especially in residential zones.

Energy

1. **Trees and other vegetation are a key variable mitigating negative energy impacts.** Plants clean and cool air and water, and also reduce air conditioning demand.
2. **Transportation infrastructure creation and maintenance require energy, whereas transit and alternative transportation modes reduce energy consumption.** Program solutions that reduce infrastructure needs and support alternative modes of transportation can reduce overall energy use.
3. **At the regional scale, fossil fuel use for transportation constitutes a key use of energy and contributes to warming of air and water, as well as air pollution.** Reducing vehicle miles traveled, and the infrastructure required to support such travel, is an important variable in reducing energy use. Clustered housing in single family zones, as well as mixed-use centers and multi-family zoning types provide three potential ways to reduce VMT and infrastructure needs.

4. **Protection of fish and wildlife habitat can increase energy use by increasing VMT, because drivers must travel around the protected areas.** However, trees and other vegetation also help mitigate negative energy effects. A limit decision could provide a balance between compact urban form and retention of green infrastructure within the urban area.

Next steps

The right balance between preserving and developing fish and wildlife habitat is not obvious. Allowing 100 percent of the desired development activities or protecting 100 percent of the habitat areas from development will not satisfy the many competing interests, as described above. The ESEE tradeoffs and key points identified in this report create a base of facts as a foundation for the public debate and decision making process. Metro's ESEE analysis shows the difficulty inherent in balancing the goals of protecting fish and wildlife habitat and providing for the development needs of the region.

The next step in Metro's planning process involves defining several program options for protecting fish and wildlife habitat. The tradeoffs associated with each option will be evaluated and compared, providing valuable information to the Metro Council as it considers a final decision to allow, limit, or prohibit conflicting uses in regionally significant fish and wildlife habitat areas.

Table 8-1. ESEE consequences of allowing, limiting and prohibiting conflicting uses by habitat class

ESEE Consequences of *ALLOWING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS I RIPARIAN *Score: 18-30* *3-5 primary functions, plus secondary functions*	+ Property owners realize full development potential + Supports intrinsic value of built environment + No affect on employment and income related to development activities + Buildable land with habitat accounts for almost half of the total buildable land in UGB, reduces need to expand UGB by allowing development + SFR: No impact on development value on large portion of habitat land + IF a restoration component is included impacts on ecosystem services could be mitigated but at higher cost - Negative impacts on employment and income that depend on quality of riparian and wildlife habitat - Increased municipal spending on flood and water quality management - Cumulative negative impacts on all ecosystem services (e.g., flood management, water-quality) - Increases risk of foregoing future uses and benefits associated with habitat - Increases risk of irreversible outcome (e.g., extinction of salmon) that may have future negative economic consequences - May increase cost of municipal compliance with federal regulations (ESA) - Majority of habitat occurs on land with low development value and employment density, protection of ecosystem values could occur with less economic impact	+ Maintain housing and employment options + No change in property rights + No takings concerns + Equitable impact on property owners + SFR: Maintain personal financial security (equity) + MUC: Does not impact 2040 densities and development in centers + MUC: Allows residents opportunity to live near where they work + POS: Maintain or increase opportunities for active recreation - May lose cultural heritage - May not protect salmon and thus impact Native American culture and regional identity - May change neighborhood character and sense of place - Scenic values may be lost - Incompatible land uses may lose buffers - May degrade environmental quality and impact health - May lose recreational and educational opportunities - Loss of tree canopy and vegetation may increase stress levels and impact mental health - Aggression and violent behavior could increase - May increase risk of landslides and floods if tree canopy and vegetation is removed - Loss of intergenerational equity	+ **Functional consequences:** no positive consequences beyond that provided by existing protection + Reduced need for UGB expansion + SFR: may retain more trees/ vegetation + MFR: Increased density within UGB reduces need for UGB expansions + MFR: Decreased infrastructure requirements per dwelling unit decreases overall infrastructure/roads + MUC: tends to reduce VMT, reducing water quality impacts - **Functional consequences:** loss of 3-5 primary ecological functions - Likely harm to salmon and wildlife through habitat loss and degradation - Increased pesticide and fertilizer use degrades water quality - Landscaping uses water - Continued development in flood areas - Continued wetland conversion - Nonnative species introductions - MFR: tends to retain less vegetation and add more imperviousness - IND: Increased imperviousness and decreased canopy cover increase negative ecological effects - IND: Increased toxins may be associated with this land use - IND: Can be particularly detrimental to water quality - RUR: Livestock degrade riparian area - RUR: Septic tanks are common and may leak, reducing water quality	+ Contributes to efficiencies in provision of services + More compact development may reduce VMT (Vehicle Miles Traveled per person) and fossil fuel use + Reducing VMT and fossil fuel use reduces air pollutants and heat + MUC: High density centers reduce VMT, infrastructure, energy use + RUR: Imperviousness is typically lower and vegetation cover higher, reducing Urban Heat Island effect - Loss of trees and increased imperviousness lead to Urban Heat Island effect and global warming; higher air conditioning (AC) demand - Warmer air warms water; harms salmon - Increased energy consumption to provide engineered solutions to manage stormwater flow, reduce soil erosion, keep water cool, etc. - SFR: associated with increased offsite roads and infrastructure - MFR, COM, IND: Increased onsite imperviousness and tree loss add to Urban Heat Island effect and global warming on a per-acre basis - IND: Placement within the floodplain is common, increasing energy-requiring flood mitigation

ESEE Consequences of *ALLOWING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS II RIPARIAN *Score: 6-17* *1-2 primary functions and some secondary functions*	+ *Same as Class I riparian* – *Same as Class I Riparian, except less risk*	+ *Same as Class I riparian* – *Same as Class I Riparian, except less risk*	+ *Similar to Class I riparian habitat* – *Similar to Class I riparian habitat, except:* – Loss of restoration opportunities to regain ecological functions – Loss of functionality would be less because fewer ecological functions are present; however, loss of Class 2 Riparian removes existing water quality filtration capacity and other ecological services	+ *Same as Class I Riparian* – *Same as Class I Riparian, except less risk*
CLASS III RIPARIAN *Score: 1-5* *No primary functions, no wildlife value: includes small forest patches and developed floodplain*	+ *Same as Class I Riparian* – *Same as Class I Riparian, except less risk*	+ *Same as Class I Riparian* – *Same as Class I Riparian, except less risk*	+ *Similar to Class I riparian habitat, except:* + Class 3 Riparian ecological functions are already reduced, thus allowing conflicting uses does not have a significant impact on overall ecological function – *Similar to Class II riparian habitat, except:* – The potential for losing existing ecological functions is reduced	+ *Same as Class I Riparian* – *Same as Class I Riparian, except less risk*

ESEE Consequences of *ALLOWING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS A WILDLIFE *Score 7-9 no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I riparian* − *Same as Class I riparian*	+ *Same as Class I riparian* + Less vegetation may reduce risk of wildfires + Less habitat may reduce number of undesirable species − *Same as Class I Riparian*	+ *Similar to Class I riparian habitat* + **Functional consequences:** no positive consequences noted + SFR: may retain more natural land cover than other zoning, providing wildlife habitat and connectivity + MFR, MUC: Increased density in UGB may limit expansion to new areas + RUR: Less habitat fragmentation; tends to retain more connectivity + RUR: agricultural areas can provide important grassland habitat − **Functional consequences:** Loss of key habitat characteristics − Extensive loss of valuable wildlife habitat − Nonnative plant and animal species invasions − Increased adverse edge effects − Pesticides may harm wildlife − Noise and light disturbances − Continued native species loss over time, reduction in migratory songbirds − Decline of at-risk wildlife species; more species imperiled − Continued loss of Habitats of Concern and associated species − Mortality from roadway crossings − MFR: higher onsite imperviousness, increased negative effects on wildlife and migratory songbirds − COM, IND: Increased imperviousness and decreased canopy cover − COM, MUC: Increased human disturbance	+ *Same as Class I Riparian* − *Same as Class I Riparian*

ESEE Consequences of *ALLOWING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS B WILDLIFE *Score 4-6 no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	+ *Similar to Class I Riparian* + *Similar to Class A Wildlife* − *Similar to Class A Wildlife, except:* − Habitat interior loss less extensive than Class A − Loss of connectivity especially pronounced; extensive loss of migratory stopover habitat and movement corridors. Reduces value of Class A patches. − Loss of grassland and low-structure vegetation within 300 ft of streams − Loss of locally rare migratory stopover habitat and locally rare habitat patches with water resources	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*
CLASS C WILDLIFE *Score 2-3 no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	+ *Similar to Class I Riparian and Class A Wildlife* + These patches tend to be relatively small, isolated, and lacking substantial water resources, and are therefore reduced in quality compared to Class A and B + Isolated patches may be associated with increased wildlife mortality on roadways − *Similar to Class B, except:* − Only limited loss of habitat interior − Some loss of connectivity between patches − Important loss of migratory stopover habitat, these patches tend to occur in areas lacking substantial wildlife habitat − Loss of upland patches lacking water resources but providing important habitat to specific wildlife species	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*

ESEE Consequences of ***ALLOWING*** conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
Riparian impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Opportunities for landowner education may reduce effects of existing and future environmentally harmful practices near waterways − Potential for increased adverse impacts (e.g., pollution, altered hydrology, pesticide use, bacterial contamination, human disturbance...) to waterways due to existing and new conflicting uses in areas adjacent to waterways − These impacts are greater than in other areas because they are near water and because non-habitat areas tend to lack natural filtration provided by riparian vegetation	
Vegetation impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Opportunities for landowner education may reduce effects of existing and future environmentally harmful practices − Potential for increased adverse effects adjacent to habitat areas, primarily forested but also low-structure vegetation	

ESEE Consequences of *LIMITING* conflicting uses

Habitat type	Economic	Social	Environment	Energy
CLASS I RIPARIAN *Score: 18-30* *3-5 primary functions, plus secondary functions*	+ *Extent of impact depends on program:* + IF a restoration component is included impacts on ecosystem services could be mitigated but at higher cost + Intrinsic value of built environment can be retained if balanced with habitat needs + Positive to neutral impact on employment and income that depend on quality of riparian and wildlife habitat + Reduces municipal spending on flood and water quality management + Reduces risk of foregoing future uses and benefits associated with habitat + Reduces risk of irreversible outcome (e.g., extinction of salmon) that may have future negative economic consequences + May decrease cost of municipal compliance with federal regulations (ESA) + Majority of habitat occurs on land with low development value and employment density, protection of ecosystem values could occur with less economic impact + Primarily affects 2040 design types with lower expected levels of urbanization + Reduces cumulative negative impacts on all ecosystem services (e.g., flood management, water-quality) + SFR: Large portion of habitat, decisions on access/layout influences development and habitat value - Development potential of property is limited - Some effect on employment and income related to development activities - Buildable land with habitat accounts for almost half of the total buildable land in UGB, may impact need to expand UGB by limiting development - SFR: May substantially impact development value	+ Preserve some buffers between uses + Retain some or most cultural heritage + Provide salmon chance for recovery, lessen impacts on Native American culture and regional identity + Retain most neighborhood character and sense of place + Preserve most scenic values + Maintain environmental quality and reduce negative health impacts + Retain most educational and recreational opportunities + Retention of tree canopy/vegetation may reduce stress levels and positively impact mental health + Reduce risk of landslides and floods + Provide some intergenerational equity + SFR, MFR, MUC: Maintain housing options/affordability if development minimally impacts the habitat + COM, MUC, IND: Maintain employment opportunities + POS: Increase active recreation opportunities if habitat minimally impacted - Property rights: owners may not be able to develop land to same extent - Takings concerns - Inequitable to property owners - SFR: May reduce option for large lot single family homes - SFR: May impact property values, decreasing personal financial security - SFR, MFR, MUC: May reduce housing options/affordability if development minimally impacts the habitat - COM, MUC, IND: May reduce employment opportunities - POS: May reduce opportunities for active recreation	+ **Functional consequences:** May conserve some of 3-5 existing primary ecological functions, depending on program, as well as Class A or B wildlife habitat falling within Class I riparian; extent depends on program + Reduced need for UGB expansion + Strong potential for BMP implementation and low impact development and innovative design standards + Hydrology less altered than "allow" + MFR: Increased density within UGB reduces need for expansions + MFR: Decreased infrastructure requirements per dwelling unit reduces negative ecological effects + MUC: reduced VMT, fewer water quality impacts from transportation runoff - **Functional consequences:** Potential for substantial loss of 3-5 primary ecological functions, as described in ALLOW. Class A or B wildlife habitat falling within Class I riparian would also be compromised. Extent of loss depends on program. *See comments under "allow," except:* - Hydrology less altered, less stream damage - Greater flood area/wetland protection - Greater protection of steep slopes - Fish and other aquatic wildlife habitat impaired, but extent of loss reduced - Water quality impacts likely, but degree depends on program - MFR, MUC, COM, IND: Loss of ecological functions greater than SFR due to increased imperviousness and tree loss - IND: Increased toxins may be associated with this land use type - RUR: Septic tanks may leak bacteria into waterways, reducing water quality	+ **May reduce new infrastructure requirements** + **Reducing VMT and fossil fuel use reduces air pollutants and heat** + **Increased forest cover helps remove air pollutants and reduce smog** + **Increased forest cover cools air by shade, evapotranspiration, carbon storage; reduced Urban Heat Island effect, global warming, and AC demand** + **May result in decreased energy consumption to manage stormwater runoff, reduce sedimentation and erosion and keep water cool** + **Tree retention is cheaper, easier, and less energy-consumptive than planting new** + **MFR: Requires less land per unit than SFR, reducing extent of tree loss, infrastructure, UGB expansions** + **MUC: Higher density centers create compact urban form, reducing VMT, infrastructure,** energy use **Negative consequences similar to "ALLOW", but to a lesser degree** - Avoiding sensitive natural areas may increase infrastructure requirements - May lead to increased VMT - May result in need for UGB expansion - Loss of trees increases Urban Heat Island effect, global warming, AC demand - Warmer air warms water; harms salmon and other species - MFR, COM, IND: Increased onsite tree loss and imperviousness add to Urban Heat Island effect and global warming - COM, IND: May increase energy consumption to replace natural systems - IND: Placement within the floodplain is common, increasing energy-requiring flood mitigation

ESEE Consequences of ***LIMITING*** conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS II RIPARIAN *Score: 6-17* *1-2 primary functions and some secondary functions*	+ *Same as Class I riparian* − *Same as Class I riparian, except less risk*	+ *Same as Class I riparian* − *Same as Class I riparian, except less risk*	+ *Similar to Class I riparian habitat* + Retains restoration opportunities where ecological functions could be regained through tree canopy increases or other measures − *Similar to Class I riparian resources, except:* − Some loss of features providing ecological functions (scores 6-17), unless offset by mitigation and restoration activities	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*
CLASS III RIPARIAN *Score: 1-5* *No primary functions, no wildlife value: includes small forest patches and developed floodplain*	+ *Same as Class I riparian* − *Same as Class I riparian, except less risk*	+ *Same as Class I riparian* − *Same as Class I riparian, except less risk*	+ *Similar to Class II riparian habitat* − *Similar to Class II riparian habitat, except:* − Loss of opportunities to add forest canopy along streams where low structure currently exists	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*

ESEE Consequences of ***LIMITING*** conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS A WILDLIFE *Score 7-9* *no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I riparian* − *Same as Class I riparian*	+ *Same as Class I riparian* − *Same as Class I riparian* − More vegetation could increase risk of wildfires − Less habitat could increase nuisance species	+ **Functional consequences:** Some retention of key habitat attributes (patch size, habitat interior, connectivity and water resources) for habitat outside Class I riparian + More habitat retained than Allow + Reduced edge effects + Fewer nonnative species invasions + More connectivity retained + Less harm to native species + Reduced need for UGB expansion + Landscaping can provide diverse habitats + Low to moderate levels of development provide good habitat for some species + MFR: Increased density in UGB may limit expansion to new areas, protecting important outlying habitats + RUR: Less habitat fragmentation; tends to retain more connectivity + RUR: agricultural areas can provide important grassland habitat *Similar to "allow," but to a lesser degree depending on program options* − **Functional consequences:** Potential for *reduction* in habitat patch size, connectivity, and amount of interior habitat, reducing ecological function − Wildlife crossings across roadways cause mortality − MFR, COM, MUC, IND: More onsite imperviousness and less forest/vegetation increase negative effects on wildlife and migratory songbirds − MFR, COM, MUC, IND: Higher level of development is less valuable to wildlife − MFR, COM, MUC, IND: Increased human disturbance may negatively impact wildlife, but to a lesser degree than allow − RUR: Increased toxins may be associated with agriculture	+ *Same as Class I riparian* − *Same as Class I riparian, except less risk*

ESEE Consequences of ***LIMITING*** conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS B WILDLIFE *Score 4-6* *no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	*Similar to Class A, except:* + More habitat connectivity between large habitat patches retained + Grassland and low structure habitat within 300 ft of stream may be retained + Low to moderate levels of development provide good habitat for some species, most pronounced in Class A patches *Similar to "ALLOW," but to a lesser degree depending on program options* − To the extent the resource removed, habitat and connectivity will be lost − MFR: More onsite imperviousness and less forest and vegetation increases negative effects on wildlife and migratory songbirds − MFR, COM, IND, MUC: Higher density development less valuable to wildlife − MFR, COM, IND, MUC: Increased human disturbance may negatively impact wildlife	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*
CLASS C WILDLIFE *Score 2-3* *no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	*Similar to Class B, except:* + Most are small forested patches + Less likely to provide good habitat for some species, because these patches tend to be narrow, disconnected, and surrounded by development + Isolated patches may be associated with increased wildlife crossing mortality on roadways *Similar to "allow," but to a lesser degree depending on program options* − To the extent that conflicting uses remove the resource, habitat and connectivity will be lost	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*

ESEE Consequences of *LIMITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
Riparian impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Retains restoration opportunities where riparian functions could be regained through planting tree canopy or other measures + May help protect existing water resources from current or future adverse effects due to conflicting uses + Provides mitigation opportunities + Incentives and landowner education could enhance ecological health over time − Similar to "allow," but to a lesser degree	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone
Vegetation impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Retains restoration opportunities where habitat patch functions could be regained through planting tree canopy or other measures; for example, potential for decreased edge effects, increased interior habitat and increased connectivity to other patches and to water resources + Provides mitigation opportunities + Incentives and landowner education could enhance ecological health over time − *Similar to "allow," but to a lesser degree*	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone

ESEE Consequences of *PROHIBITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS I RIPARIAN *Score: 18-30* *3-5 primary functions, plus secondary functions*	+ Positive impact on employment and income that depend on quality of riparian and wildlife habitat + Minimizes municipal spending on flood and water quality management (as long as takings issues are avoided) + Minimizes risk of foregoing future uses and benefits associated with habitat + Minimizes risk of irreversible outcome (e.g., extinction of salmon) that may have future negative economic consequences + May decrease cost of municipal compliance with federal regulations (ESA) + Majority of habitat occurs on land with low development value and employment density, protection of ecosystem values could occur with less economic impact + Most habitat is on land with 2040 design types with lower expected levels of urbanization + Minimizes cumulative negative impacts on all ecosystem services (e.g., flood management, water-quality) − Does not support intrinsic value of built environment − Development potential of property is impacted substantially − Major affect on employment and income related to development activities if buildable land decreased − Buildable land with habitat accounts for almost half of the total buildable land in UGB, likely to impact need to expand UGB by prohibiting development − SFR: Likely to have substantial impact on development value on large portion of habitat	+ Preserve cultural heritage + Provide salmon a chance to recover and lessen impacts on Native American culture and regional identity + Preserve or increase buffers between incompatible land uses + Retain neighborhood character/sense of place + Preserve scenic values + Maintain and possibly improve environmental quality and reduce negative health impacts + Retain educational and recreational opportunities + Retention of tree canopy and vegetation may reduce stress levels and positively impact mental health + Reduce risk of landslides and floods + Provide intergenerational equity − Inequitable impact on property owners − Property rights: owners may not be able to develop land to same extent − Likely to result in takings concerns − SFR: Possible negative impact on property values, decrease in equity − SFR, MFR, MUC: Reduce housing options and opportunities − SFR, MFR, MUC: May impact housing affordability − MUC: Negative impact to 2040 if development in centers is curtailed − COM, IND, MUC: Reduce employment options and opportunities − POS: Reduce opportunities for active recreation	+ Functional consequences: Preservation of the most ecologically functional riparian areas, as well as some of the most important wildlife habitat remaining in the region, including Habitats of Concern + Helps maintain hydrologic connectivity + Minimizes hydrologic alterations, reduces flooding + Retention of important salmon habitat + IND: Minimize water quality degradation + RUR: Fewer water quality problems associated with leaky septic tanks, livestock + POS: Could help prevent human/pet disturbance to wildlife − **Functional consequences:** no adverse consequences for Class I habitat − Increased need for UGB expansion − Potential for increased infrastructure intrusion into other habitat areas if Class I riparian areas are avoided − MFR, MUC: Opportunity for increased density reduced, thereby increasing need for UGB expansion − RUR: Rural lands are low density and therefore tend to require more infrastructure per dwelling unit, increasing VMT and decreasing water quality	+ **Retention of tree canopy and other vegetation may provide strong protection from warmer air and water from Urban Heat Island effect and global warming** + **Opportunity for pleasant, accessible alternative means of transportation such as walking and bicycling through natural areas, if permitted under program** + **Likely to result in decreased need for future** restoration and flood mitigation − Limits transportation planning options − Limits infrastructure placement options − Increases extent of urban area and VMT − Potential for increased total imperviousness due to increased roads; energy is required to build and maintain roadways and other infrastructure − If utilities are prohibited from being installed along streams, may require pumping or other activities to take non-gravity driven pathways − Increased VMT, fossil fuel use, air pollution, related warming of air and water − Extent of Urban Heat Island effect may increase, potentially increasing AC demand − MUC: Most energy-efficient land use; prohibit decision would reduce energy saving opportunities

ESEE Consequences of *PROHIBITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS II RIPARIAN *Score: 6-17* *1-2 primary functions and some secondary functions*	+ *Same as Class I riparian* - *Same as Class I riparian, except less risk*	+ *Same as Class I riparian* - *Same as Class I riparian, except less risk*	+ Similar to Class I riparian habitat + Retention of some critical ecological functions and ecosystem services provided by existing natural resources + Retains restoration opportunities where ecological functions could be regained through tree canopy increases or other measures + Provides mitigation opportunities - *Similar to Class I riparian habitat, except:* - Increased need for UGB expansion, but less so than prohibit decision in Class I (scores of 6-18 – at least 1 primary function) -	+ *Same as Class I Riparian* - *Same as Class I Riparian, except less risk*
CLASS III RIPARIAN *Score: 1-5* *No primary functions, no wildlife value: includes small forest patches and developed floodplain*	+ *Same as Class I riparian* - *Same as Class I riparian, except less risk*	+ *Same as Class I riparian* - *Same as Class I riparian, except less risk*	+ Similar to Class I riparian habita, except: + Retention of some ecological functions and ecosystem services provided by existing natural resources + Retains restoration opportunities where ecological functions could be regained through tree canopy increases or other measures + Provides mitigation opportunities - *Similar to Class I riparian habitat, except:* - Increased need for UGB expansion, but less so than Class II	+ **Same** *as Class I Riparian* - *Same as Class I Riparian, except less risk*

ESEE Consequences of *PROHIBITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS A WILDLIFE *Score 7-9* *no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* - *Same as Class I Riparian, except less risk*	+ *Same as Class I Riparian* - *Same as Class I Riparian* - More vegetation increase risk of wildfires - More habitat may increase nuisance species	+ Functional consequences: Retention of key attributes for habitat outside Class I riparian + Retention of some of the best remaining wildlife habitats in the region + Provides key breeding habitat for migratory songbirds, aquatic species and habitat interior specialists + Retains Habitats of Concern + Provides important source habitats for native wildlife and plant species + Reduced wildlife road crossing mortality + RUR: Decrease in agricultural toxins + RUR: Reduced livestock damage - **Functional consequences:** Continuing functionality of Class A habitat patches may depend on connectivity with other, less valuable habitat patches - If conflicting uses are prohibited in all Class A wildlife other habitat may be disproportionately removed or altered, reducing the quality of Class A habitat - Class A patches are typically very large, may result in need for UGB expansions - RUR: Agricultural areas can provide important habitat for grassland and low structure-associated species	+ *Same as Class I Riparian* - *Same as Class I Riparian, except less risk*

ESEE Consequences of *PROHIBITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
CLASS B WILDLIFE *Score 4-6 no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	+ Similar to Class A, except: + Retention of some of the most important connectivity elements in the region + Retention of large upland habitat patches important to specific wildlife species + Important for migratory songbirds + May provide important source habitats for native wildlife and plant species + Grassland and low-structure vegetation within 300 ft of streams would be retained − *Similar to Class A Wildlife, except:* − If conflicting uses are prohibited in all Class B wildlife habitat, Class A and C may be disproportionately removed or altered, thereby reducing the quality of Class B habitat through connectivity loss and increasing isolation	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*
CLASS C WILDLIFE *Score 2-3 no primary riparian function but may contain secondary riparian functions*	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*	+ *Same as Class A Wildlife* − *Same as Class A Wildlife, except less risk*	+ Similar to Class B, except: + Not as important to regional connectivity, may provide important local connectivity + Small, isolated patches provide important and locally rare stopover habitat to migratory birds + RUR: Prohibiting conflicting uses may decrease agricultural toxins + RUR: Reduced livestock damage − *Similar to Class B, except:* − Small isolated habitat patches may limit reproductive success due to edge effects and reduced habitat quality − Isolated patches may be associated with increased roadway mortality − RUR: Agricultural areas can provide important habitat for grassland and low structure-associated species	+ *Same as Class I Riparian* − *Same as Class I Riparian, except less risk*
Riparian impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ *Similar to "limit," but to a greater degree* − Primary negative consequences relate to social, economic and energy	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone

ESEE Consequences of *PROHIBITING* conflicting uses				
Habitat type	**Economic**	**Social**	**Environment**	**Energy**
Vegetation impact area	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone	+ *Similar to "limit," but to a greater degree* − Primary negative consequences relate to social, economic and energy	+ Positive consequences depend on the general zone − Negative consequences depend on the general zone

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APPENDIX A

Federal, State, Regional, and Local Policies