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The Biota of Smith and Bybee Lakes Management Area

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February 14, 1994

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EXECUTIVE SUMMARY

Smith and Bybee Lakes, the target area of this study, are an interconnected system of shallow lakes and wetlands located on the floodplain of the Columbia River near its confluence with the Willamette River. The Smith and Bybee Lakes Management Area (SBLM, Figure 1), managed by Metro, includes Smith and Bybee Lakes.

Prior to 1930, these lakes and wetlands experienced biseasonal inundation during the freshets of the Columbia and Willamette Rivers. During summers, significant portions of the lake beds were exposed. Over the past century, human activities have extensively altered the hydrologic cycle of the lakes. Attenuation of the seasonal flow began in the 1930's with changes in the volume of upstream water input. Since the early 1980's, placement of a fixed outflow structure has maintained a minimum water level in the lakes which has prevented significant exposure of the lake beds during most summers. Much of the area previously subject only to seasonal inundation now is inundated year-round.

The extent of alterations to the hydrology of the region has contributed to drastic changes in the local biota. Vegetation and faunal studies were initiated for Smith and Bybee Lakes to assist Metro in identifying management alternatives and in refining future management options for SBLM and its environs. Baseline data for the following were collected so that comparisons with future conditions of the biota of the area will be possible and so that current conditions can be assessed:

1) species presence and abundance (birds, plants, macroinvertebrates, mammals, reptiles and amphibians);
2) the patterns of species use; and
3) habitat quality.

This report provides the following:

1) the documentation for the vegetation and faunal studies conducted from June 1992 to August 1993;
2) recommendations for management drawn from these studies (most importantly those addressing water levels);
3) proposal for a monitoring program; and
4) identification of salient data gaps needed to refine future management options.

The main recommendation of this study, which is designed to maximize native species diversity and minimize establishment of exotic species, is to allow water levels to fluctuate with the changes in the levels of the Columbia and Willamette Rivers by removal of the existing structure on the outflow to the lakes. This will result in larger seasonal fluctuations as the result of the freshets of the Columbia and Willamette Rivers, and lessen diel fluctuations in these systems as a result of tidal movements. Such a pattern would be an approach toward fluctuations observed historically, and would benefit native plants, macro-invertebrate, amphibians and reptiles, mammal and bird species.

In conjunction with these modifications a long-term monitoring program needs to be established in order to evaluate changes in vegetation assemblages, plant, macro-invertebrate, amphibian and reptile, mammal and bird species occurrences and numbers. An annual assessment of the Smith and Bybee Lakes ecosystem, including its health and direction of change must also be evaluated in order to determine whether the management implementation program especially with regard to modification of the water regime has been effective in making changes in the anticipated direction.

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INTRODUCTION

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CHAPTER 1
VEGETATION SECTION

METHODS

Aerial Photography

Plant assemblages in SBLM were delineated on color infrared photographs provided by Metro. These photographs were at a scale of 1:6000, and were flown July 28, 1992. The delineation was done on transparent overlays, then transferred to Metro's geographic information system (GIS) data base.

Field Sampling

Field sampling studies were conducted on 29-30 July 1992 and 18-19 August 1993. The project team was unable to obtain mapping or written descriptions sufficient to locate the seven aquatic transects sampled in 1982 (FES 1987), so resampling of these transects for comparison to the 1982 data could not be done.

Ten permanent transects for sampling were established in representative areas of each major plant assemblage in SBLM as well as small distinctive areas (e.g., ephemeral ponds and sedge meadows; Figure 1).

These include:

- T-1 Black cottonwood/moneyplant *(young forest)*
- T-2 Pacific willow/bittersweet *(forest)*
- T-3 Reed canarygrass *(emergent)*
- T-4 Smartweed/beggar's-tick *(pond emergent)*
- T-5 Oregon ash/reed canarygrass *(forest)*
- T-6 Piper's willow *(shrub-scrub)*
- T-7 Creeping lovegrass/beggar's-tick *(shoreline emergent)*
- T-8 Columbia sedge/Canada thistle *(sedge depression)*
- T-9 Mud flat *(shoreline emergent)*
- T-10 Creeping lovegrass/red-rooted flatsedge/ *(shoreline emergent))*

Large plots were used for sampling trees and shrubs, and smaller quadrats were used for herbaceous vegetation. Locations of the necessary plots and quadrats were determined through random selection of distances between sample sites along each transect.

(1) Tree and shrub plots were established at randomly designated points along the transect. Trees were sampled using the Point-Center-Quarter method (Bonham 1989, Mueller-Dombois and Ellenberg 1974). Using this method, distance from the sample point to the subject trees, tree species, and diameter at breast height (dbh) is measured. From these data, basal area, density, dominance, and frequency of each tree species was determined. Total shrub cover was estimated within a 3-m radius of the same point. Species composition and information on detritus (e.g., litter,

large woody debris) and standing dead trees was also recorded. Sample points were taken along the transect to characterize species composition and cover within the vegetation assemblage were collected.

(2) Herbaceous ground cover was sampled using 1 m^2 quadrats. Total herbaceous cover, species composition, and cover for each species were recorded. Quadrats were sampled to characterize species composition, density, dominance and basal area within the vegetative assemblage.

Because baseline sampling year, 1992, was one of the driest spring-summer periods on record, whereas the following year, 1993, was one of the wettest, sample sites were revisited in June 1993 to compare hydrologic conditions to 1992.

Floating aquatic, submerged aquatic and flooded emergent vegetation were not systematically sampled during the study. Gathering data on these aquatic assemblages is extremely time-consuming, and a sampling effort equivalent in time to the other assemblages was not covered in the scope of work for this project.

RESULTS AND DISCUSSION

Data from previous studies (FES 1987), aerial photointerpretation, field observations, and vegetation sampling were combined to map plant assemblages within the study area (Figure 1). A list of plant species observed during this study is included in Appendix A. Data sheets used during vegetation sampling are provided in Appendix B.

The mapped herbaceous assemblages and the open water in Figure 1 depict conditions of high water levels in early summer. As summer advances, receding water exposes larger areas of lake bottom. The exposed shorelines and increasingly shallower ponds and channels develop emergent vegetation (rooted wetland species that may be temporarily to permanently flooded at the base but are not tolerant to prolonged inundation of the entire plant). Aquatic species (wetland plants that are free-floating on the surface or submerged in the water) flourish and fill much of the open water with large mats or networks of vegetation. Therefore, as the summer season advances, the total area of emergent and aquatic vegetation increases at the expense of open water. Figure 1 is a "snapshot" of herbaceous emergent and aquatic vegetation development determined from a set of aerial photographs taken on 28 July 1992.

Fourteen plant assemblages were identified and each is described below. Twelve of these were wetland assemblages that included seven herbaceous assemblages, one shrub/scrub, and four forested assemblages. One upland shrub/scrub assemblage was identified. All other uplands were lumped together as one map unit, disturbed and/or developed, and this "assemblage" was mostly associated with the St. Johns landfill. The US Fish and Wildlife Service wetland classification system descriptor and abbreviations in parentheses (Cowardin et al. 1989) follows the name of each wetland assemblage.

HERBACEOUS ASSEMBLAGES

1. Water Smartweed Assemblages—palustrine aquatic bed (PAB). Water smartweed (*Polygonum coccineum [=P. amphibium]*) forms large continuous networks in the water which are especially prominent in Smith Lake. Later in the season, extremely large colonies of Mexican water-fern (*Azolla mexicana)* also develop. Other common floating species in this assemblage include lesser duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrhiza*), and curly-leaved pondweed (*Potamogeton crispus*).

2. Dead Piper's Willow Assemblage—palustrine shrub/scrub—palustrine aquatic bed (PSS/PAB). Although the willows in this extensive assemblage are dead, their remnant trunks and branches delineate its recent historical location. It is included with the herbaceous assemblages because water smartweed is often a prominent component of this assemblage, and it is now inundated most of the year. Two USFWS wetland classifications reflect respectively the historical and current appearance of this assemblage. The history of this shrub assemblage is further discussed in the Recommendations section.

3. Shoreline Emergent Assemblage—palustrine emergent (PEM). This assemblage develops on mud flats along lake edges as water recedes seasonally. The dominant species are usually nodding beggars-tick (*Bidens cernua)*, creeping lovegrass (*Eragrostis hypnoides*), and red-rooted flatsedge (*Cyperus erythrorhizos*). Two other common species include leafy beggars-tick (*Bidens frondosa*) and ovate spikerush (*Eleocharis ovata*). Data from this assemblage was collected at sample transects T-7 and T-10. T-9 was sampled on a recently exposed mud flat. Data from T-9 supports the supposition that the shoreline emergent assemblage establishes itself on recently exposed sites along the receding lake edge.

4. Drainage Channel Emergent Assemblage—palustrine emergent (PEM). This herbaceous assemblage that develops in the summer after water has receded, but this assemblage occurs in the bottom of narrow channels that connect with the lakes. Composition is similar to the shoreline assemblage except that leafy beggars-tick is the dominant species rather than nodding beggars-tick.

5. Pond Emergent Assemblage—palustrine emergent (PEM). Ponds in which this assemblage develops lack open connections to the lakes, but they are areas similar to the two previous described assemblages in that they develop an emergent herbaceous vegetation as the water dries seasonally. The two most common species are nodding beggars-tick and marshpepper smartweed (*Polygonum hydropiper)*. Associated species are similar to those in the shoreline emergent assemblage. A band of dense reed canarygrass (*Phalaris arundinacea*) is also often present along the upper edge of these ponds. Transect 4 was sampled in this pond assemblage.

6. Columbia Sedge Assemblage —palustrine emergent (PEM). This assemblage occurs at sites with a shorter hydroperiod than the previously discussed assemblages. These sites are usually small and subtle, and occupy slight depressions that hold water only early in the season. The dominant species is Columbia sedge (*Carex aperta*). At some sites, Canada thistle (*Cirsium arvense*) is a sub-dominant. Transect 8 is representative of this assemblage.

7. Reed Canarygrass Assemblage—palustrine emergent (PEM). This is the driest of the herbaceous wetland assemblages and occupies a significant portion of the higher elevation sites on the study area that generally receive the least inundation. Some sites, especially the ones with slightly longer hydroperiod, are completely dominated by reed canarygrass (e.g., Transect 3). Other areas have a savanna-like appearance because scattered Pacific willow (*Salix lasiandra)* and/or Oregon ash (*Fraxinus latifolia)* associated with the assemblage. In some places, it grows in conjunction with upland species forming the transitional assemblage between wetland and upland areas.

SHRUB-SCRUB ASSEMBLAGES

8. Willow Shrub-Scrub Assemblage—palustrine shrub/scrub (PSS). These willow-dominated assemblages have standing water in the spring and early summer, but dry out later in the summer. The most common dominant is Piper's willow (*Salix piperi*) as was sampled in Transect 6. Occasional associated shrubby willow species are soft-leaved willow (*Salix sessilifolia)* and Sitka willow (*Salix sitchensis)*. Willow dominants often form a dense thicket with little or no understory vegetation. Reed canarygrass appears as an understory species that can be relatively common if the canopy is open enough to allow herb development.

9. Blackberry Shrub-Scrub Assemblage. This is the sole upland assemblage mapped during this study. It consists of a dense, impenetrable thickets of Himalayan blackberry (*Rubus discolor)* with occasional willow, ash, and/or black cottonwood (*Populus trichocarpa*) on its edges. Most of it occurs between Smith Lake and Columbia Slough near the southeast end of the landfill. One small patch exists near Transect 2 at the west end of the St. John's landfill.

10. Pacific Willow Forest Assemblage—palustrine forested (PFO). Pacific willow is one species of willow that often grows into a tree rather than maintaining the shrubby habit often associated with other willow species. Several tree willow stands occur on the study area, including the one sampled on Transect 2. The most common understory species are bittersweet nightshade (*Solanum dulcamara)* and reed canarygrass. Other species are marshpepper smartweed, water smartweed, and blue skullcap (*Scutellaria lateriflora*).

11. Oregon Ash Forest Assemblage—palustrine forested (PFO). Although Oregon ash trees are scattered over the study area, only one area consists of a large stand. This stand is located between Bybee Lake and the landfill, and is the location of Transect 5. Reed canarygrass dominates the understory of this stand. Although it is inundated in the spring, this site may have a shorter hydroperiod than any other forest assemblages.

12. Black Cottonwood Forest Assemblage—palustrine forested (PFO). A few places in the study area have forest stands of black cottonwood. Reed canarygrass is often the understory dominant in these areas. However, one site at the junction of Portland Road and Marine Drive (the northeast corner of Smith Lake) has a very young stand of black cottonwood. Although not treated separately here, the trees are small enough (under 6 m. tall) for this stand to qualify as a shrub-scrub assemblage rather than a forest. The canopy of this young stand is dense enough that little understory development exists. Where herbaceous species are present, the dominant one is moneyplant (*Lysimachia nummularia*). Transect 1 was sampled in this assemblage.

13. Mixed Deciduous Forest Assemblage—palustrine forested (PFO). This is a common forested assemblage on the site. Varying amounts of Pacific willow, Oregon ash, and black cottonwood dominate the canopy. The understory is typical of the other forested communities, and reflects the degree of wetness probably mostly as a function of the hydroperiod. Smartweed species at the wetter end of the gradient and reed canarygrass dominates at the drier end of the gradient.

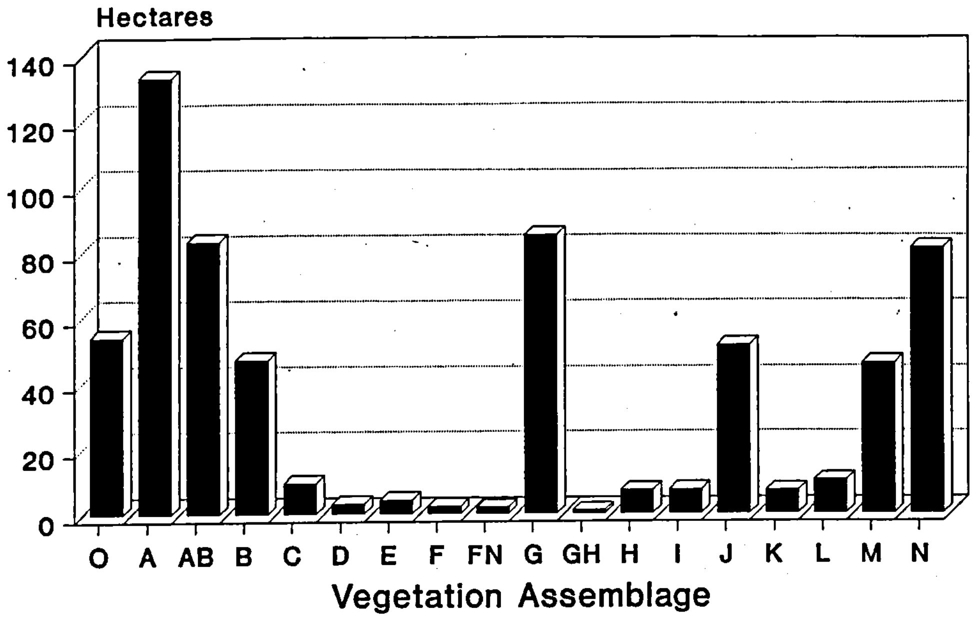
14. Disturbed/Developed Upland. Most of this map unit is associated with the St. John's landfill. Some areas also occur in the vicinity of the Ramsey Lake mitigation ponds. One additional site in the southeast corner of the study area is mapped as a combination of sedge assemblage and disturbed/developed upland. This open field is part of a parcel in private ownership, and is north of some buildings. In the droughty summer of 1992, it had a different species composition than anywhere else on the study area. It was mostly bentgrass (*Agrostis sp.*), velvetgrass (*Holcus lanatus*), and Queen Anne's lace (*Daucus carota*) with Columbia sedge and other hydrophytic species mixed with upland species in the lower spots.

The study area occupies approximately 722 hectares. Comparison of areas covered by each of the 14 vegetation assemblages and open water is given in Figure 2. Uplands occupy about 17 percent (124 ha) of the total area, most of which is the St. John's land fill. The remaining 598 ha are wetlands and open water. In July 1992, when the vegetation was mapped, the water smartweed assemblage was the most extensive in the study area. When combined with the water smartweed/dead willow and dead willow assemblages, they occupied 41 percent (298 ha) of the site. Forest wetland assemblages covered 16 percent (113 ha), and reed canarygrass assemblages comprised 12 percent (86 ha), although reed canarygrass occurs as a component of several other assemblages. The smaller assemblages (shoreline emergent, drainage channel emergent, pond emergent, Columbia sedge, and willow shrub/scrub combined made up 4 percent (26 ha), and open water covered 11 percent (75 ha).

Data from these permanent transects are summarized in Tables 1 and 2. Table 1 provides vegetation cover data for herbaceous species on each transect. Table 2 summarizes data on shrubs and trees on each of the four transects supporting woody species.

FIGURE 2

Area of Vegetation Assemblages at Smith and Bybee Lakes



LEGEND

O	Open Water	G	Reed Canarygrass
A	Water Smartweed	GH	Reed Canarygrass & Willow
AB	Water Smartweed & Dead Willow	H	Willow Shrub/Scrub
B	Dead Willow	I	Blackberry Shrub/Scrub
C	Shoreline Emergent	J	Pacific Willow Forest
D	Drainage Channel Emergent	K	Oregon Ash Forest
E	Pond Emergent	L	Black Cottonwood Forest
F	Columbia Sedge	M	Mixed Deciduous Forest
FN	Sedge & Developed	N	Disturbed/Developed

TABLE 1

MEAN HERBACEOUS COVER, AND MEAN COVER BY SPECIES, ON EACH TRANSECT SAMPLED DURING JULY 1992 AT SMITH AND BYBEE LAKES, OREGON

An * indicates dominant species on the transect.

MEAN COVER (%)

SPECIES	TREE/SHRUB PLOTS				HERBACEOUS PLOTS					
	T-2	T-5	T-1	T-6	T-4	T-7	T-10	T-9	T-8	T-3
All species	89.4	98.6	55.4	14.8	98.6	99.8	100.0	40.5	100.0	99.0
Actaea rubra	0.3									
Agrostis					1.0					
Azolla mexicana								*24.4		
Bidens cernua					*28.2	*13.0	8.7	<0.1		
Bidens frondosa						0.8	<0.1	<0.1		
Bidens vulgata					1.4					
Carex aperta			<0.1			*14.8			*78.0	
Carex deweyana			0.3							
Cirsium arvense						<0.1				
Cirsium vulgare			0.5						*17.1	
Cyperus erythrorhizos						2.2	*50.3	5.3		
Echinochloa crusgalli							<0.1			
Eleocharis ovata					0.2	3.3	1.1			
Epilobium			0.3			0.1				
Epilobium watsonii						0.9			4.8	
Equisetum						<0.1				
Eragrostis hypnoides						*19.5	*36.9	<0.1		
Galium			<0.1							
Gnaphalium uliginosum					1.8	<0.1				
Heleochloa alopecuroides						1.2				
Hypericum perforatum									<0.1	
Leersia oryzoides						<0.1	0.1			
Lemna minor								<0.1		
Ludwigia palustris					<0.1	0.2		<0.1		
Lycopus americana			0.4							
Lycopus uniflora			1.1							
Lysimachia nummularia			*35.4							
Moss			*17.1							
Myriophyllum								2.0		
Phalaris arundinacea	10.2	*98.6		*13.9		*40.2			<0.1	*99.0
Polygonum coccineum	2.4					0.6	1.4	1.3	<0.1	
Polygonum hydropiper	3.3				*65.8					
Polygonum lapathifolium							1.4			
Polygonum persicaria							0.3			
Potamogeton crispus								0.3		
Potentilla						2.9				
Ranunculus repens			0.3							
Ricciocarpus natans								<0.1		
Salix piperi						<0.1				
Scutellaria lateriflora	10.0									
Solanum dulcamara	*63.0			0.9						
Solidago occidentalis			<0.1							
Spirodela polyrhiza								<0.1		
Wolffia								<0.1		
Xanthium strumarium							<0.1			

TABLE 2

SUMMARIES OF TREE AND SHRUB DATA FOR EACH OF FOUR TRANSECTS SAMPLED DURING JULY 1992 AT SMITH AND BYBEE LAKES, OREGON

	TREE/SHRUB PLOTS			
	T-2	T-5	T-1	T-6
TREES				
Fraxinus latifolia				
Mean basal area (sq in)		129.45		
Density (no. of trees)*		0.49		
Dominance (sq in)*		63.9		
Frequency (percent)*		100.0		
Populus trichocarpa				
Mean basal area (sq in)			2.19	
Density (no. of trees)			12.47	
Dominance (sq in)			27.3	
Frequency (percent)			93.0	
Salix lasiandra				
Mean basal area (sq in)	91.3	297.12	4.22	
Density (no. of trees)	0.83	0.03	1.39	
Dominance (sq in)	75.8	7.7	5.8	
Frequency (percent)	100.0	20.0	13.0	
SHRUBS (mean percent cover)				
All species	0	<0.1	<0.1	64.6
Cornus stolonifera		<0.1	<0.1	
Salix lasiandra			<0.1	0.8
Salix piperi				63.8
Sambucus racemosa		<0.1		
LITTER (mean percent cover)	9.5		41.3	80.4
WOODY DEBRIS (mean percent cover)	0.5	<0.1		5.0
SNAGS (mean percent cover)		<0.1		

* Density = no. of trees/100 sq ft
Dominance = basal area (sq in)/100 sq ft
Frequency = percent of sample points containing species in question

Herbaceous cover was usually quite high, ranging from 89.4 percent to 100 percent on seven of the ten plots. Herb cover was much lower on T-1 (black cottonwood assemblage) and T-4 (Piper's willow assemblage), where the canopy cover was dense enough to limit understory vegetation development, and on T-9, a recently exposed shoreline mud flat that was just beginning to develop vegetation. Species diversity was highest on the three transects on the lake margins (T-7, T-9, T-10) and young cottonwood stand (T-1). Diversity was lowest on T-5 (Pacific willow forest) and T-3 (reed canarygrass) where reed canarygrass was the only herbaceous species present.

The three tree transects were quite different from one another. On T-2, only Pacific willow occurred on the transect, with an average basal area of 587 cm^2, and density of about one for every 10 m^2 On T-5, the dominant tree was Oregon ash, with average basal area of 832 cm^2, and a density of about one every 10 m^2. Only a few Pacific willow were present, but they were large (basal area, 1916 cm^2). Young cottonwoods on T-1 had a small mean basal area with an average of 13 cm^2, with a density of 13 per 10 m^2. A few young Pacific willows that were about twice as large were also present. Very few shrubs were present in the understory of these forest stands. T-6, a scrub-shrub assemblage had a significant Piper's willow dominated shrub layer.

Little or no large woody debris or standing dead snags were present in the tree and shrub assemblages sampled, and only T-1 and T-6 had a significant litter layer on the ground. On most of the sample sites, a dense herbaceous community concealed what litfer layer might be present.

Purple loosestrife *(Lythrum salicaria)* was found along the ditches and ponds near transect T-3 and is widespread on the disturbed area south of the Ramsey Lake mitigation ponds. These locations should be reported to the Oregon Department of Agriculture as part of their Noxious Weed Control Program if they are not yet aware of it.

Marked differences in inundation were noted during the 1993 revisit of the transect sites. During this visit, transects T-2, T-4, T-6, T-7, T-9, and T-10 were still inundated. Transects T-1, T-5, and T-8 had no standing water but had saturated soils. Transect T-3 was the driest of the ten sites, but still had significant soil moisture in 1993.

Based on these observations and comparisons of species composition, the wetland vegetation assemblages on the lakes can be arranged on a gradient from most fluctuating inundated (wettest) to least fluctuating inundated (driest); the latter also represent assemblages transitional between wetlands and uplands. The wettest of the assemblages sampled occur on lake margins and ephemeral ponds. Willow assemblages, both tree and shrub-scrub, are the next most hydric. The Columbia sedge assemblage seem to be occur in areas flooded for a slightly briefer interval than the willow-dominated areas. The cottonwood, ash and mixed deciduous forests occur generally at slightly higher elevations that appear to dry out sooner than other wetland areas. The least inundated sites support the reed canarygrass plant assemblage.

RECOMMENDATIONS

The main recommendation is to allow for more significant seasonal fluctuations of the lake levels to match the rise and fall of river levels in the Columbia and Willamette. Two major modifications in the vegetation of the lakes have occurred since the fixed level outflow structure has increased the annual constancy and extent of inundation: (1) loss of extensive Piper's willow assemblage on the lake margins and (2) increases in the flooded emergent (i.e., water smartweed), submerged, and floating aquatic plant communities with a concomitant loss of open water in the lakes. The Pacific Northwest has a predominance of seasonal wetlands, those that are inundated early in the winter, but that dry out during the summer months. As a consequence, wetland vegetation in the Pacific Northwest is strongly adapted to varying degrees of drying during the summer as well as varying levels of inundation during the winter and spring. If the water levels in the lakes underwent a great enough annual fluctuation to decrease the extent of seasonal inundation, it would both favor the Piper's willow assemblage and increase the ratio of open water to submerged and floating aquatic vegetation seasonally.

Dead Piper's Willow Assemblage. More than 500 acres of this assemblage are present (Figure 1, Map Unit 2). This assemblage was adapted to winter and spring flooding, but could not tolerate year-round inundation. All that now remain are the dead stems and branches of the dead willows. If water levels were allowed to drop enough to allow exposure of significant areas of the substrate during the summer and fall, these assemblages should become reestablished.

Aquatic plant communities. Aquatic plant species, both floating and submerged, have increased significantly over the past ten years. During the summer months, almost no open water remains, especially in Smith Lake. Maintaining a higher, more constant water level has significantly reduced the seasonal outflux of the lake during the summer and fall and the influx of fresh water during the winter and spring. Nutrient levels have increased as a result, and eutrophication has favored the aquatic species. Greater outflux during the dry season, and greater fresh water influx each wet season would be less conducive to growth of the aquatics, especially some of the exotic species present.

In areas that are seasonally flooded, adjacent upland areas provide refuges for wildlife during times of high water. Very few upland areas exist within the study area that could serve as wildlife refuges during high water. Because of the latter, efforts that help promote native vegetation on the St. John's landfill to provide an upland refuge for mobile wildlife species should be encouraged.

ADDITIONAL STUDY RECOMMENDATIONS

1. Adequate draw-down of the lakes in summer will increase the amount of lake bottom exposed each year (compared to the recent past). Any monitoring plan should include an assessment of what draw-down in late summer actually does to the area of exposed lake margin and its vegetation.

2. The sedge meadow and other temporary inundated sites , although small, are quite important for invertebrates and amphibians and their bird and reptile predators. Aerial photo interpretation of changes in the size and location of sedge areas would provide key baseline data on how such areas may have changed. In addition, it would be especially informative to mark the boundaries of some meadows, and monitor them over time to see if changes in their boundaries occur if a program of lake level fluctuation is implemented.

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CHAPTER 2
AQUATIC MACROINVERTEBRATES

INTRODUCTION

In addition to the plant and vertebrate animal survey of Smith and Bybee Lakes Management Area, limnological studies were undertaken to assess current hydrologic and physical conditions, and to characterize the invertebrate biota of the aquatic areas. Aquatic macroinvertebrate studies addressed:

1. *Characterization of the current invertebrate assemblages in the dominant habitat types of the two lakes.*

2. *Provide a subjective assessment of likely changes in invertebrate assemblages under a management regime that increase summer draw down of lake water levels and restore lake systems to a more fluctuating hydrologic regime to Smith and Bybee Lakes.*

METHODS

Aquatic macroinvertebrates were collected from dominant habitat types during the summer (26 August 1992) and the spring (28 May 1993). Habitats sampled are listed at the top of Tables 3-6. They include: 1. open water areas with muck bottoms, 2. smartweed beds, 3. floating water fern, 4. reed canary grass in the littoral zone, 5. pondweed vegetation, and 6. floating and submerged wood.

An Ekman dredge was used to collect samples from soft bottoms in open water areas. Alternatively, a 30 cm-wide rectangular dip-net (500 micron) was dragged through surface sediments for a known distance to obtain semi-quantitative samples. All samples were sieved using a 500 micron mesh size.

Invertebrates associated with submerged, emergent or floating vegetative assemblages were sampled qualitatively with a dip-net by sweeping back-and-forth through the leaves and stems. Only qualitative samples were taken in vegetation because of the expense and mechanical problems associated with trying to sample these habitats quantitatively.

Samples were sorted in the lab with the aid of dissecting microscopes. Invertebrates were identified to a level that was practical. Taxonomic effort was concentrated in invertebrate groups that were either better known, or were dominant in most habitats. General identifications were performed by Bob Wisseman of Aquatic Biology Associates.

The following specialists also assisted with identifications:

Molluscs	Dr. Terry Frest, Deixus Consultants, Seattle, WA
Oligochaeta	Douglas Spencer, Fowlerville, MI
Odonata	Tracey Anderson, Oregon State Univ., Corvallis, OR
Hemiptera	Jim DiGiulio, Aquatic Biol. Assoc., Corvallis, OR
Chironomidae	Janey Gaventa, Aquatic Biol. Assoc., Corvallis, OR
Tipulidae	Dr. Jon Gelhouse, Acad. Nat. Sciences, Phila., PA

RESULTS

Invertebrates associated with several habitats or vegetative assemblages during August and May samplings are listed in Tables 3 & 4, along with their relative abundance for qualitative samples, or approximate densities per square meter for the more quantitative samples from soft bottoms.

The major taxonomic groups encountered, their overall abundance in the lakes, and the number of taxa identified in each group is listed below.

NON-INSECTS

Taxonomic Group	Overall abundance	Number taxa identified
Coelenterata (Hydra)	occasional	*
Turbellaria (flatworms)	occasional	*
Nematoda (roundworms)	occasional	*
Oligochaeta (segmented worms)	abundant	25
Cladocera (water fleas)	abundant	*
Copepoda	abundant	*
Ostracoda (seed shrimps)	common	*
Amphipoda (scuds)	abundant	2
Isopoda (aquatic sowbugs)	rare	1
Acari (water mites)	common	*
Mollusca (clams & snails)	common	4

INSECTS

Taxonomic Group	Overall abundance	Number taxa identified
Odonata (dragon- & damselflies)	common	6
Hemiptera (true bugs)	common	5
Trichoptera (caddisflies)	rare	1
Lepidoptera (moths)	occasional	1
Coleoptera (beetles)	occasional	6
Diptera (flies, minus midges)	common	7
Chironomidae (midges)	common	17

* *taxonomic group not identified to a low level.*

TABLE 3

SMITH-BYBEE LAKES, PORTLAND, OREGON.
Macroinvertebrate Assemblages in Several Habitats, August 26, 1992.

Collections made with a dip-net or Ekman dredge.
*= approximate abundances in 1 square meter of bottom substrate.
**= relative abundances given for vegetation samples, not on an area basis.

LOCATION	Smith Lk.	Smith Lk.	Smith Lk.	Smith Channel	Smith Channel	Bybee Lk.	Bybee Lk.
HABITAT	open water	smartweed weed	willow fringe	open water	floating Azolla	open water	smartweed &duckweed
SUBSTRATE	muck	stems & leaves	muck & detritus	muck	leaves & algae	Potomoge-ton veg.	leaves stems
DEPTHS SAMPLED	:0.5 m	:0.35 m	:0.25 m	:0.65 m	surface	surface to 0.5 m	surface to 0.5 m
	*	**	*	*	**	**	**
SAMPLE	1	2	3	4	5	6	7
Hydra		1				15	
VERMIFORMS (worms)							
Turbellaria (flatworms)		9					12
Nematoda (roundworms)	50			3			
Oligochaeta (segmented worms)							
Aulodrilus limnobius	150						
Aulodrilus piqueti	100	2	36	48			1
Bothrioneurium vejdovskyanum							
Branchiura sowerbyi	80		24	6			
Chaetogaster diaphanus					20		
Dero digitata							
Dero vaga					200		
Dero sp.		6			20		4
Haemonais waldvogeli							
Ilyodrilus frantzi	20						
Ilyodrilus templetoni							
Immature Tubificidae w capilliforms	25		12	21			2
Imma. Tubificidae w/o capilliforms	1520	1	300	195			1
Limnodrilus hoffmeisteri	5			39			
Limnodrilus udekemanus							
Nais simplex							
Nais variabilis					580		
Ophidonais serpentina							
Pristina leidyi					40		
Quistadrilus multisetosus		1	24				
Slavina appendiculata							
Stylaria lacustris		18			20		2
Teneridrilus mastix							
Varichaetadrilus ?pacificus							
unknown sp. Naididae							3
Hirudinea (leeches)							1

TABLE 3
CONTINUED

Smith-Bybee Lakes Benthic Macroinvertebrates cont.-August 1992.

SAMPLE	1	2	3	4	5	6	7
CRUSTACEA							
Cladocera		17			20	3	
Copepoda		38		3			
Ostracoda	10		12		360		
Hyalella azteca		153		18	700	33	57
Gammarus							3
Caecidotea							8
Acari (mites)						2	
MOLLUSCA							
Ferrissia							
Pseudosuccinea columella							6
Physella gyrina		2			20		1
Menetus callioglyptus		13					5
ODONATA (dragon- & damselflies)							
Anax junius							1
Aeschnidae-early instar						9	
Enallagma/Ischnura		7			240	61	36
Leucorrhinia		2					
Tramea		1					
Libellulidae-early instar		1					1
HEMIPTERA (true bugs)							
Palmocorixa buenoi							
Palmacorixa sp.			60	3			
Gerris							
Mesovelia mulsanti		3			20	2	
Microvelia prob. californiensis		7			40		
TRICHOPTERA (caddisflies)							
Hydroptila							
LEPIDOPTERA (moths)							
Nepticula					1060	3	
COLEOPTERA (beetles)							
Curculionidae-adult					80		
Dytiscidae							
Dubiraphia-larvae				15			
Berosus							
Hydrophilidae					20		
Peltodytes							

TABLE 3
CONTINUED

Smith-Bybee Lakes, Benthic Macroinvertebrates cont.-August 1992.

SAMPLE	1	2	3	4	5	6	7
DIPTERA (flies)							
Brachycera-unknown larvae						3	
Ceratopogininae	10	2		15	60		1
Forcipomyiinae							1
Anopheles		2					
Ephydridae					20		
Stratiomyiidae		7					2
Limonia		1			60	1	
CHIRONOMIDAE (midges)							
Ablabesmyia		1				1	
Chironominni							
Chironomus	70			15			
Corynoneura							
Cricotopus							
Cryptochironomus	100		2	30			
Einfeldia	20	7		51	20		1
Endochironomus			1			10	2
Glyptotendipes							
Larsia	10						
Nanocladius							
Orthocladius complex					20	31	1
Orthocladinae							
Parachironomus							
Paratanytarsus							
Procladius	190		1	216			
Chironomidae-pupae	10			3		2	

TABLE 4

SMITH-BYBEE LAKES, PORTLAND, OREGON.

Macroinvertebrate Assemblages in Several Habitats, May 28, 1993.

Collections made with a dip-net or Ekman dredge.
*= approximate abundances in 1 square meter of bottom substrate.
**= relative abundances given for vegetation samples, not on an area basis.

LOCATION	Smith Lk.	Smith Lk.	Smith channel	Smith Lk.	Bybee Lk.
HABITAT	smartweed &duckweed	open water	floating & submerged wood	reed canary grass	open water
SUBSTRATE	leaves stems	muck	wood surface	stems leaves	muck
DEPTHS SAMPLED	surface to 0.5 m	:1.5 m	surface to 0.5 m	surface to 0.3 m	:1.5-2 m
	**	*	**	**	*
SAMPLE	1	2	3	4	5
Hydra	15		13	3	
VERMIFORMS (worms)					
Turbellaria (flatworms)			2		
Nematoda (roundworms)					
Oligochaeta (segmented worms)					
Aulodrilus limnobius		540			160
Aulodrilus piqueti		353			87
Bothrioneurium vejdovskyanum		87			287
Branchiura sowerbyi		40			
Chaetogaster diaphanus	5			2	
Dero digitata	10	227	36	6	67
Dero vaga				1	
Dero sp.					
Haemonais waldvogeli				5	
Ilyodrilus frantzi		353			20
Ilyodrilus templetoni		87			20
Immature Tubificidae w capilliforms		719			926
Imma. Tubificidae w/o capilliforms		2385			746
Limnodrilus hoffmeisteri		766			606
Limnodrilus udekemanus					20
Nais simplex	26				
Nais variabilis	185		313	21	
Ophidonais serpentina				5	
Pristina leidyi					
Quistadrilus multisetosus					20
Slavina appendiculata				2	
Stylaria lacustris	460		24	81	
Teneridrilus mastix		87			
Varichaetadrilus ?pacificus					20
unknown sp. Naididae					
Hirudinea (leeches)				4	

TABLE 4
CONTINUED

Smith-Bybee Lakes Benthic Macroinvertebrates cont.-May 1993

SAMPLE	1	2	3	4	5
CRUSTACEA					
Cladocera	499	1871		35	6147
Copepoda	301	1057		254	367
Ostracoda	14	28	9	2	
Hyalella azteca	131		105	177	
Gammarus					
Caecidotea			4		
Acari (mites)	53	14	4	170	7
MOLLUSCA					
Ferrissia	1				
Pseudosuccinea columella	1			19	
Physella gyrina	19		1	70	7
Menetus callioglyptus	34		30	49	
ODONATA (dragon- & damselflies)					
Anax junius					
Aeschnidae-early instar					
Enallagma/Ischnura	13		2	34	
Leucorrhinia					
Tramea					
Libellulidae-early instar					
HEMIPTERA (true bugs)					
Palmocorixa buenoi	4			22	
Palmacorixa sp.		14		3	
Gerris				1	
Mesovelia mulsanti	1			9	
Microvelia prob. californiensis				1	
TRICHOPTERA (caddisflies)					
Hydroptila			1		
LEPIDOPTERA (moths)					
Nepticula					
COLEOPTERA (beetles)					
Curculionidae-adult				3	
Dytiscidae				2	
Dubiraphia-larvae					
Berosus				1	
Hydrophilidae				2	
Peltodytes				2	

TABLE 4
CONTINUED

Smith-Bybee Lakes, Benthic Macroinvertebrates cont.-May 1993.

SAMPLE	1	2	3	4	5
DIPTERA (flies)					
Brachycera-unknown larvae				39	
Ceratopogininae	9	54	35	9	34
Forcipomyiinae					
Anopheles					
Ephydridae					
Stratiomyiidae	5			19	7
Limonia				1	
CHIRONOMIDAE (midges)					
Ablabesmyia					
Chironominni	8		8		
Chironomus		66			40
Corynoneura				2	
Cricotopus	21		150	30	
Cryptochironomus		26			
Einfeldia					
Endochironomus					
Glyptotendipes	20	20	26	9	
Larsia					
Nanocladius	1		2	4	
Orthocladius complex					
Orthocladinae			4		
Parachironomus	4		12		
Paratanytarsus			4		
Procladius		108			14
Chironomidae-pupae	5		3	9	

TABLE 5

SMITH-BYBEE LAKES, PORTLAND, OREGON, August 26, 1992.
Macroinvertebrate Community Composition in Several Habitats.

Collections made with a dip-net or Ekman dredge.

*= approximate abundances in 1 square meter of bottom substrate.

**= relative abundances given for vegetation samples, not on an area basis.

LOCATION	Smith Lk.	Smith Lk.	Smith Lk.	Smith Channel	Smith Channel	Bybee Lk.	Bybee Lk.
HABITAT	open water	smartweed weed	willow fringe	open water	floating Azolla	open water	smartweed &duckweed
SUBSTRATE	muck	stems & leaves	muck & detritus	muck	leaves & algae	Potomoge-ton veg.	leaves stems
DEPTHS SAMPLED	:0.5 m	:0.35 m	:0.25 m	:0.65 m	surface	surface to 0.5 m	surface to 0.5 m
	*	**	*	*	**	**	**
SAMPLE	1	2	3	4	5	6	7
TOTAL ABUNDANCE	2370	302	472	681	3620	176	152
TOTAL NUMBER OF TAXA	16	24	10	16	21	14	23
TAXONOMIC COMPOSITION (%)							
Non-insect invertebrates	82.7	86.41	86.43	48.89	54.67	30.11	69.74
Odonata (dragon- & damselflies)	0	3.64	0	0	6.63	39.77	25
Hemiptera (true bugs)	0	3.31	12.71	0.44	1.65	1.14	0
Trichoptera (caddisflies)	0	0	0	0	0	0	0
Lepidoptera (moths)	0	0	0	0	29.28	1.7	0
Coleoptera (beetles)	0	0	0	2.2	2.76	0	0
Diptera (minus midges)	0.42	3.97	0	2.2	3.87	2.27	2.64
Chironomidae (midges)	16.9	2.65	0.84	46.26	1.1	25	2.64
FUNCTIONAL FEEDING GROUP							
PERCENT CONTRIBUTION							
Predator	5.06	7.94	0.42	6.61	10.49	49.43	26.98
Parasite	0	0	0	0	0	1.14	0
Collector-gatherer	92.4	81.78	86.85	92.06	57.43	42.61	69.75
Collector-filterer	0	5.63	0	0	0.55	1.7	0
Macrophyte herbivore	0	0.33	0	0	31.49	2.27	0
Piercer-herbivore	0	0	12.71	0.44	0	0	0
Scraper	0	4.3	0	0	0	0	3.29
Omnivore	2.11	0	0	0.44	0	0	0
Unknown	0.42	0	0	0.44	0	2.84	0
% CONTRIBUTION DOM. TAXA	64.14	50.66	63.56	31.72	29.28	34.66	37.5
HILSENHOFF BIOTIC INDEX	8.8	7.87	8.87	8.78	8.17	7.51	7.84
SHANNON DIVERSITY H (log 2)	2.11	2.81	1.85	2.88	3.1	2.79	3.05
EVENNESS	0.53	0.61	0.56	0.72	0.7	0.73	0.67

TABLE 6

SMITH-BYBEE LAKES, PORTLAND, OREGON, May 28, 1993.
Macroinvertebrate Community Composition in Several Habitats.

Collections made with a dip-net or Ekman dredge.
*= approximate abundances in 1 square meter of bottom substrate.
**= relative abundances given for vegetation samples, not on an area basis.

LOCATION	Smith Lk.	Smith Lk.	Smith channel	Smith Lk.	Bybee Lk.
HABITAT	smartweed &duckweed	open water	floating & submerged wood	reed canary grass	open water
SUBSTRATE	leaves stems	muck	wood surface	stems leaves	muck
DEPTHS SAMPLED	surface to 0.5 m	:1.5 m	surface to 0.5 m	surface to 0.3 m	:1.5-2 m
	**	*	**	**	*
SAMPLE	1	2	3	4	5
TOTAL ABUNDANCE	1844	8902	784	1108	9602
TOTAL NUMBER OF TAXA	26	21	21	38	20
TAXONOMIC COMPOSITION (%)					
Non-insect invertebrates	95.04	96.78	68.5	81.75	99.03
Odonata (dragon- & damselflies)	0.7	0	0.26	3.07	0
Hemiptera (true bugs)	0.27	0.16	0	3.25	0
Trichoptera (caddisflies)	0	0	0.13	0	0
Lepidoptera (moths)	0	0	0	0	0
Coleoptera (beetles)	0	0	0	0.9	0
Diptera (minus midges)	0.76	0.6	4.46	6.13	0.42
Chironomidae (midges)	3.19	2.46	26.66	4.87	0.56
FUNCTIONAL FEEDING GROUP PERCENT CONTRIBUTION					
Predator	2.27	0.89	7.91	5.95	0.35
Parasite	2.87	0.16	0	15.34	0.07
Collector-gatherer	65.38	77.76	87.25	63.97	35.54
Collector-filterer	27.06	21.03	0	3.16	64.05
Macrophyte herbivore	0	0	0	0.54	0
Piercer-herbivore	0.22	0.16	0.13	2.26	0
Scraper	1.89	0	3.83	4.42	0
Omnivore	0	0	0	0	0
Unknown	0.27	0	0.89	4.33	0
% CONTRIBUTION DOM. TAXA	27.06	26.8	39.92	22.92	64.05
HILSENHOFF BIOTIC INDEX	7.85	8.71	7.71	7.33	8.36
SHANNON DIVERSITY H (log 2)	2.99	3.2	2.85	3.72	2.01
EVENNESS	0.64	0.73	0.65	0.71	0.46

Salient aspects of the composition of the aquatic invertebrate fauna found in Smith Bybee Lakes are described:

1. All major invertebrate groups identified from Smith and Bybee Lakes are commonly found in lentic waters throughout the northern hemisphere (cosmopolitan).

2. Over 90% of the genera of aquatic invertebrates identified from SBLM occur in standing water throughout North America, and over 75% are cosmopolitan.

3. Species such as the amphipod *Hyalella azteca* and over 50% of the Oligochaeta worm species identified are also cosmopolitan.

4. Oligochaete worms and midges of the family Chironomidae are the most species rich invertebrate group encountered. Oligochaete worms and Chironomid midges are species rich groups of freshwater invertebrates that have many taxa adapted to lentic waters and depressed dissolved oxygen (DO) levels. Several of the Oligochaeta taxa identified to species are new records for western North America, and one genus represents a new record for North America.

5. Microcrustaceans (*Cladocera, Copepoda & Ostracoda)* are common or abundant in most habitats of SBLM. The amphipod, *Hyalella azteca,* displays an affinity for dense emergent vegetation, where more cover from fish predation exists. All of the crustaceans present are swimmers loosely associated with benthic substrates. The cladocerans are filter feeders found in the water column most of the time, but often rest on the bottom during the day to avoid predation from fish.

6. Four mollusc taxa from four different families are present in the lakes. All of these taxa are common, widespread, and tolerant of nutrient enrichment and low DO levels. The mollusc fauna of Smith Bybee Lakes is depauperate compared with less eutrophied lakes at lower elevations in the Pacific Northwest. Conspicuously absent from lake bottom sediments are fingernail clams (*Sphaeriidae*). Extended periods of anoxic conditions within the sediments and at the sediment surface probably preclude the establishment of fingernail clams and other oxygen requiring molluscs.

7. Dragon- and damselflies are associated with habitats that provide perches and cover for the predatory larvae. They are common where vegetation is dense, or may be found on submerged wood. Four genera of odonates are present, all of which are tolerant of highly enriched lentic waters. Greater richness in this insect group is typically found in less eutrophic lakes in the region.

8 Mayflies are conspicuously absent from Smith Bybee Lakes. No larvae were found in the spring or summer samples. Their absence from the lakes is probably due to a combination of fish predation and low DO at the sediment surface during warmer months.

9. True bugs (*Hemiptera*) present in Smith-Bybee Lakes are limited to three water surface or semi-aquatic taxa (*Gerris, Mesovelia,* and *Microvelia*) which inhabit areas with floating or emergent vegetation, and to a *corixid* (water boatman). *Corixids* are air-breathing swimmers that must return periodically to the water surface to replenish air supplies. In Smith-Bybee Lakes, they are most commonly found near shore where emergent vegetation or wood debris provide cover. *Palmocorixa* was the only genus noted from the lakes. *Corixids* of several genera are typically found in lakes in western North America. The low *corixid* richness in Smith Bybee Lakes cannot be readily explained.

10. *Trichoptera* (caddisflies) records from Smith Bybee Lakes are limited to one collection of *Hydroptila* from submerged wood. As with the mayflies, highly eutrophic conditions found in the lakes appear to be limiting caddisfly richness. Shallow lakes in the Pacific Northwest typically support six or more caddisfly taxa.

11. Aquatic beetles are patchily distributed in Smith Bybee Lakes, but are most commonly associated with emergent vegetation. Taxa richness for beetles is low.

12. Besides chironomid midges, true flies (Diptera) in Smith and Bybee Lakes are limited to several taxa tolerant of low DO conditions, including no-see-ums (*Ceratopogoninae*), mosquitoes (*Anopheles*), and brine flies (*Ephydridae*).

13. An aquatic moth (*Nepticula*) is abundant in floating water fern in the summer. Larvae of this genus are leaf miners and borers, and presumably feed on the water fern.

Summaries of invertebrate community parameters in the habitat types and vegetative assemblages sampled are provided in Tables 5 & 6.

Slightly greater taxa richness in all habitats was observed in spring versus late summer. Disappearance of some taxa in the late summer is probably related to extreme hypoxic or anoxic conditions developing during warm summer months.

In the summer, emergent stands of native smartweed support the greatest number of taxa. In spring, near-shore emergent stands of reed canarygrass had a significantly greater overall taxa richness than any other habitat sampled. Greatest taxa richness is associated with dense aquatic vegetation which supplies cover from predation, and substrate for attachment, resting, perching, or crawling.

The greatest invertebrate richness was always associated with any type of dense aquatic vegetation which provides cover from predators, and substrate for attachment, resting, perching or crawling for various invertebrates.

Deposit-feeding invertebrates (collector-gatherers) are the dominant feeding group in most habitats of Smith Bybee Lakes, particularly on muck bottoms in open water areas . These organisms "collect" fine organic particles from sediment or substrate surfaces for their nutrition (Merritt & Cummins 1984). High proportions of collector-filterers noted in some habitats in the spring (Table 4) is due primarily to the presence of high numbers of Cladocera.

Invertebrate predators, principally beetles and dragon- and damselfly larvae, are least common on muck bottoms in open water, and most common in stands of emergent vegetation. Pondweed appears to supply particularly good perches for damselfly larvae (*Enallagma/Ischnura*).

Besides the leaf mining moth found in water fern, little herbivory is evident from strictly aquatic invertebrates on submerged portions of vascular hydrophytes. However, aerial portions of smartweed showed evidence of leaf chewing from semi-aquatic or terrestrial insect taxa. Except for the aquatic moth larvae associated with water fern, no aquatic invertebrate taxa specifically associated with a particular macrophyte species. Macrophytes are important not as a direct food source for aquatic invertebrates; but for supplying cover, perches, and solid surfaces off of which to scrape periphyton.

No shredder taxa, those taxa that feed on dead leaves and stems of plants, were recorded from any habitat sampled at Smith and Bybee Lakes. Hyper-eutrophic conditions apparently limit shredder taxa, such as some caddisflies, that would be expected to occur where DO is higher.

All strictly aquatic invertebrates present in the two lakes can be classified as highly tolerant of nutrient enriched and low DO conditions. The Hilsenhoff Biotic Index (HBI) was calculated for invertebrate assemblages found in each habitat (Hilsenhoff 1987). This is a saprobic index that rates the assemblages tolerance to organic or nutrient enrichment, and consequently also to low DO conditions (Tables 3 & 4). It is scaled on a 0-10 basis; with low values associated with highly oxygenated, running water habitats; and high values associated with highly enriched, low DO habitats. The maximum score of 10 would be represent conditions typically found in sewage lagoons. All Smith-Bybee Lake habitats sampled in the spring and summer had HBI values over 7. Open water, muck bottom substrates had HBI scores between 8 and 9. These are very high index values, which underscore the highly enriched aspect of lake waters. The faunal composition strongly suggests that the fine organic muck on the bottom of the lakes is anoxic or nearly so for much of the year. The spring samples from muck bottoms had much higher densities of invertebrates than the summer samples. The latter corresponds to the interval when temperatures are highest and DO the lowest (Tables 5 & 6).

CONCLUSIONS & MANAGEMENT CONSIDERATIONS

Hypereutrophic conditions now exist in Smith & Bybee Lakes and recent studies indicate that (FES 1987) those conditions have existed for some time. Fine organic sediments in areas where there is standing water year-round are likely anoxic for extended periods. Benthic sediments anoxic for extended periods would severely limit the establishment of many lentic invertebrate taxa in this habitat.

In areas of continuous inundation, a thick layer of fine organic detritus has accumulated over much of the lake bottoms. This is particularly evident on windward shores of both lakes. Increased summer exposure of these sediments by allowing water levels to fall further than the outflow structure currently allows, will undoubtedly accelerate decomposition processes within the sediments. This should lead to a lower BOD during periods when sediments are inundated. Invertebrate species richness and production should increase in more oxygenated sediments.

In lake habitats, maximum invertebrate richness and probably also densities in lake habitats is achieved where vegetation provides cover from fish predation, and also supplies firmer substrates for attachment, resting, perching and feeding. The anticipated increase in vegetative cover from increased summer draw-down of water levels may enhance both the richness and densities of aquatic invertebrates.

Smith and Bybee Lakes now support only a fraction of the potential aquatic invertebrate taxa associated with either permanent or seasonally flooded lentic habitats at lower elevations in the Pacific Northwest. Manipulation of water levels to increase flushing of accumulated nutrients and to increase habitat complexity will probably increase overall invertebrate species richness and secondary production.

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CHAPTER 3
AMPHIBIANS AND REPTILES

INTRODUCTION

This section addresses the herpetofauna of the Smith and Bybee Lakes Management Area. Its purpose is to identify:

1) the species present;

2) the conditions that probably affect species composition;

3) the ecology of the existing herpetofauna;

4) management recommendations needed to increase the likelihood of survival of members of the native herpetofauna in this system; and

5) future research directions that can refine understanding and management of this system.

METHODS

Fieldwork on the amphibian and reptile fauna of SBLM began in August 1992 and was completed in July 1993. Seven sampling techniques were used:

1) Aquatic vegetation and debris in shallow water (0-70 cm deep) was examined for amphibian egg clusters or masses (all amphibians encountered at SBLM during this study are known to lay their eggs in water (see Section III)).

2) Shallow water was also examined visually for the aquatic life stages of amphibians and reptiles (all amphibians and reptiles found during this study spend some of their lives in shallow water (see Section III). Sweeps through shallow water with a kick net (a long-handled (107 cm) net with a steel rim support of a 6 mm-mesh, 22 cm-deep basket with a near-rectangular mouth (25 cm x 36 cm)) supplemented visual examinations. Aquatic sites surveyed for the life stages of amphibian and reptiles are indicated in Figure 2.

3) A slow (≈0.5-1.0 km/hr) walk of prescribed routes in a visual search for surface-active animals was used to sample amphibians and reptiles in upland sites. During such searches, special effort was made to examine beneath available surface cover because both adults of the only salamander found and juveniles and adults of the two snake species found are known to occur under such surface cover (see Section III). Because such amphibian and reptile taxa are not easily visible when active and much of SBLM had limited surface cover, arrays of supplemental surface cover were set out to assist sampling these species. Supplemental cover consisted of 10 mm thick, brown-painted plywood boards numbered for identification, and cut into two sizes: 1) 60 cm x 60 cm, and 2) 30 cm x 60 cm. The fifth grade applied learning class at George Middle School cut,

painted, and numbered the boards. Forty larger and 20 smaller boards were used in SBLM sampling; boards were set out in arrays of 20 at each location. Bales of hay, originally intended for erosion control use on the powerline access road between Smith and Bybee Lakes, were also overturned during sampling for surface-active amphibians and reptiles. Location of prescribed routes and sampling board arrays are indicated in Figure 3.

4) Seven nylon, rectangular-shaped (45 cm x 45 cm x 90 cm) net traps baited with oiled sardines were used to sample the isolated ponds north of Smith Lake known to have turtles (see Section III). These traps were used only once (on 10 May 1993) because they failed to capture turtles. On the day the net traps were used, traps were placed in two groups of three and four in the two areas in these ponds where most turtles had been observed during visual surveys. Trap locations are indicate in Figure 4.

5) Aquatic areas surveyed during the daytime were scanned either with binoculars or a spotting scope in order to detect turtles. Particular effort was made to scan aquatic areas from a point distant enough (> 100 m) to reduce the likelihood of frightening any turtles present from their basking sites to an acceptable minimum. Special effort was made to scan logs, horizontal branches, and patches of floating or submergent vegetation, sites turtles use for either emergent or water basking (see Gaddis 1985; Holland 1985, 1991).

6) Dense and largely impenetrable vegetation surrounding the long closed channel between Smith/Bybee Lakes and the ponds along Marine Drive as well as its shape prevented conducting an adequate visual survey in this channel for turtles either by boat or from any terrestrial location. Instead, this channel had to be visually surveyed in a wet suit- and snorkel gear-assisted swim. On one day each in April and May, two and three people, respectively, conducted two swim surveys of the length of this channel. During swim surveys, an attempt was made to capture as many turtles as possible using a stealthy approach. This involved a slow deliberate, lateral, rather than a direct, approach of turtles while concealed in a drapery of aquatic vegetation while swimming as low as possible to the water surface. Turtles allowing approach within 2 m could often be captured with a short lunge as they attempted to escaped from the basking location. Location of the swim surveys are indicated in Figure 4.

7) Three headlamp-aided canoe or walking surveys were conducted at night to increase the probability of detection the life stages of some amphibians. This type of survey was necessary to provide adequate estimates of the bullfrog population, the adults of which are known to be largely nocturnal (Bury and Whelan 1984). Routes of the night canoe and walking surveys are indicated in Figure 5.

Diurnal aquatic and terrestrial sampling occurred once a month during August-December 1992, and twice each month for every month thereafter through July 1993 except for the months of April and May 1993, during which three samplings of each took place, and for the month of June 1993, during which no samplings for snakes took place. Two to four individuals typically conducted aquatic and terrestrial sampling except on six occasions when groups of six to eight George Middle School students assisted with selected aspects of the sampling. In particular, middle school students assisted with sampling of haybales for terrestrial invertebrates to help identify the availability of potential terrestrial prey of amphibians and reptiles. Haybales were examined once a month from January to June 1993 by rapidly counting all invertebrates before they moved out of the field of view after each bale had been turned over. During June 1992, one comparative sampling for aquatic snails was conducted at nine different locations; three points in each of Smith and Bybee Lakes and three points in the channel and ponds where western painted turtles were most frequently detected.

Wherever possible, amphibians and reptiles captured were measured, sex determined, and weighed to help estimate population-age structure, and to assess quality and sex-specific differences among individuals. Except for bullfrogs, all individuals captured and processed in this manner were released. Bullfrogs sampled for their stomach contents to determine their position in the food web were removed. Snakes with an obvious food item were palped to determine the prey species. Embryos of gravid snakes were counted by gentle external palpation to estimate litter sizes. Female turtles captured were palped to determine their general reproductive condition (with eggs or not). Snakes and turtles were individually marked to provide growth and movement information in the event of recapture; turtles were marked with notches along the carapace margin, following the Dan Holland coding system. Wherever possible, behavioral observations were recorded, especially where these seemed important to understanding how system dynamics might influence amphibians and reptiles. Amphibian and reptile sightings were plotted to help characterize habitat utilization patterns. Habitat utilization was compared to changes in water level to help identify the appropriate management recommendations. Efforts were made to record observations of other species, especially potential prey or predators of amphibians and reptiles, since these would refine understanding of the position of amphibians and reptiles in the local food web.

Considerable historical alteration of SBLM led to using a control site outside of the area to help estimate the approximate historical species composition. General similarities with SBLM and the least alteration among comparable bottomland sites made the Sandy River Delta (SRD) the best choice.

Douglas G. Brown, Daniel C. Holland, Janet D. Johnson, Jill D. Mellen, Chris R. Miller, and Virginia A. Rosenberg and the members of her applied learning class at George Middle School class helped with the various aspects of the sampling. Dan Holland also provided data on the painted turtles previously captured and released in the SBLM, and on turtles in the Columbia River bottomlands in general. Charlotte C. Corkran, Teresa M. DeLorenzo, and Phillip K. Gaddis provided current or historical records on their previous observations or surveys of the area or selected species. Drs. Richard B. Forbes, Douglas F. Markle, and David B. Wake generously allowed use of amphibian and reptile collections and records at Portland State University (PSU), Oregon State University (OSU), and the Museum of Vertebrate Zoology - University of California at Berkeley (MVZ), respectively.

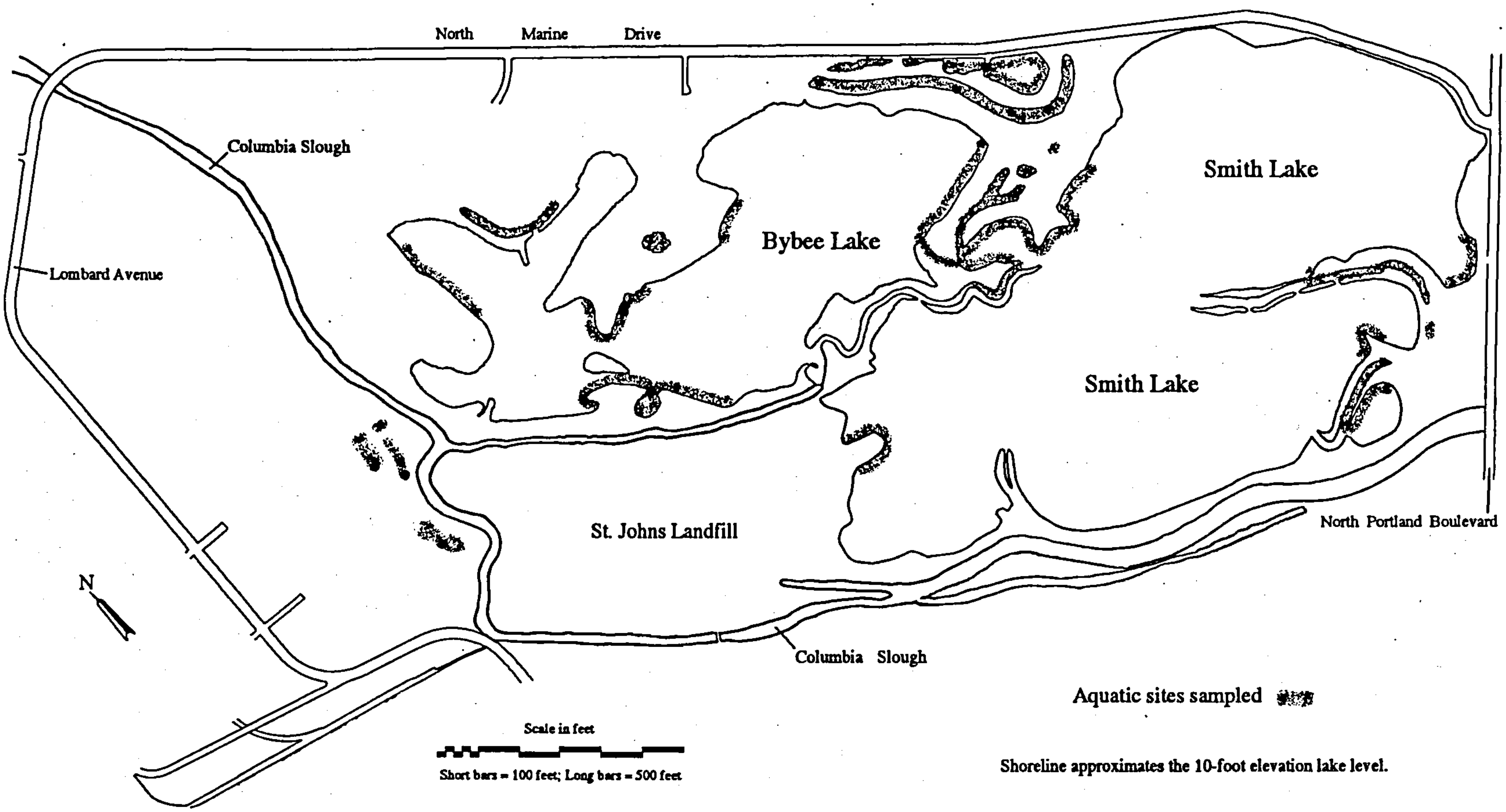
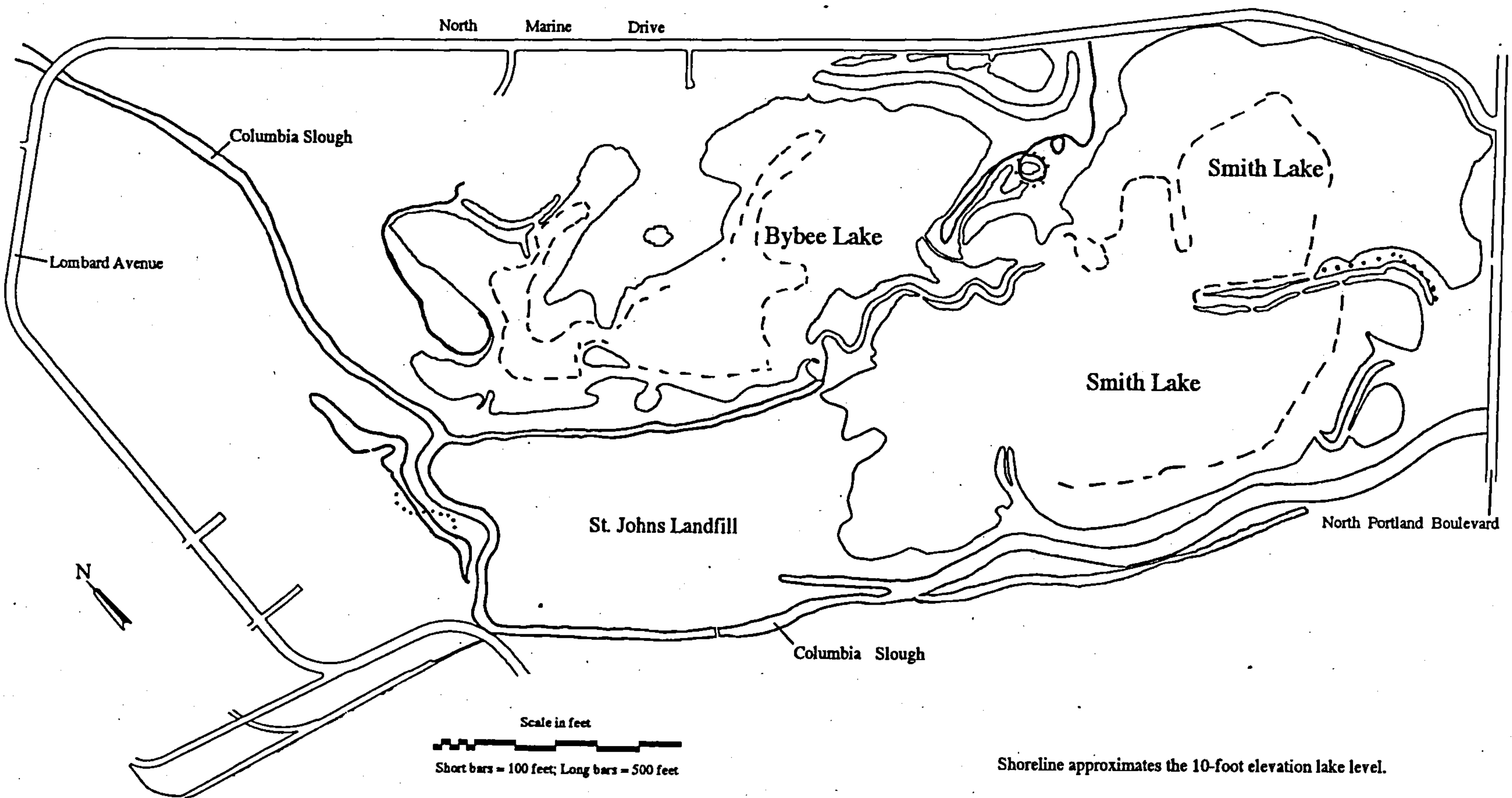

North Marine Drive
Columbia Slough
Lombard Avenue
Bybee Lake
Smith Lake
Smith Lake
St. Johns Landfill
North Portland Boulevard
Columbia Slough
N
Aquatic sites sampled
Scale in feet
Short bars = 100 feet; Long bars = 500 feet
Shoreline approximates the 10-foot elevation lake level.

FIGURE 3.



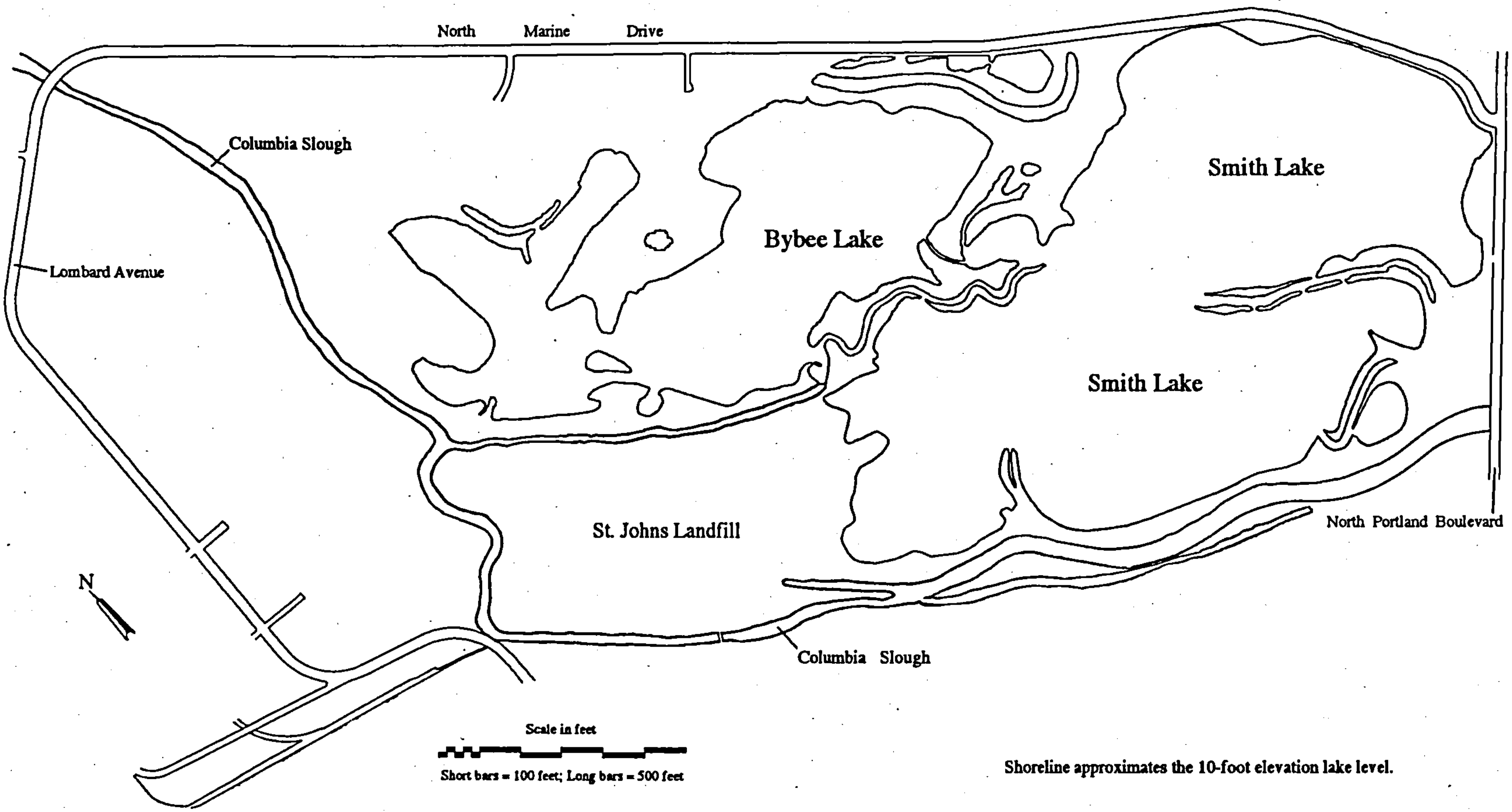
Shoreline approximates the 10-foot elevation lake level.

—— Prescribed Routes

····· Sampling Board Arrays

– – – – Canoe and Walk Night Surveys

FIGURE 4



Shoreline approximates the 10-foot elevation lake level.

Swim survey routes

FIGURE 5

RESULTS

I. Species Composition

Six species, three amphibians and three reptiles, were found in the course of fieldwork at SBLM (Table 7). One amphibian, the bullfrog, is an exotic; the remaining five species are native. By 5 April 1993, all six species recorded had been detected. Sampling of SBLM was intentionally broad-based (i.e., designed to detect the all possible amphibian and reptile species that might occur within the habitats present) and other Columbia River bottomland sites have a similar fauna (see section II below), so a high degree of confidence exists that the amphibians and reptiles detected represent the entire fauna. Previous studies have been either species-specific (turtles; Gaddis 1985) or generalized (Gaddis 1987), but with limited survey time (< 15 hrs were devoted to amphibians and reptiles; P. Gaddis, pers. comm.). This explains why only one amphibian (the long-toed salamander) and one reptile (painted turtle) were recorded previously.

II. Conditions That Probably Affect Species Composition

All amphibian and reptile species recorded at SBLM characterize the fauna of Columbia River bottomland sites. All amphibian and reptiles recorded at SBLM are also recorded at the SRD (Table 8) and at Sauvie Island (records from PSU, OSU, ODFW, and Richard Forbes (pers. comm.) represent all amphibian and reptile species likely to occur on Sauvie Island). Three features of the composition of Columbia River bottomland amphibian and reptile faunas are striking:

1) Egg-laying lizard and snake species seem to be absent. All records of egg-laying lizards and snakes (four egg-laying lizard and snake species are recorded from the Portland area (Appendix D) lie outside bottomland areas.

2) Terrestrial nesting lungless salamanders seem to be rare. Other than one record for the clouded salamander *(Aneides ferreus)* and one for the red-backed salamander *(Plethodon vehiculum)* on Sauvie Island (Jewett 1936; S. Jewett, field notes), all local records of the four terrestrial-nesting lungless salamander species from the Portland area lie outside bottomland areas; moreover, these lone records may not represent exceptions if they are associated with the upland coniferous forest pockets historically located on Sauvie Island.

3) Western pond turtle records from bottomland areas are rare. Fewer than half a dozen records, only one of which is verifiable (a Nature Conservancy photograph of one western pond turtle from Burlington Bottoms; D. Holland, pers. comm.), exist.

Amphibians and reptiles in these three categories share similar nest site requirements; nests must either be in a well-drained location or they cannot tolerate flooding. Relatively heavy precipitation and cool thermal regimes may already make records for egg-laying reptiles scarce at this latitude (see Nussbaum et al. 1983), but simply the soils and hydrology of bottomland sites like SBLM may also limit nesting by egg-laying species. In too moist a nest, the heavily calcified shells of the western pond turtle will crack medially (Feldman 1982; see also Holland 1991), increasing the risk of exposure to pathogens or inducing abortion during development. Among egg-laying lizards and snakes, even if development in too moist a nest does not abort embryos, slower development may allow fungi enough time to overwhelm eggs or predators enough time to find and eat eggs. Terrestrial eggs of lungless salamanders will drown if they are immersed for even a relatively short interval during early development (see Stebbins 1954). The soils over much of SBLM and other Columbia River bottomland areas are the Rafton and Sauvie silt loams (Soil Conservation Service (SCS) 1983), poorly drained soils that would probably make an unsuitable nesting matrix for these species. Remaining bottomland soils are at the other extreme, they are excessively well-drained sands, a substrate too desiccating for most egg-laying amphibians and reptiles found in the Pacific Northwest (PNW) to use. At SBLM, well-drained sands consists of sandy alluviums and spoils of the Pilchuck-Urban land complex (SCS 1983). Notably, the painted turtle, the only common bottomland species that lays shelled eggs, is the only local species known to nest in sand or soil with a high sand fraction (see Holland 1937 and Ream 1967). Soils observed at SBLM, characterized by a sand-, silt-, or mud-dominated substrate where rocks of any size are limited or absent, are characteristic of a lateral segment of a riverine, overburden floodplain of the size and gradient found in the lower Columbia.

TABLE 7
AMPHIBIANS AND REPTILES
OF SMITH AND BYBEE LAKES MANAGEMENT AREA

Group	Scientific Name	Common Name
Amphibians		
Salamanders	*Ambystoma macrodactylum*	long-toed salamander
Frogs and Toads	*Pseudacris (=Hyla) regilla*	Pacific treefrog
	Rana catesbeiana *	bullfrog
Reptiles		
Turtles	*Chrysemys picta belli*	western painted turtle
Snakes	*Thamnophis ordinoides*	northwestern garter snake
	Thamnophis sirtalis	common garter snake

Asterisked (*) species are exotic (non-native)

TABLE 8

COMPARISON OF THE AMPHIBIANS AND REPTILES OF COLUMBIA RIVER BOTTOMLAND SITES: SMITH AND BYBEE LAKES MANAGEMENT AREA (SBLM) AND SANDY RIVER DELTA (SRD).

Scientific Name	Common Name	Sites: SBLM	Sites: SRD	Between-site Comparison
Amphibians				
Ambystoma gracile	northwestern salamander	-	+	<
Ambystoma macrodactylum	long-toed salamander	+	+	<
Pseudacris regilla	Pacific treefrog	+	+	<
Rana aurora aurora	northern red-legged frog	-	+	<
Rana catesbeiana (E)	bullfrog	+	+	>
Rana pretiosa	spotted frog	-	-	=
Reptiles				
Chrysemys picta belli	western painted turtle	+	+	>
Elgaria coerulea	northern alligator lizard	-	+	<
Thamnophis ordinoides	northwestern garter snake	+	+	?
Thamnophis sirtalis	common garter snake	+	+	?

Categories indicate that species is currently present (+) or absent (-). Absences are necessarily based on negative evidence. However, high confidence exists that species indicated as absent on SBLM are really absent because of the large number of hours spent onsite (>150 hrs). Historical presence of the spotted frog at both sites is based on the early comment of Jewett (1936), who indicated that this species was, "Common along the sloughs of the Willamette and Columbia rivers [during the 1930s]." High confidence exists that the spotted frog is now absent at all low elevation (<100 m) areas of the Williamette and lower Columbia river systems because recent extensive survey of the region has failed to detect spotted frogs at any historical localities; and the most recent verifiable records for the region are over 25 years old (M. Hayes, unpubl. data).

Between-site comparison is based on over 20 hours of fieldwork at SRD. A (<) sign indicates that the species is more common at SRD than at SBLM because it was recorded at SRD and not SBLM, or more individuals were found at SRD despite the lesser amount of time spent there. A (>) sign indicates that the species is likely more common at SBLM than at SRD based on the considerably lesser densities of this species and habitat for this species observed at SRD. An (=) sign indicates that probably no difference exists in the abundance of this species between the two sites. A (?) mark indicates that the species is too cryptozooic to allow a between-site comparison given the relatively little amount of time spent at SRD.

An (E) indicates an exotic (non-native) species.

Beyond the general similarity of the SBLM herpetofauna to that of other bottomland sites, the SBLM amphibian and reptile fauna is depauperate. Comparison with the herpetofauna of SRD (Table 9) indicates that two aquatic-breeding amphibians (northwestern salamander and northern red-legged frog) and a live-bearing lizard (northern alligator lizard) are absent at SBLM. Although SRD is similar to SBLM in that poorly drained silty loam soils (SCS 1983) and Oregon ash-black cottonwood-willow associations dominate forested habitats (compare Geiger 1987b to Salix Associates 1992), it differs markedly from SBLM in three ways that may explain the depauperate fauna found at SBLM:

1) Exotic warmwater species (bullfrogs (Table 10) and carp, bass, and various sunfishes (compare Wills and Olson 1992 and Salix Associates 1992; and pers. observation)) appear much less frequent at SRD than at SBLM.

2) Greater surface water area exists at SBLM than at SRD (compare Ogden Beeman et al. 1987 and Salix Associates 1992), but most water at SBLM is: a) warm, shallow, and, b) based on previous measurements has a high benthic biological oxygen demand (BOD) and, c) is susceptible to significant fluctuations in oxygen level (Geiger 1987a, Johnson et al. 1985; see also Department of Environmental Quality 1974). The predominance of hypoxia-tolerant invertebrates are consistent with this interpretation (Fishman 1987a; see also Chapter 2 of this study). In contrast, the lesser area of water at SRD is cooler, on average deeper, and may have a lower benthic BOD and be less fluctuating in its levels of oxygen.

3) Dominance of reed canarygrass *(Phalaris arundinacea)* in the herb stratum is much more pronounced at SBLM than at SRD; it is both more dense and covers a greater proportion of area at SBLM than at SRD (personal observation).

The first two factors favor exotic warmwater predators, but they tend to work against the two native amphibians not found at SBLM, the embryonic stages of which require colder water (northwestern salamander, Anderson 1972; northern red-legged frog, Licht 1971) and probably consistently higher levels of oxygen. The higher benthic BOD at SBLM would likely prevent northern red-legged frogs from using benthic sites for overwintering, which may be a typical overwintering location for this species (Licht 1969, Nussbaum et al. 1983). Moreover, at least the northern red-legged frog, but likely both, of these native amphibians are susceptible to exotic aquatic predators (see Hayes and Jennings 1986). Since aquatic areas within SBLM adjoin waters dominated by exotics (i.e., the Columbia River slough; see Fishman 1987b, Wills and Olson 1992) that can easily gain entry to Smith and Bybee Lakes during high water intervals, the hydrology of SBLM has a greater likelihood of maintaining an exotic warmwater species assemblage than that of SRD, where smaller, colder, and more isolated bodies of water exist. As a result, both the physical and biotic environments at SBLM place native amphibians at a greater risk than at SRD. Northern red-legged frogs were historically common in forested areas in the vicinity of Portland (Jewett 1936)

TABLE 9

CHARACTERISTICS OF THE AMPHIBIANS AND REPTILES OF THESMITH AND BYBEE LAKES MANAGEMENT AREA (SBLM) AND SANDY RIVER DELTA (SRD)

Scientific Name	Time to Maturity	Longevity	Reproductive requirements
Ambystoma gracile	several	prob. >20	HWQ, CW, LAS = perm
Ambystoma macrodactylum	1-2	prob. 5-6	MWQ, CW, EI, LAS = 3 mo
Pseudacris regilla	1	prob. 2-4	MWQ, CW, EI, LAS = 5 wk
Rana aurora aurora	2-3	prob. 8-12	HWQ, CW, EI, LAS = 5 mo
Rana pretiosa	2	prob. 5-6	HWQ, MCW, EI, LAS = 5 mo
Chrysemys picta belli	5-7	prob. >20	High sand fraction in nest site
Elgaria coerulea	2-3	prob. >10	No special requirements
Thamnophis ordinoides	1-2	prob. >5	No special requirements
Thamnophis sirtalis	1-2	prob. >5	No special requirements

Time to maturity and longevity is given in years.
Reproductive requirements are:
HWQ = high water quality, MWQ = moderately high water quality, CW = cold water, MCW = moderately cold water, EI = aquatic exotic intolerant, and LAS = longevity of the aquatic site (this is the minimum length of time an aquatic site must last in order for the larval stage to achieve metamorphosis; length of time as indicated, perm means a permanent site is required).

TABLE 10

RELATIVE FREQUENCIES[a] OF THE SNAKES OBSERVED AT SMITH AND BYBEE LAKES MANAGEMENT AREA (SBLM)

Scientific Name	North Bybee (Bybee)	East Side (Smith)	Temporary Pond (betw Smith & Bybee)	West Side (w of slough[b])
Thamnophis ordinoides	1.32	1.12	0.72	4.53
Thamnophis sirtalis	0.65	1.26	1.46	2.67

[a] Quantified as the number of snakes observed per man-hour of survey time. This was calculated for each survey and then averaged on a site-specific basis for each species at each site.

[b] Slough here refers to the Columbia Slough

and they still exist in the bottomland forests of SRD (Table 4) and Sauvie Island (pers. comm.), so their absence at SBLM may represent a local extirpation. The third factor could potentially explain the absence of northern alligator lizard at SBLM, a common species elsewhere at this latitude (e.g., PSU 001399, 001520; MVZ 61884-6, 61888-9). Casual observation indicates that reed canarygrass habitats harbor few invertebrates, so an upland herb layer of almost exclusively reedcanary grass may provide insufficient food for a grass-swimming species like the northern alligator lizard. Notably, the native species that seems more abundant at SBLM than at SRD, the western painted turtle, may be limited by the lack of sandy soil in which to nest at SRD. Pilchuck or other alluvial sand soil types seem to be largely lacking at SRD, whereas they are localized, but cover a significant area at SBLM (SCS 1983).

Based on comparison with SRD (Table 9), the five native SBLM amphibians and reptiles represent the more generalized of the nine species that may have occurred there historically. Excluding the spotted frog, now presumably extirpated from both sites[1], the remaining three species not recorded at SBLM represent the most vulnerable species in their respective groups (Table 10), both in terms of habitat utilization (narrower habitat needs are viewed as more vulnerable) and demography (later maturing/longer-lived species are viewed as more vulnerable). Thus, the northern red-legged frog is the most vulnerable of the remaining two native frogs, the northwestern salamander is the most vulnerable of the two native salamanders, and the northern alligator lizard is most vulnerable of the three native lizards and snakes.

In summary, a high benthic biological oxygen demand, a predominance of exotic aquatic predators, and perhaps a reduced terrestrial invertebrate diversity may all be contributing to maintaining the existing amphibian and reptile species composition at SBLM.

III. Ecology of Existing Herpetofauna

The ecology of amphibians and reptiles at SBLM is best characterized by examination of food resources, and reproductive and refuge sites on a species-specific basis because identifiable limitations in one or more of these factors seems to markedly affect their local distribution.

Pacific treefrog. The Pacific treefrog is the most observable of the native amphibians at SBLM. It may also be the most common, but a direct comparison with the other native amphibian, the long-toed salamander, is not possible because the secretive behavior and nocturnal activity pattern of this salamander likely make it much less observable than the frog. Following the extreme drought conditions during 1992, only a few (n = 3) Pacific treefrogs were seen surface active during September and November surveys, during which conditions were warm enough to expect activity.

[1] The spotted frog was historically "common along the sloughs of the Willamette and Columbia Rivers" (Jewett 1936). Surveys conducted throughout the lowland Willamette and Columbia during 1993 failed to reveal spotted frogs at any of the sites where they had been historically recorded (M. Hayes, unpubl. data). Moreover, research on the spotted frog has revealed that relatively warm (> 20°C) active season water temperatures may be required (M. Hayes, unpubl. data), a characteristic unique among PNW frogs and one that would make the spotted frog the amphibian most vulnerable to exotic aquatic predators.

Brief surveys conducted during October and December 1992, and January 1993 were made under conditions that were too cold to expect activity. The first evidence of this species in 1993 was a few calling males heard during the 9 February survey. Egg clusters as well as females carrying eggs were first found during the 27 February survey; subsequently, fresh egg clusters were observed on all survey days through 4 April. Young larvae (tadpoles) were first observed on 13 March and increasingly larger larvae were found through 13 June. Metamorphosing tadpoles were first observed on 18 April, and the first completely metamorphosed young frogs were found on 5 May. By 10 July, larvae or metamorphosing individuals of Pacific treefrogs were still present at only one of the breeding ponds.

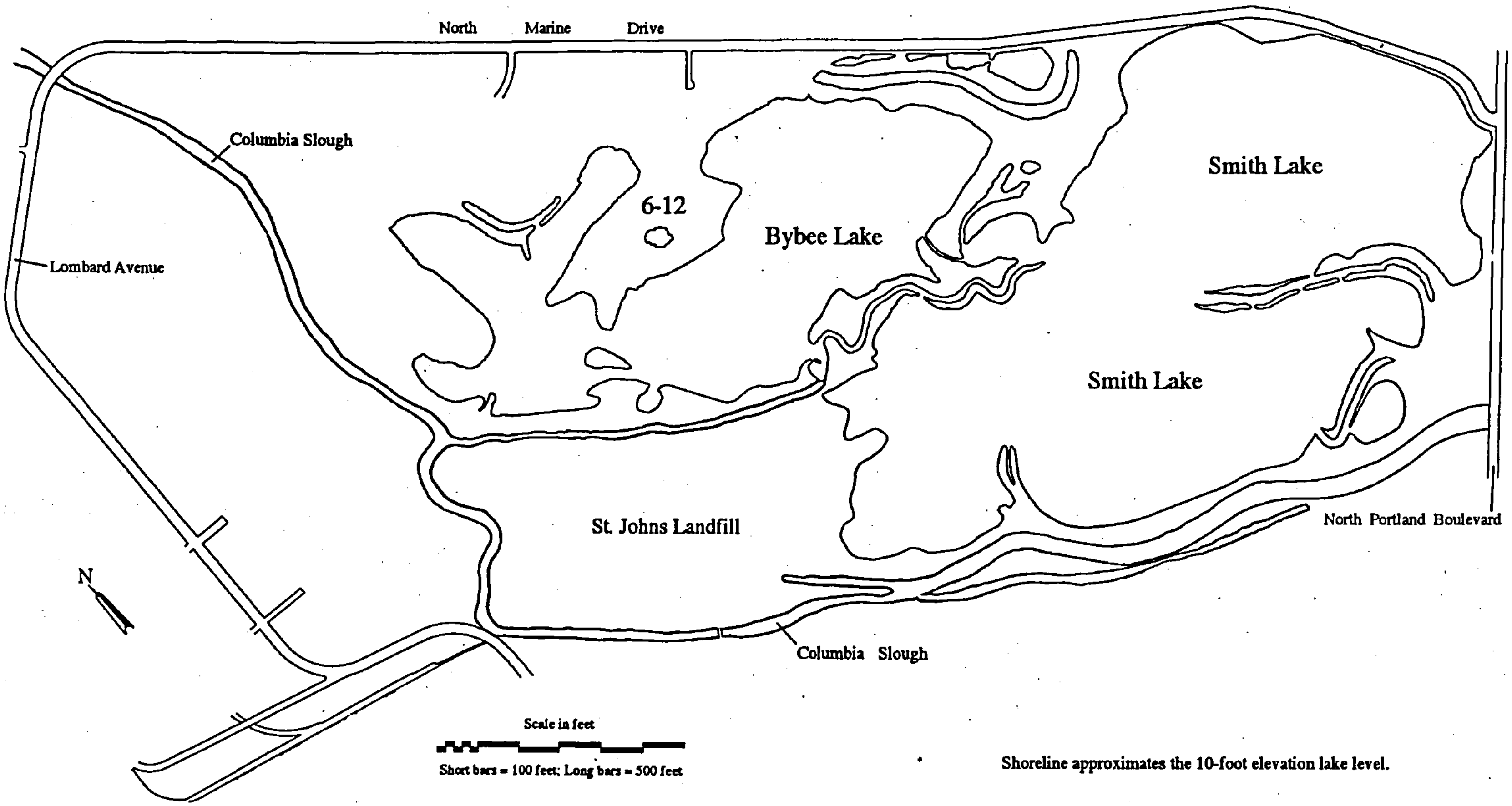
Reproduction (egg clusters) or evidence of reproduction (larvae) of the Pacific treefrog was found at 12 different sites (Figure4). However, successful recruitment (defined as a metamorphosing individual) or evidence of successful recruitment (small metamorphosed individuals within a few meters of the pond edge) was observed at only four of these sites. Six of the sites were relatively small puddles in dirt roadways that either dried before the larvae could metamorphose n= 4) or all the larvae in them vanished at a size too small for metamorphosis to have take place n=2), presumably as the result of predation. The small size of the latter sites makes it unlikely that they would be used in drier years (e.g., 1992), and it is unlikely that such sites account for significant recruitment in even the wettest years. All four sites where recruitment was successful were deeper and larger; only one was a road puddle, the largest and deepest one on the sampling area on the west side of the Columbia slough (Figure 5). Notably, three of the four sites where successful recruitment occurred (all except the road puddle) had pelagic macroinvertebrates typical of temporary pond systems (i.e., fairy shrimp and a large, bright red copepod). Searches for both the eggs and larvae of the native amphibians, including Pacific treefrogs, as well as these pelagic macroinvertebrates at 40 point locations scattered along the edge of areas on or connected to either Smith or Bybee lakes failed to reveal any of these organisms. Two sizable temporary ponds were sampled that lacked Pacific treefrog larvae, and one of these (site 4-12) also contained the pelagic macroinvertebrates observed elsewhere.

All sites from which successful recruitment of Pacific treefrogs was found were associated with dense graminoid stands that likely represent an important refuge, as metamorphosed individuals were often encountered in this cover. Reedcanary grass was the dominant cover type in upland areas adjacent to all these sites, but postmetamorphic Pacific treefrogs were seen in other cover types (Columbia sedge,and water smartweed) as frequently as in reedcanary grass despite the fact that the other cover types combined represented less than a quarter of adjacent upland area. In the area west of the Columbia Slough, where the greatest numbers of both garter snake species were observed, recently transformed Pacific treefrogs were observed in vegetation rather close to ground. Although this may be a thermoregulatory response, it may also represent a response to the presence of snake predators.

Long-toed salamander. The long-toed salamander is the only species of native salamander found at SBLM. Metamorphosed individuals were rarely found exposed during the day (n = 1), most being found under surface cover, either haybales (n = 13), sampling boards (n = 4), or logs (n = 2). A February sampling at night detected 6 individuals; none were under surface cover. Long-toed salamanders were not observed under surface cover in the droughty fall of 1992, but this species was the first to emerge following the snowy interval in early January, as it was found during the first January sampling (16 January). A series of 14 dead adult long-toed salamanders and about 50 salamander egg packets containing dead embryos were found around the edge of the large temporary pond between Smith and Bybee lakes (site 5-3) in late January; this temporary pond apparently underwent oxygen depletion along its edge when it developed a cap of ice roughly 6-8 inches thick and a light snow layer on top in early January. Similar, but very shallow, ponds used by long-toed salamanders at the SRD and observed over the same time period froze to the bottom; all male salamanders in those ponds, the few females remaining, and the embryos that had already been laid were found dead. Because long-toed salamanders are know to survive freezing in block ice, the cause of death was likely not cold. Because this was a regional effect observed at several sites in January 1993, and mortality was greater in the shallower ponds where freezing to the bottom would increase the likelihood of oxygen depletion, the latter was the probable cause of death. At SBLM, the first salamander eggs clusters were observed on 16 January, and recently laid clusters were observed through 4 April. Young salamander larvae were first observed on April 5 with increasingly larger larvae seen on all sampling days through June 13. No recently metamorphosed individuals were observed. At least one adult long-toed salamander was found under surface cover on all except one survey day through 3 May; a single adult was also found under surface cover on 11 July.

Reproduction (egg packets) or evidence of reproduction (larvae) of long-toed salamander was found at five different sites (Figure 7). At one of those sites (5-1), only a single egg packet was found, and the site dried down to a small pool in which no larvae were found. If recruitment occurred at this site, it escaped notice. Two of the other sites (5-2 and 5-4) were road puddles in which individuals were not detected until after the larvae had hatched and grown to a length of 2.5 cm. Both these sites dried prior to larval metamorphosis, and are probably locations that are not used for reproduction in most years. Only two sites (5-3 and 5-5) likely had significant levels of recruitment based on the large larvae (ca. 7.5 cm total length) seen there through June 13, but because no postmetamorphic juveniles were observed, how successful recruitment really was is unknown. Both sites where recruitment is postulated to have been successful were deeper and larger, and both had the pelagic macroinvertebrates typical of temporary pond systems (see Pacific treefrog account). As with the Pacific treefrog, eggs and larvae of this species were not found in areas on or connected to either Smith or Bybee lakes. Two sizable temporary ponds (4-11 and 4-12; Figure 6) that lacked Pacific treefrog larvae also lacked evidence of long-toed salamander.

Sites from which successful recruitment of the long-toed salamander is postulated were associated with some kind of small mammal burrows and dense herbaceous cover. Since long-toed salamander were invariably observed in mammal burrow systems when they were encountered under surface cover, they may be dependent on mammal burrows for refuge. Dense herbaceous cover may also be a requirement, but this may also be the secondary result of an association with small mammals that require the dense herb cover.



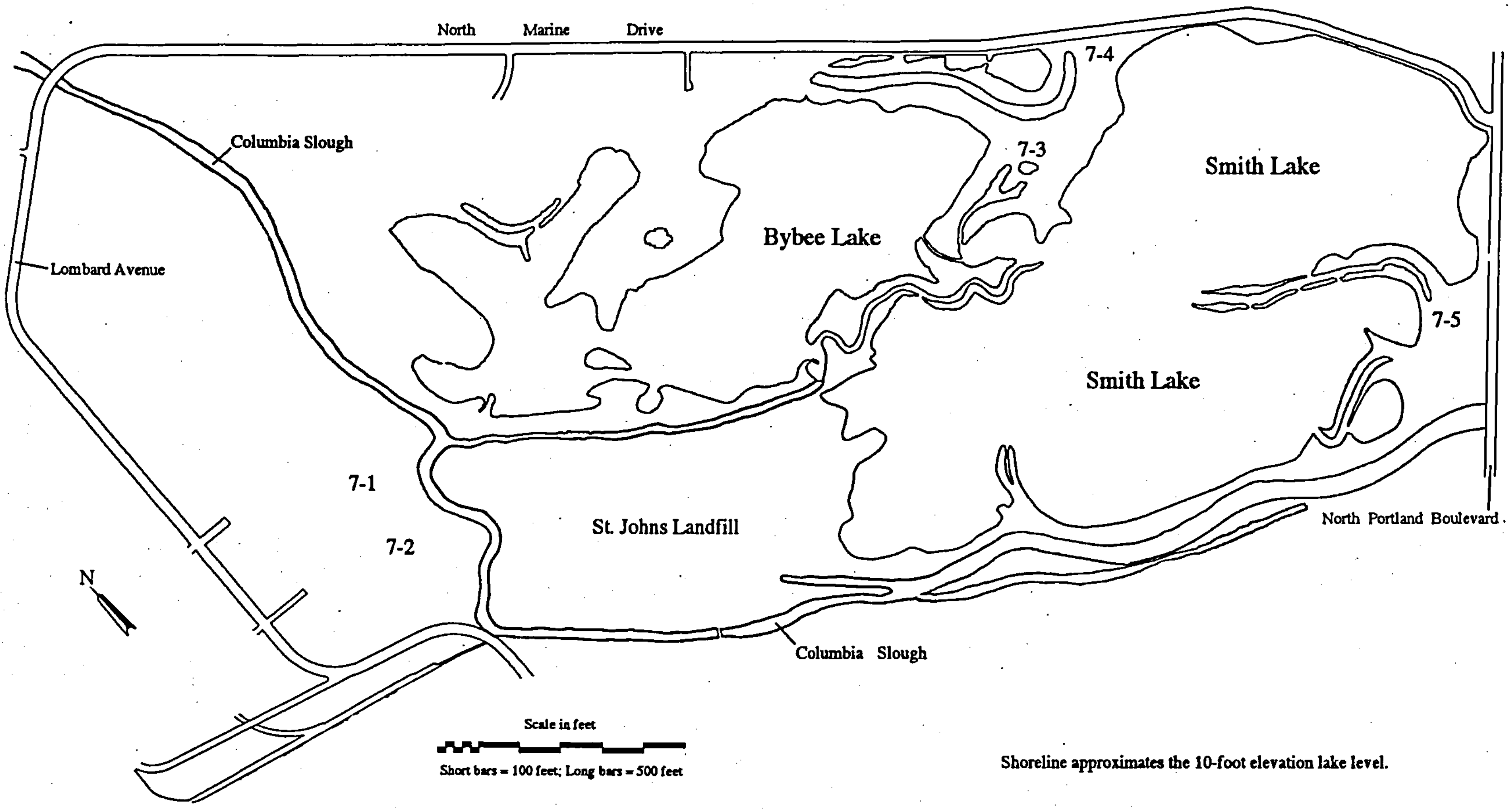
Shoreline approximates the 10-foot elevation lake level.

Pacific Tree Frog

Sites where reproduction was observed or evidence of it

Sites sampled

FIGURE 6



Shoreline approximates the 10-foot elevation lake level.

Long-toed Salamander

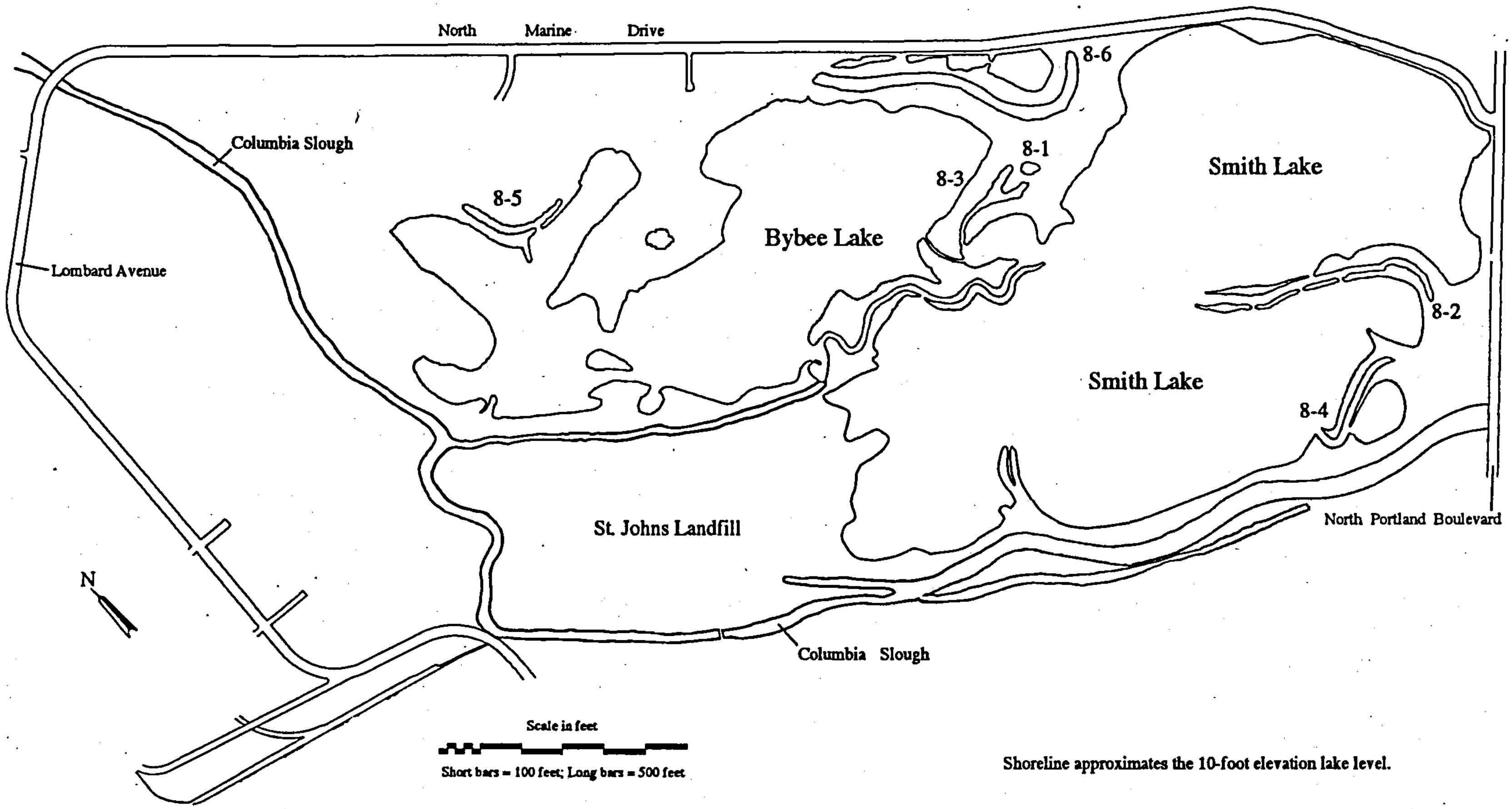
FIGURE 7

Bullfrog. The bullfrog is the only exotic amphibian found at SBLM. Bullfrogs were observed during daytime (mostly tadpoles, juveniles, and subadults) and nighttime (mostly subadults and adults) surveys. Many bullfrogs were observed during September, but a few bullfrogs were observed in November 1992 (all juveniles). Bullfrogs were the last species to emerge in spring. They were first observed on 17 April 1993 (three juveniles) and during all subsequent samplings through July. Bullfrogs were observed in all larger bodies of water, although they did not appear in the larger temporary pools (6-1 and 6-2; Figure 6) until May 15 (only juveniles were found there). All sightings involved individuals basking or floating among submergent vegetation or low, emergent cover. A population estimate of the number of bullfrogs occupying SBLM based on survey conducted in September 1992 in which extrapolation from counts on 20 10-m x 10 m plots multiplied by the estimated area of appropriate habitat gave a value of 10,120 frogs (95% confidence intervals: 6,240 (lower bound) and 16,730 (upper bound)). A parallel estimate for May 1993 gave a value of 4,530 with a 95% confidence intervals of 2,310 (lower bound) and 7,810 (upper bound). Because this value was so different from that obtained in September 1992 and there was concern that the numbers might reflect incomplete seasonal emergence, this estimate was repeated in June 1993. The June estimate gave a value of 4,380 (95% confidence interval: 2,280 (lower bound) and 7,560 (upper bound)). Based on these figures, the bullfrog population appear to have roughly halved over the winter of 1992-3. A drop of this magnitude was not anticipated, but this may represent overwintering mortality due to pond freeze caps that resulted in oxygen depletion. A few intact, but dead bullfrogs were found shallow ponds at SRD at the time the mortality in the long-toed salamanders occurred that is believed to be the result of such an effect. If this happened, what is puzzling is why no dead bullfrogs were found at SBLM.

Larvae and calling males were the only evidence of bullfrog reproduction found at SBLM. Since larvae were relatively large (ca. 14 cm) and appeared to have overwintered, it is not clear from what reproductive sites they may originated. Calling males from the arm of Smith Lake near the large temporary pond (6-3), one of the old inflow channels into Smith Lake (6-4), a shallow area on the north side of Bybee Lake (6-5), and the closed north channel in which the highest densities of painted turtles were found (6-6) may represent bullfrog oviposition sites. It is not clear how fast bullfrog larvae develop at SBLM, but they must overwinter as larvae at least once. As a consequence, the temporary ponds that occur on SBLM probably cannot serve as breeding sites for bullfrogs.

Bullfrogs sampled for their stomachs contents (n = 7; juvenile [70 mm] to adult [145 mm] size range) contained adult and juvenile mosquitofish (17 of 26 items), a juvenile sunfish, adult midges (6 of 26 items), and two craneflies. Diet items suggested that bullfrogs were feeding primarily in water on aquatic edges. Two bullfrogs observed during a May survey were found to consume nearly two dozen mosquitofish in a few minutes.

Northwestern garter snake. The northwestern garter snake is the smaller of the two species of snakes found at SBLM, and likely the more abundant. Northwestern garter snakes were observed only during daytime surveys. Only two northwestern garter snakes were seen in the interval



Bullfrog

FIGURE 8

extending from September 1992 through February 1993. First seen on 22 March 1993, the northwestern garter snake was the first of the two snake species observed in spring; it was observed during almost all subsequent surveys through July. Of the 196 sightings of this species, only 4 occurred in open situations more than one meter from cover. Sampling boards were moderately successful at sampling this species; 32 sightings were as a result of the boards.

Seventeen of 27 adult females examined at SBLM were gravid. Palpation indicated that the gravid females were carrying between four and eleven embryos. Very young juvenile snakes [total length <210 mm] with yolk scars were observed in September 1992 and presumably represent young born that year. Young anticipated to represent the size range of 1993 neonates were not identified among snakes sampling through July 1993.

The northwestern garter snakes were encountered most frequently on the west side of the Columbia Slough (Table 11). Seven individuals were palped for food items, and five of these had eaten earthworms and the remaining two had eaten slugs. Earthworms were the most frequently encountered terrestrial invertebrate in sampling of haybales. Although invertebrates were not systematically sampled on the west side of the Columbia Slough, casual observation suggested that earthworms were several times as abundant there in the area being monitored with haybales. Earthworm abundance may explain the higher observed frequencies of northwestern garter snake on the west side. Although not quantified, the west side seems to afford better cover for snakes, so a combination of food and cover may explain the greater observed frequencies of snakes on the west side.

Common garter snake. The common garter snake is the larger of the two species of snakes found at SBLM, and likely the less abundant. Common garter snakes were observed only during daytime surveys. Only two individuals of this species were observed in the interval extending from September 1992 through late March 1993. The first individuals of this species were observed on 30 March 1993 and during all subsequent samplings through July. Of the 69 sightings of this species, only two occurred in situations more than one meter from cover. Sampling boards sampled this species poorly; 9 sightings were as a result of the boards.

Eight of 14 adult female common garter snakes examined were gravid. Palpation indicated that the gravid females were carrying between four and nine embryos. Young juvenile snakes [total length < 250 mm] with yolk scars were observed in late April 1993, and presumably representing young born in 1992. Young anticipated to represent the size range of 1993 neonates were not identified among snakes sampling through July 1993, so the 1993 cohort of neonates were probably born after July 1993.

The common garter snakes appeared to be observed most frequently in the vicinity sites where their amphibian prey, mostly Pacific treefrogs, was common. Of four individuals palped for food items, three had eaten Pacific treefrogs and one had eaten a juvenile bullfrog. As a consequence, most common garter snakes were found on upland edges of the wet areas and marsh on the west side of the Columbia slough, and around the temporary pond between Smith and Bybee Lakes. The combination of appropriately dense herbaceous cover refuge and food likely explains most of the distribution of this species at SBLM.

Western painted turtle. The western painted turtle is the only species of turtle found at SBLM. Western painted turtle were observed only during daytime surveys. A young road-killed adult male individual of this species was observed on Lombard Avenue west of SBLM during July 1992. Painted turtles were not observed during the interval September 1992 through March 1993. The first individuals of this species were observed on 4 April 1993 (two individuals) and during all subsequent samplings for turtles through July. Of the 368 sightings of this species, all but eight occurred in the ponds (7-1, 7-2; Figure 8) and closed channel (7-3) near the parking lot on North Marine Drive. Remaining sightings were made in North Canal (n = 5; 7-4), the Columbia Slough (n = 1, 7-5), and the lakes' outflow near the control structure (n = 2; 7-6). Over 70% of all sightings were made in the closed channel behind the ponds (7-3).

Three of 6 adult females examined were gravid. Palpation indicated that the gravid females were carrying at least four eggs, but a precise count could not be obtained. A very young juvenile (carapace length = 23 mm) was found in the closed channel behind the ponds along North Marine Drive, and probably represents a juvenile hatched in 1992 (painted turtles are thought to hatch in the nest in the late summer-early fall in the year they are born, but actually emerge from the nest the following spring).

At least two reasons for localization of the western painted turtles in the ponds and closed channel along North Marine Drive exist. This area of SBLM is one of the only two with Pilchuk-Urban complex soils (SCS 1983), the one high sandy fraction soil in the area available for nesting except those sandy-based soils piled on top of the St. Johns landfill. Localization of the nesting site is confounded with available food. An initial sample of three stomach flushed turtles suggested that their consumption of aquatic macrophytes (n=1) might be the reason that painted turtles were found mostly in the north ponds and closed channel. The latter area contains the only significant growths of *Anacharis densa* occurring in the SBLM and the water quality, for reasons that are unclear, is higher there. However, a second sample of 11 turtles, seven of which had food in their stomachs, indicated that the presence of snails might explain painted turtle presence in the north ponds and closed channel. Six of the seven contained the remains of several snails. As a consequence of this observations, snail density was sampled in nine locations, with one third in each of the main lakes (7-6 to 7-11) and one third in the north ponds and closed channel (7-12 to 7-14). The results of this sampling indicated that snails were over an order of magnitude as abundant in the north ponds and channel as they were in either of the main lakes, an observation consistent with the relatively few snails observed in the main lakes (see Chapter 2). Thus, both nesting and food may be responsible for the western painted turtles being localized in the SBLM. Nest site searches were conducted, but no nest sites were found. Localization of nest sites in this western painted turtle population will require telemetry.

MANAGEMENT RECOMMENDATIONS

The factors that contribute to the depauperate amphibian and reptile fauna at SBLM are 1)the relatively static inundation regime, and 2) the high benthic BOD conditions. This parallels the probable cause of the depauperate condition of species diversity in other groups of organisms studied at SBLM (see other chapters in this report). As a consequence, management recommendations for SBLM should focus on:

1) a more fluctuating inundation regime, and
2) a reduction of benthic BOD. Such a regime would benefit native amphibians and reptiles in the following ways:

1) A more diverse and abundant invertebrate macrofauna would be available as a food resource (see Chapter 2). Exposure of a large amount of lake bottom is expected to have two major effects: a) it would allow establishment of a diversity of benthic invertebrates not dependent on the largely hypoxic benthic conditions that result from a pattern of continuous inundation, and b) it would promote growth of a seasonally exposed emergent vegetation upon which a diversity of non-benthic invertebrates could complete their life cycle. Non-benthic invertebrates are currently limited under a regime of relatively continuous inundation (see Fishman 1987a, Chapter 2). Such an invertebrate macrofauna should be more accessible and more abundant food source for Pacific treefrogs and long-toed salamanders, the native amphibians in this system, because postmetamorphs of both these species feed terrestrially. A greater annual, draw-down of this lake system will probably encourage the development of a more diverse pelagic macroinvertebrate fauna with more oxygen-requiring species. Such a fauna is now observed only in temporary pools at the SBLM. Improvement of the invertebrate macrofauna may also allow western painted turtles, now localized in the north ponds and channel perhaps because of food, to exploit a larger area of the SBLM.

2) More cover for native amphibians and reptiles would be available. As noted above, exposure of large areas of the lake bottom would promote a growth of seasonally exposed emergent vegetation (see also Chapter 1). This type of edge vegetation represents the key cover for the two native amphibians and reptiles. Post-metamorphic stages of Pacific treefrogs, especially juveniles, forage in such cover largely by day, and the post-metamorphic stages of long-toed salamanders could use such cover at night. Besides simply foraging areas, this cover represents important refuge habitat from bird or snake predators for both these species. Because such cover represents important foraging habitat for these amphibians, it is also a key foraging habitat for the common garter snake, that eats both these amphibians, but mostly Pacific treefrogs, because the snake is a diurnal forager. If this exposed edge cover is dense enough, it may also serve as foraging habitat for the northwestern garter snake, which might forage in such areas for earthworms and slugs. Such cover also represents key refuge habitat for the two snakes from their predators.

3) The number of exotic warmwater predators (bullfrogs, bullhead, carp, various sunfishes, etc.) would be reduced. Seasonal reduction in lake area would reduce the amount of habitat for these species, and in the case of Smith Lake drying, could eliminate the exotics so that populations would have to rebuild during those years on immigration. Even if seasonal reduction did not result in lake drying, it would force bullfrogs and remaining fishes into shallower water, making them more vulnerable to predation by wading and other birds. Perhaps most significant, because the edge gradient of Smith and Bybee Lakes is extremely shallow, it would move the water edge-utilizing juvenile and subadult bullfrogs, potential predators on the native amphibians and juvenile garter snakes, away from much of the relatively wide swath of herbaceous foraging habitat used by these species. One of the key disadvantages of the current pattern of relatively continuous inundation is that bullfrog predators are placed in close juxtaposition to the native species that use the edge areas available. Greater seasonal fluctuation in water levels is also likely to help reduce the exotic aquatic predators because the relatively more static pattern of current inundations favors a thermal and oxygen regimen that the suite of warmwater exotics better tolerates. As a consequence, such fluctuations may help increase the number of native species.

4) More reproduction among native amphibians and reptiles would be possible. If reductions in the exotic aquatic predators and improvements in the thermal and oxygen regimen can be effected according to the mechanisms described above, it may allow amphibian reproduction in many edge areas of the lake system where it does not now occur. This effect would be dependent on how much the exotic populations could be reduced on a seasonal basis and how much improvement in water quality conditions would occur. Both native amphibians lay eggs relatively early in the season (long-toed salamanders: January-February; and Pacific treefrogs: February-April), deposit eggs for enough in advance of the seasonal expansion of exotic predator populations if the exotics can be reduced sufficiently on a seasonal basis. Greater reproduction in the native amphibians could have a cascade effect that would result in greater reproduction in the common garter snake. If exposure of the significant areas of the lake edge has the anticipated effect of increasing invertebrate abundance and diversity, a cascade effect on reproduction in the western painted turtle and the northwestern garter snake can also be expected. If the exotics could be sufficiently reduced, perhaps even eliminated, from portions of SBLM, consideration could ultimately be given to reintroduction of some of the more sensitive species (e.g., northern red-legged frogs).

FUTURE RESEARCH DIRECTIONS

Of all the amphibians and reptiles present at SBLM, the western painted turtle is probably the species that is currently the most vulnerable. Relatively few painted turtles populations remain in western Oregon; even fewer of those appear to be of any size (D. Holland, pers. comm.), although data are especially needed that attempt to quantify existing populations. SBLM is one of only a dozen sites where painted turtles are known to occur on the Oregon side of the Columbia River, and it may represent the largest remaining painted turtle population in this region (D. Holland, pers. comm.). As a consequence, understanding something of the dynamics of the SBLM western painted turtle population is crucial to its management. In particular, it is important to understand how stable this population is, whether the current pattern of recruitment is successful (i.e., does it achieve at least a replacement rate in the population). Data on replacement of individuals, and in particular, where these individuals come from is essential to understanding the stability of this population. For example, no data are available to indicate whether recruitment into the SBLM population is entirely from within the population or a contribution of immigrants for other local areas exist. Since some of the recruitment appears to be from reproduction within this population, knowledge of where females nest is essential to management, particularly in the context of avoiding undue disturbance to nest sites. Since painted turtles are known to overwinter underwater elsewhere (Pearson 1937), it is can be anticipated that they would overwinter in a similar location at SBLM. Knowledge of the distribution of overwintering sites is also necessary to avoid disturbing them. Related to this, the conditions maintaining a higher water quality where the SBLM populations now occur are not understood. These need to be understood if management desires maintaining or promoting the conditions that allow survival. Much of the aforementioned data (on nesting and overwintering) cannot be obtained without a study involving telemetry. Identifying trends that may negatively affect populations cannot be achieved without long-term monitoring.

Data from this study clearly indicate that temporary aquatic sites (ephemeral ponds) are essential to the survival of amphibians at SBLM; this condition would probably be true even if this system were not as severely exotic-impacted. Temporary aquatic sites are known to display dramatic differences in amphibian recruitment between years, and such differences can mask or obscure long-term decline trends in amphibian populations, a condition that some individuals have suggested may be global. As a consequence, monitoring amphibian populations in the some of the temporary aquatic habitats onsite would not only be an essential to their management, it could provide information on the health of local ecosystems and that of SBLM.

A high density of both garter snakes on the west side of the Columbia slough was a key find in this study. This find is important because few snake populations exist that are dense enough to make gathering data from those populations not time costly; most snake populations are too hyperdispersed (occur at too low densities) to allow collecting data on them without a high time cost. Thus, SBLM presents an unusual opportunity to study snake populations. Management of SBLM snake populations would also benefit from understanding why west side densities are unusually high.

An integral portion of this study was an education component that attempted to involve students from a local school in a manner that would teach them something about the SBLM. On a relatively small scale, this was done with fifth-grade students from George Middle School, and that program was very successful as measured in the benefit to and impact on those students (V. Rosenberg, pers. comm.). It is essential that such programs be continued and expanded to allow students to develop an appreciatiation of undeveloped systems and their importance; a great deal of the failure to adequately preserve undeveloped systems can be linked to the education of individuals about those systems. An attempt was also made to involve students in the actual sampling that provided data about this system. In theory this is an excellent idea, yet in practice it is difficult to implement without a time-costly, highly-structured effort for middle school-level students. Participation in sampling without devoting a lot of time to provide a structure for the individuals assisting in the sampling can probably be done effectively with older students. This should not imply that such an approach cannot be done with middle school students, but that the structure required to implement it will be time consuming, and as a consequence, financially costly.

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CHAPTER 4
MAMMALS

INTRODUCTION

The existing aquatic, wetland, and terrestrial habitats at the Smith and Bybee Lakes Management Area (SBLM) are known to support a variety of mammals found in the Columbia River lowlands in this region. Gaddis (1987) recorded observations of 11 mammals during a 1987 wildlife study. However, to date no studies have been conducted strictly on mammalian populations and their habitat use of the SBLM. The study objectives were to:

1) identify the species present;
2) determine small mammal use by habitat type (vegetation assemblages);
3) determine how habitat changes would likely affect existing mammals;
4) identify management recommendations; and
5) outline future research needs that would assist the direction of the management of SBLM.

METHODS

Observer sightings (direct sightings or recognizable sign), recently documented observations, and trapping were used to determine the species present in the SBLM. Time and cost constraints and study objectives determined small mammal snap-trapping during two trapping periods to be the most effective method of collecting data. The cost of live trapping small to medium sized mammals was determined to be cost prohibitive because of the number of traps that would have to have been obtained in order to adequately sample the area. In addition, it was felt that the actual trapping of medium size mammals was necessary to meet the objectives of the study since observations could be used to document the presence of most species. Trapping of larger mammal species was not considered.

The preliminary vegetative assemblages map, the 1992 aerial photographs, and a site reconnaissance were used to estimate the relative proportion of the total area covered by each vegetation assemblage. This relative area information was used to ensure that a number of trapping stations were established in each of the assemblages was proportional to their size. General locations of the trapping transects were also determined prior to trapping. Specific locations transects were determined in the field in order to stratify trapping effort. Whenever possible, transects were located near the centers of the assemblages, to avoid placing traps within ecotones (edges habitats).

Transects ranged from one to seven trap stations depending on the size of the particular vegetative assemblage. A trap station consisted of three small-mammal snap traps in a triangle spaced 1 to

2 meters apart. A combination of Victor mouse and Museum special traps were used at each station with three different types of bait; peanut butter and rolled oats, night crawlers, and cut apple. Trapping stations were spaced at 10-meter intervals along a fixed azimuth bearing within each transect. Transects and trap stations were marked with orange surveyor flagging. Individual traps within each station were placed in locations that would optimize the chance of animals encountering them (i.e. against downed logs, along small-mammal runways, under low-growing shrubs, etc.). Traps were checked daily and new bait was placed on the traps if the old bait was gone or did not appear fresh.

The first trapping session was conducted 19 - 23 September 1992. Eighteen transects were established in eight of the 14 vegetative assemblages described in Chapter 1 of this report. Trapping was not conducted in six assemblages: 1) the two aquatic assemblages (Water Smartweed and Dead Willow), 2) Drainage Channel ; 3),Emergent; 4) Blackberry Shrub-Scrub; 5)Willow Shrub-Scrub; 6) or Disturbed/developed Uplands communities. The 243 traps used during this session were each left for three consecutive trap nights. All captured animals were recorded and put in zip-loc bags, one bag per transect per night, and frozen for later identification. (Note: all small mammals captured that were in satisfactory condition were given to Portland State University for use in their biology department.)

The second trapping session was conducted 21 - 23 May 1993. Water levels in May 1993 were significantly higher than the levels present in September 1992. As a consequence, the Shoreline Emergent and Pond Emergent assemblages were inundated and portions of most of the other assemblages were inundated. The initial sampling design was to trap the same transects as the previous session, however, all but two of the established transects were completely or partially inundated. Trapping of the Shoreline Emergent and Pond Emergent were eliminated. In the remaining transects, traps were placed in the same stations when possible, however, some trap stations were eliminated due to inundation. Two transect locations were moved because of high water, one in the Willow Forest and one in the Reed Canarygrass.

The available terrestrial habitat was significantly reduced during the second trapping session. Although no quantified data on the amount of available area by assemblage was available, every attempt was made to continue the relative and stratified sampling effort by; 1) visually estimating the inundated proportion of each assemblage block that established transects were located in and reducing previous effort by that percentage and 2) maintaining transect locations away from the ecotones.

A total of 132 traps were used for three consecutive nights for the second trapping session. As before, all captured animals were recorded and frozen for later identification.

Following the trapping sessions, a literature review was conducted on the observed and trapped wildlife species to evaluate life history information such as home range, habitat preference, mobility, breeding, dispersal, and other factors. This information, in conjunction with the trapping data, was used to create a matrix (Appendix D) to determine the effects of changing the hydrologic regime toward the historically more fluctuating scenario on mammals at Smith and Bybee Lakes.

RESULTS

Observations

Eighteen mammal species were observed on the SBLM (Table 11). Of those 18 species, the presence of 16 were first-hand sightings of individuals — including trapped species — or observations of sign (scats, tracks, roadkills, etc.) by the investigators. The other two species (long-tailed and short-tailed weasels) were from documented sightings (Gaddis 1987). Terrestrial species (e.g. deer, raccoon, and coyote) were observed (sightings and/or sign) throughout most assemblages. Observations of the semi-aquatic species (e.g. beaver, mink, and nutria) tended to be in the aquatic assemblages or near the edges of the open water. Some beaver sign — trials and cuttings — were observed some distance (100+ m) from the open water. Beaver appeared to be traveling this distance in search of preferred tree species for food.

TABLE 11

MAMMALS SEEN AT SMITH AND BYBEE LAKES

Common Name	Latin Name
Beaver	*Castor canadensis*
Coyote	*Canis latrans*
Deer	*Odocoileus hemionus*
Deer mouse	*Peromyscus oreas*
Domestic Cat	*Felix cattus*
Domestic Dog	*Canus familiaris*
Eastern cottontail	*Sylvilagus floridanus*
Long-tailed weasel	*Mustela frenata*
Mink	*Mustela vison*
Muskrat	*Ondatra zibethica*
Nutria	*Myocaster coypus bonariensis*
Oppossum	*Didelphis marsupialis virginiana*
Raccoon	*Procyon lotor*
Red Fox	*Vulpes fulva*
River Otter	*Lutra canadensis*
Short-tailed weasel	*Mustela erminea*
Townsend's mole	*Scapanus townsendi*
Townsend's vole	*Microtus townsendi*
Trowbridge's shrew	*Sorex trowbridgi*
Western pocket gopher	*Thomomys talpoides*

Small mammal trapping

Three small mammal species were trapped during the two trapping sessions; Townsend's vole (*Microtus townsendii*), Trowbridge's shrew (*Sorex trowbridgii*), and deer mouse (*Peromyscus maniculatus*). To calculate trapping success for each session, and by assemblage, the number of individuals caught was divided by the number of trap nights in the following formula:

$$\text{Trap Success} = \frac{(\text{\# of captures})}{(\text{\# of traps})\ (\text{\# of nights})}$$

During fall trapping, a total of 243 traps were set in eight assemblages for three consecutive nights each, or 729 total trap nights. Forty one captures were made and total trap success was 0.056 captures/trap night (Table 12). Combining data of species captured and transects within the same vegetative assemblages allows comparison of total captures/trap night by assemblage (Table 13). Trapping success ranged from 0.0 to 0.185. The Pond Emergent and the Oregon Ash Forest communities had the highest success with 0.185 and 0.167 captures/trap night, respectively. The Columbia Sedge and the Reed Canarygrass communities had the lowest success with 0.0 and 0.28, respectively.

Deer mice, an extreme generalist species, had the highest frequency of captures (28) and were trapped in all assemblages except the Columbia Sedge. Eleven Trowbridge's shrews, also a generalist species, were captured in six of the assemblages. The two assemblages — Mixed Deciduous Forest and Columbia Sedge — that had no captures of shrews are not considered preferred shrew habitat (Brown et al. 1985). The species with the lowest frequency of capture (2) was the Townsend's vole. The Townsend's vole is found in a variety of plant community types in this region but requires dense grass-forb vegetation for cover (Brown et al. 1985). Dense grass-forb vegetation is lacking in most of portions of the forested communities because of the closed canopies.

During spring trapping, a total of 132 traps were set in six assemblages for three consecutive nights each, or 396 total trap nights. Twenty one captures were made and a total trap success was 0.053 captures/trap night (Table 13), which is similar to total success in the fall session. Combining data of species captured and transects within the same vegetative assemblages allows comparison of total captures/trap night by assemblage (Table 14 and 15). Trapping success by assemblages had less variability than the results of the fall trapping period; trap success ranged from 0.037 to 0.074. At least one capture was recorded in each assemblage. The Columbia Sedge community had the highest success with 0.074 which is the complete opposite of fall trapping success. Also reversed was the results of trapping in the Oregon Ash Forest, which had the second highest capture success in the fall , and the had the lowest success with 0.037.

As in the fall session, deer mice had the highest capture of frequency (12) and were trapped in half of the assemblages. Deer mice were again absent from the Columbia Sedge community. The four Trowbridge's shrews captures occurred in only two of the six assemblages and were the lowest frequency of capture of the three species. One shrew was captured in the Columbia Sedge community which is not considered good habitat for the Trowbridge's (Brown et al. 1985). The trap success for Townsend's vole was over four times that of the fall session (0.0027 vs. 0.0126). The Townsend's vole was also captured in half of the assemblages. Three of the five vole captures were in the Reed Canarygrass.

TABLE 12

RESULTS OF THE FALL 1992 SMALL MAMMAL TRAPPING AT SMITH-BYBEE LAKES, PORTLAND, OREGON

			Species Captured		
Transect	**Habitat Type**	**# of Traps**	**Sorex trowbridgii**	**Peromyscus maniculatus**	**Microtus townsendii**
1-1	7	24			1
1-2	11	18	2	7	
1-3	7	18	1	1	
3-1	10	12			
3-2	3	9		1	
4-1	13	18		5	
4-2	10	21	1	4	
4-3	3	9			
4-4	6	3			
4-5	6	6			
4-6	5	9	1	4	
4-7	7	18	2		
4-8	3	9	2	1	
4-9	3	6	1	1	
4-10	13	15			1
4-11	12	12		1	
5-1	12	12	1	3	
5-2	10	24			
	TOTAL	243	11	28	2

Vegetation Assemblages

3 - Shoreline Emergent
5 - Pond Emergent
6 - Columbia sedge
7 - Reed Canarygrass
10 - Pacific Willow Forest
11 - Oregon Ash Forest
12 - Black Cottonwood Forest
13 - Mixed Deciduous Forest

TABLE 13

RESULTS OF THE SPRING 1993 SMALL MAMMAL TRAPPING AT SMITH-BYBEE LAKES, PORTLAND, OREGON

			Species Captured		
Transect	Habitat Type	# of Traps	Sorex trowbridgii	Peromyscus maniculatus	Microtus townsendii
1-1	7	12	3		1
1-2	11	9			1
3-1	10	12			
4-1	13	18		5	
4-2	10	9		1	
4-4	6	3			
4-5	6	6	1		1
4-7	7	18			2
4-10	13	15			
4-11	12	12			
5-1	12	12		4	
5-2	10	6		2	
	TOTAL	132	4	12	5

Vegetation Assemblages

6 - Columbia sedge
7 - Reed Canarygrass
10 - Pacific Willow Forest
11 - Oregon Ash Forest
12 - Black Cottonwood Forest
13 - Mixed Deciduous Forest

TABLE 14

COMBINED CAPTURE DATA OF THE FALL 1992 SMALL MAMMAL TRAPPING RESULTS AT SMITH-BYBEE LAKES, PORTLAND, OREGON

		Species Captured		
Habitat Type	**# of Traps**	***Sorex trowbridgii***	***Peromyscus maniculatus***	***Microtus townsendii***
3	33	3 (0.030)[1]	3 (0.030)	
5	9	1 (0.037)	4 (0.148)	
6	9			
7	60	3 (0.017)	1 (0.006)	1(0.006)
10	57	1 (0.006)	4 (0.023)	
11	18	2 (0.035)	7 (0.120)	
12	24	1 (0.014)	4 (0.056)	
13	33		5 (0.051)	1 (0.010)

Vegetation Assemblages

3 - Shoreline Emergent
5 - Pond Emergent
6 - Columbia sedge
7 - Reed Canarygrass
10 - Pacific Willow Forest
11 - Oregon Ash Forest
12 - Black Cottonwood Forest
13 - Mixed Deciduous Forest

1 $$\frac{\text{Trap}}{\text{Success}} = \frac{\text{(\# of captures)}}{\text{(\# of traps) (\# of nights)}}$$

TABLE 15

COMBINED CAPTURE DATA OF THESPRING 1993 SMALL MAMMAL TRAPPING RESULTS AT SMITH-BYBEE LAKES, PORTLAND, OREGON

Habitat Type	# of Traps	Species Captured		
		Sorex trowbridgii	Peromyscus maniculatus	Microtus townsendii
3	33	3 (0.030)[1]	3 (0.030)	
5	9	1 (0.037)	4 (0.148)	
6	9			
7	60	3 (0.017)	1 (0.006)	1(0.006)
10	57	1 (0.006)	4 (0.023)	
11	18	2 (0.035)	7 (0.120)	
12	24	1 (0.014)	4 (0.056)	
13	33		5 (0.051)	1 (0.010)

Vegetation Assemblages

6 - Columbia sedge
7 - Reed Canarygrass
10 - Pacific Willow Forest
11 - Oregon Ash Forest
12 - Black Cottonwood Forest
13 - Mixed Deciduous Forest

1 $$\frac{\text{Trap}}{\text{Success}} = \frac{(\text{\# of captures})}{(\text{\# of traps})\ (\text{\# of nights})}$$

DISCUSSION

Observations

The mammalian species observed during this study are all common species to this region of the Columbia River lowlands. Other less conspicuous mammals such as several species of bats, Bushy-tailed wood rat (*Neotoma cinerea*), vagrant shrew (*Sorex vagrans*), striped skunk (*Mephitis mephitis*), and bobcat (*Lynx rufus*) were not observed during the study, but are likely to occur on the SBLM as residents or as occasional visitors due to the availability of suitable habitat.

Populations levels of the observed or trapped mammal species were not determined. However, general observations on the frequency of sightings or sign were noted. Nutria, raccoon, opossum, and beaver sign was very common, it appears that many individuals of these species utilize the SBLM.

Beaver and nutria have sufficient numbers of individuals in SBLM to have impacted the vegetation in some areas. The nutria have made many burrows and trails along the lakes and channels. The areas of the burrows and trails are generally devoid of vegetation in contrast to areas with few or no nutria burrows. Nutria impacts are also evident in many emergent wetland habitats near open water that contain lush, palatable vegetation. The vegetation in these localized areas have been severely grazed, thus reducing vegetative cover.

The beaver have also impacted herbaceous vegetation at or near the water by digging burrows and establishing trails on and along the lake and channel banks. However, the most obvious impacts have been to the willow and ash trees near the water. Persistent high water levels since the water control structure was built have created year-round suitable habitat for beaver allowing easy access to the trees along the shores of the lakes. To compound the problem, much of the areas formerly forested are now covered by water and dead willow (Dead Willow Community). Willow is a preferred food of beaver, resulting in continued heavy use of the remaining live willows. Beaver have recently been observed cutting down several Oregon ash, a secondary food source, some of which are older trees (greater than 18 inch diameter). In addition, beaver have selected the few relatively large red alder near the turtle ponds. It is likely with persistent high water that beavers will continue to impact the willow and ash forest assemblages.

Small mammal trapping

Small mammal populations are highly variable between seasons and/or years. Population variability makes it difficult to statistically base conclusions on the data set from the two mammal trapping sessions. Consequently a trapping approach that gave preliminary evidence of the species richness and habitat use was chosen. The data collected from the trapping effort assisted in accomplishing the objectives of the study and allowed for a descriptive comparison of the trapping results.

Of the three species captured the deer mouse was the most frequently encountered and was found in all but the Columbia Sedge community. The deer mouse is the most wide spread mammal in North America and is found in almost every habitat type that supports terrestrial mammals (Ingles 1965). Deer mice also play an important role as a prey species for most predatory birds and mammals. Trap success for deer mice was the highest in the Ash Forest and Pond Emergent assemblages in the fall and Black Cottonwood and Mixed Deciduous Forest in the spring.

Trowbridge's shrew was the second most frequently trapped species and was located in all but the Mix Deciduous Forest. Brown et al. (1985) describe primary shrew use of riparian areas to be large sawtimber and old growth in hardwood assemblages and further assert that deciduous hardwood forest are not their preferred habitat. Closed canopy pole-size hardwood habitats are considered secondary habitat. They found that the use of herbaceous wetland habitats is limited. Ingles (1965) states that Trowbridge's shrew in California use meadows. The trapping data for this study found that four of the five highest trap successes for shrews were in the herbaceous assemblages. Shrews were only captured in the Reed Canarygrass and Columbia Sedge communities in the spring session. Trowbridge's shrews are said to have a diet that includes a considerable amount of plant material (Ingles 1965).

Townsend's vole had the least overall frequency of capture. Voles were found in half of the assemblages. As previously stated, Townsend's voles prefer dense grass-forb vegetation for cover (Brown et al. 1985), and open grasslands in low country (Ingles, 1965). Succulent stems and leaves of forbs (not grasses) are the chief food. The Black Cottonwood and Pacific Willow Forest lacked a dense herbaceous layer due to seasonal flooding and a closed canopy. The Shoreline Emergent and Pond Emergent assemblages, which were only trapped in the fall, contained dense herbaceous vegetation although this was only seasonal. Seasonal inundation of these assemblages may be the reason for not capturing voles in these areas.

The combined fall data showed the Pond Emergent and the Oregon Ash Forest communities with the highest trap success. However, the Oregon Ash community had the lowest trap success during spring trapping. The reverse is true for the Columbia Sedge which had no captures in the fall but highest trap success (0.074) of any of the assemblages in the spring.

Prior to beginning the spring trapping it was hypothesized that trap success may increase because small mammals were likely to be "crowded" into the non-inundated areas of the study area. This did not materialize although trapping success within most of the assemblages were different between the two seasons. It is difficult to explain the changes of trap success by assemblage and species for the two seasons when considering the limited sample set and the numerous variables that where not measured during the sampling period (e.g. seed production, weather, invertebrate populations, etc.).

The data showed that the mammals utilized most of the assemblages during some portion of the year even if those assemblages are not considered preferred by a specific species. More trapping sessions over a longer period of time would likely reduce the variance of the trapping results and allow identifying habitat use patterns. However, existing data demonstrates the importance of a mosaic of diverse vegetation assemblages within a given area. Small mammals have relatively small home ranges and it is important to have all life requisites within close proximity. Assemblages that provide preferred vegetative and animal food sources, cover and suitable nesting sites are likely utilized year round. Assemblages that provide only some of the life requisites (e.g. cover) may be utilized only during certain times of the day or year and the degree of use may be determined by habitat quality of adjacent assemblages.

Overview

Changing water levels are a fundamental variable in determining species diversity and abundance at Smith and Bybee Lakes. The water levels influence the vegetative composition and the suitability of habitat for most of the species. Inundation reduced the amount of available habitat for the terrestrial species for several months each year. When the water recedes, the lush emergent vegetation that grows in many areas provides quality food and cover for most of the mammalian species. The permanent water that remains in the lake basins because of the water control structure is providing suitable habitat for beaver, otter, nutria and muskrat). If the amount of permanent water was reduced the amount of suitable habitat for aquatic dependent species (mink, otter, beaver, muskrat and nutria) would decrease and their populations would likely decline.

RECOMMENDATIONS

Water levels in the lakes should be managed to increase fluctuations in a manner that mimics something closer to the historic regime. Management of marsh and seasonally flooding emergent wetlands offer tremendous potential for restoring some natural wetlands. Exposure of soils allows germination of plants, which produce abundant seeds, tubers, and browse for wildlife including invertebrates (Reid et al. 1989). Increasing the diversity and abundance of palatable vegetation, seed producing vegetation and invertebrate populations should assist in maintenance of healthy populations of most mammals on SBLM. This increase in emergent vegetation coincides with the time of dispersal for many breeding populations of small mammals. Juvenile dispersing animals make up a key component of the diet of most of the terrestrial carnivores (as well as raptors).

Seasonal fluctuation in water levels would reduce the amount of suitable habitat for beaver, nutria and muskrat during summer and fall. If water levels drop low enough, den (especially bank dens) would become exposed to greater risk of predation. Reduced water levels would produce conditions that encourage emigration of young of these species likely reducing the overall populations. The reduction of beaver and nutria populations is a desired objective at this time given the vegetation impacts created by these two species.

Beaver will continue to impact willow, ash and alder trees until a new management strategy is implemented. Beaver trapping and relocation may be one consideration to help temporarily reduce local populations. Fencing of individual trees (particularly older ash trees) should be considered to protect them from being cut down or girdled.

FUTURE RESEARCH DIRECTION

1. The response of the vegetative assemblages to changing water regimes and changes in wildlife populations should be systematically monitored and evaluated. Wildlife monitoring may include a) census and monitor of the existing beaver and nutria populations to see how they are effected by changes in water regime in the lakes and b) conduct small mammal trapping surveys in the future to reevaluate species richness throughout the various vegetation assemblages sampled here.

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TABLE 16

RESULTS OF WATERFOWL AND SHOREBIRD SURVEYS AT BYBEE AND SMITH LAKES, PORTLAND, OREGON. NOVEMBER 1992 AND FEBRUARY 1993

BYBEE LAKES

Species	Field Visit 10/3	Field Visit 10/27	Field Visit 2/10
American Coot	12		3
Canada Goose		15	10
Cinnamon Teal		80	158
Common Merganser	2	2	7
Double crested Cormorant			10
Dowitcher	3	1	
Gadwal			7
Great Blue Heron	12	8	7
Greater Yellowlegs	6	2	
Green wing Teal	2	3	3
Killdeer	2	2	
Kingfisher	3	4	1
Mallard	30	20	77
Northern Pintail			29
Snipe	7	3	
Spotted Sandpiper	6	6	
Wigeon	12	6	480
Wood Duck	37	1	
Total	**134**	**153**	**792**

Survey results were compared to counts by Oregon Department of Fish and Wildlife for Sauvie Island and occasional Smith and Bybee surveys, and US Fish and Wildlife Service, State of Washington for Ridgefield Wildlife Refuge and Vancouver Lake Bottoms. These areas are in the same flyway and provide similar habitat conditions for waterfowl and shorebird species. Appendix F shows the results of waterfowl counts in the Lower Columbia River, including Sauvie Island, Ridgefield, Vancouver Lowlands and Smith and Bybee Lakes for the years 1985- 1993, excluding 1990 -1991. Until 1993, no formal shorebird counts were conducted for the Lower Columbia River and interior Willamette Valley. As mudflat habitat is quickly disappearing, documentation of shorebird species and numbers becomes increasingly more critical.

The 1992 and 1993 waterfowl counts were for the entire area called Lower Columbia River, spanning both Oregon and Washington along the Columbia River Portland-Longview, rather than

TABLE 16 CONTINUED

RESULTS OF WATERFOWL AND SHOREBIRD SURVEYS
AT BYBEE AND SMITH LAKES, PORTLAND, OREGON.
NOVEMBER 1992 AND FEBRUARY 1993

SMITH LAKE

Species	Field visit 10/3/92	Field Visit 10/20/92	Field Visit 2/10/93
American Coot			31
American Pintail			4
American Wigeon			
Belted Kingfisher		1	2
Canvasback		2	4
Cinnamon Teal		2	62
Common Merganser			3
G. Yellowlegs	4	2	
Gadwall			70
Great Blue Heron	3	5	2
Gr Wing Teal	4	2	10
Greater Scaup			280
Killdeer	1	1	
Long billed Dowitcher	7	6	
Mallard		10	60
Snipe	1	5	
Spotted Sandpiper	2	4	
Total	**22**	**40**	**528**

tabulated for individual areas as in the previous years. The lowest counts for all species were in 1985, while the next year 1986 had high counts for most species in all four locations. 1985 count numbers at Smith and Bybee Lakes were higher than the number of birds seen at Smith and Bybee Lakes in 1992/93 for all species counted both times. The counts for the Lower Columbia River area had a dramatic decline from 1992 to 1993. Weather can be a large factor in numbers of birds and migration routes and feeding locations. 1993 was a very cold year with abnormal amounts of snow and ice. Counts need to be conducted during fall and spring migration and mid-winter of each year. Count should be done on or around the same dates each year, if weather conditions are similar, in years of varying weather conditions, data sampling dates should shift to allow for data collection during similar weather conditions.

DISCUSSION

Table 17 identifies the habitat, food, nesting and seasonal occurrence of the shorebird and waterfowl species seen at Smith and Bybee Lakes. Nesting information is only given for those species that are known or have a high potential of nesting at SBLM.

TABLE 17

FOOD HABITAT AND NESTING REQUIREMENTS OF SMITH AND BYBEE WATERFOWL AND SHOREBIRD SPECIES

SPECIES	HABITAT/LIFE HISTORY	FOOD	NESTING	SEASONAL OCCURRENCE
American Coot	City parks, golf courses, open water ponds and lakes, shallow marshy edges.	Aquatic plants. Aquatic macroinvertebrates, Insects, Molluscs, crustaceans, Spiders.	Over shallow open water and among flooded emergents. Nest made of emergent vegetation.	Common. Resident. Breeder.
American Wigeon	Shallow water, wet cultivated fields, cultivated lawns of parks and golf courses.	Dabbler. 90% vegetarian, sedges, pondweeds, grasses, smartweed algae, duckweed. Small amounts of insects and mollusks.	A hollow on dry ground, often some distance from water, lined with grass, plant stems and down.	Common winter resident and fall and spring migrant.
Black Crowned Night Heron	Marshes at the shallow edge of ponds and rivers. Forages at twilight or at night. Daylight in dense trees shrubs.	Fish, crustaceans, large insects and occasional small mammals and amphibians.	Twigs or marsh plants placed in trees, shrubs or on the ground	Uncommon. Resident.
Bonaparte's Gull	Ponds, lakes, coastal bays.	Crustaceans, insects and isopods.		Uncommon. Migrant.
Canada Goose	Lakes, streams, wetlands, cultivated lawns and farm fields. During July loose all their flight feathers, require thick sedges and grasses to hide.	Largely vegetarian, in winter agricultural grain and corn. In marshes; sedges, grasses, aquatic plants, insects, small crustaceans and mollusks	Built up mound of grass, rush leaves, rushes and other vegetation filled with down. Birds mate for life.	Common. Resident. Breeder

TABLE 17 CONTINUED

FOOD HABITAT AND NESTING REQUIREMENTS OF SMITH AND BYBEE WATERFOWL AND SHOREBIRD SPECIES

SPECIES	HABITAT/LIFE HISTORY	FOOD	NESTING	SEASONAL OCCURRENCE
Caspian Tern	Shallow lakes and marshes.	Small, slow-moving fish.		Uncommon. Summer resident. Breeder.
Common Merganser	Large open lakes and rivers.	Fish, mostly slow moving non-game species.	Tree cavities when available, otherwise on the ground.	Common. Winter residents and regular migrants.
Common Snipe	Open marshlands, preferring sedge meadows to dense cattails. Any grassy field that is partially flooded.	Forage in dense low marsh vegetation; bulrush, sedge, smartweed and burreed, or open plowed fields. Rarely feed on mudflats. Terrestrial and aquatic invertebrates, crustaceans, earthworms and small fish.	Well concealed, among dense sedges and grasses at the edge of marshes and flooded fields. Male stays around through incubation and assists in care of young.	Common. Resident, breeders, some migrants. April-October are the times of most abundant number of individuals.
Double Crested Cormorant	Occurs regularly on fresh water Lakes and rivers.	Sculpin, carp, suckers other small fish, some crustaceans, captured underwater.	2 ft. platform or mound of sticks and trash placed among spreading tree branches, or in colonies on rock ledges or island. Incubation shared by both adults.	Common. Resident.
Gadwall	Marsh bordered lakes and small ponds. Wet grasslands and fields.	Surface feeder. Primarily vegetarian, in summer eats animal matter. Pondweed, sedges, grain, insect larvae and water beetles. Usually feeds by dabbling in marshes and sloughs but can dive.	A down-lined hollow in thick grass or under brush.	Uncommon - Resident. Very occasional breeder.

TABLE 17 CONTINUED

FOOD HABITAT AND NESTING REQUIREMENTS OF SMITH AND BYBEE WATERFOWL AND SHOREBIRD SPECIES

SPECIES	HABITAT/LIFE HISTORY	FOOD	NESTING	SEASONAL OCCURRENCE
Great Blue Heron	Lakes, ponds, fresh water rivers and small streams, marshes, meadows, upland fields. Nest in tall trees.	75% fish,, crustaceans, frogs, salamanders, lizards, snakes, large aquatic insects, small mammals	2 ft. platform or mound of sticks and trash placed among spreading tree branches, in colonies	Common. Resident Breeder.
Greater Scaup	Small ponds and larger streams and rivers.	Diving Duck. Small fish, mollusks and crustaceans, worms, seeds, leaves and soft stems of a variety of water plants.		Uncommon. Winter resident, fall migrant.
Greater Yellowlegs	Extensive lake margins and mudflats.	Feeds in water commonly to several inches deep. Eat insects, crustaceans, molluscs and fish on or below the water surface.	Coniferous forested wetlands in the boreal forest zone. Well hidden in open sedge and grasses or low shrubs or open woodlands, often near water, partially screened by log and vegetation.	Common Migrant. March-May July-October. Occasional wintering individuals.
Green-backed Heron	Wood or log strewn streams, ponds and lakes	Fish, insects, aquatic and terrestrial invertebrates.	Sticks, amid outer or upper dense branches of trees	Uncommon. Resident Breeder.
Green-winged Teal	Marshes, small ponds, inland sloughs.	Dabbler.Tend to feed along the edges of marshy ponds. Primarily vegetarian, seeds of sedges, pondweeds, grass, smartweeds, duckweeds and other aquatic plants.	Down-lined hollow in grass or marsh.	Common. Winter resident..

TABLE 17 CONTINUED

FOOD HABITAT AND NESTING REQUIREMENTS OF SMITH AND BYBEE WATERFOWL AND SHOREBIRD SPECIES

SPECIES	HABITAT	FOOD	NESTING	SEASONAL OCCURRENCE
Killdeer	Gravel bars, muddy or grassy shores shores of ponds and lakes	Insects are primary year round food.	In almost any open natural substrate proximate to water. Both sexes incubate. May have two broods per year.	Common. Resident Breeder. March -October
Long-billed Dowitcher	Freshwater marshes and dry lakes	Aquatic insects, mollusks, crustaceans, seeds of aquatic plants	On small rises in wet marsh areas.	Uncommon.Migrants, April-mid-June, July-December.
Mallard	Lakes, streams, wetlands, cultivated lawns and farm fields. During July loose all their flight feathers, require dense vegetation to hide.	Dabbler.75% of food is plant material, including seeds of rushes and sedges, pondweeds and grasses, water insects, snails, small crustaceans and earthworms	feather-lined shallow cup of grass or sedges, usually placed amid dense marsh plants or grass within 1 mile of water. Forms pairs in the winter	Common. Breeders. Year round resident.
Northern Pintail	Marshes, lakes, wet fields and grasslands.	Dabbler. 75% of food is plant material, including seeds of rushes and sedges,pond-weeds and grasses, water insects, snails, crane fly larva, dragonfly nymphs, small crustaceans and earthworms. In mudflats high percentage of worms and crustaceans	A down-lined hollow; in marsh or prairie.	Common. Winter resident and fall and spring migrant.

TABLE 17 CONTINUED

FOOD HABITAT AND NESTING REQUIREMENTS OF SMITH AND BYBEE WATERFOWL AND SHOREBIRD SPECIES

SPECIES	HABITAT/LIFE HISTORY	FOOD	NESTING	SEASONAL OCCURRENCE
Northern Shoveler	Shallow lakes with abundant growth of tiny suspended plants and animals that they can filter.	Dabbler. Buds and shoots of young water plants, a great variety of aquatic worms, insects, snails, and tadpoles.		Common, fall migrant and winter resident.
Solitary Sandpiper	Freshwater ponds. Favors muddy ponds that dry up in late summer. Margins of heavily forested ponds and lakes	Feed in shallow water for invertebrates from the surface. They also probe in the mud and water.	Breed in boggy areas, near open water, in a-coniferous forest. Nest in trees in cup nests.	Uncommon. Migrants. April-May July-October
Spotted Sandpiper	Shores of lakes, ponds, marshes, rivers and streams.	Eat invertebrates from dry or moist substrates at the junction of water and land. May forage and rest on floating logs.	Nests are generally near water, partly concealed by projecting objects on sparsely vegetated gravel substrates or in well hidden grasses and sedges.	Common. Breeder. May-August. Occasional wintering birds.
Wood Duck	Waters with wooded shorelines.	Dabbler. Mostly vegetable matter, including duckweed, pondweed, seeds of sedges and various plants in and out of the water, including nuts. Small proportion of dragonflies, damselflies, grasshoppers and crickets.	Natural cavities of trees or in man provided boxes.	Common. Resident. Breeder.

TABLE 14

NUMBERS OF VEGETARIAN, CRUSTACEAN AND INSECT EATERS AND BOTH BY RESIDENT AND MIGRANT SPECIES.

	Vegetarian	Crustaceans, Insects	Both
Resident	6	5	1
Migrant	2	6	3

Availability of food source is critical during spring and fall migration, as well as during the breeding season. Filling wetlands and streams, and channelization and shoreline riprapping along the Columbia River and Slough have resulted in loss of mudflat and emergent wetland habitat which are critical to resident and migrating shorebird and waterfowl species.

Controlling water level into Smith and Bybee Lakes has reduced the degree to which of the lakes empty annually during the summer and fall and the degree to which they receive a fresh water influx during the winter and the spring. Current hydrodynamic conditions and water quality limit the number of invertebrate and plant food species as well as the amount of available emergent and mudflat habitats critical to shorebird and waterfowl species.

RECOMMENDATIONS

1. Lake levels should be allowed to fluctuate with the freshets depending on water levels in the Columbia and Willamette Rivers, seasonally. Greater seasonal fluctuations in water levels will increase available food (vegetation, aquatic macroinvertebrates, amphibians and reptiles), and increase habitat for waterfowl and shorebird species. Fluctuating water levels will provide more critical food for fall-migrant shorebird and waterfowl species.

2. Increasing fluctuations will raise winter water levels, providing greater open water habitat needed by resident and migrant waterfowl.

CONTINUING
RESEARCH AND MONITORING

1. Shorebird counts of the lakes should be done monthly in Spring and Fall. This should be done starting this spring and continue for a minimum of five years after lake levels are managed to replicate historic conditions. An indefinite long-term monitoring program should be initiated to assist in management in identifying trends.

2. Creation of mudflat habitat should be explored. Portions of the dead willow assemblage may provide the ideal location. The process and feasibility of creating mudflat habitat should be examined.

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CHAPTER 6
DISCUSSION

The direction of habitat change at Smith and Bybee Lakes (SBLM) is linked to the differences between current and historic flooding regimes. Differences are identifiable at two levels:

1) attenuation of seasonal fluctuation in water inputs to the lakes because of modified patterns of upstream water-use (flow regulation (dams) and diversion), and
2) attenuation of the seasonal and diel fluctuations in lake level because of the fixed minimum-level structure on the out-flow to the system.

Both decrease in the water volume of and the attenuation of seasonal fluctuations in water flowing to Smith and Bybee Lakes is traceable to two modifications. First, elimination of the the inflow into SBLM through Smith Lake by being cut off at the level of North Portland Boulevard has resulted in precipitation being the significant surface water input except when freshets of the Columbia and Willamette Rivers back water into the system (Beeman et al. 1987). Second, changes in the levels of any water being backed into the system takes place through regulation of flows by dams and upstream withdrawal in the Columbia and Willamette Rivers (Army Corps of Engineers 1982). Precise identification of when these long-standing patterns initiated the major habitat changes now observed is not possible because key aspects of habitat were not measured during the period of change (e.g., the earliest major studies of water quality in the Columbia slough date from the early 1970s (Geiger 1987a)). However, some key changes in water quality are likely to have occurred by the 1950s because the bullfrog, a low-water quality tolerant species, had become well-established in the Columbia Slough by that time (R. Macy, personal communication). An unmeasured, but historically known pattern of inputs from sewage, slaughterhouse wash, and various polluted groundwater leachates undoubtedly aggravated the water quality problems in the Columbia Slough (Geiger 1987a) and likely helped establish the current pattern of high benthic BOD and an invertebrate fauna dominated by hypoxia-tolerant species in Smith and Bybee Lakes (see Chapter 2). A few contaminant problems have been eliminated, and others reduced, but only minor improvements in water quality over the past 20-odd years indicate that contaminant sources eliminated or reduced may not be the primary factors influencing water quality in this system.

The pattern of attenuation of seasonal flows through regulation of upstream inputs was begun in the 1930s and most structures that create the current pattern were in place by the late 1960s (Army Corps of Engineers 1982). Some changes in upstream input continue to occur as a result of withdrawals for agriculture that still show increases in recent years. Since the placement of the fixed outflow structure in the interval 1982-4, this attenuation has probably decreased the magnitude of flow from North Channel into Smith and Bybee Lakes.

Placement of a fixed structure on the outflow to the Smith and Bybee lakes during the interval 1982-4 has resulted in visibly significant and dramatic changes. Structural failures and vandalism have complicated interpretation of the effects of this structure on the SBLM, but loss of the ca. 500 acres of mostly Pacific willow *(Salix lasiandra)* predicted in 1987 (Geiger 1987b) has been realized. Continuous inundation because the outflow structure prevents the lakes from drying is thought to have killed the willows because their roots were in a continuously hypoxic environment. This condition also favors a fauna that can tolerate hypoxic conditions, and includes the species that now dominate this aquatic system (i.e., bullfrogs, carp, oligochaete worms, and chironomid midges). Other salient effects of continuous inundation are near elimination of the area of seasonally exposed lake bottom and an increase in the area of submergent and emergent macrophytes (Geiger 1987b). While the area for macrophytes is theoretically increased, the hypoxic substrate will likely favor only those species with low-oxygen tolerant roots. It needs emphasis, however, that the 1982-4 control structure was only the most recent of several historical attempts to control the level of Smith and Bybee lakes (Geiger 1987b), and that a high benthic BOD was already characteristic of the flooded system in 1971, when water quality studies were initiated (Department of Environmental Quality 1974). As a consequence, continuos inundation creating benthic hypoxia was likely responsible for tree willow mortality, and it no doubt aggravated a probably already relatively high BOD, but may not have been the cause of the latter.

The high BOD in Smith and Bybee Lakes may be related to the forcing of nitrogen and phosphorus into this system, creating eutrophic conditions (Department of Environmental Quality 1974, Geiger 1987a). In the absence of historical data, it is impossible to evaluate just how eutrophic Smith and Bybee lakes became during the summer season when inflow into Smith Lake from the Columbia River was still open. However, the lack of significant anthropogenic sources of eutrophication as well as undoubtedly more fluctuating historical water levels, especially due to the Columbia River freshet probably resulted in less eutrophication than is observed today, especially early in the season. Since the attenuated fluctuation probably encourages the nutrient contribution, the historical fluctuations of the Columbia and Willamette were probably important in limiting eutrophication. If the sediment is the source of fertility, another alternative would be to somehow limit sediments inputs that contribute to eutrophication.

The relative longer intervals of inundation of transitional areas (between wetlands and uplands) may also have influenced the pattern of existing vegetation. In the SBLM, herb-dominated transitional areas are almost exclusively occupied by reed canarygrass. While reed canarygrass is known to tolerate considerable inundation (Geiger 1987b), it is unclear whether the post-1982-4 inundation regime has facilitated its expansion. Because reed canarygrass may have few herbivores, understanding its response is of some significance, because its presence may have cascade-type effects on the dimensions of the local food web.

The existing pattern of inundation at SBLM may be approaching an equilibrium because the area of dead willows no longer appears to be increasing. If the current pattern of inundation continues, the snags from the willows already dead, many of them now blown over, will ultimately disappear. Under the existing pattern, the bottom would continue to be hypoxic and support a hypoxic-tolerant fauna. Based on this analysis, bullfrogs are also likely to have reached an equilibrium that may not change unless the pattern of inundation changes. Whether subtle, longer time scale changes may be occurring to this fauna is not known; this kind of change may also apply to the reedcanary grass-dominated transitional areas.

CHAPTER 7
RECOMMENDATIONS

Based on the results of the vegetation and faunal studies completed, the following general management recommendations are proposed for the Smith and Bybee Lakes Management Area. Each study concluded that increasing the existing pattern of fluctuation in water levels is likely to benefit the native biota of the Smith and Bybee Lake Management Area. Many recommendations are similar to those made for the groups of organisms in the chapters of this report, but they are here in context of the entire management area and how it relates to those specific groups.

1. Water levels should be allowed to fluctuate with the changes in the levels of the Columbia and Willamette Rivers by removal of the existing structure on the outflow to the lakes. (Figure 9 shows Columbia River stage levels from 1973 and 1992 taken at Vancouver Station). This will result in larger seasonal fluctuations as the result of the freshets of the Columbia and Willamette Rivers, and lessen diel fluctuations in these systems as a result of tidal movements. Such a pattern would be an approach toward fluctuations observed historically. While fluctuations cannot be restored to historical pre-dam levels because of regulation of flows, this fluctuation will expose a significant amount of lake edge seasonally and less amount on a daily basis. Such fluctuations will also permit a relative increase in winter water levels. Such a regime would benefit native plants, macro-invertebrate, amphibians and reptiles, mammal and bird species because it would promote:

a) A more diverse and abundant invertebrate macrofauna as a food resource. Exposure of a large amount of lake bottom is expected to promote establishment of a diversity of benthic invertebrates not dependent on the largely hypoxic benthic conditions that result from a pattern of continuous inundation, and encourage growth of seasonally exposed emergent vegetation upon which a diversity of non-benthic invertebrates could complete their life cycle. The die exposure will probably also contribute to unrecognized invertebrate diversity.

b) Seasonally exposed emergent vegetation that provides a food source for some amphibian, mammal and bird species as well as the key cover for the two native amphibians and two snake present.

c) Seasonal reduction in lake area would reduce the amount of habitat for exotic plant species and warmwater predators (bullfrogs, bullhead, carp, various sunfishes, etc.). Even if seasonal reduction did not result in lake drying, it would force bullfrogs and remaining fishes into shallower water, making them more vulnerable to predation by wading and other birds.

d) Open water habitat for overwintering shorebirds and waterfowl would increase.

2. The aforementioned changes in hydrologic regime would reduce available habitat for the semi-aquatic mammals, nutria and beaver, and encourage their emigration. This could be a significant benefit because these mammals currently threaten the habitat structure and integrity of several vegetation assemblages on site.

3. Management of purple loosestrife, reed canarygrass, and Himalayan blackberry should be encouraged. Data on reed canarygrass response to manipulation of water levels are currently too vague to provide a good prescription. The only really successful attempt to reduce reedcanary grass has been the fall burning regimes that have been implemented at Finley National Wildlife Refuge, and it is not clear exactly what kind of frequency is needed to effect the desired level of control. Attempts at management of reed canarygrass should be encouraged, but should be treated as experimental until a satisfactory prescription is refined. Purple loosestrife should be pulled June - October of each year and be properly disposed of off site. Himalayan blackberry removal should be done manually during the winter and early spring. Removal of any of these three species should be with a minimum of soil disturbance to avoid encouragement of other exotic species. Native plants that match the hydroperiod and amount of direct sun should be planted immediately upon removal of the exotic species. Continued monitoring and removal of these exotic species must continue for a minimum of five consecutive years, to insure total elimination of roots and seed source.

4. A long-term monitoring program needs to be established in order to evaluate changes in vegetation assemblages, plant , macro-invertebrate, amphibian and reptile, mammal and bird species occurrences and numbers. An annual assessment of the Smith and Bybee Lakes ecosystem, including its health and direction of change must also be evaluated in order to determine whether the management implementation program especially with regard to modification of the water regime has been effective in making changes in the anticipated direction The results of the assessment should be used to identify changes in the management program, progressively refining the direction of subsequent management.

Suggestions made here must be viewed as experimental despite the fact that every attempt has been made to base them on the best available data. As a consequence, the degree to which management suggestions are implemented should be tracked with some kind of monitoring to identify the effectiveness of the management alternatives implemented. This is the only way to determine whether or not the management implemented has had the desired effect. Such an assessment will provide crucial guidelines for modification of subsequent management.

APPENDICES

APPENDIX A

PLANT LIST

APPENDICES

Appendix A. Plant species observed on Smith and Bybee Lakes, 1992-1993. Species codes are assigned using the first two letters of the genus and species.

CODE	SCIENTIFIC NAME	COMMON NAME
ACRU	Actaea rubra	W. red baneberry
AGROS	Agrostis sp.	Bentgrass
ALRU	Alnus Rubra	Red Alder
AZME	Azolla mexicana	Mexican water fern
BICE	Bidens cernua	Nodding beggar-tick
BIFR	Bidens frondosa	Leafy beggars-tick
BIVU	Bidens vulgata	Tall beggars-tick
CAAP	Carex aperta	Columbia sedge
CADE	Carex deweyana	Dewey's sedge
CIAR	Cirsium arvense	Canada thistle
CIVU	Cirsium vulgare	Bull thistle
COST	Cornus stolonifera	Red-osier dogwood
CYER	Cyperus erythrorhizos	Red-root flatsedge
DACA	Daucus carota	Queen Anne's lace
ECCR	Echinochloa crusgalli	Barnyard grass
ELOV	Eleocharis ovata	Ovate spikerush
EPWA	Epilobium watsonii	Watson willow-weed
ERHY	Eragrostis hypnoides	Creepinglovegrass
FRLA	Fraxinus latifolia	Oregon ash
GAAP	Galium aparine	Bedstraw
GLEL	Glyceria elata	Tall manna grass
GNUL	Gnaphalium uliginosum	Marsh cudweed
GRNE	Gratiola neglecta	Hedge-hyssop
HEAL	Heleochloa alopecuroides	Heleochloa
HOLA	Holcus lanatus	Velvetgrass
HYPE	Hypericum perforatum	St. John's wort
JUBO	Juncus bolanderi	Bolander's rush
JUBU	Juncus bufonius	Toad rush
JUEN	Juncus ensifolius	Dagger-leaf rush
LEMI	Lemna minor	Duckweed
LEOR	Leersia oryzoides	Rice cutgrass
LUPA	Ludwigia palustris	Water purslane
LYAM	Lycopus americanus	American bugleweed
LYNU	Lysimachia nummularia	Moneyplant
LYSA	Lythrum salicaria	Purple loosestrife
LYUN	Lycopus uniflora	Northern bugleweed
PEPO	Peplus portula	Peplus
PHAR	Phalaris arundinacea	Reed canarygrass
PLSC	Plagiobothrys scouleri	Scouler's popcorn flower
POCO	Polygonum coccineum	Water smartweed
POCR	Potamogeton crispus	Curly pondweed
POHY	Polygonum hydropiper	Marshpepper smartweed
POLA	Polygonum lapathifolium	Curlytop Ladythumb

POPE	Polygonum persicaria	Lady's thumb
POTR	Populus trichocarpa	Black cottonwood
RARE	Ranunculus repens	Creepingbuttercup
RASC	Ranunculus sceleratus	Celery-leaf buttercup
RINA	Ricciocarpus natans	Ricciocarpu
RUDI	Rubus discolor	Himalayan blackberry
RULA	Rubus laciniatus	Evergreen blackberry
SALA	Salix lasiandra	Pacific willow
SAPI	Salix piperi	Piper's willow
SASE	Salix sessilifolia	Soft-leaved willow
SASI	Salix sitchensis	Sitka willow
SCLA	Scutellaria lateriflora	Blue skullcap
SODU	Solanum dulcamara	Bittersweet
SOOC	Solidago occidentalis	Western goldenrod
SPDO	Spirea douglasii	Douglas spiraea
SPPO	Spirodela polyrhiza	Greater duckweed
TYLA	Typha latifolia	Cattail
WOLFF	Wolffia sp.	Water meal
XAST	Xanthium strumarium	Cocklebur

APPENDIX B

VEGETATION SAMPLING DATA SHEETS

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7/29/92 Transect # T1 Personnel LW, EL

Community Type POTR/LYNU Page 3 of 4

TREES - Point-Centered Quarter Method (taller than 2 M)

Sample #	Location (M) meter	Quarter #	Distance ~~(M)~~ (in.)	Species	DBH ~~(cm)~~ in	POTR ba (in²)	SAL
1	[illegible].65	1	6.0 in.	POTR	1.5[illegible]	1.89	
		2	23.5 in.	POTR	2.[illegible]	6.79	
		3	[illegible].5	POTR	[illegible]	0.97	
		[illegible]	46.25	POTR	3.[illegible]	8.14	
2	5.31	1	[illegible].Ø	POTR	[illegible]	1.23	
		2	25.25	POTR	1.13	1.00	
		3	43.2	POTR	3.23	8.19	
		4	41.75	POTR	1.08	0.92	
3	7.29	1	44.Ø	POTR	1.25	1.23	
		2	24.5	POTR	.099	.008	
		3	19.5	POTR	1.53	1.84	
		4	14.5	POTR	1.26	1.25	
4	16.33	1	14.Ø	POTR	1.47	1.70	
		2	74.ØØ	POTR	2.25	3.98	
		3	2.ØØ	POTR	1.54	1.86	
		4	27.ØØ	POTR	1.18	1.09	
5	19.76	1	17.ØØ	POTR	1.08	0.92	
		2	42.25	POTR	1.38	1.49	
		3	15.25	POTR	1.22	1.17	
		4	56.5Ø	POTR	1.6	2.01	
6	23.65	1	37.5	POTR	1.72	2.32	
		2	6.5	POTR	2.13	3.56	
		3	16.Ø	POTR	1.02	0.82	
		4	16.5	POTR	2.09	3.43	
7	27.47	1	25	POTR	1.25	1.23	
		2	23.25	POTR	2.34	4.30	
		3	43.5Ø	POTR	3.37	8.92	
		4	29.00	POTR	2.1	3.46	
8	29.29	1	12.5	POTR	2.3	4.15	
		2	31.5	POTR	2.09	3.43	
		3	42.25	POTR	2.11	3.50	
		4	35.25	POTR	.96	0.72	
9	31.54	1	18.00	POTR	.8Ø	0.50	
		2	28.30	POTR	1.3Ø	1.33	
		3	24.60	POTR	1.31	1.35	
		4	18.18	POTR	2.18	3.73	
10	35.42	1	28.5	POTR	.85	0.57	
		2	31.0	POTR	.94	0.69	
		3	22.75	POTR	.76	0.45	
		4	29.5	POTR	1.19	1.11	
11	43.67	1	39.5	POTR	.95	0.71	
		2	1Ø.Ø	POTR	1.Ø7	0.90	
		3	52.5	SALA	1.8Ø		2.5[illegible]
		4	38.Ø	SALA	2.2[illegible]		3.9[illegible]

TREES - continued

	Sample #	Location ~~(M)~~ m	Quarter #	Distance ~~(M)~~ in	Species	DBH ~~(cm)~~ in	ba(in²)	
	12	43.4	1	66	SALA	1.12		0.99
			2	23	SALA	3.19		7.99
			3	43	SALA	2.57		5.19
			4	23	SALA	2.43		4.64
29	13	49.9	1	11.5	POTR	1.7	2.27	
			2	46.0	POTR	1.04	0.85	
			3	39.0	POTR	.74	0.43	
			4	28.0	POTR	2.22	3.87	
23.4	14	52.4	1	2.0	POTR	.79	0.49	
			2	44.0	POTR	.94	0.69	
			3	4.0	POTR	1.1	0.95	
			4	4.0	POTR	.9	0.64	
	15	57.21	1	153.3	POTR	1.48	1.72	
			2	77.25	POTR	1.41	1.56	
			3	50.24	POTR	1.23	1.19	
			4	95.50	POTR	2.42	4.60	
			TOTAL	1934.72	in Total	ba	118.12	25.
					Mean	ba	2.19	4.

Result:

Mean Distance (D) = 1934.72/60 = 32.25 in = 2.67 ft

Absolute Density = Area/D^2

where D = mean distance

Number of trees per 100 ft² = $100/(2.67)^2$ = 100/7.22 = 13.85 trees per 100 ft²

Absolute dominance = mean basal area (ba) per tree x no. of trees in species

SPECIES	Number in Quarters		Number of Trees in 100 ft²
POTR	54/60 =	0.9	0.9 x 13.85 = 12.465 per 100 ft²
SALA	6/60 =	0.1	0.1 x 13.85 = 1.385 per 100 ft²
			Total 13.85 per 100 ft²

Dominance (as total basal area per species)

POTR	2.19	x 12.465 =	27.3 in² ba per 100 ft²
SALA	4.22	x 1.385 =	5.8 in² " " " "
			33.1 in² / 100 ft²

Absolute frequency = (no. of points w/ species / total points) x 100

POTR	=	14/15 x 100 =	93 %
SALA	=	2/15 x 100 =	13 %
			103 %

Comments: Salix sitchensis present

[illegible] – SW corner of landfill

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7-29-92 Transect # T-2 Personnel EL, LW

Community Type Salix lasiandra / Solanum dulcamara (SALA/SODU) Page 1 of 4

HERBS - Within a 1-M-square quadrat (Pacific willow / bittersweet)

Category		Sample Point No. 1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13 / 33	14 / 34	15 / 35	16 / 36	17 / 37	18 / 38	19 / 39	20 / 40 % Freq.	X̄ cover
Total Cover	1	95	80	90	90	90	90	85	99	90	90										100	89.4
	2	95	80	90	95	90	99	85	90	90	75											
Species:																						
PHAR	1	95						10			T										35	✓10.2
	2	93				T	T				5											
Polygonum coccineum POCO	1		5																		15	✓2.4
	2	2	10																			
Solanum dulcamara SODU	1		75	90	90	90	90	50	4	80	65										90	* ✓63.0
	2		40	90	95	90	90	35	75	40	70											
Polygonum hydropiper POHY	1							.5	T	T	10										30	✓3.3
	2							40		10												
Scutellaria lateriflora SCLA	1							20	95	10	15										35	✓10.0
	2							5	15	40												
Grass sp	1							T													5	<.1
	2																					
Actium Rubra ✓ ACRU	1																					
	2							5	T												10	✓.3
	1																					
	2																					
	1																					
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Comments: * - dominant

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7-29-92 Transect # T-2 Personnel LW, EL

Community Type SALA/SODU Page 2 of 4

SHRUBS - Within a 3-M radius of each sample point

Sample Point No.

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	$\bar{X}$ % cov
Total Cover																					-0-
Litter		20	5	10	10	10	10	10	10	10											9.5
Woody Debris	5																				0.5
Snags																					

Species:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Comments:

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7/29/92 Transect # F2 Personnel LW, EL

Community Type SALA / SODU Page 3 of 4

TREES - Point-Centered Quarter Method (taller than 2 M)

	Sample #	Location (M)	Quarter #	Distance ~~(M)~~ in.	Species	DBH ~~(cm)~~ in	
	1	1.1	1	65.5	SALA	5.34	22.40
			2	96.75	SALA	12.20	116.90
			3	84.75	SALA	9.9	76.98
			4	75.00	SALA	8.18	52.55
1.7		8.9	1	240	SALA	9.90	76.98
1.9			2	58.5	SALA	13.98	153.50
4.1			3	48.0	SALA	18.3	263.02
4.0			4	164.0	SALA	8.36	54.89
6.3		24.0	1	187	SALA	15.07	178.37
1.2			2	108	SALA	9.15	65.76
1.3			3	72.0	SALA	6.91	37.50
2.4			4	174.0	SALA	13.51	143.14
5.9		36.4	1	180.0	SALA	7.66	46.08
2.0			2	57.5	SALA	13.83	150.22
2.6			3	337.0	SALA	12.03	113.66
2.3			4	92.0	SALA	9.43	69.84
2.4		46.8	1	87.0	SALA	7.79	47.66
.5			2	90.0	SALA	16.41	211.50
4.7			3	252.0	SALA	12.36	119.99
1.1			4	249.0	SALA	13.66	146.55
3.0		55.0	1	104.0	SALA	9.65	73.14
3.1			2	100.0	SALA	9.25	67.20
2.4			3	46.5	SALA	11.96	112.34
2.2			4	184.3	SALA	14.26	159.71
3.8		63.1	1	166.0	SALA	2.04	3.27
3.0			2	81.0	SALA	10.11	80.28
			3	193.0	SALA	13.70	147.41
			4	60.25	SALA	2.35	4.34
		75.8	1	7.00	SALA	13.03	133.35
			2	77.00	SALA	2.19	3.77
			3	140.00	SALA	2.18	3.73
			4	65.00	SALA	2.65	5.52
		80.4	1	156.00	SALA	3.46	9.40
			2	204.00	SALA	12.47	122.13
			3	90.00	SALA	14.18	157.92
			4	168.00	SALA	4.09	13.14
	10	92.7	1	214.00	SALA	2.68	5.64
			2	181.00	SALA	11.95	112.16
			3	164.00	SALA	15.70	193.59
			4	144.00	SALA	11.16	97.82
			Total Distance =	5265.05 in	Total	ba =	3653.33
					mean	ba =	91.33

Sample #	Location (M)	Quarter #	Distance (M)	Species	DBH (cm)

Results:

Mean Distance (D) = 5265.05/40 = 131.63 in = 10.97 ft

Absolute Density = Area / D^2
where D = mean distance

Number of trees per 100 ft^2 = $100/(10.97)^2$ = 100/120.32 = 0.83 tree per 100 ft^2

Absolute Dominance = mean basal area (ba) per tree x no. of trees in species

SPECIES	No. in Quarter	No. of trees in 100 ft^2
SALA	40/40 = 1.0	1 x 0.83 = 0.83 trees per 100 ft^2

Dominance (as total basal area per species):
SALA 91.33 x 0.83 = 75.8 in^2 ba per 100 ft^2

Absolute Frequency = $\frac{\text{no. of points w/species}}{\text{total points}} \times 100$

SALA = 10/10 x 100 = 100 %

Comments:

From [illegible] lg. willow 100 ft [illegible]

[illegible] N[illegible] of [illegible]

4.0
3.6
3.9
5.1

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7/30/92 Transect # T-3 15'N Personnel LW MH EL

Community Type Phalaris arundinacea (PHAR) (Reed canarygrass) Page 1 of 1

HERBS - Within a 1-M-square quadrat

Sample Point No.

Category		1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13 / 33	14 / 34	15 / 35	16 / 36	17 / 37	18 / 38	19 / 39	20 / 40	$\bar{X}$ % cover
		2.2	6.8	10.4	14	19.1	23.6	27.1	30.6	31.9	32.5									% veg.		
Total Cover	1	99	99	99	99	99	99	99	99	99	99										100	99.0
	2																					
Species:																						
PHAR	1	99	99	99	99	99	99	99	99	99	99										100	99.0
	2																					
	1																					
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Comments:

No other species present on transect.

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date____________ Transect #____________ Personnel_______,_______

Community Type____________________ Page_____of_____

SHRUBS - Within a 3-M radius of each sample point

	Sample Point No.																			
Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total Cover																				
Litter																				
Woody Debris																				
Snags																				
Species:																				

Comments:

for. ... pond
25 - 85 ft → by willow

T... ... ponded ... ...

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 7/30/92 **Transect #** T-4 **Personnel** LW MH, EL

Community Type Ephemeral pond - Polygonum/Bidens **Page** 1 **of** 1

HERBS - Within a 1-M-square quadrat

Category		1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13 / 33	14 / 34	15 / 35	16 / 36	17 / 37	18 / 38	19 / 39	20 / 40	X̄ % cover
		.45	1.3	2.6	7.2	9.6	11.5	15.1	20.1	22.5	24.3										% freq.	
Total Cover	1	100	100	100	100	100	85	90	95	99	99										100	96.[illegible]
	2																					
Species:																						
	1																					
	2																					
Bidens cernua BICE	1	20		2	15	15	20	20	45	60	85										90	* 28.[illegible]
	2																					
Polygonum hydropiper PONY	1	80	100	98	85	85	65	65	45	35											90	* 65.[illegible]
	2																					
Gnaphalium uliginosum GNUL	1						T	3	5		10										40	1.[illegible]
	2																					
Bidens vulgata BIVU	1							2	5	4											30	1.[illegible]
	2																					
Eleocharis ovata ELOV	1										2										10	0.[illegible]
	2																					
Agrostis ? Grass sp.	1										10										10	1.[illegible]
	2																					
Ludwigia palustris LUPA	1										T										10	<a[illegible]
	2																					
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Comments: * = dominant

No woody species on transect or in pond.

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date____________ Transect #_____________ Personnel_______,_______

Community Type___________________ Page_____of_____

SHRUBS - Within a 3-M radius of each sample point

Sample Point No.

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total Cover																				
Litter																				
Woody Debris																				
Snags																				
Species:																				

Comments:

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8-18-92 Transect # T-5 Personnel EL , LW

Community Type Fraxinus latifolia/Phalaris arundinacea Page 1 of 4
FRLA/PHAR

HERBS - Within a 1-M-square quadrat Oregon ash/reed canarygrass

Sample Point No.

Category		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	X̄
		3.2	14.4	22.9	31.7	42.7	50.3	63.8	81.5	42.9	123.7									de freq.		% cover
Total Cover	1	100	100	100	92	100	100	100	100	92	100										100	98.6
	2	100	100	100	100	100	100	100	100	90												
		9.2	18.1	29.3	36.6	45.6	55.3	70.4	88.2	92.7												
Species:																						
PHAR	1	100	100	100	92	100	100	100	100	92	100										100	* 98.6
	2	100	100	100	100	100	100	100	100	90												
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Comments: * = dominant

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/18/92 Transect # T-5 Personnel LW , EL

Community Type FRLA/PHAR Page 2 of 4

SHRUBS - Within a 3-M radius of each sample point

Sample Point No.

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 (% freq -)	20	$\overline{X}$ % cover
Total Cover																					-.-
Litter																					-0-
Woody Debris								+	+										22		<0.1
Snags								+											11		<0.1
Species:																					
SARA					+		+		+										33		<0.
COST									+										11		<0.

Comments:

transect length - 125 m. Near T-3 — NW - [illegible]

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8-18-92 Transect # T-5 Personnel EL, LW

Community Type FRLA/PHAR, west end of ash stand - compass 117° Page 3 of 4

TREES - Point-Centered Quarter Method (taller than 2 M)

Sample #	Location (M)	Quarter #	Distance (M)	Species	DBH ~~(cm)~~ in	ba (in2)
1	3.2	1	7.40	FRLA	11.63	106.23
		2	3.22	FRLA	13.72	147.84
		3	2.80	FRLA	15.70	193.59
		4	9.03	FRLA	13.9	151.75
2	14.3	1	4.20	FRLA	16.57	215.64
		2	3.87	FRLA	7.69	46.45
		3	6.29	FRLA	10.43	85.44
		4	6.10	FRLA	12.98	132.32
3	22.9	1	2.4	FRLA	12.49	122.52
		2	1.52	FRLA	9.75	74.66
		3	3.32	FRLA	10.28	83.00
		4	1.58	FRLA	4.40	15.21
4	31.7	1	.75	FRLA	13.0	132.73
		2	2.60	FRLA	11.39	101.89
		3	2.95	FRLA	14.32	161.06
		4	5.2	FRLA	18.44	267.06
5	40.7	1	3.75	FRLA	4.8	18.10
		2	2.88	FRLA	5.84	26.77
		3	2.22	FRLA	16.33	209.44
		4	3.33	FRLA	3.07	7.40
6	50.3	1	2.77	FRLA	5.63	24.89
		2	7.09	FRLA	7.30	41.85
		3	2.34	FRLA	16.22	206.63
		4	2.10	FRLA	10.25	82.52
7	63.8	1	10.30	* SALA	18.34	264.17
		2	2.08	FRLA	8.80	60.82
		3	3.39	FRLA	10.79	91.44
		4	3.43	FRLA	14.90	174.37
8		1	5.27	FRLA	5.31	22.15
		2	1.80	FRLA	6.09	29.13
		3	1.94	FRLA	12.34	119.60
		4	3.63	FRLA	16.71	219.30
9	42.9	1	5.43	FRLA	10.70	89.92
		2	5.17	FRLA	16.0	201.06
		3	3.55	FRLA	27.40	589.65
		4	7.80	* SALA	20.50	330.06
10	123.7	1	6.25	FRLA	12.0	113.10
		2	2.2	FRLA	13.64	146.12
		3	2.32	FRLA	15.43	186.99
		4	15.30	FRLA	16.75	220.35
		Total =	169.54 m		Total ba =	5513.21
(M x 3.281 = ft)		=	556.26 ft		mean ba =	137.83

* tree forked measurement taken from main stem

	FRLA	SALA
Total ba	4919.01	594.
mean ba	129.45	297.

Sample #	Location (M)	Quarter #	Distance (M)	Species	DBH (cm)

Results:

Mean Distance (D) = 556.26 ft/40 = 13.91 ft

Absolute Density = Area/D^2
where D = mean distance

Number of trees per 100 ft^2 = 100/$(13.91)^2$ = 100/193.49 = 0.52 tree/100 ft^2

Absolute Dominance = mean basal area (ba) per tree x No. of trees in species.

SPECIES	No. in Quarter	No of tree in 100 ft^2
FRLA	38/40 = 0.95	0.95 x 0.52 = 0.494 tree/100 ft^2
SALA	2/40 = 0.05	0.05 x 0.52 = 0.026 tree/100 ft^2
	Total	0.52 " " "

Dominance (as total basal area per species):

FRLA 129.45 x 0.494 = 63.9 in^2 ba per 100 ft^2
SALA 297.12 x 0.026 = 7.7 in^2 ba per 100 ft^2

Absolute Frequency = $\frac{\text{NO of points w/species}}{\text{total points}} \times 100$

FRLA = 10/10 x 100 = 100%
SALA = 2/10 x 100 = 20%
Total 120%

Comments:

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8-18-92 Transect # T-6 Personnel LW, EC

Community Type Salix piperi shrub SAPI Piper's willow Page 1 of 2

HERBS - Within a 1-M-square quadrat

Sample Point No.

Category		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X̄
		1.2	4.8	8.1	13.0	17.4	20.9	24.3	27.8	32.0	36.4	41.1	45.2	48.7								
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	%cover
																				% Hel		
Total	1	5	Ø	Ø	1	5	97	85	T	Ø	Ø	Ø	Ø	Ø						46		14.8
Cover	2																					
Species:																						
PHAR	1	5			1	5	95	75	T											46		13.9
	2																					
SODU	1						2	10												15		0.9
	2																					
	1																					
	2																					
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Comments: Lythrum 3 m. n of Transect pt. 5

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8-18-92 Transect # T-6 Personnel EL , LW

Community Type Salix fujesii shrub Page 2 of 2

SHRUBS - Within a 3-M radius of each sample point

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	$\bar{X}$ %c
Sample Point No.	1.2	4.8	8.1	13.0	17.4	20.9	24.3	27.8	32.0	36.4	41.1	45.2	48.7						% freq.		
Total Cover	60	65	65	70	65	40	75	85	70	65	65	60	55						100		64.
Litter	90	98	92	100	75			100	100	100	100	90	100						85		80.4
Woody Debris	10	2	8		20		15					10							46		5.0
Snags																					-0-
Species:																					
SAPI	60	65	65	70	65	30	75	85	70	65	65	60	55						100		63.
SALA						10													8		0.

Comments:

* At sample point 6 the transect bearing shifts to 60°

compass 305'

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/18/92 **Transect #** T-7 **Personnel** LW , EL

Community Type Herbaceous Lake Margin **Page** 1 **of** 2

Bidens cernua / Eragrostis hypnoides

HERBS - Within a 1-M-square quadrat

Sample Point No.

	Category		1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13 / 33	14 / 34	15 / 35	16 / 36	17 / 37	18 / 38	19 / 39	20 / 40	frequency (%)
			.4	1.8	2.6	4.3	6.7	8.2	11.5	15.2	19.6	23.8	26.1	29.7	34.2	37.6	41.5	44.0	46.2	48.8	50.1	52.0	
	Total Cover	1	100	100	100	100	100	100	100	100	100	100	100	96	100	100	100	100	100	100	100	100	100
		2																					
	Species:																						
Bidens cernua	BICE	1	2	2	20	40	30	15	30	40	40	40											50
		2																					
Carex aperta	CAAP	1	1			2							90	40	57	52	40	15	+	+			50
		2																					
Cyprus Erythr.	CYER	1	+	+	+	1	3	2	20	5	10	2		1									55
		2																					
Eleocharis ovatum	ELOV	1	+	+	+	22	5	3	10	5		20	+	+									55
		2																					
Eragrostis hypnoides	ERHY	1	27	15	40	35	52	70	30	50	50	20											50
		2																					
	PHAR	1	70	83	40			+		+			+	25	20	20	60	85	100	100	100	100	75
		2																					
Leersia oryzoides	LEOR	1			T																		5
		2																					
Bidens frondosa	BIFR	1					+		+	+	+	10	5	+									35
		2																					
Heleochloa alopecuroides	HEAL	1					5	10	10														15
		2																					
~~Eleocharis ovata~~	~~ELOV~~	~~1~~					~~5~~	~~2~~				~~20~~	~~+~~										~~15~~
		2																					
Cirsium arvenses	CIAR	1					+																5
		2																					
Gnaphalium uliginosum	GNUL	1					+	+	+	+		1											25
		2																					
Salix piperi	SAPI	1					+			+	+												15
		2																					
epilobium sp	EP	1							+			2											10
		2																					
poly...	PO	1											+	30	3	25							20
		2																					
Ludwigia palustris	LUPA	1										5	-										5
		2																					
Polygonum coccineum	POCO												5		5	1		+	+	+	+		35
Equisetum watsoni	EPWA													+	15	2							15
Equisetum	EQ															T		+					10

Comments: ✱ = dominant

BICE/ERHY dominant at beginning (N end) of transect; CAAP/PHAR dominant at the end (S end) of transect.

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/18/92 Transect # T-7 Personnel LW, EL

Community Type BICE/ERHY Page 2 of 2

SHRUBS - Within a 3-M radius of each sample point

% freq

Sample Point No.

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Total Cover														1	1						10
Litter Woody Debris																					
Snags																					
Species:																					
SALA														1	+						10
SPDO															+						5

Comments:

Transect [illegible] 32 m
Compass – 19°

[illegible] – [illegible] – [illegible]
"NE" [illegible] Bybee [illegible] ([illegible])

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/18/92 **Transect #** T-8 **Personnel** LW, EL

Community Type Carex aperta / Cirsium arvense **Page** 1 **of** 2
CAAP/CIAR

HERBS - Within a 1-M-square quadrat Columbia sedge/Canada thistle

Sample Point No.

Category		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19 (% freq)	20	$\bar{X}$ % cover
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
		.6	1.8	3.1	4.7	6.3	7.9	9.5	11.9	13.4	16.2	19.4	23.7	27.5	29.2	30.9						
Total Cover	1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100				100		100
	2																					
Species:																						
Carex aperta CAAP	1	98	80	85	80	84	69	55	75	75	50	80	75	85	80	99				100		* 78.
	2																					
Cirsium arvense CIAR	1	1	5	5	10	15	20	30	20	20	50	20	25	15	20	1				100		* 17.
	2																					
Epilobium watsonii EPWA	1	1	15	10	16	1	10	15	5	5	+											
	2																			67		4.
Hypericum perforatum HYPE	1				T																	
	2																			7		>0.
Polygonum coccineum POCO	1					+	1	+														
	2																			20		>0.1
Phalaris arundinacea PHAR	1																					
	2															+				7		>0.1
	1																					
	2																					
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Comments: * = dominant

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/18/92 Transect # T-8 Personnel LW , EL

Community Type CAAP/CIAR Page 2 of 2

SHRUBS - Within a 3-M radius of each sample point

Sample Point No.

Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	% freq.	$\bar{X}$ % cover
Total Cover			15																	7		1.(
Litter																						
Woody Debris																						
Snags																						
Species:																						
RUDI			15																	7		1.0

Comments:

Corrpaoo [illegible]

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/19/92 Transect # T-9 Personnel LW, EL

Community Type Mudflat Page 1 of 1

HERBS - Within a 1-M-square quadrat

Sample Point No.

	Category		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	X̄
			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
			1.2	3.4	5.9	7.6	10.3	13.7	17.1	19.8	23.4	27.2	30.3	32.7	36.1	40.0	44.2				% freq		% cover
	Total Cover	1	50	50	70	70	40	42	35	11	45	60	15	10	35	3	72				100		40.5
		2																					
	Species:																						
Cyperus erythrorhizos	CYER	1	15	10	15	20	5	2	10	1				T	+	1	T				80		5.3
		2																					
Bidens cernua	BICE	1	+			+			+	+				+	+	+	+				53		<0.1
		2																					
Azolla mexicana	AZME	1	35	40	50	50	25	40	25	10	+	5	5	5	5	1	70				100		*24.[illegible]
		2																					
Lemna minor	LEMI	1	+	+	T	T	+	+	T		+	+	T	T	+	+	1				93		<0.1
		2																					
Spirodela polyrhiza	SPPO	1	+		T		+	+	T		+	+	T		+	+	+				73		<0.1
		2																					
Polygonum coccineum	POCO	1		+	5	+	5		+	+		5		5							53		1.3
		2																					
Ricciocarpus natans	Ricciocarpus	1					+														7		<0.1
		2																					
	Grass sp	1		T	T				+					+	+	+					40		<0.1
		2																					
Ludwigia palustris	Ludwigia	1				+															7		<0.1
		2																					
Bidens frondosa	BIFO	1							+												7		<0.1
		2																					
Stringy thing	Green Algae	1									40	20											4.0
		2																					
Potamogeton crispus	POCR	1									5										7		0.3
		2																					
	Wolfia	1										+	T								13		<0.[illegible]
		2																					
	Myriophyllum	1										30									7		2.[illegible]
		2																					
	Algae-dried	1											10	10	30	1	1				33		3.5
		2																					
Eragrostis Hyp.	ERHY	1														T	+				13		<0.1
		2																					

Comments: * = dominant currently, but only because rooted species are in seedling stage.
mudflat - transition area. Recently exposed due to lower water level; raccoon and deer tracks. Adjacent to 25 ft. band of dead willows.

2 ft. undercut embankment immediately adj. with 100% PHAR

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date____________ Transect #____________ Personnel_______,_______

Community Type___________________ Page_____of_____

SHRUBS - Within a 3-M radius of each sample point

	Sample Point No.																			
Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total Cover																				
Litter Woody Debris																				
Snags																				

Species:

Comments:

Compass 291°

Emergent [illegible] SE end of Smith Lake.

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date 8/19/92 **Transect #** T-10 **Personnel** LW , EL

Community Type CYPRUS/ ~~BIDENS~~ /ERAGROSTIS **Page** 1 **of** 1

HERBS - Within a 1-M-square quadrat

Sample Point No.

Category		1 / 21	2 / 22	3 / 23	4 / 24	5 / 25	6 / 26	7 / 27	8 / 28	9 / 29	10 / 30	11 / 31	12 / 32	13 / 33	14 / 34	15 / 35	16 / 36	17 / 37	18 / 38	19 / 39	20 / 40 (% freq)	$\bar{X}$ % cov
		.7	2.1	3.6	5.9	7.2	8.7	10.4	12.7	15.6	19.3	21.6	28.2	32.5	36.2	39	42.5					
Total Cover	1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100				100	100
	2																					
Species:																						
Cyperus erythrorhizos CYER	1	65	99	89	40	35	45	33	40	25	55	41	50	50	50	39	45				100	*50.3
	2																					
Bidens cernua BICE	1	2	+	1	1	3	5	33	5	10	3	10	1	5	25	30	5				100	✓ 8.
	2																					
Eleocharis ovata ELOV	1					2		T	5	10		+	+	+		1	+				56	✓ 1.1
	2																					
Eragrostis hypnoides ERHY	1	30	+	10	39	60	45	33	50	55	40	44	49	45	25	30	35				100	✓*36.
	2																					
Polygonum persicaria POPE	1	3	1		+																19	✓ 0.3
	2																					
Bidens frondosa BIFR	1	+																			6	✓ <0.
	2																					
Polygonum coccineum POCO	1		+	+	20						1	1	+								38	✓ 1.
	2																					
Xanthium strumarium XAST (Cocklebur)	1		+	+																	13	✓ <0.
	2																					
Peter's Polygonum lapathifolium POLA	1						5	1				.1+					15				25	✓ 1.
	2																					
Leersia oryzoides LEOR	1										1										6	✓ 0.1
	2																					
Echinochloa crusgalli EC CR	1														+						6	✓ <0.1
	2																					
	1																					
	2																					
	1																					
	2																					
	1																					
	2																					
	1																					
	2																					
	1																					
	2																					

Comments: Smith Lake

SMITH & BYBEE LAKES MONITORING PROGRAM
VEGETATION SAMPLING

Date____________ Transect #____________ Personnel_______,_______

Community Type____________________ Page_____of_____

SHRUBS - Within a 3-M radius of each sample point

	Sample Point No.																			
Category	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Total Cover																				
Litter																				
Woody Debris																				
Snags																				

Species:

Comments:

HERBACEOUS ASSEMBLAGES

1. Water Smartweed Assemblages—palustrine aquatic bed (PAB). Water smartweed (*Polygonum coccineum [=P. amphibium]*) forms large continuous networks in the water which are especially prominent in Smith Lake. Later in the season, extremely large colonies of Mexican water-fern (*Azolla mexicana*) also develop. Other common floating species in this assemblage include lesser duckweed (*Lemna minor*), greater duckweed (*Spirodela polyrhiza*), and curly-leaved pondweed (*Potamogeton crispus*).

2. Dead Piper's Willow Assemblage—palustrine shrub/scrub—palustrine aquatic bed (PSS/PAB). Although the willows in this extensive assemblage are dead, their remnant trunks and branches delineate its recent historical location. It is included with the herbaceous assemblages because water smartweed is often a prominent component of this assemblage, and it is now inundated most of the year. Two USFWS wetland classifications reflect respectively the historical and current appearance of this assemblage. The history of this shrub assemblage is further discussed in the Recommendations section.

3. Shoreline Emergent Assemblage—palustrine emergent (PEM). This assemblage develops on mud flats along lake edges as water recedes seasonally. The dominant species are usually nodding beggars-tick (*Bidens cernua)*, creeping lovegrass (*Eragrostis hypnoides*), and red-rooted flatsedge (*Cyperus erythrorhizos*). Two other common species include leafy beggars-tick (*Bidens frondosa*) and ovate spikerush (*Eleocharis ovata*). Data from this assemblage was collected at sample transects T-7 and T-10. T-9 was sampled on a recently exposed mud flat. Data from T-9 supports the supposition that the shoreline emergent assemblage establishes itself on recently exposed sites along the receding lake edge.

4. Drainage Channel Emergent Assemblage—palustrine emergent (PEM). This herbaceous assemblage that develops in the summer after water has receded, but this assemblage occurs in the bottom of narrow channels that connect with the lakes. Composition is similar to the shoreline assemblage except that leafy beggars-tick is the dominant species rather than nodding beggars-tick.

5. Pond Emergent Assemblage—palustrine emergent (PEM). Ponds in which this assemblage develops lack open connections to the lakes, but they are areas similar to the two previous described assemblages in that they develop an emergent herbaceous vegetation as the water dries seasonally. The two most common species are nodding beggars-tick and marshpepper smartweed (*Polygonum hydropiper)*. Associated species are similar to those in the shoreline emergent assemblage. A band of dense reed canarygrass (*Phalaris arundinacea*) is also often present along the upper edge of these ponds. Transect 4 was sampled in this pond assemblage.

6. Columbia Sedge Assemblage —palustrine emergent (PEM). This assemblage occurs at sites with a shorter hydroperiod than the previously discussed assemblages. These sites are usually

APPENDIX C

RESULTS OF MACROINVERTEBRATE SAMPLING

Smith Lake, open water, muck, 0.5 m depth, August 26, 1992.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2), one composite sample.
Aquatic Biology Associates, Corvallis, OR. 0892SB1

Taxon	Abundance	%
Nematoda	50	2.11
Aulodrilus limnobius	150	6.33
Aulodrilus piqueti	100	4.22
Branchiura sowerbyi	80	3.38
Ilyodrilus frantzi	20	0.84
Immature tubificid w capilliforms	25	1.05
Immature tubificid w/o capilliforms	1520	64.14
Limnodrilus hoffmeisteri	5	0.21
Ostracoda	10	0.42
TOTAL: MISC. TAXA	1960	82.70
Ceratopogoninae	10	0.42
TOTAL: DIPTERA	10	0.42
Chironomidae-pupae	10	0.42
Chironomus	70	2.95
Cryptochironomus	100	4.22
Einfeldia	20	0.84
Larsia	10	0.42
Procladius	190	8.02
TOTAL: CHIRONOMIDAE	400	16.88
GRAND TOTAL	2370	100.00

Smith Channel, floating Azolla, leaves & algae, surface, August 26, 1992.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB5

Taxon	Abundance	%
Chaetogaster diaphanus	20	0.55
Dero vaga	200	5.52
Dero sp.	20	0.55
Nais variabilis	580	16.02
Pristina leidyi	40	1.10
Stylaria lacustris	20	0.55
Physella (P.) gyrina	20	0.55
Cladocera	20	0.55
Ostracoda	360	9.94
Hyalella azteca	700	19.34
TOTAL: MISC. TAXA	1980	54.70
Enallagma/Ischnura	240	6.63
TOTAL: ODONATA	240	6.63
Mesovelia mulsanti	20	0.55
Microvelia prob. californiensis	40	1.10
TOTAL: HEMIPTERA	60	1.66
Nepticula	1060	29.28
TOTAL: LEPIDOPTERA	1060	29.28
Curculionidae-adult	80	2.21
Hydrophilidae	20	0.55
TOTAL: COLEOPTERA	100	2.76
Ceratopogoninae	60	1.66
Ephydridae	20	0.55
Stratiomyiidae	60	1.66
TOTAL: DIPTERA	140	3.87
Einfeldia	20	0.55
Orthocladius Complex	20	0.55
TOTAL: CHIRONOMIDAE	40	1.10
GRAND TOTAL	3620	100.00

Bybee Lake, open water, Potomogeton veg., surface, August 26, 1992.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB6

Taxon	Abundance	%
Hydra	15	8.52
Cladocera	3	1.70
Hyalella azteca	33	18.75
Acari	2	1.14
TOTAL: MISC. TAXA	53	30.11
Aeshnidae-early instar	9	5.11
Enallagma/Ischnura	61	34.66
TOTAL: ODONATA	70	39.77
Mesovelia mulsanti	2	1.14
TOTAL: HEMIPTERA	2	1.14
Nepticula	3	1.70
TOTAL: LEPIDOPTERA	3	1.70
Brachycera-unknown larvae	3	1.70
Limonia	1	0.57
TOTAL: DIPTERA	4	2.27
Chironomidae-pupae	2	1.14
Ablabesmyia	1	0.57
Endochironomus	10	5.68
Orthocladius Complex	31	17.61
TOTAL: CHIRONOMIDAE	44	25.00
GRAND TOTAL	176	100.00

Bybee Lake, smartweed & duckweed, leaves & stems, nr. surface
August 26, 1992.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB7

Taxon	Abundance	%
Turbellaria	12	7.89
Aulodrilus piqueti	1	0.66
Dero sp.	4	2.63
Immature tubificid w capilliforms	2	1.32
Immature tubificid w/o capilliforms	1	0.66
Stylaria lacustris	2	1.32
Varichaetadrilus ?pacificus	3	1.97
Hirudinea	1	0.66
Pseudosuccinea columella	6	3.95
Physella (P.) gyrina	1	0.66
Menetus (M.) callioglyptus	5	3.29
Gammarus	3	1.97
Hyalella azteca	57	37.50
Caecidotea	8	5.26
TOTAL: MISC. TAXA	106	69.74
Anax junius	1	0.66
Libellulidae-early instar	1	0.66
Enallagma/Ischnura	36	23.68
TOTAL: ODONATA	38	25.00
Ceratopogoninae	1	0.66
Forcipomyiinae	1	0.66
Stratiomyiidae	2	1.32
TOTAL: DIPTERA	4	2.63
Einfeldia	1	0.66
Endochironomus	2	1.32
Orthocladius Complex	1	0.66
TOTAL: CHIRONOMIDAE	4	2.63
GRAND TOTAL	152	100.00

Smith Lake, smartweed & duckweed, leaves & stems, near surfac
May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance, composite of 2 samples.
Aquatic Biology Associates, Corvallis, OR. 0593SB1

Taxon	Abundance	%
Hydra	15	0.81
Chaetogaster diaphanus	5	0.27
Dero digitata	10	0.54
Nais simplex	26	1.41
Nais variabilis	184	9.98
Stylaria lacustris	460	24.95
Ferrissia	1	0.05
Pseudosuccinea columella	1	0.05
Physella (P.) gyrina	19	1.03
Menetus (M.) callioglyptus	34	1.84
Cladocera	499	27.06
Copepoda	301	16.32
Ostracoda	14	0.76
Hyalella azteca	131	7.10
Acari	53	2.87
TOTAL: MISC. TAXA	1753	95.07
Enallagma/Ischnura	13	0.70
TOTAL: ODONATA	13	0.70
Palmocorixa buenoi	4	0.22
Mesovelia mulsanti	1	0.05
TOTAL: HEMIPTERA	5	0.27
Ceratopogoninae	9	0.49
Stratiomyiidae	5	0.27
TOTAL: DIPTERA	14	0.76
Chironomidae-pupae	5	0.27
Chironomini	8	0.43
Cricotopus	21	1.14
Glyptotendipes	20	1.08
Nanocladius	1	0.05
Parachironomus	4	0.22
TOTAL: CHIRONOMIDAE	59	3.20
GRAND TOTAL	1844	100.00

Smith Lake, open water, muck, 1.5 m depth, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2), 2 samples taken.
Aquatic Biology Associates, Corvallis, OR.

	Replicates				
Taxon	R1	R2	Average	STDEV	%
Aulodrilus limnobius	373	706	540	235.5	6.06
Aulodrilus piqueti	266	440	353	123.0	3.97
Bothrioneurium vejdovskyanum	80	93	87	9.2	0.97
Branchiura sowerbyi	80	0	40	56.6	0.45
Dero digitata	453	0	227	320.3	2.55
Ilyodrilus frantzi	80	626	353	386.1	3.97
Ilyodrilus templetoni	80	93	87	9.2	0.97
Immature tubificid w capilliforms	1172	266	719	640.6	8.08
Immature tubificid w/o capilliforms	2984	1785	2385	847.8	26.80
Limnodrilus hoffmeisteri	373	1159	766	555.8	8.61
Teneridrilus mastix	80	93	87	9.2	0.97
Cladocera	2184	1558	1871	442.6	21.03
Copepoda	1808	306	1057	1062.1	11.88
Ostracoda	28	27	28	0.7	0.31
Acari	28	0	14	19.8	0.16
TOTAL: MISC. TAXA	10069	7152	8611	2062.6	96.77
Palmacorixa	28	0	14	19.8	0.16
TOTAL: HEMIPTERA	28	0	14	19.8	0.16
Ceratopogoninae	80	27	54	37.5	0.60
TOTAL: DIPTERA	80	27	54	37.5	0.60
Chironomus	132	0	66	93.3	0.74
Cryptochironomus	52	0	26	36.8	0.29
Glyptotendipes	0	40	20	28.3	0.22
Procladius	108	107	108	0.7	1.21
TOTAL: CHIRONOMIDAE	292	147	220	102.5	2.47
GRAND TOTAL	10469	7326	8898	2222.4	100.00

Smith channel, floating & submerged wood, near surface, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; wood scrapings, relative abundance, 1 sample.
Aquatic Biology Associates, Corvallis, OR. 0593SB3

Taxon	Abundance	%
Hydra	13	1.66
Turbellaria	2	0.26
Dero digitata	36	4.59
Nais variabilis	313	39.92
Stylaria lacustris	24	3.06
Physella (P.) gyrina	1	0.13
Menetus (M.) callioglyptus	30	3.83
Ostracoda	9	1.15
Hyalella azteca	105	13.39
Caecidotea	4	0.51
TOTAL: MISC. TAXA	537	68.49
Enallagma/Ischnura	2	0.26
TOTAL: ODONATA	2	0.26
Hydroptila	1	0.13
TOTAL: TRICHOPTERA	1	0.13
Ceratopogoninae	35	4.46
TOTAL: DIPTERA	35	4.46
Chironomidae-pupae	3	0.38
Chironomini	8	1.02
Cricotopus	150	19.13
Glyptotendipes	26	3.32
Nanocladius	2	0.26
Orthocladiinae	4	0.51
Parachironomus	12	1.53
Paratanytarsus	4	0.51
TOTAL: CHIRONOMIDAE	209	26.66
GRAND TOTAL	784	100.00

Smith Lk. & channel, reed canary grass, stems & leaves, near surface, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.

Macroinvertebrate samples; Dip-net, relative abundance, composite of 2 samples.

Aquatic Biology Associates, Corvallis, OR. 0593SB4

Taxon	Abundance	%
Hydra	3	0.27
Chaetogaster diaphanus	2	0.18
Dero digitata	6	0.54
Dero vaga	1	0.09
Haemonais waldvogeli	5	0.45
Nais variabilis	21	1.90
Ophidonais serpentina	5	0.45
Slavina appendiculata	2	0.18
Stylaria lacustris	81	7.31
Hirudinea	4	0.36
Pseudosuccinea columella	19	1.71
Physella (P.) gyrina	70	6.32
Menetus (M.) callioglyptus	49	4.42
Cladocera	35	3.16
Copepoda	254	22.92
Ostracoda	2	0.18
Hyalella azteca	177	15.97
Acari	170	15.34
TOTAL: MISC. TAXA	906	81.77
Enallagma/Ischnura	34	3.07
TOTAL: ODONATA	34	3.07
Palmacorixa	3	0.27
Palmocorixa buenoi	22	1.99
Gerris	1	0.09
Mesovelia mulsanti	9	0.81
Microvelia prob. californiensis	1	0.09
TOTAL: HEMIPTERA	36	3.25
Curculionidae-adult	3	0.27
Dytiscidae	2	0.18
Peltodytes	2	0.18
Hydrophilidae	2	0.18
Berosus	1	0.09
TOTAL: COLEOPTERA	10	0.90
Brachycera-unknown larvae	39	3.52
Ceratopogoninae	9	0.81
Stratiomyiidae	19	1.71
Limonia	1	0.09
TOTAL: DIPTERA	68	6.14
Chironomidae-pupae	9	0.81
Corynoneura	2	0.18
Cricotopus	30	2.71
Glyptotendipes	9	0.81
Nanocladius	4	0.36
TOTAL: CHIRONOMIDAE	54	4.87
GRAND TOTAL	1108	100.00

Bybee Lake, open water, muck, 1.5 m depth, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2), average of 2 samples.
Aquatic Biology Associates, Corvallis, OR. 0593SB5

	Replicates				
Taxon	R1	R2	Average	STDEV	%
Aulodrilus limnobius	187	133	160	38.2	1.67
Aulodrilus piqueti	40	133	87	65.8	0.90
Bothrioneurium vejdovskyanum	187	386	287	140.7	2.99
Dero digitata	93	40	67	37.5	0.69
Ilyodrilus frantzi	40	0	20	28.3	0.21
Ilyodrilus templetoni	0	40	20	28.3	0.21
Immature tubificid w capilliforms	1265	586	926	480.1	9.64
Immature tubificid w/o capilliforms	1079	413	746	470.9	7.77
Limnodrilus hoffmeisteri	586	626	606	28.3	6.31
Limnodrilus udekemanus	0	40	20	28.3	0.21
Quistadrilus multisetosus	0	40	20	28.3	0.21
Varichaetadrilus ?pacificus	40	0	20	28.3	0.21
Physella (P.) gyrina	0	13	7	9.2	0.07
Cladocera	7006	5288	6147	1214.8	64.05
Copepoda	360	373	367	9.2	3.82
Acari	13	0	7	9.2	0.07
TOTAL: MISC. TAXA	10896	8111	9504	1969.3	99.03
Ceratopogoninae	67	0	34	47.4	0.35
Stratiomyiidae	0	13	7	9.2	0.07
TOTAL: DIPTERA	67	13	40	38.2	0.42
Chironomus	67	13	40	38.2	0.42
Procladius	27	0	14	19.1	0.14
TOTAL: CHIRONOMIDAE	94	13	54	57.3	0.56
GRAND TOTAL	11057	8137	9597	2064.8	100.00

Smith Lake, open water, muck, 0.5 m depth, August 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2).
Aquatic Biology Associates, Corvallis, OR. 0892SB1

TOTAL ABUNDANCE = 2370
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 16
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	9	1960	82.70
Odonata	0	0	.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	0	0	.00
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	1	10	.42
Chironomidae	6	400	16.87

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	3	120	
Parasite	0	0	
Collector-gatherer	11	2190	
Collector-filterer	0	0	
Macrophyte-herbivore	0	0	
Piercer-herbivore	0	0	
Scraper	0	0	
Shredder	0	0	
Xylophage	0	0	
Omnivore	1	50	
Unknown	1	10	

Appendix D

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - C
Scraper/(Scraper + C.-filterer) undefi
Shredder/Total organisms =

Smith Lake, open water, muck, 0.5 m depth, Aug. 26, 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Immature tubificid w/o cap	1520	64.14
Procladius	190	8.02
Aulodrilus limnobius	150	6.33
Aulodrilus piqueti	100	4.22
Cryptochironomus	100	4.22
SUBTOTAL 5 DOMINANTS	2060	86.93
Branchiura sowerbyi	80	3.38
Chironomus	70	2.95
Nematoda	50	2.11
Immature tubificid w capil	25	1.05
Ilyodrilus frantzi	20	.84
TOTAL 10 DOMINANTS	2305	97.26

SAPROBIC INDICES
Hilsenhoff Biotic Index = 8.80
Biotic Condition Index
Community Tolerance Quotient (a) = 108.00
Community Tolerance Quotient (d) = 132.00

DIVERSITY MEASURES
Shannon H (loge) = 1.46
Shannon H (log2) = 2.11
Evenness = .53
Brillouin H = 1.45
Simpson D = .43

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	360	15.19
Univoltine	1235	52.11
Semivoltine	775	32.70

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Lake, smartweed, stems & leaves, nr. surface, August 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB2

TOTAL ABUNDANCE = 302
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 24
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	12	261	86.41
Odonata	4	11	3.64
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	2	10	3.31
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	4	12	3.97
Chironomidae	2	8	2.65

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	8	24	7.94
Parasite	0	0	.00
Collector-gatherer	13	247	81.78
Collector-filterer	1	17	5.63
Macrophyte-herbivore	1	1	.33
Piercer-herbivore	0	0	.00
Scraper	1	13	4.30
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .76
Scraper/(Scraper + C.-filterer) = .43
Shredder/Total organisms = .000

Smith Lake, smartweed, August 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Hyalella azteca	153	50.66
Copepoda	38	12.58
Stylaria lacustris	18	5.96
Cladocera	17	5.63
Menetus (M.) callioglyptus	13	4.30
SUBTOTAL 5 DOMINANTS	239	79.13
Turbellaria	9	2.98
Enallagma/Ischnura	7	2.32
Microvelia prob. californi	7	2.32
Stratiomyiidae	7	2.32
Einfeldia	7	2.32
TOTAL 10 DOMINANTS	276	91.39

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.87

Biotic Condition Index

  Community Tolerance Quotient (a) = 98.61

  Community Tolerance Quotient (d) = 244.00

DIVERSITY MEASURES

Shannon H (loge) = 1.95

Shannon H (log2) = 2.81

Evenness = .61

Brillouin H = 1.83

Simpson D = .28

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	70	23.34
Univoltine	208	68.87
Semivoltine	23	7.78

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Lake, willow fringe, mud & detritus, 0.25 m depth, Aug. 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net or Ekman dredge (approx.
Aquatic Biology Associates, Corvallis, OR. 0892SB3

TOTAL ABUNDANCE = 472
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 10
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	6	408	86.43
Odonata	0	0	.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	1	60	12.71
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	0	0	.00
Chironomidae	3	4	.84

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	1	2	.42
Parasite	0	0	.00
Collector-gatherer	8	410	86.85
Collector-filterer	0	0	.00
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	1	60	12.71
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) undefined
Shredder/Total organisms = .000

Smith Lake, willow fringe, mud & detritus, Aug. 1992.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Immature tubificid w/o cap	300	63.56
Palmacorixa	60	12.71
Aulodrilus piqueti	36	7.63
Branchiura sowerbyi	24	5.08
Quistadrilus multisetosus	24	5.08
SUBTOTAL 5 DOMINANTS	444	94.06
Immature tubificid w capil	12	2.54
Ostracoda	12	2.54
Cryptochironomus	2	.42
Endochironomus	1	.21
Procladius	1	.21
TOTAL 10 DOMINANTS	472	99.98

SAPROBIC INDICES
Hilsenhoff Biotic Index = 8.87
Biotic Condition Index
Community Tolerance Quotient (a) = 108.00
Community Tolerance Quotient (d) = 148.00

DIVERSITY MEASURES
Shannon H (loge) = 1.28
Shannon H (log2) = 1.85
Evenness = .56
Brillouin H = 1.25
Simpson D = .43

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	15	3.18
Univoltine	277	58.69
Semivoltine	180	38.14

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Channel, open water, muck, 0.65 m depth, Aug. 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net or Ekman dredge (approx.
Aquatic Biology Associates, Corvallis, OR. 0892SB4

TOTAL ABUNDANCE = 681
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 16
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	8	333	48.89
Odonata	0	0	.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	1	3	.44
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	1	15	2.20
Misc. Diptera	1	15	2.20
Chironomidae	5	315	46.26

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	2	45	6.61
Parasite	0	0	.00
Collector-gatherer	11	627	92.06
Collector-filterer	0	0	.00
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	1	3	.44
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	1	3	.44
Unknown	1	3	.44

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) undefined
Shredder/Total organisms = .000

Smith Channel, open water, muck, Aug. 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Procladius	216	31.72
Immature tubificid w/o cap	195	28.63
Einfeldia	51	7.49
Aulodrilus piqueti	48	7.05
Limnodrilus hoffmeisteri	39	5.73
SUBTOTAL 5 DOMINANTS	549	80.62
Cryptochironomus	30	4.41
Immature tubificid w capil	21	3.08
Hyalella azteca	18	2.64
Dubiraphia	15	2.20
Ceratopogoninae	15	2.20
TOTAL 10 DOMINANTS	648	95.15

SAPROBIC INDICES

Hilsenhoff Biotic Index = 8.78

Biotic Condition Index

Community Tolerance Quotient (a) = 107.75

Community Tolerance Quotient (d) = 164.00

DIVERSITY MEASURES

Shannon H (loge) = 2.00

Shannon H (log2) = 2.88

Evenness = .72

Brillouin H = 1.95

Simpson D = .20

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	242	35.57
Univoltine	296	43.50
Semivoltine	142	20.93

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Channel, floating Azolla, leaves & algae, surface, Aug. 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB5

TOTAL ABUNDANCE = 3620
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 21
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	10	1980	54.67
Odonata	1	240	6.63
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	2	60	1.65
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	1	1060	29.28
Coleoptera	2	100	2.76
Misc. Diptera	3	140	3.87
Chironomidae	2	40	1.10

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	380	10.49
Parasite	0	0	.00
Collector-gatherer	13	2080	57.43
Collector-filterer	1	20	.55
Macrophyte-herbivore	2	1140	31.49
Piercer-herbivore	0	0	.00
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .00
Scraper/(Scraper + C.-filterer) = .00
Shredder/Total organisms = .000

Smith Channel, floating Azolla, Aug. 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Nepticula	1060	29.28
Hyalella azteca	700	19.34
Nais variabilis	580	16.02
Ostracoda	360	9.94
Enallagma/Ischnura	240	6.63
SUBTOTAL 5 DOMINANTS	2940	81.21
Dero vaga	200	5.52
Curculionidae-adult	80	2.21
Ceratopogoninae	60	1.66
Stratiomyiidae	60	1.66
Pristina leidyi	40	1.10
TOTAL 10 DOMINANTS	3380	93.36

SAPROBIC INDICES
Hilsenhoff Biotic Index = 8.17
Biotic Condition Index
Community Tolerance Quotient (a) = 100.42
Community Tolerance Quotient (d) = 136.00

DIVERSITY MEASURES
Shannon H (loge) = 2.15
Shannon H (log2) = 3.10
Evenness = .70
Brillouin H = 2.13
Simpson D = .17

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	410	11.33
Univoltine	2760	76.24
Semivoltine	450	12.43

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Bybee Lake, open water, Potomogeton veg., surface, Aug. 26, 1992.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB6

TOTAL ABUNDANCE = 176
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 14
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	4	53	30.11
Odonata	2	70	39.77
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	1	2	1.14
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	1	3	1.70
Coleoptera	0	0	.00
Misc. Diptera	2	4	2.27
Chironomidae	4	44	25.00

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	87	49.43
Parasite	1	2	1.14
Collector-gatherer	4	75	42.61
Collector-filterer	1	3	1.70
Macrophyte-herbivore	2	4	2.27
Piercer-herbivore	0	0	.00
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	2	5	2.84

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .00
Scraper/(Scraper + C.-filterer) = .00
Shredder/Total organisms = .000

Bybee Lake, Potomogeton veg., Aug. 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Enallagma/Ischnura	61	34.66
Hyalella azteca	33	18.75
Orthocladius Complex	31	17.61
Hydra	15	8.52
Endochironomus	10	5.68
SUBTOTAL 5 DOMINANTS	150	85.22
Aeshnidae-early instar	9	5.11
Cladocera	3	1.70
Nepticula	3	1.70
Brachycera-unknown larvae	3	1.70
Acari	2	1.14
TOTAL 10 DOMINANTS	170	96.57

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.51

Biotic Condition Index

Community Tolerance Quotient (a) = 96.00

Community Tolerance Quotient (d) = 178.00

DIVERSITY MEASURES

Shannon H (loge) = 1.93

Shannon H (log2) = 2.79

Evenness = .73

Brillouin H = 1.81

Simpson D = .20

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	45	25.85
Univoltine	121	69.03
Semivoltine	9	5.11

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Bybee Lake, smartweed & duckweed, leaves & stems, nr. surface, August 26, 1992.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0892SB7

TOTAL ABUNDANCE = 152
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 23
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	14	106	69.74
Odonata	3	38	25.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	0	0	.00
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	3	4	2.64
Chironomidae	3	4	2.64

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	41	26.98
Parasite	0	0	.00
Collector-gatherer	16	106	69.75
Collector-filterer	0	0	.00
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	0	0	.00
Scraper	1	5	3.29
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = .000

Bybee Lake, smartweed & duckweed, Aug. 1992 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Hyalella azteca	57	37.50
Enallagma/Ischnura	36	23.68
Turbellaria	12	7.89
Caecidotea	8	5.26
Pseudosuccinea columella	6	3.95
SUBTOTAL 5 DOMINANTS	119	78.28
Menetus (M.) callioglyptus	5	3.29
Dero sp.	4	2.63
Varichaetadrilus ?pacificu	3	1.97
Gammarus	3	1.97
Immature tubificid w capil	2	1.32
TOTAL 10 DOMINANTS	136	89.46

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.84

Biotic Condition Index

Community Tolerance Quotient (a) = 104.73

Community Tolerance Quotient (d) = 322.00

DIVERSITY MEASURES

Shannon H (loge) = 2.11

Shannon H (log2) = 3.05

Evenness = .67

Brillouin H = 1.92

Simpson D = .21

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	15	9.87
Univoltine	131	86.51
Semivoltine	5	3.62

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Lake, smartweed & duckweed, leaves & stems, near surface, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance.
Aquatic Biology Associates, Corvallis, OR. 0593SB1

TOTAL ABUNDANCE = 1844
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 26
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	15	1753	95.04
Odonata	1	13	.70
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	2	5	.27
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	2	14	.76
Chironomidae	6	59	3.19

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	42	2.27
Parasite	1	53	2.87
Collector-gatherer	15	1206	65.38
Collector-filterer	1	499	27.06
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	1	4	.22
Scraper	2	35	1.89
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	1	5	.27

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .07
Scraper/(Scraper + C.-filterer) = .07
Shredder/Total organisms = .000

Smith Lake, smartweed & duckweed, May 1993 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Cladocera	499	27.06
Stylaria lacustris	460	24.95
Copepoda	301	16.32
Nais variabilis	184	9.98
Hyalella azteca	131	7.10
SUBTOTAL 5 DOMINANTS	1575	85.41
Acari	53	2.87
Menetus (M.) callioglyptus	34	1.84
Nais simplex	26	1.41
Cricotopus	21	1.14
Glyptotendipes	20	1.08
TOTAL 10 DOMINANTS	1729	93.75

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.85

Biotic Condition Index

Community Tolerance Quotient (a) = 105.23

Community Tolerance Quotient (d) = 161.00

DIVERSITY MEASURES

Shannon H (loge) = 2.07

Shannon H (log2) = 2.99

Evenness = .64

Brillouin H = 2.05

Simpson D = .18

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	918	49.82
Univoltine	360	19.54
Semivoltine	565	30.64

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Lake, open water, muck, 1.5 m depth, May 28, 1993.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2), Aquatic Biology Associates, Corvallis, OR.

TOTAL ABUNDANCE = 8902
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 21
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	15	8614	96.78
Odonata	0	0	.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	1	14	.16
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	1	54	.60
Chironomidae	4	220	2.46

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	2	80	.89
Parasite	1	14	.16
Collector-gatherer	16	6923	77.76
Collector-filterer	1	1871	21.03
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	1	14	.16
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .00
Scraper/(Scraper + C.-filterer) = .00
Shredder/Total organisms = .000

Smith Lake, open water, muck, May 1993 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Immature tubificid w/o cap	2385	26.80
Cladocera	1871	21.03
Copepoda	1057	11.88
Limnodrilus hoffmeisteri	766	8.61
Immature tubificid w capil	719	8.08
SUBTOTAL 5 DOMINANTS	6798	76.40
Aulodrilus limnobius	540	6.06
Aulodrilus piqueti	353	3.97
Ilyodrilus frantzi	353	3.97
Dero digitata	227	2.55
Procladius	108	1.21
TOTAL 10 DOMINANTS	8379	94.16

SAPROBIC INDICES

Hilsenhoff Biotic Index = 8.71

Biotic Condition Index

Community Tolerance Quotient (a) = 108.00

Community Tolerance Quotient (d) = 142.00

DIVERSITY MEASURES

Shannon H (loge) = 2.22

Shannon H (log2) = 3.20

Evenness = .73

Brillouin H = 2.21

Simpson D = .15

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	3135	35.22
Univoltine	3679	41.34
Semivoltine	2087	23.45

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith channel, floating & submerged wood, near surface, May 28, 1993.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; wood scrapings, relative abundanc
Aquatic Biology Associates, Corvallis, OR. 0593SB3

TOTAL ABUNDANCE = 784
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 1

TOTAL NUMBER OF TAXA = 21
Number EPT taxa = 1

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	10	537	68.50
Odonata	1	2	.26
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	0	0	.00
Megaloptera	0	0	.00
Trichoptera	1	1	.13
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	1	35	4.46
Chironomidae	8	209	26.66

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hydropsychidae/Total Trichoptera = .00
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	62	7.91
Parasite	0	0	.00
Collector-gatherer	13	684	87.25
Collector-filterer	0	0	.00
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	1	1	.13
Scraper	1	30	3.83
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	2	7	.89

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = .000

Smith Channel, floating & submerged wood, May 1993 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Nais variabilis	313	39.92
Cricotopus	150	19.13
Hyalella azteca	105	13.39
Dero digitata	36	4.59
Ceratopogoninae	35	4.46
SUBTOTAL 5 DOMINANTS	639	81.49
Menetus (M.) callioglyptus	30	3.83
Glyptotendipes	26	3.32
Stylaria lacustris	24	3.06
Hydra	13	1.66
Parachironomus	12	1.53
TOTAL 10 DOMINANTS	744	94.89

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.71

Biotic Condition Index

Community Tolerance Quotient (a) = 106.29

Community Tolerance Quotient (d) = 175.00

DIVERSITY MEASURES

Shannon H (loge) = 1.97

Shannon H (log2) = 2.85

Evenness = .65

Brillouin H = 1.92

Simpson D = .22

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	175	22.32
Univoltine	428	54.66
Semivoltine	180	23.02

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Smith Lk. & channel, reed canary grass, stems & leaves, near surface, May 28, 1993.

Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Dip-net, relative abundance in tw
Aquatic Biology Associates, Corvallis, OR. 0593SB4

TOTAL ABUNDANCE = 1108
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 38
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	18	906	81.75
Odonata	1	34	3.07
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	5	36	3.25
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	5	10	.90
Misc. Diptera	4	68	6.13
Chironomidae	5	54	4.87

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	10	66	5.95
Parasite	1	170	15.34
Collector-gatherer	18	709	63.97
Collector-filterer	1	35	3.16
Macrophyte-herbivore	3	6	.54
Piercer-herbivore	2	25	2.26
Scraper	1	49	4.42
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	2	48	4.33

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = 1.40
Scraper/(Scraper + C.-filterer) = .58
Shredder/Total organisms = .000

Smith Lake & Channel, reed canary grass, May 1993 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Copepoda	254	22.92
Hyalella azteca	177	15.97
Acari	170	15.34
Stylaria lacustris	81	7.31
Physella (P.) gyrina	70	6.32
SUBTOTAL 5 DOMINANTS	752	67.86
Menetus (M.) callioglyptus	49	4.42
Brachycera-unknown larvae	39	3.52
Cladocera	35	3.16
Enallagma/Ischnura	34	3.07
Cricotopus	30	2.71
TOTAL 10 DOMINANTS	939	84.74

SAPROBIC INDICES

Hilsenhoff Biotic Index = 7.33

Biotic Condition Index

Community Tolerance Quotient (a) = 98.50

Community Tolerance Quotient (d) = 209.00

DIVERSITY MEASURES

Shannon H (loge) = 2.58

Shannon H (log2) = 3.72

Evenness = .71

Brillouin H = 2.52

Simpson D = .12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	503	45.40
Univoltine	496	44.81
Semivoltine	108	9.79

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

Bybee Lake, open water, muck, 1.5 m depth, May 28, 1993.
Smith-Bybee Lakes Management Area, Portland, Oregon.
Macroinvertebrate samples; Ekman dredge (adjusted to 1 m2),
Aquatic Biology Associates, Corvallis, OR. 0593SB5

TOTAL ABUNDANCE = 9602
Ephemeroptera+Plecoptera+
Trichoptera (EPT) abundance = 0

TOTAL NUMBER OF TAXA = 20
Number EPT taxa = 0

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Misc. Taxa	16	9507	99.03
Odonata	0	0	.00
Ephemeroptera	0	0	.00
Plecoptera	0	0	.00
Hemiptera	0	0	.00
Megaloptera	0	0	.00
Trichoptera	0	0	.00
Lepidoptera	0	0	.00
Coleoptera	0	0	.00
Misc. Diptera	2	41	.42
Chironomidae	2	54	.56

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = .00
Hyd./Total Tri. undefined. Total Tri.=0
Baetidae/Total Ephem. undefined. Total Ephem.=0

FUNCTIONAL FEEDING GROUP (FFG)
COMPOSITION

GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	1	34	.35
Parasite	1	7	.07
Collector-gatherer	17	3414	35.54
Collector-filterer	1	6147	64.05
Macrophyte-herbivore	0	0	.00
Piercer-herbivore	0	0	.00
Scraper	0	0	.00
Shredder	0	0	.00
Xylophage	0	0	.00
Omnivore	0	0	.00
Unknown	0	0	.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filterer = .00
Scraper/(Scraper + C.-filterer) = .00
Shredder/Total organisms = .000

Bybee Lake, open water, muck, May 1993 cont.

CONTRIBUTION OF 10 DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Cladocera	6147	64.05
Immature tubificid w capil	926	9.64
Immature tubificid w/o cap	746	7.77
Limnodrilus hoffmeisteri	606	6.31
Copepoda	367	3.82
SUBTOTAL 5 DOMINANTS	8792	91.59
Bothrioneurium vejdovskyan	287	2.99
Aulodrilus limnobius	160	1.67
Aulodrilus piqueti	87	.90
Dero digitata	67	.69
Chironomus	40	.42
TOTAL 10 DOMINANTS	9433	98.26

SAPROBIC INDICES

Hilsenhoff Biotic Index = 8.36

Biotic Condition Index

Community Tolerance Quotient (a) = 108.00

Community Tolerance Quotient (d) = 158.00

DIVERSITY MEASURES

Shannon H (loge) = 1.39

Shannon H (log2) = 2.01

Evenness = .46

Brillouin H = 1.39

Simpson D = .43

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	6561	68.33
Univoltine	1856	19.33
Semivoltine	1184	12.33

INDICATOR ASSEMBLAGES

ASSEMBLAGE	ABUNDANCE	PERCENT
A	0	.00
B	0	.00
C	0	.00
D	0	.00
E	0	.00
F	0	.00
G	0	.00
H	0	.00
I	0	.00
J	0	.00

End of report.

APPENDIX
D

EGG LAYING LIZARDS AND SNAKES

APPENDIX D

EGG-LAYING LIZARDS AND SNAKES IN THE PORTLAND AREA

This appendix provides a listing of all known records of egg-laying lizards and snakes in the greater Portland (Clackamas, Multnomah, and Washington Counties north of Oregon City) from major museum collections. It represents all known records from among 581 verifiable amphibian and reptile records from this region. For each locality, the county is indicated preceding the parentheses, and the locality specifics (insofar as they exist) follow the parentheses. Under the locality specifics, distances are in kilometers (km) and major compass directions are indicated by a single letter (e.g., w=west). Collections are specimens from the Museum of Vertebrate Zoology (MVZ) at the University of California at Berkeley, Oregon State University (OSU), and Portland State University (PSU).

Species	Locality	Collection #
Coluber constrictor (yellow-bellied racer)	Washington: 8.4 km w of Portland [vic. St. Vincents]	PSU 000156
	Multnomah: Portland [Johnson Crk]	PSU 000063
	Clackamas: Milwaukie	MVZ 062047
	Clackamas: Milwaukie	MVZ 062048
Diadophis punctatus (ring-necked snake)	Multnomah: N slope Mt Scott	PSU 002924
	Multnomah: W slope Mt Scott	PSU 001317
Eumeces skiltonianus (western skink)	Multnomah: SE 122nd Ave and Cooper St	PSU 002916
	Multnomah: SE 100th Ave and Cooper St	PSU 002085
	Multnomah: SE 100th Ave and Cooper St	PSU 002086
	Multnomah: SE 100th Ave and Cooper St	PSU 002087
	Multnomah: Portland, slough [Johnson Crk]	OSU 000627
	Multnomah: Portland, Reed [College]	OSU 000628
Sceloporus occidentalis (western fence lizard)	Multnomah: Rock Creek Rd at RR, off Skyline Boulevard	PSU 002217
	Clackamas: in Oswego	OSU 000643

APPENDIX
E

BIRD LIST

APPENDIX E . SMITH AND BYBEE LAKES BIRD LIST

American Coot
American Crow
American Goldfinch
American Kestrel
American Robin
American Wigeon
Bald Eagle
Barn Swallow
Belted Kingfisher
Bewick's Wren
Black-capped Chickadee
Black-crowned night heron
Black-throated Gray Warbler
Bonaparte's Gull
Brown-headed Cowbird
Canada Goose
Canvasback
Caspian Tern
Cedar Waxwing
Cinnamon Teal
Cliff Swallow
Common Merganser
Common Snipe
Common Yellowthroat
Dark-eyed Junco
Double crested Cormorant
Downy Woodpecker
Eurasian Wigeon
European Starling
Gadwall
Glaucous-winged Gull
Golden-crowned sparrow
Great Blue Heron
Greater Scaup
Greater Yellowlegs
Green-backed heron
Green-winged Teal
House Finch
Killdeer
Lazuli Bunting
Long-billed Dowitcher
Mallard
Marsh Wren
Mourning Dove
Northern Flicker
Northern Harrier
Northern Pintail
Northern Shoveler
Orange-crowned Warbler
Osprey
Pacific Slope Flycatcher
Peregrine Falcon

Red-breasted Nuthatch
Red-tailed Hawk
Red-winged Blackbird
Ruby-crowned Kinglet
Ruddy Duck
Rufous-sided Towhee
Savanna Sparrow
Scrub Jay
Solitary Sandpiper
Song Sparrow
Sora Rail
Spotted Sandpiper
Swainson's Thrush
Tree Swallow
Turkey Vulture
Varied Thrush
White-crowned Sparrow
Willow Flycatcher
Wood Duck
Yellow Warbler
Yellow Rumped Warbler
Yellow-Headed Blackbird

APPENDIX F

LOWER COLUMBIA RIVER WATERFOWL COUNT RESULTS

Appendix F. Waterfowl Count Results for Sauvie Island, Vancouver Lake, Ridgefield Wildlife Refuge, Smith and Bybee Lakes and Lower Columbia River, 1985-1993, excluding 1990 and 1991.

Species	Sauvie Island	Vancouver Lake	Ridgefield	Smith/ Bybee	Lower Columbia River (Or-Wa along Columbia River Portland-Longview)
Canada Goose					
1/85	12201	4315	3761	30	
1/86	18097	90	6859		
1/87	11950	890	5352		
1/88	8738	1530	5655		
1/89	14325				
11/92					53015
12/92		4780			40229
1/93		2197			42562
3/93		10745			40952
Mallard					
1/85	3580	6	1321	30	
1/86	20882	59	6882		
1/87	2354	890	580		
1/88	11292	75	449		
1/89	8690	115	3560	90	
11/92			800		36945
12/92			225		38703
1/93					20690
3/93					
American Wigeon					
1/85	90				
1/86	1160				
1/87	77		50		
1/88	2300	10	450		
1/89	2680		670		
11/92		300			8680
12/92			170		4520
1/93					4425
3/93					

Species	Sauvie Island	Vancouver Lake	Ridgefield	Smith/ Bybee	Lower Columbia River (Or-Wa along Columbia River Portland-Longview)
Green Winged Teal					
1/85		25	50		
1/86	5410		20		
1/87	115		130		
1/88	9050	520	5		
1/89	1145	280	195		
11/92		40			19505
12/92					15
1/93					6270
3/93					
Shoveler					
1/85		25			
1/86					
1/87					
1/88					
1/89			225		
11/92					525
12/92					892
1/93					60
Pintail					
1/85	1587		125	100	
1/86	16647	3000	850		
1/87	6651		1354		
1/88	24805	265	2245		
1/89	11305	785	1790		
11/92		310			24588
12/92					892
1/93					22915

Species	Sauvie Island	Vancouver Lake	Ridgefield	Smith/ Bybee	Lower Columbia River (Or-Wa along Columbia River Portland-Longview)
Merganser					
1/85	9	8			
1/86	105	3	67		
1/87	57		37		
1/88	23	5	19		
1/89	85		25	30	
11/92					225
12/92					180
1/93					265
Great Blue Heron					
1/85		14	14	1	
1/86	14	25	8		
1/87	5				
1/88	42	1	4	1	
1/89	6				
11/92					
12/92					
1/93					41
Bald Eagle					
1/85	3	2			
1/86					
1/87					
1/88			1	2	
1/89		2			17
11/92					6
12/92					
1/93					6
3/93					17