CAPITOL LAKE VERTEBRATE AND INVERTEBRATE INVENTORY

Prepared for

Washington Department of General Administration

September 2004

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CAPITOL LAKE VERTEBRATE AND INVERTEBRATE INVENTORY

Prepared for

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Executive Summary

Herrera Environmental Consultants, Inc. prepared a report to assist the Washington Department of General Administration (GA) with management of Capitol Lake in Olympia, Washington. This report provides an inventory of fish, wildlife, and invertebrates (small animals such as clams, snails, and crustaceans) that live in Capitol Lake and its shorelines. This inventory of species is intended to assist GA with evaluating impacts from different lake management practices. The objective of this study involved identifying the fish, wildlife, and invertebrates that live in Capitol Lake and estimating their population size in different parts of the lake and at different times of the year. This includes fish and amphibians that are dependent on Capitol Lake; and other wildlife such as mammals, birds, and reptiles that use Capitol Lake or the shoreline during part of their life. The invertebrate species include burrowing insects in the bottom mud and free-swimming insects in the water.

The vegetation that grows along the shoreline of Capitol Lake and Percival Cove provides different kinds of fish and wildlife habitat. This shoreline vegetation includes wetland marsh, upland forest, riprap banks, retaining walls, and landscaped park areas. The most valuable fish and wildlife habitat along the shoreline includes wetland marsh and upland forest areas because they provide a wide band of vegetation adjacent to the shoreline and fish habitat from overhanging plants and submerged logs. The fish and wildlife habitat within Capitol Lake and Percival Cove consists of shallow vegetated areas less than 15 feet deep and open water areas. The vegetated areas shallower than 15 feet are dominated by Eurasian watermilfoil, Canada waterweed, and pondweed. The open water areas occur in the central portion of the Capitol Lake north basin and the Capitol Lake south basin. The open water area in the Capitol Lake south basin provides good salmon and trout habitat because the Deschutes River provides cold, nutrient-rich water. The open water areas in the rest of Capitol Lake and Percival Cove provides good habitat for spiny ray fish.

The fish that occur in Capitol Lake include salmon and trout that migrate through on their way up the Deschutes River, and spiny ray species that live year round in the lake. The main salmon and trout species that occur in Capitol Lake include chinook salmon, coho salmon, steelhead, and cutthroat trout. The spiny ray fish include carp, three-spine stickleback, largemouth bass, and catfish. The amphibians that likely occur in Capitol Lake based on a literature review include salamander, frog, and toad species. The mammal species that live along the shoreline of Capitol Lake include rodents, opossum, raccoon, beaver, deer, and bats. The bird species using Capitol Lake and the surrounding shoreline include ducks that feed in Capitol Lake and other birds that feed over the water or along the shorelines. The reptiles that may be present along the shoreline of Capitol Lake (based on a literature review) include turtles and snakes. The invertebrate species burrowing in the bottom mud and swimming in the water include worms, clams, snails, and mayflies. Capitol Lake has good diversity and abundance of invertebrates, which indicates that the lake is returning to a healthy condition since the saltwater back-flushing ended more than 6 years ago. These invertebrate species form the base of the food chain for animals that feed in Capitol Lake or over the water surface such as fish, amphibians, birds, reptiles, and bats.

Introduction

This report has been prepared to assist the Washington Department of General Administration (GA) with management of Capitol Lake in Olympia, Washington. This report provides an inventory of animal species (vertebrate and invertebrate) that inhabit Capitol Lake and its shorelines. This inventory of species is intended to assist GA with evaluating impacts from different lake management practices.

Project Location

Capitol Lake is located in Olympia, Thurston County, Washington (Figure 1). Capitol Lake is located in sections 14, 15, 22, 23, 26, and 27 of township 18 north, range 2 west (USGS 1981). Capitol Lake lies at the mouth of the Deschutes River (designated as water resource inventory area [WRIA] #13-0028) and Percival Creek (WRIA #13-0029) (WDF 1975). The lake is divided into the north, middle, and south basins, which are separated by the Burlington Northern/Santa Fe (BNSF) railroad trestle and the Interstate 5 (I-5) bridge, respectively. Capitol Lake is bounded on the south by Deschutes Falls, on the west by the Deschutes Parkway, on the north by 5th Avenue, and on the east by residential, commercial, park and state capital properties (Figure 2). Percival Cove, located on the west side of Deschutes Parkway, is connected to the middle basin of Capitol Lake, and receives runoff from Percival Creek. The north basin of Capitol Lake drains into Budd Inlet, a Puget Sound embayment, through a tide gate at 5th Avenue.

Study Objectives

The objectives of this inventory of vertebrate and invertebrate species in Capitol Lake are listed below:

- Identify the vertebrate and invertebrate species present in Capitol Lake. The vertebrate species include fish and amphibians that are dependent on Capitol Lake; and other wildlife such as mammals, birds, and reptiles that utilize Capitol Lake and the shoreline for part of their life cycle. The invertebrate species include benthic invertebrates and zooplankton that inhabit Capitol Lake.
- Estimate the population density of these vertebrate and invertebrate species both spatially and temporally. This involves estimating the relative abundance of each species in different portions of the lake and at different times of the year.

- Outline the relationship between these species in the environment. This involves describing food chain relationships, resource partitioning, and seasonal variations.

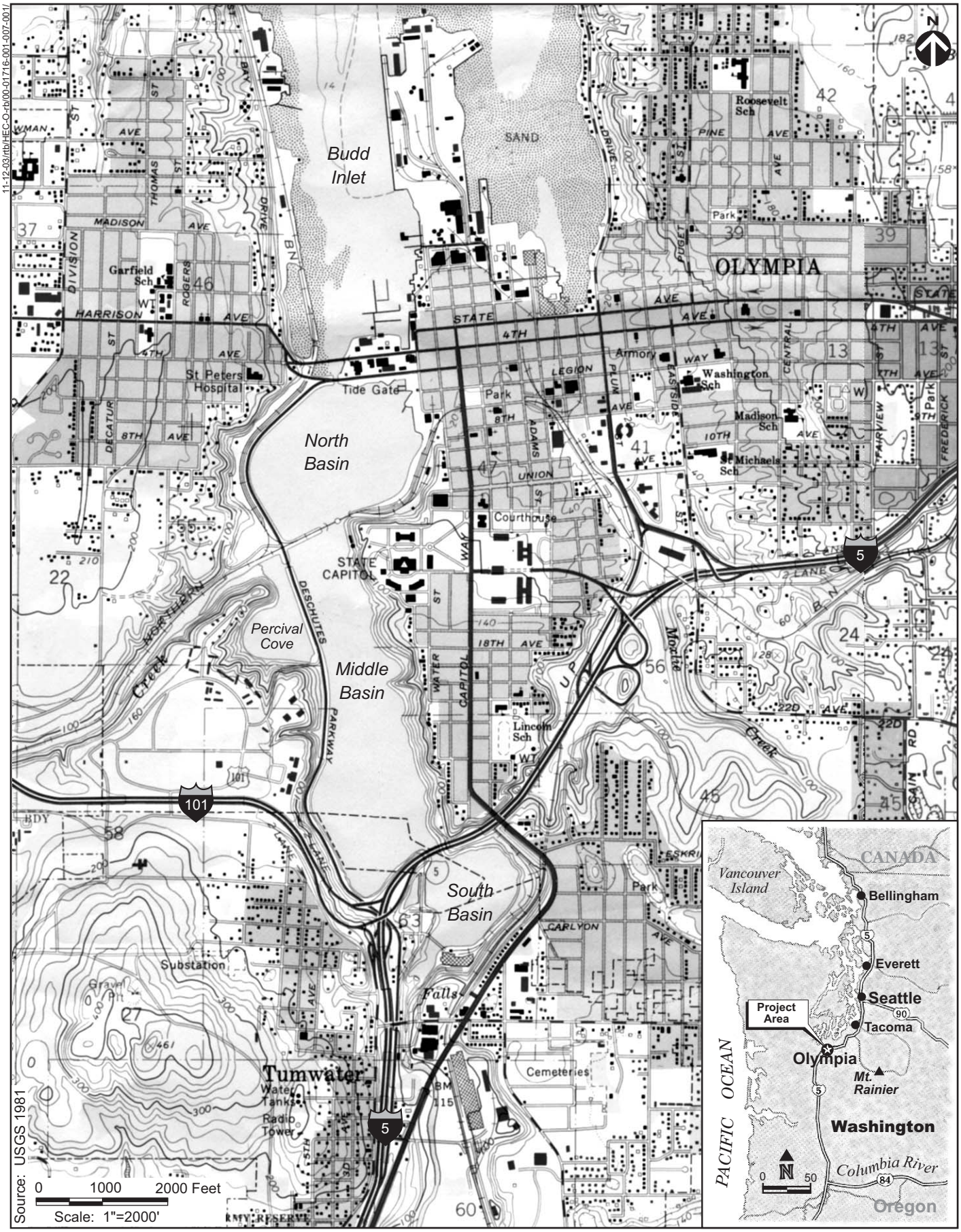

Figure 1. Vicinity map of Capitol Lake in Olympia, Washington.

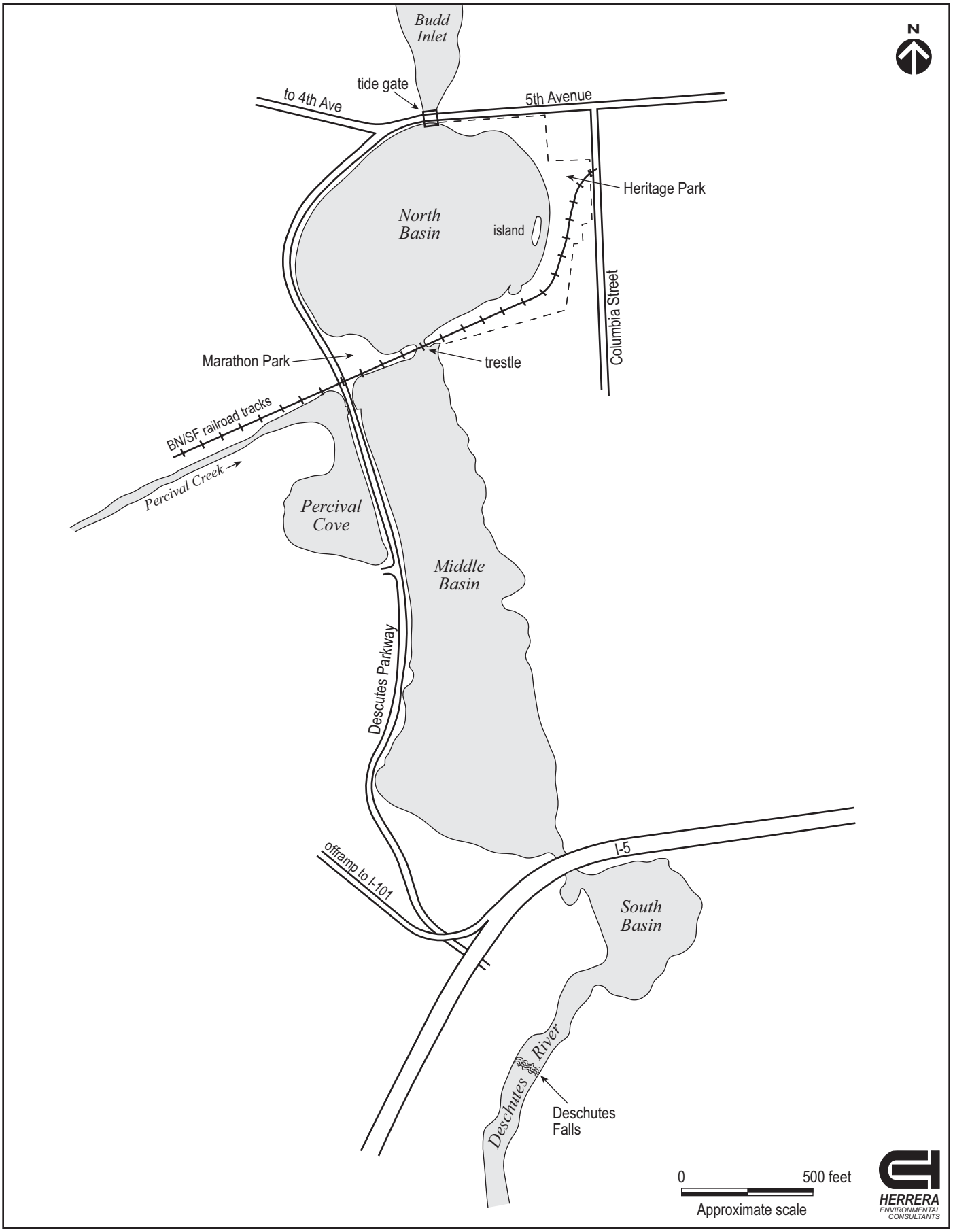

Figure 2. Location map of Capitol Lake in Olympia, Washington.

Methods and Materials

The methods and materials used to inventory vertebrate and invertebrate species in Capitol Lake are discussed below. Methods include a review of existing literature sources, a reconnaissance survey of plant community and wildlife habitat types, and invertebrate sampling methods.

Review of Existing Information

A literature review was performed to identify vertebrate and invertebrate species and habitat within Capitol Lake prior to on-site observations. Information collected specifically for this inventory report included:

- Topographic map of the Capitol Lake area (USGS 1981)
- National Wetland Inventory map of wetland areas along the shoreline of Capitol Lake (USFWS 1987)
- Capitol Lake 1996 Drawdown Water Quality Monitoring Report (Herrera 1997)
- Final environmental impact statement for Heritage Park (WDGA 1997)
- Annual monitoring report for mitigation sites at Heritage Park (Herrera 2003)
- Wild salmon production and survival evaluation annual reports from the Washington Department of Fish and Wildlife (WDFW 1997, 2000, 2001, and 2003a)
- Juvenile salmon and trout releases into the Deschutes River and tributaries from the Washington Department of Fish and Wildlife (WDFW 2003b)
- Aquatic plant list for Capitol Lake from the Thurston County Lakes Program (Thurston County 2003)
- Bird count data for Capitol Lake from the Black Hills Audubon Society (Black Hills Audubon Society 2003)
- Listings of threatened and endangered fish species in Puget Sound from the National Oceanic and Atmospheric Administration (NOAA) Fisheries (NOAA Fisheries 2003)
- Listings of threatened and endangered fish and wildlife species in Thurston County from the U.S. Fish and Wildlife Service (USFWS 2003)

- Washington Department of Fish and Wildlife (WDFW) priority habitat and species information for the project area (WDFW 2003c).

Reconnaissance Survey

A reconnaissance survey was performed to identify plant communities and wildlife habitat in Capitol Lake and along its shoreline. The methods used to map plant communities and identify wildlife habitat and use are described below.

Plant Community Mapping

The plant communities within Capitol Lake and along its shoreline were classified in order to determine their value as wildlife habitat. These plant communities included submerged macrophytes and free-floating plants in Capitol Lake and both wetland and upland plant communities along the shoreline. Prior to on-site observations, existing literature sources were reviewed for historic data on plant species presence and distribution in Capitol Lake (WDGA 1997, Herrera 1997, and Thurston County 2003).

A reconnaissance survey was conducted by boat on October 17, 2003 to map plant communities along the shoreline and within Capitol Lake and Percival Cove. Wetland plant communities were classified using the U.S. Fish and Wildlife Service system (Cowardin et al. 1979), which included palustrine classes. The upland plant communities immediately adjacent to the shoreline of Capitol Lake were classified according to Johnson and O'Neil (2001). Data was recorded on plant species presence, canopy structure, habitat features (snags and downed logs), and connection to adjacent upland habitats.

Wildlife Habitat Mapping

Prior to on-site observations, existing literature sources were reviewed for historic data on wildlife species presence and distribution in Capitol Lake (WDGA 1997, Herrera 1997, and Herrera 2003). Incidental sightings of wildlife were recorded during the reconnaissance survey conducted by boat on October 17, 2003. This included visual and auditory identification of species, signs of wildlife use (scat, burrows, nests, game trails, etc.), and the suitability of habitat for wildlife expected to occur in Capitol Lake.

Invertebrate Sampling

Samples of invertebrate species occurring in Capitol Lake were collected by boat on October 17, 2003. This involved collecting four samples of benthic invertebrates inhabiting the bottom sediments and one sample of zooplankton utilizing the water column. Figure 3 illustrates where these benthic invertebrate and zooplankton samples were collected.

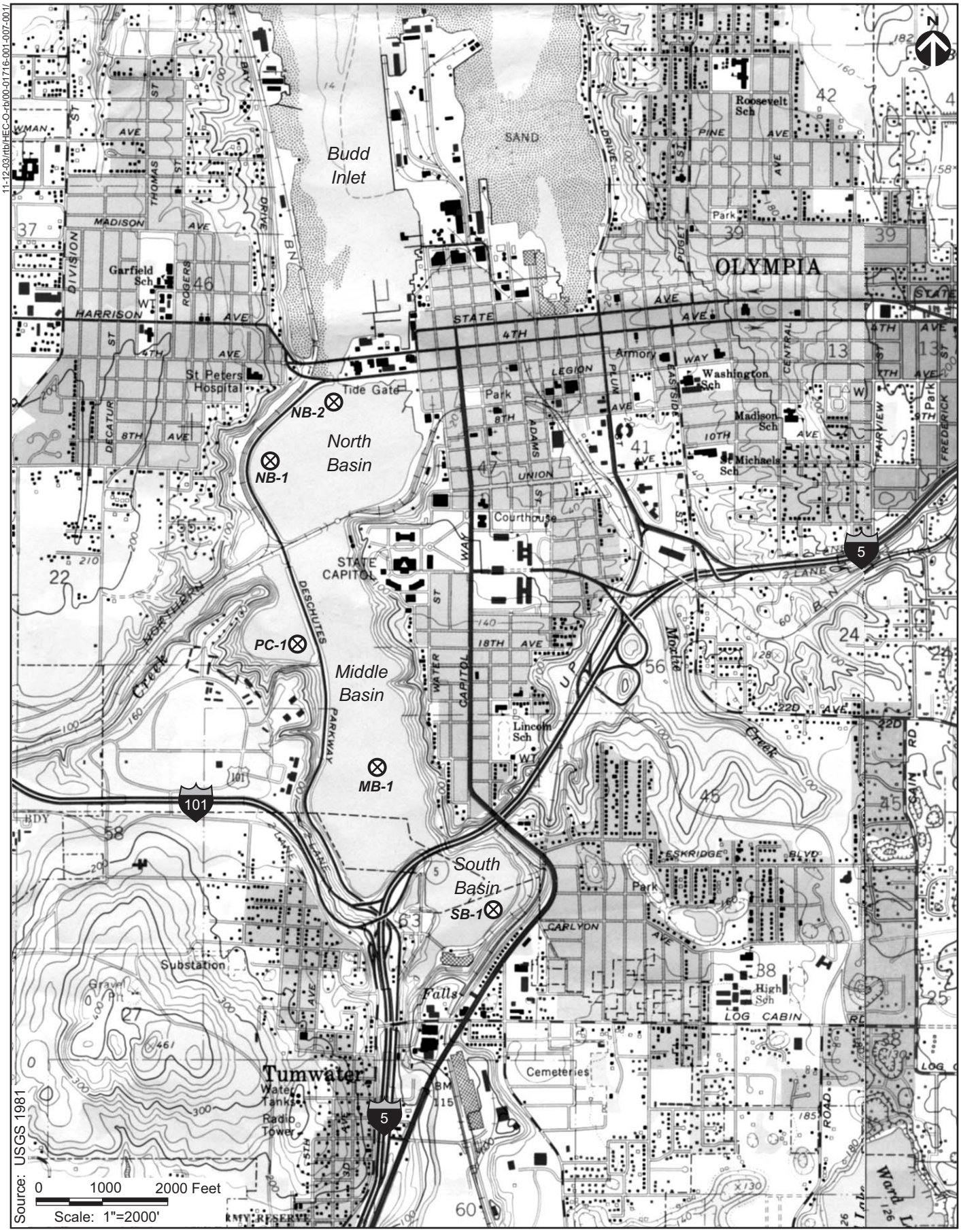

Figure 3. Invertebrate sampling locations in Capitol Lake in Olympia, Washington.

Benthic Invertebrate Samples

Four benthic invertebrate samples were collected at the following locations in Capitol Lake and Percival Cove.

- Station NB-1 located in the Capitol Lake north basin along the west shoreline at a depth of 7 feet.
- Station MB-1 located in the Capitol Lake middle basin in the south central area at a depth of 9 feet.
- Station SB-1 located in the Capitol Lake south basin in the southeast corner at a depth of 3 feet.
- Station PC-1 located in Percival Cove in the southeast corner at a depth of 3 feet.

Three of these stations (NB-1, MB-1, and PC-1) were previously sampled for benthic invertebrates on July 23, 1996 (Herrera 1997). Station SB-1 was added to include an inventory of benthic invertebrates from the Capitol Lake south basin.

A rangefinder and map were used to locate the historic sampling stations. The location of each sample was recorded using a global positioning system (GPS) unit and differential correction was used to map the site. The water depth at each sample location was measured with a calibrated rope attached to a Secchi disk.

The benthic invertebrate samples were collected from a boat by taking grab samples of the bottom sediment. One sediment sample was collected at each station using a large (9-by 9-inch) Ekman dredge having a sampling area of 0.05 square meters. Multiple attempts at collecting a representative sediment sample from each station were necessary due to the presence of submerged macrophytes and coarse substrate that prevented the Ekman dredge from penetrating the sediment. The sediment samples were predominantly dark brown in color, composed of silt and fine sand, and contained submerged macrophytes. Once a representative sample was collected, the sediment was rinsed through a 4-gallon bucket fitted with a fine screen (540 micron mesh) by repeatedly flushing water through the bucket. Benthic invertebrates present on the screen were transferred into sample jars using lake water and preserved with a 10 percent buffered formalin solution.

The samples were shipped to Aquatic Biology Associates, Inc. for taxonomic identification, and enumeration of individual taxa, functional feeding groups, and tolerance groups. The results were reported on a square meter basis and various diversity and biotic condition indices were calculated for each sample.

Zooplankton Sample

One zooplankton sample was collected at Station NB-2, located in the Capitol Lake north basin, at the deepest point (35 feet) adjacent to the tide gate on 5th Avenue. The zooplankton sample was collected from a boat by raising a plankton net from the lake bottom to the lake surface. As the plankton net was pulled to the surface, the sample of zooplankton was concentrated in the cod end of the net. The zooplankton were transferred from the net into sample jars using lake water and preserved with 10 percent buffered formalin. The cylindrical volume of water that was sampled was calculated based on the diameter of the net opening (0.2 meter) and depth of the lake at the sampling station (9.75 meters), for a total sampled area of 0.31 cubic meters. The samples were shipped to EcoAnalyst, Inc. for taxonomic identification, enumeration of individual taxa, and calculation of taxa density.

Results

The following inventory of vertebrate and invertebrate species inhabiting Capitol Lake is based on a review of existing literature sources and field investigations. This data includes all the animal species that have historically and currently used Capitol Lake. In order to understand the full range of species that may occur in Capitol Lake, a brief discussion of the project setting is provided below.

Project Setting

The following section provides a historical perspective on shoreline alterations in Capitol Lake, water quality conditions, plant communities, and fish populations. The historical perspective is necessary to identify all animal species that could utilize Capitol Lake, even if they were not observed during the reconnaissance on October 17, 2003.

Historical Shoreline Alterations in Capitol Lake

The shoreline configuration of Capitol Lake has been altered in the last 75 years with subsequent effects on fish and wildlife habitat. Therefore, a brief chronological description of these habitat changes is presented below, in order to evaluate the value of the existing habitat.

Prior to 1929, the Deschutes River flowed into the southern terminus of Budd Inlet where Capitol Lake currently exists. The deltaic mouth of the Deschutes River consisted of alluvial deposits, tidal marshes, and braided channels providing valuable estuarine habitat for fish rearing (WSU 1975). In 1929, the Burlington Northern Railroad Company (BNRR) built railroad tracks across the Deschutes River mouth, consisting of a berm and trestle that separated the middle and north basins (Ikerd 1995 personal communication). These railroad tracks also altered the eastern shoreline of the north basin. During this same time period, railroad tracks were installed that created Percival Cove and defined the western shoreline of the middle and north basins (University of Washington 1995). Around 1942, earthen fill was placed and the 5th Avenue bridge was constructed, which effectively narrowed the outlet of the Deschutes River (University of Washington 1995).

In 1951, the 5th Avenue dam and tide gate was installed, which created the freshwater habitat of Capitol Lake and significantly altered the salinity, sediment deposition, plant community structure, and fish populations at the Deschutes River mouth (WSU 1975). Tidal fluctuations from Budd Inlet, and the sediment transport energy of the Deschutes River and Percival Creek were greatly diminished with the creation of Capitol Lake (WSU 1975). In 1956, the Interstate 5 (I-5) bridge and earthen fill was constructed, which separated the south and middle basins of Capitol Lake (WDGA 1977). This narrowing of Capitol Lake by I-5 contributed to sediment deposition in the south and middle basins, and creation of freshwater wetland habitats (WSU 1975; WDGA 1977).

In approximately 1965, a city park was developed at the northeast corner of the Capitol Lake north basin. The park consisted of the parking lot, swimming beach, and ornamental plantings (University of Washington 1995). Between 1969 and 1974, the Deschutes Parkway was constructed along the west shoreline of Capitol Lake, and fill material was placed at the southwest corner of the north basin to create Marathon Park (University of Washington 1995). Between 1976 and 1999, the shoreline of the Capitol Lake north basin remained essentially unchanged (University of Washington 1995). In 1999, the northern shoreline of the Capitol Lake north basin was modified to create Heritage Park, which replaced some of the shoreline vegetation with retaining walls and walkways.

Historic Water Quality Conditions in Capitol Lake

Circulation patterns in Capitol Lake are influenced by constrictions at the I-5 bridge, BNRR railroad trestle, and 5th Avenue tide gate, which in turn affect the substrate composition and bathymetry of the lake (WSU 1975). During high discharge events in the Deschutes River, a trench is scoured through the constriction at the I-5 bridge and BNRR railroad trestle. As the Deschutes River flow enters the middle and north basins, the velocity decreases and fine sediments settle out. This has created sediment deposits in the middle basin that have periodically been dredged to maintain lake levels. As the Deschutes River flow encounters the narrow outlet of the 5th Avenue tide gate, two eddy cells are created that circulate clockwise along the east shoreline, and counterclockwise on the west shoreline (CH2M Hill 1978). During summer low flow conditions these eddy cells do not circulate appreciably, which causes poor water quality along the shorelines.

Water quality conditions in the north basin are influenced by operation of the fish ladder at the tide gate (WDGA 1977). From August to December when adult salmon migrate through Capitol Lake the fish ladder is left open, which allows some saltwater to enter the north basin (Ikerd 1995 personal communication). Twice a day during high tides, the 5th Avenue tide gate is closed which stops freshwater flow out of the lake. The small amount of denser saltwater that enters the north basin sinks to the bottom and forms a saline wedge that migrates upstream toward the BNRR railroad trestle (Entranco 1983). Slightly elevated salinity levels in the Capitol Lake north basin have negatively affected fish and benthic invertebrate diversity.

Water quality conditions in the north basin are also influenced by annual saltwater flushing (WDGA 1977). During the summer (between May to September) from 1971 to 1996, Capitol Lake was drained of freshwater and flushed with saltwater in order to acclimate juvenile salmonids and control algal and aquatic macrophyte growth (WSU 1975; WDGA 1977; Entranco 1983). From 1971 to 1985, the WDFW managed the lake flushing to acclimate juvenile salmonids to saltwater (Ikerd 1995 personal communication). Although this management practice ended in 1985, annual drawdowns and saltwater flushing occurred from 1985 to 1996 for control of algal blooms and purple loosestrife (Entranco 1990a). Through manipulation of the tide gates at low tide the majority of the lake is drained, then saltwater is allowed to fill Capitol Lake during high tides. The saltwater remains in the lake for several weeks during the summer, which kills submerged macrophytes used as fish cover and algal populations that form

the base of the food chain for fish. This management practice has restricted the growth of submerged macrophytes in Capitol Lake and may have limited fisheries productivity (WDGA 1977).

Another bathymetric feature of the north basin is a tide gate crater that was scoured out during the annual saltwater flushing of the lake (Entranco 1983). This crater in the lake bottom, located on the upstream edge of the 5th Avenue tide gate, has created conditions in the past where stratification of anoxic water at the bottom has caused fish kills (Entranco 1983). Since 1986, a siphon in the tide gate crater has drained this anoxic bottom layer to Budd Inlet and no further fish mortality has been observed (Entranco 1990a).

Historic Plant Communities in Capitol Lake

Previous studies on the phytoplankton communities in Capitol Lake were reviewed to describe the food chain available to fish populations (WSU 1975; WDGA 1977; CH2M Hill 1978). Major classes of phytoplankton identified in Capitol Lake include cyanobacteria (also known as blue-green algae), green algae, yellow-green algae, cryptomonads, dinoflagellates, euglenoids, and attached and free-floating diatoms. The dominant genera of phytoplankton identified include cyanobacteria (*Aphanizomenon*, *Oscillatoria*, *Gloeotrichia*, and *Anabaena*), green algae (*Volvox*, *Spirogyra*, *Cladophora*, and *Stichococcus*), and diatoms (*Cyclotella*). Algal blooms occurring during the summer in Capitol Lake have been controlled by saltwater flushing although nutrient sources have not been substantially reduced (Entranco 1983).

Nearshore plant cover that provides habitat for juvenile fish rearing in Capitol Lake includes emergent and submerged macrophytes. The historic presence of aquatic plants in Capitol Lake includes sago pondweed (*Potamogeton pectinatus*), curly leaf pondweed (*Potamogeton crispus*), leafy pondweed (*Potamogeton foliosus*), Canada waterweed (*Elodea canadensis*), inflated duckweed (*Lemna gibba*), and common cattail (*Typha latifolia*) (WSU 1975). A previous survey of emergent vegetation and submerged macrophytes in the Capitol Lake north basin indicates that dominant plants include purple loosestrife (*Lythrum salicaria*), common cattail, curly leaf pondweed, duckweed (*Lemna minor*), and filamentous algae (Thurston County 1995). The past management practice of lake drawdown and flushing with saltwater has limited the distribution and density of these submerged macrophytes (Entranco 1990a). The shoreline configuration of steep beach slopes composed of riprap has limited the establishment of emergent plants (Entranco 1990b). Ongoing efforts to control purple loosestrife from Capitol Lake may also have limited other species of emergent vegetation along the shorelines.

Historic Fish Populations in Capitol Lake

A literature review was performed to document historic fish populations in Capitol Lake. The habitat preferences of each fish species reported in previous studies was used to describe the historic distribution of fish in Capitol Lake.

Prior to 1953, the Deschutes River was not utilized by anadromous salmonids for spawning or rearing due to a migration barrier (Deschutes Falls) at river mile 2.0 (WDF 1975). In 1954, a fish ladder was constructed around the Deschutes Falls, which allowed coho salmon (*Oncorhynchus kisutch*) access to the Deschutes River up to another waterfall at river mile 41.1 (WDF 1975). In 1964, the Washington Department of Fisheries began releasing juvenile fall chinook salmon (*O. tshawytscha*) into Capitol Lake, and the returning adults were captured and trucked around Deschutes Falls to spawn naturally in the Deschutes River (WDF 1975). Currently, the majority of these returning fall chinook adults are captured at Deschutes Falls as brood stock for hatchery production. Coho salmon and steelhead trout (*O. mykiss*) adults are able to use the fish ladder around Deschutes Falls and spawn naturally in the Deschutes River. Small numbers of chum (*O. keta*) and sockeye (*O. nerka*) salmon and sea-run cutthroat trout (*O. clarki clarki*) also ascend the fish ladder at Deschutes Falls and spawn in the Deschutes River (WDFW 1997, 2000, 2001, and 2003a).

Juvenile releases of fall chinook salmon into the Deschutes River and Percival Cove have occurred since 1964 and large numbers of adults return every year (WDFW 2003b). Table 1 lists the number of juvenile fall chinook salmon released into the Deschutes River and Percival Cove from 1995 to 2003 by WDFW. These releases of unfed fry, fry, and yearlings occurred during the spring season (January-June) to coincide with smoltification and outmigration of the juveniles. The two main release sites are located in the Capitol Lake south basin and Percival Cove net pens. These data indicate that the number of juvenile chinook salmon released ranges from 54,000 to 3,924,127 for an average of 1,278,005 per year.

Table 1. Juvenile releases of chinook salmon in Deschutes River and Percival Cove between 1995-2003 by WDFW.

Year	Month	Location	Age Class	Number of Fish
1995	February and March	Deschutes River	Fry	1,002,000
1997	January	Percival Creek	Unfed fry	740,000
1997	May	Deschutes River	Fry	470,000
1998	April	Deschutes River	Fry	1,006,125
1998	April	Percival Creek	Fry	54,000
1999	April and May	Deschutes River	Fry	691,830
2000	April to June	Deschutes River	Fry	3,924,127
2000	May	Percival Creek	Yearling	188,980
2003	January to June	Deschutes River	Fry and Yearling	3,424,989
			Average	1,278,005

The WDFW also releases juvenile steelhead trout into the Deschutes River in the south basin of Capitol Lake (WDFW 2003b). Table 2 lists the number of juvenile steelhead trout released by WDFW into the Deschutes River from 1996 to 2003. These releases of smolts occurred during the spring season (March to May) to coincide with smoltification and outmigration of the juveniles. These data indicate that the number of steelhead trout smolts released ranges from 6,600 to 95,900 for an average of 30,420 per year.

Table 2. Juvenile releases of steelhead trout in Deschutes River between 1996-2003 by WDFW.

Year	Month	Age Class	Number of Fish
1996	April and May	Smolt	95,900
1997	April	Smolt	18,020
1998	May	Smolt	6,600
1999	April	Smolt	26,911
2000	April	Smolt	13,511
2002	March	Smolt	25,000
2003	April and May	Smolt	27,000
		Average	30,420

The number of salmon and trout smolts outmigrating from the Deschutes River basin has been recorded by WDFW at a trap at the Deschutes Falls before they enter the Capitol Lake south basin (WDFW 1997, 2000, 2001, and 2003a). This includes chinook and coho salmon; and steelhead and sea-run cutthroat trout smolts that outmigrate during April and May. Table 3 summarizes the number of salmon and trout smolts counted at the Deschutes Falls trap from 1995 to 1998. These data indicate that an average of 3,141 coho salmon, 16 chinook salmon, 1,142 steelhead trout, and 4 cutthroat trout pass through Capitol Lake as they migrate to Budd Inlet during each spring outmigration.

Table 3. Number of salmon and trout smolts counted by WDFW at the Deschutes Falls trap during the spring of 1995 to 1998.

Year	Coho Salmon	Chinook Salmon	Steelhead Trout	Sea-run Cutthroat Trout
1995	4,113	4	90	–
1996	6,109	19	815	4
1997	1,144	12	2,010	3
1998	1,199	28	1,655	9
Average	3,141	16	1,142	4

The number of adult salmon and trout returning to spawn in the Deschutes River has been recorded by WDFW at the Deschutes Falls fish ladder. This includes coho, chinook, sockeye, and chum salmon; and steelhead and sea-run cutthroat trout observed migrating upstream between late August and late December. Table 4 summarizes the number of adult salmon and trout counted at the Deschutes Falls fish ladder from 1994 to 1998. These data indicate that an average of 1,286 coho salmon, 3,841 chinook salmon, 6 sockeye salmon, 57 chum salmon, 30 steelhead trout, and 78 cutthroat trout pass through Capitol Lake as they migrate upstream to spawn in the Deschutes River during the fall season.

Table 4. Number of adult salmon and trout counted by WDFW at the Deschutes Falls fish ladder from 1994 to 1998.

Year	Coho Salmon	Chinook Salmon	Sockeye Salmon	Chum Salmon	Steelhead Trout	Sea-run Cutthroat Trout
1994	2,810	1,491	1	20	3	97
1995	663	4,972	6	84	5	80
1996	549	8,540	9	120	110	74
1997	1,124	363	7	6	2	61
Average	1,286	3,841	6	57	30	78

The results of the fish stranding surveys conducted during lake drawdown in 1996 (Herrera 1997) indicates that the most abundant fish species in Capitol Lake included three-spine stickleback (*Gasterosteus aculeatus*), riffle sculpin (*Cottus gulosus*), and western brook lamprey (*Lampetra richardsoni*). Other fish species observed included black bullhead (*Ictalurus melas*), carp (*Cyprinus carpio*), fall chinook salmon, Olympic mudminnow (*Novumbra hubbsi*), and starry flounder (*Platichthys stellatus*).

Historic Data on Invertebrate Populations

Previous studies on the benthic invertebrate and zooplankton communities in Capitol Lake were reviewed to describe historic species presence during monitoring conducted between 1974 and 1978 (WSU 1975; WDGA 1977; CH2M Hill 1978). The dominant classes and genera of benthic invertebrates that have been identified in Capitol Lake include ostracods (*Typhlocypris*), amphipods (*Corophium*), marine polychaetes (*Ampharetidae* and *Nereis*), chironomid larvae, crane flies (*Tipulidae*), and water mites (*Hydracarina*). Other invertebrates reported to exist include crayfish and snails. Major classes of zooplankton and the dominant genera within each class that have been identified in Capitol Lake include cladocerans (*Bosmina*, *Ceriodaphnia*, and *Daphnia*), copepods (*Cyclops* and *Diaptomus*), and rotifers (*Asplanchna*, *Polyarthra*, and *Synchaeta*).

The results of benthic invertebrate sampling conducted by Herrera during the lake drawdown in 1996 were reviewed for species presence (Herrera 1997). These benthic invertebrate samples were collected in the north and middle basins of Capitol Lake as well as Percival Cove in the same location as samples collected for this inventory. The dominant classes of benthic invertebrates that were identified include Oligochaeta (earthworms), Chironomidae (midges), *Isopoda* (sow bugs), Trichoptera (caddis fly), Hirudinea (leeches), and Pelecypoda (clams).

Existing Fish and Wildlife Habitat Conditions

A description of the existing habitat conditions in Capitol Lake for vertebrate and invertebrate species is provided below. This includes a description of the shoreline vegetation and open water areas that provide habitat for mammals, birds, reptiles, amphibians, and fish.

Description of Existing Shoreline Vegetation

Several distinct types of shoreline vegetation were observed within the Capitol Lake and Percival Cove areas that provide different kinds of fish and wildlife habitat (Johnson and O'Neil 2001). These shoreline habitat types include riparian and palustrine wetlands, upland mixed forest, brushy vegetation growing in riprap, sparsely vegetated riprap, deciduous forested wetlands, retaining walls, and landscaped park areas. Figure 4 illustrates the location of these different shoreline habitat types within the Capitol Lake project area. Table 5 lists these fish and wildlife habitat types observed along the shoreline of Capitol Lake and Percival Cove. A description of these shoreline habitat types in the north, middle, and south basins of Capitol Lake; and Percival Cove is presented below.

The shoreline in the Capitol Lake north basin contains a mixture of sparsely vegetated riprap, retaining walls, riparian and palustrine wetlands, and landscaped park areas. The western shoreline adjacent to the Deschutes Parkway and Marathon Park consists of a narrow band of sparsely vegetated riprap with low habitat value. The northern shoreline consists of retaining walls at the 5th Avenue tide gate and a portion of Heritage Park that provides low habitat value. The southeast shoreline in Heritage Park contains a narrow band of riparian and palustrine wetlands that provides high value fish and wildlife habitat that was created as mitigation for Heritage Park.

Typical vegetation in riparian and palustrine wetlands along the shoreline include: emergent species such as common cattail (*Typha latifolia*), soft rush (*Juncus effusus*), yellow flag (*Iris pseudacorus*), reed canarygrass (*Phalaris arundinacea*), and purple loosestrife (*Lythrum salicaria*) that are considered invasive species; and native riparian species such as willow (*Salix* sp.), hardhack (*Spiraea douglasii*), red-osier dogwood (*Cornus stolonifera*), red alder (*Alnus rubra*), and black cottonwood (*Populus balsamifera*).

The shoreline along the Capitol Lake middle basin contains a mixture of riparian and palustrine wetlands, brushy vegetation growing in riprap, sparsely vegetated riprap, deciduous forested wetlands, and upland mixed forest. The southwest shoreline adjacent to a wetland mitigation site for Heritage Park contains palustrine wetlands that provide high value fish and wildlife habitat. The western shoreline adjacent to the Deschutes Parkway and the BNRR railroad tracks consists of a narrow band of brushy vegetation growing in riprap and sparsely vegetated riprap with low habitat value. The northeast shoreline near the BNRR railroad tracks consists of deciduous forested wetland on a steep slope. The eastern shoreline is lined by an upland mixed forest on a steep slope including a stand of large Douglas-fir and grand fir. Both the deciduous forested wetland and upland mixed forest provides moderate value as fish and wildlife habitat due to the steep banks that limit access to adjacent habitats.

Table 5. Fish and wildlife habitat types observed along the shoreline of Capitol Lake and Percival Cove.

Habitat Type	Location	Total Length (ft.)	Percentage of Shoreline Length (%)	Description of Habitat Type	Relative Value of Fish and Wildlife Habitat
Riparian and palustrine wetlands	▪ Southeast shoreline of Capitol Lake north basin ▪ Southwest shoreline of Capitol Lake middle basin ▪ Northwest and southeast shorelines of Capitol Lake south basin	2,750	22	Shallow sloped beach lined with scrub/shrub and emergent vegetation.	High
Upland mixed forest	▪ Eastern shoreline of Capitol Lake middle basin ▪ Northeast shoreline of Capitol Lake south basin ▪ West shoreline of Percival Cove	4,310	34	Mixture of upland coniferous and deciduous forest on steep banks.	Moderate
Brushy vegetation growing in riprap	▪ Western shoreline of Capitol Lake middle basin ▪ Southwest shoreline of Capitol Lake south basin	1,630	13	Steep riprap lined bank covered with scattered shrubs and grasses.	Low
Sparsely vegetated riprap	▪ Western shoreline of Capitol Lake north basin ▪ Northwest shoreline of Capitol Lake middle basin ▪ East shoreline of Percival Cove	2,750	22	Steep riprap lined banks sparsely covered with invasive shrubs and grasses.	Low
Deciduous forested wetlands	▪ Southeast side of Capitol Lake north basin ▪ Northeast shoreline of Capitol Lake middle basin	250	2	Forested deciduous forest on steep slope above shoreline.	Moderate
Retaining wall	▪ Northeast shoreline of Capitol Lake north basin adjacent to 5th Avenue tide gate and Heritage Park	625	5	Concrete retaining wall over sand bottom with no emergent vegetation. Tide gate structure adjacent to deepwater.	Low
Landscaped park areas	▪ Eastern shoreline in Heritage Park and southwest shoreline in Marathon Park within Capitol Lake north basin ▪ Northwest shoreline of Capitol Lake south basin	310	2	Shallow sloped beach with minimal emergent vegetation.	Low
	Total	12,620	100		

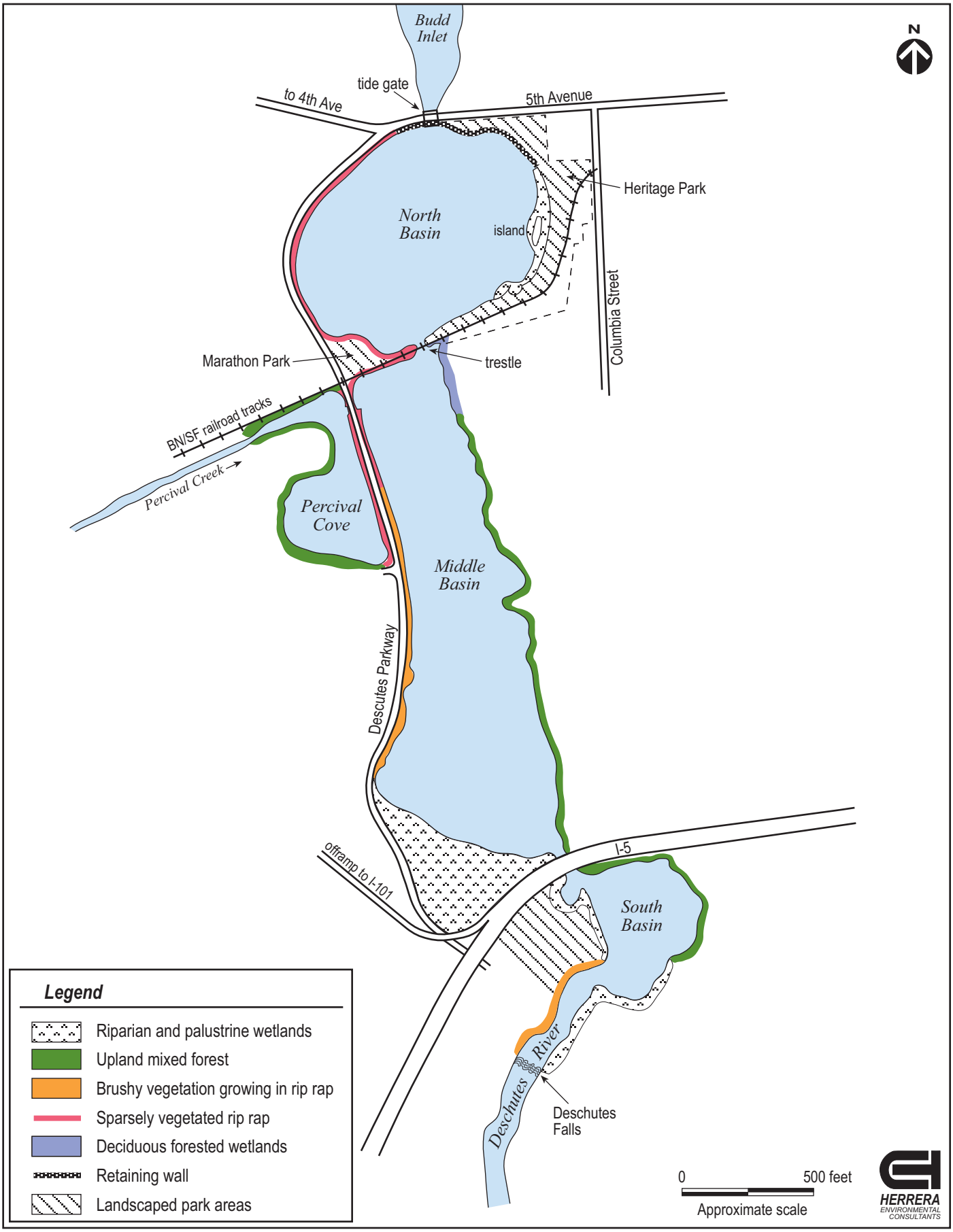

Figure 4. Shoreline habitat types within Capitol Lake in Olympia, Washington.

The shoreline of the Capitol Lake south basin consists of a mixture of brushy vegetation growing in riprap, riparian and palustrine wetlands, and upland mixed forest. The southwest shoreline consists of a narrow band of brushy vegetation growing in riprap adjacent to a city park. Two other portions of the shoreline are lined by riparian and palustrine wetlands that provide high value fish and wildlife habitat. The northeast shoreline contains upland mixed forest on a steep slope that provides moderate value habitat.

The shoreline of Percival Cove consists of a mixture of upland mixed forest and sparsely vegetated riprap. The west and north portions of the shoreline are lined by upland mixed forest on a steep slope that provides moderate value habitat. The eastern shoreline adjacent to the Deschutes Parkway consists of a narrow band of sparsely vegetated riprap with low habitat value.

The most valuable fish and wildlife habitat within the project area includes the riparian and palustrine wetland and upland mixed forest areas. These two habitat types contribute 7,060 feet of the total 12,620 feet (56 percent) of the total lake shoreline length within the project area. These two habitat types provide a wide band of vegetation adjacent to the shoreline. The bottom sediment consists of silty sand, and juvenile fish cover is provided by emergent vegetation and large woody debris.

High quality perching and nesting habitat exists in the upland mixed forest in the form of large conifers with well-developed upper branch and crown structure. These features provide suitable structure for nesting platforms for large birds, including bald eagles (*Haliaeetus leucocephalus*). The foraging habitat value of these areas is limited by the encroachment of invasive species such as English ivy (*Hedera helix*) and Himalayan blackberry (*Rubus armeniacus*).

The remaining shoreline habitat types within the project area include steep riprap banks with minimal overhanging vegetation, retaining walls with no emergent vegetation, and landscaped park areas with grass and ornamental shrubs. These portions of shoreline within the project area provide poor fish habitat due to the steep beach slope, substrate composition consisting of silty muck, and lack of overhanging or emergent vegetation providing cover.

Description of Existing Habitat in Capitol Lake and Percival Cove

The existing fish and wildlife habitat within Capitol Lake and Percival Cove is divided into vegetated areas between 2 and 15 feet deep and open water areas. The vegetated areas shallower than 15 feet are dominated by submerged macrophyte plants (Thurston County 2003). These plants include Eurasian watermilfoil (*Myriophyllum spicatum*), coontail (*Ceratphyllum demersum*), Canada waterweed (*Elodea canadensis)*, curly leaf pondweed (*Potamogeton crispus*), slender pondweed (*P. filliformis*), and sago pondweed (*P. pectinatus*). The shallow vegetated areas are present along the shorelines of the south, middle, and north basins of Capitol Lake and Percival Cove. These dense stands of submerged macrophytes provide cover from fish.

The open water areas between 15 and 35 feet in depth are devoid of submerged macrophyte plants. The open water areas are most prevalent in the central portion of the Capitol Lake north basin, due to the greater water depth, and the Capitol Lake south basin where strong currents from the Deschutes River prevent plant establishment. The open water area in the Capitol Lake north basin provides poor habitat for fish due to the lack of cover (e.g., submerged logs). The open water area in the Capitol Lake south basin provides good habitat for fish species that prefer flowing current and coarse substrate.

Inventory of Vertebrate and Invertebrate Species

The following section provides a listing of all vertebrate and invertebrate species that may occur in Capitol Lake, Percival Cove, and the adjacent shorelines. This includes threatened and endangered species, vertebrates (mammals, birds, reptiles, amphibians, and fish), and invertebrates (benthic invertebrates and zooplankton).

Threatened and Endangered Species

The National Oceanic and Atmospheric Administration (NOAA) Fisheries (formerly called the National Marine Fisheries Service) was consulted for any threatened or endangered anadromous fish species in the vicinity of the site (NOAA Fisheries 2003). NOAA Fisheries has identified Puget Sound chinook salmon, a threatened species, and Puget Sound/Strait of Georgia coho salmon, a candidate species, as potentially occurring in the project vicinity.

The U.S. Fish and Wildlife Service (USFWS) provided information on threatened and endangered wildlife species that may occur in Thurston County, but not necessarily in the Capitol Lake project area (USFWS 2003). The USFWS has identified four threatened species, five candidate species, and 19 species of concern as potentially occurring in Thurston County. Appendix A contains the agency correspondence from the USFWS according to their common and scientific names and their status. Table 6 summarizes the species identified in Thurston County by the USFWS.

The Washington Department of Fish and Wildlife (WDFW) priority habitat and species program identified fish and wildlife species presence and priority areas within the Capitol Lake project area (WDFW 2003c). Capitol Lake and the Deschutes River is identified as a migration corridor for anadromous fish that include fall chinook salmon, coho salmon, searun cutthroat trout, and winter steelhead. The south basin is identified as providing priority resident fish habitat for cutthroat trout. The Deschutes River at Deschutes Falls is identified as containing riffle sculpin, a state monitor species. The south basin is identified as containing breeding territory for wood duck (*Aix sponsa*). Percival Cove is identified as containing a breeding territory for green heron (*Butorides striatus*), a state monitor species, and a regular concentration of mink (*Mustela vison*). Two nest sites for bald eagle, a state threatened species, are identified along the eastern shoreline of the middle basin.

Table 6. Threatened and endangered species identified by the U.S. Fish and Wildlife Service as possibly occurring in Thurston County.

Category	Common Name	Scientific Name	Federal Status
Fish	Bull trout	*Salvelinus confluentus*	Threatened
	Coastal cutthroat trout	*Oncorhynchus clarki clarki*	Species of Concern
	River lamprey	*Lampetra ayresi*	Species of Concern
	Pacific lamprey	*Lampetra tridentata*	Species of Concern
Amphibian	Oregon spotted frog	*Rana pretiosa*	Candidate
	Cascades frog	*Rana cascadae*	Species of Concern
	Tailed frog	*Ascaphus truei*	Species of Concern
	Larch Mountain salamander	*Plethodon larselli*	Species of Concern
	Van Dyke's salamander	*Plethodon vandykei*	Species of Concern
Reptile	Northwestern pond turtle	*Emys marmorata marmorata*	Species of Concern
Bird	Bald eagle	*Haliaeetus leucocephalus*	Threatened
	Marbled murrelet	*Brachyramphus marmoratus*	Threatened
	Northern spotted owl	*Strix occidentalis caurina*	Threatened
	Streaked horned lark	*Eremophila alpestris strigata*	Candidate
	Northern goshawk	*Accipiter gentilis*	Species of Concern
	Oregon vesper sparrow	*Pooectetes gramineus affinis*	Species of Concern
	Olive-sided flycatcher	*Contopus cooperi*	Species of Concern
	Slender-billed white-breasted nuthatch	*Sitta carolinensis aculeata*	Species of Concern
Mammal	Mazama pocket gopher	*Thomomys mazama*	Candidate
	Long-legged myotis	*Myotis volans*	Species of Concern
	Long-eared myotis	*Myotis evotis*	Species of Concern
	Pacific Townsend's big-eared bat	*Corynorhinus townsendii townsendii*	Species of Concern
	Pacific fisher	*Martes pennanti pacifica*	Species of Concern
	California wolverine	*Gulo gulo luteus*	Species of Concern
	Northern sea otter	*Enhydra lutris keyoni*	Species of Concern
	Western gray squirrel	*Sciurus griseus griseus*	Species of Concern
Insect	Mardon skipper	*Polites mardon*	Candidate
	Whulge (Edith's) checkerspot	*Euphydryas editha taylori*	Candidate
	Valley silverspot	*Speyeria zerene bremeri*	Species of Concern

Vertebrate Species Inventory

A literature review was performed to document the historic presence of vertebrate species in the Capitol Lake area (WDGA 1977 and 1996). Reports prepared over the last 25 years from wildlife observations in the Capitol Lake area were reviewed to document historic presence and habitat conditions for mammals, birds, reptiles, amphibians, and fish. In addition, vertebrate species that are expected to occur in the Capitol Lake area based on their habitat requirements and distribution are included.

Mammals

Table 7 lists the mammal species identified in Capitol Lake based on this literature review (Eder 2002; Nagorsen and Brigham 1993; Whitaker 1980). These mammal species include shrew, vole, mole, mice and rats, squirrel, rodent, opossum, carnivore, deer, and bat classes. This list of mammal species includes wildlife that depend on aquatic habitats in Capitol Lake and Percival Cove for foraging, nesting, and breeding. Other mammal species reside in adjacent upland habitats along the shorelines and may not be dependent on the lake. The bat species feed on insects over the lake surface.

Birds

The bird species identified as occurring in Capitol Lake and the surrounding shoreline are based on a literature review (Black Hills Audubon Society 2003, Peterson 1990) and field observations. The Black Hills Audubon Society provided Christmas bird counts and other observations. These bird counts occurred on eight dates in the fall and spring seasons (December 14, 2002; and March 3, May 7, October 14, 20, and 27, and November 4 and 9, 2003). Table 8 lists the general type of birds, their common and scientific names, general locations where they were observed, and relative population size.

These species include birds that forage on Capitol Lake and Percival Cove such as grebes, loons, cormorants, geese and swans, dabbling ducks, bay ducks, sea ducks, mergansers, stiff tails, coots, herons, kingfishers, dippers, rails, shorebirds, and gulls. This also includes other birds that feed over the water or along the shorelines such as swifts, swallows, flycatchers, corvids, raptors, woodpeckers, vireos, chickadees, bushtit, nuthatches, creepers, wrens, hummingbird, kinglets, thrushes, starlings, waxwings, wood-warblers, tanagers, grosbeaks, towhees, sparrows, junco, icterids, finches, and old-world sparrows.

Reptiles

Table 9 lists the reptile species identified as possibly occurring in Capitol Lake based on a literature review and field observations. These reptiles include two turtles and three snake species that are expected to occur in the Capitol Lake area based on their habitat requirements (John 2002; National Audubon Society 1998).

Table 7. Mammal species identified as possibly occurring in the Capitol Lake project area.

Type of Mammal	Common Name	Scientific Name	Location	Population Size
Shrew	Pacific water shrew	*Sorex bendirii*	Along shoreline with emergent vegetation and deciduous forest	Less than 50
	Dusky shrew	*Sorex monticolus*	Along shoreline with deciduous forest	Less than 50
	Trowbridge's shrew	*Sorex trowbridgii*	Along shoreline with deciduous forest	Less than 50
	Vagrant shrew	*Sorex vagrans*	Along shoreline with deciduous forest	Less than 50
Vole	Townsend's vole	*Microtus townsendii*	Along shoreline with deciduous forest	Less than 50
	Creeping vole	*Microtus oregoni*	Along shoreline with deciduous forest	Less than 50
Mole	Shrew-mole	*Neurotrichus gibbsii*	Along shoreline with deciduous forest	Less than 50
	Townsend's mole	*Scapanus townsendii*	Along shoreline with deciduous forest	Less than 50
	Coast mole	*Scapanus orarius*	Along shoreline with deciduous forest	Less than 50
Mice and Rats	Deer mouse	*Peromyscus maniculatus*	Along shoreline with deciduous forest	Less than 100
	House mouse	*Mus musculus*	Along shoreline in urban areas	Less than 100
	Norway rat	*Rattus norvegicus*	Along shoreline in urban areas	Less than 50
	Black rat	*Rattus rattus*	Along shoreline in urban areas	Less than 50
Squirrel	Townsend's chipmunk	*Tamias townsendii*	Along shoreline with mixed forest	Less than 25
	Douglas' squirrel	*Tamiasciurus douglasii*	Along shoreline with mixed forest	Less than 25
Rodent	Common muskrat	*Ondatra zibethicus*	Along shoreline with emergent vegetation	Less than 25
	Mountain beaver	*Aplodontia rufa*	Along shoreline with emergent vegetation and deciduous forest	Less than 50
	Nutria	*Myocastor coypus*	Along shoreline with emergent vegetation	Less than 25
	Beaver	*Castor canadensis*	Along shoreline with emergent vegetation and deciduous forest	Less than 25
Opossum	Virginia opossum	*Didelphis virginiana*	Along shoreline with emergent vegetation and deciduous forest	Less than 25
Carnivore	Mink	*Musela vison*	Along shoreline with emergent vegetation and deciduous forest	Less than 10
	Striped skunk	*Mephitis mephitis*	Along shoreline with emergent vegetation and deciduous forest	Less than 25
	River otter	*Lutra canadensis*	Stream channels in Percival Creek and Capitol Lake south basin	Less than 10
	Sea otter	*Enhydra lutris*	Capitol Lake north basin near 5th Avenue tide gate	Less than 10
	Raccoon	*Procyon lotor*	Along shoreline with emergent vegetation and deciduous forest	Less than 50
Deer	Mule deer	*Odocoileus hemionus ssp. columbianus*	Along shoreline with mixed forest	Less than 25
Bats	Long-legged myotis	*Myotis volans*	Over lake surface	Less than 25
	Western small-footed Myotis	*Myotis ciliolabrum*	Over lake surface	Less than 25
	Long-eared myotis	*Myotis evotis*	Over lake surface	Less than 25
	Little brown myotis	*Myotis lucifugus*	Over lake surface	Less than 25
	Hoary bat	*Lasiurus cinereus*	Over lake surface	Less than 25

Sources: (Eder 2002; Nagorsen and Brigham 1993; Whitaker 1980).

Table 8. Bird species identified as possibly occurring on Capitol Lake and surrounding shoreline.

Type of Bird	Common Name	Scientific Name	Location	Population Size
Grebes	Pied-billed grebe	*Podilymbus podiceps*	North and middle basin of Capitol Lake and Percival Cove	1-20 birds in winter
	Horned grebe	*Podiceps auritus*	North and middle basin of Capitol Lake	1-2 birds in winter
	Eared grebe	*Podiceps nigricollis*	North and middle basin of Capitol Lake	1-2 birds in winter
Loons	Common loon	*Gavia immer*	North basin Capitol Lake	1-2 birds in winter
Cormorants	Double-crested cormorant	*Phalacrocorax auritus*	North and middle basin of Capitol Lake and Percival Cove	1-5 birds in fall
	Pelagic cormorant	*Phalacrocorax pelagicus*	North basin Capitol Lake	1-2 birds in winter
Geese and Swans	Canada goose	*Branta canadensis*	North and middle basin of Capitol Lake and Percival Cove	5-30 resident birds
	Trumpeter swan	*Cygnus buccinator*	North and middle basin of Capitol Lake	1-2 birds in winter
Dabbling Ducks	Wood duck	*Aix sponsa*	South basin of Capitol Lake and Percival Cove	1-2 birds in winter
	Mallard	*Anas platyrhynchos*	North, middle, and south basin of Capitol Lake and Percival Cove	15-95 resident birds
	Gadwall	*Anas strepera*	North and middle basin of Capitol Lake	4-52 birds in winter
	Northern pintail	*Anas acuta*	South and middle basins of Capitol Lake	2-6 birds in winter
	American wigeon	*Anas americana*	South and middle basins of Capitol Lake	6-470 birds in winter
	Eurasian wigeon	*Anas penelope*	South and middle basins of Capitol Lake	1-2 birds in winter
	Northern shoveler	*Anas clypeata*	North and middle basin of Capitol Lake	10-23 birds in winter
	Green-winged teal	*Anas crecca*	South and middle basins of Capitol Lake	3-11 birds in winter
Bay Ducks	Canvasback	*Aythya valisineria*	North basin of Capitol Lake	1-10 birds in winter
	Redhead	*Aythya americana*	North basin of Capitol Lake	1-2 birds in winter
	Ring-necked duck	*Aythya collaris*	North and middle basin of Capitol Lake and Percival Cove	2-230 birds in winter
	Greater scaup	*Aythya marila*	North and middle basin of Capitol Lake	8-310 birds in winter
	Lesser scaup	*Aythya affinis*	North and middle basin of Capitol Lake	15-262 birds in winter
Sea Ducks	Long-tailed duck	*Clangula hyemalis*	North basin of Capitol Lake	1-2 birds in winter
	Common goldeneye	*Bucephala clangula*	North and middle basin of Capitol Lake	1-2 birds in winter
	Barrow's goldeneye	*Bucephala islandica*	North and middle basin of Capitol Lake	1-2 birds in winter
	Bufflehead	*Bucephala albeola*	North and middle basin of Capitol Lake	6-256 birds in winter

Table 8. Bird species identified as possibly occurring on Capitol Lake and surrounding shoreline (continued).

Type of Bird	Common Name	Scientific Name	Location	Population Size
Mergansers	Hooded merganser	*Lophodytes cucullatus*	Middle basin of Capitol Lake and Percival Cove	1-26 birds in winter
	Common merganser	*Mergus merganser*	Middle basin of Capitol Lake and Percival Cove	3-13 birds in winter
Stiff tails	Ruddy duck	*Oxyura jamaicensis*	North basin of Capitol Lake	9-37 birds in winter
Coots	American coot	*Fulica americana*	North and middle basin of Capitol Lake	18-57 birds in winter
Herons	Great blue heron	*Ardea herodias*	North, middle, and south basin of Capitol Lake and Percival Cove	1-3 resident birds
	Green heron	*Butorides striatus*	Middle basin of Capitol Lake and Percival Cove	1-3 resident birds
Kingfishers	Belted kingfisher	*Ceryle alcyon*	North and middle basin of Capitol Lake and Percival Cove	1-4 resident birds
Dippers	American dipper	*Cinclus mexicanus*	South basin of Capitol Lake	1-2 resident birds
Rails	Virginia rail	*Rallus limicola*	Middle basin of Capitol Lake	1-3 birds in winter
Shorebirds	Killdeer	*Charadrius vociferous*	Middle basin of Capitol Lake	1-2 birds in winter
	Greater yellowlegs	*Tringa melanoleuca*	Middle basin of Capitol Lake	1-2 birds in winter
	Spotted sandpiper	*Actitis macularia*	Middle basin of Capitol Lake and Percival Cove	1-2 birds in winter
	Western sandpiper	*Calidris mauri*	North basin of Capitol Lake	1-2 birds in winter
	Red phalarope	*Phalaropus fulicaria*	North basin of Capitol Lake	1-2 birds in winter
Gulls	Bonaparte's gull	*Larus philadelphia*	North and middle basin of Capitol Lake	1-10 birds during spring/fall migration
	Mew gull	*Larus canus*	North and middle basin of Capitol Lake	2-7 birds in winter
	Ring-billed gull	*Larus delawarensis*	North and middle basin of Capitol Lake	2-6 birds in winter
	California gull	*Larus californicus*	North basin of Capitol Lake	1-3 birds in winter
	Glaucous-winged gull	*Larus glaucescens*	North and middle basin of Capitol Lake	10-210 resident birds
Swifts	Vaux's swift	*Chaetura vauxi*	North and middle basin of Capitol Lake	1-2 birds in summer
Swallows	Purple martin	*Progne subis*	Seen flying high over lake	Uncommon in summer, nests on east/west bay
	Violet-green swallow	*Tachycineta thalassina*	North and middle basin of Capitol Lake	Uncommon summer resident
	Tree swallow	*Tachycineta bicolor*	North and middle basin of Capitol Lake	30 summer resident birds
	Barn swallow	*Hirundo rustica*	North and middle basin of Capitol Lake	Uncommon summer resident
Flycatchers	Pacific-slope flycatcher	*Empidonax difficilis*	Middle basin of Capitol Lake	Common spring migrant and summer resident

Table 8. Bird species identified as possibly occurring on Capitol Lake and surrounding shoreline (continued).

Type of Bird	Common Name	Scientific Name	Location	Population Size
Flycatchers (continued)	Willow flycatcher	*Empidonax traillii*	Middle and south basins of Capitol Lake	Rare summer resident
Corvids	Steller's jay	*Cyanocitta stelleri*	Middle and south basins of Capitol Lake	1-3 resident birds
	American crow	*Corvus brachyrhynchos*	North and middle basin of Capitol Lake	3-58 resident birds
Raptors	Red-tailed hawk	*Buteo jamaicensis*	North basin of Capitol Lake	1-2 resident birds
	Bald eagle	*Haliaeetus leucocephalus*	North and middle basin of Capitol Lake	1-2 resident birds
	Osprey	*Pandion haliaetus*	North and middle basin of Capitol Lake	1-2 resident birds in summer
Woodpeckers	Red-breasted sapsucker	*Sphyrapicus ruber*	Middle and south basins of Capitol Lake	Uncommon secretive resident
	Downy woodpecker	*Picoides pubescens*	Middle and south basins of Capitol Lake	Common resident
	Northern flicker	*Colaptes auratus*	North and middle basin of Capitol Lake	1-3 resident birds
	Pileated woodpecker	*Dryocopus pileatus*	Middle and south basins of Capitol Lake	1-3 resident birds
Vireos	Warbling vireo	*Vireo gilvus*	Middle and south basins of Capitol Lake and Percival Cove	Spring/fall migrant, could nest in summer
	Hutton's vireo	*Vireo huttoni*	South basin of Capitol Lake	Rare resident
	Cassin's vireo	*Vireo cassinii*	Middle and south basins of Capitol Lake	Spring/Fall migrant to lake
Chickadees	Black-capped chickadee	*Poecile atricapilla*	Middle and south basins of Capitol Lake	5-11 resident birds
	Chestnut-backed chickadee	*Poecile rufescens*	Middle and south basins of Capitol Lake	5-9 resident birds
Bushtit	Bushtit	*Psaltriparus minimus*	Middle and south basins of Capitol Lake	9-20 resident birds
Nuthatches	Red-breasted nuthatch	*Sitta canadensis*	Middle and south basins of Capitol Lake	Uncommon resident bird
Creepers	Brown creeper	*Certhia americana*	Middle and south basins of Capitol Lake	1-3 resident birds
Wrens	Bewick's wren	*Thryomanes bewickii*	Middle and south basins of Capitol Lake	1-2 resident birds
	Winter wren	*Troglodytes troglodytes*	Middle and south basins of Capitol Lake	1-2 resident birds
	Marsh wren	*Cistothorus palustris*	Middle and south basins of Capitol Lake	1-2 resident birds
Hummingbirds	Rufous hummingbird	*Selasphorus rufus*	Middle and south basins of Capitol Lake	Common in summer
Kinglets	Golden-crowned kinglet	*Regulus satrapa*	Middle and south basins of Capitol Lake	3-44 resident birds
	Ruby-crowned kinglet	*Regulus calendula*	Middle and south basins of Capitol Lake	1-12 resident birds in winter

Table 8. Bird species identified as possibly occurring on Capitol Lake and surrounding shoreline (continued).

Type of Bird	Common Name	Scientific Name	Location	Population Size
Thrushes	Varied thrush	*Ixoreus naevius*	Middle and south basins of Capitol Lake	Uncommon winter resident
	American robin	*Turdus migratorius*	North and middle basin of Capitol Lake	2-16 resident birds
	Swainson's thrush	*Catharus ustulatus*	Middle and south basins of Capitol Lake	Uncommon summer resident bird
	Hermit thrush	*Catharus guttatus*	Middle and south basins of Capitol Lake	Rare winter resident
Starlings	European starling	*Sturnus vulgaris*	North basin of Capitol Lake	1-18 resident birds
Waxwings	Cedar waxwing	*Bombycilla cedrorum*	North and middle basin of Capitol Lake	Large summer flocks
Wood-warblers	Orange-crowned warbler	*Vermivora celata*	Middle and south basins of Capitol Lake	Uncommon spring migrant
	Yellow warbler	*Dendroica petechia*	Middle and south basins of Capitol Lake	Uncommon to rare
	Yellow-rumped warbler	*Dendroica coronata*	Middle and south basins of Capitol Lake	Rare spring/fall migrant
	Black-throated gray warbler	*Dendroica nigrescens*	Middle and south basins of Capitol Lake	Uncommon migrant
	Townsend's warbler	*Dendroica townsendi*	Middle and south basins of Capitol Lake	Uncommon migrant in winter
	Wilson's warbler	*Wilsonia pusilla*	Middle and south basins of Capitol Lake	Common migrant
	Common yellowthroat	*Geothlypis trichas*	Middle and south basins of Capitol Lake	Uncommon to rare
Tanagers	Western tanager	*Piranga ludoviciana*	Middle and south basins of Capitol Lake	Uncommon summer resident, common migrant
Grosbeaks	Black-headed grosbeak	*Pheucticus melanocephalus*	Middle and south basins of Capitol Lake	Uncommon migrant and summer resident
	Evening grosbeak	*Coccothraustes vespertinus*	Middle and south basins of Capitol Lake	Uncommon to rare nomadic species
Towhees	Spotted towhee	*Pipilo maculates*	Middle and south basins of Capitol Lake	1-3 resident birds
Sparrows	Golden-crowned sparrow	*Zonotrichia atricapilla*	Middle and south basins of Capitol Lake	Uncommon winter resident
	White-crowned sparrow	*Zonotrichia leucophrys*	Middle and south basins of Capitol Lake	Common summer resident
	Fox sparrow	*Passerella iliaca*	Middle and south basins of Capitol Lake	1-3 winter resident birds
	Song sparrow	*Melospiza melodia*	Middle and south basins of Capitol Lake	1-33 resident birds
	Swamp sparrow	*Melospiza georgiana*	Percival Cove	Accidental migrant
	House sparrow	*Passer domesticus*	North basin of Capitol Lake	1-17 resident birds
Junco	Dark-eyed junco	*Junco hyemalis*	North and middle basin of Capitol Lake	1-18 birds in winter

Table 8. Bird species identified as possibly occurring on Capitol Lake and surrounding shoreline (continued).

Type of Bird	Common Name	Scientific Name	Location	Population Size
Icterids	Brown-headed cowbird	*Molothrus ater*	North and middle basin of Capitol Lake	Common summer resident
	Red-winged blackbird	*Agelaius phoeniceus*	Middle and south basins of Capitol Lake	4-12 resident birds
	Bullock's oriole	*Icterus bullockii*	Middle and south basins of Capitol Lake	Uncommon summer resident
Finches	Purple finch	*Carpodacus purpureus*	Middle basin of Capitol Lake and Percival Cove	Uncommon resident bird
	House finch	*Carpodacus mexicanus*	North and middle basin of Capitol Lake	1-51 resident birds
Old-world sparrows	Red crossbill	*Loxia curvirostra*	Middle and south basins of Capitol Lake	Uncommon to rare nomadic species
	Pine siskin	*Carduelis pinus*	Middle basin of Capitol Lake and Percival Cove	55-60 birds in winter
	American goldfinch	*Carduelis tristis*	North and middle basin of Capitol Lake	1-2 birds in winter

Sources: Black Hills Audubon Society 2003, Peterson 1990

Table 9. Reptile species identified as possibly occurring in Capitol Lake.

Type of Species	Common Name	Scientific Name	Location	Population Size
Turtle	Painted turtle	*Chrysemys picta*	Emergent and submerged macrophyte vegetation along shoreline	Less than 25
	Western pond turtle	*Clemmys marmorata*	Emergent and submerged macrophyte vegetation along shoreline	Less than 25
Snake	Northwestern garter snake	*Thamnophis ordinoides*	Emergent and shrub vegetation along shoreline	Less than 25
	Western terrestrial garter snake	*Thamnophis elegans ssp. vagrans*	Emergent and shrub vegetation along shoreline	Less than 25
	Common Garter Snake	*Thamnophis sirtalis ssp. pickeringii*	Emergent and shrub vegetation along shoreline	Less than 25

Sources: John 2002; National Audubon Society 1998

Amphibians

Table 10 lists the amphibian species identified as possibly occurring in Capitol Lake based on a literature review and field observations. These amphibians include newt, salamander, frog, and toad species that are expected to occur in the Capitol Lake area based on their habitat requirements (Seattle Audubon Society 2000; Corkran and Thoms 1996; National Audubon Society 1998).

Fish

Numerous reports have been prepared on fish presence and habitat conditions in Capitol Lake during the last 20 years. Table 11 lists all fish species reported to exist in Capitol Lake based on this literature review (Herrera 1997, WDFW 2003a, Wydoski and Whitney 1979). The common and scientific names of these fish species are listed for the four types of fish (salmon, trout, lamprey, and spiny rays). The prevalence of these species is also listed based on the literature review.

Invertebrate Species Inventory

Benthic Invertebrate

The objectives of benthic macroinvertebrate sampling were to collect data for evaluating the benthic macroinvertebrate community throughout Capitol Lake and to enhance current understanding of the lake's trophic status and food web. Results of the benthic macroinvertebrate sample analysis are summarized in Tables 12 and 13, presented in Appendix B, and discussed below. The invertebrates were identified to the lowest practical taxonomic level (Table 12), enumerated, and classified in terms of functional feeding group and tolerance. The data were analyzed for typical population parameters such as taxa richness, abundance, and diversity, as well ecological indicators such as functional feeding group and tolerance to limiting water quality conditions (Table 13).

Population Parameters

In general, benthic macroinvertebrate taxa richness was moderate for a soft bottom lake. A total of 35 taxa were observed in Capital Lake with taxa richness ranging from a low of 21 taxa at station NB-1 (north basin), to a maximum number of 24 taxa at station SB-1 (south basin). This represents moderate richness for lake benthos in rooted macrophyte beds.

Non-insects were the most numerous group of invertebrates (18 taxa), which consisted of flat worms, round worms, segmented worms, fingernail clams, leeches, crustaceans, mites, snails, amphipods, and isopods. The chironomid midges were the most numerous group of insects (13 taxa) and the relatively high diversity of chironomid midges is typical of lake benthos. The remaining 5 taxa in the insect group were represented by dragonflies, mayflies, caddisflies, and midges. The taxa present are all common lentic water taxa, and most are typically associated with eutrophic conditions. *Chironomus, Glyptotendipes, and Procladius* in particular can withstand nearly anoxic conditions at the sediment/water interface.

Table 10. Amphibian species identified as possibly occurring in Capitol Lake.

Type of Species	Common Name	Scientific Name	Location	Population Size
Newt	Rough-skinned newt	*Taricha granulosa*	Emergent and shrub vegetation along shoreline	Less than 10
Salamander	Pacific giant salamander	*Dicamptodon tenebrosus*	Emergent and shrub vegetation along shoreline	Less than 10
	Northwestern salamander	*Ambystoma gracile*	Emergent and shrub vegetation along shoreline	Less than 10
	Long-toed salamander	*Ambystoma macrodactylum*	Emergent and shrub vegetation along shoreline	Less than 10
	Western red-backed salamander	*Plethodon vehiculum*	Emergent and shrub vegetation along shoreline	Less than 10
	Ensatina	*Ensatina eschscholtzii*	Emergent and shrub vegetation along shoreline	Less than 10
Frog	Tailed frog	*Ascaphus truei*	Emergent and submerged macrophyte vegetation along shoreline	Less than 50
	Red-legged frog	*Rana aurora*	Emergent and submerged macrophyte vegetation along shoreline	Less than 200
	Bull frog	*Rana catesbeiana*	Emergent and submerged macrophyte vegetation along shoreline	Less than 50
	Pacific tree frog	*Hyla regilla*	Emergent and submerged macrophyte vegetation along shoreline	Less than 50
Toad	Western toad	*Bufo boreas*	Emergent and shrub vegetation along shoreline	Less than 10

Sources: Seattle Audubon Society 2000; Corkran and Thoms 1996; National Audubon Society 1998

Table 11. Fish species identified as possibly occurring in Capitol Lake.

Type of Species	Common Name	Scientific Name	Location	Population Size
Salmon	Chum salmon	*Oncorhynchus keta*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 200
	Coho salmon	*Oncorhynchus kisutch*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 7,000
	Sockeye salmon	*Oncorhynchus nerka*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 20
	Chinook salmon	*Oncorhynchus tshawytscha*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 50
	Sea run cutthroat trout	*Oncorhynchus clarki clarki*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 10
Trout	Resident rainbow trout	*Oncorhynchus mykiss*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 100
	Steelhead trout	*Oncorhynchus mykiss*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 2,500
Lamprey	Western brook lamprey	*Lampetra richardsoni*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 500
Spiny rays	Large-scale sucker	*Catostomus macrocheilus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 100
	Prickly sculpin	*Cottus asper*	South basin of Capitol Lake	Less than 25
	Riffle sculpin	*Cottus gulosus*	South basin of Capitol Lake	Less than 50
	Carp	*Cyprinus carpio*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 200
	Northern squawfish	*Ptychocheilus oregonensis*	South basin of Capitol Lake and Percival Cove	Less than 50
	Three-spine stickleback	*Gasterosteus aculeatus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 2,000
	Bullhead catfish	*Ictalurus nebulosus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 50
	Black bullhead	*Ictalurus melas*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 50
	Pumpkinseed sunfish	*Lepomis gibbosus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 200
	Largemouth bass	*Micropterus salmonides*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 200
	Yellow perch	*Perca flavescens*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 50
	Black crappie	*Pomoxis nigromaculatus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 50
	Red-sided shiner	*Richardsonius balteatus*	North, middle, and south basin of Capitol Lake and Percival Cove	Less than 200
	Olympic mudminnow	*Novumbra hubbsi*	South basin of Capitol Lake	Less than 10
	Starry flounder	*Platichthys stellatus*	North basin of Capitol Lake	Less than 10

Sources: Herrera 1997, WDFW 2003a, Wydoski and Whitney 1979

Table 12. Benthic invertebrates in four samples collected from Capitol Lake and Percival Cove.

Class of Organism	Scientific Name	Common Name	Station			
			NB-1	MB-1	SB-1	PC-1
			Number of Organisms	Number of Organisms	Number of Organisms	Number of Organisms
Non-Insects	Turbellaria	Flatworm	19	268	478	612
	Nematoda	Roundworm	2,716	134	383	19
	Oligochaeta	Segmented Worm	765	631	1,626	631
	Sphaeriidae	Fingernail Clam	1,282	612	1,014	823
	Hirudinea	Leech	–	–	19	19
	Helobdella	Leech	–	–	134	38
	Ostracoda	Crustacean	1,435	1,033	77	19
	Hyalella	Crustacean	–	191	363	1,320
	Acari	Mite	38	96	38	77
	Radix auricularia	Snail	–	–	38	–
	Physa/Physella	Snail	19	96	1,358	19
	Corbicula fluminea	Clam	287	–		–
	Gyraulus	Snail	–	38	249	–
	Stagnicola	Snail	19	–	172	–
	Anisogammaridae	Amphipod	–	–	38	–
	Mysidacea	Shrimp	19	–	–	–
	Caecidotea	Crustacean	19	–	–	172
	Gnorimosphaeroma oregonense	Isopod	287	–	–	–
Insects						
Odonata	Coenagrionidae	Dragonfly	–	–	115	–
Ephemeroptera	*Callibaetis*	Mayfly	–	57	57	–
Trichoptera	*Oecetis*	Caddisfly	19	38	–	–
Diptera	Ceratopogoninae	Midge	–	19	–	19
	Ephydridae	Midge	–	77	–	–
Chironomidae	Chironomidae-pupae	Midge	–	19	–	–
	Ablabesmyia	Midge	–	–	19	19
	Chironomus	Midge	1,454	287	593	191
	Cryptochironomus	Midge	115	19	38	38
	Cladotanytarsus	Midge	19	823	38	–
	Glyptotendipes	Midge	–	–	19	–
	Dicrotendipes	Midge	1,492	631	115	1,205
	Endochironomus	Midge	823	19	134	96
	Parachironomus	Midge	19	77	38	153
	Polypedilum	Midge	–	–	–	19
	Procladius	Midge	210	1,339	191	172
	Pseudochironomus	Midge	134	77	–	115
	Tanytarsus	Midge	–	115	–	–

Table 13. Benthic invertebrate community metrics for Capital Lake and Percival Cove.

	Station			
	NB-1	MB-1	SB-1	PC-1
Population Summary				
Total Abundance (m^2)	11,191	6,696	7,308	5,777
Non-Insect Abundance (m^2)	6,906	3,099	5,988	3,750
Insect Abundance (m^2)	19	191	172	19
Total Chironomidea Abundance (m^2)	4,266	3,405	1,148	2,009
Total Taxa Richness	21	23	24	21
Non-insect Taxa Richness	12	9	14	11
Insect taxa Richness	9	14	10	10
Functional Group				
Predator (%)	3	22	7	8
Parasite (%)	25	3	6	2
Collector-gatherer (%)	69	72	84	90
Collector-filterer (%)	3	2	–	–
Scraper (%)	–	0.6	3	–
Omnivore (%)	0.3	0.6	–	0.3
Biotic Indices				
Modified Hilsenhoff biotic index	7.63	7.87	7.78	7.65
Shannon H (log e)	2.23	2.48	2.44	2.23
Tolerance				
Tolerant Snails (%)	3	2	25	0.3
Tolerant Flies (%)	–	1	–	–
Tolerant Midges (%)	37	35	15	32
Tolerant Caddisflies (%)	0.2	1	–	–
Tolerant Mayflies (%)	–	1	1	-
Total Tolerant Organisms (%)	40	40	41	33
Total Intolerant Organisms (%)	0	0	0	0

The distribution of taxa was similar among the four sites, with 7 of the 17 non-insect taxa present at all four sites, and 6 of the 13 midge taxa present at all four sites. The remaining taxa were evenly distributed among the sites.

Benthic invertebrate abundances ranged from 5,777 organisms per square meter (m^2) at station PC-1 (Percival Cove) to 11,191 organisms/m^2 at station NB-1 (north basin). These abundances are moderate to high for lake benthos, indicating eutrophication, but not hyper-eutrophication.

Shannon's diversity index (H) was calculated as an integrated measure of both taxa richness and abundance. The value for H ranged from 2.23 to 2.48, indicating moderate diversity throughout the lake.

Functional Feeding Groups

One way to evaluate macroinvertebrate communities is to classify each taxa into a functional feeding group to help understand the trophic structure of the community and nutrient cycling processes in the lake.

The benthic macroinvertebrate community observed in Capital Lake is typical for eutrophic lakes with rooted macrophytes, with all four stations dominated by the collector-gatherer feeding group, and a moderate population of predators and parasites. Collector-gatherers primarily eat fine particulate organic matter that settles to the lake bottom including zooplankton and phytoplankton. Predators and parasites are likely feeding on the collector-gatherers. There were very few other functional feeding groups present in the samples. There were a small amount of members of other feeding groups such as collector-filterers, scrapers, and omnivores. Many organisms utilize macrophytes as habitat, but few eat them while still green.

Biotic Indices and Tolerance

The benthic macroinvertebrate community can also be evaluated by clasifying the taxa identified based on their tolerance to poor habitat or water quality conditions, such as low dissolved oxygen content or high nutrient concentrations. Dominance of communities by specific organisms known to be intolerant or tolerant of these conditions can indicate the presence or absence of those conditions. A modified Hilsenhoff biotic index was calculated for each station to integrate this tolerance information in a summary form. The Hilsenhoff index was originally designed to evaluate trophic status and is based on the presence and dominance of taxa tolerant to pollution, nutrients, and low dissolved oxygen. The index is on a scale of 0-10, with 0 being dominated by intolerant organisms and 10 being dominated by tolerant organisms. Values ranged from 7.63 at station NB-1 (north basin) to 7.87 at station MB-1 (middle basin), which are high on the overall scale but normal for lakes.

In general, tolerant organisms dominate the benthic macroinvertebrate community in Capitol Lake. Tolerant to highly tolerant taxa were observed at every station and made up an average of 38 percent of all samples. Nearly all the invertebrates present have high tolerance to low dissolved oxygen and moderate-to-high nutrient enrichment. A few organisms are classed as highly tolerant, including the snails *Physa, Stagnicola, Radix auricularia,* and *Gyraulus*; the amphipod *Hyalella*; the clam *Corbicula fluminea*; the damselfly Coenagrionidae; the caddisfly *Oecetis*; and nearly all the chironomid midge taxa.

Two of the species encountered are introduced (non-native), the snail *Radix auricularia* and the clam *Corbicula fluminea* (Asiatic clam). The isopod *Gnorimosphaeroma oregonense*, the amphipod Anisogammaridae, and the shrimp *Mysis* are all commonly present in brackish or marine waters.

In general, benthic macroinvertebrate taxa richness was found to be moderate and abundance was moderate to high for a soft bottom lake, indicating moderate eutrophication. The benthic community is typical for eutrophic lakes with rooted macrophytes, with all four stations

exhibiting a similar abundance and diversity of organisms. Tolerant organisms in the collector-gatherer feeding group dominate the benthic macroinvertebrate community. Values of the Hilsenhoff biotic index were relatively high on the scale, but typical for eutrophic lakes.

Zooplankton

The results of the zooplankton sample analysis are presented in Table 14 and discussed below. The zooplankton were identified to the lowest practical taxonomic level, enumerated, and their density was calculated. The laboratory results from EcoAnalysts, Inc. for the zooplankton collected at Station NB-2 is provided in Appendix B. The four main groups of zooplankton identified include cladocerans, copepods, rotifers, and miscellaneous zooplankton.

Six different species of cladocerans were identified, of which *Chydorus sphaericus* was the most abundant (81 percent). *Chydorus sphaericus* is a very small (less than 2 mm) cladoceran that primarily inhabits the littoral (near shore) region of lakes (Wetzel 1983).

The copepods enumerated include both adults and immature larvae (called nauplii and copepodites). Nauplii are the youngest larval stage of copepods and were the most numerous of all organisms identified in the sample. The most abundant copepod species include *Diaptomus oregonensis* and *Ergaslis* sp. *Diaptomus oregonensis* is a non-predatory copepod that has a much lower grazing rate than cladocerans (Wetzel 1983). Adult female *Ergaslis* are parasites feeding on blood and gill tissues of fish, whereas the immature and male *Ergaslis* are free-swimming planktivores (Pennak 1989).

A total of 11 rotifer types were identified, of which *Keratella cochlearis* and *Polyarthra major* were the most abundant. The miscellaneous zooplankton include nematodes, the protozoa *Difflugia sp*., and one specimen of *Neomysis mercedis*, which is a large (up to 15 mm) opossum shrimp that feeds on other zooplankton (Pennak 1989).

These results suggest that the Capitol Lake north basin has moderate zooplankton diversity and abundance considering the time of year (October 17) that the sample was collected. Zooplankton diversity and abundance likely would be higher during the spring and summer months when phytoplankton populations are denser.

Table 14. Zooplankton data for a vertical tow sample collected from Station NB-2 located in the Capitol Lake north basin.

Group	Scientific Name	Number of Organisms	Density (organism/m^3)
Cladoceran	*Daphnia ambigua*	1	12.9
	Ceriodaphnia dubia	2	25.8
	Scapholeberis rammneri	1	12.9
	Bosmina longirostris	4	51.6
	Chydorus sphaericus	42	541.9
	Alona sp.	2	25.8
	Total Cladocerans	52	671.0
Copepoda	*Diaptomus oregonensis*	30	387.1
	Diaptomid copepodite	22	283.9
	Ergasilus sp.	26	335.5
	Ergasilid copepodite	63	812.9
	Microcyclops varicans	1	12.9
	Cyclopoid copepodite	3	38.7
	Harpacticoid copepods	16	206.4
	Copepod nauplii	263	3,393.5
	Total Copepods	424	5,471.0
Rotifera	*Brachionus angularis*	3	38.71
	Keratella cochlearis	24	309.7
	Mytilina ventralis	3	38.7
	Platyias quadricornis	4	51.6
	Trichotria pocillum	6	77.4
	Lecane luna	4	51.6
	Monostyla lunaris	1	12.9
	Polyarthra vulgaris	7	90.3
	Polyarthra major	38	490.3
	Trichocerca cylindrica	1	3.2
	Trichocerca rattus	4	51.6
	Total Rotifers	95	1,216.1
Miscellaneous Zooplankton	Nematodes	8	103.2
	Difflugia sp. (protozoan)	16	206.4
	Immature ostracod	1	12.9
	Neomysis mercedis	1	12.9
	Chironomid larvae	2	25.8
	Total Miscellaneous Zooplankton	28	361.3
	Total Density	599	7,719.4

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APPENDIX A

Agency Correspondence

Endangered Species Act Status of West Coast Salmon & Steelhead

Updated: May 2, 2003

Species/ESU Status	(E = Endangered; T = Threatened; mo/yr)	Next Steps
Pink Salmon	Listed: None	
	Not Warranted: 1) Even-year ESU (10/95)	
	2) Odd-year ESU (10/95)	
Coho Salmon	Listed: 1) Central CA ESU (T - 10/96)	* Re-assess ESU's listing status
	2) Southern OR/Northern CA Coasts ESU (T - 5/97)	* Re-assess ESU's listing status
	3) OR Coast ESU (T - 8/98)	* Re-assess ESU's listing status & critical habitat
	Candidates: 1) Puget Sound/Strait of Georgia ESU (7/95)	
	2) Lower Columbia River/Southwest WA ESU (7/95)	* Re-assess ESU's listing status
	Not Warranted: 1) Olympic Peninsula ESU (7/95)	
Chinook Salmon	Listed: 1) Sacramento River Winter-run ESU (E - 1/94)	* Re-assess ESU's listing status
	2) Snake River Fall-run ESU (T - 4/92)	* Re-assess ESU's listing status
	3) Snake River Spring/Summer-run ESU (T - 4/92)	* Re-assess ESU's listing status
	4) Puget Sound ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	5) Lower Columbia River ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	6) Upper Willamette River ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	7) Upper Columbia River Spring-run ESU (E - 3/99)	* Re-assess ESU's listing status & critical habitat
	8) Central Valley Spring-run ESU (T - 9/99)	* Re-assess ESU's listing status & critical habitat
	9) CA Coastal ESU (T - 9/99)	* Re-assess ESU's listing status & critical habitat
	Candidates: 1) Central Valley Fall and Late Fall-run ESU (9/99)	
	Not Warranted: 1) Upper Klamath-Trinity Rivers ESU (3/98)	
	2) OR Coast ESU (3/98)	
	3) WA Coast ESU (3/98)	
	4) Mid-Columbia River Spring-run ESU (3/98)	
	5) Upper Columbia River Summer/Fall-run ESU (3/98)	
	6) Southern OR and Northern CA Coastal ESU (9/99)	
	7) Deschutes River Summer/Fall-run ESU (9/99)	
Chum Salmon	Listed: 1) Hood Canal Summer-run ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	2) Columbia River ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	Not Warranted: 1) Puget Sound/Strait of Georgia ESU (3/98)	
	2) Pacific Coast ESU (3/98)	
Sockeye Salmon	Listed: 1) Snake River ESU (E - 11/91)	* Re-assess ESU's listing status
	2) Ozette Lake ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	Not Warranted: 1) Baker River ESU (3/99)	
	2) Okanogan River ESU (3/98)	
	3) Lake Wenatchee ESU (3/98)	
	4) Quinault Lake ESU (3/98)	
	5) Lake Pleasant ESU (3/98)	
Steelhead	Listed: 1) Southern CA ESU (E - 8/97)	* Re-assess ESU's listing status & critical habitat
	2) South-Central CA Coast ESU (T - 8/97)	* Re-assess ESU's listing status & critical habitat
	3) Central CA Coast ESU (T - 8/97)	* Re-assess ESU's listing status & critical habitat
	4) Upper Columbia River ESU (E - 8/97)	* Re-assess ESU's listing status & critical habitat
	5) Snake River Basin ESU (T - 8/97)	* Re-assess ESU's listing status & critical habitat
	6) Lower Columbia River ESU (T - 3/98)	* Re-assess ESU's listing status & critical habitat
	7) CA Central Valley ESU (T - 3/98)	* Re-assess ESU's listing status & critical habitat
	8) Upper Willamette ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	9) Middle Columbia River ESU (T - 3/99)	* Re-assess ESU's listing status & critical habitat
	10) Northern CA ESU (T - 6/00)	* Re-assess ESU's listing status & critical habitat
	Candidates: 1) OR Coast ESU (3/98)	
	Not Warranted: 1) Southwest WA ESU (8/96)	
	2) Olympic Peninsula ESU (8/96)	
	3) Puget Sound ESU (8/96)	
	4) Klamath Mountains Province ESU (4/01)	

* An Evolutionarily Significant Unit or "ESU" is a distinctive group of Pacific salmon or steelhead.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Western Washington Fish and Wildlife Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 534-9331

OCT 1 6 2003

Dear Species List Requester:

We (U.S. Fish and Wildlife Service) are providing the information you requested to assist your determination of possible impacts of a proposed project to species of Federal concern. Attachment A includes the listed threatened and endangered species, species proposed for listing, candidate species, and/or species of concern that may be within the area of your proposed project.

Any Federal agency, currently or in the future, that provides funding, permitting, licensing, or other authorization for this project must assure that its responsibilities under section 7(a)(2) of the Endangered Species Act of 1973, as amended (Act), are met. Attachment B outlines the responsibilities of Federal agencies for consulting or conferencing with us.

If both listed and proposed species occur in the vicinity of a project that meets the requirements of a major Federal action (i.e., "major construction activity"), impacts to both listed and proposed species must be considered in a biological assessment (BA) (section 7(c); see Attachment B). Although the Federal agency is not required, under section 7(c), to address impacts to proposed species if listed species are not known to occur in the project area, it may be in the Federal agency's best interest to address impacts to proposed species. The listing process may be completed within a year, and information gathered on a proposed species could be used to address consultation needs should the species be listed. However, if the proposed action is likely to jeopardize the continued existence of a proposed species, or result in the destruction or adverse modification of proposed critical habitat, a formal conference with us is required by the Act (section 7(a)(4)). The results of the BA will determine if conferencing is required.

The Federal agency is responsible for making a determination of the effects of the project on listed species and/or critical habitat. For a Federal agency determination that a listed species or critical habitat is likely to be affected (adversely or beneficially) by the project, you should request section 7 consultation through this office. For a "not likely to adversely affect" determination, you should request our concurrence through the informal consultation process.

Candidate species and species of concern are those species whose conservation status is of concern to us, but for which additional information is needed. Candidate species are included as an advance notice to Federal agencies of species that may be proposed and listed in the future. Conservation measures for candidate species and species of concern are voluntary but recommended. Protection provided to these species now may preclude possible listing in the future.

For other federally listed species that may occur in the vicinity of your project, contact the National Marine Fisheries Service (NOAA Fisheries) at (360) 753-9530 to request a list of species under their jurisdiction. For wetland permit requirements, contact the Seattle District of the U.S. Army Corps of Engineers for Federal permit requirements and the Washington State Department of Ecology for State permit requirements.

Thank you for your assistance in protecting listed threatened and endangered species and other species of Federal concern. If you have additional questions, please contact Tami Black at (360) 753-4322 or Yvonne Dettlaff at (360) 753-9582.

Sincerely,

for Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

Enclosure(s)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Western Washington Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98503
Phone: (360) 753-9440 Fax: (360) 534-9331

SEP 3 2003

Dear Species List Requester:

Enclosed is a list of threatened and endangered species, species proposed for listing, candidate species, and species of concern within the western Washington county(s) for your proposed project. Due to our current workload and budget constraints, we are no longer providing site-specific species lists. For site-specific species information, please contact the Washington Department of Fish and Wildlife Priority Habitats and Species at (360) 902-2543 or access their website at http://www.wa.gov/wdfw/hab/phspage.htm, and the Washington Department of Natural Resources Natural Heritage Program at (360) 902-1667 or access their website at http://www.dnr.wa.gov/nhp/.

If you have any questions, please contact Tami Black at (360) 753-4322.

Sincerely,

for

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

Enclosure(s)

ATTACHMENT A **October 8, 2003**

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CRITICAL HABITAT, CANDIDATE SPECIES, AND SPECIES OF CONCERN THAT MAY OCCUR IN WESTERN WASHINGTON

PREPARED BY
U.S. FISH AND WILDLIFE SERVICE
WESTERN WASHINGTON OFFICE

(Revised September 30, 2003)

FWS REF: 1-3-03-SP-2141
CAPITOL LAKE DRAWDOWN AND SALTWATER BACK FLUSHING ACTION PROJECT

THURSTON COUNTY

LISTED

Wintering bald eagles (*Haliaeetus leucocephalus*) occur in the county from about October 31 through March 31.

There is a bald eagle winter concentration area located in the county along the Nisqually River.

There are 19 bald eagle nesting territories located in the county. Nesting activities occur from about January 1 through August 15.

Bull trout (*Salvelinus confluentus*) may occur in the county.

Marbled murrelets (*Brachyramphus marmoratus*) occur in the county. Nesting murrelets occur from April 1 through September 15.

Northern spotted owls (*Strix occidentalis caurina*) occur in the county throughout the year.

Major concerns that should be addressed in your biological assessment of the project impacts to listed species include:

1. Level of use of the project area by listed species.

2. Effect of the project on listed species' primary food stocks, prey species, and foraging areas in all areas influenced by the project.

3. Impacts from project construction (i.e., habitat loss, increased noise levels, increased human activity) that may result in disturbance to listed species and/or their avoidance of the project area.

Castilleja levisecta (golden paintbrush) occurs in the county.

Major concerns that should be addressed in a biological assessment for a listed plant species include:

1. Distribution of the taxon in the project vicinity.

2. Disturbance (trampling, uprooting, collecting, etc.) of individual plants and loss of habitat.

3. Changes in hydrology where the taxon is found.

DESIGNATED

Critical habitat for the northern spotted owl has been designated in Thurston County.
Critical habitat for the marbled murrelet has been designated in Thurston County.

PROPOSED

None

CANDIDATE

Mardon skipper (*Polites mardon*)
Mazama pocket gopher (*Thomomys mazama* ssp.)(includes ssp. *couchi*, *glacialis*, *louiei*, *melanops*, *pugetensis*, *tacomensis*, *tumuli*, *yelmensis*)
Oregon spotted frog (*Rana pretiosa*)
Streaked horned lark (*Eremophila alpestris strigata*)
Whulge (Edith's) checkerspot (*Euphydryas editha taylori*)

SPECIES OF CONCERN

California wolverine (*Gulo gulo luteus*)
Cascades frog (*Rana cascadae*)
Coastal cutthroat trout (*Oncorhynchus clarki clarki*)
Long-eared myotis (*Myotis evotis*)
Long-legged myotis (*Myotis volans*)
Northern goshawk (*Accipiter gentilis*)
Northern sea otter (*Enhydra lutris kenyoni*)
Northwestern pond turtle (*Emys* (= *Clemmys*) *marmorata marmorata*)
Oregon vesper sparrow (*Pooectetes gramineus affinis*)
Olive-sided flycatcher (*Contopus cooperi*)

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with the U.S. Fish and Wildlife Service (FWS) when a Federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the Federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and

3. Conference with the FWS when a Federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires Federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species that is/are likely to be affected by a construction project. The process is initiated by a Federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with the Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503-1273.

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* "Construction project" means any major Federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes Federal action such as permits, grants, licenses, or other forms of Federal authorization or approval which may result in construction.

SPECIES OF CONCERN (Thurston County, Cont'd)

Pacific fisher (*Martes pennanti pacifica*)
Pacific lamprey (*Lampetra tridentata*)
Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*)
River lamprey (*Lampetra ayresi*)
Slender-billed white-breasted nuthatch (*Sitta carolinensis aculeata*)
Tailed frog (*Ascaphus truei*)
Valley silverspot (butterfly) (*Speyeria zerene bremeri*)
Van Dyke's salamander (*Plethodon vandykei*)
Western gray squirrel (*Sciurus griseus griseus*)
Aster curtus (white-top aster)
Cimicifuga elata (tall bugbane)
Sidalcea malviflora ssp. *virgata* (rose checker-mallow)

State of Washington
DEPARTMENT OF FISH AND WILDLIFE

Mailing Address: 600 Capitol Way N • Olympia, WA 98501-1091 • (360) 902-2200, TDD (360) 902-2207
Main Office Location: Natural Resources Building • 1111 Washington Street SE • Olympia, WA

Date: OCT 1 3 2003

Dear Habitats and Species Requester:

Enclosed are the habitats and species products you requested from the Washington Department of Fish and Wildlife (WDFW). This package may also contain documentation to help you understand and use these products.

These products only include information that WDFW maintains in a computer database. They are not an attempt to provide you with an official agency response as to the impacts of your project on fish and wildlife, nor are they designed to provide you with guidance on interpreting this information and determining how to proceed in consideration of fish and wildlife. These products only document the location of important fish and wildlife resources to the best of our knowledge. It is important to note that habitats or species may occur on the ground in areas not currently known to WDFW biologists, or in areas for which comprehensive surveys have not been conducted. Site-specific surveys are frequently necessary to rule out the presence of priority habitats or species.

Your project may require further field inspection or you may need to contact our field biologists or others in WDFW to assist you in interpreting and applying this information. Generally, for assistance on a specific project, you should contact the WDFW Habitat Program Manager for your county and ask for the area habitat biologist for your project area. Refer to the enclosed directory for those contacts.

Please note that sections potentially impacted by spotted owl management concerns are displayed on the 1:24,000 scale standard map products. If specific details on spotted owl site centers are required they must be requested separately.

These products are designed for users external to the forest practice permit process and as such, does not reflect all the information pertinent to forest practice review. The Forest Practice Rules adopted August 22, 1997 by the Forest Practice Board and administered by the Washington Department of Natural Resources require forest practice applications to be screened against marbled murrelet detection areas and detection sections. Marbled murrelet detection locations are included in the standard priority habitats and species products, but the detection areas and detection sections are not included. If your project is affected by Forest Practice Regulations, you should specially request murrelet detection areas.

WDFW updates this information as additional data become available. Because fish and wildlife species are mobile and because habitats and species information changes, project reviews for fish and wildlife should not rest solely on mapped information. Instead, they should also consider new information gathered from current field investigations. Remember, habitats and species information can only show that a species or habitat type is present, they cannot show that a species or habitat type is not present. These products should not be used for future projects. Please obtain updates rather than use outdated information.

Because of the high volume of requests for information that WDFW receives, we need to charge for these products to recover some of our costs. Enclosed is an invoice itemizing the costs for your request and instructions for submitting payment.

Please note that sensitive information (e.g., threatened and/or endangered species) may be included in this request. These species are vulnerable to disturbances and harassment. In order to protect the viability of these species we request that you not disseminate the information as to their whereabouts. Please refer to these species presence in general terms. For example: "A Peregrine Falcon is located within two miles of the project area".

If your request required a Sensitive Fish and Wildlife Information Release Agreement and you or your organization has one on file, please refer to that document for conditions regarding release of this information.

For more information on WDFW you may visit our web site at http://www.wa.gov/wdfw or visit the Priority Habitats and Species site at http://www.wa.gov/wdfw/hab/phspage.htm.

For information on the state's endangered, threatened, and sensitive plants as well as high quality wetland and terrestrial ecosystems, please contact the Washington Department of Natural Resources, Natural Heritage Program at PO Box 47014, Olympia Washington 98504-7014, by phone (360) 902-1667 or visit the web site at http://www.wa.gov/dnr/htdocs/fr/nhp/wanhp.html.

If you have any questions or problems with the information you received please call me at (360) 902-2543 or fax (360) 902-2946.

Sincerely,

Lori Guggenmos

Lori Guggenmos, GIS Programmer
Priority Habitats and Species

Enclosures

APPENDIX B

Invertebrate Sampling Results

Capital Lake, Station NB-1, October 17, 2003

WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL02

IDENTIFICATION CODE	03CL02
CORRECTION FACTOR	19.13

Taxon	Abundance	%
Turbellaria	19	0.17
Nematoda	2716	24.27
Oligochaeta	765	6.84
Sphaeriidae	1282	11.45
Corbicula fluminea	287	2.56
Stagnicola	19	0.17
Physa/Physella	19	0.17
Ostracoda	1435	12.82
Gnorimospaeroma oregonense	287	2.56
Caecidotea	19	0.17
Mysidae	19	0.17
Acari	38	0.34
TOTAL: NON INSECTS	6906	61.71
Oecetis	19	0.17
TOTAL: TRICHOPTERA	19	0.17
Chironomus	1454	12.99
Cladotanytarsus	19	0.17
Cryptochironomus	115	1.03
Dicrotendipes	1492	13.33
Endochironomus	823	7.35
Parachironomus	19	0.17
Procladius	210	1.88
Pseudochironomus	134	1.20
TOTAL: CHIRONOMIDAE	4266	38.12
GRAND TOTAL	11191	100.00

Capital Lake, Station NB-1, October 17, 2003
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL02

Total invertebrate abundance	= 11191.2	EPT abundance	= 19.1
Total number of taxa	= 21	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 7.63	Brillouin H	= 2.23

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	12	6906.1	61.69
Odonata	0	0.0	0.00
Ephemeroptera	0	0.0	0.00
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	1	19.1	0.17
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	0	0.0	0.00
Chironomidae	8	4266.0	38.12

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	3	344.3	3.08
Parasite	2	2754.3	24.61
Collector-gatherer	13	7767.4	69.39
Collector-filterer	1	287.0	2.56
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	0	0.0	0.00
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	2	38.3	0.34
Unknown	0	0.0	0.00

DOMINANT TAXON	ABUNDANCE	PERCENT
Nematoda	2716.0	24.27
Dicrotendipes	1492.0	13.33
Chironomus	1454.0	12.99
Ostracoda	1435.0	12.82
Sphaeriidae	1282.0	11.45
SUBTOTAL 5 DOMINANTS	8379.0	74.86
Endochironomus	822.6	7.35
Oligochaeta	765.2	6.84
Corbicula fluminea	287.0	2.56
Gnorimospaeroma oregonense	287.0	2.56
Procladius	210.4	1.88
TOTAL 10 DOMINANTS	10751.2	96.05

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	3	325.3	2.90
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	1	19.1	0.17
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	6	4112.9	36.75
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Capital Lake, Station NB-1, October 17, 2003
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL02

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 0.00
Hydropsychidae/Total Trichoptera = 0.00
Baetidae/Total Ephem. undefined. Total Ephem.=0

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter = 0.00
Scraper/(Scraper + C.-filterer) = 0.00
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 105.43
Community Tolerance Quotient (d) = 106.47

DIVERSITY MEASURES
Shannon H (loge) = 2.23
Shannon H (log2) = 3.22
Evenness = 0.73
Simpson D = 0.14

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	7407.9	66.19
Univoltine	2453.6	21.92
Semivoltine	1329.7	11.88

Capital Lake, Station MB-1, October 17, 2003.

WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL01

IDENTIFICATION CODE	03CL01
CORRECTION FACTOR	19.13

Taxon	Abundance	%
Turbellaria	268	4.00
Nematoda	134	2.00
Oligochaeta	631	9.43
Sphaeriidae	612	9.14
Physa/Physella	96	1.43
Gyraulus	38	0.57
Ostracoda	1033	15.43
Hyalella	191	2.86
Acari	96	1.43
TOTAL: NON INSECTS	3099	46.29
Callibaetis	57	0.86
TOTAL: EPHEMEROPTERA	57	0.86
Oecetis	38	0.57
TOTAL: TRICHOPTERA	38	0.57
Ceratopogoninae	19	0.29
Ephydridae	77	1.14
TOTAL: DIPTERA	96	1.43
Chironomidae-pupae	19	0.29
Chironomus	287	4.29
Cladotanytarsus	823	12.29
Cryptochironomus	19	0.29
Dicrotendipes	631	9.43
Endochironomus	19	0.29
Parachironomus	77	1.14
Procladius	1339	20.00
Pseudochironomus	77	1.14
Tanytarsus	115	1.71
TOTAL: CHIRONOMIDAE	3405	50.86
GRAND TOTAL	6696	100.00

Capital Lake, Station MB-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL01

Total invertebrate abundance	= 6695.5	EPT abundance	= 95.7
Total number of taxa	= 23	Number EPT taxa	= 2
Hilsenhoff Biotic Index	= 7.87	Brillouin H	= 2.48

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	9	3099.1	46.29
Odonata	0	0.0	0.00
Ephemeroptera	1	57.4	0.86
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	1	38.3	0.57
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	2	95.6	1.43
Chironomidae	10	3405.1	50.87

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	4	1453.8	21.72
Parasite	2	229.6	3.43
Collector-gatherer	13	4801.7	71.73
Collector-filterer	1	114.8	1.71
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	38.3	0.57
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	1	38.3	0.57
Unknown	1	19.1	0.29

DOMINANT TAXON	ABUNDANCE	PERCENT
Procladius	1339.0	20.00
Ostracoda	1033.0	15.43
Cladotanytarsus	822.6	12.29
Oligochaeta	631.3	9.43
Dicrotendipes	631.3	9.43
SUBTOTAL 5 DOMINANTS	4457.2	66.58
Sphaeriidae	612.2	9.14
Chironomus	287.0	4.29
Turbellaria	267.8	4.00
Hyalella	191.3	2.86
Nematoda	133.9	2.00
TOTAL 10 DOMINANTS	5949.4	88.87

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	2	133.9	2.00
B Tolerant mayflies	1	57.4	0.86
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	1	38.3	0.57
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	1	76.5	1.14
J Intolerant midges	0	0.0	0.00
K Tolerant midges	6	2372.1	35.44
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Capital Lake, Station MB-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL01

RATIOS OF TAX. GROUP ABUNDANCES

EPT/Chironomidae	= 0.03
Hydropsychidae/Total Trichoptera	= 0.00
Baetidae/Total Ephemeroptera	= 1.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filter	= 0.33
Scraper/(Scraper + C.-filterer)	= 0.25
Shredder/Total organisms	= 0.00

Biotic Condition Index

Community Tolerance Quotient (a)	= 104.09
Community Tolerance Quotient (d)	= 104.93

DIVERSITY MEASURES

Shannon H (loge)	= 2.49
Shannon H (log2)	= 3.59
Evenness	= 0.79
Simpson D	= 0.11

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	4127.2	61.64
Univoltine	1946.5	29.07
Semivoltine	621.8	9.29

Capital Lake, Station SB-1, October 17, 2003.

WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL04

IDENTIFICATION CODE	03CL04
CORRECTION FACTOR	19.13

Taxon	Abundance	%
Turbellaria	478	6.54
Nematoda	383	5.24
Oligochaeta	1626	22.25
Hirudinea	19	0.26
Helobdella	134	1.83
Sphaeriidae	1014	13.87
Radix auricularia	38	0.52
Stagnicola	172	2.36
Physa/Physella	1358	18.59
Gyraulus	249	3.40
Ostracoda	77	1.05
Anisogammaridae	38	0.52
Hyalella	363	4.97
Acari	38	0.52
TOTAL: NON INSECTS	5988	81.94
Coenagrionidae	115	1.57
TOTAL: ODONATA	115	1.57
Callibaetis	57	0.79
TOTAL: EPHEMEROPTERA	57	0.79
Ablabesmyia	19	0.26
Chironomus	593	8.12
Cladotanytarsus	38	0.52
Dicrotendipes	115	1.57
Endochironomus	134	1.83
Glyptotendipes	19	0.26
Parachironomus	38	0.52
Procladius	191	2.62
TOTAL: CHIRONOMIDAE	1148	15.71
GRAND TOTAL	7308	100.00

Capital Lake, Station SB-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL04

Total invertebrate abundance	= 7307.6	EPT abundance	= 57.4
Total number of taxa	= 24	Number EPT taxa	= 1
Hilsenhoff Biotic Index	= 7.78	Brillouin H	= 2.44

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	14	5987.6	81.92
Odonata	1	114.8	1.57
Ephemeroptera	1	57.4	0.79
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	0	0.0	0.00
Chironomidae	8	1147.8	15.70

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	5	497.4	6.80
Parasite	2	420.9	5.76
Collector-gatherer	16	6140.7	84.02
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	1	248.7	3.40
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	0	0.0	0.00
Unknown	0	0.0	0.00

DOMINANT TAXON	ABUNDANCE	PERCENT
Oligochaeta	1626.0	22.25
Physa/Physella	1358.0	18.59
Sphaeriidae	1014.0	13.87
Chironomus	593.0	8.12
Turbellaria	478.3	6.54
SUBTOTAL 5 DOMINANTS	5069.3	69.37
Nematoda	382.6	5.24
Hyalella	363.5	4.97
Gyraulus	248.7	3.40
Procladius	191.3	2.62
Stagnicola	172.2	2.36
TOTAL 10 DOMINANTS	6427.6	87.96

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	4	1817.2	24.87
B Tolerant mayflies	1	57.4	0.79
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	7	1109.5	15.18
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Capital Lake, Station SB-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL04

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 0.05
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephemeroptera = 1.00

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) = 1.00
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 106.50
Community Tolerance Quotient (d) = 106.75

DIVERSITY MEASURES
Shannon H (loge) = 2.45
Shannon H (log2) = 3.54
Evenness = 0.77
Simpson D = 0.12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	1879.6	25.72
Univoltine	4069.8	55.69
Semivoltine	1358.3	18.59

Capital Lake, Station PC-1, October 17, 2003.

WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL03

IDENTIFICATION CODE	03CL03
CORRECTION FACTOR	19.13

Taxon	Abundance	%
Turbellaria	612	10.60
Nematoda	19	0.33
Oligochaeta	631	10.93
Hirudinea	19	0.33
Helobdella	38	0.66
Sphaeriidae	823	14.24
Physa/Physella	19	0.33
Ostracoda	19	0.33
Hyalella	1320	22.85
Caecidotea	172	2.98
Acari	77	1.32
TOTAL: NON INSECTS	3749	64.90
Ceratopogoninae	19	0.33
TOTAL: DIPTERA	19	0.33
Ablabesmyia	19	0.33
Chironomus	191	3.31
Cryptochironomus	38	0.66
Dicrotendipes	1205	20.86
Endochironomus	96	1.66
Parachironomus	153	2.65
Polypedilum	19	0.33
Procladius	172	2.98
Pseudochironomus	115	1.99
TOTAL: CHIRONOMIDAE	2009	34.77
GRAND TOTAL	5777	100.00

Capital Lake, Station PC-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL03

Total invertebrate abundance	= 5777.2	EPT abundance	= 0.0
Total number of taxa	= 21	Number EPT taxa	= 0
Hilsenhoff Biotic Index	= 7.65	Brillouin H	= 2.23

TAXONOMIC GROUP	#TAXA	ABUNDANCE	PERCENT
Non-insects	11	3749.6	64.90
Odonata	0	0.0	0.00
Ephemeroptera	0	0.0	0.00
Plecoptera	0	0.0	0.00
Hemiptera	0	0.0	0.00
Megaloptera	0	0.0	0.00
Trichoptera	0	0.0	0.00
Lepidoptera	0	0.0	0.00
Coleoptera	0	0.0	0.00
Misc. Diptera	1	19.1	0.33
Chironomidae	9	2008.5	34.77

FEEDING GROUP	#TAXA	ABUNDANCE	PERCENT
Predator	6	440.0	7.61
Parasite	2	95.6	1.65
Collector-gatherer	12	5222.4	90.41
Collector-filterer	0	0.0	0.00
Macrophyte-herbivore	0	0.0	0.00
Piercer-herbivore	0	0.0	0.00
Scraper	0	0.0	0.00
Shredder	0	0.0	0.00
Xylophage	0	0.0	0.00
Omnivore	1	19.1	0.33
Unknown	0	0.0	0.00

DOMINANT TAXON	ABUNDANCE	PERCENT
Hyalella	1320.0	22.85
Dicrotendipes	1205.0	20.86
Sphaeriidae	822.6	14.24
Oligochaeta	631.3	10.93
Turbellaria	612.2	10.60
SUBTOTAL 5 DOMINANTS	4591.1	79.48
Chironomus	191.3	3.31
Caecidotea	172.2	2.98
Procladius	172.2	2.98
Parachironomus	153.0	2.65
Pseudochironomus	114.8	1.99
TOTAL 10 DOMINANTS	5394.6	93.39

INDICATOR ASSEMBLAGE	#TAXA	ABUNDANCE	PERCENT
A Tolerant snails	1	19.1	0.33
B Tolerant mayflies	0	0.0	0.00
C Intolerant mayflies	0	0.0	0.00
D Intolerant stoneflies	0	0.0	0.00
E Tolerant caddisflies	0	0.0	0.00
F Intolerant caddisflies	0	0.0	0.00
G Tolerant beetles	0	0.0	0.00
H Intolerant flies	0	0.0	0.00
I Tolerant flies	0	0.0	0.00
J Intolerant midges	0	0.0	0.00
K Tolerant midges	7	1874.5	32.45
L	0	0.0	0.00
M	0	0.0	0.00
N	0	0.0	0.00

Capital Lake, Station PC-1, October 17, 2003.
WA: Thurston County, Olympia. For Herrera Environmental Consultants.
Benthic invertebrates. Ekman dredge, 9X9" area, 500 micron mesh.
Abundances adjusted to a square meter basis. ABA, Inc. FILE: 03CL03

RATIOS OF TAX. GROUP ABUNDANCES
EPT/Chironomidae = 0.00
Hyd./Total Tri. undefined. Total Tri.= 0
Baetidae/Total Ephem. undefined. Total Ephem.=0

RATIOS OF FFG ABUNDANCES
Scraper/Collector-filter undefined - Coll.-Filt.=0
Scraper/(Scraper + C.-filterer) undefined
Shredder/Total organisms = 0.00

Biotic Condition Index
Community Tolerance Quotient (a) = 108.00
Community Tolerance Quotient (d) = 108.00

DIVERSITY MEASURES
Shannon H (loge) = 2.24
Shannon H (log2) = 3.23
Evenness = 0.74
Simpson D = 0.14

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	2233.3	38.66
Univoltine	2816.9	48.76
Semivoltine	727.0	12.58