NATURAL RESOURCES

Lake Kapowsin Aquatic Reserve

Draft Management Plan

2016

This is a draft document and input is welcome.
For questions or comments contact:

Birdie Davenport, Aquatic Reserves Manager
360-902-1073, roberta.davenport@dnr.wa.gov
Washington State Dept. of Natural Resources
PO Box 47027 |Olympia, WA 98504

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Acknowledgements

Washington State Department of Natural Resources

Peter Goldmark, Commissioner of Public Lands

Megan Duffy, Deputy Supervisor, Aquatic Resources

Shoreline District

Derrick Toba, Field Assistant Division Manager

Wynnae Wright, Aquatic Land Manager

Lake Kapowsin Aquatic Reserve

Planning Advisory Committee, 2015 - 2016

Amy Moreno-Sills, Futurewise

Andy Anderson, Graham/Kapowsin resident

Bud Rehberg, local resident, Friends of Pierce County

Jim Halmo, Graham/Kapowsin resident

Dave Risvold, Environmental Biologist, Pierce County Planning

Doug Wiedemeier, Habitat Biologist Washington Department of Fish and Wildlife

Greg Volkhardt, City of Tacoma

Kimberly Freeman, Pierce County Parks and Recreation

Lloyd Fetterly, Tahoma Audubon

Matt Hamilton, Graham/Kapowsin resident

Rod Heupel, Western Bass Club

Phil Fix, Graham/Kapowsin resident

Russ Blount, Graham/Kapowsin resident

Russ Ladley, Puyallup Tribe

Steve Caromile, Freshwater Fish Biologist, Washington Department of Fish and Wildlife

Lake Kapowsin Aquatic Reserve

Technical Advisory Committee, 2015

Carri J. LeRoy, Ph.D,
Member of the Faculty, Environmental Studies Program
The Evergreen State College

Isabel Ragland
Water Quality Monitoring Program Manager
Pierce Conservation District

Jim Gawel, Ph.D.
Assoc. Prof. of Environmental Chemistry and Engineering,
University of Washington Tacoma

Patrick T. Pringle
Professor of Earth Science, Science Department
Centralia College

Stephen Caromile
Freshwater Fish Biologist, Washington Department of Fish and Wildlife

Aquatic Resources Division

Kristin Swenddal, Division Manager

Michal Rechner, Assistant Division Manager

David Palazzi, Planning Program Manager

Roberta Davenport, Aquatic Reserves Program Manager

Betty Bookheim, Natural Resource Scientist

Jamie Kilgo, Environmental Planner

Angie Hong, Environmental Planner

Communications

Joe Smillie, DNR Communications

Principal Authors

Roberta Davenport, Aquatic Reserves Program Manager

Betty Bookheim, Natural Resource Scientist

Jamie Kilgo, Environmental Planner

Angie Hong, Environmental Planner

GIS and Mapping

Jamie Kilgo, Environmental Planner

Contributors

Brooke McIntyre, Puget SoundCorps Team

David Schroeder, Puget SoundCorps Team

Cover Photo: Lake Kapowsin. Provided by Aquatic Reserve Program

Copies of this report may be obtained from the Washington State Department of Natural Resources Aquatic Reserves Program or copied from the web page. Copies may also be obtained by contacting:

Aquatic Reserves Program Manager
Phone: 360-902-1100
E-mail: aquaticreserve@dnr.wa.gov
Web: www.dnr.wa.gov

Those needing this information in an alternative format, please call TTY-711

Lake Kapowsin Aquatic Reserve Draft Management Plan

AN ENVIRONMENTAL AQUATIC RESERVE

DRAFT

Washington State Department of Natural Resources
Aquatic Resources Division

Executive Summary

The Lake Kapowsin Aquatic Reserve is established as an environmental reserve to protect important native ecosystems, to facilitate collaborative partnerships, and to maintain existing uses and recreational opportunities for current and future generations. Aquatic reserves are also created for the benefit of the public as areas where natural ecological systems can be enjoyed, restored, studied, and used for recreation. Lake Kapowsin has relatively undeveloped shorelines, a unique and important geologic and cultural history, a submerged forest, plentiful woody structure, floating log habitat, and extensive wetland complexes. The natural character and predominately forested drainage basin of the lake are unusual in the Puget Sound lowlands region. These qualities make the lake a popular destination for sport fishing, waterfowl hunting, birdwatching, and boating destination.

Important Environmental Features

Lake Kapowsin is a 512-acre low elevation freshwater lake in eastern Pierce County near the community of Graham. It was created approximately 500 years ago when the Electron mudflow rushed down the Puyallup Valley from the west slopes of Mount Rainier and dammed present-day Kapowsin Creek. This natural dam flooded the valley floor and drowned a coniferous forest. Massive stumps are still embedded in the lake bottom today.

The complex structure created by the remnant stumps and large wood provide valuable habitat for fishes, amphibians, and invertebrates. The extensive wetlands support many small mammals and amphibians, including beavers, river otters, Northwest salamander, red-legged frog, rough skinned newt and chorus frog. Lake Kapowsin provides essential nesting, rearing and foraging habitat for both resident and migratory birds throughout the year.

Recreation and Public Access

The aquatic reserve will protect important aquatic habitats used by fish and waterfowl ensuring that future generations can continue to enjoy hunting, fishing, and boating at Lake Kapowsin. DNR supports current uses and recreation at Lake Kapowsin. Washington Department of Fish and Wildlife (WDFW) stocks Rainbow Trout and manages the lake as a mixed-species waterbody. DNR will continue to work with WDFW and local community to foster recreation and public access, and support clean shorelines and a safe public access.

Collaborative Partnerships

This plan provides the overarching vision for the aquatic reserve and the practical management guidance for realizing that vision. The aquatic reserve goals and objectives can only be achieved by cultivating broad partnerships on multiples scales – local, county, state. The values of the community will help guide aquatic reserve management. DNR will facilitate collaborative management efforts and leverage resources. Important aquatic resources will be protected and recreational activities will be supported by connecting the diverse expertise of local residents, recreational users, managers, and scientists.

DRAFT

Management Plan Organization

The Aquatic Reserves Program and the Lake Kapowsin Planning Advisory Committee developed this management plan during a collaborative planning process. This document presents a comprehensive description of the natural environment (Appendix A) and human environment (Appendix B), and a vision for the management of the Lake Kapowsin Aquatic Reserve. The three management sections are:

- **Conservation Targets**: Identifies important native habitats and species, and unique features that maintain biological diversity and sustain ecological function.
- **Management Guidance**: Describes the desired future conditions, which will direct management of the reserve during its 90-year term. The goals, objectives and strategies provide the overall vision for the reserve's desired future conditions
- **Implementation Guidance**: Describes collaborative partnerships and the role of the Aquatic Reserve Program as facilitator working with partners and the community toward common goals.

Management Goals

This plan identifies the management strategies the Washington Department of Natural Resources will employ to ensure Lake Kapowsin's environmental quality supports existing uses and future compatible uses. Below are the reserve's management goals:

1) **Public access and recreation**: Promote public access, encourage sustainable recreation, and support continued fishing and hunting opportunities.
2) **Resource protection and restoration**: Protect, enhance and restore the integrity of natural processes and habitats for the benefit of native plants and wildlife.
3) **Monitoring and research:** Gather and assess ecological and human-use information to inform and support management.
4) **Partnerships and community engagement:** Promote stewardship of aquatic habitats and species by developing partnerships with adjacent landowners, tribes, non-profit organizations, local government, agencies, resource managers, the local community and regular recreational users.
5) **Use authorizations on state-owned aquatic lands:** Ensure uses authorized on state-owned aquatic lands in the reserve are consistent with the desired future conditions.

Table of Contents

List of Acronyms

Corps	U.S. Army Corps of Engineers
DNR	Washington State Department of Natural Resources
DOE	Washington State Department of Ecology
DOH	Washington State Department of Health
EPA	United States Environmental Protection Agency
HSM	Habitat Stewardship Measures
IBA	Important Bird Area
NOAA	National Oceanographic and Atmospheric Administration
PSC	Puget SoundCorps
PSP	Puget Sound Partnership
RCW	Revised Code of Washington
RM	River Mile
SEPA	State Environmental Policy Act
SMP	Shoreline Master Program
WAC	Washington Administrative Code
WDFW	Washington State Department of Fish and Wildlife

DRAFT

1. Introduction

Washington's Department of Natural Resources

DNR is the steward of 2.6 million acres of aquatic lands – tidelands, shorelands, and lands submerged under Puget Sound, lakes and navigable rivers. DNR manages these lands to protect fish and wildlife while also providing public access, commerce and navigation.

DNR is directed by statute to manage these state-owned aquatic lands to:

- Encourage public use and access
- Foster water-dependent uses
- Ensure environmental protection
- Promote production of renewable resources, such shellfish
- Generate income from use of aquatic lands, consistent with these management goals

Aquatic Reserves Program

Aquatic reserves protect and restore important native ecosystems on state-owned aquatic lands that are of special educational, scientific and/or environmental value. Aquatic reserves are established through robust scientific review and cooperation with citizens, stakeholders, and partner agencies. DNR and its partners manage reserves by adhering to goals, objectives and strategies developed with the community in each reserve's management plan. Aquatic reserves support community engagement, public access, research and monitoring, and protection and restoration of important native ecosystems. More information can be found on the DNR webpage and in the *Aquatic Reserve Program Implementation and Designation Guidance*.

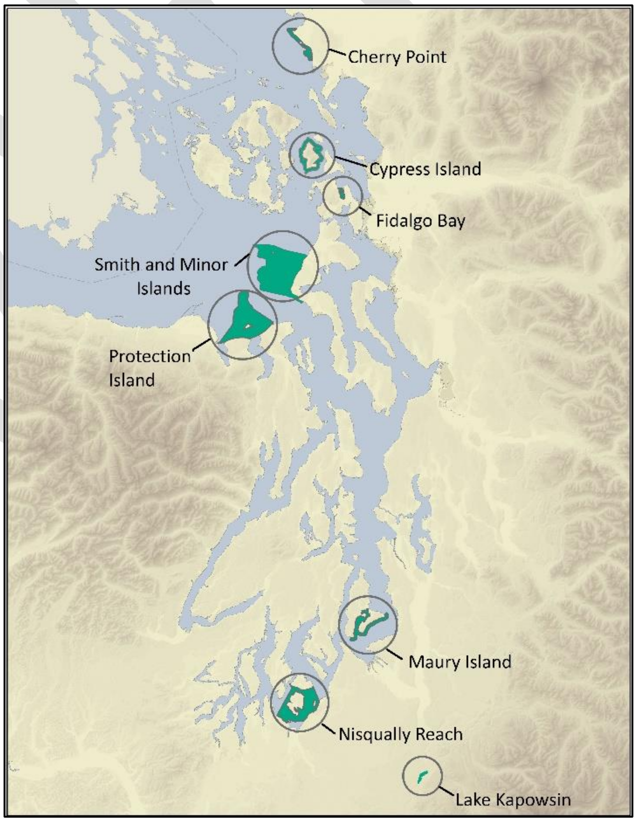


Figure 1. Washington State Aquatic Reserves

DRAFT

Legal Authorities for Establishing State Aquatic Reserves

The constitutional authority for proprietary management of state-owned aquatic lands is derived from Articles XV and XVII of the Washington State Constitution. DNR is directed by state legislature in RCW 79.100 through 79.145 to manage the state-owned aquatic lands to provide a balance of public benefits that include encouraging public use and access, fostering water-dependent use, ensuring environmental protection, and utilizing renewable resources. In addition, generating revenue from state-owned aquatic lands when consistent with the other legislatively directed public benefits is also considered a public benefit.

RCW 79.10.210 authorizes DNR to identify and withdraw limited acreages of public land from conflicting uses. The purpose of withdrawal is to increase continuity in public land management and facilitate long range planning. Withdrawn public lands are to be maintained for the benefit of the public as areas where natural ecological systems can be observed, studied, enjoyed, or otherwise used.

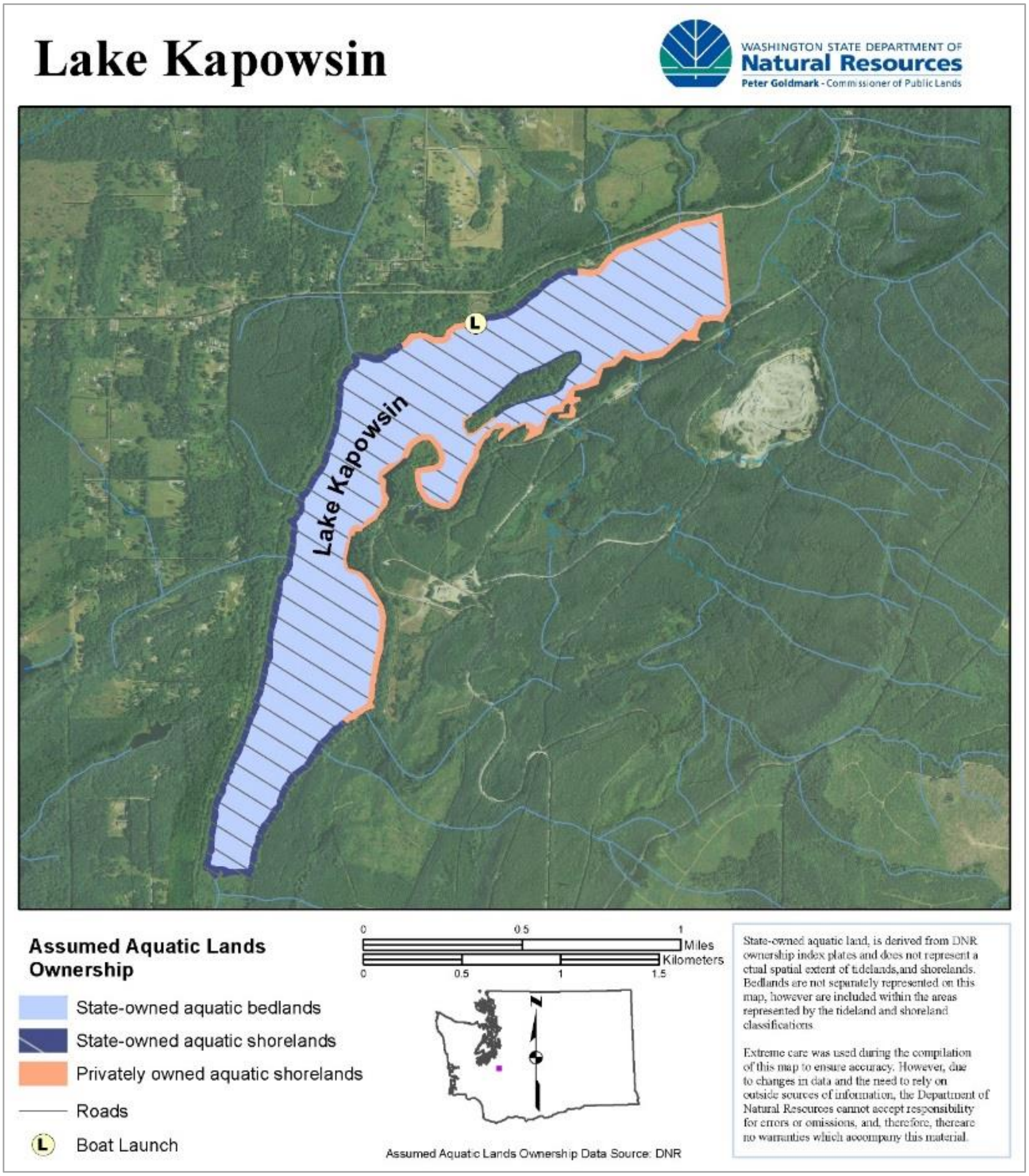
WAC 332-30-151 directs DNR to consider lands with educational, scientific, and environmental values for aquatic reserve status, and identifies management guidelines for aquatic reserves. WAC 332-30-106(16) defines environmental reserves as sites of environmental importance, which are established for the continuance of environmental baseline monitoring and/or areas of historical, geological, or biological interest requiring special protective management. WAC 332-30-106(14) defines educational reserves as educationally important areas with aquatic lands typical of selected habitat types which are suitable for educational projects. WAC 332-30-106(64) defines scientific reserves as sites important for scientific research projects and/or areas of unusually rich plant and animal communities suitable for continuing scientific observation.

Lake Kapowsin Aquatic Reserve Description

The Lake Kapowsin Aquatic Reserve is established as an environmental reserve to protect important native ecosystems, to facilitate collaborative partnerships, and to maintain existing uses and recreational opportunities for current and future generations. The Lake Kapowsin Aquatic Reserve includes all of the state-owned shorelands and bedlands of Lake Kapowsin, totaling approximately 475 acres (Figure 2). Appendix A provides a more thorough geographic, physical, and biological description of the Lake Kapowsin Aquatic Reserve. For a complete legal description of the Lake Kapowsin Aquatic Reserve boundaries please refer to Appendix E.

DRAFT

Figure 2: Assumed aquatic lands ownership



Purpose of the Lake Kapowsin Aquatic Reserve Management Plan

This management plan describes native species and habitats, ecosystem features, and recreational uses in the aquatic reserve. The plan reflects the current site conditions, scientific knowledge and human uses within the reserve, and will be used to guide management of the Lake Kapowsin Aquatic Reserve.

Planning Process

Lake Kapowsin Aquatic Reserve Planning Advisory Committee (September 2015, DNR)

DNR completed a lengthy outreach and evaluation process for the Lake Kapowsin Aquatic Reserve. The process included outreach to the public, local community groups, agencies, and tribal interests. Two open house public meetings were held in fall of 2014 to address questions and gather feedback from the community. An objective scientific evaluation of the site was completed in the spring of 2015 by a Technical Advisory Committee, a panel of natural resource experts. The Technical Advisory Committee unanimously recommended Lake Kapowsin be designated an aquatic reserve. A Planning Advisory Committee representing a wide range of local interests assisted with plan development. Members of the committee included habitat and fish biologists, county and local planners, fishermen, recreational users, and local residents. The Planning Advisory Committee met four times in the fall of 2015 and winter of 2016 to identify monitoring, outreach, and restoration needs and to direct and review the content of the Lake Kapowsin Management Plan.

Ongoing Review

DNR will work with state and local governments, tribes, hunters, fishers, area organizations, adjacent landowners, leaseholders, and local citizens to review the management plan every 10 years as necessary over its 90-year term. This will ensure the aquatic reserve goals are being met and that the plan is updated to reflect changes in scientific knowledge, condition of habitats and species, and human uses of state-owned aquatic lands

DRAFT

2. Current Uses, Recreation & Stewardship

It is important to identify current uses and impacts in order to assess the baseline conditions of the aquatic reserve's ecosystem. This information informs the goals and strategies of the management plan and defines appropriate uses and best management practices, monitoring, restoration, enhancement, and outreach.

Lake Kapowsin is a popular destination for recreational fishing, waterfowl hunting, and boating. DNR is under mandate to encourage public use and access to state-owned aquatic lands. These uses are consistent with that mandate, and the Aquatic Reserve Program supports current recreational uses at Lake Kapowsin.

Maintaining appropriate uses within the reserve is a critical component of DNR's overall strategy under WAC 332-30-151(2), which states that "leases for activities in conflict with reserve status shall not be issued."

Ownership and Land Use

Aquatic Lands Ownership

There are two classifications of aquatic lands within the aquatic reserve area: bedlands and shorelands. Bedlands are aquatic lands that are submerged at all times and are solely managed by DNR. Shorelands are located at the shore of all freshwater areas. The waterside boundary is the line of permanent upland vegetation or line of mean high water. Approximately 50% of the Lake Kapowsin shorelands are managed by DNR and 50% are privately-owned (Table 1). Private shoreland owners include Hancock Timber Resource Group, the Muckleshoot Tribe, the Puyallup Tribe, Tacoma City Water, and others.

Table 1: Lake Kapowsin aquatic land ownership.

Ownership	Aquatic land classification	Acres	Percent
State-owned	Bedlands	435.03	100
State-owned	Shorelands	40.61	49.7
Private	Shorelands	41.17	50.3

Upland Ownership

The uplands adjacent to Lake Kapowsin shorelands are owned by other-public and private entities. Adjacent upland landowners include Hancock Timber Resource Group, the Puyallup Tribe, the Muckleshoot Tribe, Tacoma Water, Washington Department of Fish and Wildlife (WDFW) and other private entities.

Uplands on the eastern side of the lake are primarily forested areas managed for timber harvest or other natural resources extraction. Owners include the Hancock Timber Resource Group, the Puyallup Tribe, Rainier Resources and Rainier Timber.

DRAFT

DRAFT

Hancock Forest Management is steward of the Kapowsin Timberlands Recreational Area east of Lake Kapowsin. This forested neighboring area spans about 182 square miles and offers fee-based public recreation opportunities for permitted firewood harvest, hunting, fishing, camping, and equestrian use. See their website for more information: https://www.hancockrecreationnw.com/kapowsin/about/about-kapowsin.

The Kapowsin Quarry, located approximately 700' to the northeast of Lake Kapowsin, is owned by Rainier Resources LLC and leased to Washington Rock Quarry Inc. Kapowsin Quarry produces crushed rock, quarry spalls, rip rap, and large armor rock used in shoreline protection.

The Washington Department of Fish and Wildlife (WDFW) manages the public access on the northwest side of the lake and owns the upland parcel with the parking lot and restroom.

WDFW boat ramp and dock at Lake Kapowsin (August 2014, DNR)

The wetlands on the north outlet and south inlet of the lake are primarily privately-owned lands. Hancock and B.A. & A. Holdings own the majority of the wetland on the north end of the lake, while Hancock and Tacoma Water own the wetland on the south end of the lake.

City of Tacoma Public Works and Tacoma Water own several parcels on the south and west shoreline. The railroad bed that runs along the west side of the lake is owned by City of Tacoma Public Works Mountain Division.

Utility – Cable Crossing

DNR currently has a right-of-way agreement in perpetuity with Hancock (#51-020341) for an electric transmission line. The line crosses Lake Kapowsin starting near the WDFW boat launch, over Jaybird Island, and to the eastern shore of Lake Kapowsin. The right-of-way is established to include a buffer to protect the transmission line from potential damage. This is the only encumbrance on state-owned aquatic lands at Lake Kapowsin.

Overwater Structures

There are three docks on Lake Kapowsin; none of them occupy state-owned shorelands. Two of the three docks are private. The first dock is associated with a private picnic area on the east side of the lake and the second, near the north end of the lake, is part of a private residence that was formerly a small resort. The third is the WDFW public dock with boat ramp and parking area. WDFW has a non-exclusive easement with the City of Tacoma for the adjacent second-class shorelands where the public dock and boat launch are located. The WDFW public access area is used for a variety of uses including fishing, hunting, bird watching, and other recreational boating activities.

Remnant pilings from docks and overwater structures that supported historical logging and timber mills are present at the south end of the lake and west of the WDFW public access boat ramp.

Recreational Uses

The natural character of Lake Kapowsin, the habitat provided by its submerged forest, and public access make it desirable spot for sport fishing, bird hunting, birdwatching, photography, and boating.

The emergent and subsurface remnant stumps and woody debris naturally limit the speed and size of watercraft used on the lake. Non-motorized watercraft, or boats with electric trolling motors or low-speed gas-powered motors are favored by recreational users. Water skis are not allowed on Lake Kapowsin and operating any vessel over five miles per hour is unlawful per the Pierce County Code (8.88.460.B.3.a).

Fishing and boating at Lake Kapowsin (April 2016, DNR)

Lake Kapowsin is a popular fishing location and receives relatively high fishing pressure. Lake Kapowsin is open to fishing year-round and is managed by WDFW as a mixed-species water (Jackson and Caromile 2000). The lake has been stocked regularly since the 1960s with legal-sized Rainbow Trout. In 2015, almost 30,000 Rainbow Trout were planted between March and May (WDFW 2015a). Warmwater fish species, including Largemouth Bass, Black Crappie, Yellow Perch, Pumpkinseed Sunfish, and Rock Bass, are the primary targets for anglers (Jackson and Caromile 2000).

WDFW conducted a recreational fishing survey in 2008 to assess fishing use at the lake. There were an estimated 12,330 shore angler trips and 11,094 boat angler trips (5,604 boats) between January and December. The majority of fishing activity took place between May and October during the summer season (S. Caromile, WDFW, personal communication, 2015).

Waterfowl hunting is another popular activity at Lake Kapowsin and the entire lake is open to waterfowl hunting (M. Tirhi, WDFW, personal communication, 2015). The fringing wetlands and abundant large woody debris provide good nesting duck habitat. WDFW manages waterfowl hunting and regulations can be found on the WDFW website.

Stewardship

Clean Shorelines

Scattered littering and concentrated trash dumping are evident along the shoreline of Lake Kapowsin. In a survey of 20 wetland and physical habitat sites in the summer of 2015, trash was observed at 40% of the sites (Hamer Environmental 2015). Small debris, such as wrappers, cans, bottles, and plastic bags, were most common, but large debris such as tires and an abandoned car were also present (Hamer Environmental 2015; DNR staff observation).

DRAFT

Trash dumping is an ongoing problem around Lake Kapowsin and occurs on both private and public lands. Concentrated dumping of large debris, such as tires, piles of paint cans, and burnt trash piles, was especially problematic in areas accessible by car and was most apparent near Orville Road East and areas west of the public access boat launch. Smaller items, such as cans and Styrofoam bait containers, were commonly found in shallow water and lodged in driftwood and vegetation along the lakeshore.

Trash dumping, vandalism, and theft at the public boat launch and surrounding areas were the most common issues of concern expressed by the community at a series of Open House meetings in 2014. Fences have been cut, vehicles broken into and property stolen.

Meeting attendees also expressed concern over the unauthorized use of quads and off-road vehicles on private lands around the lake. Attendees reported that quads have damaged No Name Creek, a creek which may have previously supported Coho Salmon. Efforts have been made by the property owner to block access to these areas.

Other observations of human influence include dispersed trails to the lakeshore, unofficial campsites, and a hunting blind (Hamer Environmental 2015).

Habitat Restoration and Enhancement

Several habitat restoration and enhancement projects have taken place at Lake Kapowsin. WDFW has competed restoration work that involved invasive species control and native vegetation plantings to mitigate impacts of the public boat launch developed in 2008. Native shrubs, such as ninebark and twinberry, were planted east of the boat launch, and are now well established along the shoreline. Landscape fabric was used to suppress weeds around native plants and prevent erosion.

In the spring of 2015, DNR hosted a community cleanup that involved 17 people who removed an estimated 15 bags of trash from the shores east and west of the boat launch. Invasive blackberries and Scotch broom were also removed during this event. The Muckleshoot Tribe Public Works Department also conducted a cleanup on tribal property west of the boat launch that same week.

References

Hamer Environmental L.P. 2015. Lake Kapowsin Biological Inventory, Final Report. Prepared for Washington Department of Natural Resources, Aquatic Reserves Program.

Jackson, C. and S.J. Caromile. 2000. An Assessment of the Warmwater Fish Community in Kapowsin Lake (Pierce County), Sept. 1999. WDFW Fish Program, Warmwater Enhancement Program. Olympia (WA).

[WDFW] Washington Department of Fish and Wildlife. 2015. Catchable trout plant reports [internet]. Olympia (WA): WDFW Fish Program; Accessed 18 August 2015. http://wdfw.wa.gov/fishing/plants/weekly/search.php?searchby=County&search=Pierce&orderby=LakeStocked%20ASC,%20StockDate%20DESC.

3. Conservation Targets

Conservation targets are important native habitats and species, and unique features identified to maintain biological diversity and ecological function within the reserve. The conservation targets support the aesthetic and recreational value of the natural setting of Lake Kapowsin. The Lake Kapowsin Technical Advisory Committee recognized these attributes, and their work was further refined by the Planning Advisory Committee. Management strategies were developed to meet the protection and conservation needs of these priority species and habitats.

Refer to Appendix A for a full description of the natural environment. Appendix C contains a comprehensive observed species list and WDFW Priority Species and Habitats list.

Geophysical characteristics & Habitats

a) Geologic origins related to damming of Kapowsin Creek by the Electron Mudflow

Lake Kapowsin was formed by the Electron mudflow approximately 500 years ago. Originating on the west slopes of Mount Rainier, the Electron mudflow streamed down the Puyallup Valley and up Kapowsin Creek, damming the creek at a narrow constriction of the valley. The dense, mature forest that occupied the valley was flooded, resulting in a drowned forest and massive stumps that reach to or near the lake's surface and are still embedded in the lake bottom today. These ancient submerged stumps, along with abundant floating logs, large wetland habitat areas, and natural forested shorelines provide diverse habitat areas for numerous species (Crandall 1963).

Lahar-formed lakes and drowned forests are extremely rare in the Puget Lowland region. These features highlight a unique geologic history and link to the landscape-forming legacy of Mount Rainier. The preserved "sub-fossil" trees present excellent opportunities for education and research. In addition, Lake Kapowsin is situated on the divide between the Puget Lowland and Cascade physiographic regions. The forested terraces to the east of the lake were created by the rapid retreat of the Vashon ice flow and are characteristic of eastern glacial margins in the Pacific Northwest. The glacial terraces and drowned forest are easily accessible and visible to visitors and provide a distinctive perspective of the dynamic geological forces that created the regional landscape geologic.

b) Tree stumps, drowned subfossil forest, and large woody debris

Large woody debris (LWD) and structure is a key physical element of the Lake Kapowsin environment. Submerged and emergent tree stumps, remnants of the mature drowned forest, are still scattered throughout the lake. Fallen trees, a large floating log raft area at the north outlet, and small log assemblies along the lake shore also contribute to the fringing wetlands and complex habitat structure.

The ancient submerged stumps, abundant floating logs, and woody structure are the basis for the form and ecological function of the lake and create complex physical habitat for fishes, amphibians, and invertebrates. The tops of subsurface stumps create pockets of shallow water habitat in deeper, open water areas that are used by warmwater fish for spawning. Emergent stumps create additional midwater structure that birds use for nesting and foraging. The floating log rafts and other large woody debris stabilize shoreline areas, reduce water flow, and trap sediments, nutrient and leaf litter. They also

DRAFT

increase available habitat for insect production and create small protected backwater areas that offer refuge and suitable structure for amphibian egg masses. The structural diversity created by LWD is essential to many aquatic species for refuge (hiding), overwintering habitat, and juvenile rearing (Maser et al. 1988; Nakamura and Swanson 1993; Collins and Montgomery 2002; Montgomery and Bolton et. al. 2003; Montgomery and Masson et. al. 2003; Knutson and Naef 1997).

c) Large, undisturbed wetlands at lake inlet and outlet, fringing shoreline wetlands, and floating log habitat

Wetlands complex at the south end of Lake Kapowsin (August 2014, DNR)

Several types of wetland communities are associated with the Lake Kapowsin ecosystem. A large, forest and shrub wetland complex persists along Kapowsin Creek just north of the lake. This wetland system extends southerly along the lake shore including a well-vegetated riparian area, then merges with the large floating log habitat complex. A large diverse wetland assemblage emerges out of the south margin of the lake. This wetland community transitions from a unique exposed flats area with emergent wetland plants, to a large shrub-covered wetland area, then grades into a deciduous forested wetland. The extensive transitional zone provides sheltered nursery grounds and migratory passage for several species, including salmonids heading to their upstream spawning habitat. There are also 23 lake-fringe wetland areas that comprise 48 percent of the shoreline (Hamer Environmental 2015).

Wetlands are known to play a vital role in the landscape through hydrologic functions related to maintaining the water regime and quality in a watershed. They do this by intercepting surface flow, retaining water, sediment, and processing nutrients, reducing flooding, and potentially minimizing drought (Granger et al. 2005). Wetlands also provide habitat connectivity from upland regions and stream corridors to the open lake area. A host of fish and wildlife species, including waterfowl, warmwater fishes, sensitive salmon species, amphibians and other wetland-dependent wildlife use these habitat areas.

d) Contiguous and relatively intact lake habitat, state-owned aquatic shorelines, and shallow nearshore habitat

The shorelines of Lake Kapowsin are relatively undeveloped compared to other Puget Lowland lakes in the region. The tranquil and intact shoreline supports the potential of a healthier, integrated, lake ecosystem. The nearshore area captures much of the sediments, wrack and plant parts washing in from the watershed. Both aquatic and wetland plants in the nearshore, provide habitat for diverse species. These aquatic plants provide substrate for algae and other epiphytes, insects, crustaceans, and fishes that use this area for

DRAFT

DRAFT

breeding, cover and foraging. In addition, almost 90% of the drainage area for Lake Kapowsin is either forested or part of the large tract of forestry lands to the east. The forest cover provides for greater infiltration, surface water storage, and soil stabilization. These forests are dominated by Douglas fir, western hemlock, and western red cedar. Breeding, feeding, nesting, migration and rearing habitat for vertebrate and invertebrate grazers and seed eaters, omnivores, carnivores, and scavengers exist throughout the area (Kruckeberg 1991).

Fish & Wildlife

a) Salmonid species and habitats, including Chinook Salmon, Coho Salmon, Cutthroat Trout, and steelhead

The lake supports Coho Salmon and Cutthroat Trout, which move through the lake, and occasional Steelhead (B. Smith, Puyallup Tribe, personal communication, 2015; Jackson and Caromile 2000). Chinook Salmon, Pink Salmon, Coho Salmon, steelhead and occasionally Chum Salmon are found in Kapowsin Creek (Marks et.al. 2013).

Coho Salmon travel through the lake into upper Ohop Creek to spawn. Upper Ohop Creek is technically considered the continuation of Kapowsin Creek and is the main feeder stream to Lake Kapowsin (Pierce County 2010). Because young Coho Salmon often remain in freshwater for up to two years before making their way to the ocean, the lake provides dependable rearing and migratory opportunity. The lake also may attract Coho Salmon fingerlings from other portions of the upper and mid-Puyallup basin, as sizeable good quality winter rearing habitat is not very accessible in the mid basin area (B. Smith, Puyallup Tribe, personal communication, 2015)

b) Amphibian species, including Northwest salamander, red-legged frog, rough-skinned newt, Pacific tree frog, and Western toad, and associated habitats

The presence of four native amphibian species have been confirmed at Lake Kapowsin: Pacific tree frog, Northern red-legged frog, Northwestern salamander, and Rough-skinned newt (DNR 2015; Hamer Environmental 2015). In addition, Western Toad, Oregon spotted frog, and two other salamander species are predicted to inhabit the Pierce County Biodiversity Management Area 8, which is located four miles west of Lake Kapowsin and has similar habitat (Brooks et al. 2004).

Northwest Salamander egg mass (March 2015, DNR)

The northern red-legged frog is listed as a federal species of concern, but has no state listing. The Oregon spotted frog is listed as a Washington state endangered species and a federal candidate species. The Western toad is a state candidate species and listed as a federal species of concern (WDFW 2008).

c) Migratory waterfowl and raptors, including nesting Bald Eagles and Osprey, and Purple Martins

Lake Kapowsin hosts a diverse number of bird species throughout the year as there is essential nesting, rearing and foraging habitat for both resident and migratory birds. The lake is designated as a WDFW Waterfowl Concentration area and six species of state or federal concern have been identified, including Bald Eagle, Great Blue Heron, Osprey, Pileated Woodpecker, Purple Martin, and Wood Duck.

Refer to Appendix A for complete reference list.

DRAFT

4. Management Guidance

The Lake Kapowsin Aquatic Reserve is established as an environmental reserve to protect important native ecosystems, to facilitate collaborative partnerships, and to maintain existing uses and recreational opportunities for current and future generations. This section of the plan outlines the desired future conditions of the lake. The following goals and objectives are designed to achieve these conditions. The management guidance was developed collaboratively with the Lake Kapowsin Planning Advisory Committee.

Desired Future Conditions

Desired Future Conditions describe the overall target, or ideal, conditions through the 90-year term of the aquatic reserve. They provide guidance for developing the management goals and objectives.

a) Public Access and Recreation

Throughout the 90-year term of the reserve, public access and recreation will be fostered. The aquatic reserve will project important aquatic habitats used by fish and waterfow ensuring that future generations can continue to enjoy hunting, fishing, and boating at Lake Kapowsin. Recreational areas, such as trails and picnic areas, will enhance community stewardship and public access to the lake. Community support, involvement, and stewardship of the reserve, will result in clean shorelines, and a safe and secure public access area. Education and outreach, including interpretive signs, will increase public appreciation for Lake Kapowsin and the unique geology, habitats, history, and cultural resources of the lake.

b) Resource Protection and Restoration

Natural processes, lake and shoreline habitats will be kept intact. The submerged ancient forest stumps and the floating logjam at the northern outlet will continue to provide complex structural habitat for birds, fish, and amphibians. Aquatic vegetation fringing the shorelines and large wetlands at the inlet and outlet will be maintained as functioning, high quality habitat that supports thriving amphibian and invertebrate communities. Native plant species will predominate in nearshore and aquatic habitats. Important habitat areas where birds feed, breed, and overwinter will be protected, and diverse migratory bird and waterfowl populations will continue to use the lake. The recreational fishery for trout and warmwater fish will be sustained. Salmon migration and habitat areas will be maintained and enhanced.

c) Monitoring and research

A strong program of monitoring and research will provide a greater understanding of species diversity, wildlife and fish communities, habitat use, and human impacts at Lake Kapowsin. Baseline knowledge and continued monitoring will guide adaptive management practices. Information will be broadly shared with partners, stakeholders, and the community.

d) Partnerships and community engagement

In the future, strong partnerships with adjacent landowners, community organizations, local government, and other natural resource managers will be cultivated to support a broad watershed strategy for the Lake Kapowsin area. The partners will work cooperatively to implement best management practices that reduce upland impacts and maintain water quality.

Goals

The Lake Kapowsin Aquatic Reserve will be managed to protect important native ecosystems, to facilitate collaborative partnerships, and to maintain existing uses and recreational opportunities for current and future generations. Fishing and hunting are both managed by the Washington Department of Fish and Wildlife and designation as an aquatic reserve does not affect fishing or hunting rules at Lake Kapowsin. The lake will continue to be managed as a mixed-species waterbody with warmwater fish and trout fishing.

The following management goals have been established for the Lake Kapowsin Aquatic Reserve:

1) **Public access and recreation**: Promote public access, encourage sustainable recreation, and support continued fishing and hunting opportunities.
2) **Resource protection and restoration**: Protect, enhance and restore the integrity of natural processes and habitats for the benefit of native plants and wildlife.
3) **Monitoring and research:** Gather and assess ecological and human-use information to inform and support management.
4) **Partnerships and community engagement:** Promote stewardship of aquatic habitats and species by developing partnerships with adjacent landowners, tribes, non-profit organizations, local government, agencies, resource managers, the local community and regular recreational users.
5) **Use authorizations on state-owned aquatic lands:** Ensure uses authorized on state-owned aquatic lands in the reserve are consistent with the desired future conditions.

DRAFT

Objectives and Strategies

Goal 1: Public Access & Recreation

Promote public access, encourage sustainable recreation, and support continued fishing and hunting opportunities.

Objectives

1.1: **Hunting, fishing, and public access** – Foster public access, sustainable recreational use, fishing, and hunting on state-owned aquatic lands within and adjacent to the reserve

Strategies

a) Work with WDFW, Pierce County and the Graham/Kapowsin community to support boating, hiking, picnicking, fishing, and hunting users

b) Support the 2006 Graham Community Plan to establish an upland park adjacent to Lake Kapowsin, the development of a community wide trail system, open space corridor and associated recreational activities

c) Post signs or fliers at the public access area educating users about recreational opportunities and boating hazards

d) Sponsor family-oriented events at the lake, such as kids fishing days to encourage recreation and stewardship

e) Promote the unique history, geology and ecology of Lake Kapowsin, working with local historians, geologists, Tribes, local organizations and WDFW to develop interpretive signs, public stewardship, and educational opportunities

f) Facilitate public access, which could include a private boat rental facility (in the past the lake supported a facility that rented small boats.)

1.2: **Safe public access** – Increase safety and security at the WDFW public boat launch

Strategies

a) Foster conservation ethic that supports the aquatic reserve and recreational opportunities to prevent theft and vandalism at public access areas

b) Work with partners and community to increase law enforcement or site steward presence at the WDFW public access and surrounding areas

c) Coordinate with WDFW, adjacent property owners, and the community to develop additional strategies to reduce theft and vandalism at the WDFW public boat launch

1.3: **Clean shorelines** – Encourage clean shorelines and reduce trash dumping around the lake

Strategies

a) Raise awareness of the aquatic reserve and the impacts of trash dumping through outreach and educational materials and signs

DRAFT

b) Sponsor, encourage, and participate in community clean-ups events

c) Coordinate with adjacent land owners to help reduce trash dumping

Goal 2: Resource Protection & Restoration

Protect, enhance and restore the integrity of natural processes and habitats for the benefit of native plants and wildlife.

Objectives

2.1: **Native habitat areas** – Protect and enhance important habitat areas including wetlands, floating log mats, submerged tree stumps, nearshore and riparian areas

Strategies

a) Protect habitat areas that support native amphibian, waterfowl and migratory bird, wildlife, and macroinvertebrate communities

b) Preserve native plant communities and wetland areas

c) Maintain large woody structural habitat, including submerged stumps and floating logs

d) Sustain existing areas of natural shoreline and riparian vegetation

e) Encourage partnerships with adjacent landowners for important habitat areas (such as wetlands)

2.2: **Fish habitat** – Protect fish spawning, rearing habitat, and movement corridors

Strategies

a) Maintain submerged logs and stumps for warmwater fish spawning and adult habitat

b) Maintain nearshore area substrate and riparian areas to support migratory corridors, spawning structure, rearing areas, and refugia

c) Incorporate a collaborative watershed approach to fish habitat protection to ensure benefits extend to adjacent salmon-bearing streams

d) Coordinate with adjacent landowners and resource managers to maintain the integrity of fish habitat in Lake Kapowsin drainage, including “No Name Creek” and Kapowsin Creek

2.3: **Restoration** – Restore and enhance degraded or impaired native habitat areas and lacustrine (lake) processes to better functioning conditions

Strategies

a) Work with partners to identify restoration needs within the reserve and prioritize projects

b) Develop partnerships to seek funding for restoration implementation and completion

c) Work with cooperating landowners on nearshore restoration proposals and replant shoreline areas where possible

DRAFT

d) Coordinate with upland landowners to incorporate adjacent wetlands and tributaries in restoration planning (such as “No Name Creek”, Kapowsin Creek and Ohop Creek, refer to Appendix D for location)

e) Survey for invasive species annually and control invasive plants using integrated pest management strategies that reduce need for chemical control. Use only aquatic approved herbicides in limited amounts.

f) Develop management control strategy for bullfrogs

2.4: **Water quality** - Promote and support collaborations focused on improving water quality that reduce impacts to fish, aquatic vegetation and other sensitive species

Strategies

a) Inventory stormwater inputs and identify improved management strategies

b) Collaborate with adjacent landowners and land managers to improve shoreline conditions and minimize potential erosion and pollution sources

c) Build strong conservation partnerships to support a broad watershed approach (refer to objective 4.5)

d) Avoid authorizing new uses that could negatively affect water quality and ensure lessees follow habitat stewardship measures (refer to Goal 5)

Goal 3: Monitoring & Research

Gather and assess ecological and human-use information to inform and support management.

Objectives

3.1: **Baseline inventories & trend monitoring** – Conduct, facilitate, and support inventory and monitoring programs to guide management.

Strategies

a) Collaborate with partners and local organizations to increase inventory and monitoring surveys of conservation targets (wetland habitats, native plants, amphibians, invertebrates, lacustrine processes, and fish)

b) Develop comprehensive monitoring plan with established survey sites

c) Continue year-round water quality monitoring and use monitoring results to inform lake management strategies

d) Determine presence/absence of Oregon spotted frog, Western pond turtle, Western Toad, and Pacific shrew

e) Work with partners to understand species habitat usage

f) Continue to inventory aquatic/emergent plant communities with an emphasis on documenting the presence of rare plants and plant communities, such as identifying Class I wetland areas and verifying bog community

3.2: **Data organization and evaluation** – Compile and share data to inform and support management

DRAFT

Strategies

a) Coordinate with partners to inventory data and identify gaps

b) Coordinate monitoring and research efforts with local and state agencies, local non-profits, universities and citizen science groups

c) Develop a process for sharing data and research with partners, scientists and community through online resources, outreach materials, and signage

d) Support a collective data repository with research, monitoring data, current uses, and local knowledge

e) Review and evaluate scientific and management information regularly to guide research, monitoring, protection and restoration decisions

3.3: **Research** – Promote and support research within the reserve

Strategies

a) Catalog historical and existing studies and use information from monitoring activities to shape and inform research projects

b) Support research that investigates native salmonid and non-native warmwater fish species interactions

c) Support research projects that focus on conservation targets, human-use influences, habitat usage, and geologic history

d) Support or partner to research hydrologic budget and nutrient sources

Goal 4: Partnerships & Community engagement

Promote stewardship of aquatic habitats and species by developing partnerships with adjacent landowners, tribes, non-profit organizations, local government, agencies, resource managers, the local community and regular recreational users.

Objectives

4.1: **Partnerships -** Develop partnerships to increase the Aquatic Reserve Program's outreach, monitoring & research, and restoration capacity

Strategies

a) Work cooperatively with partners to develop outreach and education materials

b) Collaborate with partners to identify and fund potential enhancement and restoration activities that will support the management goals of the aquatic reserve

c) Collaborate with local universities and colleges to strengthen links to limnology, wetland programs, and potential research thesis topics

d) Maintain strong relationships with tribal governments and staff at all levels of DNR management regarding Lake Kapowsin

DRAFT

e) Establish a partner and citizen stewardship group that guides and implements the management plan in conjunction with the reserve program

4.2: **Education and outreach** – Increase public knowledge of the aquatic reserve, natural environment, local history, and cultural context

Strategies

a) Develop interpretive signs and install reserve identifier signs in conjunction with WDFW and stewardship groups

b) Provide information on the history, geology, and ecology of the Lake Kapowsin area on the DNR website

c) Work with stewardship group and other partners to develop outreach and education programs

d) Incorporate historical and geological context in outreach materials

4.3: **Community stewardship** – Increase voluntary stewardship by reserve users and adjacent landowners, and develop stewardship of the lake through community engagement

Strategies

a) Promote community interest in the reserve and public access through outreach materials, signs and an annual appreciation event or festival

b) Provide information on best practices and voluntary stewardship to adjacent property owners and recreational users

c) Partner with local organizations to provide education about upland impacts on lakes and water quality (i.e. importance of riparian vegetation buffers, the impacts of invasive species, impervious surfaces, and stormwater runoff)

d) Work with community and partners, such as Northwest Trek, to strengthen the local citizen science network

e) Work with adjacent landowners to support opportunities for compatible management and restoration

4.4: **Watershed management strategy-** Coordinate with existing area organizations, such as Puyallup Watershed Council, to incorporate Lake Kapowsin in a larger watershed management strategy

Strategies

a) Encourage conservation partnerships that focus on protecting water quality, tributary, and shoreland condition

b) Work with watershed management groups in the mid-upper Puyallup basin that restore and monitor conditions in the basin

DRAFT

Goal 5: Use Authorizations on State-Owned Aquatic Lands

Ensure uses authorized on state-owned aquatic lands in the reserve are consistent with the desired future conditions.

Objectives

5.1 **Use Authorizations on State-Owned Aquatic Lands** (does not include privately owned aquatic lands) - Evaluate use reauthorizations and proposed uses to ensure uses authorized on state-owned aquatic lands within the reserve are consistent with the goals and objectives of the reserve and support the desired future conditions.

Strategies

a) Perform a critical review of new use proposals pursuant to WAC 332-30-151. DNR will make determinations about the consistency with the management plan of proposed uses prior to granting a use authorization

b) DNR will use existing knowledge and science and work with other resource management authorities to identify regulatory and proprietary actions necessary to protect resources

c) New project proponents must clearly demonstrate and document consistency with the purpose of the reserve, the goals and objectives, and strategies

d) New use proponents, where potential impacts to ecosystem processes have not been documented in peer reviewed literature, must review the best available science for the type and scale of use, associated impacts and present their findings to DNR

e) DNR will consider the following when evaluating re-applications from existing authorizations and to determine consistency with this plan:

- Is the authorization in compliance with conditions of federal, state and local laws and permits?
- Is the authorization in good financial and contractual standing with DNR?
- Is the use managed in accordance with and consistent with the goals of this plan?

5.2: **Habitat stewardship measures** - Ensure uses on state-owned aquatic land are consistent with current and future DNR Aquatic Habitat Stewardship Measures

Strategies

a) Apply habitat stewardship measures to all land-use authorizations on state-owned aquatic land

b) Work with existing tenants or lessees to ensure any significant proposed changes incorporate current habitat stewardship measures

c) Work collaboratively with existing tenants or lessees to encourage voluntary best management practices that reduce impacts to habitats and species

5.3: **Unauthorized use –** Reduce potential impacts of unauthorized uses and overwater and in-water structures

DRAFT

Strategies

a) Determine the possible impacts of unauthorized structures to habitats and species, whether the use is appropriate for state-owned aquatic lands, and whether it meets the reserve's objectives

b) Unauthorized structures that are not able to meet local and state permit terms, are not an appropriate use of state-owned aquatic lands, or are not consistent with the reserve's objectives, will not be authorized and must be removed by the owner. DNR may remove the unauthorized use when the owner cannot be identified and funding sources are available

DRAFT

5. Implementation Guidance

Collaborative Partnerships

Successful management of the Lake Kapowsin Aquatic Reserve requires collaborative partnerships with adjacent landowners, tribes, non-profit organizations, local government, agencies, resource managers, the local community and regular recreational users. DNR develop local partnerships to implement the reserve management strategy and coordinate stewardship efforts. DNR may choose to work directly with existing non-profit organizations or watershed groups to maximize project capacity and link Lake Kapowsin Aquatic Reserve management to the larger landscape context.

Cooperative implementation of the Lake Kapowsin Aquatic Reserve Management Plan will require:

- A collaborative evaluation of restoration, research, monitoring, and educational needs.
- Support from partners, stakeholders, and community.
- Consideration of potential funding sources for project implementation.
- A review and evaluation of scientific and management information to guide future development, restoration and protection decisions.

DNR will seek to include a broad spectrum of input from stakeholders and the community during implementation planning and stewardship project development, including:

- Community members
- Recreationists, hunters and fishermen
- Adjacent landowners
- Educational organizations
- Local, county & state representatives
- Tribal government
- Scientific community
- Environmental non-profits
- Local businesses

Management decisions are not required to be made based on consensus, however, community and stakeholder input will be considered in the prioritization of management actions.

Site Stewardship

Site stewardship is essential to meet the goals of Aquatic Reserves management. The preceding plan points to this need, and this section will elaborate on examples of possible projects that site stewards can lead in order to benefit the Lake Kapowsin Aquatic Reserve.

Community and regional level stewardship could be fostered through annual events that highlight the natural and historic features of the site, such as “Kapowsin Appreciation Day.” This would follow the model of many highly successful events such as the Nisqually Watershed Festival, Maury Island Low Tide Festival, Cherry Point “What’s the Point?” celebration, and Fidalgo Bay Day. These fun events connect families and communities to the citizen stewards, experts, and reserve staff and build stronger knowledge and appreciation for special and unique sites, natural science and history.

DRAFT

Local students could carry out science projects and cleanup work parties at the lake in conjunction with site stewards. Education grants could support student field trips and utilize water quality curriculum to foster greater understanding of lake science.

Coordination among site users could lead to organized fishing events and increased stewardship of the public access area. Individual or paired site stewards could help monitor the site and report illegal activity to law enforcement. The Aquatic Reserves Program (or WDFW) can support volunteers by providing training and signing them up as agency volunteers. Programs like this can lead to an effective citizen work group and self-sustaining and self-organized groups that work on behalf of the site. For example Citizen Stewardship Committees for Puget Sound Aquatic reserves provide an excellent model of successful citizen stewardship. Local organizations, such as Northwest Trek, train and lead citizen science and monitoring projects that could support the collection of water quality and amphibian data at the lake. The local Audubon chapter could provide volunteers for bird surveys to monitor both raptors and wintering migrants. Wetland studies and advanced lake studies (limnology) could be supported by faculty from local universities and colleges.

In conclusion, collaborative partnership are vital to the reserve management and strategy implementation. Excellent stewardship and management of a reserve stems from a close working relationship with the community, stakeholders, agencies, tribes and non-profits. The work of program staff can be matched and multiplied through volunteer organizations, grants, and local partner organizations. High quality monitoring and research data can be developed with the support of university and college faculty that use and support the reserve. All these efforts lead to synergy among project partners and positive outcomes for both the site and the community that surrounds it.

DRAFT

Appendix A – Natural Environment

Appendix A – Table of Contents

DRAFT

1. Introduction

The following section summarizes the physical and biological characteristics in and adjacent to the reserve, including physical processes, habitat areas, species, sediment, and water quality. A baseline for existing conditions is developed by characterizing local ecosystem processes, and how they contribute to lake ecology, shoreline functions, and the species that inhabit the area. Along with the social and historical context of the lake area, these components provide a basis to assess the values of the shoreline and lake resources. This process also refines conservation targets, highlights opportunities for ecological restoration, identifies data gaps, and guides aquatic land management actions that sustain and improve the lake resources.

Natural resource descriptions have benefited from a Biological Assessment completed in June 2015 by Hamer Environmental L.P. However, remaining gaps in hydrology, limnology and biological detail persist for the reserve area. Further research and monitoring will allow DNR to diminish these gaps and adopt specific management actions for the reserve that relate to future desired conditions.

2. Geographic Context

Located in the Puget Trough ecoregion in western Washington, at approximately 600' elevation, Lake Kapowsin is a low-elevation lake in the southeastern corner of the Puget Lowland Region. The lake is at the eastern limit of the Puget Sound lowlands, with the Cascade foothills rising from the lake's eastern shore and immediately transitioning to the Western Cascade ecoregion. As part of the mid Puyallup River basin, Lake Kapowsin, upper Ohop Creek and other smaller tributaries drain into Kapowsin Creek and into the Puyallup River below the Puget Sound Energy Electron Power House (at RM 31.2 and approximately 1 mile west of Lake Kapowsin). Forest resources and timber harvest are the principal land cover and use. Other land uses in the immediate area include residential, recreational, limited transportation and commercial uses. An actively mined rock quarry exists approximately 700' east and at approximately 800'elevation at the north end of the lake. Private lots, recreational fishing, hunting, Tribal forest and recreational lands, forestry lands and conservation lands, exist within or directly adjacent to the aquatic reserve area.

Climate

Like most of Western Washington, the climate in this area is influenced by maritime patterns and is generally characterized by mild, wet fall to spring months, with cool dry summer months. Precipitation typically occurs as low-intensity, long-duration storms. The prevailing wind directions are south or southwest during the wet season and northwest in summer. The average wind velocity is less than 10 mph. Prevailing winds are off the Pacific Ocean and bring moist air inland. Precipitation in the Lake Kapowsin area falls principally as rain. About 65 percent of the yearly precipitation in the Kapowsin area falls during the 6-month period from October to March with an annual average of 43.49 inches over the last 30 years through 2014. Average temperatures range from 37.3º F in December to 65.7º F in July with a yearly average of 52.0 º F (http://www.usa.com/seattle-wa-weather.htm). The growing season (the frost free period) is generally from the latter half of April until the middle of October.

3. Geomorphic Development

The Puget Trough is a depression formed by the uplifted Cascade and Coast Range mountains, then repeatedly scoured by recurring glaciation. During these glacial episodes of advance and retreat, the characteristic glacial "drift" plains made of various sized gravel, sand, silt, clay, and till were created, filling most of the Puget Sound lowlands. The last Vashon glacial recession began about 14,000 years ago, and bared numerous troughs and valleys. The steady, rapid retreat of the Vashon ice front resulted in the construction of extensive unmatched terraces formed by streams bounded on one side by ice and cutting into moraine deposits on the other (Walsh and Logan 2007). Contiguous with the eastern margin of the Puget lowlands, terraces at approximately 800'- 1200' elevation dominate the topography along the eastern wall of the Kapowsin/Ohop valley. Also characteristic of this eastern margin of the continental ice lobe retreat are remnant narrow linear valleys with low gradients, small drainage areas, and steep sidewalls indicating subglacial meltwater channelways (Booth and Hallet 1993). These channelways are occupied by lakes, bogs and "underfit" streams, such as, the long narrow valley floor, at almost the same elevation throughout, which includes Lake Kapowsin, Ohop Creek and Ohop Lake (Pierce County Shoreline Inventory and Characterization Report, 2010). Approximately 13,500 BP as deglaciation of the Puget Lowland progressed northward, the melting ice was replaced by a small early stage of Lake Puyallup (Bretz 1913). "The lake initially discharged southward through the Ohop channel, but lower gaps in the valley wall west of Orting (Muck Creek and Kirby channels) were uncovered as the ice front retreated and the bulk of the discharge diverted to these channels"(Troost 2007).

Regionally, numerous lake basins formed from deposited material across streams beds, or by buried chunks of ice that melted out into their own basins (kettle lakes). Lake Kapowsin, however, has a different geologic history unique to this region. Approximately 1600 AD, the Electron mudflow, originating from the upper west flanks of Mount Rainier, spread down the Puyallup River valley. This massive clay-rich flow entered the present day Kapowsin Creek tributary channel depositing 30 feet of sediment, creating a natural dam, and effectively cutting-off the southern portion of the tributary basin from the river. The result of this event was the flooding of the historic glacial melt-water valley and subsequent formation of Lake Kapowsin between the mudflow dam to the north and the historic Ohop Creek alluvial fan to the south. The newly formed lake retained the pre-existing glacial valley morphology, and was eventually re-connected to the Puyallup River via a naturally recovered Kapowsin Creek at the north end. The present-day lake depression is 2.5 miles long and between 0.15 to 0.5 miles wide. "The maximum known depth within the lake is 30 feet, with the southern half of the lake bottom remaining remarkably flat at 28 feet" for a distance of 1000 feet (Crandell 1963).

4. Ecosystem Description

Freshwater aquatic ecosystems have the greatest ecological value per unit area of all terrestrially-based habitats (Dodds and Whiles 2010). Lake ecosystems are integrally influenced by their watersheds, the geological, chemical and biological processes that occur on the land and streams that lie uphill. The movement of chemicals, sediments, detritus, and of many organisms, typically flows in one direction from the watershed to the lake, but fish may migrate upstream, and aquatic insects and amphibians may emerge and disperse on to land. A lake and its watershed are often considered to be a single ecosystem (Likens 1985).

DRAFT

Compared to our current understanding of conditions of other lowland lakes in western Washington State, the Lake Kapowsin ecosystem is reasonably intact with minor disturbances. A primary, unique characteristic that distinguishes Lake Kapowsin and also contributes to the lake's ecological qualities and functions is the presence of an ancient drowned subfossil forest. A rare habitat feature, the submerged stumps of this coniferous, subfossil forest, are pervasive throughout much of the lake. The majority of the massive stumps reach close to or within a few feet of the lake's surface and are still embedded in the lake bottom. The formidable trunk structures provide increased habitat complexity and nutrient input into the lake environment. The submerged stumps, abundant floating logs, intact vegetative cover, along with a predominantly natural shoreline, provide diverse habitat areas for numerous species. The overhanging shrubs and trees, emergent marsh plants, and the large associated wetland complexes enhance food availability, improve water quality, and foster nursery and refuge areas for amphibians, fishes, birds, and mammals. In a few areas, human changes to nearshore environs have compromised the ecological integrity of the lake zone area. However, in contrast to other regional lakes, the relative proportion of the lake shore zone and the drainage basin affected is minimal. Many of the historic developments were abandoned more than 80 years ago, and over time the shoreline habitat and ecological function has substantially recovered. Presently, more than 90% of land cover in the Lake Kapowsin watershed consists of "regrowth," mixed-conifer, managed forest lands. Forested tract areas support native conifers and other native flora with well-vegetated understory plants. The extensive area of forest lands, along with wetlands bordering both ends of the lake, establishes broad habitat connectivity, supports critical ecological services and a more balanced, functioning ecosystem.

Finally, ecosystem characterization cannot be fully evaluated without the biological component. Vital ecosystem processes, such as decomposition and nutrient cycling are influenced by various microbes, plants, and animals, and thus significant changes in these population can imbalance and potentially negatively affect the lake ecosystem (Dodds and Whiles 2010). Similar to other large lakes in the Puget Sound lowlands, non-native warmwater fishes and stocked rainbow trout are the most common fish in the lake. A few native species of freshwater fish, salmon, and trout intermittently use the lake habitat. The dominance of non-native fishes and amphibians has changed the natural equilibrium in the lake, particularly the predator/prey dynamic leading to declines in native fishes, amphibians and invertebrate populations. However, the existing habitat conditions presently support a self-sustaining population of warmwater fishes, which have become an integral part of the lake's character and popularity.

5. Ecosystem Processes

Freshwater ecosystem processes focus on the movement, partitioning, and storage of water, sediment, nutrients, bacteria, pathogens, and plants within an ecosystem at many scales over time and space (Town of Eatonville 2010). This characterization includes a basic review of (1) hydrology, (2) sediment and transport, and (3) lake processes, characteristics and water quality are included.

Hydrologic Cycle

In western Washington, about 3/4ths of the precipitation that falls reenters the atmosphere by transpiration from plants and evaporation from the earth's surface. Much of the remaining water seeps or soaks into the ground water and moves underground toward lakes and rivers. Precipitation is the principal cause of lake level fluctuation. However, the lag between precipitation and lake level change varies from days to years, depending on the lake, but fluctuating lake levels are normal.

Surface Hydrology

Lake Kapowsin, Kapowsin Creek, and Ohop Creek, are part of the middle Puyallup River basin and are located below the Puget Sound Energy Electron Power House (RM 0.0 to 31.2) which is located about 1 mile northeast of Lake Kapowsin. Ohop Creek is the main feeder stream to Lake Kapowsin and is considered a continuation of Kapowsin Creek.

As part of the Puyallup River watershed, surface water runoff in the area is largely from the north and northwestern slopes of Mount Rainier including the western Cascade foothills. The foothills in the eastern part of the Lake Kapowsin drainage basin are largely forested, with the rain or snow falling through layers of predominantly coniferous canopy. This precipitation is largely retained within and on the structure of the vegetation, with some reaching the forest floor and assimilated into the soil. Generally, about 1/3 of the incoming precipitation leaves the area as runoff or groundwater seepage to the streams (Schlesinger 1997).

The dominant inflows to the lake and outflow from the lake occur in surface streams. Several (3-5) smaller streams along with upper Ohop Creek, as the principal tributary to the lake, channel the surface water flow from an approximate 24.83 sq. mile drainage area. Upper Ohop Creek extends approximately 8.5 miles upstream from the lake, divides into two far reaching upper forks, and includes approximately 72 percentage of this eastern drainage area. Historically, the drainage area for Lake Kapowsin was fairly small and did not include Ohop Creek which drained southerly into the Nisqually River basin. In the late 1800's, Ohop Creek emptied into Ohop Valley causing regular flooding of farmlands. Sometime before 1889, local farmers constructed a dam and dikes diverting Ohop Creek northward into the south end of Lake Kapowsin (Anderson 2007). The desired outcome of less flooding in Ohop Valley was accomplished, but not without the consequence of significantly diminished water flow to lower Ohop Creek. Aside from the substantial increase in drainage area of the Kapowsin basin, it is not clear how this major hydrologic conversion affected the ecological dynamics of the Kapowsin and Ohop drainage basins.

Alterations to surface hydrology and flow have occurred from development and resource extraction in the watershed, including structures, roads, other impervious surfaces, as well as rock mining and forestry practices. The mine and roads along and above the northeastern portion of the lake have created some alteration to surface hydrology and flow in the vicinity. Along the "main line" logging road which runs adjacent to upper Ohop Creek culverts have been installed and most barriers to stream flow have been made passable (WDFW 2015). Adjacent forests are managed for timber harvest, which increases road use and the need for good quality road maintenance. The roads are engineered to divert surface water runoff into drainage ditches and in a few observed locations, water is directed into retention ponds. The ditches, ponds and other observed geotextile barriers in strategic locations also help moderate sediment and particulate movement into the lake. Indications of measures to control, direct and minimize water flow and runoff from these local roads help mitigate adverse impacts to the lake environment. Runoff from the WDFW public access parking lot is diverted into two on-site retention basins that allow for stormwater infiltration.

DRAFT

Possible groundwater input to the lake has been inferred from sampling done in October 2014, but is not conclusive. Higher conductivity measurements were detected at the lake bottom at the southern and central sample sites, which could indicate a different source of water, i.e., potentially groundwater infiltration (J. Gawel, UW-Tacoma, personal communication, 2015). A "spring" is indicated to flow into the middle of the northern wetland area, as shown on a map published in an Ecology Water Bulletin (Water Supply Bulletin 22 1968). Additionally, seepage inflow was indicated at a few of the Hamer Environmental survey sites along the western shore.

Kapowsin Creek Average Discharge and Flow Data

Kapowsin Creek is a tannic stream originating at the north end of Lake Kapowsin and flowing 3.6 miles into the Puyallup River. According to the USGS, Kapowsin Creek does not have an operating streamgage that measures stream discharge (Hamer Environmental 2015). USGS historical data shows that a streamgage (USGS #12093000 Kapowsin Creek, Near Kapowsin, WA) was operated on Kapowsin Creek from 1927 to 1957. This gage collected stream discharge data during that time period and some field peak flow measurements were made in 1970, and in 2001. The graph of these historic data shows daily mean discharge in Kapowsin Creek ranging from about 1 cfs up to about 600 cfs (USGS 2015). This gage site was located on Kapowsin Creek at about RM 2.9 (Lat. 46°59'44", Long. 122°11"44"), at 561 feet above mean sea level, with a reported drainage area of 25.9 square miles. Kapowsin Creek enters the Puyallup River at RM 27.6 (Hamer Environmental 2015).

Sediment and Upland Road Management

Sediment delivery and transport processes in the area include some steep slopes with erodible soils and stream alluvial input. Land uses, including the rock quarry, timber harvest and associated road construction and use, can exacerbate sediment erosion and increase sediment input to streams and the lake. The removal of any forest cover or vegetative cover in larger tracts has potential to increase the production of fine sediment as runoff, both volumes and peak flows increase. In this area, the most extensive clear-cut timber harvest took place more than 100 years ago. For current information from the major forest land manager in the area, Hancock Forest Management was contacted for information on their road maintenance and sediment management:

> Hancock Forest Management (HFM) manages the timberlands surrounding Lake Kapowsin in accordance with state rules and regulations (regulated by the Forest Practices division of the Washington Department of Natural Resources) and in conformance with the Sustainable Forestry Initiative® (SFI) Land Management Standard.
>
> HFM uses Best Management Practices (BMPs) to facilitate and prioritize the management of the road network and infrastructure. The primary focus of these BMPs is to manage rainwater runoff to ensure it travels the minimum distance possible before reaching the forest floor and minimizing the amount of sediment which could potentially reach waterways.
>
> The Road Maintenance and Abandonment Plan (RMAP), mandated by the state, has been completed, including all associated work. This includes

DRAFT

removing fish passage barriers (i.e. undersized culverts), upgrading crossings on non-fish perennial (Np) streams to adequately pass 100 year rain events and any debris which may be associated with that, provide adequate ditchwater disconnects via 18 inch cross drain culverts, and installing sediment and erosion control devices where applicable. Please reference Washington Department of Natural Resources (DNR) Section 3 of the Board Manual for state requirements.

Hancock Forest Management's BMP manual is distributed to road construction and maintenance contractors to standardize practices for all performed work and ensure they understand HFM's expectations. This includes but is not limited to: proper ditching technique and proper location of cross drains; proper culvert installation techniques to minimize scour and reduce impact on the landscape; guidelines for when and where to install sediment traps, silt fence and straw bales or wattles to remove any suspended sediment in ditch water, particularly when located on stream adjacent roads or near bridges.

In addition to state regulations, forest certification, RMAP improvements, and BMP's; HFM also controls heavy truck hauling during severe rain events to minimize the amount of sediment movement. During these events, the road network, stream crossings and infrastructure are actively monitored as part of their storm response program (R. Bass, Hancock Forest Management, personal communication, April 2016).

Well log data in the area show significant quaternary alluvial deposits consisting of fine reworked glacial sediments within parts of the northern wetland area, which have accumulated since the Electron mudflow in 1600 AD (DOE, Water Supply Bulletin 22, 1968). Also, in the same general vicinity in eight localities, Crandell found mudflow sediments on the bottom in all the shallower bore sites, but how far to the south the mudflow extended was not determined (1963). These same borings in this northern area of the lake, uncovered a maximum of 6 inches of peat. The bottom sediment characteristics in the middle and southern areas of the lake were not investigated (Crandell 1963).

Glacial sediments mantle the hills to the east and compose the primary surface cover on the Kapowsin-Ohop valley floor and adjacent vicinities. Advanced outwash of undifferentiated fine sediment from the Vashon stade is present throughout the Ohop valley. At slightly higher elevations in the adjacent eastern foothills, advances of Alpine glaciation from Mount Rainier mantle the slopes of the Kapowsin drainage basin. Diorite (an intrusive igneous rock) bedrock is also present in prominent outcrops toward the upper reaches of Ohop Creek and just below the Kapowsin Creek outlet from the lake's northern wetland area. Presently, basaltic (volcanic in origin) rock is exposed and being mined at the Kapowsin Quarry operation northeast of the lake, in addition to aggregate, sourced from the mantle of glacial deposits on top.

At the ten physical habitat sampling stations around the lake, Hamer Environmental collected several physical habitat characterization measurements within the shore zone areas of the lake. The littoral substrate and sediment sample cover at these stations is dominated by silt, clay or muck, followed by woody debris and organic material. Only two locations had cobble/gravel substrates. Silt, clay or muck, when present at the sampling site was heavy, representing 40 – 75% of the substrate. On average, woody debris and organic material cover was moderate, representing 10-40% of the substrate when present. Overall, sediment composition was organic for most physical habitat stations (Hamer Environmental 2015).

Further information is available from well logs in the area, which are difficult to firmly interpret. When plotted on a GIS base map, many of the well locations are inaccurate and no records of wells or borings that investigate deeper lake sediments are available. Additional investigation and professional interpretation could help unveil some useful information from these well logs.

6. Water Quality and Chemistry

Chemical, physical and biological processes, lake morphology, water inflows, and geology all affect water quality and chemistry. Human activities and land-use practices within the watershed also impact water quality. Lake Kapowsin water quality parameters have been measured intermittently since 1972 (Table 2).

Table 2. Lake Kapowsin water quality. Sample locations show in Appendix D.

Source	Parameter or Analyte	Date	Sites
DNR	Temperature, dissolved oxygen (D.O.), percent oxygen saturation depth profile, Secchi depth	Monthly, Dec. 2014 – Nov. 2015	3 Sites
Gawel 2015 UW-Tacoma	Temperature, dissolved oxygen, pH and specific conductance depth profile, total phosphorus, total nitrogen, and ammonia [NH_4-N]), and chlorophyll-*a*	24 Oct. 2014	3 Sites
Hamer Environmental 2015	Temperature, dissolved oxygen, pH and specific conductance depth profile, total phosphorus, total nitrogen, and ammonia [NH_4-N]), and chlorophyll-*a*	30 Apr. 2015	1 Site
Jackson and Caromile 2000	Temperature, dissolved oxygen, pH, and conductivity	7 Sept. 1999 (mid-lake)	1 Site
Bortleson et. al. 1976	Temperature, dissolved oxygen, pH and specific conductance depth, Secchi depth, total phosphorus, total nitrogen, and ammonia, and fecal coliform	10 Aug.1973	1 Site

DRAFT

Temperature & Dissolved Oxygen

During the late fall and winter months, temperature throughout the water column is relatively uniform, allowing the water mix. In the spring, the uppermost layer of water (epilimnion) warms as the deep water (hypolimnion) stays cool (Figure 3). The metalimnion is the distinct transition zone between the upper, well-mixed epilimnion and the deeper, stagnant hypolimnion (Figure 4). This stratification isolates the bottom layer of water from the surface and atmospheric oxygen, and can severely deplete the amount of dissolved oxygen in the hypolimnion. As the temperature declines in the fall, surface water cools and the epilimnion and hypolimnion begin to mix. This is known as fall turnover. This seasonal cycle of mixing in fall/winter and vertical stratification in the spring/summer drives many of the patterns seen in commonly monitored water quality parameters.

Glossary of Terms:

- **Epilimnion**: Upper layer of water in a lake that is comprised of uniformly warm water that may be well-mixed.
- **Metalimnion**: Middle layer of water in a lake that marks the transition between the top and bottom layers where temperature changes rapidly with depth.
- **Hypolimnion**: Bottom layer of water in a lake that is comprised of uniformly cold and relatively undisturbed water (shown in Figure 3).

From Michaud 1991.

Monthly water quality monitoring in 2015 showed that Lake Kapowsin follows this seasonal mixing/stratification pattern (DNR 2015). Late fall and winter dissolved oxygen concentrations ranged between 8 mg/L to 12 mg/L, which is ideal for a wide range of aquatic species, including cold water fish. The lake began to stratify in May, and by June, dissolved oxygen concentrations in the hypolimnion had decreased to an annual low of .07 mg/L. Dissolved oxygen stayed below 1 mg/L at the bottom of the lake until fall turnover in October (Figure 5). Extremely low dissolved oxygen concentrations, or hypolimnetic anoxia, can be especially problematic in nutrient rich lakes where bacteria decompose organic matter and consume the already scarce amounts of dissolved oxygen (Wetzel 2001; Hamer Environmental 2015). Water quality monitoring in August 1973 and September 1999 also revealed anoxic conditions below 6 m (0.3 mg/L and 0.2 mg/L, respectively). Summertime dissolved oxygen concentrations were below ideal conditions for cold water fish and could stress other aquatic organisms. Further field monitoring is recommended to understand summertime hypolimnetic anoxia and possible impacts to aquatic species.

Water quality sampling at Lake Kapowsin (November 2015, DNR)

DRAFT

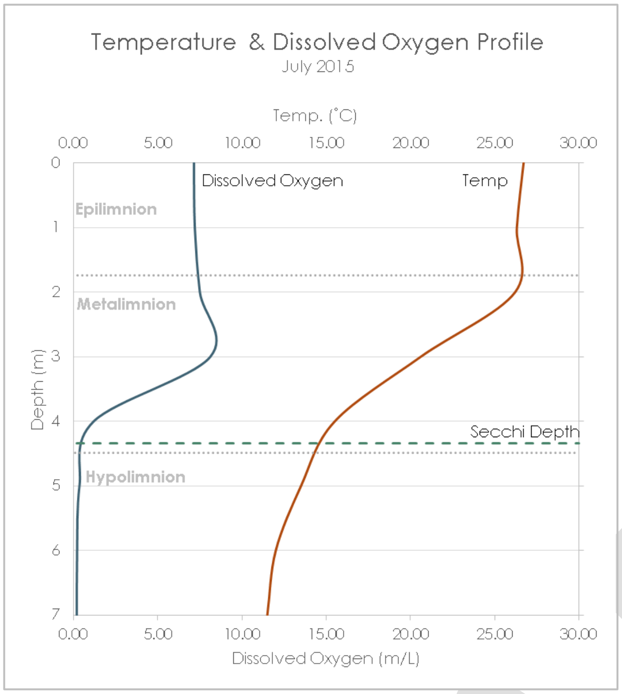


Figure 2. Lake Kapowsin temperature and dissolved oxygen profile 8 July 2015 at DNR_C (DNR 2015).

DRAFT

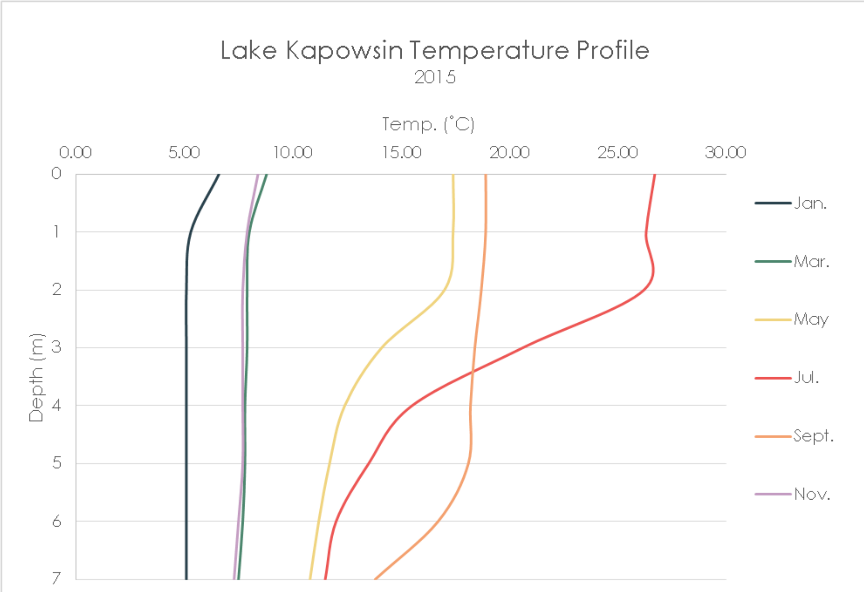


Figure 4. Bimonthly vertical temperature profile for DNR_C. The lake was stratified between May and August, with the largest temperature difference between the epilimnion and hypolimnion found in July. Mixing began in September and the lake was well-mixed November through April (DNR 2015).

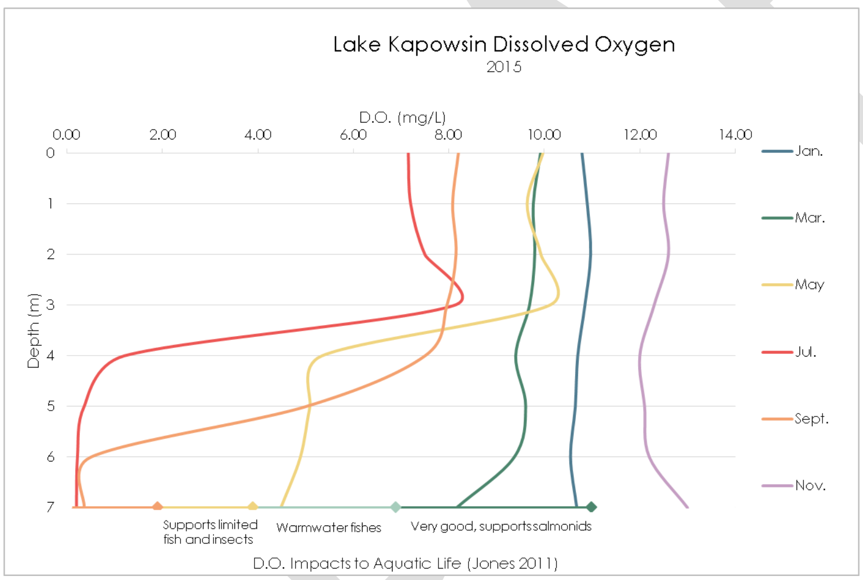


Figure 5. Bimonthly vertical dissolved oxygen profile for DNR_C (see Appendix D for location) and dissolved oxygen impacts to aquatic life. The hypolimnion was anoxic June through September (DNR 2015).

Water Clarity

Secchi disk depth is a measure of water transparency and clarity. The amount of both dissolved and particulate matter in the water column influence the water transparency (Wetzel 2001). Seasonal algal growth, overland flow carrying particulates, stream inflows, and precipitation may all influence changes in Secchi disk depth throughout the year and create varying annual patterns. In 2015, Secchi disk depth was greatest (4.2 meters) in July (Figure 6). Lake Kapowsin waters have a tea color, termed humic stain, which is caused by the presence of tannins and lignins released by decaying plants and organisms. Hamer environmental suggests that this humic stain decreases water clarity year-round and therefore affect Secchi disk depths. Since humic stain is not linked to algal growth, it may be particularly difficult to estimate productivity biomass based on the Secchi disk depth (Wetzel 2001).

Turbidity and total suspended solids were measured in April 2015 and were found to be relatively low (Table 3; Hamer Environmental 2015). Chlorophyll-*a* concentrations are a good approximation of algal productivity and field sampling indicated higher chlorophyll-*a* concentrations in April 2015 than October 2014 (Hamer Environmental 2015; Gawel 2015).

Table 3. Lake Kapowsin water chemistry (Gawel 2014; Hamer Environmental 2015).

Analyte	24 October 2014 UW-Central	29 April 2015 Hamer-Index
Total Suspended Sediment (mg/L)	-	3.20
Turbidity (NTU)	-	3.07
Chlorophyll-a (Index) (ug/L)	5.3	13.5
Chlorophyll-a (Littoral St J) (ug/L)	-	16.2

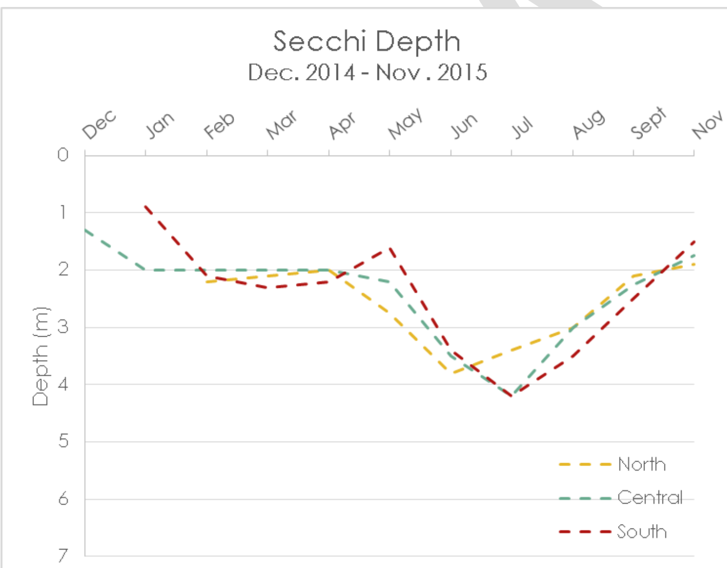


Figure 6. Monthly Secchi-disk depths at the DNR sample sites (DNR 2015).

Specific Conductance and pH

Specific conductance is a measure of the resistance to electrical flow. It is used to approximate the amount of dissolved minerals in water. Higher specific conductance indicates more dissolved ions (Wetzel 2001). Lakes with higher specific conductance generally “contain more salts, are often turbid and nutrient poor (eutrophic)” (Helfrich et. al. 2009). Differences in specific conductance measurements can also be used to differentiate water from different sources, such as groundwater seems or stream inflows (Gawel 2015).

Specific conductance generally increases near the bottom of a lake due to decomposing organic materials, as documented by Bortleson et. al. and Jackson and Caromile (1976; 2000) However, Gawel reported lower specific conductance with increasing depth at the south and mid-lake sample stations in October 2014 (Table 4). This could indicate a groundwater seep near these stations. Further monitoring is recommended to investigate this finding and indicate whether further research on groundwater sources is warranted (Gawel 2015).

Table 4. Lake Kapowsin specific conductance at mid-lake sample stations (Bortleson et. al. 1976; Gawel 2014; Jackson and Caromile 2000).

Date and Location	1m depth	7m depth
10 Aug. 1973	56us/cm	68 us/cm
7 Sept. 1999	54.5 us/cm	99.1 us/cm
24 Oct. 2014	57.5 us/cm	54.7 us/cm

Lake Kapowsin pH was relatively vertically uniform at all three UW sites on 24 Oct. 2014 and values ranged between 6.6 and 6.8 (Figure 7). In April 2015, as the lake was beginning to stratify, surface pH was 5.5 and reached 4.9 at 7 meters (Figure 8; Hamer Environmental 2015). Most natural, unpolluted lakes have pH values between 6 and 9. Low pH values are often found in natural lakes with high dissolved organic matter (Wetzel 2001). Negative impacts are observed at pH values just below 6 and can affect fish reproductive success, larval and egg survival, and eventually increase adult mortality (Table 5; Hamer Environmental 2015; Dodd and Whiles 2010). Additional pH sampling is recommended to understand seasonal changes and possible impacts of low pH observed in April 2015.

Table 5. Influences of decreasing pH on Several Groups of Aquatic Organisms

Organism or process	Approximate pH Value
Bacterial decomposition slows/fungal decomposition	5
Phytoplankton species decline/green filamentous periphyton dominate	6
Most mollusks disappear	5.5-6
Most mayflies disappear	6.5
Beetles, bugs, dragonflies damselflies disappear	4.5
Caddis flies, stoneflies, Megaloptera disappear	4.5-5
Salmonid reproduction fails, aluminum toxicity increases	5
Most adult fishes harmed	4.5
Most amphibians disappear	5
Waterfowl breeding declines	5.5

From Dodd and Whiles 2010

DRAFT

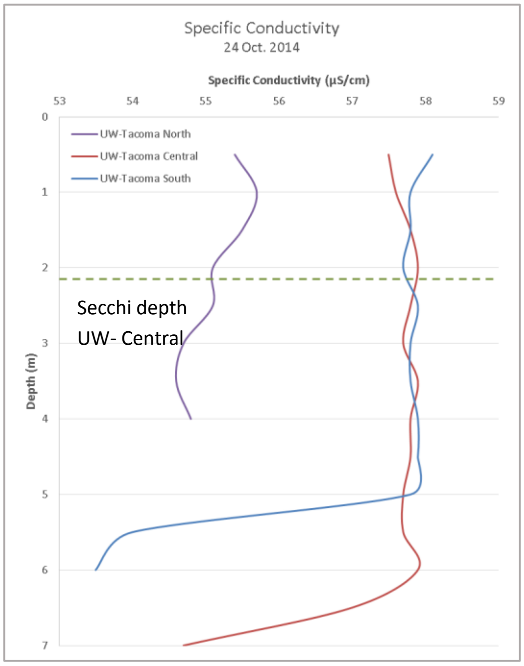


Figure 7. Lake Kapowsin specific conductivity profile (Gawel 2015).

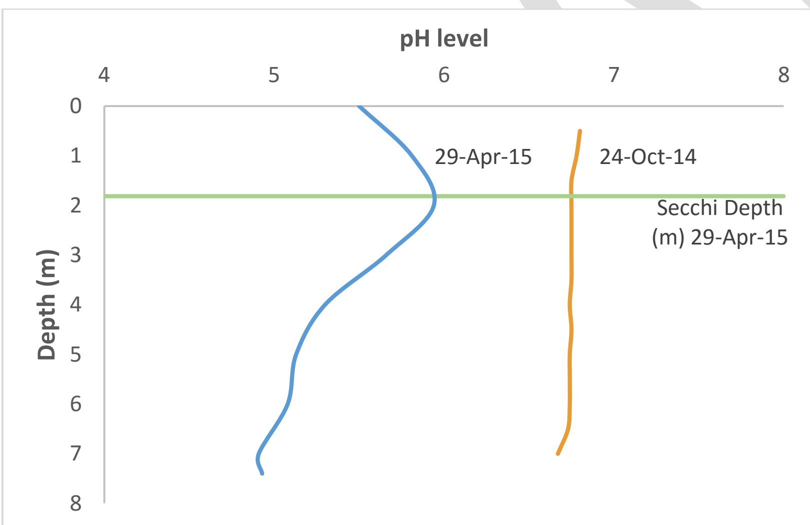


Figure 8. Lake Kapowsin pH profile for 24 October 2014 (UWT_C) and 29 April 2015 (H_index) (Hamer Environmental 2015; Gawel 2015).

Nutrients

Nutrients such as nitrogen and phosphorous support algal production in lakes. Dissolved inorganic nitrogen is naturally found in lakes in the form of nitrate, nitrite and ammonium. The type of dissolved inorganic nitrogen may indicate which algal species will be abundant, and high levels of nitrite are often associated with polluted waters (Dodd and Whiles 2010; Hamer Environmental 2015).

Phosphorus is an important nutrient for plant growth and can be a limiting factor for biological productivity. The concentration of phosphorus available for algal growth is generally low in lakes, and small increases in phosphorus can produce large increases in algal growth (Hamer Environmental 2015). Total phosphorus concentrations observed October 2014 and April 2015 are both associated with eutrophic lakes (Table 6). Increased algal growth in April may use much of the available phosphorus, driving the lower summer concentrations (Hamer Environmental 2015).

Table 6. Lake Kapowsin nutrients on at mid-lake stations (Bortleson et. al. 1976; Gawel 2014; Hamer Environmental 2015).

Analyte	24 October 2014	29 April 2015	10 August 1973
Ammonium (NH_3-N mg/L)	-	*0.007	-
Nitrate/Nitrite (NO_3-N mg/L)	-	0.041	-
Total Nitrogen (mg N/L)	396.8	390.0	-
Total Phosphorus (ug P/L)	97.9	30.0	15.0

Nutrients naturally vary over time, however, excess nitrogen and phosphorus from such human sources as fertilizers or sewage can result in rapid lake eutrophication (Michaud 1991). Nutrient-loading can cause algal blooms, decrease dissolved oxygen, and ultimately impact fish and aquatic vegetation (DOE 2015). A low-density algal bloom was observed in August 1973 and Hamer Environmental documented several small filamentous green algae blooms in June 2015 (Bortleson et. al. 1976). Additional nitrogen and phosphorus sampling during the summer growing season is recommended.

Trophic State Index

Trophic classification reflects the biological productivity and nutrient availability in a lake. Lake Kapowsin is described as a "lake system, with high nutrient inputs (woody detritus, aquatic vegetation) and shallow water depths" (Gawel 2015; Hamer Environmental 2015). Chlorophyll- *a* concentrations are the best measure of trophic class, though Secchi depth, total phosphorus, and total nitrogen can also be used to estimate trophic status, or Trophic State Index (TSI). The Trophic State Index (TSI) ranges from 0-100 and limits for each trophic state are listed below (Bortleson et. al. 1976).

Past characterizations described Lake Kapowsin as an mesotrophic to eutrophic lake. Bortleson et. al. classified the lake as mesotrophic with a TSI of 47 based on Secchi disk depth, total phosphorus, and chlorophyll-*a* (1976). In October 2014, Lake Kapowsin was mesotrophic to eutrophic, depending on the parameter used to classify the lake, see (Table 7; Gawel 2015). Based on chlorophyll-*a* concentrations, Hamer Environmental found Lake Kapowsin to be eutrophic in April 2015 (TSI 56.1).

Trophic classifications:

- **Oligotropic**: Low nutrient content and algal production, very clear, with TSI 0- 41
- **Mesotrophic**: Intermediate level of nutrients and algae, with TSI 42-50
- **Eutrophic**: High productivity, nutrients, nutrients and algae; with TSI 51and above
- **Hypereutrophic**: Very high nutrient levels, may have algal blooms

DRAFT

Table 7. Lake Kapowsin Trophic State Index on 24 October 2014 based on multiple parameters, from Gawel 2015.

Parameter	TSI value	Trophic State
TSI (Secchi Disk)	48.64	Mesotrophic
TSI (Chlorophyll-*a*)	46.61	Mesotrophic
TSI (Total Phosphorus)	69.35	Eutrophic
TSI (Total Nitrogen)	43.00	Mesotrophic

Lakes may naturally become eutrophic over time as nutrients accumulate, plant production increases, and sedimentation fills in the lake. Eutrophic lakes can be highly productive and support diverse fish and aquatic plant communities (Dodds and Whiles 2010). Most lakes experience seasonal fluctuations, with the highest productivity generally in the summer. Further field sampling is recommended in the summer when the lake may be more eutrophic.

7. Physical Habitat

The lake has a unique and rare geologic history that created a relatively shallow-to-medium depth lake with a dense drowned subfossil forest. Jackson and Caromile described Lake Kapowsin as having a maximum depth of 8.8 meters (2000). Abundant submerged subfossil stumps, large amounts of floating logs and other woody debris, provide structurally complex habitat for numerous species. The predominantly; natural, undeveloped shoreline; riparian vegetation and diverse wetland areas maintain a sheltered and productive zone for fish and wildlife spawning, rearing, foraging, and refuge. The site is contained within a moderately large system of forested wetlands and emergent marsh wetland habitats at both ends of the lake with a significant component of native vegetation. Input and outfall streams at both ends of the lake are integrated into these extensive wetland areas providing habitat connectivity for several salmon species, other fishes, waterfowl, amphibians and mammals.

Drowned Subfossil Forest

Five hundred years ago, the Electron mudflow came down the Puyallup River valley and forced its way up the Kapowsin Creek tributary, terminating with a 30-foot high mudflow dam at a constriction in the valley. At the time, a dense, mature forest occupied the tributary valley. The after-effects of the mudflow event resulted in the flooding of the Kapowsin Creek valley between the 30-foot high mudflow debris dam, and a higher elevation delta fan farther up-valley, and the subsequent drowning of the mature forest. The newly formed lake retained the standing trees as they were when the valley was flooded by water. The original condition of nearly all of the lake’s bedlands with the drowned coniferous forest exists present day and most of these subfossil stumps remain vertical and embedded in the substrate. There are numerous large stumps throughout the lake; the biggest of these observed by Crandell in his investigations was 5 feet in diameter at the lake surface at a point where the lake was 22 feet deep (1963). Some mining of the submerged stumps has occurred in a few vicinities around the lake. In the late 1800s to early 1900s, many remnant trunks were still standing above the lake water level. Most of the residual trunks were harvested and cut off at the lake’s surface. However, most species except western red cedar had probably rotted to water level within two centuries after the drowning event (P. Pringle, Centralia College, personal communication, 2015).

DRAFT

Drowned trunks - Large woody structure

Large pillars of drowned coniferous trees persist within Lake Kapowsin's waters. In addition to being a unique, key physical element of the lake environ, this large woody structure (LWS) significantly influences the form and ecological functioning of the lake ecosystem (Maser et al. 1988; Nakamura and Swanson 1993; Collins and Montgomery 2002; Montgomery and Bolton et. al. 2003; Montgomery and Masson et. al. 2003). The prevalence of LWS in the lake provides a unique variety of ecosystem functions. LWS in open water is known to attract fish and bird populations to the vicinity. The submerged stumps, offer complex physical habitat for a variety of other species including amphibians, reptiles, and invertebrates. The structures function as perching areas for birds, shelter and protection, foraging and spawning substrate for fishes, amphibians and invertebrates. Largemouth Bass have been observed guarding nests on submerged stumps in the middle of the lake. The bark and fibrous texture of the partially decayed wood presents other physical and biochemical changes, while providing a base for bacteria, fungus, algae, epiphytes and other microorganisms to flourish. This attracts a plethora of grazers and detritivores and associated prey. The abundance of LWS also serves as thermal protection and a medium for long term carbon sequestration other than the atmosphere. Overall, LWS contribute vital organic material to the aquatic ecosystem by adding wood particulate, organic nutrients and debris to the water column and bottom sediment that can affect water quality, vegetation, sediment composition and invertebrate species diversity. If submerged woody debris is removed in lake nearshore areas, it permanently reduces the biomass of primary and secondary productivity (particularly invertebrates) (Smokorowski et. al. 2006).

Large woody debris - Lografts and floating log community

In addition to the prominent submerged forest, other LWD and LWS, are prevalent throughout the lake ecosystem in large floating log raft areas, small log assemblies bordering the lake shore, contributing to fringing wetlands, as well as other shoreline areas where trees have fallen into the lake. In addition to increasing habitat complexity, the floating log rafts and other LWD provide many similar ecosystem benefits as the LWS of the drowned forest. Specific contributions of LWD include stabilizing, shoreline areas, reducing water flow, trapping sediments, nutrients and leaf litter, increasing areas for insect production and producing small protected backwater areas that offer refuge and suitable structure for amphibian egg masses. The structural diversity created by LWD is essential to many aquatic species for refuge (hiding), overwintering habitat, and juvenile rearing (Knutson and Naef 1997).

Bortleson et al. described Lake Kapowsin with "The north end of the lake is choked with floating logs and snags extending 1,000-2,000 feet from shore…the next 1,000 feet into the lake was covered with submersed plants interspersed with stumps and snags." (1976). This imposing area with interconnected floating logs, LWD and log rafts spans across the narrowing terminus in the north portion of the lake creating an extensive unique structural habitat area. An earlier description by Walcott reported Lake Kapowsin as being "Used partially for log storage" (1973). Perhaps part of this northern area was used for log storage, but prevailing winds have pushed LWD north and further compacted this floating log/raft/wetland habitat area. Varied configurations of floating logs and partially submerged LWD and log raft masses create a partial barrier at the north end of the lake. The logs and rafts north of this barrier, lay in all directions creating a patchwork of lushly vegetated log islets contrasting with occasional bare floating logs amongst a maze of small channels. Logs and log rafts support a high diversity of mostly wetland plants, including sphagnum moss, dwarf shrubs (Labrador tea and swamp laurel), and marsh cinquefoil. Some sparsely vegetated sections of logs feature round-leaved sundews and support sphagnum moss, a typical bog species. More densely compacted logs support assorted vegetative types, such as small alder trees, blackberries, fireweed, as well as wetland vegetation. Narrow channels with patches of open water are interspersed between rafts, some areas support emergent, floating, and submerged vegetation, ranging from sedges, cattails, pond lilies, large-leafed pondweed and various other submerged plant species. Like the large structural subfossil trunks of the drowned forest, log rafts also attract and support epiphytes, invertebrates, amphibians and fishes. In areas such as the lower Columbia River, Largemouth Bass have been observed spawning on log rafts and other woody debris (Hamer Environmental 2015). Three separate wetland areas of this northern floating log/ habitat complex were surveyed by Hamer Environmental and were characterized with slightly different structural composition and plant assemblages.

Sundew at Lake Kapowsin (March 2015, DNR)

The LWS and LWD provide the foundation for and are an integral part of most of the wetland communities throughout the lake area. Consequently, this distinctive floating log raft environ melds into lake fringe wetlands areas and also shares many of the same functions, characteristics, fauna and plant species as other wetland areas around the lake. In ten wetland sites evaluated by Hamer Environmental, floating logs were omnipresent and at a third of the sites represented the dominant constituent.

Wetland Habitat Areas

The plants, water and soils of wetlands are among the most productive ecosystems on the planet (Tiner 1989). They are essential not only to waterfowl and scores of other wildlife species, but also to the overall quality of life in the region. The diversity of creatures found in wetlands stems from the uniqueness of wetland habitat types. In unperturbed situations, the combination of hydrology, soil-type, plant cover and composition determine the level of biochemical processing and other functions related to trapping and transforming sediment and nutrients. The habitat structure, function and organisms, primarily smaller invertebrates, bacteria, algae and decaying plants create a productive base for the food chain that serve a high diversity and abundance of larger organisms.

Several types of wetland communities are associated with the Lake Kapowsin ecosystem. A large, mostly forested/scrub-shrub wetland complex persists along Kapowsin Creek just north of the lake. This wetland system extends southerly along the lake shore including a well-vegetated riparian area, then merges with the large floating log complex. The extensive vegetated transitional zone provides sheltered nursery grounds and migratory passage for several species, including salmonids heading to their upstream spawning habitat.

Another large wetland complex emerges out of the south margin of the lake. The wetland community transitions from a unique exposed flats area with emergent wetland plants, to a large scrub/shrub wetland community, then grades into a deciduous forested wetland. The extensive and diverse aquatic vegetation community in this area is partially due to low-sloping lake shore topography forming an extensive shallow littoral zone with mudflats (Hamer Environmental 2015). These wetlands also provide habitat connectivity from upland regions and stream corridors to the open lake area. A host of fish and wildlife species, including waterfowl, warmwater fishes, sensitive salmon species, amphibians and other wetland-dependent wildlife utilize these habitat areas during several life phases. According to Jackson and Caromile the mixture of aquatic vegetation and wood debris provides optimal habitat conditions for several warmwater fishes, particularly Largemouth Bass and Bluegill (2000). In due course, the entire community of species present in the basin rely on the rich habitat diversity provided by the mosaic of flats, emergent marsh areas, sloughs, streams, scrub/shrub and fringing wetland expanses.

Wetlands are also known to play a vital role in the landscape through hydrologic functions related to maintaining the water regime in a watershed by intercepting surface flow, retaining water, reducing flooding, and potentially minimizing drought.

Hamer Environmental mapped 28 lake-fringe wetland areas around Lake Kapowsin, comprising 48 percent of the shoreline areas of Lake Kapowsin (2015). Additionally, Hamer Environmental conducted wetland inventories at ten sites along the perimeter of the lake, as well as carried-out ten aquatic plant transects on the lake on June 8, 2015. Each of ten wetland sites were rated to provide information on wetland quality on the Lake and to highlight those wetland localities with higher functions, uniqueness, priority for further protection, enhancement, and/or study. The rating resulted in a range of Category I to Category III wetlands found at Lake Kapowsin. One wetland area received a dual rating as both Category I and Category III wetland, due to a portion of the wetland meeting the criteria to be classified as a bog (Category I, more detail later). Two wetland sites were rated as Category II wetlands, which perform all wetland functions well, or one group of functions very well, and are difficult to replace. The remaining seven (plus the half) wetland sites were rated as Category III wetlands, which typically perform wetland functions moderately well, have likely been disturbed or degraded somehow, may be less diverse than other wetlands, and are more likely to be replaceable through mitigation efforts. All wetland sites received moderate to high scores for improving water quality and high scores for providing important wildlife habitat and habitat

DRAFT

functions. The hydrologic functions of the lake-fringe wetlands scored low to moderate, however lake-fringe wetlands are deemed less critical for erosion control and peak water flow reduction than other types of wetland systems (Hruby 2014).

Several wetland sites on Lake Kapowsin exhibited soils, moss layer and plant species composition consistent with bog wetlands. However, these wetland sites (1, 2, 3, 4 and most of 6), didn't meet the minimum plant cover (30 percent of plant species exclusive to bogs) requirement to be rated as Category I bog (Hruby 2014). Only a portion of one wetland on the southwest shore of Jaybird Island met the minimum criteria to be classified and rated as a Category I bog. Category I bog wetlands are not common, and are a priority for protection because restoration of bog habitat is difficult due to the slow rate of formation and delicate balance of abiotic and biotic factors (Rigg 1958; Hruby 2014).

Littoral Areas

The littoral zone in a lake is defined as the nearshore area where sunlight penetrates deep enough to allow for aquatic plants to grow. Jackson and Caromile described Lake Kapowsin as having steep sloping shorelines in areas and extensive littoral zones located at the northern and southern ends of the lake, with many shoreline irregularities (2000). The euphotic depth, which is the lower limit of the littoral zone is located at an average of about 2.4 meters depth in Lake Kapowsin (DNR 2015). The littoral zone captures much of the sediments, detritus, and other constituents washing in from the watershed and processes these materials before they reach the limnetic zone. Both submergent and emergent vegetation arise in the littoral zone, providing primary productivity and habitat for a diverse assortment of species. According to Hamer Environmental, submersed rooted plants (macrophytes) growing at the lake margin also help define the littoral zone (2000). These aquatic plants provide substrate for algae and other epiphytes, insects, crustaceans, and fishes that use this area for breeding, cover and foraging. In addition to habitat structure for this assemblage of species, submergent vegetation in nearshore areas also supply a vital food source. In most littoral areas around the lake, suitable conditions are available, i.e. sediment, detritus and structure, to support macrophytes, emergent vegetation and the associated biological communities identified by Hamer Environmental in 2015.

Riparian Habitat Areas

Riparian zones are defined as the transitional zone between land and water environments that are directly upland of the shoreline and provide important ecological functions such as improving water quality, shoreline stabilization, and creating habitat. Vegetated riparian areas play an important role in aquatic ecosystems by sustaining beneficial habitat which provides shade, nutrients, and large woody debris to both aquatic and terrestrial ecosystems. These vegetated areas adjacent to the lake and wetlands also contribute to maintaining healthy ecosystem conditions by suppressing the erosional processes that move sediment, and by mechanically filtering and/or storing upland sediments before they can enter waterbodies (Town of Eatonville 2010). If stable, riparian areas that are occupied by early-successional native species such as alder, willow, and other shrubs, will transition toward a plant community dominated by conifers. These functions take many decades to recover once disturbed (Washington State Department of Agriculture 2012 Progress report).

The observation of a natural, well-vegetated riparian shoreline is substantiated by Hamer Environmental. Ten sample sites evaluated physical habitat within the littoral, shoreline, and riparian

DRAFT

areas of the lake. "At nine of the sites, "90-100% of the vegetation present within the riparian area was native" with four of the plots shaded by a mixed conifer and deciduous tree canopy at least 15' tall (2015).

Generally, shoreline areas along Lake Kapowsin, outside of wetlands, consist of a narrow fringe of understory emergent vegetation before grading into upland habitats. Riparian habitats along the lake were also varied, but tended to be deciduous forest along the south, southwest and northwest banks, and were mixed conifer-deciduous or conifer forest along Jaybird Island and the east banks of the lake (Hamer Environmental 2015).

Overall, emergent aquatic vegetation covers approximately 20 percent of the Lake Kapowsin shoreline mostly from the extensive wetland areas along the northeast and southwest ends of the lake (Pierce County 2009a). For all wetland sites combined, Hamer Environmental documented a total of 45 submerged, floating & emergent aquatic plant species, indicating high species diversity. Additional wetland and plant surveys should be conducted during different periods of the growing season May - September targeting sites with suitable conditions for specific rare plants

Shoreline zones contained a mix of native and non-native species. A few areas along the southwest and northwest shoreline had higher concentrations of non-native and invasive species, including yellow flag iris *Iris pseudacorus* and non-native redtop grass *Agrostis gigantea*. Native, common cat-tail *Typha angustifolia* was found throughout the lake shorelines, frequently as the dominant plant cover, particularly along eastern shoreline areas.

Upland Habitat Areas

Farther from the lake shorelands, the majority of the adjacent uplands are populated by lowland coniferous forests. Almost 90% of the drainage area for Lake Kapowsin is either forested or part of the large tract of forestry lands to the east. The forest cover provides for greater infiltration, surface water storage, soil stabilization, and evapotranspiration. These forests are dominated by Douglas fir, western hemlock, and western red cedar. Breeding, feeding, nesting, migration and rearing habitat for vertebrate and invertebrate grazers and seed eaters, omnivores, carnivores, and scavengers exist throughout the area (Kruckeberg 1991).

Upland habitat has been modified and altered by human use at locations along the shoreline. Disturbances in the nearshore area include parts of the historic Kapowsin town site, one residence, remnant pilings in the lake, logs and debris from former mill and logging operations, boat ramps, small docks, and farther upland clearing and constrictions from roads and bridges. Activities that could contribute to sediment and nutrient input to the lake, include removal of riparian vegetation, altered hydrologic processes associated with the mine operations, a shoreline adjacent rail line near the western lake shore, and historic and present-day forest practices. Generally, effects from development to associated lake systems are well-documented and can result in complex and varied consequences to biological communities and the overall integrity of the lacustrine ecosystem. (Rosenberger et al 2008; Edmondson 1994; Leavitt et al. 2006).

A widespread threat throughout the State and common disturbance in some upland areas around Lake Kapowsin are infestations of invasive species. Invasive plants can drastically alter the landscape and have long-term ecological effects if not controlled. The Lake Kapowsin shoreline is affected by landscape transforming species capable of suppressing trees and understory plants including English ivy, English hawthorn, Himalayan blackberry, Scot's broom, knotweed species, and invasive clematis. These species are found in or near disturbed areas and dump sites near the lake and railroad right of way. Knotweed is listed as Class B noxious weed and affects riparian areas by competing with and crowding out native vegetation, reducing nutrient inputs, and negating riparian restoration efforts if not eradicated (WSDA 2013).

Noxious Weeds

The presence of non-native invasive plant species can threaten the integrity of aquatic and riparian ecosystems. These introduced species are highly competitive with native species, often difficult to control or eliminate, and in extreme cases may be quite destructive to native ecosystems (King County). Six species of noxious weeds, all Class C, were identified during aquatic plant and lake-fringe wetland surveys carried-out by Hamer and associates in the spring and summer of 2015 (Table 8). A total of 22 noxious weed infestations were documented during April and June field survey efforts. Aquatic Reserve staff observed purple loosestrife present in the northern wetland and portions of northwest fringing wetland areas. Purple loosestrife is a class B noxious weed that is a vigorous competitor and can crowd out native plant species. Significantly, no observations of noxious aquatic plant species such as, Eurasian watermilfoil *Myriophyllum spicatum*, Brazilian elodea *Egeria densa*, curly-leaf pondweed *Potamogeton crispus* or fragrant water lily *Nymphaea odorata* were made. However, lack of observation does not mean probable absence, as many areas of the lake were not thoroughly surveyed for noxious weeds and most detections were incidental to other data being collected (Hamer Environmental 2015).

DRAFT

Table 8. Noxious Weed species identified at Lake Kapowsin (DNR 2015; Hamer Environmental 2015).

NRCS Code	Scientific Name	Common Name	Weed Class
IRPS	*Iris pseudoacorus*	yellow flag iris	C
PHAR3	*Phalaris arundinacea*	reed canarygrass	C
RULA	*Rubus laciniatus*	evergreen blackberry	C
RUAR9	*Rubus armeniacus (was R. discolor)*	Himalayan blackberry	C
HYPE3	*Hypericum perforatum*	common St. Johnswort	C
CIAR4	*Cirsium arvense*	Canada thistle	C
	Lythrum salicaria	Purple Loosestrife	B

Hamer Environmental found yellow flag iris infestations as the most widespread non-native invasive weed around the perimeter of the Lake study area. Iris are found in patches amongst other emergent plant species fringing the shoreline, in the northeastern areas of the lake, and in small clumps on vegetated floating logs. In the same area, Himalayan *Rubus armeniacus* and evergreen blackberry *R. laciniatus* were documented sporadically and in small clusters. Dense patches of Himalayan and evergreen blackberry are located along the west and northern upland portions of the lake and dominate the understory vegetation. Reed canarygrass *Phalaris arundinacea* infestations were limited to two small patches at the northern end of the lake and a larger infestation within the southern wetland along a narrow stream channel. Typically, Reed canarygrass is found more abundantly along the lake margins and fringe wetland areas in western Washington. Curiously, redtop grass *Agrostis gigantea*, an introduced species not classified as a noxious weed, occupies this disturbed shoreline niche at the lake. Canada thistle *Cirsium arvense* and common St. Johnswort *Hypericum perforatum* were also noted in single, smaller patches on vegetated floating logs in the northeastern wetland area of Lake Kapowsin (Hamer Environmental 2015).This is a preliminary invasive species list, and a full invasive inventory should be completed as part of reserve management and in cooperation with neighboring landowners. Treatment of Class C weeds is recommended but not mandatory, due to their widespread establishment throughout Washington State (Washington NWCB 2015). However, new and small infestations of Class C noxious weeds should be treated to avoid the development of large infestations.

8. Fish and Wildlife Resources

Lake Kapowsin is one of the most popular fishing locations in the lowland Puget Sound area for year-round, warmwater and trout fishing. The lake has a year-round fishery managed by Washington Department of Fish and Wildlife (WDFW) as a mixed-species water body. The lake provides good fishing opportunity for Largemouth Bass *Micropterus salmoides*, Yellow Perch *Perca flavescens*, Rock Bass *Ambloplites rupestris*, Black Crappie *Pomoxis nigromaculatus*, Bluegill *Lepomis macrochirus*, Pumpkinseed *Lepomis gibbosus*, Brown Bullhead *Ameiurus nebulosus*, and stocked Rainbow Trout *Oncorhynchus mykiss* (Jackson and Caromile 2000). Since the 1960s, the lake has received annual plants of legal-sized rainbow trout. Even with annual trout plantings, warmwater fish species, particularly largemouth bass, black crappie, yellow perch, and rock bass, are the primary target for most anglers. An angler creel survey conducted in 2008 by WDFW, verified that the majority of anglers are targeting warmwater fish (S. Caromile, WDFW, personal communication, 2015). Coho Salmon *Oncorhynchus kisutch*, steelhead (anadromous Rainbow Trout), and Cutthroat Trout *Oncorhynchus clarki* have been observed in the lake. Coho Salmon and steelhead are likely to move through the lake to reach spawning habitat on Ohop Creek (B. Smith, Puyallup Tribe, personal communication, 2015). Because Coho Salmon fry may remain in freshwater for up to two years before making their way to the ocean, the lake is potentially rearing habitat for this species. Coho Salmon late release net pens existed in the lake for 5 years. After the pens were removed from the lake, Coho Salmon returns persisted for several years in the small tributaries that feed the lake as well as Ohop Creek. Coho are also stocked yearly in the upper reaches of Ohop Creek to supplement the current spawning population (R. Ladley, Puyallup Tribe, personal communication, 2015).

Fish

Warmwater fishes

Warmwater fish introductions were widespread in Washington State and practically all lowland lakes and many river systems in the region contain introduced fish (Bonar et al. 2004). There are records of warmwater fish species being stocked in Lake Kapowsin as early as 1906, continuing until 1939. In 1999 when Jackson and Caromile surveyed Lake Kapowsin they reported collecting eight species of fish from the lake. Of the fish collected, Largemouth Bass and Bluegill were the most abundant, at 32.6% and 42.5% respectively. In terms of total biomass, Largemouth Bass accounted for 32.7%, while Bluegill represented 21.8 %.with the combined biomass of for both species adding up to 54% of the total catch. According to Jackson and Caromile the mixture of aquatic vegetation and timber (LWS) provides optimal habitat conditions for Largemouth Bass, Bluegill, and other warmwater fish (2000).

DRAFT

Other fish sampled during the survey, in order of highest to lowest abundance, included: Yellow Perch, Rock Bass, Pumpkinseed, Black Crappie, Brown Bullhead, and Coho Salmon (Jackson and Caromile 2000). Lake Kapowsin has the diversity of habitat types, including masses of LWS and LWD that can sustain a diverse population of warmwater fishes. For instance, at the top of the prominent submerged stumps, Largemouth Bass have been observed guarding their nests, while Black Crappie congregate around the stumps and pilings. The large percentage of shoreline with fringing wetland areas can provide Bluegills and Pumpkinseed with high quality suitable vegetated backwater habitat.

Largemouth Bass males generally excavate circular depressions in one to ten feet of water in which females deposit their eggs. Males guard the nest during incubation and early fry growth. Largemouth begin their spawning activity in the spring when water temperatures reach 60 to 65° F. Firm bottom areas at a depth of about three feet are preferred, but successful spawning is sometimes accomplished over sand, and even silted bottoms. In lakes, the amount of relatively shallow water effectively determines the carrying capacity for largemouths. Largemouth Bass are skilled predators. They feed not only by sight, but also use their highly-developed olfactory and auditory senses. The lateral line functions as a sensitive low-frequency sound receptor, allowing bass to zero in on their prey in highly turbid waters or during the darkest nights. Largemouth Bass are generally found near cover, either aquatic vegetation, stumps, docks, rocks, or on the bottom near obstructions or changes in depth. Because of their tremendous reproductive potential and their ability to tolerate a wide range of temperatures, species such as largemouths will likely be the most able to adapt and thrive in a changing climate (Wydoski and Whitney 2003).

Black Crappies are the earliest of the centrarchids to spawn in the lake, actively spawning when water temperatures approach 55° F. Unlike bass, these fish are gregarious, and commonly found in schools during the spring. The schools break up somewhat after spawning, and fish are more likely to be scattered and in deeper water during the summer. Black Crappies seem to be more dependent on vegetation, but are often found congregated around old pilings, stumps, snags, or near rocks (WDFW 2015b). Bluegill and Pumpkinseed characteristically inhabit vegetated, quiet or slow-moving waters. They spawn when water temperatures approach 70° F, congregating in large groups on common spawning grounds in water six to 12 inches deep. The fish may move to deeper water later in the summer as temperatures climb.

According to local fishermen, the Rock Bass fishery in Lake Kapowsin is unique. Rock Bass are not common in the state and their distribution in Washington is probably confined to a few lakes and small tributary streams in Pierce and Thurston Counties, and in slower stretches of the Chehalis River in Lewis County. Their origin in Washington lakes is uncertain. Immediately preceding and during the spawning period, adult females congregate in pools of streams until they become ripe (Wydoski and Whitney 2003). The males make a nest by digging a depression in gravel where the current is slow and they may also make a nest in shallow water along the shoreline (Wydoski and Whitney 2003). Consequently, Kapowsin Creek and Ohop Creek may be important spawning areas for rock bass that inhabit Lake Kapowsin (Hamer Environmental 2105).

Yellow Perch spawn earlier than crappies, beginning when water temperatures reach 45 or 50° F. Spawning is extended over a short period, each female extruding all of her eggs at once. Reproductive potential (fecundity) is high, with as many as 15,000 eggs for a six-inch fish, (Wydoski

DRAFT

and Whitney 2003) and many times more for larger fish. Consequently, perch eggs provide a great deal of forage for other species.

Bullheads, like other catfish, are omnivorous, eating almost anything that is available. Almost all food is taken on or near the lake bottom. A member of the catfish family, Brown Bullheads are often abundant in water a little muddier and warmer than most other fish prefer. They can tolerate high water temperatures and low dissolved oxygen levels that would be lethal to most other game fish. Having a highly-developed sense of smell and touch, bullheads are well equipped to negotiate murky waters and find food. Female bullheads will lay from 2,000 to over 10,000 eggs, depending on size. Spawning usually occurs when water temperature reaches about 70° F (Wydoski and Whitney 2003).

Although these warmwater fishes are non-native to Lake Kapowsin, (as well as other western Washington lakes), most of these popular species were deliberately introduced to enhance fishing opportunities. WDFW does not consider any of these as an "undesirable" fish. "Undesirable fish are species that are unwanted, like a weed, and therefore unused; or more often, a species that makes it difficult or impossible to produce and manage a healthy population of more desirable fish" (WDFW 2005). In 2008, after WDFW improved access to the lake, angler creel surveys showed increased fishing effort and a targeted preference for the warmwater species. Accordingly, WDFW will continue to manage Lake Kapowsin as a mixed-species lake.

Trout and Salmon

Various Rainbow Trout stocks have been the primary species stocked in Lake Kapowsin since the 1960's and has continued to be supported by WDFW, the Tribes and other recreational fishing groups. In 2015, more than 30,000 Rainbow Trout were planted between March and May (WDFW 2015).

In Jackson and Caromile's survey in 1999 of Lake Kapowsin, they caught Rainbow Trout as well as Coho Salmon. The lake supports Coho Salmon and adfluvial Cutthroat Trout, which move through the lake, as well as, an occasional Steelhead (B. Smith, Puyallup Tribe, personal communication, 2015). Coho Salmon travel through the lake into upper Ohop Creek to spawn. Upper Ohop Creek is technically considered the continuation of Kapowsin Creek and is the main feeder stream to Lake Kapowsin (Town of Eatonville 2010). Several other smaller lake tributaries provide good spawning and rearing habitat and historically supported Coho Salmon runs (R. Ladley, Puyallup Tribe, personal communication, 2015). Because young Coho Salmon often remain in freshwater for up to two years before making their way to the ocean, the lake provides dependable rearing and migratory opportunity. The lake also may attract Coho Salmon fingerlings from other portions of the upper and mid-Puyallup basin, as sizeable good quality winter rearing habitat is not very accessible in the mid basin area (B. Smith, Puyallup Tribe, personal communication, 2015)

From 1993 to 1997, the Puyallup Tribe fisheries staff transported approximately 200,000-one-year old juvenile Coho Salmon from WDFW's Voights Creek Hatchery to rear in four pens for four months until acclimated. After initial releases of Coho Salmon from the lake net pens, good survival was verified at a smolt traps set-up down river on the mainstem of the Puyallup below the confluence with Kapowsin Creek (B. Smith, Puyallup Tribe, personal communication, 2015). Spawning Coho Salmon were common in most of the Lake Kapowsin tributaries and upper Ohop Creek for approximately 5 years after the Coho Salmon net pen operations were abandoned. However, to augment continued declining Coho Salmon escapement numbers in Ohop Creek, the Puyallup Tribe has continued to stock the creek almost yearly in November with surplus adult Coho Salmon from Voights Creek hatchery (B. Smith, Puyallup Tribe, personal communication, 2015). According to Marks et al., "Prior to the fish restoration project in the lake and the local creeks, few or no Coho Salmon were observed in Kapowsin Creek or Ohop Creek" (2013). Between 1993 and 2011 annual live adult Coho Salmon counts ranged from two in 2010 (survey data incomplete due to extreme high water and poor visibility) to a maximum of 2,023 in 2002 (Marks et al. 2013). Redd counts and population surveys are carried out on a regular basis on upper Ohop Creek by the Puyallup Tribe from late September thru February (B. Smith, Puyallup Tribe, personal communication, 2015).

According to Wydoski and Whitney migrating juvenile salmonids are highly susceptible to predation by Largemouth Bass (2003). It is most common to manage for trout and bass in the same water, with trout found in the deeper water where the water temperature is more suitable for them when lakes stratify during the summer, while bass will be found in the warmer littoral zone (Wydoski and Whitney 2003). Although predation on salmon fry by bass has been insinuated as a possible issue, both WDFW and Tribal fisheries biologists have suggested that there may be a spatial and temporal separation between outmigrating Coho Salmon and bass, thus reducing predation risks in lakes.

Other Fish Species

Based on their known distribution in the Puyallup River basin and other lowland lakes in western Washington, Caromile suggests that other fish species that could occur in Lake Kapowsin and/or its tributaries may include: Mountain Whitefish *Prosopium williamsoni*, Pacific, River, and Western Brook lampreys *Lampetra* spp., Peamouth *Mylocheilus carinus*, Northern Pikeminnow *Ptychocheilus oregonensis*, Speckled Dace *Rhinichthys osculus*, Redside Shiner *Richardsonius balteatus*, Salish Sucker *Catostomus catostomus*, Largescale Sucker *C. macrocheilus*, and Threespine Stickleback *Gasterosteus aculeatus* , and multiple species of sculpin *Cottus* spp. (Caromile, personal communication, 2015).

Kapowsin Creek

According to Marks et.al. Kapowsin Creek supports Chinook *Onchorhynchus tshawytscha*, Pink *Oncorhynchus gorbuscha*, Coho Salmon, steelhead and occasionally Chum Salmon *Onchorhynchus keta* (2013). Marks et al. stated that "Chinook have not been observed beyond the top of Kapowsin Creek where it enters the lake" (2013). This information is substantiated on the WDFW distribution maps (2015).

Kapowsin Creek and the Puyallup River basin fish status is not a focus for this characterization. However, it is significant to note that populations of these species have been sparse and in decline in Kapowsin Creek in recent years (B. Smith, Puyallup Tribe, personal communication, 2015).

Ohop Creek

Ohop Creek, where it enters the south end of the lake is the main feeder stream to Lake Kapowsin. The Creek continues for approximately 8.5 miles upstream from Lake Kapowsin and currently supports Coho Salmon and a limited number of steelhead (Marks et al. 2013). According to DNR calculations, upper Ohop Creek has a basin area of 15.8 sq. miles and an average flow of 0.34 square meters per second (7.0 cubic feet/sec.) (Sullivan 1990). Marks et al. described the lower 0.2 miles of Ohop Creek as flowing through a narrow and incised wetland boundary at the southern end of Lake

Kapowsin that is nonconductive to spawning and is heavily vegetated with reed canary grass and has a lot of beaver activity (2013). From RM 6.5 to 7.0, the creek has a low gradient pool-riffle structure, containing excellent spawning gravel, with several deep pools and moderate amounts of woody debris. Coho Salmon and occasionally a few steelhead move through Lake Kapowsin into Ohop Creek to spawn (Marks et. al. 2013). In WDFW database and map tool the lower reach of Ohop Creek, before it enters the valley, has documented observations of steelhead, as well as spawning and rearing habitat for Coho Salmon (WDFW 2015c). .

Although documented in Kapowsin Creek, Chinook, Chum and Pink Salmon have not been observed in Ohop Creek (Marks et. al. 2013).

Birds

Lake Kapowsin hosts a diverse number of bird species throughout the year as there is essential nesting, rearing and foraging habitat for both resident and migratory birds. During the Christmas Bird Counts from the Audubon Society as well as the previous five years of bird survey reports from eBird's website (http://ebird.org/ebird/eBirdReports) conducted at Lake Kapowsin, 127 overall species were sited near or on the lake. Hamer Environmental also received waterfowl survey data from WDFW collected between 1991 and 2015. The 127 sighted species were greater than the 113 predicted by the Pierce County Biodiversity Network Assessment for this region and is the 2nd highest predicted in the Biodiversity Network Assessment Region of Pierce County.

During the field surveys by Hamer Environmental and WDFW and the sighting reports from eBird, six species of concern, Bald Eagle (Federal Species of Concern, State Sensitive Species), Great Blue Heron (State Monitored Species), Osprey (State Monitored Species), Pileated Woodpecker (State Candidate Species), Purple Martin (State Candidate Species), and Wood Duck (PHS Priority Species), were identified. The only active nest observed as of April 2015 was an Osprey nest located along the east-central shore but according to the WDFW PHS Database, Bald Eagle nests have been sighted in close proximity to the lake.

The waterfowl population is important to Lake Kapowsin both ecologically and recreationally. The lake is designated as a WDFW Waterfowl Concentration area. Waterfowl hunting is a popular activity at this lake and the entire lake is open during the WDFW prescribed hunting season (M. Tirhi, WDFW, personal communication, 2015). The fringing wetlands, shallow waters, abundant large woody debris, and well-vegetated riparian shore areas provide good refuge, foraging, and nesting habitat.

Seven species or species groups were detected during WDFW waterfowl counts at Lake Kapowsin: Green-winged Teal (*Anas crecca*), Northern Shoveler (*Anas clypeata*), Ringed-neck Duck (*Aythya collaris*), Common Goldeneye (*Bucephala clangula*), Bufflehead (*Bucephala albeola*), scaups (*Aythya* sp.) and mergansers (*Mergus* sp.). Although not observed in WDFW waterfowl counts, local hunters relate that other popular waterfowl in the lake are White-fronted Goose and Mallards. Refer to Appendix C for an observed species list.

Amphibians

The lakes and wetlands around Western Washington provide primary and secondary breeding habitat for ten known amphibian species (Brown 1985). Brooks et al. predict that seven of these ten species inhabit the Pierce County Biodiversity Management Area 8, which is located four miles west of Lake Kapowsin and has similar habitat (2004). Three of the ten amphibian species known to utilize this area are federally or state listed. The northern red-legged frog is listed as a federal species of concern, but has no state listing. The Oregon spotted frog is listed as a Washington state endangered species and a federal candidate species. The Western toad is a state candidate species and listed as a federal species of concern (WDFW 2008).

DNR and Hamer Environmental biologists identified five amphibian species in multiple locations at Lake Kapowsin by visual encounter surveys from March to August of 2015 (Table 9). The identified species include two native frog species, the Pacific tree frog (*Pseudacris regilla)* and northern red-legged frog (*Rana aurora aurora*); one invasive frog species, the American bullfrog (*Lithobates catesbeianus*); and two native salamander species, the northwestern salamander (*Ambystoma gracile*) and roughskin newt (*Taricha granulosa*). Biologists observed all of these species, except for the roughskin newt, utilizing lake areas as breeding habitat based on the presence of egg masses. Only adult stage roughskin newts were observed. Since roughskin newts lay single eggs hidden in vegetation, it is extremely difficult to detect and definitively identify their eggs (Hallock and McAllister 2005).

Biologists observed the northwestern salamander egg masses the most frequently of the five species, but did not observe any juvenile or adult northwestern salamanders. American bullfrogs were the second most frequently observed species, and were at the lake every month from March to August. They also occurred in every life stage: egg masses, juvenile, and adult. Additionally, biologists observed 9 egg masses and 36 tadpoles of unknown species during March and April. Further surveys and efforts will be made to identify the observed unknown eggs and tadpoles, as well as verify the presence or absence of the species of concern.

Table 9. Amphibian species observed by DNR staff and Hamer Environmental L.P. during 2015 visual surveys (Hamer Environmental 2015).

Common Name	Species Name
Pacific tree frog	*Pseudacris regilla*
Northern red-legged frog	*Rana aurora aurora*
American bullfrog	*Lithobates catesbeianus*
Roughskin newt	*Taricha granulosa*
Northwestern salamander	*Ambystoma gracile*

Western Toad (*Bufo boreas*)

Federal species of concern and State candidate listing

The western toad is found in a variety of terrestrial habitats and typically breeds in permanent wetlands, ponds, lakes, reservoir coves, and stillwater off-channel habitats of rivers. They are widespread throughout Washington State, but have suffered rapid and unexplained population declines throughout the western United States. Within the Puget Trough Ecoregion, only 21 of their historical 86 sites remain. These population declines and further threats to habitat are the reasons for federal and state concern (Hallock and McAllister 2005). Lake Kapowsin is within the predicted core habitat and forage buffer for the western toad, but there is no apparent record of the frogs inhabiting the lake (DNR 2014; Hamer Environmental 2015). However, Tanwax Lake, located about two miles southwest of Lake Kapowsin, had a breeding population of western toad as recently as 2012 (WDFW 2015). Although DNR Aquatics and Hamer Environmental did not observe western toads during surveys in 2015, they did measure that water surface temperatures and observed habitat conditions are favorable for the western toad (Hamer Environmental 2015). Further surveys should be conducted to verify presence or absence of the species.

Oregon Spotted Frog (*Rana pretiosa*)

Federal candidate and state endangered

The Oregon spotted frog (*Rana pretiosa*) is endemic to the Pacific Northwest. Historically, the Oregon spotted frog was found throughout Washington State in the Puget Trough from the Canadian border down to the Columbia River, and east into the southern Washington Cascades. Washington State listed the Oregon spotted frog as a state endangered species, and they are a federal candidate species, because few populations remain (McAllister and Leonard 1997). Oregon spotted frogs have not been identified at Lake Kapowsin and an old recorded site (with no new verification) is several miles away.

Northern Red-Legged Frog (*Rana aurora*)

Federal species of concern

Northern red-legged frogs are found throughout Washington in moist lowland forested habitat with access to still-water bodies for breeding. Although the species remains widespread in western Washington, declining populations throughout its range along the west coast raise concern (Hallock and McAllister 2009). During March and April 2015 surveys, DNR and Hamer Environmental observed egg masses, juveniles, and one adult northern red-legged frog at Lake Kapowsin. All egg masses and juveniles were observed in emergent wetland along the southern edge of the lake (DNR 2015; Hamer Environmental 2015).

American Bullfrog (Rana catesbeiana or Lithobates catesbeianus)

State invasive problematic

The American bullfrog is native to the eastern United States. They were introduced to western North America in the early 1900s and have been prevalent since. They are found throughout Washington State in most ecoregions, and are considered an invasive problematic species in the state. They are most common in the Puget Trough, Columbia Plateau, and Canadian Rocky Mountain ecoregions and inhabit a variety of lowland permanent water bodies including wetlands, ponds, lakes, sloughs, creeks and rivers. They breed in permanent still-water bodies (Hallock and McAllister 2009). DNR and Hamer Environmental observed American bullfrogs in all life stages (egg mass, juvenile, adult) on Lake Kapowsin (2015). Bullfrogs are predators that eat practically anything they can catch. They can swallow tree frogs, other amphibians and reptiles such as the western pond turtle, minnows, small birds, and young snakes. Because of their large size and voracious appetite, bullfrogs

DRAFT

outcompete and prey upon many indigenous species. They can cause significant negative impacts, which may contribute to the endangerment and extinction of some sensitive species (Snow 2010). Introduced bullfrogs are linked to declines in many native amphibian and other species in the West.

Benthic Macroinvertebrates

The high nutrient levels and warm water temperatures in Lake Kapowsin support a variety of benthic macroinvertebrates. Moderate to large amounts of woody debris (10-40% of the total substrate when present) on the bottom of the lake is a main source of nutrient input. Macroinvertebrates are important environmental indicators for the health of the ecosystem because they are affected by the physical, chemical, and biological conditions of the water over time. Their presence, or lack thereof, can determine the health of the ecosystem as they are a critical part in the food web.

On April 29th and 30th of 2015, Hamer Environmental sampled for macroinvertebrates in the littoral zone at ten physical habitat stations. Using kick nets, one-meter sweeps were scooped up from the disturbed substrate to collect the macroinvertebrates. Twenty-seven unique invertebrate taxa were collected, of which seventy-six percent of the macroinvertebrates were crustaceans (2015). Further analysis of these samples showed that there were two dominant species: the isopod *Caecidotea sp*. (52.3%) and the amphipod *Crangonyx sp*. (22.1%). The dominance *Caecidotea sp*. suggests warm water temperatures and relatively high organic nutrient concentrations persist in the lake. The most abundant functional group, by a large margin, is the detritivores. Benthic detritivores are most likely a significant part of the food web in Lake Kapowsin, as the importance of benthic communities are inversely proportional to lake size (Vadeboncoeur et al. 2002). This preliminary data suggests that the relatively small size of Lake Kapowsin makes the benthic detritivores an important part of the food web. This report will serve as a baseline condition for Lake Kapowsin with future data collection needed to construct a more comprehensive list of the species present and potentially determine trends over time.

Mammals

The 2004 Pierce County Biodiversity Network Assessment predicted a total of 51 mammals to occur within the Lake Kapowsin vicinity. In Pierce County, of the 17 mapped biodiversity management areas, the Kapowsin region had the third highest predicted mammal diversity. For the lake and adjacent habitat areas, WDFW priority species records identify state endangered and federally threatened grizzly bear (*Ursus arctos*) and migratory elk (*Cervus elaphus*). Other state and federal-listed mammal species predicted to occur in this region included the brush prairie pocket gopher (*Thomomys mazama douglasii*), fisher (*Martes pennanti*), long-eared myotis (*Myotis septentrionalis*), long-legged myotis (*Myotis volans*), Pacific water shrew (*Sorex bendirii*), Townsend's big-eared bat (*Corynorhinus townsendii*), and Yuma myotis (*Myotis yumanensis*). Several species observed by local hunters, recreational users, and residents include black bear (*Ursus americanus*), cougar (*Puma concolor*), and Eastern red fox (*Vulpes fulva*). Other observations or indications of mammal species documented along the lake shoreline or in the local vicinity include black-tailed deer, beaver and beaver lodges, and signs of river otter trails and scat noted on the lake shore. Many terrestrial species rely on the lake shoreline habitats for some of their life stage requirements. Additional notable species that use these adjacent areas include elk, raccoons, and many rodents. Lake Kapowsin is included in the WDFW Puyallup River Elk Management Area.

Non-native fauna

The largest assemblage of non-native species in the lake are warmwater fishes. By 1900, warmwater fish species were common in many of the lowland lakes of the state and are now ubiquitous in nearly all lowland lakes in Washington State. The warmwater fish component of the lake has supported popular year-round fishing opportunities and are the most significant draw for recreational anglers to the lake (Caromile 2000).

The amount of predation on juvenile salmonids in Lake Kapowsin is not known, however, based on studies in other similar western Washington lakes this predation could be substantial (Wydoski and Whitney 2003; Bonar et. al. 2004). The other popular recreational fishing opportunity in Lake Kapowsin is large numbers of yearly stocked triploid rainbow trout. Although these fish are technically cultured from a native species, and have potential deleterious effects on native species and habitat, they are a vital component of the sport fishery at Lake Kapowsin.

As part of the Hamer Environmental Biological inventory, several non-native and invasive species in and around Lake Kapowsin were identified. A non-native aquatic mollusk, the Chinese mystery snail was documented and regularly observed throughout Lake Kapowsin. This snail was found ubiquitously in shallow littoral areas and on floating logs in the lake, however it is considered to be a benign non-invasive species where it has been studied in the Great Lakes region (Hamer Environmental 2015).

The American bullfrog (*Lithobates catesbeianus*) was regularly encountered in Lake Kapowsin by DNR Aquatic reserve staff and by Hamer Environmental during their surveys. Impacts are detailed in the amphibian section.

DRAFT

References

Anderson, Andy. 2007. In the Shadow of the Mountain: A history of early Graham, Kapowsin, Benston, Electron, and vicinity

Booth, D.B and Hallet, B. 1993, Channel Networks carved by subglacial water: Observations and reconstruction in the eastern Puget Sound lowland of Washington. Geologic Society of America Bulletin, v. 105. p 671-683

Bonar, S., B.D. Bolding, M. Divens, and W. Meyer. 2005. Effects of Introduced Fishes on Wild Juvenile Coho Salmon in Three Shallow Pacific Northwest Lakes. Transactions of the American Fisheries Society 134:641–652, 2005 [Article] q Copyright by the American Fisheries Society.

Bortleson, G.C., N.P. Dion, J.B. McConnell, and L.M. Nelson. 1976. Reconnaissance data on lakes in Washington. Volume 3. Kitsap, Mason, and Pierce Counties. Water-Supply Bulletin 43, Vol. 3. State of Washington Department of Ecology, Prepared in cooperation with U.S. Geological Survey. Pages 183-185.

Bretz, J. H. 1913. Glaciation of the Puget Sound region: Washington Geol. Survey Bull. 8,244 p. 126-128

Brooks, K., K.M. Dvornich, M. Tirhi, E. Neatherlin, M. McCalmon, and J. Jacobson. 2004. Pierce County Biodiversity Network Assessment: August, 2004. Report to Pierce County Council, Pierce County, 146 pp.

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. March 1977. V. 22(2): 361-369.

Caromile, Steve. 2015. Personal communication by email and phone. WDFW, Warmwater Fish Biologist, Olympia, WA 98504.

Collins, B.D. and D.R. Montgomery. 2002. Forest Development, Wood Jams, and Restoration of Floodplain Rivers in the Puget Lowland, Washington. Restoration Ecology, v. 10, n. 2, p. 237-247.

Corkran, and Thomas.1996. *Identification Guide for Eggs of Pond-breeding Amphibians of the North Shore*. *Community Mapping Network*. N.p.Web.

Crandell, D.R. 1963. Surficial geology and geomorphology of the Lake Tapps Quadrangle, Washington. Geological Survey Professional Paper 388-A. US Geological Survey Publications. Accesses Feb. 16, 2015. Available at *http://pubs/pp/pp/pp388A*

Dodds, W. and M. Whiles. 2010. Freshwater Ecology: concepts, & environmental applications of limnology 2nd edition. Elsevier Inc.

[DOE] Department of Ecology. The Washington Lakes Book [internet]. Lacey (WA): DOE Water Quality Program; Accessed 20 August 2015. www.ecy.wa.gov/programs/wq/plants/lakes/BookContents.html

DOE] Department of Ecology. Water Supply Bulletins. Water Supply Bulletin 22 (1968) Ground-water occurrence and stratigraphy of unconsolidated deposits, Central Pierce County, Washington; Accessed January 6, 2016. http://www.ecy.wa.gov/programs/eap/wsb/wsb_All.html

[DNR] Department of Natural Resources. 2015. Water Quality Data Dec. 2014 – Nov. 2015.

Edmondson W.T. 1991. The Uses of Ecology: Lake Washington and Beyond. University of Washington Press, Seattle, WA. Edmondson W.T. (1994) Sixty years of Lake Washington

Gawel, J. 2014. University of Washington – Tacoma. Unpublished Lake Kapowsin Water Quality and Water Chemistry data. 24 Oct. 2014.

Gawel, J. 2015. Presentation to Lake Kapowsin Planning Advisory Committee. 9 Nov. 2015. Lake Kapowsin 2014, Data Collected by University of Washington-Tacoma.

Hallock, L.A. and McAllister, K.R. 2009. American Bullfrog. Washington Herp Atlas. Accessed online at http://www1.dnr.wa.gov/nhp/refdesk/herp/

Hallock, L.A. and McAllister, K.R. 2009. Northern Red-legged Frog. Washington Herp Atlas. Accessed online at http://www1.dnr.wa.gov/nhp/refdesk/herp/

Hallock, L.A. and McAllister, K.R. 2005. Rough-skinned Newt. Washington Herp Atlas. http://www1.dnr.wa.gov/nhp/refdesk/herp/

Hamer Environmental L.P. 2015. Lake Kapowsin Biological Inventory, Final Report. Prepared for Washington Department of Natural Resources, Aquatic Reserves Program. 30 June 2015.

Helfrich, L.A., Parkhurst, J. Neves R. 2009. Guide to Understanding and Managing Lakes: Part I (Physical Measurements). Publication 420-538. Virginia Tech Cooperative Extension.

Hruby. T. 2014. Washington State Wetland Ratings System for Western Washington: 2014 Update. Publication #14-06-029. Washington Department of Ecology, Olympia, WA.

Jackson, C., and S.J. Caromile. 2000. An assessment of the warmwater fish community in Kapowsin Lake (Pierce County), Sept. 1999. WDFW. April 2000. Fish Program, Warmwater Enhancement Program, 600, Capitol Way North, Olympia, WA. 98501-1091. 20pp.

Jones, B. 2011. Oxygen – the most important water quality parameter? Water Column Spring 2011 issue – Vol. 23, No. 1. Indiana Clean Lakes Program. Web. Accessed 23 November 2015. http://www.indiana.edu/~clp/documents/water_column/Water_Col_V23N1.pdf

DRAFT

King County, Noxious Weeds in King County Invasive Species and Biodiversity in King County http://www.kingcounty.gov/environment/animalsAndPlants/biodiversity/threats/Invasives.aspx

Kruckeberg, A.R. 1991. The Natural History of Puget Sound Country. University of Washington Press, Seattle.

Knutson, K. L., and V. L. Naef. 1997. Management recommendations for Washington's priority habitats: riparian. Wash. Dept. Fish and Wildlife, Olympia. 181pp.

Ladley, Russ. 2015. Personal communication by email and phone. Resource Protection Manager, Puyallup Tribal Fisheries, 6824 Pioneer Way East, Puyallup, WA 98371.

Leavitt P.R., Brock C.S., Ebel C. & Patoine A. 2006. Landscape-scale effects of urban nitrogen on a chain of freshwater lakes in central North America. Limnology and Oceanography, 51, 2262–2277.

Leonard, W. P., Brown, H. A., Jones, L.C., McAllister, K. R. and R.M. Storm. 1993. *Amphibians of Washington and Oregon.* Seattle Audubon Society. Seattle, Washington.

Livingood, Tara. 2015. Personal communication 12-26 March 2015 by email. *Lake Kapowsin* creel surveys and stocking records. WDFW, Area Fish Biologist, Pierce County. 818 79th Ave. SE, Suite C (mailstop 43138), Olympia, WA 98504.

Marks, E.L., R.C. Ladley, B.E. Smith, A.G. Berger, J.A. Paul, T.G. Sebastian, and K.W. Williamson. 2013. 2012-2013 Annual salmon, steelhead, and bull trout report: Puyallup/White River Watershed- Water resource Inventory Area 10. Puyallup Tribal Fisheries, Puyallup, WA.

Maser, C., R. F. Tarrant, J. M. Trappe, and J. F. Franklin (eds.). 1988. From the forest to the sea: a story of fallen trees. General Technical Report PNW-GTR-229. Portland, OR: USDA Forest Service. pp 153.

McAllister, K. R. and W. P. Leonard. 1997. Washington State status report for the Oregon Spotted Frog. Washington Department Fish and Wildlife, Olympia. 38 pp. Accessed online at http://wdfw.wa.gov/publications/pub.php?id=00382

Michaud, J.P. 1991. A citizen's guide to understanding and monitoring lakes and streams. Publ. #94-149. Washington State Department of Ecology, Publications Office, Olympia, WA, USA 360-407-7472.

Montgomery, D.R., S. Bolton, D.B. Booth, and L. Wall (eds). 2003. Restoration of Puget Sound Rivers. Center for Watershed and Streamside Studies, Seattle, WA: University of Washington Press.

Montgomery, D.R., T.M. Massong and S.C.S. Hawley. 2003. Debris flows, log jams, and the formation of pools and alluvial channel reaches in the Oregon Coast Range: Geological Society of America Bulletin, v. 115, p. 78–88

Pierce County. 2013. 2013 Surface water management water quality index. Pierce County Surface Water Management, Pierce County, Washington. Web. Accessed 13 April 2015. http://co.pierce.wa.us/ArchiveCenter/ViewFile/Item/2694

Rigg, G.B. 1958. Peat Resources of Washington (Bulletin No. 44). Division of Mines and Geology, Washington Department of Conservation, Olympia WA.

Rosenberger, E.E., S.E. Hampton, S.C. Fradkin, and B.P. Kennedy. 2008. Effects of shoreline development on the nearshore environment in large deep oligotrophic lakes. Freshwater Biology (2008) 53, 1673–1691 doi:10.1111/j.1365-2427.2008.01990.x

Schlesinger, W.H. 1997. Biogeochemistry: an analysis of global change. 2nd edition. Academic Press, California.

Smith, B. 2015. Personal communication email and by phone, Enhancement Chief, Puyallup Tribe of Indians Fisheries Division.

Smokorowski, K.E.., T.C. Pratt, W.G. Cole, L.J. McEachern, and E.C. Mallory 2006. Effects on periphyton and macroinvertebrates from removal of submerged wood in three Ontario lakes. *Canadian Journal of Fisheries and Aquatic Sciences*, 2006, 63(9): 2038-2049, 10.1139/f06-104

Snow, N. and Witmer, G. "American Bullfrogs as Invasive Species: A Review of the Introduction, Subsequent Problems, Management Options, and Future Directions" 2010. USDA National Wildlife Research Center - Staff Publications. Paper 1288.

Sullivan, K., J. Tooley, K. Doughty, J.E. Caldwell, and P. Knudsen. 1990. Evaluation of prediction models and characterization of stream temperature regimes in Washington. Timber/Fish/Wildlife Rep.No.TFW-WQ3-90-006. Washington Department of Natural Resources, Olympia, WA

Sumioka, S.S., and N.P. Dion. 1985. Trophic classification of Washington Lakes using reconnaissance data. Water-Supply Bulletin 57. State of Washington, Department of Ecology, Prepared in cooperation with the USDI US Geological Survey, Olympia, WA. 320 pp.

Tiner, R.W., 1989. Wetlands of Rhode Island: Newton Corner, Mass., U.S. Fish and Wildlife Service, National Wetlands Inventory, 71 p., appendix.

Tirhi ,Michele, Personal communication, Washington Dept. Fish and Wildlife, October 22, 2015, michelle.tirhi@dfw.wa.gov

Town of Eatonville. 2010. Shoreline Master Program Update Final Inventory and Characterization Report. Eatonville, WA. ESA Adolfson. July 2010

Troost, K.G. 2007. JKulhlaups from Glacial lake Puyallup, Pierce County, Washington. Washington Department of Natural Resources, Division of Geology and Earth Resources. 103rd Annual GSA Meeting Geologic Society of America

DRAFT

USA.com Kapowsin, WA Weather. Lake Kapowsin Historical weather topics. Accessed Nov 2015 http://www.usa.com/kapowsin-wa-weather.htm

U.S. Department of Agriculture, 1970, Irrigation water requirements: U.S. Soil ... G.E., 1968, Ground-water occurrence and stratigraphy of unconsolidated deposits, Washington Department of Water Resources Water-Supply Bulletin 22, 428 p., 3 pi. 12.

Vadeboncoeur, M., J. Vander Zanden, and D. M. Lodge. 2002 Putting the lake back together: Reintegrating benthic pathways into lake EXPANDING food web models. BioScience 52: 44-54. Walsh, Timothy J.; Logan, Robert L., 2007, Extending and expanding the stratigraphy of the southern Puget Lowland [abstract]: Geological Society of America Abstracts with Programs, v. 39, no. 4, p. 12.

Walsh, Timothy J.; Logan, Robert L., 2007, Extending and expanding the stratigraphy of the southern Puget Lowland [abstract]: Geological Society of America Abstracts with Programs, v. 39, no. 4, p. 12.

[WDFW] Washington Department of Fish and Wildlife April 2005. Warmwater Fishes of Washington, Olympia, Publication Number: FM93-9. . 26pp

[WDFW] Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp.

[WDFW] Washington Department of Fish and Wildlife. 2015a. PHS Priority Habitats and Species Database. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp.

[WDFW] Washington Department of Fish and Wildlife. 2015b. Fishing and Shellfish. Accessed 22 Nov 2015. http://wdfw.wa.gov/fishing/washington/Species/1741/

[WDFW] Washington Department of Fish and Wildlife. 2015c. Salmonscape. Fisheries Division. Accessed 22 Nov 2015. http://apps.wdfw.wa.gov/salmonscape/map.html

[WDFW] Washington Department of Fish and Wildlife. 2016. Washington State Fish passage. Olympia, WA. http://apps.wdfw.wa.gov/fishpassage/

Washington Noxious Weed Control Board. 2015. Noxious Weed List. Olympia, WA. Web. http://www.nwcb.wa.gov/ Accessed 22 Nov 2015.

Wetzel, R. G. 2001. Limnology: Lake and River Ecosystems, Third Edition. Academic Press, San Diego

Wydoski, R.S. and R.L. Whitney. 2003. Inland Fishes of Washington. University of Washington Press. Seattle, Washington.

Other resources:

Hunted Waterfowl species list: http://wdfw.wa.gov/hunting/waterfowl/duck_id_guide.pdf

DRAFT

Hunting current occurring at LK. http://www.dispatchnews.com/2015/04/09/one-lake-two-views-of-future/

WDFW Frogs (General): http://wdfw.wa.gov/living/frogs.html

WSDA March. 2013. Statewide Knotweed Control Program. 2012 Progress Report AGR PUB 809-384 (N/5/13)

http://www1.dnr.wa.gov/nhp/refdesk/herp/speciesmain.html

DRAFT

Appendix B – Human Environment

Appendix B - Table of Contents

DRAFT

1. Relationship to other Federal, State, Local and Tribal Management

Introduction

This plan is promulgated under DNR's proprietary authority to manage state-owned aquatic lands. The successful management of the reserve will require coordination and collaboration with public and private entities at the local, state, federal, and tribal levels. This section provides detail on proprietary, regulatory and management interests within or adjacent to the boundaries of the Lake Kapowsin Aquatic Reserve.

Tribal Interests at Lake Kapowsin

Tribes have an integral and interdependent relationship with their natural areas as a place of spiritual connections and a landscape of cultural and emotional meaning, beyond the historical and contemporary provision of subsistence. Each of Washington's federally recognized tribes have a unique political/legal history, culture, language, and the sovereign right to use their own natural and cultural resources as recognized by treaties, statues, executive orders, and court decisions. Tribal governments are autonomous political entities and DNR will work to ensure that decision making considers and respects tribal sovereignty. [1]

The Puyallup Tribe and Muckleshoot Tribe both own shorelands and uplands adjacent to Lake Kapowsin. Tribal governments and their members have a vital role in natural resources management and development in part because of their traditional ecological knowledge and cultural practices. The Aquatic Reserves Program will work with Tribes to achieve sustainable management of natural resources on aquatic lands managed as aquatic reserves by DNR. The Aquatic Reserves Program will also cooperate with Tribes to improve scientific understanding and will promote mutually beneficial research using sound science, data, and information. Conservation goals and management activities identified in this management plan are not intended to impair any reserved tribal treaty rights or be in conflict with tribal natural resource or cultural interests.

Federal

U.S. Army Corps of Engineers

Under Section 10 of the Rivers and Harbors Act, the U.S. Army Corps of Engineers (Corps) oversees any in-water construction in navigable waters. Additionally, the Corps has been delegated authority under the Clean Water Act for the issuance of Section 404 permits. The Corps supports navigation by maintaining and improving channels; develops projects to reduce flood damage, and regulates dredging and filling activities in wetlands and waterways including the construction of any structures such as bulkheads or piers. Like all federal agencies, the Corps must ensure that tribal trust resources are protected prior to taking any action that could potentially affect treaty-protected resources, including fishing and traditional cultural properties.

[1] Commissioner's Order 201029: Tribal Relations. September 10th, 2010. Commissioner of Public Lands, Peter Goldmark. State of Washington Department of Natural Resources.

DRAFT

U.S. Environmental Protection Agency

The Environmental Protection Agency (EPA) is the lead federal response agency for oil spills occurring in inland waters and jointly administers Section 404 of the Clean Water Act with the U.S. Army Corps of Engineers.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service is charged with protecting plant, terrestrial animal, freshwater and some anadromous fish species and associated habitats listed under the federal Endangered Species Act and the Migratory Bird Treaty Act. They are also mandated to coordinate with state agencies through the Fish and Wildlife Coordination Act.

National Oceanic and Atmospheric Administration Fisheries

National Oceanic and Atmospheric Administration (NOAA) Fisheries, also known as National Marine Fisheries Service (NMFS), is responsible for the protection and stewardship of marine resources and habitat under the Endangered Species Act, Marine Mammal Protection Act, and Magnuson-Stevens Fishery Conservation and Management Act. NOAA Fisheries has jurisdiction over both marine and some anadromous fish listed under the Endangered Species Act including some salmonids such as Puget Sound Chinook.

State

Washington State Department of Ecology

The Washington State Department of Ecology (DOE) administers several programs that protect environmental resources, including Spill Prevention, Preparedness and Response, Air Quality, Water Quality, Toxics Cleanup, Shorelands and Environmental Assistance, Water Resources, Solid Waste, and Hazardous Waste and Toxic Reduction.

The State Water Pollution Control Act and Shoreline Management Act give DOE the authority to regulate wetlands. In addition, DOE provides technical assistance to local government on wetland policies and regulations in comprehensive plans under the Growth Management Act. DOE must also review and approve local Shoreline Master Programs and all plans for substantial development permits involving construction in waters of the state.

DOE’s Spill Prevention, Preparedness and Response Program focuses on prevention of oil spills to Washington waters and land, as well as planning for an effective response to any oil and hazardous substance spills that may occur.

DOE works to maintain water and sediment quality standards, such that listing of waterbodies or segments as impaired under section 303(d) of the Clean Water Act is unnecessary. They are responsible for developing and approving National Pollutant Discharge Elimination System permits for industrial and municipal discharges. Nonpoint source pollution is managed through a variety of state and local programs; DOE has developed a nonpoint pollution plan that focuses on local land-use activities. Finally, DOE issues water quality consistency certifications under Section 401 of the Clean Water Act, which help ensure compliance with the law’s Anti-degradation Policy.

DRAFT

Washington State Department of Fish and Wildlife

The Washington Department of Fish and Wildlife (WDFW) is responsible for preserving, protecting, and perpetuating all fish and wildlife resources of the State. To assist in achieving this mission, the WDFW Priority Habitats and Species Program provides the most comprehensive data on fish and wildlife distribution and habitat utilization in the State. This information is used for Hydraulic Project Approval, SEPA reviews, oil spill response, development of Habitat Conservation Plans, and local government planning. The program developed a list of priority habitats and species that are conservation priorities due to State Endangered, Threatened Sensitive and Candidate species status or other vulnerabilities. The Priority Species and Habitats List is used in the development of Shoreline Master Plans and Comprehensive Plans to fulfill requirements under the Shoreline Management Act and Growth Management Act. Refer to Appendix C for list of priority habitats and species in the reserve vicinity.

Together with Tribal governments, WDFW co-manages commercial fisheries in the State. WDFW also manages recreational fishing, waterfowl hunting and wild game hunting while balancing conservation of native fish and wildlife with providing sustainable fishing and hunting opportunities. Seasons and regulations for fishing, waterfowl hunting, and wild game hunting are available at www.wdfw.wa.gov.

Puget Sound Partnership

The Puget Sound Partnership is a state agency that was established by the Legislature in 2007 to coordinate Puget Sound recovery efforts. In collaboration with local governments, tribes, citizens, scientists, and non-profits, the Partnership adopted an Action Agenda with a comprehensive list of strategies and actions to guide long-term recovery of Puget Sound. A list of ecosystem indicators, known as Vital Signs, were approved in 2011 to help track progress. Freshwater and terrestrial strategies and actions are included in the Action Agenda and several Vital Signs, such as freshwater quality and land development and cover, are applicable to the reserve area.

Water Resource Inventory Areas (WRIA)

Water Resource Inventory Areas (WRIA) were established as watershed planning units by RCW 90.82 formalized under Washington Administrative Code (WAC) 173-500-040 and authorized under the Water Resources Act of 1971, Revised Code of Washington (RCW) 90.54. WRIAs are administrative planning units and until 2012, many units used state funding to develop collaborative Watershed Plans. Lake Kapowsin is part of WRIA 10 (Puyallup River watershed) and is located in the Upper Puyallup River drainage basin.

WRIAs are also used as the planning units for Salmon Habitat Protection and Restoration Plans. Pierce County is lead entity for the Salmon Habitat Protection and Restoration Strategy in both WRIA 10 & 12, Puyallup River and Chambers-Clover Creeks watershed.

Pierce County

Pierce County regulates land and shoreline use through the Development Regulations, the Comprehensive Plan, and the Shoreline Master Plan. Pierce County is responsible for the regulation of clearing, grading, and construction activities, identification and protection of Critical Areas, providing pollution control though their management of stormwater runoff and inspection of onsite septic systems.

Critical Areas

The Washington State Growth Management Act (RCW 36.70A) was passed in 1990 to guide land-use decisions in local jurisdictions. The Growth Management Act requires designation of critical areas to protect important natural environments and human health and welfare. Critical areas include:

- Wetlands
- Fish and wildlife habitat conservation areas
- Flood plains
- Aquifer recharge areas
- Geologically hazardous areas, such as steep slopes

Refer to Pierce County's Title 18E, 'Development Regulations –Critical Areas' for comprehensive and current critical area rules and regulations. Many critical areas and critical area indicators that may prompt a critical area study or merit additional investigation are identified in the Pierce County PublicGIS.

Shoreline Master Program

The Washington State Shoreline Management Act of 1971 (RCW 90.58.020) requires cities and counties to develop Shoreline Master Programs (SMP) that establish standards for shoreline use, zoning ordinances, and development permit systems. Under the 2003 Shoreline Master Program Guidelines (WAC 173.26, Part III), most cities and counties were required to update their Shoreline Master Programs in order to consider the most current conditions and make use of the latest available science and management practices.

The Pierce County Shoreline Master Program applies to incorporated lands and small cities throughout the county, including the Lake Kapowsin area. The existing Pierce County Shoreline Master Program was adopted in 1974 and was most recently updated in 1988. The Pierce County SMP is currently being updated to meet the 2003 Shoreline Master Program Guidelines and up-to-date information can be found on the Pierce County Shoreline Master Program website.

Under both the existing SMP and proposed update, the majority of Lake Kapowsin shoreline is designated as Conservancy Shoreline. The proposed SMP update includes additional Natural Shoreline on the northeast portion of the lake (Pierce County 2015).

Natural Shoreline Environmental Designation (SED)

The intent of the Natural SED is to ensure long-term preservation of shorelines that are ecologically intact or minimally degraded, sensitive to human influence, or retain value because of their natural unaltered condition 18S.20.030**.**

Conservancy Shoreline Environment Designation (SED)

The intent of the Conservancy SED is to conserve and manage existing natural resources and valuable historic and cultural areas while providing recreational benefits to the public and while achieving sustained resource utilization and maintenance of floodplain processes. Shoreline ecological functions should be preserved by avoiding development that would be incompatible with existing functions and processes, locating restoration efforts in areas where benefits to ecological functions can be realized, keeping overall intensity of development or use low, and maintaining most of the area's natural character 18S.20.040.

Aquatic Shoreline Environment Designation (SED)

The intent of the Aquatic SED is to protect, restore, and manage the unique characteristics and resources of marine and fresh waters. The Aquatic SED applies to all shoreline areas waterward of the ordinary high-water mark 18S.20.070.

Graham Community Plan

The Graham Community Plan, a component of the Pierce County Comprehensive Plan, includes Lake Kapowsin and the surrounding lands. The plan was enacted in October 2006 and went into effect on March 1, 2007, and provides a framework for land use standards in the urban, rural and natural resource lands in the planning area. Adjacent upland zoning designations include:

- Forest Land (52%): 'Forest Lands for long-term commercial timber harvesting activities… and limited residential development at a density of one du per 80 acres.'
- Rural 20 (15%): 'Rural uses at a rural density of one dwelling unit per 20 acres and maximum impervious surface coverage of 10%.'
- Rural Sensitive Resource (33%): 'Low density rural residential development in order to protect environmentally sensitive areas such as stream corridors, aquifer recharge areas, and fish and wildlife habitat areas' (Pierce County 2008).

References:

Pierce County. 2015. Ordinance No. 213-45s4. Tacoma, Washington.

Pierce County. 2008. *Graham Community Plan*. Graham, Washington. Effective March 1, 2007.

Pierce County PublicGIS online map. [Accessed September 2015]. http://matterhorn3.co.pierce.wa.us/publicgis/

DRAFT

2. Archeological, Cultural and Historical Resources

Early History

The valley that is presently occupied by Lake Kapowsin has likely been used by people for thousands of years since the glaciers retreated, and may have been one of the earliest ice free areas in the Puget Sound lowlands. The ancient glacial drainage channel provides a nearly level connection between the Puyallup and Nisqually Rivers, and formed a natural travel route at the base of the Cascade foothills. Evidence of early human use may be preserved under the waters of the lake. After the Electron mudflow created the lake, the shoreline could have been occupied and used for fishing and other resources. The varied geography of the landscape and nearby foothills support a diversity of food sources that early Salish peoples relied on.

References:

M. Major, DNR archeologist, pers. comm. February 2015.

Troost, Kathy. Jokulhlaups from Glacial Lake Puyallup, Pierce County, Washington. Conference proceedings, Geological Society of America May 2007

Old Town Kapowsin (1888-1930)

The town of Kapowsin on the northwest shore of the lake had a vibrant yet brief history. The first permanent European settlers, Fred and Mete Hilgert, purchased 152 acres on the shore of Lake Kapowsin in 1888 while Fred was working for St. Paul and Tacoma Lumber Company. The St. Paul Lumber Company partnered with Northern Pacific Railroad Company to build a railroad spur from the mainline in Orting to the hills east of Lake Kapowsin. This railroad spur allowed St. Paul to deliver logs to their lumber mill in Tacoma and also attracted a small community of settlers at the north end of the lake. This area became known as the Kapousen Precinct and persisted until the 1890s when many of the settlers departed to partake in the Klondike gold rush (Anderson 2007).

> **Ohop Creek**
>
> Before 1889, upper Ohop Creek and its tributaries drained south into Ohop Valley and regularly flooded farmlands. A dam was built at the south end of Lake Kapowsin, which caused water that had originally flowed south through Ohop Valley and into the Nisqually River to flow north into Lake Kapowsin and eventually into the Puyallup River (Reese 1989).

In 1901, the Tacoma Eastern railroad was extended to the northwest shores of Lake Kapowsin. This rail line was particularly significant because it allowed numerous log mills to begin operating on the lake. Lake Kapowsin was an ideal logging and mill site due to its log booming capacity, its proximity to old growth timber, and east and west bound rail connectivity. By 1904 there were five mills, and one mill, Kapowsin Lumber Company, produced 15 million feet of lumber for shipment in one year. Pilings at both the north and south end of the lake can still be seen today and supported railroad log dumps for the mills. From the lake, logs were conveyed into mills and processed into lumber and shingles.

Lumber supplied from the Kapowsin mills was used in the construction of the Electron Power Plant on the Puyallup River starting in 1903. The project stretched 10 miles toward Mount Rainier where

DRAFT

water was diverted to turn the generators at the Electron plant. It created a large demand for laborers, as well as for Kapowsin lumber. A decade later, Pierce County rock quarry and a 30-acre farm would create additional work opportunities for the town.

With ample work opportunities, Kapowsin town grew in population, and by 1910, the U.S. Census recorded 900 people in the precinct. Children from the town and surrounding areas attended an esteemed schoolhouse. By 1913, Kapowsin had reached its boarding and housing maximum and many residents lived in overflow tents.

Mill and town fires were a regular occurrence at Kapowsin. Whistles and church bells alerted a town bucket brigade of fires. Emergency calls were also made to Tacoma where fire response arrived by rail to put out the coals of lost buildings. Rebuilding after fires was a constant process at Kapowsin.

Meanwhile, nearby Tacoma experienced an increased water demand which prompted the city to seek out additional water sources. In 1928, the Tacoma City Council approved a Lake Kapowsin reservoir project that would carry water from Kapowsin to Tacoma at a cost in excess of two million dollars. Plans to redirect the Puyallup River into the lake, which was to be used as a settling tank for the silt-laden river, would raise the water level and flood nearshore buildings. In anticipation of the reservoir project, the City of Tacoma began acquiring shorelands. Potential flooding discouraged mills and businesses from rebuilding after fires and many began to relocate. Trees in the Kapowsin area had mostly been harvested and logging camps were moving on. With many of the mills and town businesses condemned due to flooding and declining logging opportunities in the area, the population of Kapowsin dwindled.

The stock market crash of 1929 sidelined plans for the reservoir and the city of Tacoma established a new well that met the increased water demand. Although the reservoir project at Kapowsin was never completed, the city of Tacoma still owns substantial acreage at the southern end of the lake.

The area around Kapowsin eventually reverted back to a rural farming community and continues to maintain an enduring legacy of logging and mill operations.

References

Anderson, Andy. 2007. In the Shadow of the Mountain: A history of early Graham, Kapowsin, Benston, Electron, and vicinity.

Reese, G. F. 1989. *Origins of Pierce County place names*. Tacoma: R&M Press.

1930s to Present

As roads throughout the Graham and Kapowsin area became more established, use of semi-trucks for hauling logs increased and slowly phased out the use of rail. Residents began to commute to work in urban centers like Tacoma. Towns along major highways, including Kapowsin, began to see increased tourism from travelers heading to Mount Rainier (Pierce County 2008).

In 1923, waterfront property along the west shore of Lake Kapowsin was privately purchased and became Voss Resort. After WWII, the resort began to rent rowboats to fishermen (A. Anderson, personal communication 26 October 2015).

The school at Kapowsin continued to be the primary high school in the area that would become the Bethel District. Its facilities were modern for the times and included a large gymnasium and swimming pool. In 1949, it was damaged in an earthquake. Not long after, the Bethel School District was formed and a new Bethel High School was built. Kapowsin students transitioned to the new school by 1953 (A. Anderson, personal communication 26 October 2015).

The land east of the lake has previously been owned by St. Regis Paper Company, Champion, and is now currently owned by Hancock Forest Management Company and the Puyallup Tribe (A. Anderson, personal communication 26 October 2015). The Muckleshoot Tribe acquired 27 parcels at the old Kapowsin town site, shoreline, and part of Jaybird Island from the City of Tacoma in September 2005. In December 2009, The Puyallup Tribe of Indians acquired 13 forest parcels on the eastern side of the lake, including shoreline, part of Jaybird Island and forested tracts (Pierce County website, assessor parcel data).

People have continued to move into the Graham and Kapowsin area to enjoy its rural character and country life-style. From the 1970s to the early 1990s, the surrounding area experienced a rise in residential development. In 2000, the population of Graham was 8,739, growing quickly to 23,491 in 2010 (US Census data).

References:

Pierce County. 2008. *Graham Community Plan*. Graham, Washington. Effective March 1, 2007.

Pierce County PublicGIS online map. [Accessed September 2015]. http://matterhorn3.co.pierce.wa.us/publicgis/

DRAFT

Appendix C – Observed Species List

Appendix C - Table of Figures

Introduction

Tables C-1 to C-7 identify the documented flora and fauna within the area of Lake Kapowsin.

The species lists include birds, fish, mammals, benthic macroinvertebrates, vegetation, and amphibians. These are preliminary, non-comprehensive lists that include predicted and confirmed species in and around Lake Kapowsin.

State and Federal species statuses were obtained from the Washington Natural Heritage Program at http://www1.dnr.wa.gov/nhp/refdesk/lists/animal_ranks.html, and the Washington Department of Fish and Wildlife's Conservation site at http://wdfw.wa.gov/conservation/endangered/. Invasive species listings were found on the Early Detection and Distribution Mapping System at http://www.eddmaps.org/Species/.

For up-to-date State and Federal species listing visit the Washington Department of Fish and Wildlife's Conservation site at http://wdfw.wa.gov/conservation/endangered/ .

DRAFT

Sources

1. *eBird sightings species from 2010-2015 at Lake Kapowsin*
2. WDFW Waterfowl Counts from 1991-2015
3. Hamer Environmental observations 2015
4. Tahoma Christmas Bird Count Data from 2011-2013
5. Puget SoundCorps Team and DNR staff observations 2014-2015
6. Brooks, K., K.M. Dvornich, M. Tirhi, E. Neatherlin, M. McCalmon, and J. Jacobson. 2004. Pierce County Biodiversity Network Assessment: August, 2004. Report to Pierce County Council, Pierce County, 146 pp.
7. Brown, E.R. (ed.). 1985. Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington, Part 2- Appendices. USDA Forest Service Pacific Northwest Region and USDI Bur. of Land Manage. Publ. No. R6-F&WL-192-1985. 302pp.
8. WDFW Ground Surveys from 1985-2014 in Lake Kapowsin and Kapowsin Creek
9. Jackson, C., and S.J. Caromile. 2000. An assessment of the warmwater fish community in Kapowsin Lake (Pierce County), Sept. 1999. WDFW. April 2000. Fish Program, Warmwater Enhancement Program, 600, Capitol Way North, Olympia, WA. 98501-1091. 20pp.

Key for State Status:
(http://www1.dnr.wa.gov/nhp/refdesk/lists/animal_ranks.html)

State rank characterizes the relative rarity or endangerment within the state of Washington. Factors including, but not limited to, number of known occurrences are considered when assigning a rank. Two codes together represent an inexact range (e.g., S1S2) or different ranks for breeding and non-breeding populations (e.g., S1B, S3N).Values and their definitions:

S1 = Critically imperiled in the state because of extreme rarity or other factors making it especially vulnerable to extirpation from the state. (Typically 5 or fewer occurrences or very few remaining individuals or acres)

S2 = Imperiled in the state because of rarity or other factors making it very vulnerable to extirpation from the state. (Typically 6 to 20 occurrences or few remaining individuals or acres)

S3 = Rare or uncommon in the state. (Typically 21 to 100 occurrences)

S4 = Widespread, abundant, and apparently secure in state, with many occurrences, but the taxon is of long-term concern. (Usually more than 100 occurrences)

S5 = Demonstrably widespread, abundant, and secure in the state; believed to be ineradicable under present conditions.

DRAFT

Table C - 1: Birds Observed in Lake Kapowsin

* Species protected by the Federal Migratory Bird Treaty Act

Common Name	Scientific Name	State Status	Federal Status	Source
Waterfowl – Anseriformes				
Wood Duck	*Aix sponsa*		*	1, 3, 4
Northern Pintail	*Anas acuta*		*	4
American Wigeon	*Anas americana*		*	4
Northern Shoveler	*Anas clypeata*		*	2, 4
Green-winged Teal	*Anas crecca*		*	2, 4
Eurasian Wigeon	*Anas penelope*		*	4
Mallard	*Anas platyrhynchos*		*	1, 3, 4, 5
Gadwall	*Anas strepera*		*	4
Redhead	*Aythya americana*		*	4
Lesser Scaup	*Aythya affins*		*	4
Ring-necked Duck	*Aythya collaris*		*	1, 2, 4, 5
Greater Scaup	*Aythya marila*		*	4
Canvasback	*Aythya valisineria*		*	4
Common Goldeneye	*Becephala clangula*		*	1, 2, 4
Barrow's Goldeneye	*Becephala islandica*		*	4
Canada Goose	*Branta canadensis minima*		*	1, 3, 4
Cackling Goose	*Branta hutchinsii*	Monitored	*	4
Bufflehead	*Bucephala albeola*		*	1, 2, 4, 5
Long-tailed Duck	*Clangula hyemalis*		*	4
Trumpeter Swan	*Cygnus buccinator*			4
Harlequin Duck	*Histrionicus histrionicus*		*	4
Hooded Merganser	*Lophodytes cucullatus*		*	1, 4
Common Merganser	*Mergus merganser*		*	1, 4
Red-breasted Merganser	*Mergus serrator*		*	4
Ruddy Duck	*Oxyura jamaicensis*		*	4
Loons – Gaviiformes				
Common Loon	*Gavia immer*	Sensitive	*	4
Pacific Loon	*Gavia pacifica*		*	4
Grebes – Podicipediformes				

Common Name	Scientific Name	State Status	Federal Status	Source
Western Grebe	*Aechmophorus occidentalis*	Candidate	*	4
Pied-billed Grebe	*Podilymbus podiceps*		*	4
Pelicans, Cormorants and Allies – Pelecaniformes				
Double-crested Cormorant	*Phalacrocorax auritus*		*	3, 4, 5
Pelagic Cormorant	*Phalacrocorax pelagicus*		*	4
Herons, Ibises and Allies – Ciconiformes				
Great Blue Heron	*Ardea herodias*	Monitored	*	3, 4, 5
New World Vultures, Hawks, Falcons and Allies – Accipitriformes				
Cooper's Hawk	*Accipiter cooperii*		*	4
Sharp-shinned Hawk	*Accipiter striatus*		*	4
Red-tailed Hawk	*Buteo jamaicensis*		*	1, 4
Red-shouldered Hawk	*Buteo lineatus*		*	4
Rough-legged Hawk	*Buteo lagopus*		*	4
Northern Harrier	*Circus cyaneus*		*	4
Merlin	*Falco columbarius*	Candidate	*	4
Peregrine Falcon	*Falco peregrinus*	Sensitive	*Delisted	4
American Kestrel	*Falco sparverius*		*	4
Bald Eagle	*Haliaetus leucocephalus*	Sensitive	*Delisted	1, 3, 4, 5
Osprey	*Pandion haliaetus*	Monitored	*	3, 5
Rails, Cranes and Allies – Gruiformes				
American Coot	*Fulica americana*		*	4
Virginia Rail	*Rallus limicola*		*	4
Shorebirds, Gulls, Auks and Allies – Charadriiformes				
Spotted Sandpiper	*Actitis macularius*		*	4
Western Sandpiper	*Calidris mauri*		*	3
Killdeer	*Charadrius vociferus*		*	4
California Gull	*Larus califonicus*		*	4
Ring-billed Gull	*Larus delawarensis*		*	4
Glaucous-winged Gull	*Larus glaucescens*		*	4
Woodpeckers, and Flickers—Piciformes				
Northern Flicker	*Colaptes auratus*		*	1, 4
Pileated Woodpecker	*Dryocopus pileatus*	Candidate	*	1, 3, 4, 5
Downy Woodpecker	*Picoides pubescens*		*	4
Hairy Woodpecker	*Picoides villosus*		*	1, 4
Red-breasted Sapsucker	*Sphyrapicus ruber*		*	1, 4
Pigeons, Doves, and Allies—Columbiformes				
Rock Pigeon	*Columba livia*			4

Common Name	Scientific Name	State Status	Federal Status	Source
Band-tailed Pigeon	*Patagioenas fasciata*		*	4
Eurasian Collared-Dove	*Streptopelia decaocto*			4
Mourning Dove	*Zenaida macroura*		*	1, 3, 4
Owls—Strigiformes				
Great Horned Owl	*Bubo virginianus*		*	1, 4
Western Screech-Owl	*Megascops kennicottii*		*	4
Barred Owl	*Strix varia*		*	4
Barn Owl	*Tyto alba*		*	4
Kingfisher, Bee-eater, Roller, and Allies--Coraciiformes				
Belted Kingfisher	*Megaceryle alcyon*		*	1, 4, 5
Hummingbirds, Swifts, and Allies—Apodiformes				
Anna's Hummingbird	*Calypte anna*		*	4
Rufous Hummingbird	*Selasphorus rufus*		*	1
Turkeys, Guinefowls, Grouses, and Allies--Galliformes				
Ruffed Grouse	*Bonasa umbellus*			4
California Quail	*Callipepla californica*			4
Flycatchers, Songbirds and Allies – Passeriformes				
Red-winged Blackbird	*Agelaius phoeniceus*		*	1, 3, 4
Western Scrub-Jay	*Aphelocoma californica*		*	4
Cedar Waxwing	*Bombycilla cedrorum*		*	4, 5
Wilson's Warbler	*Cardellina pusilla*		*	4
Hermit Thrush	*Catharus guttatus*		*	4
Swainson's Thrush	*Catharus ustulatus*		*	1
Brown Creeper	*Certhia americana*		*	1, 4
Marsh Wren	*Cistothorus palustris*		*	4
Evening Grosbeak	*Coccothraustes vespertinus*		*	4
American Crow	*Corvus brachyrynchos*		*	1, 3, 4, 5
Common Raven	*Corvus corax*		*	1, 4
Steller's Jay	*Cyanocitta stelleri*		*	1, 4, 5
Willow Flycatcher	*Empidonax traillii*		*	1
Brewer's Blackbird	*Euphagus cyanocephalus*		*	4
House Finch	*Haemorhous mexicanus*		*	4
Purple Finch	*Haemorhous purpureus*		*	1, 4
Barn Swallow	*Hirundo rustica*		*	1, 5
Varied Thrush	*Ixoreus naevius*		*	1, 4
Dark-eyed Junco	*Junco hyemalis*		*	1, 4
Northern Shrike	*Lanius excubitor*		*	4
Red Crossbill	*Loxia curvirostra*		*	4

Common Name	Scientific Name	State Status	Federal Status	Source
Lincoln's Sparrow	*Melospiza lincolnii*		*	4
Song Sparrow	*Melospiza melodia*		*	1, 4
Brown-headed Cowbird	*Molothrus ater*		*	4
Orange-crowned Warbler	*Oreothlypis celata*		*	4
House Sparrow	*Passer domesticus*			4
Savannah Sparrow	*Passerculus sandwichensis*		*	4
Fox Sparrow	*Passerella iliaca*		*	4
Pine Grosbeak	*Pinicola enucleator*		*	4
Spotted Towhee	*Pipilo maculatus*		*	4
Western Tanager	*Piranga ludoviciana*			5
Black-capped Chickadee	*Poecile atricapillus*		*	1, 4
Chestnut-backed Chickadee	*Poecile rufescens*		*	1, 3, 4
Purple Martin	*Progne subis*	Candidate	*	3, 5
Bushtit	*Psaltriparus minimus*		*	4
Ruby-crowned Kinglet	*Regulus calendula*		*	4
Golden-crowned Kinglet	*Regulus satrapa*		*	1, 4
Yellow Warbler	*Setophaga petechia*		*	1
Red-breasted Nuthatch	*Sitta canadensis*		*	1, 4
White-breasted Nuthatch	*Sitta carolinensis*	Candidate	*	4
Pine Siskin	*Spinus pinus*		*	1, 4
American Goldfinch	*Spinus tristis*		*	4
Yellow-rumped Warbler	*Setophaga coronata*		*	1, 4
Townsend's Warbler	*Setophaga townsendi*		*	4
Western Meadowlark	*Sturnella neglecta*		*	4
European Starling	*Sturnus vulgaris*			4
Tree Swallow	*Tachycineta bicolor*		*	1, 5
Violet-green Swallow	*Tachycineta thalassina*		*	1, 3
Bewick's Wren	*Thryomanes bewickii*		*	1, 4
Pacific Wren	*Troglodytes pacificus*		*	1, 4
American Robin	*Turdus migratorius*		*	1, 4, 5
Hutton's Vireo	*Vireo huttoni*		*	1, 4
White-throated Sparrow	*Zonotrichia albicollis*		*	4
Golden-crowned Sparrow	*Zonotrichia atricapilla*		*	4
Harris's Sparrow	*Zonotrichia querula*		*	4
White-crowned Sparrow	*Zonotrichia leucophrys*		*	1, 4

Table C - 2: Fish Observed in Lake Kapowsin

Common Name	Scientific Name	State Status	Federal Status	Source
Bony Fish – Perciformes				
Rock Bass	*Ambloplites rupestris*			3, 8, 9
Pumpkinseed	*Lepomis gibbosus*			3, 8, 9
Bluegill	*Lepomis macrochirus*			3, 8, 9
Largemouth Bass	*Micropterus salmoides*			3, 8, 9
Yellow Perch	*Perca flavescens*			3, 8, 9
Black Crappie	*Pomoxis nigromaculatus*			3, 8, 9
Catfish, Ray-finned Fish -- Siluriformes				
Brown Bullhead	*Ictalurus nebulosus*			3, 8, 9
Salmons – Salmoniformes				
Cutthroat Trout	*Oncorhynchus clarkia*			3, 8, 9
Coho Salmon	*Oncorhynchus kisutch*	S3	Threatened	3, 8, 9
Rainbow Trout	*Oncorhynchus mykiss*		Threatened	3, 8, 9

DRAFT

Table C - 3: Predicted Mammals for the Upland Biodiversity Management Area (BMA 8)

*(Brookes et al. 2004).

Common Name	Scientific Name	State Status	Federal Status	Source
Carnivores – Carnivora				
Coyote	*Canis latrans*			6
River Otter	*Lutra Canadensis pacifica*			6
Bobcat	*Lynx rufus*			6
Fisher	*Martes pennanti*			6
Striped Skunk	*Mephitis mephitis*			6
Ermine	*Mustela erminea*			6
Long-tailed Weasel	*Mustela frenata*			6
Mink	*Neovison vison*			6
Raccoon	*Procyon lotor*			6
Mountain Lion	*Puma concolor cougar*			6
Western Spotted Skunk	*Spilogale gracilis*			6
Black Bear	*Ursus americanus*			6
Red Fox	*Vulpes vulpes*	S1		6
Rodents -- Rodentia				
Mountain Beaver	*Aplodontia rufa*			6
Beaver	*Castor canadensis*			6
Porcupine	*Erethizon dorsatum*			6
Northern Flying Squirrel	*Glaucomys sabrinus*			6
Long-tailed Vole	*Microtus longicaudus*			6
Creeping Vole	*Microtus oregoni*	S4		6
Townsend's Vole	*Microtus townsendii*			6
Southern Red-backed Vole	*Myodes gapperi*			6
Bushy-tailed Woodrat	*Neotoma cinerea*			6
Muskrat	*Ondatra zibethicus*			6
Long-tailed (Forest) Deer-mouse	*Peromyscus maniculatus*			6
Deer Mouse	*Peromyscus sp.*			6
Norway Rat	*Rattus norvegicus*			6
Black Rat	*Rattus rattus*			6
Western Gray Squirrel	*Sciurus griseus*	S2; Threatened	Species of Concern	6
Brush Prairie Pocket Gopher	*Thomomys talpoides douglasii*	S2; Candidate		6
Pacific Jumping Mouse	*Zapus trinotatus*			6
Hedgehogs, Shrews, Moles, and Allies -- Eulipotyphla				
Mountain Beaver	*Neurotrichus gibbsii*			6
Beaver	*Scapanus orarius*			6

Common Name	Scientific Name	State Status	Federal Status	Source
Porcupine	*Scapanus townsendii*			6
Pacific Water Shrew	*Sorex bendirii*	S4; Monitored		6
Dusky (Montane) Shrew	*Sorex monticolus*	S4		6
Towbridge's Shrew	*Sorex trowbridgii*			6
Vagrant Shrew	*Sorex vagrans*			6
Bats -- Chiroptera				
Townsend's Big-eared Bat	*Corynorhinus townsendii*	S2S3; Candidate	Species of Concern	6
Big Brown Bat	*Eptesicus fuscus*			6
Silver-haired Bat	*Lasionycteris noctivagans*	S3		6
Hoary Bat	*Lasiurus cinereus*	S3		6
California Myotis	*Myotis californicus*	S3S4		6
Long-eared Myotis	*Myotis evotis*	S4; Monitored	Species of Concern	6
Little Brown Myotis	*Myotis lucifugus*	S3		6
Long-legged Myotis	*Myotis volans*	S3S4; Monitored	Species of Concern	6
Yuma Myotis	*Myotis yumanensis*			6
Ungulates -- Artiodactyla				
Black-tailed Deer	*Odocoileus hemionus columbianus*			6
Rabbits, Hares, and Allies -- Lagomorpha				
Snowshoe Hare	*Lepus americanus*			6
Eastern Cottontail	*Sylvilagus floridanus*			6
Marsupials -- Didelphimorphia				
Virginia Opossum	*Didelphis virginiana*			6

DRAFT

Table C - 4: Invertebrates Observed in Lake Kapowsin

Family	Taxon	State Status	Federal Status	Source
Annelida				
Glossiphoniidae	*Glossiphoniidae*			3
Glossiphoniidae	*Helobdella stagnalis*			3
Naididae	*Naididae*			3
Arthropoda				
Chironomidae	*Ablabesmyia*			3
Aeshnidae	*Aeshnidae*			3
Chironomidae	*Brillia*			3
Asellidae	*Caecidotea*			3
Ceratopogonidae	Ceratopogonidae			3
Ceratopogonidae	Ceratopogonidae			3
Chaoboridae	*Chaoborus*			3
Chironomidae	*Chironomus*			3
Chironomidae	*Clinotanypus*			3
Coenagrionidae	*Cpemagropmodae*			3
Crangonyctidae	*Crangonyx*			3
Hyalellidae	*Hyalella*			3
Libellulidae	*Libellulidae*			3
Limnephilidae	*Limnephilidae*			3
Limnephilidae	*Limnephilidae*			3
Limnephilidae	*Limnephilus*			3
Chironomidae	*Microtendipes*			3
Leptoceridae	*Oecetis*			3
Chironomidae	*Polypedilum*			3
Chironomidae	*Psectrocladius*			3
Chironomidae	*Tanytarsini*			3
Chironomidae	*Tanytarsus*			3
Unknown	*Amphipoda*			3
Mollusca				
Viviparidae	*Cipangopaludina chinesis*			3
Physidae	*Physidae*			3
Planorbidae	*Planorbidae*			3
Sphaeriidae	*Sphaeriidae*			3
Nemata				
Unknown	*Nemata*			3

Table C- 5: Vegetation Observed in Lake Kapowsin

Common Name	Scientific Name	State Status	Federal Status	Source
Aquatic Plants -- Forbes				
Northern Water Plantain	*Alisma triviale*			3
Mexican Water Fern	*Azolla microphylla*			3
Watershield	*Brasenia schreberi*			3
Pond Water Starwort	*Callitriche stagnalis*	Non-native		3
Coontail; hornwort	*Ceratophyllum demersum*			3
Common Elodea	*Elodea canadensis*			3
Common Duckweed	*Lemna minor*	Non-native		3
Water Mudwort	*Limosella aquatic*			3
Water Purslane	*Ludwigia palustris*			3
Common Naiad	*Najas flexilis*			3
Stonewort	*Nitella sp.*			3
Yellow Pond Lilly	*Nuphar lutea*			3
Large-leaf Pondweed	*Potamogeton amplifolius*			3
Ribbonleaf Pondweed	*Potamogeton epihydrus*			3
Whitestem Pondweed	*Potamogeton praelongus*			3
Small Pondweed	*Potamogeton pusillus*			3
Robbins' Pondweed	*Potamogeton robbinsii*			3
Flatstem Pondweed	*Potamogeton zosteriformis*			3
Sago Pondweed	*Stuckenia pectinate*			3
Common Bladderwort	*Utricularia macrorhiza*			3
Aquatic Plants – Mosses				
Water Moss	*Fontinalis antipyretica*			3
Vascular Plants -- Trees				
Red Alder	*Alnus rubra*			3
Oregon Ash	*Fraxinus latifolia*			3
Oregon Crab Apple	*Malus fusca*			3
Western Red Cedar	*Thuja plicata*			3
Western Hemlock	*Tsuga heterophylla*			3
Vascular Plants -- Shrubs				
Red-Osier Dogwood	*Cornus sericea*			3
Cascara Buckthorn	*Frangula purshiana*			3
Salal	*Gaultheria shallon*			3
Western Swamp Laurel	*Kalmia microphylla*			3
Bog Labrador Tea	*Ledum groenlandicum*			3
Twinberry	*Lonicera involucrate*			3
Rusty Menziesia	*Menziesia ferruginea*			3
Himalayan Blackberry	*Rubus armeniacus*	Non-native; Class C		3

Common Name	Scientific Name	State Status	Federal Status	Source
Evergreen Blackberry	*Rubus laciniatus*	Non-native; Class C		3
Geyer Willow	*Salix geyeriana*			3
Coastal Willow	*Salix hookeriana*			3
Sitka Willow	*Salix sitchensis*			3
Hardhack, Rose Spirea	*Spirea douglasii*			3
Common Snowberry	*Symphoricarpos albus*			3
California Huckleberry	*Vaccinium ovatum*			3
Bog Cranberry	*Vaccinium oxycoccos*			3
Vascular Plants -- Forbes				
Beggarticks	*Bidens sp.*			3
Western Water Hemlock	*Cicuta douglasii*			3
Canada Thistle	*Cirsium arvense*	Non-native; Class C		3
Purple Marshlocks	*Comarum palustre*			3
Smooth Hawksbeard	*Crepis capillaris*	Non-native		3
Roundleaf Sundew	*Drosera rotunifolia*			3
Watson Willow Herb	*Epilobium ciliatum ssp. Watsonii*			3
Water Horsetail	*Equisetum fluviatile*			3
Chamisso's Cottongrass	*Eriophorum chamissonis*			3
Three-petal Bedstraw	*Galium trifidum ssp. columbianum*			3
St. John's Wort	*Hypericum anagalloides*	Non-native		3
Pacific Jewelweed	*Impatiens x pacifica*	Non-native		3
Yellow Flag Iris	*Iris pseudoacorus*	Non-native; Class C		3
Bird's-foot trefoil	*Lotus corniculatus*	Non-native		3
Northern Bugleweed	*Lycopus uniflorus*			3
American Skunk Cabbage	*Lysichiton americanus*			3
Purple Loosestrife	*Lythrum salicaria*	Non-native Class B		2
Wild Mint	*Mentha arvensis*			3
Seep Monkey Flower	*Mimulus guttatus*			3
Bay Forget-Me-Not	*Myosotis laxa*			3
True Forget-Me-Not	*Myosotis scorpioides*	Non-native		3
Watercress	*Nasturtium officinale*	Non-native		3
Narrowleaf Plantain	*Plantago lanceolate*	Non-native		3
Swamp Smartweed	*Polygonum hydropiperoides*			3
Curvepod Yellowcress	*Rorippa curvisiliqua*			3
Climbing Nightshade	*Solanum dulcamara*	Non-native		3
Common Dandelion	*Taraxicum officinale*	Non-native		3

Common Name	Scientific Name	State Status	Federal Status	Source
Common Cat-tail	*Typha latifolia*	Non-native		3
American Speedwell	*Veronica Americana*			3
Water Speedwell	*Veronica anagallis-aquatica*	Non-native		3
Skullcap Speedwell	*Veronica scuttelatta*			3
Small White Violet	*Viola macloskeyi*			3
Grasses				
Colonial Bentgrass	*Agrostis capillaris*	Non-native		3
Redtop Grass	*Agrostis gigantean*	Non-native		3
Slender Hair-grass	*Deschampsia elongate*	Non-native		3
Fowl Manna Grass	*Glyceria striata*			3
Common Velvet Grass	*Holcus lanatus*	Non-native		3
Reed Canary Grass	*Phalaris arundinacea*	Non-native		3
Bluegrass	*Poa sp.*			3
Vascular Plants -- Rushes				
Common Rush	*Juncus effuses*			3
Rush	*Juncus sp.*			3
Poverty Rush	*Juncus tenuis*			3
Vascular Plants -- Sedges				
Slenderbeak Sedge	*Carex athrostachya*			3
Cusick's Sedge	*Carex cusickii*			3
Star Sedge	*Carex echinata ssp. echinata*			3
Smoothstem Sedge	*Carex laeviculmis*			3
Awlfruit Sedge	*Carex stipata*			3
NW Territory Sedge	*Carex utriculata*			3
Blister Sedge	*Carex vesicaria*			3
Three-way Sedge	*Dulicium arundinaceum*			3
Needle Spikerush	*Eleocharis acicularis*			3
Common Spikerush	*Eleocharis palustris*			3
American Bulrush	*Schoenoplectus americanus*			3
Swaying Bulrush	*Schoenoplectus subterminalis*			3
Softstem Bulrush	*Schoenoplectus tabernaemontani*			3
Panicled Bulrush	*Scirpus microcarpus*			3
Vascular Plants – Fern				
Lady Fern	*Athyrium filix-femina*			3
Bracken Fern	*Pteridium aquilinum*			3
Vascular Plants – Moss				
Red Peatmoss	*Sphagnum rubellum*			3

Table C - 6: Amphibians predicted or observed to inhabit Lake Kapowsin.

* Predicted to inhabit the Upland Biodiversity Management Area (BMA 8)[6]
◊ Observed by DNR Aquatics and Hamer Environmental L.P. during 2015 visual surveys

Common Name	Scientific Name	State Status	Federal Status	Source
Salamanders and Newts				
Northwestern salamander * ◊	*Ambystoma gracile*	S5		3, 5. 6
Long-toed salamander *	*Ambystoma macrodactylum*	S5		6
Pacific giant salamander *	*Dicamptodon tenebrosus*	S5		6
Roughskin newt *◊	*Taricha granulosa*	S5		3, 5, 6
Frogs				
American bullfrog ◊	*Lithobates catesbeianus*	Invasive problematic		3, 5
Pacific treefrog (Chorus frog) *◊	*Pseudacris regilla*	S5		3, 5. 6
Northern Red-legged frog *◊	*Rana aurora aurora*	S4; Species of Concern	Species of concern	3, 5, 6
Oregon spotted frog	*Rana pretiosa*	S1; Endangered	Listed Endangered	3(Predicted), 7
Toads				
Western Toad *	*Anaxyrus boreas*	S3; Candidate	Species of concern	6

DRAFT

Table C - 7: WDFW Priority Species and Habitat in Lake Kapowsin Area

* Kapowsin Creek

Common Name	Scientific Name	Priority Area/Type
Winter Steelhead	*Oncorhynchus mykiss*	Occurrence/Migration
Steelhead	*Oncorhynchus mykiss*	Occurrence
Coho Salmon	*Oncorhynchus kisutch*	Breeding Area
Bull Trout	*Salvelinus confluentus*	Occurrence/Migration
Chinook Salmon*	*Oncorhynchus tshawytscha*	Occurrence
Fall Chinook Salmon*	*Oncorhynchus tshawytscha*	Breeding Area
Pink Salmon Odd Year*	*Oncorhynchus gorbuscha*	Occurrence, Breeding Area
Fall Chum Salmon*	*Oncorhynchus keta*	Occurrence/Migration
Grizzly bear	*Ursus arctos*	Occurrence
Habitats		
Freshwater Emergent Wetland		Aquatic Habitat
Freshwater Forested/Shrub Wetland		Aquatic Habitat
Waterfowl Concentrations		Aquatic Habitat

Refer to WDFW Priority Species and Habitat Program website for more information.

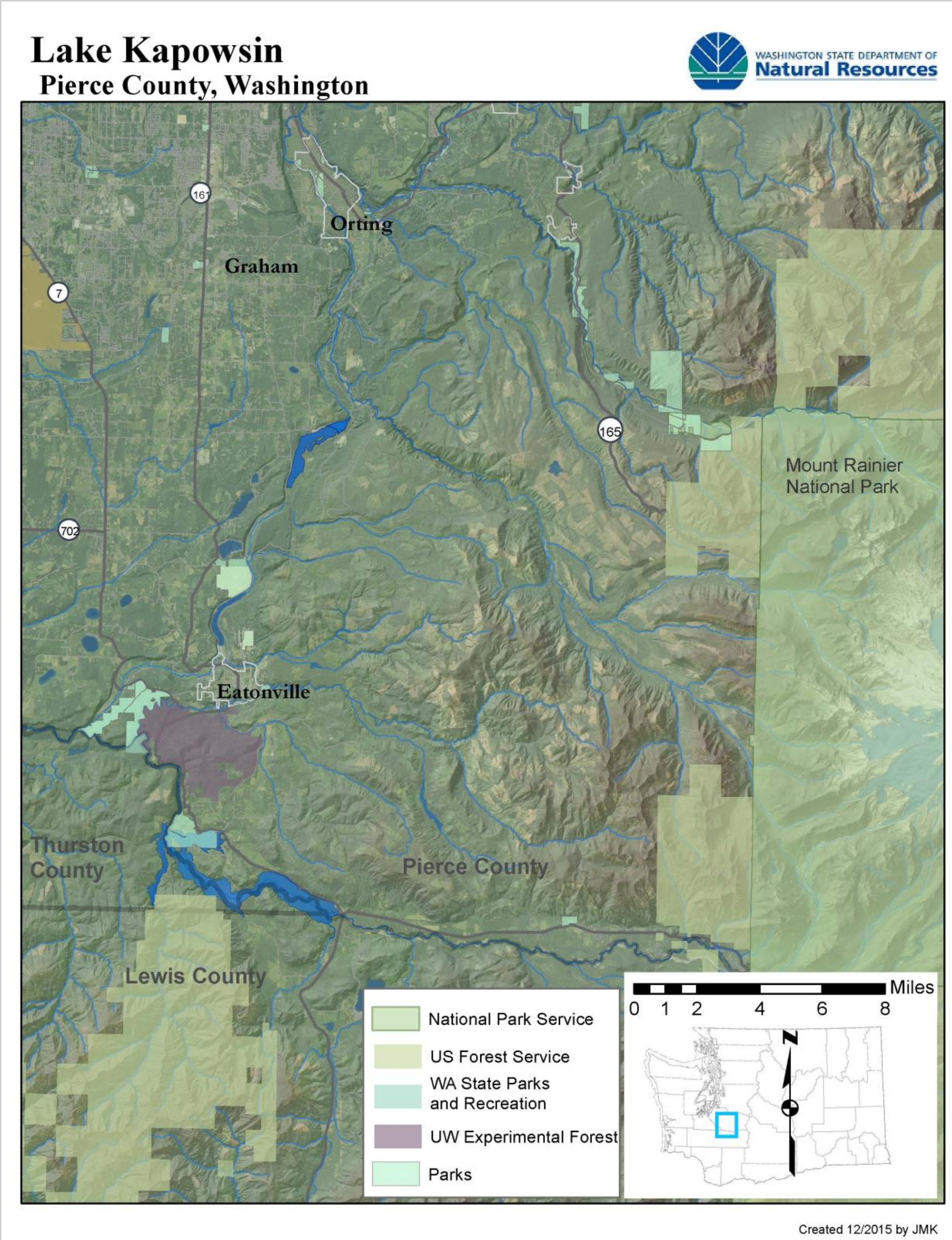
DRAFT

Appendix D – Maps

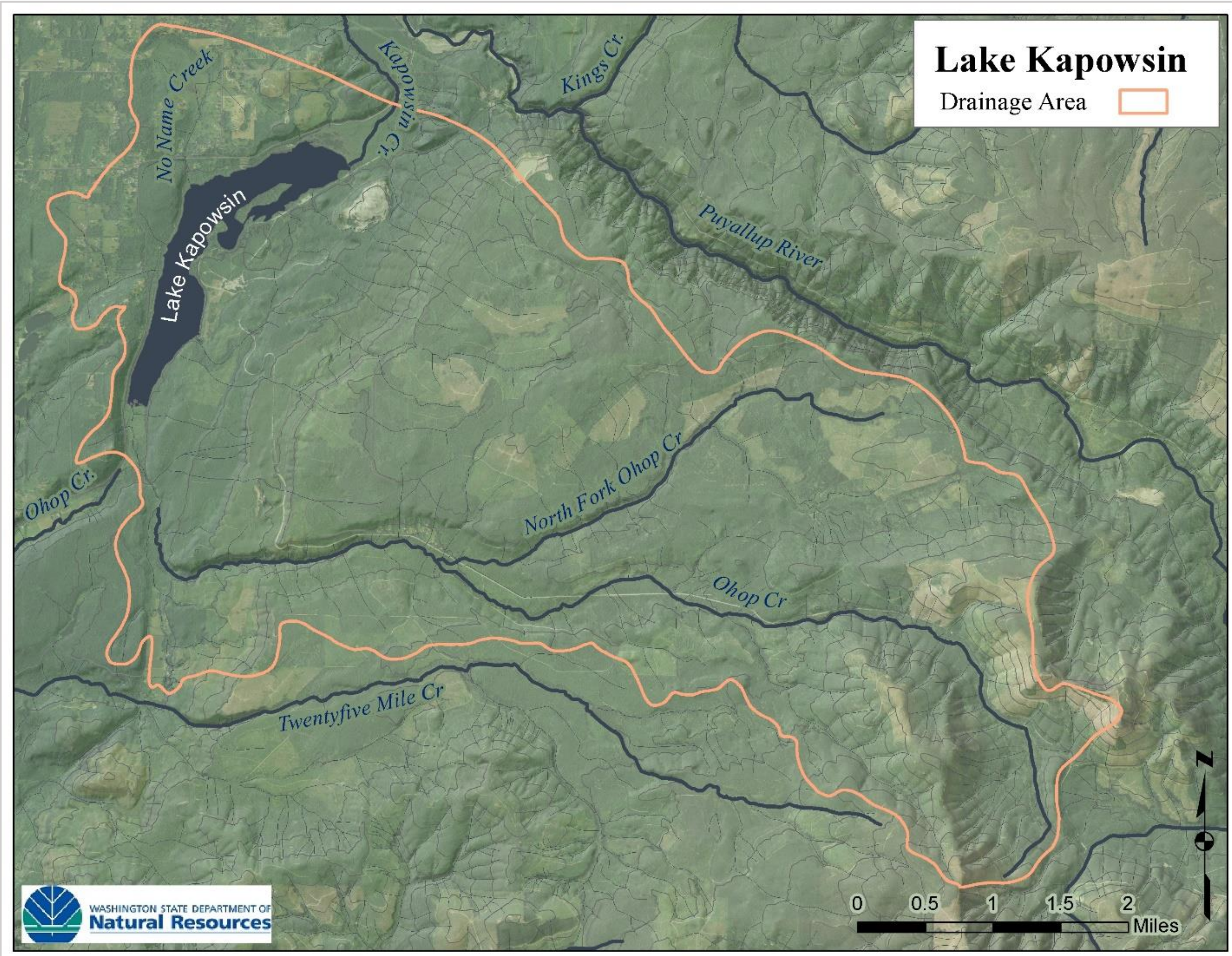
Appendix D – Table of Maps

DRAFT

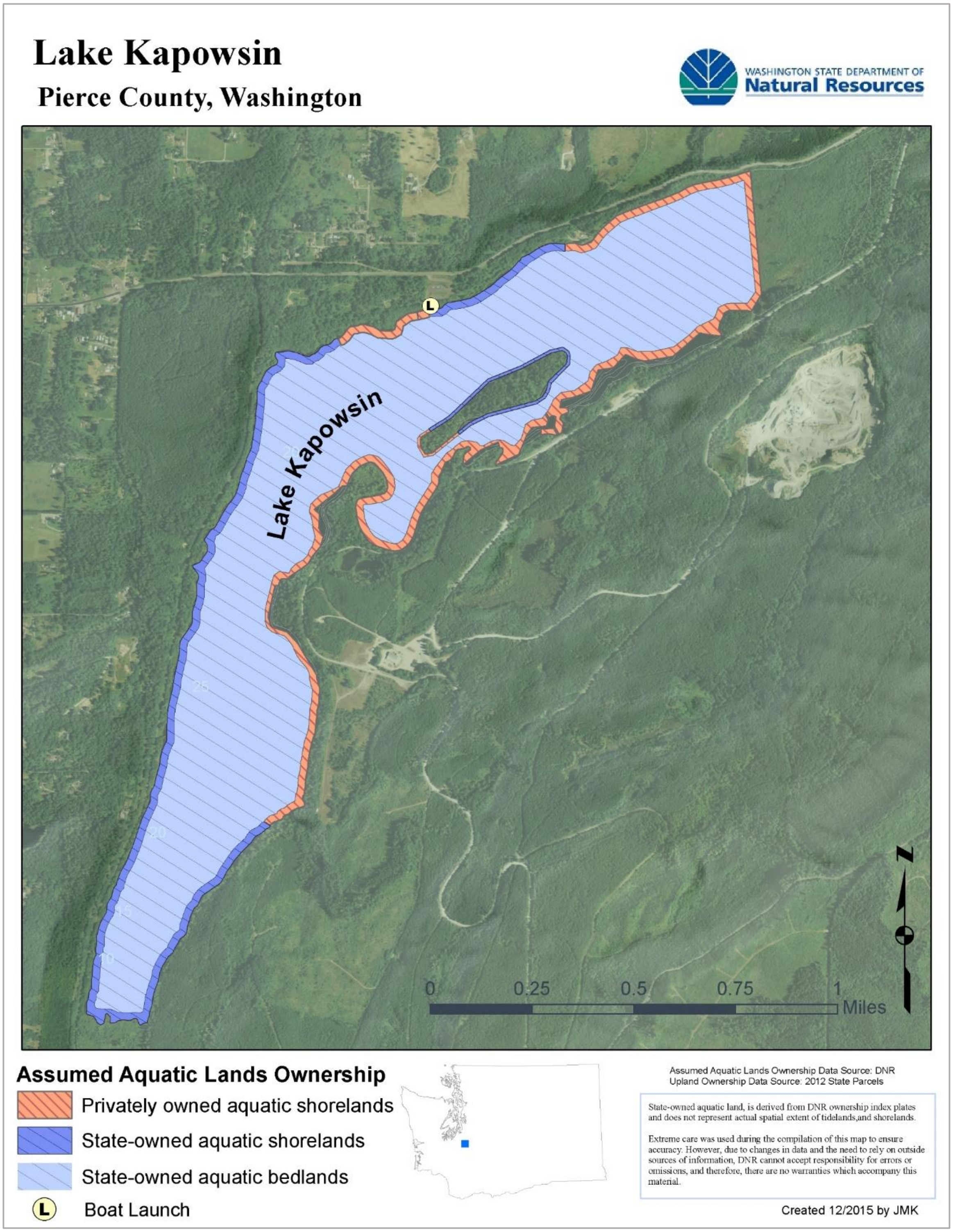
D-1. Lake Kapowsin Vicinity



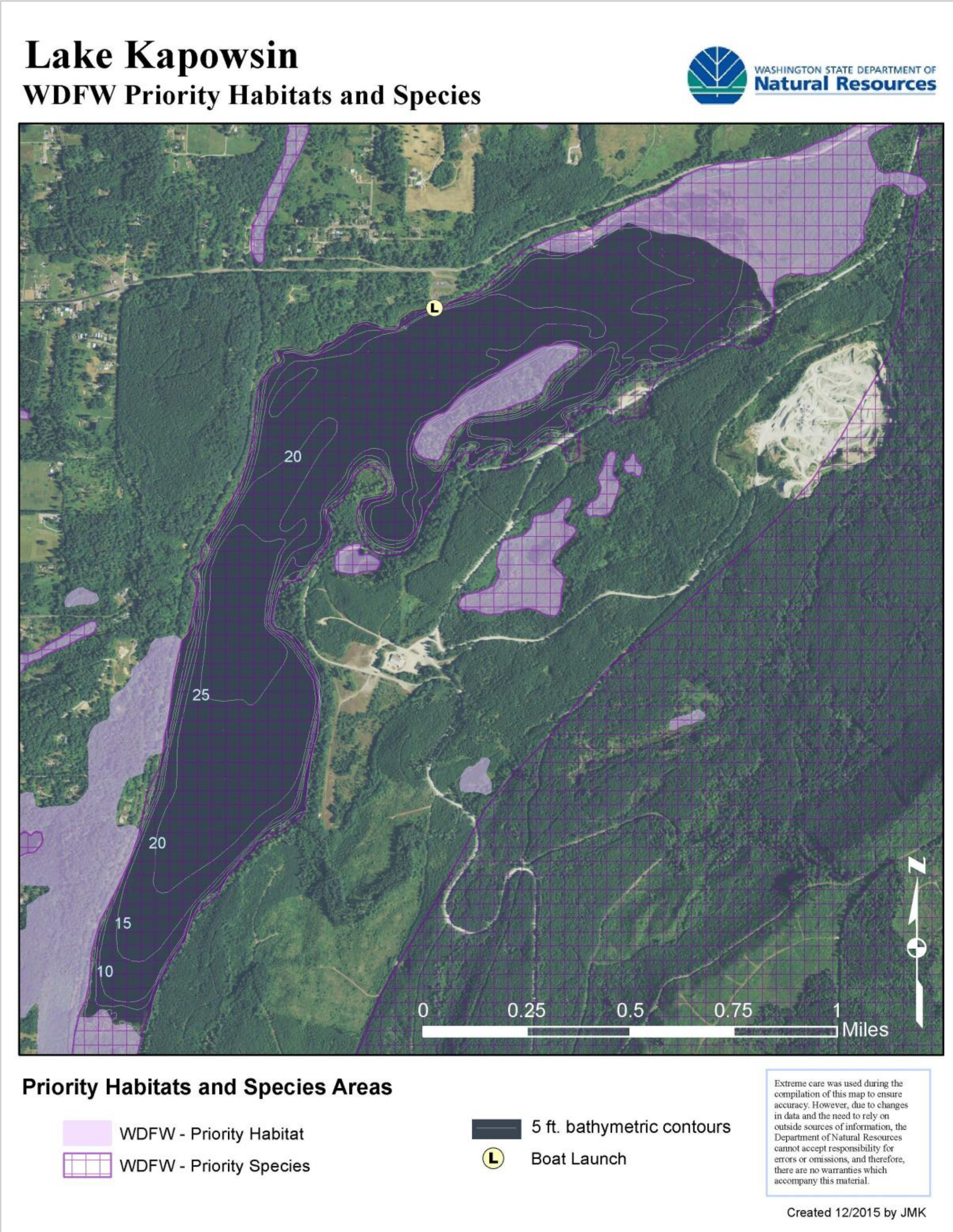
D-2. Lake Kapowsin Drainage Area



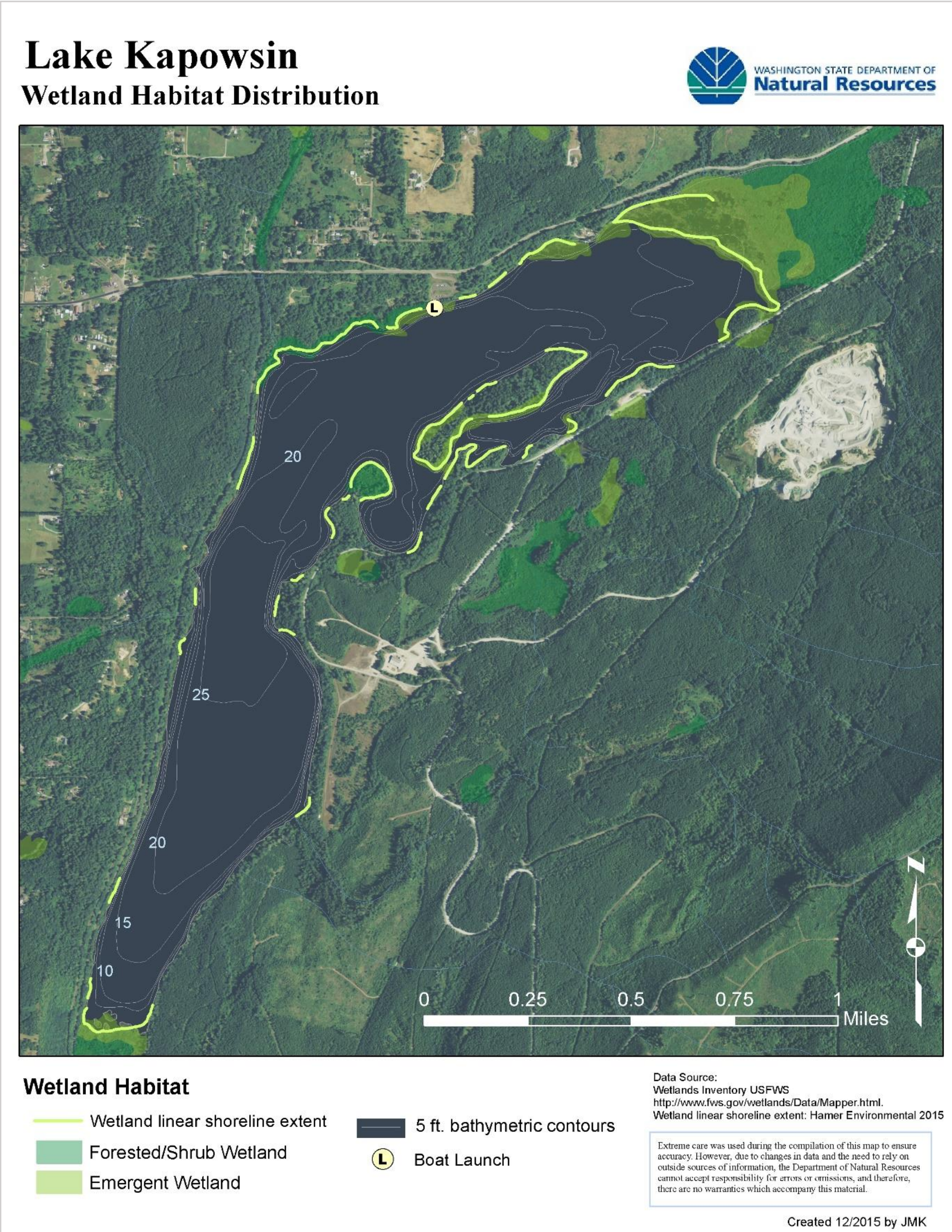
D-3. Lake Kapowsin Assumed Aquatic Lands Ownership



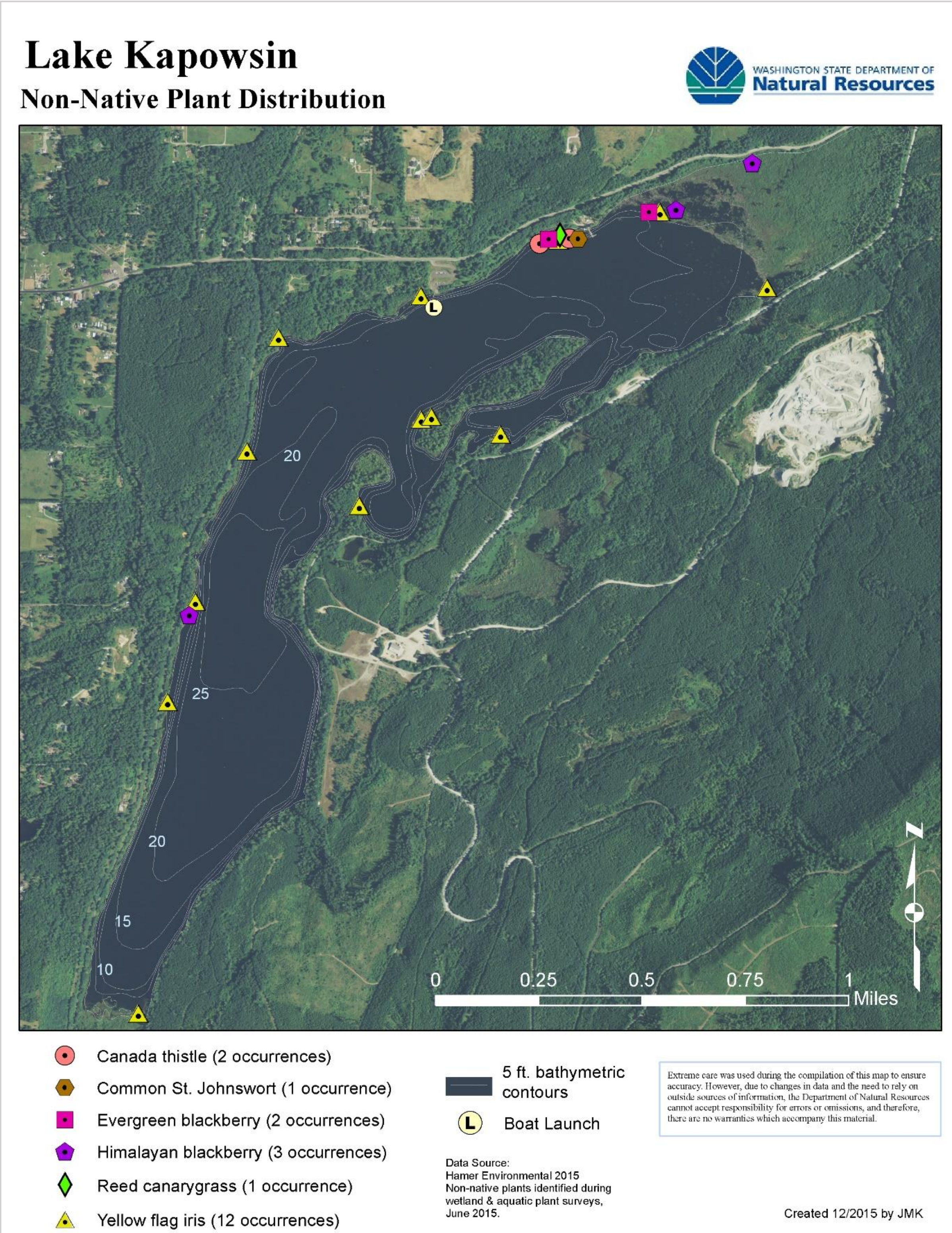
D-4. WDFW Priority Species and Habitats



D-5. Wetland Habitat Distribution

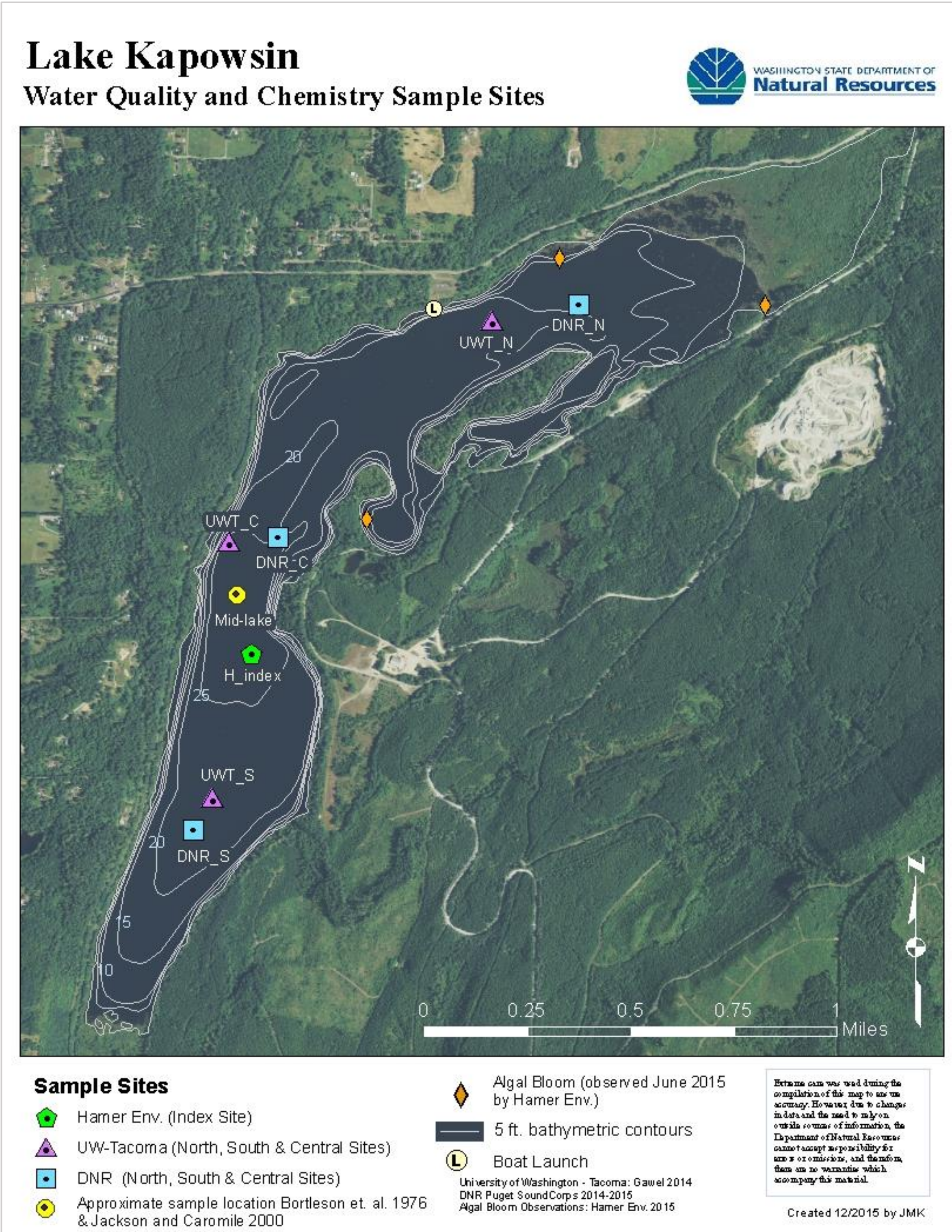


D-6. Non-Native Plant Occurrence

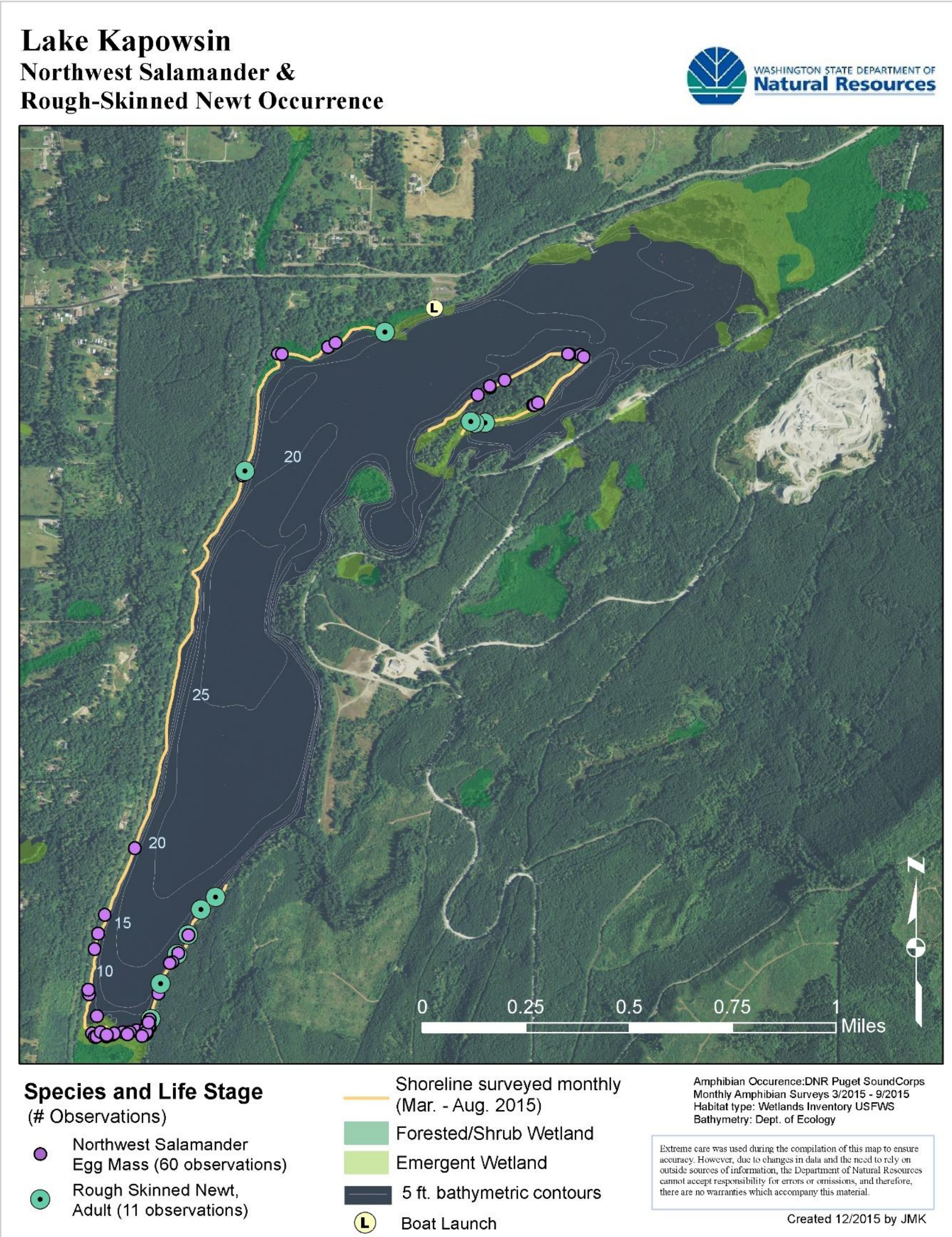


DRAFT

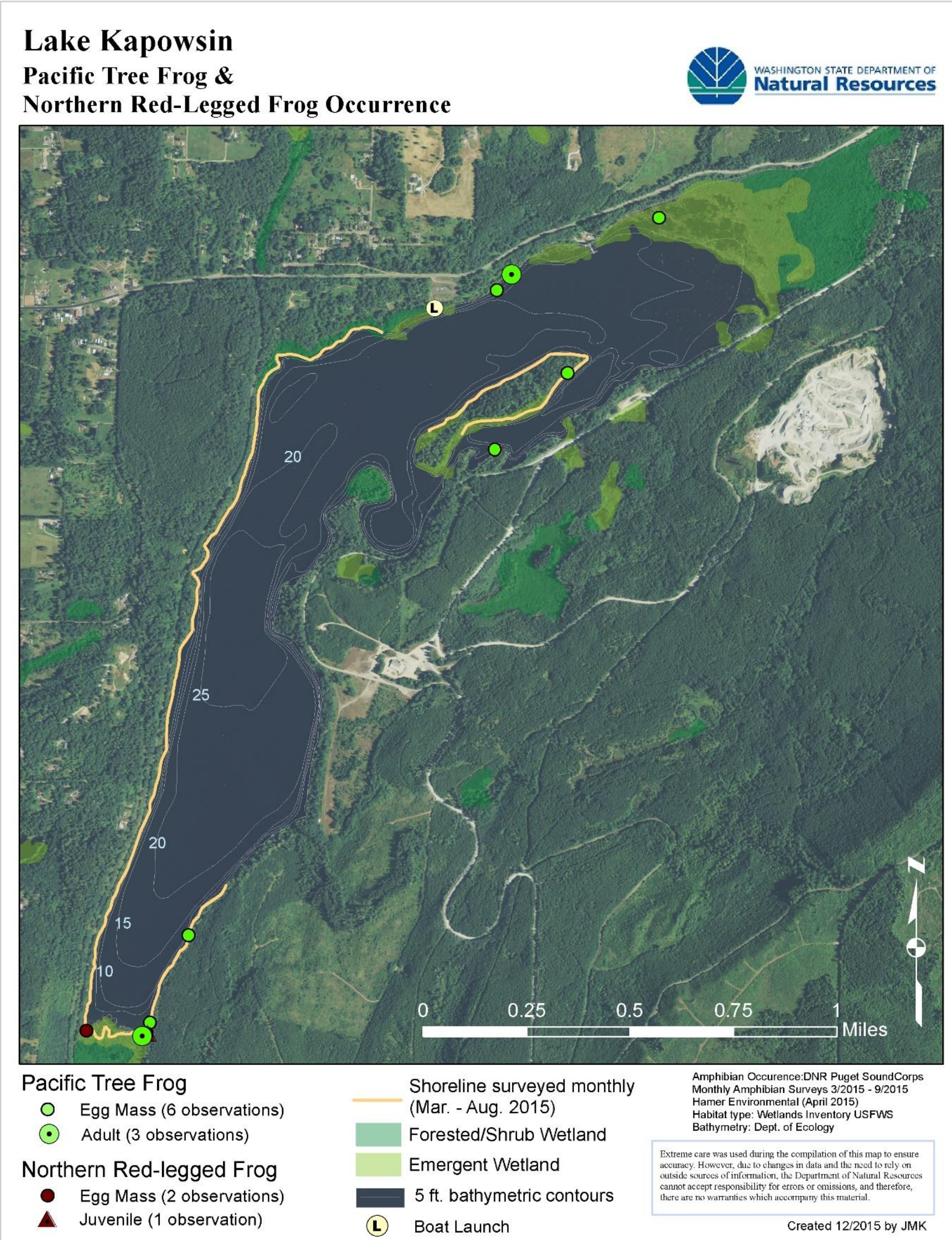
D-7. Water Quality and Chemistry Sample Sites



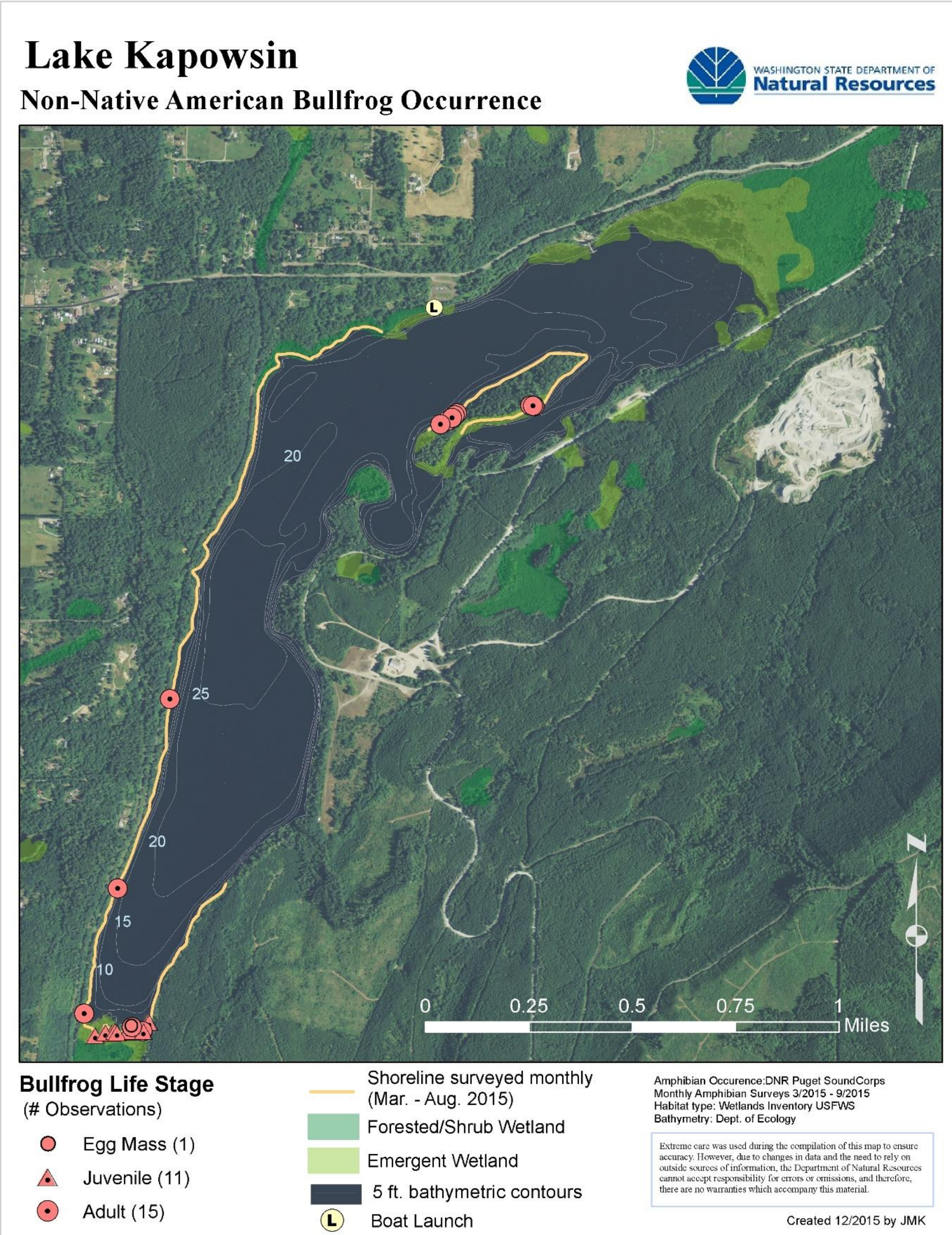
D-8. Northwest Salamander & Rough-Skinned Newt Occurrence



D – 9. Pacific Tree Frog & Northern Red-Legged Frog Occurrence



D – 10. Non-native American Bullfrog Occurrence



Appendix E – Designation and Withdrawal Order

DRAFT