An Ecological Description of the Numbered Lakes Ecosystem and Potential Development Impact Assessment

Prepared by:

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The Aquatic Restoration and Research Institute is a nonprofit corporation formed to
"Conduct scientific research of aquatic ecosystems and conduct aquatic ecosystem restoration, and disseminate information on aquatic ecosystems and aquatic ecosystem restoration equally to the public, government agencies, and non-government organizations through publications, seminars, lectures, demonstration projects and any other means."

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Gay A Davis (Muhlberg) has a B.S. degree in Wildlife and Fisheries Science from the University of Maine, is a resident of Alaska and has worked for 15 years with the Alaska Department of Fish and Game, Habitat and Restoration Division. She has 15 years of experience implementing a regulatory program that required evaluating the effects of any and all types of development on the State's water quality. Interpreting, evaluating, and implementing the State's water quality standards are an integral part of the previous AS 16.05.870 (currently AS 41.14.870). This statute requires all those proposing to pollute streams specified as important for anadromous fish to present plans and receive authorization prior to conducting any proposed project. Although pollution was rarely authorized, except through a short-term variance, all projects were evaluated to determine whether they could be conducted in a manner that would avoid exceeding State water quality standards. She has worked in concert with the Department of Environmental Conservation through the Alaska Coastal Management program reviewing all projects in either marine or fresh waters for compliance with water quality standards which were written in by reference as an enforceable standard of the Coastal Management Program. Plan and site reviews including on-site best management practices have been Gay's daily focus throughout her career. Some of the projects she has worked on include Cook Inlet oil and gas exploration and development; Hydroelectric licensing, construction, and monitoring; municipal waste water treatment; seafood processing; mariculture farming; highway construction; and municipal stormwater treatment and monitoring.

Ms. Davis has spent a large portion of her time reviewing, evaluating, and developing State regulations. She worked extensively on the development and regulations for the Kenai River Special Management Area. She reviewed and commented on the Municipality of Anchorage's Coastal District Program including the wetland classification and evaluation system. Ms. Davis has conducted multiple water quality assessment projects under DEC section 319 funding to address ACWA water quality priorities. Ms. Davis is the lead author of the most widely used aquatic restoration guidance document within the State. She has designed and overseen the construction of dozens of stream restoration projects intended to reduce rates of sediment input and restore the physical aspects of fish habitat. Gay is considered to be the state's expert on stream restoration methods and applications.

Cover Photograph. Question Creek upstream of Lake Six.

Summary

This document describes some of the major physical characteristics and aquatic and terrestrial biotic resources of the Numbered Lakes Ecosystem and some of the more common human impacts. The plant communities and animal species referenced, represent only a few of those that live or can be found within the diverse habitats available in the ecosystem.

The Numbered Lakes Ecosystem is located approximately 7 miles south of Talkeetna, Alaska, primarily within sections 29, 30 and 32 of Township 25, North, Range 4 West of the Seward Meridian. A 720 acre core area including all of section 32 and an 80 acre parcel in section 29 is identified as “future parkland” in the Talkeetna Community Comprehensive Plan. The core area is public land owned by the Matanuska-Susitna Borough. The remaining lands are privately owned. The system is composed of 8 named lakes, a number of ponds and spring-fed palustrine streams and associated uplands. Lakes Five and Six drain north and west into Question Lake and Little Question Lake, respectively and into Question Creek. Lakes One and Three drain into Lake Four. The outlet stream of Lake Four flows west directly into Question Creek. This lake system provides an estimated 194 acres of open water habitat. Answer Creek and Question Creek join west of the Talkeetna Spur Road and flow south into Sunshine Creek and the Susitna River. An estimated 40% of the surface area of section 32 is composed of lakes and associated wetlands.

The Numbered Lakes Ecosystem provides high quality spawning and rearing habitat for anadromous coho salmon, Chinook salmon, sockeye salmon, rainbow trout, Dolly Varden, long-nose suckers and stickleback. The high productivity within adjacent wetlands and shallow ponds provides the energy base to support large numbers of rearing fish and waterfowl. The fish, in turn, support piscivorous birds and mammals. In addition to wetland plant communities, the Numbered Lakes system contains black spruce and mixed spruce and birch forests. The diverse aquatic, wetland, and terrestrial communities provide a diversity of animal habitats rarely seen in such a small geographic area.

The extensive stream, lake, and wetland habitats can be negatively impacted by both recreational use and residential development. Road construction associated with residential development can disrupt the natural water flow pathways, water storage, and filtering capacity of wetland systems. Stream crossing structures can result in the direct loss of fish habitat, affect fish passage, and disrupt up- to down-stream linkages. All-terrain vehicle (ATV) and snow machine use of wet and moist soils can rapidly result in the loss of vegetation, changes in hydrology and increases in erosion rates. Human activities can disrupt normal nesting and animal feeding patterns, and lead to increased bear human interactions at concentrated fish spawning locations.

Aquatic and Terrestrial Biological Resources

The Numbered Lakes are part of the Sunshine Creek drainage, which consists of three sub-drainages: Question Creek, Answer Creek, and Sunshine Creek (Figure 1). Question Lake, Little Question Lake, Lake Five and Lake Six are located to the north and drain into Question Creek. Lake One and Lake Three drain into Lake Four, the outlet stream flowing to the west also into Question Creek, while Lake Two does not have surface flow but is likely hydraulically connected to Lakes One and Four. Estimated surface area of lakes within these sub drainages are provided in Table 1. Approximately half of the total surface area (94 acres excluding Question and Little Question Lakes) is within the future parklands owned by the Matanuska-Susitna Borough (Figure 2), while the remainder are covered under Lake Management Plans or private Conservation Easements.

Table 1. Surface area of Lakes within the Numbered Lakes system.

Lake	Area (m^2)	Area (acres)
Question Lake	350,781	86.68
Lake Four	89,189	22.04
Lake Two	68,095	16.83
Little Question Lake	56,642	14.00
Lake One	55,298	13.66
Lake Six	53,727	13.28
Lake Five	48,510	11.99
Pond 2 (North of Lake Six)	20,763	5.13
South Pond	15,189	3.75
Outlet Pond	13,489	3.33
Lake Three	12,542	3.10
Pond 1 (Northeast of Lake Six)	1,707	0.42
Total	785,932	194.21

A number of streams and lakes within the Number Lakes area have been identified by the State of Alaska as important for spawning, rearing, or migration of anadromous fish pursuant to AS 41.14.870 (Table 2) (Johnson et al. 2004). Coho salmon spawning habitat has been identified throughout the Question Lakes drainage. Coho salmon (*Oncorhynchus kisutch)* spawn within the stream system upstream of Question Lake, between Little Question Lake and Lake Six and within all of the stream system upstream of Lake Six. Coho salmon spawn between Question Lake and Lake Five, and the Lake Five inlet stream. Coho salmon spawning also occurs within the outlet stream of Lake Four and rearing within both flowing and still water habitats. Lake One is not specified as supporting anadromous fish; however, as there is an open water connection to Lake Four, it probably supports rearing coho salmon.

Although there is an active Chinook salmon fishery at the mouth of Sunshine Creek, the Lake Four tributary is the only site listed as providing Chinook or king salmon (*Oncorhynchus)* rearing habitat. Local residents have reported Chinook salmon in Question Lake. No other streams within the drainage are identified as important for Chinook salmon spawning or rearing, which again likely reflects limited sampling.

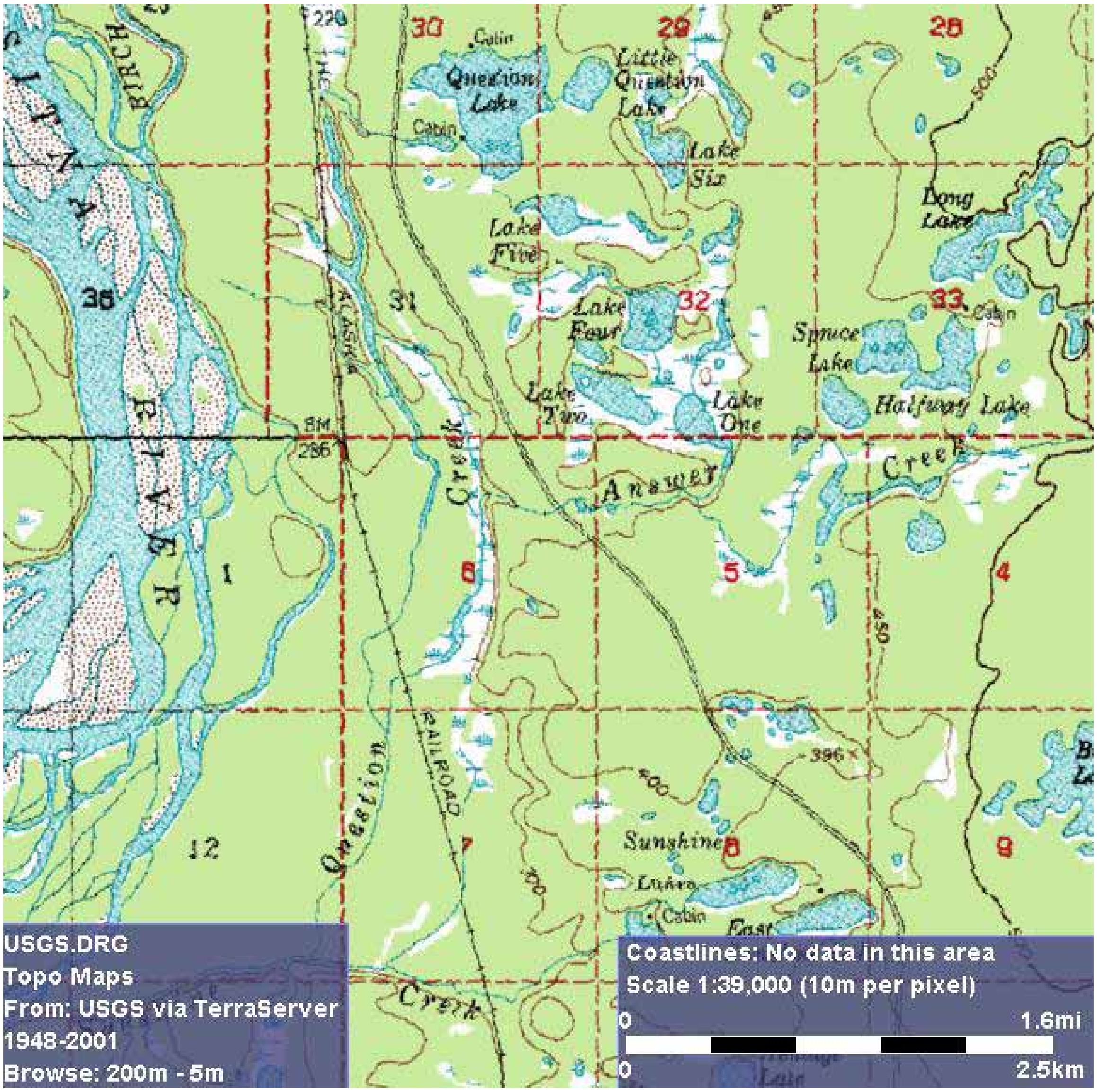

Figure 1. USGS topographical map of the Lower Sunshine Creek Drainage.

Similarly, sockeye salmon (*Oncorhynchus nerka*) spawning and rearing probably extends beyond the cataloged sites within Sunshine Creek. Sockeye salmon have been observed within Question Lake by local residents.

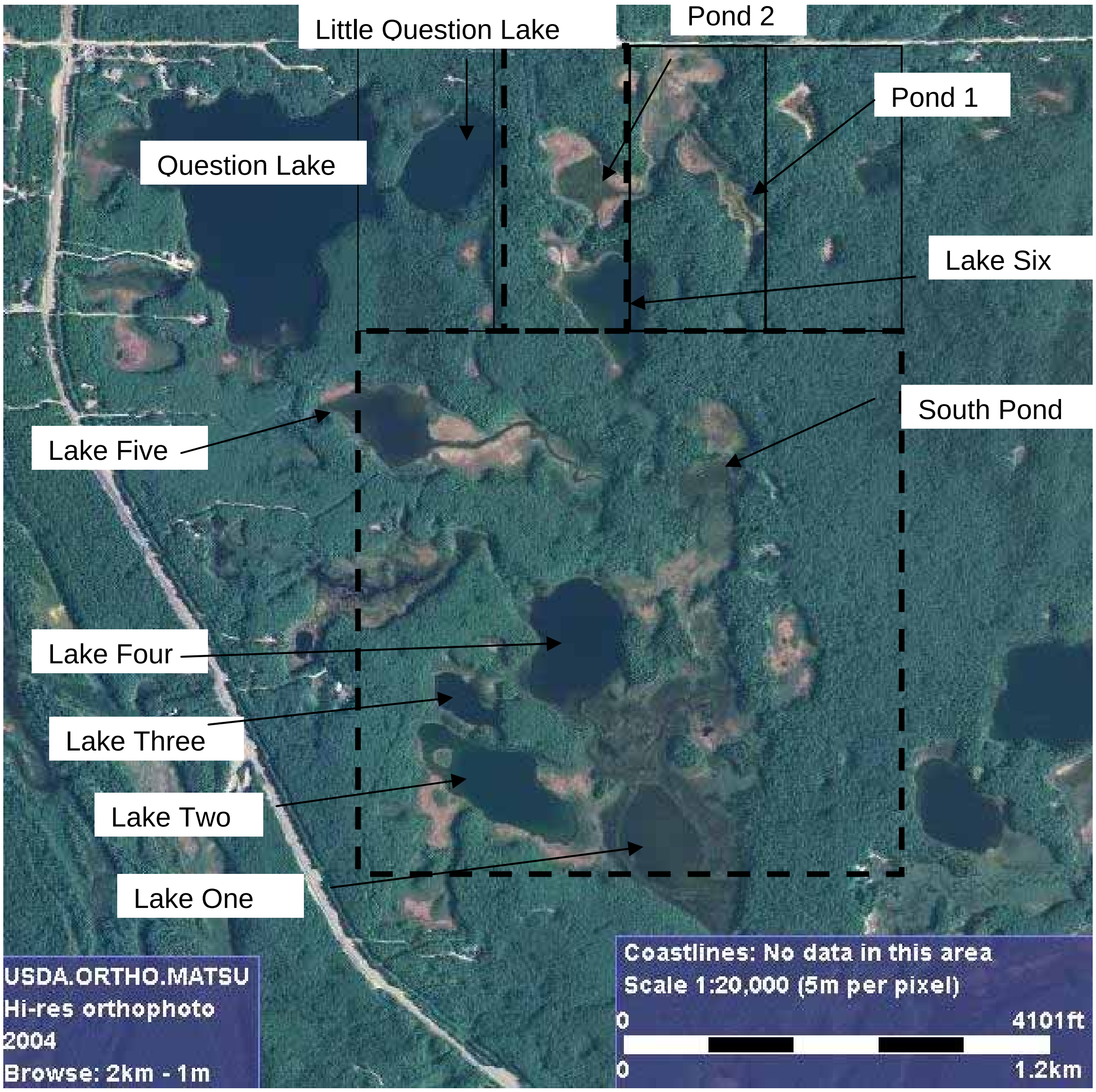

Figure 2. Aerial photograph of numbered lakes showing approximate boundaries of Mat-Su Borough owned lands (dashed lines).

In addition to the anadromous salmon, the Numbered Lakes also support resident rainbow trout (*Oncorhynchus mykis*), sticklebacks (*Gasterosteus aculeatus*), long-nose suckers (*Catostomus catostomus*) and Dolly Varden Char (*Salvelinus malma Walbaum*).

Adult coho salmon migrate to spawning locations in the fall (August and September) (Figure 3). Spawning takes place within flowing water streams with gravel to small cobble substrates. Egg survival and development depends upon exposure to well oxygenated water, which can be affected by changes in water flow volume and concentrations of fine sediments. Egg development rates vary with temperature; however, sac fry and juvenile emergence generally occurs in early spring. Coho salmon juveniles rear for one or two years in fresh water prior to migrating to the ocean as smolts. Coho salmon generally return to spawning streams one year later.

The life history of Chinook salmon is similar to coho salmon; however, adult migration to spawning sites occurs in June. Spawning habitats are generally within larger streams, higher velocities, and on larger substrate (Vincent-Lang et al. 1984). Egg development rates are temperature dependent with spring juvenile emergence. Most of the juvenile Chinook salmon from the Susitna River drainage spend two years in fresh water (Barrett et al. 1985). Chinook salmon spend four to five years in ocean waters prior to returning to spawning streams.

Figure 3. Adult coho salmon at the outlet of Question Lake.

Sockeye salmon adult migration begins in July. There are two runs of Sockeye salmon in the Upper Susitna River. The first run spawns in the Papa Bear lake system and the second run spawns in main-stem sloughs and Larson Lake (Barrett et al. 1985). Sockeye salmon in the Numbered and Question Lakes likely are a part of this second run. Sockeye salmon spawn primarily at lake inlet and outlet streams and at upwelling locations along lake margins. Emergent fry migrate to lakes where they rear for one or two years prior to smolt migration. Adult salmon return after three to four years in ocean waters.

Rainbow trout spawn in the spring, and unlike anadromous species, do not die after spawning. Rainbow trout migrate up tributary streams to spawn. Eggs do not develop over the winter but emerge after one or two month's incubation. Juvenile rearing occurs within fresh-water systems. Juvenile rainbow trout feed primarily on aquatic invertebrates. Sticklebacks have been documented as being a major food source for adult rainbow trout in South-central Alaskan streams (Whitesel et al 1957).

The importance of salmon as an energy and nutrient base can not be overstated. Adult salmon transport a large amount of ocean-derived carbon and nutrients to fresh-water streams. The organic carbon provides an energy base for a number of other species including river otter, eagles and bears. Decomposing carcasses support invertebrate biomass directly and indirectly through nutrient enrichment of algae and aquatic plants. The invertebrate larvae in turn support rearing juvenile salmon and birds such as dippers (*Cinclus mexicanus*).

Table 2. Streams and Lakes specified as important for salmon by the Alaska Department of Fish and Game within the Sunshine Creek Drainage.

Stream Name	Anadromous Steam Number	Species and Life Stage
Answer Creek	247-41-10200-2300-3011-4016	Sockeye (present) Coho (spawning and rearing)
Question Creek	247-41-10200-2300-3011	Coho (spawning and rearing)
Lake Four Outlet Stream	247-41-10200-2300-3011-4030	King (rearing) Coho (rearing)
Lake Five Outlet Stream	247-41-10200-2300-3011-4010	Coho (spawning and rearing)
Lake Five	247-41-10200-2300-3011-4010-0005	Coho (spawning and rearing)
Lake Six	247-41-10200-2300-3011-4018-0006	Coho (rearing)
Question Lake	247-41-10200-2300-3011-0010	Coho (rearing)
Little Question Lake	247-41-10200-2300-3011-0012	Coho (rearing)

The Numbered Lakes system provides nesting and rearing habitat for waterfowl including Common Loons (*Gravia immer*) and Red-Necked Grebes (*Podiceps grisegena*) (Figures 4 and 5). Both of these bird species are piscivorous, depending upon juvenile salmon and sticklebacks. Both Grebes and Loons build nests of plant accumulations along the margins of lakes. Loons generally lay one or two eggs, and upon hatching, the chicks quickly abandon the nest, can swim, and are carried upon the water on the backs of their parents. Both adults spend time collecting food for the developing young. Loons and grebes feed upon fish, aquatic insects, and other invertebrates.

Figure 4. Common Loon.

Swans (*Cygnus sp.*) with cygnets and Cranes (*Grus canadensis*) have been observed within the Numbered Lakes parkland and are believed to nest there. Swans generally build large nests in wetlands next to lakes and ponds. Lakes are used for foraging and shelter and wetland habitats for foraging (Earnst and Rothe 2004). Swans feed on aquatic macrophytes and algae. Cranes also nest within wetland habitats. Cranes feed primarily on organic matter and to a lesser extent invertebrates and fish.

Wetlands and Riparian Areas

The Numbered Lakes area contains a number of different types of vegetative community types. There are approximately 180 acres of wetlands within Section 32, or 28 % of the surface area. These wetlands are dominated by subartic lowland sedge-shrub wet meadows with sweet gale and willow shrubs (Viereck et al. 1992). Other vegetation community types within the Numbered Lakes area include closed black spruce forest, and closed mixed birch spruce forests (Viereck et al. 1992). Therefore, the Numbered Lakes area is composed of a diversity of open water, wetland, and upland habitats.

The importance of wetland and wetland riparian habitats to the productivity of adjacent streams and lakes is well documented (see Correll 1999). Wetlands are important for the storage and discharge of water to surrounding waterbodies. This storage capacity allows for more constant flows and reduces the volume of flood flows and ensures constant water supply between spring runoff and rain events. The storage and discharge of water from wetlands often is relatively warm preventing complete freeze down during winter. These open-water habitats provide important resting and foraging habitat for migrating water birds (LaMontagne et al. 2005).

Figure 5. Red-throated Grebe on Pond 2.

Primary productivity within wetlands exceeds other vegetative communities and is an important source of organic matter to stream systems. The amount of dissolved organic matter within streams can be directly related to the wetland area within the watershed (Gergel et al. 1999, Eckhardt and Moore 1990). This organic matter serves as a food base for the stream systems. Riparian plant communities stabilize stream banks and filter sediment and toxins prior to their entry into streams and lakes (Petterjohn and Correll 1984, Kodolf and Curry 1986).

The majority of the wetlands within the Numbered Lakes ecosystem are contiguous with or hydraulically connected to streams and lakes that support salmon. Therefore, the contribution of wetlands and riparian habitats to the function of aquatic ecosystems directly affects the survival and propagation of salmon. The energy base, overhanging banks, and deep slow-water habitats provide excellent coho salmon rearing habitat. The commercial and sport fisheries are an important local and state resource. In addition to supporting these fisheries, numerous other species depend upon salmon for survival. Buffers of natural vegetation have been used to minimize impacts to aquatic systems. In general, the filtering and hydraulic retention capacity increases with buffer widths. Buffers of terrestrial vegetation around wetland communities helps to maintain a diversity of animal habitat types.

Potential Impacts Related to Recreation or Residential Development

The construction of roads, residential or commercial development, and undeveloped motorized recreational use can alter the function of stream and wetland ecosystems affecting their ability to support fish and wildlife species. Road construction often results in the direct loss of wetland or stream habitats, alters drainage patterns and vegetation communities, can block fish migration, and the transport of sediment and toxins. The wetland fill and surcharge of gravel access roads disrupts normal sheet flow of water through wetlands. This often results in a reduction in soil saturation on the down-slope side of the road and a change in vegetation community. This can be observed at the Glenn Highway crossing of the Palmer Hay Flats and at the Talkeetna Spur Road crossing of Twister Creek. Water originating from the upslope side of the roadway is collected into culverts and generally channelized on the down-slope side. Therefore, circumventing the retention and filtering wetland functions.

Figure 6. Sedimentation of stream from road runoff in the Houston Area.

Road construction provides a direct source of fine sediment that is transported to streams during storm runoff or as airborne particles. During storm events or snow runoff, water transported along road surfaces or along roadside ditches entrains and delivers suspended sediment to streams at crossing sites (Figure 6). The suspension of sediment increases with road use. The amount of fine sediment in streams has been shown to be positively correlated with road density and the diversity and abundance of invertebrates and fish to be negatively correlated (Baxter et al. 1999, Shaw and Richardson 2001).

Stream crossing structures can result in the direct loss of important fish habitat, block adult and juvenile fish migration, and disrupt stream transport processes. While there is a large amount of slow-water fish rearing habitat, there is only a limited amount of stream spawning habitat: upstream of Little Question Lake and Lake Six, between Question Lake and Lake Five, and upstream of Lake Five. The use of culverts as road crossing structures causes a direct loss of spawning habitat by changing substrate suitability (size and depth for redd

Figure 7. Perched outlet of the Question Creek culvert at the Talkeetna Spur Highway.

construction) and upwelling of hyporheic and ground water.

Culverted stream crossing structures also can cause blockages to fish movement due to high velocities or perched outlets (Figure 7). In addition to blocking adult migration to spawning habitat, juvenile salmon and other fish species migrate throughout stream systems. Juvenile salmon will distribute from spawning locations throughout available rearing habitat and to deep-water overwinter sites. Rainbow trout, long-nose suckers and stickleback all migrate between spawning, rearing, and overwintering locations. Maximum sustained swimming speeds for juvenile salmon are approximately 0.5 feet per second (Fish Xing, version 2.2 San Demas Laboratory). Concentrated water flows in sloped culverts often exceed these velocities thereby eliminating portions of the total available habitats. Maximum swimming speeds for suckers and sticklebacks are likely less that those for coho salmon. The flow through culverts also can be restricted by beaver-dam construction at the inlets and within culverts limiting fish movement.

Figure 8. Wetland damage due to ATV use.

Culverts and bridges can restrict flow during high flow events. The constriction of flows at the upstream end of culverts and bridges can reduce stream energy gradients. Reduced energy gradients lower the capacity of streams to carry sediment and can disrupt the normal flushing of fine materials during high flows. Culverts and bridges can reduce the transport of large woody debris which is important in providing cover and diverse fish habitat as well as the retention of transported organic matter and associated nutrients.

Rural housing development often leads to undeveloped recreational ATV and snow machine use which can cause significant impacts to wetlands and water quality, increase in defense of life and property wildlife (DLP) kills, and disrupt nesting waterfowl. Pioneered ATV trails and stream

Figure 9. ATV trail crossing of Answer Creek upstream of the Talkeetna Spur Road.

crossings are considered a major cause of non-point-source water pollution in the Matanuska-Susitna Borough (Figure 8). Nearly 100 illegal ATV fords of anadromous fish streams have been identified east of the Parks Highway between Willow Creek and the Talkeetna River (Davis and Ryland 2002). ATV trails concentrate runoff across disturbed mineral soils that are delivered to adjacent waterbodies (Brown 1994) (Figure 9). The removal of the overlying vegetation varies with soil and vegetation types but occurs after only a few passes (Meyer 2002). The development of an ATV trail on wetland soils creates a low point creating a surface water connection to streams. This can reduce the water storage and retention capacity of wetlands. Surface water connections are not filtered through wetland vegetation eliminating the potential for the removal of sediments and toxins.

The effects of snow machine use to underlying vegetation and hydrology has not been as extensively investigated. However, considerable work has been conducted on the construction of winter roads to support log skidders and log hauling (Ott 1998, Ministry of Natural Resources 2001, Mihalow 1992). Potential impacts can be reduced or eliminated if the underlying soil is frozen and the surface vegetation is protected by snow. Recommendations vary; however, a minimum of 6 inches of frost and 8 to 12 inches of snow is considered necessary (Mihalow 1992). The State of Alaska, Division of Parks and Outdoor Recreation, by Statute is not able to open Parks for snow machine use unless the Director determines that there is adequate snow cover to protect underlying vegetation. In general, 18 inches of snow is required at Nancy Lake, 24 inches at Denali, and 30 inches in Hatcher Pass State Parks (John Wilber, Chief Ranger). Enforcing these guidelines outside of State Parks is often difficult and snow machine use of trails without adequate snow cover can result in impacts at water crossings similar to those observed by ATVs (Davis and Ryland 2002). Similar to summer ATV use, winter travel can affect water movement, runoff, and water quality. Other potential snow machine impacts include wildlife harassment, including denning bears, and the increase in concentrations of hydrocarbons and nitric and sulfuric acids within the snow pack due to incomplete fuel combustion.

Increases in human activity can disrupt wildlife during critical life stages and lead to defense of life and property (DLP) wildlife kills. For example, nesting loons or swans disrupted by human activity often will abandon their nests. Food availability has been related to loon chick survival (Merrill et al. 2005), and human activity can reduce adult loon foraging time and success. Other human factors affecting loon and grebe survival include boat wake damage to nests, loss of shoreline habitat, and lead poisoning from fishing sinkers and ammunition. Both brown and black bears concentrate at fish spawning locations and often depend upon fish biomass for winter survival. Human activity disrupts bear feeding and can increase the likelihood of DLP bear kills (Light, and Burbridge 1985, Schoen 1991). The Alaska Department of Fish and Game (ADFG) 1996 report to the Alaska Board of Game expressed concern for the increase in DLP deaths due to increases in ATV and snow machine use (ADFG 1996).

Due to the importance of wetland and anadromous fish habitat and the potential for developmental impacts, construction within or adjacent to these systems is restricted by local, state and federal laws. Borough ordinance adopting the Question and Little Question Lake Management Plan restricts certain activities within these lakes, such as limiting or prohibiting motorized use. Borough ordinances also prohibit the construction of habitable structures within 75 feet of anadromous lakes and streams. State authorization is required prior to constructing cross-channel structures that may affect migration of any fish species (AS 41.14.840) and prior to conducting activities within specified anadromous fish streams (AS 41.14.870). Section 404 of the federal Water Pollution Control Act requires authorization prior to the placement of fill within waters of the United States, which includes wetlands.

Relative Importance of Resources

The extent of anadromous fish habitat and the diversity of fish species, wetlands and terrestrial habitats within the Numbered Lake Ecosystem is greater than most other similar sized areas within the Upper Susitna and Talkeetna Drainages. For example, the Talkeetna Lakes Park located to the north contains four lakes and stream with a comparable surface area (approximately 194 acres and 2.25 miles) but does not provide the diversity of fish habitat, upland and terrestrial habitats, and bird and wildlife species.

The Talkeetna Lakes are isolated in that they do not have an open water connection to other lakes and stream, and; therefore, do not support anadromous fish or other migrating fish species. Anadromous fish habitat is limited to the tributary stream to Fish Lake. In addition, the Numbered Lakes contain many different types of lake habitats, from large deep lakes to shallow highly productive ponds.

Where the Numbered Lakes are surrounded by contiguous wetland habitats, mixed spruce birch forests extend to the shores of the Talkeetna Lakes. Therefore, the Talkeetna Lakes lack the diverse types of wetland and upland plant community types as well as the ecotones, or areas of transition between different vegetation community types. These diverse plant community types provide multiple different bird and wildlife habitat. Therefore, the Numbered Lakes have multiple different types of spring-fed stream, lake and pond habitats that have a high productivity supporting herbivorous water birds during migration and nesting and rearing. The Numbered Lakes support an abundance of fish species with high quality rearing habitat. Anadromous fish migrations support many different types of wildlife as well as piscivorous birds including loons, grebes, and eagles.

The relatively large amount of salmon spawning habitat and extensive wetlands makes the Numbered Lakes region more susceptible to impacts from human activities relative to the isolated lakes and terrestrial plant communities of the Talkeetna Lakes Park.

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