

APPENDIX B9. PREDATION

1. PREDATION

Several fish species in Alaska, in particular anadromous salmon provide valuable food resources for a variety of aquatic and terrestrial vertebrates. Cederholm et al. (2000) reported that 130 species of terrestrial vertebrates native to Pacific Northwest benefit (or historically benefited) from salmon and 80 of these species regularly utilize salmon. Salmon are consumed by a wide variety of aquatic and terrestrial wildlife including fishes, amphibians, reptiles, waterfowl, gulls, corvids, raptors, rodents, mustelids, canids, and ursids, pinnipeds, and cetaceans (Hilderbrand et al. 2004). The large and concentrated numbers of prey available during downstream and upstream migrations of salmon make these events attractive to many of the predatory species listed above.

Dams, spillways, regulating outlets, and fish passage facilities may increase susceptibility to predation by concentrating and constricting migratory fish, causing fatigue from migration delay, disorientation or injury during passage, or by other means. Focused predation efforts are often evident on migratory fish upstream and downstream of dams when fish are delayed and/or concentrated and the dam forebay and tailrace habitats offer suitable habitat for predatory species. Migrating species may suffer increased susceptibility to predation in the vicinity of an installation as a consequence of operations or passage conditions, for example if fish becoming trapped in turbulence or recirculating eddies or after passage through or spill over a dam if fish are injured, stressed or disoriented.

In addition, as a consequence of altering a stream to create a reservoir, the fish community can be impacted resulting in the expansion and growth of some populations and the decline of others. Often the fish species that can best adapt and thrive in the comparatively slow moving and deep lacustrine environment of a reservoir are different from those that inhabit swift moving riverine environments and frequently are non-native. The results for fish that have evolved migrating through a riverine system can be substantial.

In the extensively studied Columbia River, stress associated with passage through the mainstem dams has made smolts more vulnerable to piscine predators in the immediate vicinity of the dams (Rieman et al. 1991, Mesa 1994, Mesa and Warren 1997). Piscivorous fishes consume large numbers of juvenile salmonids in the Columbia River basin. Annually, an estimated 16 million juvenile salmonids were consumed throughout the basin by a native fish predator, northern pikeminnow (*Ptychocheilus oregonensis*), in the early 1990s (Ward et al. 1995; Beamesderfer et al. 1996). This consumption estimate led to large scale management activities, such as the establishment of bounty fisheries to reduce the number of predatory-sized pikeminnow and reconfiguration of dam outflows to reduce predation rates.

Predation by piscivorous birds on migrating juvenile salmonids may represent a large source of predation mortality. In the Columbia River, piscivorous birds aggregate below hydroelectric dams in the spring to feed on outmigrating fish (Ruggerone 1986). Juvenile salmonids are especially vulnerable to birds and other predators directly below dams because of the disorienting effect of passage and upwelling waters that carries fish close to the surface. Predation on juvenile salmonids during out-migration to the Pacific Ocean is considered a limiting factor in the recovery of Columbia River basin salmonid populations (NMFS 2008a). Studies of avian predation in the Columbia River basin have focused on colonial waterbirds that

nest in the estuary, which currently hosts the largest known colonies of Caspian terns *Hydroprogne caspia* and double-crested cormorants *Phalacrocorax auritus* in western North America (Evans et al. 2012; Lyons et al. 2010).

Research by Evans et al. (2012) indicates that avian predation on outmigrant salmonids can vary by bird and salmonid species. Of the eight salmonid ESUs evaluated, minimum predation rates were highest steelhead, with an estimated 14-16% consumed by terns and cormorants. Among avian predators in the estuary, predation on steelhead was significantly higher from terns (9.7–10.7%) than from cormorants (3.1–5.5%). Of the four Chinook salmon ESUs evaluated, minimum predation rates by terns and cormorants in the estuary varied from 2.5-4.6%. Terns and cormorants in the estuary consumed between 0.9% and 2.4% of available Chinook salmon, which suggests that Chinook salmon ESUs exhibited similar susceptibility to predation. The combined minimum predation rate on Snake River sockeye salmon by terns and cormorants in the estuary was estimated at 3.0%; the predation rate on sockeye salmon was higher for cormorants (2.1%) than for terns (0.9%).

The following additional factors to consider affect fish predation are taken from Bell (1990).

- Unusual congregations of fish, which could result from screens, diversions, bypasses, other obstructions, or large numbers of fish being released at a given location, can lead to increased predation from aquatic, avian, and terrestrial predators.
- Delayed migration, which can result from obstructions and/or disorientation associated with releases, may increase predation.
- Small or juvenile fish concentrated in shallow ponded areas may be particularly vulnerable to predation from certain avian species, such as mergansers, kingfishers, gulls, and blue herons.
- Downstream migrants that have been stressed and/or injured as a result of fish capture and/or handling are more vulnerable to predation.
- Turbid water conditions offer a measure of protection to smaller fish species and life stages by reducing their visibility to aquatic and avian predators.
- Shadowed pathways may be used advantageously by aquatic predators.
- Aquatic predators may utilize sheltered low-velocity areas to attack small fish moving in an active current, such as those associated with the bypasses and collection areas.

2. SUSITNA RIVER FISH PREDATORS

Potential piscivorous fish species in the Study Area include: Arctic grayling, burbot, Dolly Varden, lake trout, northern pike, and rainbow trout (Table B9-1).

2.1. Arctic Grayling

Grayling typically feed on a variety of aquatic and terrestrial invertebrates in the water column or air-water interface (Armstrong 1986). Adult arctic grayling are sight feeders, which consume a wide array of food items primarily in drift. As adults they depend heavily on benthic and terrestrial insects in stream drift but have been observed to feed opportunistically on fish eggs,

small fish, and small mammals (Armstrong 1986; Bishop 1967; Moore and Kenagy 2004; Stewart et al. 2007). Arctic grayling have been found to feed on their own eggs and the eggs of salmon, and small fish including ninespine stickleback and sockeye salmon fry (Warner 1958; Williams 1969; Northcote 1993).

Arctic Grayling are distributed throughout the entire Susitna River Basin, including the following tributaries: Oshetna River (HRM 233.4), Kosina Creek (HRM 206.8), Portage Creek (HRM 148.9), Indian River (HRM 138.6), Montana Creek (HRM 77.0), Kashwitna River (HRM 61.0) and Deshka River (HRM 40.6) (Delaney et al. 1981a, Delaney et al. 1981b, Sundet and Pechek 1985). In the Middle Susitna River, Arctic grayling primarily use mainstem habitats for overwintering and tributaries for spawning and rearing (Schmidt et al. 1983, Schmidt et al. 1984). Upstream of Talkeetna, Arctic grayling move into tributaries to spawn in May and early June (Schmidt et al. 1983, Schmidt et al. 1984). Based on 1980s mark-recapture data, estimated Arctic grayling abundance was higher in the Upper Susitna River relative to the Middle and Lower segments; although, comparable abundance data are limited (Delaney et al. 1981a, Delaney et al. 1981b, Schmidt et al. 1983). Estimated abundance of grayling greater than 200 mm fork length in the Upper Segment was 10,279 (95% confidence interval: 9,194 – 11,654) based on 1981 mark-recapture data, and was 6,783 (95% confidence interval: 4,070 – 15,152) in the Middle Segment based on 1981-1984 data (Delaney et al. 1981b, Sundet and Pechek 1985).

2.2. Burbot

Adult burbot are typically described as piscivores, although the diet can include invertebrates (insects, iso-pods, leeches and crayfish). Numerous studies reviewed by Polacek et al. (2006) indicate that the diet of adult fish is comprised from 38-100% fish. Fish prey made up 75% of the diet in Great Slave Lake (Rawson 1951) and by age-4 fish dominated the diet of burbot in upper Yukon and Tanana River drainages, Alaska (Chen 1969). Common prey items can include ciscoes, sticklebacks, whitefish, etc., as available (McPhail and Lindsey 1970). During the winter, large burbot may shift their diets to include more benthic macroinvertebrates.

Burbot occur throughout the lower, middle, and upper Susitna River basin (Delaney et al. 1981a, Delaney 1981b, Schmidt et al. 1983). Burbot were documented in 8 tributaries in the Upper Susitna River with Jay Creek and Watana Creek supporting the highest abundances (Delaney 1981a). In the mainstem Susitna River, the mouth of the Deshka River (HRM 40.5) is a known spawning area (Schmidt et al. 1983). Burbot spawning also occurs in the Deshka River and likely in the Alexander River (Sundet and Pechek 1985).

Based on studies from the 1980s, burbot appear to be more abundant downstream from the Chulitna River confluence (HRM 98.6) (Sundet and Wenger 1984). In 1983, 15 burbot were estimated to occur between RM 138.9 and 140.1 (Sundet and Wenger 1984). This abundance estimate should be viewed as an approximation because few fish were caught during this study (Sundet and Wenger 1984). During the 1983 sampling efforts, 163 burbot were caught in the Middle Segment of the Susitna River between the Chulitna confluence and Devils Canyon (Sundet and Wenger 1984).

2.3. Dolly Varden

Dolly Varden feed on fish eggs, small fishes and benthic organisms including molluscs, mysids, amphipods, chironomids, plecopterans and other insect larvae and crustaceans (Palmisano and Helm

1971; Stevens and Deschermeier 1986). As Dolly Varden grow and mature, feeding activity decreases and aquatic insects became less important in the diet while crustaceans and fish became more important (Palmisano and Helm 1971). Adult fish incorporate juvenile salmon in the diet (Roos 1959).

Dolly Varden occur in the Susitna River Basin upstream to at least the Oshetna River (Delaney et al. 1981a, Sautner and Stratton 1983). In the Talkeetna-to-Devils Canyon reach, Dolly Varden are found primarily in the upper reaches of tributaries and at tributary mouths (Schmidt et al. 1983, Sundet and Wenger 1984) but also in the mainstem for overwintering (Sundet and Wenger 1984). Spawning and juvenile rearing areas are suspected to be in tributaries (Schmidt et al. 1983). Dolly Varden have been documented in the Upper Susitna River including Lake Louise, the mouth of Fog Creek and within Cheechako, Devil, Watana, Jay, and Deadman creeks (Delaney et al. 1981a, Sautner and Stratton 1983). During June to September 1981, sampling in the Cook Inlet to Talkeetna reach collected Dolly Varden at 52 percent of the habitat locations sampled (Delaney et al. 1981b). Based on two-week sampling periods, the presence of Dolly Varden during sampling efforts ranged from 8 to 20 percent of habitat locations sampled. Dolly Varden were captured most consistently in tributary stream mouth habitat locations, with the highest catches occurring at the mouth of Portage Creek (R.M. 148.8) in early June. Sampling conducted in 1982 captured Dolly Varden at only nine (53%) of the 17 Designated Fish Habitat (DFH) sites (Schmidt et al. 1983). Total Dolly Varden catch was greatest at the Lane Creek and Slough 8 site (n=8); however, only 28 were capture at all DFH sites combined. The population size of Dolly Varden in the Talkeetna-to-Devils Canyon reach appears to be low; they are apparently more abundant downstream from the Chulitna River confluence (RM 98.6) (Schmidt et al. 1984).

2.4. Lake Trout

Lake trout are opportunistic feeders, food items may include zooplankton, insect larvae, small crustaceans, clams, snails, leeches, fish, small mammal and birds. Adult fish incorporate more fish into the diet and may feed extensively on whitefish, grayling, sticklebacks, sculpin, and juvenile salmon (Redick 1967; Morrow 1980).

Jennings (1985) reported that Lake trout occur in the relative large and deep lakes throughout the Susitna Basin. Occasionally, lake trout can also be found in the inlet or outlet streams of these lakes (Jennings 1985). Lake trout distribution in the Susitna River basin is not well understood, but they have been documented in Beaver, Clarence, Crater, Curtis, Stephens, Louise, Little Louise, and Butte lakes (Burr 1987) as well as Deadman and Sally lakes (Sautner and Stratton 1984). Lake trout have not been captured in the mainstem-influenced areas of the Susitna River below Devils Canyon (Jennings 1985). The most detailed information comes from sampling during 1981 in Deadman Lake and during 1981 and 1982 in Sally Lake, which would have been inundated under the proposed project configuration of the 1980s (Delaney et al. 1981a, Sautner and Stratton 1983).

2.5. Rainbow trout

Rainbow trout are opportunistic predators that feed on a wide variety of prey items, including various insects (e.g., dipteran larvae and adults), plankton, crustaceans, snails, leeches, fish eggs, smaller fishes, and adult salmon carcasses (Morrow 1980, Quinn 2005, Scott and Crossman

1973). As fish grow and mature they incorporate fish, salmon carcasses, eggs, and small mammals into the diet.

Within the Susitna River, rainbow trout populations are found up to and including Portage Creek at RM 148.8 (ADF&G 1983). No rainbow trout have been identified upstream of Devils Canyon in the impoundment zone (FERC 1983). Rainbow trout in the Susitna River are distributed throughout tributary and mainstem areas downstream of Devils Canyon (RM 152; Schmidt et al. 1983). Upstream of the Chulitna River confluence (RM 98.6), Whiskers Creek (RM 104.4), Lane Creek (RM 113.6), Fourth of July Creek (RM 131.1), and Portage Creek are the major spawning areas (Sundet and Wenger 1984, Sundet and Pechek 1985). Primary spawning tributaries in the 1980s were the Talkeetna River (RM 97.2), Montana Creek (RM 77.0), and Kashwitna River (RM 61.0) in the Lower Segment (Sundet and Pechek 1985). Primary holding and feeding locations for rainbow trout were the Fourth of July Creek and Indian River (RM 138.6) tributary mouths, Slough 8A (RM 125.1), and Whiskers Creek Slough (RM 101.2; Schmidt et al. 1983). Data collected in the 1980s indicate that adult rainbow trout are more abundant in the Middle Segment of the Susitna River than in the Lower Segment (Schmidt et al. 1983). Based on a tag-recapture study conducted from 1981 to 1983, the estimated abundance of rainbow trout greater than 150 mm in FL in the Middle Segment was approximately 4,000 fish (Sundet and Wenger 1984). In the Lower River in 1984, a total of 155 rainbow trout were captured using multiple capture methods (Sundet and Wenger 1984). The highest number of rainbow trout captures (i.e., 62 fish) occurred in the Deshka River.

2.6. Northern Pike

Northern pike feed primarily on other fish, including their own species. Prey selection is largely based on availability. In Alaska, major prey items include whitefish, small pike, blackfish, burbot, suckers, dragonflies and damselflies (Morrow 1980). Adults may also consume water fowl, frogs, small mammals, and crayfish (Morrow 1980). Northern pike are known to consume large portions of stocked and migrating juvenile salmonids. In southcentral Alaska, juvenile salmon and trout, particularly coho salmon, sockeye salmon, and rainbow trout, are preferred prey for pike (Rutz 1996, 1999). All five species of pacific salmon, along with Arctic grayling, Arctic char, Dolly Varden, burbot, whitefish, blackfish and threespine stickleback are potential prey items (Rutz 1999).

Northern pike are not native to South-central Alaska. They have been illegally released into lakes and streams on the Kenai Peninsula, the Anchorage area, and in the Matanuska-Susitna valleys, and have spread through connected water bodies (Rutz 1999). Within the Susitna River, Northern Pike have been documented in Lower River tributaries as far upstream as the Deshka River (RM 45). The suspected distribution extends to tributaries up to the Three Rivers (Ivey 2009). There is little information specific to the Susitna River regarding northern pike spawning, juvenile emergence, or juvenile rearing. Telemetry studies suggest that adult northern pike do not migrate significant distances within the Susitna Basin; a 1996 study found that over the course of one year, only one out of 18 radio-tagged northern pike moved a distance greater than 10 km and many moved less than 1 km (Rutz 1999).

3. SUSITNA RIVER AVIAN PREDATORS

Of the avifauna that may occur in the study area, cormorants, terns, mergansers, kittiwakes, loons, gulls, kingfishers, grebes, and osprey pose the greatest predation threat to juvenile salmonids (Table B9-2). Other avifauna potentially occurring in the study area that pose a lesser threat but that have been documented to prey on early life stage salmon or small fish include: dippers, goldeneye, scoters, magpies, ravens, canvasbacks, gadwall, scaup, shovelers, swans, and wimbrels (Table B9-2).

3.1. Double breasted cormorant

The double-breasted cormorant *Phalacrocorax auritus* is presently rare in the study area (Table B9-2). The diet of double-breasted cormorants consists largely of fish (generally slow-moving or schooling species), with some occurrence of aquatic animals such as insects, crustaceans, reptiles, and amphibians (Johnsgard 1993, Hatch and Weseloh 1999). They eat a wide variety of fish (more than 250 species have been reported). Its diet is almost exclusively fish with a few crustaceans, with the prey species changing depending on locality. Prey is caught by pursuit-diving, and individuals can fish co-operatively, sometimes with thousands of birds together at one time. Fish prey are usually slow-moving or schooling fish, ranging in size from 3-40 cm [1.2-16 in]), although most commonly less than 15 cm (6 in). The daily dietary requirement of double breasted cormorants is around 500 grams of fish/day (Major et al. 2003). Double-breasted cormorants respond rapidly to high concentrations of fish and will congregate where fish are easily caught, such as “put and take” lakes, stocking release sites, and aquaculture ponds (Hatch and Weseloh 1999, Wires et al. 2001). Predation of juvenile salmonids in the Columbia River system has led to management and control actions including hazing to limit cormorant predation (NMFS 2008a).

3.2. Arctic Tern

Arctic terns *Sterna paradisaea* are fairly common in the lower river study area and pose one of the greatest threats to out migrating juvenile salmonids. Arctic terns typically gather in foraging flocks to plunge dive for juvenile salmonids migrating near the water surface in estuaries or the marine environment (Scheel and Hough 1997). The daily dietary requirement of terns is 60-230 grams of fish/day (Major et al. 2003).

3.3. Mergansers

Common merganser (*Mergus merganser*) and red-breasted merganser (*Mergus serrator*) may be present in the study area during the breeding season. In terms of relative abundance, both species are uncommon. During the outmigration period mergansers foraging in streams prey almost exclusively on juvenile salmon (Wood 1987). Juvenile salmon are consumed extensively by common merganser broods (contributing 80% of body mass at 10 days of age to 40% of body mass at 40 days of age) inhabiting streams in coastal British Columbia (Wood 1987). The daily dietary requirement of mergansers is around 240 grams of fish/day (Major et al. 2003).

3.4. Black-legged kittiwake

The black-legged kittiwake (*Rissa tridactyla*) is a piscivorous seabird that occurs rarely in the study area. Kittiwakes typically gather in foraging flocks to plunge dive for juvenile salmonids migrating near the water surface in estuaries or the marine environment (Scheel and Hough 1997).

3.5. Loons

Common loon (*Gavia immer*), Pacific loon (*Gavia pacifica*), and red throated loon (*Gavia stellata*), may be present in the study area. In terms of relative abundance, the common loon is fairly common while the other species are uncommon (Table B9-2). Loons are visual predators, locating fish by sight and diving deep to catch them. They generally hunt in water 2 to 4 meters deep. Because they rely on sight, clear water is critical to common loons. Loons are principle bird predators of lake resident sockeye salmon fry (Emmett et al. 1991) and other juvenile salmonids in estuaries (Allen and Hassler 1986; Cederholm et al. 2001).

3.6. Herring gull

The herring gull *Larus argentatus* is uncommon in the study area. Small fish encompass the majority of the diet of herring gulls. Herring gulls can consume 200-430 grams of fish each day (Ruggerone 1986). Gulls aggregate at river-mouths during the season of chum salmon migration and feed heavily on juveniles (Kawamura et al. 2000). Predation by ring-billed gulls (*Larus delawarensis*) below hydroelectric dams has been identified as a significant threat to migrant steelhead and salmon smolts in the Columbia and Snake Rivers (Steuber et al 1995). This has led managers to install overhead wire/cable exclusion systems over the tailrace area of 12 dams to reduce gull predation (Steuber et al 1995).

3.7. Belted Kingfisher

The belted kingfisher *Megaceryle alcyon* is uncommon in the study area. The diet of the kingfisher is composed mainly of fish and 88.4% of the diet can be comprised of salmonids when present (Cornwell, 1963). Kingfishers consume salmonids 70-165 mm in length and require 60 grams of prey per day (Major et al 2003). Belted kingfishers are a common predator at hatcheries and smolt acclimation sites (Siegel and Fast 2005).

3.8. Grebes

Grebes that may be present in the study area include horned *Podiceps auritus*, Red-necked *Podiceps grisegena*, and double-crested *Phalacrocorax auritus*. In terms of relative abundance grebes are rare to uncommon in the study area (Table B9-2). Grebes can be significant avian predators of sockeye smolts (Cederholm et al. 2000).

3.9. Osprey

The osprey *Pandion haliaetus* is rare in the study area. The daily dietary requirement of osprey is around 350 grams of fish/day (Major et al. 2003). Fish prey are first sighted when the osprey is 10-40 m above the water surface, after which the bird hovers momentarily then plunges feet

first into the water. While fish make up 99% of the osprey's diet, they are not likely to catch and prey on juvenile or adult salmon as they prefer prey 250-350 mm in length (Evans 1982).

4. SUSITNA RIVER MAMMALIAN PREDATORS

Throughout the Study Area, several terrestrial mammals that prey on fish have been documented (Table B9-3). Many of these species are primarily carnivorous and heavily reliant on fish as part of their diet, while other species exhibit more opportunistic or omnivorous feeding behavior. Fish represent a smaller portion of the diet of the opportunistic feeders. Mammals typically prey upon adult salmon during the migration run to spawning areas or on post-spawn carcasses.

4.1. Brown Bear

Brown bear (*Ursus arctos*) are known to seasonally congregate along salmon-bearing streams and feed heavily on salmon during adult salmon migration and spawning seasons. On the Kenai Peninsula, Alaska, spawning adult salmon and salmon carcasses are the single most important fall food resource to brown bears as they accumulate energy reserves necessary to meet the demands of hibernation and cub production (Hilderbrand et al. 2004). Brown bear presence in the Project Study Area is well known. Previous studies of brown bears in relation to the Project Area in the 1980s were conducted upstream of Devils Canyon; no downstream study was conducted for this species. Brown bears were studied from 1980 to 1985, during which time 97 bears were equipped with VHF radio-collars (Miller 1987). Density was estimated at 27.9 bears/1,000 km² (386 mi²; Miller 1987). Studies in the western Susitna basin (south of the Alaska Range between the Yentna and Chulitna rivers) during 1998–2000 found that habitat use by brown bears varied significantly within years and among seasons for different bears, and habitat use also differed between daytime and night-time periods. Brown bears foraged heavily at salmon spawning streams and salmon consistently composed a major portion of their diet, making an important contribution to body condition (Belant et al. 2006). Black bears avoided salmon streams occupied by defensive brown bears and instead foraged heavily on berries (Belant et al. 2006). The Alaska Department of Fish and Game periodically estimates brown bear density in various parts of GMU 13 encompassing the Project area. Since 1979, those estimates have ranged from 16 to 41 bears/1,000 km² (386 mi²), some of the highest brown bear densities in interior and northern Alaska (Tobey and Kelleyhouse 2007).

4.2. Black Bear

Black bear (*Ursus americanus*) also feed on salmon, but generally avoid salmon-bearing streams when brown bears are present. There are no current estimates of population size for black bears in the upstream or downstream study areas along the Susitna River (AEA PAD 2011). Although black bears in the upstream area occasionally ate moose calves, berries seemed to be their most important food source (LGL 1985). Bears spent most of their time in forested areas along creek bottoms, but moved out into adjacent shrublands during late summer as they foraged for berries, particularly in the area between Tsusena and Deadman creeks, near the proposed Watana reservoir (Miller 1987). Berries were an important food for black bears in the downstream area as well. In contrast to the upstream area, movement data showed that black bears in the downstream area moved to riparian areas in July and August. Miller (1987) hypothesized that

those black bears were eating salmon along river sloughs; however, he conducted a scat study in late August and concluded that black bears were foraging almost exclusively on the berries of devil's club (*Oplopanax horridus*) rather than salmon.

4.3. Red fox

Red foxes (*Vulpes vulpes*) are canine species that consume fish as part of their diet. The red fox is an opportunistic predator and consumes a wide-variety of prey items, including both invertebrates and vertebrates. The population density of red foxes in the study area was estimated at 1 family/83 km² (32 mi²; Gipson et al. 1982). Radiotelemetry data showed that dispersing foxes readily crossed the Susitna River (Gipson et al. 1982).

4.4. Gray Wolf

Gray wolves (*Canis lupus*) are canine species that consume fish as part of their diet. The gray wolf commonly hunts large mammal species such as caribou (*Rangifer tarandus*), although recent studies in coastal Alaska and British Columbia suggest adult salmon may also be an important part of a wolf's diet, particularly during salmon spawning runs (Szepanski et al. 1999; Darimont and Reimchen 2002; Darimont et al. 2008). Since 2006, the number of wolves has been within the current management goal range of 135–165 wolves (3.3–4.1 wolves/1,000 km²) for the unit, after the end of the hunting and trapping seasons (AEA PAD 2011).

4.5. Marten

In years of low rodent numbers, salmon carcasses are a major component of the autumn diet of martens (*Martes americana*) in southeast Alaska (Ben-David et al. 1997). The population density of marten in the area that would have been inundated by both of the original APA Susitna Hydroelectric Project reservoirs was estimated at 84.7 animals/100 km² (Gipson et al. 1984). Marten occurred from Portage Creek to the Tyrone River, but their density was highest between Devil Creek and Vee Canyon (Gipson et al. 1982). The total population of marten in both impoundment zones was estimated as a minimum of 218 animals, but aerial track surveys suggested that the population could be up to twice that number (Gipson et al. 1984). Nearly three times as many marten were estimated to inhabit the Watana impoundment zone as the Devils Canyon impoundment zone (Gipson et al. 1982). Marten rarely crossed water that would require them to swim; the Susitna River and larger creeks formed home range boundaries (Gipson et al. 1982). Food habits were studied by analyzing marten scat and gastrointestinal tract contents (Gipson et al. 1984). Microtine rodents and squirrels were the most important food classes during fall, winter, and spring.

River otter (*Lontra canadensis*) and mink, and weasel are small furbearing species that feed on a variety of prey items, including fish. These species are associated with riparian and aquatic habitats. River otters were distributed fairly evenly throughout the upper Susitna drainage below 1,200 m (3,936 ft) elevation. During a November survey in the 1980s, large numbers of otter tracks were seen on shelf ice along the Susitna River; those otters were thought to have been feeding on grayling as the fish left tributaries to overwinter in the Susitna. River otters have been documented preying adult salmon in fish passage facilities (Mehaffey 2012). Mink tracks were observed along all major tributaries below 1,200 m elevation; 50 percent of all mink tracks

were in the upper reaches of the Watana impoundment zone. Most (87 percent) of the weasel tracks recorded were in the upper reaches of the study area near the Oshetna River.

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6. TABLES

Table B9-1. Summary of life history, known Susitna River usage, and known extent of distribution of fish species within the Lower, Middle, and Upper Susitna River Segments (from RSP compiled from ADF&G 1981 a, b, c, etc.).

Common Name	Scientific Name	Life History ^a	Susitna Usage ^b	Distribution ^c	Piscivorous
Alaska blackfish	<i>Dallia pectoralis</i>	F	U	U	n/a
Arctic grayling	<i>Thymallus arcticus</i>	F	O, R, P	Low, Mid, Up	Yes
Arctic lamprey	<i>Lethenteron japonicum</i>	A,F	O, M ₂ , R, P	Low, Mid	n/a
Bering cisco	<i>Coregonus laurettae</i>	A	M ₂ , S	Low, Mid	No
Burbot	<i>Lota lota</i>	F	O, R, P	Low, Mid, Up	Yes
Chinook salmon	<i>Oncorhynchus tshawytscha</i>	A	M ₂ , R	Low, Mid, Up	n/a
Chum salmon	<i>Oncorhynchus keta</i>	A	M ₂ , S	Low, Mid	n/a
Coho salmon	<i>Oncorhynchus kisutch</i>	A	M ₂ , S, R	Low, Mid	n/a
Dolly Varden	<i>Salvelinus malma</i>	A,F	O, P	Low, Mid, Up	Yes
Eulachon	<i>Thaleichthys pacificus</i>	A	M ₂ , S	Low	No
Humpback whitefish ^d	<i>Coregonus pidschian</i>	A,F	O, R, P	Low, Mid, Up	No
Lake trout	<i>Salvelinus namaycush</i>	F	U	U	Yes
Longnose sucker	<i>Catostomus catostomus</i>	F	R, P	Low, Mid, Up	No
Northern pike	<i>Esox lucius</i>	F	P	Low, Mid	Yes
Pink salmon	<i>Oncorhynchus gorbuscha</i>	A	M ₂ , R	Low, Mid	n/a
Rainbow trout	<i>Oncorhynchus mykiss</i>	F	O, M ₂ , P	Low, Mid	Yes
Round whitefish	<i>Prosopium cylindraceum</i>	F	O, M ₂ , P	Low, Mid, Up	No
Sculpin ^e	<i>Cottid</i>	M ₁ ^f , F	P	Low, Mid, Up	n/a
Sockeye salmon	<i>Oncorhynchus nerka</i>	A	M ₂ , S	Low, Mid	n/a
Threespine stickleback	<i>Gasterosteus aculeatus</i>	A,F	M ₂ , S, R, P	Low, Mid	No

Notes:

- 1 ^a A = anadromous, F = freshwater, M1 = marine
- 2 ^b O = overwintering, P = present, R = rearing, S = spawning, U = unknown, M2 = migration
- 3 ^c Low = Lower River, Mid = Middle River, Up = Upper River, U = Unknown
- 4 ^d Whitefish species that were not identifiable to species by physical characteristics in the field were called humpback by default. This group may have contained Lake (*Coregonus clupeaformis*), or Alaska (*Coregonus nelsonii*) whitefish.
- 5 ^e Sculpin species generally were not differentiated in the field. This group may have included Slimy (*Cottus cognatus*), Prickly (*Cottus asper*), Coastal range (*Cottus aleuticus*), and Pacific staghorn (*Leptocottus armatus*).
- 6 ^f Pacific staghorn sculpin were found in freshwater habitat within the Lower Susitna River Segment.

Table B9-2. Avian species potentially occurring in the study area (from AEA PAD 2011 and ABR 2011), relative abundance, and association with salmon predation by lifestage.

English Name	Scientific Name	Status ¹	Relative Abundance ²	Salmon Predation ³			
				Incubation	Freshwater Rearing	Spawning	Carcass
Alder Flycatcher	<i>Empidonax alnorum</i>	B	uncommon				
American Dipper	<i>Cinclus mexicanus</i>	R	uncommon	x	x		
American Golden-Plover	<i>Pluvialis dominica</i>	B	common				
American Kestrel	<i>Falco sparverius</i>	M	rare				
American Pipit	<i>Anthus rubescens</i>	B	common				
American Robin	<i>Turdus migratorius</i>	B	common	x			
American Three-toed woodpecker	<i>Picoides dorsalis</i>	R	uncommon				
American Tree Sparrow	<i>Spizella aborea</i>	B	abundant				
American Wigeon	<i>Anas americana</i>	B	fairly common				
Arctic Tern	<i>Sterna paradisaea</i>	B	fairly common		X		
Arctic Warbler	<i>Phylloscopus borealis</i>	B	fairly common				
Baird's Sandpiper	<i>Calidris bairdii</i>	B	uncommon				
Bald Eagle	<i>Haliaeetus leucocephalus</i>	B	uncommon			x	X
Bank Swallow	<i>Riparia riparia</i>	B	common				
Barrow's Goldeneye	<i>Bucephala islandica</i>	B	fairly common	x	x		x
Belted Kingfisher	<i>Megaceryle alcyon</i>	B	uncommon		X	X	
Black Scoter	<i>Melanitta americana</i>	B	fairly common	x	x		
Black-backed Woodpecker	<i>Picoides arcticus</i>	R	rare				
Black-billed Magpie	<i>Pica hudsonia</i>	R	uncommon		x		x
Black-capped Chickadee	<i>Poecile atricapillus</i>	R	uncommon				
Black-legged Kittiwake	<i>Rissa tridactyla</i>	M	rare		X		
Blackpoll Warbler	<i>Dendroica striata</i>	B	fairly common				
Blue-winged Teal	<i>Anas discors</i>	M	rare				
Bohemian Waxwing	<i>Bombycilla garrulus</i>	B	common				
Bonaparte's Gull	<i>Chroicocephalus philadelphia</i>	B, S	uncommon	x			x
Boreal Chickadee	<i>Poecile hudsonicus</i>	R	fairly common				
Boreal Owl	<i>Aegolius funereus</i>	R	rare				
Brant	<i>Branta bernicla</i>	M	not present				
Brown Creeper	<i>Certhia americana</i>	B	uncommon				
Bufflehead	<i>Bucephala albeola</i>	M	uncommon	x			
Canada Goose	<i>Branta canadensis</i>	M	uncommon				

English Name	Scientific Name	Status ¹	Relative Abundance ²	Salmon Predation ³			
				Incubation	Freshwater Rearing	Spawning	Carcass
Canvasback	<i>Aythya valisineria</i>	M	uncommon		x		
Cliff Swallow	<i>Petrochelidon pyrrhonota</i>	B	common				
Common Goldeneye	<i>Bucephala clangula</i>	B	fairly common	x	x		x
Common Loon	<i>Gavia immer</i>	B	fairly common		X		
Common Merganser	<i>Mergus merganser</i>	B	uncommon	x	X		
Common Raven	<i>Corvus corax</i>	R	common		x	x	X
Common Redpoll	<i>Acanthis flammea</i>	R	abundant				
Dark-eyed Junco	<i>Junco hyemalis</i>	B	common				
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	?	rare		X		
Downy Woodpecker	<i>Picoides pubescens</i>	R	uncommon				
Eastern Kingbird	<i>Tyrannus tyrannus</i>	A	accidental				
Fox Sparrow	<i>Passerella iliaca</i>	B	fairly common				
Gadwall	<i>Anas strepera</i>	M, S	rare		x		
Golden Eagle	<i>Aquila chrysaetos</i>	B	fairly common			x	X
Golden-crowned Kinglet	<i>Regulus satrapa</i>	M	uncommon				
Golden-crowned Sparrow	<i>Zonotrichia atricapilla</i>	B	uncommon				
Gray Jay	<i>Perisoreus canadensis</i>	R	common				
Gray-cheeked Thrush	<i>Catharus minimus</i>	B	fairly common				
Gray-crowned Rosy-Finch	<i>Leucosticte tephrocotis</i>	B	common				
Great Horned Owl	<i>Bubo virginianus</i>	R	uncommon				
Greater Scaup	<i>Aythya marila</i>	B	common	x			
Greater White-fronted goose	<i>Anser albifrons</i>	M	uncommon				
Greater Yellowlegs	<i>Tringa melanoleuca</i>	B	uncommon	x			
Green-winged Teal	<i>Anas crecca</i>	B	fairly common				
Gyr Falcon	<i>Falco rusticolus</i>	R	uncommon				
Hairy Woodpecker	<i>Picoides villosus</i>	R	uncommon				
Harlequin Duck	<i>Histrionicus histrionicus</i>	B	fairly common	x			
Hermit Thrush	<i>Catharus guttatus</i>	B	common				
Herring Gull	<i>Larus argentatus</i>	M, S	uncommon		X		x
Horned Grebe	<i>Podiceps auritus</i>	B	uncommon	x			
Horned Lark	<i>Eremophila alpestris</i>	B	common				
Lapland Longspur	<i>Calcarius lapponicus</i>	B	abundant				

English Name	Scientific Name	Status ¹	Relative Abundance ²	Salmon Predation ³			
				Incubation	Freshwater Rearing	Spawning	Carcass
Least Sandpiper	<i>Calidris minutilla</i>	B	fairly common				
Lesser Scaup	<i>Aythya affinis</i>	B	common		x		
Lesser Yellowlegs	<i>Tringa flavipes</i>	B, M	fairly common				
Lincoln's Sparrow	<i>Melospiza lincolni</i>	B	uncommon				
Long-billed Dowitcher	<i>Limnodromus scolopaceus</i>	M	uncommon				
Long-tailed Duck	<i>Clangula hyemalis</i>	B	fairly common				
Long-tailed Jaeger	<i>Stercorarius longicaudus</i>	B	fairly common				
Mallard	<i>Anas platyrhynchos</i>	B	common	x			
Merlin	<i>Falco columbarius</i>	B	uncommon				
Mew Gull	<i>Larus canus</i>	B, S	common	x			
Northern Flicker	<i>Colaptes auratus</i>	B	uncommon				
Northern Goshawk	<i>Accipiter gentilis</i>	B	uncommon				
Northern Harrier	<i>Circus cyaneus</i>	B	fairly common				
Northern Hawk Owl	<i>Surnia ulula</i>	R	uncommon				
Northern Pintail	<i>Anas acuta</i>	B	common				
Northern Shoveler	<i>Anas clypeata</i>	B	uncommon		x		
Northern Shrike	<i>Lanius excubitor</i>	B	uncommon				
Northern Waterthrush	<i>Parkesia noveboracensis</i>	B	fairly common				
Northern Wheatear	<i>Oenanthe oenanthe</i>	B	uncommon				
Olive-sided Flycatcher	<i>Contopus cooperi</i>	B	uncommon				
Orange-crowned Warbler	<i>Oreothlypis celata</i>	B	uncommon				
Osprey	<i>Pandion haliaetus</i>	M	rare		X	x	
Pacific Loon	<i>Gavia pacifica</i>	B	uncommon		X		
Parasitic Jaeger	<i>Stercorarius parasiticus</i>	M	rare				
Pectoral Sandpiper	<i>Calidris melanotos</i>	M	uncommon				
Peregrine Falcon	<i>Falco peregrinus</i>	M	unknown				
Pine Grosbeak	<i>Pinicola enucleator</i>	R	uncommon				
Pine Siskin	<i>Spinus pinus</i>	B	uncommon				
Pine Siskin	<i>Spinus pinus</i>	B	uncommon				
Red-breasted Merganser	<i>Mergus serrator</i>	B	uncommon	x	X		
Redhead	<i>Aythya americana</i>	M	uncommon				
Red-necked Grebe	<i>Podiceps grisegena</i>	B	uncommon		X		
Red-necked Phalarope	<i>Phalaropus lobatus</i>	B	fairly common				

English Name	Scientific Name	Status ¹	Relative Abundance ²	Salmon Predation ³			
				Incubation	Freshwater Rearing	Spawning	Carcass
Red-tailed Hawk	<i>Buteo jamaicensis</i>	B	uncommon				
Red-throated Loon	<i>Gavia stellata</i>	B	uncommon		X		
Ring-necked Duck	<i>Aythya collaris</i>	M	rare				
Rock Ptarmigan	<i>Lagopus muta</i>	R	common				
Ruby-crowned Kinglet	<i>Regulus calendula</i>	B	common				
Ruffed Grouse	<i>Bonasa umbellus</i>	R	rare				
Rusty Blackbird	<i>Euphagus carolinus</i>	B?, M, S	uncommon				
Sanderling	<i>Calidris alba</i>	M	rare				
Sandhill Crane	<i>Grus canadensis</i>	M	uncommon				
Savannah Sparrow	<i>Passerculus sandwichensis</i>	B	abundant				
Say's Phoebe	<i>Sayornis saya</i>	B	uncommon				
Semipalmated Plover	<i>Charadrius semipalmatus</i>	B	uncommon				
Semipalmated Sandpiper	<i>Calidris pusilla</i>	B, M	uncommon				
Sharp-shinned Hawk	<i>Accipiter striatus</i>	B	uncommon				
Short-eared Owl	<i>Asio flammeus</i>	B?, M, S	uncommon				
Smith's Longspur	<i>Calcarius pictus</i>	B	uncommon				
Snow Bunting	<i>Plectrophenax nivalis</i>	B	fairly common				
Snow Goose	<i>Chen caerulescens</i>	M	uncommon				
Snowy Owl	<i>Bubo scandiacus</i>	M	rare				
Solitary Sandpiper	<i>Tringa solitaria</i>	B	uncommon				
Spotted Sandpiper	<i>Actitis macularius</i>	B	common				
Spruce Grouse	<i>Falcipecten canadensis</i>	R	fairly common				
Surf Scoter	<i>Melanitta perspicillata</i>	B	fairly common				
Surfbird	<i>Aphriza virgata</i>	B	rare				
Swainson's Thrush	<i>Catharus ustulatus</i>	B	fairly common				
Townsend's Solitaire	<i>Myadestes townsendi</i>	B	uncommon				
Tree Swallow	<i>Tachycineta bicolor</i>	B	fairly common				
Trumpeter Swan	<i>Cygnus buccinator</i>	B	fairly common	x	x		
Tundra Swan	<i>Cygnus columbianus</i>	M	uncommon	x	x		
Upland Sandpiper	<i>Bartramia longicauda</i>	B	rare				
Varied Thrush	<i>Ixoreus naevius</i>	B	common	x			
Violet-green Swallow	<i>Tachycineta thalassina</i>	B	fairly common				
Wandering Tattler	<i>Tringa incana</i>	B, M	uncommon				

English Name	Scientific Name	Status ¹	Relative Abundance ²	Salmon Predation ³			
				Incubation	Freshwater Rearing	Spawning	Carcass
Western Wood-Pewee	<i>Contopus sordidulus</i>	B	rare				
Whimbrel	<i>Numenius phaeopus</i>	B	uncommon		x		
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>	B	abundant				
White-tailed Ptarmigan	<i>Lagopus leucura</i>	R	uncommon				
White-winged Crossbill	<i>Loxia leucoptera</i>	B, S	fairly common				
White-winged Scoter	<i>Melanitta fusca</i>	M	fairly common		x		
Willow Ptarmigan	<i>Lagopus lagopus</i>	R	common				
Wilson's Snipe	<i>Gallinago delicata</i>	B	common				
Wilson's Warbler	<i>Wilsonia pusilla</i>	B	common				
Yellow Warbler	<i>Dendroica petechia</i>	B	rare				
Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>	?	rare				
Yellow-rumped Warbler	<i>Dendroica coronata</i>	B	common				

Notes:

- 1 ¹M = migrant (transient); B = breeding; S = summering; R = resident; ? = uncertain (Kessel et al. 1982; APA 1985: AEA PAD 2011 Appendices E5.3 and E6.3).
- 2 ² From Kessel et al. (1982) and APA (1985: AEA PAD 2011 Appendices E5.3 and E6.3).
- 3 ³ predation of salmon by lifestage based on Cederholm et al. 2000; and birdlife.org. 2013; X: major predator, x: lesser predator

Table B9-3. Mammalian species potentially occurring in the study area (from AEA PAD 2011 and ABR 2011 and association with salmon predation by lifestage.

English Name	Scientific Name	Predation ¹			
		Incubation	Freshwater Rearing	Spawning	Carcass
Alaska tiny shrew	<i>Sorex yukonicus</i>				X
Arctic ground squirrel	<i>Spermophilus parryii</i>				
Beaver	<i>Castor canadensis</i>				
Black bear	<i>Ursus americanus</i>			X	X
Brown bear	<i>Ursus arctos</i>			X	X
Brown lemming	<i>Lemmus trimucronatus</i>				
Caribou	<i>Rangifer tarandus</i>				
Cinereus shrew	<i>Sorex cinereus</i>				X
Collared pika	<i>Ochotona collaris</i>				
Coyote	<i>Canis latrans</i>				X
Dall's sheep	<i>Ovis dalli</i>				
Dusky shrew	<i>Sorex monticolus</i>				X
Hoary marmot	<i>Marmota caligata</i>				
Least weasel	<i>Mustela nivalis</i>				X
Little brown bat	<i>Myotis lucifugus</i>				
Lynx	<i>Lynx canadensis</i>				
Marten	<i>Martes americana</i>				X
Meadow jumping mouse	<i>Zapus hudsonius</i>				
Meadow vole	<i>Microtus pennsylvanicus</i>				
Mink	<i>Neovison vison</i>		X	X	X
Moose	<i>Alces americanus</i>				
Mountain goat	<i>Oreamnos americanus</i>				
Muskrat	<i>Ondatra zibethicus</i>				
Northern bog lemming	<i>Synaptomys borealis</i>				
Northern red-backed vole	<i>Myodes rutilus</i>				
Porcupine	<i>Erethizon dorsatum</i>				
Pygmy shrew	<i>Sorex hoyi</i>				
Red fox	<i>Vulpes vulpes</i>				X
Red squirrel	<i>Tamiasciurus hudsonicus</i>				
River otter	<i>Lontra canadensis</i>		X	X	X
Root vole	<i>Microtus oeconomus</i>				
short-tailed weasel	<i>Mustela erminea</i>				X

English Name	Scientific Name	Predation ¹			
		Incubation	Freshwater Rearing	Spawning	Carcass
Singing vole	<i>Microtus miurus</i>				
Snowshoe hare	<i>Lepus americanus</i>				
Tundra shrew	<i>Sorex tundrensis</i>				X
Water shrew	<i>Sorex palustris</i>	X	X		X
Wolf	<i>Canis lupus</i>			X	X
Wolverine	<i>Gulo gulo</i>				X

Notes:

- 1 ¹predation of salmon by lifestage based on Cederholm et al. 2000
- 2 Sources: Kessel et al. (1982); APA (1985b: Appendix E7.3); MacDonald and Cook (2009); continental modifiers of English names (e.g., North American river otter) have been dropped from this list.