16. WILDLIFE AND HABITAT

16.1 Habitat Mapping and Habitat-value Assessments—Mine Study Area

16.1.1 Introduction

Wildlife habitats in the mine study area (Figure 1-4 in Chapter 1) were mapped to provide a baseline inventory of the availability of wildlife habitats and evaluated for use by wildlife to assess the value of those mapped habitats to a selected set of bird and mammal species of concern.

Field surveys to collect information on vegetation, physiography, landforms, and surface forms in the mine study area were conducted in August 2004 and August and September 2005. Physiography was mapped by photo-interpretation of true-color aerial photographs acquired for the mine study area in July 2004. Multivariate wildlife habitats were derived by adding physiographic information (and landform and surface-form information, as needed) to the vegetation mapping polygons prepared for the study area by Three Parameters Plus, Inc., and HDR Alaska, Inc.

To assess the use of the mapped habitat types by important species of wildlife, 38 bird and mammal species of concern (25 bird species and 13 mammal species) that are known or have the potential to occur in the mine study area were selected for their conservation, cultural, and/or ecological importance. Habitat use for each species in each mapped habitat type was qualitatively categorized into one of four value classes (high, moderate, low, or negligible value) based primarily on wildlife survey data specific to the mine study area and habitat-use information from scientific literature.

16.1.2 Results and Discussion

Twenty-five types of wildlife habitat were mapped in the mine study area. Two habitat types (Upland Moist Dwarf Scrub and Alpine Moist Dwarf Scrub[1]) account for 52 percent of the study area. Barren habitats in upland and alpine areas cover another 7 percent of the area. Willow- and alder-scrub habitats in both low and tall forms are common (21 percent of the study area) and occur primarily in protected upland and riverine areas. Wetter low and tall willow-scrub habitats are more rare (2 percent of the study area) and occur in poorly drained lowland areas often adjacent to inactive riverine features. As is typical of other mountainous areas in southwestern Alaska, only small patches of forest habitats occur. Lacustrine waterbodies, wet graminoid-dominated meadows, and shrub-dominated bog habitats occur primarily in lowland and riverine physiographic settings (8 percent of the study area). Marsh habitats are rare and occur along the margins of lakes and ponds. Three prominent riverine corridors (the north and

1. The names of habitat types that were mapped in this study are capitalized, while the names of general habitat types that were not mapped, such as forest, scrub, meadow, etc., are not capitalized.

south forks of the Koktuli River and Upper Talarik Creek) traverse the study area and support numerous stream channels and associated riverine meadow and scrub vegetation. Many of the streams support anadromous fish populations and provide foraging opportunities for wildlife.

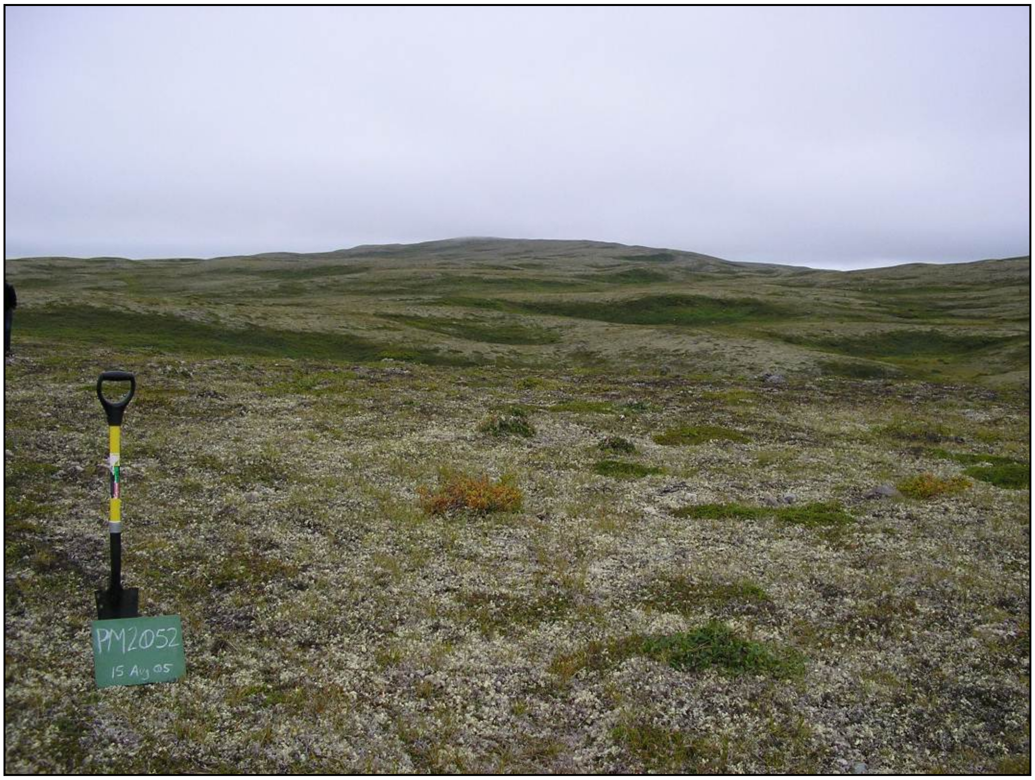
The results of the wildlife habitat-value assessments indicate that the most species-rich habitats are the open and poorly drained types. Three habitats (Lowland Ericaceous Scrub Bog, Lowland Wet Graminoid-Shrub Meadow, and Riverine Wet Graminoid-Shrub Meadow) had the greatest numbers (19 to 20 species) of bird and mammal species of concern that were given moderate- or high-value habitat rankings based on study specific criteria. Concentrations of these habitat types occur directly north of Frying Pan Lake, in the headwaters of Upper Talarik Creek, in the complex of waterbodies in the north-central portion of the study area, and along the north and south forks of the Koktuli River.

The mine study area provides at least some suitable habitat (moderate- and/or high-value habitat rankings) for 13 mammal species of concern—wolf, red fox, river otter, wolverine, brown bear, moose, caribou, arctic ground squirrel, red squirrel, beaver, northern red-backed vole, tundra vole, and snowshoe hare.

Brown bears are known to use a wide variety of habitats depending on the season, and 20 habitat types were considered to be of moderate value for brown bears; these types are common and widespread in the study area. One habitat type (Rivers and Streams [Anadromous]) was considered to be of high value for brown bears because salmon streams are heavily used by foraging bears in late summer. For moose, willow-scrub habitats, riverine forests, and lacustrine waterbodies were considered to be of high value, although moose have been recorded only infrequently. Moderate- and high-value moose habitats are concentrated in the stream drainage systems. Caribou pass through in midsummer after calving elsewhere, and they are not known to winter in the area. Because of this, no habitats were considered to be of high value for caribou. However, a set of 14 (primarily open) habitats was considered to be of moderate value for caribou; these habitats are common and widespread in the study area.

For birds, the mine study area provides at least some suitable habitat (moderate- and/or high-value habitat rankings) for 25 species of concern: seven raptor species (Bald Eagle, Northern Goshawk, Golden Eagle, Merlin, Gyrfalcon, Peregrine Falcon, Great Horned Owl), eight waterbird species (Tundra Swan, Harlequin Duck, Surf Scoter, American Scoter, Long-tailed Duck, Red-throated Loon, Common Loon, Arctic Tern), six shorebird species (American Golden-Plover, Lesser Yellowlegs, Whimbrel, Hudsonian Godwit, Surfbird, Short-billed Dowitcher), and four landbird species (Willow Ptarmigan, Rock Ptarmigan, Gray-cheeked Thrush, Blackpoll Warbler).

Habitats considered suitable for nesting and/or foraging tree-nesting raptors (forests, lacustrine and riverine waterbodies, and some barren habitats) are of limited occurrence in the study area. In contrast, the study area provides abundant (mostly open) habitat for cliff-nesting raptors. Thirteen barren, scrub, forest, meadow, scrub-bog, marsh, riverine, and lacustrine habitats suitable for nesting and/or foraging cliff-nesting raptors are common and widespread. For breeding and migrant waterbirds, suitable habitats in the study area include lacustrine waterbodies and stream drainages and associated wetland habitats, low and dwarf scrub, riverine forests, marshes, scrub-bogs, and meadows. These habitats are concentrated in the lower-elevation headwaters areas of the three primary riverine corridors. Suitable habitats for breeding shorebirds include wet, lowland meadows, scrub-bogs, and marshes, especially when adjacent to lacustrine or riverine waterbodies. Concentrations of these habitats occur directly north of Frying Pan Lake, in the headwaters of Upper Talarik Creek, and in the complex of waterbodies in the north-central portion of the study area. Well-drained upland and alpine habitats also are used for breeding by other shorebird species, and these habitats are widely distributed in the study area. Habitats suitable for breeding landbirds include tall willow and alder scrub in upland, lowland, and riverine areas. In general, these habitats are widely distributed across the study area, although concentrations tend to occur in stream drainage systems. Landbirds also use low- and dwarf-scrub habitats, barrens, scrub-bogs, and forests in a variety of physiographic settings. These landbird habitats occur commonly across the study area.



Upland Dry Dwarf Shrub-Lichen Scrub, mine study area, August 2005

Rivers and Streams (Anadromous) with Riverine Low and Tall Willow Scrub, mine study area, August 2005

Lowland Low and Tall Willow Scrub, mine study area, August 2005

Lowland Sedge-Forb Marsh, mine study area, August 2005

16.2 Terrestrial Mammals—Mine Study Area

16.2.1 Introduction

Forty species of mammals are known (or are strongly suspected) to occur in the geographic region of the Bristol Bay drainages in which the mine study area (Figure 1-4 in Chapter 1) is located.

The caribou is one of the most abundant large mammals in the region and is important to both subsistence and sport hunters. The mine study area is located within the annual range of the Mulchatna Caribou Herd (MCH), one of the larger herds in the state. Other species of large mammals also are ecologically and economically important inhabitants of the region. Brown bears are abundant in southwestern Alaska, whereas black bears occur only in the northern portion of the region in lower densities. Moose occur throughout the region in low densities, and winter concentrations have been noted previously in the Upper Talarik Creek drainage on the east side of the mine study area. These species were of primary interest for Pebble Project surveys, but all mammal species encountered incidentally, such as gray wolf and other species of large furbearers, were recorded. Mammal observations also were recorded incidentally during bird surveys (waterfowl, raptors, and breeding birds).

Field surveys were conducted periodically from April through November 2004, March through December 2005, May through July and in December 2006, June and July 2007, May 2009, and April 2010. Specific work elements included the following tasks:

- Collection and review of relevant literature on all species of mammals inhabiting the region around the Pebble Deposit.
- Acquisition and analysis of radio-telemetry data on the MCH collected by the interagency MCH Technical Working Group.
- Aerial strip-transect surveys within the mine study area during various seasons.
- Aerial line-transect survey to estimate the population density of bears in the Iliamna Lake region.
- Aerial quadrat survey to estimate the population density of moose in the mine and transportation-corridor study areas.
- Aerial survey of brown bears along salmon-spawning streams and examination of dens of brown bears and gray wolves in and near the mine study area.
- Aerial survey of beaver colonies throughout the mine study area.
- Collection of wildlife observations by other Pebble Project personnel.

16.2.2 Results and Discussion

Analysis of 29 years of telemetry data from radio-collared animals in the MCH documented seasonal patterns and changes in range use as the herd grew and expanded its range during the 1980s and 1990s. According to telemetry data locations, over all years, the greater mine study area has experienced moderate- to high-density use during spring, low-density use during calving, high-density use during summer and winter, and moderate-density use during autumn.

Brown bears were common in the mine study area, whereas black bears were recorded only rarely. Brown bears were recorded consistently during mammal surveys conducted during the nondenning season (May-October) in 2004 through 2007. Incidental sightings during other wildlife surveys in and near the mine study area produced additional sightings. The bear population survey conducted in collaboration with the Alaska Department of Fish and Game during May 2009 in the region surrounding Iliamna Lake produced density estimates of 47.7 to 58.3 brown bears per 1,000 square kilometers.

A moose population survey in the mine study area in April 2010 estimated 33 moose in the 1,178-square-kilometer survey area, an estimated density of 0.03 moose per square kilometer. The population density of moose may be higher in the fall and early winter when moose use habitats at higher elevations than they frequent later in the winter.

Wolves and wolverines were seen during aerial surveys for mammals and as incidental observations during surveys for other species. The mine study area generally hosts low densities of brown bears, moose, wolves, and wolverines throughout the year.

Because most of these species are highly mobile and cover relatively large home ranges, the numbers of animals using the area vary seasonally and even daily; in addition, the detectability of animals in shrub and forest cover is low. Therefore, the numbers observed and densities calculated from these surveys are low estimates of the use of the mine study area by large mammals throughout the year.

A family of river otters observed during a waterbird brood survey in the deposit area, July 2005.

A wolverine encountered in the mine study area during a waterbird brood survey in July 2005.

Part of a large aggregation of caribou finds relief from insect harassment on a remnant snowfield, Koktuli Mountain, late June 2007.

A group of caribou finds relief from insect harassment on a remnant snow bank, Koktuli Mountain, July 2007.

A family group of brown bears feeds on fresh spring vegetation, May 2009.

Two moose observed during the moose population survey in April 2010.

16.3 Raptors—Mine Study Area

16.3.1 Introduction

Studies were undertaken in 2004 and 2005 to collect baseline data on the distribution, abundance, and nesting status and habitat use of large tree- and cliff-nesting birds of prey (raptors) in the mine study area (Figure 1-4 in Chapter 1). Information on all raptors and Common Ravens was recorded, but special emphasis was placed on species of conservation concern, protected species, and species potentially sensitive to disturbance (Bald and Golden eagles, Gyrfalcon, Peregrine Falcon, Rough-legged Hawk, Northern Goshawk, Osprey, and Great Horned Owl). In addition, fall and winter surveys were undertaken in 2005 and 2006 to gather information on wintering Bald Eagles. Also, researchers developed aircraft guidelines to avoid disturbance of wildlife, including nesting raptors.

Field work was conducted primarily during April and May 2004, May through August 2005, and late fall and mid-winter 2005 and 2006. Aerial surveys were conducted by helicopter for all nest occupancy and productivity surveys and for most winter Bald Eagle surveys.

16.3.2 Results and Discussion

During aerial surveys, researchers recorded ten raptor species and Common Ravens in the mine study area, but at least 19 species of raptors may occur in the general region. Seventy-three nests of seven raptor species (Bald and Golden eagles, Osprey, Gyrfalcon, Merlin, Rough-legged Hawk, and Great Horned Owl) and the Common Raven were recorded in the mine study area. The greatest densities of woodland nest sites were located along Upper Talarik Creek, while the greatest densities of nest sites on cliffs were found on small canyons along Upper Talarik Creek and uplands between and including Groundhog Mountain and mountains east of Frying Pan Lake.

Bald Eagles were the most abundant nesting raptor (21 nests or 30 percent of all raptor nests in 2005), followed by Golden Eagle (20 percent), Rough-legged Hawk (14 percent), and Gyrfalcon (13 percent). Merlin, Osprey, and Great Horned Owl also were recorded nesting in the mine study area. No Peregrine Falcons or Northern Goshawks were recorded, but some suitable habitat occurs for these species in the mine study area. Common Ravens were found nesting in the mine study area where they regularly use both cliff and tree substrates and “improve” habitats for some raptor species that do not build their own nests (e.g., Gyrfalcon, Peregrine Falcon).

Information on nesting success and productivity was determined for five species of raptors, including Bald and Golden eagles, Gyrfalcon, and Rough-legged Hawk. Nesting success ranged from 67 percent for Rough-legged Hawk and Golden Eagle to 71 and 80 percent for Bald Eagle and Gyrfalcon, respectively. Productivity (young per successful nest) for each of these species generally fell within the ranges of productivity determined for studies conducted elsewhere in Alaska and/or North America. Bald Eagle nests were found along the lower north and south forks of the Koktuli River, Upper Talarik Creek, and Lower Talarik Creek. Golden Eagle, Gyrfalcon, and Rough-legged Hawk, which are primary cliff-nesting raptors, were found in uplands and on cliffs along the Upper Talarik and Koktuli drainages and the uplands between them.

Although open water was present in small sections of the Koktuli and Talarik drainages in winter, no Bald Eagles were recorded on the aerial surveys designed to record wintering eagles in the mine study area. Wintering Bald Eagles have been recorded in the region, but probably occur uncommonly, particularly by mid-winter (November through February).

View from Golden Eagle Nest GE015 (looking north) on Talarik Creek, August 2005.

Cliff-nesting habitat for Gyrfalcons, Rough-legged Hawks, and Golden Eagles in the UpperTalarik-Groundhog Mountain area, August 2005.

Riparian forest stands used by Bald Eagles for nesting, Upper Talarik Creek, April 2004.

Bald Eagle nest in cottonwood tree, Upper Talarik drainage, April 2004.

Cliff used by Gyrfalcons in the upper Koktuli drainage, 2004.

16.4 Waterbirds—Mine Study Area

16.4.1 Introduction

The waterbird studies were conducted in the mine study area (Figure 1-4 in Chapter 1) to collect baseline data on the distribution, abundance, species composition, and habitat use of waterbird species during the breeding season and during spring and fall migration. Waterbirds observed included geese, swans, ducks, loons, grebes, cormorants, cranes, shorebirds, gulls, terns, and jaegers. Species-specific surveys were conducted during the breeding season for Tundra Swan and Harlequin Duck because they are key indicator species of the environmental health of lakes and rivers, respectively. Additionally, studies determined the productivity of waterfowl based on brood-rearing surveys.

Field work was conducted during April through October 2004 and 2005 and in September 2006. Surveys were conducted using helicopter or fixed-wing aircraft and followed standard survey techniques.

16.4.2 Results and Discussion

Ponds, lakes, rivers, and wetlands in the mine study area support a diverse assemblage of waterbirds during breeding and during spring and fall migration. Thirty-seven species were observed. Twenty-one of these species, including swans, ducks, loons, shorebirds, and gulls, were recorded as confirmed breeders.

Waterbirds use lakes and rivers throughout the mine study area for staging during spring and fall migration. Swans and dabbling ducks arrived in late April to early May and fed in mixed-species flocks on rivers and on lakes in open water created by stream runoff. Many of these birds probably nested in the area. Diving ducks arrived in mid- to late May and staged on rivers and lakes. Some of these diving ducks probably nested in the area, while others, in small flocks (approximately 60 birds), rested and fed on lakes before continuing their migration. During fall migration, both dabbling and diving ducks staged in flocks of 60 to 120 birds, using primarily large lakes. Concentrations of birds occurred in both seasons in the northern half of the mine study area from Frying Pan Lake north to the lakes in the North Fork Koktuli River basin. Upper Talarik Creek was the creek most heavily used by dabbling and diving ducks. Some small flocks of dabbling and diving ducks stayed in the mine study area to molt during late summer. Scaup, in flocks of 35 to 60 birds, were the most common duck observed during summer and were found on Big Wiggly Lake, Frying Pan Lake, and other large lakes adjacent to the north and south forks of Koktuli River.

Nikabuna and Long lakes, and the outlets of Upper and Lower Talarik creeks at Iliamna Lake, are important stopover sites for large flocks of waterfowl and are within 20 kilometers of the Pebble Deposit. The outlet of Upper Talarik Creek is an important staging location for swans, ducks, and gulls during spring. Lower Talarik Creek, particularly the area of lakes and wetlands near the outlet, supports large flocks of ducks, gulls, and terns during both spring and fall. Nikabuna and Long lakes are important staging areas for swans, geese, and ducks during spring and fall. In late April 2005, hundreds of swans, Greater White-fronted and Canada geese, and dabbling and diving ducks staged at the lakes. From August to mid-October 2005, thousands of ducks were counted on the lakes and hundreds of swans congregated on the lakes starting in early October.

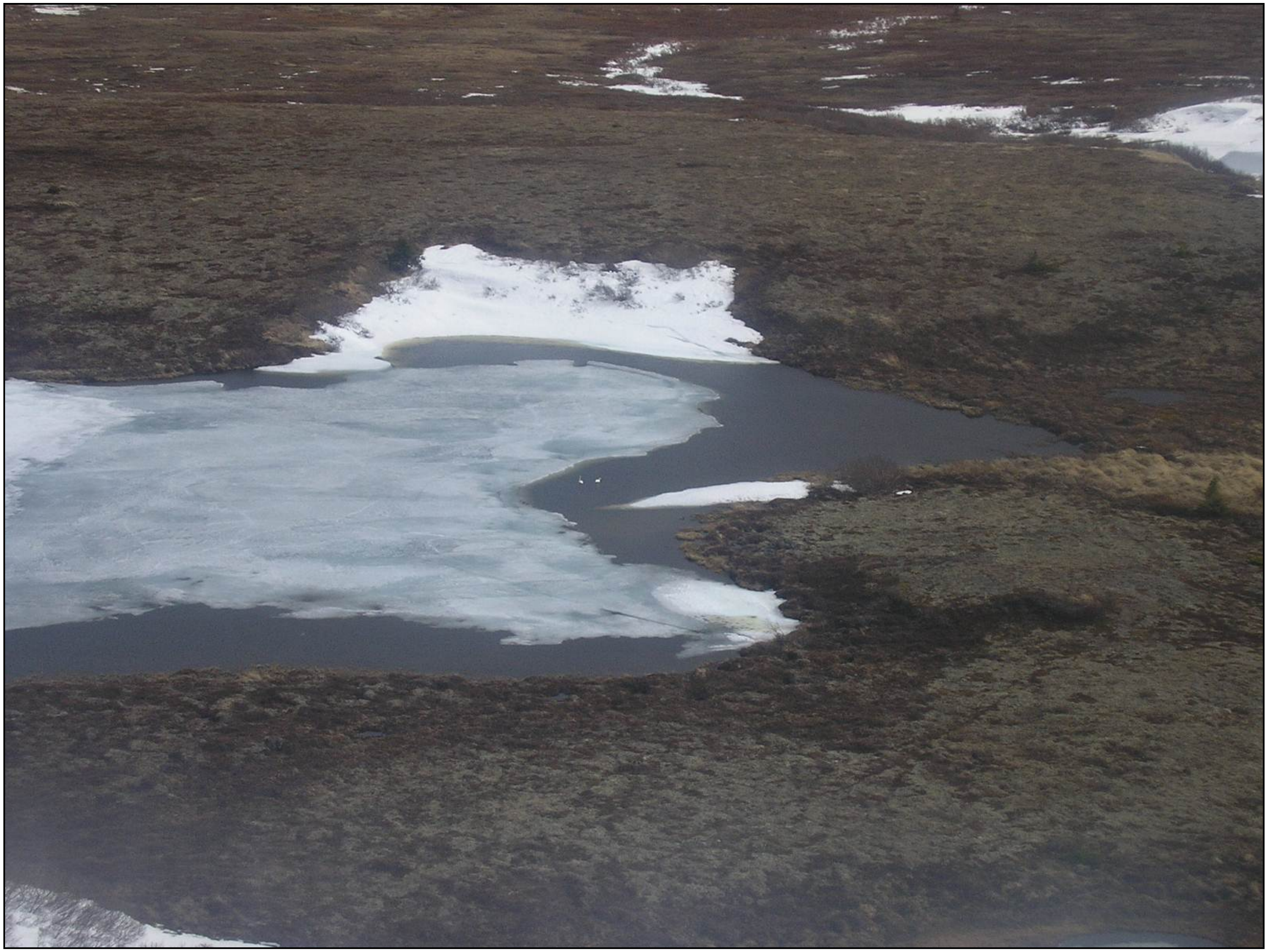
Tundra Swans were a common breeding bird in the mine study area, where over half the nests found in 2004 and 2005 occurred near lakes and wetlands in the North Fork Koktuli River drainage. Many swans returned to the same territories in 2005 and some to the same nest sites used in 2004. Harlequin Ducks were common and were found breeding in all three river drainages in the mine study area. During pre-nesting and brood-rearing surveys, Harlequin Ducks were most numerous on Upper Talarik Creek, followed by North Fork Koktuli River and South Fork Koktuli River. Common Loons nested and raised young on large lakes in the mine study area. Three lakes (including Big Wiggly Lake) were confirmed as breeding lakes by the presence of a Common Loon nest or brood, and another three lakes were suspected to be breeding lakes because of the repeated presence of loons. Two small colonies of nesting Mew Gulls were found, both north of Frying Pan Lake, and a breeding pair was observed in the North Fork Koktuli River drainage.

Eighteen species of waterbird broods were recorded in the mine study area. Brood-rearing groups were found on 33 percent of the lakes sampled in 2004 and 25 percent of the lakes sampled in 2005. In the same years, respectively, 75 and 88 percent of broods were ducks. American Wigeon, Northern Pintail, and scaup were the most common broods seen on lakes, while Red-breasted Merganser, Green-winged Teal, and Mallard broods were more common on rivers. Brood distribution was patchy, with most broods found on lowland lakes in the central part of the North Fork Koktuli River drainage, in upland and lowland lakes north of Frying Pan Lake in the South Fork Koktuli River drainage, in Frying Pan Lake, and in lakes in the floodplain of the lower South Fork Koktuli River drainage.

American Wigeon brood observed during waterbird brood-rearing survey, mine study area, July 2005.

A researcher counts waterbird broods on a lake during the waterbird brood-rearing survey, mine study area, July 2005.

Greater Scaup nest found during the waterbird brood-rearing survey, mine study area, May 2005.



Pair of Tundra Swans observed on lake during a spring migration survey, mine study area, May 2005.

16.5 Breeding Landbirds and Shorebirds—Mine Study Area

16.5.1 Introduction

Field surveys for breeding landbirds and shorebirds were conducted to collect baseline data on the distribution, abundance, and habitat use of these species during the nesting season in the mine study area (Figure 1-4 in Chapter 1). Landbirds recorded in the mine study area included ptarmigan and passerines (songbirds), and shorebirds included plovers and sandpipers. Researchers recorded all bird species observed in the field, paying special attention to species of conservation concern. Only landbirds and shorebirds are discussed in this section, however. Raptors and waterbirds are discussed separately (Sections 16.3 and 16.4, respectively).

The ground-based field work for this study was conducted during late May and June 2004 and 2005, using standard point-count survey methods. All birds seen or heard were recorded and, as is typical in point-count surveys, most observations were made by sound (songs and calls of breeding birds).

16.5.2 Results and Discussion

Including observations recorded outside the point-count periods, researchers identified 28 landbird species and 14 shorebird species in the mine study area. In addition to there being a greater number of landbird species, landbirds also were numerically more abundant than shorebirds.

Nine of the 28 landbird species (Savannah Sparrow, Golden-crowned Sparrow, Wilson's Warbler, Orange-crowned Warbler, Common Redpoll, American Tree Sparrow, Gray-cheeked Thrush, Fox Sparrow, and Yellow Warbler) were considered to be abundant breeders in the mine study area. Three species (Savannah Sparrow, Golden-crowned Sparrow, and Wilson's Warbler) were especially abundant and comprised 37 percent of the point-count observations in both years combined. Eight other landbird species (Northern Waterthrush, Lapland Longspur, American Robin, American Pipit, Blackpoll Warbler, Hermit Thrush, Horned Lark, and Snow Bunting) occurred less frequently, but were considered to be common in the mine study area. Of the 14 shorebird species observed in the mine study area, six species (Greater Yellowlegs, Wilson's Snipe, Least Sandpiper, Black-bellied Plover, Whimbrel, and American Golden-Plover) were considered common breeders. Of the various landbird and shorebird species-groups observed, sparrows were by far the most abundant, while warblers, thrushes, and finches also were common. Larks, pipits, and swallows were less common, and ptarmigan, flycatchers, corvids, and kinglets were rarely recorded. Sandpipers and plovers were the only shorebird species-groups recorded.

Landbirds were recorded in 15 of the 19 wildlife habitat types sampled in the study area, and shorebirds were recorded in 12. Eight scrub, bog, or meadow habitats (Riverine Tall Alder or Willow Scrub, Riverine Low Willow Scrub, Lowland Low and Tall Willow Scrub, Lowland Ericaceous Scrub Bog, Lowland Wet Graminoid-Shrub Meadow, Upland Moist Tall Alder Scrub, Upland Moist Tall Willow Scrub, and Upland Moist Low Willow Scrub) had the greatest numbers of breeding landbird and shorebird species (with both bird groups considered together). The most productive breeding habitats, in terms of bird abundance, were Lowland Low and Tall Willow Scrub, Riverine Tall Alder or Willow Scrub, and Upland Moist Tall Willow Scrub. In these three habitats, more than nine birds were observed per point-count. Most landbirds regularly used tall- and low-scrub habitats, but some landbird species favor more open habitats (bogs, meadows, dwarf-scrub types, and barrens). Shorebirds were found most commonly in these same open habitats.

Point-count sampling in Lowland Low and Tall Willow Scrub, mine study area, June 2005.

Point-count sampling in Upland Moist Tall Willow Scrub, mine study area, June 2005.

Point-count sampling in Alpine Wet Dwarf Shrub-Sedge Scrub Meadow, mine study area, June 2005.

Point-count sampling in Alpine Dry Barrens, mine study area, June 2005.

16.6 Habitat Mapping and Habitat-value Assessments—Transportation-corridor Study Area

16.6.1 Introduction

Wildlife habitats in the Bristol Bay transportation-corridor study area (Figure 1-4 in Chapter 1) were mapped to provide a baseline inventory of the availability of wildlife habitats and were evaluated for use by wildlife to assess the value of those mapped habitats to a selected set of bird and mammal species of concern.

Field surveys to collect information on vegetation, physiography, landforms, and surface forms were conducted in August 2004 and August and September 2005. Physiography was mapped by photo-interpretation of true-color aerial photography acquired for the study area in July and October 2004 and September 2008. Multivariate wildlife habitats were derived by adding physiographic information (and landform and surface-form information, as needed) to the vegetation mapping polygons prepared for the study area by Three Parameters Plus, Inc., and HDR Alaska, Inc.

To assess use of the mapped habitat types by important species of wildlife, 45 bird and mammal species of concern (32 bird species and 13 mammal species) that are known or have the potential to occur in the transportation-corridor study area were selected for their conservation, cultural, and/or ecological importance. Habitat use for each species in each mapped habitat type was qualitatively categorized into one of four value classes (high, moderate, low, or negligible value) based primarily on wildlife survey data specific to the area and habitat-use information from scientific literature.

16.6.2 Results and Discussion

Twenty-five wildlife habitat types were mapped in the transportation-corridor study area. Forest habitats strongly dominate in the area. Four forest types in upland, lowland, and riverine settings (Upland and Lowland Spruce Forest, Upland and Lowland Moist Mixed Forest, Riverine Moist White Spruce Forest, and Riverine Moist Mixed Forest) cover 65 percent of the study area. Low- and tall-scrub habitats dominated by willow and alder, also occurring in upland, lowland, and riverine areas, are relatively common and comprise 15 percent of the study area. Open dwarf-scrub and barren habitats in upland and alpine areas are less common and cover 11 percent of the study area. Lacustrine waterbodies, wet graminoid-dominated meadows, and shrub-dominated bog habitats are relatively uncommon (7 percent of the study area) and occur primarily in lowland and riverine physiographic settings. Marsh habitats are rare and occur along the margins of lakes and ponds. A large number of riverine corridors occur in the area and support numerous stream channels and associated riverine forest, scrub, and meadow vegetation. Prominent streams in the study area, all of which drain into Iliamna Lake, include, from east to west, Chinkelyes Creek; Iliamna and Pile rivers; Knutson, Canyon, and Chekok creeks; and the Newhalen River (Figures 1-3c and 1-3b in Chapter 1). Many of the streams support anadromous fish populations and provide foraging opportunities for wildlife.

Results of the wildlife habitat-value assessments indicate that four forested habitats (Upland and Lowland Moist Mixed Forest, Upland and Lowland Spruce Forest, Riverine Moist Mixed Forest, and Riverine Moist White Spruce Forest) and one open wetland habitat (Lowland Ericaceous Scrub Bog) had the greatest numbers (20 to 24 species) of bird and mammal species of concern that were given moderate- or high-value habitat rankings based on study-specific criteria. The species-rich forest habitats are concentrated in the westernmost portion of the study area to the west of the Newhalen River and also from the base of Roadhouse Mountain east to where the transportation-corridor study area runs along Chinkelyes Creek to Summit Lakes. The species-rich lowland-bog habitats are scattered throughout the study area, occurring in small patches in poorly drained areas.

The study area provides at least some suitable habitat (moderate- and/or high-value habitat rankings) for 13 mammal species of concern—wolf, red fox, river otter, wolverine, black bear, brown bear, moose, arctic ground squirrel, red squirrel, beaver, northern red-backed vole, tundra vole, and snowshoe hare.

Black bears favor habitats that provide cover, and most forest and tall-scrub habitats were considered to be of high value for black bears. Other forest, scrub, scrub-bog, meadow, marsh, and lacustrine habitats, and those rivers and streams supporting anadromous fishes were considered to be of moderate value for black bears. In contrast, brown bears are known to use a broader array of habitats, and 20 habitats in the study area were considered to be of moderate value for brown bears. One habitat type (Rivers and Streams [Anadromous]) was considered to be of high value for brown bears because salmon streams are heavily used by foraging brown bears in late summer. Habitats suitable for both black and brown bears are common and widespread in the study area. For moose, low and/or tall willow-scrub habitats, riverine forests, and lakes and ponds were considered to be of high value, primarily for forage. The high-value moose habitats in the study area tend to be concentrated in stream drainage systems. Other scrub, scrub-bog, forest, meadow, marsh, and lacustrine habitats were considered to be of moderate value for moose, again for forage.

For birds, the study area provides at least some suitable habitat (moderate- and/or high-value habitat rankings) for 29 species of concern: seven raptors (Bald Eagle, Northern Goshawk, Golden Eagle, Merlin, Gyrfalcon, Peregrine Falcon, Great Horned Owl), nine waterbirds (Trumpeter Swan, Tundra Swan, Harlequin Duck, Surf Scoter, American Scoter, Long-tailed Duck, Red-throated Loon, Common Loon, Arctic Tern), four shorebirds (American Golden-Plover, Solitary Sandpiper, Lesser Yellowlegs, Surfbird), and nine landbirds (Spruce Grouse, Willow Ptarmigan, Rock Ptarmigan, Black-backed Woodpecker, Olive-sided Flycatcher, Gray-cheeked Thrush, Varied Thrush, Blackpoll Warbler, Rusty Blackbird). Habitats considered suitable for nesting and/or foraging tree-nesting raptors (forests, some scrub and barren habitats, meadows, lacustrine and riverine waterbodies) are common and widespread. For cliff-nesting raptors, a set of higher-elevation, open dwarf-scrub and barren habitats and some forest, scrub, scrub-bog, meadow, marsh, and aquatic habitats were considered suitable for nesting and/or foraging. The habitats preferred for foraging by cliff-nesting raptors in the study area are relatively common and widespread, but nesting habitats (cliffs) are uncommon. For breeding and migrant waterbirds, lacustrine waterbodies and associated wet meadow habitats were considered to be of high value. Scrub-bogs, marshes, anadromous fish streams, and some forest and dwarf-, low-, and tall-scrub habitats were considered to be of moderate value.

Suitable habitats for breeding and migrant waterbirds are relatively common and widespread in the study area, but these habitats have a higher likelihood of use when adjacent to aquatic habitats, especially lacustrine waterbodies. Suitable habitats for breeding shorebirds include open wetland types such as Lowland Ericaceous Scrub Bog and a diverse set of nine other habitats including well-drained barrens, dwarf-scrub, tall-scrub, some forests, streams (both anadromous and non-anadromous types), meadows, marshes, and the shorelines of lacustrine waterbodies. The suitable habitats for breeding shorebirds are widely scattered throughout the transportation-corridor study area. Habitats suitable for breeding landbirds include forests, tall-scrub and scrub-bog, low-scrub, dwarf-scrub, and barren types in a variety of physiographic settings. Suitable habitats for breeding landbirds are common and widespread across the study area.

Upland and Lowland Spruce Forest (in an upland, open woodland form), transportation-corridor study area, August 2005.

Upland Moist Tall Alder Scrub (foreground), and Rivers and Streams (Anadromous, below), transportation-corridor study area, August 2005.

Upland and Lowland Moist Mixed Forest, transportation-corridor study area, August 2005.

Riverine Moist Mixed Forest, transportation-corridor study area, August 2005.

16.7 Terrestrial Mammals—Transportation-corridor Study Area

16.7.1 Introduction

Forty species of mammals are known (or are strongly suspected) to occur in the geographic region of the Bristol Bay drainages in which the transportation-corridor study area for the Pebble Project is located.

Although caribou are one of the most abundant large mammals in the Bristol Bay drainages, the transportation-corridor study area is at the eastern edge of the annual range of the Mulchatna Caribou Herd, and few caribou occur in the study area. Other species of large mammals are ecologically and economically important inhabitants of the region. Brown bears are common, occurring at moderate densities, whereas black bears are present in low densities. Moose occur throughout the study area in low densities. These species were of primary interest for the surveys, but all mammal species encountered incidentally, such as gray wolf and other species of large furbearers, were recorded. Another source of mammal observations was incidental sightings during other wildlife surveys conducted for the Pebble Project (notably waterfowl, raptor, and breeding-bird surveys) and field delineation of wildlife habitats.

Field surveys were conducted periodically from April through November 2004, March through December 2005, December 2006, May 2009, and April 2010. Specific work elements included the following tasks:

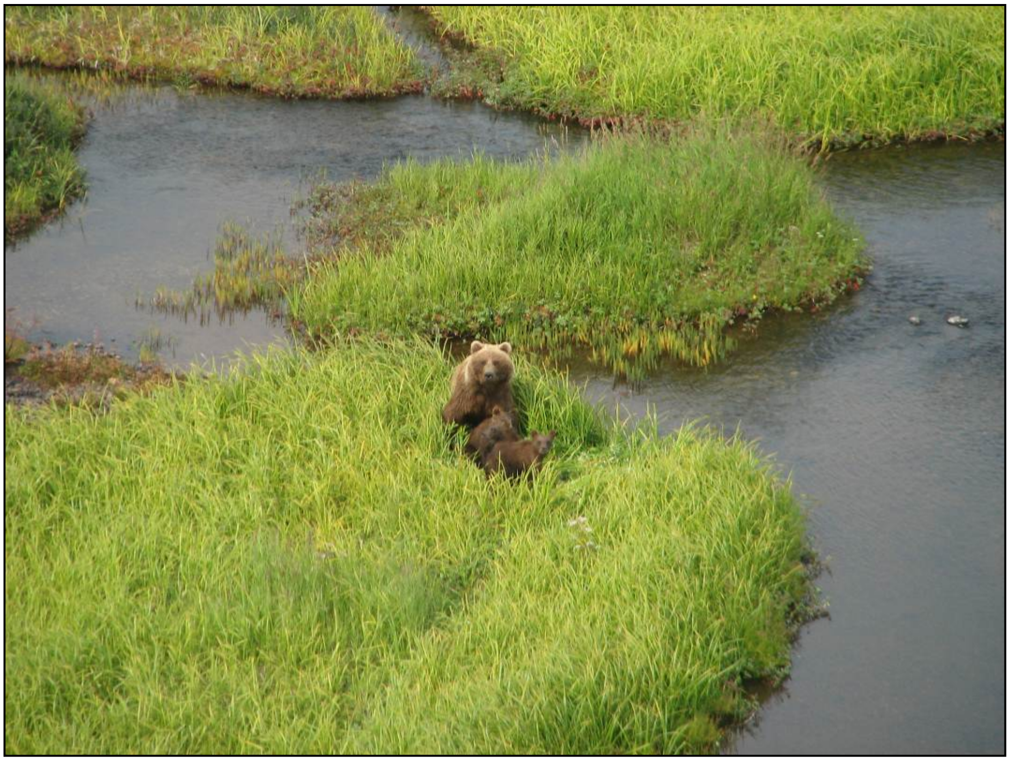
- Collection and review of relevant literature on all species of mammals inhabiting the region.
- Five aerial reconnaissance surveys of the study area during various seasons.
- Aerial line-transect survey to estimate the population density of bears in and near the study area.
- Aerial quadrat survey to estimate the population density of moose in and near the study area.
- Aerial survey of brown bears along salmon-spawning streams and examination of reported dens of brown bears and gray wolves.
- Aerial survey of beaver colonies.
- Acquisition and analysis of radio-telemetry data for the MCH.
- Collection of wildlife observations by other Pebble Project personnel.

16.7.2 Results and Discussion

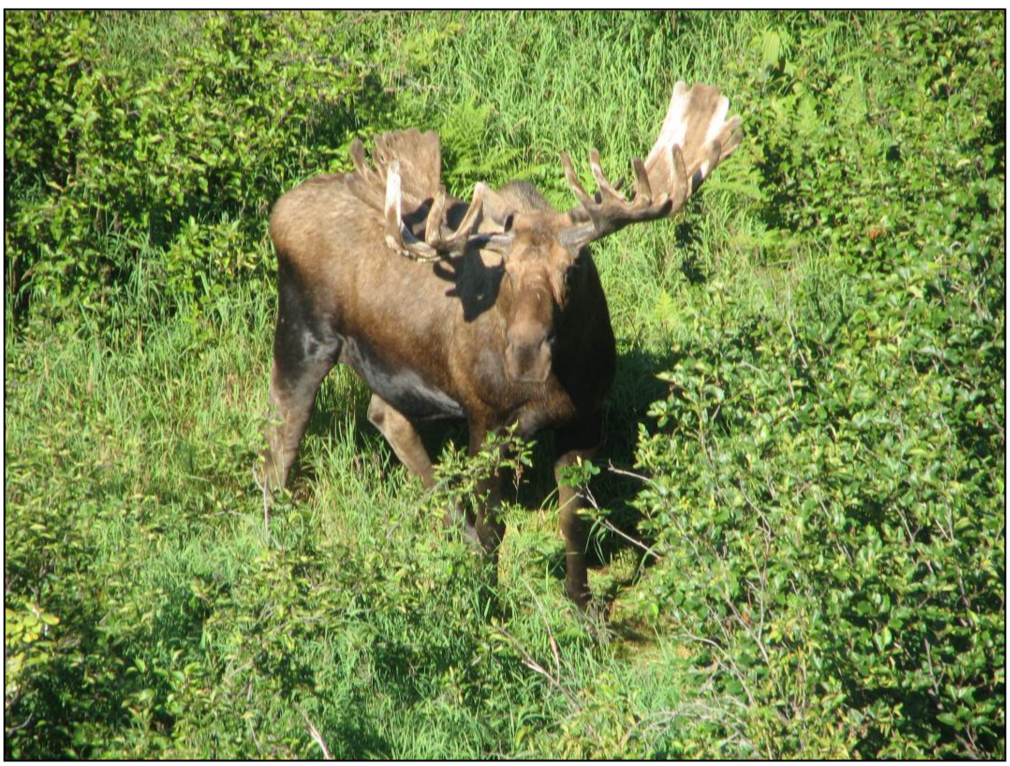
The study area contained moderate densities of brown bears and low densities of black bears, moose, coyotes, wolves, river otters, and wolverines. Judging from telemetry data collected during 1981 through 2008, caribou from the MCH were found in the area only rarely; their principal range is located farther west. Because of the low densities of large mammals and the thick vegetation in the survey area, accurate calculation of density was difficult, requiring calculation of a sightability correction factor.

Small numbers of brown bears and black bears were observed on fixed-wing and helicopter surveys during 2004 and 2005. Incidental observations during other wildlife surveys produced sightings of both species. The bear population survey conducted in collaboration with the Alaska Department of Fish and Game in May 2009 in the region surrounding Iliamna Lake produced density estimates of 47.7 to 58.3 brown bears per 1,000 square kilometers. Although the numbers of black bears seen on that survey were insufficient to calculate a density estimate, all but one of the 18 black bear sightings occurred in the northeastern quadrant of the bear survey area, east of Nondalton and north of Iliamna Lake.

Pebble researchers recorded small numbers of moose throughout the study area during the aerial reconnaissance surveys in 2004 through 2006; the largest number seen on a single survey was 27 moose during the transect survey in December 2006. Incidental observations during bird surveys consistently produced moose sightings. Among all surveys in 2005, the estimated mean density of moose in the study area was 0.03 moose per square kilometer, incorporating a sightability correction estimated by simultaneous double-count surveys. The moose population survey in April 2010 estimated 63 moose in the 1,219-square-kilometer portion of the survey area in the transportation-corridor study area, for an estimated density of 0.05 moose per square kilometer.



A female brown bear with three spring cubs rests beside a salmon-spawning stream, July 2005.



Bull moose with antlers in velvet, July 2005.

16.8 Iliamna Lake Harbor Seals

16.8.1 Introduction

Harbor seals typically inhabit marine waters, but they also enter freshwater rivers and lakes. Iliamna Lake supports one of the few freshwater populations of harbor seals in the world, but relatively little is known about the population size, movements, and behavior of seals in the lake. This population of seals provides a source of food for local subsistence hunters.

Multiple aerial surveys of known and potential haulout sites in the eastern and central portions of Iliamna Lake were flown in 2005, 2007, and 2008 to examine the seasonal occurrence and abundance of the species. The study had four objectives:

- Review existing information on the population of harbor seals inhabiting the lake.
- Enumerate harbor seals hauled out at known and newly discovered sites in Iliamna Lake during spring, summer, and fall.
- Search for new haulout sites.
- Examine factors affecting haulout use.

16.8.2 Results and Discussion

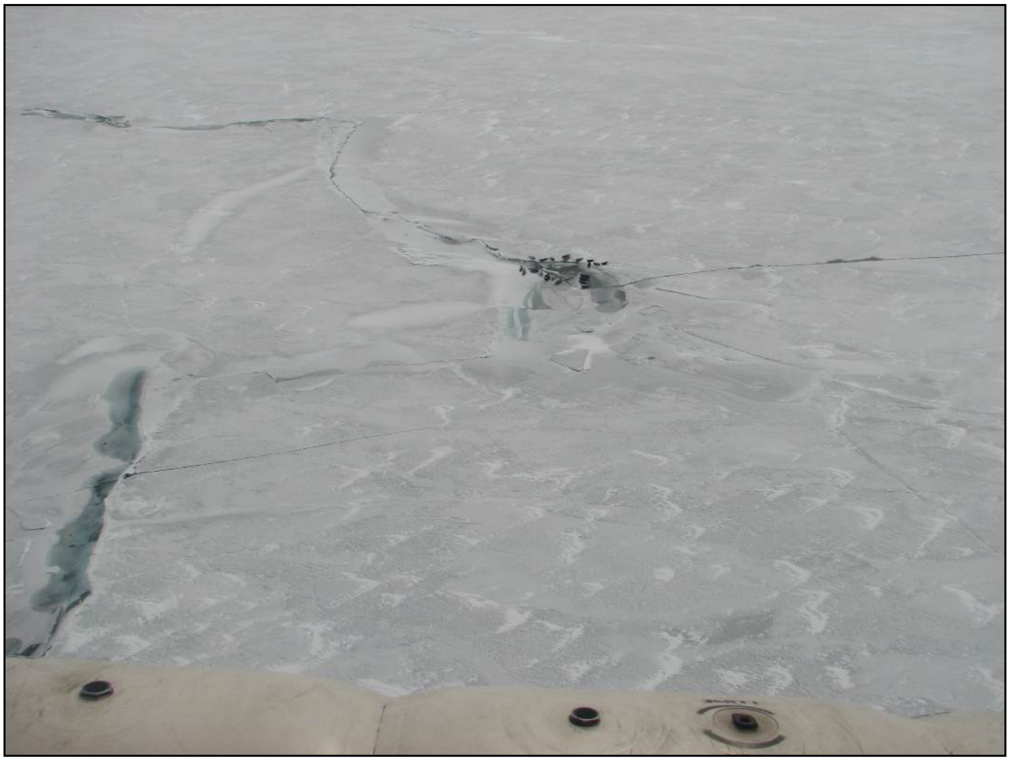
Freshwater populations of harbor seals are rare; the best known such populations of this species occur in the Hudson Bay in Canada. Harbor seals have been documented inhabiting Iliamna Lake since at least the late 19th century. The Iliamna Lake seals are considered to be year-round residents, but there are no geographic barriers to the movement of seals between the lake and Bristol Bay. Observations and harvests of seals in the Kvichak River near Igiugig and experience in the Canadian Arctic suggest that, despite the fact that seals are present year round, the Iliamna Lake population may not be as isolated as it might appear. Current evidence is insufficient to evaluate the degree of ecological or genetic isolation of the lake population from the marine population in Bristol Bay.

Surveys conducted for the Pebble Project examined previously described haulout locations in Iliamna Lake and also searched for additional haulout sites. Twenty aerial surveys were flown in a small fixed-wing airplane between March and December 2005, nine surveys were flown between May and October 2007, and seven surveys were flown in August 2008. During each survey, seals were counted as the aircraft circled each potential haulout location; photographs were taken if more than about 20 seals were present.

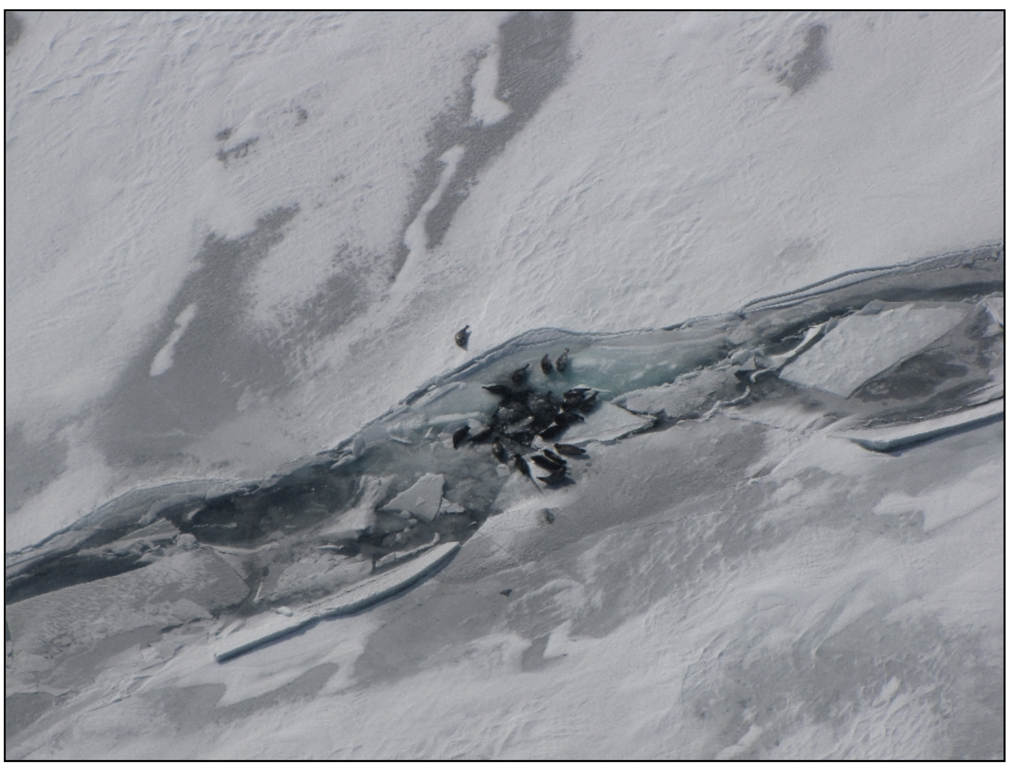
Most of the haulout sites documented in this study were identified from existing literature and consultation with agency researchers, but five more sites were added in 2005, two were added in 2007, and one was added in 2008. Seals were observed using 15 different haulout sites at various times during the three study years; seals were never observed at several other potential haulout sites.

Total counts among all surveys ranged from zero to 276 harbor seals in 2005, zero to 313 seals in 2007, and 205 to 357 seals in 2008. The number of seals hauled out varied substantially among seasons and was highest in summer, peaking in August during the molting period. Annual peak counts were obtained on August 17, 2005, August 15, 2007, and August 18, 2008. The largest number observed during a single survey was 357 seals. That count represents a minimum population estimate because not all seals in the lake would have been hauled out at one time and because there may have been additional, undiscovered haulout sites. The peak number counted during the 2008 surveys (357 seals) was greater than the peak numbers counted by other researchers in 1991 (137 seals), 1998 (321 seals), 1999 (225 seals), and 2003 (171 seals), suggesting that the population is stable or possibly increasing. Comparisons among years are confounded, however, by an increase in the number of known haulout locations and by seasonal differences in survey timing.

The highest level of use was at haulouts in the Flat/Seal Island group (southwest of Pedro Bay) and the Thompson Island group (north of Kokhanok). Despite substantial variability among surveys, two haulout locations (LI-05 on Seal Island and LI-07 east of Thompson Island) accounted for two-thirds of all the seals observed. Haulout use by harbor seals in Iliamna Lake is influenced by substrate conditions, seasonal variations in the water level of the lake, and by annual variation in the extent and duration of winter ice cover. The timing and location of spawning activity by sockeye salmon in summer and early fall also appear to influence haulout use.



A group of 23 harbor seals rests beside a hole in the ice cover of Iliamna Lake, March 17, 2008.



A group of 18 harbor seals rests beside a hole in the ice cover of Iliamna Lake, March 28, 2010.

Harbor seals resting at Site LI-07, a regularly used haulout east of Thompson Island in the southern portion of Iliamna Lake, August 11, 2005.

Harbor seals hauled out on Seal Island in Iliamna Lake during light rain, August 14, 2007.

Harbor seals resting on small islet in Iliamna Lake, August 29, 2007. Note sockeye salmon (live and carcasses) near left end of islet.

16.9 Raptors—Transportation-corridor Study Area

16.9.1 Introduction

Studies were undertaken in 2004 and 2005 to collect baseline data on the distribution, abundance, and nesting status and habitat use of large tree- and cliff-nesting birds of prey (raptors) in the transportation-corridor study area (Figure 1-4 in Chapter 1). Information on all raptors and Common Ravens was recorded, but special emphasis was placed on species of conservation concern, protected species, and species potentially sensitivity to disturbance (Bald and Golden eagles, Gyrfalcon, Peregrine Falcon, Rough-legged Hawk, Northern Goshawk, Osprey, and Great Horned Owl). In addition, fall and winter surveys were undertaken in 2005 and 2006 to gather information on wintering Bald Eagles. Also, researchers developed aircraft guidelines to avoid disturbance of wildlife, including nesting raptors.

Field work was conducted primarily during April and May 2004, May through August 2005, and late fall and mid-winter 2005 and 2006. Aerial surveys were conducted by helicopter for all nest occupancy and productivity surveys and for most winter Bald Eagle surveys.

16.9.2 Results and Discussion

Twelve raptor species and Common Ravens were recorded in the transportation-corridor study area during aerial surveys, but at least 19 species of raptors probably occur at least occasionally in the vicinity. Researchers located 125 nests of eight of these raptor species (Rough-legged Hawk, Red-tailed Hawk, Golden Eagle, Bald Eagle, Osprey, Gyrfalcon, Peregrine Falcon, and Great Horned Owl) and Common Ravens. A few sightings of Merlin suggested nesting by this species. Only a single Northern Goshawk was observed, although surveys were undertaken to find their nests. The greatest densities of tree-nesting raptor sites were located along the Newhalen River and sections of the shoreline of Iliamna Lake. The greatest densities of cliff-nesting raptor sites were found on Canyon Creek and along the southern edge of the Alaska Range north of Iliamna Lake.

Only Bald and Golden eagle nests were common, representing 43 and 19 percent, respectively, of nests found in 2005. Nests of Osprey were the next most abundant (5 percent of the nests found). Other species—Peregrine Falcon, Gyrfalcon, Rough-legged Hawk, Great Horned Owl, and Red-tailed Hawk—had three or fewer nests located in the study area. Common Raven regularly nested in the study area (13 percent of nests). Common Ravens regularly use both cliff and tree substrates and “improve” habitats for some raptor species that do not build their own nests (e.g., Gyrfalcon, Peregrine Falcon).

Nesting success and productivity were determined for five raptor species in the study area in 2005. Ospreys and Golden Eagles, although represented by only a few nests, had high nesting success and productivity compared to other populations in Alaska and North America. Bald Eagles, on the other hand, had lower nesting success (33 percent) than comparative subpopulations in southern Alaska (range 53 to 88 percent); however, productivity (young per successful nest) was similar to values for these other populations. A single Red-tailed Hawk nest, probably at the southwestern extent of it breeding range, was successful. Finally, one of three occupied Peregrine Falcon nests produced young.

Habitats for tree-nesting raptors are abundant in the study area, particularly east of and including the Newhalen River and below 400 meters in elevation. The best habitats for large tree-nesting species, like Bald Eagles, occur in cottonwood stands most closely associated with the floodplains of major rivers like the Newhalen and Iliamna rivers. Suitable and high-value habitats for cliff-nesting species are found along the southern front of the Alaska Range. Good to excellent habitats occur in the hills between Upper Talarik Creek and the Newhalen River, along Canyon Creek and Knutson Mountain, and along the upper Iliamna River (including a few cliffs on Chinkelyes Creek). A few cliffs along the shoreline of Iliamna Lake are suitable, including those on islands in the eastern extent of the lake and those on some lakes between the Pile and Iliamna rivers.

Bald Eagles were recorded on aerial surveys conducted during winter, and observations ranged from a single bird (February) to 120 birds (early November). Roughly two thirds of sightings were of adult plumaged eagles. Most were associated with open water along the Iliamna River, but eagles also were recorded along the Newhalen River, the north shore of Iliamna Lake, and the Knutson River. Wintering Bald Eagles may gather in numbers in fall, but occur uncommonly in the study area, particularly by mid-winter (mid-December through February). Bald Eagles are probably more common along the coast throughout the winter.

Eagle nest (BE058A), New Halen River, August 2005.

Osprey nest, Pile River area, August 2005.

Lower Canyon Creek cliff-nesting raptor habitat (Peregrine Falcons and Golden Eagles), August 2005.

Gyrfalcon nesting in old Golden Eagle nest (GYF060), Upper New Halen River drainage, May 2004.

16.10 Waterbirds—Transportation-corridor Study Area

16.10.1 Introduction

The waterbird studies were conducted in the transportation-corridor study area (Figure 1-4 in Chapter 1) to collect baseline data on distribution, abundance, species composition, and habitat use during the breeding season and during spring and fall migration. Waterbirds observed included geese, swans, ducks, loons, grebes, cormorants, cranes, shorebirds, gulls, terns, and jaegers. Observations of all waterbird species were recorded during breeding and migration surveys. Species-specific surveys were conducted during the breeding season for Tundra Swan and Harlequin Duck because they are key indicator species of the environmental health of lakes and rivers, respectively.

Field work was conducted during April through October 2004 and 2005 and in September 2006. Most surveys were conducted using helicopter or fixed-wing aircraft and followed standard survey techniques.

16.10.2 Results and Discussion

Ponds, lakes, rivers, and wetlands in the study area support a diverse assemblage of waterbirds during breeding and during spring and fall migration. Thirty-four species were observed in the transportation-corridor study area, and 14 of those, including swans, ducks, loons, cranes, and gulls, were recorded as breeders.

Waterbirds used lakes and rivers for staging throughout the study area during spring and fall migration. Swans, geese, and dabbling ducks arrived in late April to early May and fed in mixed-species flocks on rivers and on lakes and the bays of Iliamna Lake in open water created by river runoff. The highest concentrations of swans, geese, and dabbling ducks were found in an area of the Newhalen River known as Three-mile Lake and at Goose Cove, a small cove off Chekok Bay in Iliamna Lake. During spring, dabbling ducks also were concentrated at river outlets in the bays of Iliamna Lake and in adjacent flooded lake and wetland habitats. Diving ducks arrived in mid- to late May and staged in large flocks at protected bays of Iliamna Lake, at a large inland lake 15 kilometers north of Iliamna, and on the Iliamna and Newhalen rivers. During fall migration, concentrations of waterbirds occurred at many of the same locations where they were found in spring. No groups of swans or geese staged in the study area during fall; only brood-rearing groups and adult swans as singles or pairs were observed. Thousands of ducks and gulls were recorded during fall surveys, with duck abundance remaining high during the entire period from mid-August to mid-October and gull abundance peaking in mid- to late September.

Swans were common breeding birds. All nests, except for one, were found in the western half of the study area between Upper Talarik and Chekok creeks. Swans within this area were identified as Tundra Swans. A pair of breeding Trumpeter Swans was found each year near the Pile River. Many swans returned to the same territories in 2005 and some to the same nest sites used in 2004. Harlequin Ducks were found during the breeding season on seven different rivers in the study area. Pairs of ducks during the pre-nesting season and females with broods during the brood-rearing season were most numerous on the Newhalen and Iliamna rivers. Additionally, broods were observed on the Pile River and on Stonehouse Lake, a creek-fed lake 15 kilometers east of Iliamna. Common Loons were found on large, deep lakes between Upper Talarik Creek and the Iliamna River from early May to late September in 2004 and 2005. Five broods were recorded in each year; these 10 broods were found on eight different lakes, most of which were near the Newhalen or Iliamna rivers.

Goose Cove, a small cove off Chekok Bay in Iliamna Lake, where hundreds of swans, geese, and dabbling ducks stage during spring and fall migration, April 2005.

Tundra Swan identified during species delineation survey, September 2006.

Surveying the Iliamna River for Harlequin Duck broods, April 2005.

16.11 Breeding Landbirds and Shorebirds—Transportation-corridor Study Area

16.11.1 Introduction

Field surveys for breeding landbirds and shorebirds were conducted to collect baseline data on the distribution, abundance, and habitat use of these species during the nesting season in the transportation-corridor study area (Figure 1-4 in Chapter 1). Landbirds recorded in the study area included grouse, ptarmigan, cranes, kingfishers, woodpeckers, and passerines (songbirds), and shorebirds included plovers and sandpipers. Researchers recorded all bird species observed in the field, paying special attention to species of conservation concern. Only observations of landbirds and shorebirds, however, are discussed in this summary. Only landbirds and shorebirds are discussed in this section, however. Raptors and waterbirds are discussed separately (Sections 16.9 and 16.10, respectively).

The ground-based field work was conducted during June 2005, using standard point-count survey methods. All birds seen or heard were recorded and, as is typical in point-count surveys, most observations were made by sound (songs and calls of breeding birds).

16.11.2 Results and Discussion

Including observations recorded outside the point-count periods, researchers identified 46 landbird species and seven shorebird species in the study area. In addition to there being a greater number of landbird species, landbirds also were numerically more abundant than shorebirds.

Ten of the 46 landbird species (Wilson’s Warbler, Orange-crowned Warbler, Swainson’s Thrush, Yellow-rumped Warbler, Golden-crowned Sparrow, Dark-eyed Junco, Ruby-crowned Kinglet, American Robin, Varied Thrush, and Hermit Thrush) were considered to be abundant breeders in the study area. Three of these species (Wilson’s Warbler, Orange-crowned Warbler, and Swainson’s Thrush) were especially abundant and comprised 33 percent of all point-count observations. Sixteen additional landbird species (Blackpoll Warbler, White-crowned Sparrow, Common Redpoll, Yellow Warbler, Fox Sparrow, Gray-cheeked Thrush, Savannah Sparrow, Olive-sided Flycatcher, White-winged Crossbill, Northern Waterthrush, Tree Swallow, Gray Jay, Boreal Chickadee, American Tree Sparrow, Alder Flycatcher, and Lincoln’s Sparrow) occurred less frequently, but were considered to be common in the study area. The two most frequently observed shorebird species were Greater Yellowlegs and Wilson’s Snipe, and they were considered common breeders. These two species accounted for 92 percent of all point-count observations of shorebirds. Of the landbird and shorebird species-groups observed, warblers were by far the most abundant. Thrushes were the second most abundant group, and sparrows and allies (including juncos) also were common. Kinglets and finches were less common, and the rest of the landbird and shorebirds species-groups were much less common in the study area.

Landbirds were recorded in all 12 of the wildlife habitat types sampled, and shorebirds were recorded in four of the 12. The three sampled forest habitats in the study area (Upland and Lowland Moist Mixed Forest, Upland and Lowland Spruce Forest, and Riverine Moist Mixed Forest) had the greatest numbers of breeding landbird and shorebird species (with both bird groups considered together). In terms of bird abundance, six forest and scrub habitats (Riverine Moist Mixed Forest, Riverine Low Willow Scrub, Upland and Lowland Moist Mixed Forest, Upland and Lowland Spruce Forest, Upland Moist Tall Alder Scrub, and Upland Moist Low Willow Scrub) were the most productive and supported five or more birds per point-count. Individual landbird species often used a range of different forest, scrub, bog, and meadow habitats, with the more common species using a larger set of habitats than the uncommon species. Shorebirds, however, were found primarily in four relatively open habitat types: Lowland Wet Graminoid-Shrub Meadow, Lowland Ericaceous Scrub Bog, Upland Moist Dwarf Scrub, and Upland and Lowland Spruce Forest (when in an open forest form).

Point-count sampling in Lowland Ericaceous Scrub Bog, June 2005.

Moving between point-count locations, Riverine Moist Mixed forest, June 2005.

Checking data in the field, Lowland Wet Graminoid-Shrub Meadow, June 2005.

Point-count sampling in Upland and Lowland Spruce Forest, June 2005.

16.12 Wood Frogs—Mine Study Area

16.12.1 Introduction

The wood frog study was undertaken to collect baseline data on the occupancy rate of breeding wood frogs and the distribution of occupied waterbodies in the mine study area (Figure 1-4 in Chapter 1) and to evaluate habitat characteristics of waterbodies used by breeding wood frogs.

Researchers conducted ground-based surveys of randomly chosen waterbodies in the mine study area during mid-May 2007. An occupancy estimation modeling technique, using a repeated survey design with pseudo double-blind observers, was used to accurately estimate the population probability of wood frogs using waterbodies in the study area.

Researchers conducted ground-based surveys for breeding wood frogs at 119 waterbodies randomly selected from the set of 1,668 mapped waterbodies in the mine study area. Of these 119 waterbodies, 86 were surveyed a second time following the repeated survey protocol. Data from the surveys were used to map the general distribution of wood frog occurrence and to estimate the occupancy rate of wood frogs breeding in waterbodies in the mine study area.

16.12.2 Results and Discussion

Wood frogs were detected at waterbodies throughout the mine study area, and their distribution did not indicate any obvious spatial pattern of occupancy within the study area. An occupancy estimate, corrected for the calculated detectability (27 percent) of wood frogs, indicated wood frogs likely bred in 50 percent of the mapped waterbodies in the mine study area during 2007.

Several waterbody habitat characteristics also were evaluated for their influence on wood frog occupancy of waterbodies. The habitat characteristics chosen as potentially important in influencing breeding wood frog occupancy were as follows:

- Percent hibernation habitat within 50 meters of the waterbody shoreline.
- Waterbody size.
- Depth of the waterbody.
- Presence of emergent and/or aquatic vegetation within the waterbody.
- Whether or not the waterbody was a beaver pond.

(Although the presence of fish likely is an important characteristic influencing amphibian occupancy of waterbodies, researchers were unable to adequately determine fish presence in the waterbodies studied. Thus, a variable representing the presence of fish was not used in the analyses.)

Although not statistically conclusive, modeling of the habitat covariates indicated that various independent characteristics had varying degrees of influence on wood frog occupancy of waterbodies in the mine study area. Depth of the waterbody had a stronger magnitude of effect than the presence of emergent/aquatic vegetation and whether or not the waterbody was a beaver pond. Deep waterbodies (greater than 1.5 meters deep) were 10.1 times more likely to be occupied by wood frogs than shallow waterbodies (less than 1.5 meters deep). As the percent of hibernation habitat surrounding waterbodies increased, wood frog occupancy increased in a near linear manner (the influence of percent of hibernation habitat on occupancy was most pronounced for shallow waterbodies). Waterbodies with more than 1 percent cover of emergent or aquatic vegetation were 2.9 times more likely to be used by wood frogs than waterbodies without emergent/aquatic vegetation. The size of a waterbody was only marginally important, but the model results suggested a moderate increase in wood frog occupancy as waterbody size increased, and the magnitude of influence was fairly linear and most pronounced in shallow waterbodies. Finally, whether a waterbody was a beaver pond or not was not a strong factor affecting wood frog occupancy.

Overall, model results suggested that depth of the waterbody and percent of hibernation habitat were the most important factors influencing wood frog occupancy and that the presence of emergent/aquatic vegetation also may have increased occupation of waterbodies by wood frogs in the mine study area. The size of a waterbody and whether it was a beaver pond had only minimal influence and little magnitude of effect on wood frog occupancy rates in the study area. Therefore, study results suggested that if a waterbody in the mine study area was more than 1.5 meters deep, that if herbaceous, low shrub, and tall shrub vegetation were present within 50 meters of its shoreline, and if the waterbody contained even a small amount (greater than 1 percent) of emergent/aquatic vegetation, it was more likely to be occupied by wood frogs.

An example of an ice-free waterbody that was surveyed for wood frog occupancy in the mine study area, May 2007.

An example of a partially ice-covered waterbody that was surveyed for wood frog occupancy in the mine study area, May 2007.

An example of a beaver-occupied waterbody that was surveyed for wood frog occupancy in the mine study area, May 2007.