Species Status Assessment Report

Yellow-billed Loon

(*Gavia adamsii*)

Prepared by the Listing Review Team

U.S. Fish and Wildlife Service

Fairbanks, Alaska

August 28, 2014

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EXECUTIVE SUMMARY

This document is a Species Status Assessment (SSA) for the yellow-billed loon (*Gavia adamsii)*. This SSA presents a comprehensive evaluation of the biological status of species. This SSA report contains in-depth information on life history, biology, and current and future risks facing yellow-billed loons. We emphasize that this SSA is not a decision document; rather, it will be used to inform our decision on whether to list or not list the yellow-billed loon under the Endangered Species Act (Act).

This species status assessment reports the results of the comprehensive status review for the yellow-billed loon and provides a thorough account of the species' overall viability and conversely, extinction risk. The yellow-billed loon is a large diving bird, similar in size and appearance to the common loon (*G. immer*), with a yellow or ivory-colored bill. Its historical breeding distribution is in Arctic and sub-Arctic areas from the Pechora River Delta in Russia east to Hudson Bay, and the species winters in coastal waters of southern Alaska and British Columbia from the Aleutian Islands to Puget Sound; the Pacific coast of Asia from the Sea of Okhotsk south to the Yellow Sea; the Barents Sea and the coast of the Kola Peninsula; coastal waters of Norway; and possibly Great Britain and interior lakes or reservoirs in North America (Figure 1).

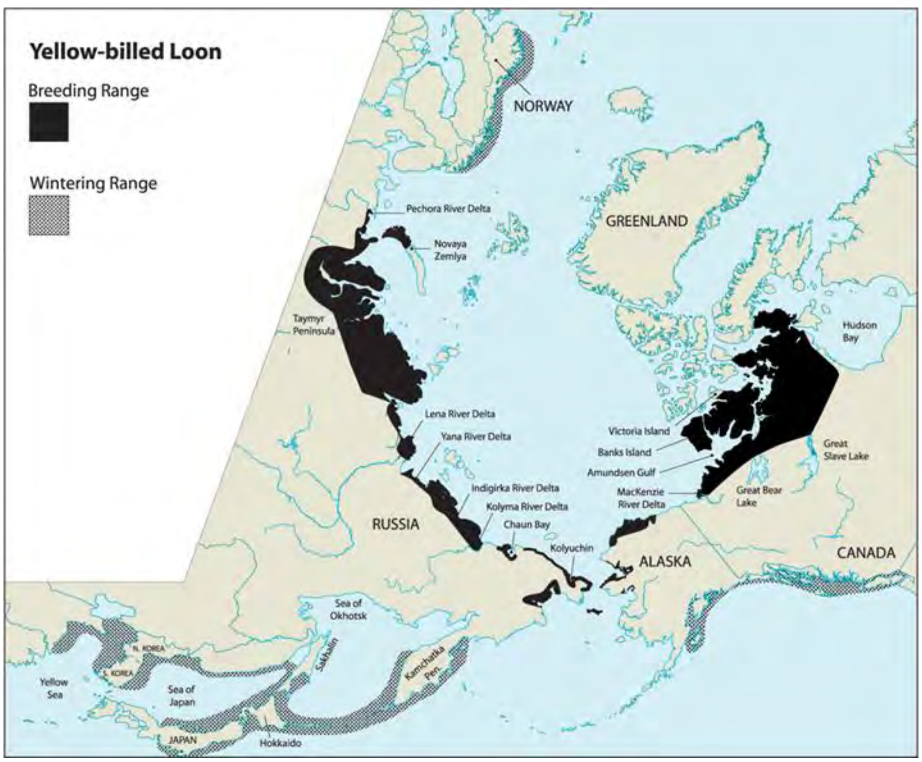

Figure 1. Breeding and wintering range of the yellow-billed loon.

In conducting our SSA report, we first considered resources that yellow-billed loon individuals, populations, and the species rangewide may need to ensure viability (the ability of a species to persist over time), and conversely, to avoid extinction. We next evaluated whether those identified needs are currently being met and effects on individuals, populations, and the species rangewide when those needs are not met, now and into the future. We evaluated the current viability of the species using the previous information as well as abundance and trend estimates from a monitored population (the Alaska-Arctic Coastal Plain (Alaska-ACP) breeding population) that we assume has a similar population status to other breeding populations because it faces similar or greater threats, and evaluated the future viability of the species in terms of resiliency, redundancy, and representation. Resiliency is the ability of the species to withstand stochastic events and is measured by population health metrics (e.g., abundance, growth rates) or genetic variation. Redundancy is the ability of a species to withstand catastrophic events by spreading the risk through duplication and distribution of resilient populations across its range. Representation is the ability of a species to adapt to changing environmental conditions and can be measured by the breadth of genetic diversity within and among populations, and the ecological diversity of populations across the species' range.

Our assessment found the yellow-billed loon has an overall high probability of persistence (i.e., a low probability of extinction) in the short term, defined as the time interval where climatic and associated environmental conditions remain similar to those between 1986-2013 (i.e., the period for which we have abundance trend data). In the long term, climate change is likely to alter loon habitat to an increasing degree. However, the rate, mechanisms, effects, and proportion of the species and/or range affected are uncertain.

Based on our current understanding, resources needed to sustain the life-history processes of yellow-billed loon individuals, populations, and the species rangewide include:

- Northern breeding areas with large lakes (8-229 hectares (ha) or 19.8-565.9 acres (ac)) that have suitable nesting habitat (i.e., highly convoluted, vegetated, and low-lying shorelines). Nest sites are located on islands, hummocks, or peninsulas, along low shorelines and within 1 meter (m) or 3 feet (ft) of the water; clear water for hunting prey fish; water depths greater than 2 m (6.5 ft) that allows for unfrozen wintering fish habitat under the ice; large lake areas; and adequate prey (fish) availability.
- Marine (or freshwater) migratory and wintering areas with access to adequate prey, primarily fish.
- Habitats that are relatively free from disturbance and pollution.
- High adult survival rates.
- Sufficient average annual productivity.
- Sufficient number and distribution of resilient populations across its range.

The species' status was evaluated using abundance estimates, the species' geographic range, and trend information from the U.S. Fish and Wildlife Service's Migratory Bird Management annual aerial surveys of the Alaska-ACP breeding population. The global yellow-billed loon population is estimated to number 16,000 to 32,000, spread among five breeding areas on two continents. The Alaska-ACP breeding population is representative of other breeding populations, because it faces the same threats of other breeding populations. The Alaska-ACP breeding population is the only population with data from which trends were estimated. Trend data from 1986 to 2013 indicate that the Alaska-ACP breeding population is stable or slightly increasing (Stehn *et. al.* 2014, p. 3; Stehn *et. al.* 2013, p. 23). Because the Alaska-ACP breeding population is representative of other breeding populations throughout its range, we assume that other yellow-billed loon populations also have an adequate growth rate and sufficient resiliency to withstand stochastic events.

Representation is the ability of a species to adapt to changing environmental conditions and is considered a function of a species ecological and genetic diversity. The more represented or diverse a species is, the more capable it is of adapting to changes (natural or human-caused) in its environment. Although one study has been conducted on genetic markers in yellow-billed loons, the results from the small sample size are very preliminary and cannot be used to evaluate representation. Therefore, we considered representation through yellow-billed loon ecological diversity.

Yellow-billed loons have specific breeding habitat needs, such as large lakes with shallow vegetated shorelines and sufficient prey. Their Arctic breeding range is exhibiting effects of climate change, resulting in hydrological changes that may end with widespread lake drying and drainage (depending upon the underlying substrate). Yet, we expect that important polynyas (areas of open water at predictable, recurrent locations in sea-ice covered regions) and ice-lead spring staging habitat are likely to continue to exist in the future, which will continue to provide spring migration habitat for yellow-billed loons, even as the Arctic climate continues to warm. Changes in productivity associated with ice melt, changes in water chemistry, and northward migration of previously southern species may result in changes in Arctic food webs and yellow-billed loon marine prey availability, which could either increase or decrease in response. On the other hand, yellow-billed loons winter exclusively or nearly exclusively in coastal marine waters, likely within 32 kilometers (km) (or 20 miles (mi)) of shore in areas that are protected and harbor adequate prey resources. If the species is, in fact, limited by narrow, specific habitat associations or requirements, this may indicate low ecological diversity, which would limit the species' ability to adapt to environmental change. Although some information indicates that representation may be low, we do not have enough information at this time to determine if representation of yellow-billed loons is having or will have implications for the long term future viability of the species.

As part of our SSA report we also analyzed current causes and effects of activities that may affect the short- and longer-term persistence of yellow-billed loons at the individual, population, and species rangewide levels. For example, we looked at climate change effects on breeding and marine habitats, oil and gas exploration and development, degradation of marine habitats in response to increasing anthropogenic stressors, research activities, disease, predation, oil spills, collisions, subsistence activities including harvest and fishing bycatch, commercial fishing bycatch, pollution, existing regulatory mechanisms, and conservation measures. We identified stressors that had documented effects at the individual level, but there is no information to indicate that these stressors have affected populations of yellow-billed loons. Conservation measures and regulations may have effectively reduced the effects of some potential stressors, such as disturbance from oil and gas activities in Alaska-ACP breeding areas. Research implemented from cooperative conservation efforts has filled data gaps and addressed mortality from subsistence harvest, which was previously thought to affect yellow-billed loons at the population level. Based on current information on the health of populations and an analysis of the effects of stressors, we have determined that the yellow-billed loon rangewide population is viable for the short term.

In the longer term, climate change is likely to alter loon habitat to an increasing degree. However, the rate, mechanisms, effects, and proportion of the species and/or range affected are uncertain.

Chapter 1. Introduction

The yellow-billed loon (*Gavia adamsii*) is a migratory water bird that breeds on large lakes (at least 13.4 ha or 33 ac) in Arctic and sub-Arctic wetlands and coastal areas, and winters primarily in temperate marine environments. It has been a species of conservation concern since 2009 when it was designated a candidate for listing by the U.S. Fish and Wildlife Service (Service) under the Endangered Species Act (74 FR 12931, March 25, 2009).

This SSA report for the yellow-billed loon is a comprehensive evaluation of the biological status of the species, including information on its life history and biology and consideration of current and future risks to the viability of the species. This SSA is not a decision document; rather, it will be used to inform our decision in the listing process for the yellow-billed loon under the Endangered Species Act. This document is a compilation of the best available scientific and commercial information.

For the purpose of this assessment, we define viability as the ability of a species to persist over time, and conversely, to avoid extinction. We divided our analysis into short term and long term. Short term is defined as the time interval where climatic and associated environmental conditions remain similar to those between 1986-2013 (i.e., the period for which we have abundance trend data). In the long term, climate change is likely to alter loon habitat to an increasing degree. However, the rate, mechanisms, effects, and proportion of the species and/or range affected are uncertain.

Using the SSA framework, we consider what the species needs to maintain viability by characterizing the status of the species in terms of its resiliency, redundancy, and representation in the short and long term:

- **Resiliency** is defined as the ability of the species to withstand stochastic (random) events, and can be measured with metrics of population health such as birth versus death rates or population size. Healthy populations are more resilient and better able to withstand disturbances such as random fluctuations in birth rates (demographic stochasticity), variations in weather (environmental stochasticity), or the effects of anthropogenic activities.

- **Redundancy** is defined as the ability of a species to withstand catastrophic events. Redundancy is about spreading the risk and can be measured through the duplication and distribution of resilient populations across the range of the species. The more resilient populations a species has distributed over a larger landscape, the better able it can withstand catastrophic events.

- **Representation** is defined as the ability of a species to adapt to changing environmental conditions. Representation can be measured through the breadth of genetic diversity within and among populations, and the ecological diversity (also called environmental variation or diversity) of populations across the species' range. The more representation, or diversity, a species has, the more it is capable of adapting to changes in its environment.

To evaluate the viability of the yellow-billed loon both currently and into the future, we considered the species' resiliency, redundancy, and representation with an assessment of biology, natural history, demography, and present and likely future threats (causes and effects). The format for this SSA Report includes: (1) resources needed for individuals, populations, and the species rangewide; (2) the current abundance, distribution, and population metrics of the species; (3) a review of likely threats (causes and effects) to the current and future status of the species; and (4) an assessment of viability and risk of extinction in terms of resiliency, redundancy, and representation.

Chapter 2: Species Needs-Life History, Biology, and Range

This chapter contains basic biological information about the yellow-billed loon, including its taxonomy, morphology, known life history traits, and the range and distribution of populations. We used this biological information to then determine the resources needed by individuals, populations, and the species to maintain viability and, conversely, reduce the risk of extinction. The following chapters contain an evaluation of whether those resource needs are being met and whether they are likely to be met in the future, forming a basis for discussing the current and future viability of the yellow-billed loon.

2.1 Taxonomy

Yellow-billed loons (Order Gaviiformes, Family Gaviidae) are one of five loon species (*Gavia* spp.), and most closely related to common loons (*G. immer*), with similarities in size and appearance except for their yellow or ivory-colored bill. The distribution of yellow-billed loons overlaps, to varying extents, with those of the four other loon species (Sibley 2000, pp. 24–25). There are no recognized subspecies or geographic variations (American Ornithologists' Union 1998, p. 5). A small number of yellow-billed-common loon hybrid specimens and mixed-species breeding pairs have been reported (Roselar *et. al.* 2005, p. 24-30; McCarthy 2006, p. 196; Evers *et. al.* 2010, http://bna.birds.cornell.edu/bna/species/313/articles/systematics, accessed July 9, 2014; J. Schmutz, USGS, pers. comm.).

2.2 Species Description

Yellow-billed loons are very similar in size and plumage to common loons, and this may lead to issues with species identification. The yellow-billed loon can be distinguished from common loons by their larger yellow or ivory-colored bill. Yellow-billed adults weigh approximately 4,600 to 5,900 grams (g) (8.8–13.2 pounds (lbs)), and are 774 to 920 millimeters (mm) (30 to 37 inches (in)) in length (North 1994, p. 2). Breeding (alternate) plumage of adults of both sexes is black on top with white spots on the wings and underside and white stripes on the neck. Non-breeding (basic) plumage is gray-brown with fewer and less distinct white spots than breeding plumage, paler undersides and head, and a blue-gray bill. Hatchlings have dark brown and gray down, and juveniles are gray with a paler head (North 1994, p. 2). Like all loons, yellow-billed loons are especially adapted for aquatic foraging, with a streamlined shape and legs near the rear of the body. These aquatic adaptations mean, however, that they have difficulty walking on and are unable to take flight from land.

2.3 Life History

Breeding

As large-bodied birds with low clutch size, the yellow-billed loon is a K-selected species (long-lived and dependent upon high annual adult survival to maintain populations). Based on common loons, birds may reach sexual maturity at three years of age, but may not acquire breeding territories until later. The average age at first breeding for common loons is six years (Evers 2004, p. 18). Annual adult survival (from 70 satellite-tracked breeding adults) of yellow-billed loons is 0.91 (J. Schmutz, USGS, pers.comm.), virtually identical to that of common loons (Mitro *et. al.* 2008, p. 669).

Nesting

Yellow-billed loons nest from June to September on shores of coastal and inland low-lying tundra lakes from latitude 62 to 74 degrees north. Breeding lakes may be near major rivers, but lakes connected to rivers are usually not used for breeding (Johnson *et. al.* 2014, p. 5; North and Ryan 1989, p. 303), possibly because lakes with river connections are prone to flooding, and turbidity associated with fluctuating water levels may compromise foraging success. Falling water levels may also expose loon nests to increased risk of predation (Kertell 1996, p. 356). Yellow-billed loons may use the same lakes for breeding and rearing of young. However, they may move broods from nesting to rearing lakes if nesting lakes are too small (Johnson *et al.* 2014, p. 8).

Nesting territories, which are areas defended against other yellow-billed loons and other loon species, may include one or more lakes or parts of lakes (North 1994, p. 10). Nesting territory size, likely dependent upon lake size and quality, ranges from 13.8 to greater than 100 ha (34 to greater than 247 ac) on the Colville River Delta, Alaska (North 1986, p. 12). Breeding lakes are known to be reoccupied over long time spans, and in the Western Alaska breeding area, yellow-billed loon reuse, including nesting, of individual lakes was greater than 0.70, suggesting that either net site fidelity or long term attractiveness of specific lakes was high (North 1994, p. 10; Schmidt *et. al.* 2014, p. 13). However, the same individuals may not occupy the same territory over their lifespan (Piper *et. al.* 2000, p 387; Piper *et. al.* 2006, p. 5; Schmutz *et. al.* 2014, p. 59). These long-lived birds will often battle to the death to obtain or retain a territory, which implies that availability of quality breeding habitat may be limiting (Piper *et. al.* 2008, p. 209; J. Schmutz, USGS, pers. comm.).

Breeding lake habitat characteristics associated with yellow-billed loon presence includes highly convoluted, vegetated, and low-lying shorelines and dependable (from year to year), non-fluctuating (within the breeding season) water levels (Earnst *et. al.* 2006, pp. 230–233; Stehn *et. al.* 2005, pp. 9–10; North 1994, p. 6). In other words, the yellow-billed loon needs sheltered, stable areas close to the water to build nests. Because yellow-billed loons cannot walk on land and can only take flight from water, nest sites are usually located on islands, hummocks, or peninsulas along low shorelines and within 1 m (3 ft) of the water. The nest location, which may be used in multiple years, often provides a better view of the surrounding land and water than other available lakeshore locations, possibly to detect approaching predators (Haynes *et. al.* 2014a, p. 1). Nests are constructed of mud or peat, and are often lined with vegetation (Bowman 2004, pp. 7–11). Other characteristics associated with yellow-billed loons' breeding lake habitat include clear water for hunting prey fish (Earnst *et. al.* 2006, pp. 230–233; Stehn *et. al.* 2005, pp. 9–10; North 1994, p. 6); water depths greater than 2 m or 6.5 ft that allows for unfrozen wintering fish habitat under the ice; large lake areas (at least 13.4 ha or 33 ac); and adequate prey (fish) availability (Earnst *et. al.* 2006, pp. 230–233; Stehn *et. al.* 2005, pp. 9–10; North 1994, p. 6; Johnson *et. al.* 2014, p. 17).

Recruitment

Yellow-billed loons lay one or two large, smooth, mottled brown eggs in mid- to late June (North 1994, pp. 11–12). Yellow-billed loon eggs are similar in size to common loon eggs, but may be distinguished from red-throated (*G. stellata*) and Pacific loons (*G. pacifica*) by their larger size. On average, yellow-billed loon eggs are 91 x 55 mm (3.6 x 2.2 in) in size, while the red-throated or Pacific loon eggs are 74 mm x 47 mm (2.9 x 1.9 in) in size (Bowman 2004, pp. 8–11).

Egg replacement after nest predation is unusual; the short Arctic summer provides inadequate time for another cycle of egg production and sufficient chick growth unless failure occurs very early in the season (Earnst 2004, p. 8). Hatching occurs after 27–28 days of incubation; incubation is shared equally by both sexes. Although the age at which young yellow-billed loons are capable of flight is unknown, it is probably similar to common loons (8–11 weeks). Young leave the nest soon after hatching, and the family may move between natal and brood-rearing lakes. Both males and females participate in feeding and caring for young (North 1994, p. 13).

Information on reproductive success is limited, but significant variation among years has been described. Survival rates to six weeks of age for yellow-billed loons on the Colville River Delta between 1995 and 2000 ranged from four to 60 percent with low success attributed to late ice melt or extreme flooding (Earnst 2004, p. 9). Apparent nest success on the Colville River Delta recorded by aerial surveys was highly variable, ranging from 19 to 64 percent between 1993 and 2007 (ABR Inc. 2007, p. 16).

When disturbed, the yellow-billed loon is easily displaced from normal activities, including incubation. Reduced productivity in common loon has been attributed to human disturbance (Evers *et. al.* 2010, http://bna.birds.cornell.edu/bna/species/313/articles/conservation, accessed July 6, 2014). Preliminary data from Rizzolo *et. al.* (2014, *in press*) and Schmutz and Uher-Koch (2014, unpubl. data) indicates negative impacts (increased avian predation) to red-throated and yellow-billed loons from human disturbance of nests in Alaska. Conversely, Johnson *et. al.* (2014, p. 20) modeled yellow-billed loon territory occupancy on the Colville River Delta, Alaska in association with oilfield development and did not find any adverse effects on nest or brood territories. However, effects may have occurred at smaller scales than were modeled or were overridden by variation in habitat quality of lakes (Johnson *et. al.* 2014, pp. 20–21).

Competition

The probability of yellow-billed loon presence on a lake increases with the absence of Pacific loons (Earnst *et. al.* 2006, p. 233; Stehn *et. al.* 2005, p. 9). In the Western Alaska breeding area, two out of three lakes less than 7 ha (17.3 ac) were occupied by Pacific loons, and one out of three were occupied by yellow-billed loons with very little overlap between the two species (Schmidt *et. al.* 2014, p. 12). On the other hand, presence on lakes greater than 7 ha (17.3 ac) by Pacific and yellow-billed loons was high (Schmidt *et. al.* 2014, p. 12). On the Alaska-ACP, Haynes *et. al.* (2014a, p. 1) found strong evidence for interspecific competition between yellow-billed and Pacific loons, concluding that yellow-billed loons were dominant, but that both species could co-occur on large lakes or lakes with convoluted shorelines.

Prey

Yellow-billed loons eat relatively small fish and other aquatic prey (North 1994, p. 6). During the summer breeding season, adults feed their young almost entirely from brood-rearing freshwater lakes (North 1994, p. 14). However, satellite telemetry data suggest that at least some yellow-billed loons on the Seward Peninsula in Alaska make multiple daily movements between brood lakes and the marine environment to feed on marine prey (J. Schmutz, USGS, pers. comm.). Small fish, such as ninespine sticklebacks (*Pungitius pungitius*) and least cisco (*Coregonus sardinella*) are thought to be the main foods of chicks in Alaska (Earnst 2004, p. 9). Other freshwater and brackish prey may include Alaska blackfish (*Dallia pectoralis*) and slimy sculpin (*Cottus cognatus*) (Haynes *et. al.* 2013, p. 1056).

In their wintering range, yellow-billed loons primarily prey on marine fish, crustaceans, and worms. Yellow-billed loon prey data collected from the winter season in southeast Alaska and Canada included fish, such as sculpins (*Leptocottus armatus, Myoxocephalus* spp.), Pacific tomcod (*Microgadus proximus*), and rock cod (*Sebastodes* spp.); and invertebrates, such as amphipods (*Orchomonella* spp., *Anonyx nirgax*), isopods (*Idothea* sp.), shrimps (*Pandalus danae, Spirontocaris ochotensis*), hermit crabs (*Pagarus* spp.), and marine worms (*Nereis* spp.) (Earnst 2004, pp. 9–10; North 1994, pp. 6–7; Cottam and Knappen 1939, p. 139; Bailey 1922, p. 205).

Amphipods, isopods, and aquatic plant material may also be used as food (Earnst 2004, p. 9; Sjölander and Ågren 1976, p. 460). In Arctic Russia, stomach content analyses indicated sticklebacks, salmon, crustaceans, beetles, and plant vegetation were consumed during the breeding season (Uspenskii 1969, p. 130). Rainbow smelt (*Osmerus mordax*), Arctic grayling (*Thymallus arcticus*), burbot (*Lota lota*), and round whitefish (*Prosopium cylindraceum*) have overlapping distributions with yellow-billed loons and small individuals of these species may also be prey items (T. Haynes, University of Alaska Fairbanks, pers. comm.).

Migration

Yellow-billed loon migration routes are primarily marine, although some inland Canada breeders may migrate overland, presumably via large lakes, to marine wintering areas (Schmutz 2011, p. 1). Yellow-billed loons migrate singly or in pairs, but gather in polynyas (areas of open water at predictable, recurrent locations in sea-ice covered regions), ice leads (more ephemeral breaks in sea ice, often along coastlines), and early-melting areas off river deltas near breeding grounds in spring along the Beaufort Sea coast of Alaska and Canada (Mallory and Fontaine 2004, pp. 52–53; Alexander *et. al.* 1997, pp. 15, 17; Barr 1997, pp. 12–13; Johnson and Herter, 1989, p. 9; Woodby and Divoky 1982, p. 406; Barry and Barry 1982, p. 25; Barry *et. al.* 1981, pp. 29–30). Satellite telemetry data indicate some yellow-billed loons depart breeding areas in late September, and arrive in wintering locations in mid-November (North 1994, p. 5). Spring migration begins in April, and yellow-billed loons arrive on breeding grounds during the first half of June (North 1994, p. 5). Non-breeders or failed nesters may start their fall migration in July (North 1994, p. 5).

Juvenile loons may not migrate for the summer, likely spending their first several years on wintering areas. A small sample (n=5) of juvenile red-throated loons remained on wintering areas in the first summer after their birth (Rizzolo and Schmutz, unpubl. data), and common loons marked as juveniles do not typically appear on breeding lakes until at least age 3 (Evers *et. al.* 2010, http://bna.birds.cornell.edu/bna/species/313/articles/demography, accessed July 6, 2014). Yellow-billed loons observed during the summer in coastal waters of southeast Alaska, a known wintering area, may be nonbreeding, juvenile birds (J. Hodges and J. Schmutz, USGS, pers. comm.).

2.4 Range

Because yellow-billed loons have not been thoroughly surveyed throughout their known historical range, we are not able to determine changes in overall range and distribution. Most of the information available for Alaska and Canada is recent (i.e., past 10 years), as described below. Even though we describe potential changes to the yellow-billed loon's historical ranges in Russia below, there is more uncertainty and consequently less specificity in defining Russian and Canadian breeding populations compared to those in Alaska. We have used the best available information to distinguish breeding populations based on geographic separation of areas (two each in Alaska and Canada, and one or two in Russia), separate migratory pathways and wintering areas.

2.4.1 Breeding (Summer) Range

In North America, yellow-billed loons nest in Alaska on the Arctic Coastal Plain of the North Slope (the region north of the Brooks Range), and the region surrounding Kotzebue Sound in western Alaska, primarily the northern Seward Peninsula (Earnst 2004, pp. 3–4; North 1993, pp. 38–42). In Canada, yellow-billed loons nest on islands in the Arctic Ocean (hereafter "Canadian arctic islands") and on the mainland between the Mackenzie Delta and Hudson Bay.

In Russia, yellow-billed loons nest on a relatively narrow strip of coastal tundra from the Chukotka Peninsula in the east and on the western Taymyr Peninsula in the west, with a break in distribution between these two areas (Earnst 2004, p. 3; Ryabitsev 2001, p. 22; Red Data Book of the Russian Federation 2001, p. 366; Pearce *et. al.* 1998, p. 369; North 1993, p. 42; Il'ichev and Flint 1982, p. 277). The Red Data Book of the Russian Federation (2001, p. 366) stated that the species no longer nests in European Russia where it was formerly found, e.g., the Kola Peninsula, the archipelago of Novaya Zemlya, and Vaigach and Ainovy Islands in the Kara Sea. It is unclear how abundant or widespread the species was in these areas historically. Kalyakin (2001, p. 10) reported finding yellow-billed loons nesting on Novaya Zemlya, although the species was extremely rare.

Distribution of yellow-billed loons within their breeding range is clumped at a regional scale, probably in response to availability of preferred habitat. For example, the greatest concentration of yellow-billed loons on the ACP occurs between the Meade and Colville Rivers where large lakes are abundant (Larned *et. al.* 2011, p. 8; Earnst 2004, p. 3).

Nearshore and offshore marine waters adjacent to breeding areas are likely used by both breeding adults and non-territorial birds for foraging (Earnst 2004, p. 7). Earnst (2004, pp. 6–7) reviewed yellow-billed loon distribution information obtained from fixed-wing aerial waterfowl surveys that Fischer *et. al.* (2002, pp. 40-41, 52, 68-69) conducted in 1999 and 2000 off the coasts of Canadian arctic islands and the ACP of Alaska between Cape Halkett and Brownlow Point. Similar surveys conducted between Barrow and Demarcation Point in 2001 also included yellow-billed loon observations in Elson Lagoon (Fischer and Larned 2004, p. 146; Fischer 2001, p. 4). While conducting fixed-wing aerial surveys for common eiders in late June of 1999 through 2009, between 23 and 99 yellow-billed loons were observed in nearshore waters and along barrier islands of the Beaufort and Chukchi Seas (Dau and Bollinger 2009, p. 20). Yellow-billed loons used lagoons and nearshore waters along the coast of St. Lawrence Island in summer in the 1950s (Fay and Cade 1959, pp. 92, 100).

In Russia, Solovyova (2007, p. 6) conducted coastal boat surveys and reported densities of 0.24 yellow-billed loons/km in coastal waters near the Kyttyk Peninsula and Ayon Island at the northern end of Chaun Bay in western Chukotka, and 0.04 yellow-billed loons/km at the southern end of Chaun Bay near the Chaun River Delta in 2006. Vronskiy (1987, p. 30) observed yellow-billed loons in bays 100 to 150 m (328 to 492 ft) offshore of northwestern Taymyr during summer. Yellow-billed loons occurred in summer along the coast of Wrangel Island, although there were no indications of nesting on the island (Stishov *et. al.* 1991, p. 20). In boat-based surveys in the Kara and Barents Seas, no yellow-billed loons were observed; however, arctic (*G. arctica*) and red-throated loons were abundant in the nearshore marine waters of the western Kara Sea and in the Ob' and Yenisey estuaries, especially in Baidaratskaya Bay, and occurred in smaller numbers in the Pechora Bay in the Barents Sea in August and September 1995 (Decker *et. al.* 1998, pp. 9, 11). In subsequent boat surveys between 1998 and 2003, only one yellow-billed loon was observed in mid-August 1998 in coastal waters northeast of Dolgy Island (west of Vaigach Island) in the Pechora Sea (M. Gavrilo in litt. 2008). According to the Red Data Book of the Yamal-Nenets Autonomous District (1997, p. 26) near the western end of the Russian breeding range, only a few non-breeding yellow-billed loons were recorded in the district in the previous 20 years, and the Red Data Book of Kamchatka (2006, p. 92) indicates non-breeding birds occur off the coast of Kamchatka in summer.

Earnst (2004, pp. 11–12) summarized yellow-billed loon observations in summer marine boat-based surveys conducted in lower Cook Inlet and Prince William Sound in southcentral Alaska, and in Southeast Alaska. Estimates from all these surveys totaled only 339 yellow-billed loons, but many loons were not identified to species (Earnst 2004, p. 11). In boat-based surveys of murrelets conducted in July of 2002-2004 from Icy Bay to LeConte Bay in southeast Alaska, Kissling *et. al.* (2007, appendices 7-8) counted 20 yellow-billed loons. Yellow-billed loons have been observed throughout summer months in the Aleutians (Gibson and Byrd 2007, p. 68).

2.4.2 Migratory Routes and Wintering Range

The best available information indicates that there are two migration routes for yellow-billed loons breeding on Canadian arctic islands and along the adjacent Canadian mainland. Fourteen of 15 breeding yellow-billed loons marked with satellite transmitters on Victoria Island, Canada, (2 in 2009 and 13 in 2013) migrated west along the Beaufort Sea coast and south through the Bering Strait to either the Alaska Peninsula or Asian waters (J. Schmutz, USGS, pers. comm.). Fourteen of 15 breeding yellow-billed loons marked with satellite transmitters in 2010 on the Canadian mainland near Daring Lake used an overland route southwest to locations in southeast Alaska, the Kodiak archipelago or southern Alaska Peninsula (Schmutz 2011, p. 1); the other marked bird used the marine route through the Bering Strait.

North's (1993, pp. 45–46) examination of alternative return migration routes for yellow-billed loons wintering in southeast Alaska and British Columbia suggested that they could migrate over land to mainland breeding areas in Canada, particularly around Great Slave Lake, and yellow-billed loons have been observed on inland lakes in Canada and Alaska (North 1993, pp. 43, 46). Thus, yellow-billed loons from the Canadian arctic islands migrate along the coast and through the Chukchi Sea to Asia, while those from mainland Canada migrate overland to the coast of southern Alaska and British Columbia (Figure 2), resulting in two separate populations.

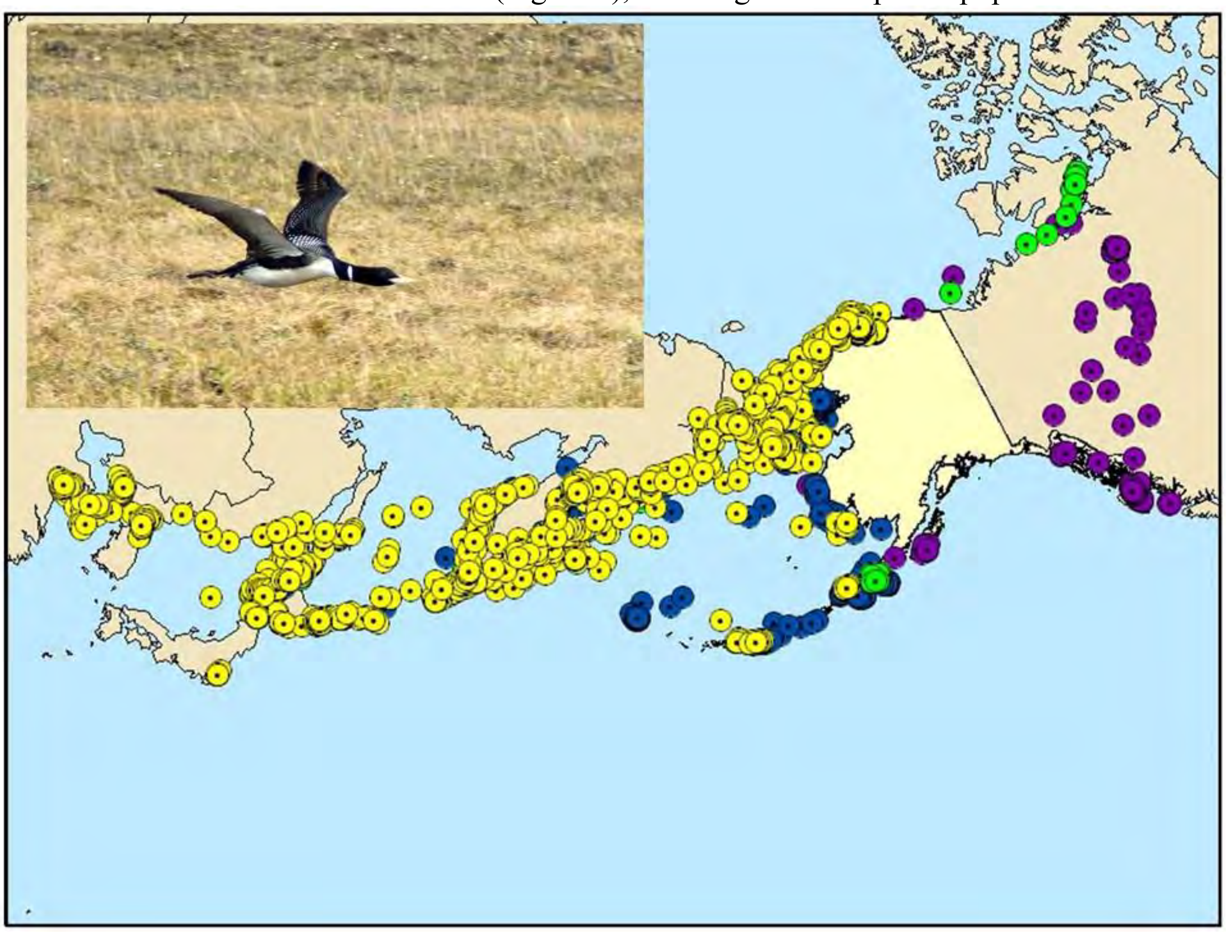

Figure 2. Locations of yellow-billed loons marked with satellite transmitters from the Alaska-ACP (yellow), western Alaska (blue), Canadian arctic islands (green), and Canadian mainland

(purple) breeding populations, 2009 to 2013. Figure courtesy of J. Schmutz, USGS (unpubl. data).

In the Bering Strait, yellow-billed loons are considered an uncommon to fairly common migrant at Gambell (Lehman 2011, p. 11). In 2011, 53 of 70 yellow-billed loons observed on St. Lawrence Island were recorded from Gambell, indicating that yellow-billed loons may aggregate along western and southern shores of the island (Ahmasuk 2009, p. 4; Zeller 2012, p. 1). Between 2002 and 2010, 32 of 34 breeding yellow-billed loons marked with satellite transmitters on the ACP migrated south to Asia, predominantly along the Russian coastline from the Chukotka Peninsula (either through the Bering Strait or across the mountains from the north side of the Chukotka Peninsula to the Gulf of Anadyr), and along the Kamchatka coast (Schmutz 2011, p. 1; 2008, p. 1). They wintered in the Yellow Sea and Sea of Japan off the coasts of China, North Korea, Russia, and Japan (near Hokkaido). The other two migrated to southwest Alaska. In 2007 and 2008, all 10 breeding yellow-billed loons marked with satellite transmitters used the Bering Strait region to migrate after leaving their breeding grounds on the Seward Peninsula, Alaska. Five of these yellow-billed loons migrated to Asian wintering grounds as described above for ACP breeding birds; the other five wintered throughout the Aleutian Islands from Shemya Island in the west to the Semidi Islands off the coast of the Alaska Peninsula (Schmutz 2008, p. 1). In conclusion, most yellow-billed loons breeding in Alaska migrate to and winter in Asia, but some migrate to and wintering off North America (Figure 2).

In Russia, the migration routes of breeding yellow-billed loons have not been studied. Because of the proximity of the Chukotka Peninsula to the ACP in Alaska, and the fact that ACP breeding yellow-billed loons use the Chukotka Peninsula during migration (Schmutz 2008, p. 1), it is likely that some or all yellow-billed loons from eastern Russia migrate through the Bering Strait to Asian wintering areas.

The yellow-billed loon's wintering range includes coastal waters of southern Alaska and British Columbia from the Aleutian Islands to Puget Sound (Audubon Christmas Bird Count data, http://netapp.audubon.org/CBCObservation/Historical/ResultsBySpecies.aspx?1, accessed July 6, 2014); the Pacific coast of Asia from the Sea of Okhotsk south to the Yellow Sea; the Barents Sea and the coast of the Kola Peninsula; coastal waters of Norway; and possibly Great Britain (Schmutz 2008, p. 1; Gibson and Byrd 2007, p. 68; Strann and Østnes 2007, p. 2; Earnst 2004, pp. 13–14; Ryabitsev 2001, p. 22; North 1993, pp. 42–43; Burn and Mather 1974, p. 278). Wintering habitats in Norway include sheltered marine waters less than 30 m (98.4 ft) deep, such as fiords and areas between islands along the inner coast (Strann and Østnes 2007, p. 2). Schmutz (2008, p. 1) found that throughout migrating and wintering seasons, yellow-billed loons marked with satellite transmitters occurred from 1.6 to 32 km (1 to 20 mi) offshore. Some yellow-billed loons also winter in interior lakes or reservoirs in North America (North 1994, p. 3).

2.5 Genetic Diversity

Talbot *et. al.* (2014, p. 2) have conducted some work on the genetics of yellow-billed loons. They provided preliminary results during their ongoing development of microsatellite markers for yellow-billed loons. They reported that 10 of 45 dinucleotide loci they developed were polymorphic in a sample of six yellow-billed loons (p. 2). They further tested 8 of those 10 polymorphic loci for allele frequency differences between 2 breeding aggregations (34 samples from Alaska-ACP and 14 samples from Daring Lake in Canada). They found significant differences in allele frequencies between the two aggregations, suggesting genetic population structuring may exist within the species. They also reported low overall genetic diversity in the 48 individuals analyzed from the two breeding aggregations (average numbers of alleles = 2.63 for both aggregations; expected heterozygosities = 0.40 and 0.37 for the Alaskan and Canadian aggregations, respectively). Talbot *et. al.* (2014, p. 2) analyses are based on small samples sizes and are preliminary. Further analyses are necessary to determine if the low levels of genetic diversity reported are indicative of the species as a whole.

2.6 Resources Needed for Individuals, Populations, and the Species

Habitat requirements and spatial distribution of breeding yellow-billed loons are linked to large freshwater lakes (8-229 ha (19.8-565.9 ac)) which provide shorelines suitable for nest building, that are large enough for loons to take flight from, are relatively free from human disturbance, and proximal to sufficient quantity and quality of prey. Although we are beginning to document migratory and wintering areas for certain populations through the use of satellite telemetry, we have little information on specific migratory or wintering habitat characteristics important to individuals. Yellow-billed loons need large areas of open water to take off because they cannot walk on land, and, as aquatic eaters, they need sufficient prey fish or invertebrate populations to allow overwinter survival and return to breeding areas.

Ecological resources are often phrased in terms of habitats, such as geographic areas that provide food, shelter, and water. These can be quantified, and in the case of many rare species have been altered or destroyed, justifying management focus on habitat protection. A less tangible but still measurable need is longevity sufficient to allow for adequate reproduction. This need is met by protection from mortality. For a K-selected species, this means that an individual survives over enough breeding seasons to result in some minimum measure of lifetime fitness. The term "fitness" can be thought of as the ability to survive and reproduce, or more specifically as the genetic contributions of an individual to the population. Therefore, a need for individual yellow-billed loons is protection from mortality, resulting in sufficient survival time to maximize their own fitness. At a population level, yellow-billed loons need high adult survival for healthy populations, as adult survival is an important determinant of K-selected species' population size and persistence (Smith and Smith 2001, p. 235). If enough adults are removed from the population prior to replacing themselves (i.e., adult survival is decreased), the population will decline.

Similarly, low productivity means that depleted K-selected species have lower recovery potential and slower recovery rates following population declines than r-selected species, which are characterized by high annual productivity. Stressors that reduce productivity, including loss of productive breeding habitats, reduction in prey populations, and increases in nest predators, may further constrain K-selected species' recovery potential. Further, most Arctic-breeding species are characterized by variable annual productivity, given the unpredictable and severe nature of Arctic weather, fluctuations in predator-prey relationships, and other aspects of Arctic ecology.

The population impact of threats that reduce productivity could be magnified if coincident with a year that would have had high productivity but for the threats.

Multiple resilient populations distributed throughout the range create the necessary redundancy to reduce the risk that a large portion of the species' range will be negatively affected by any particular natural or anthropogenic event at any one time. Species that are well-distributed across their historical range (i.e., having high redundancy) are less susceptible to extinction and more likely to be viable than species confined to a small portion of their range. Yellow-billed loons occur in five geographically distinct breeding populations distributed across two continents (Alaska-ACP, Western Alaska, Canadian arctic islands, Canadian mainland, and Russia).

Based on the best available information, resources needed to sustain the life-history processes of yellow-billed loon individuals, populations, and the species rangewide include:

- Northern breeding areas with large lakes (8-229 hectares (ha) or 19.8-565.9 acres (ac)) that have suitable nesting habitat (i.e., highly convoluted, vegetated, and low-lying shorelines). Nest sites are located on islands, hummocks, or peninsulas, along low shorelines and within 1 meter (m) or 3 feet (ft) of the water; clear water for hunting prey fish; water depths greater than 2 m (6.5 ft) that allows for unfrozen wintering fish habitat under the ice; large lake areas; and adequate prey (fish) availability.
- Marine (or freshwater) migratory and wintering areas with access to adequate prey, primarily fish.
- Habitats that are relatively free from disturbance and pollution.
- High adult survival rates.
- Sufficient average annual productivity.
- Sufficient number and distribution of resilient populations across its range.

Chapter 3. Current Species Conditions

In this chapter we review current conditions of yellow-billed loons using the best available information on population status, trends, range, and distribution.

3.1 Population Estimates

Most of the yellow-billed loon's breeding range has not been extensively surveyed, and only in Alaska have surveys been conducted specifically for breeding yellow-billed loons. Population sizes in Russia and Canada have been estimated using anecdotal observations and analysis of available habitats. The global breeding population size of yellow-billed loons is unknown, but it is probably in the range of 16,000 to 32,000 with 3,000 to 4,000 breeding in Alaska (74 FR 12932, March 25, 2009).

3.1.1 Alaska-ACP

The breeding population of yellow-billed loons on the Alaska-ACP is monitored each year by the Service's Migratory Bird Management program (MBM) using a fixed-wing aerial transect survey. The aerial survey was designed to obtain annual indices of yellow-billed loons present on the entire ACP during the nesting period in mid-June (Larned *et. al.* 2011, p. 2). The population index does not account for undetected loons present on breeding grounds or loons not present on the Alaska-ACP during mid-June. The average yellow-billed loon breeding population on the Alaska-ACP from 2004 to 2013 was 2,199 individuals (90 percent CI = 1873-2526) (Stehn *et. al.* 2014, p. 3).

3.1.2 Western Alaska

Seward Peninsula and Cape Krusenstern (together, the Western Alaska breeding area) fixed-wing aerial surveys flown in June 2005 and 2007 resulted in an index of 431 (95 percent CI = 280–582) yellow-billed loons (Bollinger *et. al.* 2008, p. 1). The U.S. National Park Service (NPS) continues to monitor the Seward Peninsula and Cape Krusenstern area bi-annually, flying the same plots to count adults and nests. During the June 2009 survey, 171 adult yellow-billed loons were observed in the Bering Land Bridge stratum, and 8 in the Cape Krusenstern stratum (Figure 3). In 2011 and 2013, respectively, the NPS estimated that 225 (95 percent credible intervals ((CrI) =154–312) and 205 (95 percent CrI=143–279) lakes were used by nesting yellow-billed loons (Schmidt *et. al.* 2014, p. 12-14). Although not directly comparable to previous population estimates in Bollinger *et. al.* (2008, p. 6) (because Bollinger *et. al.* 2008 assumed 100% detection and Schmidt *et. al.* 2014, *in press* quantified detection rates), the 2011 and 2013 estimates lead to a larger population. Multiplying the number of lakes used for nesting (which equals the number of nests), by two (for a yellow-billed loon pair) results in an estimated 450 (2011) and 410 (2013) adult yellow-billed loons in the survey area, which is only a portion of the total Western Alaska breeding area. Therefore, the population in western Alaska may be higher than previously estimated, perhaps consisting of 500 to 1000 yellow-billed loons.

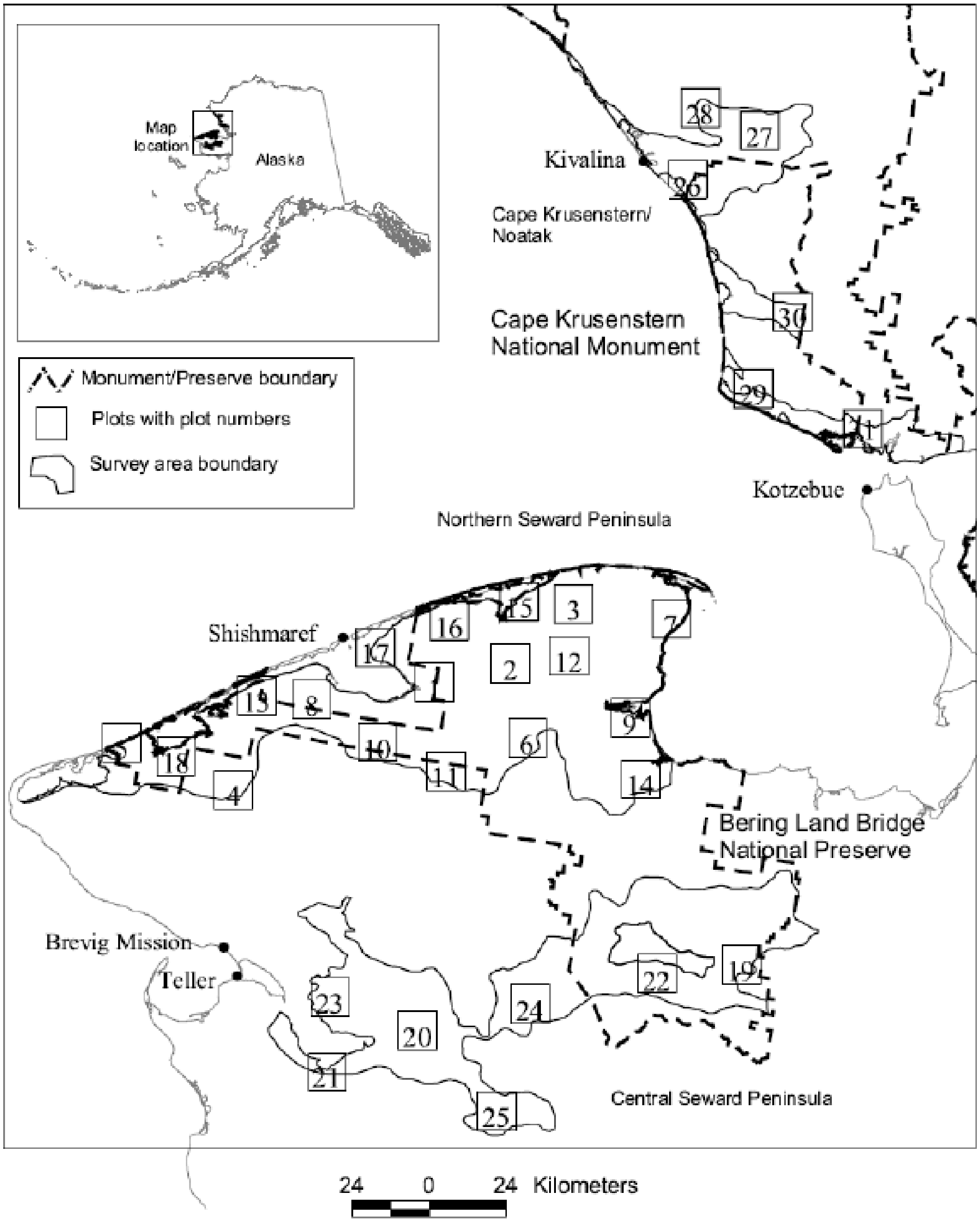

Figure 3. Plots containing lakes aerially searched for yellow-billed loons by the Service on three survey areas in the vicinity of Bering Land Bridge National Preserve and Cake Krusenstern National Monument, Alaska (Mallek *et. al.* 2005, p. 6).

Aerial transects were flown on Selawik National Wildlife Refuge and adjacent wetlands in June 1996 and 1997 (Platte 1999, p. 3), but only three yellow-billed loons were sighted, resulting in an estimated mean population of 44 birds (95 percent CI = 0 to 95) (USFWS, unpubl. data). Although there is no survey estimate of yellow-billed loons nesting on St. Lawrence Island since the late 1950s, the number nesting there is thought to be approximately 50 birds (Fay and Cade 1959, pp. 84, 100; Fair 2002, p. 28; 74 FR 12931, March 25, 2009). Yellow-billed loons may migrate along the western Alaska coast, including that of the Yukon-Kuskokwim (Y-K) Delta. However, they are considered a migrant on the Y-K Delta (USFWS 2006, p. 2), are rarely seen inland of the coast (B. McCaffrey, USFWS, pers. comm.), and are not documented in reports from annual aerial and nest surveys of the Y-K Delta's coastal zone (Fischer *et. al.* 2010, p. 34; Platte and Stehn 2011, p. 43). In summary, survey and observational data suggest that approximately 500 to 1,000 yellow-billed loons occur in western Alaska during the breeding season.

3.1.3 Canada – Arctic Islands and Mainland

Although we have no breeding population estimates for yellow-billed loons in Canada (http://www.bsc-eoc.org/clls-bw1.html, accessed January 29, 2014), and yellow-billed loons are not summarized in the Waterfowl Population Status annual reports compiled by the U.S. and Canadian governments for North American Waterfowl (USFWS 2010a, pp. 1–80), several aerial waterfowl surveys in parts of Nunavut and Northwest Territories included yellow-billed loon observations. Yellow-billed loons were not the focus of the surveys, so it is possible that observer effort or identification ability varied, and no visibility correction factors or seasonal timing factors were applied. Hines (2008, p. 1) estimated there were 500 to 1,000 yellow-billed loons on Banks Island, based on helicopter aerial surveys conducted in 1992 and 1993. Groves and Mallek (2011b, p. 28) later estimated 931 (SE 187) yellow-billed loons on Banks Island from a fixed-wing survey conducted in June 2010. Helicopter surveys yielded estimates ranging from 659 to 1,784 (SE 502) yellow-billed loons on northwest Victoria Island and from 98 to 258 in the southwest part of the island (Raven and Dickson 2006, p. 30). In 2008, Groves *et. al.* (2009b, p. 28, Table 3) estimated 2,671 (SE 335) yellow-billed loons on western Victoria Island. A fixed-winged survey included Kent Peninsula and southeastern Victoria Island in 2005, and Queen Maud Gulf, King William Island, Rasmussen Lowlands, and near Kugluktuk in 2006; all areas from both years were repeated in 2007, but with fewer transects sampled per unit area. The combined estimate for both areas from 2005 and 2006 fixed-winged surveys and the 2007 estimate were similar, at 2,500 to 3,000 yellow-billed loons (Conant *et. al.* 2006, p. 7; Conant *et. al.* 2007, p. 12; Groves *et. al.* 2009a, p. 29, Table 3). Groves and Mallek (2011a, p. 29) estimated 2,408 yellow-billed loons on southern and southeastern Victoria Island, King William Island, and the north coast mainland in 2009. The total area surveyed in 2009 included areas surveyed previously, but was not exactly comparable to the area surveyed in any previous year (Figure 4).

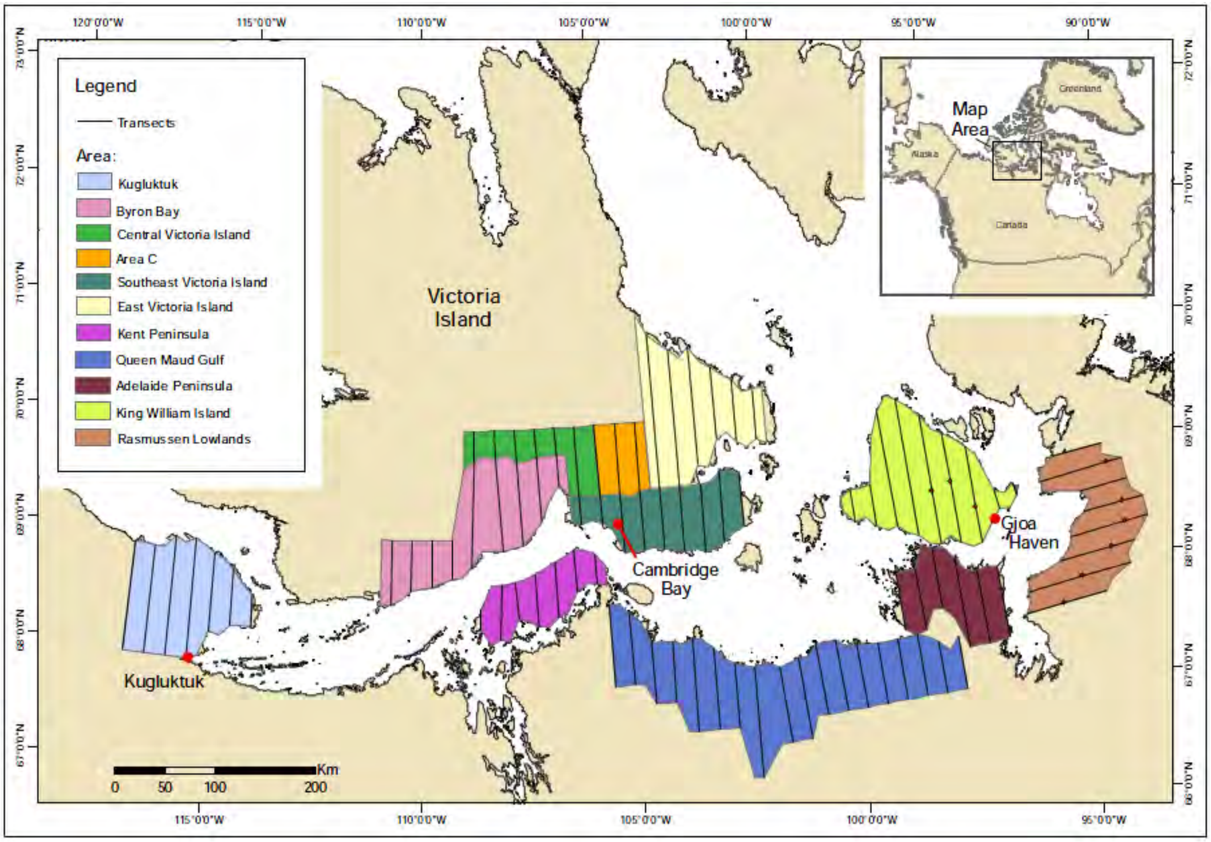

Figure 4. Transect lines within 11 areas surveyed for wildlife by fixed-wing aircraft in Nunavut, Canada, 19 June to 1 July 2009. Red dots mark locations where transects were partitioned to facilitate comparability with previous surveys. From Groves and Mallek (2011a, p. 8).

The remaining yellow-billed loon's range on the Canadian mainland has not been surveyed, making it necessary to use habitat availability and expert opinion as a surrogate for actual survey data to estimate population size. For these reasons the following estimate should be treated only as a rough approximation. By taking the area with large, fish-bearing lakes north of the treeline (500,000 to 750,000 km^2 (193,051 to 289,577 mi^2)) minus the surveyed areas on the mainland (46,000 km^2 (17,761 mi^2)) to adjust from Hines (2008, p. 1), and using opportunistic observations of yellow-billed loons by Northwest Territory and Nunavut checklist survey cooperators over the last decade, Poter (2008, p. 2) calculated that a density of 0.01 to 0.02 yellow-billed loons/km^2 would yield an estimate of 4,500 to 14,000 individuals in mainland breeding areas of Canada. This does not include surveyed areas in the Arctic described above. This estimate is based on a large land area bounded to the south by documented yellow-billed loon breeding territories between Great Slave Lake and Baker Lake, particularly in or near the Thelon Game Sanctuary (North 1993, p. 42). Between this area and the Arctic coast, breeding by yellow-billed loons has not been documented (North 1993, p. 40). Fair (2002, p. 30) estimated the yellow-billed loon population on interior Canadian breeding grounds to be 4,800, using a density of 0.02 loons in a 100,000 km^2 (38,610 mi^2) area around the Sanctuary, and a lower density of 0.007 for the wider area of 400,000 km^2 (154,440 mi^2). Fair's estimate of 4,800 is close to the lower end of Poter's (2008, p. 1) estimate of 4,500. Fair's analysis more accurately reflects likely yellow-billed loon distribution in Canada, because it assumes a low average density for the large area where breeding has not been documented.

Combining the 4,500 to 14,000 breeding birds estimated for mainland Canada, and 3,750 to 6,000 breeding yellow-billed loons estimated for Canadian arctic islands (and rounding to thousands), the best available information suggests that there may be 8,000 to 20,000 breeding yellow-billed loons in Canada. The lower estimate of 8,000 breeding yellow-billed loons may be a more accurate estimate considering that the higher estimate was calculated under the assumption that yellow-billed loons were present in areas where nesting has not been documented.

3.1.4 Russia

Information on the Russian breeding-ground population size of yellow-billed loons is limited. Hodges and Eldridge (2001, Appendix 2) estimated 674 yellow-billed loons with a coefficient of variation (CV) of 0.55 in a 157,611km^2 (60,854mi^2) from a fixed-wing aerial survey area of the eastern Siberia arctic coast from Kolyuchin Bay to the Lena River Delta. We have no other information on yellow-billed loon surveys within the breeding range in Russia. Red Data Books for the Russian Federation (2001, pp. 366–367), Yakutskaya (1987, p. 33), and the Northern Far East of Russia (1998, pp. 97–98) do not offer population estimates. Kondratiev (1989, p. 37) estimated that 2,000 yellow-billed loons nested in Chukotka, but did not give a basis or sources for his estimate. Fair (2002, p. 31) projected, based on this estimate of 2,000 yellow-billed loons in Chukotka, that another 2,000 nested on the Taymyr Peninsula, and that perhaps another 1,000 were scattered across the arctic coast, which results in an estimated 5,000 yellow-billed loons on Russian breeding areas. Syroechkovsky (2008, p. 1) suggested (based on anecdotal observations) that the number of yellow-billed loons on breeding grounds (including non-breeding birds) is around 3,000 for Chukotka, 500 for Yakutia, and about 1,200 for Taymyr, for a total of around 4,700 birds. However, Solovyova (2008, p. 1; calculated from Solovyova 2007, p. 6) recently estimated the post-breeding population of the Kyttyk Peninsula on Chaun Bay in western Chukotka at 1,000, and the post-breeding population of nearby Ayon Island at 900 birds. Solovyova (2008, p. 1) estimates the total breeding-ground population in Chukotka may be as high as 5,000 birds, based on estimates of the yellow-billed loon population in the Chukotka study area. If the Chukotka population is 5,000, the total for Russia could be as high as 8,000 based on habitat availability. However, the accuracy of these estimates, based on anecdotal information, is unknown.

3.1.5 Wintering estimates

Winter abundance of yellow-billed loons is not well documented, but some information is available from marine bird surveys. Earnst (2004, p. 14) summarized yellow-billed loon observations in boat-based winter marine bird 21)population surveys of Lower Cook Inlet, Prince William Sound, and Kodiak Island. Strann and Østnes (2007, p. 3) counted 1,160 to 1,605 yellow-billed loons during surveys conducted off the coast of Norway from 1986 to 1994, confirming Norway as the most important known wintering area for the species in Europe. No surveys have been conducted in Asian wintering areas. In some regularly used yellow-billed loon wintering areas, such as the Yellow Sea, the Aleutian Islands, and Great Britain, their scattered marine distribution and low abundance may have contributed to the impression that yellow-billed loons are vagrants or rare visitors (Lepage 2008, p. 1; Scott and Shaw 2008, pp. 241–248; Gibson and Byrd 2007, p. 68; Dudley *et. al.* 2006, p. 533). Immature yellow-billed loons and possibly some non-breeding adults stay in wintering areas throughout the year (North 1994, p. 4).

There have been limited surveys of yellow-billed loons wintering at Kodiak Island, where an unrecorded number of individuals were observed on three occasions in November and four occasions in February of 1980 (Forsell and Gould 1981, p. 9). Winter marine surveys conducted between 1979 and 1984 in selected bays of Kodiak Island identified loons to species but categorized them as a single group (loons) when reporting densities (Zwiefelhofer and Forsell 1989, pp. 17–21). Although Zwiefelhofer and Forsell (1989) indicated yellow-billed and common loons are regular winter residents on Kodiak Island (p. 17), and densities during this 5-year period were consistent (p. 21), little inference can be made without species-specific information. Additionally, although a multi-year survey of marine birds wintering in Prince William Sound indicated an increase in the density of common loons (McKnight *et. al.* 2008, p. 9), other loons were only identified to genus (McKnight *et. al.* 2008, p. 5). Furthermore, there have been numerous sightings of yellow-billed loons on the Alaska Birding List-Serve near Seward, Homer, and Prince William Sound (T. Zeller, USFWS, pers. comm. 2012). Additionally, the 2012 Christmas Bird Count include yellow-billed loon sightings in the Juneau, Sequim-Dungeness, Hecate Strait, Port Townsend, Vashon, Greater Masset (British Columbia), and Comox (British Columbia) counting units. However, similar to previous years, the number of yellow-billed loons reported were small (e.g., often less than 20 per year from 2000 to 2012 for the entire United States and often less than 30 for Canada) (http://birds.audubon.org/data-research, accessed July 6, 2014).

3.2 Population Trends

The Alaska-ACP breeding population is the only population for which standardized surveys over several years allow for estimation of population trends. There, aerial surveys from 1986 to 2013 provide an index of abundance which was used to estimate an abundance trend.

Limited surveys have been conducted in small parts of the Russian and Canadian breeding ranges; abundance estimates there are gross approximations and provide no information on trends. However, we believe that the Alaska-ACP breeding population is likely representative of other breeding populations, because it faces threats that are similar in type and similar or greater in magnitude as those faced by other breeding populations. Therefore, in the absence of information to the contrary, we assume that other yellow-billed loon populations have growth rates comparable to that seen on the Alaska-ACP.

3.2.1 Alaska-ACP

Aerial surveys from 1986 to 2013 provide an index of abundance which was used to estimate trend, using various subsets of observations that included or excluded exceptionally high and low counts, included all or just the most experienced observer, and included all years or just the most recent ten (Stehn *et al*. 2014, p. 3; Stehn *et al.* 2013, p. 23). Estimates varied slightly with analytical approach, but nearly all estimated growth rates of about 1.01 (i.e., a 1 percent increase per year), although estimates are based on only the last ten years, suggesting growth rates of six to seven percent per year. The most precise estimate, which included all years and all observations, estimated population growth of 1.014 (95 percent CI: 1.001-1.027; Stehn *et al*. 2014, p. 3; Stehn *et al.* 2013, p. 23). We conclude, based on the observations and various analytical approaches used, that the Alaska-ACP population is stable or increasing in abundance.

In conclusion, because the Alaska-ACP surveys represent the most extensive surveys conducted for yellow-billed loons, they provide the best available information used to estimate population trends. Aerial surveys conducted over a 28-year interval using standardized methods indicate that yellow-billed loon populations on the Alaska-ACP are stable or possibly slightly increasing. Analyzing yellow-billed loon population trends over different subsets of years or applying differing control for covariates yields slightly different trend estimates, but most estimates show a growth rate of 1.0, suggesting a stable population.

3.2.2 Western Alaska

Surveys in western Alaska have been conducted in 2005, 2007, 2009, 2011, and 2013 (Bollinger and Platte 2008, p. 1; Schmidt *et. al.* 2014, *in press*; Flamme *et. al.* 2011, pp. 1-12). These surveys cover slightly different areas and the data is insufficient to determine yellow-billed loon population trends.

3.2.3 Canada

As described above (Section 3.1.3), survey data for Canadian breeding grounds cover a small portion of the range, and the data is insufficient to determine yellow-billed loon population trends.

3.2.4 Russia

In Russia, the available information suggests a possible contraction in range size, but recent data are fragmentary, making it difficult to determine yellow-billed loon population trends. In western Russia, the Red Data Book of the Russian Federation (2001, p. 366) stated that the species no longer nests in European Russia where it was formerly found, such as the Kola Peninsula, the archipelago of Novaya Zemlya, and Vaigach and Ainovy Islands in the Kara Sea. However, it is unclear how abundant or widespread the species was in these areas historically. Furthermore, Kalyakin (2001, p. 10) reported finding yellow-billed loons nesting on Novaya Zemlya, although they were extremely rare. Similarly, the Red Data Book of the Yamal-Nenets Autonomous District (1997, p. 26), near the western end of the Russian breeding range, indicates only a few non-breeding yellow-billed loons were recorded in the District in the past 20 years. Strann (2008, p. 1) speculated that since the early 1990s, there may have been a decline in the number of yellow-billed loons in the main Norway wintering area. This is consistent with a range contraction in the western Russian breeding ground, especially if birds nesting in western Russia migrate to Norway for the winter. In any case, we were unable to determine the source of the Red Data Book information or further evidence of a potential range contraction in western Russia.

In eastern Russia, yellow-billed loons no longer nest along the northern coast of the Sea of Okhotsk where they occurred 30 to 50 years ago, nor on the Anadyr River delta (Red Data Book of the Russian Federation 2001, p. 366; Red Data Book of the Northern Far East of Russia 1998, p. 97). However, Solovyeva (2008, p. 1) reported that the number of breeding yellow-billed loons may be increasing in some locations in eastern Siberia, specifically near Chaun Bay in western Chukotka, and at Belyaka Spit near Kolyuchin Bay in northeastern Chukotka.

In summary, we found unverified reports that the species may no longer be found in parts of its historical range in Russia. However, there is contradictory information for some areas and a lack of survey data for all areas. For instance, some information indicates that yellow-billed loons may be increasing in parts of Russia. In any case, the best available information is too limited to be able to estimate yellow-billed loon population trends in Russia.

3.3 Summary of Current Species Conditions

The global population of yellow-billed loons is estimated to be around 16,000 to 32,000 birds. Population viability analyses based on demographic and environmental data, generating minimum viable population sizes (the theoretical number of individuals a species must have to survive in the wild for a specified time period or number of generations), are typically performed on or for already diminished populations for recovery planning (Traill *et. al.* 2007, p. 165). Traill *et. al.*'s (2007, p. 159) meta-analysis of studies on over 200 species concluded that the minimum viable population for most species will exceed a few thousand individuals. Reed *et. al.*'s (2003, p. 30) meta-analysis minimum viable population estimate for conservation planning purposes was 7,000 individuals. These general minimal viable population sizes generally correspond to both the Alaskan and global population estimates for yellow-billed loons (3,000 to 4,000 and 16,000 to 32,000, respectively), indicating that the yellow-billed loon population size is sufficient to ensure the persistence of the species over the long term.

Satellite telemetry studies demonstrated that the majority of the Alaska-ACP yellow-billed loons (32 of 34 individuals tracked) winter in Asian seas, whereas 14 of 15 yellow-billed loons that bred near Daring Lake in mainland Canada used an overland route southwest to marine locations off Alaska (J. Schmutz 2011, p. 1). Individuals wintering in Asian seas would have greater risk of exposure to contaminants (e.g., Schmutz *et. al.* 2009, pp. 2391-2392), entanglement in commercial fishing nets, and depletion of winter prey base from poorly-regulated fishing practices compared to individuals wintering in North American seas. The migratory routes and wintering distribution of yellow-billed loons breeding in Russia have not been studied, although Schmutz (2008, p. 1) speculated that some or all likely winter in Asian waters. Because Russian and Canadian populations of yellow-billed loons have similar exposure to potential winter-based threats as those breeding on the Alaska-ACP, it is reasonable to assume the yellow-billed loon population growth rate on the Alaska-ACP reflects the rangewide population-level response to current threats. Because the Alaska-ACP population growth rate indicates the yellow-billed loon is currently stable or slightly increasing, it is reasonable to assume that the species rangewide is stable or slightly increasing as well.

As discussed above, the best available information is too limited to be able to assess long term trends in abundance and distribution of yellow-billed loons across the majority of the species' range. However, there is some information that indicates a possible range contraction for one of five yellow-billed loon breeding populations. On the other hand, aerial transect surveys conducted annually on Alaska's ACP since 1986 have provided reliable information on yellow-billed loon abundance trends for that breeding area. While yellow-billed loons breeding on the

Alaska-ACP represent a small proportion of the species' distribution and total numbers, the threats (see chapter 4) faced by the Alaska-ACP breeding population are comparable to or greater than those faced other breeding populations.

Chapter 4. Causes and Effects

In this chapter we evaluated causes and effects that may contribute to current and future yellow-billed loon viability. We also reviewed the existing regulatory environment and conservation efforts.

4.1 Climate Change

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over multi-annual time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., air temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Available models predict warming surface air temperatures over the next century, although the predicted magnitude and timing of change vary substantially with greenhouse gas emission scenarios (NOAA 2013, p. 26) and across the species' broad range (IPCC 2013, entire document). Despite uncertainties and spatial variation, the magnitude of change is projected to increase over time, however. For example, for northern Alaska, including the Alaska-ACP, temperatures are projected to increase 3.5–5.5 degrees F (1.9–3.1 degrees C) by 2021–2050, 5.5–7.5 degrees F (3.1–4.2 degrees C) by 2041–2070, and 9.5–13.5 degrees F (5.3–7.5 degrees C) by 2070–2099 (as compared to 1971–1999, under the high (A2) emissions scenario; NOAA 2013, p. 26). Various types of changes in climate can have direct or indirect effects on species and their needs. Effects may be positive, neutral, or negative, may change over time, and may be influenced by other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). Here, we evaluate evidence for climate change effects on yellow-billed loon habitats, including potential for increased competition for limited and specific breeding habitats (sections 4.1.1 through 4.1.3) and for potential increased exposure to novel diseases (section 4.1.4; see also section 4.5). Many postulated changes are already occurring, but we lack data to link those to changes in yellow-billed loon populations, and the rates of change vary with different mechanisms and are highly variable and uncertain. Most yellow-billed loon populations have not been adequately surveyed over sufficient time to determine changes in abundance or other population health parameters including age distributions and basic life history characteristics.

4.1.1 Breeding habitat

Climate change may result in specific changes to yellow-billed loon breeding habitats, including lake water level changes or disappearance (drainage or drying) and water quality changes that affect prey populations. Coastal erosion resulting in breached lakes is occurring in the Arctic (Mars and Houseknecht 2007, p. 585) including within the breeding range of the Alaska-ACP yellow-billed loon population (Arp *et. al.* 2010, p. 1630). Coastal freshwater lakes can be affected by saltwater inundation, storm-caused lake shoreline breaches resulting in drainage or increased salinity, and windblown salt intrusion; these have occurred on the Yukon-Kuskokwim Delta in western Alaska (J. Michaelson, USFWS, pers. comm.; Anderson *et. al.* 2013, pp. 1-76; Jorgenson and Dissing 2010, p. 1-27), and increasing salinity can alter freshwater prey communities. Yellow-billed loons do not use brackish lakes for nesting or brood-rearing in the Colville River Delta within the ACP breeding area (Johnson *et. al.* 2014, p. 5). However, we lack data to estimate the percentage of nesting habitats that may be affected by coastal erosion or saltwater intrusion.

Yellow-billed loons nest on lakes underlain by bedrock and continuous or discontinuous permafrost; however, the proportion of the population nesting in each of these areas is unknown. Climate change affects lakes, and hence yellow-billed loon nesting habitat on these different substrates will be impacted in different ways. Smith *et. al.* (2005, p. 1429) point out that initial permafrost warming leads to development of thermokarst and lake expansion, followed by lake drainage as the permafrost degrades further. On the northern Seward Peninsula, within the breeding range of the Western Alaska yellow-billed loon population, expansion of thermokarst lakes in the continuous permafrost zone is occurring as a result of surface permafrost degradation. However as lakes expand, the opportunity for drainage increases due to the encroachment towards a drainage gradient (Jones *et al.* 2011, p. 12). Changes in lakes in this area varied by size, with larger lakes (10-40 ha or 24.7-98.8 ac), such as those used by yellow-billed loons, increasing by 6.8% in the most recent time period examined, while the largest lakes (40 ha–100 ha or 98.8-247.1 ac), a size also favored by nesting yellow-billed loons, decreased. This indicates that while there has been an increase in the number of small ponds and lakes, there has been a loss of large lakes in the study area (Jones *et al.*, 2011, p. 5).

Permafrost degradation has the potential to result in drained lakes adjacent to stream channels (Mars and Houseknecht 2007, p. 586). There is strong evidence that permafrost loss caused by climate change is decreasing lake area and abundance in areas with discontinuous permafrost in Siberia (Smith *et. al.* 2005, p. 1). These changes have also been documented in parts of Alaska including the subarctic boreal forest (Riordan *et al.*, 2006 p. 1; Roach *et. al.* 2011, p. 2567; Yoshikawa and Hinzman 2003, p. 151). However, a decrease in the area of shallow, closed-basin ponds was negligible in a study site underlain by deep continuous permafrost on Alaska's North Slope (Riordan *et al*. 2006 p. 4). Additionally, Briggs *et. al.* (2014, entire document) report that in regions with discontinuous and shallow permafrost, vegetative succession near margins of receding lakes may cause permafrost aggradation, which could slow lake contraction and affect surface/ground water flux, further complicating predictions for yellow-billed loon habitat change. The rate of change, magnitude, and type of effects of climate change on lakes used by yellow-billed loons during breeding varies by the material which underlies them, and, significant changes to these water bodies is likely to continue.

Overall, a number of studies pointed out the importance of landscape-scale hydrology and precipitation/evaporation conditions for the water balance of Arctic, Subarctic, and Boreal lakes (Plug *et al*. 2008, p. 2; Turner *et al*. 2010, p. 103; Roach *et al*., 2011, p. 2567; Karlsson *et al*. 2011, p. 4; Arp *et al*., 2010, p. 1630; Warwick et al., 2013, p. 28). These changes will also affect the fish species and other prey upon which yellow-billed loons depend during the nesting and brood-rearing period. Mechanisms for climate change effects to fish include warmer summer temperatures affecting primary productivity and prey species (Prowse *et. al.* 2006, p. 348), suboptimal to detrimental thermal regimes (Reist *et al.* 2006, p. 372), changes in taxa as species move northward (Reist *et al.,* 2006 p. 374), and changes in water chemistry (Reist *et al.,* 2006, p. 376).

Other climate change-induced factors may also affect breeding habitats. The northward migration of shrubs and trees (Prowse *et. al.* 2006, p. 348) may result in lake shorelines having vegetation unsuitable for yellow-billed loon nesting. However, other factors such as longer ice-free seasons and increased productivity in running and standing arctic freshwater systems (Prowse *et al.* 2006, pp. 353–357) may positively affect nesting habitat in some areas; additionally, longer ice-free periods in autumn may allow additional time to fledge, as early freeze-up has been implicated as a source of mortality for chicks (M. North, pers. comm.). Yellow-billed loons currently prevail in interactions with congeneric Pacific and red-throated loons (North 1994, pp. 9–10; Haynes *et. al.* 2014b, *in press*), probably because yellow-billed loons are bigger. But, climate change may alter that competitive balance by expanding the range of the larger common loon northward (Schmutz *et al.* 2014, *in press*).

At this point, we do not have the information to describe the extent to which climate change will affect specific characteristics of yellow-billed loon breeding habitats or specific time frames in which those impacts may occur. However, we anticipate that climate change will continue to affect multiple physical and biological features of the habitat occupied by breeding yellow-billed loons into the future.

4.1.2 Arctic marine habitat

Changes in Arctic marine ice thickness and cover could benefit yellow-billed loons by increasing areas and timing of open water, which is a key resource need for yellow-billed loons during migration and breeding. Ice thickness generally increases from areas with mainly first-year ice (e.g., from a few tenths of a meter near the southern margin of the marine cryosphere to 2.5 m (8.2 ft) in the high Arctic at the end of winter) to areas with multiyear ice cover (e.g., average thickness in the Arctic Ocean is about 3 m (9.8 ft), and the thickest ice (about 6 m (20 ft)) is found adjacent to northern Canada and Greenland [ACIA 2004, p. 30]). Recent observations show changes in annual sea ice thickness, extent (measured in September), and freeze/thaw dates. Submarine observations indicate a substantial reduction in ice thickness of about 15 percent per decade, a loss of summer ice extent by three percent per decade, and multiyear ice by seven percent per decade in various parts of the Arctic (ACIA 2005, p. 457). Since the ACIA 2004 report, satellite imagery has further documented a downward trend in September sea ice extent (historically when sea ice extent is at its minimum). The lowest on record was 3.61 million km^2 in 2012, and although 2013 showed a slight increase at 5.1 million km^2 , this was still the sixth smallest sea ice extent recorded (Figure 5; NSIDC 2014, p. 2; Perovich *et. al.* 2013, p. 1). From 1979 through 2009, satellite data indicated that nine out of 10 Arctic regions experienced trends towards earlier spring melt and later autumn freeze onset, and the melt season length has increased by about 20 days over the entire Arctic during this period (Markus *et. al.* 2009, p. 9). The Chukchi/Beaufort seas region, which is part of the range of the yellow-billed loon, experienced one of the strongest trends towards a later autumn freeze date and longer melt season length (Markus *et. al.* 2009, pp. 9, 12–13).

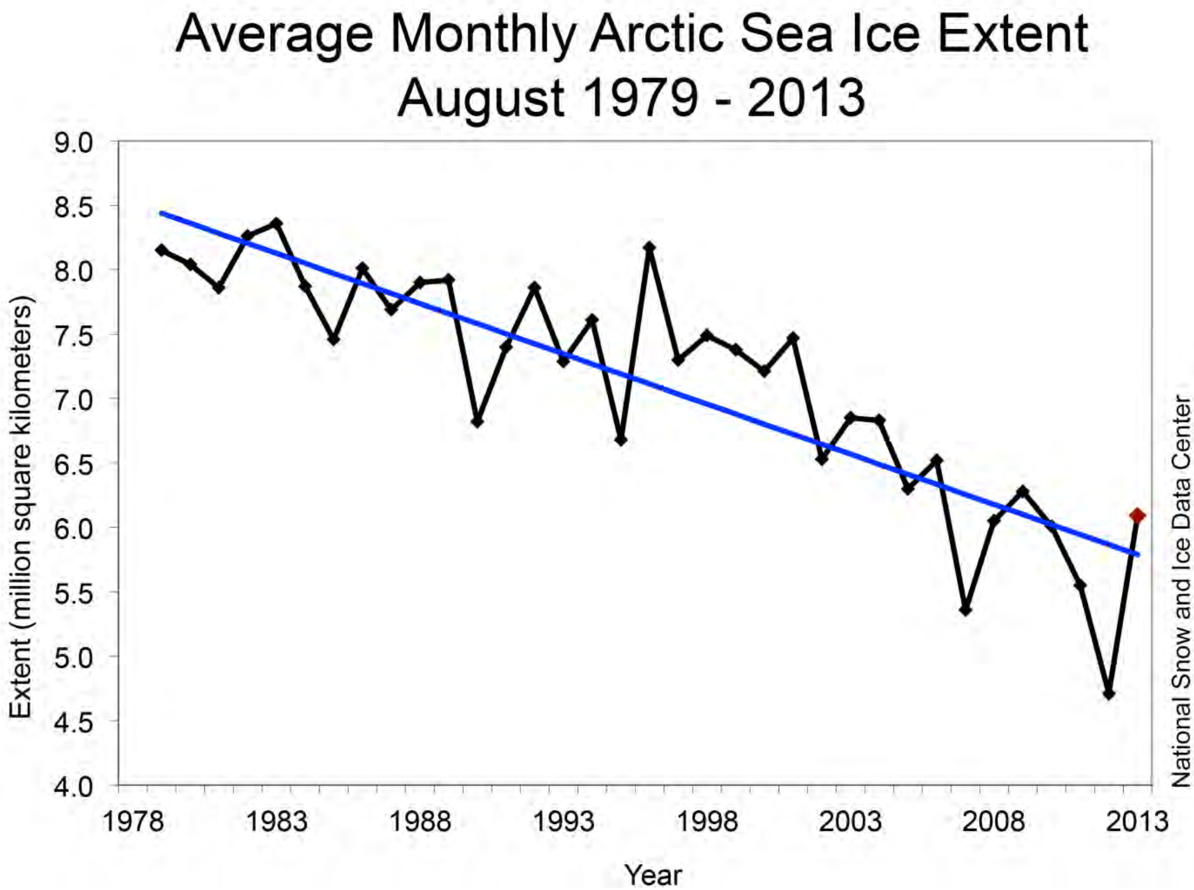

Figure 5. Average September Arctic sea ice extent from 1979 through 2013. From NSIDC (2014), http://nsidc.org/arcticseaicenews/2013/09/, accessed 2/4/2014.

Increased open water at the expense of ice cover could alter the Arctic food web, including affecting prey fish that are a key resource for yellow-billed loons. For example, some research suggests changes in algae due to melting sea ice could cascade up the food web causing a change from a benthic to a pelagic-dominated food web (Grebmeier 2012, p. 67). Additionally, some commercially fished species previously documented only in the Bering Sea have now been documented in the Beaufort Sea (Rand and Logerwell 2010 cited in Grebmeier 2012, p. 73). In addition, ocean acidification attributed to climate change will likely cause aragonite (a form of calcium used by marine organisms) undersaturation in Arctic marine communities, resulting in decreased populations of calcified marine organisms, many of which form the base of the Arctic food chain (Fabry *et. al.* 2009, pp. 161–163). Aragonite undersaturation is already occurring in the Gulf of Alaska and perhaps the Bering Sea (Fabry *et. al.* 2009, pp. 163-164). Calciferous yellow-billed loon prey, such as amphipods and hermit crabs, will be negatively affected (Fabry *et. al.* 2009, pp. 163–164).

While the timing of winter ice formation and melting and the overall duration of winter ice will likely change based on predictions by Overland and Stabenow (2008, p. 2), we expect that important polynyas (areas of open water at predictable, recurrent locations in sea-ice covered regions) and ice-lead spring staging habitat are likely to continue to exist in the short term. Although Arctic sea ice will continue to decrease seasonally in late summer and fall, it will still form in winter, extending south to the Bering Sea. If this projection is correct, polynyas and ice leads should continue to provide spring migration habitat for yellow-billed loons, even as the arctic climate continues to warm. Changes in productivity associated with ice melt, changes in water chemistry, and northward migration of previously southern species may result in changes in Arctic food webs and yellow-billed loon marine prey availability could either increase or decrease in response.

4.1.3 Shipping

Climate change resulting in less ice in northern seas has resulted in increased shipping traffic in migratory and nearshore breeding habitats. In 2008, the Northern Sea Route and the Amundsen portion of the Northwest Passage from the North Atlantic to Asia were ice-free for the first time in recorded history (NSIDC 2008, pp. 1-2). Multi-model simulations predict future conditions where light ice-class ships that do not require an icebreaker escort could navigate the Northern Sea Route for three to six months annually and for two to four months in the Northwest Passage by the end of twenty-first century (Khon *et. al.* 2010, p. 766). Models also predict that year-round transit cost from Western Europe to the Far East through the Northern Sea Route may be 15 percent lower than transit through the Suez Canal by the end of twenty-first century (Khon *et. al.* 2010, p. 766). Although interest in shipping within and through Arctic waters has increased, recent reports indicate commercial U.S. Arctic maritime activities are expected to be limited for the next 10 years due to a variety of factors. Interviews with industry representatives highlighted a variety of general challenges related to operating in the Arctic, such as geography, extreme weather, and hard-to-predict ice floes (GAO 2014, p. 1).

In the future, this potential increase in shipping could affect yellow-billed loons through disturbance, fuel spills, and collisions with vessels, but the wide distribution and low density of yellow-billed loons in Arctic marine areas during the potential shipping seasons makes population-level impacts unlikely.

4.1.4 Temperate habitats

Global ocean temperatures increased 0.1°C (0.2°F) from 1961 to 2003, with some cooling since 2003 (Bindoff *et. al.* 2007, p. 387). The effects of this shift on primary productivity and dissolved oxygen varied with latitude. Primary productivity in warm, low-latitude oceans declines as upper-ocean temperature increases, while warmer temperature at high latitudes increases productivity, but decreases oxygen levels (Behrenfeld *et. al.* 2006, p. 752; Bindoff *et. al.* 2007, p. 400).

For the yellow-billed loon wintering at low latitudes in the Yellow Sea and the Sea of Japan (also known as the East Sea), a decline in primary productivity might mean decreased prey availability. However, as already observed in northern environments, fish have begun to shift their mean latitude northward, presumably to colder, more productive waters (Perry *et. al.* 2005, pp. 1912–1915). Yellow-billed loons, whose main food is fish, may shift their mean latitude as well if winter sea ice is not a barrier. As noted for northern marine species, the movements of species as a result of climate change will likely be complex, so predicting the form of new species assemblages is difficult (Perry *et. al.* 2005, p. 1914). At this time, it is not clear how climate change may affect wintering yellow-billed loon prey community structure, and hence, yellow-billed loon populations.

Potential expansion of oxygen-deficient dead zones in Asian coastal waters where yellow-billed loons winter depends partly on how climate change affects water-column stratification (Diaz and Rosenberg 2008, p. 929). Warming ocean temperatures could increase stratification, deepening the depletion of oxygen, but increased frequency or severity of storms, could increase mixing and thereby lessen stratification. Changes in rainfall patterns could alter freshwater and nutrient inputs. At this time based on the available data, the effects of climate change on dead zones in winter marine habitats of the yellow-billed loon, and how those changes may affect the species, are unknown.

4.1.5 Novel Diseases

Postulated effects of climate change on yellow-billed loons include exposure to novel diseases or parasites through range shifts in disease organisms or their vectors (Lafferty 2009, p. 898). Avian influenza and other viral diseases may spread through climate-change induced alterations in migratory routes, stopovers, or communities (Gilbert *et. al.* 2008, pp. 1-10). In fact, avian malaria, which is transmitted by mosquitoes, has been recently documented for the first time in Alaska (Loiseau *et. al.* 2012, pp. 1-6). Also, the first incidence of highly contagious bacterial avian cholera in Alaska was recently documented at St. Lawrence Island, where yellow-billed loons occur (http://www.nwhc.usgs.gov/disease_information/avian_cholera/, accessed June 26, 2014).

4.1.6 Climate Change Summary

Multiple mechanisms associated with climate change may act as stressors on yellow-billed loons and may affect their breeding and non-breeding habitats over the long term. However, at this time we there is no information to indicate how climate change will affect yellow-billed loons in Arctic and temperate habitats, and there is no evidence that climate change is affecting disease prevalence in yellow-billed loons. Manifestations of climate-mediated changes throughout Arctic and temperate yellow-billed loon habitats will emerge as models continue to be refined and effects, both negative and positive, of climate change on yellow-billed loon needs for specific breeding habitats and prey are documented. However, the particular effect of lake drying or drainage may result in widespread loss of breeding habitats over time. The species' ecological diversity may result in relatively low adaptability to rapidly changing environmental conditions. It is possible that yellow-billed loons may experience population and species-level reductions from reduced breeding opportunities in a warmer Arctic environment. However, additional information regarding potential yellow-billed loon response to climate change is necessary to further evaluate the impact to this species.

4.2 Oil and Gas Exploration and Development

4.2.1 Terrestrial breeding areas

Oil and gas extraction activities in breeding areas throughout the range of yellow-billed loons are expected to occur for at least the next few decades. We expect large spatial and temporal variation in the level of oil and gas development activities on yellow-billed loon breeding habitat, but most breeding habitat will remain undeveloped in the short term. We do not expect terrestrial oil and gas development to occur in most of the Canadian breeding range, as development is limited to areas on and offshore near the Mackenzie River Delta (http://en.wikipedia.org/wiki/Petroleum_production_in_Canada, accessed July 24, 2014). However, oil and gas companies have invested in oil and gas leasing opportunities in the Canadian Beaufort Sea (EIA 2012, p. 8). Russian oil and gas development is currently confined mostly to the western edge of the breeding range between the Ural Mountains and the Central Siberian Plateau, and in the Volga-Urals region, extending into the Caspian Sea (EIA 2014, p. 2; http://en.wikipedia.org/wiki/Oil_reserves_in_Russia, accessed July 24, 2014; http://en.wikipedia.org/wiki/User:Ps480, accessed July 24, 2014). However, the Russian Ministry of Natural Resources estimated 4.7 million barrels may exist in eastern Siberian deposits (http://en.wikipedia.org/wiki/Oil_reserves_in_Russia, accessed July 24, 2014; http://en.wikipedia.org/wiki/User:Ps480, accessed July 24, 2014). Because the range of the yellow-billed loon overlaps with current arctic oil and gas infrastructure, these activities may be affecting yellow-billed loons. We expect development, and thus impacts on yellow-billed loons, to continue in various breeding areas in the Arctic in the long term.

Effects of oil and gas exploration and development vary by location. Development will be limited in Canada within the breeding range of yellow-billed loons geographically, and effects are likely to be limited in Alaska because the U.S. Bureau of Land Management (BLM) will likely incorporate mitigation measures into future oil and gas development in the National Petroleum Reserve-Alaska (NPR-A). While oil and gas development is limited in extent in Russia, some reports suggest that the infrastructure in Russia is degrading such that "at least one percent of Russia's annual oil production, or 5 million tons, is spilled every year" (http://www.boston.com/business/articles/2011/12/17/ap_enterprise_russia_oil_spills_wreak_devastation/ accessed March 21, 2012, http://news.yahoo.com/photos/russia-oil-spills-wreak-devastation-1324348862-slideshow/ accessed March 21, 2012). Some of these areas (e.g., near Komi and Usinsk, Russia, http://www.boston.com/business/articles/2011/12/17/ap_enterprise_russia_oil_spills_wreak_devastation/, accessed March 21, 2012) are within the breeding range of yellow-billed loons. We have limited information regarding the extent of overlap between breeding yellow-billed loons and areas affected by degraded oil and gas infrastructure in Russia. If development occurs in Arctic waters off eastern Siberia, the overlap between the range of the yellow-billed loon and oil and gas development could increase significantly.

Yellow-billed loons are sensitive to human-related disturbance. Where oil and gas development activities do overlap with yellow-billed loons in the breeding season, foot and vehicle travel, and construction and maintenance of gravel roads, pads, pipelines, and buildings, may cause temporary displacement of adult yellow-billed loons from nests (subjecting eggs or chicks to predation) or permanent displacement of yellow-billed loons from preferred aquatic habitats.

However, a significant proportion of yellow-billed loons nesting on Alaska's North Slope are found within the NPR-A. The BLM, which administers the NPR-A, developed an Integrated Activity Plan for this area (USBLM 2013, entire document), and the U.S. Army Corps of Engineers (USACE) has authorized the development of another Alpine satellite facility (CD-5; USACE Permit No. POA-2005-1576, issued December 19, 2011). The BLM has and will apply a number of required operating procedures and stipulations on oil and gas exploration and development projects in NPR-A (USBLM 2004, pp. B1–B17; USBLM 2008, pp. 33–34; USBLM 2013, p. 61), which significantly reduce potential disturbance of yellow-billed loons. These include requiring multi-year pre-development surveys for yellow-billed loons and other species of concern prior to construction, and the development of a 1.6-km (1-mi) buffer around yellow-billed loon nests and a 0.5-km (0.3 mi) buffer around the remainder of the nest lake so nesting and brood rearing yellow-billed loons are not disturbed by oil and gas development activities.

Powerlines and oil field structures, particularly those which emit high levels of artificial light, also pose a collision risk for avian species, especially in poor weather when visibility is low (Russell 2005, pp. 1-348; Weir 1976, pp. 1-29). Out of 214 birds found dead at North Slope oil facilities and Barrow from 2000 to 2013, there were no yellow-billed loons (and only two Pacific loons reported to the Fairbanks Fish and Wildlife Field Office (USFWS, unpubl. data). Of more concern are open water operations, as loons tend to migrate over water. However, in 2012 and 2013, during operations conducted by Shell in the Chukchi and Beaufort seas, no loons were reported out of 131 (2012) and 17 (2013) bird strikes and incidents (Schroeder 2013, p. 3). Therefore, the current population impact of collisions is likely minimal, but this may change as development continues into new areas that overlap with yellow-billed loon breeding habitats.

In summary, terrestrial oil and gas activities are limited and area of overlap with nesting yellow-billed loons is minimal. The greatest numbers of yellow-billed loons in potential oil and gas development areas occur in NPR-A, in the Alaska-ACP population breeding range, where there are protective regulations. Therefore, while oil and gas activities and the resulting disturbance, habitat impacts, and collisions may affect the species at the individual level, the proportion of affected individuals in the Alaska-ACP breeding population is likely low.

4.2.2 Arctic marine habitats

The Alaska Department of Fish and Game estimates that 50 to 75 percent of adult yellow-billed loons on Alaska's North Slope use marine areas of the Beaufort and Chukchi seas to forage (D. Vincent-Lang, pers. comm.). Oil and gas exploration activities are likely to occur in Arctic marine areas used by yellow-billed loons, and may result in disturbance and displacement of yellow-billed loons in those habitats. A 2006 assessment by then MMS (now the Bureau of Ocean Energy and Management, BOEM), estimated the Chukchi and Beaufort Seas Outer Continental Shelf (OCS) Planning Areas could contain technically recoverable resources of 23 billion barrels of oil and 105 trillion cubic feet of gas (USMMS 2008, pp. 2–22). Despite these potential resources, no offshore development has occurred to date in the Chukchi Sea, and in the Beaufort Sea development is limited to State of Alaska waters (within 4.8 km (3 mi) of shore). While the high resource potential will likely continue to attract industry interest, oil and gas development is unlikely to occur (MMS 2008, pp. 2–24). Therefore, there is no information to indicate that oil and gas development will impact yellow-billed loon's use of marine areas on Alaska's OCS.

Aircraft used during various oil and gas exploratory activities may disturb yellow-billed loons using Arctic marine habitats. Most fixed-wing operations will be marine mammal observation flights, which typically take place at an altitude of 457 m (1,500 ft). Based on data from other species, flights at this altitude are not anticipated to disturb yellow-billed loons (Mosbech and Boertmann 1999, pp. 197–198). In addition, BOEM requires helicopter operators to avoid flying below an altitude of 1,500 feet over Ledyard Bay between July 1 and November 15 (the period of fall migration), and over the spring lead system between April 1 and June 10 (during spring migration), unless it is unsafe to do so. These flight altitude restrictions likely reduce the number of yellow-billed loons that may be disturbed by aircraft operations. Further, the number of flights predicted by BOEM is relatively low and the flights disturb a relatively discrete area for only a short period of time.

Vessels transiting and operating in an area may displace birds from the immediate area, presumably at some energetic cost to the bird. However, BOEM anticipates a very limited number of boat-based seismic surveys, exploratory drilling operations, or development activities would occur in the OCS areas each year. While these could disturb and displace a few yellow-billed loons to adjacent habitat, given the low number of exploration activities and the availability of undisturbed habitat, impacts to individual yellow-billed loons are expected to be minor.

The severity of disturbance and displacement on individual yellow-billed loons depends upon the duration, frequency, and timing of the activity causing the disturbance. Disturbance that results in agitated behavior, flushing, or other movements can increase energy costs and result in a negative bioenergetics balance, especially for birds that are already energetically stressed from cold, lack of food, or physiologically demanding life cycle stages such as molt. Birds may be displaced from preferred habitats to areas where resources are less abundant or are of lower quality. However, the low density of loons across the marine seascape, combined with a low number and density of currently projected oil and gas activities is likely to result in relatively few yellow-billed loons being disturbed, with consequently minor impacts to populations.

4.3 Degradation of Marine Habitats in Migration and Wintering Areas

Temperate marine environment wintering areas are important for yellow-billed loons. Yellow-billed loons spend at minimum their first three years in wintering areas. Once they reach breeding status, adults spend eight months of the year in wintering areas. Wintering areas along the coast of Norway, Alaska, and British Columbia, Canada, are relatively pristine. However, the wintering areas along the western Pacific Ocean coastal waters of the Yellow Sea and Sea of Japan, and the North and Norwegian seas have identified among the ocean ecosystems with the greatest human impacts, and therefore, degradation (Halpern *et. al.* 2008, p. 949). Even though there may be possible effects of human activities on yellow-billed loon marine migrating and wintering habitats, there is no information to indicate that impacts have occurred to individuals, populations, or the rangewide population of the yellow-billed loon.

4.4 Research Activities

Much of the research on yellow-billed loons is conducted remotely (e.g., by aerial surveys) and at an altitude where only minimal disturbance occurs. Some individual yellow-billed loons have been injured (n=2) or killed (n=3) as a result of capture or satellite transmitter implantation, and nest survival rates decrease in response to researcher visits or adult capture efforts at nests (J. Schmutz, USGS, pers. comm.; Uher-Koch *et al.*, 2014, *in review*, pp. 13–16). In other studies, eggs were collected over several years to evaluate contaminants (A. Matz, USFWS, pers. comm.). However, only a small number of eggs were taken, and only one egg was taken from a two-egg nest (leaving a remaining egg). Because a very small proportion of yellow-billed loons and nests are subject to research activities, the effects of these activities do not constitute a threat to the yellow-billed loon at population or species levels.

4.5 Disease

Loons are susceptible to avian diseases, including avian cholera (from *Pasteurella multocida*), aspergillosis (from *Aspergillus fumigatus*), and avian botulism (from *Clostridium botulinum*), but we are not aware of any large disease-related die-offs in yellow-billed loons (Friend and Franson 1999, pp. 79, 130, 274). For example, no yellow-billed loon mortality was associated with the St. Lawrence Island cholera outbreak in late 2013 (L. Labunski, USFWS, pers. comm.). Loon species are also susceptible to avian influenza. However, none of the six loons tested in Alaska in 2006 tested positive for avian influenza viruses, and worldwide the highly pathogenic H5N1 has not been detected in loons (USFWS/USGS 2007, pp. 1–93; Gillies 2008, p. 1; http://www.nwhc.usgs.gov/disease_information/avian_influenza/affected_species_chart.jsp, accessed May 4, 2010).

Although yellow-billed loons could be susceptible to avian diseases, no disease outbreaks or dieoffs have been observed. Therefore, disease does not represent a significant threat to the species nor does it pose a substantial concern for yellow-billed loon long term viability.

4.6 Predation

Predation on adult yellow-billed loons is thought to be uncommon, but nest depredation on the Alaska-ACP is likely the primary cause of egg loss and reduced productivity in some years (Earnst 2004, p. 22). Yellow-billed loon nest predators include arctic fox (*Alopex lagopus*), common raven (*Corvus corax*), glaucous gull (*Larus hyperboreus*), grizzly bear (*Ursus arctos horribilis*) parasitic jaeger (*Stercorarius parasiticus*), pomarine jaeger (*Stercorarius pomarinus*), red fox (*Vulpes fulva*), and snowy owl (*Nyctea scandiaca*) (North 1994, p. 11; Earnst 2004, p. 22).

While nest depredation likely occurs in all areas, the number of predators, and hence predation rates, may be higher in areas close to human development. Many of these predators are attracted to human-built structures, which they use as nesting platforms or to anthropogenic food sources. It is possible predation rates may increase as development in yellow-billed loon nesting habitat increases (NRC 2003, p. 6; Earnst 2004, p. 19). However, in Alaska the oil and gas industry is required to control food and other waste reducing availability to wildlife. Further, in NPR-A the

BLM imposes a number of required operating procedures and stipulations to avoid attracting wildlife, which reduces the risks to yellow-billed loons associated with future development. The extent of infrastructure increase in Russian and Canadian yellow-billed loon nesting habitats, and accompanying regulation, is unknown; but as stated previously, development in Russia is only likely to occur in a limited portion of the loon's range.

4.7 Oil Spills

In addition to the potential effects to terrestrial breeding habitat described above, oil and gas activities may affect yellow-billed loons directly through oil spills. While a terrestrial oil spill may occur, it would likely only impact a very small area of habitat and a very low number of, if any, yellow-billed loons (USFWS 2008, pp. 56-58). The largest potential impacts from a spill of crude or refined oil to yellow-billed loons would occur if a spill occurred in marine waters.

Accidental releases of hydrocarbons into the marine environment could occur throughout the range of the yellow-billed loon. Exposure to oil or fuel products could cause mortality and sub-lethal effects to yellow-billed loons and degrade habitat or affect their prey base (USFWS 2012a, p. 42). Offshore oil and gas exploration and development in Alaska State and OCS waters in areas used by yellow-billed loons during spring and fall migration are ongoing and are likely to continue in the future (74 FR 12931, March 25, 2009). In Canada, offshore resources are being explored and developed in the southern Beaufort Sea near the McKenzie Delta, where loons gather in polynyas and ice leads in spring to stage before arriving on breeding grounds (https://www.aadnc-aandc.gc.ca/eng/1100100036656/1100100036657, accessed July 31, 2014). Recently, there has been renewed interest in exploring for oil and gas in the Russian Chukchi Sea, as new evidence suggests the region may harbor large reserves (Frantzen 2007, p. 1).

Most oil spills are small (less than 1,000 barrels (bbl)). To illustrate, McMahon Anderson and LaBelle (2000, pp. 32, 35) found that from 1985 to 1999, 98.9 percent of spills in the U.S. OCS were 9 bbl or less, and that 99.7 percent were 50 bbl or less. These low volume spills would affect only a small area. Small spills are also likely to evaporate, weather, or be almost entirely recovered (BOEM 2011, pp. 173-174). Moreover, the density of yellow-billed loons is low in most of the area of overlap with current and probable oil and gas activities. Therefore, if a small spill occurred, a few if any, yellow-billed loons would be affected.

A large oil spill from an oil well blowout in summer and close to breeding areas with nearshore marine feeding, such as western Alaska, or a spring spill affecting polynyas or feeding areas, may impact a large number of individual yellow-billed loons. However, large oil spills (greater than 1,000 bbl) in the marine environment are unlikely (BOEM 2011, p. A-6). Since 1949, Alaska's 7,533 wells had 19 blowouts and none have resulted in oil spills reaching tundra or water (BOEM 2011, p. A-6). Even if a large spill did occur, its impact on yellow-billed loons would depend on the time of year and location. During wintering and migration periods, yellow-billed loons occur at low densities over a wide area, so few individual loons may be affected.

In summary, while oil spills could occur in areas occupied by yellow-billed loons, it would likely only impact a very small area of habitat and a very low number of yellow-billed loons. Based on the best available information, there is no evidence to indicate that yellow-billed loons have ever been impacted by oil spills. Therefore, we do not consider oil spills to have significant impacts to yellow-billed loon populations or the species rangewide.

4.8 Collisions

Yellow-billed loon flight behavior over water places them at risk of colliding with vessels and other structures in the marine Arctic environment. Yellow-billed loons fly low over the water and at species up to 64 km per hour (40 mi per hour) (North 1994, pp. 5–8). In an effort to reduce collision risks resulting from bird attraction to lighted structures, BOEM requires that oil and gas vessels operating in the Alaska OCS minimize the use of high-intensity work lights, especially within the 20-m (66-ft) bathymetric contour (USFWS 2012a, p. 77). BOEM requires that exterior lights only be used as necessary to illuminate active, on-deck work areas during periods of darkness or inclement weather; otherwise they have to be turned off. Interior and navigation lights are required to remain on for safety (USFWS 2012a, p. 77). Lessees are also required to implement lighting protocols aimed at minimizing the radiation of light outward from exploratory drilling structures (USFWS 2012a, p. 77). Despite these measures, a few yellow-billed loons could be at risk of collisions with vessels and other structures during migration. However, the best available information does not indicate that collisions are a major source of concern for the viability of the species in the short term.

4.9 Subsistence Activities

4.9.1 Subsistence Harvest

Subsistence hunting of migratory birds, including yellow-billed loons, is an important component of the customs, traditions, and economies of Native Americans. Subsistence is defined in U.S. Federal and State of Alaska law as the customary and traditional uses of wild resources for a variety of purposes, including food, clothing, fuel, transportation, construction, art, crafts, sharing, and customary trade (Wolfe 2000, p. 1). In this section, we present available information on harvest in Alaska, Canada, and Russia. This section also includes information on traditional ecological knowledge relevant for interpretation of harvest in Alaska, efforts for improving harvest survey data and understanding of loon harvest, a summary of subsistence harvest in Alaska, and a general summary and conclusion.

Alaska

Yellow-billed loons have historically been harvested by Alaska Natives as part of their traditional subsistence hunts. Under the Migratory Bird Treaty Act and associated regulations, yellow-billed loons are not open for subsistence hunting at any time in Alaska. However, this law is not always well known, understood, or enforced in rural Alaska. Issues with identification of loon species, cultural differences in hunting practices, and naming of bird species represent additional difficulties for compliance with this law (Naves and Zeller 2013, pp. 44–45).

In the Service's 2009 12-month finding (74 FR 12931, March 25, 2009), subsistence harvest in Alaska was identified as a threat, primarily based on 2007 harvest estimates for the Bering Strait-Norton Sound region, in northwest Alaska. In that region, yellow-billed loons occur in small numbers in the mainland, and in some years, relatively large numbers migrate across the Bering

Sea nearing St. Lawrence Island (Rizzolo and Schmutz 2010, p. 12). However, harvest estimates were inconsistent with information on loon species on St. Lawrence Island, especially in relation to composition and abundance, which raised concerns about the precision and accuracy of estimated harvest amounts and issues with species identification (USFWS 2010b p. 7; 2010c, p. 59).

Following the 2009, 12-month finding (74 FR 12931, March 25, 2009), which categorized the yellow-billed loon as a candidate species, the Service and its partners expanded efforts to better understand yellow-billed loon harvest, abundance, and distribution in the Bering Strait-Norton Sound region. These efforts included: (1) literature review on loon harvest in western and northern Alaska (Huntington 2009, entire document); (2) ethnographic study on historic and current harvests and uses of loons on St. Lawrence Island (Omelak 2009, p. 3); (3) attempts to conduct census surveys in Gambell and Savoonga in 2009 and 2010 as part of regular Alaska Migratory Bird Co-Management Council's (AMBCC) harvest survey program (Naves 2011, 2012, 2014 entire documents); (4) development of direct partnership with the villages, including several community and tribal council meetings to share conservation concerns, develop study plans, present research findings, and discuss loon species identification (the use of loon study skins was effective in prompting these discussions); (5) community outreach, interviews, and fall bird counts in 2010 to determine the relative abundance of loon species on St. Lawrence Island (Zeller *et. al.* 2011, pp. 14–26); (6) development of a loon identification guide specific for the Bering Strait region focusing on the local composition of species and breeding and non-breeding plumages; (7) development and extensive use of a poster highlighting loon conservation issues and species identification; and (8) a 2011 to 2012 St. Lawrence Island study conducted by Naves and Zeller (2013, entire document) on harvest surveys, ethnographic research, and bird counts as a species verification system for the harvest survey.

Below we present and discuss several sources of information used in this evaluation of yellow-billed loon harvest in Alaska, including:

1) The 1965 to 2006 bird harvest data for western and northern Alaska as summarized in Huntington (2009, entire document). This summary included surveys conducted in selected villages and years by a range of organizations and the 1985 to 2002 annual harvest monitoring on the Y-K Delta and semi-annual 1995 to 2002 harvest monitoring in the Bristol Bay region conducted in the context of the Goose Management Plan;

2) The 1994 to 2003 North Slope harvest data collected by the North Slope Borough Department of Wildlife Management (Bacon *et. al.* 2011, entire document);

3) The 2004 to 2011 bird and eggs harvest data produced by the annual harvest monitoring program of the AMBCC (Naves 2010a, 2010b, 2011, 2012, 2014, entire documents). This program was created to implement provisions of the Migratory Bird Treaty Act Amendment, which allowed legal spring-summer subsistence harvest of migratory birds in Alaska. Data have been reported by management regions (further divided in sub-regions) and harvest seasons (spring, summer, fall). These data were not included in Huntington (2009, entire document); and

4) A 2011 to 2012 study conducted on St. Lawrence Island specifically addressing yellow-billed loon conservation concerns (Naves and Zeller 2013, entire document). This study addressed loon identification issues and harvest levels.

Huntington (2009, entire document) summarized historical Alaska bird harvest data from 1965 to 2006. Harvest of yellow-billed loons was reported in the Bering Strait-Norton Sound, Y-K Delta, and Bristol Bay regions. Over this 19-year time span, reported harvest ranged from 14 to 650 yellow-billed loons per year. In most years, four to 370 loons per year were reported in the Y-K Delta. In the Bering Strait-Norton Sound region, 25 to 322 loons per year were reported. In the Bristol Bay region, five to 269 loons per year were reported. Estimates of yellow-billed loon harvest on the North Slope from 1994 to 2003 were low in most communities and years. In Barrow, yellow-billed loon harvest was 12 to 18 yellow-billed loons per year (Bacon *et. al.* 2011, pp. 52, 56).

The AMBCC surveys (2004 to 2011, entire documents) show harvest reports of yellow-billed loons and their eggs in the Bering Strait-Norton Sound, Bristol Bay, North Slope, and Y-K Delta regions (Naves 2010a, 2010b, 2011, 2012, 2014, entire documents). Harvest from 2004 to 2011 was reported from the four regions with a total of 1,924 yellow-billed loons (average 241 per year) estimated to be taken. As noted above, about half of the 237 estimated from the North Slope in 2007 to 2009 were reported as drowned in fishing nets (Naves 2010a, p. 170; 2010b, p. 56; 2010c, pp. 1–2). However, it is not possible to distinguish shooting and entanglement in fishing nets as a source of take for other regions of the state because AMBCC surveys do not ask about means of capture (Naves 2010a, p. 170; Naves 2010b, p. 56; Naves 2010c, pp. 1–2). The NSB-DWM (2011b, p. 1) reports that yellow-billed loons are not targeted using fishing nets or any other means by subsistence users. Fewer than five yellow-billed loons per year were reported in the Y-K Delta in contrast to earlier survey reports summarized by Huntington (2009). By far the greatest reported harvest was from Bering Strait-Norton sound, where annual harvest estimates ranged from 22 to 1,077 (Naves 2010a, pp. 82, 158; Naves 2010b, pp. 44–45, Naves 2011, p. 44; Naves 2012, p. 59; Naves 2014, p. 32). Concurrent with high estimated yellow-billed loon harvest from the Bering Strait-Norton Sound were high common loon harvest estimates, which ranged from 404 to 2,514, and comprised 60 percent of reported loon harvest from these years. Common loons are considered rare near St. Lawrence Island (Lehman 2011, p. 11), suggesting significant misidentification and reporting error in the loon harvest survey reports from this area.

Across eight years of harvest reports, point estimates for statewide yellow-billed loon egg harvest ranged from 0 to 60, annually with an eight-year total of 162 eggs harvested. Ninety-two (57 percent) of the reported total egg harvest occurred in the Y-K Delta, where the species rarely nests (B. McCaffery, USFWS, pers. comm., USFWS 2006, p. 2). Furthermore, 70 eggs (43 percent) were harvested from the Bering Strait-Norton Sound region. Because 57 percent of the total egg harvest was reported from an area where yellow-billed loons rarely nest, it is likely that there is significant error in harvest survey estimates for yellow-billed loons.

A 2011 to 2012 yellow-billed loon study conducted by Naves and Zeller (2013, entire document) on St. Lawrence Island included fall bird counts, harvest surveys, ethnographic research, and outreach activities addressing conservation concerns. A key goal of the project was to conduct the St. Lawrence Island bird harvest surveys with scientific rigor. Naves and Zeller's (2013, entire document) study addressed some difficulties with previous harvest surveys and provided more reliable harvest estimates representing bird and egg harvest levels in the study communities.

In 2011, use of the historical survey materials in a context of increased sampling effort and dedicated expertise in harvest data collection and loon identification clarified harvest levels and highlighted difficulties in species identification. Modifications to the 2012 survey materials minimized species identification issues and allowed quantification of harvest preference for young loons. The 2011 to 2012 annual average total bird harvest was 5,171 birds in Gambell and 4,038 birds in Savoonga, representing 0.3 percent and 3.7 percent of the total birds harvested, respectively. In 2011, harvest estimates included 151 loons reported as common (53.6 percent), Pacific/Arctic (27.8 percent), yellow-billed (11.3 percent), and red-throated (7.3 percent) loons. In 2012, harvest estimates included 179 loons reported as nonbreeding unidentified (64.2 percent), common (3.4 percent), Pacific/Arctic (26.3 percent), yellow-billed (1.7 percent), and red-throated (4.4 percent) loons.

Because of indications of significant misidentification in reported harvest, species composition was also estimated by adjusting for the proportion of nonbreeding loons in harvest reports and the proportion of species and plumages in counts of loons seen from St. Lawrence Island. First, the proportion of nonbreeding loons in 2012 summer and fall harvests (64.2 percent, seasons combined) was applied to 2011summer and fall harvests to account for selective harvest of young loons (the 2011 survey did not include nonbreeding loon plumages). Second, the 2011 to 2012 average species and plumage composition in counts of loons seen near St. Lawrence Island were used to estimate adjusted species-specific harvest estimates (2011 breeding and nonbreeding plumages, 2012 nonbreeding plumages; Naves and Zeller 2013; p. 22). Yellow-billed loon harvest estimated using these adjustments were four birds in 2011 and five birds in 2012 (Naves and Zeller 2013, p. 41). Note these adjusted estimates assume that loons are taken in proportion to their relative abundance near the island, with no differences in hunter preference or vulnerability to hunting among species.

In the context of the 2011 to 2012 St. Lawrence Island loon study, a new data release agreement was established with the villages to retrospectively evaluate 2004 to 2010 AMBCC harvest estimates. In 2007, loon harvest estimates for the Bering Strait-Norton Sound region (4,042 loons) were largely associated with unusually high estimates for the community of Savoonga (3,748 loons, all species) (Naves 2010a, p. 94). Actual variability in harvest effort and resource availability may have resulted in the unusual 2007 harvest estimates. However, during this review no evidence was found of unusual ecological or socio-economic events that could have affected bird and egg harvests in 2007. Therefore, potential issues with 2007 harvest estimates were a result of the sampling design (Naves and Zeller 2013, p. 52).

Canada

Yellow-billed loons are thought to breed in several of the native land claims in northern Canada, but primarily in Inuvialuit and Nunavut. The land claims are in different phases of settlement, and harvest data are only available for those areas where claims have been settled and

Renewable Resource Boards are in operation to jointly manage wildlife resources (http://www.mb.ec.gc.ca/nature/ecb/da02s11.en.html, accessed October 2008). The Renewable Resource Boards use similar methodology to determine wildlife harvest levels for their areas of jurisdiction. Possible sources of error in these harvest estimates include enumeration, coverage and non-response, measurement and questionnaire design, recall bias, and strategic response bias (Priest and Usher 2004, pp. 35–42).

Harvest survey data from 1998 to 2003 are available for the Nunavut, Inuvialuit, and Sahtu regions, which encompass the vast majority of the yellow-billed loon's breeding range in Canada (see map at http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B0DQ, accessed January 28, 2014). Nunavut harvest surveys were conducted in 1996 to 2001 (Priest and Usher 2004, entire document). Five communities reported harvesting yellow-billed loons from May through October, while 22 communities did not report harvest of yellow-billed or unidentified loons. The estimated yearly harvest was three to eight yellow-billed and one to six unidentified loons (Priest and Usher 2004, pp. 651-674). Inuvialuit harvest surveys were conducted from 1988 to 1997 (Inuvialuit Harvest Study 2003, pp. 1-209). Loons, including yellow-billed loons, were reported harvested from May through July in three of six communities surveyed. Estimated mean annual harvest for the region was 10 yellow-billed loons and 1 unidentified loon (Inuvialuit Harvest Study 2003, p. 13). Sahtu Region surveys were conducted from 1998 to 2003 (Bayha and Snortland 2002, 2003, 2004, entire documents). Yellow-billed loons occur only in the northern Sahtu region. No yellow-billed loons were reported harvested and a total of five unidentified loons were harvested over the six years from May to August (Bayha and Snortland 2002, p. 16; 2003, p. 18; 2004, p. 19), with no extrapolation to the entire Sahtu region. Based on these data, only a few yellow-billed loons are harvested by subsistence hunters annually in Canada.

Russia

The Red Data Book of the Russian Federation (2001, p. 367) states, "during the nesting period, loons are often killed/harvested by the indigenous population for food and pelts particularly in the northeast of Russia." More recent information reported harvest of about 200 yellow-billed loons per year, including take associated with the protection of fishing nets (Syroechkovskiy 2008, pp 1–2). Few harvest surveys have been conducted (limited information from Yakutia and Chukotka), the species' range has not been adequately sampled, and the species has an uneven distribution across Russia (Syroechkovskiy 2008, p. 1). No subsistence harvest information is available for the Taymyr Peninsula, which is one of the two core areas of the breeding range in Arctic Russia and the only region where Syroechkovskiy (2008, pp. 1–2) reported hunting of the species as a food source.

Unidentified loons were reported taken in two Providensky communities in 1997 and 1998 in subsistence harvest surveys for marine mammals (Ainana *et. al.* 2000, pp. 66, 71; Ainana *et. al.* 1999, p. 83). No loons were listed in 1999 surveys, which included fewer and less detailed reports of bird harvest (Ainana *et. al.* 2001, entire document). From 2002 to 2005, Service-funded waterfowl subsistence harvest surveys were conducted by the Goose, Swan, and Duck Study Group of Northern Eurasia in 19 out of 100 communities in northeastern Russia (Yakutia and Chukotka regions) within 100 km (62 mi) of the coastline (Syroechkovski and Klokov 2007,

p. 8). Based on previous year recall by hunters, yellow-billed loons harvested ranged from 0 to 58 among villages, with only three villages reporting 10 or more yellow-billed loons harvested. Harvest was greatest in northern Chukotka, where the species nests. One village reported 44 eggs harvested in one year (Syroechkovski and Klokov 2007, p. 1).

Based on Syroechkovski and Klokov (2007, p. 1) and the nationwide estimate provided in Syroechkovskiy (2008, p. 2), the annual harvest by subsistence hunters in Russia ranges from 0 to 200 yellow-billed loons per year. These yellow-billed loons are harvested from the breeding population, which is estimated to be 5,000 to 8,000 individuals across the Russian breeding range (Kondratiev 1989, p. 37; Syroechkovsky 2008, p. 1; Fair 2002, p. 31; Solovyova 2008, p. 1). Even though these estimates are based on incomplete information, the best available information does not indicate that harvest is a concern for the long term viability of the yellow-billed loon in Russia.

Difficulties in Using Available Data to Evaluate Yellow-billed Loon Harvest

Most available yellow-billed loon harvest data comes from surveys designed to include many bird species across a large area. Some surveys also include all subsistence resources (caribou, marine mammals, moose, salmon, etc.), such as the surveys conducted by the North Slope Borough and selected villages summarized in Huntington (2009, entire document). Some species are abundant and harvested in relatively large numbers and others, such as the yellow-billed loon, are harvested only occasionally because they are rare, have restricted distribution, or are not widely used for subsistence. Harvest estimates for species rarely harvested will be less accurate and less precise than those for more commonly harvested species.

Additionally, harvest data collection faces its own challenges (Huntington 2009, p. 3; Naves and Zeller 2013, pp. 47–54). Subsistence harvest surveys usually involve specific socio-cultural settings in remote areas, and depend on collaborations and relationships that are sometimes fragile. It may be difficult to implement standard sampling and data collection procedures, resulting in unquantifiable measurement errors. Also, respondents may under report species closed to harvest (biasing estimates low), or may over-estimate harvest to emphasize the importance of subsistence (biasing estimates high). Other potential biases include recall error and failure to report birds downed, but not recovered. These sources of errors and biases compromise the accuracy of harvest data, but it is impossible to know the magnitude and direction (over- or underestimating) of each and their cumulative effect upon estimates. Additionally, differences in effort and methods among studies compromise comparisons among years and studies. Another bias in yellow-billed loon harvest estimates is the mischaracterization of fishing bycatch as hunting harvest (Huntington 2009, p 3–4; Omelak 2009, p. ii; Naves 2010c, pp. 1-2). This likely has resulted in overestimation of loon hunting harvest at least for the North Slope. Finally, reported yellow-billed loon harvest survey data make clear that estimates are significantly compromised by misidentification among loon species. This topic, discussed in detail in the following section, indicates that without targeted surveys accompanied by significant effort, and discussion targeting individual hunters, harvest survey estimates of loons at the species level is unreliable.

Misidentification of Yellow-billed Loons

Misidentification of loon species reported in harvest surveys likely a large source of error in yellow-billed loon harvest estimates. In historical surveys, a significant number of yellow-billed loons (greater than 100 birds per year) were reported as harvested in the Y-K Delta, of which over half occurred in inland areas where the species is extremely rare (Huntington 2009, entire document). Because of the natural rarity of the yellow-billed loon in areas where large harvests were reported, this level of harvest is therefore unlikely (USFWS 2006; B. McCaffery, Yukon Delta National Wildlife Refuge, pers. comm.). In more recent surveys, 82 percent of the estimated statewide egg harvest occurred in the Y-K Delta (Naves 2010a, p. 80), where the species is not known to nest (USFWS 2006; B. McCaffery, Yukon Delta National Refuge, pers. comm.). These estimates of high harvest rates for areas outside the species' normal range suggest a high rate of misidentification or reporting error.

Evidence of misidentification in harvest reports is also occurs for the Bering Strait-Norton Sound region, where the largest yellow-billed loon harvest estimates occurred in the AMBCC survey. High harvest rates of yellow-billed loons are possible for this region given that a large proportion of the rangewide population migrates through the Bering Strait in spring and fall, and that a small number of yellow-billed loons nest on St. Lawrence Island and the northern Seward Peninsula. Among 31 hunters interviewed on St. Lawrence Island, 26 (84 percent) stated that they harvested loons; Pacific and yellow-billed loons were the most frequently reported loons harvested (Zeller *et. al.* 2011, pp. 22–26). Over half of the loons harvested in this region were reported as common loons (404–2,514, Naves 2010a, p. 80), although common loons are rare in this region (Fay and Cade 1959, pp. 100–101; Kessel 1989, pp. 66–68; Lehman 2011, pp. 10-11). Therefore, it is likely that other species more common near St. Lawrence Island and on the Northern Seward Peninsula (Pacific, yellow-billed, and red-throated loons) were misidentified as common loons. In late August to early October, observations of birds migrating past Gambell, Alaska, made by skilled birders showed that Pacific loons outnumbered yellow-billed loons by 3 to 1 or 4 to 1 (Lehman 2011, p. 42). Visual bird counts were conducted in 2011 and 2012 close to the communities of Gambell and Savoonga, Alaska, to assess the relative abundance of species in coastal waters from mid-September to mid-October, when most loon harvest occurs, and compared with species reported in harvest surveys (Naves and Zeller 2013, pp. 1-97). Sixty species were recorded in fall bird counts. Loons represented up to 0.1 percent of the total number of birds. Four loon species were observed: Pacific (94.5 percent of total number of loons), yellow-billed (4.2 percent), red-throated (0.5 percent), and Arctic (0.4 percent) loons. The common loon was not recorded.

The majority of loon eggs reported as harvested likely results from misidentification or reporting error. Eggs of all loon species are similar in shape and size (Baicich and Harrison 1997, pp. 1-6). Loon nests are widely dispersed, and in general, there is only one nest per lake. Loon clutches contain only one to two eggs, as compared to ducks (10 or more eggs) and gulls (four eggs). Targeting loon eggs for harvest would involve high effort and low return, although sporadic and opportunistic harvest may occur. St. Lawrence Island hunters interviewed about loon harvest and subsistence practices informed us that they did not harvest loon eggs or know of others who did (Zeller *et. al.* 2011, entire document). Several people explained that loons are aggressive and are generally avoided during the breeding season (T. Zeller, USFWS, and L. C. Naves, ADFG, pers. comm.). Absent any historical or contemporary indication that yellow-billed loon eggs are important subsistence resources, we surmise that at most, less than 10 yellow-billed loon eggs are harvested each year in Alaska, and reports suggesting higher numbers very likely reflect error.

On St. Lawrence Island, attempts to verify identification of harvested loons on a large scale have not been successful. Verification of hunter bags is not a common practice in subsistence communities and it is very difficult to implement, because birds are commonly harvested and consumed at camps far from villages (Zeller *et. al.* 2011, p. 8). In 2010 and 2012, species verification by a Service biologist was possible in a few cases on St. Lawrence Island. Based on voluntary communications by hunters, positive identification of one Pacific loon, one red-throated loon, and two yellow-billed loons was made (T. Zeller, USFWS, pers. comm.).

During studies of loon harvest on St. Lawrence Island, 31 hunters interviewed by Zeller *et. al.* (2011, p. 7) referred to the Pacific loon as the common loon due to its frequency of occurrence. This indicates that some reports of common loons may be Pacific loons. When interviewees were shown pictures of loons without the western science names, 42 percent stated that the Pacific loon was the most common or abundant loon seen. Only four of 31 hunters interviewed identified the common loon correctly. Furthermore, three hunters stated that they had never seen a common loon in their lifetime. In addition, many hunters simply refer to loons in general terms and do not differentiate among species especially when juvenile loons or loons in non-breeding plumage are taken (Zeller *et. al.* 2011, p. 8).

The St. Lawrence Island, Yupik names for loons do not match western biological taxonomy (Omelak 2009, pp. ii, 9–11; Amhasuk 2009, p. 4; Zeller *et. al.* 2011, pp. 22–26; Naves and Zeller 2013, pp. 47–53). Local people identify kinds of loons based on size and plumage. *Yuwayu* is the name for all species of loons, although it may refer to small loons (Pacific, Arctic, and red-throated loons), or yet more specifically, to small loons in breeding plumage. *Yuwayaaghaq* refers to all species of young loons in nonbreeding plumage. *Elqupak* is the name for Pacific and Arctic loons in breeding plumage, and *eghqaaq* refers to red-throated loons in breeding plumage. *Nangqwalek* is the name for large loons, both yellow-billed and common loons, or specifically for large loons in breeding plumage. Large loons in nonbreeding plumage are named *nangqwalgaaghaq*. Possibly because of the way Yupik names are used for loons, a considerable proportion of Yupik people could not tell loon species apart according to western taxonomy. The dominant factor for loon identification in harvest surveys was the word “common” presented in survey materials rather than morphologic characteristics (size, plumage, and bill color). “Common loons” reported in harvest surveys most likely refer to the most common loon in the area, which is the Pacific loon. Harvest surveys, bird counts, and ethnographic information indicated that identification of loon species in harvest surveys is possible for breeding plumages and likely not possible for nonbreeding plumages. Efforts to obtain more detailed loon species identification in harvest surveys may lead to unreliable data (Naves and Zeller 2013, pp. 47–53).

Previous common loon harvest estimates seemed excessively high compared to numbers known to occur on St. Lawrence Island (Naves 2010a, p. 56). This led biologists to consider that yellow-billed loons could have been misidentified as common loons based on similar body sizes. On the contrary, yellow-billed loon harvests could be underestimated, because common loon harvest estimates were high (USFWS 2010b, p. 28). It is now established that the Pacific loon is by far the most abundant loon on St. Lawrence Island and that summer and fall records of common loons are occasional (Lehman 2011, p. 11; Naves and Zeller 2013, p. 49). Changes to harvest survey materials in 2012 resulted in a reduction of common loon harvest reports. These results indicate that because the main factor for loon identification in harvest surveys prior to 2012 was the word "common" rather than morphologic characteristics, the prior reports of common loons most were likely Pacific loons (Naves and Zeller 2013, pp. 47–53).

Annual Variation in Availability of Loons as Subsistence Resources

Subsistence harvest estimates show high annual variation, which may be explained by annual variation in loon migration routes and timing. Regional annual bird harvest estimates ranged from 4 to 370 yellow-billed loons on the Y-K Delta over 19 years (Huntington 2009, pp. 30–34), five to 269 yellow-billed loons in Bristol Bay over seven years (Huntington 2009, p. 25), and 44 to 1,077 in the Bering Strait region over three years (Naves 2010a, p. 168). Egg harvests ranged from 0 to 60 over five years (Naves 2010a, p. 29). In a study investigating yellow-billed loon migration routes, some birds implanted with transmitters in 2002, 2003, and 2007, on Alaskan breeding grounds moved to marine waters near St. Lawrence Island before migrating south, while other birds (including all eight birds tracked in 2008) moved from Alaskan breeding grounds to Kolyuchin Bay on the north side of the Chukotka Peninsula, and crossed overland to the southwest over the peninsula and into Anadyr Bay, thereby bypassing St. Lawrence Island (J. Schmutz USGS, pers. comm.). Point counts on St. Lawrence Island in 2011 showed a 47 percent decrease in numbers of yellow-billed loons observed compared to 2010, despite a 30 percent increase in observation efforts (Zeller *et. al.* 2011, pp. 22–26; Naves and Zeller 2013, p. 49). In fall of 2011 and 2012, there were no large movements of yellow-billed loons as observed in 2010, which may reflect differences in migration conditions between years. Migratory behavior may vary from year to year due to many environmental and ecological factors in breeding and migrating areas, and loon harvest could vary with the number and timing of loons migrating across hunting areas. Weather conditions may also affect access by hunters to hunting areas, especially in fall, and could also account for substantial annual variation in harvest (Naves and Zeller 2013, pp. 47–53). However, knowledge of conditions affecting migratory behavior and their interactions with harvest effort are still poorly understood. It is likely that high annual variation in harvest estimates could at least partially reflect measurement and species identification errors in reported harvest (SHSAC 2003, p. 13).

Fishing Bycatch as a Source of Error

An additional factor affecting some harvest estimates for yellow-billed loons is apparent mis-reporting of yellow-billed loon fishing bycatch on the North Slope. Yellow-billed loon harvest estimates on the North Slope for the years 1994 to 2003 provide little indication of harvest of yellow-billed loons from most communities in most years, although reports from Barrow in two years resulted in village-wide estimates of 12 and 18 (Bacon *et. al.* 2011, p. 54). In contrast, AMBCC harvest survey estimates from 2004 to 2009 ranged from 2 to 102; however, reports indicate that about half were drowned in fishing nets (Naves 2010a, p. 170; 2010b, p. 56; 2010c, pp. 1-2). The NSB-DWM (2010 p. 1; 2014, p. 3) reported that yellow-billed loons are not targeted using fishing nets or any other means by subsistence users on the North Slope. Because of substantial measurement and species identification errors in harvest estimates, it is impossible to balance potential under- and overestimation of harvests in a quantifiable manner.

Ethnographic Information and Local and Traditional Knowledge

Other sources of information can help assess risk to yellow-billed loons from subsistence harvest in Alaska. Current studies of yellow-billed loon migration ecology, local and traditional knowledge, and the study conducted on St. Lawrence Island have contributed to our understanding of subsistence harvest as a potential threat to the species. Yellow-billed loons occur in areas traditionally used for subsistence harvests of diverse resources and hunters state that some are taken. Loons breeding in Alaska may be available for harvest in late May through late August. Also, a large proportion of yellow-billed loons breeding in Alaska, Canada, and Russia are potentially subject to harvest during their spring and fall migration through the Chukchi and Bering Seas (J. Schmutz, USGS, unpubl. data).

Although some St. Lawrence Island hunters (11 percent, three out of 28) informed us that they target loons for harvest, local and traditional knowledge and ethnographic information indicates that yellow-billed loons are not an important subsistence resource (USFWS 2010b, p.40). Therefore, harvest estimates described above may be biased high, at least in some cases. Discussions with St. Lawrence Island hunters indicated that most hunters do not target loons in spring and summer, which would serve to limit the number harvested (Ahmasuk 2009, p. 2; Zeller *et. al.* 2011, p. 8). A small proportion of Gambell hunters (10 percent of households) reported hunting loons in fall, and those that do so reported to harvest only a few yellow-billed loons (Ahmasuk 2009, p. 2). Hunters portrayed their yellow-billed loon take as opportunistic, small, and incidental (90 percent, 25 out of 28; Zeller *et. al.* 2011, p. 8). Loon harvests occurred mainly by boat and in combination with seal hunting (222 out of 237 reports). Rough sea and weather conditions in fall appear to limit opportunities for boat trips. Loons were also harvested from onshore blinds or otherwise as opportunities arose (Naves and Zeller 2013, p. 43).

Information provided by local residents and fall bird counts indicates that yellow-billed loons typically occur as single birds or pairs, and only sporadically occur in groups of dozens of birds. From fall bird counts, five groups with 20 to 49 loons, 1 group with 78 loons, and 1 group with 182 loons were observed (Naves and Zeller 2013, p. 13). Day *et. al.* (2003, p. 14) reported average size of loon groups close to Gambell, Alaska, was 1.4. Large groups may be related to migration waves (environmental conditions cause migration to be compressed in time, as it may have been in 2012) and local feeding aggregations on high concentrations of forage fish. These feeding aggregations occur more frequently at a few locations, such as 32 km (20 mi) north of Eevwak Point (8-10 km (5-6 mi) west of Savoonga, Alaska) and off the Stolbi Rocks (2-3 km (1-2 mi) east of Savoonga, Alaska (Huntington *et. al.* 2013, p. 328).

All households that reported harvest said that loons are only used for food and that loons are not currently used for Native crafts, traditional regalia, or other uses. Birds are mostly eaten fresh, although some are frozen or air-dried. Loons were usually prepared as a stew, soup, or roast. Current cultural, religious, and ceremonial uses of loons by the communities of St. Lawrence Island were not identified (Naves and Zeller 2013, p. 43). In this regard, St. Lawrence Island differs from the cultural setting of the Iñupiaq people of the North Slope and Northwest Arctic where *qaqigluk* (a headdress) made with the skin and bill of a yellow-billed loon symbolizes aspects of the traditional worldview during *Kivġiq* (Messenger Feast) (Ikuta 2007, p. 2; Spencer 1984, p. 333). In the past, birds also provided raw materials for clothing and utensils, especially bird skin parkas (Hughes 1984, pp. 263-277). Skins of loons in breeding plumage were used for decoration of functional items such as bags and parkas (Omelak 2009, pp. 2-7). Pacific loon skins were used for infant bedding and clothing (Ehrlich *et. al.* 1993, p. 22).

St. Lawrence Island local and traditional knowledge did not indicate harvest preferences for bird species. On the other hand, many respondents reported to prefer young birds (babies or juveniles) over adults (parents) of species such as kittiwake, puffin, cormorant, guillemot, gulls, and loons because young birds are tender and have more fat. Young birds harvested just before or after fledging are likely easy to tell apart from other age categories. However, in late fall and winter, young may also include adults in nonbreeding plumage. The proportion of loons (all species combined) in fall harvests (0.4 percent in 2011, 4.4 percent in 2012) was similar to that in bird counts (1.3 percent in 2011, 3.0 percent in 2012), which did not indicate selective harvest of loons. However, higher proportion of nonbreeding loons in 2012 fall harvest estimates (63 percent) compared to the proportion of loons in nonbreeding plumage in the 2012 bird count (24 percent) suggest positive harvest selectivity of loons in nonbreeding plumage, in accordance with harvest preference for young birds in general. Yet, difficulties in loon species identification precluded an assessment of harvest selectivity for individual loon species, especially in 2011 when misidentification of common loons was prominent (Naves and Zeller 2013, pp. 42-28).

Molting of adult yellow-billed loons may extend from late September until December, progressing from neck feathers through flight feathers, lesser wing coverts, back, head, and scapulars (North 1994, pp. 17-18). Adult Pacific loons may retain breeding plumage into October or November (Russel 2002, p. 32). The yellow-billed loon adult plumage is acquired through a succession of molts in the first 3 years of life. The first plumage of hatching year yellow-billed loons is worn during the first fall and winter (North 1994, pp. 17-18). However, subadults and some nonbreeding adults may remain on wintering grounds throughout the year. Therefore, yellow-billed and Pacific loon juveniles reported in fall harvest surveys on St. Lawrence Island likely consist largely of hatching-year birds (Naves and Zeller 2013, p. 48).

Yellow-billed loons are considered an uncommon to fairly common migrant at Gambell, Alaska, and may aggregate along western and southern shores of the island (Ahmasuk 2009, p. 4; Lehman 2011, p. 11). However, radio-telemetry data of 13 yellow-billed loons that passed by St. Lawrence Island showed that most remained well offshore (only 49 of 254 radio-relocations were within 10 km (6 mi) of shore; J. Schmutz, USGS, unpubl. data). This indicates that hunters may have to travel far offshore to access significant numbers of yellow-billed loons. A limited sample of all subsistence-harvested loon species on St. Lawrence Island in 2006 (n=31) and 2009 (n=1) examined by biologists included only two yellow-billed loons (USFWS 2010b, p. 37). However, yellow-billed loons represent 23 percent of contemporary loon harvest estimates (Naves 2010a, p. 28). While these observations and local and traditional knowledge do not provide a basis for quantitative estimation of harvest, they suggest that recent harvest estimates are likely biased high (Naves and Zeller 2013, p. 48).

Summary of Alaska Subsistence Harvest

Biological data on species distribution, harvest survey data, and ethnographic information indicate that yellow-billed loons are available for subsistence harvest in Alaska during summer (breeding season) and spring and fall migrations. Although some individuals are taken, harvest estimates are not precise. Most yellow-billed loons harvested are likely migrants and little reliable evidence exists for summer harvest in nesting areas. For the North Slope, the available information suggests a large proportion of the reported yellow-billed loon harvest may result from bycatch in fishing nets rather than hunting. Methods to quantify harvest are subject to a number of unquantifiable errors and biases including extensive evidence of systemic misidentification of loon species, which compromises all loon harvest estimates at the species level. Furthermore, high annual variation in harvest estimates likely indicates survey errors and variation in availability of loons and harvest effort. Several factors likely bias estimates high, but it is possible that some also bias estimates low. These cannot be quantified or cumulatively assessed with the currently available information, which seriously constrains accurate and precise estimation of harvest. All things considered, we estimate that few yellow-billed loons are taken each year in Alaska. Additional information may be required to fully understand the historical, current, and potential impact subsistence harvest has on the yellow-billed loon, but the best available information does not indicate that subsistence harvest is a major source of concern.

Subsistence Harvest Conclusion

The best available data on yellow-billed loon subsistence harvest from harvest surveys are subject to unquantifiable errors and biases that make it impossible to accurately estimate subsistence harvest levels. Issues identified in harvest data for Alaska are of a general nature and similar issues likely affect harvest data for Canada and Russia. Despite errors in the harvest data, considering survey estimates, local and traditional ecological knowledge, and ethnographic information, the available information collectively suggest that anywhere from tens to possibly a few hundred yellow-billed loons from multiple breeding and migration areas may be harvested annually by subsistence hunters across the species' range in Alaska, Canada, and Russia.

In summary, because available harvest data contains errors and biases of unknown direction and magnitude, we cannot use it to precisely estimate harvest. However, the best available information does indicate that only a small percentage of yellow-billed loons are harvested throughout Alaska, Russia, and Canada annually. Also, the best available information suggests that few eggs or adults are taken during the breeding season, so most harvest likely occurs during spring and fall migrations, as yellow-billed loons move along the coast of Alaska and Chukchi and Bering seas. Birds migrating through the Bering Strait include those nesting in Chukotka and the Arctic Coastal Plain, and perhaps a small portion nesting in mainland Canada. Therefore, even though the rangewide population of yellow-billed loons is subject to harvest, impacts to the species are not substantial.

Despite recognized uncertainties regarding harvest levels, breeding-population composition of migrant groups and total population size, it is reasonable to surmise that a small proportion of migrants are harvested each year. Recent studies indicate that fewer yellow-billed loons may be harvested than previously thought, and that the harvest likely represents a relatively small proportion of the total number of migrant loons of all species (Naves and Zeller 2013, p. 1). Although we recognize that tens to low hundreds of yellow-billed loons are likely harvested each year, the best available information indicates that a small proportion of the total rangewide population is harvested annually, and the effect is diffused across the species range. Also, there is no evidence to indicate that current populations are being impacted by harvest. Therefore, we conclude that the best available information does not indicate that subsistence harvest is a threat to the yellow-billed loon now or in the future.

4.9.2 Subsistence Fishing Bycatch

Subsistence fishing is an important component of the customs, traditions, and economies of many indigenous groups in the Arctic. Across the breeding range of the yellow-billed loon, rural residents fish primarily with gill nets, although some angling and ice jigging does occur (Craig 1987, p. 17). Gill-net use is localized near villages and fish camps in marine inlets and lagoons, lakes, and rivers, depending on season and target fish species (Craig 1987, p. 17). During the breeding season, yellow-billed loons will forage in large lakes close to their nests, as well as other nearby lakes, rivers, and marine areas, where the potential for bycatch in subsistence fisheries exists (Earnst 2004, pp. 4, 6–7). Yellow-billed loons may also be susceptible to fishing bycatch during spring and fall migrations when foraging in near-shore marine habitats.

Limited observations confirm that yellow-billed loons have been inadvertently caught in subsistence gill nets in Canada, Russia, and Alaska, although the level of bycatch is not extensively documented. In Canada, researchers on Victoria Island documented yellow-billed loon entanglement in nets on several occasions, including one instance where seven yellow-billed loons were found dead in nets in a single day (Parmelee *et al*. 1967, p. 212; Sutton 1963, p. 1). In Russia, Syroechkovski (2008, p. 2) reported that two reasons for subsistence mortality were accidental entanglement in fishing nests and deliberate shooting to scare loons from fishing areas. The Red Data Book of the Russian Federation (2001, pp. 366–367) states that yellow-billed loon mortality in fishing nets is the main threat to the species, with bycatch rates described as catastrophic in the Chukchi Peninsula region. However, we could not locate supporting data or a source for that assessment.

In Alaska, harvest survey data on loon bycatch from subsistence fishing is available only for the North Slope and St. Lawrence Island. Five households interviewed on St. Lawrence Island reported that they spend the summer at fishing camps on the southeast shore of the island, and caught and then harvested yellow-billed loons in gill nets. On the North Slope Inupiat Eskimos use yellow-billed loon parts for subsistence and ceremonial purposes (NSB-DWM 2008, p.1). While it is illegal to kill or possess yellow-billed loons under the MBTA, an exception for the North Slope region was incorporated into the regulations allowing possession for subsistence use of up to 20 (total for the region each year) yellow-billed loons inadvertently caught in subsistence nets (50 CFR Part 92). Little information is available regarding the number of yellow-billed loons caught in subsistence nets for most of the state, with the exception of the North Slope, which is discussed in more detail below.

Fishermen on the North Slope, as part of the AMBCC regulation allowing possession of yellow-billed loons, are required to report their catch to the North Slope Borough Department of Wildlife Management (NSB), which provides a summary report to the AMBCC at the end of the fishing season. Participation by fishermen is incomplete, subject to numerous unquantifiable biases, and likely varies annually. However, recent Sformo *et. al.* (2012, p. 1; 2013, p. 1) reported a high response rate (greater than 96 percent in both studies) for the three villages of Barrow, Nuiqsut, and Atqasuk. The NSB reports indicate that two to 14 yellow-billed loons were killed in subsistence nets annually from 2005 to 2010 in Barrow (NSB-DWM 2006, p.1; 2007, p. 1; 2008, p. 1; 2009, p. 1; 2010 p. 1; 2011, p. 1). Small numbers of loons, including yellow-billed loons, were also reported as found alive and released. These numbers are likely a minimum estimate of yellow-billed loon subsistence bycatch in the Barrow area, because not all fishermen were contacted (NSB-DWM 2008, p. 2). Additionally, evidence suggests that some yellow-billed loons killed in fishing nets have been reported as part of the subsistence harvest rather than as inadvertent catch in fishing nets (USFWS 2010b, p. 21; 2011, p. 41; 2013, p. 47). At least half of yellow-billed loons reported in the subsistence harvest survey for the North Slope region were actually bycatch in fishing nets rather than intentionally harvested birds (Naves 2010a, p. 170; 2010b, p. 56; 2010c, pp. 1–2). This suggested that larger numbers of yellow-billed loons are taken as fisheries bycatch than assumed previously. To address this discrepancy, the North Slope Borough developed a more robust study design to better quantify take in this region. From 2011 to 2012, a total of 125 and 116 households in Barrow, Atqasuk, and Nuiqsut were surveyed to estimate the number of yellow-billed loons inadvertently entangled in subsistence fishing nets. The response rate for both years was approximately 97 percent. The total number of dead yellow-billed loons reported was 18 in 2011 and 10 in 2012. A total of 13 were released alive, 8 were kept for traditional and ceremonial purposes, and the disposition of the remaining loon carcasses were unreported (Sformo *et. al.* 2012 p. 1; 2013, p. 1).

In summary, data is limited on the number of yellow-billed loons taken inadvertently as bycatch during subsistence fishing. Yellow-billed loon bycatch has been documented either anecdotally or in reporting programs on the breeding grounds in Alaska, Canada, and Russia. Yet, we do not have enough information to extrapolate subsistence bycatch accounts to areas lacking data or to evaluate population-level effects. We recognize that lethal entanglement of yellow-billed loons during subsistence fishing kills an unknown number annually. However, we do not have sufficient information at this time to determine that subsistence bycatch is occurring at a magnitude that results in population-level impacts. The best available information does not indicate that bycatch from subsistence fishing is a major source of concern for the persistence of the yellow-billed loon.

4.10 Commercial Fishing Bycatch

Yellow-billed loon bycatch has been documented in commercial drift-net, gill-net, trap-net, and longline fisheries. Compared to other fisheries, gill-net fisheries have the greatest potential to impact loon populations. For example, a 1998 study of commercial fishing bycatch in winter gill-net fisheries on the U.S. mid-Atlantic coast found that loons (red-throated and common) accounted for 89 percent of all avian bycatch (Forsell 1999, p. 23). While loon species have been recorded as bycatch in several longline fisheries (Brothers *et. al.* 1999, p. 12), in general, longlines attract surface-feeding seabirds rather than species that dive to feed such as loons.

In Washington State, Russia, and Norway, yellow-billed loon bycatch in commercial fisheries has been documented anecdotally or by observer programs (74 FR 12931, March 25, 2009). Few data exist from large portions of the species' wintering range (Yellow Sea, Sea of Japan, and coastal Japan), but bycatch is likely to occur in extensive gill net fisheries that overlap with wintering yellow-billed loons. A recent report by the Russian Academy of Sciences indicates that yellow-billed loons are caught incidentally in salmon gill nets in the northwestern Pacific Ocean (Artukhin *et. al.* 2010; p. 61). However, translation to English is ongoing and survey methods have not been examined to determine whether the data can be used to estimate annual bycatch in this area.

In conclusion, yellow-billed loon bycatch in commercial fisheries has been documented anecdotally or by observer programs, but little data exist from large portions of the species' wintering range. Bycatch is likely to occur in gill net fisheries that overlap with wintering yellow-billed loons, but we lack information to explain the difference in catch rates reported from various observer programs and do not have enough information to extrapolate bycatch estimates to areas lacking data, or to evaluate population-level effects. Consequently, although we recognize bycatch as a stressor that kills a number of adult yellow-billed loons annually, we do not have enough information to evaluate population or species-level effects. Additional information may be required to fully understand the historical, current, and potential impact commercial fisheries has on yellow-billed loons, but the best available information does not indicate that commercial fishing bycatch is a major source of concern.

4.11 Pollution

Pollution (contaminants) accumulated within individuals can affect populations and species through direct effects on individuals (such as illness or death) or reproduction (such as embryo inviability), and indirect effects (such as alterations in prey abundance).

Risk factors for contaminant exposure include trophic status (species higher in a food chain are more likely to accumulate persistent pollutants), contact with pollution point sources, location (including migratory pathways), and lifespan (long-lived individuals have more time to accumulate persistent compounds). Yellow-billed loons are relatively long-lived birds, and being piscivorous (fish eaters), are high on the trophic food chain; thus, this species has a high risk potential for exposure/accumulation of/to contaminants. Both Arctic breeding areas and temperate wintering areas have documented pollution.

Yellow-billed loons spend the majority of the year in southern wintering areas, which are primarily coastal and are more likely to have elevated environmental concentrations of persistent organic pollutants, such as organochlorine pesticides and polychlorinated biphenyls (PCBs), compared to northern breeding areas. Twenty-four out of 29 yellow-billed loons fitted with transmitters on Alaska breeding grounds wintered in Asian waters have been demonstrably affected by pollution (Schmutz 2008, p. 1). For example, Ma *et. al.* (2001, pp. 133–134) reported high levels of persistent organic pollutants (dichlorodiphenyltrichloroethane (DDT) and PCBs) petroleum-derived contaminants in the intertidal zone of the Bohai and Yellow seas offshore of China. In Korea, PCBs were greater in fish and birds from industrially contaminated areas of the Nakdong estuary than non-industrial areas (Choi *et. al.* 1999, p. 233). Other studies document contamination of Asian sea sediments and biota, including fish and birds, that support potential exposure for wintering migratory birds such as yellow-billed loons (e.g., Nie *et. al.* 2005, pp. 537–546; Oh *et. al.* 2005, pp. 217–222; Daoji and Daler 2004, pp. 107–113; Guruge *et. al.* 1997, pp. 186–193). In a test of exposure to persistent contaminants in Asian wintering areas compared to northern breeding areas, Kunisue *et. al.* (2002, p. 1397) found that herring gulls (*Larus argentatus*) and other migratory birds nesting on Lake Baikal in Russia had higher levels of organochlorine contaminants on arrival from Asian wintering areas than at the end of the breeding season.

Sympatrically nesting red-throated loons from the Alaska-ACP had PCB concentrations and formulations great enough, when compared to thresholds developed for other species, to cause abnormal development or other reproductive defects (Schmutz *et. al.* 2009, p. 2392). Preliminary satellite telemetry data indicate that these red-throated loons winter in Asian marine waters, similar to yellow-billed loons (Rizzolo and Schmutz 2010, p. 12). Because of this study on red-throated loons, yellow-billed loon eggs from the Alaska-ACP were tested for contaminants (Hoffman *et. al.* 1996, p. 191). Although PCBs were present in 45 yellow-billed loon eggs collected over three years, preliminary data show that the most toxic individual PCB congeners (PCBs 77 and 81) found in red-throated loon eggs were not present in yellow-billed loon eggs (Hoffman *et. al.* 1996, p. 191). Also, yellow-billed loon eggs had lower total toxic equivalents (a combined measure of toxicity for all 209 PCBs), and lower than published thresholds for embryonic toxicity than other avian species, such as great blue herons (*Ardea herodias*) (Hoffman *et. al.* 1996, p. 191).

Recent sampling of yellow-billed loon tissues and comparison of historical with contemporary samples have been conducted to evaluate mercury exposure (Evers *et al*. 2014, entire document). Concentrations in blood during the breeding season, which were thought to reflect exposure in Arctic breeding habitat, were below "background levels" (Evers *et al*. 2014, p. 153). However, concentrations in feathers and eggs, which presumably reflect exposure during winter in Asian marine waters, indicated that a small proportion (seven percent of individuals sampled) exceeded thresholds associated with reproductive effects in common loons (Evers *et al*. 2014, p. 155). Mercury concentrations are predicted to increase (Evers *et al.* 2014, p. 155), and hence effects to yellow-billed loons may increase in future decades, yet we are not able to predict at this time whether increased exposure would impact loons at the population or species level.

In conclusion, current data on contaminant concentrations in yellow-billed loons from Alaska indicate that yellow-billed loons are likely not currently being affected at the population level through a reduction in productivity. Because yellow-billed loons nesting in Canada and some proportion of those nesting in Russia likely winter with Alaska loons in Asian seas or on the Pacific coast of North America, we assume that PCB and other persistent contaminant concentrations in their eggs would be equal to or less than those from Alaska. The contaminant loading for yellow-billed loons wintering in the North Sea is unknown, but those loons represent a small proportion of the total population. Future exposure to pollutants, including mercury, may significantly increase in Arctic marine habitats by 2050 resulting in population-level effects via declining productivity (Sunderland *et. al.* 2009, p. 12) or Asian marine waters where some yellow-billed loons winter (Evers *et al.* 2014, p. 155), possibly resulting in decreased productivity. However, at present we are unable to predict the rate and extent of increasing environmental contaminant loads or potential population- or species-level response of yellow-billed loons. Currently, there is no evidence suggesting that pollution poses a substantial concern to the viability of the yellow-billed loon.

4.12 Existing regulatory mechanisms

Russia is the only nation that includes the yellow-billed loon on an endangered or sensitive species list. Some countries (Canada, Japan, Norway, Russia, and the United States) have laws that prohibit the possession and hunting of migratory birds, such as the yellow-billed loon, unless specific regulations are issued, or unless the animals are harvested for subsistence. Provisions to prevent habitat degradation for wildlife and migratory birds or to protect the environment exist, but enforcement levels are unknown and in some countries may not be effective at protecting habitats. As discussed earlier, the BLM, the land management agency with authority over most of the yellow-billed loon's breeding range in Alaska, has instituted protective measures for the species and its habitat. Additionally, BOEM includes protective measures for migrating sea birds, including yellow-billed loons, during activities it regulates.

While existing regulatory mechanisms appear adequate to minimize stressors to yellow-billed loons in the United States, lack of public knowledge and compliance with some regulations may be issues in some locations. For example, although the species is closed to subsistence hunting in Alaska, harvest surveys and anecdotal observations have shown that some level of harvest continues to take place. Additionally, an unknown level of bycatch from fishing activities also occurs, which is a violation of the Migratory Bird Treaty Act (except for the North Slope region where up to 20 yellow-billed loons per year inadvertently caught in subsistence nets may be kept for subsistence or ceremonial purposes; 50 CFR Part 92). Additionally, the Service has focused efforts on education and outreach instead of enforcement to inform hunters and potentially gain compliance with hunting regulations. It is difficult to determine whether existing regulations and enforcement are adequate in other countries. The lack of knowledge of regulations in the United States and the potential lack of regulation, knowledge, and enforcement in other countries are likely stressors to yellow-billed loons; however, the magnitude and subsequent effect on the population are difficult to determine at this time. Therefore, we do not consider an inadequacy of existing regulatory mechanisms to be a threat to the yellow-billed loon now or in the future.

4.13 Conservation measures

Several yellow-billed loon conservation measures were planned and implemented since the species was first petitioned to be listed under the Endangered Species Act. These include the Conservation Agreement for the Yellow-billed Loon (*Gavia adamsii*) in 2006, the Spotlight Species Action Plan in 2009, conservation actions occurring on St. Lawrence Island, a loon entanglement study, and current and future requirements and conservation recommendations for oil and gas operations in the Arctic terrestrial and OCS regions. We expect these cumulative planned and implemented actions have and will minimize impacts on yellow-billed loons.

The Conservation Agreement for the Yellow-billed Loon, which was signed by five Federal, state, and local agencies in 2006, addresses research and management needs for yellow-billed loons in Alaska. In the agreement, the Service and its partners planned to implement the following strategies: (1) specific actions to protect yellow-billed loons and their breeding habitats in Alaska from potential impacts of land uses and management activities, including oil and gas development; (2) inventory and monitor yellow-billed loon breeding populations in Alaska; (3) reduce the impact of subsistence activities (including fishing and hunting) on yellow-billed loons in Alaska; and (4) conduct biological research on yellow-billed loons, including response to management actions. In April 2009, the Service organized a workshop for yellow-billed loon biologists to prioritize information needs to conserve the species. This was followed in May 2009 with a conservation planning meeting for agency managers, biologists, and other stakeholders to strengthen or expand the conservation agreement and identify partnerships and funding sources to implement high priority projects.

The strategies outlined in the Conservation Agreement for the Yellow-billed Loon demonstrate the partners' commitment to prioritize yellow-billed loon conservation in Alaska. To fulfill the first strategy, the Service will continue to work with partners to maintain actions that protect yellow-billed loons. In particular, we work closely with the BLM to monitor and maintain protection of loons in NPR-A, as expressed in their memorandum on the yellow-billed loon (Galterio 2008, pp. 1–3). For the second strategy, we will continue to inventory yellow-billed loons through waterfowl surveys on the Alaska-ACP; the NPS will continue loon-specific surveys in operation on the Seward Peninsula, and we will investigate the potential for initiating other yellow-billed loon-specific surveys (e.g., in Arctic waters). Some of the data already obtained are available in a spatial database (http://arcticlcc.org/projects/geospatial-data/yellow-billed-loon-geodatabase/, accessed July 24, 2014). For the third strategy, the Service's Endangered Species and Migratory Bird Management programs are working closely with the Alaska Migratory Bird Co-management Council (AMBCC), the native corporation of Kawerak Inc., local communities in the Bering Strait region, the North Slope Borough, and the State of Alaska to acquire reliable, verifiable information on subsistence harvest and fishing bycatch levels in Alaska, and to substantially increase education efforts and support research to clarify and reduce levels of this threat. Finally, we financially support the ongoing research by the U.S. Geological Survey and others on yellow-billed loons in Alaska, and will continue to advocate for further research where it will inform management of yellow-billed loons, such as understanding effects of disturbance on nesting loons to ensure that buffers separating loons from human activity are adequate.

In 2009, the Service completed the Spotlight Species Action Plan for the yellow-billed loon, which identifies actions in conjunction with other cooperating parties that will reduce the magnitude of stressors on yellow-billed loons, especially harvest. Improving the currently questionable information about actual levels of harvest and eliminating harvest are high priority actions for this species. However, other potential stressors are also poorly understood and need further study so that actual impacts to the species can be better evaluated and addressed. Actions addressing harvest include improving harvest survey methods and implementation, conducting studies to analyze cultural use of yellow-billed loons and migration pathways, and maintaining the species' closed species status while providing education to reduce harvest. Actions addressing oil and gas development include developing and implementing best management practices benefiting yellow-billed loons to be followed by oil and gas lessees on Federal and state lands in Alaska, continued monitoring of populations, and conducting further research to understand effects of disturbance and breeding-lake water withdrawals. In addition, further information is needed on specific locations that might be of importance to migrating and wintering loons from all populations.

The BLM, BOEM, and the Bureau of Safety and Environmental Enforcement (BSEE) have and will continue to implement and enforce best management practices and permit stipulations of their lessees to minimize impacts on yellow-billed loons from oil and gas activities in the Arctic OCS regions. We expect these requirements will minimize effects on yellow-billed loons, and thus, act as conservation measures. We also made conservation recommendations to the BOEM and BSEE that are specific to yellow-billed loons (USFWS 2012b, pp. 133–135):

- Conduct surveys specifically designed to assess abundance, population trends, habitat use, and productivity of yellow-billed loon populations that may be affected by oil and gas development (i.e., lake circling surveys on the Alaska-ACP during the breeding season);
- Characterize habitat use and distribution of non-breeding yellow-billed loons; and,
- Research the breeding ecology and demography of yellow-billed loons, such as estimating breeding probability, age at first reproduction, etc.

Research and management of yellow-billed loons have also begun outside Alaska. In particular, we need to understand population sizes and trends for Russian and Canadian breeding populations, migration corridors, and where breeding populations winter. Currently, recent and ongoing research is being conducted in Canada (satellite telemetry studies on migration routes and survival; J. Schmutz, USGS, pers. comm.) and Russia (breeding densities and other parameters in the Chaun Delta, Chukotka; Solovyeva 2012, pp. 1-19).

4.14 Summary of Causes and Effects

For each potential stressor, we evaluated sources and potential effects upon resources needed by yellow-billed loons, and potential responses at the individual, population, and species levels. The Alaska-ACP breeding population, for which we have the most information, likely encounters all of the stressors outlined above at the individual level, is subject to conservation measures, and is currently either stable or slightly increasing. There is evidence that changes may occur to yellow-billed loon's habitat due to the effects of current and future climate change, but we do not have enough evidence to know the specific types of changes that may occur or how those changes will impact the yellow-billed loon in the future. Therefore, we do not know if climate change will have positive, negative, or neutral impacts on individuals, populations, or the long term viability of the species.

Climate-induced changes to breeding and Arctic marine yellow-billed loon habitat have occurred and are likely to occur over the next 50 to 100 years. The mechanisms and magnitude of these effects on yellow-billed loons are becoming more well understood as climate change research and documentation efforts in the Arctic proceed, but there is a great deal of imprecision and uncertainty around timing and magnitude of possible effects. Increased ship traffic in newly ice-free zones present oil spill, disturbance, and collision hazards, but the widespread distribution and low density of yellow-billed loons on the marine seascape mitigate the risk that this will affect yellow-billed loons at the population or species level. Given the species ecological diversity, of particular concern are predicted changes over the next 50 to 100 years in yellow-billed loon breeding habitats, particularly lake drying and drainage. If additional genetic analyses show low genetic diversity and hence the inability to quickly adapt, the loss of lakes, currently saturated lake habitats, or lake-habitat characteristics needed by yellow-billed loons (especially shallow vegetated shorelines and access to prey), may result in population and species-level declines over this time period. Additional information regarding the potential response of yellow-billed loons to climate change is necessary to further evaluate the impact to these species.

While onshore **oil and gas exploration and development** may be affecting yellow-billed loons in localized areas, impacts from these activities are minor and only affect individuals rather than a significant proportion of the population. In summary, oil and gas activities are occurring and are likely to continue to occur in portions of the yellow-billed loons range. While these activities may affect small numbers of individual yellow-billed loons, the potential for future adverse effects is decreased as a relatively small portion of the species breeding range is affected, and there are stipulations and required operating procedures in effect in NPR-A, an area that contains approximately 90 percent of the Alaska-breeding population, to reduce impacts to yellow-billed loons.

Potential effects on individual loons from depletion of the winter prey base, exposure to pollution and oil spills, or other effects of **degradation of marine habitats** have not been documented relative to winter condition of individuals or populations.

Furthermore, we do not have any evidence of risks to yellow-billed loon populations or the species as a whole from **research activities, disease, or predation**. Although a small number of yellow-billed loons are taken for scientific research, we find that this is not significantly affecting yellow-billed loons. No large disease-related mortality events have been documented for yellow-billed loons, and we have no data that suggests disease outbreaks will increase or will have more severe effects on yellow-billed loons in the future. Nest predation may be affecting current productivity but due to requirements implemented by BLM in the NPR-A and by the oil industry in other areas of Alaska's North Slope oilfields, we expect that nest predation is unlikely to cause population-level effects in the future, at least in Alaska; no information is available that would indicate future effects of such development in Russia or Canada.

We are concerned about **oil spill** response capability in the Arctic and will continue to review and provide input on proposed response plans as they become available. Large spills, while unlikely, could have catastrophic consequences. Yellow-billed loons would be affected if they were present in the area at the time of the spill and came into contact with the oil. However, yellow-billed loons occur in low densities across the marine landscape; accordingly, while there is a risk of a large spill from activities in the Alaska OCS areas, we consider the likelihood of it occurring and overlapping with a significant number of yellow-billed loons to be unlikely. Consequently, we conclude that oil spills are not stressors that rise to the level of a population level effect.

Some yellow-billed loons may die as a result of **collisions** with ships or structures. Although the loss of individual adult loons is important, because of the protections in place, the low density of the birds, and the low density of structures and vessels, we conclude that collisions do not rise to the level of having population-level effects to yellow-billed loons.

Numerous uncertainties continue to surround the effects of **subsistence activities**; but tens to hundreds of yellow-billed loons from all breeding populations are likely killed annually, which does not rise to population or species-level effects.

Commercial fishing bycatch kills an unknown number of yellow-billed loons annually. We do not have enough information to extrapolate subsistence bycatch accounts to areas lacking data or to evaluate population-level effects. At this time, the best available information does not indicate commercial fishing bycatch is a major source of concern nor will it be in the future.

Information is limited on most of the **pollution** or contaminants that could directly affect yellow-billed loons throughout their range. We know, however, that yellow-billed loon eggs from the Alaska-ACP breeding population have low concentrations of toxic PCBs, and these birds winter in the relatively polluted marine areas near Asia. Because yellow-billed loons nesting in Canada, and some proportion of those nesting in Russia, likely winter in Asian seas or on the Pacific coast of North America, we assume that PCB and other persistent contaminant concentrations in their eggs would be equal to or less than those from the Alaska-ACP. Mercury concentrations in a small proportion of individuals exceed thresholds associated with reproductive effects. Because mercury concentrations are predicted to increase, population-level effects could be occurring within a few decades. However, there is no current evidence to indicate that pollution poses a substantial concern to the viability of the yellow-billed loon at this time.

Existing regulatory mechanisms appear adequate to minimize threats to yellow-billed loons in the United States; however, lack of public knowledge of and compliance with some regulations may be issues in some locations. For example, although the species is closed to subsistence hunting in Alaska, harvest surveys and anecdotal observations show some level of harvest continues to take place. Additionally, an unknown level of bycatch from fishing activities also occurs, which is a violation of the Migratory Bird Treaty Act. It is difficult to determine whether existing regulations and enforcement are adequate in other countries. Based on the best available information we do have, we do not consider an inadequacy of existing regulatory mechanisms to be a threat to the yellow-billed loon now or in the future.

Ongoing **conservation measures** for the yellow-billed loon include protections from disturbance and maintenance of prey fish in NPR-A, the multi-agency Yellow-billed Loon Conservation Agreement, outreach and education on the effects of subsistence activities, and multi-faceted research activities in Alaska, Canada, and Russia. While we lack correlative data at this time, it is likely that conservation measures, particularly those in NPR-A, have reduced impacts to individual yellow-billed loons, and hence, to populations.

Chapter 5. Viability

In this chapter we consider yellow-billed loon viability as characterized by its resiliency, redundancy, and representation by considering all analyses in this status review. We divided our evaluation over three time periods: current; short term; and over the long term. Resiliency is the ability of the species to withstand stochastic events and is measured by population health metrics (e.g., abundance and growth rates). Redundancy is the ability of a species to withstand catastrophic events by spreading the risk of effects of stressors through duplication and distribution of resilient populations across its range. Representation is the ability of a species to adapt to changing environmental conditions and can be measured by the breadth of genetic diversity within and among populations, and the ecological diversity of populations across the species range.

5.1 Resiliency

The global yellow-billed loon population is spread among five breeding areas on two continents: the Alaska-ACP, Western Alaska, Canadian (which may be further divided between Canadian arctic islands and the Canadian mainland), and Russian breeding populations with an overall rangewide population estimate of 16,000 to 32,000 individuals. We evaluated yellow-billed loon resiliency using population health metrics for the Alaska-ACP breeding population, which has the most associated information and research. The Alaska-ACP breeding population is reasonably representative of the status of other breeding populations because threats to it are likely to affect other breeding populations. The best available information indicates that the Alaska-ACP population is stable or slightly increasing. Because the Alaska-ACP is representative of other breeding populations, it is reasonable to assume that yellow-billed loon populations rangewide are currently healthy, and thus have sufficient resiliency to withstand stochastic events.

Yellow-billed loon distribution across the terrestrial landscape during breeding is patchy (associated with breeding lakes); but, over the area that each population occupies, they are widespread and occur at low densities. Because yellow-billed loons are spread out across the landscape and occur in low densities, most stressors are thought to have effects at the individual level, rather than on populations or the species rangewide. The stable or increasing Alaska-ACP breeding population suggests that currently identified and unindentified stressors on yellow-billed loons are not resulting in effects on population growth.

Certain intrinsic aspects of yellow-billed loon ecology and demography, including low and variable productivity, high adult survival, and low population numbers, are relevant to the species' future status. Stable populations of K-selected species, such as the yellow-billed loon, are characterized by low annual productivity rates balanced with high annual survival rates, meaning that individuals must live many years to replace themselves with offspring that survive to recruit into the breeding population. Although stressors that compromise productivity can cause populations to decline, adult survival is often the more important determinant of population size and persistence (Smith and Smith 2001, p. 235). If enough adults are removed from the population prior to replacing themselves (i.e., adult survival is decreased), the population will decline. At this time, there is no information to indicate that future trends of many identified stressors will cause adult mortality at a magnitude that will impact the species long term viability. Because yellow-billed loons occur in a widespread distribution and low densities across landscapes and seascapes, exposure to even increasing localized stressors is reduced, thus protecting the species from increased adult mortality and maintaining resiliency.

5.2 Redundancy

We evaluated yellow-billed loon redundancy by the number of breeding populations and their global distribution. The global yellow-billed loon population is estimated to be between 16,000 and 32,000 individuals spread among five breeding areas on two continents. Wintering areas include at least four regions: Asian seas, such as the Yellow Sea and South China Sea; the west coast of North America, the northern coast of Europe, and possibly large inland freshwater lakes in Canada. The wide geographic spread of yellow-billed loon breeding and wintering areas adds to redundancy and reduces potential species-level impacts from local or regional stressors. Therefore, we conclude that the current redundancy of yellow-billed loons is sufficient for species viability, now and in the short term.

In the longer term, predicted changes to Arctic freshwater ecosystems (e.g., saltwater incursions, warming temperatures, trophic changes, and hydrological changes) may affect the viability of yellow-billed loons. Redundancy of even widely distributed populations may decrease due to global-scale stressors, such as climate change; however, the rate, magnitude, and timeframes of decline are difficult to predict. Additional information regarding the potential response of yellow-billed loons to climate change is necessary to further evaluate impacts to these species. At this time, we do not have sufficient information to indicate that climate change is a significant threat to the long term viability of the species.

5.3 Representation

Representation is the ability of a species to adapt to changing environmental conditions and is considered a function of a species ecological and genetic diversity. The more represented or diverse a species is, the more capable it is of adapting to changes (natural or human-caused) in its environment. Although one study has been conducted on genetic markers in yellow-billed loons, the results from the small sample size are very preliminary and cannot be used to evaluate representation. Therefore, we considered representation through yellow-billed loon ecological diversity. Yellow-billed loons have specific breeding habitat needs, such as large lakes with shallow vegetated shorelines and sufficient prey. As previously discussed, their Arctic breeding range is exhibiting effects of climate change, resulting in hydrological changes that may end with widespread lake drying and drainage (depending upon the underlying substrate). Yet, we expect that important polynyas (areas of open water at predictable, recurrent locations in sea-ice covered regions) and ice-lead spring staging habitat are likely to continue to exist in the future, which will continue to provide spring migration habitat for yellow-billed loons, even as the arctic climate continues to warm. Changes in productivity associated with ice melt, changes in water chemistry, and northward migration of previously southern species may result in changes in Arctic food webs and yellow-billed loon marine prey availability, which could either increase or decrease in response. On the other hand, yellow-billed loons winter exclusively or nearly exclusively in coastal marine waters, likely within 32 km (20 mi) of shore, in areas that are protected and harbor adequate prey resources. If the species is, in fact, limited by narrow, specific habitat associations or requirements, this may indicate low ecological diversity, which would limit the species' ability to adapt to environmental change. Although some information indicates that representation may be low, we do not have enough information at this time to determine if representation of yellow-billed loons is having or will have implications for the long term future viability of the species.

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