Yellow-billed Loon (*Gavia adamsii*)

Vulnerability: **Moderately Vulnerable** Confidence: Low

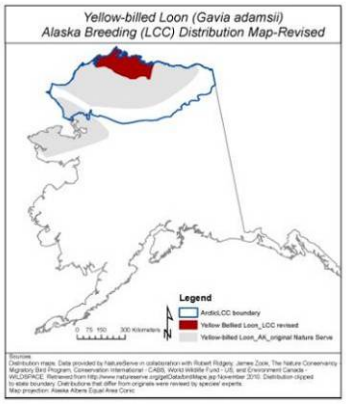
The Yellow-billed loon, the largest of the world's five loon species, and also the rarest, has one of the highest nesting densities in the world on the central Arctic Coastal Plain of Alaska (Earnst et al. 2005). In Alaska, this species typically breeds on the edges of relatively deep (>2 m), large (usu. >12 ha) fish-bearing lakes (http://alaska.fws.gov/). Little is known about their diet in Alaska, but they are believed to depend on several fish species, with cisco (*Coregonus* spp.) being the most important (J. Schmutz, pers. comm.). Although previously thought to winter off the coast of the Pacific Northwest, new evidence suggests the North American breeding population winters in East Asia from the western Kuril Islands to the Yellow Sea (J. Schmutz et al., unpublished data). Earnst et al. (2005) estimates that <1000 nesting pairs breed in n. Alaska.

Range: For this assessment, we modified the NatureServe map to more closely match the core breeding range of this species based on a recent study and expert opinion. In Arctic Alaska, Yellow-billed Loons principally occur in the large lake region of the National Petroleum Reserve - Alaska. Few nest east of the Colville River, west of the Meade River, or in the Brooks Range foothills (Earnst et al. 2005).

Physiological Hydro Niche: The Yellow-billed Loon scored as most vulnerable to climate change in the hydrological niche category ranging from "slightly" to "greatly increased". Since this species relies on large lakes for breeding a drying trend will not likely lead to loss of such lakes. In fact current patterns of permafrost melt indicate an increase in size of such lakes (Martin et al. 2009) yet recent evidence suggests a doubling of lake expansion results in a six fold increase in lake drainage (Grosse and Jones 2012). A drying trend or change in hydrology from increased thermokarst could limit fish colonization of lakes by restricting passage. Current projections of annual potential evapotranspiration suggest negligible atmospheric-driven drying for the foreseeable future (TWS and SNAP). Thus atmospheric moisture, as an exposure factor (most influential on the "hydrological niche" sensitivity category), was not heavily weighted in the assessment.

Disturbance Regime: Climate-mediated disturbance processes, namely thermokarst, could both create and destroy lake habitats through both ice wedge degradation and draining of thaw lakes (Martin et al. 2009).

Human Response to CC: All-weather roads (necessitated by a warming climate and shortened ice road season) associated with energy extraction activities could impact this species by limiting fish passage due to insufficient bridge/culvert design associated with the road construction. At this point, there is little information to determine the significance of such a potential impact.



Physiological Thermal Niche: Yellow-billed Loons would unlikely be stressed thermally by an expected increase in temperature over the timeframe of this assessment. The rationale for this inference is simply based on the physical similarity to the congeneric Common Loon (*Gavia immer*), which appears essentially morphologically identical, yet breeds over a

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Vulnerability Factors	D	SD	N	SI	I	GI	Unknown or N/A
B1. Sea level rise			*				
B2a. Natural barriers			*				
B2b. Anthropogenic barriers			*				
B3. Human response to CC			*	*			
C1. Dispersal/Movement			*				
C2ai. Historical thermal niche (GIS)			*				
C2aii. Physiological thermal niche			*	*			
C2bi. Historical hydro niche (GIS)						*	
C2bii. Physiological hydro niche				*	*	*	
C2c. Disturbance regime		*	*	*			
C2d. Ice & Snow habitats			*				
C3. Physical habitat restrictions		*					
C4a. Biotic habitat dependence			*	*			
C4b. Dietary versatility		*	*	*			
C4d. Biotic dispersal dependence			*				
C4e. Interactions with other species			*				
C5a. Genetic variation				*			
C5b. Genetic bottlenecks							*
C6. Phenological response		*	*	*			*
D1. CC-related distribution response							*

D=Decrease vulnerability, SD=Somewhat decrease vulnerability, N=Neutral effect, SI=Slightly increase vulnerability, I=Increase vulnerability, GI=Greatly increase vulnerability.

wider latitudinal gradient. It is possible that feather density is higher on Yellow-billed Loons, to deal with the colder water temperatures, which might cause heat stress if lake temperatures were substantially higher, but this is speculative.

Interactions with Other Species: Competition with Common Loons, more than habitat limitation, might be the more important climate threat for Yellow-billed Loons, if Common Loons expand northward (J. Schmutz, pers. comm.).

Dietary Versatility: Because Yellow-billed Loon diet may depend heavily on ciscos during the breeding season, they may have less flexibility in their diet compared to some other loon species. However, details of their diet are not well known.

Genetic Variation: This species is believed to have low genetic variability (A. McMillan, unpublished data) and so would be susceptible to climate-mediated impacts that stress them at the population level (e.g. disease outbreaks).

Phenological Response: Despite the existence of long-term data sets for loons in northern Alaska (Mallek et al. 2005), an assessment of phenology-related variables has not been a part of that effort, nor has not been examined, so it is currently unknown how this species will respond to changing biotic schedules.

In summary, the accumulation of potential sources of vulnerability, particularly with regard to this species dependence of fish-bearing lakes and their limited core range, yielded a result of "moderately vulnerable" for all three climate change projections we considered.

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