Tundra Swan (*Cygnus columbianus*)

Vulnerability: **Presumed Stable** Confidence: High

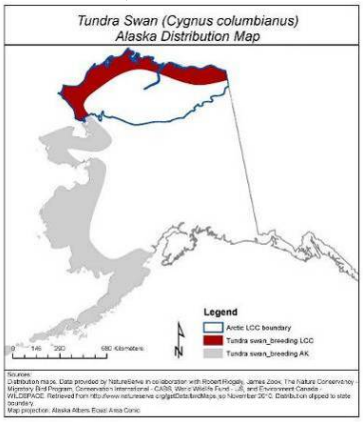
The Tundra Swan is the more widespread and northerly ranging of the two native swan species in North America. In Arctic Alaska, they nest in wet to dry tundra habitat types preferring islands in lakes or ponds, or naturally occurring frost heaves at the intersection of polygon pond rims. Nesting territories almost always include a large lake that the family will use as a safe haven from terrestrial predators (Limpert and Earnst 1994). During the breeding season, their diet is primarily vegetarian, eating emergent and submerged vegetation in lakes and ponds. They also graze on terrestrial vegetation near the water (Limpert and Earnst 1994). Most North Slope breeders winter on the east coast Mid-Atlantic States (Limpert and Earnst 1994). The current Arctic Coastal Plain population is estimated at approximately 10,000 (Larned et al. 2012).

Range: We used the extant NatureServe range map for the assessment as it closely matched the Birds of North America and other range descriptions (Johnson and Herter 1989, Bart et al. 2012).

Human Response to CC: Human activities in response to climate change, in particular, shoreline fortification against erosion could impact Tundra Swans as they sometimes use near coastal areas for resting and foraging during migratory staging (Limpert and Earnst 1994). However, such activity will likely be localized in the near future so it was considered to slightly increase vulnerability, if at all.

Physiological Hydro Niche: Tundra Swans were ranked as particularly vulnerable to changes in hydrologic niche because of their dependence on lakes for breeding and molting (to avoid predation) and aquatic vegetation (for foraging). Non-breeding flocks also rely heavily on lakes. If substantial drying occurs, this species could experience a considerable negative impact. Current projections of annual potential evapo-transpiration suggest negligible atmospheric-driven drying for the foreseeable future (TWS and SNAP), and atmospheric moisture, as an exposure factor (most influential on the "hydrological niche" sensitivity category), was not heavily weighted in the assessment. However, its interaction with hydrologic processes is very poorly understood (Martin et al. 2009).

Disturbance Regime: Climate-mediated disturbance events, namely thermokarst, could both create and destroy good foraging and nesting habitats through both ice wedge degradation and draining of thaw lakes (Martin et al. 2009). Likewise, predicted increased storm frequency (Jones et al. 2009) could reduce availability of their primary forage (submerged/emergent vegetation) as water turbulence in bays and rivers could increase (S. Earnst, pers. comm.).



Biotic Habitat Dependence: Tundra Swans depend on *Arctophila* grass for brood-rearing cover thus the "biotic habitat dependence category" was considered a source of vulnerability. The broad range of responses in this category (from "neutral" to "greatly increased" vulnerability) reflects the uncertainty

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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.

in how climate-change would affect this relationship.

Phenological Response: A long-term data set (1987-1990) indicates Tundra Swan breeding was associated with the timing of river break-up, and incubation and brood-rearing success were higher in earlier years (S. Earnst, unpublished data). However this finding was preliminary, and, in general, the relationship between seasonal temperature / precipitation and phenology for this species in the Alaska portion of the Arctic LCC has not been studied comprehensively.

In summary, despite some vulnerability, current information suggests Tundra Swans will remain "stable" and be able to adjust to climate-mediated changes in their breeding range within the time frame of this assessment.

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