FEDERAL AID
INTERIM PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
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Partner: University of Alaska Fairbanks, Institute of Arctic Biology & School of Fisheries and Ocean Sciences

I. PROBLEM OR NEED THAT PROMPTED THIS RESEARCH

Although some basic information has been gathered, knowledge of yellow-billed loon breeding ecology is limited. For example, during brooding, yellow-billed loons are thought to feed chicks primarily fish from the brood lake; however, no empirical information is available for inland areas regarding the diet of adults or chicks. Additionally, the distribution and habitat use of yellow-billed loons during breeding season is not well understood. The arctic coastal plain is vast, remote, and difficult to survey. The U.S. Fish and Wildlife Service (USFWS) conducts annual breeding bird surveys across the North Slope of Alaska; however, yellow-billed loons occur in such low densities that the surveys have limited utility for examining their distribution and habitat use. Because surveying yellow-billed loons across their range is impractical, a model or set of habitat models can be used to predict loon distribution as well as provide insight into their ecology.

II. REVIEW OF PRIOR RESEARCH AND STUDIES IN PROGRESS ON THE PROBLEM OR NEED

Models of breeding yellow-billed loon distributions from Stehn *et al.* (2005) and Earnst *et al.* (2006) found similar habitat features to be important. In both studies, yellow-billed loons were found to more likely occupy a lake if it was larger, deeper, had a more complex shoreline with emergent vegetation present and showed some level of hydrologic connectivity. Also, both studies showed that yellow-billed loons were less likely to be on lakes occupied by Pacific loons (*G. pacifica*). Additionally, Stehn *et al.* (2005) found that yellow-billed loons were less likely to be found on lakes with relatively higher elevation or lakes surrounded by more upland tundra landcover types.

Both previous modeling efforts used only remotely sensed explanatory variables. This approach is applicable over broad spatial scales because continuous data layers from GIS and remote sensing databases are available for the entire region. However, remotely sensed variables are often indirect measures of habitat characteristics that directly affect an organism's distribution, making it more difficult to propose mechanistic relationships between remotely sensed variables and habitat use. Also, model performance may be poor if variables are proximate to ultimate habitat features influencing distribution. Stehn *et al.* (2005) suggested that incorporating empirical limnological and biological characteristics of lakes would likely improve the performance of their distribution models and that measures of forage fish prey were likely the most important missing variables in their models. Earnst *et al.* (2006) reiterated this, suggesting that yellow-billed loon distribution models would be more accurate if models incorporated landscape scale models of fish communities.

Fish distribution models may provide information on how prey species are distributed which, in turn, can be related to yellow-billed loon distribution based on an expected spatial concordance between avian predators and their fish prey. However, fish distributions can affect aquatic bird distributions in multiple ways. Piscivorous birds may have positive associations with the distribution of prey fish in lakes (Paszkowski and Tonn 2006). Conversely, some fish species may have negative associations with birds because fish may compete for similar prey (Wagner and Hansson 1998, Haas *et al.* 2007) or alter the trophic characteristics of the lake (Scheffer *et al.* 2006, Elmberg *et al.* 2010, McParland *et al.* 2010). In addition, fish and aquatic birds may show a high spatial concordance because they are responding to similar environmental factors (Paszkowski and Tonn 2000).

III. APPROACHES USED AND FINDINGS RELATED TO THE OBJECTIVES AND TO PROBLEM OR NEED

This study examines the habitat use and diet of breeding yellow-billed loons on the North Slope of Alaska. Past distribution models for yellow-billed loons, based on remotely sensed data (Stehn *et al.* 2005, Earnst *et al.* 2006), have identified important landscape factors influencing distribution, but models generally over-predicted loon occupancy. Empirical data measured in the field has the potential to enhance past models (Stehn *et al.* 2005) and our understanding of loon breeding ecology. Because the distribution of fish prey likely will be important in determining the distribution of yellow-billed loons, we will first examine how fish species are distributed across the landscape. We will then use molecular techniques to resolve what prey items may be important in the diet of yellow-billed loons during breeding. Next, we will examine past distribution models for yellow-billed loons (Stehn *et al.* 2005, Earnst *et al.* 2006). Using new survey data on breeding distribution we will cross-validate previous models and refine models using field data from the interior arctic coastal plain, such as information on fish distribution and lake characteristics. Lastly, we will create distribution models for yellow-billed loons on the Colville River Delta using an independent dataset from this region. This will allow us to determine whether the species-environment relationship is similar between the two regions.

IV. MANAGEMENT IMPLICATIONS

The distribution of yellow-billed loons in Alaska is largely restricted to areas that are currently open for oil and gas development (U.S. Fish and Wildlife Service 2009). This, in combination with concerns such as potential effects of climate change, subsistence harvest and bycatch, and pollution and overfishing in its wintering range, prompted a petition to list the yellow-billed loon as an endangered species. On March 24th, 2009, the USFWS returned the results from a one-year review of the yellow-billed loon, assessing whether the conservation status should be changed to threatened or endangered. The review concluded that listing the yellow-billed loon was “warranted but precluded”, and listed the species as a “candidate”. The result of “warranted but precluded” suggests that potential threats to yellow-billed loons are a conservation concern; however, gaps in information about this species prevents a more conclusive result of the species’ conservation status. The creation and refinement of distribution models for yellow-billed loons from this study will lead to a more accurate assessment of the distribution of breeding yellow-billed loons for the interior arctic coastal plain. This will be critical for managing yellow-billed loons in an area that will likely see an increase in development in the near future. Also, distribution models, along with new dietary information, will help fill gaps in the understanding of the ecology of this species, which is necessary for long-term management and conservation.

OBJECTIVE 1: Record the absence or presence of adults, nests, and chicks of yellow-billed loons (and other loon species) during lake circling surveys during June and August during 2008-2010.

OBJECTIVE 2: Capture loons at up to 36 lakes, where blood samples and fat biopsies are taken for diet studies (and contaminants work unrelated to SWG). An additional 25 loons will be captured for satellite telemetry work and will similarly be sampled for blood and fat.

OBJECTIVE 3: Quantify fish species presence at 70 - 100 lakes in the NPRA study area (For objectives 3 and 4, the first 36 lakes will be sampled using BLM funds; the remainder will be using SWG monies).

OBJECTIVE 4: For these 70 - 100 lakes gather water quality data (nutrients, chlorophyll, turbidity, salinity and temperature), bathymetry, and assess all tributary connections (for comparison to existing remote assessment of these).

OBJECTIVE 5: Use synthetic aperture radar (SAR) data to estimate timing of ice out on all survey lakes in each year to examine its relation to the presence and timing of breeding.

OBJECTIVE 6: If a relation between ground assessments of turbidity, chlorophyll, tributary connection, or temperature with remote assessments (color infrared photography or satellite image) is established, then gather these remote assessments for all lakes in the study areas.

OBJECTIVE 7: Using survey data sets and the remotely sensed covariates, build statistical models to evaluate the association of yellow-billed loons with habitat attributes. Do so for each area in each year, to test the reliability of these models, and do so for each category of loon breeding status (pair, nested, chicks present).

OBJECTIVE 8: On a subset of lakes, quantify fish presence over multiple years (incorporate inter-annual variability in fish presence).

OBJECTIVE 9: Using collections of fish, loon blood, and loon fat biopsies, conduct stable isotope and fatty acid analyses to assess diet composition of adult yellow-billed loons.

OBJECTIVE 10: In 1 to 3 survey sample blocks (each of which contains 4-20 lakes), conduct ground-based observations of loons to assess behavioral responses to capture, presence of fishing gear, and interactions with neighboring pairs.

Summary of Project Accomplishments:

OBJECTIVE 1: Completed. Summarized in previous reporting.

OBJECTIVE 2: In 2012 we captured and implanted 8 YBLOs with satellite transmitters. All birds were captured while nesting, and each member of one mated pair is currently transmittered. This set of birds were all captured near the mouth of the Ikpikpuk Delta. The motivation for this location was to mark birds that nested close to the saltwater to see if they used saltwater habitats during breeding. Prior deployments of transmitters in YBLOs on the north slope were too far inland for it to be a consideration for a loon to use saltwater habitats while still remaining territorial on a lake. However, in 2007-2008, we transmittered 10 YBLOs on the Seward Peninsula, where they were nesting close to the ocean, and the majority of those YBLOs did make regular use of saltwater habitats during breeding.   Thus far, most of the birds at the Ikpikpuk Delta area have not used saltwater habitats, suggesting that perhaps the relatively value of lake habitats vs nearshore coastal habitats differs between these 2 regions of the state. If so, that could be either because lake habitats are comparatively poor on the Seward Peninsula or that coastal saltwater habitats are comparatively poor on the North Slope.

OBJECTIVE 3: Completed. Summarized in previous reporting.

OBJECTIVE 4: All lakes sampled for fish (from objective 3) were also sampled for water quality characteristics, tributary information, and bathymetry except in cases where sampling equipment for water quality and bathymetry failed or was unavailable. Water quality data showed little variation across the study area and thus we did not include it in analysis of fish occupancy.

OBJECTIVE 5: We collaborated with Jess Grunblatt (UAF, International Arctic Research Center) by providing our groundtruthied lake depth data which was used to test a remote sensing model that predicts lake depths based on SAR imagery of winter ice thickness. This modeled data layer extends for our entire study region,has already been used in completed analyses, and will be used in our future analyses of loon occupancy.

To further investigate issues of nesting with regards to lake ice, we used indirect measures, such as lake size, and shape to see how lake ice may influence nest site selection. In our analysis of nesting location (Haynes et al. *in press*), we found that loons preferred nesting in areas sheltered from exposure to waves and ice, and prevailing winds.

Haynes T.B., J.A. Schmutz, M.S. Lindberg, A.E. Rosenberger. In Press. Risk of predation and weather events affect nest site selection by sympatric yellow-billed and Pacific loons in Arctic habitats. Waterbirds.

OBJECTIVE 6: We have used a GIS approach to model local and regional factors that may be of importance for Yellow-billed loon occupancy. In collaboration with Peter Hickman (UAF, Geographic Information Network of Alaska), we have modeled and extracted available data on a suite of local and landscape features (e.g., lake connectivity, lake size, elevation gradients) that will be useful for modeling loon distributions. These variables were extracted at two scales: the scale of the lake and a 7x7 km scale created by gridding off the study extent with 7x7 km grid cells and extracting the mean value for the cell. Thus, we have environmental covariates at both the local and regional scales.

OBJECTIVE 7: We have analyzed distribution data and have results that suggest Yellow-billed loons are strongly excluding Pacific loons from lakes except on lakes that are large in area and have convoluted shoreline (Haynes et al. in review).This will help provide insight as to how different loon species are distributed across the landscape. We are continuing analysis on loon distribution data to provide species specific distribution models. We are also investigating detection probability differences between ground and air surveys for adult loons, chicks and nests and the factors related to detection. Detection probability results suggest that loon adults and nests have similar detection probabilities regardless of species but Yellow-billed loon chicks were harder to detect than Pacific loon chicks. Detection probabilities of nests were almost twice as high for ground surveys compared with aerial surveys. We are working on a manuscript that examines detection probabilities with an emphasis on how differences in detection probability may affect survey results and, in turn, conservation and management decisions.

Haynes, T.B., Schmutz, J. A., Lindberg, M. S., Wright, K.G., Uher-Koch, B.D., Rosenberger, A.E. (In Review) Occupancy of yellow-billed and Pacific loons: evidence for interspecific competition and habitat mediated co-occurrence. Journal of Avian Biology.

OBJECTIVE 8: Similarly to Objective 7, we have published data from fish distribution and detection probability data collected in 2009 and 2010 (Haynes et al. 2013). Overall, we found detection varied greatly among methods and species with fyke nets having the highest detection probability for all species. Detection probability for large-bodied species sampled with a fyke net ranged from 0.727 for Least Cisco to 0.095 for Arctic Grayling. For small-bodied species, detection probabilities ranged from 0.729 for Ninespine Stickleback to 0.083 for Slimy Sculpin. The detection probability of large bodied species was affected negatively by lake depth and positively by day of season while that of the small species was negatively affected by lake area and day of season and positively by lake depth. Our results will be useful for designing optimal sampling and monitoring protocol of fish distributions in a sparsely sampled region where climate change and industry development will necessitate further field studies.

Haynes T.B., A.E. Rosenberger, M.S. Lindberg, M. Whitman, J.A. Schmutz. 2013. Method- and species-specific detection probabilities of fish occupancy in Arctic lakes: implications

for design and management. Canadian Journal of Fisheries and Aquatic Sciences. 70(7): 1055-1062.

With regards to fish occupancy, we modeled occupancy and how environmental factors influenced occupancy probabilities for six fish species sampled from 86 lakes on the Arctic Coastal Plain, Alaska. We examined whether occupancy was driven by patch size, colonization potential, or overwinter habitat variables at the lake or regional (7 x 7 km) scale. All species were more likely to be found in lakes with a hydrological connection. The three large-bodied species, least cisco (*Coregonus sardinella*), broad whitefish (*Coregonus nasus*), and arctic grayling (*Thymallus arcticus*), were influenced by factors affecting colonization potential through migratory pathways. Least cisco had the highest occupancy probability of the large-bodied species (0.52 ± 0.05) and models indicated some populations of cisco may be less migratory (i.e., lake residents). Small-bodied fishes showed multiple strategies, depending on the species. Ninespine stickleback (*Pungitius pungitius)* were found in almost every lake (occupancy probability = 0.97 ± 0.01), including lakes that freeze to the bottom, suggesting they are fast dispersers, inhabit sink habitats, and tolerate harsh conditions. Alaska blackfish (*Dallia pectoralis*) had a lower occupancy (occupancy probability = 0.76 ± 0.05) with a distribution that reflected its ability to tolerate harsh conditions and limited dispersal abilities. Slimy sculpin (*Cottus cognatus*) had an occupancy probability of 0.23 ± 0.06, with a distribution that was biogeographically limited by its marine origin, suggesting limited dispersal capabilities. This manuscript is currently being reviewed by the coauthors before submission. The data from this manuscript will be used as a data layer in the occupancy models for Yellow-billed loons.

Haynes, T.B., Rosenberger, A.E., Lindberg M.S., Whitman, M. Schmutz, J.A. (In preparation) Occupancy Patterns of Fishes in Arctic Lakes Provide Clues to Dispersal Mechanisms in a Harsh Landscape. To be submitted to Hydrobiologia

OBJECTIVE 9: Stable isotope and fatty acid samples have been analyzed by the laboratories and we are currently working up results. Preliminary results from fatty acid analysis suggests that yellow-billed loons have a strong marine signature (i.e. have been eating marine fish) which may be due to the fact that samples were taken from loons shortly after they arrived on the lakes from marine waters.

OBJECTIVE 10: See Objective 7.

Prepared for Mark Lindberg, UAF Institute of Arctic Biology by Trevor Haynes, UAF SFOS