

Summary report for surveys of riparian passerine assemblages conducted in Yukon-Charley NP and Gates of the Arctic NP, 2013-2014

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Introduction

The Arctic and Central Alaska Networks identified monitoring of landbird assemblages as important to assessing local and broad-scale ecological patterns within network parks (MacCluskie 2005, Lawler et al. 2009). In the Central Alaska Network (CAKN), landbird monitoring has been conducted in Denali National Park since 1992 and, more recently, in Wrangell-St. Elias National Park. In seeking to expand this program to Yukon-Charley Rivers National Preserve (YUCH), CAKN identified monitoring of riparian passerine assemblages along the Yukon River as the focus of this effort and then implemented this work in 2013. Through the influence of fire and hydrologic disturbance regimes, boreal forest floodplains, including those of the Yukon River, are highly dynamic systems (Butler et al. 2007). Aerial insectivorous birds, many of which are disturbance-adapted, are a large component of the passerine community along the Yukon River in YUCH. Monitoring of this passerine community holds particular importance given predominantly negative trend estimates from the Breeding Bird Survey (BBS) among aerial insectivorous passerines (Nebel et al. 2010, Sauer et al. 2012).

With the intention of sampling a similar suite of species and integrating landbird monitoring across networks, the Arctic Network (ARCN) conducted a pilot survey of riparian passerine assemblages along the North Fork of the Koyukuk (hereafter, North Fork), Gates of the Arctic National Park (GAAR), in 2014. Objectives for this combined effort included documenting temporal trends in occupancy and abundance of riparian-breeding passerines.

Study area and field methods

Using its centerline, we divided the Yukon River within YUCH into 6, 33.6 km sections each to contain a route of 30-35 survey points (Fig. 1). In GAAR, we established a single route of 137 points extending from our landing strip at Gates Bar (along the North Fork) to the park boundary a few miles downriver of the North Fork's confluence with Middle Fork of the Koyukuk (Fig. 2).

Surveys along the Yukon were conducted by two observers using a boat with an outboard prop, while those along the North Fork were accomplished via two inflatable rafts each manned by two people. Along both the Yukon and North Fork, we used an adaptive sampling scheme to randomly establish points ≥ 800 m apart along river banks. Along the North Fork, we floated 800 m (straight-line distance according to the GPS) from the previous point and established a point at the next location along the banks where it appeared that we could land consistently. The same approach was adopted along the Yukon but differed slightly due to the width of the river, the presence of large islands

(which we incorporated into the sampling frame), and long stretches where we could not land a boat with an outboard prop (see the 2013 annual report for a detailed description of the design). Along both rivers, points were located above the high waterline (i.e., above the cutbank). Along the North Fork, prohibitive river noise often necessitated locating points 20-50 m away from the river.

Along the Yukon in 2013, one, 2-person crew launched from Circle and conducted repeat surveys of the westernmost routes (6-4) between 15-24 June (Fig. 1). We averaged 3.0 visits to each of 99 points. Along the North Fork in 2014, we conducted repeat surveys (mean = 3.5 visits) at 137 points. Upon landing at Gates Bar on 4 June, one crew floated roughly 16 km while the other crew remained at Gates Bar for the night. In doing so, one crew remained a day ahead of the other during the downriver progression. Crews arrived in Bettles on 12-13 June and then conducted additional surveys during a second float trip from Gates Bar on 15-24 June.

Surveys were generally conducted between 02:00-09:30 and were 3 minutes in duration. One person served as a scribe for the observer. Along the Yukon, observers recorded the location of each detection as being above the bank or cross-channel. Facing the above bank habitat, the cross-channel habitat lay behind the observer and extended 400 m across the channel paralleling the bank. Detection of individuals using the above-bank habitat was given priority. Due to the width of the river, detections were predominantly of individuals at above-bank locations (Table 1). Consequently, only above-bank, singing detections were used in the Yukon analysis. Along the North Fork, observers recorded the location of each detection as being above the bank, within the channelized area of the river, or above the opposite bank. In the analysis of the North Fork data, we used all singing detections from all location classes.

For each observation, we also recorded detection type, number of individuals, and the time of detection in one minute intervals. Along the Yukon, we classified the habitat at each point as being: shrub, mid-successional forest, closed coniferous forest, open coniferous forest, closed deciduous forest, or closed mixed forest. At survey points along the North Fork, we took photos at each of the cardinal directions.

Analysis

We used “single-season” occupancy models (MacKenzie et al. 2003, MacKenzie et al. 2006) to jointly estimate occupancy and detection probabilities from repeated detection/non-detection data. We restricted the occupancy analysis to species detected at $\geq 10\%$ of sites to provide sufficient data to adequately model both the detection and occupancy processes. We also did not fit occupancy models for species detected at $\geq 70\%$ of sites within each river corridor because estimates for occupancy probability would likely approach 1.0 and, therefore, would be relatively uninformative. For these widely distributed species, we used binomial mixture models to jointly estimate local abundance and detection probability (Royle 2004). We fit models for each species individually within each river corridor in a Bayesian hierarchical framework using the parameterization of Kéry and Schaub (2012). We attempted to estimate abundance for

Swainson's Thrush (*Catharus ustulatus*) and Dark-eyed Junco (*Junco hyemalis*) along the North Fork, but models would not converge.

Occupancy

Within an occupancy framework, y_{ij} observations were Bernoulli random variables with success probability specified as the product $z_i p_{ij}$ in which detection probability p_{ij} is conditional on the occupancy state z_i . The y_{ij} corresponded to detection/non-detection at each point $i = 1, 2, \dots, I$, during each repeat survey $j = 1, 2, \dots, J$. We specified a model in which p_{ij} was a linear function of survey date and time after sunrise on the logit-scale. For the Yukon analyses, we included both the linear and quadratic effects of survey timing (relative to sunrise) to account for variation in the probability of availability or diurnal patterns of singing intensity. We only included the linear effect of Julian date and not the quadratic effect due to the timing of the 2013 Yukon surveys in mid- to late June.

For the North Fork analysis, we included the linear and quadratic effects of survey date to account for variation in the probability of presence and availability over a survey period that began prior to the arrival of some individuals and then extended past peak singing (Schmidt et al. 2013). We also included the linear effect of survey timing, but, given the limited size of this dataset, we did not fit models with the quadratic effect of survey timing or additional covariates, such as an observer effect and the effect of river-associated background noise, which undoubtedly had some effect on detection.

The occupancy states z_{it} were Bernoulli random variables with parameter ψ_i . We specified a model in which the logit-transformed occupancy probability ψ_i was a linear function of random site-level adjustments α_i around μ .

Abundance

Within the framework of binomial mixture models, y_{ij} observations were binomial random variables with success probability p_{ij} and sample size N_i . We treated the N_i as overdispersed Poisson random variables through the inclusion of a site-visit random effect. With the exception of the latter, linear predictors for both state and observation models were parameterized identically to those in the occupancy models.

We fit occupancy and binomial mixture models using WinBugs 1.4.3 (Spiegelhalter et al. 2004) via the R2WinBUGS package (Sturtz et al. 2005) in program R 3.0.2 (R Core Development Team 2013). We used vague priors for all fixed state and detection parameters, and with the exception of survey date effects, all random effects had normal distributions with mean 0 and standard deviations with uniform distributions from 0 to 100. Summaries of the posterior distribution were calculated from three independent Markov chains run for 10,000-160,000 iterations with a 2,000-80,000 iteration burn-in and thinning every 2-4 draws. We assessed convergence using the Gelman-Rubin diagnostic (Brooks and Gelman 1998) and scaled continuous covariates (mean = 0, SD = 1) to improve convergence properties. All estimates are presented as means and 95% Bayesian credible intervals ([CrI]).

Results

Occupancy

Estimates for detection and occupancy probabilities were imprecise for both study areas, particularly for North Fork species (Fig. 3). Detection probabilities were <0.3 for half of the species that we considered across study areas. Estimates for detection and occupancy probabilities for early-arriving species, including American Robin (*Turdus migratorius*), Ruby-crowned Kinglet (*Regulus calendula*), and Varied Thrush (*Ixoreus naevius*), were highly imprecise (Fig. 3). A few Yukon species, including Alder Flycatcher (*Empidonax alnorum*), Yellow Warbler (*Setophaga petechia*), Wilson's Warbler (*Wilsonia pusilla*), and Hammond's Flycatcher (*Empidonax hammondi*), had relatively high detection probabilities (≥ 0.61) and relatively precise estimates for occupancy probability. We detected relatively few aerial insectivores along the North Fork (Table 2) and the majority of these were found in burned areas along the Middle Fork and lower sections of the North Fork.

Abundance

Detection probability and precision for expected abundance (λ) was low for all species across study areas except for Fox Sparrow (*Passerella iliaca*) (Fig. 4). Swainson's Thrush and Yellow-rumped (Myrtle) Warbler (*Setophaga coronata*) had highly imprecise estimates of abundance.

Discussion

We found low detection probabilities for most species, particularly along the North Fork and among early-arriving species within both river corridors. Estimates of detection probability and state variables were relatively imprecise suggesting our level of temporal replication was insufficient to overcome low detection probability. This was to be expected of the Yukon data given the historically late spring of 2013 and the abbreviated sampling effort. In a year in which breakup is not delayed, it seems likely that the sampling effort could be extended to ~20 days in comparison to 10 survey days in 2013 (but see discussion below). In contrast, it seems unlikely that the North Fork survey, given modest increases in temporal replication relative to 2014, can overcome an adverse detection environment.

Although we did not model the effect of background noise on detection, it likely can partially explain the low detectability of passerines along the North Fork. Approximately 65% of site-visits along the North Fork were classified as having prohibitive background noise or a noticeable reduction in hearing (Table 3). We did not include this covariate in our models due to our limited sample size. Background noise on the Yukon, which tended to be related to mosquitoes rather than riffles in the river, was less than that experienced on the North Fork (Table 3).

The effective survey radius along the North Fork was likely rather asymmetric, potentially contributing to low detection probability and imprecise estimation of state variables. That is, birds singing along the opposite river bank (~125 m away) may have more detectable than birds singing relatively near (<125 m) the bank that the point was

located on. It may also have been that once birds with these cross-channel territories moved away from the wall of vegetation along the river's edge, their detectability declined precipitously. However, we fit occupancy models to the above bank detections alone and found a decrease in detection probability without an increase in precision (results not shown). In restricting the analysis in this way, fewer individuals were exposed to sampling, and, consequently, there were fewer opportunities to detect occupancy leading to lower estimates of detection probability.

The timing of when rivers become navigable by boat in the spring may often fail to coincide with the arrival of many short-distance migrants. We attempted to time the North Fork surveys so that aufeis was not an impediment to progressing down the river. However, the imprecision of our estimates for short-distance migrants suggest that initiating surveys in late May might have helped. During the first few days of surveying in early June, we found a couple of nests with incubating Swainson's Thrushes, a late-arriving, long-distance migrant. Our experience on the Yukon does not provide a particularly good frame of reference considering the late spring of 2013. Given that we can drive to and launch from Circle, there is greater flexibility in conducting surveys on the Yukon, but still, we would anticipate often initiating surveys too late in the season for capturing peak detectability of some early-arriving species.

The primary issue with the Yukon surveys is whether the dynamic nature of the river will shift point locations between years. We anticipate estimating trends with greater precision if we sample repeatedly at the same sites year after year. In contrast, estimates from independent random samples (taken each year) will incorporate noise from between-site differences. Given the considerable spatial heterogeneity and dynamic nature of vegetation communities along the Yukon River, adopting the latter approach may lower power in detecting trends in state variables.

Sampling randomly across the landscape gradient is inherently more appealing than focusing surveys on the riparian corridor. The latter approach focuses largely on estimating long-term temporal trends in state variables and limits our capacity to relate changes in state variables to landscape change. Having the capacity to document changes in distribution over environmental gradients will allow greater integration of monitoring data into bird conservation than a program focusing primarily on estimating long-term temporal trends in population size.

Instead of conducting points solely along the river banks, transects or grids could be randomly located across the river valley but could still be accessed in part through river floating, thereby expanding our area of spatial inference. In this approach, the ability of 2, 2-person crews to achieve sufficient temporal replication for relatively precise estimation of state variables is questionable. An alternative would be to base out of Anaktuvuk Pass and thereby eliminate the need for backcountry aviation support. This could allow for greater temporal replication (via 3, 2-person crews) through the availability of volunteers/NPS staff who would need only to fly seatfare to the village and make relatively short time commitments. This approach would allow for random sampling

across the landscape gradient, albeit with low spatial inference, and greater flexibility in the timing of surveys.

For surveys in which points are accessed on-foot, our sampling methods would likely need to be modified from the current roadside and riverine protocol; i.e. walking 800 m and doing a 3 minute point count is inefficient and could result in relatively imprecise estimates of detection probability and state variables. The Denali roadside survey likely overcomes considerable variability in the availability of individuals for detection (i.e., temporal variation in exposure to sampling due to movement of individuals, in part) by conducting >6 visits/site on average. Given that this level of temporal replication is likely not feasible for a hiking-based survey, methods that increase the effective sampling area could be more appropriate (e.g., line transects or area searches).

Literature Cited

- Brooks, S. and A. Gelman. 1998. General methods for monitoring convergence of iterative simulations. *Journal of Computational and Graphical Statistics* 7:434-455.
- Butler, L. G., K. Kielland, T. Scott Rupp, and T.A. Hanley. 2007. Interactive controls of herbivory and fluvial dynamics on landscape vegetation patterns on the Tanana River floodplain, interior Alaska. *Journal of Biogeography* 34:1622-1631.
- Kéry, M., and M. Schaub. 2012. Bayesian population analysis using WinBUGS: a hierarchical perspective. Academic Press, Waltham, Massachusetts.
- Lawler, J.P., S.D. Miller, D. M. Sanzone, J. Ver Hoef, and S.B. Young. 2009. Arctic Network vital signs monitoring plan. Natural Resource Report NPS/ARC/NRR—2009/088. National Park Service, Fort Collins, Colorado.
- MacCluskie, M., and K.O. Oakley. 2005. Central Alaska Network Vital Signs Monitoring Plan. Unpublished Report. National Park Service, Fairbanks, AK.
- Nebel, S., A. Mills, J.D. McCracken, and P.D. Taylor. 2010. Declines of aerial insectivores in North America follow a geographic gradient. *Avian Conservation and Ecology* 5:1[online] URL: <http://www.ace-eco.org/vol5/iss2/art1/>.
- Royle, J.A. 2004. N-mixture models for estimating population size from spatially replicated counts. *Biometrics* 60:108-115.
- R Development Core Team. 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, <http://www.R-project.org>.
- Sauer, J.R., J.E. Hines, J.E. Fallon, K.L. Pardieck, D.J. Ziolkowski, Jr., and W.A. Link. 2012. The North American Breeding Bird Survey, Results and Analysis 1966 - 2011. Version 12.13.2011 USGS Patuxent Wildlife Research Center, Laurel, MD.
- Schmidt, J.H., C.L. McIntyre, and M.C. MacCluskie. 2013. Accounting for incomplete detection: what are we estimating and how might it affect long-term passerine monitoring programs? *Biological Conservation* 160:130–139.
- Spiegelhalter, D.J., A. Thomas, N.G. Best, and D. Lunn. 2004. WinBUGS Version 1.4.1 User manual. MRC [Medical Research Council] Biostatistics Unit, Cambridge, UK.

Sturtz, S., Ligges, U. & Gelman, A. 2005. R2WinBUGS: A package for running WinBugs from R. *Journal Statistical Software* 12:1–16.

Table 1. Proportion of singing detections in each location category recorded during passerine surveys along the Yukon River (2013) and North Fork of the Koyukuk (2014).

	Above bank	Cross-channel	
Yukon	0.95	0.05	
	Above bank	Channelized floodplain	Above opposite bank
North Fork	0.64	0.03	0.33

Table 2. Number of singing detections for passerine species along the Yukon River (2013) and the North Fork of the Koyukuk (2014). Aerial insectivores are in bold.

Species	AOU code	Yukon River 2013	N.F. of the Koyukuk 2014
Alder Flycatcher	ALFL	202	18
American Robin	AMRO	18	30
American Tree Sparrow	ATSP	1	0
Boreal Chickadee	BOCH	2	0
Dark-eyed Junco	DEJU	184	230
Fox Sparrow	FOSP	182	328
Gray-cheeked Thrush	GCTH	17	17
Hammond's Flycatcher	HAFL	67	1
Lincoln's Sparrow	LISP	18	12
Northern Waterthrush	NOWA	1	262
Orange-crowned Warbler	OCWA	10	65
Olive-sided Flycatcher	OSFL	4	23
Pine Grosbeak	PIGR	0	2
Pine Siskin	PISI	1	0
Ruby-crowned Kinglet	RCKI	39	23
Redpoll spp.	na	0	1
Rusty Blackbird	RUBL	0	2
Say's Pheobe	SAPH	4	0
Swainson's Thrush	SWTH	369	848
Townsend's Solitaire	TOSO	3	0
Townsend's Warbler	TOWA	6	0
Varied Thrush	VATH	35	132
White-crowned Sparrow	WCSP	108	292
Western Wood-Pewee	WEWP	0	4
Wilson's Warbler	WIWA	127	101
White-winged Crossbill	WWCR	40	1
Yellow-bellied Flycatcher	YBFL	28	0
Yellow-rumped (Myrtle)	MYWA		
Warbler		85	233
Yellow Warbler	YWAR	232	90

Table 3. Proportion of site-visits in four background noise categories (none, hearing barely reduced, hearing noticeably reduced, and prohibitive noise) recorded during passerine surveys along the Yukon River (2013) and North Fork of the Koyukuk (2014).

Routes	None	Barely	Noticeable	Prohibitive
Yukon	0.04	0.49	0.42	0.03
North Fork	0.03	0.33	0.58	0.07

Figure 1. Survey routes 1-6 along the Yukon River, Yukon-Charley National Preserve (inset) and points sampled in routes 4-6 in 2013.

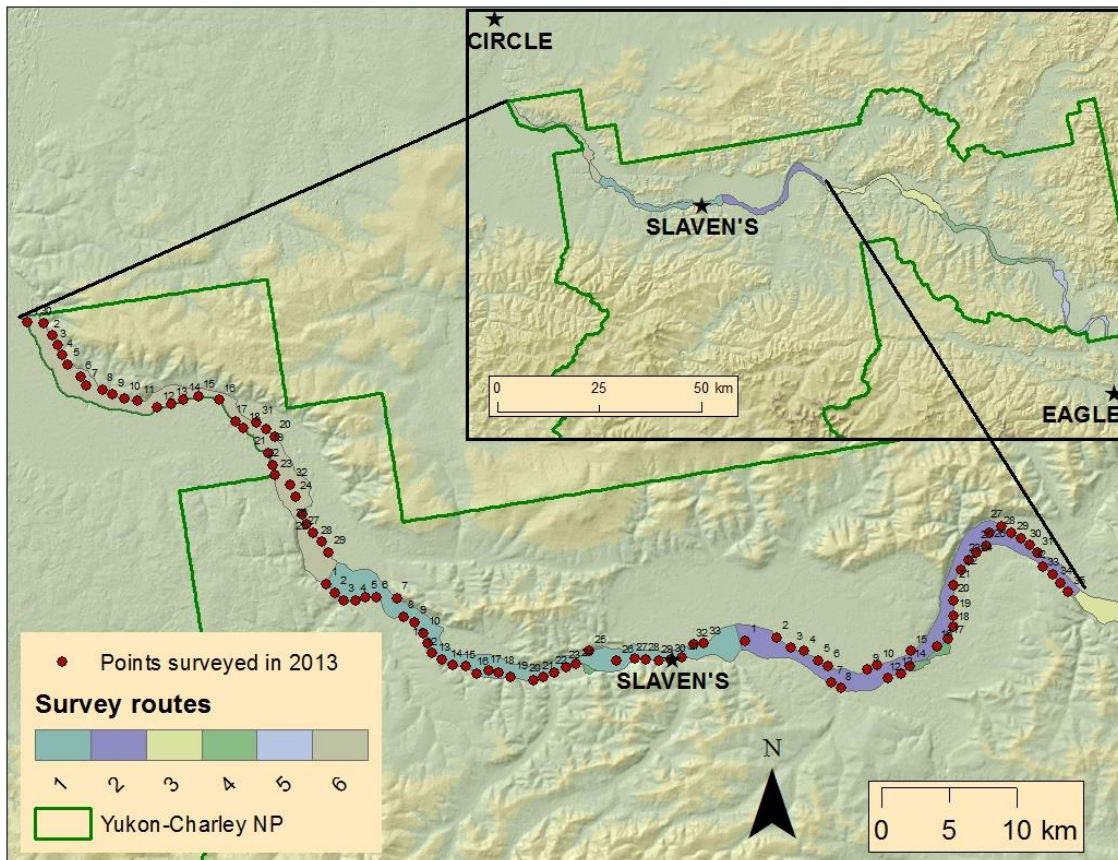


Figure 2. Surveys conducted along the North Fork of the Koyukuk, Gates of the Arctic, in 2014.

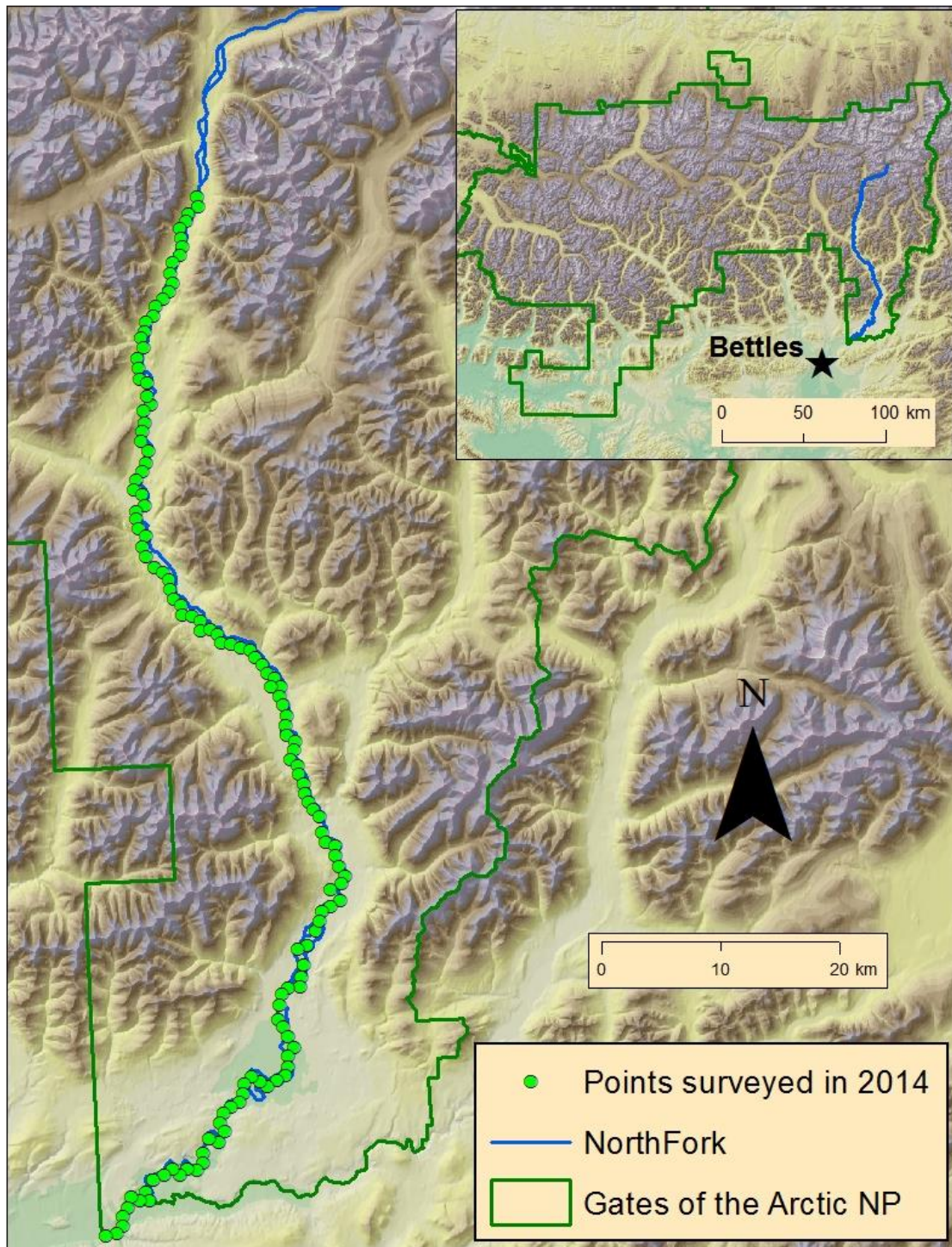
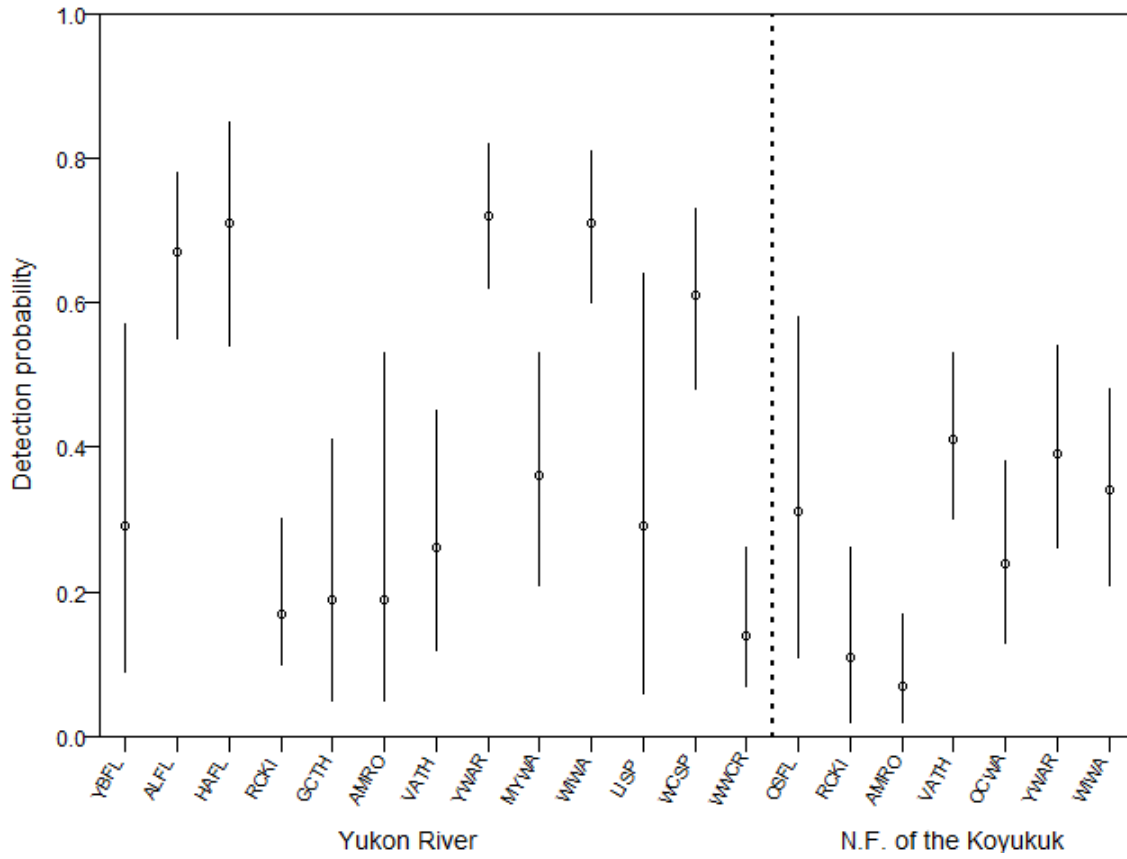


Figure 3. Estimated mean (A) detection and (B) occupancy probabilities (95% Bayesian credible intervals) for passerine species along the Yukon River (YUCH) in 2013 and the North Fork of the Koyukuk (GAAR) in 2014. Error bars represent 95% Bayesian credible intervals. Dotted, vertical line separates estimates from the two study areas. See Table 2 for the association of common names to 4-letter (AOU) codes.

(A)



(B)

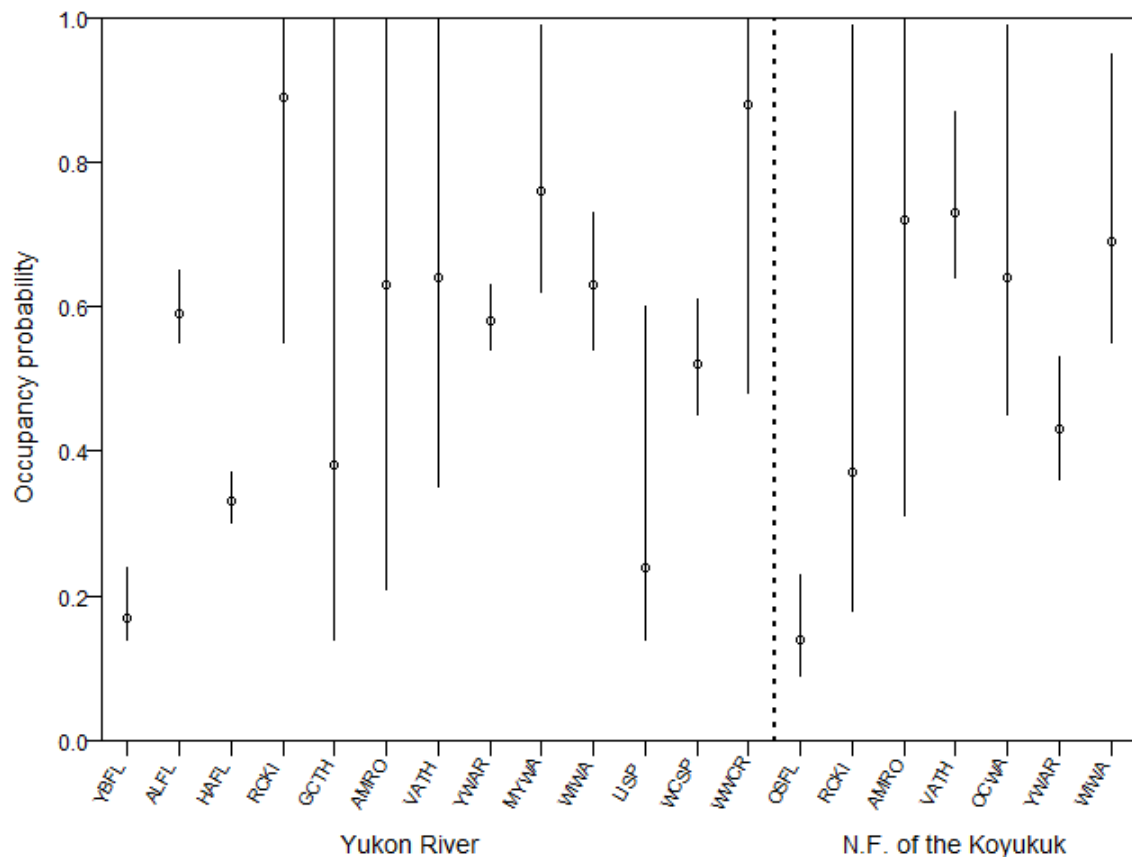
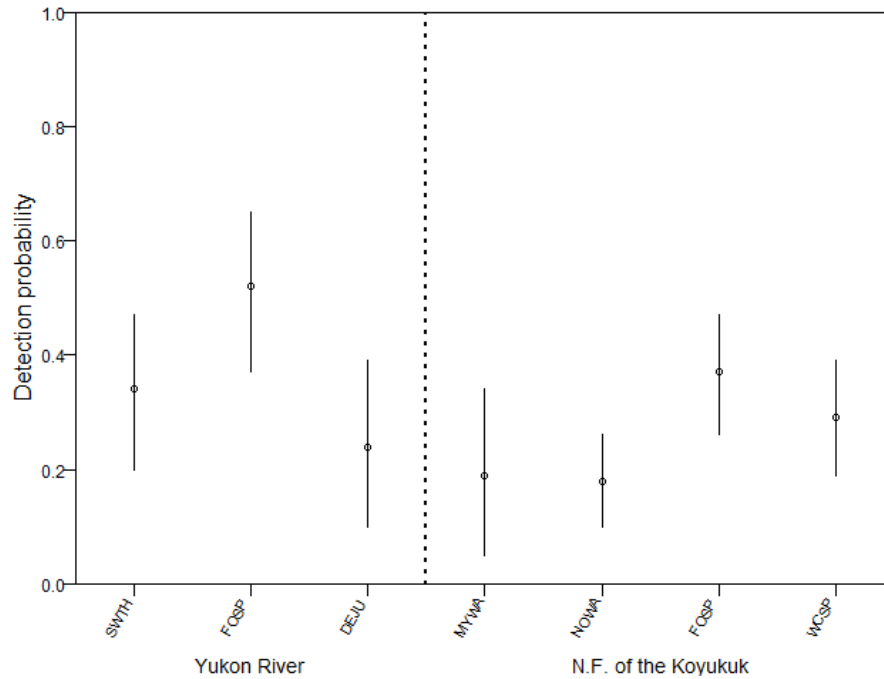


Figure 4. Estimated mean (A) detection probability and (B) abundance (95% Bayesian credible intervals) for passerine species along the Yukon River (YUCH) in 2013 and the North Fork of the Koyukuk (GAAR) in 2014. Error bars represent 95% Bayesian credible intervals. Dotted, vertical line separates estimates from the two study areas. See Table 2 for the association of common names to 4-letter (AOU) codes.

(A)



(B)

