Fall Migration Bird Banding: 20 Years of Monitoring Migratory Landbirds

Summary, Assessment and Exploration of Site Move

Tetlin National Wildlife Refuge

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Figure 1. A male Wilson's Warbler captured and banded at the Tetlin NWR bird banding station. Photo: USFWS

Introduction & Background

Tetlin National Wildlife Refuge (Tetlin NWR) was established in 1980 under the Alaska National Interest Lands Conservation Act (ANILCA). One of the purposes of the refuge is "to conserve fish and wildlife populations and their habitats in their natural diversity including, but not limited to waterfowl, raptors and other migratory birds." (ANILCA, Section 302 (8)(b)). In addition, ANILCA mandated that each refuge identify the special values of the refuge (ANILCA Section 304(g)(3)(b)). Tetlin's special values, as identified in their Comprehensive Conservation Plan (CCP, section 1.5) include migratory corridor, waterfowl and bird diversity.

The Upper Tanana Valley (UTV), which includes Tetlin NWR, is a globally important migratory corridor for a variety of birds, including waterfowl, raptors and passerines, using all four continental flyways. The UTV supports approximately 190 species of breeding and migratory birds. In 2008, this area was designated a Globally Important Bird Area, a designation that recognizes the UTV as a site that "provides essential habitat for one or more species of…breeding, wintering and/or migrating birds" (The National Audubon Society 2015).

Goals and objectives outlined in Tetlin's CCP stress the importance of this area for migratory birds. Included in those goals are "conserve fish and wildlife populations representative of the natural diversity of the Upper Tanana Valley and the boreal forest ecosystem" (Goal A) and "recognizing the position of Tetlin Refuge along three major flyways, conserve migratory birds and their habitats to fulfill our international responsibilities under the Migratory Bird Treaty Act" (Goal C). Eleven specific objectives are listed under Goal C and designed to clearly state what the Refuge plans to accomplish.

Figure 2. Biologist Buddy Johnson processes a bird at the Tetlin NWR bird banding station. Photo: USFWS

Due to legal mandates of ANILCA, the significance of the UTV for migratory birds and our obligations under the CCP Tetlin NWR has supported a variety of bird monitoring projects, beginning in 1986 with the Christmas Bird Count. Currently, Tetlin NWR conducts spring migration surveys, Breeding Bird Surveys, Alaska Landbird Monitoring Surveys, raptor nest occupancy and productivity surveys and fall migration bird banding.

Tetlin NWR established the fall migration banding station in 1993 as part of a larger initiative (The Alaska Landbird Inventory & Monitoring Program) to better understand distribution, abundance and population trends of migratory landbirds in Alaska (Doyle and Andres 1992). As part of this initiative, Doyle and Andres (1992) developed a series of protocols for monitoring landbirds on refuges, which included refuge checklists, BBS surveys, nest searches and migration monitoring. Several Alaska refuges, including Tetlin NWR, collectively established over 30 spring and fall migration banding stations. Initial goals of this banding network were to track trends in populations and productivity.

Since initiation of the The Alaska Landbird Inventory & Monitoring Program, all refuges that initially participated have dropped out. Declines in budgets, priority shifts and staff turnover have all likely contributed to reduced participation in the program. Now, Tetlin NWR and the Alaska Songbird Institute (formerly Alaska Bird Observatory, which operates at Creamer's Field in Fairbanks) are the only organizations that operate long-term fall migration banding stations in the state.

Without a large network of stations, the initial goals of the state-wide program cannot be met. These changes have made it necessary to reassess the purposes and goals of the Tetlin NWR banding station. Refuge staff have consulted with other banding operations, statisticians and refuge staff to come up with a new set of goals and objectives for the station (see below). To meet these objectives, it is also necessary to make some changes to banding operations.

Tetlin NWR staff would like to continue operating the station and collecting valuable data on migration timing, productivity and population health. The fact that Tetlin NWR is one of two stations collecting this information makes its continued existence that much more important. The purposes of this report are to document the issues surrounding operations at our current banding station and propose a potential solution to these problems. Tetlin NWR staff hope that changes to operations will ensure some stability and continuity to support long-term existence of this valuable program.

Station Goals & Objectives

We've identified two broad goals for our banding station:

1. Monitor trends in the magnitude and timing of life-history events of landbirds migrating through the Upper Tanana Valley for the purpose of detecting long-term changes and providing valuable baseline information to trigger research and further investigation into mechanisms for detected changes.
2. Provide a safe and comfortable environment in which refuge staff can educate professional biologists, students and the general public through demonstrations, internships, volunteer positions and other opportunities for the purpose of enhancing understanding of science, bird biology and environmental issues.

We've identified three primary and two secondary objectives. These objectives should be considered adaptive and plastic. They may be refined and altered in the future to best meet the most current needs and priorities of the refuge and its partners and to adapt to new information and current scientific thinking.

We've identified six species to target for long-term monitoring: Swainson's Thrush (SWTH), Slate-colored Junco (SCJU), Wilson's Warbler (WIWA), Ruby-crowned Kinglet (RCKI), Orange-crowned Warbler (OCWA) and Myrtle's Warbler (MYWA; see appendix for scientific names). These species were selected because 1) they are commonly found on Tetlin NWR and the UTV and, therefore, provide adequate data for long-term monitoring, 2) together, they represent a wide variety of niches (mature-forest and shrub breeders; gleaners and seed-eaters, ground- and tree-nesters,etc.), 3) because of the diversity they represent, they are indicators for other species with over-lapping niches and life-history requirements,

and 4) several species are showing worrisome population declines (SCJU, RCKI, WIWA) and, therefore, warrant close monitoring.

The primary objectives are:

1. Monitor migration timing (phenology) for target species. Detect significant shifts in median date of migration for these species for both adult (AHY) and juvenile birds (HY).
2. Monitor timing of accumulation of body fat and relative changes in fat scores (an index of body condition) for target species. Investigate long-term shifts in fat scores of fall migrants both inter- and intra-annually for both AHY and HY birds. Examine whether changes in fat scores are related to weather events such as storms or temperature shifts.
3. Monitor long-term trends in relative capture rates as an index of productivity for the target species.

Secondary objectives are:

1. Provide on-site educational opportunities for a minimum of 20 people and/or 3 school groups per year.
2. Provide educational and hands-on volunteer experience for 2 students and/or professionals per year.

Methods

We used standard mist nets (30-mm mesh, 2.6 m x 12 m polyester) to capture birds. We banded birds with federal metal leg bands and collected a variety of data to determine species, age, sex, body size, body fat, degree of molt, breeding condition, etc. (Pyle 1997). We excluded birds captured prior to Julian date 211 (July 29 in leap years and July 30 in non-leap years) and after 270 (September 26 in leap years and 27 in non-leap years). These dates represent the approximate start and end of autumn migration in interior Alaska.

The study site is located approximately seven miles west of Tok on an abandoned US Army fuel pumping station for the former Haines Pipeline, the site was chosen for: (1) its location in an elevated second-growth forest within a mostly flat, spruce river valley; (2) Department of Defense ownership which offered long-term access to an area unlikely to be disturbed; and, (3) proximity to the town of Tok.

Figure 3. Biologist Hank Timm extracts a Boreal Chickadee from a mist net at the Tetlin NWR bird banding station. Photo: USFWS

The site was cleared of vegetation in 1979 and was considered early successional deciduous forest when the banding station was established in 1993. The site is on a westerly facing hillside and the predominant vegetation is a mix of aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*),

balsam poplar (*Populus balsamifera*), white spruce (*Picea glauca*), willow (*Salix* spp.), and alder (*Alnus viridis*). A closed-canopy white spruce forest borders the north side of the site. The site was previously considered to have good stopover habitat for migrating songbirds. A map of net lanes, trails, census points, and the banding lab is included in the Tetlin NWR Landird Banding Manual (2008).

We use a standard mist-netting protocol outlined in the Tetlin NWR Landird Banding Manual (2008) and modeled after the North American Banders' Study Guide (2001) and the North American Banders' Manual for Banding Passerines and Near Passerines (2001). Twenty-one nets were operated prior to 1999, except in 1993 and 1994, when we ran 20 and 23 nets, respectively. Beginning in 1999, we consistently operated 20 nets. We used data collected in 1994-2013 for this report. We excluded data collected in 1993 because nets were only operated for 33 days, rather than the standard 60 days nets were operated in subsequent years.

For the purpose of documenting long-term changes in vegetation structure at the site, photos were taken from the center of 20 net lanes at compass bearings of 30° and 300° in May of 1999 and 2006 and July of 2014 (Figures 5 and 6).

In addition, vegetation surveys were conducted at 20 plots at the banding station in 1996, 2003 and 2014. Plots were located at net locations and visited on July 31 and August 8 in 1996 and on June 11 in 2003. Plots were located at nets and vegetation was assessed within a 50m radius circle around the net center according to the Alaska Landbird Monitoring Survey protocol (2004). Observers broadly classified the vegetation community according to percent canopy cover of trees and percent of coniferous species.

All data were summarized using program R (R Development Core Team 2012).

The Problem

Vegetation Succession

Vegetation structure and composition has changed dramatically at the Pump Station site over the years. The site was cleared of vegetation in the 1960's during the construction of the Haines-Fairbanks Pipeline (CEMML 2003). Aerial photos taken at the site in June 1968 and May 2005 (Figure 4) show extensive and long-lasting impacts to vegetation. Establishment of the Tetlin NWR bird banding station in 1993, approximately 30 years after vegetation clearing, took place at a time when regenerating vegetation would have created early-successional habitat, which is important for migrating birds (Rodewald and Brittingham 2004, Packett and Dunning 2009). Since that time, however, succession has changed vegetation structure and composition such that the site has shifted from a shrub/open forest habitat dominated by broadleaf species to a closed-forest habitat dominated by needle-leaf species (Tables 1 and 2).

In addition, ground-based photos taken at the site in 1999, 2006 and 2014 suggest substantial increases in the height and girth of woody vegetation, especially spruce, at the site (Figures 5 and 6) . Using reference points in both photos, it's evident that the size of white spruce in the understory is

remarkably taller and denser, despite the relatively short (15 years) time lapse between photos. Also, early-successional species such as aspen are present but not increasing much in girth or regenerating in the understory.

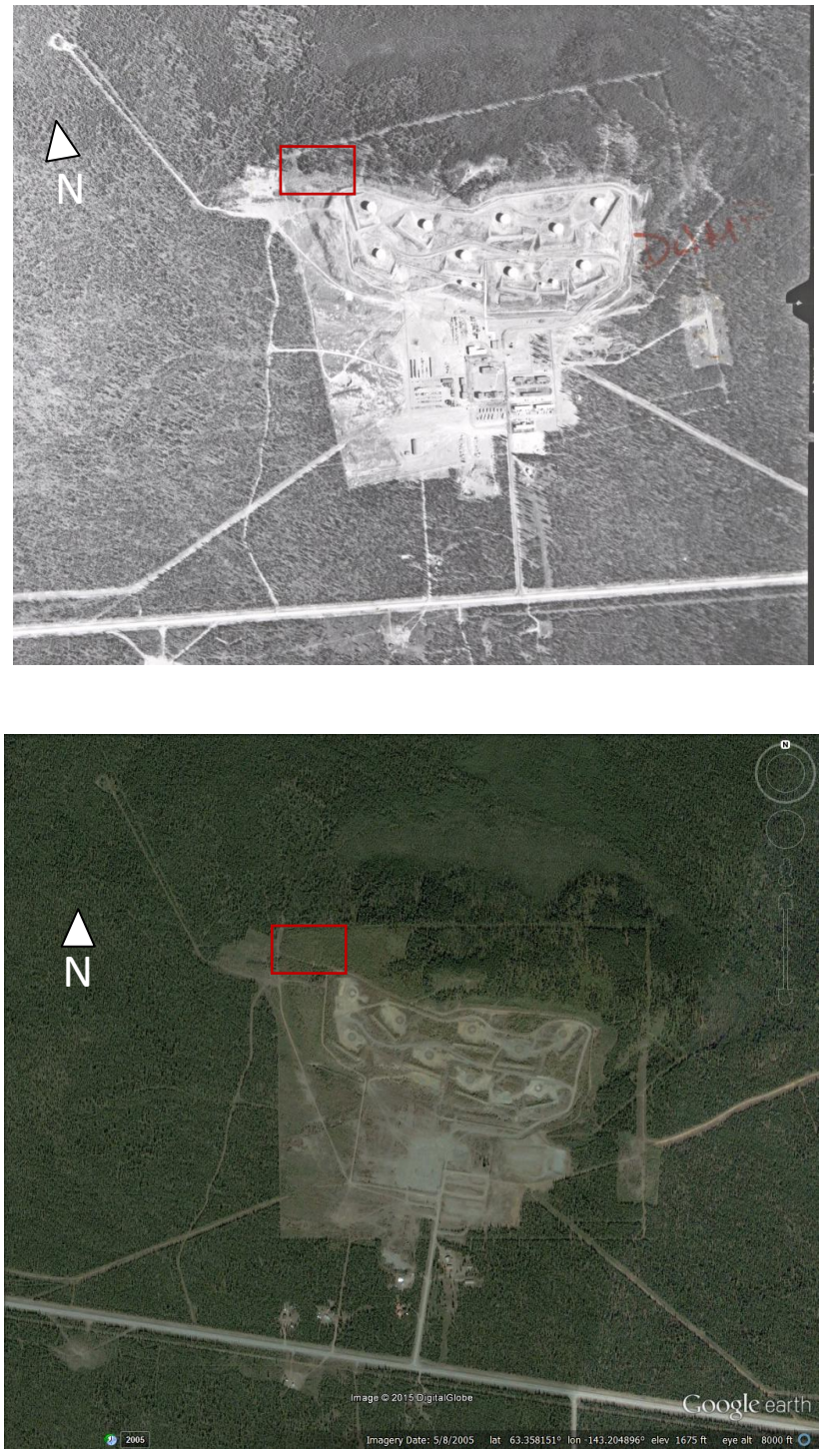
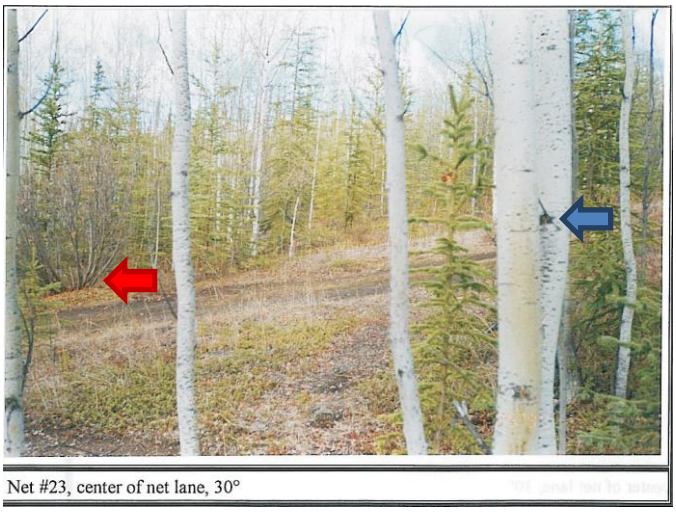


Figure 4. Overhead views of the Pump Station site. Top image is an aerial photograph taken in 1968 of the fully-operational Tok Pump Station built to transport fuel through the Haines-Alaska Pipeline. Bottom is a satellite image from 2005 of the decommissioned and abandoned site. Location of the Tetlin NWR banding station is shown in the red box.



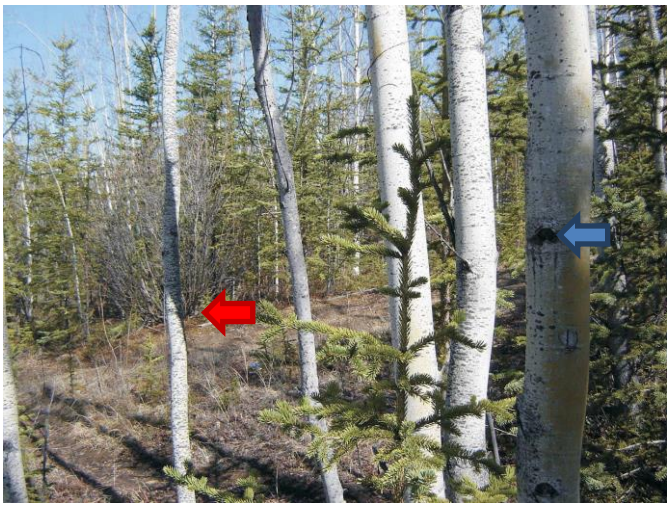


Figure 5. Photos taken at the Tetlin NWR Pump Station bird banding site in May of 1999 (top) and 2006 (middle) and July of 2014 (bottom). Photos were taken from the center of net lane #23 at a 30° bearing. Two colored arrows indicate reference points on aspen (foreground) and base of willow (background) for comparison. Photos: USFWS

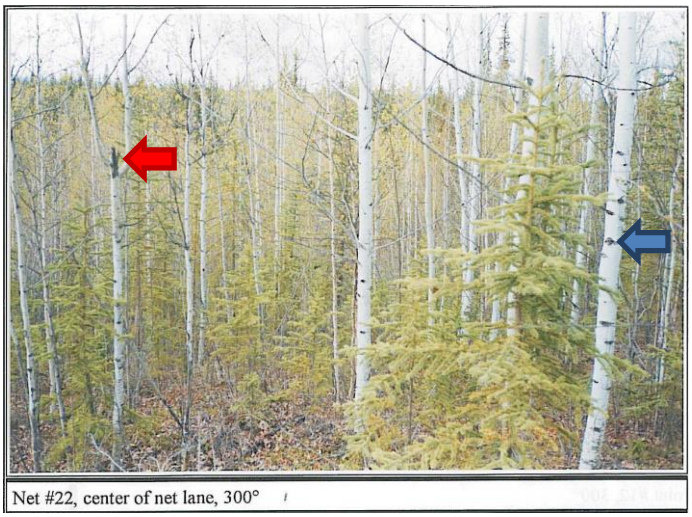


Figure 6. photos taken at the Tetlin NWR Pump Station bird banding site in May of 1999 (top) and 2006 (middle) and July of 2014 (bottom). Photos were taken from the center of net lane #22 at a 300° bearing. Colored arrows indicate reference points for comparison. Photos: USFWS

Changes are also evident from vegetation surveys conducted over 15 years. The majority of plots were classified as woodland or forest during the initial vegetation survey in 1996 (18 plots, Table 1), indicating that the site had largely progressed from a cleared area to a forested site by the time the banding station was established in 1993. However, by 2014 all plots are classified as forest, 75% as closed forest, and no plots as shrub, indicating a shift to a more densely-forested site.

Table 1. Total number of 20 plots classified into four broad categories based on percent tree canopy cover at the Tetlin NWR Pump Station bird banding site. Percents are in parentheses. Categorical definitions follow Viereck (1992).

	Shrub or Herb (0-9%)	Woodland (10-24%)	Open forest (25-59%)	Closed forest (≥60%)
1996	2 (10)	4 (20)	8 (40)	6 (30)
2003	2 (10)	6 (30)	11 (55)	1 (5)
2014	0 (0)	0 (0)	5 (25)	15 (75)

In addition, the data indicate a shift from a deciduous (broadleaf) dominated site to one with a greater proportion of conifers (Table 2). In 1996, 95% of plots on the site were classified as broadleaf forest. By 2003, that number drops to 65%, then 0% in 2014. In addition, 18 of 20 plots were classified as mixed forest in 2014, compared with 0 plots in 1996. This supports the observation that succession is causing a shift in habitat from one dominated by deciduous trees and shrubs, to one gradually being replaced by white spruce.

Table 2. Total number of 20 plots classified into three broad categories based on percent cover of coniferous tree species at the Tetlin NWR Pump Station bird banding site. Percents are in parentheses. Definitions follow Viereck (1992).

	Broadleaf (0-25%)	Mixed (26-74%)	Needleleaf (75-100%)
1996	19 (95)	0(0)	1 (5)
2003	13 (65)	6 (30)	1 (5)
2014	0 (0)	18 (90)	2 (10)

Fewer Captures, Shifts in Species Richness and Composition

In 20 years of operation, we captured 43,348 birds of 57 species (see Appendix). The majority of birds captured (77%) were hatch year birds (Figure 7). Total annual captures ranged from 3,362 birds in 2004 to 1,068 in 2013. The most common species captured were Slate-colored Junco, Ruby-crowned Kinglet, Swainson's Thrush, Wilson's Warbler, Myrtle's Warbler, Orange-crowned Warbler and Fox Sparrow.

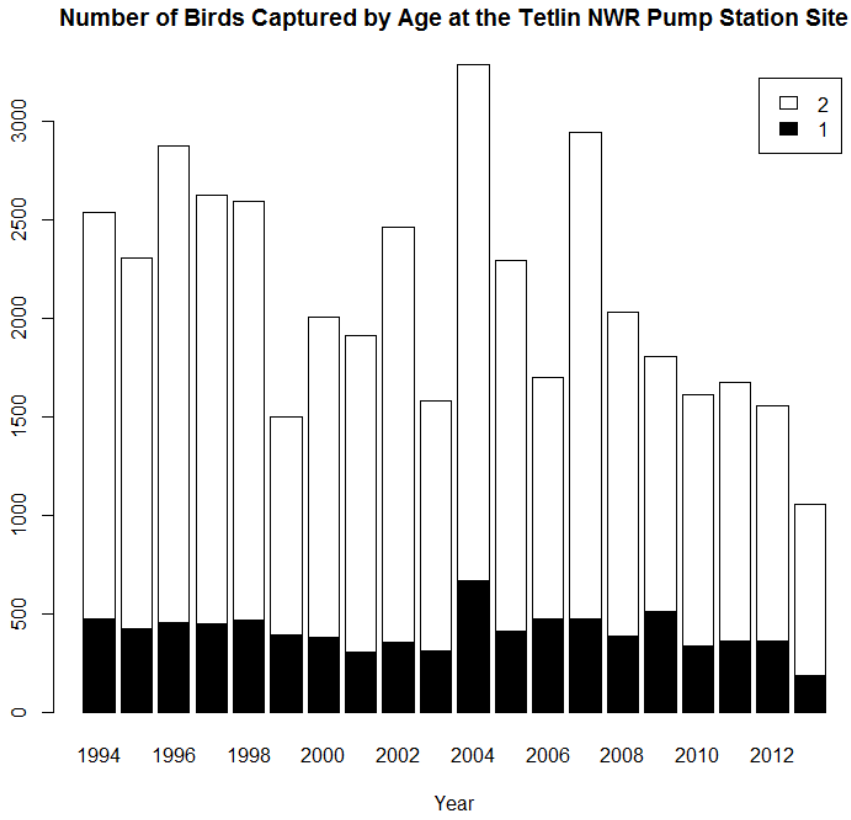


Figure 7. Total number of birds captured at the Tetlin NWR Pump Station banding site, 1994-2013. Black bars represent AHY birds and white bars HY birds.

Shifts in vegetation structure have, predictably, correlated with changes in the total numbers of birds captured and species richness. Overall, the total number of birds captured each year has been declining by approximately 54 birds per year (simple linear regression; slope = -54, intercept = 2736), a rate of about 3% per year. We captured almost 5500 fewer birds in the first 5 years of operation (13,300 total) than we caught in the last 5 years (7830 total; Figure 7).

In addition, species richness has declined. To examine this we looked at the total number of species captured in the first (1994-1998) and last (2009-2013) 5 years of operation. In the first 5 years, the site averaged 36 species per year. In contrast, we captured 30 species in the last 5 years. We think this is because birds of all species, including mature forest species, will use shrub habitat during migration, whereas mature forest habitat is used infrequently by shrub-associated species such as Wilson's warbler and yellow warbler (Rodewald and Brittingham 2004).

We expected that species composition had also shifted towards those that prefer mature forest and away from shrub-associated species. To examine this we first assigned each species a category based on whether it was commonly considered a shrub- or woodland/forest-associated species in the Central Alaska Bioregion by Cotter and Andres (2000). Then, we selected the most commonly captured species at the site, defined as those with ≥ 500 total captures during the 20 year study period (n=14). Six of

those species were considered primarily shrub-associated species (WIWA, FOSP, YWAR, ALFL, GCTH and ATSP) and eight classified as woodland- or forest-associated (SCJU, RCKI, SWTH, MYWA, OCWA, BOCH, VATH and HETH). Then, we looked at the overall trend in total number of birds captured within each group over the 20 year period. We found declines in the total number of birds captured in both the shrub- (slope = -18.6, intercept = 691) and forest-associated groups (slope = -29.7, intercept = 1824), although declines in shrub-associated species were much greater than forest-associated (Figure 8). We attributed this to the fact that all species (including those that use forested habitat during the breeding season) preferentially use shrub and early-successional habitat during migration (Rodewald and Brittingham 2004).

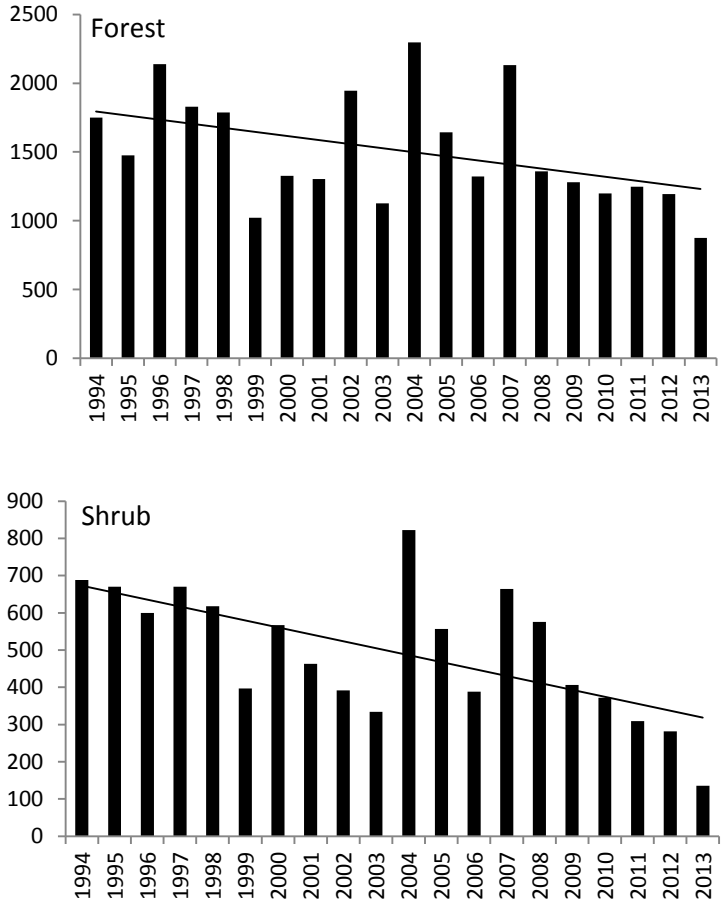


Figure 8. Trends in total number of captures of forest- and shrub-associated bird species captured at the Tetlin NWR Pump Station banding site, 1994-2013. Forest-associated species include SCJU, RCKI, SWTH, MYWA, OCWA, BOCH, VATH and HETH; shrub-associated species include WIWA, FOSP, YWAR, ALFL, GCTH and ATSP.

Selection of the current Pump Station site in the early 1990s for a bird banding station was a well-informed and practical. High-quality shrub and early successional habitats are important stopover areas for feeding and resting during migration by providing abundant food necessary to replenish fat stores needed for migration (Rodewald and Brittingham 2004, Major and Desrochers 2012, Packett and Dunning 2009, Mudrzynski and Norment 2013). However, subsequent changes to vegetation have

altered the bird community such that it is impacting our ability to make inferences about migration phenology, productivity, etc. and, therefore, meet our objectives.

Changes in capture rates and species richness could be explained by long-term changes in bird populations and species composition at a large scale, rather than changes at the study site level that we've observed. Indeed, long-term declines have been documented for 7 of the 14 above species using Breeding Bird Survey data (SCJU, RCKI, SWTH, OCWA, BOCH, WIWA and ATSP; Boreal Avian Modelling Project 2015). However, detecting those signals at the site level is dependent upon maintaining a consistent and stable operation. Significant site-level changes, such as alterations to capture protocol or changes to vegetation, will impact our capture rates and, therefore, hinder our ability to make valuable inferences about the health of birds migrating through the UTV.

The Potential Solution

In order to reach our objectives we need to address the issue of vegetation succession. Potential solutions are two-fold: 1) manage the vegetation community to maintain an early-successional seral stage or 2) move the station to a site that will experience little succession or slower rates of succession.

Vegetation management may not be a feasible option for Tetlin NWR at current budget and staffing levels. Management would require regular mechanical and manual removal of vegetation in and around the 0.4 ha station. In order to make the site an attractive stop-over habitat for migrating species, we estimate that we would need to maintain an area around the station, encompassing approximately 2.4 ha. Bird banding stations that have successfully used this technique have utilized heavy equipment and regular management to remove trees and maintain shrub habitat. This adds significant cost and effort that may be beyond the means of the Tetlin NWR. In addition, there are private lands immediately adjacent to the station and maintaining permission to manage the vegetation on those lands over the long-term would be unlikely.

In 2009 Tetlin NWR staff thinned trees in a portion of the site for this very purpose. They cut a total of 346 trees: 242 white spruce, 55 quaking aspen, 37 balsam popular and 12 paper birch. Methods were not well documented but we have seen no noticeable impact to the structure of the vegetation or bird captures at the site. Manual thinning such as this is costly, time-consuming and may be difficult to maintain over the long-term.

Instead, we propose moving the station to a new site. In order to successfully meet our objectives and keep the project cost-effective a new site should be 1) relatively close to Tetlin NWR headquarters, 3) on accessible public land, 4) safe and 5) largely composed of early-successional habitat that is unlikely to change over the long-term (30+ years).

Currently, we are considering a site southwest of Tok on the Tok River to implement these changes. The site is owned by the State of Alaska Department of Natural Resources Division of Forestry (Tok Forestry) and is approximately 20 miles driving distance from Tetlin NWR headquarters and 25 miles from the Pump Station site. The site is in the riparian corridor of the Tok River, which floods regularly in spring. Vegetation classification conducted by Tok Forestry indicates that this area has maintained shrubby,

early-successional vegetation since the 1970's (J. Hermanns, pers. comm.). Tok Forestry is a willing cooperator on this work and able to give us long-term access to the site. A pilot season will be conducted in fall of 2014 to determine short-term feasibility of the site and make changes in anticipation of the 2015 season.

We plan to operate at both the Pump Station and the Tok River sites for three years. Methods will be identical. However, we will operate the Tok River site only during peak migration period (mid-August – mid-September) due to the budgetary and logistical constraints of operating two stations simultaneously.

Evaluating the Effectiveness of Implemented Changes

After three years of operation at both sites, we will evaluate the effectiveness of implemented changes. To do this, we will work with a statistician to compare data collected at both sites and answer the following questions: 1) do capture rates differ between sites?, 2) does species richness differ between sites?, 3) do both sites capture the same suite of species?, 4) does the timing of peak migration differ between sites?

Answering these questions will allow us to evaluate whether a) capture rates at the Tok River site are comparable with historic capture rates at the Pump Station site and b) we can continue to use data collected at the Pump Station site in conjunction with that collected at the new site (species richness, migration timing).

Timeline & Budget

May 2014: Tok River site setup

Fall 2014: Pilot season, operate both stations

Fall 2015: operate both stations

Fall 2016: operate both stations

Winter 2016-17: evaluate station move, determine appropriate path forward

Fall 2017: fully implement changes

	Both sites			One site
	2014	2015	2016	2017 & beyond
Seasonal Staff: 2-3 technicians paid full time for 4 pay periods at GS05 rate [$1342/PP]	$16,000.00	$16,000.00	$16,000.00	$11,000.00
Volunteers: 3-5 volunteers working full time for 4 pay periods at $35/day	$7,000.00	$7,000.00	$7,000.00	$4,000.00
Equipment	$4,500.00	$500.00	$500.00	$500.00
TOTAL	**$27,500.00**	**$23,500.00**	**$23,500.00**	**$15,500.00**

*based on past years, we estimate that permanent staff working part-time would contribute about 600 hours per year to the station

Table 3. Birds captured at the Tetlin NWR fall migration Pump Station bird banding site, 1994-2013. Species in bold are those targeted for long-term monitoring.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**Total**
ALFL	80	62	148	54	104	27	67	47	49	32	77	46	31	54	48	15	18	35	12	14	**1020**
AMPI	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	**3**
AMRE	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**1**
AMRO	15	18	25	22	29	15	9	16	35	14	13	3	9	5	8	26	10	24	34	19	**349**
ARWA	2	0	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**6**
ATSP	51	47	47	78	19	23	73	57	26	62	61	48	31	32	23	28	16	13	9	7	**751**
BBMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
BBWO	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
BCCH	2	23	6	32	29	11	7	7	4	53	8	2	1	18	7	2	0	14	0	0	**226**
BLPW	8	9	19	11	23	5	17	9	6	5	21	15	13	48	13	15	3	7	8	3	**258**
BOCH	36	199	23	64	37	60	53	57	22	53	58	13	40	238	24	101	28	81	70	13	**1270**
BOOW	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	**3**
BOWA	0	1	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	**3**
BRCR	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	2	0	0	**7**
CHSP	4	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	**8**
CORE	31	50	5	9	4	16	20	37	1	10	1	2	6	33	4	8	8	25	8	2	**280**
DOWO	2	1	1	0	1	1	0	0	2	0	1	0	0	0	0	0	0	0	0	0	**9**
FOSP	53	69	66	142	95	91	84	165	70	75	186	133	99	112	235	139	136	109	121	45	**2225**
GCKI	2	4	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**10**

Table 3 (cont'd). Birds captured at the Tetlin NWR fall migration Pump Station bird banding site, 1994-2013. Species in bold are those targeted for long-term monitoring.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**Total**
GCSP	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	1	0	**4**
GCTH	41	25	42	56	48	15	57	32	40	34	94	66	45	56	51	43	38	32	44	17	**876**
GRAJ	0	1	1	1	3	3	0	4	3	2	4	2	2	0	5	2	4	3	1	2	**43**
GWCS	32	29	26	35	27	8	19	14	14	11	45	38	19	14	17	28	9	10	11	7	**413**
HAFL	12	16	12	20	8	4	10	3	2	6	9	4	3	7	5	8	5	8	5	3	**150**
HAWO	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	1	2	0	0	**5**
HETH	13	7	9	26	37	16	11	27	32	28	37	38	32	48	33	42	71	47	55	26	**635**
HORE	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**2**
LEFL	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
LISP	11	17	6	12	18	4	5	4	12	5	7	8	4	5	3	8	8	3	3	1	**144**
MYWA	147	109	77	145	105	138	175	76	189	41	241	198	102	185	97	86	66	166	78	89	**2510**
NHOW	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**
NOWA	17	16	27	29	31	16	22	18	17	13	34	22	12	40	42	15	13	12	6	3	**405**
NSHR	1	0	0	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**5**
OCWA	254	115	147	109	93	113	102	77	104	60	272	164	169	130	80	109	106	55	34	44	**2337**
PIGR	0	0	1	1	1	0	0	0	3	0	0	1	1	1	1	0	0	0	0	0	**10**
PISI	0	0	0	0	1	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	**11**
RBNU	14	1	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	**18**
RCKI	244	540	945	422	202	181	198	261	350	152	297	474	354	278	176	203	182	95	191	96	**5841**
RUBL	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**2**
RUGR	1	2	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	**6**

Table3 (cont'd). Birds captured at the Tetlin NWR fall migration Pump Station bird banding site, 1994-2013. Species in bold are those targeted for long-term monitoring.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	**Total**
SAVS	25	15	21	42	16	10	12	15	13	12	62	23	6	11	5	8	6	4	3	2	**311**
SCJU	898	352	675	738	1010	352	509	487	845	588	938	456	317	897	538	525	391	440	363	148	**11467**
SPGR	0	0	1	0	0	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	**5**
SSHA	5	1	3	8	7	6	3	7	9	3	11	9	6	4	8	6	3	12	7	6	**124**
SWTH	138	145	217	269	239	146	235	277	374	172	376	277	270	311	347	174	304	304	360	436	**5371**
TEWA	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
TOSO	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	**3**
TOWA	2	2	2	0	4	1	5	2	2	4	1	3	8	2	5	1	1	4	2	1	**52**
TTWO	3	3	5	0	1	2	4	3	3	1	2	0	2	0	3	0	0	1	2	2	**37**
UNKN	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	**3**
VATH	21	9	46	56	65	15	43	41	30	32	78	23	38	45	65	40	51	59	44	24	**825**
WEWP	1	0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	**5**
WIWA	345	357	213	222	270	163	215	138	174	116	376	246	152	230	177	110	154	81	83	46	**3868**
WWCR	2	0	14	0	16	0	0	17	27	0	6	0	0	9	0	2	3	0	0	0	**96**
YBFL	4	0	1	0	1	1	4	3	0	0	0	1	5	4	4	2	0	2	1	2	**35**
YSFL	2	5	7	1	9	2	7	1	2	0	3	1	1	1	3	1	0	1	4	1	**52**
YWAR	118	110	84	118	82	78	71	24	33	15	28	18	30	180	42	71	10	39	13	7	**1171**
<NA>	0	0	0	0	0	0	0	0	3	1	3	8	14	6	6	12	6	9	3	1	**72**
Total	**2637**	**2365**	**2930**	**2726**	**2642**	**1525**	**2039**	**1930**	**2505**	**1603**	**3362**	**2348**	**1825**	**3004**	**2077**	**1832**	**1653**	**1700**	**1577**	**1068**	**43348**

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Appendix. Bird species captured at the Tetlin NWR fall migration Pump Station bird banding site, 1994-2013. Species in bold are those targeted for long-term monitoring.

Species Code	Common Name	Scientific Name
ALFL	Alder Flycatcher	Empidonax alnorum
AMPI	American Pipit	Anthus rubescens
AMRE	American Redstart	Setophaga ruticilla
AMRO	American Robin	Turdus migratorius
ARWA	Arctic Warbler	Phylloscopus borealis
ATSP	American Tree Sparrow	Spizella arborea
BBMA	Black-billed Magpie	Pica hudsonia
BBWO	Black-backed Woodpecker	Picoides arcticus
BCCH	Black-capped Chickadee	Poecile atricapillus
BLPW	Blackpoll Warbler	Setophaga striata
BOCH	Boreal Chickadee	Poecile hudsonicus
BOOW	Boreal Owl	Aegolius funereus
BOWA	Bohemian Waxwing	Bombycilla garrulus
BRCR	Brown Creeper	Certhia americana
CHSP	Chipping Sparrow	Spizella passerina
CORE	Common Redpoll	Acanthis flammea
DOWO	Downy Woodpecker	Picoides pubescens
FOSP	Fox Sparrow	Passerella iliaca
GCKI	Golden-crowned Kinglet	Regulus satrapa
GCSP	Golden-crowned Sparrow	Zonotrichia atricapilla
GCTH	Gray-cheeked Thrush	Catharus minimus
GRAJ	Gray Jay	Perisoreus canadensis
GWCS	White-crowned Sparrow (Gambell's subspecies)	Zonotrichia leucophrys gambelii
HAFL	Hammond's Flycatcher	Empidonax hammondii
HAWO	Hairy Woodpecker	Picoides villosus
HETH	Hermit Thrush	Catharus guttatus
HORE	Hoary Redpoll	Acanthis hornemanni
LEFL	Least Flycatcher	Empidonax minimus
LISP	Lincoln's Sparrow	Melospiza lincolnii
MYWA	**Yellow-rumped Warbler (Myrtle's subspecies)**	**Setophaga coronata coronata**
NHOW	Northern Hawk Owl	Surnia ulula
NOWA	Northern Waterthrush	Parkesia noveboracensis
NSHR	Northern Shrike	Lanius excubitor
OCWA	**Orange-crowned Warbler**	**Oreothlypis celata**
PIGR	Pine Grosbeak	Pinicola enucleator
PISI	Pine Siskin	Spinus pinus
RBNU	Red-breasted Nuthatch	Sitta canadensis
RCKI	**Ruby-crowned Kinglet**	**Regulus calendula**
RUBL	Rusty Blackbird	Euphagus carolinus
RUGR	Ruffed Grouse	Bonasa umbellus
SAVS	Savannah Sparrow	Passerculus sandwichensis
SCJU	Dark-eyed Junco (Slate-colored subspecies)	Junco hyemalis hyemalis
SPGR	Spruce Grouse	Falcipennis canadensis
SSHA	Sharp-shinned Hawk	Accipiter striatus
SWTH	**Swainson's Thrush**	**Catharus ustulatus**
TEWA	Tennessee Warbler	Oreothlypis peregrina
TOSO	Townsend's Solitaire	Myadestes townsendi
TOWA	Townsend's Warbler	Setophaga townsendi
TTWO	American Three-toed Woodpecker	Picoides dorsalis

Appendix (cont'd). Bird species captured at the Tetlin NWR fall migration Pump Station bird banding site, 1994-2013. Species in bold are those targeted for long-term monitoring.

Species Code	Common Name	Scientific Name
UNKN	Unknown species	
VATH	Varied Thrush	Ixoreus naevius
WEWP	Western Wood-Pewee	Contopus sordidulus
WIWA	**Wilson's Warbler**	**Cardellina pusilla**
WWCR	White-winged Crossbill	Loxia leucoptera
YBFL	Yellow-bellied Flycatcher	Empidonax flaviventris
YSFL	Northern Flicker (Yellow-shafted subspecies)	Colaptes auratus auratus
YWAR	Yellow Warbler	Setophaga petechia
<NA>	Unidentified species	