2011 SMALL OWL MIGRATORY BANDING STATIONS IN THE BLACK HILLS

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Rocky Mountain Bird Observatory

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***Cover Photo**:* Measuring wing chord of a Northern Saw-whet Owl. Photo by Nancy Drilling

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EXECUTIVE SUMMARY

The Black Hills, a mixed-coniferous island in the middle of a sea of grass, hosts a variety of forest owl species throughout the year (Backlund and Dowd-Stukel 2006; U.S. Forest Service 2009; Drilling 2010). Many of these species are migratory, yet the role of this forested island for migrant forest owls is not known. This project established owl banding stations during the 2011fall migration period, focusing on the two smallest owls - Flammulated Owl *Otus flammeus* (FLOW) and Northern Saw-whet Owl *Aegolius acadicus* (NSWO). The banding stations aimed to gain a better understanding of small owl migration through Black Hills and western South Dakota. A banding station consisted of an audiolure which broadcast the territorial call of the targeted species surrounded by mist nets.

Flammulated Owls were targeted at banding stations run between August 30 and September 10, 2011. Banders attempted to catch FLOW for 11 nights, for a total of 197 net-hours, at four locations in the southern Black Hills. No FLOW were caught or detected. Northern Saw-whet Owl banding stations operated between October 4 - November 16, 2011 at three locations in the northern Black Hills (BH) and at Slim Buttes in Custer National Forest, Harding County. At Black Hills stations, 42 NSWOs were caught during 24 nights of the migration period (640 net-hours) for an overall average capture rate of 0.07 owls/net-hour. An additional four NSWOs were netted and banded in early September in Custer county. At Slim Buttes, 39 NSWOs were caught during four nights of netting (124 net-hours), resulting in a capture rate of 0.3 owls/net-hour. The two areas had similar sex ratios (BH-59% female, Slim Buttes-69%) but significantly more hatch-year birds were caught at Slim Buttes (77%) than at Black Hills stations (35%). Six locally-banded owls were recaptured at a later date; the longest interval between first and second capture was 16 days. No birds banded at other banding stations ('foreign recaptures') were caught at any of the South Dakota banding stations.

Owls are popular with the general public but rarely seen. Visitors and volunteers were encouraged to come to the banding stations to learn about and see owls in person. Thirty-six people, including seven children or teenagers, visited banding stations. Adult visitors included natural resource agency staff, teachers, university students, birders, and spouses.

Recommendations resulting from this study are:

1) Continue migration banding efforts in western South Dakota to better understand regional migration pathways and monitor owl populations
2) Conduct Flammulated Owl banding efforts in August
3) Establish more banding stations in the U.S. portion of the Great Plains, such as at Theodore Roosevelt National Park-South Unit/Sully Creek State Park in North Dakota, Pierre area and Lake Hiddenwood State Park in South Dakota, and Chadron State Park and Wildcat Hills in the Nebraska panhandle

4) Attempt to band Northern Saw-whet Owls in western South Dakota, including nestlings, throughout the year to better understand local status
5) Continue to recruit and train banding station volunteers
6) Develop owl programs to educate the public about owls

Hopefully, this is the first year of a long-term effort to band NSWO in western South Dakota. Data from the banding stations will not only help us understand local owl status, but also would fill a gap in the continent-wide NSWO monitoring network of banding stations.

ACKNOWLEDGEMENTS

This project was made possible through a Wildlife Diversity small grant from South Dakota Department of Game, Fish, and Parks.

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TABLE OF CONTENTS

Executive Summary..... i

Acknowledgements.....ii

Table of Contents.....iii

List of Figures.....iv

List of Tables.....iv

Introduction..... .1

Methods..... 3
- Banding Stations..... 3
- Set-up and Net Checks..... 3
- Banding and Processing Owls…..... 5
- Data Analyses and Dissemination..... 6

Results..... 7
- Flammulated Owl..... 7
- Northern Saw-whet owl..... 7
- Visitors and Volunteers.....11

Discussion and Recommendations.....11

Literature Cited.....18

Appendix I. Banding station codes and their definitions…….....21

Appendix II. Guidelines for sexing Northern Saw-whet Owls.....23

Appendix III. Daily summaries at Flammulated Owl banding stations 24

Appendix IV. Daily summaries at Northern Saw-whet Owl banding stations.....25

LIST OF FIGURES

Figure 1. Locations of 2010 N. Saw-whet Owl banding stations in North America 1

Figure 2. Locations of 2011 small owl banding stations in western South Dakota.....5

Figure 3. Number of Northern Saw-whet Owls caught by date……11

LIST OF TABLES

Table 1. Location details of 2011 owl banding stations in western South Dakota.....3

Table 2. Summary of capture effort and owls caught by banding station..……8

Table 3. Summary of capture effort and owls caught by National Forest.....8

Table 4. Origin and recapture details of recaught owls.....9

Table 5. Sex- and age-ratios of Northern Saw-whet Owls.....9

Table 6. Sex- and age-ratios of Northern Saw-whet Owls by National Forest.....10

Table 7. Summary of Northern Saw-whet Owl measurements.....10

Table 8. Summary of 2011 Northern Saw-whet Owl captures at other banding stations.....13

INTRODUCTION

The Black Hills, a mixed-coniferous island in the middle of a sea of grass, hosts a variety of forest owl species throughout the year (Backlund and Dowd-Stukel 2006; U.S. Forest Service 2009; Drilling 2010). NSWO are present throughout the year and breed in the Black Hills (Pettingill and Whitney 1965; Tallman 2002; Backlund and Dowd-Stukel 2006). As a result of monitoring projects such as the Breeding Bird Atlas and recent special owl surveys, we know a little bit about NSWO presence in the Black Hills during the breeding season (Peterson 1995; Drilling 2010). However, we do not know if the population is resident, partially-migratory or entirely migratory. NSWO are highly responsive to a broadcast of its territorial call at any time of the year (pers. obser.). When a NSWO calls during a survey, we don't know if it is a migrant, resident, or overwintering bird. The only way to understand the status of the Black Hills population is through mark-recapture techniques. In addition we do not know if elevational migration occurs, whether migrants pass through the Black Hills, or the importance of the Black Hills to small owls migrating through the Great Plains. Banding and analysis of recaptures address these questions.

Project Owlnet, a continent-wide migratory NSWO monitoring project, aims to understand NSWO migration and monitor NSWO populations via hundreds of banding stations throughout North America. For this small secretive owl, analysis of banding data is the only way to understand migration patterns and banding is the most cost-efficient way to monitor NSWO populations (Dunn 2001). For this effort to be successful, banding stations need to be located throughout the continent. However, there is only one active owl banding station in the U.S. Great Plains (Figure 1), limiting our ability to understand owl migration through the area. For example, Priestley et al. (2010), analyzing NSWO recapture data from five years of banding in Alberta and Saskatchewan, concluded that their owls migrated east/southeast. However, with no

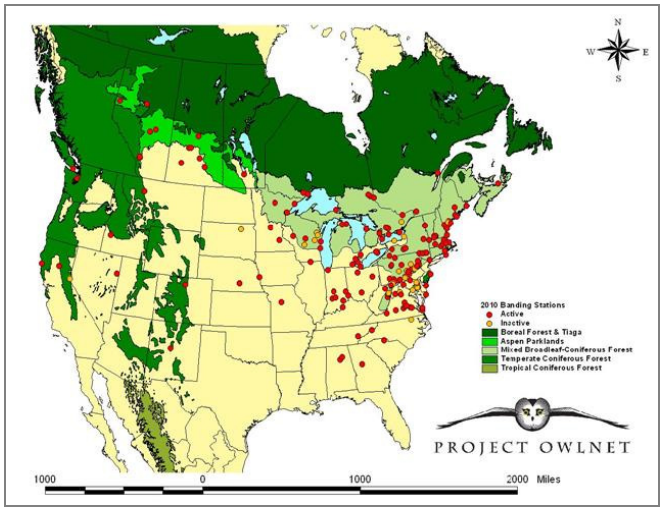

Figure 1. Location of 2010 NSWO banding stations in North America (from Project Owlnet, used with permission)

banding stations to the south to recapture southward-migrating birds, this conclusion was premature. Black Hills banding stations would start to fill a huge gap in banding station coverage.

Flammulated Owl has never been confirmed to occur in South Dakota but there have been at least four reliable unconfirmed reports in the past several years (Tigner 1995; R. Olson, pers. comm.). Because the Black Hills has seemingly appropriate habitat (McCallum 1994b), there have been limited, and unsuccessful, point count surveys for breeding FLOW (J. Blakesley, pers. comm.). Point count surveys which listen for calling FLOW are not effective during fall migration when the owls are silent. Banding stations are the best way to determine whether FLOW migrate through the Black Hills. A FLOW captured at a Black Hills banding station would be a first state confirmed record. In addition, FLOW is a U.S. Forest Service Region 2 'Sensitive Species'. If FLOW occurs in the Black Hills, the Forest Service would need to develop monitoring and conservation plans to protect the species. These assessments would be incomplete without knowledge of FLOW's migratory status in the region; data which only can be obtained through banding stations.

Project objectives were to:

1. Establish migration monitoring banding stations for small owls in the Black Hills
2. Confirm whether Flammulated Owls migrate through the Black Hills
3. Enable South Dakota to be part of regional and continental small owl monitoring network, to better understand small owl migration pathways through the Great Plains
4. Stimulate interest in small owls among general public, managers, and researchers of the Black Hills
5. Create a corps of owl volunteers who are committed to assisting in future years

Expected short-term results included to:

- Gain a clearer understanding of which owl species migrate through the Black Hills, especially regarding FLOW
- Identify suitable locations for longer-term banding stations
- Collect first information on NSWO movements, gained from recaptures of local and 'foreign' banded owls
- Band as many owls as possible to increase likelihood of recapture
- Provide close-up experience of small owls for general public and bird enthusiasts

By continuing this project in future years, we hope to gain a

- Better understanding of small owl migration through Black Hills
- Better understanding of role of Black Hills to regional owl migration pathways
- Better understanding of residency status of Black Hills NSWO
- Stimulate research and education projects concerning Black Hills small owls

METHODS

Banding Stations

Efforts to catch owls occurred at stationary Banding Stations in the Black Hills and Custer National Forests (Table 1, Figure 2). All banding stations were on public land, except at Whitney Preserve which is owned by The Nature Conservancy. Stations primarily targeting Flammulated Owls were located in the southern portion of the Black Hills, either at previously reported sites (Woodcock Springs, Tigner 1995) or in habitat characterized by conifer overstory with dense understory near meadows with flowering plants or water, habitat generally used by FLOW (McCallum 1994a) (Figure 2, Table 1). Because NSWO are found throughout the Black Hills (Drilling 2010), locations were selected first on geography – where southward-migrating owls would first 'bump' into the forested hills or be funneled along a ridge or major valley. Once these areas were identified, a specific location was selected based on local habitat (dense undercover with pine overstory) and logistics (e.g., access to processing area, ease of visitation by volunteers). In mid-October, we received reliable reports of a large number of Northern Saw-whet Owls observed at Slim Buttes in Custer National Forest, Harding county. Therefore, we established one banding station towards the north end of the Butte, at the narrowest portion, again selecting an area with dense undercover and pine overstory.

Table 1. County, latitude and longitude, elevation and targeted species of 2011 owl banding stations in western South Dakota. FLOW = Flammulated Owl; NSWO = Northern Saw-whet Owl.

Site Name	County	Latitude	Longitude	Elev.	Targeted species
Whitney Preserve	Fall River	43.33937	-103.55548	3440'	FLOW
Rudenvale Springs	Pennington	43.94141	-104.05169	6090'	FLOW NSWO
Dewey Road	Custer	43.53748	-103.99456	3985'	FLOW
Woodcock Springs	Custer	43.51436	-103.53734	4280'	FLOW
Sheridan Lake	Pennington	43.96936	-103.46217	4670'	NSWO
Dumont Trailhead	Lawrence	44.22552	-103.78680	6080'	NSWO
Tinton Road #1	Lawrence	44.42438	-103.93147	5330'	NSWO
Tinton Road-S	Lawrence	44.40936	-103.95300	5550'	NSWO
Tinton Road #2	Lawrence	44.44988	-103.92004	4898'	NSWO
Slim Buttes	Harding	45.54623	-103.17725	3550'	NSWO

Site Descriptions

Whitney Preserve. Nets were placed in a riparian corridor along the nature trail. Habitat was an overstory of Plains Cottonwood (*Populus deltoides*) and Green Ash (*Fraxinus*

pennsylvanica), a midstory of Russian Olive (*Elaeagnus angustifolia*) , willows (*Salix* spp), and other shrubs, and an understory of tall grass and forbs, many of which were flowering.

Dewey Road. Nets were placed in a dry hilly area characterized by a Ponderosa Pine (*Pinus ponderosa*) - Rocky Mountain Juniper (*Juniperus scopulorum*) mix, with an understory of short grasses.

Woodcock Springs. General area has a fenced-off natural spring in a pasture with stock tanks, surrounded by Ponderosa Pine forest. Nets were placed within young pine thickets at the forest edge; understory had grasses, flowering forbs and Northern Gooseberry (*Ribes oxyacanthoides*) shrubs.

Rudenvale Springs. The springs have been dammed to create a series of small ponds; the area was fenced off, resulting in a dense lush growth of grasses and flowering forbs. Nets were placed outside the fences, in Ponderosa Pine-Juniper thickets, with an understory of Gooseberry, forbs, and grass.

Sheridan Lake. Nets were placed on a small peninsula jutting into the lake, among small and medium sized Ponderosa Pine thickets with an understory of grass. This banding stations had to be shut down mid-season (October 22nd) because a pair of Great Horned Owls (*Bubo virginianus*), a small owl predator, set up a territory near the nets.

Dumont trailhead. Habitat to the north of the nets was a very large pasture. Nets were placed at the edge under an open Ponderosa Pine overstory and within mixed young pine-small Black Hills Spruce (*Picea glauca*)-Quaking Aspen (*Populus* tremuloides) thickets and a ground cover of grasses, forbs, mosses, Oregon Grape (*Mahonis repens*), and Bearberry (*Arctostaphylos uva-ursi*).

Tinton Road 1 & 2. Nets were located within 50 m of recently-thinned forest, within mature pine forest with young pine-aspen-Bur Oak (*Quercus macrocarpa*) understory and grass as a ground cover. The first banding station (#1) had to be shut down mid-season (October 27th) because Great Horned Owls set up territories near the nets. We moved the station (#2) 2.25 miles north to an area with similar habitat.

Slim Buttes . The general location was at the narrowest east-west portion of the north section of Slim Buttes. Nets were placed within a young Ponderosa Pine thicket within mature pine forest with nearby small grass-forbs openings. We had to shut down the station at this popular deer-hunting area before the hunting season began on November 12th.

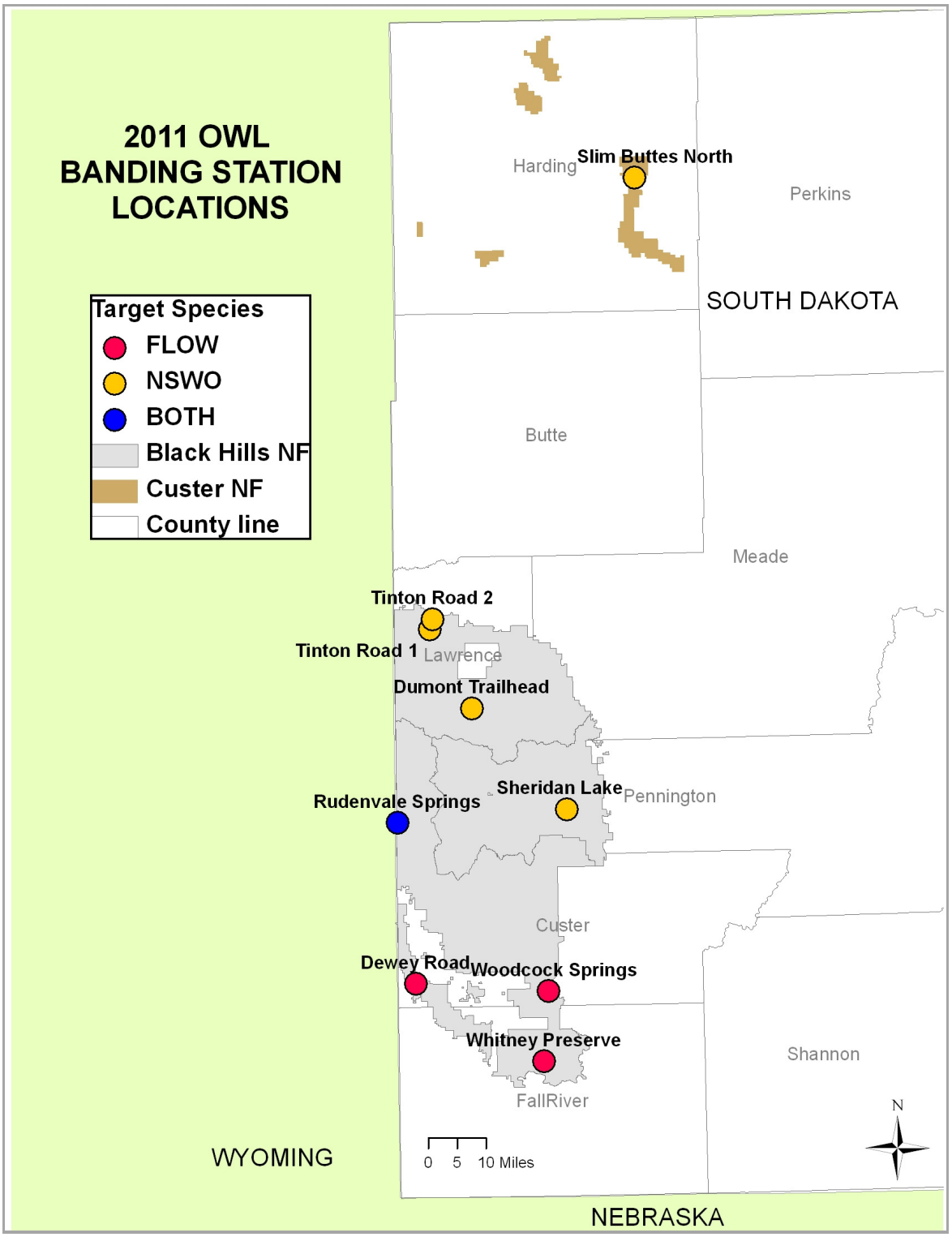

Figure 2. Location of Fall 2011 small owl banding stations in western South Dakota and targeted owl species at each station. FLOW=Flammulated Owl and NSWO = Northern Saw-whet Owl. See Table 1 and text for site descriptions.

Net Set-up and Net Checks

The western South Dakota migratory owl banding stations followed standard net set-up and protocols to allow for these data to be integrated into regional and continental population monitoring schemes (Dunn 2001; Project Owlnet 2001a, Project Owlnet 2001b). A banding station consisted of 5 - 11 mist nets set up around an audiolure, with the nets positioned to catch owls attracted to the audiolure. The audiolure, a Foxpro NX2 game caller, broadcast the territorial calls of the targeted owl species throughout the time the nets were open. An audiolure increases NSWO net capture rates by 5 - 40% (Erdman and Brinker 1997; Whalen and Watts 1999); no studies have been done to determine if an audiolure increases FLOW capture rates. Territorial calls of both NSWO and FLOW were broadcast during September banding efforts; only NSWO calls were broadcast in October and November. We used the 'Voices of North American Owls' territorial call recording of each species (Cornell Lab 2006).

We used 4-panel avian mist nets to catch owls. Nets were made of black nylon 50-denier thread with a 60 mm mesh size. Nets were 6-meter, 9-meter, or 12-meter long and when opened, were 1.8 – 2.1 meters tall. Net ends were looped and tied onto 1/2" aluminum electrical conduit poles which were mounted over steel reinforcement rod pounded into the ground. Three to six nets were set up within 2 – 10 meters of audiolure, surrounding it in a triangle, rectangle, or polygon configuration. Additional nets extended up to 50 meters from the central set-up in straight-line, 'V' or 'T' configurations. Nets and the audiolure were located in areas with dense low vegetation up to at least four meters high with a closed upper canopy cover.

Nets were opened around civil twilight (approximately 30 – 45 minutes after sunset) and were checked every ½ hour for owls. If the bander(s) felt that they would not be able to process all owls within a half hour, the audiolure was turned off so that no new owls would be caught and possibly be in the net for more than ½ hour. Nets were not open during heavy snow, rain, high winds, or the presence of a predator. Weather permitting, nets were open for a minimum of four hours per night.

When nets were opened at sunset and closed at the end of the evening, banders recorded number and size of opened nets, number of banders and guests, temperature, wind speed (Beaufort Scale) and direction, precipitation, and light conditions (very bright, bright, average, dark, very dark). See Appendix I for weather codes and definitions. At each half-hour net check, banders recorded weather variables (temperature, wind speed, and light conditions), number, species and location within net of caught birds, and number of open nets.

Banding and Processing Protocols

Once extracted from the net, each owl was taken to a nearby processing area for banding, measuring, aging, and sexing. We banded each unbanded owl with one uniquely numbered aluminum band that is distributed by the USGS Bird-Banding

Laboratory. Banders were subpermittees under the Master permit of RMBO biologist Nancy Gobris in Brighton, CO. We weighed all owls and measured unflattened wing chord and tail length. We determined sex of each NSWO using a regression equation that utilizes mass and wing chord measurements (Project Owlnet 2001a) (Appendix II). We aged each NSWO by their wing feather molt pattern (Evans and Rosenfield 1987; Pyle 1997), using a regular flashlight to examine the top side of the wing and a 9 LED ultra-violet blacklight flashlight (400 nm) to examine the underside (Weidensaul *et al*. 2011). For any owls older than hatch-year, we recorded the age of each flight feather for both wings (Appendix I). Finally, to assess body condition, we recorded amount of fat in the wing pit area in one of six categories (Appendix I). To release birds and ensure they were not injured during processing, we placed the owl on a volunteer's arm and watched it fly off. This project's Field manual for netting, banding and processing owls is available upon request.

Data Analyses and Dissemination

To compare data among banding stations, nights, or national forests, we standardized the amount of effort expended trying to catch owls as 'net-hours.' A net-hour was defined as one 12-meter net open for one hour. A 6-meter net open for one hour was 0.5 net-hours and a 9-meter net was 0.75 net-hours. For each night, we multiplied the number of hours when nets were open by the number of nets of each size and its correction factor (1.0, 0.5, or 0.75 for 12-m, 6-m, and 9-m nets respectively) to obtain 'nightly effort'. The number of new owls caught was divided by the nightly effort to obtain owls per net-hour; similarly the number of new owls caught was divided by total number of hours when nets were open to obtain owls per hour. Recaught owls that had been banded earlier in the same evening (repeats) or at an earlier date at the same location (retraps) were not included in effort calculations.

Banding and measurement data have been submitted, as required by law, to the U.S. Geological Survey's Bird-Banding Lab. Summary data (e.g., number of owls caught, number of nights) will be given to Project Owlnet. Data will be kept in a file such that subsequent years' data can easily be added and analyzed.

RESULTS

Flammulated Owl

Banders attempted to capture Flammulated Owls at four different banding station locations in the Southern Black Hills (Table 1, Figure 2). Nets were open between August 30 - September 13 for a total of 11 nights for 37 hours with a total effort of 197.25 net-hours (Appendix III). No Flammulated Owls were caught or heard.

Northern Saw-whet Owl

Pre-migration period. Before NSWO migration began, banders attempted to catch NSWO on six nights in early September (Appendix IV). Four owls were caught at Rudenvale Springs (Table 2). These owls, three second-year females and a hatch-year bird of unknown sex, are presumed to be local birds.

Migration period summary. Banding stations exclusively targeting migrating NSWO operated between October 4 – November 16, 2011 (Table 2, Appendix IV). Banders caught 81 Northern Saw-whet Owls – 42 at Black Hills banding stations and 39 at the Custer National Forest banding station (Appendix IV, Table 2, Table 3). None of these owls were previously banded. An unbanded Long-eared Owl (*Asio otus*) flew into a Slim Buttes net on November 7th; this bird was released without banding.

Table 2. Summary of effort and Northern Saw-whet Owl captures at each western South Dakota banding station during fall 2011.

Station	Num nights	2011 dates	Num hours	Num net-hrs	Num owls	Num owls /hour	Num owls /net-hour
Rud. Sprgs	2	9/3-9/4	7.0	28.5	4	0.57	0.14
Sher. Lake	4	10/4-10/21	16.5	95.0	7	0.42	0.07
Dumont	9	10/10-11/4	45.0	326.7	17	0.37	0.05
Tinton Rd	11	10/11-11/16	44.7	217.5	18	0.40	0.08
Slim Buttes	4	10/30-11/9	22.5	123.8	39	1.73	0.31
Overall	**30**	**9/3 – 11/16**	**135.7**	**791.5**	**85**	**0.63**	**0.11**

Table 3. Summary of effort and Northern Saw-whet Owl captures during fall 2011 migration by National Forest. The Black Hills data do not include effort or captures in September at Rudenvale Springs.

	Num nights	2011 dates	Num hours	Num net-hrs	Num owls	Num owls /hour	Num owls /net-hour
Black Hills	24	10/4-11/16	106.2	639.5	42	0.40	0.07
Custer	4	10/30-11/9	22.5	123.8	39	1.73	0.31
Overall	**28**	**10/4-11/16**	**128.7**	**763.3**	**81**	**0.63**	**0.11**

Recaptures. Six of the 81 NSWOs were recaught at a later date (Table 4). All were recaptured at the same location they were banded except for the Tinton Road owl which was recaptured approximately 2.25 miles from her initial banding site. Five of the owls lost weight between first and second capture. Of the two owls recaptured twice, one owl lost weight between first and second capture and gained weight between second and third capture while the second owl exhibited the opposite pattern (Table 4).

Table 4. Locations and dates of first and subsequent captures of NSWO that were caught more than once in 2011. Age codes: HY = Hatch-year, AHY = After hatch year.

Band Number	Sex Age	Station	Date 1st capture	Date(s) of subsequent captures	Weight change (g)
0924-35413	Female AHY	Tinton Rd	10/11/11	10/27/11	-2.9
0924-35427	Unknown AHY	Dumont	10/21/11	10/30/11	-0.8
0924-35438	Female AHY	Slim Buttes	11/2/11	11/7/11	-0.7
1014-56513	Female HY	Slim Buttes	10/29/11	11/7/11 11/9/11	-0.6 +1.7
1014-56514	Female AHY	Slim Buttes	10/29/11	11/2/11	-2.4
1014-56515	Male AHY	Slim Buttes	10/29/11	11/2/11 11/7/11	+5.6 +2.0

Sex and age ratios. Overall, sex could not be identified on 22% of owls while 63% of owls were female and 15% were male. Lumping all birds into two age categories, 56% were Hatch-year birds (i.e., young of the year, juveniles) while 44% were After Hatch-year birds (i.e., adults). There was no significant difference in proportions of Hatch-year and After Hatch-year owls among the three sex categories (χ^2 = 0.2978, df=1, p>0.5) (Table 5). Comparing the two National Forests, the same proportion of females, males, and unknown owls were caught at banding stations in each forest (χ^2 = 1.632, df=2, p>0.25) (Table 6). However, proportions of Hatch-year and After Hatch-year owls caught were significantly different between the two National Forests (χ^2 = 13.9080, df = 1, p<0.001) with more Hatch-year birds caught at the Custer National Forest banding station compared to those caught at Black Hills stations (Table 6). If we only include owls caught after October 27th in the Black Hills (14 Hatch-year and 14 After Hatch-year owls), we obtain the same result - significantly more Hatch-year birds were caught at the Custer National Forest banding station (χ^2 = 5.24, df =1, p<0.025)

Table 5. Sex and age ratios of NSWO caught during 2011 fall migration in western South Dakota.

	n	Hatch-year	After hatch year
Female	54	0.54	0.46
Male	12	0.58	0.42
Unknown	18	0.53	0.47

Table 6. Sex and age ratios of NSWO caught in Black Hills and Custer National Forests during 2011 fall migration. HY = Hatch-year, AHY=After hatch year.

	Num owls	% female	% male	% unknown	% HY	% AHY
Black Hills	42	59	8	24	35	65
Custer	39	69	10	21	77	23
Overall	**81**	**63**	**15**	**22**	**56**	**44**

Measurements. Table 7 presents mean and ranges of measurements of Northern Saw-whet Owls caught during this project, including birds caught in early September at Rudenvale Springs.

Table 7. Measurement means and ranges of Northern Saw-whet Owls caught during 2011 in western South Dakota. HY = Hatch year, AHY = After Hatch year.

	n	Wing Chord (mm)	Weight (g)	Tail Length (mm)	Fat Category
Female	54	140.6 (134-147)	93.8 (87-107)	68.1 (58-76)	1.8 (0-3)
HY	29	140.4 (134-147)	94.0 (88-107)	68.4 (58-73)	1.7 (0-3)
AHY	25	140.8 (134-146)	93.7 (87-106)	67.8 (62-76)	1.9 (1-3)
Male	12	131.7 (126-139)	77.8 (73-83)	64.7 (57-69)	1.4 (0-2)
HY	7	130.8 (126-134)	77.6 (73-81)	65.1 (63-67)	1.1 (0-2)
AHY	5	132.8 (128-139)	78.1 (74-83)	64.0 (57-69)	1.8 (1-3)
Unknown	19	135.7 (129-142)	84.2 (82-86)	66.2 (61-73)	1.4 (0-4)
HY	10	136.4 (134-140)	84.8 (83-87)	66.4 (62-71)	1.4 (1-3)
AHY	9	134.9 (129-142)	83.4* (80-86)	65.9 (61-73)	1.2 (0-4)
All HY	46	138.1 (126-147)	89.5 (73-107)	67.4 (58-73)	1.6 (0-2)
All AHY	39	138.4 (128-146)	89.5**(74-106)	66.9 (57-76)	1.7 (0-4)

* *n* = 8, one owl not weighed because of equipment malfunction
** *n* = 38, one owl not weighed because of equipment malfunction

Timing of migration. Northern Saw-whet Owls were caught on 21 of 28 nights when nets were open during October and November (Appendix IV, Figure 3). Owls were not caught on October 7th, 12th, 13th, 23rd, 26th, 27th, and November 16th. At Black Hills stations, owls were most consistently caught October 15 – 22, with notable spikes around October 10-11 and at the end of the month.

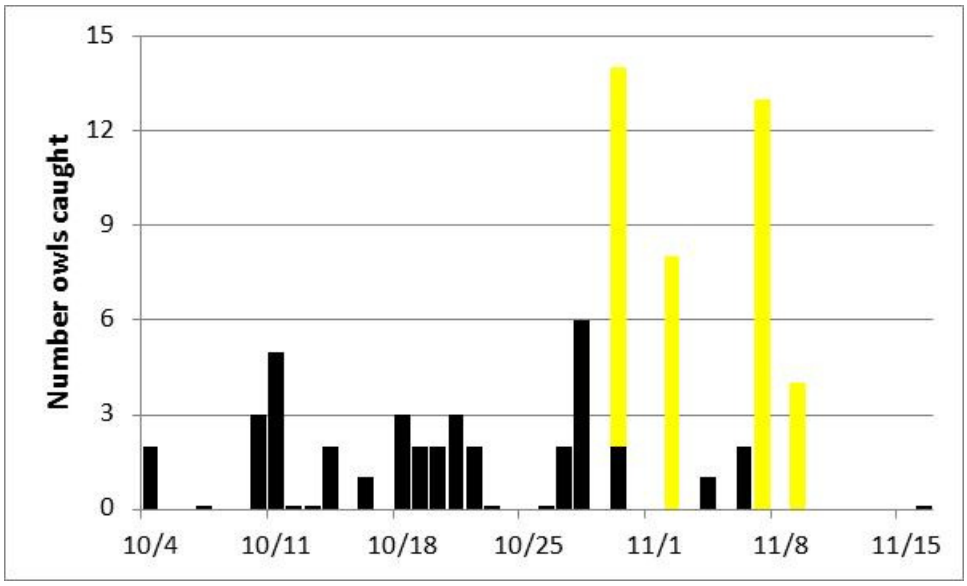

Figure 3. Number of Northern Saw-whet Owls caught by date at 2011 owl banding stations in western South Dakota. Black bars represent Black Hills stations, yellow bars represent the Slim Buttes station. Banding stations were closed on dates with no data.

Visitors and Volunteers.

Thirty-six different visitors, including seven children, came to a banding station on 18 of 39 nights. Almost all visitors came on a Friday, Saturday, or Sunday night. Two visitors came two different nights while a third volunteer helped on six nights. Of the adults, 13 were federal or state agency staff, two were school teachers, two were university students, five were birders, and seven were spouses of other visitors.

In addition to those who were able to come to a banding station, another 14 people expressed keen interest in attending but had schedule conflicts.

DISCUSSION AND RECOMMENDATIONS

Flammulated Owl

While disappointing, we are not particularly surprised that no Flammulated Owls were caught or detected. Past records show that this species does occur in the Black Hills during the migration period. What is the status of the species in the Black Hills? We do not know if the species breeds in the area; 2011 summer surveys were inconclusive (P.

Lynch and B. Phillips, *pers. comm.*) The nearest known breeding populations are in western Montana (Bitteroot range) (Smucker *et al.* 2008) and extreme south-central Wyoming (Medicine Bow range) (Faulkner 2010). Assuming little to no breeding in the Hills, late summer records could be either immature birds who arrive during their post-natal dispersal or post-breeding movements or southward migration by any age class. Young owls disperse about 25-32 days post-fledging in mid-August to mid-September (McCallum 1994a). Southward-migrating owls generally pass through Arizona beginning in August. McCallum (1994a) also notes that the species may migrate east of their breeding range. Finally, this species has shown up as far away as Florida. So while it is not surprising that FLOW occasionally are observed in the Black Hills, numbers are likely to be very small; perhaps none occur in the area during some years.

No detections during our banding efforts could be because a) owls were absent in the Black Hills this fall, b) owls were present but not near the banding station site, or c) owls were present earlier but had left by late August when banding began. Flammulated Owls migrate relatively early, while their insectivorous prey, primarily moths, are still present (McCallum 1994a). In 2012, although some forbs still were flowering in late August and some moths were attracted to station lights into mid-October, the number of moths clearly was much greater during site scouting two weeks earlier (*pers. obser.*). Thus, the major recommendation is to open FLOW banding stations during the first three weeks of August, rather than during late August-early September.

Northern Saw-whet Owl

Based on numbers of owls caught at other banding stations in previous years, we expected to catch a minimum of 100 Northern Saw-whet Owls at Black Hills banding stations. This was based on 2007-2010 summaries submitted by NSWO banders to a Project Owlnet online database. During that period, nine Prairie Province banding stations averaged 4.4 owls per night (range 1.3-9.1) while seven upper-Midwest banding stations averaged 5.0 owls per night (range 0.9-13.1). Thus, catching only 42 owls during the 24 nights of migration (1.75 owls/night) at Black Hills stations was much lower than anticipated, although within the range of capture rates at other stations in the region.

Several factors influence number of owls caught, including location and year. On a continental scale, banding stations that catch the most owls are located on shorelines around the Great Lakes, where migrating owls are funneled along the shoreline (Beckett and Proudfoot, 2011). For this reason, banders in other areas, including in western South Dakota, attempt to locate banding stations where migrants may funnel, such as ridgelines, riparian corridors, and abrupt ecosystem borders. However, we really do not know if this species actually migrates in this manner away from major water bodies. Of the three station locations in the Black Hills, Tinton Road stations were along the leading edge of the northern Hills and along a ridge, the Dumont station was near a major north-south ridge, and the Sheridan Lake station did not appear to be located near any type of 'funneling' topography. Yet we caught approximately the same number

of owls per unit effort at all three locations. In contrast, we caught 9.75 owls per night at the Slim Buttes banding station. One possible reason is that this station was located at the narrowest portion of a ridge, in a sliver of pine forest within a sagebrush-grassland landscape. This forest island may have aggregated owls unwilling to land in grassland. In contrast, owls migrating over the Black Hills can disperse throughout more than 1.25 million acres of forest.

To put the western South Dakota capture data in context, we can compare our data to 2011 summary capture data from other banding stations reported to the Project Owlnet online database (Table 8). These stations are not randomly selected from all stations in the continent but do represent a wide geographic range. For owls captured per night,

Table 8. Summary statistics of 2011 Northern Saw-whet Owl Banding Stations submitted to Project Owlnet online database. Western Black Hills banding station data are highlighted.

State or Province	# Nights Open	Total Owls	Owls/ Night	% Adult	% Female	% Male
CA	27	91	3.37	56	82	8
IA	35	73	2.09	26	76	14
IN	24	26	1.08	38	73	8
IN	24	40	1.67	73	73	15
MA	38	220	5.79	71	85	3
MD	28	25	0.89	30	85	0
MD	27	15	0.56	53	87	0
MD	19	5	0.26	50	60	20
MI	18	74	4.11	46	72	8
MN	33	61	1.85	56	61	15
NY	20	29	1.45	64	93	0
NY	41	55	1.34	42	89	7
PA	39	46	1.18	61	91	0
PA	23	80	3.48	42	96	1
PA	43	34	0.79	41	82	6
Sask.	58	284	4.90	39	67	8
Sask.	27	54	2.00	18	65	20
SD	24	42	1.75	65	59	8
SD	4	39	9.75	23	69	10
WA	28	62	2.21	56	56	13
WV	19	20	1.05	75	90	5

Black Hills banding stations fell in the middle - six stations had fewer captures, one was similar, and seven had more captures. Thus, although numbers captured were lower than expected in the Black Hills, they were not unusual in 2011, relative to other stations. We will need several more years of Black Hills banding effort to discover the 'normal' capture rate in this area and put the 2011 data in proper perspective.

The Slim Buttes station had the highest capture rate of any of the stations reporting to the online database. The next highest was a 5.79 owls/night capture rate at a Massachusetts station. In fact, for all 140 records of annual summary data entered into the online database since 2007, only eight banding stations reported capture rates greater than 9.75 owls per night. At this point, we do not know why we had such a high capture rate at Slim Buttes in 2011. Possible reasons include the location, as discussed above, the timing within the migration period, discussed below, or a relationship with high local reproductive success, also discussed below.

Not only are Northern Saw-whet Owls migratory, but they will migrate in irruptive numbers during some years (Marks 1997, Rasmussen *et al.* 2008, Brittain *et al.* 2009). A banding station located in the same spot, using the same protocol with the same number of nets, may catch up to 10 times as many owls per unit effort in irruptive years versus 'low' years. These irruptions occur roughly every four years, although there are regional differences in timing and magnitude. In 2011 in the Black Hills, we can't be certain what phase of this irruptive cycle occurred. Based on Project Owlnet listserve discussions, the overall impression was that 2011 owl captures were lower than average in much of the continent. An examination of summary data from the online database partially confirms this impression. Owls caught per night averaged 2.47 in 2011, lower than the averages in 2010 (4.05), 2009 (3.33), 2008 (4.28), and 2007 (5.83) (Project Owlnet online dataset). A caveat of these data is that not all stations entered their summary data for all years. For banding stations reporting at least three years of data since 2007, 2011 had the lowest reported owl captures rate for three stations (in Maryland, West Virginia, and Minnesota), but had the highest rate in the previous five years for two stations (in Massachusetts and California). To better understand these migratory cycles, we will need to gather more years of data in South Dakota and elsewhere.

We did not capture any Northern Saw-whet Owls that had been banded outside of South Dakota ('foreign' capture). This is not surprising, given that only 1.5-3% of banded NSWO are ever encountered again (Priestley *et al.* 2010) and that there are relatively few owls banded in the region. Potential sources of 'foreign' owls are banding stations in Saskatchewan, where 700 - 2,000 NSWO are banded each year (H. Fisher, pers. comm.); Minnesota where 500-2,000 NSWO are banded each year, and western Iowa where 50-100 are banded each year (J. Toll, pers. comm.). Capturing a 'foreign' owl would give information on migratory pathways and would suggest that not all NSWO in the Black Hills are resident birds. In addition, if a western South Dakota owl were to be caught in other parts of the country, we would learn more about migration pathways and how far and how rapidly South Dakota owls move. In order to increase the likelihood for 'foreign' recaptures, we recommend that more banding stations be created in the U.S.

portion of the Great Plains. Recommended locations are Theodore Roosevelt National Park-South Unit/Sully Creek State Park in North Dakota, Pierre area and Lake Hiddenwood State Park in South Dakota, and Chadron State Park and Wildcat Hills in the Nebraska panhandle.

Local recaptures, the recapture of an owl banded at that station earlier in the season, gives information on how long owls stay in the area, and by comparing weight loss or gain, their physical condition. Most of our local recaptures were at Slim Buttes but with only 11 days between first and last banding sessions, there was little opportunity to determine stopover duration. Our longest interval was 16 days between captures of an individual. This is well within the stopover period observed by others (Whalen and Watts 2002). Some banders feel that owls hear the broadcast of their territorial call as they fly overhead during migration and fly down to the nets to investigate. In this case we would expect that such owls would continue on their migration after being released and would not be recaptured at the same location. The fact that we recaptured some owls several days after release shows that at least some owls use the area as a stopover site. Judging by little variation in weight between captures, these owls appeared to be successful at finding food; if they were not, we would see quite dramatic weight loss.

The most startling result was the difference in owl age ratios between the South Dakota portions of two national forests. Banders have long observed that hatch-year to after-hatch-year age ratios vary dramatically among years (Mueller and Berger 1967). Within a year, age ratios differ among regions and banding stations (Table 8, Beckett and Proudfoot 2011). Of the 143 2007-20011 annual banding station summaries in the Project Owlnet database, 37 reported hatch-year proportions less than 50% of captures, while 106 reported hatch-year proportions greater than or equal to 50%. Reasons for differences among years and stations are unclear. One observation is that there seems to be a higher proportion of hatch-year owls captured during irruptive years (Whalen and Watts 2002, Rasmussen *et al*. 2008). This argues that irruptions are caused by good reproductive success years, which presumably are caused by high prey populations (Marks and Doremus 2000, Côtè *et al.*2007). If true, this implies that within-year variation in age ratios among banding stations are because of prey populations or reproductive success 'upstream' of the stations. Whether this explains the age ratio difference between Custer and Black Hills national forest is unknown. We do not know yet the source of the owls we catch; this question is the reason for establishing the banding stations. However, if the reproductive success hypothesis is true, the very different age ratios implies different breeding area sources that had different levels of reproductive success in 2011. We know that the local NSWO breeding population in Custer National Forest had phenomenally high reproductive success in 2011 (C. Miller, unpubl. data). We do not know the level of reproductive success in the local Black Hills breeding population, nor in any potential 'upstream' breeding areas.

Another potential explanation for the age ratio difference between Custer and Black Hills National Forests is timing within the migration period. Some studies have noted differential migration among age-classes, with hatch-year birds migrating earlier than adult birds in some studies (Duffy and Kerlinger 1992; Brittain *et al*. 2009) and the

reverse true in others (Rasmussen *et al*. 2008) . However, other banding stations have not observed this phenomenon (Mueller and Berger 1967). If we had begun banding earlier at Slim Buttes, Custer National Forest, we may have caught a different overall proportion of adults. Even when we reanalyze the age ratios using only birds caught after October 27th at either site, we still caught a significantly higher proportion of hatch-year owls at Slim Buttes compared to the Black Hills banding stations. Interestingly, only two other 2011 banding stations that reported to Project Owlnet caught less than 30% adults - one in Iowa (26%) and one in Saskatchewan (18%); both in the same region as western South Dakota. In future years, we recommend that all banding stations are open at the same time to allow for better comparisons among stations.

In western South Dakota, we caught a higher proportion of females than males. This is an almost universal finding at any banding station (e.g., Priestley *et al*. 2010). Compared to other banding stations that reported their 2011 results to the online database, the 59% female rate caught at Black Hills stations was very low; only one station, in Washington state, had a lower percentage of females (56%). However, because intermediate-sized birds can not be classified according to gender, the actual sex ratio may be somewhat different. Two suggestions have been put forward as to why more females generally are caught - females may be more migratory than males who may stay on their territories through winter rather than lose them, or females are more likely to be attracted to the broadcasted call. These two suggestions are not mutually exclusive but there are little data or research concerning this issue.

Besides elucidating migration pathways, an objective of the western South Dakota banding stations is to determine whether the local breeding population is resident, partially migratory or entirely migratory (Johnson and Anderson 2003, Backlund 2006, Backlund and Dowd-Stukel 2006). We will need to band more birds to meet this objective. We recommend that 1) NSWO nestlings and breeding adults in the Custer National Forest nest box project be banded, as well as in any nests found in the Black Hills, 2) banding stations be opened at other times of the year, perhaps two nights a month weather permitting, and 3) researchers consider attaching color-coded plastic leg bands with tabs to identify visually-sighted birds without the need to recapture the birds (Forsman *et al*. 1996).

We anticipate that 2011 would be the first year of a long-term migratory NSWO monitoring project using banding stations in the Black Hills. One year of data gave us valuable information. But truly understanding NSWO status and migration in the Black Hills will require several years of banding to produce enough recapture data for analysis.

Visitors and volunteers

While many visitors, including children, were able to come to banding stations, several issues arose during the fall banding 'season.' Some were unavoidable and will always be issues. For example, changes in weather, especially increasing wind speeds, caused

relatively last-minute cancellations and made the pre-planned schedule moot. Fortunately, most people were understanding of the situation but it caused more work for the coordinator to notify people of cancellations and to try to reschedule.

Another issue occurred because most visitors were adults with daytime, Monday-Friday jobs and children going to school. Thus most visitors wanted to come on a Saturday night. As the banding occurs over a three- to four-week period at the most, this leaves only a handful of dates which are ideal for these types of visitors. In addition, poor weather conditions on two Saturday evenings further reduced the number of opportunities. Because we were able to run two stations simultaneously, we only had to turn away one group because both stations were 'full.' However in the future when there probably will be just one station, not all visitors will be able to attend on the ideal night. Many people did agree to come on a non-Saturday evening. In general, these people were more concerned about the distance to the site from their home and tended to leave earlier in the evening. This highlights the importance of the banding station location - not only does the site have to be easily accessible (i.e., on a good gravel or paved road), but it should be as close as possible to major urban areas. The downside to this tactic is that such a location may not catch as many owls. This fall, we had four nights when we had visitors at a station but no owls. Although they appreciate the opportunity to be out there, visitors of course are disappointed when no owls are caught and the experience is diminished for them. This especially may be a potential issue with children. However, because the objective of the banding station project is to band as many owls as possible in order to increase the probability of recaptures, running a station in a sub-par location wastes valuable time in an already too-short banding season. Two recommendations may partially address this issue. First, less-accessible but more-productive stations could be open on weekday evenings and the more-convenient but less-productive stations could be open just on Friday and Saturday nights. This would not eliminate 'no-owl' capture nights when visitors are present but would balance the need to catch many owls with the need to teach the public about owls. Second, funding to hire a full- or part-time bander would allow two banding stations to run simultaneously, such as occurred this year. A third option would be to permit larger groups. This fall, we had a maximum of five visitors plus one or two banders per station. With larger groups, the bander would need to control more for noise and would have to give less attention per individual.

Another goal of the banding project is to turn visitors into volunteers who would be willing to come back for multiple sessions and help out with educating others, as well as setting up and running the station and banding effort. This year, three people came to stations multiple times; one person returned enough times to be of significant help in all phases of the set-up, banding, and take-down. Several issues seemed to prevent more people from committing as volunteers. First, most people were employed during the week and weren't able to make the commitment to return on multiple nights. Secondly, only one of the banding stations had a building within which visitors could wait and where owls were processed. For many, the outside setting was a bit too uncomfortable. It was tolerable for one night but clearly not an enticement for visitors to return. This was especially true for guests who brought children. To recruit, train, and retain volunteers

we recommend 1) developing and conducting training sessions, 2) recruit people who are retired, part-time workers, or have flexible job schedules, and 3) continue to find suitable locations with buildings or protection from the elements.

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APPENDIX I

Western South Dakota Banding Station codes and their definitions.

WEATHER VARIABLES:

Wind Speed - Beaufort scale:

0 = Calm; smoke rises vertically, nets motionless
1 = Light air - Direction of wind shown by smoke drift. Nets still.
2 = Light breeze - Wind felt on face; leaves rustle. Nets blown partly open/moving slightly
3 = Leaves and small twigs in constant motion; wind extends light flag. Nets blown open, shelf string slightly bowed
4 = Raises dust and loose paper; small branches move. Nets open, shelf string bowed, conditions marginal for netting.
5 = Small trees begin to sway. Time to close nets!

Light Conditions:

VB = Very Bright = Light enough to read, nets visible
B = Bright = A flashlight is not needed to walk in open areas
A = Average = Flashlight may or may not be needed
D = Dark = Flashlight needed at all times
VD = Very Dark = Hardly possible to see hand in front of your face

Precipitation:

N = None
F = Fog, mist (water/frost on nets)
LR = Light Rain/showers
LS = Light Snow/showers
R = Rain
S = Snow

NORTHERN SAW-WHET OWL MEASUREMENT VARIABLES:

Fat:

0 = No fat
1 = Trace, linear deposit. Thin deposit along crease of wingpit
2 = Thicker, somewhat bulbous line of fat
3 = Most or all of wingpit filled with fat, but not bulging upward
4 = Same as three, but nice, rounded bulge
5 = Entire wingpit filled, with fat spilling into surrounding areas

APPENDIX I *continued*

Wing Feather Ages:

Code	Category	Description
N	Newly replaced	• Fresh, dark brown on top, with little wear; • Under normal light, a faint pink sheen is visible on the underside; • Under black light, the underside fluoresces dark pink
1	1st generation after N, 1-year old feathers	• Paler and more worn than the N feathers; • No pink underwing sheen visible in normal light; • Under black light, underside shows paler pink than N feathers
2	2nd generation after N, 2-years old feathers	• Paler and more worn than 1 year-old feathers; • Under black light, underside may show some faint pink
3	3rd or more generations after N	• Any feather that is paler and more worn than 2, and clearly representing an older generation; • Shows hardly any pink under black light
U	Unknown	• Age of feather unclear.
X	Missing	• Feather broken or missing.

APPENDIX II

Guidelines for sexing Northern Saw-Whet Owls (Project Owlnet 2001a). When using these criteria to sex owls, the following remark was included on the banding form for each owl: **Sex determined using the wing-mass Discrimant Function available from Project Owlnet**.

Wing Chord	Mass (grams)			
	Male	Unknown		Female
120	≤88	≥89	≤92	≥93
121	≤87	≥88	≤92	≥93
122	≤87	≥88	≤92	≥93
123	≤86	≥87	≤91	≥92
124	≤85	≥86	≤91	≥92
125	≤85	≥86	≤90	≥91
126	≤84	≥85	≤90	≥91
127	≤84	≥85	≤90	≥91
128	≤83	≥84	≤89	≥90
129	≤82	≥83	≤89	≥90
130	≤82	≥83	≤89	≥90
131	≤81	≥82	≤88	≥89
132	≤80	≥81	≤88	≥89
133	≤80	≥81	≤88	≥89
134	≤79	≥80	≤87	≥88
135	≤78	≥79	≤87	≥88
136			≤87	≥88
137			≤87	≥88
138			≤86	≥87
139			≤86	≥87
140			≤86	≥87
141			≤85	≥86

APPENDIX III

Daily summary of net effort, owl captures, and number of visitors at Flammulated Owl (FLOW) banding stations in the Black Hills.

Banding Station	Date	Num Hours	Num Nets	Num Net-Hours	Num FLOW	Num Visitors
Whitney Preserve	8/30/11	4.0	4	14.0	0	0
Whitney Preserve	8/31/11	4.0	9	30.0	0	0
Rudenvale Sprg	9/3/11	1.5	4	5.25	0	0
Rudenvale Sprg	9/4/11	4.0	6	18.0	0	2
Rudenvale Sprg	9/5/11	4.0	12	36.0	0	0
Dewey Road	9/7/11	3.5	6	14.0	0	0
Dewey Road	9/8/11	3.0	9	19.5	0	0
Dewey Road	9/9/11	3.0	9	19.5	0	0
Woodcock Sprg	9/10/11	4.0	3	8.0	0	0
Woodcock Sprg	9/11/11	3.0	7	16.5	0	0
Woodcock Sprg	9/12/11	3.0	7	16.5	0	0

APPENDIX IV

Daily summary of net effort, owl captures, and number of visitors at Northern Saw-whet Owl banding stations. Note that owl captures only include new captures, not recaptures.

Banding Station	Date	Num Hours	Num Nets	Num Net-hrs	Num Owls	Num owls/net-hour	Num owls/ hour	Num Visitors
Rudenvale Sprg	9/3/11	3.0	4	10.5	3	0.29	1.00	0
Rudenvale Sprg	9/4/11	4.0	6	18.0	1	0.06	0.25	2
Dewey Road	9/8/11	1.0	9	6.5	0	0.00	0.00	0
Dewey Road	9/9/11	1.0	9	6.5	0	0.00	0.00	0
Woodcock Sprg	9/11/11	1.0	7	5.5	0	0.00	0.00	0
Woodcock Sprg	9/12/11	1.0	7	5.5	0	0.00	0.00	0
Sheridan Lake	10/4/11	4.0	5	14.0	2	0.14	0.50	0
Sheridan Lake	10/7/11	4.0	5	14.0	0	0.00	0.00	0
Dumont TH	10/10/11	4.2	5	16.7	3	0.18	0.71	0
Tinton Rd 1	10/11/11	2.5	4	7.5	5	0.67	2.00	0
Dumont TH	10/12/11	4.0	10	31.0	0	0.00	0.00	0
Tinton Rd 1	10/13/11	4.0	9	29.0	0	0.00	0.00	1
Sheridan Lake	10/14/11	4.5	12	37.1	2	0.05	0.44	1
Tinton Rd 1	10/16/11	2.0	8	12.5	1	0.08	0.50	2
Tinton Rd 1	10/18/11	4.0	9	29.0	3	0.10	0.75	0
Tinton Rd 1	10/19/11	4.5	9	32.6	2	0.06	0.44	0
Tinton Rd 1	10/20/11	4.0	9	29.0	2	0.07	0.50	3
Dumont TH	10/21/11	4.5	9	32.6	3	0.09	0.67	0
Sheridan Lake	10/21/11	4.0	10	30.0	3	0.10	0.75	3
Dumont TH	10/22/11	4.0	9	29.0	2	0.00	0.50	3
Dumont TH	10/23/11	4.0	9	29.0	0	0.00	0.00	1
Dumont TH	10/26/11	4.0	10	31.0	0	0.00	0.00	3
Tinton Rd south	10/27/11	4.0	4	13.0	0	0.00	0.00	0
Tinton Rd 2	10/27/11	4.0	3	10.0	2	0.20	0.50	0
Tinton Rd 2	10/28/11	7.2	5	26.9	1	0.04	0.14	2
Dumont TH	10/28/11	11.5	10	89.1	6	0.07	0.52	4
Dumont TH	10/30/11	4.8	10	37.3	2	0.05	0.41	3
Slim Buttes	10/30/11	4.0	6	22.0	14	0.64	3.50	1
Slim Buttes	11/2/11	4.0	6	22.0	8	0.36	2.00	1
Dumont TH	11/4/11	4.0	10	31.0	1	0.03	0.25	4
Tinton Rd 2	11/6/11	4.5	5	16.9	2	0.12	0.44	0
Slim Buttes	11/7/11	9.0	6	49.5	13	0.26	1.44	1
Slim Buttes	11/9/11	5.5	6	30.2	4	0.13	0.73	5
Tinton Rd 2	11/16/11	4.0	5	11.1	0	0.00	0.00	0