FEDERAL AID
FINAL PERFORMANCE REPORT

ALASKA DEPARTMENT OF FISH AND GAME
DIVISION OF WILDLIFE CONSERVATION
PO Box 115526
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I. SUMMARY OF WORK COMPLETED ON JOBS FOR LAST SEGMENT PERIOD ONLY

Project Objectives:

Objective 1: Participate in the rollout and implementation of the Alaska Species Ranking System (ASRS).

JOB/ACTIVITY 1A: Develop web-ready products, including final report, tables and individual species scoring sheets.

Accomplishments: We developed several web-ready products in preparation for launching the ASRS website. This included finalization of the project final report and conversion into pdf for ease of viewing. We also prepared a methods overview, for those users interested in using the ranking system and its results, but not requiring them to read the entire final report. We prepared separate tables of project final results – using the ranking list appendices from the project final report. We also designed and prepared scoring sheets for individual taxa for easy display on the project website. Below we provide an example species summary report that contains all the categories and associated information used to calculate the numerical scores and categorical classification for the taxon.

Alaska Species Ranking System Summary Report - Brown Creeper

Brown Creeper

Certhia americana

Class: Aves
Order: Passeriformes

Conservation Status

Heritage	*Agency*		
G Rank: G5	USFWS/NOAA:	BLM:	AA:
S Rank: S4	SOA: Species of Greatest Conservation Need	USFS:	IUCN: Least Concern

Final Rank

Conservation category: **III. Orange**

III = high status and low biological vulnerability and action need

Category	Range	Score
Status:	-20 to 20	0
Biological:	-50 to 50	-36
Action:	-40 to 40	-10

Higher numerical scores denote greater concern

Status - variables measure the trend in a taxon's population status or distribution. Higher status scores denote taxa with known declining trends. Status scores range from -20 (increasing) to 20 (decreasing). **Score**

Population Trend (-10 to 10) -6

BBS data shows an insignificant annual increase of 13.6 from 1980 to 2007 in Alaska (P=0.23, n=16, c=3). BBS data in the Continental US and Canada demonstrated an insignificant decline of -0.3% annually between 1980 and 2007 (p=0.74, n=620, c=2; Matsuoka and Pardieck 2009).

Distribution Trend (-10 to 10) 6

May have expanded range into central and southcoastal Alaska. Prior to the 1950s considered uncommon (Gabrielson and Lincoln 1959). However, expansion started more than 50 years ago.

Clear-cutting of old growth forests in Southeast Alaska has occurred since the early 1950s (McClellan et al. 2000). Approximately 10 % of high-volume, old growth remains in the Tongass National Forest, and much of this is scheduled for harvesting (Dellasala et al. 1999). Forests on Prince of Wales, Heceta, northeast Chichagof, Kupreanof, and Kuiu islands are particularly degraded from extensive clearcut logging (Dellasala et al. 1999). Similarly, large tracts of state and private land on the Kenai Peninsula are highly degraded due to salvage logging.

In Southcentral Alaska, a rapid loss of large spruce trees has resulted from spruce beetle (Dendroctonus rufipennis) infestations. Spruce trees on about 3 million acres of mature forest have been killed; in Kachemak Bay beetle infestation has caused upwards of 90% mortality of coastal old-growth stands (Kuletz 1997). Birds associated with mature white spruce and mature mixed spruce/birch forests in Alaska's boreal forests decreased in density following removal of large trees from outbreaks of bark beetles and associated salvage logging (Collins et al. 1999, Lance and Howell 2000, Matsuoka et al. 2001).

Status Total: 0

Biological - variables measure aspects of a taxon's distribution, abundance and life history. Higher biological scores suggest greater vulnerability to extirpation. Biological scores range from -50 (least vulnerable) to 50 (most vulnerable). **Score**

Population Size (-10 to 10) -10

Statewide population estimated at 350,000 although this estimate is likely inaccurate (Rosenberg 2004b).

Range Size (-10 to 10) -8

Occurs from Kodiak Island, Cook Inlet, and Kenai Peninsula east and south near coast to Southeast Alaska (Tyler 1948, Gabrielson and Lincoln 1959, Harrap and Quinn 1996). ~290,000 km2.

1

Alaska Species Ranking System Summary Report - Brown Creeper

Population Concentration (-10 to 10) -10

Does not concentrate.

Reproductive Potential

Age of First Reproduction (-5 to 5) -5

No data, but probably breeds in first year (Hejl et al. 2002b).

Number of Young (-5 to 5) 1

Lays 4-8 eggs (usually 5 or 6; Bent 1948, Davis 1978).

Ecological Specialization

Dietary (-5 to 5) -5

Eats mainly insects and other invertebrates, including immature stages, obtained from bark of tree trunks and branches; also eats some nuts and seeds (Terres 1980).

Habitat (-5 to 5) 1

Mainly associated with mid-successional to mature and old growth coniferous and deciduous forests (Kessler and Kogut 1985, Dellasala et al. 1996, Hejl et al. 2002b). Dead trees are an essential component of nesting habitat. Nests usually behind loose slab of bark still attached to living or dead tree. In interior Alaska, occurs in upland white spruce (Picea glauca) and mixed white spruce-birch (Betula papyrifera) forests (Spindler and Kessel 1980) and in cottonwood (Populus balsamifera) and mixed white spruce-birch forests (Kessel 1998). In Prince William Sound, found primarily in hemlock (Tsuga spp.)-Sitka spruce (Picea sitchensis) and mixed deciduous spruce woodlands (Isleib and Kessel 1973). In the Chugach Mountains of the Kenai Peninsula in southcoastal Alaska, the species occurred in forest stands over 100 years old and in a 10-year-old burn area; Brown Creepers were twice as abundant in the older stands (Quinlan 1979). In a study of island habitats in Southeast Alaska, creepers were found only in old growth habitats near saltwater, and were generally uncommon in that habitat (Kessler and Kogut 1985); on the mainland they were uncommon in spruce/hemlock forests (Gibson and MacDonald 1975).

Biological Total: -36

Action - variables measure current state of knowledge or extent of conservation efforts directed toward a given taxon. Higher action scores denote greater information needs due of lack of knowledge or conservation action. Action scores range from -40 (lower needs) to 40 (greater needs). **Score**

Management Needs (-10 to 10) 2

Managed and protected under the Migratory Bird Treaty Act.

Monitoring Needs (-10 to 10) 2

Trend precision not adequate (Dunn et al. 2005). Due to the species' cryptic plumage and high-pitched call, it may not be adequately monitored by existing survey programs (i.e. BBS, ORBBS, and Alaska Landbird Monitoring System, or ALMs).

Research Needs (-10 to 10) -4

Species is sensitive to loss and fragmentation of mature coniferous forest as a result of timber and salvage harvest (even partial cutting and thinning) and associated road construction, bark beetle, prescribed burns (Hejl et al. 2002b, Hayes et al. 2003, Quinlan 1978, Spindler and Kessel 1980, Collins et al. 1999, Hobson and Schiek 1999, Lance and Howell 2000, Chambers and McComb 1997). Studies have documented declines in densities in response to forestry practices, forest thinning, and fires (Hejl et al. 2002b, Hayes et al. 2003). Climate change may have large-scale effects on Alaska's forests. Warming trends have favored reproduction of spruce beetles and larch sawflies (Pristiphora erichsonii), leading to unprecedented outbreaks in the last decade (ADFG 2005a). Still need research on degree to which these disturbances affect populations.

Survey Needs (-10 to 10) -10

Little is known about migratory path. Small numbers have been captured at the Yakutat banding station (Andres unpubl. in Pogson et al. 1999). Habitat associations described for Chugach Mountains (Quinlan 1979), central Alaska (Spindler and Kessel 1980, Hannah et al. 2003), Anchorage (Andres pers. comm. in Pogson et al. 1999), Southeast (Gibson and MacDonald 1975, Kessler and Kogut 1985, Andres et al. 2004). Distribution captured by BBS (USGS 2006), CBC in southcentral (National Audubon Society 2002), and ALMS throughout their range (USGS 2008a).

Action Total: -10

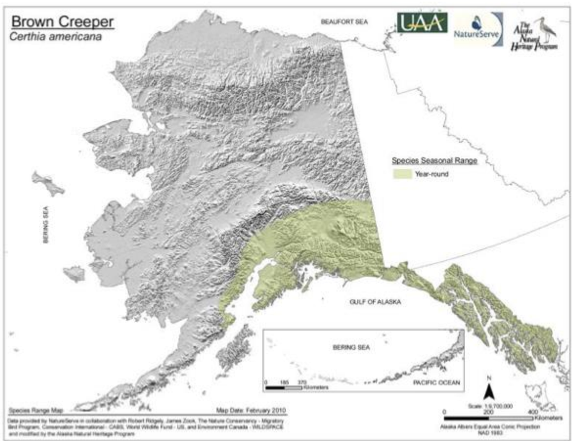
2

Supplemental Information

- variables do not receive numerical scores. Instead, they that are used to sort taxa to answer specific biological or managerial questions.

Harvest:	None or Prohibited
Seasonal Occurrence:	Year-round
Taxonomic Significance:	Monotypic species
% Global Range in Alaska:	<10%
% Global Population in Alaska:	<25%
Peripheral:	No

Range Map



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JOB/ACTIVITY 1B: Contract with web designer.

Accomplishments: During FY12 we worked with the Anchorage based web contracting agency, AXIOM Consulting and Design (http://www.axiomalaska.com/), to design and implement a project specific interactive website for the ASRS. This website is now accessible online at: http://aknhp.uaa.alaska.edu/zoology/wildlife-diversity/asrs/#content. . This is a beta-version (Phase I) of the ASRS website, as we anticipate this process to be iterative and occur over the course of three years.

JOB/ACTIVITY 1C: Develop web content and design web page with the assistance of web contractor and input from ADF&G Wildlife Diversity Program staff.

Accomplishments: Web-ready product development and web contractor information are described above under JOB/ACTIVITY 1A and 1B. In this activity, we created an interactive webpage where users can query for individual species summary reports. Users can navigate through an expandable table or search for an individual species using a text query to access summary reports and range maps for each species in the ASRS (http://aknhp.uaa.alaska.edu/zoology/programs/adfg-wildlife-diversity-cooperative/the-alaska-species-ranking-system-asrs/asrs-species-search-tool/). Users can also access a list of results for all taxa and are able to sort by the three ranking scores, or the final conservation categorization (http://aknhp.uaa.alaska.edu/zoology/wildlife-diversity/asrs/species-list/#content). Wildlife Diversity Program staff were consulted with periodically throughout the web-design process and provided comments on web-design, content, and future direction.

JOB/ACTIVITY 1D: Assist ADF&G with presentations to cooperators including conferences, meetings, and publications. This task included development of presentation materials for agency personnel and general users.

Accomplishments: We developed a MS PowerPoint presentation that summarizes the methodologies, findings, and utility of the ASRS, for various audiences. This presentation was given at the Alaska Bird Conference, November 2012. This presentation will be made available on the ASRS website during the next phase of the agreement (2013-2014). We also prepared the ASRS final report for publication in a peer-reviewed journal. This task will also be completed during 2013-2014, under the next phase of this research collaborative.

Objective 2: Continue to refine and develop Element Occurrences (EOs) for high ranking species, as well as ASRS category 1 to 5 species.

JOB/ACTIVITY 2A: Develop list of potential species that need new EOs or require updating.

Accomplishments: Using high scoring taxa from the ASRS and taxa with high Heritage State(S) or Global (G) ranks to help guide our decisions, we developed a list of species that either required new EOs to be built, or had not been reviewed over several years and required updating. From this list, we decided to focus most of our efforts on updating (maintaining) information for taxa we were already tracking in the AKNHP Biotics database, while continuing to develop new EOs for a few high ranking taxa. The full list of taxa undressed under the current contract is presented below under JOB/ACTIVITY 2B.

JOB/ACTIVITY 2B: Update/develop EO s for select species and enter into Biotics database. This task includes data discovery and acquisition as well as metadata development.

Accomplishments: We updated EOs for 15 taxa and created new EOs for four taxa. Results of this effort are summarized in Table 1. FGDC compliant metadata was prepared for each shapefile and is available for download at the Biotics web-portal: http://aknhp.uaa.alaska.edu/services/AKNHP/metadata/biotics_element_occurrence_metadata.htm.

Table 1. List of 12 taxa included in this year's EO updates. Taxa are listed by common name, scientific name, Heritage State- (S) and Global- (G) ranks (1 to 5) and ASRS Category (I to IX). Also provided are the number of EOs that existed in Biotics before the update, the number of new source features (individual point occurrence sources) added to create new EOs, and the resultant number of new EOs that were derived from the source features.

FY	Common Name	Scientific Name	S Rank	G Rank	ASRS Category /Color Code	# Existing EOs	# New source features	# New EOs
Updated EOs								
2013	St. Lawrence Island Shrew	*Sorex jacksoni*	S4	G4	VIII/ Yellow	7	2	0
2013	St. Lawrence Island Red-backed Vole	*Myodes rutilus albiventer*	S3S4	G5T3	IV/ Orange	1	55	2
2013	Keen's Myotis	*Myotis keenii*	S1S2	G2G3	IV/ Orange	11	8	2
2013	Polar bear	*Ursus maritimus*	S2	G3	II/Red	31	45	15
2013	Steller's Eider	*Polysticta stelleri*	S1B, S2S3N	G3	II/Red	123	1029	0
2013	Yellow-billed Loon	*Gavia adamsii*	S2S3B , S3N	G4	IX/Blue	723		
2013	Alaskan Hare	*Lepus othus*	S3S4	G3G4	VIII/ Yellow	26	14	4
2013	St. Lawrence Root Vole	*Microtus oeconomus innuitus*	S3	G5T3	VII/ Yellow	8	22	0
New EOs								
2013	Northern Pygmy Owl	*Glaucidium gnoma*	S3	G4G5	II/Red	0	70	18
2013	Northern Saw-whet Owl	*Aegolius acadicus*	S3	G5	V/ Orange	0	159	37
2013	Hudsonian	*Limosa*	S2S3B	G4	VII/	0	39	18

FY	Common Name	Scientific Name	S Rank	G Rank	ASRS Category /Color Code	# Existing EOs	# New source features	# New EOs
	Godwit	*haemastica*			Yellow			
2013	Bar-tailed Godwit	*Limosa lapponica*	S3B	G5	II/Red	0	305	45

We also initiated data discovery for seven additional taxa: little brown myotis, Californai myotis, Pacific walrus, Pribilof Rock Sandpiper, Aleutian Tern, Red-face Cormorant, and Prince of Wales Flying Squirrel. EO updates for these taxa will be completed during FY14 under the next phase of this project.

JOB/ACTIVITY 2C: Maintain searchable on-line system for species of concern data.

Accomplishments: During this phase of the project we update and maintained the on-line spatial web portal (referred to as the Biotics portal) that serves EO, range, and conservation status information for individual terrestrial vertebrate taxa via the AKNHP website (http://aknhp.uaa.alaska.edu/maps/biotics/#).

In summary, we:

- Addressed general maintenance issues and participated in a data exchange with NatureServe.
- Began preparations for upgrading to a new web-based version of Biotics. The conversion from the Oracle-based Biotics to the web-based interface will occur in November 2013.
- Worked with Axiom (web-designers) to make the following updates to the portal:
    - Updated content and established a mechanism for automatically updating the portal content monthly.
    - Added range maps and a mechanism to allow users to download them as GIS shapefiles.
    - Redesigned the web interface to make it more user-friendly.
    - Updated the bounding box query function so users can generate a species list for a given area and download all the EOs and range maps that intersect that area.
- Filled data requests
    - Approximately ~100 users/month entered the Biotics portal.
    - Responded to 25 data request via email since July 1, 2012. Additional data request were likely filled without the assistance of AKNHP staff by users downloading data directly from the Biotics web portal on their own.
        - Breakdown of 25 data requests: Educational: 3, Non-profit: 3, State and federal government: 4, Private and consulting: 15.

Objective 3: Conduct inventories for rare and data deficient species.

Accomplishments: We conducted surveys for endemic small mammal taxa on St. Lawrence Island during July 2012. We are preparing our findings for submission into the journal *Northwest Naturalist*. Here we provide a draft version of the manuscript in fulfillment of this task. Please do not distribute or cite without permission of the authors.

OCCURRENCE AND STATUS OF SMALL MAMMALS ON ST. LAWRENCE ISLAND, ALASKA

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Abstract—St. Lawrence Island's unique biogeographic history as an intermittent landmass and refugium of the Bering Land Bridge during the last glacial interval has resulted in the evolution of several insular endemic small mammal taxa on the island including: the St. Lawrence Island shrew (*Sorex jacksoni*) and subspecies of the northern red-backed vole (*Myodes rutilus albiventer*), root vole (*Microtis oeconomus innuitus*), Nearctic collared lemming (*Dicrostonyx groenlandicus exsul*), and arctic ground squirrel (*Spermophilus parryii lyratus*). Early studies of these mammalian taxa in the 1950s-70s focused on specimen collection efforts to identify the taxa and their general distributions and habitat associations. More up to date information on the basic ecology of these taxa are lacking. Our objective was to update the available information on the distribution, status, habitats, and ecology of small mammals on St. Lawrence Island in the Bering Sea of Alaska. We captured 61 individuals from the 19th to the 27th of July 2012 using Sherman and pitfall traps placed in all major habitat types near the villages of Gambell and Savoonga. We compared out trapping results to earlier studies to determine the current status, distribution, and relative abundance of each taxa in relation to previous years. In 2012, we found that root and northern red-backed voles were most abundant, occurring in mesic and mesic to dry dwarf shrub and herbaceous habitats, respectively. Arctic ground squirrels were observed in mesic to dry habitats, particularly areas with sandy soil or rocky outcrops. The St. Lawrence Island shrew was the least abundant of the species we captured (n= 2), and was found exclusively in the rocky auklet colonies near Savoonga. Despite our trapping efforts targeted in habitats where Nearctic collared lemmings were thought to occur, we were unable to capture or observe lemmings in any habitat. Although this survey was limited to a relatively short time period, its finding suggest the need for additional surveys to determine the status of the Nearctic collared lemming and to determine factors that regulate the population size of each of the small mammal species on the island.

Key words
Nearctic collared lemming, northern red-backed vole, root vole, St. Lawrence Island shrew, small mammals**,** conservation status, habitat, survey, western Alaska

INTRODUCTION

St. Lawrence Island, Alaska, located in the northern portion of the Bering Sea, was connected intermittently to mainland Alaska and Russia by the Bering Land Bridge during the last 50 million years of the tertiary and quaternary time periods (Hopkins 1959). The Bering Land Bridge allowed interchange of fauna between Asia and North America (Sempson 1947) and served as a refugium for taxa from advancing ice sheets (Hulten 1937). During the Land Bridge time period, St. Lawrence Island would have been an isolated highland on the temporary landmass. As a result of being connected, then isolated from neighboring continents over time, a unique set of small mammal taxa have evolved on St. Lawrence Island that differ from taxa on the mainland of Alaska and Russia. Small mammals endemic to the island include the St. Lawrence Island shrew (*Sorex jacksoni*), and subspecies of the northern red-backed vole

(*Myodes rutilus albiventer*), root vole (*Microtis oeconomus innuitus*), Nearctic collared lemming (*Dicrostonyx groenlandicus exsul*), and arctic ground squirrel (*Spermophilus parryii lyratus*). The Nearctic collared lemming occurs from Alaska through the high arctic of Canada and into northern Greenland (Hall 1981; Nagy and Grower 1999), with St. Lawrence Island at the western edge of its range. In contrast, the northern red-backed vole and root vole occur across northern Eurasia, Alaska, and northwestern Canada (Musser and Carleton 2005). The global range of the arctic ground squirrel is similar to the voles except it is less widely distributed in Eurasia, being restricted to northeastern Siberia (Hall 1981; Thorington and Hoffmann 2005). The St. Lawrence Island shrew is restricted to St. Lawrence Island and its exact relationship to other Beringian shrews is unresolved (Demboski and Cook 2003).

The first biological studies of the small mammals on St. Lawrence Island focused on specimen collections to inventory taxa and determine taxonomic uniqueness and relationships to other taxa in the Beringian region (Hall and Gilmore 1932; Murie 1936; Rausch 1953; Fay 1973). More recent studies (e.g., Demboski and Cook 2003; Galbreath and Cook 2004) have continued to investigate the phylogenetic relationships of several taxa using molecular techniques; yet in spite of these other surveys there is still a lack of recent information on the distribution, status, habitat use, and ecology of small mammals on St. Lawrence Island. In 1932, Hall and Gilmore published an account of three previously undescribed taxa on the island (arctic ground squirrel, St. Lawrence Island shrew, and northern red-backed vole) based on morphology of specimens collected in 1931. In 1936 Murie published notes from specimens recovered by Mr. Geist in the 1930s from an archeological dig in the ancient village site of Kukulik, near the present day village of Savoonga on the northern coast. In the 1950s-1970s Rausch (1953) and Fay (1973), conducted more detailed studies gathering specimens, updating taxonomic classifications, and recording brief descriptions of distribution and abundance of all land mammals on the island as part of an animal-borne disease study. These initial studies have formed the foundation of knowledge on the distribution, status, and habitat preferences of the small mammal taxa. Several additional studies have focused on using morphological and more recently, molecular techniques to [illegible] the taxonomy and phylogenies of these taxa. Existing small mammal specimens in the University of Alaska Museum (UAM) collection from St. Lawrence Island include [illegible]2 arctic ground squirrels, 35 St. Lawrence Island shrews, 13 Nearctic collared lemmings, 36 northern red-backed voles, and 195 root voles (Link Olsen, University of Alaska Fairbanks, Fairbanks, AK, pers. comm.). The majority of these specimens were collected during the 193[illegible] or earlier. More recent collections are lacking.

More recently, the need to collect and compile information on these endemic small mammals has been recognized by international (Hafner and others 1998) and state agencies (ADF&G 2006). The Rodent Specialist Group (Hafner and others 1998) suggests identifying immediate threats to survival and conducting surveys on St. Lawrence Island to monitor the population of ground squirrels at regular intervals, to determine the status of Nearctic collared lemmings, and to determine the distribution and population status of root voles. The Alaska Wildlife Action Plan (ADF&G 2006) highlights the need to collect and archive material to examine taxonomic distinctiveness and to map the spatial distribution of taxa to examine habitat usage of insular endemic small mammals in southwestern Alaska and the Bering Sea region.

The goal of this survey was to update the status, distribution, and habitat usage of small mammal taxa on St. Lawrence Island by trapping near the villages of Gambell and Savoonga. Specifically, our objectives were to 1) Inventory the current small mammal taxa inhabiting St. Lawrence Island, 2) Determine distribution and detailed habitat associations for each taxon, and

3) Update the conservation status of each taxon, including identifying current and future threats to survival.

METHODS

Study Area

St. Lawrence Island is located in Bering Sea approximately 130 miles west of the mainland of western Alaska and 40 miles southeast of the Chukchi Peninsula in Russia (Patton and Csejtey 1971). The island is approximately 100 miles long and 10 to 40 miles in width, making up a total of 2,000 square miles in area (Young 1971). The climate is characterized by short, cool summers and relatively high precipitation for an arctic region. The growing season is from early June through August with daily highs in the summer [illegible] above 10° C. From early winter through spring, St. Lawrence Island is surrounded by the polar ice pack, making it relatively cold for its maritime geography (Young 1971).

About half of the island is low lying below [illegible] meters in elevation and is characterized by wet and moist tundra vegetation intermixed with swallow lakes and ponds. Mountainous regions in the southwestern (Poovookpuk Range), central (Kookooligit Range), and northeastern (Kinipaghulghat Range) portions of St. Lawrence Island reach up to [illegible] meters and are characterized by drier alpine vegetation and rocky areas dominated by granite rocks on the western and eastern ends of the island and lava flows and cinder cones in the central portion (Young 1971; Fay 1973).

Trapping

We trapped small mammals from the 19th to the 27th of July 2012 in areas accessible by all-terrain vehicle (ATV) from the villages of Gambell and Savoonga on the northern coast of St. Lawrence Island. We set traps in three major terrestrial habitat types. Young (1971) classified the island into three terrestrial habitats: bog and wet tundra, mesic tundra, and alpine and fell-field. Bog and wet tundra was described as occurring at low elevations with close to 100% vegetation cover. The wettest areas were dominated by *Carex aquatilis*, while *Eriophorum angustifolium* and areas with slightly better drainage were dominated by *Duponita fisheri*. Wet areas were interspersed with *Sphagnum* tussocks, frost boils, and raised polygons. Young's (1971) mesic tundra habitat type included a variety of well drained habitats such as upland tundra, riparian gravel areas, and coastal beaches and shores. The alpine fell-field habitat (Young 1971) occurred from sea level to high elevations and was often dry with considerable cover of granite or lava rocks, licheans, and sparse herbaceous vegetation. We described capture locations and habitat usages of taxa using a more recent, statewide vegetation classification system, the Alaska vegetation classification system (Viereck and others 1992). This hierarchical classification system is based on plant community characteristics such as composition of dominate species, vegetation height (for shrubs), canopy closure (for forest and shrubs), and moisture level (for herbaceous). As a result, in this study we classified the plant communities on St. Lawrence Island primarily based on height and composition for shrubs, and composition and moisture level for herbaceous vegetation (see results for a more detailed description of habitats we trapped in).

We established transects at sites where previous specimens were collected, as well as in new areas with habitats where target species were expected to occur. Target species included the root vole, northern red-backed vole, Nearctic collared lemming, and St. Lawrence Island shrew. We did not attempt to capture arctic ground squirrels; however, we recorded the habitats in which ground squirrels were observed. We spent more time trapping in locations where rarer species were expected (i.e., collared lemming and St. Lawrence Island shrew) in comparison to areas where we repeatedly captured only the most common species (i.e., root voles). Transects were placed in a single habitat type when possible and consisted of a series of trapping stations spaced every 5 to 10 meters. At each trapping station, 2 Sherman box traps and/or pitfall traps were placed within 2 meters of each other. Pitfall traps were constructed of 13 cm deep (35.5 ounce) cups buried flush with the ground. When possible, we placed traps in microhabitats that had indications of high animal use, such as along runways, near burrow entrances, and near areas with browsed vegetation. We baited Sherman traps with a mixture of peanut butter and rolled oats and pitfall traps were not baited.

Trapping sessions ranged from 4 to 8 hours and occurred both during the day and at night. Depending on the species and number of individuals captured, transects were kept open from 4 hours (1 trapping session for pitfall traps) to [illegible] days (multiple trapping sessions). For each individual captured, we recorded standardized body length measurements, mass, sex, and breeding condition, and then released the individual. For each transect and within a 5 meter radius of each capture location we characterized the vegetation to level III of Viereck and others (1992) Alaska vegetation classification system. All mortalities were collected as specimens, and were immediately frozen and sent to the University of Alaska Museum (UAM) to be archived in the small mammals collection. We calculated capture success as the number of captures per 100 trap hours. Traps that were sprung (e.g., triggered without a capture) were not included in this calculation.

RESULTS

We captured a total of [illegible] small mammals in [illegible] trap hours. Captures included 22 root voles, 37 northern red-backed voles, and [illegible] St. Lawrence Island shrews (Table 1). No Nearctic collared lemmings were captured. Captures were along 10 transects that were set within a 2 mile radius of the villages of Gambell and Savoonga in all [illegible] major habitats (i.e., graminoid, forb, and dwarf shrub plant communities). All captures were made in Sherman traps.

TABLE 1. Trapping effort and captures for each transect, expressed as trap hours, capture success (captures per 100 trap hours) and number of captures, St. Lawrence Island, July 2012.

Transect No. and Location		No. Stations	Trap Hrs.	Capture Success	No. and Identification of Individuals Captured
Gambell					
1	Lower slope of Sevuokuk Mtn	9	161.9	3.7	4 root voles and 2 red-backed voles
2	Lower slope of Sevuokuk Mtn	10	163.8	1.2	2 root voles
3	West shore of Troutman Lk	29	487.6	2.7	13 root voles
4	Base of Sevoukuk Mtn south of Gambell	14	362.2	0.6	2 red-backed voles
5	Northeast side of Troutman Lk	15	346.5	[illegible]	0 captures
6	Base of Sevoukuk Mtn near boneyard	10	18[illegible]	0.0	0 captures
7	Wetland south of Troutman Lk	10	81.[illegible]	0.0	0 captures
Savoonga					
1	Auklet colony 1 mile east of village	21	1183.4	1.[illegible]	1 St. Lawrence Island shrew, 2 root voles, 20 red-backed voles
2	Auklet colony 2 miles east of village	20	853.[illegible]	1.2	1 St. Lawrence Island shrew, 1 root vole, 8 red-backed voles
3	3 miles west of village	25	[illegible]122[illegible]	0.5	5 red-backed voles

Descriptions of Habitats

Our trapping efforts were focused specifically in herbaceous and dwarf shrub habitats that dominate the vegetation cover of the island (Table 2). We trapped in wet and dry graminoid herbaceous, mesic and dry forb herbaceous, and Dryas and ericaceous dwarf shrub habitats. The wet graminoid herbaceous habitats were in low lying areas with saturated soils. The vegetation in these wetter areas was generally characterized by *Carex aquatilis*, *Dupontia fisheri*, and sphagnum moss mixed with other wet tundra associated species at low abundances. The mesic forb herbaceous habitats we trapped in had better drained soils and were at both low elevations and on hillslopes. The vegetation was co-dominated by a variety of small herbs, graminoids, and dwarf shrubs, often interspersed with boulders. The soils in both the dry forb and dry gaminoid herbaceous habitat types were well drained. The dry graminoid herbaceous habitat in which we focused our trapping effort in, was located along the shoreline of a large inland lake. The habitat was characterized almost exclusively by beach pebbles, *Leymus mollis*, and *Artemisia tilesii.* Similar habitat was also located along much of the coastline, just inland of the shoreline zone. The dry forb herbaceous habitat was more diverse than the dry graminoid and occurred on transects in rocky coastal uplands in active auklet colonies. The auklet colonies were characterized by boulder fields interspersed with vegetation patches containing a diversity of forbs, graminoids, and dwarf shrubs. Dryas and ericaceous dwarf shrub habitats also occurred on well-drained soil and were at mid to high elevations on upland tundra and in mountainous areas. The Dryas dwarf shrub habitat we trapped in was characterized by a combination of boulders, mosses, *Dryas* sp., *Cassiope* sp., and lichens. The ericaceous dwarf shrub habitat was characterized by dwarf willow (*Salix polaris*), *Empetrum nigrum*, *Carex* sp., mosses, and lichens interspersed with boulders.

We used the National Land Cover Database (NLCD) to spatially visualize the distribution of plant communities on St. Lawrence Island. Although the NLCD land cover classification does not contain the exact same cover classes as the Viereck and others (1992) classification system that we used, it does give a gauge of the area and distribution of major land cover types across the entire island (Fig. 1).

TABLE 2. Classification of the vegetation on survey transects using the Alaska vegetation classification system (Viereck and others 1992).

Transect	**Viereck Classification**	**Ground Cover**	
		Dominate	**Sub-dominate**
Gambell			
1 and 2	III. B. 2. Mesic forb herbaceous	Mosses and *Wilhelmsia physodes*	*Artemisia tilesii*, *Petasites frigidus*, boulders up to 3.0 m diameter
3	III. A. 1. Dry graminoid herbaceous	*Leymus mollis*	*Artemisia tilesii*, beach pebbles
4	II. D. 2. Ericaceous dwarf shrub	*Salix polaris*, boulders up to 3.0 m diameter, lichens	*Empetrum nigrum*, *Carex sp.*, mosses, lichens
5	III. A. 2. Wet graminoid herbaceous	Mosses, *Rumex arcticus*	*Carex aquatilis*, *Dupontia fisheri*, *Arctagrostis latifolia*, lichens, boulders
6	Mix of: III. B. 2. Mesic forb herbaceous and [illegible]ted	Beach pebbles	*Artemisia tilesii* and mosses
7	III. A. 2. Wet graminoid herbaceous	*Dupontia fisheri*, *Puccinellia langeana*, *Carex glareosa*	-
Savoonga			
1	III. B. 1. Dry forb herbaceous	Boulders up to 0.6 m diameter	Mosses, *Salix arctica*
2	III. B. 1. Dry forb herbaceous	Boulders up to 1 m diameter	Mosses, *Arctagrostis sp.*
3	II. D. 1. Dryas dwarf shrub	Boulders up to 1 m diameter	Mosses, *Dryas sp.*, *Cassiope sp.*, Lichens

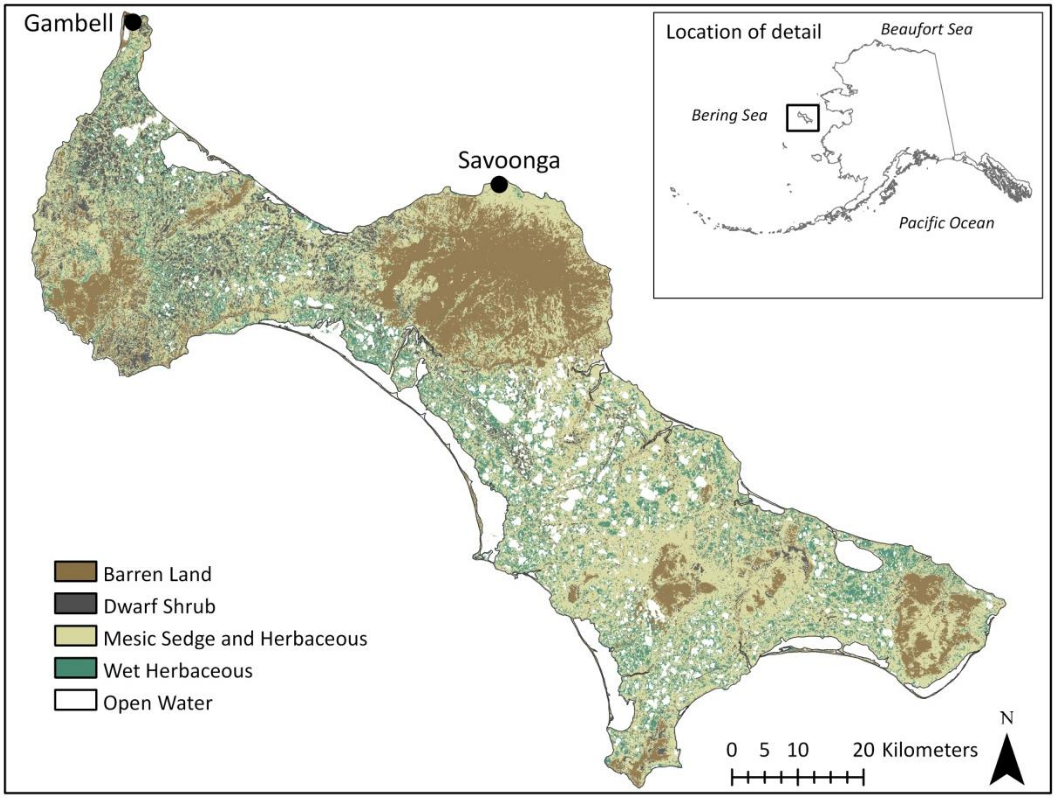

FIGURE 1. Five major National Land Cover Database (NLCD) classes on St. Lawrence Island. The percent of the island classified as each class is approximately: [illegible]% barren land, 10% dwarf shrub, 45% mesic sedge and herbaceous, 14% wet herbaceous, and 12% open water.

Patterns of Habitat Use

Trapping in dry graminoid and mesic forb herbaceous habitats yielded the greatest number of captures followed by forb herbaceous, Dryas and ericaceous dwarf shrub, and the lowest capture success was in the wettest tundra habitats . Root voles were captured and observed in a variety of habitats, primarily at mid to lower elevations. The dry graminoid habitat had the highest overall capture rate of 2.67 individuals per 100 trap hours and was used exclusively by root voles (Fig. 2). The high density of root voles in this habitat was evident by the impressive number of burrows in the vegetation patches of *Artemisia tilesii* that were connected by extensive systems of runways through the beach pebbles and *Leymus mollis* (beach rye). Two transects in mesic tundra that were characterized by forbs, also had an abundance of root voles. Root voles were also captured in low numbers along the periphery of rocky dry forb habitat of the auklet colonies east of Savoonga. Root voles were absent from drier sites characterized by dwarf shrubs and lichens and the wettest graminoid habitats. Northern red-backed voles were common in drier sites than root voles, although both species co-occurred on the mesic transects. Northern red-backed voles dominated the captures, with a capture rate of 1.37 captures per 100 trap hours, in the dry forb habitat of the auklet colony near Savoonga. In the auklet colony, burrows were typically located adjacent to rocks and runways traversed through vegetation patches and boulder fields. Northern red-backed voles were the only species captured in the dwarf shrub habitats; although, the capture success was lower at 0.47 captures per 100 trap hours. Burrows within the dwarf shrub habitats were also typically within rocky outcropping. Two St. Lawrence Island shrews were captured, both during daytime trapping sessions, in dry forb patches within the auklet colony east of Savoonga. Although ground squirrels were not captured, observations were made in mesic to dry habitats, and squirrels were often observed in areas with some topography to allow a view of the surrounding landscape, such as small hills, banks of riverbeds, and rocky outcroppings. Overall, no small mammals were trapped or observed along transects located in wet graminoid herbaceous habitats. Soils were completely saturated with water and represented the wettest terrestrial habitat on the island. Small burrows and runways were observed in these wet areas; however, it was difficult to determine the intensity, time period, and seasonality of last use.

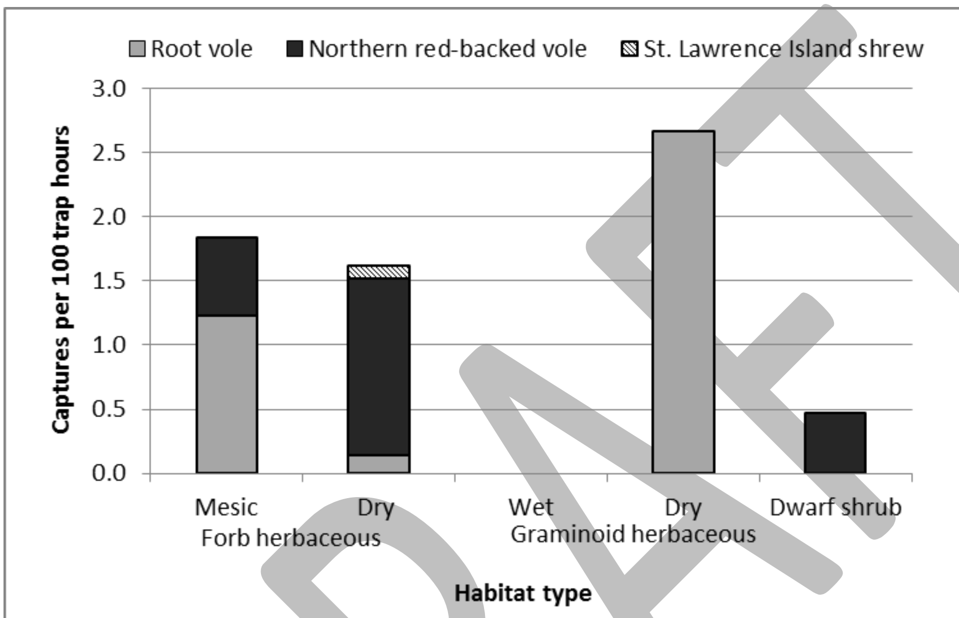

FIGURE 2. Capture rate (per 100 trap hours) for each taxon by major habitat type, St. Lawrence Island, July [illegible]

DISCUSSION

This survey confirmed the presence of [illegible] small mammal taxa on the Island and suggests that additional surveys are needed to more thoroughly assess the status of the Nearctic collared lemming and St. Lawrence Island shrew. Although this survey was limited to a relatively short time period in a single year, it still provides base information on the current status and habitat preferences of small mammals.

By accounting for the capture rate of each taxon by habitat type and the relative abundance of each habitat on the island, we qualitatively ranked the relative abundance of each taxon. We found that root voles were the most abundant species occurring in mesic areas that make up a large part of the low lying areas of the island. The second most abundant species was the northern red-backed vole, which was found in mesic to dry areas, often at slightly higher elevations than the root vole. Arctic ground squirrels were the next most abundant species and were often observed in mesic to dry habitats, particularly areas with sandy soil or rocky outcrops. The St. Lawrence Island shrew was the least abundant of the species we captured, and was found exclusively in rocky auklet colonies. We were unable to capture Nearctic collared lemmings in any habitat.

Patterns of Abundance and Habitat Use

Our survey effort resulted in only 2 St. Lawrence Island shrew captures, which indicates the need for regular survey efforts to better understand their distribution and abundance. Previous surveys on St. Lawrence Island also found this species was scare. In 1931, Hall and Gilmore's (1932) collecting efforts resulted in specimens only from within an auklet colony, although they trapped in wet tundra and offered a reward to local residents for specimens. However, according to Fay (1973) the number of shrews was highly variable from year to year, with periods of abundance. When abundant, shrews were found in old village sites, rocky alpine tundra, and mesic tundra and when scarce they were only found in rocky, boulder scree habitats, especially in auklet colonies (Fay and Sease 1985). Our captures were in a rocky boulder field of an auklet colony. The rarity and confinement to the auklet colony suggests that the St. Lawrence Island shrew was uncommon in the areas we sampled in 2012. The habitat requirements of shrews are often related to invertebrate abundance and physical conditions (Nagorsen 1996). We recommend conducting regular surveys to determine population dynamics and to determine the factors that limit population size and distribution on St. Lawrence Island.

Our survey effort resulted in no captures of the Nearctic collared lemming. This species seems to have always been uncommon, occurring at low densities on the island, and is considered the rarest of the indigenous mammals on St. Lawrence Island (Murie 1936; Fay 1973; Fay and Sease 1985). In previous surveys on St. Lawrence Island, collared lemmings have been found almost exclusively in high elevation dry habitats such as rocky areas with heath-lichen vegetation (Rausch and Rausch 1972). An inventory in Alaska's arctic National Parks found the collared lemming was uncommon and it took thousands of trap nights to collect only 11 specimens (Cook and MacDonald 2006). A survey along the Goodnews River in southwest Alaska also noted the lack of lemming specimens collected in the area (Peirce and Peirce 2005). Collared lemmings are known for their cyclic population trends in Alaska (MacDonald and Cook 2009). Elsewhere in the Nearctic, lemmings are key species in tundra ecosystems as their multiannual population fluctuations directly influence the productivity of higher (i.e., predatory birds, carnivorous mammals) and lower (plant communities) trophic levels (See summaries of trophic interactions in Ims and Fuglei 2005; Reid and others 2012). Fay (1985) suggested that on St. Lawrence Island, the root vole fills the so called "lemming niche" as the primary herbivore and principle prey for predatory birds and arctic fox. When found on St. Lawrence Island, the lemming has been in habitats with few or no competitors (Fay 1985), suggesting it may be excluded from habitats by other competing small mammals. We recommend conducting additional surveys to determine if this subspecies is still present on St. Lawrence Island. If present, we suggest monitoring the population to determine if its population is cyclic or simply present at low densities and to determine the lemming's role in the dynamics of the ecosystem, particularly as a food source to predators.

The root vole was the most abundant small mammal in 2012. We captured and observed root voles in a variety of herbaceous habitats, especially in mesic herbaceous vegetation and in a riparian beach area. Since root voles were easy to capture in Sherman traps because they were so prevalent in lowland areas, we instead focused much of our trapping efforts on the other less common and poorly understood species. Fay and Sease (1985) described the root vole as the most abundant small mammal on the island. This species is reported to be weakly cyclic over a 3 to 4 year period (Rausch 1953; Rausch and Schiller 1956; Fay 1973) and is the primary herbivore on the island and the main prey source for arctic fox and predatory birds (i.e., jaegers and snowy owls; Fay and Sease 1985). Previous studies have also recorded the root vole in mesic habitats dominated by sedge and moss (Fay and Sease 1985).

Northern red-backed voles were the second most abundant small mammal in 2012, and co-inhabited mesic areas with the root vole and were the primarily mammal occupant in dry dwarf shrub and rocky alpine habitats. Northern red-backed voles have a more omnivorous diet (i.e., seeds, fruits, leaves) than root voles (primarily graminoids; Cook and MacDonald 2006) and therefore may be better suited for these shrub and forb dominated habitats. Rausch (1953) found the northern red-backed vole difficult to collect and only 4 specimens were collected in comparison to 600 of the root vole and 2 of the collared lemming. Similarly, Hall and Gilmore (1932) collected only 3 specimens in 1931, compared to 35 for the root vole, 16 for the St. Lawrence Island shrew, and 3 for the collared lemming. These historical accounts indicate this species is not always as abundant as in 2012. We recommend monitoring the population to determine if it is cyclic and to determine if competition with the root vole has a large influence on the abundance and distribution of this species.

We observed ground squirrels in a variety of mesic to dry habitats and they were fairly common in abundance in 2012. In the past, ground squirrel have been considered scarce (in 1931; Hall and Gilmore) to common (Murie 1936; Rausch 1953; Fay 1973). We observed ground squirrels in similar habitat types to others, including sandy, rocky, drier tundra (Hall and Gilmore), mesic tundra (Fay 1973), and more barren areas (Fay and Cade 1959).

Conservation Status and Threats

NatureServe conservation status ranks assess the rarity of taxa based on the risk of extinction or extirpation at the global (G) and state (S) geographic scales using rarity, threat, and trend information. Ranks range for critically imperiled (G1/ S1) to secure (G5/S5) (Faber-Langendoen and others 2012). The NatureServe global status ranks for the St. Lawrence Island subspecies of ground squirrel, collared lemming, northern red-backed vole, and root vole are G5T3 (T-rank symbolizes the status of subspecies which follows the species level global rank) and the state ranks are S3 (S2 for the northern red-backed vole), indicating they are vulnerable. The S-rank of the northern red-backed vole, arctic ground squirrel, and root vole are assigned based on a restricted range size, unknown abundance and population trend, and low threat risk. The Nearctic collared lemming rank is based on similar reasons except its population is suspected to be abundant instead of unknown. The St. Lawrence Island shrew is currently ranked as G4, S4 (apparently secure) based on scant information which predicted a high (>10,000 individuals) abundance, unknown population trend, a restricted range size, and a low threat risk. Our study has revealed the St. Lawrence Island shrew and Nearctic collared lemming likely undergo periods of low abundance and their status ranks should be lowered to reflect their potential rarity; whereas, the root vole appears to be abundant and its rank should indicate it is more secure then some of the other taxa (Tracey can you expand on this section since you are more familiar with the process of assigning NatureServe ranks).

The range of all these endemic taxa are restricted to a single island, furthermore, the distribution of each taxon is restricted to the habitats it utilizes, both of which pose a suite of threats common to endemic insular species. Likewise, the population sizes for all taxa are relatively small because of the restricted range. The root vole uses the vast interconnected lowland areas of the island, so threats may be lower than for species such as the St. Lawrence Island shrew and possibly the Nearctic collared lemming that may occur in low densities and utilize patchy habitats that are not as broadly distributed or interconnected. In general, human destruction and degradation of habitat is not a large threat on St. Lawrence Island as human activity is confined to within several miles of the 2 major village sites. The introduction of non-native species by humans, such as Norway rats could threaten populations in the future; with the primarily mode of entry likely being within cargo on airplanes. Predation is limited to a few major predators (primarily arctic fox, low densities of jaegers, snowy owls) and competition may occur for food resources (primarily plants), between voles, lemmings, ground squirrels, and introduced reindeer (Fay 1985). However, the abundance of small mammals and low density of predators, especially avian predators, in 2012 indicate predation was not likely limiting populations that year. There was no evidence of overgrazing of food resources in 2012. Fay (1985) suggested Nearctic collared lemmings may be restricted to drier alpine sites because of competition with other small mammals. If predation is not limiting individual populations, competition between the small mammal taxa may occur as population sizes increase.

Climate change may pose a major threat in the future. Climate change has the potential to cause complex changes in arctic regions as a result of interactions between multiple components (e.g., terrestrial, freshwater, and marine habitats, species and trophic interactions, etc.) in the ecosystem (Post and others 20[illegible]). Arctic islands ecosystems are particularly vulnerable to climate because they have very little functional redundancy among taxa in comparison to a more speciose systems (Post and others 2009). A myriad of changes are possible, such as (but not limited to) changes to food quality and availability, changes to distribution of predators, changes in temperature and precipitation that may cause declines in populations and range contraction in specialized taxa (Post and other 2010; Reid and others 2012).

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II. PUBLICATIONS

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