IDAHO DEPARTMENT OF FISH AND GAME

Virgil Moore, Director

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Final Statewide Report
State Wildlife Grant Program

STATE WILDLIFE ACTION PLAN IMPLEMENTATION

July 1, 2017 to June 30, 2018

Prepared by:

Michael Lucid .... Panhandle Region
Joel Sauder .... Clearwater Region
Bill Bosworth, Diane Evans-Mack .... Southwest Region
Ross Winton .... Magic Valley Region
Becky Abel .... Southeast Region
Matt Proett .... Upper Snake Region
Beth Waterbury .... Salmon Region
David Smith .... Grants Specialist

Compiled and edited by: Rita Dixon, State Wildlife Action Plan Coordinator

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State: Idaho

Grant number: F17AF00770

Grant name: State Wildlife Action Plan Implementation

Report Period: July 1, 2017 through June 30, 2018

Report due date: September 28, 2018

Location of work Statewide

If the work in this grant was part of a larger undertaking with other components and funding, present a brief overview of the larger activity and the role of this project.
N/A

Describe how objectives were met:
See individual project reports contained herein.

Discuss differences between work anticipated in grant proposal and grant agreement, and that actually carried out with WSFR grant funds; include differences between expected and actual costs
N/A

List any publications or in-house reports resulting from this work.
See Appendix.

Project 1—Panhandle Region SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are addressed as specific needs identified in the following 3 sections: Okanogan Highlands, Flathead Valley, and Bitterroot Mountains. The SWAP describes the need for developing a climate monitoring program, maintaining or restoring connectivity, and controlling invasive, nonnative species.

1. An informational need exists to correlate how changes in climate are reflected in impacts to species and habitats. The changing climate will impact SGCN in various ways and before management decisions can be formulated, more information is needed.

2. Habitat fragmentation across the country is likely to result in the disruption of gene flow, which will require an assessment of genetic connectivity across the Okanogan Highlands, Flathead Valley, and Bitterroot Mountains sections. For example, Fisher was nearly or completely extirpated from the lower 48 states in the early 20th century. A variety of human-mitigated recolonization events for Fisher have likely affected the genetic structure of populations of this species. Fisher populations likely have low genetic diversity due to founder affects. Proper habitat management and gene flow mitigation may help to reduce genetic isolation and increase species occurrence on the landscape. Consequently, the need exists to conduct genetic analyses to determine current population size and levels of gene flow.

3. An imminent need exists to initiate control and extirpation efforts on the most northern American Bullfrog (*Lithobates catesbeianus*) populations in Idaho to prevent their dispersal into British Columbia. Surveys indicate that the Northern Leopard Frog (*Lithobates pipiens*) has been extirpated from the Okanogan Highlands (Lucid et al. 2016). The closest known colony of this species occurs at the Creston Valley Wildlife Management Area in British Columbia, Canada. This population could potentially serve as a source population for human-assisted reintroduction or natural recolonization efforts. Nonnative American Bullfrogs occur on the US side of the border but have not been detected on the British Columbia side.

Purpose

The purpose of this project is to:

1. provide leadership for SWAP adaptive management teams in the Okanogan Highlands–Flathead Valley and Bitterroot Mountains sections
2. develop a microclimate and multiple SGCN monitoring program
3. develop regional capacity to implement conservation actions for selected bumble bee SGCN
4. advance Northern Leopard Frog conservation in the Okanogan Highlands
5. assess Fisher population status in the Flathead Valley

6. explore the feasibility of implementing a project to assess (and potentially maintain) or restore areas of genetic connectivity in the Forested Lowlands of the Okanogan Highlands

Results or Benefits Expected

- Establishment and implementation of SWAP adaptive management teams for the Okanogan Highlands–Flathead Valley and Bitterroot Mountains sections.
- Development of a microclimate and multiple SGCN monitoring program.
- Incorporation of bumble bee forage foods in ITD roadside vegetation seed mixtures.
- American Bullfrog control will reduce the potential spread of this nonnative species into native Northern Leopard Frog colonies in the Creston Valley Wildlife Management Area, British Columbia, and Canada.
- We will determine if adequate data exist to conduct a population estimate of Fisher in the Flathead Valley Section of Idaho.
- We will identify areas of current and historical connectivity for multiple species in the Forested Lowlands conservation target of the Okanogan Highlands and determine appropriate actions for maintaining or restoring key habitats to promote genetic diversity within wildlife populations.

Approach

1. The objective for this approach is to lead SWAP adaptive management teams for the Okanogan Highlands–Flathead Valley and Bitterroot Mountains sections; organize and conduct at least 1 meeting for each team by 31 December 2017 (5–10 days). The Adaptive Management Team project will consist of in-person and telephone meetings to establish Idaho State Wildlife Action Plan (SWAP) teams and discuss implementation of SWAP goals for the Okanogan Highlands–Flathead Valley and Bitterroot Mountains sections. The project has no physical footprint and will occur August–December 2017.

2. The objective for this approach is to coordinate with other staff and non-IDFG partners, develop a microclimate and multiple SGCN monitoring program for the following species: Tier 1: Wolverine (*Gulo gulo*) Magnum Mantleslug (*Magnipelta mycophaga*), Western Bumble Bee (*Bombus occidentalis*), and Suckley's Cuckoo Bumble Bee (*B. suckleyi*); Tier 2: Northern Leopard Frog (*Lithobates pipiens*), Fisher (*Pekania pennant*), a roundback slug (*Hemphillia* sp. 1), and Western Toad (*Anaxyrus boreas*); Tier 3: Clark's Nutcracker (*Nucifraga columbiana*), Mountain Goat (*Oreamnos americanus*), Hoary Marmot (*Marmota caligata*), Pale Jumping-slug (*Hemphillia camelus*), the mayflies *Paraleptophlebia falcula* and *Parameletus columbiae*, and Clearwater Roachfly (*Soliperla salish*). Okanogan Highlands, Flathead Valley, and Bitterroot Mountains (90–100 days). This microclimate and co-occurring SGCN program consists primarily of office work including planning, data analysis, and meetings. Field work may include establishment of microclimate data loggers and Idaho SGCN surveys with a variety of techniques including terrestrial gastropod timed searches, pollinator visual timed searches, visual surveys for alpine species, and amphibian dipnet surveys. The project will consist of 3 phases:

1) Data analysis and completed written drafts of 3 publications. The publications will focus on multispecies survey methodologies for forest carnivores and terrestrial

gastropods as well as taxonomic description of a new terrestrial gastropod species. This work is necessary to complete phases 2 and 3 of the project.

2) Development of a microclimate and multi-SGCN monitoring program. The product of this work will be a written document.
3) Field implementation of at least 2 pilot monitoring plots. Monitoring will take place in the Okanogan Highlands, Flathead Valley, and Bitterroot Mountains sections during April, May, and June 2018. Sampling schemes may include: remote cameras; visual, nondestructive observational surveys; pitfall traps for invertebrates; sweep-net capture of insects; dipnet capture of amphibians; water samples for E-DNA analysis and/or microclimate data loggers attached to trees. Focal species for surveys are restricted to SGCN as identified in the 2015 Idaho State Wildlife Action Plan, including Wolverine, Magnum Mantleslug, Western Bumble Bee, Suckley's Cuckoo Bumble Bee, Northern Leopard Frog, Fisher, a roundback slug, Western Toad, Clark's Nutcracker, Mountain Goat, Hoary Marmot, Pale Jumping-slug, Western Ridged Mussel (*Gonidea angulata*), mayflies and Clearwater Roachfly. Success of the various sampling schemes will be evaluated for broader implementation in a future project.

3. The Regional diversity biologist will subsequently work with regional habitat staff in an office environment to develop a recommended wildflower seed mix to benefit multiple bumble bee SGCN in the region including Western Bumble Bee, Suckley's Cuckoo Bumble Bee, Morrison's Bumble Bee (*Bombus morrisoni*), and Hunt's Bumble Bee (*Bombus huntii*). The project area where field work will occur will encompass less than 1 square mile within the Boundary–Smith Creek WMA, Boundary Co., ID, and will occur July–September 2017.

4. The Northern Leopard Frog conservation project will occur at Bass Lake, Idaho. Bass Lake is 0.5 mi from the Kootenai River. This portion of the Kootenai River is designated Bull Trout critical habitat. Bass lake is >1 mi from White Sturgeon (*Acipenser transmontanus*; Kootenai River DPS) critical habitat. However, White Sturgeon may occur within 1 mi of the project area. The project will consist of 3 parts:

1) American Bullfrog lethal control will help reduce the potential of this nonnative species to spread north into native Northern Leopard Frog colonies at Creston Valley Wildlife Management Area, British Columbia, and Canada. Field work will consist of capturing amphibians with nets, identifying them, and releasing native amphibians unharmed. We will use a technique known as electrofrogging (similar to electroshocking of fish) in small ponds. All captured bullfrogs will be euthanized with clove oil.
2) Regional diversity biologist will train habitat and population biologists to conduct amphibian dipnet surveys to map and inventory additional bullfrog populations. These surveys are for inventory purposes only and will not include bullfrog euthanasia.
3) Follow-up lethal bullfrog control actions may be initiated at additional waterbodies where bullfrogs are detected.

5. The objective for this approach is to estimate the effective population size of the West Cabinet Mountains (Flathead Valley) Fisher (Tier 2) population and summarize results in draft

manuscript for submission to a peer-reviewed journal by 30 June 2018 (5–10 days). The Fisher population assessment project will perform an initial database assessment to determine if adequate data exist to construct a population estimate for Fisher in the Flathead Valley Section of Idaho. Project activities will consist of office work including literature searches, extensive computer use, and consultation with other researchers via phone, email, and in person. The project has no physical footprint and will occur July 2017 to June 2018.

6. The objective for this approach is to explore the feasibility of implementing a project to assess (and potentially maintain) or restore areas of genetic connectivity in the Forested Lowlands of the Okanogan Highlands Section to benefit the following SGCN: Tier 1: Western Bumble Bee, Wolverine, Grizzly Bear (*Ursus arctos*), Magnum Mantleslug, Suckley's Cuckoo Bumble Bee; Tier 2: Western Toad, Silver-haired Bat (*Lasionycteris noctivagans*),Fisher, *Hemphillia* sp. 1; Tier 3: Common Nighthawk (*Chordeiles minor*), Pale Jumping-slug, Shiny Tightcoil (*Pristiloma wascoense*), and Coeur d'Alene Oregonian (*Cryptomastix mullani*) (1–5 days). IDFG will engage potential partners to identify areas of current and historical connectivity for multiple species in the Forested Lowlands conservation target of the Okanogan Highlands and determine appropriate actions for maintaining or restoring key habitats to promote genetic diversity within wildlife populations. This approach involves office work only, no field activities. Project occurs July–September 2017.

Geographic Location

Benewah, Boundary, Bonner, Shoshone, and Kootenai counties, ID.

Describe how objectives were met.

Objective 1: Adaptive Management Team. *Organize* and conduct at least 1 SWAP adaptive management meeting for the Okanogan Highlands–Flathead Valley and Bitterroot Mountains sections by 31 December 2017 (5–10 days).

Results: A total of 3 adaptive management team meetings were held. One of these meetings occurred prior to 31 December 2017.

One Adaptive Management Team meeting was held on 25 November 2017 in Sandpoint, Idaho. Attendees included: Evan DeHamer (Idaho Department of Fish and Game [IDFG]), Michael Lucid (IDFG), and Lacy Robinson (Yellowstone to Yukon Conservation Initiative). The outcome of the meeting was a decision to focus adaptive management resources toward the Idaho Panhandle Bees to Bears Climate Adaptation Project. There were no formal notes or agenda.

One Bees to Bears Climate Adaptation Project meeting was held on 6 February 2018 in Coeur d'Alene, Idaho. Attendees included: Chris Bonsignore (Ducks Unlimited), Brian Heck (Ducks Unlimited), Lacy Robinson (Yellowstone to Yukon Conservation Initiative), Evan DeHamer (IDFG), Jim Teare (IDFG), and Michael Lucid (IDFG). The outcome of the meeting was a proposal for climate adaptation engineering work on the Bees to Bears project. There were no formal notes or agenda.

One Idaho Panhandle Bees to Bears Climate Adaptation Project meeting was held on 23 April 2018 in Sandpoint, Idaho. Attendees included: Jessie Grossman (Yellowstone to Yukon Conservation Initiative), Evan DeHamer (IDFG), Michael Lucid (IDFG), Kristina Boyd (IDFG Contractor), and Lacy Robinson (Rainforest Ecological). The outcome of the meeting was a definition of roles in the Bees to Bears project. There were no formal notes or agenda.
Objective 2: Microclimate and multiple SGCN monitoring programs.

Objective 2a: *Submit* 1 manuscript of multispecies terrestrial gastropod inventory methodologies for submission to peer-reviewed journal by 30 June 2018.

Results: One manuscript of multispecies terrestrial gastropod inventory was developed. The manuscript was not submitted to a peer-reviewed journal by 30 June 2018 due to unexpected delays of coauthor manuscript revisions. It is anticipated that the manuscript will be submitted to a peer-reviewed journal by 30 September 2018 (Appendix).

Objective 2b: *Submit* 1 manuscript describing *Hemphillia* sp. 1 as a distinct taxonomic unit by 30 June 2018.

Results: One manuscript describing *Hemphillia* sp. 1 (now *Hemphillia skadei*) was submitted to and accepted by the *Canadian Journal of Zoology*. The paper was published on 30 March 2018 (Appendix).

Objective 2c: *Deploy* a minimum of 2 pilot monitoring plots in Boundary or Bonner County, ID by 30 June 2018.

Results: One wetland/alpine ecosystem monitoring plot was established in Bonner County on 6 August 2017.

One wetland/alpine ecosystem monitoring plot was established in Boundary County on 27 June 2018.

Objective 3: Conservation actions for Bumble-bee SGCN. *Work* with habitat staff to provide technical advisement to Idaho Transportation Department (ITD) staff regarding roadside vegetation seeding mix by 30 September 2017.

Results: A suggested pollinator mix was submitted to ITD on 8 May 2018. The date is later than anticipated because pollinator mix discussions were more in depth and took more time than expected (Fig. 1).

	Spring	Summer	Fall	Color	Family	Genus	species
Flowers							
Lupine	X			Blue	Fabaceae	Lupinus	
Lewis Flax	X			Blue	Linaceae	Linum	lewisii
Arrowleaf Balsamroot	X			Yellow	Asteraceae	Balsamorhiza	sagittata
Western Yarrow	X	X		White	Asteraceae	Achillea	millefolium
Oregon Sunshine	X	X		Yellow	Asteraceae	Eriophyllum	lanatum
Blanketflower	X	X		Yellow	Asteraceae	Gaillardia	aristata
Sticky Purple Geranium		X		Purple	Geraniaceae	Geranium	viscosissim
Fireweed		X	X	Purple	Onagraceae	Chamerion	angustifoliu
Canada Goldenrod		X	X	Yellow	Asteraceae	Solidago	canadensis
Little Sunflower		X		Yellow	Asteraceae	Helianthella	uniflora
Sulphur-flower Buckwheat		X	X	Yellow	Polygonaceae	Eriogonum	umbellatun
Western Mountain Aster			X	Blue			
Rocky Mountain Penstemon	Bloom time tbd						
Fernleaf Bisquitroot	Bloom time tbd						
Shrubs							
Oceanspray	X	X		White	Rosacea	Holodiscus	discolor
Woods Rose	X	X		Red	Rosacea	Rosa	woodsii
Grasses (no bloom time)							
Idaho Fescue					Poaceae	Festuca	idahoensis
Bluebunch Wheatgrass					Poaceae	Pseudoroegneria	spicata

Figure 1. Suggested roadside vegetation seeding mix.

Objective 4: Control Invasive Bull Frogs. *Conduct* at least 1 American Bullfrog control event at a minimum of 1 pond in Boundary County, ID by 30 September 2017.

Results: Eight bullfrog control events were conducted at 3 ponds in Boundary County between 1 July 2017 and 30 September 2017. A report was developed and is attached. One outreach blog and video were also produced and can be viewed at the following URL: https://idfg.idaho.gov/blog/2017/11/international-effort-slows-invasive-bullfrogs

Objective 5: Fisher population in the West Cabinet Mountains. *Estimate* the effective population size of the West Cabinet Mountains (Flathead Valley) Fisher (Tier 2) population and summarize results in draft manuscript for submission to peer-reviewed journal by 30 June 2018 (5–10 days).

Results: One manuscript was developed that estimates the effective size of the Fisher population in the West Cabinet Mountains (Appendix).

Objective 6: Assessment and restoration of genetic connectivity. *Conduct* at least 1 meeting with partner(s) to continue discussions of this project by 30 June 2018.

Results: One meeting to discuss this objective was held on 29 March 2018. Attendees included Dr. Elizabeth Bancroft (Gonzaga University), Dr. Sam Cushman (US Forest Service), and Michael Lucid (IDFG). The meeting was conducted over the phone. The outcome of the meeting was a decision to pursue a project to assess genetic connectivity of amphibians in the Idaho Panhandle. No formal agenda or notes were prepared for this meeting.

Principal Investigator(s) for Research Projects

Michael Lucid, Idaho Department of Fish and Game, Panhandle Region, 2885 W Kathleen Ave, Coeur d'Alene, ID 83815, 208 830-1451

Michael.lucid@idfg.idaho.gov

Project 2—Clearwater Region SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are to address the following specific high priority strategies identified within the Palouse Prairie, Bitterroot Mountains, Idaho Batholith, and Blue Mountains sections of the SWAP: improved distribution and habitat use information for Fisher (*Pekania pennanti*), and long-term monitoring of bat populations.

1. The Fisher is a low-density forest carnivore generally associated with mature forest characteristics. The Fisher population in the Northern Rocky Mountains is a distinct population and has been petitioned for listing under the Endangered Species Act of 1973, as amended (16 USC 1531 et seq.; ESA) multiple times. The known distribution of Fisher in north-central Idaho closely aligns with landscapes deemed suitable for active management, potentially leading to conflicting priorities and legal challenges to forest management actions. Better information is needed about the distribution of Fisher in wilderness to ascertain if these areas are suitable and widely occupied by the species. Similarly, better information about fine-scale habitat use by Fisher is critical to integrating the needs of this species into proposed forest management actions.

2. Little is known about bat population status and trends, migration routes, and hibernacula. The need exists to implement and incorporate bats into long-term multitaxa monitoring programs to monitor trends in species distribution and population size. The Idaho Department of Fish and Game needs a contemporary assessment of bat species composition and relative abundance to inform conservation and management recommendations.

Purpose

Implement high-priority strategies of the Idaho SWAP to advance conservation of SGCN in the Palouse Prairie, Bitterroot Mountains, Idaho Batholith, and Blue Mountains sections.

Results or Benefits Expected

- Contemporary information on the distribution, movements, and habitat use of Fisher in the Clearwater River Basin will inform federal land management decisions.
- A contemporary assessment of bat species composition and relative abundance in Idaho County will inform conservation and management recommendations through an understanding of the distribution and habitat association of SGCN bat species.

Approach

1a. Fisher distribution and fine-scale habitat use: The objective of this approach is to document the distribution of Fisher in the wilderness portions of the Idaho Batholith section, and to evaluate models of Fisher habitat, deploy ≤40 remote camera scent stations in the Selway–Bitterroot Wilderness, Idaho County, ID by 1 November 2017, and retrieve cameras in June 2018. Wilderness Fisher Surveys: work started in FY2017 under SWG grant #215814324 will continue in FY2018. We will install up to 40 remote cameras/scent stations throughout the

Selway–Bitterroot wilderness during the winter of 2017–2018. We will deploy the units in October of 2017 before travel becomes difficult due to snow. The units will be retrieved in June 2018 when the snow has melted. Locations will be accessed by foot and pack animals and will generally be located along game trails. A station will consist of a Reconyx remote camera screwed and locked to 1 tree, and approximately 10 ft away in the view of the camera, a Steady Scent, a device that releases scent daily for ≥7 months, will be screwed to another tree. Both will be 8–9 ft above the ground to elevate them above the line of sight for people. Below the Steady Scent, a small piece of bone (6–9 in) will be anchored to catch the scented fluid and to provide the animal something to chew on while a photograph is taken. Sites will be GPSed but not flagged to keep them discreet and not infringe on the wilderness experience of others. No mechanized vehicles will be used in the wilderness for this project.

1b. Fine-scale habitat use: The objective of this approach is to better integrate Fisher habitat needs into proposed forest management actions, collect data on fine-scale habitat use of Fisher in the Idaho Batholith section by operating ≥30 live traps for Fisher in Idaho County, ID in January and February 2018; track any collared individuals to collect GPS locations of areas used, and/or work on data analysis from previously collared Fishers. Work conducted in FY 2017 under SWG grant #215814324 will continue in FY2018. We will continue live-trapping efforts to put GPS collars on adult female Fishers to reach a sample size of ≥10 individuals. We will do this in areas with recently acquired LIDAR imagery that will provide detailed measurements on vegetation structure. We will use Tomahawk live traps, set in a cubby trap style, and baited with carrion and scented with skunk essence. Traps will be checked at least once every 24 hours. For each captured Fisher, we will conduct a general health assessment, take morphological measurements, fit with a radio collar, and release at the capture site. Trapping will occur at various sites within Idaho and Clearwater counties and will conclude by the 3rd week of March, a time when female Fisher are known to be giving birth to their kits.

2. Bat Surveys: The objective of this approach is to document bat species distribution and to evaluate the effects of forest management on occurrence, conduct passive and mobile transects for bat SGCN in the Idaho Batholith, Palouse Prairie, and Blue Mountains sections on 7 BLM-owned landscapes, 5 NABat grid cells, and 6 long-term mobile transects located in the Nez Perce–Clearwater National Forest between June and September 2017. Activities are as described and approved in ID F12AF01281 SWG Implementation. The distribution of bat species and their habitat associations are generally poorly known. To improve our knowledge of bats in north-central Idaho, surveys will be conducted using both passive and active techniques. Passive surveys involve setting up a bat detector at sites thought to have high use by bats and having it record bat calls all night for 2–4 nights. Active surveys consist of a driving transect that is driven at 15–20 mph starting a half hour after sunset. An acoustic bat detector records calls from bats passing overhead and records a GPS point location. In both survey types, recorded calls are analyzed to identify the species of bat and statistical models are used to evaluate distribution and habitat associations. SGCN bats likely to be encountered include: Townsend's Big-eared Bat (*Corynorhinus townsendii*), Silver-haired Bat (*Lasionycteris noctivagans*), Hoary Bat (*Lasiurus cinereus*), and Little Brown Myotis (*Myotis lucifugus*).

Geographic Location

Various locations within Idaho County, ID.

Describe how objectives were met.

Objective 1a: Deploy ≤40 remote camera scent stations in the Selway–Bitterroot Wilderness, Idaho County, ID by 1 November 2017, and retrieve cameras in June 2018.

Results: In October of 2017, 16 remote camera scent stations were placed in the north half of the Selway–Bitterroot Wilderness. In June 2018, the stations were recovered. Fisher was detected at 6 of 16 stations, American Black Bear at 14 stations, American Marten at 11 stations, Gray Wolf at 11 stations, Red Fox at 7 stations, Cougar at 5 stations, and Wolverine at 2 stations (Figs. 1, 2, & 3). From these data, it is possible to conclude that Fishers are widely spread in the north half of the Selway–Bitterroot Wilderness, and generally occur where habitat models suggest the best habitat is.

Figure 1. Fisher detection at scent station in Selway–Bitterroot Wilderness.

Figure 2. Fisher detection at scent station in Selway–Bitterroot Wilderness.

Figure 3. Wolverine detection at scent station in Selway–Bitterroot Wilderness.

Objective 1b: Collect data on fine-scale habitat use of Fisher in the Idaho Batholith section by operating ≥30 live traps for Fisher and track any collared individuals to collect GPS locations in Idaho County, ID in January and February 2018.

Results: Between December 2017 and March 2018, technicians collared and tracked 3 adult female Fishers in the Elk City area. At the end of the season, all individuals were recaptured and collars removed. We were successful in downloading 617, 886, and 4,446 GPS locations from the 3 collared individuals. This brings the number of collared individuals for this study to 12, with over 12,000 GPS locations collected. Analysis of these data to evaluate fine-scale habitat selection is being conducted by the Rocky Mountain Research Station.

Objective 2. Conduct passive and mobile transects for bat SGCN in the Idaho Batholith, Palouse Prairie, and Blue Mountains sections on 7 BLM-owned landscapes, 5 NABat grid cells, and 6 long-term mobile transects located in the Nez Perce–Clearwater National Forest between June and September 2017.

Results: During the summer of 2017, we conducted surveys for bats in the BLM Cottonwood Field Office, on and directly adjacent to lands owned by the BLM. We conducted surveys on 4 general habitat types and to the extent practical, we followed the protocol of the North American Bat Monitoring Program (NABat). We ran passive detector stations at 2–4 of the 4 quadrants that compose a grid cell, depending on access. Passive stations were run from 3 to 9 nights; no mobile transects were run due to the limited road systems in these landscapes. We sampled 7 cells composed of 24 quadrants, resulting in >200 GB of acoustic call recordings. All acoustic call files were processed using Kaleidoscope automated bat call identification software, which resulted in 26,512 bat passes identified to species and 10,200 additional bat passes for which auto-id was not possible. Because all auto-identification software has known errors, a second layer of analysis will be done in by a contracted bat specialist to confirm and improve the identification results.

Overall, 13 bat species were confirmed to occur in the BLM Cottonwood Field Office, with the Sliver-haired Bat, California Myotis, Western Small-footed Myotis, and Little Brown Myotis being the most common and widespread species. Townsend's Big-eared Bat appears to be uniformly rare across the areas sampled. Generally, subalpine habitat types had the lowest amounts of bat activity, often only 30–70 bat passes per night. Grassland sites near forest and open dry forest had moderate to high bat activity, 200–500 bat passes per night. Sites with any sort of water feature dramatically increased bat activity, regardless of habitat type, resulting in up to >900 bat passes per night.

Surveys were also conducted on 6 long-term mobile transects located in the Nez Perce–Clearwater National Forest and on 4 NABat cells. The 5th NABat cell was not successfully completed due to lack of time. Data from these surveys are scheduled to undergo manual vetting by a contracted bat specialist.

Principal Investigator(s)

Joel Sauder, Idaho Department of Fish and Game, Clearwater Region, 3316 16th St, Lewiston, ID 83501; 208 799-5010

Joel.sauder@idfg.idaho.gov

List of Partners

The Nez Perce–Clearwater National Forest is an integral partner in both the Fisher and bat work associated with this grant.

Project 3a—McCall SubRegion SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are to address the following specific high priority strategies to address habitat needs or SGCN baseline occurrence and distribution identified within the Idaho Batholith, Blue Mountains, and Challis Volcanics sections of the SWAP.

1. Many SGCN occur at high elevations in alpine habitats where access is challenging and survey windows are relatively short. As a result, information on occurrence, distribution, or specific habitat associations is limited for Black Rosy-Finch (*Leucosticte atrata*), Hoary Marmot (*Marmota caligata*), Mountain Goat (*Oreamnos americanus*), and a suite of grasshopper species in the genus *Melanoplus*. IDFG biologists conducted surveys for these species along habitat-defined transects during the past 2 summers and documented new locations of all target species except Black Rosy-Finch. Based on that effort, the survey approach could be developed into more reliable, cost-effective, and accurate monitoring design, a high priority action in the SWAP. In addition, there is a need to incorporate climate monitoring at survey locations to better understand how species occurrence is related to environmental factors in a changing climate, given the potential sensitivity of alpine-adapted species to warmer temperatures.

2. Western (*Aechmophorus occidentalis*) and Clark's grebes (*A. clarkii*) occur in mixed-species nesting colonies, the largest of which occurs at Lake Cascade in the Idaho Batholith section. Grebes build floating nests in emergent vegetation found in shallow back channels and coves, and these nests are vulnerable to abrupt rises or falls in water levels, whether from natural high wind and wave events or water-level management. Maintaining consistent water levels for the approximately 3 weeks of nest incubation is an important management strategy. Grebe productivity has dropped significantly in recent years at all Idaho locations that are monitored regularly. The SWAP identifies the need to determine causes of low nesting success and recruitment with respect to unstable water levels at managed impoundments and take steps to reverse the trend of nest failures.

3. Within 2 SWAP conservation targets (Dry Lower Montane–Foothill Forest and Subalpine–High Montane Conifer Forest) across 2 sections (Blue Mountains and Idaho Batholith), there are 8 priority strategies addressing the need for forest restoration. All of these strategies work toward reversing the trend of increasing frequency and intensity of wildfire and toward creating a mosaic of insect- and fire-resistant stands on the landscape though a combination of silvicultural treatments and/or prescribed fire. Because these key habitats are managed by the US Forest Service (FS), the most effective way to advance Idaho's SWAP and benefit the 7 SGCN associated most closely with these forest systems is to engage in the Payette Forest Coalition to help develop prescriptions to restore more resilient forest conditions.

Purpose

Implement the following high priority strategies of the Idaho SWAP to advance conservation of SGCN species in the Idaho Batholith, Blue Mountains, and Challis Volcanics sections: (1) gather baseline data on SGCN occurrence in relation to temperature regimes in alpine habitats in the Idaho Batholith and Challis Volcanics sections, (2) investigate causes of low nest success of Western/Clark's Grebes in the Idaho Batholith by implementing year 1 of a multiyear, multipartner collaborative study, and (3) participate in Payette Forest Coalition to help develop prescriptions for more resilient forests in the Blue Mountains and Idaho Batholith sections that benefit SGCN birds, bees, gastropods, and the Northern Idaho Ground Squirrel (*Urocitellus brunneus*).

Results or Benefits Expected

- From alpine surveys, we will document baseline occurrence and distribution of SGCN in central Idaho that generally occur at elevations >6,000 ft. We will associate their occurrence with temperature and snow variables to begin to assess how changes in precipitation and broad-scale hydrologic regimes in alpine habitat could affect this suite of SGCN.
- The Western/Clark's grebe project contributes to our understanding of grebe population dynamics at the largest nesting colony in Idaho. We will determine if nest failures are high and the extent to which fluctuating water level contributes to nest failure. This information will identify possible strategies for water level management at Lake Cascade to increase grebe productivity and recruitment.
- Participation in the Payette Forest Coalition, and specifically direct involvement with developing and implementing restoration prescriptions, will result in improved forest resiliency to natural disturbance, including wildfire, insects and disease, and thus improved habitat for terrestrial and aquatic SGCN.

Approach

1. Alpine Survey: The objectives for this approach are to: 1a. Conduct 3–5 transect-based surveys in alpine habitat in the Salmon River and/or Seven Devils Mountains, Valley and Idaho counties, to document presence and distribution of Black Rosy-Finch, Hoary Marmot, Mountain Goat, and Spur-throated Grasshoppers from June through October 2017; and to 1b. Deploy up to 20 environmental sensors along transects surveyed for alpine species from June through October 2017.We will conduct observational surveys on foot along transects and at fixed points within modeled habitat for our target SGCN (Hoary Marmot, Mountain Goat, and Black Rosy-Finch) as defined by Northwest ReGAP distribution models and IDFG data. At a subset of locations, we will deploy environmental sensors to record temperature and snow coverage (depth or duration). Details on specific survey protocols and the type of sensors to deploy will be determined during April and May 2017, prior to the beginning of this project, in collaboration with USGS biologists and climate scientists. Many grasshopper species above 8,000 ft in central Idaho are undescribed. Individual grasshoppers will be netted, examined closely in hand, and photographed. A representative individual from each location may be collected for identification.

2. The objectives for this approach are to: 2a. Conduct 2 boat-based surveys of grebe abundance and productivity at Lake Cascade, Valley County, from July through August 2017; and 2b. Assist with 2 nest monitoring visits during July and August 2017 to count nests and document

productivity. The investigation of nest success of Western/Clark's Grebes at Lake Cascade is part of a larger collaborative study that includes 2 additional waterbodies (Lake Lowell at Deer Flat National Wildlife Refuge [NWR] and Lake Minidoka at Minidoka NWR). IDFG will conduct 2 surveys of Lake Cascade by boat, the first a prenesting survey in late June or early July to obtain a baseline estimate of resident adults, and the second a post-nesting productivity survey in late July or early August to count adults and young. Nest success will be monitored with cameras at a subset of nests and with 1–2 entries to the colony to count eggs and assess success. HOBO® water level data loggers and remote cameras will be deployed to record daily water levels during the nesting season.

3. The objective for this approach is to develop recommendations for specific silvicultural and fuels treatments in dry montane and subalpine forest stands within the Huckleberry landscape project at a minimum of 4 meetings of the Payette Forest Coalition and its Vegetation Subcommittee from July 2017 through June 2018. The Payette Forest Coalition's Vegetation Subcommittee has identified a framework for restoration opportunities based on departure of forests from historical range of variability. Important metrics include tree species composition, stand age, stand structure, fuel loading, fire regime, and patch size and arrangement on the landscape. The Vegetation Subcommittee will analyze current conditions in the Huckleberry landscape to identify treatments that increase tree size, reduce small-tree density, increase seral species in stands (i.e., ponderosa pine and western larch at lower elevations and whitebark pine at higher elevations), and promote large snags to benefit White-headed Woodpecker (*Picoides albolarvatus*), Olive-sided Flycatcher (*Picoides albolarvatus*), Clark's Nutcracker (*Nucifraga columbiana*), Fisher (*Pekania pennanti*), Northern Idaho Ground Squirrel, Silver-haired Bat (*Lasionycteris noctivagans*), Hoary Bat (*Lasiurus cinereus*), and SGCN gastropods.

Geographic Location

Various locations within Idaho, Valley, and Adams counties, Idaho.

Describe how objectives were met.

<u>Objective 1a:</u> Conduct 3–5 transect-based surveys in alpine habitat in the Salmon River and/or Seven Devils Mountains, Valley and Idaho counties, to document presence and distribution of Black Rosy-Finch, Hoary Marmot, Mountain Goat, and Spur-throated Grasshoppers from June through October 2017.

Results: We completed 3 surveys in alpine habitat in the Salmon River Mountains, Payette National Forest, during August 2017, and 2 surveys in the Lost River Range, Salmon–Challis National Forest south of Mt. Borah, in June 2018. This represented 30 km of transect. We observed 7 Mountain Goats in August 2017 in the Salmon River Mountains, and documented the possible presence of at least 1 Mountain Goat in the Lost River Range by finding possible goat hair. We observed 2 possible Hoary Marmots in the Salmon River Mountains. We had no observations of Black Rosy-Finch or high-elevation grasshoppers. In addition to our transect surveys, we enlisted volunteer observers to report sightings of alpine SGCN. We gained 1 additional observation of Hoary Marmot during this grant period. Given the paucity of Hoary Marmot records in our IDFG database (23 records through 2016), each of these sightings adds significantly to our knowledge of this species' occurrence in Idaho.

The 2 alpine surveys conducted in the Lost River Range in June 2018 were opportunistic additions to the original objectives established for the project. We added these transects while retrieving remote cameras set the previous fall for Wolverine. We surveyed these locations specifically for Black Rosy-Finch because they were located in a large block of continuous modeled habitat; they were relatively close to where Black Rosy-Finch had been observed previously, based on sightings in the IDFG database; and because both of these locations held snow fields (foraging habitat) at the time of our survey.

<u>Objective 1b:</u> Deploy up to 20 environmental sensors along transects surveyed for alpine species from June through October 2017.

Results: No environmental sensors were deployed during this grant period. Our objective was to use remote sensors that would provide information on snow depth and timing of spring melt to inform our knowledge of change in our local alpine systems and potentially feed into broader climate change modeling efforts. After consultation with Leona Svancara, IDFG GIS Analyst, we learned that the technology for sensors measuring snow depth, as opposed to presence of snow, was relatively limited and more costly than anticipated. As a different approach, researchers at the University of Idaho were proposing to classify images from remote cameras generated by the Multispecies Baseline Initiative (MBI) in north Idaho to determine if they could develop algorithms to identify fractional snow coverage from camera images (Marshall and Link 2017, Appendix). Given the timing of this proposal and the potential results that could draw from a larger remote camera dataset, we decided to postpone deploying sensors in our region pending further information.

<u>Objective 2a:</u> Conduct 2 boat-based surveys of grebe abundance and productivity at Lake Cascade, Valley County, from July through August 2017.

Results: We conducted 2 boat-based surveys for Western Grebe abundance and productivity during this grant period. In August 2017, we completed a productivity survey after chicks hatched and adults had moved with their chicks back to open water. We counted 2,522 adults (±288) and 1,190 (±50) chicks. We documented brood sizes of 1–4 chicks, with similar numbers of broods of 1, 2, and 3 chicks. This was the highest chick count in 10 years (since 2007) and almost twice as high as the previous year. The number of adults was similar (within 39 birds) to the number counted prior to nesting. High chick productivity corresponded with a comparatively longer period of full pool before water levels began to drop as the reservoir was drawn down for irrigation.

In June 2018, we completed a prenesting abundance survey of adult grebes. We counted 2,951 grebes, most of which were on open water but some of which were visible in emergent vegetation of the nest colony. According to University of Idaho researchers studying grebe nesting phenology and success, a small number of adults likely were on nests at the time of our boat survey and not available to be counted. The adult count was 11% higher than the 5-year average from 2014–2018, and similar to the prenesting count in 2015.

Dates of our grebe surveys do not align with our stated objectives because the original objectives were incorrect and should have followed the state fiscal year and grant period rather than the field season. The confusion stems from the fact that, within any given field season, our 2 annual surveys span 2 grant periods, such that the first prenesting survey for abundance occurs in 1 grant period and the second postnesting survey for productivity occurs in the next grant period. Objective 2b: Assist with 2 nest monitoring visits during July and August 2017 to count nests and document productivity.

Results: We completed 1 nest count in September 2017, after grebes had left the nest colony for open water. We systematically covered 27.4 ha on foot to document the perimeter of the colony, and determined that nests were concentrated in a 4.9-ha area (Fig. 1). We counted and marked with GPS 1,252 nest structures. This was approximately twice the number of broods detected on the water during our boat-based productivity survey a month earlier (see 2a above). Direct comparisons are inexact because not all nests were successful and our brood count on the water has some level of error. Conversely, the number of nests we counted tracks quite closely the number of adults (assuming 2 adults/nest) detected on the water in a prenesting survey completed in June 2017.

As stated above under 2a, dates of our surveys do not align with our stated objectives because the original objectives were incorrect and should have followed the state fiscal year and grant period rather than the field season. In addition, the work we conducted differed from the work anticipated because a collaborative study on nesting phenology and success led by the University of Idaho evolved to a different approach. Specifically, the project shifted from a land-based study to a drone-based study. Thus, where we had originally anticipated assisting with nest monitoring by walking through the colony at strategic times during nesting to count active nests and eggs, that work was replaced with drone flights that remotely accessed the colony from above and generated images from which nest phenology and success could be monitored.

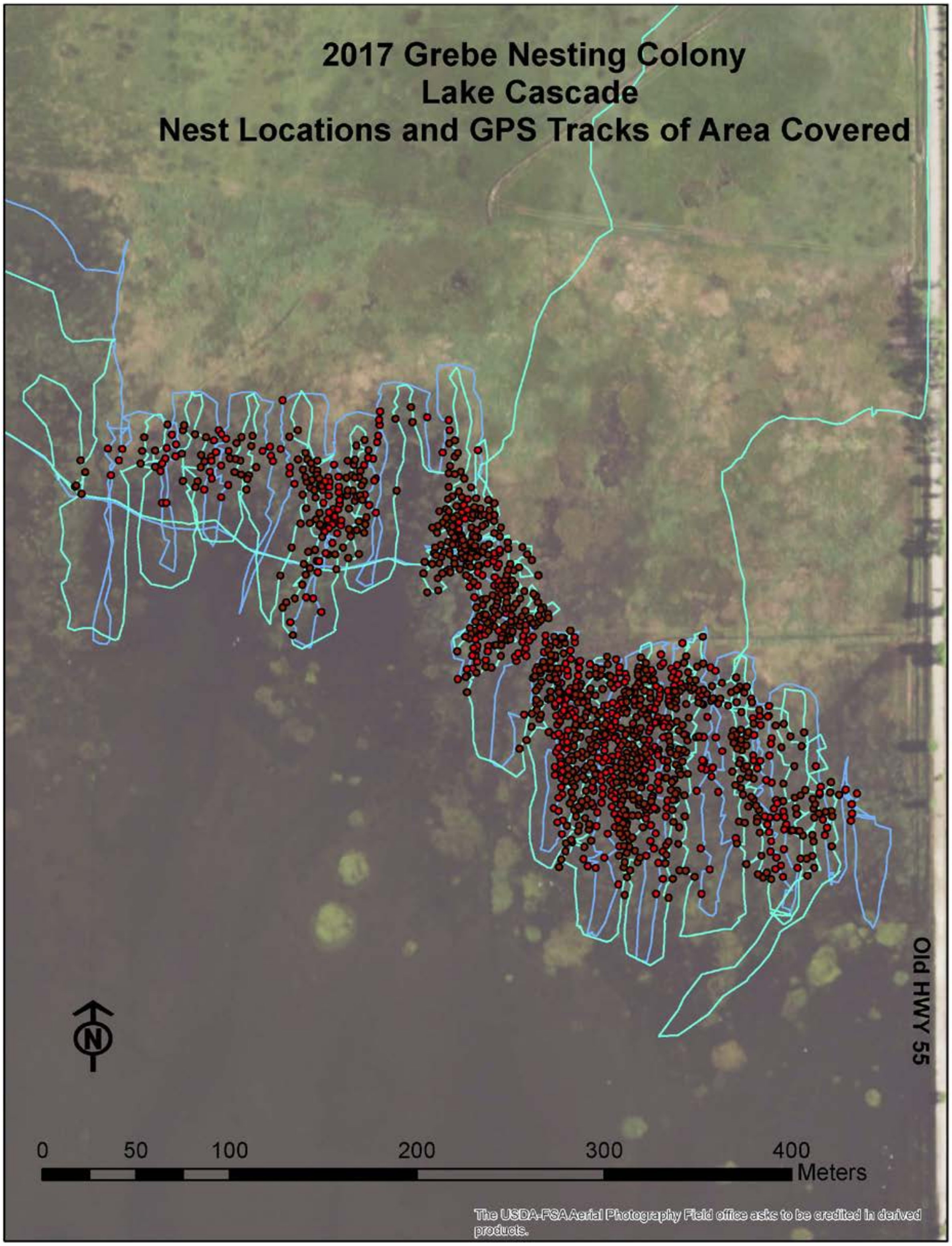

Figure 1. 2017 Grebe nesting colony, Lake Cascade.

Objective 3: Develop recommendations for specific silvicultural and fuels treatments in dry montane and subalpine forest stands within the Huckleberry landscape project at a minimum of 4 meetings of the Payette Forest Coalition and its Vegetation Subcommittee from July 2017 through June 2018.

Results: As a member of the Payette Forest Coalition (PFC) and its Vegetation Subcommittee, I participated in 4 meetings and 1 field trip focused entirely or partially on vegetation treatments within the Huckleberry landscape restoration project during this grant period. In July 2017, the full PFC discussed concepts brought forward by the Vegetation Subcommittee to improve vegetation treatments on all projects. These concepts included targeting the middle ground of condition classes when quantifying acres of treatment opportunity, better describing objectives for forest resiliency, and how to balance desired objectives for increasing landscape mosaics at higher elevations to address catastrophic wildfire while balancing wildlife needs. In October 2017, the full PFC engaged in a field trip to examine ongoing forest treatments using prescriptions that would carry forward to the Huckleberry project. The field trip gave a first-hand look at how recommended forest treatments (thinning and prescribed fire) translated on the ground. This led to an assessment of "is it what we expected, or are modifications needed to achieve objectives in Huckleberry?" In March 2017, the full PFC discussed whitebark pine restoration strategies.

In May 2018, the full PFC received proposed alternatives to be analyzed in a Draft Environmental Impact Statement for the Huckleberry project. In June 2018, the Vegetation Subcommittee met to review vegetation recommendations based on prescriptive treatments for restoration. The subcommittee addressed ways to simplify direction for on-the-ground implementation; examined trade-offs among Management Prescription Classes related to legacy trees, large-diameter trees, and desirable seral tree species; discussed treatment of subalpine fir/whitebark pine forests and problems associated with treating this type for regeneration of whitebark pine; and discussed limitations on treating plantations where tree size, slope, and other factors make treatments difficult and expensive.

The significance of this work to Idaho's SWAP is that dry lower montane–foothill forest and subalpine–high montane forest are conservation targets in the Idaho Batholith ecological section and support 32 SGCN.

Literature Cited

Marshall, A., and T. Link. 2017. Variability in snow disappearance date due to climate, vegetation, and topography: Leveraging novel data for improved understanding of snowpack dynamics and products for wildlife management. Proposal to Northwest Climate Science Center. University of Idaho, Water Resources NSF IGERT Program, 2 June 2017.

Principal Investigator(s)

Diane Evans Mack, Idaho Department of Fish and Game, Southwest Region—McCall Office, 555 Deinhard Ln, McCall, ID 83638 208 634-8137

Diane.evans-mack@idfg.idaho.gov

Timeline

July–September 2017	conduct grebe boat surveys and nest counts
July–October 2017	conduct alpine surveys
November 2017–June 2018	summarize data
July 2017–June 2018	attend monthly PFC meetings, field trips, and/or vegetation subcommittee meetings

List of Partners

USGS
IDFG Region 1
Idaho Cooperative Fish and Wildlife Research Unit
Minidoka and Deer Flat National Wildlife Refuges
Payette Forest Coalition

Project 3b—Southwest Region—Nampa Office SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) identifies priority resource management actions for species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project address needs identified within the Owyhee Uplands section to be implemented within IDFG's Southwest Region–Nampa Subregion.

1. Columbia Plateau (syn. Merriam's) Ground Squirrel (*Urocitellus canus*; Tier 2) is identified as a species of greatest conservation need and is listed in the Owyhee Uplands as a target SGCN of many objectives directed at land management and maintaining habitat values in Sagebrush-Steppe habitat. It is also a foundational species in the sense that it serves a multitude of ecological functions involving soils, vegetation dynamics, and food chains. Notably, it is a dominant component of the prey base for predatory mammals and birds, including Golden Eagle (*Aquila chrysaetos*; Tier 2 SGCN) and Ferruginous Hawk (*Buteo regalis*; Tier 2 SGCN). However, basic information regarding the distribution and status of the ground squirrel is lacking, which precludes strategic targeting of management actions intended to benefit this species. As summarized in the Owyhee Uplands Section chapter (page 711, Idaho SWAP, 2015):

   Columbia Plateau (syn. Merriam's) Ground Squirrel (*Urocitellus canus*) occurs south of the Snake River and west of Reynolds Creek. Range disjunction between *U. canus* and Great Basin (syn. Piute) Ground Squirrel (*U. mollis*) is not well demonstrated; contact zones could result in hybrids, but this topic has not been investigated. Current distribution and status is uncertain, complicated by the difficulty in differentiating *U. canus* and *U. mollis*; as of January 2014, extirpation from Idaho remains a possibility, but extant colonies have been reported in the Owyhee foothills in the Reynolds Creek vicinity. Efforts are needed to determine the identity of ground squirrel populations in northwest Owyhee County, to characterize distribution, contact zones between Columbia Plateau (syn. Merriam's) Ground Squirrel and Great Basin (syn. Piute) ground squirrel populations, and reevaluate the taxonomic positions of the nominal taxa.

2. American Beaver Restoration: Source Population Development. The American Beaver (*Castor canadensis*) has been characterized as a transformative species in ecosystems within which it occurs. Beaver herbivory is a process that stimulates regeneration of some woody plants, such as willow, cottonwood, and aspen. Stream damming creates lentic aquatic habitat within lotic systems, increases water infiltration, expands saturated soils and associated primary and secondary productivity, and promotes retention of fine sediments. Benefits also include improved subsurface water storage and stream shading, both of which contribute to reduced water temperature, leading some authorities to consider beaver population expansion to be a climate change mitigation approach. Beaver population expansion is identified throughout SWAP as a strategy for improving habitat for SGCN, and in the Owyhee Uplands is included as a strategy targeting riparian and wetland habitat to benefit, among others, Western Toad (*Anaxyrus boreas*; Tier 2), Columbia Spotted Frog (*Rana luteiventris*; Tier 1), Greater Sage-Grouse (*Centrocercus urophasianus*; Tier 1; brood habitat, in particular), and Sandhill Crane (*Grus canadensis*; Tier 3).

In circumstances where natural expansion into restored habitat is unlikely to occur, beaver restoration projects use translocation to augment existing populations or expand distribution. Ongoing work in the Owyhee Mountains has been directed at assessing restoration potential, which has included assessing current distribution and modeling potential beaver habitat. This work has also included field surveys to validate predictions and observations from remotely sensed data. No work elements have yet been directed toward identification of source populations or developing relationships and agreements to support removal of live beavers from source populations, or protocols or procedures for evaluating potential source populations.

Purpose

1. Determine the distribution and assess conservation genetics of Merriam's Ground Squirrel populations in Idaho.
2. This new project is being proposed to develop landowner contacts and evaluate sites that may serve as source populations for translocation projects. These sites may include beaver populations occurring on private lands in Owyhee, Canyon, and Ada counties.

Results or Benefits Expected

- Understanding the current distribution, taxonomic status, and population genetic characteristics are paramount to making informed management decisions and prioritizing conservation actions. This project will solidify current understanding of Merriam's Ground Squirrel status in Idaho.
- Beaver restoration programs necessarily require source populations from which animals can be removed. In circumstances in which beavers cause property damage, reducing or eliminating damage is often accomplished through lethal removal programs. However, in some circumstances animals removed from these areas can serve as stock for restoration in other areas where local populations are insufficient for serving important functions in water and sediment retention, stream aggradation, and development of riparian habitat. This project will advance a beaver management program directed at expanding beaver populations in portions of Owyhee County to improve aquatic habitat conditions in high-desert environments. This program has the potential to improve habitat quality and availability for a variety of SGCN and other high-value or economically important fish and wildlife populations.

Approach

1. The objective of this approach is to collect molecular samples from at least 5 Merriam's Ground Squirrels from at least 3 sites by 30 June 2018. Merriam's Ground Squirrel colonies will be located through ground surveys by vehicle and by foot to assess historical sites of occurrence and areas within the expected range having suitable habitat characteristics. Extant ground squirrel colonies will be sampled using Tomahawk live traps baited with rolled oats. Molecular samples will comprise a 2 mm punch from the ear pinnae and 20 plucked hairs. Squirrels will be released at site of capture. Molecular samples will be provided to a research lab (Joe Cook Lab; University of New Mexico) conducting studies on ground squirrels, where DNA extraction and analysis will be conducted.

2. The objective of this approach is to identify and assess at least 5 sites in Owyhee, Canyon, or Ada counties to serve as source populations for beaver restoration program by 30 June 2018. IDFG receives numerous, frequent complaints of beaver damage. We will use these contacts to initiate site visits to evaluate local beaver populations and site characteristics in relation to source population characteristics and feasibility of live-trapping operations on private lands. Damage complaints are frequently also directed at officials from county and municipal governments, and addressing these complaints may involve government agencies, such as USDA APHIS Wildlife Services (WS). We will conduct outreach activities to evaluate the potential to incorporate trap-and-translocate procedures into complaint responses. Where appropriate, we will discuss development of ad hoc and/or formal agreements with municipalities, wildlife damage responders, and private landowners to create flexible arrangements for using translocation as an alternative to lethal removal when addressing private property losses resulting from beaver.

Geographic Location

Owyhee, Ada, and Canyon counties, Idaho.

Describe how objectives were met.

Objective 1: Collect molecular samples from at least 5 Merriam's Ground Squirrels from at least 3 sites by 30 June 2018.

Results: Through 30 June 2018, the molecular sample collection objective, as outlined in the Southwest Region—Nampa office SWAP Implementation Project Statement, has been met. Columbia Plateau (syn. Merriam's) Ground Squirrel (*Urocitellus canus*; Tier 2) and Great Basin (syn. Piute) (*Urocitellus mollis*) Ground Squirrel colonies were located during 2017 through ground surveys at locations of known historic colonies. Bill Bosworth (Regional Wildlife Biologist) and a crew trapped squirrels and collected genetic samples at 3 sites in the Reynolds Creek drainage and 5 sites in the Sinker Creek Drainage. These 2 drainages in northern Owyhee County, Idaho are within the reported historic range of *U. canus* (Reynolds Creek) and *U. mollis* (Sinker Creek) and represent potential contact zones between the populations. A total of 16 presumed *U. canus* samples were collected at Reynolds Creek and 19 presumed *U. mollis* samples were collected further east in Sinker Creek. Samples were provided to collaborators at the University of New Mexico for use in molecular studies of these populations.

Objective 2: Identify and assess at least 5 sites in Owyhee, Canyon, or Ada counties to serve as source populations for beaver restoration program by 30 June 2018.

Results: During evaluation of beaver translocation protocols, we identified a risk of amphibian and fish pathogen translocation. Beaver fur has the potential to carry pathogen organisms, including *Batrachochytrium dendrobatidis* (*Bd*, amphibian chytridiomycosis), as well as pathogenic bacteria and viruses. Until protocols can be developed to address this risk, we decided to limit beaver translocations such that animals would be moved only within subbasins (i.e., Level 5 Hydrologic Units). Each translocation would be further evaluated for risks. For example, no translocations would be conducted between areas having bullfrogs, which can carry *Bd*, and areas that do not have bullfrogs. Within this context, we developed contacts and communication protocols to identify potential sources for beaver translocations. The IDFG Southwest Region receives numerous complaints of beavers damaging private property when they cause tree damage and flooding. Previously, damage complaints were handled with infrequent ad-hoc translocations and, most frequently, lethal removal. Complaints were generally routed to IDFG Conservation Officers, private trappers, or Wildlife Services. During the course of this project, complaints were routed to Wildlife Program staff. We received complaints from approximately 30 landowners. Most were from the Boise River corridor through Ada County, primarily within the cities of Boise, Garden City, and Eagle. However, given concerns with pathogen translocation, these sites were not eligible for translocating to Owyhee County. Pending development of handling protocols to reduce risks of translocation, we initiated discussions with city officials, as well as Wildlife Services staff. Within Owyhee County, we identified landowners in the vicinity of Silver City, Triangle, and in the Castle Creek drainage having potential damage management concerns or well-established beaver populations that could serve as sources for translocation.

Principal Investigator(s)

Bill Bosworth, Regional Wildlife Biologist, Idaho Department of Fish and Game, Southwest Region, 3101 S Powerline Rd, Nampa, ID 83686, 208 465-8465.

Bill.bosworth@idfg.idaho.gov

List of Partners

FWS; University of New Mexico
TBD. Potential partners include: City of Boise, City of Eagle, City of Star; USDA APHIS WS; private landowners.

Project 4—Magic Valley Region SWAP Implementation Project Statement

Need

The 2015 Idaho State Wildlife Action Plan, 2015 (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are addressed as specific needs identified in the Snake River Basalts and Owyhee Uplands sections. The SWAP describes the need to monitor the status of cave-associated fauna (bats and invertebrates) and to determine the status of historic populations of several sand-associated and pollinator SGCN.

1. We have an inadequate understanding of the current population status of bats, cavernicolous (cave dwelling) invertebrate fauna and lava-associated insects. The Department needs to conduct regular monitoring of occupied, historic, and potential caves, tubes, kipukas, and adjacent habitat for SGCN in the Magic Valley Region to inform conservation and management recommendations.

2. We lack an adequate understanding of the current population status of sand-obligate SGCN such as Idaho Dunes Tiger Beetle (*Cicindela arenicola*), Bruneau Dune Tiger Beetle (*Cicindela waynei*), and Lined June Beetle (*Polyphylla devestiva*). Regular status assessments of occupied and recently-colonized habitats are important as the effectiveness of management actions continues to be evaluated. Likewise, the status of the populations of Wiest's Primrose Sphinx, an ant-like flower beetle (*Amblyderus owyhee*), a miner bee (*Calliopsis barri*), and a leafcutting bee (*Ashmeadiella sculleni*) and their life histories have not been fully documented or updated. To better understand these species and their habitat needs, surveys of historic sites are needed.

3. We have an inadequate understanding of the current population status of multiple bee and beetle pollinator SGCN. The Department needs to conduct regular monitoring of historic and potentially suitable locations for SGCN in the Magic Valley Region and other high-priority locations in the state to inform conservation and management recommendations.

Purpose

To monitor the status of cave-associated fauna (bats and invertebrates) and to determine the status of historic populations of several sand-associated and pollinator SGCN.

Results or Benefits Expected

1. The surveys will provide information on the current distribution of bats and invertebrate cavernicolous fauna in the Magic Valley Region and environmental conditions within cave environments. This will enhance IDFG efforts to conserve and manage SGCN species in southern Idaho and also inform responses to future management decisions in these highly specialized and uncommon habitats.
2. The surveys will provide information on the current distribution of sand-obligate SGCN in the Magic Valley and Southwest regions. This will enhance IDFG efforts to conserve and manage SGCN species in southern Idaho and also inform responses to future management decisions in these highly specialized and uncommon habitats.

3. The surveys will provide information on the current distribution of SGCN bee and beetle fauna in the Magic Valley. This will enhance IDFG efforts to conserve and manage SGCN in southern Idaho and also inform responses to future management decisions.

Approach

1. The objectives for this approach are to: 1a. Determine the population status of nongame SGCN found in the Lava Flows, Kipukas, Caves and Tubes in the Snake River Basalts section, conduct at least 5 cave faunal surveys at new cave localities in Lincoln, Jerome, Gooding, Blaine, Minidoka, and Butte counties ID by 30 June 2018; and to 1b. Conduct at least 10 surveys for SGCN with inadequate distribution and biological information thought to be associated with lava flows and kipukas in Washington, Lincoln, Gooding, Blaine, and Butte counties, ID by 30 June 2018. The cave faunal survey project is intended provide new information on the distribution and population status of SGCN species in lava tubes (Objective ID-1) and across several lava flow-dominated habitats such as kipukas in south-central Idaho (Objective ID-2) and to gauge the extent and quality of associated habitats.

Objective ID-1

The cave faunal surveys will occur in 10 to 15 caves. Bat counts of multiple species including Western Small-footed Myotis (Tier 3); Townsend's Big-eared Bat (Tier 3) and Little Brown Myotis (Tier 3) and opportunistic hand collecting of invertebrates will be used to determine species presence and estimate abundance. Sampling of invertebrates will focus on Blind Cave Leiodid Beetle (*Glacicavicola bathyscioides*; Tier 1), a cave obligate mite (*Flabellorhagidia pecki*; Tier 2), Idaho Lava Tube Millipede (*Idagona westcotti*; Tier 2), and the cave obligate harvestmen *Speleomaster lexi* (Tier 2) and *Speleomaster pecki* (Tier 2). Sampling will occur during 2 windows in January and February while bats are hibernating and during annual hibernacula counts focusing on Western Small-footed Myotis, Townsend's Big-eared Bat, and Little Brown Myotis, or in August and September (when young are volant) using mist nets. Bat surveys may also be conducted during April and May during spring emergence mist netting during WNS sampling events or during the summer season using mobile and/or stationary acoustic methods. Sampling protocols and prioritization of locations will be coordinated with IDFG Headquarters and in concert with partners such as BLM and NPS staff, and the local National Speleological Society Grotto (Silver Sage Grotto). The project's field activities should take no longer than 3 months to complete. Coordination, prioritization and protocol development will take no more than 1 month. No herbicides, pesticides or machinery will be used on this project. Temperature and humidity measurements will be taken at each site in addition to bat swab sampling and/or cave sediment sampling at those sites prioritized for WNS/*Pd* diagnostics. All bat and cave work will adhere to the most current WNS national decontamination protocol available at https://www.whitenosesyndrome.org. When complete, the proposed project will give IDFG staff an increased knowledge of the distribution of cavernicolous SGCN in the Magic Valley region. This knowledge will allow us to better conserve and manage these wildlife species in the region and also provide more educated responses to future land management actions.

Objective ID-2

Survey activities will occur in 3 primary areas in the Magic Valley, which include the Wapi lava flows, Craters of the Moon National Monument and Preserve (CRMO) in addition to adjacent flows, and Gooding–Shoshone area flows. Surveys will specifically target SGCN known to be associated with these lava-influenced habitats such as the metallic wood-boring beetles *Chrysobothris horning* and *Chrysobothris idahoensis*, and a yellow-masked bee (*Hylaeus lunicraterius*). Both species of *Chrysobothris* are known to occur at or near CRMO but *Chrysobothris idahoensis* also has a paratype collected in Washington County. We will also visit this location, which is north of Midvale, Idaho. We will visit 10 randomized points in each of the main lava flow project areas and 3 sites at the paratype locality near where the suspected host plants (buckwheat, *Eriogonum* sp.) occur. Collecting will be conducted by hand and net, material will be collected into 95% ETOH for later identification in the lab. The proposed project will give IDFG staff an increased knowledge of the distribution of these SGCN in the Magic Valley region and also potentially provide information on their host plants, biology, and distribution in adjacent parts of the state.

2. The objective for this approach is to monitor populations of 6 sand-obligate SGCN in the Sparsely Vegetated Dune Scrub & Grassland of the Snake River Basalts and Owyhee Uplands sections at 4 sites in Gooding, Owyhee, and Elmore counties, ID by 30 June 2018. The sand dune obligate species project is intended to provide new information on the distribution of sand-obligate SGCN at 4 southern Idaho dune systems and to assess the stability of the aeolian habitats that they occupy. The dune surveys will target SGCN for which we lack information on their occurrence and status in the proposed survey areas. Dune habitats are under an increasing threat of stabilization due to nonnative vegetation encroachment. The target species include Bruneau Dune Tiger Beetle (*Cicindela waynei*; S1, Tier1), *Amblyderus owyhee* (Tier 2), *Calliopsis barri*; S1, Tier 2), *Ashmeadiella sculleni* (S2, Tier 3), *Euproserpinus wiesti* (S1, Tier3) and *Polyphylla devestiva* (S2, Tier 2). Any other SGCN encountered will also be identified and the data provided to the Idaho Fish and Wildlife Information System (IFWIS). Dune-obligate fauna will be surveyed at 4 southern Idaho dunes, Minidoka Area Dune Complex, Bliss Dam Dunes, Bruneau Dunes Complex, and Celebration Park Dunes. Each of the 4 dune complexes will be sampled along 500-m transects at 5 to 10 randomly selected locations where access to the open sand system occurs. The area surveyed will cover no more than 3,200 acres after sites are randomly selected. All sampling will occur from September to October 2017 and March to May 2018 and should take no longer than two and a half months to complete the field aspects of the project. Sampling methods will consist of hand netting, pitfall trapping, FIT trapping and UV light trapping. No herbicides will be applied under this project within the project area. When complete, the proposed project will give IDFG staff an increased knowledge of the current distribution of sand-obligate SGCN in the Magic Valley and Southwest regions. This knowledge will allow us to better conserve and manage these SGCN in southern Idaho and also inform responses to future habitat management decisions. Under this project, IDFG staff will also work with land management agencies to opportunistically identify sand-dominated areas following fire and recommend limiting the amount of reseeding that occurs in those sites, which will reduce stabilization and the loss of sand-associated species' habitats.

3. The objective for this approach is to conduct yellow pan trap and sweep surveys at 15–20 historic and predicted sites within Sagebrush Steppe in the Snake River Basalts, Owyhee Uplands, and Northwestern Basin and Range sections and to coordinate with taxonomic experts to learn to properly determine species and better understand species biology and habitat specifications in Twin Falls, Jerome, Gooding, Owyhee, Elmore, Blaine, Lincoln, and Cassia

counties, ID by 30 June 2018. The pollinator species project is intended to provide new information on the distribution of bee and beetle SGCN and to assess the stability of the habitats that they occupy. Surveys will target SGCN for which there is little to no knowledge of their occurrence and status in the proposed survey areas. Survey areas will be identified by the historic distribution of identified species. Bumble bee species distributions are still currently being compiled but work is anticipated to include most of the Magic Valley Region with potential expansion into other parts of the state for rarer species. The target species include Morrison's Bumble Bee, Suckley's Cuckoo Bumble Bee, Western Bumble Bee, Yellow Bumble Bee, Hunt's Bumble Bee, *Hoplitis producta* subgracilis, and *Agrilus pubifrons*. Any other SGCN species encountered will also be identified and the data provided to the Idaho Fish and Wildlife Information System (IFWIS). Surveys will be conducted opportunistically and also in historic locations with the help of master naturalists. Identified sites will be sampled along 500-m transects at 5 to 10 locations. The area surveyed will cover no more than 1,000 acres after sites are randomly selected. All sampling will occur from July to October 2017 and March to June 2018 and should take no longer than two and a half months to complete the field aspects of the project. Sampling methods will consist of hand netting, yellow pan trapping, and vein traps. No herbicides will be applied under this project within the project area. Nondeterminable specimens will be sent to taxonomic experts for assistance with identifications. When complete, the proposed project will give IDFG staff an increased knowledge of the current distribution of bee and beetle SGCN in the Magic Valley. This knowledge will allow us to better conserve and manage these SGCN in southern Idaho and also inform responses to future habitat management decisions.

Geographic Location

Washington, Ada, Owyhee, Elmore, Lincoln, Jerome, Gooding, Blaine, Butte, Minidoka, Twin Falls, and Cassia counties.

Describe how objectives were met.

<u>Objective 1a:</u> Conduct at least 5 cave faunal surveys at new cave localities in Lincoln, Jerome, Gooding, Blaine, Minidoka, and Butte counties, Idaho by 30 June 2018.

Results: Cave faunal surveys were conducted in February and March of 2018. Twenty-nine caves were visited with nineteen being new cave localities that had not been previously visited to determine the presence of cave fauna. Hibernating bat species were documented at all locations (Fig. 5). Some caves had not been surveyed since the 1990s primarily due to access issues and the technical nature of the caves (Fig. 2). Five new localities of *Idagona westcotti* were discovered and 2 new localities of *Glacicavicola bathyscioides* (Figs. 3 and 4). Two *Speleomaster* SGCN (Fig. 1) were also documented at 5 new cave locations. In addition, a new species of troglobiotic centipede was discovered in a single cave and was the largest specimen known to date in the family. This species was in the process of being described by Dr. William Shear when the specimen was found (Fig. 3). *Speleopsobius weaveri*, n. gen., n. sp., was being described by Dr. Shear from specimens collected from 2 lava tube caves in south-central Idaho: Tee Cave and Spider Cave. Both caves have a long history of recreational use and have been surveyed multiple times in the past several years for cave fauna and *S. weaveri* was not encountered. It is an Idaho endemic species and a cave obligate species that should be included in future faunal inventory work.

Figure 1. *Speleomaster* sp. in Tomb Cave, 7 February 2018. These slow-moving arachnids have no pigment due to the pitch black conditions in the cave environment. Having no functional eyes they use their second pair of legs as modified antennae to maneuver around the cave environment waiting to encounter prey. They have modified mouthparts that are used to impale their prey once found (similar to praying mantis protibial spines).

Figure 2. The principal investigator "stuck" in Boulder Cave on 8 February 2018. After a few minutes and one torn pair of coveralls later he was successful in exiting the small room that was being searched for hibernating bats.

Figure 3: A troglomorphic anopsobiid millipede (*Speleopsobius weaveri*, n. gen., n. sp. recently described by William Shear at Hampden–Sydney College) and *Glacicavicola bathyscioides* from Boulder Cave 8 February 2018.

Figure 4 *Glacicavicola bathyscioides* from Boulder Cave 8 February 2018.

Figure 5. A Townsend's Big-eared Bat and Western Small-footed Myotis in Jawdropper Cave. *Myotis* spp. are typically difficult to accurately survey for due to their tendency to squeeze into small cracks and crevices.

Objective 1b: Conduct at least 10 surveys for SGCN with inadequate distribution and biological information thought to be associated with lava flows and kipukas in Washington, Lincoln, Gooding, Blaine, and Butte counties, ID by 30 June 2018.

Results: Twelve surveys were conducted to learn more about the biology and distribution on lava-flow-associated SGCN. Six surveys were conducted at Craters of the Moon National Monument and Preserve (Fig. 6). These surveys used hand and sweep net collecting at several sites. Specimens of *Chrysobothris* sp. were collected but all were not collected on Buckwheat (*Eriogonum*) or on cinders as outlined in the literature. Most were hand collected on cinquefoil flowers. It is unknown if these are SGCN but determination will be conducted by experts on the genus over the winter. In addition to hand collection surveys, we used yellow pan traps and green panel traps. Yellow pan traps, due to the similar color to the cinquefoil flowers, was effective at collecting *Chrysobothris* sp. (Fig. 9). Green panel traps baited with α-pinene (Figs. 7 and 8) were effective at sampling conifer-associated species including *Chrysobothris*. However, the total catch was small given the 2-week time period in which they were deployed.

Surveys were conducted at locations north of Gooding, Shoshone, and in the Cambridge area. Only a few specimens of *Chrysobothris* were collected because surveys were completed at these locations prior to learning that yellow pan traps were an effective sampling method. Several specimens that appear to be Yellow-masked Bees were collected but it will not be known if they are *Hylaeus lunicraterius* until they are examined by experts at the USDA–ARS Logan Bee Lab.

Figure 6. *Eriogonum* flowers in bloom at Craters of the Moon National Monument and Preserve.

Figure 7. A green panel trap with funnel catchment and an α-pinene lure deployed at Craters of the Moon National Monument and Preserve.

Figure 8. The catch in the collection cup of a green panel trap.

Figure 9. The catch of a yellow pan trap after 1 hour of deployment.

<u>Objective 2</u>: Monitor populations of 6 sand-obligate SGCN in the Sparsely Vegetated Dune Scrub & Grassland of the Snake River Basalts and Owyhee Uplands sections at 4 sites in Gooding, Owyhee, and Elmore counties, ID by 30 June 2018.

Results: Populations of *Cicindela waynei* were monitored 3 separate times. The first monitoring event took place during spring emergence of adults to determine activity. Locations within the previously occupied habitat were surveyed for adults and larvae. Few adults were observed and only the largest larval burrows were active. The second visit to Bruneau Dunes yielded better results with L1-L3 larvae being active and many adults (Fig. 10). Larval burrow counts at historic monitoring locations demonstrated that many larvae were being recruited into the population at the 4 selected locations. This is encouraging news for the population and monitoring will continue in future years to ensure that larvae are being recruited into the next age class. The third visit to the dunes in May was during a major rain event and no monitoring was able to be conducted and other field obligations did not allow for monitoring at Bruneau following the precipitation. While headlamping and blacklighting at night, large numbers of *Amblyderus owyhee* were observed at Bruneau Dunes on the slip faces of the major dune slopes. *Polyphylla devestiva* adult males were observed at 2 locations at the dunes while headlamping, but none were encountered during blacklighting. Evening primrose was checked for the larvae of *Euproserpinus wiesti* but none were encountered nor were they observed nectaring on flowers during the day.

Populations of *Cicindela arenicola* were monitored at Dietrich Dunes, Heyburn Dunes, and sites at Minidoka National Wildlife Refuge (Fig. 11) that had not been monitored in several years.

Figure 10. *Cicindela waynei* adults observed during monitoring activities in late April 2018 at Bruneau Dunes

Figure 11. *Cicindela arenicola* adults (below), note the difference in color between the 2 individuals in the lower right image. This population and those found on adjacent dunes were originally thought to be an intermediate population between Bruneau and St. Anthony Dunes because the colors were more of a coppery green as opposed to the brown at St. Anthony and the blue-green at Bruneau Dunes.

<u>Objective 3:</u> Conduct yellow pan trap and sweep surveys at 15–20 historic and predicted sites within Sagebrush Steppe in the Snake River Basalts, Owyhee Uplands, and Northwestern Basin and Range sections and coordinate with taxonomic experts to learn to properly determine species and better understand species biology and habitat specifications in Twin Falls, Jerome, Gooding, Owyhee, Elmore, Blaine, Lincoln, and Cassia counties, ID by 30 June 2018.

Results: Using plant distribution databases for the locations of plants favored by bee SGCN, sites were identified in advance of field work. Plants were selected for bloom throughout the entire growing season and those that had documented preference or regular use by the target species. Ten sites at predicted locations targeted plants blooming from May to June as many sites had already senesced during the sampling windows in the late season of 2017 as planned. Yellow Bumble Bee and Hunt's Bumble Bee were encountered during these surveys with Hunt's being the most commonly encountered bumble bee (Fig. 12). Due to regularly encountering *Bombus huntii*, its status should be reviewed as it appears to be common at most sites from urban to rural environments. Surveys were conducted at 20 additional sites in southern Idaho with some being selected based on historic observations and others due to suitable habitat and flowers being encountered during other field activities (Fig. 13). Bumble bees observed were entered into Bumble Bee Watch for photo determination and many specimens were retained for deposition into entomological collections as vouchers. All targeted SGCN were encountered during surveys with the exception of *Bombus suckleyi*, Suckley's Cuckoo Bumble Bee. Yellow pan traps were also used opportunistically, but were not effective due to the time needed for bees to encounter the pans.

Figure 12. Number of bumble bees encountered during one standard survey.

Figure 13. IDFG staff conducting an opportunistic bumble bee survey. Western Bumble Bee (*Bombus occidentalis*) was encountered twice at this location.

Principal Investigator(s) for Research Projects

Ross Winton, Idaho Department of Fish and Game, Magic Valley Region, 324 S 417 East, Suite #1, Jerome, ID 83338 208 644-6307

Ross.winton@idfg.idaho.gov

Project 5—Southeast Region SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan, 2015 (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are addressed as specific needs identified in the Overthrust Mountains, Snake River Basalts, Bear Lake, and Northwestern Basin and Range sections. The SWAP describes the need for gathering baseline data on the presence and relative abundance of bats in Idaho, cave-obligate invertebrate species, and to identify what is/are the root cause(s) of apparent decline in multiple SGCN such as Yellow-billed Cuckoo.

1. Declines in bat populations at both continental and local levels have led to concern about the future of migratory and resident bats in Idaho. Bats are vulnerable to rapid declines in abundance because of their low reproductive rates and specialized behaviors. Habitat loss, modification, and fragmentation; roost site disturbances; wind turbine-caused mortality; pesticides; and emerging pathogens have all been implicated in these declines. Declines in abundance of bats could have far-reaching consequences as bats help to maintain functional ecosystems and provide economic benefits to Idaho's agricultural industry (e.g., insect pest control) in excess of $300 million. Little is known about bat population status and trends, migration routes, and hibernacula. The need exists to implement and incorporate bats into long-term multitaxa monitoring programs to monitor trends in species distribution and population size. The Idaho Department of Fish and Game needs a contemporary assessment of bat species composition and relative abundance to inform conservation and management recommendations.

2. The decline of the western Yellow-billed Cuckoo is primarily the result of riparian habitat loss and degradation. Principal causes of riparian habitat destruction, modification, and degradation in the range have occurred from alteration of hydrology due to dams, water diversions, management of river flow that differs from natural hydrologic patterns, channelization, and levees and other forms of bank stabilization that encroach into the floodplain. These losses are further exacerbated by conversion of floodplains for agricultural uses, such as crops and livestock grazing. In combination with altered hydrology, these threats promote the conversion of existing primarily native habitats to monotypic stands of nonnative vegetation, reducing the suitability of riparian habitats for the cuckoo (Halterman et al. 2015). Consequently, the Department identified the need to determine causes of decline in Yellow-billed Cuckoo.

3. We have an inadequate understanding of the current population status of bats and invertebrate cavernicolous fauna. The Department needs to conduct regular monitoring of occupied, historic, and potential caves and tubes for SGCN species in the Southeast Region to inform conservation and management recommendations.

Purpose

To gather baseline data on the presence and relative abundance of bats in Idaho, to identify what is/are the root cause(s) of apparent decline in multiple SGCN such as Yellow-billed Cuckoo, and to assess the status of cave-obligate invertebrate species.

Results or Benefits Expected

- Through the East Idaho Bat Collaborative, partners will have the resources and support to address bat conservation challenges in East Idaho.
- By conducting surveys for YBCU, we will be able to determine if YBCU are present within habitat patches identified by the model. We will use this information to refine YBCU model predictions. By improving the predictive model, we will be able to prioritize habitat in Idaho for conservation actions that will benefit YBCU.
- The surveys will provide information on the current distribution of bats and invertebrate cavernicolous fauna in the Southeast Region and environmental conditions within cave environments. This will enhance IDFG efforts to conserve and manage SGCN species in southern Idaho and also inform responses to future management decisions in these highly specialized and uncommon habitats.

Approach

1. The objectives for this approach are to: 1a. Increase capacity for bat conservation in eastern Idaho and to foster collaboration by organizing and facilitating 2 meetings among members of the East Idaho Bat Collaborative by 30 June 2018; and to 1b. Consistent with statewide white-nose syndrome (WNS) direction and prioritization, coordinate and/or conduct 3–5 hibernacula counts (including WNS surveillance and bat swab sampling/cave sediment sampling where appropriate) identified as priorities in the Southeast Region and provide support for counts conducted in other regions (e.g., Upper Snake and Magic Valley Regions) by 30 June 2018. IDFG Wildlife Diversity Biologist in the Southeast Region will act as Chair of the East Idaho Bat Collaborative. The group works together to improve knowledge of bats, share information, and provide in-kind support for conservation projects for bats. The East Idaho Bat Collaborative and other partners (including members of the Idaho Bat Working Group) will work together to address the following needs in bat conservation:

- Standardized analysis of a backlog of acoustic bat recordings from several years of mobile acoustic transects and other acoustic surveys.
- Hibernacula counts at priority caves and counts at new or under-surveyed caves
- Analysis to inform IDFG recommendations for bats to the wind industry
- Foster a mutually beneficial relationship with cavers to expand knowledge of our bat roosts in East Idaho
- Consistent with statewide WNS response and surveillance efforts, conduct WNS surveillance (e.g., bat swab sampling/cave sediment sampling at priority hibernacula during late winter or during spring emergence)

2. The objective for this approach is to coordinate with federal and NGO partners to conduct a minimum of 8 standardized surveys for YBCU in areas prioritized by habitat model predictions along the Main Stem of the Snake River and Blackfoot River (Bingham County) by 30 June 2018. We will use the most recent version of the standard survey protocol for the western distinct population segment of YBCU developed by Halterman et al. (2015) to survey potential habitat for YBCU along the Snake River in southeast Idaho. Colorado Plateau Research Station Director and Ecologist, Matt Johnson, was contracted by IDFG to model potential YBCU habitat in Idaho, with the output finalized in 2016. By conducting surveys for YBCU, we will be able to determine if YBCU are present within habitat patches identified by the model, but not determine abundance or exact distribution. We will not conduct nest searches for YBCU. If a nest is

unintentionally located by the observer however, we will record the breeding observation. We will use this information to refine YBCU habitat model predictions. By improving the predictive model, we will be able to prioritize habitat in Idaho for conservation actions that will benefit YBCU.

3. The objective for this approach is to determine the population status of SGCNs found in the Lava Flows, Caves and Tubes in the Overthrust Mountains, Snake River Basalts, and Northwestern Basin and Range sections by conducting at least 5 cave faunal surveys at new or known cave localities in Power, Bingham, Caribou, and Bear Lake counties, ID by 30 June 2018. The cave faunal survey project is intended provide new information on the distribution and population status of SGCN species in lava tubes and caves to gauge the extent and quality of associated habitats. The cave faunal surveys will occur in 5 to 10 caves. Bat counts of multiple species including Western Small-footed Myotis (S3, Tier 3), Townsend's Big-eared Bat (S3, Tier 3) and Little Brown Myotis (S3, Tier 3) and opportunistic hand collecting of invertebrates will be used to determine species presence and estimate abundance. Sampling of invertebrates will focus on Blind Cave Leiodid Beetle (S1, Tier 1), *Flabellorhagidia pecki* (S1, Tier 2), Idaho Lava Tube Millipede (S1, Tier 2), and SGCN cave obligate harvestmen (*Speleomaster lexi* and *Speleomaster pecki*; both S1, Tier 2). Sampling will occur during 2 windows in January and February while bats are hibernating and during annual hibernacula counts focusing on Western Small-footed Myotis, Townsend's Big-eared Bat, and Little Brown Myotis, or in August and September (when young are volant) using mist nets. Bat surveys may also be conducted during April and May during spring emergence mist netting during WNS sampling events or during the summer season using mobile and/or stationary acoustic methods. The project's field activities should take no longer than 2 months to complete. Temperature and humidity measurements will be taken at each site in addition to bat swab sampling and/or cave sediment sampling at those sites prioritized for WNS/*Pd* diagnostics. All bat and cave work will adhere to the most current WNS national decontamination protocol available at https://www.whitenosesyndrome.org. When complete, the proposed project will give IDFG staff an increased knowledge of the distribution of cavernicolous SGCN fauna in the Southeast Region. This knowledge will allow us to better conserve and manage these wildlife species in the region and also provide more educated responses to future land management actions.

Geographic Location

Bannock, Bear Lake, Blaine and Butte (Big Desert), Bingham, Caribou, Franklin, Fremont (Sand Creek Desert), Oneida, and Power.

Describe how objectives were met.

<u>Objective 1a:</u> Facilitate 2 meetings among members of the East Idaho Bat Collaborative by 30 June 2018.

Results: I facilitated 2 meetings among members of the East Idaho Bat Collaborative, including IDFG, FWS, FS, BLM, NPS, NGOs and Master Naturalists on 19 December 2017 and 11 April 2018. Agenda, attendee list, and minutes for each meeting are attached in the appendix.

Objective 1b: Coordinate and/or conduct 3–5 hibernacula counts in the Southeast Region and provide support for counts conducted in other regions (e.g., Upper Snake and Magic Valley Regions) by 30 June 2018. A

Results: I coordinated and/or conducted bat hibernacula counts at 12 caves in the Southeast and Upper Snake Region. Sites surveyed included Minnetonka, Corroded Abode, Kettle Butte, 17 mile, Owl 1, Owl 2, Owl 3, Swiss Cheese Ceiling, Niter Ice Cave, Natural Bridge, Fool's Wading Pool, and Condor. Additionally, I coordinated with BLM partners who surveyed an additional 4 caves including Cinderwall, Falcon, Garden, and Government caves. At each site, we counted hibernating bats (if present), collected cave obligate invertebrates (if present), recorded temperature and humidity, and examined hibernating bats for signs of *Pd* or white-nose syndrome.

Table 1. Bat species observed during hibernacula counts in FY18 in East Idaho.

Cave	Bat Species	Count
Minnetonka	Townsend's Big-eared Bat	89
	Western Small-footed Myotis	4
	Long-eared Myotis	1
	Myotis species	861
Niter Ice Cave	Townsend's Big-eared Bat	46
	Western Small-footed Myotis	1
	Myotis species	1
Swiss Cheese Ceiling	Townsend's Big-eared Bat	16
Corroded Abode	Townsend's Big-eared Bat	67
Natural Bridge	Western Small-footed Myotis	3
	Long-eared Myotis	1
	Myotis species	65
Bobcat	Townsend's Big-eared Bat	262
Cinderwall	Townsend's Big-eared Bat	624
	Western Small-footed Myotis	8
Falcon	Townsend's Big-eared Bat	113
	Western Small-footed Myotis	9
Fools Wading Pool	Myotis species	144
Garden	Townsend's Big-eared Bat	202
	Western Small-footed Myotis	2
Government	Townsend's Big-eared Bat	74
	Western Small-footed Myotis	3
Owl 1	-	0
Owl 2	-	0
Owl 3	-	0
17 Mile	-	0
Kettle Butte	-	0

Objective 2: Conduct a minimum of 8 standardized surveys for Yellow-billed Cuckoo along the Main Stem of the Snake River and Blackfoot River (Bingham County) by 30 June 2018.

Results: I conducted 7 standardized surveys for Yellow-billed Cuckoo: 4 surveys on the lower Blackfoot River and 3 surveys at McTucker Ponds on the Main Stem Snake River. I planned 4 surveys at McTucker, for a total of 8 surveys; however, I canceled the last survey due to the camping activity and noise levels at the site. I audibly and visually detected 1 Yellow-billed Cuckoo at the McTucker site during 1 of 3 surveys, and had no detections during any of the surveys on the Blackfoot River. This work contributed to model validation for Yellow-billed Cuckoo breeding habitat in Idaho.

Objective 3: Conduct at least 5 cave faunal surveys for SGCNs at new or known cave localities in Power, Bingham, Caribou, and Bear Lake counties, ID by 30 June 2018.

Results: I conducted 5 cave faunal surveys for SGCN at sites that had either no history of being surveyed in the winter for bats or hadn't been visited since the 1990s. I surveyed Kettle Butte, 17 mile, Owl 1, Owl 2, and Owl 3. We thoroughly surveyed the cave for bats and cave obligate invertebrates and found no indication of hibernating or roosting bats at the 5 sites, and no visible invertebrates. This winter was particularly dry and warm, potentially affecting the distribution and activity of invertebrates inside the caves.

Principal Investigator(s) for Research Projects

Becky Abel, Idaho Department of Fish and Game, Southeast Region, 1345 Barton Rd, Pocatello, ID 83204-1819, 208 236-1258

Becky.abel@idfg.idaho.gov

Project 6—Upper Snake Region SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are addressed as specific needs identified in the Yellowstone Highlands and Snake River Basalts sections. The Idaho SWAP describes the need for increasing the number of nesting Trumpeter Swans (*Cygnus buccinator*) in Teton County to meet conservation and wildlife management goals, employing multiple strategies to improve aquatic and riparian habitats, and monitoring habitats and populations of White-faced Ibis (*Plegadis chihi*) and Franklin's Gull (*Leucophaeus pipixcan*).

1. Trumpeter Swan Reintroduction: Trumpeters in eastern Idaho are part of the Rocky Mountain Population (RMP) that numbers approximately 7,000 individuals. Most RMP swans breed in Canada but there is a smaller struggling breeding flock in the Greater Yellowstone area (Idaho, Wyoming, Montana). Despite the ongoing recovery of RMP Trumpeter Swans, the viability of the Greater Yellowstone Flock remains a conservation challenge as production at nest sites in eastern Idaho and Yellowstone National Park are perennially low. In the Yellowstone Highlands, the average number of active Trumpeter Swan nest sites since 2012 is five (Henry 2012, 2013; Shea 2014*a,b*). The Department needs to increase the number of nesting Trumpeter Swans in Teton County to meet conservation and wildlife management goals.

2. Beaver Restoration: Program Expansion and Direction. Recently, there has been widespread recognition that American Beaver (*Castor canadensis*) plays a vital role in maintaining and diversifying stream and riparian habitat through its dam building (Collen and Gibson 2000, Burchsted and Daniels 2014). Some examples of the influence of beavers on riparian systems include: increased water retention, decreased peak flows, expansion of habitat area and complexity, sediment retention, temperature moderation, and nutrient cycling. As a result, the beaver is frequently referred to as a keystone species, meaning that it has a disproportionately large effect on its environment relative to its abundance. Vegetation and multiple species including aquatic invertebrates, fish, amphibians, and birds benefit from habitats created by beavers. Beaver population expansion is identified in SWAP as a strategy for improving habitat for the Yellowstone Highlands SGCN including Western Toad (*Anaxyrus boreas*), Silver-haired Bat (*Lasionycteris noctivagans*), Olive-sided Flycatcher (*Contopus cooperi*), and Grizzly Bear (*Ursus arctos*). In circumstances where natural expansion is unlikely to occur, beaver restoration projects use translocation to augment existing populations or expand distribution. The Idaho Department of Fish and Game (IDFG) Upper Snake Region has developed a beaver co-op and strategic plan to use nuisance beavers to aid in restoration efforts. Although capture and relocation efforts have begun, this fledgling program still lacks consistency and direction.

3. White-faced Ibis is a colonial breeder, generally choosing to nest in shallow marshes with dense emergent vegetation. In Idaho, most colonies are found in hardstem bulrush/cattail marshes. Agricultural conversion to center-pivot from flood irrigation is the biggest threat to this species in Idaho. Forty percent of Idaho's breeding population resides at Market

Lake and Mud Lake WMAs. The surrounding landscape is rapidly losing flood-irrigated habitats that are used extensively by ibis for foraging. Franklin's Gull breeds in large areas with fairly open emergent vegetation (particularly bulrush/cattail marshes) and deep water. Nests are formed on floating mats built on the water's surface, on muskrat lodges, or on floating debris, and are constructed of dead marsh plants. Agricultural conversion to center-pivot from flood irrigation is the biggest threat to this species in Idaho as well. Periodic population monitoring of these 2 colonial breeders is necessary to track population trends and assess habitat management practices.

Purpose

1. Establish summer occupancy and breeding of Trumpeter Swans in suitable wetland sites in Teton Basin
2. Provide organizational leadership to multiagency beaver restoration co-op
3. Monitor White-faced Ibis/Franklin's Gull colonies at important regional breeding sites

Results or Benefits Expected

- We will establish Trumpeter Swan breeding pairs at 3 protected wetlands in Teton Basin. This will expand the Idaho breeding flock and aid similar conservation efforts underway in Yellowstone National Park.
- Leadership provided to the beaver co-op program will aid in successful restoration efforts that will enhance riparian habitats, providing benefits to multiple SGCN.
- Data obtained from colonial waterbird surveys will help track population trends and aid in habitat management efforts.

Approach

1. The objective for this approach is to facilitate the release of 4–5 captive reared Trumpeter Swans in suitable wetland habitats in Teton Basin by 1 June 2018. As recommended in the Pacific Flyway Trumpeter Swan Implementation Plan, IDFG staff will work with partners to establish 3 Trumpeter Swan nesting territories and/or summer occupancy in Teton Basin Idaho. This is year 2 of a 10-year project. Teton Basin contains unoccupied but suitable Trumpeter Swan nesting habitat within the core breeding area of the Greater Yellowstone flock of the Rocky Mountain Population (RMP). We define Teton Basin as the upper portion of the Teton River watershed between the Idaho–Wyoming state line near Victor, Idaho north to the town of Tetonia, Idaho. This area lies near the south end of Idaho's core Trumpeter Swan habitat, south and east of core nesting sites at Sand Creek Wildlife Management Area, Camas National Wildlife Refuge (NWR) and Island Park, Idaho. It lies west of Jackson, Wyoming, and about 70 miles north of the Grays Lake NWR expansion flock. Despite the recovery of RMP Trumpeter Swans, the viability of the Greater Yellowstone flock remains a conservation challenge. Production at nests in eastern Idaho is perennially low and there is current concern about Trumpeter Swans becoming extirpated in nearby Yellowstone National Park. Project partners will release 5–10 Trumpeter Swan cygnets and/or yearlings per year in approved wetland habitat for approximately the next 10 years. This action has been formally approved by both the Greater Yellowstone Trumpeter Swan Working Group and the Pacific Flyway Council. The Wyoming Wetlands Society will raise Trumpeter Swan cygnets and/or yearlings at their captive-rearing facility in Jackson, Wyoming until they are ready to relocate to a Teton Valley wetland. The release protocol for cygnets will begin in late August, when 70-day-old cygnets and a surrogate

mother will be introduced into a temporary enclosure near the Teton River. The release protocol for yearlings will begin immediately after ice-out when yearlings will also be released into a temporary enclosure. The goal is to establish a bond between released swans and protected wetland habitats that will result in summer occupancy and eventual breeding at suitable sites in Teton Basin. This technique has been effective at other locations in Wyoming and Montana.

2. The objective for this approach is to organize and lead 2 Upper Snake Beaver Co-op meetings between 1 July 2017 and 30 June 2018; to prepare (with assistance from partners) an annual report of co-op activities, due 31 March 2018. Activities of this approach include:

- Engage with IDFG staff and partners to improve overall function/performance of the Upper Snake Beaver Co-op.
- Encourage communication and information sharing among co-op participants, including IDFG, Bureau of Land Management (BLM), US Forest Service (FS), and local NGOs.
- Work with IDFG habitat biologists to incorporate the Utah State University Beaver Restoration Assessment Tool (BRAT) into local restoration efforts.
- Work with Co-op partners to develop and implement pre/post-release habitat monitoring protocols.
- Work with IDFG population staff, contract trappers, and landowners to improve trapping, holding and release efforts.
- Research methods for noninvasive beaver marking for resighting released beavers.
- Coordinate regular meetings among co-op participants.

3. The objective for this approach is to coordinate and conduct surveys at Market Lake, Mud Lake, and Island Park Reservoir White-faced Ibis/Franklin's Gull colonies to assess current breeding population size by 30 June 2018. Colony surveys will occur at 2–3 locations (Market Lake WMA, Mud Lake WMA, and Island Park Reservoir [if active]). Surveys at White-faced Ibis/Franklin's Gull colonies entail 2 visits to the colony. The first visit is to collect spatial information on the boundaries of the colony, which are used to delineate transects for the nest count. This visit takes place during the incubation period, which is approximately late May. The colony itself is not entered during this visit. The second visit entails on-the-ground counting of nests. Nest counts are during mid-incubation to early nestling stage, which is typically in early June. Colonies are not entered if chicks are large or highly mobile. Surveys are conducted when air temperatures are at least 65 °F and rain is unlikely. Fully-formed nests containing eggs or chicks are counted by walking (at least 1 observer) or canoeing (at least 2 observers) through the colony along predefined transects. Vegetation type and density, and water depths will also be recorded.

Geographic Location

Clark, Fremont, Madison, Teton, and Jefferson counties

Describe how objectives were met.

<u>Objective 1</u>: Facilitate the release of 4–5 captive reared Trumpeter Swans in suitable wetland habitats in Teton Basin by 1 June 2018. Approximately 24 hours.

Results: The Idaho SWAP describes the need for increasing the number of nesting Trumpeter Swans (*Cygnus buccinator*) in Teton County to meet conservation and wildlife management goals. Trumpeters in eastern Idaho are part of the Rocky Mountain Population (RMP) that numbers approximately 7,000 individuals. Most RMP swans breed in Canada but there is a smaller struggling breeding flock in the Greater Yellowstone area (Idaho, Wyoming, Montana). Despite the ongoing recovery of RMP Trumpeter Swans, the viability of the Greater Yellowstone Flock remains a conservation challenge as production at nest sites in eastern Idaho and Yellowstone National Park are perennially low. The Yellowstone Highlands has averaged 5 active Trumpeter Swan nest sites since 2012.

Working with partners from the Wyoming Wetlands Society, Teton Regional Land Trust, The US Fish and Wildlife Service, and Intermountain Aquatics, Inc., we released 4 captive-reared yearling Trumpeter Swans at a restored wetland site in Teton Basin, ID (Fig. 1). On 27 April 2018 we released one male and one female and on 10 May 2018 we released an additional male and female. All swans received health clearances before transport between the rearing facility in Wyoming and an additional health check from the IDFG state veterinarian. Swans received aluminum federal leg bands and uniquely-numbered green-and-white neck collars prior to release (Table 1). The May release was used as an outreach and educational event as project partners extended an invitation to a local elementary school class. The release was also filmed by a local East Idaho television news team and developed into a news story.

Monitoring of the released swans was conducted through 30 June 2018 by staff of Teton Regional Land Trust. Through the study period, all swans were documented alive and healthy at the release site. Numbered neck bands will be used for long-term monitoring and will allow documentation of potential future pairing activities and/or nesting. Results from the release will be documented in an annual report to the Greater Yellowstone Trumpeter Swan Group in 2019.

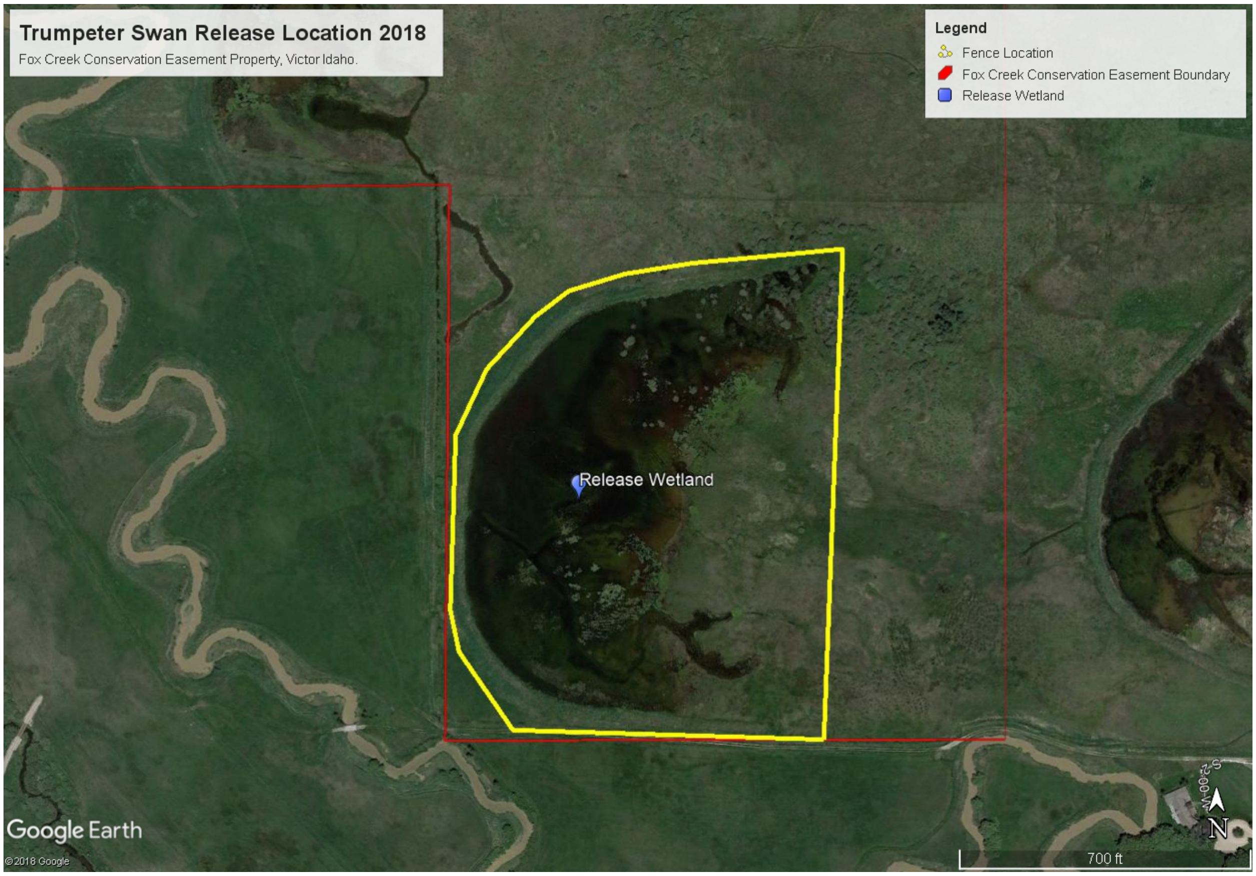

Figure 1. Release location for captive-reared Trumpeter Swans, 2018.

Table 1. Band, collar, and gender data for released, captive-reared Trumpeter Swans, 2018.

Leg Band	Collar	Age	Sex	Date	Location
1959-04353	K20	Yearling	F	4/27/18	Huntsman Fox Creek Pond 2
1959-04352	K21	Yearling	M	4/27/18	Huntsman Fox Creek Pond 2
1959-04397	K23	Yearling	M	5/10/18	Huntsman Fox Creek Pond 2
1959-04396	K24	Yearling	F	5/10/18	Huntsman Fox Creek Pond 2

Objective 2: Organize and lead 2 Upper Snake Beaver Co-op meetings between 1 July 2017 and 30 June 2018. Prepare (with assistance from partners) an annual report of co-op activities, due 31 March 2018 (approximately 32 hours).

Results: Recently, there has been widespread recognition that American Beaver (*Castor canadensis*) plays a vital role in maintaining and diversifying stream and riparian habitat through its dam building. Some examples of the influence of beavers on riparian systems include: increased water retention, decreased peak flows, expansion of habitat area and complexity, sediment retention, temperature moderation, and nutrient cycling. As a result, the beaver is frequently referred to as a keystone species, meaning that it has a disproportionately large effect on its environment relative to its abundance. Vegetation and multiple species including aquatic invertebrates, fish, amphibians, and birds benefit from habitats created by beavers. Beaver population expansion is identified in SWAP as a strategy for improving habitat for the Yellowstone Highlands SGCN including Western Toad (*Anaxyrus boreas*), Silver-haired Bat (*Lasionycteris noctivagans*), Olive-sided Flycatcher (*Contopus cooperi*), and Grizzly Bear (*Ursus arctos*). In circumstances where natural expansion is unlikely to occur, beaver restoration projects use translocation to augment existing populations or expand distribution. The Idaho Department of Fish and Game (IDFG) Upper Snake Region has developed a beaver co-op and strategic plan to use nuisance beavers to aid in restoration efforts. Although capture and relocation efforts have begun, this fledgling program still lacks consistency and direction. Between July 2017 and June 2018 I organized and lead 2 Upper Snake Beaver Co-op meetings (Appendix).

Objective 3: Coordinate and conduct surveys at Market Lake, Mud Lake, and Island Park Reservoir White-faced Ibis/Franklin’s Gull colonies to assess current breeding population size by 30 June 2018. Approximately 48 hours.

Results: White-faced Ibis is a colonial breeder, generally choosing to nest in shallow marshes with dense emergent vegetation. In Idaho, most colonies are found in hardstem bulrush/cattail marshes. Agricultural conversion to center-pivot from flood irrigation is the biggest threat to this species in Idaho. Forty percent of Idaho’s breeding population resides at Market Lake and Mud Lake WMAs. The surrounding landscape is rapidly losing flood-irrigated habitats that are used extensively by ibis for foraging. Franklin’s Gull breeds in large areas with fairly open emergent vegetation (particularly bulrush/cattail marshes) and deep water. Nests are formed on floating mats built on the water’s surface, on muskrat lodges, or on floating debris, and are constructed of dead marsh plants. Agricultural conversion to center-pivot from flood irrigation is the biggest threat to this species in Idaho as well. Periodic population monitoring of these 2 colonial breeders is necessary to track population trends and assess habitat management practices.

In May and June of 2018 we monitored White-faced Ibis/Franklin’s Gull colonies at Market Lake and Mud Lake WMAs in eastern Idaho. Although important for multiple colonial waterbird species, Island Park Reservoir does not have colonies of White-faced Ibis or Franklin’s Gull. We conducted reconnaissance canoe surveys to delineate colonies for actual bird surveys. Multiple reconnaissance efforts revealed that no White-Faced Ibis or Franklin’s Gull nesting colonies were established on Market Lake WMA in 2018, although we did document several hundred nonbreeding ibis roosting on marshes. On 13 June 2018, with assistance from US Fish and Wildlife Service staff, we conducted a drone survey of the entire Mud Lake WMA colony (Fig. 2). Image processing from the survey is ongoing.

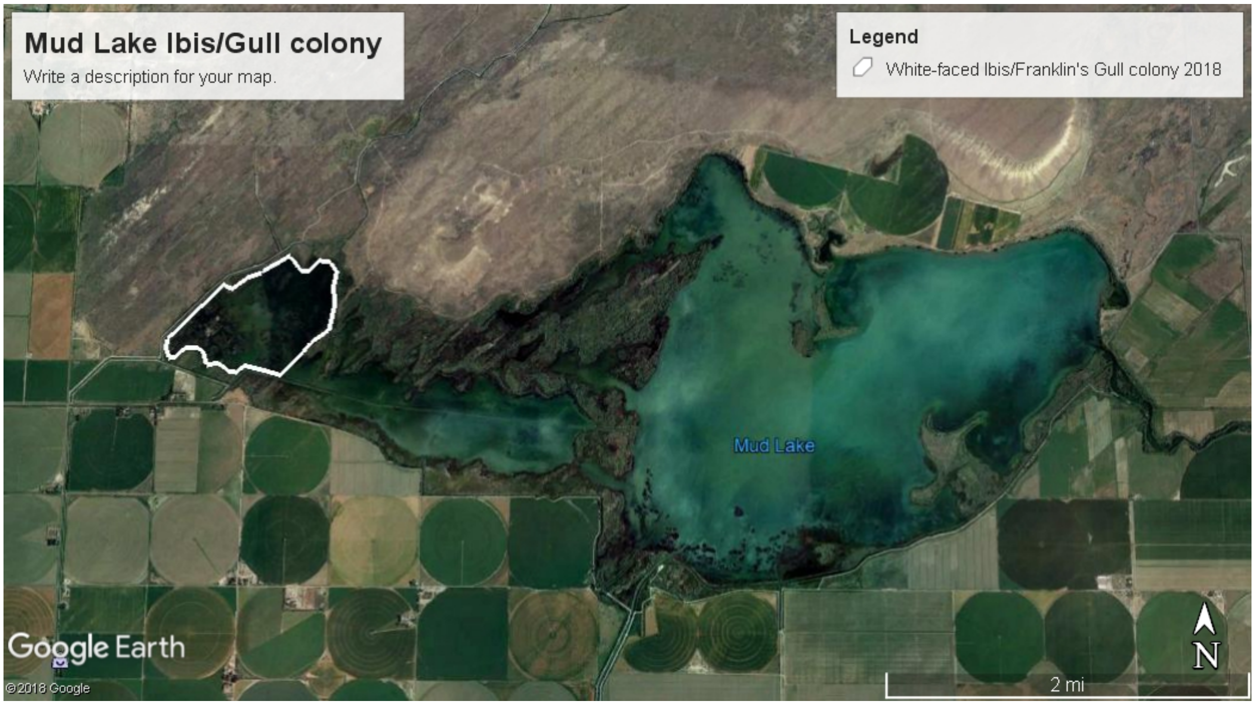

Figure 2. Mud Lake WMA White-faced Ibis/Franklin's Gull colony boundary, 2018.

Principal Investigator(s)

Matt Proett, Regional Diversity Biologist, Idaho Department of Fish and Game, Upper Snake Region, 4279 Commerce Circle, Idaho Falls, ID 83401, 208 525-7290

Matt.proett@idfg.idaho.gov

List of Partners

FS, BLM, FWS, Teton Regional Land Trust, other NGOs, private landowners.

Project 7—Salmon Region SWAP Implementation

Need

The 2015 Idaho State Wildlife Action Plan (SWAP) sets out a plan for priority actions to benefit species of greatest conservation need (SGCN) over the next 10 years. The objectives of this project are addressed as specific needs identified statewide and in the Challis Volcanics, Beaverhead Mountains, and Idaho Batholith sections of the SWAP: conduct surveys to document pollinator species distribution and population status, educate about and implement practices that benefit pollinators, and implement actions aimed at increasing the health and vigor of aspen stands.

1. As recently as 2014, only a handful of records existed for Monarch (*Danaus plexippus*) and its milkweed (*Asclepias* spp.) host plants in Idaho, and even fewer records confirmed Monarch breeding activity. In 2016, Idaho Department of Fish and Game (IDFG) undertook a statewide survey of milkweeds and Monarch natal habitats to better understand their distributions, habitat associations, and conservation threats. These data were needed to appropriately evaluate the status of Monarch for possible inclusion as a species of greatest conservation need in the Idaho State Wildlife Action Plan 10-year revision. Surveys documented breeding Monarchs in all 10 of Idaho's climate divisions, a much wider distribution than the single climate division predicted as suitable for Monarch breeding by Stevens and Fry (2010). Recent isotopic analyses of Monarchs collected at California overwintering sites found approximately 40% of Monarchs (n = 114) had natal origins in the "northern inland range" of Idaho, eastern Oregon, eastern Washington, Montana, and Wyoming (Yang et al. 2015). These recent studies suggest that Idaho may be an important contributor to the western Monarch population. Further surveys of breeding Monarchs and milkweeds are needed to help refine Idaho distributions and ongoing habitat suitability modeling of the western Monarch population.

   As part of the survey project, IDFG conducted extensive public outreach on Monarchs and milkweeds through news releases, newsletters, presentations, and workshops co-hosted with Monarch Joint Venture and Xerces Society partners. This outreach was met with extraordinary, statewide public interest in Monarch conservation, particularly requests from educators and citizen scientists for workshops emphasizing Monarch biology, life cycle, milkweed cultivation, field identification, migration, and programs for further involvement. The February 2017 launch of the Western Monarch Milkweed Mapper (WMMM) website (in which IDFG was a primary partner) generated another wave of interest and enthusiasm among Idaho citizen scientists, educators, and conservation practitioners to contribute to Monarch and milkweed monitoring efforts. As demonstrated by public response to our survey and outreach, Monarchs serve as powerful catalysts to engage, network, and mobilize people on their behalf. We propose to harness this mounting interest by providing education and outreach workshops to increase public awareness of Monarch conservation issues, promote Monarch citizen science opportunities, and increase volunteer reporting of Monarchs and milkweeds in Idaho.

2. Aspen is considered a keystone species and an indicator of ecological integrity and biodiversity. In the Beaverhead Mountains and Challis Volcanics sections, aspen is restricted in extent (<2% of the land base) but is a unique and ecologically important forest type within

landscapes dominated by conifers and sagebrush. Due to their productivity and species diversity, aspen communities are one of the most valued habitat types in east-central Idaho and are a high priority conservation target in these ecological sections. Although aspen is naturally seral in this part of Idaho, it has declined about 60% since European settlement (Worrall et al. 2013). Several factors, including a lack of disturbance (fire), invasion by conifers, and heavy ungulate grazing, contribute to aspen's decline. Climate change resulting in less precipitation, higher temperatures, and recurring drought, could exacerbate aspen decline (Rehfeldt et al. 2009, Morelli and Carr 2011). To ensure the long-term viability of aspen, IDFG is committed to working with federal land managers and other partners on initiatives that increase and restore aspen communities to benefit wildlife and biodiversity. IDFG is currently working with the US Forest Service (FS) and Bureau of Land Management (BLM) to identify and treat aspen stands in decline due to conifer encroachment. There is a need to develop formal guidelines for conifer removal in aspen stands that balance the necessary "disturbance" for regeneration to occur and the retention of microhabitat components required by aspen-associated SGCN.

Purpose

This purpose of this project is to: 1) actively engage citizen scientists in Monarch and pollinator conservation in Idaho; and 2) develop guidelines for conifer removal in aspen stands to retain microhabitat features for SGCN.

Results or Benefits Expected

- We anticipate improved SWAP and pollinator conservation implementation through active engagement with citizen scientists. These workshops will allow us to disseminate information on the collection and reporting of Monarch and milkweed observations, thereby increasing data inputs to IDFG and Xerces Society online databases. Workshops will "train the trainers" (Master Naturalists, Master Gardeners, educators) to encourage education sharing and further expansion of Monarch awareness and conservation, management, and monitoring techniques to other audiences. Data outputs as a result of training will provide IDFG/WDFW with location-specific information for on-the-ground protection, restoration, and management of milkweed stands, and help refine habitat suitability models for the western Monarch population.
- Development of guidelines for conifer removal in aspen stands will provide consistent, specific direction to stewardship contractors to ensure desirable aspen habitat components (i.e., aspen snags with heart rot, downed wood, conifer snags) required by SGCN are retained and recruited and result in improved health and vigor of aspen communities. These guidelines will benefit several SGCN, from *Hoplitis producta subgracilis* (a mason bee) to Lewis's Woodpecker (*Melanerpes lewis*) to Fisher (*Pekania pennanti*), and a wide array of wildlife species including invertebrates, amphibians, reptiles, birds, and mammals. Public benefits include improved vegetative health, cover, and composition providing a diversity of habitat for wildlife species, recreational opportunities and natural biological diversity, including water quality and conservation, soil stability, and overall improved aspen ecosystem health.

Approach

1. Citizen Science Workshops—the objective for this approach is to develop and present 3 workshops in Idaho (Coeur d'Alene, Lewiston, Idaho Falls) in July-August 2017 to train ≥75 citizen naturalists in the identification of milkweed and Monarch breeding locations and engage 100% of them in collecting these data through the WMMM website. Objective is dependent on funding awarded by Monarch Joint Venture. The Principal Investigator (PI) will host 3 *Monarch Conservation and Citizen Science* workshops, 1 each in Coeur d'Alene, Lewiston, and Idaho Falls, to recruit and train volunteers to participate in Monarch monitoring, habitat development, and public outreach opportunities. Workshops will include an evening classroom module, followed by a half-day (a.m.) field module. Workshop content will be developed by the PI using Monarch Joint Venture and Xerces Society curricula, programs (e.g., Monarch Larva Monitoring Protocol, WMMM, Monarch SOS app), and published materials. Workshop instructors will be the PI and other biologists, botanists, and natural resource specialists with IDFG, FS, BLM, and Natural Resources Conservation Service, all members of the Idaho Monarch Working Group with technical expertise in Monarch and pollinator conservation. IDFG will publicize the workshops as far in advance as possible through news releases, newsletters, list-serves, and social media platforms. Workshop outreach will directly target Idaho Master Naturalists, Master Gardeners, Native Plant Society chapters, and educators: audiences interested in education sharing and further expansion of Monarch awareness, conservation issues, management, and knowledge to public stakeholders and K-12 students.

2. Guidelines for conifer removal in aspen stands—The objective for this approach is to develop prescriptive guidelines for conifer removal in aspen stands targeted for restoration by FS and BLM in the Beaverhead Mountains and Challis Volcanics sections by November 2017. The PI will investigate wildlife and aspen restoration literature and consult with aspen restoration experts and FS/BLM silviculturalists to identify key structural, vegetative, and abiotic attributes required for SGCN habitats. Acquired information will be developed into guidelines that outline best management practices for conifer removal in aspen stands at risk of decline. Guidelines will address SGCN taxa habitat requirements (e.g., snag density, diameter, distribution), timing of treatments, slash treatment alternatives, and retention of both aspen and conifer green trees. Guidelines will be reviewed with and distributed to FS and BLM wildlife and forestry personnel. Guidelines will be incorporated into FS and BLM stewardship contracts developed to conduct aspen restoration work and will be reviewed with contractors prior to ground work.

Geographic Location

1. Workshops will be held in northern Idaho (Coeur d'Alene), west-central Idaho (Lewiston), and east Idaho (Idaho Falls), locations where active Master Naturalist and Master Gardener chapters are established. These locations have been underserved by previous Monarch/milkweed workshops presented by the PI in 2015 and 2016.
2. The "guidelines for conifer removal in aspen stands" product will apply to public lands managed by the Salmon–Challis National Forest (SCNF) and Salmon (SFO) and Challis (CFO) Field Offices of the Bureau of Land Management in east-central Idaho (Beaverhead Mountains and Challis Volcanics sections).

Describe how objectives were met.

Objective 1: Develop and present 3 Citizen Science workshops during July-August 2017.

Results: In 2017, IDFG was awarded a grant by the Monarch Joint Venture to present 3 additional monarch conservation workshops in Idaho. The workshops were held during summer 2017 in Lewiston, Pocatello, and Coeur d'Alene, Idaho, and engaged 86 citizen scientists in monarch conservation through education and action. These workshops targeted citizen scientists, but were well attended by educators, amateur lepidopterists, Master Naturalists, conservation advocates, and other interested individuals. The workshop curriculum served to both educate attendees and engage them to take direct action for Monarchs given opportunities at every scale. Most of those attending these citizen science workshops were recruited for one or more of the following activities:

1. Reporting Monarch and milkweed records to the Mapper.
2. Searching for Monarchs in previously unsurveyed areas.
3. Resurveying historical Monarch and milkweed sites.
4. Tagging Monarch adults.
5. Sampling adult Monarchs for the protozoan parasite *Ophryocystis elektroscirrha* (OE).
6. Monitoring Monarch breeding habitat in the Boise Greenbelt for City of Boise Parks and Recreation.
7. Growing milkweed.
8. Creating pollinator gardens.

Workshops provided a synergistic platform for expanded communication, networking, and information-sharing among participants, agencies, and the general public

<u>Objective 2</u>: Develop prescriptive guidelines for conifer removal in aspen stands targeted for restoration by FS and BLM in the Beaverhead Mountains and Challis Volcanics sections by November 2017.

*Results***:** Wildlife Diversity Biologist Beth Waterbury retired in June 2018. It was initially thought she would have time to complete this objective, but the final completion of other workload requirements and additional requirements of retirement precluded her from starting and completing this project. Also, her workload increased during this time due to additional IDFG data requests from the Salmon–Challis National Forest for an extended Forest Plan Revision public input period.

Principal Investigator (retired)
Beth Waterbury, Idaho Department of Fish and Game, Salmon Region Wildlife Diversity Biologist, 99 Hwy 93 North, Salmon, ID 83467

Greg Painter, Idaho Department of Fish and Game, Salmon Region Wildlife Diversity Biologist, 99 Hwy 93 North, Salmon, ID 83467
Greg.painter@idfg.idaho.gov

Timeline

1. Early June 2017: Notification of grant award by Monarch Joint Venture
   June 2017: Secure dates and venues for workshops
   June-July 2017: Publicize workshops; secure instructors; order workshop packets from Xerces Society
   July-August 2017: Present 3 workshops

2. July 2017: PI will consult peer-reviewed literature and aspen restoration specialists for applicable research and findings on aspen restoration techniques in the western US.
   August-September 2017: PI will draft guidelines for conifer removal in aspen stands and review draft with SCNF, SFO, and CFO wildlife and forestry personnel.
   November 2017: Complete final guidelines and provide electronic and print copies to SCNF, SFO, and CFO personnel.

List of Partners

1. Monarch Conservation and Citizen Science Workshops:
   - Xerces Society for Invertebrate Conservation
   - Monarch Joint Venture
   - Idaho Master Naturalist Program
   - Monarchs of the Pacific Northwest—Dr. David James, Washington State University
   - Dr. Dusty Perkins, College of Western Idaho

2. Guidelines for conifer removal in aspen stands:
   - Salmon-Challis National Forest
   - BLM Challis Field Office
   - BLM Salmon Field Office
   - Idaho Mule Deer Initiative

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Project 8a—Idaho Department of Fish and Game Headquarters Statewide Administration, Coordination, and Data Management

Need

There is a need for the Idaho Department of Fish and Game (Department) to coordinate the ongoing development and implementation of the Idaho State Wildlife Action Plan (SWAP) and to maintain its State Wildlife Grants (SWG) Program eligibility requirements. Idaho is apportioned approximately $550,000 each year under the SWG Program, authorized by Annual Interior Appropriations Acts. These funds are administered by the US Fish and Wildlife Service (FWS), Wildlife and Sport Fish Restoration Program (WSFR) and used by the State through approved grant agreements for eligible projects. Approved projects must have as their objective conservation actions such as research, surveys, species and/or habitat management, and monitoring that are identified in the approved Idaho SWAP; updating, revising, or modifying the SWAP; or addressing emerging issues. The use of these funds through several diverse project statements requires coordination and administration, from the application process through post-closeout. To maintain eligibility for the program, the Department must establish and maintain management control systems adequate to meet requirements for participation in this WSFR Financial Assistance program, and must comply with applicable federal laws and regulations.

Purpose

The purpose of this project is to coordinate the ongoing development and implementation of the Idaho State Wildlife Action Plan (SWAP) to benefit species of greatest conservation need (SGCN) and their habitat.

Results or Benefits Expected

- The Idaho Department of Fish and Game retains its eligibility for participation in the WSFR Program
- Timely submission of complete grant application packages and performance reports
- Effective communication and coordination of all aspects of program and grant activities with the WSFR regional office
- Advancement of conservation priorities outlined in the Idaho SWAP
- Maintaining and sharing data on SGCN to allow the Department to adapt SWAP to new information
- Ensuring the continued engagement of SWAP partners and stakeholders

Approach

1. The objective for this approach is to administer 9 projects under this grant agreement by 30 June 2018. The Department's State Wildlife Action Plan (SWAP) Coordinator will work with Grants/Contracts Specialist, compliance officer, and project personnel to maintain management control systems adequate for participation in the WSFR Program and establish appropriate procedures to effectively administer approved grant. SWAP Coordinator will have primary oversight of project statements, compliance, and submission of applications, amendments, and performance reports. SWAP Coordinator will review project statements to ensure that they address the needs outlined in approved SWAP. SWAP Coordinator will work with Wildlife Diversity Program Manager (WDPM) and Regional Wildlife Managers to direct and coordinate

SWAP implementation activities of 8 Regional Wildlife Diversity Program biologists by attending monthly conference calls with regional staff, attending 3-day Annual WDP SWAP Implementation Coordination Meeting, and attending 8 regional WDP work plan meetings with WDPM, managers, and biologists to establish SWAP implementation priorities by 30 June 2018. In addition, this objective includes the ongoing improvement of a prioritization tool developed in December 2016 and implemented in 2017 to prioritize SWAP actions for incorporation into regional work plans. The Wildlife Diversity Program will hold a 3-day meeting in October 2017 to review and discuss programmatic priorities for inclusion in next year's SWAP Implementation Grant. Based on priorities established during that meeting, the WDPM and SWAP Coordinator will meet with each of the 8 Regional WDP biologists and managers to discuss work plan priorities. SWAP Coordinator will also create new template and guidance for developing 2018 project statements.

2. The objective for this approach is to work with the Department's Idaho Fish and Wildlife Information System (IFWIS) staff to manage observations and locational data for SGCN collected as a result of SWAP implementation at the statewide level including entering data, responding to information requests, and providing semiannual data exports to agency partners by 30 June 2018. SWAP Coordinator will work with IFWIS staff to update the underlying data that informs SWAP by incorporating new observations and locational data for SGCN provided by Department staff and partners. Housed within the Department, the IFWIS is a comprehensive information system for standardizing data on fish, wildlife, and plants in Idaho. The Idaho Species Diversity Database—the most comprehensive repository for site-specific data on Idaho's fish, wildlife, and plant diversity—is maintained by IFWIS under the stewardship of the Wildlife Diversity Program at the Idaho Department of Fish and Game. Data acquired through SWAP implementation (in particular SWG-funded projects) and monitoring will likewise be entered into the database. IFWIS is readily accessible via the Web and these observational data will continue to inform ongoing SWAP development, particularly with respect to distributional data on SGCN, which will be used to inform the range and area of occupancy factors in the conservation status assessments. SGCN observational data will be packaged into a shapefile on a semiannual basis and exported to partners.

3. The objective for this approach is to convene SWAP Adaptive Management (and implementation) Teams for each section at least once to discuss successes, challenges, and opportunities for implementing SWAP by 30 June 2018. During the 2015 SWAP revision process, we identified key partners and stakeholders for each of the 14 sections that compose ongoing Adaptive Management (and implementation) teams for each section. Our long-term goal is to convene these groups at least once per year to discuss successes, challenges, and opportunities for implementing SWAP; thus maintaining an adaptive and community-based approach to conservation and management. During this performance period, we will review membership in these adaptive management teams and consider combining some section teams for greater efficiency. Based on the resulting teams, SWAP Coordinator will organize a meeting for each in coordination with relevant section leads and the Idaho Fish and Wildlife Office's lead for its Landscape Conservation Strategy (LCS). Information captured during these meetings will be used to adapt SWAP to remain current and relevant based on changing ecological, political, economic, and social factors. We will also use these meetings to identify which SWAP actions can be implemented by partners.

Geographic Location
Statewide—most activities will be carried out at 600 S Walnut St, Boise, ID 83712

Describe how objectives were met.
<u>Objective 1</u>: Administer 9 projects under this grant agreement by 30 June 2018.

Results: Principal Investigator (PI) Rita Dixon worked with IDFG Regional Wildlife Biologists and Headquarters staff to oversee 9 projects under this grant agreement. During the reporting period, 1 Regional Wildlife Biologist (Nampa Subregion) transitioned into a new position so PI worked with Regional Wildlife Manager and newly hired Regional Wildlife Biologist to ensure project completion. In addition, the Salmon Region Wildlife Biologist retired and so PI worked with Regional Wildlife Manager to ensure report completion for that project. All 9 projects were completed.

<u>Objective 2</u>: Work with the Department's Idaho Fish and Wildlife Information System (IFWIS) staff to manage observations and locational data for SGCN collected as a result of SWAP implementation at the statewide level including entering data, responding to information requests, and providing semiannual data exports to agency partners by 30 June 2018.

Results: PI continued to work with the Department's Idaho Fish and Wildlife Information System (IFWIS) staff to manage observations and locational data for SGCN collected as a result of SWAP implementation at the statewide level including entering data. One challenge encountered this year was multiple requests for sensitive bat roost data and the resolution at which we will provide those data. We plan to resolve this issue during the next grant agreement reporting period. PI worked with IFWIS Manager and IDFG Deputy Attorney General to draft a letter to federal land management agencies requesting available information regarding the nature and location of significant caves or potentially significant caves within their respective management jurisdictions. These data are needed to support implementation of the Idaho State Wildlife Action Plan (in particular bat and cave-dwelling invertebrate SGCN), North American Bat Monitoring Program, and white-nose syndrome surveillance. These letters went out to the Bureau of Land Management, US Forest Service Northern and Intermountain regions, National Park Service Pacific West Region, and US Fish and Wildlife Service. As a result, we were able to add new cave data to our database.

In addition to work completed under the current grant agreement, we were able to secure additional funds through challenge cost-share programs to focus on incorporating additional datasets (e.g., invertebrates).

<u>Objective 3</u>: Convene SWAP Adaptive Management (and implementation) Teams for each section at least once to discuss successes, challenges, and opportunities for implementing SWAP by 30 June 2018.

Results: Although the original intent for this objective was to convene SWAP Adaptive Management Teams to discuss successes, challenges, and opportunities for implementing SWAP, we instead modified this objective to engage selected SWAP Adaptive Management Team members in a project to integrate climate resilience into the Idaho State Wildlife Action

Plan using the Marxan conservation planning software. The SWAP revision did not identify site-level geographic priorities nor did it address climate change in a spatially explicit way. In the Best Practices for State Wildlife Action Plans, states were encouraged to identify and spatially depict priority areas on the landscape that offer the best opportunities and potential for SGCN conservation as determined by the state, i.e., Conservation Opportunity Areas (COAs). So instead of convening the original SWAP Adaptive Management Teams, we instead assembled a steering committee (many of who also serve on one or more SWAP Adaptive Management Teams) to be part of the decision making with respect to the assessment units and geographic units, building the cost of suitability index, setting conservation goals, and then later when we presented draft Marxan scenarios to share and discuss. The resulting Marxan Steering Committee included:

- *Rita D Dixon, Co-chair, Idaho Department of Fish and Game
- *Robert Unnasch, Co-chair, The Nature Conservancy in Idaho
- *Trisha Cracroft, Natural Resources Conservation Service
- *Sean Finn, Great Northern Landscape Conservation Cooperative
- *Dave Hopper, US Fish and Wildlife Service, Idaho Fish and Wildlife Office
- Lee Jacobson, US Forest Service Intermountain Region
- *Paul Makela, Bureau of Land Management (US) Idaho
- Teri Murrison, Idaho Soil and Water Conservation Commission
- *Diane Probasco, US Forest Service, Idaho Panhandle National Forests
- Michael Pruss, US Forest Service, Nez Perce–Clearwater National Forests
- *Pat Seymour, Idaho Department of Lands
- Eric Sproles, Western Association of Fish and Wildlife Agencies
- Shawn Testin, Idaho Coalition of Land Trusts
- John Tull, Great Basin Landscape Conservation Cooperative
- Joshua Uriarte, Idaho Governor's Office of Species Conservation
- *Kerey Barnowe–Meyer, Nez Perce Tribe

  * depicts members of one or more SWAP Adaptive Management Teams

We hosted a kickoff webinar in December 2017 with the Steering Committee to describe the project and to ensure that everyone understood the purpose of what we planned to do as well as the proposed analytical process. The Steering Committee's role was to help us develop, and then review, the goals for each conservation target (i.e., SGCN and ecological systems). This work involved a series of virtual meetings. We also engaged subsets of Steering Committee members knowledgeable about a particular section (e.g., the Owyhee Uplands) more deeply to assess the output, clarify conservation goals, and make decisions about appropriate changes to the methods.

During the kickoff webinar, we shared the results of a pilot analysis and presented the work plan for completing this analysis throughout the state. We then hosted 3 additional webinars in February 2018 to get feedback from the Steering Committee on the proposed work flow and conservation goal decisions.

We completed a draft of COAs by 30 June 2018. Final work on this project will be completed under the FY19 SWAP Implementation Grant Agreement (Figs. 1, 2, and 3).

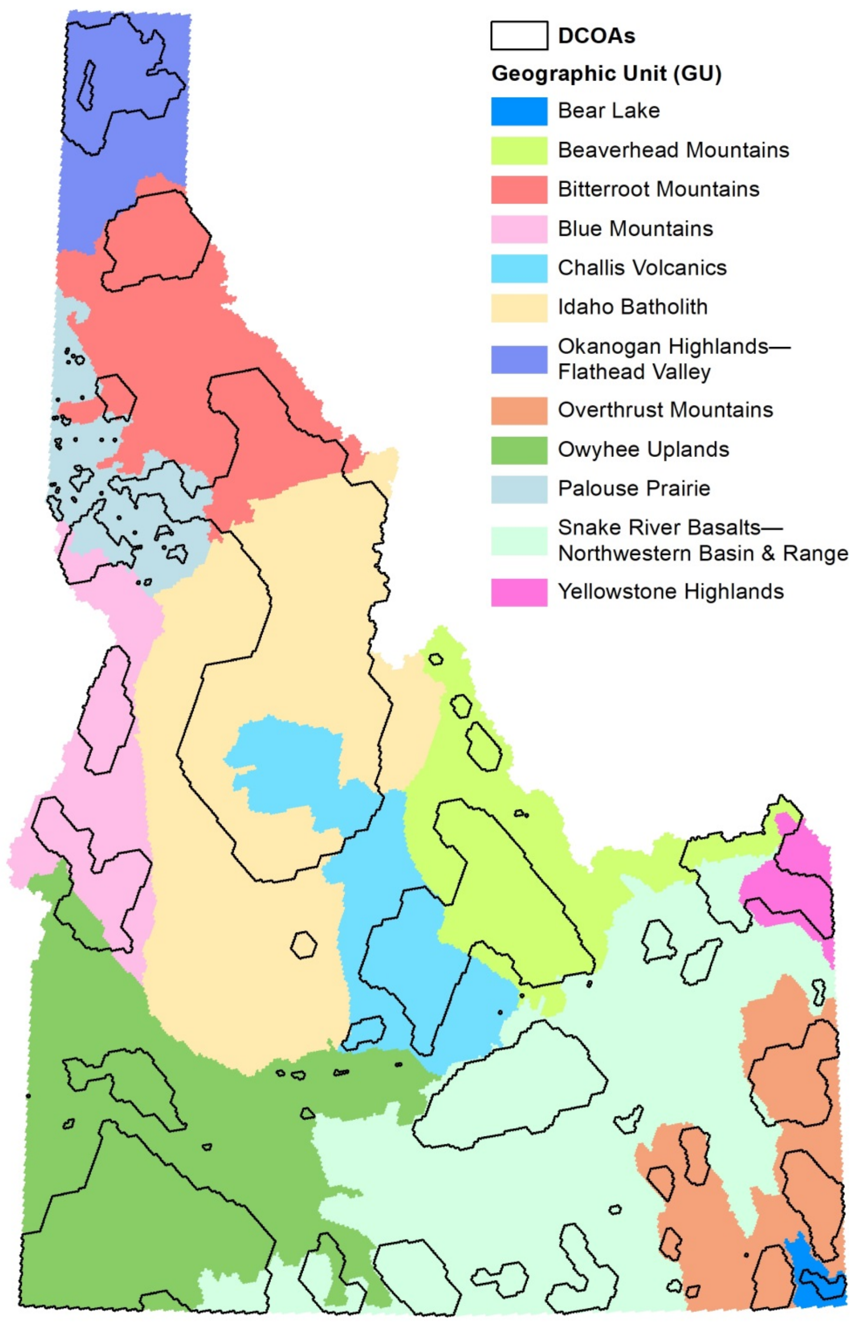

Figure 1. Preliminary Draft Conservation Opportunity Areas (DCOAs) for Idaho based on calculated cost. Polygons represent the best solution from a statewide Marxan analysis (2 billion iterations) with assessment unit cost calculated using products from the Protected Areas Database of the United States (PAD-US) (May 2016–) and Conserving Nature's Stage: Identifying Resilient Terrestrial Landscapes in the Pacific Northwest (Buttrick et al. 2015). This statewide analysis was seeded using the best solutions from Marxan analyses of the Geographic Units (*n* = 12; 1 billion iterations).

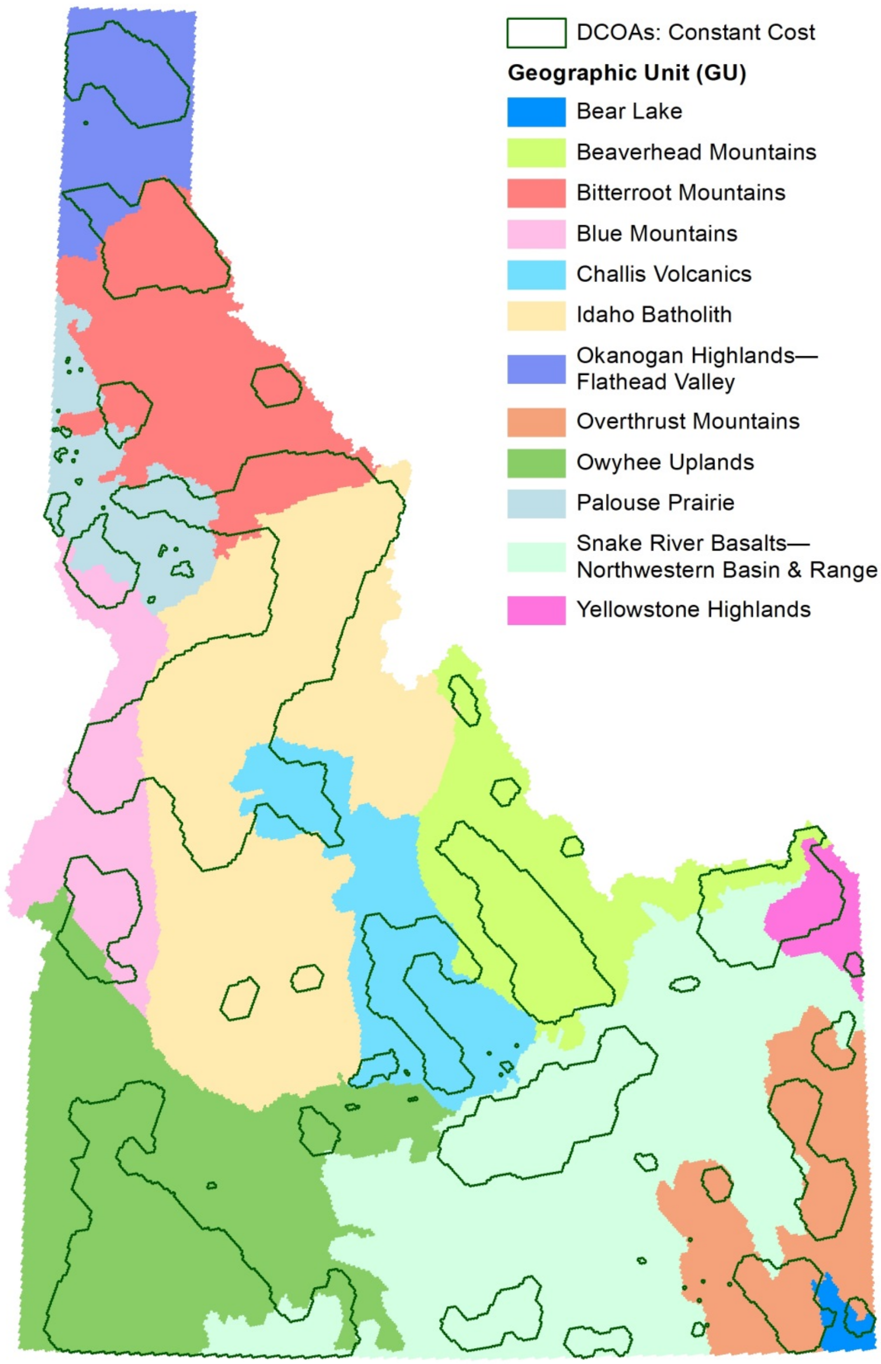

Figure 2. Preliminary Draft Conservation Opportunity Areas (DCOAs) for Idaho based on constant cost. Polygons represent the best solution from a statewide Marxan analysis (2 billion iterations) with a constant assessment unit cost (value = 1). This statewide analysis was seeded using the best solutions from Marxan analyses of the geographic units (*n* = 12; 1 billion iterations).

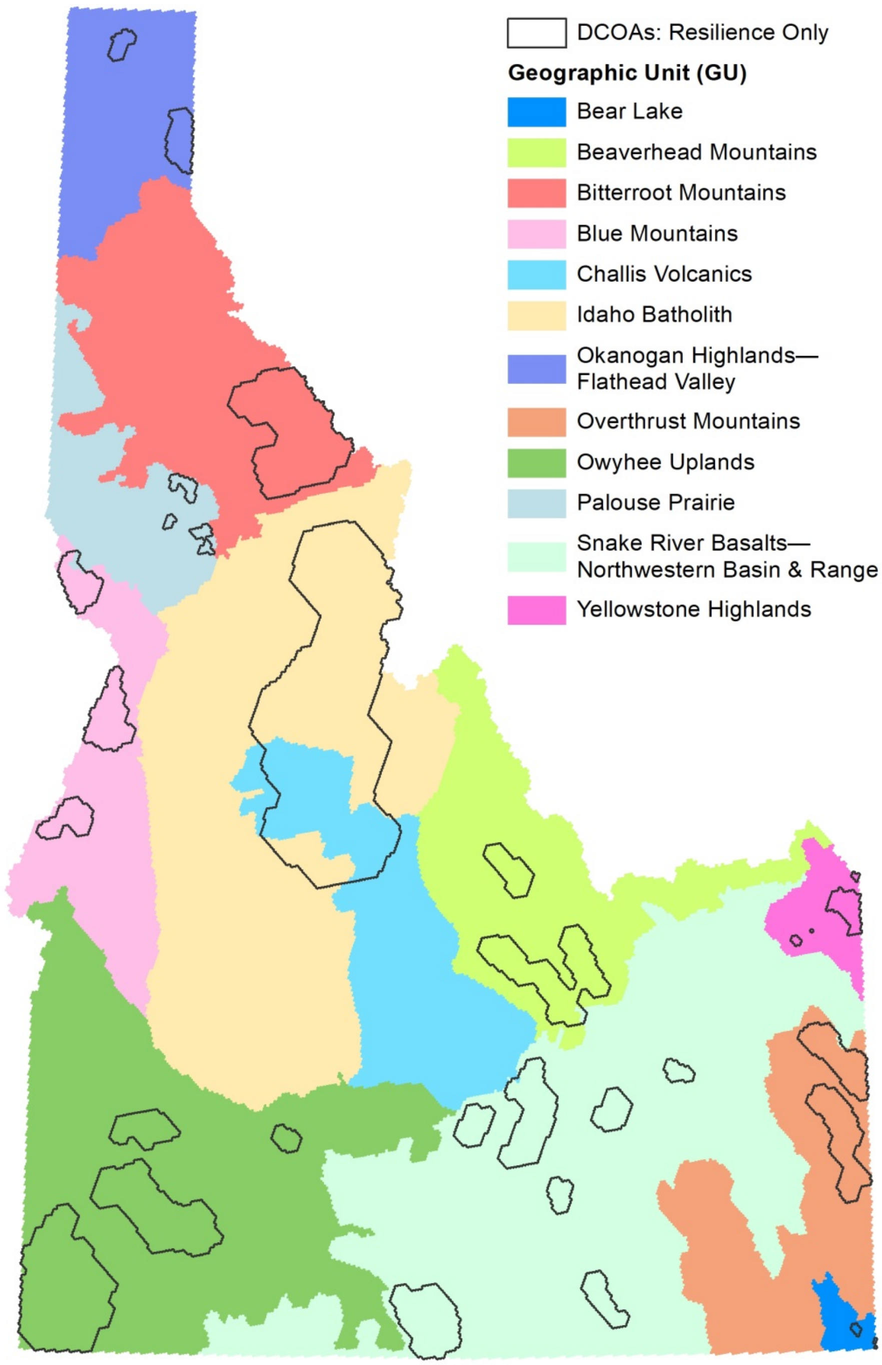

Figure 3. Preliminary Draft Conservation Opportunity Areas (DCOAs) for Idaho based on terrestrial climate resilience only. Polygons represent the best solution from a statewide Marxan analysis (2 billion iterations) based on a single conservation target (terrestrial climate resilience) and calculated cost. This statewide analysis was NOT seeded using the best solutions from Marxan analyses of the geographic units (n = 12; 1 billion iterations).

Principal Investigator(s) for Research Projects

Rita D Dixon PhD, Idaho Department of Fish and Game, PO Box 25, Boise, ID 83707, 208 287-2735

Rita.dixon@idfg.idaho.gov

Other personnel include:

Tim Weekley	208 287-2768
Angie Schmidt	208 287-2716
Nikki Wade	208 287-2761
Jeff May	208 287-2785

Timeline

Review final performance reports for submission to the US Fish and Wildlife Service from prior year awards

- July–June
  - Manage SGCN data
- August and February
  - Provide data exports to partners
- August–September
  - Convene SWAP Adaptive Management Team meetings
- October
  - Attend annual WDP SWAP implementation coordination meeting
- November—April
  - Regional WDP work plan meetings
- April–May
  - Review regional project statements for SWAP Implementation Grant
  - Submit new project proposal package to US Fish and Wildlife Service

Project 8b HQ FY18 American White Pelican

Need

The Idaho State Wildlife Action Plan, 2015 (SWAP) describes the need for conserving American White Pelican (*Pelecanus erythrorhynchos*) populations while managing impacts to fisheries resources in Idaho, as outlined in the Management Plan for the Conservation of American White Pelicans in Idaho. Future management will require careful monitoring of colonial waterbirds in key sections of the state (Northwestern Basin and Range, Owyhee Uplands, Snake River Basalts, Yellowstone Highlands) to meet desired objectives.

Purpose

To ensure that a viable American White Pelican population in Idaho is maintained while management activities in the state are implemented.

Results or Benefits Expected

The overall goal is to maintain viable breeding populations of American White Pelicans in Idaho while reducing impacts to native fish and recreational fisheries. The activities of this project will enable the Idaho Department of Fish and Game to track progress and make adjustments as necessary to accomplish this goal.

Approach

Project activities will support the implementation of the Management Plan for the Conservation of American White Pelicans in Idaho. The goal of this plan is to maintain viable breeding populations of pelicans in Idaho while reducing impacts to native fish and recreational fisheries. This project is focused on (1) monitoring the breeding population and subsequent productivity, (2) assessing movement patterns and survivorship, and (3) reducing predation rates on priority fisheries, such as Yellowstone Cutthroat Trout (YCT) in the Blackfoot River.

1. The objectives for this approach are to: 1a. Assess population viability by conducting 1 late-incubation ground survey at each known American White Pelican (AWPE) colony by 10 June 2018 and conduct 1 prefledging survey at each AWPE colony by 15 August 2017; and to 1b. If deemed appropriate, conduct at least 2 unmanned aircraft systems (UAS) flights at each known AWPE colony in conjunction with ground counts by 10 June 2018. Breeding population and productivity monitoring: field activities include conducting nondestructive observational surveys of breeding colonies to determine number of nests and prefledglings. Nest surveys entail a combination of in-colony ground surveys where 1–7 observers walk through the colony and count nests, and take photos of the colony using unmanned aircraft systems (UAS; e.g., drone) for post-survey processing. Prefledging surveys entail ground counts conducted either within the colony or from the perimeter of the colony to document all chicks present near fledging in mid-July. We will experiment with using UAS for these prefledging surveys as well.

2. The objectives for this approach are to assess movement patterns and update survivorship estimates, band and patagial tag up to 300 AWPE individuals per colony by 30 July 2017 and to track establishment of new AWPE colonies and to visit via air or ground all identified potential nesting islands at least once by 30 June 2018.

Assessing movement patterns and survivorship: field activities include banding and patagial-tagging juvenile pelicans on the nesting colony just prior to fledging, and conducting searches for tagged birds on regional waterbodies. Tagging activities entail a single visit to the nesting colony in mid-July.

3. The objectives for this approach are to: 3a. Manipulate AWPE nesting access to portions of nesting islands at Blackfoot and Island Park Reservoirs by installing fencing by 15 April 2018; and to 3b. Manipulate pelican nesting access and success at Blackfoot Reservoir with hazing and nest take (as authorized by federal depredation permit) by 30 June 2018.

Hazing of foraging pelicans: Hazing typically includes the use of pyrotechnics, which may be used 1–2 times daily in areas of high pelican concentration on waters of concern (e.g., Blackfoot River, Silver Creek). Hazing may also be used to discourage nest initiation on some islands. Lethal reinforcement of actively foraging birds at Blackfoot River (under federal depredation permit authorization; MB65979-A) is accomplished using nontoxic shot via shotgun or rifle. Lethal reinforcement activities will only be done in conjunction with pyrotechnics.

Manipulation of nesting habitat: The most commonly used techniques involve exclusion fencing and fladry. Fencing is used to physically deter nest initiation in unwanted areas, and is repaired or replaced as needed during the breeding season. If nesting is initiated in unwanted areas in the Blackfoot Reservoir, nest removal (under federal depredation permit authorization; MB65979-A) will occur immediately upon detection to reduce the likelihood of additional nesting. Nests may be destroyed by physically removing eggs from unwanted areas, or oiling to reduce disturbance to the colony and reduce the chance of renesting.

Geographic Location

Statewide

Describe how objectives were met.

Objective 1a: Conduct 1 late-incubation ground survey at each known American White Pelican (AWPE) colony by 10 June 2018 and 1 prefledging survey at each AWPE colony by 15 August 2017.

Results: Blackfoot Reservoir AWPE Colony: We conducted 1 late-incubation ground survey on Gull Island at Blackfoot Reservoir on 31 May 2018, during which we counted 708 active nests.

We conducted 1 productivity count at Gull Island on 1 September 2017. Because of the late date, all but one bird was on the water rather than on the Island. We counted 193 prefledglings on Blackfoot Reservoir; 193 fledglings from 616 nests is 0.31 chicks produced/nest.

Minidoka AWPE Colony: We conducted 1 late-incubation ground survey on all 3 islands at Minidoka on 1 June 2018, during which we counted 1,838 active nests.

We conducted 1 productivity count, via drone, on 14 July 2017; the photos from which we counted 401 pre-fledglings; 401 fledglings from 1,838 actives nests is 0.22 chicks produced/nest. This was the first year we were successful in obtaining a productivity count at this location.

Island Park AWPE Colony: We conducted 1 late-incubation ground survey on Trude Island on 14 June 2018. The nest count was delayed approximately 2 weeks to match objectives of a FWS scientific collecting permit study. No pelican nests were documented on the island. We incidentally documented approximately 200 pelican nests on the adjacent mainland on 10 May 2018, all of which failed. We conducted one productivity count via drone on 8 August 2017. The estimate for the drone survey was 281 chicks (0.34 chicks per nest based on 825 nests).

Objective 1b: Conduct at least 2 unmanned aircraft systems (UAS) flights at each known AWPE colony in conjunction with ground counts by 10 June 2018.

Results: Blackfoot Reservoir AWPE Colony: We conducted 2 UAS flights at Gull Island. The first on 30 May 2018, the second on 31 May 2018. The UAS was flown above the island at 250-ft altitude and took photos at predetermined photo points.

Minidoka AWPE Colony: FWS conducted 2 early UAS flights at Minidoka on 22 May 2018 and 23 May 2018. The UAS was flown above the island at 100-ft altitude. Shortly thereafter, the drone was accidentally destroyed. A replacement wasn't available until after the traditional survey window (last week of May/first week of June) had passed.

Island Park AWPE Colony: No UAS surveys were conducted at the Island Park colony, as the colony was inactive in 2018.

Objective 2a: Band and patagial tag up to 300 AWPE individuals per colony by 30 July 2017.

Results: Blackfoot Reservoir AWPE Colony: We banded and patagial-tagged 172 prefledgling pelicans on Gull Island on 1 August 2017.

Minidoka AWPE Colony: We banded and patagial-tagged 171 prefledgling pelicans on Pelican Island on 25 July 2017.

Objective 2b: Conduct via air or ground surveys to identify potential nesting islands at least once by 30 June 2018.

Results: Our pelican technician traveled throughout the Upper Snake, Southeast, and Magic Valley regions looking for pelicans and potential nesting islands, and recording tagged pelicans in July 2017. Potential nesting islands were not visited in 2018, with the exception of a few islands in CJ Strike Reservoir that have seen pelican activity (e.g., egg dumping) in the past. We did not identify any new or potential pelican nesting islands.

Objective 3a: Manipulate AWPE nesting access to portions of nesting islands at Blackfoot and Island Park Reservoirs by installing fencing by 15 April 2018.

Results: Blackfoot Reservoir AWPE Colony: We removed fladry lines on Gull Island on 31 July 2017. We visited Gull Island again on 11 October 2017 to fix fence panels and create a new "high-water conservation area" to be used during years of high water when the original conservation area is inundated. On 13 March 2018, we visited Gull Island to install fladry lines for the upcoming nesting season. The reservoir was at capacity; therefore the perimeter fence around the island was under water. On 25 April 2018 we visited Gull Island to install a temporary perimeter fence above the high water line. That perimeter fence was removed on 5 June 2018.

Island Park Reservoir AWPE Colony: On 8 August 2017, we removed a 1-km long, 4.5-foot tenax fence that was installed in an attempt to deter nesting during the 2017 nesting season. On 22 May 2018 we installed a 4–5 ft tall tenax fence with ground cloth attached as a visual barrier, to delineate a conservation nesting area on the east end of the island.

Objective 3b: Manipulate pelican nesting access and success at Blackfoot Reservoir with hazing and nest take (as authorized by federal depredation permit) by 30 June 2018.

Results: We hazed pelicans from nesting on islands (Long, Willow, and Sheep Islands) on Blackfoot Reservoir from 22 April 2018 to 17 May 2018. We hazed foraging pelicans from areas of the Blackfoot River known to be supporting migrating Yellowstone Cutthroat Trout from 28 April to 30 June 2018. We destroyed eggs at nests on 22 April 2018 (3 nests), 25 April 2018 (169 nests), 27 April 2018 (11 nests), 30 April 2018 (50 nests), and 5 June 2018 (217 nests).

Principal Investigator

Colleen Moulton, Idaho Department of Fish and Game, PO Box 25, Boise, ID 83707, 208 287-2735

Colleen.moulton@idfg.idaho.gov

APPENDIX

Project 1—Panhandle Region SWAP Implementation

Objective 1: Adaptive Management Team meeting proposal for climate adaptation engineering work on the Bees to Bears project. *Proposal for Wetland Services.*

Objective 2a: Manuscript of multispecies terrestrial gastropod inventory methodologies. *Evaluating Beer, Brains, and Braun as Tools to Describe Terrestrial Gastropod Richness in North America's Inland Temperate Rainforest.*

Objective 2b: Manuscript describing *Hemphillia* sp. 1 as a distinct taxonomic unit. *Taxonomy and biogeography of Hemphillia (Gastropoda: Pulmonata: Arionidae) in North American rainforests, with description of a new species (Skade's jumping-slug, Hemphillia skadei sp. nov.)*

Objective 4; Control invasive bullfrogs. *Distribution of Native Pond Breeding Amphigians and Potential Threat Mitigation on and Adjacent to Boundary-Smith Creek Wildlife Management Area*.

Objective 5: Estimate the effective population size of the West Cabinet Mountains (Flathead Valley) Fisher (Tier 2) population and summarize results in draft manuscript for submission to peer-reviewed journal. *A carnivores' oasis? An isolated fisher (Pekania pennanti) population provides insight on persistence of a metapopulation.*

PROPOSAL for WETLAND SERVICES

Prepared For:

Prepared By:

February 13, 2018

Proposal for Wetland Design Services for Boundary Creek WMA
Boundary County, Idaho

1.0 INTRODUCTION

Ducks Unlimited Inc. (DU) is pleased to present this proposal to Idaho Department of Fish & Game (IDFG) and Yellowstone to Yukon Conservation Initiative (Y2Y) to conduct wetland design and construction services located on The Boundary Creek WMA located in Boundary County, Idaho.

Wetland restoration services are expected to include the following activities:

- Project Administration
- Field Work
- Habitat Design
- Construction Bidding & Contracting
- Construction Management

DU is an 81-year-old, private, non-profit 501(c)(3) conservation organization dedicated to restoring, enhancing, protecting, and managing wetlands and associated habitats to help fulfill the annual life cycle needs of North American waterfowl. Wetland restoration and enhancement projects have been the primary DU mission since 1937. DU engineers, biologists and support teams have fine-tuned the science of wetland restoration and enhancement, resulting in DU's widely recognized reputation as the "Leader in Wetlands Conservation."

For over eight decades, Ducks Unlimited has maintained a singleness of purpose to conserve and restore wetland habitats across North America. Ducks Unlimited works across diverse political, geographic and ecological boundaries to achieve our mission. Because DU takes a landscape approach to habitat conservation, our efforts benefit a rich diversity of waterfowl as well as hundreds of other species of birds, amphibians, fish, mammals and other aquatic organisms.

DU maintains a full-time staff dedicated to the sole purpose of conserving wetlands. The staff includes licensed engineers, wildlife and wetland biologists, land surveyors, GIS and computer drafting staff, land protection specialists and support staff. For almost all wetland planning and restoration projects, DU utilizes a biologist/engineer team approach which is both unique and critical to the successful delivery of the projects.

This proposal includes a description of the tasks DU will perform, our technical approach for completing those tasks, conditions and exclusions, and our proposed costs.

<u>Task 1. Project Administration:</u>

Project Administration will include executing cooperative agreements with project partners, project tracking, budgeting, coordination and invoicing. DU staff will provide relevant project information to project partners as necessary to meet grant reporting requirements. DU will not be responsible for producing grant or permit-required reports. This task will be completed primarily by a DU Biologist.

Cost: The above task will be completed at an estimated cost of $3,100.

Task #2 Field Work:

Data collection activities will consist of approximately 1-2 days of field work for evaluating the site for the proposed activity. This work would include soil augering and meeting with IDFG personnel to review probably locations for project work. Some topographic information may need to be collected during that time. This may also include a site visit to the Creston Wildlife Area if needed to review their ephemeral ponds. It is anticipated that the existing LiDAR topographic data can be used during the design process. This task will be completed by both DU Engineer and Biologist.

Cost: The above task will be completed at an estimated cost of $7,480.

Task #3. Habitat Design:

The habitat design phase consists of a collaboration between the project biologists (from IDFG, Y2Y, and DU) and the design engineer. For this project, there are three design elements as previously discussed. They are 1) design of two ephemeral ponds, 2) design of approximately one mile of ephemeral stream-bed type habitat, and 3) design of areas considered to be "cool-air refugia" (CAR) consisting of hummocky clusters of berms and shallow excavations. The design of CAR areas can be applied to multiple areas within the WMA. Since the CAR design is considered a pilot design there may be several alternative configurations that are tried. Final design products include the construction set of plans as well as specification for the project. DU will not be responsible for generating planting plans or specifications for the project. DU biologists will provide initial design input and review of plans. The design process may be an iterative review process between the group to finalize all restoration components. This proposed task will be completed mainly by a DU Engineer.

Cost: The above task is estimated to cost approximately $16,800.

Task 4 – Bidding and Contracting

Ducks Unlimited would prepare all documents needed to solicit bids for earthwork via the competitive sealed bid process unless otherwise directed by partners or agreements. Documents generally include DU's construction plans, construction specifications, bid forms, and general and supplemental conditions. Ducks Unlimited would solicit bids from qualified earthwork contractors specializing in wetland construction and meeting any requirements set forth by the partners. DU would require all contractors at a minimum to be licensed and bonded with a company resume submitted.

DU would require all contractors to attend a mandatory pre-bid meeting in which all proposed work and any known site conditions would be thoroughly described prior to the contractor being allowed to bid on the project. DU would require all contractors to provide bid bonds or other acceptable security upon submission of bid and the selected contractor would provide proof or workman's compensation and performance and payment bonds upon signing the contract.

DU maintains an in-house contract compliance staff and legal department which have a great deal of experience working with private and governmental funding to complete wetland restoration projects. This proposed task will be completed mainly by DU Engineer.

Cost: The above task is estimated to cost approximately $3,280.

Task 5 - Construction

DU will conduct a pre-construction meeting with the selected contractor to review all necessary documents and construction procedures and schedules.

DU would provide the initial construction staking and control needed for the contractor to complete the project. DU would utilized our in-house personnel to complete this portion and would also provide a limited amount of construction inspection and oversight (60 hours) during all phases of the project. It is anticipated that IDFG personnel will oversee the general day to day inspection and DU would provide periodic construction inspection up to the agreed time allotment. This proposed task will be completed mainly by DU Engineer.

Cost: The above task is estimated to cost approximately $17,260.

Project Schedule:

Field Data Collected Spring-Summer 2018 or as weather allows upon completion of agreements

Conditions and Exclusions:

1. IDFG to provide updated conceptual map/shapefiles of project elements and locations.
2. Wetland delineation and development of planting plans are not included in the estimate but could be provided at an additional cost.
3. Any required permitting is not included.
4. No surveyed record drawings will be provided.

Budget Summary Table

Tasks	Subtotal	Indirect (14.83%)	Total
1. PROJECT ADMINISTRATION	$2,700	$400	$3,100
2. FIELD WORK	$6,515	$966	$7,481
CONCEPTUAL PLANNING- NOT APPLICABLE			
3. DESIGN	$14,640	$2,171	$16,811
PERMITTING- NOT APPLICABLE			
4. BIDDING/CONTRACTING	$2,861	$424	$3,285
5. CONSTRUCTION MANAGEMENT	$15,032	$2,229	$17,261
TOTAL	$41,747	$6,191	$47,938.08

Tasks will be completed by:

CHRIS BONSIGNORE – MANAGER, CONSERVATION PROGRAMS

As Regional Biologist and more recently Manager of Conservation Programs for Ducks Unlimited, Mr. Bonsignore has helped complete a wide variety of environmental projects that have included restoration, enhancement and protection of wetland, riparian and upland habitats in the states of Washington, Oregon, Idaho and California. During the last 20 years, Mr. Bonsignore has worked on over 150 projects that have resulted in the conservation of thousands of acres in these states. His contributions to these projects have included restoration feasibility assessments, wetland delineations, restoration planning and design, grant writing and administration, contract development, permitting, construction oversight and project budgeting and administration. Land protection efforts have included fee title acquisitions and purchased conservation easements in partnership with private landowners, federal, state and local agencies and other NGOs. Currently, Mr. Bonsignore oversees conservation program operations in the Intermountain West areas of WA, OR, ID and UT for Ducks Unlimited.

EDUCATION

- MS, Wildlife Science, University of Washington, 1998.
- BS, Biology, Eastern Washington University, 1990.

BRIAN HECK, PE – REGIONAL ENGINEER

Mr. Heck serves as Regional Engineer for Ducks Unlimited, Inc. in Eastern Washington and Idaho and is located in Spokane, WA. Mr. Heck has design and construction management responsibility for wetland restoration projects located in the states of Washington and Idaho. Over the past 20 years with DU, Mr. Heck has been involved in over 100 wetland projects. Mr. Heck has surveyed, designed and constructed wetland restoration projects involving thousands of acres or new or restored habitat and millions of dollars in construction contracts. Mr. Heck has designed projects involving the following wetland restoration practices: dikes, water control structures, pipelines, concrete structures, channel restoration, fencing, and vegetation control. Mr. Heck is responsible for preparation of plans, specifications, bid documents, budgets, contract administration and construction management for all wetland restoration projects within his area.

EDUCATION

- B.S., Civil Engineering, 1989, University of Kansas.
- M.S., Water Resource Engineering, 1991, University of Kansas

REGISTRATIONS

- Professional Civil Engineer, Washington (No. 35540)
- Professional Civil Engineer, Oregon (No. 61204)
- Professional Civil Engineer, Idaho (No. 8663)
- Professional Civil Engineer, Montana (No. 38155)

CHRISTINA BLEWETT - REGIONAL BIOLOGIST

Ms. Blewett has worked on bird projects in Washington, Costa Rica and Panama. She brings a combination of extensive experience in GIS and biology to DU. She has performed field work, grant writing, scientific writing, and working in multi-disciplinary environments with many stakeholders. Her most recent position prior to working for DU was researching three rare bird species in Coiba National Park in Panama for the Panamanian government, to support conservation of important species in congress with a multi-use oriented management plan for the Park.

EDUCATION

- B.S. in Biological Oceanography, University of Washington, 1993
- M.Sc. in Wildlife Ecology and Management, University of Washington, 2002

BRIAN MARKER, PE – PROJECT ENGINEER

Brian Marker, Engineer with Ducks Unlimited Inc. (DU) for the past 5 years also has worked in geotechnical and civil engineering for 14 years as a consultant, for a state agency, and for a non-profit. Brian is responsible for habitat restoration projects in eastern Oregon and southern Idaho. His geotechnical engineering projects include design and construction recommendations for shallow and deep foundations, embankment design/evaluation, slope stability, lateral earth pressures and retaining walls, seismic evaluations, drainage and site infiltration, site earthwork, subgrade improvement, and pavement/road design and rehabilitation. His civil engineering projects have included design of levees, swale channels, water control structures, riprap protection, emergency spillways, and native vegetation installation. Brian is responsible for guiding projects from initiation to completion; including development of the scope of work, field work, engineering plans, specifications, and construction inspection. To complete the projects, Brian manages subcontractors, develops schedules, tracks budgets, and coordinates with landowners and permitting agencies.

EDUCATION

- BS, Civil Engineering, University of Idaho, 1996
- MS, Civil Engineering, Emphasis in Geotechnical Engineering, Auburn University, 2001

REGISTRATION

- Professional Civil Engineer, Idaho (No. 10391)

DUCKS UNLIMITED, INC. RATES - DIRECT AND INDIRECT COSTS

STAFF	ROLE	2018 HOURLY RATE CHARGE *
Chris Bonsignore	Project Manager/Biologist	$150.00
Brian Heck	Regional Engineer	$150.00
Tina Blewett	Regional Biologist	$123.00
Brian Marker	Regional Engineer	$123.00
John Spolar	ACAD Technician	$94.00
Various	Administration/Clerical	No Charge

* Hourly Rate Charge includes salary and all benefits

Fiscal Year 2018 Indirect Rate: 14.83%

Names of Authors:

Michael K. Lucid*†
Shannon Ehlers*[Δ]
Lacy Robinson*[‡]
Sam Cushman[□]

Evaluating Beer, Brains, and Braun as Tools to Describe Terrestrial Gastropod Richness in North America's Inland Temperate Rainforest.

Affiliations and addresses of authors:
***** Idaho Department of Fish and Game, 2885 Kathleen Ave. Coeur d'Alene, ID 83815, USA
□ U.S. Forest Service Rocky Mountain Research Station, Flagstaff, AZ, USA

Present Address:
Δ Missouri Department of Conservation, 2929 County Road 618, Ellington, MO 63638, USA.
‡ Rainforest Ecological, P.O. Box 733, Sandpoint, ID 83864, USA.

The email address and phone number of the corresponding author:
† michael.lucid@idfg.idaho.gov (208) 830-1451

Keywords: terrestrial gastropod, inventory, cover-board trap, leaf litter, pitfall trap, timed search, observer bias, biodiversity

Abstract

Terrestrial gastropods are part of one of the most vulnerable taxonomic groups, Mollusks, but receive relatively little conservation attention. This is partially due to the paucity of peer-reviewed statistical evaluations of common survey techniques. From 2010-14 we conducted a massive survey for terrestrial gastropods in North America's inland temperate rainforest. We fused several commonly used gastropod survey techniques (cover board traps baited with beer or water, pitfall traps, visual search, and leaf litter sorting) into a single survey transect which we deployed at 991 survey sites across our 22,975 km^2 study area. We used a variety of variables, including air temperature and relative humidity (collected at each site for ≥12 calendar months) to evaluate the effects of seasonality, observer bias, and repeated site visits on collection rate of individual specimens and detection of numbers of species. We found a combination of timed searches and leaf litter to be most effective in describing the maximum number of species with the least amount of effort. Although re-visiting sites significantly increased the number of species detected, more time spent at each site likely would have a similar effect and preclude the need for additional expense to visit remote survey locations. Observer bias was determined not to be a factor of concern for within-group observers. But when grouped by observer type, different classifications of observers performed quite differently. Beer, regardless of brand, was clearly a superior bait to water. However, because beer only out-performed timed searches slightly for one gastropod sub-group (small slugs) we do not recommend trapping, beer baited or otherwise, be used as part of major landscape level survey efforts. Our study is the most extensive evaluation of survey techniques available in the literature to date and provides a framework for other practitioners implementing landscape level surveys for terrestrial gastropods.

Introduction

The conservation and management of Molluscan species poses a formidable challenge; despite being among the taxonomic groups with highest conservation need they receive relatively little conservation attention. Mollusks have the highest documented extinction rate of any major taxonomic group, with 42% of the 693 recorded animal species extinctions since the year 1500 (Lydeard et al. 2004). Globally, mollusks are listed as the third largest group of International Union of Conservation of Nature (IUCN) threatened animal species and are the most numerous group of IUCN threatened species in North America (http://www.iucnredlist.org/, accessed 27 February, 2017). In the United States mollusks are listed as Species of Greatest Conservation Need (SGCN) in 54 of 56 states and territories with federally approved State Wildlife Action Plans and comprise 13.5% (n = 1,209) of all animal SGCN in the nation (https://www1.usgs.gov/csas/swap/index.html, accessed 28 June, 2018).

Despite non-marine mollusks being one of the most imperiled groups of animals, resources dedicated to their conservation and management are limited compared to other species (Lydeard et al. 2004). Vertebrates in particular (Clark and May 2002) receive disproportional attention and in the context of number of described animal species, only arachnids and insects receive less scientific attention than mollusks (Titley et al. 2017). Lydeard et al (2004) outlined four areas of need for molluscan conservation including identifying biodiversity hotspots, research, management, and education. Although successful implementation of these needs depends on inventory data there remains a striking paucity of survey techniques available in the peer reviewed literature. This is particularly true for terrestrial gastropods.

Cameron and Pokryszko (2005) and Emberton et al. (1996) provide some of the only technical comparisons of survey techniques (visual searching and leaf litter sorting). Visual searching is a primary technique used to survey for gastropods with inclusion of a timed or spatial element for standardization (Pearce and Örstan 2006). Leaf litter searches involve sieving and sorting of leaf litter and/or soil samples for specimens (Cameron and Pokryszko 2005). Other commonly used techniques include cover board (McDade and Maguire 2005, Oggier et al. 1998) and pitfall traps (McDade and Maguire 2005). Each method targets gastropod sub-groups of different sizes and life histories (Emberton et al. 1996), making it problematic to select a single method for all species. Multi-species inventory techniques require technical evaluations (Robinson et al. 2017) and the effectiveness of combining these techniques to detect a wide variety of gastropod species across time and space is lacking.

To address this issue we developed a hybrid survey protocol which fuses several commonly used gastropod inventory techniques. From 2010-14 we deployed 991 hybrid sampling plots across a large and diverse study area covering portions of northern Idaho, northeastern Washington, and northwestern Montana, U.S.A. The objective was to evaluate the effectiveness of these techniques in the context of number of terrestrial gastropod specimens collected and species detected.

MATERIAL and METHODS

Study Area

The study area consists of a 22,975 km^2 area centered on the Idaho Panhandle and containing portions of northeastern Washington ansd northwestern Montana (Figure 1). It comprises portions of the Selkirk, Purcell, West Cabinet, Coeur d' Alene, and Saint Joe mountain ranges. The topography is mountainous, ranging in elevation from 702 to 2326 m. The climate is characterized by mild summers and wet and moderately cold winters. The heavily forested area is dominated by a diverse mix of conifer species and is characterized as supporting inland temperate rainforest (DellaSala et al. 2011).

<u>Sampling Design</u>

We stratified our study area into 5x5 km sampling cells and surveyed 991 sites for terrestrial gastropods in 879 cells. We used ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, CA) to generate a buffer around each road and trail from 50-150 m. We then generated a random point within this buffer for the survey location. This resulted in survey sites that were randomly located, but biased to roads and trails (n = 842) to improve field efficiency. Additional sites were sub-selected from randomly selected FIA plots (n = 149) based on site characteristics described in Lucid et al. (2016). The FIA plots were not biased to roads.

<u>*Fused Survey Transect (Figure 2)*</u>

Microclimate data logger – A data logger housed in a radiation shield was attached with nails to a conifer tree >30 cm in diameter within 40 m of the assigned point (see Lucid et al. 2016 Chapter 5 for more details). Beginning at the data logger, an observer used a compass to set a 45° bearing on which to set up the survey transect. Data loggers collected air temperature data every

90 minutes for a 12 month period and the mean temperature was calculated to determine site average annual air temperature.

Cardboard cover boards - Three 30x30 cm cardboard cover board traps were placed 5 meters apart from each other (Lucid et al. 2016, Appendix II-a). In 2010 traps were initially deployed dry and un-baited (6%, n = 63 transects). After the first round of trapping, we began baiting traps to improve capture rates. Gardeners have long considered beer to be an effective slug attractant. Beer has been shown to be a more effective slug attractant than water (Piechowicz et al. 2014) and some commercially available molluscicides (Dankowska 2011). We tested the effectiveness of dry, water baited, and beer baited traps.

The majority of transects deployed in 2010 (11%, n = 109) had one dry control trap, one trap baited with 12 oz. of water, and one trap baited with 12 oz. of Natural Ice® beer. In 2011 all transects (32%, n = 322) had one trap each baited with 12 oz. of water, Natural Ice® beer, or Laughing Dog microbrew beer. In 2013 each of the three traps in all transects (50%, n = 497) were baited with 12 oz. of Natural Ice® beer. We chose Natural Ice® beer because it was the cheapest commercially available.

Traps were baited in the field by placing the trap and bait in a two-gallon zip-top bag and allowing the cardboard to become saturated. Traps were placed 5 m apart along the transect. Leaf litter was moved aside, the trap was placed directly on the soil, any remaining bait was poured on the trap, and the trap was covered with leaf litter to slow drying. Traps were re-visited after approximately 14 days when an observer used a magnifying glass to view the trap and remove all gastropods.

Leaf litter - Leaf litter was collected during the second visit to the survey transect. We sampled the top 10 cm of leaf litter where leaf litter associated gastropods are found (Hawkins et al. 1982) at three locations five meters perpendicular to each trap. We collected 333 mL of leaf litter from each of the three locations for a total of one liter of leaf litter from each transect. Leaf litter samples remained in the field with observers for 1-8 days and were then frozen upon return from the field. Samples were later removed from the freezer and placed in paper bags which were stapled shut to prevent contamination by other organisms while they dried at room temperature. Litter was then sifted through a series of three filters (Lucid et al 2016, Appendix II-a) by wildlife technicians biological science technicians (38%, n = 374 samples), paid workers from a temporary job service (18%, n = 179 samples), college students (6%, n = 57 samples) and volunteer citizen naturalists (39%, n = 382 samples). Gastropod shells were preserved in separate dry vials.

Timed searches - During each site visit an observer conducted at least one gastropod timed search (GTS). Beginning at the climate station, one observer spent 15 minutes searching under rocks and logs for gastropods, traveling no farther than 50 m from the climate station. FIA sites received two additional GTS in the fall of 2014.

Pitfall traps - Three 8 oz. plastic cups with a 4 cm^2 piece of Hot Shot® No-Pest fumigant strip (Spectrum Brands, Middletown, WI) were placed 5 meters apart along the transect to act as pitfall traps. A trowel was used to dig a small hole and then the rim of the cup was placed level with the ground.

During subsequent visit(s), collected rainwater was poured from the trap (amount of water was measured in 2013) through a strainer. Gastropods were handpicked from the strainer and placed in a vial of 95% ethanol.

Statistical Methods

Summary - We summarized survey method effectiveness by species and species group. We grouped species as large slug (>10mm length), small slug (<10 mm), large snail (>10 mm diameter), and small snail (< 10mm). We compared the number and percentage of surveys that detected each group.

Bait Type - We used mixed effects ANOVA with PLOT as a random factor to determine if bait type or transect type affected number of animals and number of species detected. A post-hoc Tukey multiple comparisons test was used to determine the extent that bait types or transect types differed from each other.

Seasonality - For trap transects and leaf litter detections, we independently evaluated the effect of 5 variables on number of species detected per transect. Temp_13 (mean air temperature for 13 day trap deployment period), precipitation (rainfall collected during trap deployment period), and RH_13 (mean relative humidity for 13 day trap deployment period) were available for 772, 398, and 140 transects respectively. Additionally, we removed the trap transects where all traps were un-baited and dry for the analysis. We first used GLM Poisson regression for Julian date and elevation because those variables were available for all transects. We then subsetted the data three times to run regressions for remaining variables.

For GTS, we used 2,222 searches to evaluate the effect of 8 variables on number of species detected per GTS. We used the same variables as above and added temp_2 (mean air temperature for 2 days prior or after survey) and RH_2 (mean relative humidity 2 days prior or after survey). Julian date and elevation were available for all transects. Sample size of the remaining variables was as follows: temp_13 and $temp\_13^2$ (n = 1549), temp_2 (n = 1013), RH_13 (n = 277), RH_2 (n = 421), and ppt (n = 420). As above, we ran a series of regressions, sub-setting the data each time to reduce to the records containing the newly included variable. As a separate test, we then used a mixed effect ANOVA to test if collection season (summer or fall, independent of the preceding variables) affected number of animals or number of species detected with GTS. This test was done only on the 149 FIA plots.

Observer Bias GTS/Leaf Litter - We ran a mixed effect ANOVA using our best observer as the relative class to test if there was a significant observer bias in number of animals or species detected in GTS. Each of the 21 observers conducted 25-120 GTS. For leaf litter, we ran a mixed effect ANOVA using our best observer type (paid college student) as the relative class to test if there was a significant observer bias in number of animals or species detected. Observer classes included paid college student (n = 57 searches), paid wildlife technician (n = 352), community volunteer (n =379), and paid temporary job-service employee (n = 179).

Re-sampling - To test trap re-sampling we used the 110 dry-water-pilsner deployed in 2010 because they were visited three times. To avoid seasonal bias in testing GTS re-sampling we used only summer GTS (n = 948). For both trap and GTS re-sampling testing we ran mixed effects ANOVAs with site as a random factor to evaluate new species detections during the first visit, redetected on the second visit, and new detections on the second visit.

RESULTS

Overall Comparison (Table 1) - Overall we detected the most gastropods (66.41%, n = 1902) via GTS followed by traps (17.60%, n = 504), leaf litter (10.37%, n = 297), and pitfall (5.62%, n = 161). We did not detect any slugs in leaf litter. All groups were detected in similar ratios with the exception of small snails which were detected more often in leaf litter (24.72%, n = 262) than on traps (13.40%, n = 142). Leaf litter varied in importance by snail size, with small snail species detected more frequently in litter. Additionally, some species or species groups were predominately detected in leaf litter. For example, 88.50% (n = 100) of Punctum *spp.* detections were reported from leaf litter searches.

<u>Bait Type</u>

Trap Bait Type - For both traps and transects we found significant effects of bait type on number of animals (trap: $p < 2.2e-16$, transect: $p = 1.1093e-07$) and number of species (trap $p = 1.146e-06$, transect: $p = 0.0001826$) detected. We calculated likelihood ratios that represent the weight of evidence for the effect of bait type for both number of individuals (trap = 160.5243, transect = 37.76) and number of species (trap = 35.177, transect = 19.98), which indicate very large effects of trap bait type.

The trap Tukey test (Table 2, Figure 3) showed that dry traps detected fewer animals ($p < 0.001$) and species ($p < 0.004$) than all baits. There was not a significant difference between pilsner or microbrew baits for animal ($p = 0.0936$) or species detections ($p = 0.9921$). Both pilsner ($p = <0.001$) and microbrew ($p = 0.0032$) outperformed water in individual detections. However, pilsner outperformed water ($p = 0.0436$) in species detections while microwbrew ($p = 0.2039$) did not outperform water in species detections.

Transect Bait Type - The transect Tukey test (Table 3, Figure 4) showed that the all dry transect detected significantly fewer animals ($p \leq 0.008$) than all other transects. The all dry transect detected significantly fewer species than the all pilsner ($p < 0.001$) and the dry/water/pilsner ($p = 0.019$) transects and fewer species than water/micro/pilsner ($p = 0.0631$), but not at the alpha 0.05 level. The all pilsner transect detected significantly more animals than the water/micro/pilsner (p = 0.03554). All pilsner transects also detected more animals than dry/water/pilsner (p = 0.0589) but not at the alpha 0.05 level. All pilsner transects detected more species than the water/micro/pilsner transects (p = 0.088) at the alpha 0.10 level but did not outperform the dry/water/pilsner (p = 0.559) transects. We found no differences between water/micro/pilsner and dry/water/pilsner transects for number of animals (p = 0.996) or species detected ($p \geq 0.877$).

<u>Seasonality</u>

Trap Seasonality - Zero to eight species (mean = 0.55) were detected per transect but 0 gastropods were detected at the majority of transects (n = 613). An average of 1.72 species were detected on the 299 transects that did detected gastropods.

There are highly significant relationships with both elevation and Julian date across the full data-set, with fewer species detected at higher elevations ($p< 0.001$) and fewer species detected later in the season ($p < 0.001$). There was a decreasing number of species across , with few plots showing any detections between date 250 and 270 (September 7-27). The spline shows low average detections per site in all dates but declining to near 0 on average after day 205 (July 24).

The all subset Poisson regression model (Table 4) averaged variable importance value indicates that precipitation and elevation are the strongest predictors of species richness per plot. Temp_13, Julian_date and RH_13 were similar in influence to each other and about half as important as elevation and precipitation. Together this suggests that the highest richness is found on plots at low elevations early in the season in periods that have had precipitation and high humidity, with low temperatures.

Gastropod Timed Search Seasonality (Table 5) - Zero to eight species (mean = 0.86, n = 2,222) were detected per search and 0 gastropods were detected at 48.65% of searches (n = 1,081). An average of 1.68 species were detected on the 1,141 searches that did detected gastropods. Across the full dataset, the only model with any AIC support was the global model including both variables with highly significant relationships between number of species detected and elevation and Julian date ($p < 0.001$), with more species detected at lower elevations and earlier in the season.

For the second collection season test we detected nearly twice as many animals per plot in the dates we defined as summer (Julian Date = 144–222) than fall (Julian Date = 248–284). There was a highly significant ($p < 2.2e-16$) seasonal effect with a large likelihood ratio (173.588) in terms of number of animals detected. We detected 1.3 more species per plot in the summer than the fall and there was a significant difference ($p = 2.09e-07$) with a large likelihood ratio (35.99) in terms of number of species detected.

Leaf Litter Seasonality (Table 6) - Zero to five species (mean = 0.32) were detected per transect and 0 gastropods were detected at the 76.21% of transects (n = 695). An average of 1.36 species were detected in the 217 samples that did detect gastropods.

The global model including elevation and Julian date was the only model with AIC support in the first step, with negative coefficients for both date and elevation indicating more species detected at lower elevations and earlier in the season.

In the full subset with all variables, elevation, precipitation and Julian date were all significant. Elevation had a negative coefficient indicating more species detected at lower elevation. Julian date had a positive sign indicating more species detected later in the year. Precipitation had a positive sign indicating more species detected with increasing precipitation. All three of these variables had AIC importance value of 1. In contrast both RH_13 and temp_13 had non-significant coefficients and AIC importance values of 0.21.

Observer Bias GTS/Leaf Litter

Gastropod Timed Search Observer Bias (Figure 5) - Observer 1 detected significantly more animals ($p \leq 1.44e-11$) than all other observers except observer 2 ($p = 0.299$). Observer 2 detected significantly more species ($p \leq 0.012021$) than all other observers including observer 1.

Leaf Litter Observer Bias (Figure 6) - College students detected significantly more animals ($p = 0.000872$) and species ($p = 4.33e-11$) than all other groups. Paid temporary employees performed the worst, detecting only 3.80% ($n = 42$) of all animals detected ($n = 1107$) even though they performed 18.40% of the surveys.

Re-sampling

Trap Re-sampling - We found significant differences ($p = 0.0031$) and a large likelihood ratio (9.736) between species detected on the first trap check (mean = 0.56, range 0-5 new species), redetected on second trap check (mean = 0.19, range 0-5 new species), and new species detections on the second trap check (mean = 0.32, range 0-3 new species).

Gastropod Timed Search Re-sampling - We found significant differences ($p = 5.536e-11$) with a high likelihood ratio (59.11) between species detected during the first GTS (mean = 0.89, range = 0-7), redetected on second GTS (mean = 0.27, range = 0-3), and new species detections on second GTS (mean = 0.65, range = 0-6).

DISCUSSION

We examined a variety of variables affecting gastropod detection by incorporating several established techniques into a single fused transect. Our detection of 51 terrestrial gastropod species was affected by a wide range of factors both on a species and species group level.

Cover Board Trapping and Bait Type - Traps performed reasonably well for most groups but were generally outperformed by GTS. Small slugs were the exception to this rule with traps collecting more small slugs (16.56%, $n = 151$) than GTS (9.81%, $n = 218$). The key to trap performance was keeping the trap moist or baited as dry control traps were nearly a complete failure. Although we did not measure precipitation during the control trapping portion of the study, we suspect gastropods collected on these cover boards likely entered during rain events when the traps were naturally wet.

Although, single species studies have shown *Arion lusitancius* (Piechowicz et al. 2014) and *Arion vulgaris* (Piechowicz et al. 2016) preferentially select certain beer brandsour multi-species study found no difference in beer bait type (micro or pilsner). We suspect the wide range of species in our study in concert with trap location being more important than beer type (Piechowicz et al. 2016) influenced this finding.

With the assumption that all beers are equal behind us we are next led to the question of are gastropods attracted to moisture or the beer bait. Piechowicz et al. (2014 and 2016) found beer was clearly more effective bait than water as a slug attractant and our results support and we expand on these findings. In all tests but one, both micro and pilsner outperformed water in detection of animals and species. The confounding exception is, although there was no difference between beer types, the micro did detect more species per trap than water (*p = 0.2)* but not at the 0.05 level. Despite this result the majority of evidence points toward beer, of any form, being the bait of choice for terrestrial gastropod trapping.

Seasonality - For all survey methods, except the final leaf litter output, we detected more species earlier in the season, at lower elevation, in periods of higher precipitation. Although higher species richness at lower elevations is not surprising (Baur et al. 2014, Schmera & Baur 2014) we must interpret this result with some caution. We generally surveyed lower elevation sites earlier in the season as snowpack prevented access to higher elevation sites until late season hotter and drier weather prevailed. We addressed this concern by comparing summer and fall GTS results at the 149 FIA plots. Although other northern hemisphere studies have indicated autumn as a more effective gastropod sampling season (e.g. Johnston et al. 2017), our summer vs. fall comparison of GTS results still supported early season sampling detecting more species. Therefore, our recommendation is to survey locations relatively early in the snow-free season. In studies aiming to describe gastropod diversity in temperate mountain ecosystems, it remains important to include higher elevation areas as some species, such as *Magnipelta mycrophaga*, occur predominately along higher elevation gradients.

Observer Bias - Observer bias is often cited as a confounding factor making quantitative gastropod surveys challenging if not impossible (e.g. Pearce and Örstan 2006). Our large observer sample size presented a unique opportunity to assess this commonly held malacological belief. Our 21 GTS observers were all paid wildlife technicians or biologists. They each participated in a short training exercise in how to search for gastropods and none had prior experience working with gastropods. We were quite surprised to find, with two exceptions, they performed nearly equally.

The two exceptions both developed strategies, within the sideboards of the protocol, which likely influenced success. Observer 1, who performed best in species detections, moved quickly about the defined search area searching in a wide variety of micro-habitats. Observer 2, who detected the most animals, did not move widely during the search and generally sat down and did not leave a certain spot during the search period (thus generally focusing on a single micro-habitat).

The leaf litter results presented an opportunity to evaluate success of different classes of observers. College students, wildlife technicians, and paid temporaries were paid an hourly wage to sort leaf litter samples. Paid temporaries were hired from a temporary employment company, had no background in science or natural resources, and were supervised directly by a paid wildlife technician. Despite extra guidance and oversight, the paid temporaries performed abysmally. It is difficult to provide reasons for this result but possibilities range from a general lack of investment in the purpose of the work (conservation) or to their being older on average (and perhaps having poorer eyesight) than other observer groups. We may have seen greater success from paid temporaries had we provided a small cash incentive for the most and smallest shells similar to Emberton et al (1996).

It seems ‘grouping’ observers by type may be a possible way to achieve quantitative survey goals. For instance, only use paid wildlife technicians or only use un-paid volunteers. Still the occasional observer may possess a knack that could skew results. Regardless, our overall results suggest quantitative measures of gastropod diversity are possible despite potential observer bias, and observer bias may be more of a malacological perception than reality.

Re-sampling - Our results show a clear increase in the number of species detected on subsequent visits of both traps and GTS. Given the predominance of elevation and season as predictive factors in species richness, we may have seen similar results had we put more effort into each site visit (i.e. 6 traps during the same visit could yield a similar increase to 3 traps visited twice). Given the amount of effort taken to reach remote survey sites and the decrease in species detections we see over the snow-free season and recognizing the possibility of missing species with short seasons (e.g. Baur et al 2014, Cameron and Pkryzko 2005, Emberton et al 1996), we suggest more effort be put into individual site visits early in the season rather than visiting the same site multiple times over the course of a season. On the other hand, smaller scale studies or those with less remote sites may find it worthwhile to include a trapping component.

Conclusions - Were our goal to definitively map the full diversity of terrestrial gastropods in our study area, our protocol could be criticized for not targeting soil (Emberton et al. 1996) or arboreal specialists (Johnston et al 2017). Indeed, our irregular detection of species such as *Pupillidae* suggest we may have under-detected some groups, perhaps due to their seasonal nature (Cameron and Pokrysko 2005). However, our goal was to broadly map the range and distribution of the majority of terrestrial gastropods in our study area and it is generally considered acceptable to miss some species at the site level when the goal is broad survey results (Cameron and Pokrysko 2005). Although we certainly did not detect each species at the site level the broad picture we paint appears reasonably accurate. For the majority of species we were able to develop range maps which clearly show edges of distributions and contact zones (Lucid et al 2016, Lucid et al 2018). Additionally, our survey drastically changed the scope of knowledge of this taxonomic group in our study area as evidenced by the substantial influence this data set had on species status changes species during the 2015 state species ranking and Idaho SGCN assignment process (IDFG 2017, Lucid et al 2016). Data collected as part of this project were partially or wholly responsible in the removal of 7 gastropod species from (*Cryptomastix mullani blandi, Kootenai burkei*, *Polygyrella polygyrella, Prisiloma idahoense, Radiodiscus abietum, Udosarx lyrata*, and *Zacoleus idahoensis*) and addition of 4 gastropod species (*Hemphillia skadei*, *Prophysaon coeruleum*, and *Prophysaon dubium)* to the Idaho SGCN list (IDFG 2017, Lucid et al 2016, Lucid et al 2018)

Our data and analyses leave us with the opportunity to ask what we would have done differently. Given the difficulty and expense of accessing sites in our remote and mountainous study area, we would likely not re-visit survey sites. Although re-sampling clearly increased our detections, we would recommend spending more time during a single site visit and conduct multiple sampling sessions during a single visit. This strategy would effectively remove the opportunity for trapping. This is clearly fine for pitfall traps as they were rather ineffectual. Although the cover board traps did outperformed GTS in detecting small slugs, they are still likely not worth the additional effort to re-visit sites. To describe terrestrial gastropod diversity in a large study area we recommend a combination of GTS and leaf litter collection relatively early in the snow-free period. We would increase the time searched and volume of litter collected. Beer worked well as a bait and we recommend its use in studies that do include a trapping component.

Understanding species status is a necessary and critical part of resource management. Our survey effort profoundly changed our understanding of terrestrial gastropod diversity in our study area and we suspect efforts in other study areas would provide similar benefits. We hope this study provides a roadmap to others seeking to implement this crucial first step in terrestrial gastropod conservation.

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ARTICLE

Taxonomy and biogeography of *Hemphillia* (Gastropoda: Pulmonata: Arionidae) in North American rainforests, with description of a new species (Skade's jumping-slug, *Hemphillia skadei* sp. nov.)

M.K. Lucid, A. Rankin, A. Espíndola, L. Chichester, S. Ehlers, L. Robinson, and J. Sullivan

Abstract: Species diversity of the genus *Hemphillia* Bland and W.G. Binney, 1872 (jumping-slugs) was studied across its range in western North America's inland temperate rainforests. The taxonomic relationships among jumping-slug populations were clarified by integrating morphological, molecular, and biogeographic approaches. A new species, Skade's jumping-slug (***Hemphillia skadei*** sp. nov.), was discovered in this process and is described herein. We base this taxonomic decision on molecular comparison of representatives from other *Hemphillia* species and four morphological characters that distinguish *H. skadei* from its sister species, the pale jumping-slug (*Hemphillia camelus* Pilsbry and Vanatta, 1897). The distribution of *H. skadei* and *H. camelus* is described along with the notable lack of detection of the marbled jumping-slug (*Hemphillia danielsi* Vanatta, 1914) within the primary survey area.

Key words: biodiversity, forest, Gastropoda, *Hemphillia camelus*, *Hemphillia danielsi*, *Hemphillia dromedarius*, *Hemphillia glandulosa*, *Hemphillia malonei*, *Hemphillia skadei*, *Magnipelta mycophaga*, morphology, phylogeny, temperate, taxonomy, systematics.

Résumé : La diversité spécifique du genre *Hemphillia* Bland and W.G. Binney, 1872 (limaces-sauteuses) a été étudiée à la grandeur de son aire de répartition dans les forêts humides tempérées intérieures de l'ouest de l'Amérique du Nord. Les relations taxonomiques au sein des populations de limaces-sauteuses ont été précisées en intégrant des approches morphologiques, moléculaires et biogéographiques. Ce faisant, une nouvelle espèce, ***Hemphillia skadei*** sp. nov., a été découverte et est décrite. Nous basons cette décision taxonomique sur la comparaison moléculaire à des représentants d'autres espèces d'*Hemphillia* et quatre caractères morphologiques qui distinguent *H. skadei* de son espèce-sœur, la limace-sauteuse pâle (*Hemphillia camelus* Pilsbry et Vanatta, 1897). Les répartitions de *H. skadei* et *H. camelus* sont décrites, ainsi que l'absence notable de détection de limaces-sauteuses marbrées (*Hemphillia danielsi* Vanatta, 1914) dans la principale région d'étude. [Traduit par la Rédaction]

Mots-clés : biodiversité, forêt, gastéropodes, *Hemphillia camelus*, *Hemphillia danielsi*, *Hemphillia dromedarius*, *Hemphillia glandulosa*, *Hemphillia malonei*, *Hemphillia skadei*, *Magnipelta mycophaga*, morphologie, phylogénie, tempérée, systématique, taxonomique.

Introduction

The demographic and distribution data necessary for landscape-level species conservation are only usable in the context of accurate taxonomic frameworks (Wilson 2000). Within this context, spatially expansive inventory programs are a necessary component of species status assessments, particularly for data-deficient species (e.g., Bland et al. 2017), to determine if they should be targeted for conservation action. North American terrestrial gastropods are a case in point. Mollusk species comprise the second largest phylum (Mollusca) of Animalia, and this highlights their ecological impact on the biosphere. Mollusks serve a wide variety of ecological roles including decomposing organic matter, hosting parasites, vectoring disease, soil building, and providing a prey base for many species (Jordan and Black 2012). Although mollusks are listed as the third largest group of International Union of Conservation of Nature (IUCN) threatened animal species globally and are the most numerous group of IUCN threatened species in North America (http://www.iucnredlist.org/, accessed 27 February 2017), biological knowledge is limited and much remains to be discovered. Without thorough knowledge of the ecology, evolution, and systematics of these animals, it will be difficult to describe and conserve the diversity that mollusks represent.

Up to 25% of North American terrestrial gastropods await description (Nekola 2014) and new species and genera from the Pacific Northwest are described regularly (e.g., Leonard et al. 2003; 2011). Some areas of the Pacific Northwest have exceptionally high terrestrial mollusk diversity and endemism (Frest and Johannes 1995; Burke 2013), some of which may still be undescribed. Jumping-slugs, gastropods in the genus *Hemphillia* Bland and W.G. Binney, 1872 (Bland and Binney 1874), are endemic to North America's Pacific Northwest. The genus currently consists of five recognized species

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M.K. Lucid, S. Ehlers,* and L. Robinson.† Idaho Department of Fish and Game, 2885 Kathleen Avenue, Coeur d'Alene, ID 83815, USA.
A. Rankin, A. Espíndola,‡ and J. Sullivan. Department of Biological Sciences, Life Sciences South 252, 875 Perimeter Drive MS 3051, University of Idaho, Moscow, ID 83844-3051, USA.
L. Chichester. 209 Chestnut Springs Way, Williamston, SC 29697, USA.
Corresponding author: M.K. Lucid (email: michael.lucid@idfg.idaho.gov).
*Present address: Missouri Department of Conservation, 2929 County Road 618, Ellington, MO 63638, USA.
†Present address: Rainforest Ecological, P.O. Box 733, Sandpoint, ID 83864, USA.
‡Present address: Department of Entomology, University of Maryland, College Park, MD 20742, USA.

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(Burke 2013) distributed in a mesic forest disjunct pattern (Brunsfeld et al. 2001).

The dromedary jumping-slug (*Hemphillia dromedarius* Branson, 1972), warty jumping-slug (*Hemphillia glandulosa* Bland and W.G. Binney, 1872), and malone jumping-slug (*Hemphillia malonei* Pilsbry, 1917) have coastal distributions, whereas the pale jumping-slug (*Hemphillia camelus* Pilsbry and Vanatta, 1897) (Pilsbry and Vanatta 1898) and marbled jumping-slug (*Hemphillia danielsi* Vanatta, 1914) are distributed in inland forests. The Burrington jumping-slug (*Hemphillia burringtoni* Pilsbry, 1948; also known as the keeled jumping-slug) (Branson, 1972), a sixth purported species, is not supported by molecular analysis (Wilke and ZIegltrum 2004). The panther jumping-slug (*Hemphillia pantherina* Branson, 1975), a seventh purported species, was described from a single coastal specimen (Branson 1975) but is now widely viewed as not warranting specific recognition (Burke 2015; T.E. Burke, personal communication).

The two inland *Hemphillia* species (*H. camelus* and *H. danielsi*) were included as part of a multitaxa inventory program in the inland Pacific Northwest (Lucid et al. 2016). Specifically, *H. camelus* was known to occur within the study area (Burke 2013), and *H. danielsi* was known to occur adjacent to (Hendricks 2003), as well as predicted to occur within (Burke 2013), the study area. Our objectives were to (*i*) identify the *Hemphillia* species diversity from northern Idaho and the surrounding regions, (*ii*) clarify the taxonomic relationships of those entities by integrating morphological, molecular, and biogeographic approaches, (*iii*) describe anatomical, molecular, distributional, and natural history characteristics of a new taxon discovered in this process.

Materials and methods

Study area

Centered on northern Idaho's Panhandle region, the study area encompassed portions of northeastern Washington and northwestern Montana, USA (Figs. 1A and 1B). It included parts of the Selkirk, Purcell, West Cabinet, Coeur d'Alene, and Saint Joe mountain ranges. The topography is mountainous, ranging in elevation from 702 to 2326 m, with a climate characterized by mild summers and wet and moderately cold winters. The heavily forested area is dominated by a diverse mix of conifer species and is characterized as supporting inland temperate rainforest (DellaSala et al. 2011).

Field methods

We stratified our study area into 920 sampling cells that were 5 km × 5 km each and conducted 992 surveys in 879 of those cells. Our survey sites were either randomly selected but biased to roads and trails (n = 842) or subselected from random forest inventory and analysis plots (n = 150) (Bechtold and Patterson 2005) based on site characteristics (stand age, elevation, and distance to road; for details see Lucid et al. 2016). Gastropod surveys were conducted from May to November, 2010–2014. Each site was surveyed once during this time period with each survey consisting of two repeat visits. Each survey consisted of (*i*) three 30 cm × 30 cm cardboard cover board traps (Boag 1982) from which specimens were collected after a 14 day deployment period, (*ii*) collection, freezing, and drying of 1 L of leaf litter (Coney et al. 1981) from which gastropods were sorted, and (*iii*) two 15 min timed visual searches conducted 14 days apart. Air temperature was recorded every 90 min at survey sites for 1 year as described in Lucid et al. (2016). Field personnel collected all terrestrial gastropods encountered, drowned each specimen in water, and then preserved specimens in 70% ethanol.

Morphological identification

To identify the species present in the area, we identified all ethanol preserved specimens following Burke (2013). Of 177 preserved specimens identified as *Hemphillia* spp., we measured total body length and mantle length of 34. Our dissection sample size was limited because we restricted specimens selected for dissection to those with body length ≥10 mm to maximize the potential for specimens to possess mature genitalia. Thirty-four specimens genetically identified (see below) as *H. camelus* (n = 22) or ***Hemphillia skadei*** sp. nov. (Skade's jumping-slug; n = 12) were dissected under a binocular dissecting microscope (Table 1). Microsurgical scissors and fine dental probes were employed to access the internal organs, with special emphasis on the reproductive system. The technique was modified from Gregg (1958).

Molecular identification

For initial analyses, DNA was extracted at Wildlife Genetics International (WGI) using a DNeasy Blood and Tissue Kit (Qiagen, Valencia, California, USA) per the manufacturer's protocols. WGI developed a species test for this group of organisms using a portion of the mitochondrial *16s* rRNA gene that was compared with reference data. WGI downloaded *16s* rDNA sequences from GenBank (https://www.ncbi.nlm.nih.gov/genbank/) for *H. dromedarius* (AY382638), *H. camelus* (AY382639), and the pygmy slug (*Kootenaia burkei* Leonard, Chichester, Baugh and Wilke, 2003) (AY382640, AY382641, AY382642, and AY382643). Using these sequences, primers were designed to target two conserved regions across a range of slug species that flanked the highly variable portion of the *16S* rRNA gene (16sbr-H 5′-CCGGTCTGAACTCAGATCACGT-3′ and 16sar-L 5′-CGCCTGTTTATCAAAAACAT-3′). Polymerase chain reaction (PCR), electrophoresis, and Sanger sequencing were used to produce sequence profiles of a highly variable portion of the *16S* rDNA region. These sequences were afterwards compared with reference data from GenBank, using the program BLAST (Altschul et al. 1997).

Extended molecular analyses

Based on the results of the molecular species ID and comparative anatomy analyses (see below), we sampled additional individuals to subject to phylogenetic and DNA barcoding analyses. All laboratory work described henceforth was performed at the University of Idaho. Data were obtained from 30 *H. camelus* specimens (plus one from GenBank AY382632_AY382639) and 28 *H. skadei* specimens originating from multiple localities in northern Idaho and the surrounding regions. In addition, nine specimens from *H. danielsi*, eight from *H. glandulosa*, five from *H. dromedarius*, and seven from *H. malonei* were obtained (Table 2, Fig. 1B). The magnum mantleslug (*Magnipelta mycophaga* Pilsbry, 1953) was included as an outgroup. Total DNA was extracted from the foot of each specimen (10–15 mg) using a DNeasy Blood and Tissue Kit (Qiagen, Valencia, California, USA) per the manufacturer's protocols. Partial sequences of the mitochondrial *COI* gene, mitochondrial *16S* rRNA gene, and nuclear *ITS1* marker were amplified by the PCR with the primers LCO1490/HCO2198 (5′-TAAACTTCAGGGTGACCA AAAAATCA-3′ and 5′-GGTCAACAAATCATAAAGATATTGG-3′; Folmer et al. 1994), 16Sar-L/16Sbr-H (described above), and ITS1F/ITS1R (5′-GCTGCGTTCTTCATCGATGC-3′ and 5′-TAACAAGGTTTCCGTAGGT GAA-3′; Armbruster et al. 2000; Mumladze et al. 2013), respectively. All PCRs were carried out in 50 μL reactions containing 3 μL DNA, 37.75 μL water, 5 μL buffer, 1 μL of 25 mmol/L $MgCl_2$, 1 μL of 10 mmol/L dNTPs, 1 μL of 10 mmol/L forward and reverse primers, and 0.25 μL of 5 U/μL of New England Biolabs *Taq* polymerase. The PCR reactions consisted of an initial denaturation step at 95 °C for 2 min, followed by 30 cycles of a denaturation step at 95 °C for 35 s, an annealing step (52 °C for *COI*, 47.5 °C for *16s* rDNA, and 52 °C for *ITS1*) for 60 s, and an elongation step at 72 °C for 45 s, and finalized with a final extension step at 72 °C for 5 min. Amplicons were electrophoresed in a 1% agarose gel to verify the amplifications and were cleaned up using the Qiaquick PCR Cleanup Kit (Qiagen). PCR products were sequenced in both the forward and reverse directions, and sequences were visually examined and edited with Chromas version 2.6.2 (Technelysium Pte Ltd.; http://www.technelysium.com.au/chromas.html). Nuclear *ITS1* electropherograms showed

Fig. 1. *Hemphillia* sampling. (A) Survey area and visited sampling cells. Dashed cells: visited cells; dotted outlines: Skade's jumping-slug (*Hemphillia skadei*) found; gray cells: pale jumping-slug (*Hemphillia camelus*) found. (B) Samples used in our phylogenetic study. Shapes and colors indicate species.

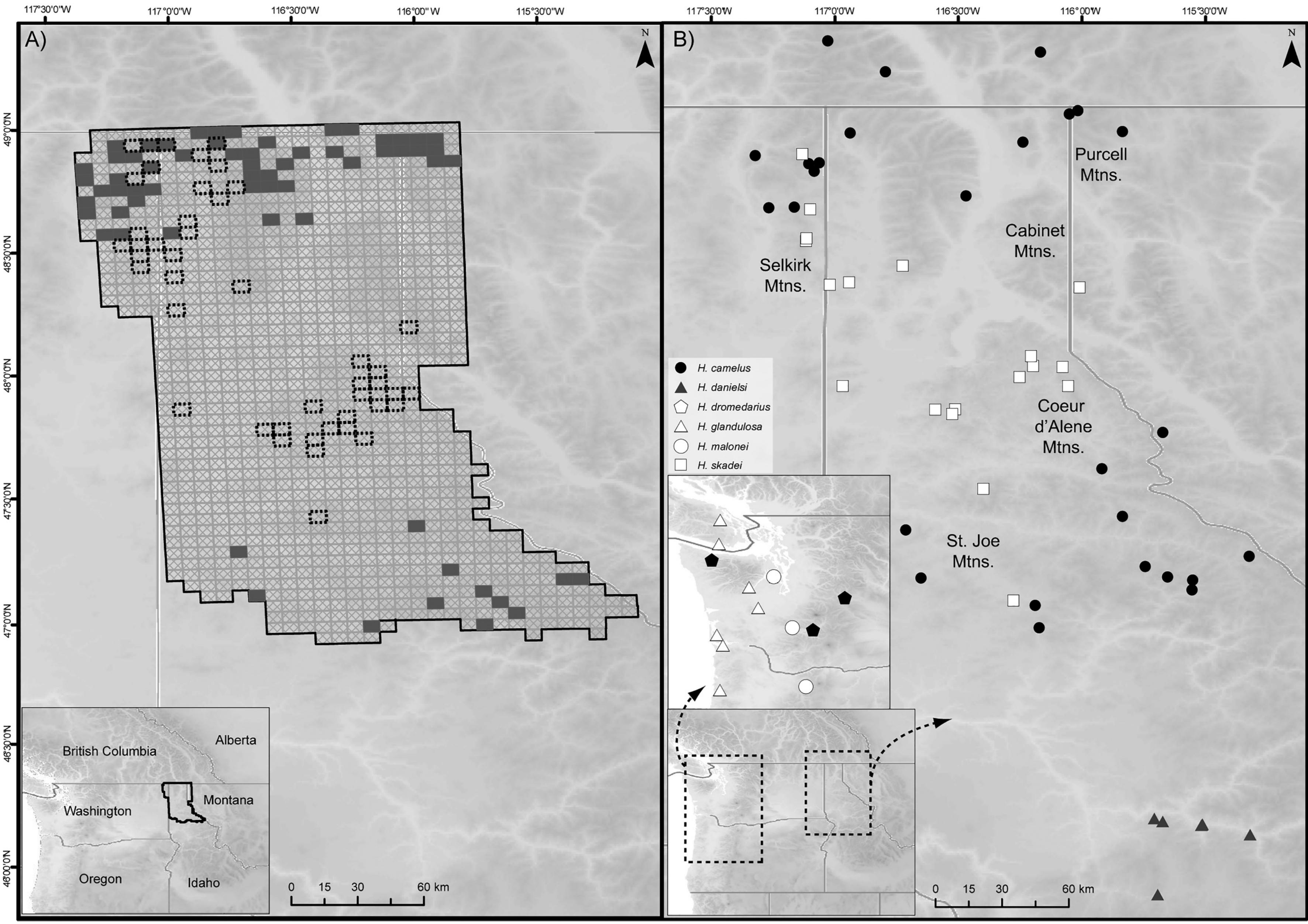


Table 1. Dissected specimens of the pale jumping-slug (*Hemphillia camelus*) and Skade's jumping-slug (*Hemphillia skadei*) specimens.

		Length (mm)			
Specimen	Genetic ID	Body	Mantle	Maturity	Collection date[a]
C113GTSD	*H. camelus*	23	13.5	Mature	7/16/2010
C50GTSV2D	*H. camelus*	10	8	Immature	8/29/2010
C97GTS	*H. camelus*	20	15	Immature	8/17/2010
C113GTSC	*H. camelus*	27	19	Mature	7/16/2010
C2GBV2	*H. camelus*	30	16	Mature	8/28/2010
C20GTS	*H. camelus*	31	21	Mature	8/14/2010
C137GTSA	*H. camelus*	21	18	Mature	8/19/2010
GDNA2	*H. camelus*	28	19	Mature	8/3/2012
GDNA3	*H. camelus*	28	18	Mature	8/3/2012
GDNA4	*H. camelus*	28	17	Mature	8/3/2012
GDNA5	*H. camelus*	21	13	Mature	8/3/2012
GDNA6	*H. camelus*	24	16.5	Mature	8/3/2012
GDNA7	*H. camelus*	24	13	Immature	8/3/2012
GDNA8	*H. camelus*	32	21	Mature	8/3/2012
GDNA9	*H. camelus*	37	18	Mature	10/1/2012
GDNA10	*H. camelus*	27	16	Mature	10/1/2012
GDNA11	*H. camelus*	31	19	Mature	10/1/2012
GDNA12	*H. camelus*	39	20	Mature	10/1/2012
GDNA13	*H. camelus*	30	21	Mature	10/1/2012
GDNA14	*H. camelus*	40	20	Mature	10/1/2012
GDNA15	*H. camelus*	32	21	Mature	10/1/2012
GDNA16	*H. camelus*	27	20	Mature	10/13/2012
C108GTS	*H. skadei*	12	8	Immature	8/12/2010
C43GTSV2A	*H. skadei*	17	12	Immature	8/27/2010
C50GTSV2A	*H. skadei*	20	11	Immature	8/29/2010
C95GTSA	*H. skadei*	15	13	Immature	7/16/2010
C92GTS	*H. skadei*	25	14	Mature	8/13/2010
C26GTSV2	*H. skadei*	21	11	Immature	8/27/2010
GDNA1	*H. skadei*	24	12.5	Immature	6/21/2012
FIA1180GTSV3A	*H. skadei*	24	16	Mature	9/20/2014
FIA76GTSV3AB	*H. skadei*	21	14	Mature	9/24/2014
FIA76GTSV3B(1)	*H. skadei*	11.5	9	Immature	9/24/2014
FIA125GTSV3B(1)	*H. skadei*	14	8	Immature	9/25/2014
FIA125GTSV3B(2)	*H. skadei*	17.5	5	Immature	9/25/2014

[a]Collection date format is month/day/year.

low levels of heterogeneity, and a consensus sequence was generated. The mitochondrial *COI* gene and mitochondrial *16S* rRNA gene were concatenated into a single data set, and the resulting sequence data were assembled into two separate sets: the concatenated *COI-16S* and the *ITS1*. All new sequences are deposited on GenBank (accession Nos. MG640377-MG640475, MG640486-MG640561, MG641787-MG641883; additional details, including sample names and collection localities, are available in Supplementary Table S1[1]).

Phylogenetic analyses

Multiple alignments were constructed between *H. camelus*, *H. skadei*, *H. danielsi*, *H. dromedarius*, *H. glandulosa*, *H. malonei*, and *M. mycophaga* using MAFFT online (https://www.ebi.ac.uk/Tools/msa/mafft/). In both data sets, many regions were too divergent to be aligned across lineages (i.e., parts of *16S* and *ITS1*). Therefore, we used the Gblocks algorithm (Castresana 2002) to eliminate ambiguous regions and extract the conserved regions from each alignment, resulting in 992 bp for the concatenated *COI-16S* and 390 bp for *ITS1*.

The mitochondrial *COI-16S* data matrix was subjected to maximum likelihood (ML) and Bayesian phylogeny estimation. We used the decision theoretic approach (DT; Minin et al. 2003) implemented in PAUP* version 4.0a152 (Swofford 2003) to select a model of nucleotide sequence evolution using the Bayesian information criterion (BIC). ML analyses were performed in Garli (Zwickl 2006) using the TrN+I+Γ model and default parameters. The ML tree was first determined by conducting 10 replicate runs with random starting trees, and nodal support was then assessed using 100 bootstrap replicates using two tree searches per bootstrap. Bootstrap values were viewed in PAUP* by constructing a majority rule consensus tree. Bayesian analyses with the Metropolis-coupled Markov chain Monte Carlo method were performed in MrBayes version 3.2.5 (Huelsenbeck and Ronquist 2001) using the TrN+I+Γ model and default parameters. The analysis was run twice with four chains per run for 2 million generations, and trees were saved every 200 generations. Convergence was assessed by the standard deviation of split frequencies. We assumed runs had converged when this value reached 0.01. We also assessed parameter estimates with Tracer version 1.4 (Rambaut and Drummond 2007) to assure that these values had stabilized. We discarded the first 25% of samples from each run and built a majority-rule consensus tree from the remaining trees. All tree output files were viewed and summarized using Figtree version 1.3 (Rambaut and Drummond 2014).

For the nuclear *ITS1* data set, an ultrametric tree was estimated in BEAST version 2 (Bouckaert et al. 2014), under a strict molecular clock with the mean substitution rate set to 1, so that time would be reported in units of substitutions per site. The Yule speciation

[1]Supplementary Table S1 is available with the article through the journal Web site at http://nrcresearchpress.com/doi/suppl/10.1139/cjz-2017-0260.

Table 2. Specimens of the pale jumping-slug (*Hemphillia camelus*), Skade's jumping-slug (*Hemphillia skadei*), marbled jumping-slug (*Hemphillia danielsi*), dromedary jumping-slug (*Hemphillia dromedarius*), warty jumping-slug (*Hemphillia glandulosa*), malone jumping-slug (*Hemphillia malonei*), and magnum mantleslug (*Magnipelta mycophaga*) used in phylogenetic and DNA barcoding analyses, with asterisks denoting sequences from GenBank.

Sample	ID	State or province[a]	Latitude (°N)	Longitude (°E)	Collection date[b]
C798GTSV2	*H. camelus*	ID	47.2795	–116.71259	7/14/2011
C833GTSV1A	*H. camelus*	ID	47.08485	–116.65096	8/2/2013
C1110GTSV1A	*H. camelus*	ID	46.97431	–116.18865	7/21/2013
FIA1539BGNCA	*H. camelus*	ID	47.036	–115.555	7/27/2013
C798GN	*H. camelus*	ID	47.2795	–116.71259	7/14/2011
FIA1343GTSV1A	*H. camelus*	ID	47.222	–115.878	7/16/2013
C4GTSV2A	*H. camelus*	WA	48.79582	–117.32204	8/31/2010
FIA83GTSV2B	*H. camelus*	ID	48.888	–116.937	6/15/2013
C32GNAC	*H. camelus*	WA	48.76273	–117.10503	6/15/2013
C1291GW	*H. camelus*	ID	48.96342	–116.05133	7/28/2011
C31GW	*H. camelus*	WA	48.73202	–117.08286	8/14/2010
C1152GN	*H. camelus*	ID	48.85086	–116.23873	7/4/2011
C1110GTSV2A	*H. camelus*	ID	46.97431	–116.18865	8/4/2013
C1428GW	*H. camelus*	MT	48.89293	–115.83614	7/3/2011
C1110GNCB	*H. camelus*	ID	46.97431	–116.18865	8/4/2013
FIA1539AGTSV3BA	*H. camelus*	ID	47.052	–115.580	9/13/2014
C1336PGA	*H. camelus*	MT	48.9783	–116.01607	7/28/2011
C1336GWA	*H. camelus*	MT	48.9783	–116.01607	7/28/2011
C584BGTSV1	*H. camelus*	WA	48.58734	–117.1638	7/27/2011
C1743GTSV2A	*H. camelus*	ID	47.17297	–115.32325	7/26/2013
C167GTSB	*H. camelus*	ID	48.63165	–116.46842	7/3/2010
FIA1436GNB	*H. camelus*	ID	46.989	–115.696	7/28/2013
C1489GTSV1C	*H. camelus*	ID	47.08875	–115.65327	7/12/2013
C541GTSV2B	*H. camelus*	WA	48.58376	–117.26717	6/13/2013
C1304GTSV1A	*H. camelus*	ID	47.5275	–115.91911	6/22/2013
UI05	*H. camelus*	ID	46.883395	–116.172734	9/11/2015
AY382632_AY382639*	*H. camelus*	WA			
51111666	*H. camelus*	MT	47.6738	–115.673	
RBCM-013-00058-002	*H. camelus*	BC	49.260754	–117.02835	9/12/2010
RBCM-998-00267-001	*H. camelus*	BC	49.135821	–116.794549	9/21/1998
RBCM-998-00287-001	*H. camelus*	BC	49.215358	–116.167895	9/20/1998
C25BGTSV2C	*H. skadei*	WA	48.44899	–117.11639	8/11/2011
FIA1131GTSV1C	*H. skadei*	ID	47.943	–116.198	6/28/2013
C1223GNCB	*H. skadei*	ID	47.93804	–116.07764	7/12/2013
FIA883GTSV1	*H. skadei*	ID	47.765	–116.594	6/9/2013
FIA1080PGA	*H. skadei*	ID	47.813	–116.270	6/8/2013
C1222GTSV2	*H. skadei*	ID	47.86182	–116.0567	7/13/2013
FIA116GTSV3BC(1)	*H. skadei*	ID	48.349	–116.725	9/27/2014
C919GTSV1B	*H. skadei*	ID	47.7672	–116.51242	5/25/2013
FIA1127GTSV3A	*H. skadei*	ID	47.771	–116.192	9/22/2014
C919GNCA	*H. skadei*	ID	47.7672	–116.51242	6/7/2013
C697GTSV1B	*H. skadei*	ID	48.28077	–116.94193	5/30/2013
C918GNBB	*H. skadei*	ID	47.748	–116.52481	6/7/2013
C1132GNAC	*H. skadei*	ID	47.98217	–116.20507	7/13/2013
FIA992GTSV2B(1)	*H. skadei*	ID	47.856	–116.405	7/14/2013
C25BGTSV2A	*H. skadei*	WA	48.44899	–117.11639	8/11/2011
C918GNBA	*H. skadei*	ID	47.748	–116.52481	6/7/2013
C1223GNBC	*H. skadei*	ID	47.93804	–116.07764	7/12/2013
C688GTSV2A	*H. skadei*	ID	47.86127	–116.96848	6/25/2013
C918GTSV2A	*H. skadei*	ID	47.748	–116.52481	6/7/2013
C25GTSC	*H. skadei*	WA	48.45904	–117.11486	8/17/2010
C28GTSV2A	*H. skadei*	WA	48.57685	–117.09885	8/26/2010
C28GTSV2B	*H. skadei*	WA	48.57685	–117.09885	8/26/2010
C25GTSE	*H. skadei*	WA	48.45904	–117.11486	8/17/2010
C33GW	*H. skadei*	WA	48.8012	–117.13055	8/14/2010
C982GTSV2	*H. skadei*	ID	47.44566	–116.39922	6/14/2013
C697GNB	*H. skadei*	ID	48.28077	–116.94193	6/13/2013
C658GTSV2B	*H. skadei*	ID	48.27209	–117.01922	6/13/2013
FIA116GTSV3A	*H. skadei*	ID	48.349	–116.725	9/27/2014
BLdan01	*H. danielsi*	ID			9/12/2010
BLdan07	*H. danielsi*	ID	46.77501	–11548071	9/14/2010
UI01	*H. danielsi*	ID	46.085226	–115.51515	2/–/2015
UI03	*H. danielsi*	ID	46.083801	–115.516957	5/23/2016

Table 2 (*concluded*).

Sample	ID	State or province[a]	Latitude (°N)	Longitude (°E)	Collection date[b]
UI04	*H. danielsi*	ID	46.085226	–115.51515	2/–/2015
CM-64157	*H. danielsi*	ID	45.803047	–115.6942	9/14/2002
Ma12DG01380	*H. danielsi*	ID	46.099668	–115.67396	12/15/2015
Ma16AG01403_1	*H. danielsi*	ID	46.111797	–115.707343	1/20/2016
UN5CG01604_3	*H. danielsi*	ID	46.046097	–115.320409	12/15/2015
CM-63984_1	*H. dromedarius*	WA	47.223244	–121.144828	7/13/2001
CM-63984_2	*H. dromedarius*	WA	47.223244	–121.144828	7/13/2001
CM-68014	*H. dromedarius*	WA	47.68067	–122.68133	11/28/2003
CM-64708	*H. dromedarius*	WA	46.534204	–121.831656	4/12/2003
AY382631_AY382638*	*H. dromedarius*	WA			
RBCM-014-00268-001	*H. glandulosa*	BC			8/25/2001
RBCM-016-00167-001	*H. glandulosa*	BC			6/7/2015
CM-63982_1	*H. glandulosa*	WA	46.41185	–123.906166	10/22/2002
CM-63982_2	*H. glandulosa*	WA	46.41185	–123.906166	10/22/2002
CM-80083	*H. glandulosa*	OR	45.224833	–123.838667	4/12/2007
CM-64903	*H. glandulosa*	WA	47.44667	–123.21056	2/20/2003
CM-63972	*H. glandulosa*	WA	47.002005	–123.01096	10/22/2002
AY382630_AY382637*	*H. glandulosa*	OR			
CM-63526_2	*H. malonei*	WA	46.578892	–122.273635	9/4/2001
CM-63526_3	*H. malonei*	WA	46.578892	–122.273635	9/4/2001
CM-70373_2	*H. malonei*	WA	47.68067	–122.68133	10/29/2004
CM-70373_3	*H. malonei*	WA	47.68067	–122.68133	10/29/2004
CM-70373_4	*H. malonei*	WA	47.68067	–122.68133	10/29/2004
AY357609_AY357656*	*H. malonei*	OR			
FIA121GTSV3B	*M mycophaga101*	ID	48.574	–116.732	9/26/2014
FIA1234PGA	*M. mycophaga102*	ID	48.438	–116.120	7/8/2013
C896GTSV2	*M. mycophaga103*	ID	48.36953	–116.66483	7/15/2013
C1144GTSV1A	*M. mycophaga104*	ID	48.52729	–116.20406	6/25/2013
C154GNA	*M. mycophaga105*	ID	48.96629	–116.62474	8/2/2013

Note: CM prefix denotes specimens from the Carnegie Museum and RBCM denotes specimens from the Royal British Columbia Museum. Coordinates for the samples with the FIA prefix have been purposely altered in compliance with a U.S. Forest Service legal agreement but are within 500 m of the actual location.

[a]State or province abbreviation (listed alphabetically within country): ID, Idaho; MT, Montana; OR, Oregon; WA, Washington; BC, British Columbia.

[b]Collection date format is month/day/year.

model was used as a tree prior with the JC+Γ model (selected using DT; Minin et al. 2003). The chain was run for 10 million steps, sampling every 1000 steps. The BEAST output was analyzed using Tracer version 1.4 and the first 25% of samples were discarded as burn-in. TreeAnnotator was used to produce a maximum clade credibility tree from the post-burn-in trees. The ultrametric gene tree was used as a guide tree in the generalized mixed Yule-coalescent (GMYC) model (Pons et al. 2006; Fontaneto et al. 2007; Fujisawa and Barraclough 2013) methodology to delimit independently evolving lineages. We applied the single-threshold model GMYC method using the splits package (Ezard et al. 2009) in R (R Foundation for Statistical Computing, Vienna, Austria; https://www.r-project.org).

Intraspecific and interspecific genetic distance

We examined the overlap between intraspecific and interspecific genetic distance between *H. camelus* and its candidate sister species using the concatenated *COI-16s* data set and the *ITS1* data set separately. A genetic distance matrix was produced in PAUP* (using an appropriate nucleotide substitution model selected using the DT approach) for pairwise sequence divergences calculated separately for both intraspecific and interspecific comparisons. We report the mean intra- and inter-specific distances, as well as the smallest and largest inter- and intra-specific distances.

Results

Six species of coastal (*H. dromedarius*, *H. glandulosa*, and *H. malonei*) or inland (*H. camelus*, *H. danielsi*, and *H. skadei*) distributed species can be distinguished by the morphological or molecular characters that we examined. *Hemphillia skadei* holotype OSAC_AC_2017_06_09-01-001 was collected on 13 August 2010 in the Selkirk Mountains, Boundary County, Idaho, USA (48.75886°N, –116.84624°E; 763 m elevation). Paratypes may also be accessed via the above accession number.

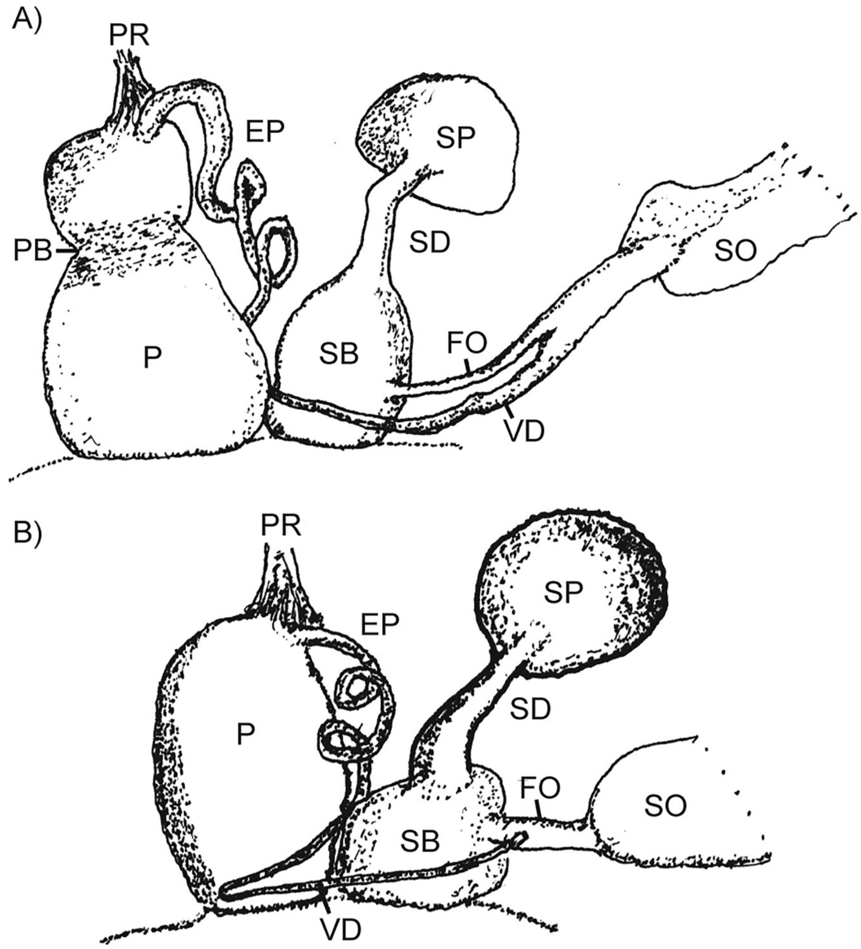
Table 3. Differences (upper) and similarities (lower) in genitalia of mature dissected specimens.

Pale jumping-slug, *Hemphillia camelus*	Skade's jumping-slug, *Hemphillia skadei*
Penis peanut-shaped	Penis barrel- or acorn-shaped
Penis pigmented	Penis unpigmented
Free oviduct long	Free oviduct short
Spermatophore robust	Spermatophore slender
Long highly coiled epiphallus	
Base of spermathecal duct very swollen in mature animals	
Penis contains a large lobe-like stimulator	
Ovotestis, hermaphroditic duct, and spermoviduct alike	

Etymology of *H. skadei*

In Norse mythology, the goddess Skaði (often anglicized as Skadi or Skade) is associated with winter, mountains, skiing, and bow hunting (Sturluson 1916). The specific name *skadei* recognizes the relatively cool air temperatures with which this mountain-dwelling species is associated, while acknowledging the cultural and recreational value skiing and hunting provide to many of the people who share the range of *H. skadei*. We suggest the common name "Skade's jumping-slug".

Fig. 2. Distal genitalia of (A) pale jumping-slug (*Hemphillia camelus*) and (B) Skade's jumping-slug (*Hemphillia skadei*). SB: swollen base of spermathecal duct at its junction with free oviduct; SP: spermatheca (bursa copulatrix); P: penis; PR: penis retractor muscle; EP: epiphallus; SD: spermathecal duct; VD: vas deferens; SO: spermoviduct (common duct); FO: free oviduct (vagina); HD: hermaphroditic duct; OV: ovotestis; PB: pigmented band. Modified from Lucid et al. (2016) and reproduced with permission of M.K. Lucid, Idaho Department of Fish and Game, Coeur d'Alene.



Morphology

Reproductive anatomy of H. skadei

The ovotestis consists of a small number of darkly pigmented lobules located in the rearmost portion of the visceral hump. The hermaphroditic duct is highly convoluted and long (about 9 mm). The yellow albumen gland is 4 mm or more in length. The bicolored spermoviduct is about 15 mm in length. The distal end of the free oviduct joins the swollen base of the spermathecal duct (bursa copulatrtix). The vas deferens originates just proximal to this junction. It is a very fine duct loosely adherent to the free oviduct (vagina). In one specimen, the duct formed a small loop and re-entered the wall of the oviduct only to emerge again as a separate duct a short distance away. The vas deferens continues to the base of the penis. It then follows the junction of the penis with the body wall before doing a 180° turn to join the epiphallus. The epiphallus is a stout, highly coiled and folded duct that joins the penis terminally or subterminally. The penis is an unpigmented barrel-shaped structure about 5 mm in length. The penis retractor inserts either on the penis or the epiphallus, or on both. The bisected penis reveals a large stimulator and a complex verge. There is a shallow atrial depression at the genital pore into which the penis and the vagina open.

Comparative anatomy

We found no external anatomical character that differentiated *H. skadei* from *H. camelus*. Both species are tan to gray in color. The genital opening is behind the right tentacle and the pneumostome is on the right side of the third quarter of the mantle. The mantle forms a visceral hump and clearly has an exposed portion of shell on the dorsal portion. Both slug species are of medium size, but the preserved, mature *H. skadei* specimens were smaller than the preserved, mature *H. camelus* specimens. Mature *H. skadei* specimens (n = 3) had a mean body length of 23 mm (minimum 21 mm, maximum 25 mm) and a mean mantle length of 15 mm (minimum 14 mm, maximum 16 mm) (Table 1). Mature *H. camelus* specimens (n = 19) had a mean body length of 29 mm (minimum 21 mm, maximum 40 mm) and a mean mantle length of 18 mm (minimum 13.5 mm, maximum 21 mm). Anatomical characters differentiating the two species are limited to mature genitalia. *Hemphillia skadei* has an unpigmented barrel- or acorn-shaped penis, short free oviduct, and slender spermatophore. *Hemphillia camelus* has a pigmented peanut-shaped penis, long free oviduct, and robust spermatophore (Table 3; Figs. 2A and 2B).

Molecular analysis

Molecular species identification

There were 54 *16S* rDNA sequences produced by WGI, which identified two distinct genetic clusters corresponding to the groups

Fig. 3. Phylogenetic reconstruction of the concatenated mitochondrial data matrix. Node supports show maximum likelihood bootstrap values and Bayesian posterior probabilities. Scale bar indicates number of substitutions per site.

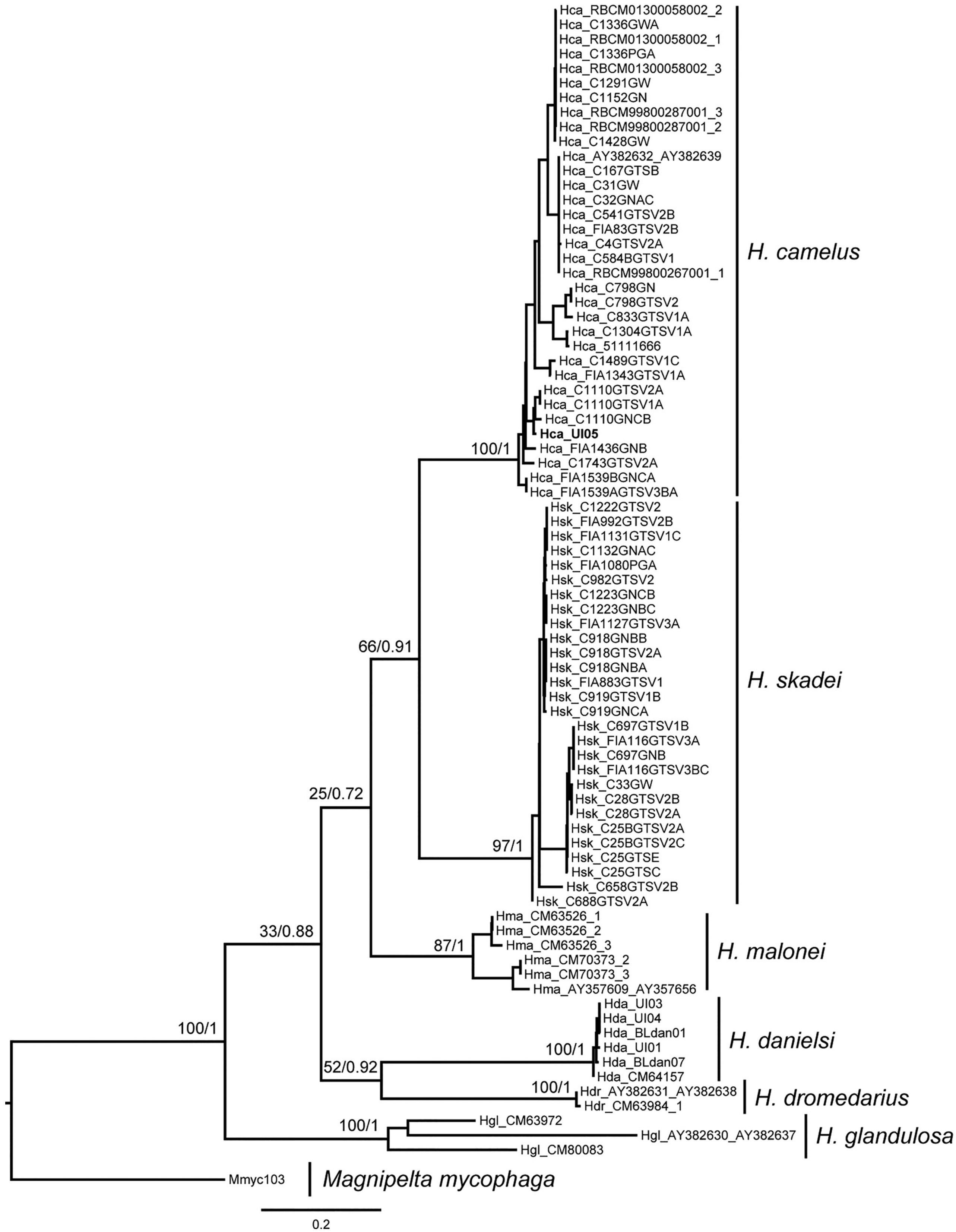
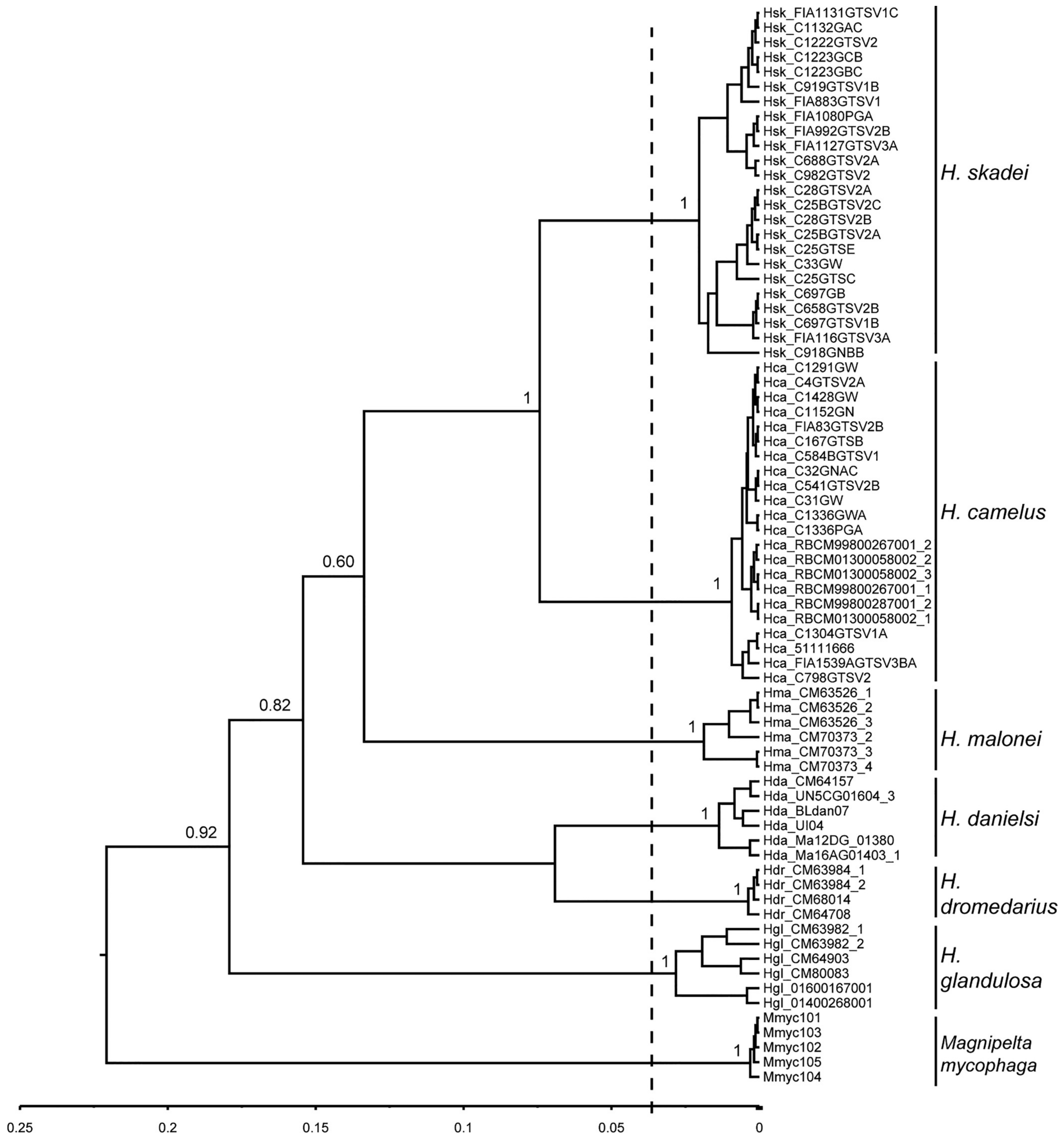


Fig. 4. Phylogenetic reconstruction of the *ITS1* data set using the Yule speciation prior and JC+G model. Node supports show Bayesian posterior probabilities. Vertical broken line indicates the inferred transition from interspecific speciation events to the intraspecific coalescent events.

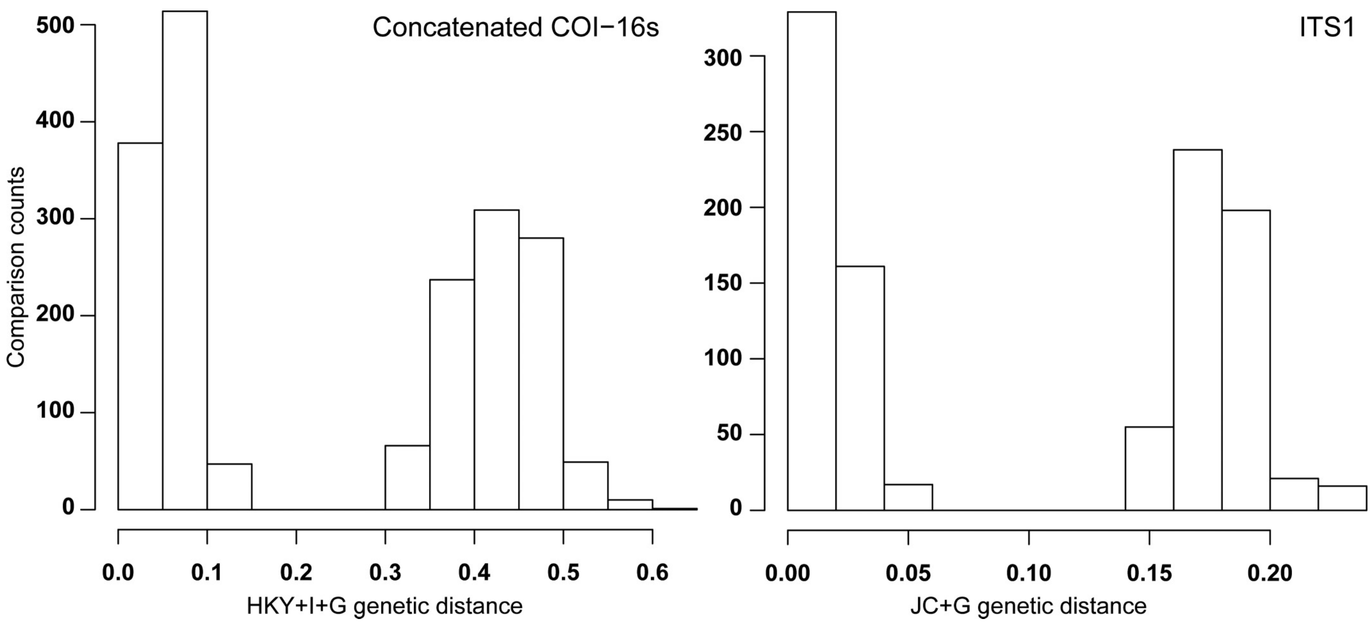


identified in the morphological identification (33 *H. camelus* sequences and 21 *H. skadei* sequences) (Figs. 3 and 4). Of approximately 424 nucleotides, there were 45 variable sites. Thirty-five of these exhibit fixed differences between the two taxa and therefore distinguish the two groups perfectly.

Intra- and inter-specific genetic distance

For the concatenated *COI-16S* data matrix, the mean interspecific HKY+I+Γ distance was estimated to be 0.427 substitutions/site (0.312–0.619 substitutions/site) (Fig. 5). The mean intraspecific distances for *H. camelus* and *H. skadei* were estimated to be 0.057 substitutions/site (0–0.133 substitutions/site) and 0.046 substitutions/site (0–0.131 substitutions/site), respectively. For the nuclear *ITS1* marker, the mean interspecific JC+Γ distance was 0.179 substitutions/site (0.141–0.238 substitutions/site; Fig. 5), whereas the mean intraspecific distances for *H. camelus* and *H. skadei* were estimated to be 0.0037 substitutions/site (0–0.0114 substitutions/site) and 0.0208 substitutions/site (0–0.0554 substitutions/site), respectively. Therefore, there is no overlap between intra- and inter-specific

Fig. 5. Distribution of intraspecific and interspecific genetic distances using the concatenated mitochondrial (left) and the nuclear (right) data sets.



variability; there is a distinct barcoding gap in the distribution of divergences, with higher interspecific variation than intraspecific variation, thereby distinguishing *H. camelus* and *H. skadei*.

Phylogenetic analyses

ML and Bayesian phylogenetic estimates were similar in topology (Fig. 3) and congruent with morphology; that is, *H. camelus* forms a strongly supported phylogroup that is sister to a strongly diverged, well-supported clade that contains all individuals of *H. skadei*. Additionally, *H. glandulosa*, which is distributed along the coast, is sister to all other *Hemphillia*. The inland-species *H. danielsi* is sister to coastally distributed *H. dromedarius*, whereas *H. malonei*, which occurs in coastal locations, is sister to the *H. camelus* – *H. skadei* complex.

The GMYC analysis rejected the null model of single coalescence (i.e., all sequences belong to the same species) model for the nuclear *ITS1* Yule tree (Fig. 4). The likelihood-ratio statistic for the comparison of the single coalescent (null) model versus the GMYC model was 10.24 ($p = 0.006$), indicating support for more than one species. The analysis estimated seven clusters (independent lineages) consistent with previous taxonomic assignment and with the addition of the new taxon, *H. skadei*, as a different entity.

Distribution, intraspecific genetic structure, and natural history

We detected *H. skadei* in 47 (5%) and *H. camelus* in 64 (7%) of 879 surveyed cells (Fig. 1A). *Hemphillia skadei* was the only species detected in the West Cabinet and Coeur d'Alene mountain ranges, whereas *H. camelus* was the only species detected in the Purcell Mountains. *Hemphillia skadei* was detected in one cell in the northern St. Joe Mountains, whereas all other detections in that range were *H. camelus*. In the Selkirks, *H. skadei* was detected in 26 cells and *H. camelus* was detected in 38 cells. Both species were detected in five Selkirk cells and in one instance both species were detected on the same Selkirk cover board trap.

In the mtDNA phylogeny (Fig. 3), *H. camelus* showed a monophyletic "northern" Selkirk–Purcells clade, which is nested within "southern" samples from Saint Joe and Coeur d'Alene. *Hemphillia skadei* shows an unresolved polytomy among a monophyletic "southern" Coeur d'Alene–Saint Joe clade, a "northern" Selkirk group, and one sequence (C658GTSV2B) from the Selkirks. An additional sequence (C688GTSV2A) from the Selkirks is sister to this group. Likewise, in the *ITS1* phylogeny, *H. camelus* shows reciprocally monophyletic "southern" Coeur d'Alene–Saint Joe and "northern" Selkirk–Purcells clades, whereas *H. skadei* shows reciprocally monophyletic "southern" Coeur d'Alene–Saint Joe and "northern" Selkirk clades (apart from C688GTSV2A from the Selkirks, which groups with the Coeur d'Alene clade).

Although either *H. skadei* or *H. camelus* were present in most parts of the study area, the exception appears to be the West Cabinet Mountains, where *H. skadei* was detected in just one cell (Figs. 1A and 1B). With no reason to suspect our techniques would lead to disparate detection rates, we conclude *H. skadei* occurs at relatively low densities and *H. camelus* may not occur in this mountain range.

Both species were typically collected in forested areas and most often found under logs or rocks. Occasionally both species could be found on the forest floor surface, especially during rain events. During particularly dry conditions, specimens could be found by breaking open decomposing logs and searching for moist sections. This suggests that both species retreat toward moist refuges as required by drying conditions. The latest collection date for immature specimens was 29 August for *H. camelus* and 25 September for *H. skadei* (Table 1). Late-season collection of immature specimens is suggestive that neither are annual species and likely overwinter as immature and mature animals. Mean annual air temperature at *H. camelus* (4.28 °C, $n = 51$) and *H. skadei* (5.16 °C, $n = 34$) collection sites was >1 °C lower than the study area's mean annual air temperature (6.17 °C). Future research should focus on whether these cooler than average air temperature sites are merely associative or ecological requirements and what plasticity the species may or may not possess for climate change adaptation. Both species occur more often at elevations greater than the study average (1112 m) with *H. camelus* found at elevations averaging 1383 m (605–1827 m, $n = 71$ sites) and *H. skadei* at 1199 m (723–1833 m, $n = 48$ sites).

Discussion

Hemphillia in northern Idaho and surrounding regions

Prior to our study, two described species (*H. camelus* and *H. danielsi*) were known to occur within or adjacent to our study area (Burke 2015; Hendricks 2012); however, survey effort in the area had been limited. Our results indicate that *H. danielsi* is not present in our survey area (Fig. 1A). Furthermore, our morphological and molecular analyses show what was formerly considered *H. camelus* represents in fact two distinct taxa: *H. skadei* and *H. camelus*, which are themselves distinct from *H. danielsi*.

Hemphillia skadei was detected in Washington, Idaho, Montana, and within 10 km of British Columbia, which suggests that it likely occurs in that Canadian province. *Hemphillia camelus* populations appear to exhibit a disjunct range, which are separated by a range inhabited by *H. skadei*. Although the distribution of the two species is predominately allopatric, there appears to be a northern contact zone in the Selkirk Mountains. Given these observations, it seems that biological or ecological barriers between these two groups are present and genetically isolate the lineages. Past populations may have been isolated within separate mountain refugia in which divergence was fostered by limited gene flow and genetic drift (Brunsfeld et al. 2001). Refugium populations may have since spread from their area of origin, but since making secondary contact, it appears that reproductive barriers may prevent gene flow.

Considering the possible contact zone and differences in penis structure, we suggest that future research investigates interbreeding capability of the two taxa. The divergence in genital shape can contribute to reproductive isolation, and future studies should investigate how this divergence affects reproductive success between *H. camelus* and *H. skadei*. For example, variation in mating behavior might indicate precopulatory reproductive barriers if individuals from separate lineages exhibit mechanical difficulty in genital insertion (Masly 2012). Additional contributing factors to consider may be the ability of individuals from separate lineages to recognize one another as potential mates (Rundle and Nosil 2005), differences in the timing of sexual maturity, and (or) the degree of parentage success given successful interspecific crosses.

Conservation implications

Prior to our study, populations of *H. camelus* in Idaho were listed as a NatureServe S2 ranked imperiled species (IDFG 2005) and considered to be in decline (Frest 1999). *Hemphillia camelus* was known from just 13 sites across the entire state of Idaho and only 4 Idaho sites within our study area (IDFG 2005). We documented three times the number of occupied Idaho sites in a single survey effort because we included this species in a broad multitaxa inventory program. We also demonstrated the importance of genetically screening a portion of samples to detect the presence of cryptic species. Without the genetic screening component of our survey, we would not have detected *H. skadei*, nor demonstrated that *H. danielsi* is not likely to occur within our study area. Modelling efforts proliferate as ways to determine range, distribution, and conservation status of species. However, our results indicate incorporation of a wide variety of taxonomic groups into broad-scale inventory and monitoring programs is not only feasible and practical, but necessary, to measure species distribution and conservation need.

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DISTRIBUTION OF NATIVE POND BREEDING AMPHIBIANS AND POTENTIAL THREAT MITIGATION ON AND ADJACENT TO BOUNDARY-SMITH CREEK WILDLIFE MANAGEMENT AREA

Idaho Department of Fish and Game

Leah Swartz, Senior Wildlife Diversity Technician
Michael Lucid, Regional Wildlife Diversity Biologist

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INTRODUCTION

Amphibians have experienced dramatic declines worldwide due to disease, habitat loss and degradation, climate change, and invasive species (Collins and Storfer 2003, Stuart et al. 2004). These declines are not limited to areas with high human populations, but have also occurred in seemingly pristine environments and protected areas (Adams et al. 2013). For example, the northern leopard frog (*Rana pipiens*) was once widely distributed across the western US and Canada but has apparently been extirpated from large portions of its historic range, including the Idaho panhandle (Lucid et al 2016). However, an isolated native population remains just 15 km across the border at British Columbia's Creston Valley Wildlife Management area (CVWMA).

Recent detections of bullfrogs (*Lithobates catesbeianus*) in the Kootenai River Valley near the Canadian border have raised concern about potential detrimental impacts on native amphibians, including the nearby leopard frog population and western toads (*Anaxyrus boreas*), a Species of Greatest Conservation Need (SGCN) in Idaho (IDFG 2017, Lucid 2015). Bullfrogs are native to the eastern United States, but have been introduced throughout the western United States and the world. Bullfrogs are considered one of the 100 most harmful invasive species and threaten native amphibians through predation, competition, and by serving as vectors for disease including the amphibian chytrid fungus (*Batrachochytrium dendrobatidis* [Bd]) (Lowe et al. 2000, Adams and Pearl 2007).

Bullfrogs have proven challenging to eradicate due to their high fecundity, ability to disperse long distances, and density dependence in the larval and adult stages (Govindarajulu et al. 2005, Adams and Pearl 2007). These characteristics highlight the importance of preventing introductions from occurring in the first place and early detection of new invasions. Studies of the efficacy of direct removal indicate that removal actions should focus on post-metamorphic individuals and must eradicate a high proportion of the population to successfully reduce the population size (Govindarajulu et al. 2005, Orchard 2011). These actions are most effective in areas with small, isolated ponds where the probability of reinvasion via overland dispersal is low (Adams and Pearl 2007). Because we suspect that the Kootenai River Valley has only recently been invaded by bullfrogs and there are only a few permanent waterbodies suitable for their reproduction, it may be a good system in which to test these removal methods. With no action, we anticipate that bullfrogs will soon invade the CVWMA.

In 2017, Idaho Fish and Game initiated a project to gain a better understanding of the distribution of native pond-breeding amphibians and their threats including bullfrogs and disease in the Kootenai River Valley. Our objectives were to (1) map the distribution of native amphibians and non-native bullfrogs, (2) test and implement a potential bullfrog control method, and (3) test for the presence of the amphibian chytrid fungus (Bd) in the study area.

MATERIALS AND METHODS

Study Area

Our study was located in the portion of the Kootenai River Valley from Copeland Road to the Canadian border in northern Idaho (Map 1). This area is bordered by the Selkirk Mountains on the west and the Purcell Mountains on the east. The valley is primarily private agricultural land (wheat, canola, and cattle). We used Google Earth satellite imagery (imagery date: 11 July 2014) to identify all ponds and wetlands in the study area. For waterbodies located on private land, we contacted landowners by phone or email to request permission to access their land.

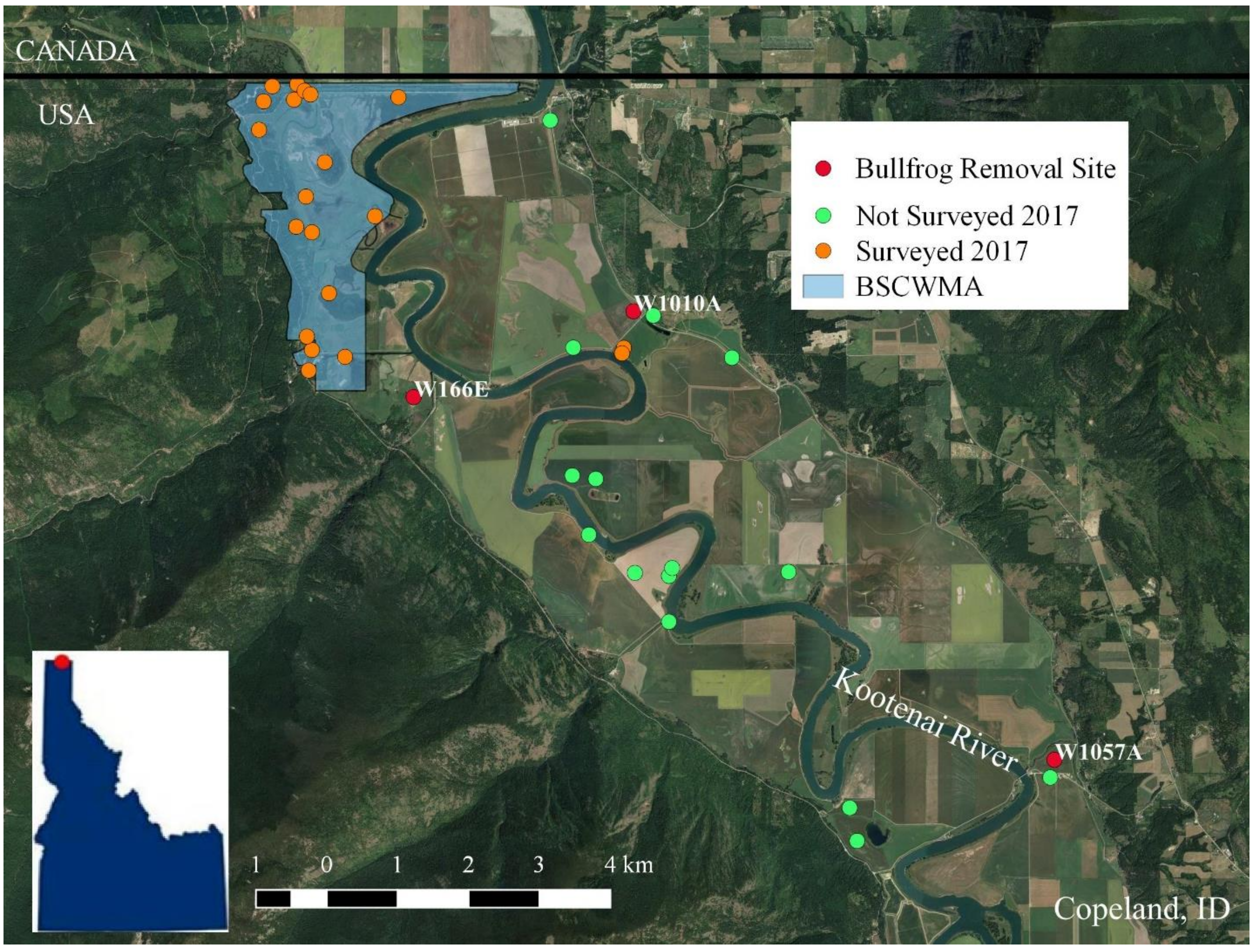
The Kootenai Valley has undergone dramatic hydrologic changes since Libby Dam was constructed in 1975 and most natural wetlands are no longer functional. The majority of privately held wetlands are highly modified or constructed ponds connected to irrigation ditches. This is also true for the wetlands in the northern portion of the study area which occur within Boundary Smith Creek Wildlife Management Area (BSCWMA), a restored wetland complex owned and managed by IDFG. Four native pond-breeding amphibian species currently occur in the area: western toads (*Anaxyrus boreas)*, Columbia spotted frogs (*Rana luteiventris*), long toed salamanders (*Ambystoma macrodactylum*), and pacific tree frogs (*Pseudacris regilla*). Northern leopard frogs (*Rana pipiens)* historically occurred in the area.

Figure 1: Photo of a restored wetland surveyed on BSCWMA

Amphibian Surveys

At each wetland that we were granted permission to access, we conducted a full perimeter dip net survey in late June or early July when amphibian larvae should be free swimming and easily detectable (Lucid et al 2016). We used 12” deep, 3/16” mesh dip nets (Delta Net and Twine, Greenville, MS) and sampled all microhabitats along the shoreline. We counted each amphibian species by life stage (egg, no legs, two legs, four legs and tail, or fully formed). Exact quantities were recorded for 0-10 individuals per section. If there were more than

10 individuals per section, quantities were estimated by order of magnitude to the nearest 10, 100, or 1000. We took photographs of one larval and one adult amphibian of each species observed at each wetland. We also took tissue samples from up to five individuals of each species. We characterized habitat characteristics for each wetland and recorded presence of other species of interest including painted turtles, garter snakes, fish, and invasive weeds (Appendices 1 and 2).



Map 1: Map of wetlands surveyed for amphibians in 2017. Orange dots represent wetlands surveyed for amphibians, red dots are wetlands where we conducted bullfrog removal, and green dots are wetlands on private land that we did not have permission to survey. Bullfrog removal sites were also surveyed for native amphibians.


Figure 2: IDFG intern Modeline Celestin conducts a dip net survey for amphibians

Bullfrog Removal

We conducted bullfrog removal in three focal wetlands by electrofrogging at night. The electrofrogger is a backpack electrofisher with specialized wand (Orchard 2012) designed specifically for frog capture. We worked in a team of two and used a canoe to access the targeted wetlands. Once in the wetland, we slowly paddled the shoreline. The person in the back paddled and steered while the person in the front used a high-powered headlamp (Fenix HL60R Rechargable Headlamp, Fenix Lighting, Lone Tree, CO) and handheld flashlight (Fenix RC11 Rechargable Flashlight, Fenix Lighting, Lone Tree, CO) to search for bullfrogs. Bullfrog eye shine indicated the presence of a bullfrog and the bright light caused the bullfrog to stay still (Orchard 2011).

When a bullfrog was spotted, we paddled slowly and quietly toward the frog and used the electrofrogger to shock the frog. Once the frog was immobilized, we scooped it up using a net attached to the bottom of the electrofrogger and stored it in a lidded bucket. We then continued around the perimeter of the wetland removing all fully formed bullfrogs observed. We continued doing laps around the wetland until no more bullfrogs were observed, keeping track of which lap each frog was captured. At the end of the night we used digital calipers to measure snout to vent length (SVL) and determined the sex of each bullfrog captured and then euthanized frogs with several drops of clove oil diluted in water. We conducted bullfrog removal at least three times in each wetland over the course of the summer (Appendices 3 and 4).

Figure 3: IDFG wildlife technician Steven Jenson measures a bullfrog

Disease testing

We tested the first ten adult bullfrogs encountered at each focal removal site for the amphibian chytrid fungus (Batrachochytrium dendrobatidis [Bd]), a widespread pathogen that is hypothesized to be the cause of mass mortality in some amphibian populations (Daszak et al. 2003). To avoid contaminating disease samples, we placed all tested bullfrogs in their own gallon Ziploc bag and used new vinyl gloves for each individual. We used fine tip swabs from Advantage Bundling/Medical Wire Co. (catalog number MW113) and gently swabbed the ventral surfaces of the skin approximately 20-30 times, targeting the pelvic patch, ventral thighs, and toe webbing. Swabs were stored in vials without ethanol and were frozen for storage. Swabs were analyzed at the Amphibian Disease Lab at the San Diego Zoo using PCR.

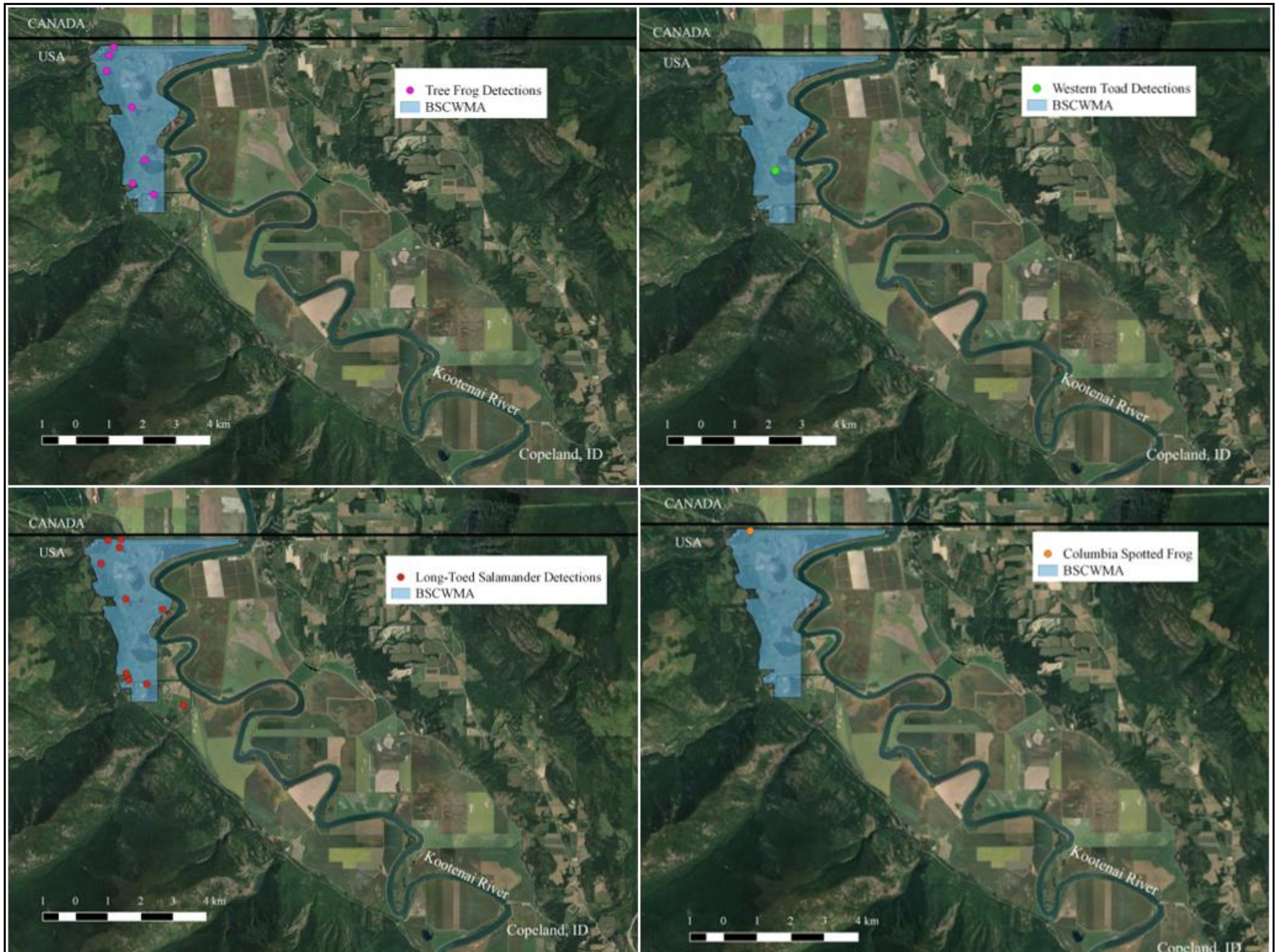
RESULTS

Amphibian Surveys

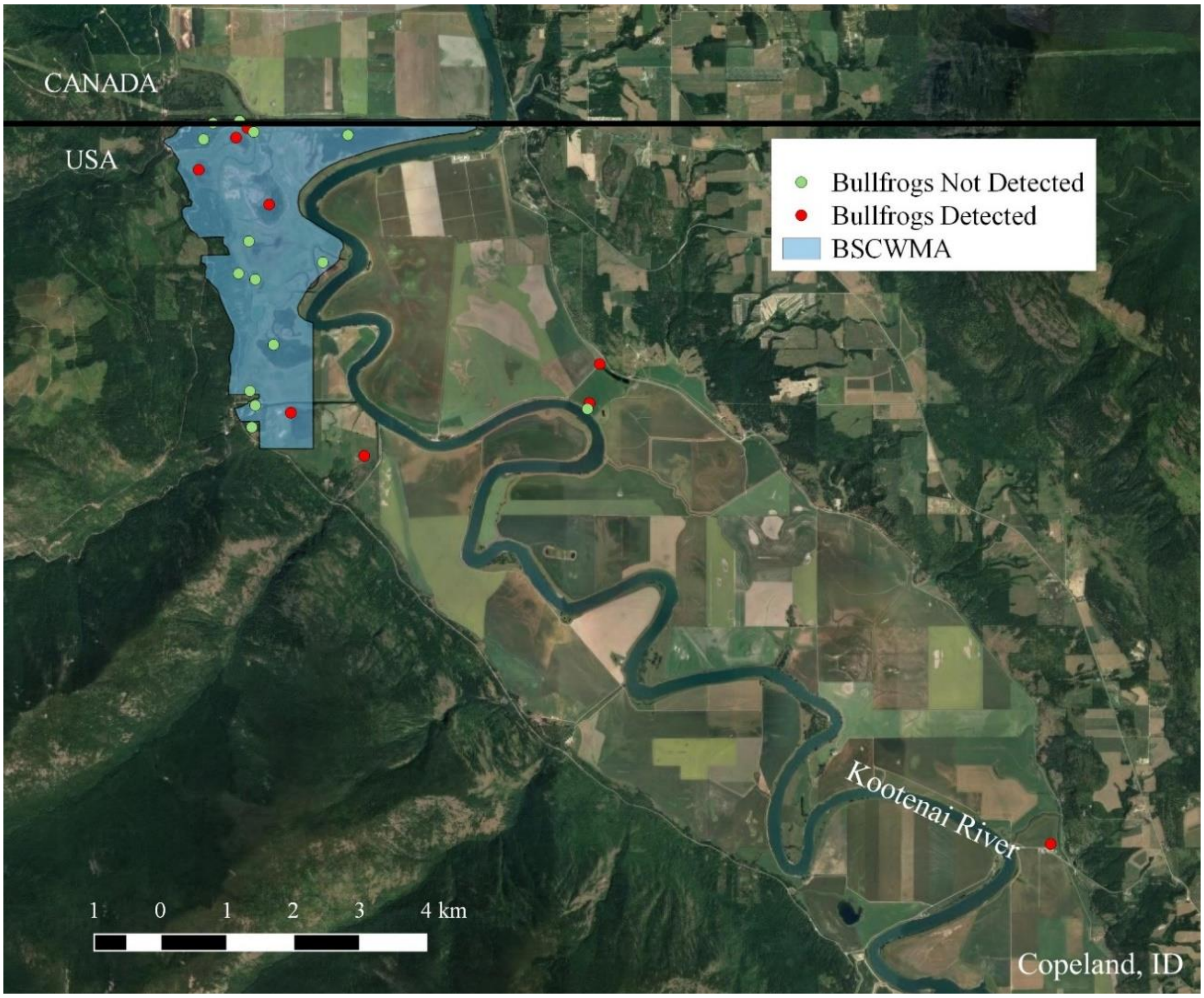
We identified a total of 38 wetlands in our study area and conducted amphibian surveys at 23 wetlands. Of the 21 wetlands located on private land, we obtained permission to survey a total of six. Of those that we didn't get permission to survey, we contacted landowners but were refused permission to survey seven and we were unable to contact the owners of eight wetlands. We surveyed all distinct waterbodies on BSCWMA, a total of 17 wetlands (Map 1, Appendix 5).

Figure 4: Photos of two common amphibian species in the Kootenai Valley, a long toed salamander larva on the left and a Pacific tree frog metamorph on the right.

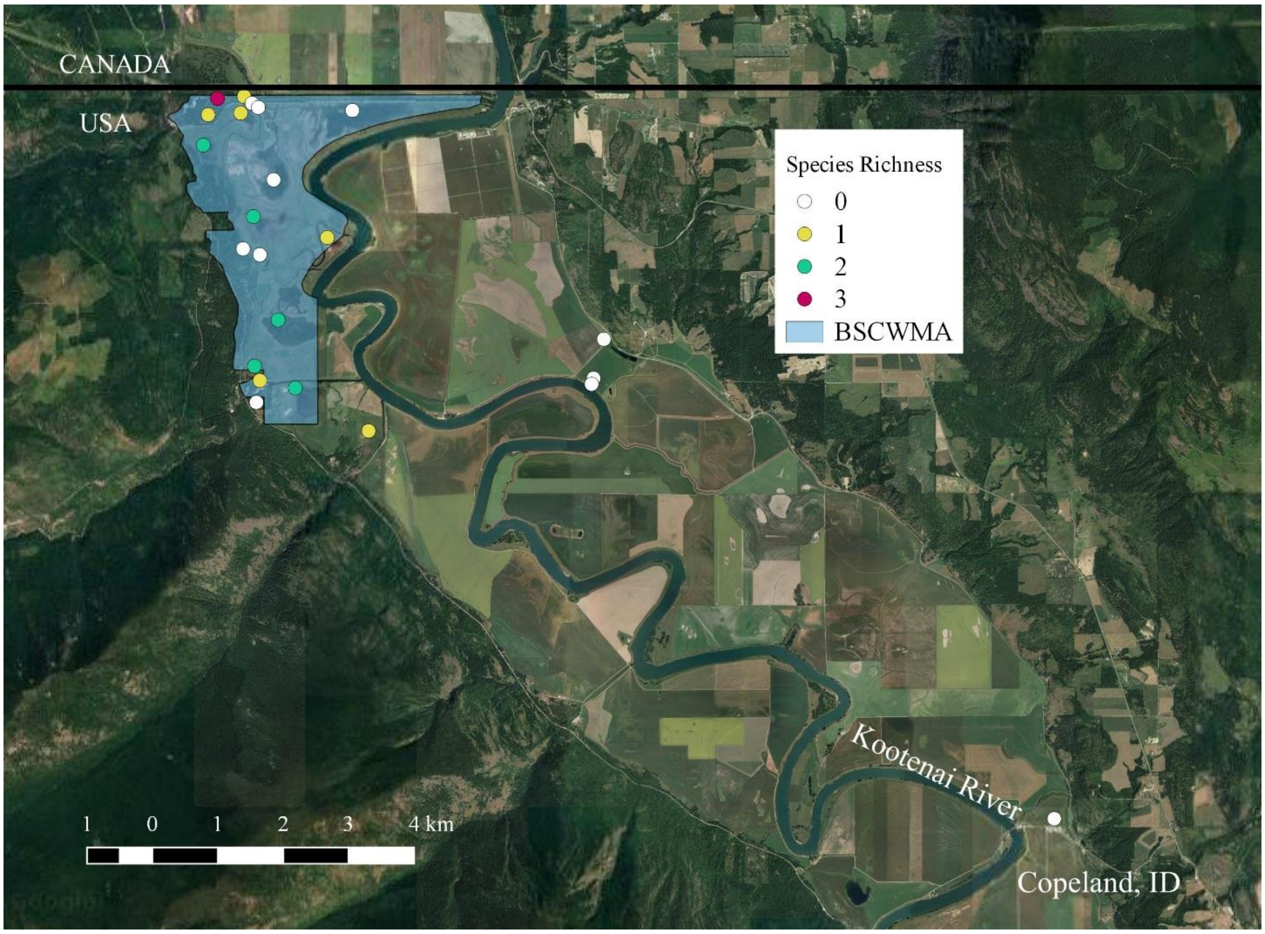
We detected all four common, native, pond breeding amphibian species during our dip net surveys (Table 1, Map 2). Long-toed salamanders and Pacific tree frogs were detected most often, at ten and seven wetlands, respectively. Columbia spotted frogs and western toads were only detected at one wetland each. Native amphibian species richness ranged from zero to three amphibian species per wetland (mean = 0.83).Surprisingly, we did not detect bullfrog larvae at any wetland in the study area during our dip net surveys. However, we did detect bullfrog adults either visually or audibly in nine wetlands (Map 3). Because their calls carry long distances, it was often difficult to pinpoint the location of bullfrog calls, so some of these detections may have been from the same wetland. Bullfrogs were exclusively detected in wetlands with maximum depth greater than 1.5 m. Painted turtles and common garter snakes were detected in five wetlands each (Table 1).



Map 2: Native amphibian larvae detections from dip net surveys in 2017



Map 3: Adult bullfrog detections (auditory or visual) during amphibian surveys. Bullfrog larvae were not detected during dip net surveys.



Map 4: Number of species of native amphibians detected at each wetland.

Table 1: Species detected during wetland surveys in 2017. Species names are abbreviated; PT = Painted Turtle, GS = common garter snake, BULL = American bullfrog, CSF = Columbia spotted frog, LTS = long-toed salamander, TREE=Pacific tree frog, WT = western toad. Bullfrog site indicates whether or not a site was a focal bullfrog removal pond.

Wetland	Landowner	Bullfrog Site	PT	GS	BULL	CSF	LTS	TREE	WT
W166A	IDFG	No	0	0	0	0	0	1	1
W166B	IDFG	No	0	0	1	0	1	1	0
W166D	IDFG	No	0	0	0	0	1	0	0
W166F	IDFG	No	1	0	0	0	1	1	0
W970A	IDFG	No	0	1	1	0	1	0	0
W970B	IDFG	No	0	0	1	0	1	1	0
W970C	IDFG	No	0	0	0	0	0	0	0
W970D	IDFG	No	0	0	1	0	0	0	0
W970E	IDFG	No	0	0	0	0	1	1	0
W970F	IDFG	No	1	0	0	0	1	0	0
W970G	IDFG	No	0	0	0	0	1	0	0
W970I	IDFG	No	0	0	1	0	0	0	0
W970J	IDFG	No	0	0	0	1	1	1	0
W970K	IDFG	No	0	0	0	0	0	1	0
W970L	IDFG	No	0	1	0	0	0	0	0
W970M	IDFG	No	1	1	0	0	0	0	0
W970O	IDFG	No	0	0	0	0	0	0	0
W1010A	Private	Yes	1	1	1	0	0	0	0
W1010C	Private	No	0	0	1	0	0	0	0
W1010D	Private	No	0	0	0	0	0	0	0
W1057A	Private	Yes	1	1	1	0	0	0	0
W166C	Private	No	0	0	0	0	0	0	0
W166E	Private	Yes	0	0	1	0	1	0	0

Bullfrog Removal

We removed a total of 50 bullfrogs (8 male, 42 female) from three wetlands over nine visits. Bullfrogs ranged in size from 48 mm SVL to 166 mm SVL, with different size distributions at each wetland (Figure 5). W166E contained many smaller, juvenile frogs, while we only removed three large adult frogs from W1010A. W1057A contained frogs that spanned the entire size range.

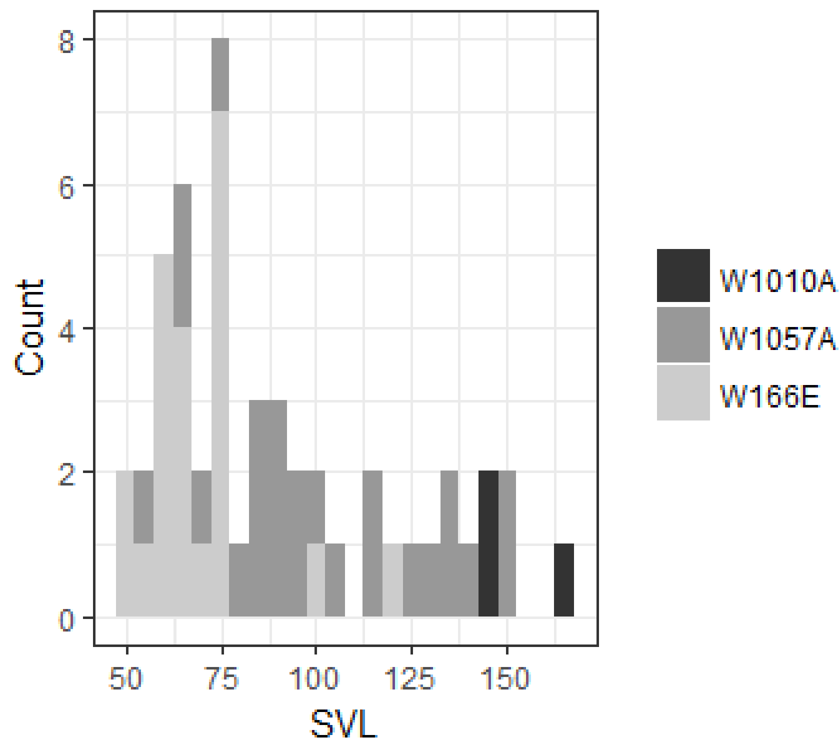


Figure 5: Size distribution of bullfrogs removed from each site.

Efficacy of bullfrog removal varied by site (Figure 6). While we were unable to estimate total abundance of bullfrogs and detection probability due to low numbers of captures at each site, habitat characteristics were important in our ability to locate and shock frogs. For example, at W166E, we removed 15 frogs on the first visit, 7 on the second visit, and 0 on the third visit, suggesting that electrofrogging was successful at reducing the population size considerably. W166E was a relatively small site, and we were able to access all parts of the wetland. In contrast, at W1057A, we removed 7 frogs on the first visit, 9 on the second, and 9 on the third. This site contained extensive woody debris, limiting our ability to access frogs and allowing them to escape more easily.

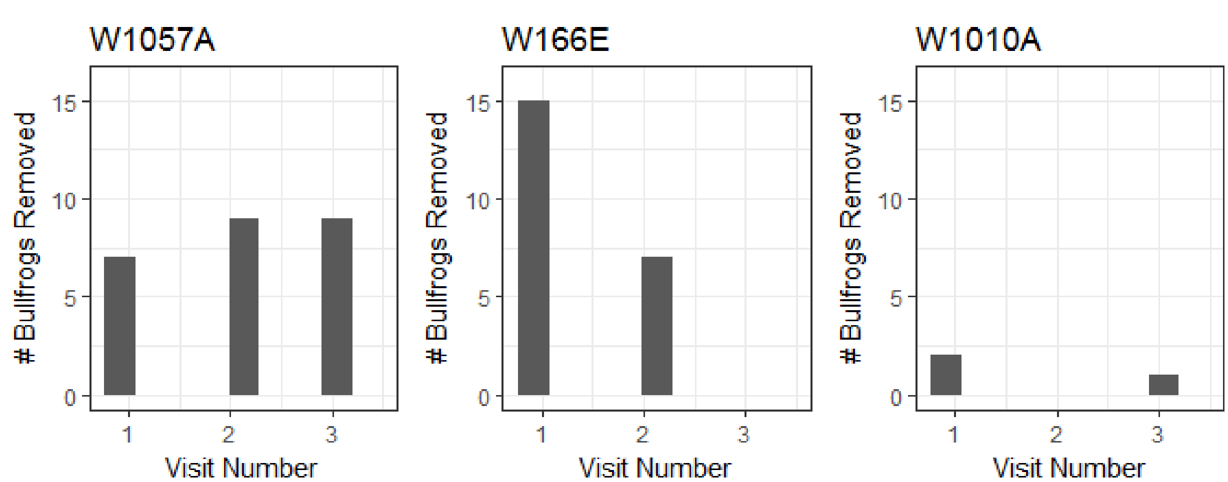


Figure 6: Number of bullfrogs removed from each site on each visit.

Disease

We tested 23 adult bullfrogs from three wetlands for Bd. Of these, 6 were determined to be Bd positive, 3 were equivocal, and the remaining 14 were negative. At least one bullfrog from each site came back as positive, indicating that Bd is likely widespread but occurring at low density in the Kootenai Valley (Table 2).

Table 2: Bd results for each bullfrog tested in 2017

Wetland ID	Sample ID	Species	Bd	Date Collected
W1010A	W1010AV1BULLBDA	American Bullfrog	Equivocal	6/22/2017
W1010A	W1010AV1BULLBDB	American Bullfrog	Positive	6/22/2017
W1010A	W1010AV3BULLBDC	American Bullfrog	Equivocal	7/19/2017
W1057A	W1057AV1BULLBDA	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDB	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDC	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDD	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDE	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDF	American Bullfrog	Negative	7/17/2017
W1057A	W1057AV1BULLBDG	American Bullfrog	Positive	7/17/2017
W1057A	W1057AV2BULLBDH	American Bullfrog	Negative	7/25/2017
W1057A	W1057AV2BULLBDI	American Bullfrog	Negative	7/25/2017
W1057A	W1057AV2BULLBDJ	American Bullfrog	Negative	7/25/2017
W166E	W166EV1BULLBDA	American Bullfrog	Positive	7/6/2017
W166E	W166EV1BULLBDB	American Bullfrog	Negative	7/6/2017
W166E	W166EV1BULLBDC	American Bullfrog	Equivocal	7/6/2017
W166E	W166EV1BULLBDD	American Bullfrog	Positive	7/6/2017
W166E	W166EV1BULLBDE	American Bullfrog	Positive	7/6/2017
W166E	W166EV1BULLBDF	American Bullfrog	Positive	7/6/2017
W166E	W166EV1BULLBDG	American Bullfrog	Negative	7/6/2017
W166E	W166EV1BULLBDH	American Bullfrog	Negative	7/6/2017
W166E	W166EV1BULLBDI	American Bullfrog	Negative	7/6/2017
W166E	W166EV1BULLBDJ	American Bullfrog	Negative	7/6/2017

DISCUSSION

We were surprised at the lack of detection of bullfrog reproduction (eggs, larvae, or metamorphs) at any of our surveyed wetlands, even though adults were heard or seen at nine wetlands. Although bullfrog larvae have been detected in the study area in recent years (Lucid 2015), this suggests support for our hypothesis that bullfrogs have only recently invaded the Kootenai Valley and have yet to become fully established. Additionally, our surveys were not designed to account for detection probability so these results likely underestimate the distribution of native amphibians and bullfrogs. Many of the wetlands that we surveyed were dominated by thick reed canary grass and cattails, which likely reduced our ability to detect amphibian larvae, especially when they occurred at low density. Doing night-time callback surveys for adults may be a better way to identify additional wetlands to target for bullfrog removal. Bullfrogs were detected in the restored wetland cells on BSCWMA, but the large size and thick vegetation in these sites would make removal challenging. In colder climates, including northern Idaho, bullfrogs require permanent water to successfully reproduce because larvae are unable to complete metamorphosis in a single season, so removal efforts should focus on these waterbodies.

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We are appreciative of Sean Sweeny who facilitated the loan of an electrofisher from the US Fish and Wildlife North Idaho Field Office. Stan Orchard provided very helpful electrofrogging instruction. The San Diego Zoo Amphibian Disease Laboratory provided excellent disease testing services. David Moskowitz provided excellent photographs of north Idaho amphibians. Scott Rulander of GemVision Productions produced an outstanding short film on the bullfrog removal project.

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APPENDIX 1: IDAHO PANHANDLE WETLAND SURVEY – PROTOCOL 2017

SURVEY

1) Approach wetland quietly and scan for turtles as you approach
2) Write the wetland number and 'begin' on the laminated card. Photograph wetland from aspect which best shows its character. Take waypoint and compass bearing of wetland photo.
3) While at the wetland keep an eye out for, and take note of, target non-amphibian species
4) If there are two observers available, survey the wetland in opposite directions so that each person surveys half the wetland.
5) Turn on GPS track before beginning survey.
6) Dip net and visually search along wetland shoreline and record each amphibian species and development stage you detect.
7) Estimate the number of each species you detect. If <10 individuals, count each one. If 10-100 individuals estimate to the nearest 10 (i.e. 20, 30, 40...). If there are more estimate '100s' or '1000s'. Don't just count what's in the net; count all the amphibians you see.
8) Collect 5 individual animals of each species detected in zip top bags partially filled with water (make sure adults have access to air for breathing). Preferentially collect adults, then fully formed metamorphs, then larval stage individuals.
9) **Photographs:** Photograph 1 adult and 1 larval stage individual from each species. Take 3 photographs of each animal selected for photography. Place animal in photo booth and take a dorsal, ventral, and lateral view photo. Label as directed below.
10) Collect a Bd and tissue sample from each adult or fully formed juvenile collected. Collect a tissue sample (but not Bd) sample from each collected larvae. Record SVL length of each fully formed animal sampled.
11) **Bd Samples**: Follow protocol outlined below.
12) **Tissue Samples:** Clip one digit (digit 3 or 5 is best) from hind foot of adult, collect whole small tadpoles, clip tail from large tadpole, or collect single egg. Place tissue sample into dry coin envelope (do not place in a vial) and seal the envelope. *Fill sample envelopes out completely (including life stage).* Between each sample wipe scissors with cotton (your shirt) then with a bleach wipe. Spread coin envelopes out to dry at room temperature then store at room temperature.
13) If bumblebees are encountered during survey spend 10 minutes attempting to capture bumblebee and put in zip lock bag. Photograph the dorsal side of the bumblebee in bag.
14) Draw a diagram of the wetland which includes relevant habitat: submerged logs, emergent vegetation, talus slopes, cliffs, inlet, and outlet. Record habitat covariates on datasheet.
15) Write the wetland number on laminated 'end' card and take a photo.
16) If additional wetlands are encountered beyond what's on the list: Photograph and waypoint the wetland as protocol dictates. If time permits, complete a survey of the wetland. If time does not permit, partially fill out a data sheet with a wetland name, photoID, and photo bearing.

Photo ID *Photo IDs and Sample IDs should correspond
Wetland: W, cell #, P: The photo of the wetland from wetland 867A: **W867AP**
Plant/Bee: W, cell #, P, letter: bee photo after pictures have been taken of two plants wetland 867A: **W867APC**
Amphibian: W, cell #, A, Sample ID, P, photo#: The third photograph of the fourth amphibian to be sampled at wetland 867A: **W867AADP3**
Sample ID
Tissue: W, cell #, A, letter: The fourth amphibian to be sampled at wetland 867: **W867AD**
BD: W, cell #, BD, letter: second frog swabbed at wetland 867: W867

HYGIENE, ANIMAL HANDLING, AND EQUIPMENT CLEANING

1) When you arrive at the wetland wash hands with biodegradable soap in a spot the soap will not run off into the water (like on the road by the truck) Do not apply additional sunscreen or bug spray unless you wash your hands again.

2) Handle adult amphibians with clean wet hands. Observe tadpoles and transport other amphibians in plastic zip top bags. Do not handle tadpoles directly unless collecting tissues. Discard bags after one use.

3) Clean mud, snails, and plants from equipment with stiff brush at site. Rinse in wetland.

4) At truck spray all equipment which touched wetland with Quat (.5 oz/ gallon) (preferred) or bleach (10%). Spread equipment out to dry in back of truck while traveling to next site.

BD SAMPLING

1) **Sample only the first 5 fully formed adults (preferred) or juveniles of each species at each wetland.**
2) Start the swabbing procedure as soon as possible after capture, without putting amphibians in a container together or in water that another amphibian has just been held in.
3) Wear a fresh vinyl glove for each amphibian handled to prevent transfer of chytid to the swab sample between amphibians or from stream water, etc.
4) Open the swab package and tube on a stable surface if working alone, or have another person handle them. Do not touch or get water onto swab tip or inside of tube during handling.
5) Pick up the amphibian from the top and try to minimize touching the animal's underside during handling.
6) Using a single swab, gently swab the ventral surfaces of the skin approximately 20-30 times. Target areas to include the pelvic patch (5 passes with the swab), ventral thighs (5 passes each side with the swab) and toe webbing (5 passes on each foot). It is not necessary to swab the dorsal skin surfaces.
7) Place swab inside empty tube without brushing it against the outside or rim of the tube. After swab tip is about half way inside tube, bend swab handle against rim of tube to snap it off.
8) Screw the cap on the tube firmly (but do not over tighten).
9) Label the side and top of the tube with sample ID. Place tube in coin envelope and fill envelope out completely (make sure to include species name, date collected, and sample ID).
10) To prevent spreading disease, dispose of swab stick and glove in a designated, sealed bag.
11) **Do not let sample get extremely hot (like in the cab of your truck). Put samples in freezer at Smith creek at the end of each day. Samples must be kept frozen.**

APPENDIX 2: IDAHO PANHANDLE WETLAND SURVEY – Datasheet 2017

Bullfrog Detected? (Y/N) _____
Stage (s):
How? (circle): Heard, seen, handled

Idaho Panhandle Wetland Survey – Data Sheet - 2017

**Create track of wetland survey. All waypoints should be in WGS84 (decimal degrees)

Wetland ID_________ MBI Cell:______ Date (e.g. 15 June 2014):_____________ Start Time:_______ Observer(s):______
Visit number: _______________ Track ID:____(WetlandID, Date, T)
Directions to Wetland:

Landowner:____________________ Phone #(if Private Individual): __________________ Email:____________________

Site is (circle one): Wet or Dry Search Type (circle one): Full Perimeter, Partial Perimeter (reason)________

Photo Waypoint: __________ __________, Bearing: ____°Wetland Photo ID (W, cell#, P):_______

Weather (circle one): Sunny, Mostly Sunny, Partly Sunny, Overcast, Light Rain, Heavy Rain, Snow

Wetland Type (circle one): Natural Pond, Ephemeral Natural Pond, Constructed Pond, Modified Natural Pond, Lake, Stream , Channels Near Stream, Puddles, Emergent Wetland, Meadow, Forest-No Wetland, Not-Forested-No Wetland, Beaver Pond, Other: _____________

Surrounding Vegetation Type: Forest, Cattle Grazing, Farming, Natural Grassland, Natural Riparian, WMA

Dominate Vegetation Type (circle one): sedges/rushes, cattails, willows, reed canary grass, bare ground, other ________

%open water (circle one) : <25%, 25-50%, 50-75%, >75%

Max. Depth (circle one): <0.5 M, 0.5 – 1.5 M, >1.5M

Wetland Diagram

Wetland Perimeter (m)____

Amphibians Detected

Species	Stage	Abundance

Samples Collected
Tissue sample ID: W, Cell#, A, Letter
BD sample ID: W, Cell#, BD, Letter
*mm Fully formed only

Species	Stage	A or Juvy	Bd ID	Tissue ID	Photo Y/N

Abundance Categories
1, 2, 3, 4, 5, 6, 7, 8, 9
10s (estimate to nearest 10, 20, 30, 40...
100s
1000s

Stages
EGG: Eggs
NL: No Legs
BL: Beginning Legs
LEGS: 4 legs + Tail
AJ: Fully formed juvy or adult.
AJF: AJ Fledging - only use when mass of juvys is leaving pond. Usually late summer.

Observed - record number detected (0 if not detected) - do not take photo

Painted Turtle______ Snapping Turtle______

T. Garter Snake:______ (red dorsal spots) C. Garter Snake:______ (no red dorsal spots)

Hoary Marmot:____ Golden Mantled G.S.______

Yellow-bellied Marmot:______ Pika:__________

Species Codes:
Bullfrog: **BULL**
Columbia Spotted Frog: **CSF**
Long Toed Salamander: **LTS**
Tree/Chorus Frog: **TREE**
Western Toad: **WT**
Northern Leopard Frog: **NLF**
Tailed Frog: **TAIL**
ID Giant Salamander: **GIANT**

Bumblebee Observed?(Y/N)______
PhotoID: W, Cell#, P, letter

Photo ID

Fish Observed? (Y/N) ______

Fish Species (if known) ____________

Observed - Yes or No
do not take photo

Spotted Knapweed:______

Devil's Club:______

Whitebark Pine:______

Tansy: __________

Sundew Observed - Yes or No
Sundew:______
PhotoID: W, Cell#, P, letter

Latitude	Longitude	Photo ID

APPENDIX 3: BULLFROG REMOVAL PROTOCOL 2017

Conduct work only under the following conditions:

- After sunset, when it is fully dark
- When nighttime low air temperature is predicted to be ≥ 35 degrees F and there is no precipitation and winds are predicted to be calm.

Electroshocker Settings: 135 Volts 55Hz Frequency 20% Duty Cycle

Personnel

Two people should work together from a boat during each removal event. One person paddles the boat while the other operates the shocker.

1. Record waypoint directly from GPS (decimal degrees), start air/water temperature (Celsius), and start time (military).
2. Paddle around the perimeter of the wetland while both people shine bright lights ahead. When a fully formed bullfrog is observed paddle slowly toward it while maintaining the beam of the light pointed at the frog.
3. Shock the frog and remove from the water. Confirm species is bullfrog and return to water if it is not a bullfrog. Do not return bullfrogs to the water.
4. Continue perimeter search and process bullfrogs and end of first lap.
5. Place animal in 5 gallon bucket with screw top lid. Place first 10 animals in 1gal zip tops.
6. Swab the 1st 10 bullfrogs encountered at each focal site for Bd. For each swabbed frog, use a clean pair of gloves and thoroughly swab the belly, legs, and feet. Swabs should be labeled with site name, date, and species.

Example: First bullfrog swabbed for Bd during the first visit to wetland 1412A on July 18 2017

W1412AVIBULLBDA
18 July 2017


Male


Femal

7. Identify frog as male (tympanic membrane much larger than eye) or female (tympanic membrane about same size as eye).
8. Use digital calipers to measure (mm) snout to vent length (SVL) from tip of animals nose to the opening of the cloaca.
9. Take a toe clip tissue sample from first 10 bullfrogs.
10. Repeat perimeter repeats of pond until no more fully formed bullfrogs are encountered. Record stop time (military) and total number of laps completed.
11. After exiting boat fill the 5 gallon bucket with enough water to cover bullfrogs and add several drops of clove oil. Replace screw top lid and leave bucket overnight.
12. In the morning drain water from euthanized bullfrogs. Dispose of carcasses in woods.

HYGIENE and EQUIPMENT CLEANING

1) Wash hands away from wetland with biodegradable soap before beginning work. Handle adult amphibians with clean wet hands or gloves.
2) After work is complete clean mud, snails, and plants from equipment with stiff brush at site. Rinse in wetland.
3) Spray all equipment that touched wetland with Quat solution (.25oz/gallon). Spread equipment out to dry in back of truck while travelling to next site or dry in sun the next day.

APPENDIX 4: BULLFROG REMOVAL DATASHEET 2017

Wetland ID__________ Cell: ______ Date (e.g. 15 June 2017):_____________ Observer(s):_____________
Visit Number ___________________
Wetland Waypoint: ___________ ____________ Wetland Name (e.g. 'Nancy's Pond'): ________________
Weather (circle one): Clear, Mostly Clear, Partly Cloudy, Overcast, Light Rain, Heavy Rain, Snow
Start Time: _______ Start Air Temperature: ________°C Start Water Temperature: ________°C
End Time: _______ Laps around perimeter ___________
Bullfrog Captures

BF#	Gender	SVL (mm)	Bd? (y/n)	Tissue? (y/n)	Lap #	BF#	Gender	SVL (mm)	Bd? (y/n)	Tissue? (y/n)	Lap #
1						21					
2						22					
3						23					
4						24					
5						25					
6						26					
7						27					
8						28					
9						29					
10						30					
11						31					
12						32					
13						33					
14						34					
15						35					
16						36					
17						37					
18						38					
19						39					
20						40					

Total # Females: ________________ Total # Males: ___________________

Total # Captured Bullfrogs (F+M): ________________ Total # Missed Bullfrogs by Lap: ___________

Bd sample names (range) ____________________ Total # Bd Samples: _____________
Tissue sample names (range) _________________ Total# Tissue Samples: ___________

HOW TO LABEL BD SWABS: Wetland ID, Visit number, species, BD, letter
Example: W1412V1BULLBDA- the first bullfrog sampled for bd at the first visit of wetland 1412

HOW TO LABEL Tissue Samples: Wetland ID, Visit number, species, letter
Example: W1412V1BULLA- the first bullfrog sampled for tissue at the first visit of wetland 1412

Draw diagram of pond including bullfrog capture (B) and miss (M) locations.

APPENDIX 5: Locations of wetlands in study area

Wetland	Longitude	Latitude	Bullfrog Site	Permission	Surveyed 2017
W1010A	-116.481	48.96724	Yes	Yes	Yes
W1010C	-116.483	48.96202	No	Yes	Yes
W1010D	-116.483	48.96125	No	Yes	Yes
W1057A	-116.389	48.90324	Yes	Yes	Yes
W166A	-116.547	48.96981	No	WMA	Yes
W166B	-116.543	48.96074	No	WMA	Yes
W166C	-116.551	48.95881	No	Yes	Yes
W166D	-116.551	48.96172	No	WMA	Yes
W166E	-116.528	48.955	Yes	Yes	Yes
W166F	-116.552	48.96364	No	WMA	Yes
W970A	-116.554	48.9974	No	WMA	Yes
W970B	-116.562	48.99311	No	WMA	Yes
W970C	-116.532	48.99774	No	WMA	Yes
W970D	-116.548	48.98849	No	WMA	Yes
W970E	-116.552	48.98359	No	WMA	Yes
W970F	-116.537	48.98079	No	WMA	Yes
W970G	-116.554	48.9996	No	WMA	Yes
W970I	-116.552	48.99868	No	WMA	Yes
W970J	-116.559	48.99931	No	WMA	Yes
W970K	-116.561	48.99716	No	WMA	Yes
W970L	-116.554	48.97928	No	WMA	Yes
W970M	-116.551	48.9785	No	WMA	Yes
W970O	-116.551	48.99814	No	WMA	Yes
W1009A	-116.48	48.92992	No	No	No
W1009B	-116.473	48.92949	No	No Contact	No
W1009C	-116.472	48.93061	No	No Contact	No
W1009D	-116.473	48.92295	No	No	No
W1009E	-116.447	48.93006	No	No Contact	No
W1009F	-116.434	48.89639	No	No	No
W1009G	-116.432	48.89167	No	No	No
W1010B	-116.476	48.96663	No	No Contact	No
W1010E	-116.494	48.96205	No	No	No
W1010F	-116.459	48.96062	No	No Contact	No
W1010G	-116.489	48.94333	No	No Contact	No
W1010H	-116.494	48.94381	No	No Contact	No
W1010I	-116.49	48.93537	No	No	No
W1057B	-116.39	48.90072	No	No	No
W970N	-116.499	48.99444	No	No Contact	No

Project 3a—McCall SubRegion SWAP Implementation

Objective 1b: Deploy up to 20 environmental sensors along transects surveyed for alpine species. University of Idaho were proposing to classify images from remote cameras generated by the Multispecies Baseline Initiative (MBI) in north Idaho to determine if they could develop algorithms to identify fractional snow coverage from camera images (Marshall and Link 2017).

Variability in snow disappearance date due to climate, vegetation, and topography: Leveraging novel data for improved understanding of snowpack dynamics and products for wildlife management.

DRAFT PROPOSAL

Title: Variability in snow disappearance date due to climate, vegetation, and topography: Leveraging novel data for improved understanding of snowpack dynamics and products for wildlife management

Authors: Adrienne Marshall and Timothy Link

Abstract: The timing of snow disappearance is a critical metric that affects wildlife, ecosystems, and human uses of water resources, but it is difficult to characterize at fine scales in complex terrain. One particularly important wildlife species that is sensitive to spring snow disappearance timing is the wolverine (*Gulo gulo*). We propose to leverage a unique set of imagery from wildlife cameras obtained by the Idaho Department of Fish and Game (IDFG) to assess the spatial variability of snow disappearance date (SDD) and to develop and test a physically-based model of SDD in mountainous regions. This model will be used to develop a gridded estimate of SDD and to test sensitivity of SDD to topographic characteristics, climate change, forest density, and interactions between these factors. This proposal was co-developed with IDFG to produce information about SDD distribution and sensitivity to climate change to support wolverine and other wildlife habitat management while advancing widely applicable knowledge of the processes that govern SDD in complex terrain.

Introduction

The spatial variability of snow in mountainous terrain and attendant complexities of accumulation and melt timing are of critical importance for water resources management, ecosystem function, and for wildlife populations (Barnett et al 2005). Snow depth distribution and melt timing vary with topography, climate, and vegetation density, and impacts of these factors and their interactions with each other vary across catchments (e.g., Grünewald et al 2013, Ellis et al 2013, Harpold et al 2015, Dickerson-Lange et al 2017). Moreover, as temperatures increase due to anthropogenic climate change, projections suggest less snow accumulation and earlier melt dates, along with changing effects of vegetation on snowpack dynamics (Lundquist et al 2013, Cristea et al 2014).

The distribution of snow and the timing of its disappearance are of critical importance for wildlife. In particular, wolverines are a Tier 1 Species of Greatest Conservation Need in Idaho (IDFG 2017), and rely on spring snow for denning and reproduction (IDFG 2016). Wolverines have been associated with reliable spring snow cover at a depth of at least 1 m (Magoun and Copeland 1998), and persistent spring snow cover (Aubry et al 2007, Copeland et al 2010, McKelvey et al 2011, Inman et al 2012), though recent work has suggested that wolverines may be more flexible with regards to snow habitat needs than previously assumed (Webb et al 2016). Models of spring snow extent and depth under climate change project a contraction in wolverine habitats within the contiguous United States (Peacock 2011), while the incorporation of fine-scale processes, such as cold-air pooling and topographic shading, suggests greater habitat availability than relatively coarse models (Curtis et al 2014). The IDFG Management Plan for the Conservation of Wolverines in Idaho 2014-2019 identifies the need to "work with researchers to develop regionally downscaled global climate models … and associated climate indicators (e.g., snow data) to support a wolverine vulnerability assessment" (IDFG 2014). In this project, ***we will support this urgent management need by developing novel assessments of spring snow persistence under climate change in critical wolverine habitat***.

Despite the social and ecological importance of snow and the complexity of its distribution, ground-based monitoring in mountainous regions is sparse and does not constitute a representative sample (Strachan et al 2016). Remote sensing products exist but have a variety of shortcomings; they may not be appropriate in complex terrain, be confounded by forest cover, have low spatial or temporal resolution, or extend only over individual watersheds (Painter et al 2016). Spatially distributed data that provides insight into snow accumulation and melt processes in complex terrain is extremely valuable but severely limited at fine scales in complex terrain.

Between 2010 and 2014, IDFG developed detailed wildlife surveys through the Multi-Species Baseline Initiative (MBI). The sites were developed through a systematic stratified sampling of a 5km x 5km grid in the Northern Idaho panhandle, with extensions into Washington, Montana, and British Columbia (Lucid et al 2016). Almost 500 sites included bait station cameras that, in addition to gathering information about wildlife, effectively gather information about snowpack. The goal of this project is to leverage the information collected by these cameras in order to improve knowledge about: (1) fine-scale variability of snow disappearance timing throughout the region, (2) physical processes that govern this spatial variability, and (3) the independent and combined effects of forest density and warming temperatures on distribution and persistence of spring snow. These goals will be achieved through image analysis, development of a fine-scale physically based model and model testing through image data, climate sensitivity tests of the developed model, and application of the model across the northern Panhandle region. This project will improve the characterization of snow disappearance timing and its sensitivity to climate change as it relates to wolverine habitat throughout northern Idaho while advancing broadly applicable process-based understanding of the interactive effects of vegetation, topography, and climate on snow refugia.

Methods

The proposed workflow to accomplish the objectives of this proposal is depicted in Figure 1. Supervised image classification methods will be used to assess fractional snow cover in images gathered through the MBI. Candidate image classification algorithms include relatively simple methods, such as logistic regression or random forests with pixel values as independent variables and classification as snow/not snow as a dependent variable, as well as more complex methods, such as support vector machines. Image classification methods will be tested to maximize accuracy while minimizing computational complexity. For each site and year, snow disappearance date (SDD) will be calculated based on image classifications. Topographic, vegetative, and climatic conditions for each site will be determined using digital elevation models, climate layers, and high-resolution remotely sensed imagery (e.g. Quickbird, Planet) to estimate LAI or canopy cover.

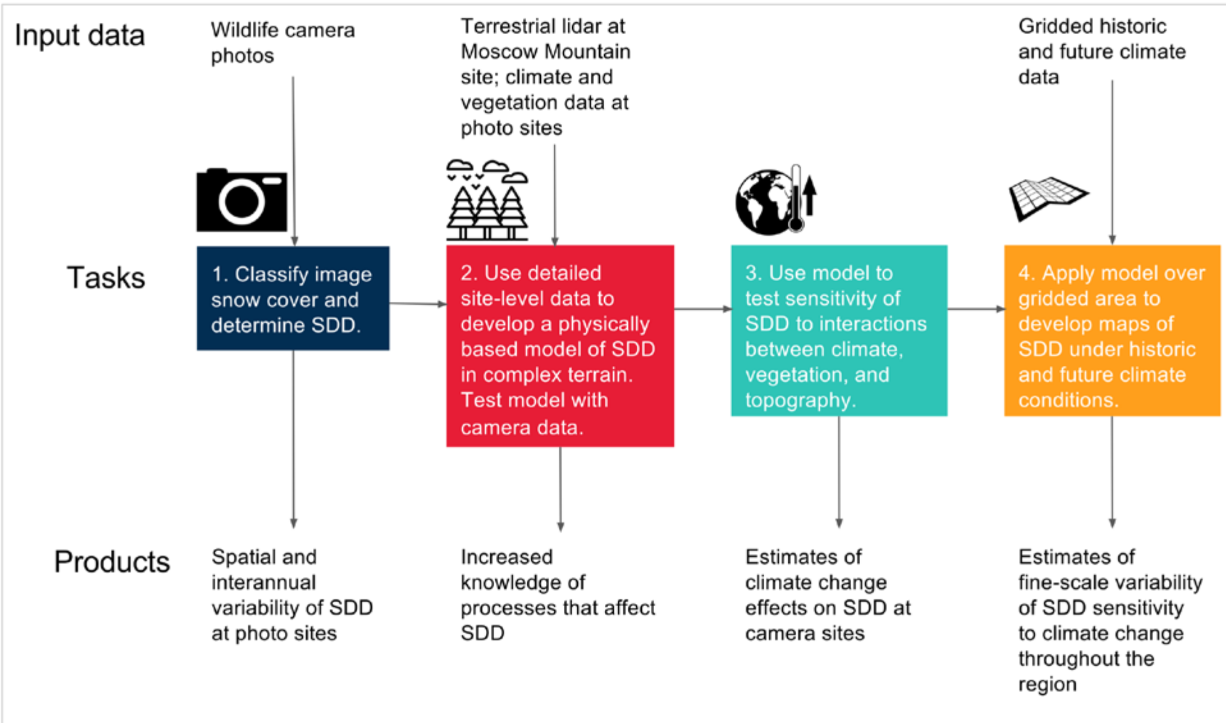

Figure 1. Components of analysis, input data, and products that contribute to both fundamental science needs and management objectives.

At an experimental forest thinning site in the University of Idaho Experimental Forest (UIEF) on Moscow Mountain, we will use terrestrial LiDAR scanners to gather high spatial and temporal resolution snow accumulation and melt data at two forested sites of different densities, along with relevant meteorological and site characteristic data. LiDAR data at this site will be paired with a camera similar to those in the network of wildlife cameras used in the MBI, such that the UIEF acts as a data-rich natural laboratory for testing methods of extracting information from photos. UIEF data will also be used to test the performance the Cold Regions Hydrologic Model (CRHM), a physically-based hydrologic model developed for simulation of snow dynamics in complex terrain (Ellis et al 2010, Fang et al 2013) and develop approaches to accurately simulate snow dynamics in discontinuous forests. Observed SDD data from MBI photos will also be used to assess model performance in mountainous regions that comprise critical wolverine habitat.

We will then run climate scenarios to assess the relative sensitivity of SDD to warming throughout the region. CRHM will be run with varying topographic characteristics, vegetation density, and climate to determine how each of these variables affect SDD. We will also construct scenarios to test the interaction between forest density and warming temperature to identify conditions under which forest thinning would be most or least likely to buffer SDD against the effects of warming.

Finally, we will apply the model throughout the region using gridded climate, topographic, and vegetation data. This step will yield maps of SDD throughout the region, applied under multiple climate and forest management scenarios to identify regions that may be refugia or that are particularly sensitive.

Expected outcomes and products

This research will yield new understanding of how SDD varies across complex terrain, under different vegetation densities, and in different climates. Several outcomes will result from different stages of this project. The first task, obtaining SDD from photos, will yield point-scale distributed estimates of SDD at a much higher density than is possible with existing networks. The model development task will yield greater insight into the physical processes that control SDD, and the third task will yield information about the sensitivity of SDD to climate change and forest density conditions at the scale of image data. Finally, the fourth task will result in gridded maps of SDD across the region, and their sensitivity to climate change and variable forest density. Each of these outcomes will be integrated into an interactive dashboard that will be available to wildlife managers and other stakeholders. Managers will be able to use the dashboard to identify spring snow refugia, as well as areas that may be particularly sensitive to warming, to prioritize the most efficacious conservation activities.

This work builds on previous research funded by the NWCSC that identified the effects of forest canopy versus open areas on SDD (Dickerson-Lange et al 2017). By leveraging a novel dataset and physically based modeling, this project develops a greater density of observations and more detailed climate sensitivity assessment than was previously possible. The findings of this project will be applicable beyond the immediate region of study in two important ways: first, the development of an automated method to assess SDD from wildlife cameras could be used in any of the many regions in which wildlife cameras are deployed. Second, the incorporation of a physically-based model will provide insight about ecohydrologic processes that are broadly applicable to snow-dominated regions. The outcomes of this research will advance fundamental process-based knowledge while producing actionable science that will immediately be used by managers to support proactive wildlife conservation decisions to in the context of a rapidly changing climate.

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Budget
Budget is attached as Excel spreadsheet.

Budget justification
Salaries: Salaries account for two years of salary for PhD student Adrienne Marshall to conduct research, including image analysis, model development and sensitivity tests, and gridded product development. This rate includes 0.5 FTE for the academic year and 1.0 FTE for summer at the rate recommended by University of Idaho College of Natural Resources for PhD students who have passed preliminary exams. This salary leverages funding from the National Science Foundation Integrative Graduate Education and Research Traineeship (NSF IGERT), which provides two years of salary. One year of salary under IGERT has been used during FY 2017; Marshall completed the bulk of coursework and gained research experience (data analysis, management, hydrologic modeling) on related projects during that period. During the second year of IGERT funding, coursework, proposal, and preliminary exams will be completed, and the first stage of the proposed project will be completed. PI Link will devote 0.5 summer month per year to the project for research supervision and direction.

Fringe benefits: Fringe benefits are calculated per University of Idaho College of Natural Resources guidelines at 25.9% for FY18 for PI Link, and 2.4% for students. Graduate student tuition, fees, and stipend is also included for PhD student Marshall. University of Idaho College of Natural Resources recommends 5-7% annual increase in tuition and fees; a 6% increase has been applied.

Domestic travel: For each year, PhD student Marshall will travel to the American Geophysical Union (AGU) fall meeting to present study findings. Travel budget assumes $600/round-trip flight to San Francisco or Washington, D.C., lodging at $194/night, per diem at $51/day, and $50 for local transportation and parking. Flight and lodging budgets are based on Google Flights and hotel search tools.

Other expenses: Registration fees for the AGU fall meeting, anticipated software upgrades, and computing (hardware resources) will support data analysis and modeling and dissemination of results.

Project 5—Southeast Region SWAP Implementation

Objective 1a: Facilitate 2 meetings among members of the East Idaho Bat Collaborative.

Agenda and minutes 19 December 2017.

Agenda and minutes 11 April 2018.

East Idaho Bat Collaborative Meeting
December 19, 2017
Idaho Falls, ID

Agenda:

- WNS Surveillance—Rita Dixon
  - WNS Prioritization spreadsheet
    - Post hoc steps
- WNS Response Planning update—Rita Dixon
  - Roles of extended team members on WNS Response Plan
- Hibernacula counts 2018
  - Cost/Benefit
  - Scheduling
  - Decontamination
- WNS Surveillance
  - WNS Reporting protocol
  - Priority of actions for WNS surveillance:

Swabbing hibernating bats >> Spring emergence trapping & swabbing >> Environmental/substrate swabbing >> Swabbing bats on the landscape (thru May)

- Surveys of "other" caves in 2018
  - Caves that haven't been surveyed in recent years
  - Caves in which we're unsure of status or use by bats
  - Invertebrate sampling
- Update on Driving Transect Project
- Next meeting date

Attending: Becky Abel (IDFG), Matt Proett (IDFG), Jericho Whiting (BYUI), Todd Stefanic NPS CRMO), Dan Nolfi (FWS), Brenda Pace (INL, Idaho Master Naturalists), Justin Frye (BLM), Jeremy Welch (BLM), Ross Winton (IDFG), Devin Englestead (BLM), Bryan Bybee (INL), Bill Doering (INL), Zannita Fast Horse-Pongah (Shoshone–Bannock Tribes), Jamie Eagle-Speaker (Shoshone–Bannock Tribes)
On the phone: Rita Dixon (IDFG), Devon Green (FS), and Kevin Warner (Idaho Army National Guard)

Minutes:

- **WNS Surveillance—**Rita Dixon

Rita gave context for WNS surveillance and gave an overview of the WNS Surveillance Prioritization spreadsheet. She explained each criterion and how it was scored.

  - Questions:
  - How do we deal with blank fields? *You can still enter the data that you know and the worksheet will still score that site.*
  - Should we use the most recent data or should we take an average of past survey data (i.e., a 10-year average?) *The most conservative method would be to use the highest known count and the highest species diversity. The less conservative method would be to use the most recent count data.*
  - How do we score the human disturbance criterion? *Using the matrix in Table 1 of the "Criteria Reference" workbook, use the highest score. For example even if all*

indicators are at a "1," but the "Road Size" indicator is at level "3," score the human disturbance criterion as a "3."
    - The criterion for the ability to closely observe bats seems to leave out the possibility to trap at the entrance of the cave during spring emergence, in which the bats would be closely observed. Should we consider that when we score this criterion? *Rita will ask Anne Ballmann about this and get back to us.*
    - Relative colony size criterion is Large = ≥21 and small = <21 but the sample size requirements for bat swabs is 25. Should we change the criteria to accommodate this? *No, because if you cannot swab 25 bats you can get environmental samples at the site to fill the rest of the vials, so let's not change the criterion.*
    - Should we lump complexes of caves? (one score for multiple closely associated or connected caves) *If the caves are connected (e.g., Falcon) then you can do this. If they are independent caves, score each separately*.
- **WNS Response Planning update—**Rita Dixon
    - Rita updated the group on the progress of the plan and the proposed timeline. The plan is in skeleton format. After Rita sends out the outline to the Core Team to populate sections, the draft will then go out for review by the extended WNS Response Team. We hope to have the plan finalized by May 2018.
    - **Action Item**: Rita needs information from the extended WNS Response Team:
        - **Roles** (what do you expect your role is in this process? Inventory? Hibernacula counts? Swabbing? Land management? Etc?)
        - **Rabies vaccination status**
        - **Training needs** (e.g., Are you vaccinated but have never handled a bat?)
        - **Scientific collection permit needs**
        - **Geography** (where can you work? Can you travel if necessary?)
- WNS Surveillance
    - Priority of actions for WNS surveillance:

Swabbing hibernating bats >> Spring emergence trapping & swabbing >> Environmental/substrate swabbing >> Swabbing bats on the landscape (thru May)

    - The group discussed when we should think about doing swabbing during spring emergence trapping rather than during hibernation.
    - We have homework to do. We need to run through the prioritization process for all sites (Big Desert, Sand Creek Desert, other IDFG R5 caves, INL, and CRMO)
        - **Action Item**: Justin and Devin will get all caves into prioritization spreadsheet for Big and Sand Creek Deserts (Just caves we have been regularly monitoring)
        - **Action Item:** Becky will run R5 caves through prioritization spreadsheet
        - **Action Item:** Bill and Bryan will run INL caves through prioritization spreadsheet
        - **Action Item:** Todd and Ross will run CRMO caves through prioritization spreadsheet
    - After we all have prioritized, let's get together on a conference call to discuss plans and options.
    - **Action Item:** Becky can collect the various spreadsheets to lump into one document so we can view them all during the conference call (Go To Meeting).

    - Bill can help us with determining timing of spring emergence surveys (Mid-April was discussed as a good time to shoot for)
- Surveys of "other" caves in 2018—Becky Abel
    - Becky is working with Matt and the BLM to prioritize caves that haven't been surveyed in recent years. We have information on sites that were surveyed by Scott and April Earl in late 1990s and early 2000s and haven't been regularly monitored since.
    - We're unsure of status or use by bats at this point.
    - We're planning on conducting some invertebrate sampling as well.
    - Becky plans to visit 5 of these sites in 2018.
- Update on Driving Transect Project—Becky Abel
    - Becky updated the group on the status of the project. Becky received extra funds from the BLM in 2017 to be used for acoustic analysis. Becky contracted with Roger Rodriguez (Zotz Ecological) to analyze data from 2014–2016 acoustic surveys. He should have results back by March. Becky would like to discuss results and next steps with the group in April.
    - The mobile acoustic surveys will continue in 2018. Becky will discuss plans for Idaho Master Naturalists volunteers with Brenda Pace.
- Other discussions
    - Becky has asked Dan Nolfi to give an informal ropes and vertical caving training. Dan and Ross discussed other avenues for vertical training with the local grottos. More information to come soon.
    - Becky threw out the idea of getting Idaho Master Naturalists or student volunteers to conduct bridge surveys for bats. Becky will contact Jericho to chat about this soon.
- Next meeting date April 2018

East Idaho Bat Collaborative Meeting
April 11, 2018
Idaho Falls, ID
<u>Agenda</u>:

- Brainstorm data analysis
- Data gaps discussion
- Problems with the data and how to improve
- Routes and which ones to keep and/or lose
- Plans for the coming summer for Idaho Master Naturalists
- Spring emergence trapping planning

<u>Attending</u>: Becky Abel (IDFG), Matt Proett (IDFG), Jericho Whiting (BYUI), Brenda Pace (Idaho Master Naturalists), Justin Frye (BLM), Jeremy Welch (BLM), Devin Englestead (BLM), Bryan Bybee (INL), Bill Doering (INL)
<u>Minutes</u>:

- East Idaho mobile transect survey data analysis
    - Problems with the data and how to improve
        - Questionable species IDs—Bill will double check Roger's work.
        - Certain transects had acoustic bat data but no GPS data, so the detections are not georeferenced
        - Some months/years transects weren't surveyed regularly;
        - We should keep the one-week window for surveys—makes it easy to schedule and removes source of variation in data
        - We will change the survey season from May–October to June– September because very little acoustic data is recorded during May and October and some roads are not accessible.

    - Transects and which ones to keep and/or lose
        - The group discussed omitting the transects that are difficult to locate because these are least likely to be surveyed regularly. We will omit Stage Road transect. We should omit one transect in the northeast corner because there are so many transects close to each other, and we want spatial independence. We should keep Red Road transect because of importance of location. We should add Falls River.
    - Jericho will work with students at BYUI to analyze data—Bat activity by Ecotype, Ruggedness, Land cover type, Distance to water, etc.

- Plans for Idaho Master Naturalists (IMN) for the upcoming summer
    - Brenda will recruit new IMNs for this season
    - We will hold a training in June for IMNs
    - We will present data from 3 previous years to IMNs late summer

- Spring emergence trapping plans

Becky will send the group a prioritized list of sites to trap this spring

Project 6—Upper Snake Region SWAP Implementation

Objective 2: Organize and lead 2 Upper Snake Beaver Co-op meetings. Prepare (with assistance from partners) an annual report of co-op activities.

Agenda and minutes 28 August 2017.

Agenda and minutes 2 April 2018.

Upper Snake Beaver Co-op Meeting Agenda Minutes
August 28, 2017
1:30 pm
IDFG Region 6 Office

Attendees: Roy L (IDFG volunteer), Curtis Hendricks (IDFG), Justin Frye (BLM), Tony Applehans (Volunteer), Ruth Shea (NGO), Earth Fire, Ryan Walker (IDFG), Matthew Ward (TNC), Duston Cureton (IDFG), Matt Proett (IDFG), Randy Poole (IDFG)

Topics for Discussion:

1. **Updates on 2017 captures and releases (Duston Cureton, Roy L.)**
   Duston Cureton reported 15 captures to date this year (8 by the Dept., 2 by Drew Reed and the rest by contractors). Divide Creek, 5 early, 1 later, RR pond 7, and Harold Winther 2. Elevated water levels at RR pond and additional dam building. BDAs at Divide Creek not being occupied.

2. **Contract trappers (Duston/Curtis)**
   Stoeller's trapping this summer/fall. Curtis reported that we don't want to get into a situation where we have too many contract trappers

3. **BRAT model status (Ryan Walker/IDFG Habitat staff)**
   Ryan walker is working with our Bureau and USU. Trying to avoid excessive USU overhead costs. Dept. has committed up to $75K. Curtis mentioned seeing if we could get model output for R6 in advance so we could start using it.

4. **Marking (Matt Proett, Steve Roberts)**
   Matt Proett researched marking (tail transmitters and ear tags). Based on successful marking employed by MSU grad student (Torrey Ritter), intends to move forward with initial transmitter purchase for late 2017 and 2017 (n = 20). Funding from State Wildlife Grants (Proett's budget, $2K) and IDFG habitat budget ($2K). Proett will work with Torrey Ritter and/or Veterinarian Dr. Mark Drew on transmitter attachment and figure our labor for telemetry (Idaho Master Naturalists [IMNs], FS techs, TNC). Telemetry will allow us to better understand variables influencing survival of translocated beaver as well as monitor movements.

5. **Sexing**
   Curtis will inquire about sexing with Mark Drew and Matt Proett will inquire with Torrey Ritter. Possible use of anesthesia. All agree that sex identification is very important component of this release program.

6. **Priority release areas for late summer/fall**
   Duck Creek (Damon Keen installing BDAs on 6th), Modoc Creek. BLM has ideas but is still trying to figure out NEPA. Matt Proett will contact Lee M. to inquire about what he is doing with regard to NEPA.

7. **Collaboration with other IDFG beaver projects**

Matt Proett is working with Bill Bosworth (IDFG Region 3—Nampa) to develop consistent methods and variable/data collection. Matt has initiated contact with a small number of IDFG staff interested in starting a statewide beaver working group.

8. **Funding for transmitters, technicians, etc.**
   Have funding for 20 transmitters. Additional sources of funding would be useful.

9. **Habitat monitoring**
   Group agrees that some level of habitat monitoring would be useful but not the highest priority. We know what beaver do; we just need to figure out how to successfully transplant them to get the desired effects. Documentation of habitat changes could help leverage more support/money for efforts. Some ideas mentioned included drones, Google Earth imagery, photo stations, and water level measurements. Ryan Walker will work with IDFG habitat program on ideas. Matt Proett will work with IMNs on ideas and labor end and discuss options with Matt Pieron (IDFG Mule Deer Initiative Coordinator).

10. **Data collection/management**
    Duston has data entered in Excel. Duston and Matt will work to improve data management and data forms.

Upper Snake Beaver Co-op Meeting Agenda Minutes
April 2, 2018
2:00 pm
IFFG Region 6 Office

Attendees: Tony Appelhans (volunteer), Roy Leavitt (volunteer), Duston Cureton (IDFG), James Brower (IDFG), Matt Proett (IDFG), Emma Doden (IDFG), Ryan Hillyard (IDFG), Anna Owsiak (IDFG), Maria Paciorетty (IDFG), Ryan Walker (IDFG), David Weskamp (TNC), Lee Mabey (US Forest Service), Jim Gregory (NGO), Steve Roberts (IDFG), Cary Myler (FWS), Jason Beck (IDFG)

Agenda

- **The BRAT (Beaver Restoration Assessment Tool) model has been purchased but will not be available for use until 2019 most likely. We will need to discuss site prioritization without the model.**
  Duck Creek
  Tom's Creek
  Modoc Creek
  Tygee Creek
- **Tail transmitters have been purchased and I have a technician that will be able to assist with all phases of the beaver work including telemetry.**
  IDFG technician Emma Doden will monitor radio-marked beaver weekly and gather location and survival data. She will build Excel database for marked beaver and data will be housed on IDFG R6 S drive.
- **There has been internal (IDFG) discussion on the potential for disease/pathogen/nonnative species spread as beavers are moved among drainages. How can we address this with the best available information and still maintain an active/aggressive transplant program?**
  We will try not to move beaver outside of drainage systems where they were captured. Little information is known about the distribution of pathogens/nonnative species so we will use preventive measures. All beaver will be washed with dish soap and water to remove external dirt/debris from coat that may carry pathogens/nonnative species. When feasible, we will attempt to dry dock beaver before release.
- **Habitat monitoring protocols**
  Minimally, some photopoints (before/after). Water levels/flow? Some form of documentation of habitat changes post-establishment would be beneficial but group agrees that ultimately our goal should be to become proficient at reestablishing beaver colonies. We know we will get habitat changes/improvement but that is somewhat out of our control.
- **The IDFG Wildlife Bureau has identified Beaver restoration as a statewide priority and has recently hired a new furbearer biologist that will play a role in statewide beaver efforts.**
  Matt, Duston, and Curtis are in communication with Cory Mosby. At the state level, primary interests are getting the BRAT model up and running and addressing the potential pathogen/nonnative species issues.

An annual report for 2017 Upper Snake Beaver Co-op activities is in progress. We will likely combine 2017 and 2018 activities into one report (Table 1) for beaver translocation data. Annual reporting efforts were delayed due to prioritization (at the IDFG Wildlife Bureau level) of Pelican Management and Dissuasion Study in the Upper Snake Region.

Table 2. Release data for translocated beaver in IDFG Upper Snake Region, July 2017 – June 2018.

Release Date	Gender	Radio-Tagged?	Release Location
7/17/17	N/A	No	Railroad Pond, Targhee NF, Island Park
8/15/17	N/A	No	Railroad Pond, Targhee NF, Island Park
8/17/17	N/A	No	Railroad Pond, Targhee NF, Island Park
8/23/17	N/A	No	Divide Creek, Targhee NF
8/25/17	N/A	No	Private Property in Unit 69 (Harold Winther)
9/20/17	F	Yes	Duck Creek, Targhee NF, west of Henry's Lake
9/20/17	M	Yes	Duck Creek, Targhee NF, west of Henry's Lake
6/12/18	F	Yes	Duck Creek, Targhee NF, west of Henry's Lake
6/22/18	F	Yes	Duck Creek, Targhee NF, west of Henry's Lake