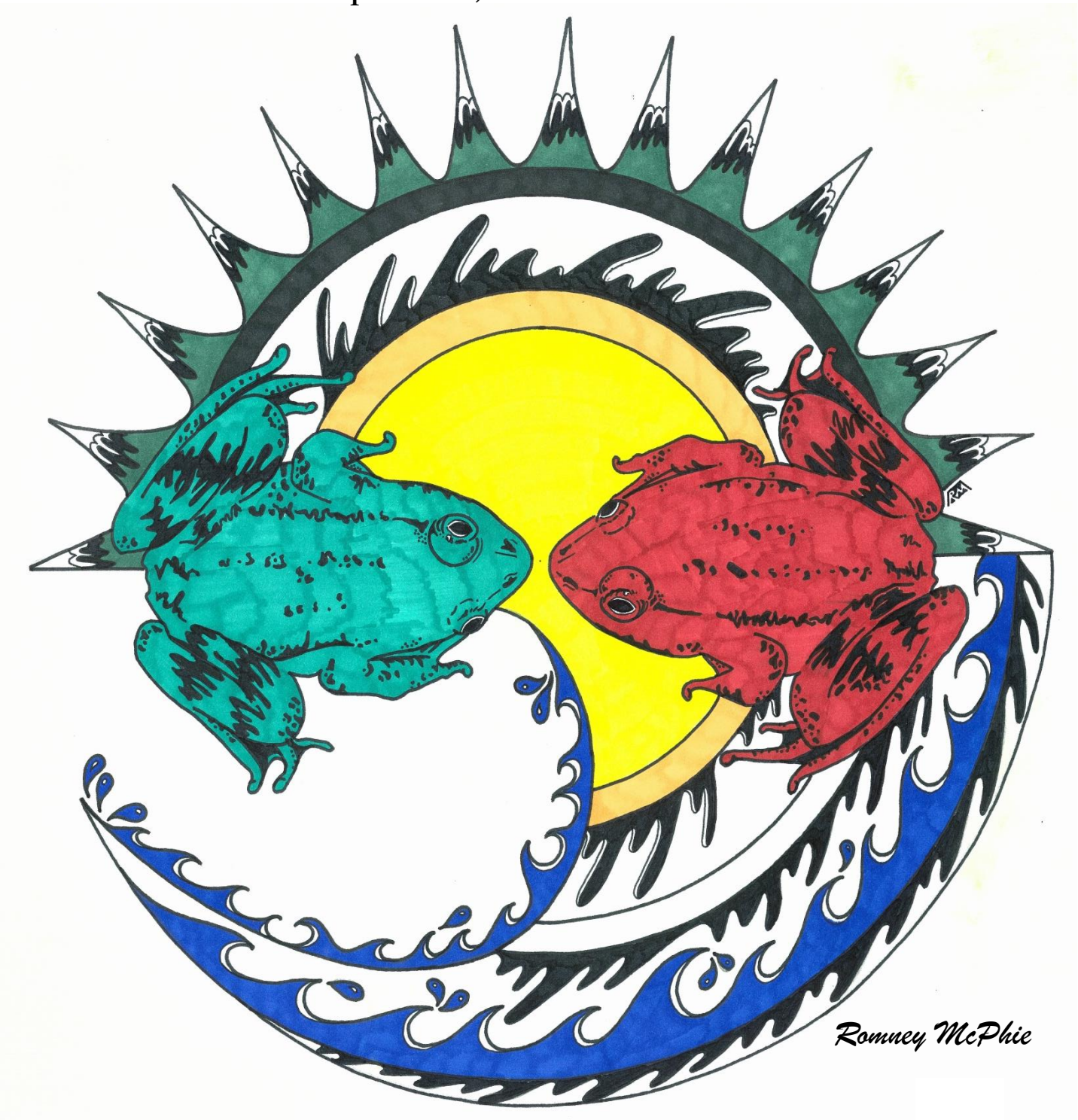
From Sea to Sky: Assessing Cumulative Effects across Pacific Northwest Ecosystems

Society for Northwestern Vertebrate Biology
2013 Annual Meeting

April 8th - 12th

Squamish, British Columbia



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NW Partners in Reptile and Amphibian Conservation

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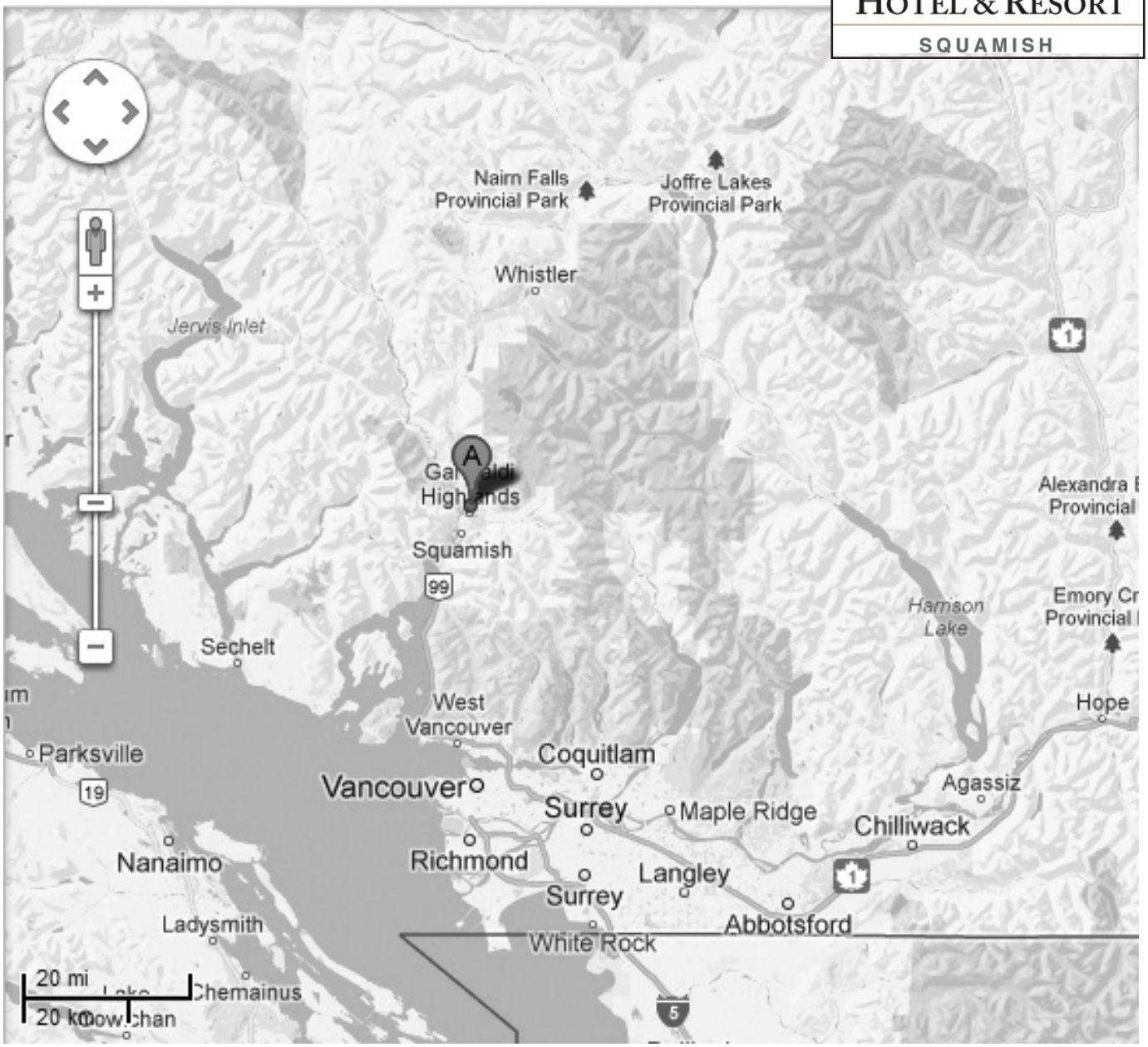

Squamish is the home of the Squamish Nation

Sḵwx̱wú7mesh Úxwumixw
SQUAMISH NATION NETWORK

Our Mission Statement:
The Sḵwx̱wú7mesh Úxwumixw will protect the Amalgamation and enhance the Úxwumixw cultural values and traditions through respect, equality and harmony for all.

SQUAMISHCHAMBER OF COMMERCE

Society for Northwestern Vertebrate Biology
2013 Annual Meeting
"From Sea to Sky: Assessing Cumulative Effects across Pacific Northwest Ecosystems"

President's Message

Welcome to Squamish, affectionately called The Squish by locals. If the sun was shining upon your arrival on the scenic Sea-to-Sky highway then you would see why Squamish is known as the Outdoor Recreation Capital of Canada. The giant granite rockface greeting travelers along the highway is the Stawamus Chief (or St'a7mes in the Squamish language), named after the aboriginal village of the same name occupied by the Squamish (or Sḵwxwú7mesh) Nation, who will be greeting and opening our meeting. This beautiful area is still their traditional territory and it is understandable why it is so revered given the landscapes and diversity of flora and fauna.

The Squish is mecca for rock-climbers, with over 1200 climbing routes in the area, fantastic views from the top of the Chief if you prefer to hike it instead (giant stairmaster), some 600 mountain-biking trails, acclaimed kiteboarding, wind surfing and river rafting, and if you want to hit Whistler less than an hour away, one of the world's best ski and snowboard resorts. There are also incredible wildlife-viewing opportunities, with one of North America's largest populations of Bald Eagles in Brackendale just north of Squamish, and a high diversity of wildlife given the variable landscapes combining the tidal influence of Howe Sound, the mountains of the Coast Range, and extensive wetlands throughout the entire valley.

As host to the 2010 Winter Olympics, the Vancouver to Whistler corridor was subjected to a billion dollars-worth of highway upgrades, resulting in some highly controversial decisions that led to the destruction of prime wetland habitat for listed amphibians. Josh Malt will talk about the ensuing issues and mitigation measures that followed as a result of those decisions. To balance out our conference theme focusing on cumulative effects, we have Dale Siep and Craig Machtans discussing similar issues with respectively, caribou populations and songbirds. And to round off the meeting, Lorne Greig will share his wealth of knowledge developing risk management frameworks, cumulative effects assessment approaches, environmental policy advice and environmental conflict resolution. Whether you work in consultanting, civil service, NGOs, research or academia, cumulative effects is an increasingly hot topic that is only going to balloon down the road, so as scientists it is important that we keep abreast of current measures to deal with this emerging field.

We are once again partnering with Northwest Partners in Amphibian and Reptile Conservation, and have some great workshops and field trips lined up for you. Our northern VP, Darcy Pickard, and Trustee Kim Walters, have been working endlessly to put together a great conference for you, so be sure to thank them when you see them. And thank you for participating! We realize that purse strings are very tight these days, and will miss so many of our members from south of the border as a result. For those of you who are here, kick back and enjoy the great setting mixed with great company. SNVB doesn't hold many meetings in Canada (last one was Victoria in 2007) so we plan on making it a memorable one!

Brent Matsuda
SNVB President

Dejá view? We used this image for last year's program, but it's even more appropriate this year, as it was taken near Squamish. Howe Sound and St. Mark's Summit, Cypress Provincial Park, West Vancouver, BC. Photo by Kim Walters.

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Big Brown Bat, *Eptesicus fuscus*. art by Lorraine Andrusiak.

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Rough-skinned Newts, by Lindsey Thurman

Western Toad, by Lindsey Thurman

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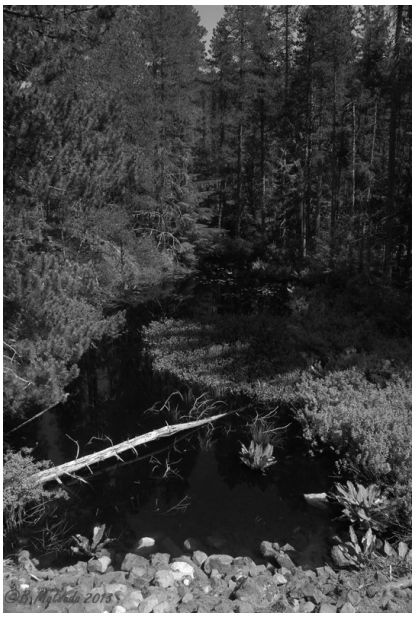
Cooperation

This meeting would not have been possible without the hard work of many board members and members from the Society for Northwestern Vertebrate Biology. Thank you to all who contributed to meeting planning, workshop development, and session coordination. Thank you, too, to all who presented posters and presentations. We wouldn't have a meeting without you. We would also like to acknowledge and thank Northwest Partners in Amphibian and Reptile Conservation for their participation and coordination of the Remote Sampling Techniques workshop. These meetings are only successful with a diversity of participants. SNVB would also like to extend our appreciation to the Squamish Nation for graciously welcoming us to their home.



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Special Events

NWPARC Social — Monday 8 April, 5:00 pm, location TBA

Northwest Partners in Amphibian and Reptile Conservation will be hosting an evening social and poster session on Monday 8 April after the Remote Sampling Workshop.

SNVB Poster Session & Social — Wednesday 10 April, 5:30 - 7:30 pm, Club House

Join us for a drink and light snacks during the SNVB poster session, Wednesday evening, following in the Sea to Sky field trip.

SNVB Member Luncheon

Thursday 11 April, noon - 1:00 pm, 'The Living Room'

There will be a build-your-own-sandwich buffet for all SNVB members who signed up for the luncheon on their registration form. Board members will provide an overview of the business dealings over the past year, a summary of some of the projects we currently have going on, and will answer questions or hear any ideas that you have for the society moving forward.

Photography Contest — Thursday 11 April

We will once again hold our photo contest at our annual meeting. This year images will be presented entirely in digital format for the first time! Digital images should be high quality (300 dpi or more) and in .jpg, .png, or .tif format. Photos will play during the banquet on Thursday evening and will be available as PowerPoint slides on a laptop during voting periods. Entrants are encouraged to submit their images to: snvb.board@gmail.com (include "photo contest" in the subject line) though they can also be brought to the photo contest organizer at meeting. Photos will be judged in a variety of categories including: Wildlife Portrait, Landscapes, Biologists in Action, and Social Behavior. Winning photographs in each category will have the opportunity to be displayed on our website.

Silent Auction

Thursday 11 April, 5:30 pm, Club House

Many items donated by generous sponsors and members will be on display Thursday, April 11 in the Club House Room. This silent auction is a fund raiser to support registration waivers for student participants at annual meetings and the student scholarship. So, browse the items and bid away!

Katie Moriarty and Marten

Annual Banquet

Thursday 11 April, 5:30 pm, Club House

Join us at the annual banquet to socialize, eat good food and enjoy our silent auction while we summarize society announcements from the past year. Before dinner, Katie Moriarty will regale us with tales of tracking movement of American Martens through the snows of California! Full details are available in the banquet section of this program.

Field Trips

Something different this year! The first of two fascinating field trips will be an extension of the plenary session on the first day of the meeting--Wednesday afternoon. A second field trip will take place on Friday afternoon. Additional details are available at our meeting registration desk.

Sea to Sky Highway: Wetland fragmentation and road-crossing mitigation efforts & Tour of constructed wetlands

Date: Wednesday 10 April 2013 **Time:** 2:30-5:30 **Trip leaders:** Josh Malt & Edith Tobe
Logistics: Ride sharing will be arranged in the Club House room during lunch. Participants should bring good footwear (there may be snow on the ground). **Cost:** No additional cost for meeting attendees.

Join us for a first-hand look at the wetland fragmentation and mitigation efforts on the Sea to Sky Highway. As described by invited speaker Josh Malt during the plenary session, "the ecological impacts of roads on wildlife are both varied and pervasive, and are a significant contributor to cumulative effects at landscape and regional scales". Josh will lead us on a tour of the Pinecrest site, north of Squamish, where he estimates 1,483 amphibians have been killed over a two-year period since the highway was moved, cutting through a number of wetlands. As part of the tour, we'll have an opportunity to view some of the road crossing mitigation measures that were implemented. Those participants with a particular interest in road crossings may follow Josh back to Squamish, stopping at a few additional crossing sites of different sizes.

Also at the Pinecrest site, Edith Tobe will provide a tour of a constructed wetland. We will discuss: site selection, the techniques utilized for construction, how to build a lined wetland, and strategies for long-term monitoring. Edith Tobe is the Executive Director of the Squamish River Watershed Society (SRWS). Over the past two years she has been actively involved in wetland restoration, designing and building many wetlands in the area. More information on the SRWS and their wetland construction efforts can be found on their website at http://www.squamishwatershed.com/amphibian-wetlands.html. Those participants with a particular interest in wetland construction may follow Edith back to Squamish to visit an additional series of constructed wetlands, closer to the hotel (e.g., 6 lined wetlands, 5 minutes north of the hotel, or one of 15 constructed groundwater ephemeral wetlands 5 minutes south of the hotel). Breeding should be well under way, so this should be a great time to get out and see these wetlands.

Tour of the Ashlu Creek Run-of-river Hydroelectric Facility

Date: Friday 12 April 2013 **Time:** 12:00 – 2:30 **Trip leaders:** Kirsten Lyle & Isabelle Deguise
Logistics: Ride sharing will be arranged in the Club House room during the morning sessions. Participants should bring their own lunch and good footwear (there may be snow on the ground). **Cost:** No additional cost for meeting attendees.

The Ashlu Creek run-of-river hydroelectric power generating plant is located approximately 35 kilometers northwest of Squamish, British Columbia, on Ashlu Creek, a tributary of the Squamish River. It began generating electricity in 2009 with a nameplate capacity of 49.9MW. Its estimated annual energy output is 265,000 MWh (approximately enough electricity to power 26,000 households). The project consists of an intake structure which diverts a portion of the creek flow through a 4.9 km tunnel down to the turbines located in the powerhouse, the water is then returned to the creek via the tailrace. The project's Conditional Water Licence stipulates that there must always be at least a minimum of 2.42 m^3/sec remaining in the creek, with a maximum diversion of 29 m^3/sec.

As part of the project development, a fish compensation area was developed to offset the 5,000 m^2 of fish habitat that was impacted as a result of the Project infrastructure and operation. In collaboration with DFO, First Nations, and Local Stewardship groups, a total of 58,852 m^2 of fish habitat was constructed. The project also features a fish ladder at the intake to allow the resident fish population to migrate past the intake structure. An Environmental Monitoring Program is currently underway to assess the biological, physical and chemical responses of the ecosystem to project development and operation. This monitoring program is currently in the third of five years of study.

Meeting At A Glance

Workshop descriptions begin on p. 15

Monday 8 April - SNVB Workshop & NW PARC Workshop

noon — registration opens, hotel lobby

	Club House	Chief Room A
1:00 - 5:00 pm (5:30 for R)	**NW PARC Workshop - Session I: Remote Sensing Techniques for Wildlife** in-class component	**SNVB Workshop: Introduction to R Software** *Instructors: Darcy Pickard & Brian Ma*

NWPARC-sponsored social and poster session - location TBA

Tuesday 9 April - SNVB Workshops & NW PARC Meeting

7:30 am — registration opens, hotel lobby

	Club House	Chief Room A
times vary - see room	8:00 am - noon **NW PARC Annual Meeting** Herpetofauna Salvage Operations Session	8:30 am - 1:00 pm **SNVB Workshop: Quantum GIS** *Instructors: Simon Casley & Nick Ochoski*
	Lunch on your own	
times vary - see room	1:00 - 4:30 pm **NW PARC Workshop - Session II: Remote Sensing Techniques for Wildlife** field component	**SNVB Workshop: Bat Survey Monitoring** *Instructors: David Nagorsen & Erin Rutherford* in-class session 2:00 - 5:00 pm field session (weather permitting) ~7:00 pm

Wednesday 10 April

7:30 am — Registration opens - Hotel lobby

Club House

8:30 - 8:45 am — Opening remarks - Brent Matsuda, SNVB President
Welcome - Chief Bill Williams of the Squamish Nation

8:45 - 9:30 am — **Plenary I:** Lorne Greig

9:30 - 10:15 am — **Plenary II:** Craig Machtans

10:15 - 10:45 am — *coffee break*

10:45 - 11:30am — **Plenary III:** Dale Seip

11:30 am - 12:15 pm — **Plenary IV:** Joshua Malt

12:15 - 1:30 pm — *lunch (on your own)*

Club House

1:30 - 2:30 pm — **Cumulative Effects Session**

Field Trip - Sea to Sky Highway

2:30 - 5:30 pm — Sea to Sky Amphibian Road Crossing Site & Constructed Wetlands. See page 7 for field trip description and details.

5:30 - 7:30 pm — **SNVB poster session and social - Club House**
appetizers and refreshments will be served

Meeting At A Glance

Thursday 11 April

7:30 am	Registration opens - Hotel lobby		
	Club House **Concurrent Session I**	**Chief Room A** **Concurrent Session II**	**Chief Room B**
8:30 - 9:50 am	**Climate Change & Biotic Responses**	**Vertebrate Ecology**	**Prep room**
9:50 - 10:20 am		*coffee and snacks in Chief Room B*	
10:20 - 11:40 am	**Management (Impacts & Strategies)**	**Vertebrate Ecology**, cont.	**Prep room**
noon - 1:00 pm	***SNVB Member Luncheon in 'The Living Room'***		
1:00 - 2:20 pm	**Management (Impacts & Strategies)**, cont.	**Vertebrate Ecology, cont.**	**Prep room**
2:20 - 2:50 pm		*coffee and snacks in Chief Room B*	
2:50 - 3:50 pm		**Past and Future**	
5:30 pm	**Banquet, Silent Auction & Raffle, Scholarships, Photo Contest - Club House** Banquet Speaker: Katie Moriarty - Martens, powered by persistence		

Friday 12 April

8:15 am	registration opens, hotel lobby
	Club House
9:00 - 10:20 am	**Hydroelectric Development & Biotic Response**
10:20 - 10:40	*coffee break*
10:40 - 11:40	**Hydroelectric Development & Biotic Response, cont.**
11:40 - noon	*bring your own lunch to the field trip*
	Field Trip - Ashlu Creek Hydro Facility
noon - 2:30 pm	Tour of Ashlu Creek Run-of-river Hydroelectric Power Facility bring your own lunch - see page 7 for details
2:30 pm	meeting adjourns

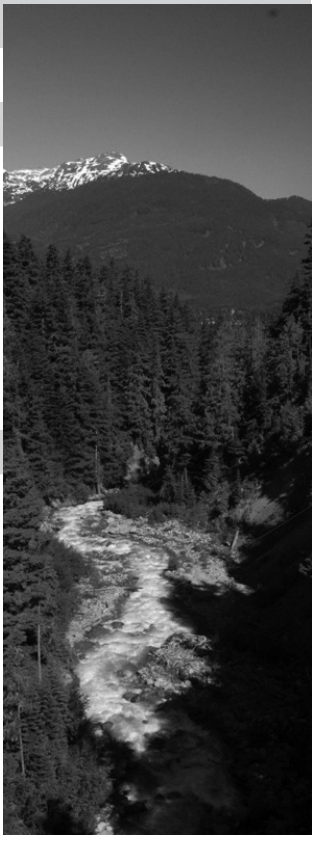
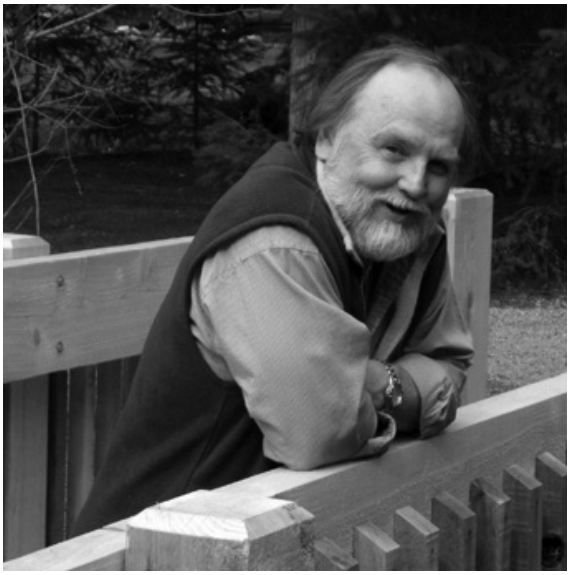


Photo by Brent Matsuda

Lorne Greig

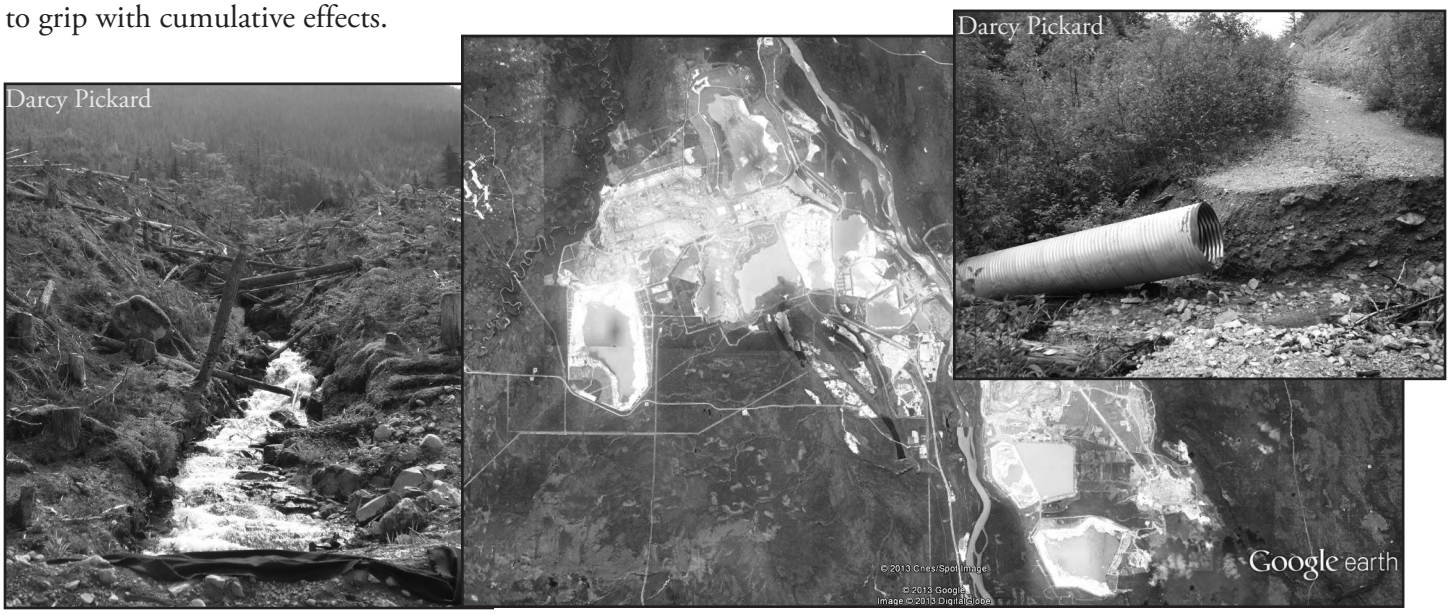


Lorne Greig holds an M.Sc. in biology, and is a Senior Systems Ecologist / Managing Partner in ESSA Technologies Ltd. Lorne has 37 years of experience in environmental management, including 8 years in government and 29 years consulting for government, industry, and multi-lateral development banks. Lorne's consulting experience includes conceptual and simulation modelling of ecological systems, teaching and supporting implementation of adaptive management (AM), leading decision analysis, developing risk management frameworks, cumulative effects assessment (CEA) approaches and frameworks, environmental policy advice and environmental conflict resolution. This mix of assignments reflects his continuing interest in enabling sustainable human-environment interactions.

Although much CEA work is found in the context of the environmental assessment (EA) of individual development projects, Lorne's work with Cumulative Effects is rooted in his background in AM in which accounting for cumulative effects is a natural requirement for understanding the projected and observed condition of valued ecosystem components. In this way, he neither views nor practices CEA as something additive or supplementary to EA but rather approaches it as a naturally integrated feature of both EA and of resource management.

Coming to Grips with Cumulative Effects. Lorne Greig, *ESSA Technologies Ltd., Suite 600-2695 Granville St., Vancouver, BC. V6H 3H4; lgreig@essa.com*

The need to assess and prevent cumulative effects has been formally recognized since the 1960s, yet forty-plus years later our experience with doing so is disappointing to say the least. The result is a growing plethora of environmental problems, all of which are driven largely by cumulative effects. While discussed extensively in the literature in regard to environmental impact assessment, a cumulative effects approach is also a natural fit with resource management. This talk explores a mindset and the extraordinary governance collaboration needed to come to grip with cumulative effects.



Craig Machtans

Craig works for the Canadian Wildlife Service of Environment Canada and lives in Yellowknife, NWT. Craig specializes in monitoring and research on boreal songbirds, both in the NWT and in other parts of Canada. Craig has an MSc (1995) from the University of Alberta for research on effects of forest patch isolation on songbirds. In addition to forestry, Craig has conducted research on the impacts of some oil and gas development practices on songbirds. He has also spent considerable time on policy development around human-related avian mortality as well as authoring or co-authoring three recent papers on the topic.

Rusty Blackbird (*Euphagus carolinus*). Photo by Erin Cooper, US Forest Service, Chugach National Forest, Cordova, AK

A Synthesis of Human-related Avian Mortality in Canada.

Craig Machtans, *Canadian Wildlife Service, Environment Canada, Yellowknife, NT X1A, Canada; craig.machtans@ec.gc.ca*

Many human activities in Canada kill wild birds, yet the relative magnitude of mortality from different sources and the consequent effects on bird populations have not been systematically evaluated. Here, we synthesize recent estimates of avian mortality in Canada from a range of industrial and other human activities, to provide context for the estimates from individual sources presented in this special issue. We assessed the geographic, seasonal, and taxonomic variation in the magnitude of national-scale mortality and in population-level effects on species or groups across Canada, by combining these estimates into a stochastic model of stage-specific mortality. The range of estimates of avian mortality from each source covers several orders of magnitude, and, numerically, landbirds were the most affected group. In total, we estimate that approximately 276 million birds and 2 million nests are destroyed annually in Canada, the equivalent of over 188 million breeding individuals. Combined, cat predation and collisions with windows, vehicles, and transmission lines caused >95% of all mortality; the highest industrial causes of mortality were the electrical power and agriculture sectors. Other mortality sources such as fisheries bycatch can have important local or species-specific impacts, but are relatively small at a national scale. Mortality rates differed across species and families within major bird groups, highlighting that mortality is not simply proportional to abundance. We also found that mortality is not evenly spread across the country; the largest mortality sources are coincident with human population distribution, while industrial sources are concentrated in southern Ontario, Alberta, and southwestern British Columbia. Many species are therefore likely to be vulnerable to cumulative effects of multiple human-related impacts. This assessment also confirms the high uncertainty in estimating anthropogenic avian mortality in terms of species involved, potential for population-level effects and the cumulative effects of mortality across the landscape. Effort is still required to improve these estimates, and to guide conservation efforts to minimize direct mortality caused by human activities on Canada's wild bird populations. As avian mortality represents only a portion of the overall impact to avifauna, indirect effects such as habitat fragmentation and alteration, site avoidance, disturbance and related issues must also be carefully considered.

Dale Seip

Dr. Dale Seip is a wildlife biologist with the B.C. Ministry of Environment in Prince George. He has been involved in caribou research in B.C. for almost 30 years and has also conducted research on mountain sheep, grizzly bears, wolves and biodiversity. For the past 10 years, he has been leading the caribou research program in the South Peace area of B.C., where Threatened caribou populations are encountering a wide range of habitat impacts including forest harvesting, oil and gas development, pipelines, coal mines, windfarms, snowmobiling, and mountain pine beetle.

Cumulative Effects on Northern Caribou in the South Peace Region of British Columbia. Dale Seip, *British Columbia Ministry of Environment, Ecosystems Branch, Conservation Science Section, Prince George, BC, Canada; dale.seip@gov.bc.ca*

Woodland Caribou (*Rangifer tarandus*) herds in the South Peace Region of B.C. are currently listed as Threatened and most herds have experienced major population declines over the past few decades. Excessive predation by natural predators appears to be the proximate cause, but habitat alteration leading to an altered predator-prey system appears to be the ultimate cause of the decline. Caribou habitat is impacted by a wide range of industrial activities including forest harvesting, natural gas developments, coal mines, wind-farms, and backcountry recreation. Initially, industrial activities occurred primarily at low elevations, directly impacting caribou that lived at low elevations and indirectly impacting caribou that lived at high elevations. More recently, many industrial activities are proposed on high-elevation caribou habitat, which will further threaten the ongoing survival of these herds.

Rangifer tarandus caribou, Woodland Caribou (mountain ecotype). Photo copyright Jared Hobbs.

Josh Malt

Josh Malt is an Ecosystems Biologist with the Ministry of Forests, Lands and Natural Resources (FLNR), with an interest in a variety of taxa and management issues. Josh received his M.Sc. from Simon Fraser University, where he investigated the effects of habitat fragmentation on nest predation risk for the Marbled Murrelet. Josh started with FLNR in 2008, and shortly thereafter began a two-year project studying the effectiveness of an amphibian underpass system, and related population-level effects, on the Sea to Sky Highway. At the Ministry, Josh has also worked on application review and inspection of Run-of-the-River (ROR) Hydropower Projects, cumulative effects assessments for Marbled Murrelets, and a Red-legged Frog wetland occupancy study in Metro Vancouver / Fraser Valley. Josh is currently developing a study to assess the effects of ROR Hydropower on Coastal Tailed Frogs.

Assessing Impacts of Wetland Fragmentation on the Sea to Sky Highway: Cumulative Population-level Effects on Red-legged Frogs (*Rana aurora*). Josh Malt, *Ministry of Forest, Lands and Natural Resource Operations. Ecosystems. 10428-153rd Street, Surrey, BC V3R 1E1; Joshua.malt@gov.bc.ca*

The ecological impacts of roads on wildlife are both varied and pervasive, and are a significant contributor to cumulative effects at landscape and regional scales. In this study, we investigate the cumulative population-level effects of highway fragmentation of a wetland complex north of Squamish, B.C., with a focus on Northern Red-legged Frogs (*Rana aurora*). Roadkill surveys along a 1.9-km realignment estimated that 1,483 amphibians were killed over two years, including 915 red-legged frogs. Using our 2010 local population size estimate of 1,952-2,335 individuals, we estimated that 16-28% of the local population suffered road mortality in 2010. Under this scenario, our models predict local population extirpation in 20-40 years. Moreover, at one wetland where "before-after" data was available, we estimated a 73-92% population reduction from pre-highway construction in 2007 to post-construction in 2010. Remote cameras documented that only 9% of frogs and toads and 4% of salamanders used passageways, and 51% of individuals were observed climbing or jumping over fences. These results suggest that initial mitigation measures at Pinecrest were not sufficient to mitigate cumulative population-level effects of frog translocation, road mortality, and habitat loss and fragmentation. However, mitigation measure such as fencing can be effective in reducing mortality, providing it is of sufficient length and properly installed. Highway routes which fragment high-quality amphibian habitat should be avoided, or alternative measures such as wildlife overpasses should be constructed, in order to minimize cumulative effects on populations of amphibians and other wildlife.

Red-legged Frog (*Rana aurora*), photo by Brent Matsuda.

Banquet Speaker

Katie Moriarty

Katie is a PhD candidate at Oregon State University. She finished her master's in Wildlife Science at OSU in 2009 and her bachelor's degree in Wildlife from Humboldt State University in 2004. Although she's worked with a wide array of species from bats to passerines and wolves to small mammals, her work over the past decade has largely focused on martens. In her master's research, she used remote cameras to resurvey areas for forest carnivores that were first surveyed as long as 28 years ago, allowing her to investigate long-term changes in marten distributions. In the course of her field work she also documented the first wolverine in California since 1922. Her PhD is focused on investigating marten movement and activity patterns in a managed landscape and includes novel approaches to studying these small carnivores. She ended a winter field season two weeks ago and will be presenting some preliminary results from the last three years of intensive field work.

Martens, Powered by Persistence. Katie M. Moriarty. *Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331; ktmoriarty22@gmail.com.*

North American martens (*Martes americana*, *M. caurina*) are forest-dependent carnivores sensitive to habitat fragmentation and loss. The distributions of Pacific Marten (*M. c. sierrae*) and Humboldt Marten (*M. c. humboldtensis*) in the Coast Range, Cascades, and Sierra Nevada of California have changed from being relatively continuous throughout the early 1900s to isolated and discontinuous today. Mechanistic causes for these declines are poorly understood. I am using the smallest GPS collars available for mammals to quantify the effects of timber harvest on Marten movement and activity patterns, coupled with experiments designed to assess Martens' willingness to move through managed habitats. This research has also given me the unique opportunity to closely observe two Marten populations over three years. I reveal new insights into the daily lives of Martens, uncovering a life-style characterized by persistence and predictably mysterious behavior. Movement, activity patterns, and experimental approaches can provide new insights on the importance of individual variation and animal behavior. This knowledge can improve our ability to manage and conserve a wide array of species, particularly active carnivores.

SNVB Workshop Descriptions

Introduction to R Software (April 8th – afternoon)
Instructors: Darcy Pickard & Brian Ma

Overview: R is a free software environment for statistical computing and graphics. It is a powerful package and has been adopted by many researchers and statisticians, but is also useful for beginners who only wish to complete simple analyses and graphics. With R, you'll never need to buy another stats package! One of R's strengths is the ease with which well-designed publication-quality plots can be produced. Because R is open source, new packages are being developed all the time giving R users access to an extensive community of scientists. For example, specialty packages exist for many ecological applications (e.g., Mark-recapture/occupancy analysis, sampling design, and community ecology applications). This workshop is intended to help new users become comfortable enough with the basic R environment that they can pursue the more technical tools as needed. This course will cover the following material:

- Getting started with R - installing, exploring the software, basics of the user interface, data types
- Data selection and manipulation – sorting, merging, queries
- Exploring built in functions – what they are, how you find them, structure, help pages & built in examples
- Reading in data / exporting data– options, pitfalls, examples
- Plotting – creating standard plots, manipulating plot attributes, examples of more complex plot types, custom plots, exporting plots for reports, batch production of plots
- Creating custom functions – how to write your own function and why you might want to!
- Introduction to common statistical analysis functions (e.g., t-test, Mann-Whitney test, ANOVA, regression etc.) and ecological packages of note.
- References and online resources

Darcy Pickard is a Senior Statistician with ESSA Technologies Ltd. where she works to find rigorous solutions to complex ecological problems. She is a Professional Statistician and holds a B.Sc. in Statistics, minor in Ecology and a M.Sc. in Statistics from Simon Fraser University. Darcy has broad research interests and counts herself lucky to be able to contribute to a wide variety of ecological projects involving: sampling design, experimental design, data analysis, simulation modeling, and field work throughout North America. She has also been an instructor for the Ecological Restoration program at the British Columbia Institute for Technology and is currently involved with several large-scale restoration projects (e.g., Trinity River Restoration Program and Oil sands reclamation).

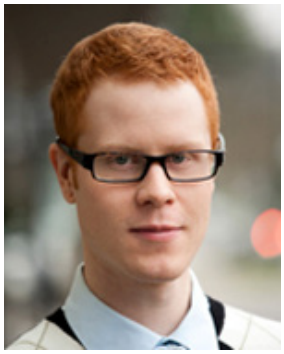
Brian Ma is a Systems Ecologist with ESSA Technologies Ltd. where he works on a wide variety of ecological modeling and data analysis projects. Brian holds a B.Sc. in Biological Sciences majoring in ecology and evolution from the University of Calgary, where he worked on population dynamics of Sage Grouse in Alberta; a M.Sc. in Zoology from the University of Toronto working on diet choice rules in one-predator-two-prey communities; and a Ph.D. in Biological Sciences at Simon Fraser University, where he worked on how behavioral responses of African mosquitoes (*Anopheles gambiae*) can affect the spread of parasites leading to malaria in humans. Most recently, he was an NSERC Postdoctoral Fellow with Fisheries and Oceans Canada, sharing time between the Pacific Biological Station in Nanaimo, BC, and the University of British Columbia in Vancouver, BC. During this time, he worked as an ecological modeler for a high-profile sockeye salmon genomics project, developing population models and Bayesian network models exploring the potential role of new technologies such as functional genomics on fisheries management. Brian's main interests lie in the coupling of individual-level responses to population-level consequences. He has extensive training in the design and implementation of mathematical, computer simulation, and statistical models that can be readily adapted to different ecological systems and applied problems.

SNVB Workshop Descriptions

Quantum GIS (April 9th – morning, half day)
Instructors: Simon Casley & Nick Ochoski

Overview: Quantum GIS (QGIS) is a free and open source geographic information system (GIS) that runs on your desktop, allowing you to visualize, manage, edit, analyse spatial data, and compose printable maps. This workshop will provide an introduction to the basics of QGIS, including the following:

- Getting started with QGIS - downloading, exploring the software, GIS basics
- Setting up a new project and adding data - data formats, projections, free data, using web map services (WMS)
- Working with features and attributes - selecting, identifying, querying, editing
- Introduction to some more advanced geoprocessing elements (e.g., spatial joins and overlays, intersecting data layers, applying buffers etc.)
- Creating a map - symbolizing features, map layout, saving and exporting



Nick Ochoski is a geospatial modeler and programmer for ESSA Technologies Ltd. with a background in remote sensing and ecology. He holds a B.Sc. (Hons) in Geomatics and a M.Sc. in Physical Geography with a specialization in GIS and Remote Sensing from Carleton University. Before joining ESSA, Nick worked on a variety of projects with the Federal government and independent research labs. He has experience working with an assortment of remotely sensed data types including RADAR, LiDAR, and multi/hyperspectral and has undertaken field work in various environments as a means of investigating various environmental problems, especially those related to fluvial geomorphology. Nick's current work has focused on spatial modeling and software development, including work on the River Bathymetry Toolkit, which is concerned with the automated processing of LiDAR imagery for the purpose of understanding fish habitat in freshwater waterways.

Simon Casley holds a B.Sc. in Geography from the University of Sheffield (UK) and a M.Sc. in Remote Sensing from University College London (UK) with a thesis that explored the production of digital elevation models of Mars using high resolution data from the HRSC onboard Mars Express. Simon is a GIS Analyst for ESSA Technologies Ltd. His recent work at ESSA has included developing an ecological land metric in support of monitoring land use changes for tracking environmental impacts; GIS analysis as part of a fish habitat monitoring program for designated Fisheries Sensitive Watersheds in BC; and GIS analysis in support of ecological modeling of a reservoir ecosystem. Prior to joining ESSA, Simon worked as a Remote Sensing and GIS Scientist on numerous projects in the UK extracting information from satellite imagery for environmental monitoring and security, and developing spatial data driven web services using remote sensing and GIS products.

Bat Survey Monitoring (April 9th – afternoon and evening)
Instructors: David Nagorsen & Erin Rutherford

Overview: This is an introductory level workshop intended for wildlife biologists, environmental consultants, and naturalists with limited or no experience with bat monitoring. Participants will be introduced to the identification of roost sites, methods for capturing, handling, and identifying live bats; monitoring bat acoustic activity with bat detectors; and some of the provincial regulations and protocols for handling and monitoring bats. Equipment for capturing bats such as mist nets and examples of several detector types such as the Titley Anabat, Wildlife Acoustics Songmeter, and Pettersson systems will be displayed. Software for identifying and analyzing bat echolocation recordings will be demonstrated. Weather permitting, the organizers will set up a few mist nets and bat detectors the night of the workshop.

David Nagorsen (B. Sc., M.Sc.) was the mammal curator at the Royal British Columbia Museum for many years and has been a wildlife consultant since 2002. He has conducted bat inventories in various regions of Canada including Ontario, British Columbia, and the Yukon Territory. He has published research papers on bats, co-authored the Royal BC Museum handbook "Bats of British Columbia", and authored or co-authored a number of bat reports including three COSEWIC bat status reports. Recent bat projects include bat assessments at proposed wind farms (northeastern BC, Vancouver Island), a study of the long-eared Myotis bat species for BC Ministry of Environment funded by the Forest Sciences Program, an update of the range maps of BC bats for Ministry of Environment, bat acoustic file analyses for the proposed site C dam site in the Peace River area, and bat house mitigation projects with BC Hydro.

Wednesday 10 April

7:30 am	Registration opens - Hotel lobby
	Plenary Session - Club House
8:30 am	Opening remarks - Brent Matsuda, SNVB President Welcome - Chief Bill Williams of the Squamish Nation
8:45 am	Plenary I: **Lorne Greig** - Coming to Grips with Cumulative Effects
9:30 am	Plenary II: **Craig Machtans** - A Synthesis of Human-related Avian Mortality in Canada
10:15 am	*coffee break*
10:45 am	Plenary III: **Dale Seip** - Cumulative Effects on Northern Caribou in the South Peace Region of B.C.
11:30 am	Plenary IV: **Joshua Malt** - Assessing Impacts of Wetland Fragmentation on the Sea to Sky Highway: Cumulative Population-level Effects
12:15 pm	*Lunch* (on your own) - arrange ride sharing for field trip

1:30 - 5:30 pm, Cumulative Effects Session

Numbered abstracts begin on p. 21	**Club House**
1:30 pm	[21]Bats and British Columbia Wind Energy - the Known and Unknown – David Nagorsen
1:50 pm	[27]Assessing Landscape Impacts on Sockeye Salmon in B.C.'s Skeena Region – Marc Porter
2:10 pm	[36]Innovative Modeling Tools and Planning Approaches for Economic Development, Social Well-being, and Environmental Resilience – Barry Wilson
	Field Trip
2:30 - 5:30 pm	**Sea to Sky Amphibian Road Crossing Site & Constructed Wetlands Field Trip** Trip leaders: Josh Malt and Edith Tobe arrange ride sharing during lunch in the Club House room bring good footwear in case of snow
	Club House
5:30 - 7:30 pm	**SNVB Poster Session and Social** appetizers and refreshments will be available

Sharp-tailed Snake, *Contia tenuis*, photo by Brent Matsuda

Tritelia, photo by F. Teal Waterstrat

Thursday 11 April

7:30 am Registration opens – Hotel lobby

8:30 - 9:50 am, Concurrent Paper Presentation Sessions

Numbered abstracts begin on p. 21	Club House	Chief Room A	Chief Room B
	Climate Change & Biotic Response	**Vertebrate Ecology**	**Prep Room**
8:30 am	[9]Modeling climate change biology and landscape ecology of amphibians in Palouse Prairie wetlands – Erim Gomez	[7]Experience with Tailed Frog habitat capability modeling using GIS tools – Pierre Friele	
8:50 am	[25]Patterns of reptile species richness and vulnerability across northwestern North America – David Pilliod	[18]Habitat ecology of the Coastal Tailed Frog in Terrace, British Columbia, Canada – Alexis McEwan	
9:10 am	[31]In hot water: developmental plasticity to a warming climate in a high-elevation amphibian assemblage – Lindsey Thurman	[28]Revisiting the use of electrofishing for sampling non-fish values – Ron Ptolemy	
9:30 am	[20]Out of Hot Water: Bullfrog Invasions Cool Off in Exotic Climate – Rylee Murray	[34]What it Means to be Rare: Status of the Desert Nightsnake in Washington, and Management of this Species in British Columbia – Robert Weaver	

9:50 am *Coffee & snacks in Chief Room B*

10:20 - 11:40 am, Concurrent Paper Presentation Sessions

	Club House	Chief Room A	Chief Room B
	Management (Impacts & Stragies)	**Vertebrate Ecology**, continued	**Prep Room**
10:20 am	[5]Preliminary responses of Pacific Fisher to the Ashland Forest Resiliency Fuel Reduction Project in southwest OR – Dave Clayton	[33]The enigmatic Sharp-tailed Snake in Washington State: implications for conservation and management strategies in British Columbia – Robert Weaver	
10:40 am	[32]Can the effect of tall structures on birds be isolated from other aspects of development? – Kim Walters	[4]Aggressive behavior in the Western Pond Turtle on stable and rolling logs – Gwen Bury	
11:00 am	[30]Cascading impacts on amphibian assemblages in restored wetlands – Jennifer Rowe	[16]Seasonal movement and cause-specific mortality of Short-tailed Weasels in a managed forest landscape in western Oregon – Mark Linnell	
11:20 am	[2]Testing SPLAT mitigation: monitoring amphibian movements to and through culverts, west coast of Vancouver Island, British Columbia – Barbara Beasley	[19]Describing Marten activity patterns using accelerometers – Katie Moriarty	

noon **SNVB Member Luncheon** noon - 1:00 pm - **'The Living Room'**

Thursday 11 April

1:00 - 2:20 pm, Concurrent Paper Presentation Sessions

Numbered abstracts begin on p. 21	Club House	Chief Room A	Chief Room B
	Management (Impacts & Strategies), continued	**Vertebrate Ecology**, continued	**Prep Room**
1:00 pm	[10]Planning for the unpredictable: White Nose Syndrome arrival and potential impacts in British Columbia, Canada – Purnima Govindarajulu	[29]Recognition of refuge sites using olfactory cues in the Coastal Giant Salamander (*Dicamptodon tenebrosus*) – David Reavill	
1:20 pm	[22]Science and management of emerging wildlife diseases: *Gd* in *Bd*'s slipstream – Dede Olson	[35]Kinematic analysis of prey capture in Coastal Giant Salamanders – Laura Westervelt	
1:40 pm	[15]Quantifying the biological tradeoffs of two common supplementation strategies for imperiled amphibian populations – Amanda Kissel	[13]Difference in flight initiation distance between recently metamorphosed Oregon Spotted Frogs and American Bullfrogs – Marc Hayes	
2:00 pm	[24]Spotties vs. bullies: differentiation of habitat selection by Oregon Spotted Frogs and American Bullfrogs – Monica Pearson	[8]Annual stream temperature regimes and the distribution of the Rocky Mountain Tailed Frog in southeastern British Columbia – Pierre Friele	
2:20 pm	*Coffee & Snacks in Chief Room B*		

2:50 - 3:50 pm, Concurrent Paper Presentation Sessions

	Club House	Chief Room A
		Past and Future
2:50 pm	(no session - set up for banquet)	[11]Changing perspectives of North American wildlife attitudes – David Hancock
3:20 pm		[3]History and future of the US Biological Surveys (or, was C Hart Merriam a Jedi Master?) – Bruce Bury

5:30 pm **Banquet - Club House - Banquet Speaker: Katie Moriarty**
Silent Auction, Scholarships, & Photo Contest

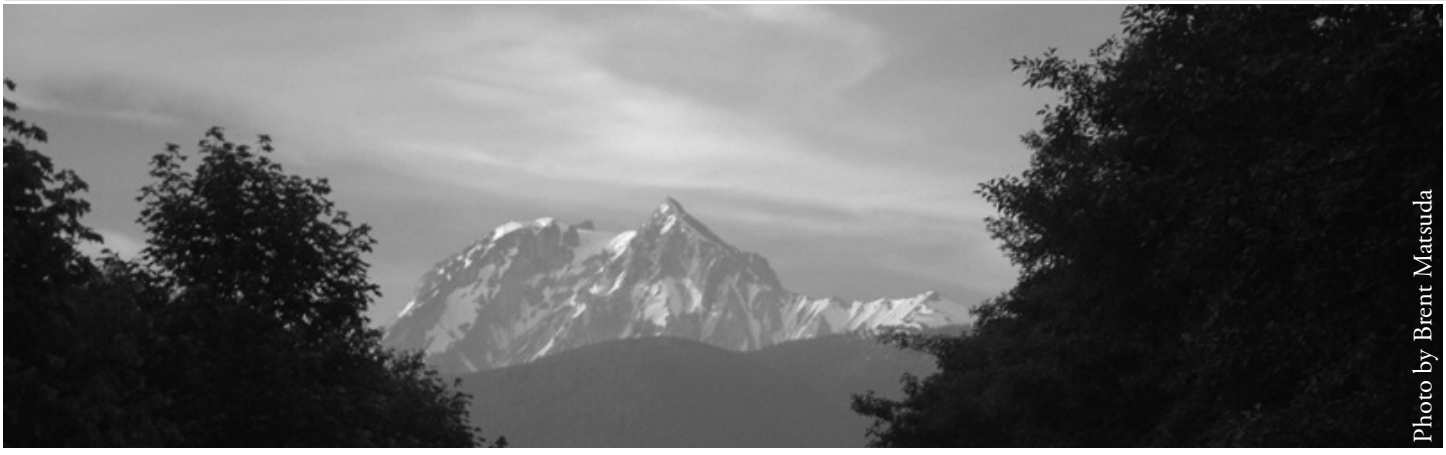


Photo by Brent Matsuda

Friday 12 April

8:15 pm Registration opens, Hotel lobby

9:00 - noon, Hydroelectric Development & Biotic Response Session

Numbered abstracts begin on p. 21	Club House
9:00 am	[23]Balancing species conservation and small hydropower development in British Columbia—Part I: the process – Wendy Palen
9:20 am	[26]Balancing species conservation and small hydropower development in British Columbia—Part II: the science – Viorel Popescu
9:40 am	[14]Riverine bird response to controlled flow release on the Lower Bridge River – Ralph Heinrich
10:00 am	[12]Kinbasket and Arrow Lakes Reservoirs: amphibian and reptile life history and habitat use assessment – Virgil Hawkes
10:20 am	*Coffee Break*
10:40 am	[1]Ecology of Western Painted Turtles in a northern reservoir: life in fluctuation – Nicole Basaraba
11:00 am	[17]Assessing the impacts of run-of-river hydropower on Coastal Tailed Frogs: preliminary study design and power analysis – Josh Malt
11:20 am	[6]Environmental monitoring at run-of-river hydroelectric projects in BC – Isabelle Deguise
11:40 am	TBA
	Field Trip
noon - 2:30 pm	**Tour of Ashlu Creek Run-of River Hydroelectric Power Facility** Trip Leaders: Kirsten Lyle & Isabelle Deguise bring your own lunch - details on p. 7

Wetland sampling photo by Brent Matsuda

2013 SNVB Oral Presentation Abstracts

Notes

Abstracts are in alphabetical sequence by last name of primary author A -Z
* = student presentation

1. Ecology of Western Painted Turtles in a Northern Reservoir: Life in Fluctuation. *Nicole Basaraba, *; nbasaraba@gmail.com;* Karl Larsen, *klarsen@tru.ca; Thompson Rivers University, 900 McGill Road, Kamloops BC V2C 5N3*

The catchment of hydroelectric reservoirs and fluctuations in water levels (drawdown zone) can have significant impacts on aquatic ecosystems. For herpetofauna that live in cold climates, these human-induced alterations may affect their ability to manage and tolerate their environment. Our objective was to investigate the ecology of an extreme northern population (Revelstoke, British Columbia) of Western Painted Turtles (WPT; *Chrysemys picta bellii*) that inhabits an environment constantly fluctuating due to hydroelectric operations. Our data suggest that all age and sex classes use the drawdown zone, and that juveniles, adults, and likely neonates overwinter within the drawdown zone. Nest inundation as a result of reservoir operations was not a significant threat to the animals, simply because all nesting sites detected, thus far, lay above the high-water mark. Similarly, no incidents of mortality to turtles could be attributed to the reservoir operation. However, changes in water levels affect habitat availability. Areas of use and basking sites during early spring are lost as water levels rise, while as other areas flood, more 'usable' habitat becomes available for turtles than would normally be accessible. Modeling of turtle behaviors, with water levels, water temperature, and season, suggested that changes in water levels did not significantly influence the behaviors defined in this study. The size-frequency distribution of the turtles appears consistent with that reported for other northern turtle populations, yet there is a very strong female bias (1♂: 6 ♀). Possible reasons for this bias will be discussed. My research provides information on the ecology of WPTs living in a dynamic northern environment that can assist in management decisions.

2. **Testing SPLAT Mitigation: Monitoring Amphibian Movements to and through Culverts under Highway 4 on the West Coast of Vancouver Island, British Columbia.** Barbara Beasley, *Association of Wetland Stewards for Clayoquot and Barkley Sounds, P.O. Box 927, Ucluelet, BC V0R 3A0; wetlandstewards@gmail.com*

We used time-lapse photography and pitfall trapping to measure amphibian movements along guiding fences and through two culverts at a site where five species of amphibians, *Rana aurora*, *Pseudacris regilla*, *Ambystoma gracile*, *Taricha granulosa* and *Plethodon vehiculum*, are frequently killed by traffic. The culverts are 50 m apart on a two-lane highway (14 m wide). One culvert is an old, round corrugated metal "drainage culvert" (60 cm in diameter) placed to carry storm water under the road. The second is a larger rectangular concrete "box culvert" (180 cm x 45 cm) installed in 2011 to serve as an un-flooded amphibian passageway. Plastic fences, extending 10 to 60 m into the forest, guide amphibians to the culvert entranceways. We photographed 388 amphibians (~65% *R. aurora* and 30% *A. gracile*) moving through the culverts over 175 nights of surveillance in the autumn of 2011, and spring, late summer, and autumn of 2012. We trapped an additional 200 individuals (not photographed) in pitfall traps at the exits of the culverts over the same nights. Two-thirds of the total number moved through the larger "box culvert", but more amphibians used the "drainage culvert" than expected given the numbers funneled by the guiding fences. We photographed Mink (*Mustela vison*) and Ermine (*Mustela erminea*) moving and occasionally hunting in both culverts. The frequency of predators and predation events was higher in the "drainage culvert". Although amphibians use both culverts, we argue that the more spacious "box culvert", with natural cover and no water-flow, is a safer type of passageway.

3. History and Future of the US Biological Surveys (or, was C Hart Merriam a Jedi Master?). R Bruce Bury, *1410 NW12th Street, Corvallis, OR 97331; burybr@peak.org;* A R Weisbrod, *2154 False Bay Road Friday Harbor, WA 98250; weisbrod@rockisland.com*

Biological field studies go back to Aristotle and were rooted in works of Darwin. The U.S. Biological Survey (Survey) was established in 1896, with a precursor in 1885. An earlier leader was C Hart Merriam, who helped develop the life zone concept in North America. Survey teams explored and studied wildlife in many remote areas of the United States. They participated in the Alaska Native Claims Settlement Act of 1970. Results have contributed widely to scientific achievements and wise management of natural resources. Although the Survey persisted >120 years, its visibility today is limited. Still, we urge solid

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training of biologists in systematics, biogeography, and field studies. The Survey may rise again. Its flagship monograph series, North America Fauna, has been reactivated. There is need for better coordination among biologists in the Survey, other agencies (local, state, and national) and interested private entities. One proposal would form field teams of expertise from many quarters to address specific issues. Many opportunities remain.

4. Aggressive Behavior in the Western Pond Turtle on Stable and Rolling Logs. Gwendolynn W Bury, Christina L Baggett, *Department of Zoology, 3029 Cordley Hall, Oregon State Univ., Corvallis, OR 97330; buryg@onid.orst.edu;* Jason T Bracken, *Institute for Environment and Sustainability, 254 Upham Hall, Miami Univ., Oxford, OH 45056; brackejt@MiamiOh.edu;* R Bruce Bury, *1410 NW 12 St, Corvallis, OR 97331; burybr@peak.org*

Western Pond Turtles (*Actinemys marmorata*) engage in atmospheric basking during warm portions of the year and, often, become crowded on preferred structures (e.g., a log away from the edge of shore). Earlier studies recorded aggressive interactions in this turtle, including shoving, open mouth gestures and, rarely, biting attacks. Such behavior likely ensures retention of position of turtles on crowded basking sites. In the Willamette Valley, Oregon, we observed these social interactions among turtles on stable wood structures as well as a rolling log (many turtles repeatedly tipped over a small log as they emerged). We show the first photo documentation of a sequence of behaviors: approach, open mouth gesture, and avoidance by turtles. Further, we obtained video footage of frequent interactions on the unstable log, where many turtles actively moved to maintain upright positions and reacted to other turtles in the chaos. We recorded no interaction of the native Western Pond Turtle and some introduced Red-eared Sliders (*Trachemys scripta elegans*) co-occurring at two ponds, but further study of this situation is needed.

5. Preliminary Responses of Pacific Fisher to the Ashland Forest Resiliency Fuel Reduction Project in Southwest Oregon. David Clayton, *Rogue River-Siskiyou National Forest, Medford, Oregon; dclayton@fs.fed.us;* Zane Mille, and Craig Thompson, *US Forest Service, Pacific Southwest Research Station, Fresno, CA.*

The Ashland Forest Resiliency Project (AFR) is a 7,700-acre landscape-scale fuels reduction effort in SW Oregon within the Ashland, Oregon municipal watershed, which is attempting to return the landscape to a pre-fire suppression condition in a fire adapted ecosystem. The area is also located within the extreme northeastern portion of the NW California and SW Oregon population of Pacific Fisher (*Martes pennanti*), a rare forest meso-carnivore that may soon be listed under the Endangered Species Act due to the potential of effects of this type of forest management on the species. Here we describe home-range size, habitat use, rest-site characteristics, and initial responses of Fisher within the project area to both non-commercial and commercial fuel reduction treatments. Preliminary results indicate that these Fishers may be somewhat tolerant to some types of fuels treatments.

6. Environmental Monitoring at Run-of-River Hydroelectric Projects in BC. Isabelle Deguise, *Innergex Renewable Energy Inc., 200-666 Burrard St, Vancouver, BC V6C 2X8; ideguise@innergex.com*

Innergex Renewable Energy Inc. owns and operates ten run-of-river hydroelectric projects in southwestern BC, all of which have ongoing long-term environmental monitoring programs. Monitoring components include both aquatic and terrestrial, with project-specific commitments established during the pre-construction permitting stage. Information on general monitoring requirements will be presented, along with preliminary results and general trends across Innergex's ten projects.

7. Experience with Tailed Frog Habitat Capability Modeling Using GIS Tools. Pierre A. Friele, *Cordilleran Geoscience, PO Box 612, Squamish, BC V8B 0A5; pfriele@gmail.com*

The Ministry of Forests, Lands, and Natural Resource Operations requires development proponents, for example in the Independent Power Sector, to create habitat capability models as a basis for assessing potential development impacts. Tailed frog (*Ascaphus* spp.) habitat associations are well known from an abundance of past research. Key associations are with cool (not cold), montane streams and the conditions found therein: cascade and step-pool bed morphologies, stable clean substrates, low substrate embeddedness, moderate to low levels of geomorphic disturbance, old-growth, etc. The problem is to predict these site-level conditions using proximate independent variables derived from available DEMs (TRIM) and other available mapping resources (terrain mapping, biogeoclimatic mapping, etc). The most

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common proxies presently used to predict tailed frog occurrence in BC are basin area, basin ruggedness, and biogeoclimatic zones. These may be applied sequentially/additively to rank capability. The conceptual framework behind proxy selection will be discussed, and examples from several previous projects are presented.

8. Watershed-wide Annual Stream Temperature Regimes and the Distribution of the Rocky Mountain Tailed Frog at its Northern Range Limit, Southeastern British Columbia. Pierre A. Friele, *Cordilleran Geoscience, PO Box 612, Squamish, BC V8B 0A5;* Kathy Paige, *Ecosystem Conservation Section, Ecosystems Branch, Ministry of Environment, PO Box 9338, Station Provincial Government, Victoria, BC V8W 9M;* Dan Moore, *Dept of Geography and Dept of Forest Resources Management, University of British Columbia, 1984 West Mall Vancouver, BC V6T 1Z2*

We placed Thermochron iButtons at 41 stations throughout the range of the Rocky Mountain Tailed Frog (*Ascaphus montanus*) in southeastern British Columbia. We characterized annual stream thermal regime from headwaters to valley bottom mainstem channels, in several subbasins known from previous work to have contrasting thermal regimes. At a subset (n = 28) of these sites, we collected tailed frog absolute abundance and biomass estimates. We correlated the catchment scale, GIS based metrics, basin area, basin slope, mean basin elevation, aspect, and insolation to annual maximum weekly temperature and cumulative annual degree-days > 5ºC, two thermal metrics relevant to tailed frog life history. Further, we correlated these thermal metrics to tailed frog presence/absence and abundance. We found that GIS-based variables perform reasonably well in predicting thermal conditions, but that unexplained variance is due to site-level conditions. Cold streams have catchments with high mean basin elevation, specifically those draining alpine rather than forested catchments. Cold streams with annual maximum weekly temperature below 8ºC and cumulative annual degree-days > 5ºC below 150-200 days do not support tailed frogs. The presence of lakes within cold basins ameliorates the thermal regime, providing local population strongholds in otherwise inhospitable physiographic settings. No breeding streams exceeded the maximum critical thermal thresholds for tailed frog eggs (18ºC). Larger mainstems, used primarily for dispersal, did not exceed 20ºC, below the critical thermal thresholds for tadpole and frog life stages. This is the first known empirical characterization of physiologic time for tailed frog, and may find utility in habitat capability mapping and predicting climate change effects on population distribution.

9. Modeling Climate Change Biology and Landscape Ecology of Amphibians in Palouse Prairie Wetlands. *Erim Gomez and Rodney Sayler, *School of the Environment, Washington State University, PO Box 646410, Pullman, WA 99164-6410; erimgomez@gmail.com; rdsayler@wsu.edu*

Global climate change, coupled with habitat loss, environmental degradation, and introduced species (plant, animal, disease vectors), may permanently influence wetland ecology and population dynamics of many amphibian species in the Pacific Northwest. We used algorithmic modeling to develop empirical ecological models predicting the presence of over 5000 amphibian larvae and adults of 7 species captured or observed in 71 wetlands and artificial constructed ponds in Palouse Prairie in 2009 and 2012. Various ecological factors, including the annual wetland flooding cycle, surrounding habitat types and landscape matrix (grassland, urban, rural agriculture), wetland spatial relationships, and introduced non-native fish were strongly associated with different amphibian populations. Except for introduced Bullfrogs (*Lithobates catesbeianus*), breeding amphibians were essentially permanently eliminated in Palouse Prairie wetlands containing fish or reduced in wetlands containing large Tiger Salamander (*Ambystoma tigrinum*) neonates, while Northern Leopard Frogs (*Lithobates pipiens*) and Columbia Spotted Frogs (*Rana luteiventris*) were capable of rapid colonization events in other suitable wetlands. Long-toed Salamander larvae (*Ambystoma macrodactylum*) were: 1) smaller in vernal ponds that dried up more quickly; 2) larger in more permanent wetlands; but 3) varied significantly in length and mass among similar wetlands in the same local landscape. We conclude that each wetland constitutes its own somewhat unique ecosystem, which complicates studying the metrics of climate change biology and developing future conservation strategies across large geographic landscapes. However, algorithmic modeling allows diverse wetlands to be objectively grouped and compared for ecological features relevant to amphibian populations and improves conservation planning.

Notes

1**0. Planning for the Unpredictable: White Nose Syndrome Arrival and Potential Impacts in British Columbia, Canada.** Purnima Govindarajulu, *BC Ministry of Environment, PO Box 9338 Stn Prov Govt, Victoria, BC V8W 9M1; Purnima.Govindarajulu@gov.bc.ca;* Cori Lausen, *Wildlife Conservation Society Canada, 202 B Ave, PO Box 606, Kaslo, BC V0G1M0; corilausen@birchdalebc.ca;* Helen Schwantje, *BC Ministry of Environment, PO Box 9338 Stn Prov Govt, Victoria, BC V8W 9M1;Helen.Schwantje@gov.bc.ca.*

White Nose Syndrome (WNS) is an emerging disease in bats in North America caused by the fungus *Geomyces destructans*. First documented in 2006 in New York, the disease has spread hundreds of kilometers each year and has killed over 5 million bats in less than 5 years. White Nose Syndrome was first documented in Canada in 2010 and has now spread to all the provinces east of Ontario. The primary mode of transmission is currently thought to be through bat to bat contact, although the role of humans in the introduction of WNS to North America and its subsequent spread is still debatable. In response to the devastation caused by this disease, the national plan to manage WNS in Canada lists five priority actions for 2013: establish national coordination, monitor bat populations, carry out surveillance for WNS and *Geomyces destructans*, mitigate WNS where present, and promote research into WNS detection and mitigation. The arrival of WNS in the Pacific Northwest including British Columbia is unpredictable because the extent of bat to bat contact across the Rockies is not well understood, and the potential for human vectored transport of the disease cannot be easily monitored or controlled. The detection and management of the disease is also a challenge due to large knowledge gaps in bat winter range and behaviour in British Columbia. This talk presents early results of winter monitoring for bats in southern Vancouver Island and discusses the potential for these early results to inform WNS management in British Columbia.

11. Changing Perspectives of North American Wildlife Attitudes. David Hancock, *Hancock Wildlife Foundation, 19313 Zero Avenue, Surrey, BC, V3S 9R9; david@hancockwildlife.org*

A presentation on how changing attitudes towards wildlife from the early 1950s through to today have effected wildlife populations. From the early years of conducting aerial surveys for waterfowl and raptors on the west coast to present-day live streaming of wildlife cams for education and science, our changing attitudes have led to incredible unintended impacts on wildlife populations. In the USA, bounties paid on Bald Eagles (*Haliaeetus leucocephalus*) led to their disappearance from coastal Washington State by the 1950s; Canadians similarly despised Bald Eagles, seals, sea lions and orcas (*Orcinus orca*), and took appropriate measures considered acceptable at the time, but often with different outcomes. David Hancock will also share telling anecdotes about the herring fisheries and review how our changing attitudes to wildlife have changed wildlife populations, from fish to raptors to marine mammals.

12. Kinbasket and Arrow Lakes Reservoirs: Amphibian and Reptile Life History and Habitat Use Assessment. Virgil C Hawkes and Krysia Tuttle. *LGL Limited environmental research associates, 9768 Second Street, Sidney, British Columbia, V8L 3Y8; vhawkes@lgl.com*

A 10-year amphibian and reptile life history and habitat use monitoring study was initiated in 2008 in the drawdown zones of Kinbasket and Arrow Lakes Reservoirs, located in southeastern British Columbia. This study is intended to address the relative contribution and importance of the current reservoir operating regimes (i.e., timing, duration, and depth of inundation) on the life history (e.g., abundance, distribution and productivity) and habitat use of amphibians and reptiles occurring in the drawdown zones of each reservoir. In 2011, an additional study was incorporated to specifically address the potential impacts of the installation of units 5 and 6 at Mica Dam on amphibian survivorship in the drawdown zone of Kinbasket Reservoir. Ten management questions are investigated in this study, with the primary objective being to provide information on how amphibian and reptile communities are affected by long-term variations in water levels at the landscape scale and whether changes to the reservoir's operating regime (e.g., altering the timing, duration, or frequency of inundation) may be required to maintain or enhance these communities or the habitats in which they occur. Reservoir operations influence habitat availability and suitability and the influence of these operations on amphibian populations are discussed, with an emphasis on Western Toad (*Anaxyrus boreas*) and Columbia Spotted Frog (*Rana luteventris*).

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13. Difference in Flight Initiation Distance between Recently Metamorphosed Oregon Spotted Frogs and American Bullfrogs. Marc P. Hayes, *Washington Department of Fish and Wildlife, Habitat Program, Science Division, 600 Capitol Way North, Olympia, Washington 98501; Marc.Hayes@dfw.wa.gov;* Kyle S. Tidwell, *Portland State University, Department of Biology, 246 Science Building 2, 1719 SW 10th Avenue Portland, Oregon 97201; tidwell2@pdx.edu*

Observations that recently metamorphosed Oregon Spotted Frogs (*Rana pretiosa*) appear to allow close approach before fleeing led us to contrast their flight initiation distances with those of introduced American Bullfrogs (*Lithobates catesbeianus*) in order to determine whether this anti-predator variable had the potential to make *R. pretiosa* vulnerable to predation. Using a rangefinder radio-linked to a high-resolution GPS unit, we quantified flight initiation distance for recently metamorphosed juveniles of both species using a controlled approach at Conboy Lake National Wildlife Refuge, Washington State, USA. Recently metamorphosed *R. pretiosa* typically allowed extremely close approach (flight initiation distances $\tilde{x}$= 0.07 m, range: 0–6.5 m) with over 30% of frogs approached allowing themselves to be touched prior to fleeing. In contrast, recently metamorphosed *L. catesbeianus* typically did not allow close approach, always fleeing at distances ≥ 1.7 m (flight initiation distances $\tilde{x}$= 6.1 m, range: 1.7–13.9 m). The close approach tactic of *R. pretiosa* would be consistent with a crypsis-based anti-predator strategy, whereas *L. catesbeianus* uses a flight-oriented method of avoiding predation. Permitting close approach may place recently metamorphosed *R. pretiosa* within the typical predatory strike range of *L. catesbeianus*, which may explain the disappearance of *R. pretiosa* in areas invaded by *L. catesbeianus*. *Rana pretiosa* at Conboy Lake represents a unique instance of long-term co-occurrence with *L. catesbeianus*, raising questions about the basis of this co-occurrence.

14. Riverine Bird Response to Controlled Flow Release on the Lower Bridge River. Ralph Heinrich. *R.P. Bio, Wildlife Biologist, 643 Bissette Road, Kamloops, BC, V2b 6L3, wildtech@telus.net;* Russ Walton, *Wildlife Biologist, 3160 Bank Road, Kamloops, BC, V2B 6Z5 russ_walton@telus.net.*

Terzaghi Dam (completed1960) diverted water from the Bridge River to powerhouses on Seton Reservoir, leaving approximately 4.1 km of dry river bed below the dam. In August 2000, BC Hydro initiated an average annual release of 3 m^3/s, converting the 4.1-km section of dry river bed into potentially usable habitat. In May 2011, the average annual release was increased to 6 m^3/s. Pre-release surveys were conducted in 1999 and 2000. We conducted three years of full-length post-release surveys on the 15.9-km section from the Terzaghi Dam to the Yalakom River confluence under the 3 m^3/s flow regime. We repeated these surveys (2011 and 2012) under the 6 m^3/s flow regime. The most common riverine species observed were Common Mergansers (*Mergus merganser*), Spotted Sandpipers (*Actitis macularius*), Harlequin Ducks (*Histrionicus histrionicus*), Belted Kingfishers (*Megaceryle alcyon*), and American Dippers (*Cinclus mexicanus*). Spotted Sandpipers and American Dippers increased on the 4.1 km previously de-watered section with the 3 m^3/s release, suggesting that riverine birds have adapted to new opportunities presented by the controlled release. Over the full 15.9-km section, Spotted Sandpiper numbers more than doubled and Harlequin Duck and Common Merganser numbers increased during the brood surveys, suggesting that, overall, the Bridge River has improved as a brood-rearing habitat under the 3 m^3/s flow regime. Other species numbers have not changed but seem to have shifted their distribution upstream towards the previously de-watered section below the dam. Effects of the new 6 m^3/s release are less clear, with only 2 years of data available, and should be interpreted cautiously. Five more survey years are scheduled at the 6 m^3/s flow rate (2013-2020).

15. Quantifying the Biological Tradeoffs of Two Common Supplementation Strategies for Imperiled Amphibian Populations. *Amanda M. Kissel, *Simon Fraser University, 8888 University Dr., Burnaby BC, V5N1S1, Amanda.m.kissel@gmail.com;* Wendy J. Palen, *Simon Fraser University, 8888 University Dr., Burnaby BC, V5N 1S1,wpalen@gmail.com;* Purnima Govindarajulu, *Ministry of Environment, PO Box 9338 Stn Prov, Govt, Victoria BC, V8W 9M1, Purnima.Govindarajulu@gov.bc.ca;* Christine A. Bishop, *Environment Canada, Science and Technology Branch, 5421 Robertson Road, Delta BC, V4K 3N2, CAB.Bishop@ec.gc.ca*

Global biodiversity loss continues to accelerate, which has prompted the adoption of diverse efforts to stem or reverse declines for many imperiled species around the world. Such efforts are often implemented before mechanisms of decline are fully understood, and without a means to compare the likelihood of success of alternative management actions. Here, we develop a novel modeling framework for comparing the effectiveness of alternative management strategies aimed at reducing the extinction risk of declining

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amphibian populations. We used demographic data collected for the highly imperiled Oregon Spotted Frog (*Rana pretiosa*) as a case study, and examined the tradeoffs between two population supplementation strategies, head-starting of early life stages and captive breeding with subsequent release. We calculated the sensitivity of each strategy to variation in wild population size (the degree of imperilment) and the amount of effort invested in supplementation. We find at low levels of effort and small population sizes, captive breeding is 2.8 times more biologically effective at reducing extinction probabilities of wild populations, but the gap in effectiveness declines at populations above 150 breeding females. In contrast, we find that head-starting only weakly reduces the probability of extinction even when effort is high, and is ineffective if wild populations shrink to fewer than 100 individuals. Our conclusions highlight the value of quantitatively assessing the biological tradeoffs of alternative management strategies and suggest that for critically low populations, captive breeding is a more effective strategy for reducing extinction probability.

16. Seasonal Movement and Cause-specific Mortality of Short-tailed Weasels in a Managed Forest Landscape in Western Oregon. Mark A Linnell, *Oregon State University, 104 Nash Hall, Corvallis, OR 97331; Mark.Linnell@oregonstate.edu;* Clinton Epps, *Oregon State University, 104 Nash Hall, Corvallis, OR 97331; Clinton.Epps@oregonstate.edu*

Short-tailed Weasels (*Mustela erminea*) are small predators that fulfill an ecological niche as both predator and prey, but despite their widespread occurrence in forested ecosystems of the Pacific states very little is known about their movement ecology and survival. We used VHF radio collars to track the movement and fate of a sample of 22 male Short-tailed Weasels in a managed forest landscape during the dry (June 1, 2012–October 31, 2012) and wet seasons (November 1, 2012–March 31, 2013). Short-Tailed Weasels were in poorer body condition, had a greater likelihood of predation, and were limited by available rest sites in the wet season compared to the dry season. Most mortality events occurred in or adjacent to riparian corridors which were commonly used by Short-tailed Weasels in both seasons. Rest sites were located in or near slash piles in open forest (recently clear-cut) and in or near large, decayed logs and hardwoods in closed forest (>20 years since clear-cut). Leaving large woody debris may increase weasel use of closed forests, leading to increased connectivity as landscapes transition through continued cycles of timber harvest. Higher predation risk in riparian corridors indicates that despite high prey availability, these areas represent considerable risk to Short-tailed Weasels in the wet season.

17. Assessing the Impacts of Run-of-River Hydropower on Coastal Tailed Frogs: Preliminary Study Design and Power Analysis. Josh Malt, *Forests, Lands, and Natural Resource Operations, Suite 200, 10428 - 153 St, Surrey, BC, V3R 1E1; Joshua.Malt@gov.bc.ca;* Erin Crockett, *Forests, Lands, and Natural Resource Operations, Suite 200, 10428 - 153 St, Surrey, BC, V3R 1E1; Crockett.Erin@gmail.com;* Chris Johnson, *University of Northern British Columbia, 3333 University Way Prince George, BC, V2N 4Z9; johnsoch@unbc.ca*

Rapid expansion of the Run-of-River Hydropower Industry in B.C. has outpaced the current state of knowledge regarding potential impacts of these projects on wildlife species. Coastal Tailed Frogs (*Ascaphus truei*), a Species at Risk, lay their eggs in permanent mountain streams, where they remain as tadpoles for 2-4 years. Because of frequent overlap with suitable habitat, concerns have arisen regarding the potential impacts of hydropower on tailed frog populations. Potential impacts include a decrease in the availability of aquatic habitat, reduced cobble and gravel-sized substrate, increased sedimentation in certain reaches, and impacts on habitat connectivity. Here we present a power analysis, preliminary study design, and proposed sites designed to form a study to assess the potential impacts of hydropower on tailed frogs. We propose to sample habitat variables and larval abundance within diversion reaches ("impact" sites), and upstream of the intake beyond the effects of water diversion ("controls"). Sampling will be conducted before and after project construction for hydropower facilities currently in their design phase (N = ~5), enabling a "Before-After-Control-Impact" (BACI) study. These data will be bolstered with data from facilities currently in operation (N = ~7; "Retrospective Impact" study). Using preliminary data collected at 3 hydropower facilities, we demonstrate how statistical power changes with various levels of replication at the facility, 100-m reach, and TCS sampling levels. We discuss the trade-offs of different study design options with respect to feasibility and level of effort. Unexpected impacts from buried penstock crossings, and alternative sampling methods for larger river systems are also discussed.

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18. Habitat Ecology of the Coastal Tailed Frog in Terrace, British Columbia Canada. *Alexis McEwan, *University of Northern British Columbia, Prince George, BC V2N4Z9; mcewan@unbc.ca;* Chris Johnson, *University of Northern British Columbia, Prince George, BC V2N4Z9;* Melissa A. Todd, *BC Ministry of Forests, Lands and Natural Resource Operations, Coast Area, Nanaimo, BC V9T4R5;* Purnima Govindarajulu, *BC Ministry of Environment, Victoria, BC V8W9M1.*

Coastal Tailed Frogs (*Ascaphus truei*) are endemic to the Pacific Northwest. As habitat specialists, they have evolved life history requirements closely associated with fast-flowing headwater streams and old forests. Most research supporting habitat management in British Columbia has concentrated on larval populations. This limits our understanding of the sensitivity of post-metamorphic frogs to land management activities across terrestrial habitats. We are investigating the spatial ecology of tailed frog populations, as revealed by seasonal variation in activity and movement. This research will reveal population processes that may be influenced by timber harvest or other forms of habitat alteration. Over two consecutive field seasons (June-October), we outfitted 37 frogs (15 males, 32 females) with radio-transmitters. In total, 22 frogs (9 males, 13 females) were successfully monitored for 6-24 days. Resulting distribution data suggests that these frogs will move relatively large distances (up to 172 m) from larval streams and have an affinity to large and decayed coarse woody debris. In addition to the radio telemetry, we monitored systematic pitfall arrays (~1.2 ha) at 6 known larval streams. Preliminary trapping results suggest that site variability in abundance can be attributed to forest stand age and climate conditions associated with elevation. Additionally, more individuals were captured during the spring (July) and fall (October) when compared to the summer (August) trapping sessions. These movement patterns correspond with ovipositioning during the spring and movement to breeding aggregate sites during the fall.

19. Describing Marten Activity Patterns Using Accelerometers. *Katie M. Moriarty and Clinton W. Epps, *Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 97331; ktmoriarty22@gmail.com; Clinton.epps@oregonstate.edu*

North American martens (*Martes americana*, *M. caurina*) are forest-dwelling species associated with complex vegetation structure. Five previous studies that used signal modulation of VHF collars to assess marten activity types (e.g. diurnal, crepuscular) did not find consistent patterns, suggesting that behavior varies seasonally, with weather, and with activity of prey. We deployed micro-GPS collars with activity sensors (accelerometers) on adult Pacific Martens (*M. caurina*; n = 6 females, 12 males) in Lassen National Forest, California between August 2010 and March 2013. Accelerometers collected an index of activity every 2 minutes for up to 9.7 days, providing a consistent and continuous representation of activity patterns. We compared accelerometer-derived activity patterns with published data and evaluated individual activity types in relation to season (snowfree, snow). When all data were combined, diel activity patterns were similar to previous studies in California. However, seasonal patterns in our study differed from previous descriptions. Activity type varied among individuals, where half of the individuals were diurnal in the summer and nocturnal in the winter, but the other half were either diurnal or nocturnal in both seasons. These high-resolution data will allow us to assess the effects of habitat type, prey and predator activity, and landscape configuration on marten activity. Although logistical constraints such as battery life are severe, micro-GPS collars with an accelerometer may be an effective research tool to quantify mustelid activity patterns.

20. Out of Hot Water: Bullfrog Invasions Cool Off in Exotic Climate. Rylee Murray; *ryleem@sfu.ca*, Wendy J. Palen; *wpalen@gmail.com*, Viorel D. Popescu, *vioreldpopescu@gmail.com; Simon Fraser University Department of Biological Sciences, 8888 University Drive Burnaby, BC V5A 1S6;* Purnima Govindarajulu, *BC Ministry of Environment PO Box 9338 Stn Prov Govt, Victoria, BC, V8W 9M1; Purnima.Govindarajulu@gov.bc.ca*

Introduced species threaten biodiversity worldwide, yet we remain challenged to define what makes a successful invader or predict invasion progressions. Although new methods have increased our power to predict exotic species expansions using data-hungry analyses, few provide a useful approach for managers with small data sets or limited resources. We provide a simple approach to assessing the invasion of American Bullfrog (*Lithobates catesbeianus*) in British Columbia. We conducted presence-absence surveys to build single-season occupancy models used to predict occupancy outside the current range. We found that current site occupancy is best predicted by the amount of freshwater habitat within 500 m, and distance

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from the original introduction site. These models suggest that the rate of expansion in BC is much lower than in other invaded regions around the globe. By comparing climate envelopes we find that bullfrogs in BC occur in climate space that is significantly different from the native range. Using a relatively small data set we inferred the likelihood of future colonization. Such information can support proactive management planning for species and ecosystems threatened by bullfrog invasion.

21. Bats and British Columbia Wind Energy- The Known and Unknown. David W. Nagorsen, *Mammalia Biological Consulting, 4268 Metchosin Road, Victoria, BC V9C 3Z4; mammalia@shaw.ca.*

Bats, particularly species of migratory tree bats, have shown high fatality rates at some wind energy facilities in North America. The impact of wind energy development on British Columbian bats is unknown. Currently only 3 wind facilities are operational in the province; another 19 proposed projects have environmental approval or are under review. Using available data from pre-construction and post-construction assessments, I describe patterns of bat activity and fatality at wind energy facilities in northeastern BC. Pre-construction acoustic surveys revealed mean bat activity rates (August-September) of 3.5-70.6 passes/detector night at 4 facilities. Activity varied seasonally, with peaks in late summer. Nightly variation in activity was correlated with wind speed and temperature. Detections at all facilities were predominately (80-90%) *Myotis* bats. Only 1-15% of passes were low-frequency bats (*Eptesicus fuscus*, *Lasionycteris noctivagans*, *Lasiurus cinereus*), with *L. cinereus* accounting for < 1% of the low-frequency files. Corrected fatality estimates for 2 facilities were 1.3 and 4.6 fatalities /turbine/year. Six bat species were killed, with most *L. noctivagans* and *Myotis lucifugus*. I discuss the concordance of these results with other North American facilities. Predicting and managing bat mortality at BC wind facilities is hindered by few data, no provincial protocols for pre and post construction bat assessments, and a lack basic research.

22. The Science and Management of Emerging Wildlife Diseases: *Gd* in *Bd*'s Slipstream. Deanna H. Olson, *US Forest Service, Pacific Northwest Research Station, 3200 SW Jefferson Way, Corvallis, OR 97331; dedeolson@fs.fed.us;* Sybill K. Amelon, *US Forest Service, Northern Research Station, 202 Natural Resources Building, University of Missouri, Columbia, MO 65211; samelon@fs.fed.us.*

Emerging infectious diseases in wildlife appear to be on the rise, with fungal pathogens implicated in mass-mortality events among diverse taxa including amphibians, reptiles, and mammals. Mass-mortality events from fungal pathogens appear to be a relatively novel concern for wildlife, either due to their being a cryptic scourge relative to our notice in the past, or due to new levels of virulence or transmission. Fungi can spread quickly within populations, decimating local abundances, and may be able to move easily among populations, rapidly dispersing across broader regions. Furthermore, human globalization patterns may assist fungal migration. For instance, Chestnut Blight (*Cryphonectria parasitica*) is believed to have been introduced to North America from Europe. Amphibian trade, including species such as the African Clawed Frog *(Xenopus laevis*) and American Bullfrogs (*Lithobates catesbeianus*), has been linked to transportation of the amphibian chytrid fungus (*Batrachochytrium dendrobatidis, Bd*) around the world. Recent evidence indicates that the fungus *Geomyces destructans*, *Gd*, linked to white-nose syndrome in bats, arrived in a New York cave via human-mediated transport from Europe. Hence, in several regards, fungal pathogens present a very different wildlife problem than other microbes, and their ecology and epidemiology are relatively little-known. What can herpetologists and mammalogists learn from each other that may contribute not only to dealing with these current threats, but to those that may arise in the future? We examine the similarity and contrasts between *Bd* and *Gd* in pathogen characteristics as well as scientific and management approaches to understanding and arresting the diseases they cause.

23. Balancing Species Conservation and Small Hydropower Development in British Columbia—Part I: the Process. Viorel D. Popescu, *vioreldpopescu@gmail.com;* **Wendy J. Palen [speaker]**, *wpalen@gmail.com;* Eugenia Dubman, *jda9@sfu.ca;* Robin Munshaw, *robinmunshaw@gmail.com; Earth2Ocean Research Group, Simon Fraser University, 8888 University Drive, Burnaby BC V5A 4G5*

Small, distributed sources of renewable energy are increasingly used to meet future energy demand, and are viewed as minimum-impact alternatives to traditional technologies. We examined the trade-offs between small hydropower development and species conservation objectives in British Columbia, Canada using the spatial conservation prioritization framework Zonation. We concentrated on evaluating potential impacts on salmonids (*Oncorhynchus* spp.) and Grizzly Bears (*Ursus arctos*), due to their economic, cultural,

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and conservation importance. Of the 7,000 potential development locations for small hydropower in the province, ~1,500 are economically feasible in present energy markets, and concentrated on Vancouver Island, the coastal mainland, and Rockies. The density of potential hydropower projects per watershed ranged between 0.02 and 1.5 projects/100 km^2. The highest potential conflicts with Grizzly conservation occur in SW and SE watersheds, where threatened populations occur in areas of high energy potential (up to 1636 GWh/year). We identified that 15-40% of watersheds in coastal BC and Vancouver Island have potential conflicts between salmonids and small hydropower development, but conflicts may be reduced by siting projects upstream of salmon habitats. We identified a range of future scenarios that attempt to balance energy development and species conservation goals, suggesting that conflicts between energy and environment could be partially mitigated by strategic spatial planning.

24. Spotties vs. Bullies: Differentiation of Habitat Selection by Endangered Oregon Spotted Frogs and Invasive American Bullfrogs in Shallow Water Wetland Habitats. *Monica M Pearson, *University of British Columbia, 2357 Main Mall, Vancouver, BC V6T 1Z4; monica@balance-ecological.com.*

The Oregon Spotted Frog (*Rana pretiosa*, OSF) is a critically endangered species in Canada. Reintroduction into historic and new habitats is essential for the survival and recovery of this species. However, American Bullfrogs (*Lithobates catesbeianus*) in remnant OSF habitats are proposed as a direct cause of local extinctions. As both OSF and Bullfrogs prefer shallow, warm slow-moving wetland habitats, reintroductions of OSF must consider habitat selection of both species, and restoration efforts must provide appropriate habitat for OSF while deterring colonization by Bullfrogs. We used radio-telemetry to identify and differentiate habitat selection of both Oregon Spotted Frogs and Bullfrogs in a shared habitat, and developed criteria for habitat modification and creation. Adults of the two species used different habitat typologies, with endangered Oregon Spotted Frogs using shallower and more structurally complex sites than the Bullfrogs. Adult Bullfrogs almost exclusively used deeper water with a low density of emergent islands or hummocks and dominated by rooted floating vegetation. Habitats designed to benefit Oregon Spotted Frogs should provide a shallow yet complex topology with a high density of vegetation clumps and leafy emergents. Habitat alterations to reduce Bullfrog densities should include water-level controls that maintain shallow depths and promote islands of clumped emergent vegetation rather than rooted floating vegetation. This project will inform the Canadian Oregon Spotted Frog Recovery Team's efforts to restore Oregon Spotted Frog populations across their historic range in BC's Lower Mainland Region.

25. Patterns of Reptile Species Richness and Vulnerability across Northwestern North America. David S Pilliod, *US Geological Survey Forest and Rangeland Ecosystem Science Center, Boise, ID 83706; dpilliod@usgs.gov;* Deanna H Olson, *USDA Forest Service Pacific Northwest Research Station, Corvallis, OR; dedeolson@fs.fed.us.*

Climate change and persistent loss and fragmentation of habitat are influencing the vulnerabilities of lizard and snake species in Northwestern North America. We are taking a first step in assessing species vulnerabilities by identifying areas of high species richness and evaluating anthropogenic and natural stressors in those areas. We compiled all available location records for each snake and lizard species in Alberta, British Columbia, Idaho, Montana, Oregon, Washington, and Wyoming. We used various tessellations of the Northwest to identify reptile diversity hotspots and ecological factors associated with variations in species richness. We then examined ecological changes and potential stressors in those areas, including vegetation conversion, fire, invasive species, human impact (human footprint), and land conservation status. Preliminary analyses have identified concentrated areas of high species richness for the 18 lizard and 35 snake species in the US-Canada boundary area of the Northwest. Only 4 lizard and 9 snake species range into Canada, but this number may increase as climate change progresses, assuming habitat and connectivity are available. Two lizard species have been introduced to the region, but with little range expansion since introduction. We expect that our initial distribution models will generate hypotheses for potential follow-up empirical investigations. Future work will examine relationships between current and future climate and reptile species vulnerabilities. This information could be used by land and resource agencies and conservation organizations to prioritize habitat protection for vulnerable species.

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26. Balancing Species Conservation and Small Hydropower Development in British Columbia—Part II: the Science. Viorel D. Popescu, *vioreldpopescu@gmail.com;* Wendy J. Palen, *wpalen@gmail.com;* Eugenia Dubman, jda9@sfu.ca; Robin Munshaw, *robinmunshaw@gmail.com; Earth2Ocean Research Group, Simon Fraser University, 8888 University Drive, Burnaby BC V5A 4G5*

Small, distributed sources of renewable energy are increasingly used to meet future energy demand, and are viewed as minimum-impact alternatives to traditional technologies. We examined the trade-offs between small hydropower development and species conservation objectives in British Columbia, Canada using the spatial conservation prioritization framework Zonation. We concentrated on evaluating potential impacts on salmonids (*Oncorhynchus* spp.) and Grizzly Bears (*Ursus arctos*), due to their economic, cultural, and conservation importance. Of the 7,000 potential development locations for small hydropower in the province, ~1,500 are economically feasible in present energy markets, and concentrated on Vancouver Island, the coastal mainland, and Rockies. The density of potential hydropower projects per watershed ranged between 0.02 and 1.5 projects/100 km^2. The highest potential conflicts with Grizzly conservation occur in SW and SE watersheds, where threatened populations occur in areas of high energy potential (up to 1636 GWh/year). We identified that 15-40% of watersheds in coastal BC and Vancouver Island have potential conflicts between salmonids and small hydropower development, but conflicts may be reduced by siting projects upstream of salmon habitats. We identified a range of future scenarios that attempt to balance energy development and species conservation goals, suggesting that conflicts between energy and environment could be partially mitigated by strategic spatial planning.

27. Assessing Landscape Impacts on Sockeye Salmon in BC's Skeena Region. Marc Porter, *ESSA Technologies Ltd., Suite 600-2695 Granville St., Vancouver, BC. V6H 3H4; mporter@essa.com;* Simon Casley, *scasley@essa.com;* Darcy Pickard, *dpickard@essa.com;* and Nick Ochoski, *nochoski@essa.com*

BC's Skeena River provides extensive freshwater habitats for five salmon species, Steelhead (anadromous *Oncorhynchus mykiss*), and 30 other fish species. This includes 32 evolutionarily distinct Sockeye Conservation Units (CUs), 8 Chinook CUs, 4 Coho CUs, 4 Chum CUs, and 5 Pink Salmon CUs (*O. nerka*, *O. tshawytscha*, *O. kisutch*, *O. keta*, and *O. gorbuscha*, respectively). The Skeena's Babine Lake is Canada's largest Sockeye producing system, contributing millions of salmon to First Nations sustenance and commercial fisheries. The Skeena has avoided much of the development pressure that has compromised fish habitats in other large watersheds. However, there are exceptions (e.g., areas of extensive logging) where habitat deterioration has harmed fish populations, while numerous development proposals (pipelines, mines, highways, etc.) and other landscape stressors (e.g., Mountain Pine Beetle [*Dendroctonus ponderosae*], climate change) present a growing threat to Skeena salmon habitats. The Skeena may be at a critical juncture; it is an incredibly productive region, but it may be vulnerable to continuing degradation. ESSA Technologies Ltd., under contract to the Pacific Salmon Foundation (PSF), is currently undertaking quantitative GIS-based assessments of the relative extent/intensity of regional watershed-scale pressures affecting freshwater habitats used by Skeena Sockeye for different life-history needs (mainstem migration, tributary spawning, and lake rearing). This project provides a broad-level synoptic overview of current individual and cumulative stresses on Skeena Sockeye habitats. Information is summarized in CU habitat indicator "report cards" that reflect the current and future risk/vulnerability of individual Skeena Sockeye CUs to habitat degradation. This work provides the frame for similar habitat report cards that will be developed for all Skeena salmon species and their associated CUs.

28. Revisiting the Use of Electrofishing for Sampling Non-fish Values. Ronald A. Ptolemy & Kathy Paige, *Ministry of Environment. PO Box 9338 Stn Prov Govt Victoria, BC V8W 9M1*. Darcy Pickard, *ESSA Technologies Ltd., 600 - 2695 Granville St. Vancouver, B.C., Canada V6H 3H4.*

During routine fisheries stock assessments other vertebrate and invertebrate species such as Coastal Tailed Frogs (*Ascaphus truei*) and Coastal Giant Salamanders (*Dicamptodon tenebrosus*) are often observed. We report densities of these species observed during B.C. Provincial fisheries stock assessments of two large rivers using total removal shore-based electrofishing (1984-1993). Watershed area and channel width at sample sites were approximately: 630 km^2, 40 m (Coquihalla River); 645 km^2–1230 km^2, 50 m-100 m (Chilliwack River). We also report Coastal Tailed Frog densities from a pilot study using amphibian aquatic time-constrained searches for a range of stream sizes in the Cascades region of BC (2012). Sites were selected from the region using a probabilistic sampling design from each of 3 categories of stream,

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defined by basin area: 0.2-2.0 km^2, 2.0-10 km^2, and 10-50 km^2. Tailed frogs and giant salamanders are not traditionally sampled in large streams because current sampling methods are either inefficient or impossible or this habitat has been considered less suitable. The importance of individuals found in large rivers to the population is unclear, and therefore so are the implications of restricting the sampling frame for these species to smaller streams. This is particularly true in light of the trend towards more run-of-river hydroelectric development and the uncertainty in how these will affect stream amphibians. We pose the question as to whether electrofishing in edge habitat of large rivers is worth considering as a component of stream amphibian monitoring programs and whether there are opportunities to gain efficiencies by coordinating with fisheries assessments.

29. Recognition of Refuge Sites Using Olfactory Cues in the Coastal Giant Salamander (*Dicamptodon tenebrosus*). *David Reavill, Robert E Weaver, R Steven Wagner, Laura Westervelt, Brandon Fessler, *Department of Biological Sciences, Central Washington University, 400 East University Way, Ellensburg, WA 98926; reavilld@cwu.edu*

Chemical cues are used as ubiquitous markers in salamanders, and serve as the primary modality for conveying interspecific information such as species identity, kinship, and individual information, as well as territorial markers. Although the role of chemical cues has been widely studied in many salamander families particularly plethodontids, studies on the family Dicamptodontidae are very scarce. In order to test whether Coastal Giant Salamanders (*Dicamptodon tenebrosus*) are able to use chemical cues to discriminate among self-marked, conspecific marked, and blank substrates, we performed unforced two-choice trials. One of 15 individuals was provided with 2 shelters (plastic tubes), and tested under 3 scenarios: (i) self-marked vs control, (ii) conspecific-marked vs control, and (iii) self-marked vs conspecific-marked. Trials were filmed for 12-hour periods and the video analyzed to determine time spent in each shelter. Our results show that *D. tenebrosus* were able to (i) discriminate between self-marked vs blank tubes, (ii) preferred a tube marked by a conspecific over a blank tube, and (iii) preferred a self-marked over a conspecific-marked tube. We suggest that attraction to previously marked refuge sites serves as an economical indicator of site quality, which may reduce the risk of unnecessary exposure.

30. Cascading Impacts on Amphibian Assemblages in Restored Wetlands. * Jennifer C. Rowe, Tiffany S. Garcia, *Department of Fisheries and Wildlife, Oregon State University, 104 Nash Hall, Corvallis, OR 9733; jennifer.rowe@oregonstate.edu*

Novel interactions that arise within human-modified habitats pose a unique challenge to restoration. The objective of this study was to determine whether intensity of invasive plant management (active or passive) and presence of invasive species produces cascading effects on amphibian assemblages in restored wetlands. We documented biodiversity and vegetative cover at 26 sites enrolled in the Wetlands Reserve Program in Oregon's Willamette Valley. Multivariate statistical methods were employed to evaluate the relative importance of interacting biotic and abiotic factors thought to influence amphibian abundance at multiple spatial scales. Actively managed wetlands had significantly less cover by invasive plant species and higher Simpson's plant diversity compared to passively managed sites. Percent invasive plant cover (proxy for management intensity) was found to disproportionately affect abundance of early life stages at the local (wetland) scale. However, the candidate set of generalized linear models inferred by Akaike's information criterion indicated that the presence of non-native fish was the most consistently strong predictor of Bullfrog (*Lithobates catesbeianus*, positive effect) and native anuran (negative effect) abundance. When broad spatial scale models were considered, landscape composition (i.e., wetland cover, forest cover, and urban/developed cover) replaced site-scale variables in importance, with the exception of non-native fish. The relative significance of landscape variables varied among species and life stages, and this may reflect species-specific differences in dispersal capabilities and habitat requirements. This study elucidates the synergistic stressors placed on native amphibians and emphasizes the importance of holistic, adaptive approaches to maintaining diverse communities and preventing the creation of localized population sinks.

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31. In Hot Water: Developmental Plasticity to a Warming Climate in a High-elevation Amphibian Assemblage. *Lindsey L. Thurman, Oregon State University Department of Fisheries and Wildlife, 104 Nash Hall, Corvallis, OR 97331; lindsey.thurman@oregonstate.edu; Tiffany S. Garcia, Oregon State University Department of Fisheries and Wildlife, 104 Nash Hall, Corvallis, OR 97331; tiffany.garcia@oregonstate.edu

The rapid loss of habitable climate space in montane ecosystems has resulted in a disproportionate number of extinctions in high-elevation-restricted amphibian species. However, species capable of plastically altering life-history traits, such as larval development rate, may exhibit optimal strategies for resisting a warming climate. We examined the larvae of three high-elevation Anuran species from the US Pacific Northwest, the Cascades Frog (*Rana cascadae*), Western Toad (*Anaxyrus boreas*), and Pacific Chorus Frog (*Pseudacris regilla*), for their ability to increase larval development rates in response to warming. Each species was exposed to two temperature regimes: the control treatment simulated historical, summer temperatures for the decade of 2001 to 2011; the warmed treatment mirrored the seasonal trend, but simulated a 4°C average increase in temperature. We quantified multiple larval growth characteristics to compare the variability in development as a function of these temperature regimes. We found significant acceleration in larval development rates under the warmed temperature regime ($F = 21.68$, $P < 0.01$), with differential reductions in body size at metamorphosis, for all three species ($F = 85.64$, $P < 0.01$). For R. cascadae, the consequences of plasticity in development rates for emerging adults may be detrimental to populations that are already of serious conservation concern. The relative vulnerability of high-elevation amphibian species to extinction will depend on their capacity for rapid adaptation to pervasive environmental change.

32. Can the Effect of Tall Structures on Birds Be Isolated from Other Aspects of Development? Kimberly Walters, *Hemmera, 250 - 1380 Burrard Street, Vancouver, British Columbia V6Z 2H3; kwalters@hemmera.com;* Karl Kosciuch, *Tetra Tech, 1750 SW Harbor Way, Portland, Oregon 97201; karl.kosciuch@tetratech.com*; Jason Jones, *Tetra Tech, 800 - 555 West Hastings Street, Vancouver, British Columbia V6B 1M1; jason.jones@tetratech.com*

As technology and energy development increases, undeveloped land and land traditionally used for agriculture now host structures not part of the historical landscape. These structures (e.g., communication towers, transmission lines) are taller than many objects in natural landscapes. Concerns have been raised regarding the effects of tall structures on birds, primarily functional habitat loss due to avoidance. Two hypotheses have been advanced to explain observed patterns of birds near tall structures: increased perceived predation risk and neophobia. We examined the literature and used a vote-counting methodology to document (a) the reported direction (positive or negative) of a potential tall-structure effect; (b) if the effect of tall structures can be isolated from other effects of development; (c) whether the study design leant itself to drawing a supportable conclusion; and (d) if the authors suggested a causal mechanism for any observed pattern. We did not detect any consistent response to tall structures, nor did we find evidence to support the two hypotheses. In addition, a structure's "tallness" could not be isolated from other factors associated with development, such as human activity. Understanding causal mechanisms is important for management and conservation because observed effects might not be related to the tallness of the structure but to other factors that could be managed, such as timing of construction. Our results suggest that the effect of tall structures on birds is not well understood, and focused studies that examine before-and-after effects and specific causal mechanisms are needed to support effective project siting and conservation planning.

33. The Enigmatic Sharp-tailed Snake (*Contia tenuis*) in Washington State: Implications for Conservation and Management Strategies in British Columbia. Robert E Weaver, *Department of Biological Sciences, Central Washington University, 400 E University Way, Ellensburg WA 98926; weaverro@cwu.edu*

The Sharp-tailed Snake (*Contia tenuis*) is endemic to the west coast of the United States, as well as limited portions of southern British Columbia. It is often described (and repeated) throughout the literature that *C. tenuis* is a species with limited diel and seasonal activity patterns, and primarily associated with moist coniferous forests, and less so with oak-savannah habitat. Because of this, survey efforts are focused in these habitats during cool, moist weather. These limited attempts to locate this species have led to a perception of rarity in the northern portion of its range. In Washington State, since the early 2002 I have observed over 300 individuals of *C. tenuis* in a wide range of habitats, from deciduous forests

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and intact shrub-steppe desert, or Bromus spp.-covered hillsides, to extremely disturbed plots of land adjacent to shopping centers. In addition to finding *C. tenuis* in the spring and fall, I have observed several individuals crossing roads at night at air temps exceeding 30°C. Based upon these observations I strongly feel this species has a much broader distribution in British Columbia than current knowledge indicates. The August, 2011, discovery of an individual on the BC mainland at Pemberton should not be a surprise. This area is similar to macrohabitats throughout central Washington, where this species is active during the dry summer months. Continued survey efforts in this area and several nearby valleys should reveal previously unknown populations of *C. tenuis*.

34. What it Means to be Rare: Status of the Desert Nightsnake (*Hypsiglena chlorophaea*) in Washington State, and its Relevance to the Management of this Species in British Columbia. Robert E Weaver, *Department of Biological Sciences, Central Washington University, 400 E University Way, Ellensburg WA 98926; weaverro@cwu.edu*

Within the geographic borders of the Pacific Northwest (for this talk, limited to WA, OR, ID, and BC) there are 19 species of snake. Some species are quite common (*Thamnophis* spp., *Pituophis catenifer*), while others abundant but secretive (*Charina bottae*). In a few cases, there are truly rare species (*Rhinocheilus lecontei* and *Opheodrys vernalis*). In my talk, I discuss the current and historical status of the Desert Nightsnake (*Hypsiglena chlorophaea*) in Washington State. I make a case that the perceived rarity of this species is a result of a lack of survey efforts, or from use of inappropriate techniques. Since 2002, I have observed over 700 individuals of *H. chlorophaea* throughout much of eastern Washington, and in a wide range of habitat. This is in stark contrast to the less than 40 individuals reported during the previous 60 years. In British Columbia *H. chlorophaea* is known from just 50 specimens, and is considered Canada's most endangered snake. Its known distribution is limited to the southern Okanagan and lower Similkameen Valley in south-central British Columbia. My goal is to apply what I have learned about the ecology of *H. chlorophaea* to on-going survey and research efforts in British Columbia. This will hopefully increase the known number of individuals and expand its distribution, similar to what is occurring just to the south in Washington.

35. Kinematic Analysis of Prey Capture in Coastal Giant Salamanders (*Dicamptodon tenebrosus*). *Laura H Westervelt, Robert E Weaver, Brandon Fessler, David Reavill, Sara Richbourg, R Steven Wagner, *Department of Biological Sciences, Central Washington University, 400 East University Way, Ellensburg, WA 98926; weaverro@cwu.edu*

Salamanders use a variety of techniques to capture prey that involves a combination of lingual and jaw prehension. For example, some plethodontid salamanders often use ballistic tongue projection to capture prey. Salamanders of the family Dicamptodontidae are the largest-sized terrestrial salamanders in the world, and feed on a diverse array of prey items (arthropods, annelids, small mammals, and reptiles). Objectives of our study were to describe and quantify the behavior of terrestrial adult Coastal Giant Salamanders (*Dicamptodon tenebrosus*). Feeding bouts of 3 distinct prey types (e.g., crickets, earthworms, and slugs) were recorded using high-speed video (420-1000 frames/second) recorded with a Casio Exlim EX-ZR100 digital camera. For a feeding trial, salamanders were placed in a clear viewing tank with 5 mm graph paper behind them and offered a single prey items with forceps. Trials were repeated on separated days with each salamander (N = 12) being exposed to 3 crickets, 2 earthworms, and 1 slug for a total of 144 trials. Videos were analyzed for velocity of initial strike, lingual projection, lower and upper jaw prehension, and feeding success. Non-metric multi-dimensional scaling analysis indicated significant differences in feeding patterns among prey types. Lingual prehension was the prominent method of ingestion when a small prey item was offered (crickets) and the use of upper and lower mandible were used in a snapping motion with larger prey items (earthworms). Future work will incorporate different prey items, as well as examine prey preference and foraging behaviors of *D. tenebrosus*.

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36. Innovative Modeling Tools and Planning Approaches for Economic Development, Social Well-being, and Environmental Resilience. Barry J. Wilson, *Silvatech Consulting Ltd. PO Box 1030, Salmon Arm, BC, Canada, V1E 4P2; b.wilson@silvatech.ca*

Evaluating the implications of economic growth requires proven and responsible cumulative effects assessments that extend beyond simply the potential for negative impacts resulting from a particular development compared to current conditions. This presentation provides examples of approaches that examine both the positive and negative implications of the simultaneous interaction of multi-sector human activities and natural disturbance, historically and into the future. These systems add value to existing studies, GIS data, and practitioner knowledge to provide unique insights into natural resource management and social benefit solutions on complex landscapes. Join analyst Barry Wilson in exploring these innovative tools and how they can be used in BC. See examples of where biologists are using tools like the ALCES model (a landscape cumulative effects simulator) to evaluate current policy effectiveness for species at risk, the establishment of biodiversity management frameworks, and testing the potential for new and innovative management strategies. Explore how these approaches are being used in hotspots like the Alberta Oilsands region and opportunities for this kind of approach in British Columbia.

Juan de Fuca Trail, west coast of Vancouver Island.
Photo by Kim Walters

In alphabetical sequence by last name of primary author A –Z
* = student presentation

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P1. A Tad Too High: UV-B Radiation Exposure May Limit Invasion Potential of American Bullfrogs in the Pacific Northwest Invasion Range. *James B. Doyle, Jennifer C. Rowe and Tiffany S. Garcia, *Department of Fisheries and Wildlife, Oregon State University, Corvallis, OR 97331 USA; tiffany.garcia@oregonstate.edu;rowej@onid.orst.edu;doylejam@onid.orst.edu*

To understand the risks an invasive species poses to wild biodiversity it is important to distinguish the abiotic factors that may influence invasion range potential. Assessment of phenotypically plastic responses induced by novel abiotic stressors can aid in the management and control of important invaders. Our study explored tolerance and trait response to UV-B radiation in an invasive anuran, the American Bullfrog (*Lithobates catesbeianus*). We quantified larval survivorship, phenotypically plastic refuge use and color-change responses across two larval size classes in three populations. We predicted that phenotypic plasticity may allow individuals to respond appropriately to stressful and potentially novel UV-B conditions. We found that Bullfrog larval survivorship in both size classes was negatively affected by exposure to UV-B exposure rates found at low and high elevation breeding sites (10-12$\mu W/cm^2$ and 20-24$\mu W/cm^2$ respectively). Bullfrog larvae in low UV-B treatments exhibited a darkening of body color in response to high UV-B radiation exposure, but only in the small size class. Although this smaller size class did become darker, they did not correlate this alteration in body coloration with behavioral refuge use changes. Populations did not differ in their response to UV-B radiation within either larval size class. Our results suggested a differential ability of Bullfrog larvae to adapt to UV-B stress across ontogeny. These findings are important in understanding differences in Bullfrog presence and population densities across elevational gradients, particularly in Oregon's Cascade Range.

P2. Factors Affecting Human-Coyote Coexistence in Urban Ecosystems. *Brooks Estes, *Fairhaven College, Western Washington University, 516 High St., Bellingham, WA 98225; estesb3@students.wwu.edu;* John Bower, *Fairhaven College, Western Washington University, 516 High St., Bellingham, WA 98225; john.bower@wwu.edu*

A recent addition to urban ecosystems, Coyotes (*Canis latrans*) have successfully adapted to urban life. This review focuses on urban Coyote habitat use, diet, human-Coyote interactions, and programs that promote coexistence with humans. Studies shows that urban Coyotes tend to stay on the periphery of human development during the day, moving into human-created green spaces, such as parks and golf courses, at night. Scat studies indicate urban Coyotes maintain similar diets to rural Coyotes, subsisting largely on small rodents, deer, and naturally occurring fruits and vegetation. Human-associated foods make up a less than 2% of urban Coyote diets, with higher rates where anthropogenic food is readily available. Positive effects of urban Coyotes include reduction in nuisance rodent, Canada Goose (*Anser canadensis*), and feral cat (*Felis catus*) populations. Negative human-Coyote interactions are rare, with only about 2% of interactions resulting in physical contact with a human or pet. Most negative effects result from habituation caused by accidental or intentional feeding. Education programs may reduce negative interactions and can enhance human appreciation of the presence of coyotes in urban areas. One example, the "Co-existing with Coyotes" program in Vancouver, BC raises awareness about urban Coyotes by working with educators and providing scientifically accurate information to the public. In the ten years since this program began, Coyote attacks on children in Vancouver have decreased from a high of five to less than one attack per year. Further study of urban Coyotes and educational programs will enhance the coexistence of humans and urban Coyotes.

P3. Evaluating Roadways as Barriers to Gene Flow in the American Pika: A Focal Species for the I-90 Snoqualmie Pass East Project. *Craig Fergus, *FergusC@cwu.edu;* Joseph Lorenz, *LorenzJ@cwu.edu;* K.A. Ernest, *ErnestK@cwu.edu;* Steve Wagner, *WagnerS@cwu.edu; Central Washington University, 400 East University Way, Ellensburg, WA 98926*

Habitat fragmentation is often considered detrimental to the long-term persistence of wildlife populations yet efforts to quantifying its impact have been challenging. Modern genetic techniques and advanced GIS mapping software now allow biologists to examine population genetic data in an explicitly spatial context. Our study uses landscape genetic tools to assess genetic connectivity of the American Pika (*Ochotona princeps*) across a 77-km^2 area adjacent to Interstate 90 near Snoqualmie Pass in central

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Washington State. Data were collected from 2008 through 2012, resulting in a collection of 247 fecal and 67 tissue samples referenced to specific GPS locations. I genotyped these samples at 9 microsatellite loci and used that information to assign individuals to population clusters using the program STRUCTURE. Three straight line models with light, moderate, and heavy weighting for roads were used to assign "distance scores" between populations that were then compared with corresponding F statistic values using the Mantel test. Finally, I used AIC to determine the model of best fit and thus the level of influence roads have on pika gene flow. The Washington State Department of Transportation (WSDOT) is in the process of adding multiple wildlife crossing structures to I-90, these models should provide a baseline for future assessment of the structures' ability to improve population connectivity.

P4. Ecology and Distribution of the Rocky Mountain Ridged Mussel in British Columbia. Lea Gelling, *B.C. Ministry of Environment, Conservation Data Centre. P.O. Box 9358 Stn. Prov. Govt., Victoria, B.C. Canada V8W 9M2; lea.gelling@gov.bc.ca*.

In 2003, Rocky Mountain Ridged Mussel, *Gonidea angulata*, was assessed by COSEWIC (Committee on the Status of Endangered Wildlife in Canada) as Special Concern. The assessment was based on 12 records between 1906 and 2002 in the Okanagan Basin in southern British Columbia, Canada. From 2005 to 2008, staff from the BC Ministry of Environment and volunteers spent 430 person-hours searching 179 sites by wading, snorkelling, beach walking, and boating along a linear distance of 90.8 kilometres across southern BC, to gain information to re-assess the status in 2010. Results of the surveys included an additional 165 records which increased the known area of occupancy, a range extent of 100 km to the north, new habitat information and spawning data, and a greater understanding of threats to the mussel, including non-native species (Eurasian Watermilfoil [*Myriophyllum spicatum*], Zebra and Quagga Mussels [*Dreissena polymorpha* and *D. bugensis*]), channelization of the Okanagan River, dams and weirs, pollution, and shoreline and littoral zone development. *G. angulata* was re-assessed by COSEWIC in 2010, which resulted in an "Endangered" status.

P5. *Oncorhynchus mykiss* Summer Microhabitat and Mesohabitat Preference in Three Small Washington Streams in the Context of Beaver Reintroduction Programs. *Jonathan Hegna, *Department of Biological Sciences, Central Washington University, 400 E. University Way, Ellensburg, WA 98926; hegnaj@cwu.edu*

Beaver (*Castor canadensis*) reintroduction programs are increasingly being viewed as a way to enhance salmonid habitat and production. However, the actual effectiveness of using Beavers as a habitat enhancement tool for ESA listed *Oncorhynchus mykiss* (Rainbow Trout / Steelhead) populations is unknown. Standard snorkel surveys and habitat measurements were used to examine the type of habitat, at both the microhabitat and mesohabitat levels, preferred by *O. mykiss* populations in three small streams in the Yakima River basin. Preliminary results suggest that *O. mykiss* in small streams strongly prefer (relative to availability) microhabitats that have deeper depths (> 29 cm), slow stream velocities (< 0.05 m/s), and complex cover types. Mesohabitat analyses indicate that all size classes of *O. mykiss* strongly prefer pool habitat, while only larger individuals (> 90 mm) strongly preferred Beaver pond habitat. Conversely, riffle habitat was strongly avoided, and glide habitat was used proportionate to its availability. *O. mykiss* density was also examined, and this revealed that pool and Beaver pond habitats supported the highest densities of fish. While *O. mykiss* in larger streams have previously been shown to prefer faster-flowing habitats like riffles and glides, the situation appears to be reversed in small streams. During the summer months, depth appears to be extremely limiting in a way that causes *O. mykiss* to prefer slow-flowing, pool-like habitat. Consequently, in small streams the creation of pool habitat either through artificial means or through Beaver reintroduction will have the greatest effect upon increasing stream carrying capacity and production.

P6. Engaging Volunteers within Alberta Conservation Association Wildlife Projects. Kris Kendell, *Alberta Conservation Association, Alberta, 101 – 9 Chippewa Road, Sherwood Park, AB, T8A 6J7; kris.kendell@ab-conservation.com*

We believe the use of volunteers as part of Alberta Conservation Association (ACA) projects is mutually beneficial to both the volunteer and ACA. Our volunteers increase their knowledge of conservation issues and are able to network with wildlife professionals, while at the same time allowing us to increase our capacity to deliver our wildlife projects. Currently, our largest wildlife volunteer component is the

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Alberta Volunteer Amphibian Monitoring Program (AVAMP). AVAMP positively impacts conservation in Alberta through increased awareness of Alberta's herpetofauna and by providing baseline population data to wildlife managers and researchers. We are also actively engaging conservation groups to help us answer targeted research questions. For example, ACA is partnering with Crowsnest Conservation Society (CCS), a volunteer-based conservation group, to achieve a better understanding of the distribution of the Boreal Toad (*Anaxyrus boreas*). Data collected by CCS volunteers can be used by wildlife managers to help incorporate setback distances around Boreal Toad breeding ponds into forestry harvest plans and to support an occupancy study for the species. AVAMP and CCS volunteers are trained in survey methods developed by ACA staff and are then able to collect data on their own without direct supervision from ACA. We have also been working with the Alberta Trappers' Association in a citizen science initiative to collect observations, photos, and hair samples of Wolverine (*Gulo gulo*) in order to determine occurrence and gene flow of this data-deficient species in the province. The involvement of ACA volunteers has been an important component and critical to the success of many of our projects.

P7. Assessing the Effectiveness of Riparian Habitat Reserves for Coastal Giant Salamanders in the Chilliwack Valley, British Columbia. Anne-Sophie Massard, Chris Mackenzie, Nicole Simpson, Brienna Altrogge, Dan Stewart, *British Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, BC V5G 3H2;* Chris M A Currie, *Athene Ecological, 1516 E. 1st Avenue, Vancouver, BC, V5N 1A5; chriscurrie77@gmail.com*

The Coastal Giant Salamander (*Dicamptodon tenebrosus*) is federally designated as Threatened in Canada, and is red-listed in British Columbia. Its range within Canada is restricted to the Chilliwack River Valley and a few adjacent streams in southwestern British Columbia. In 2011 and 2012, we surveyed 13 streams for salamanders and a range of habitat characteristics to assess the efficacy of existing riparian habitat reserves (called Wildlife Habitat Areas). Our results indicated that the existing system of riparian habitat reserves is somewhat effective at maintaining important habitat characteristics and salamander populations when compared to areas outside these reserves. However, salamanders and their habitat in both unprotected streams and streams within reserves appeared to be affected by levels of anthropogenic disturbance in adjacent areas, as well as by seasonal and annual climatic changes. These potentially adverse effects on the habitat and populations of this threatened species are not being addressed by the current reserve system.

P8. A Comprehensive Approach to Assessing Watershed Condition as Applied to Watersheds with Fish-values in British Columbia. Darcy Pickard, Marc Porter, & Simon Casley, *ESSA Technologies Ltd., 600 - 2695 Granville St. Vancouver, B.C., Canada V6H 3H4.* Lars Reese-Hansen, Richard Thompson, *BC Ministry of Environment, P.O. Box 9338, Stn Prov Govt Victoria, B.C., V8W 9M1.* Derek Tripp, 1*05-44 Anderton Avenue, Courtenay, BC, V9N 2G8.* Brian Carson, *Carson Land Resource Management Ltd., 1861 Lower Road, Roberts Creek, BC, V0N 2W6.*

Values associated with fish and their habitat can be recognized in B.C. through the designations under several statutes (e.g. Forest and Range Practices Act, Oil and Gas Activities Act, and the Land Act). A designation under one of these requires the respective sector(s) to operate such that they do not adversely impact aquatic habitat values necessary to fish. Assessing watershed condition, and understanding the effectiveness of legalized watershed designations under these statutes, is critical to the future management and maintenance of key values hosted in these watersheds. Watershed condition depends on the interaction of processes in the upslope, riparian, and stream channel subsystems. We use a combination of remote-sensed and field data to evaluate these three subsystems within a watershed. Repeatable rapid biological assessment protocols were developed to collect key field data at a broad spatial scale with limited budgets. A pilot sampling design and associated data collection were undertaken within two candidate watersheds in the Province: Skeena Region's Lakelse drainage (2010-2011) and Campbell River's Memekay drainage (2012). We show that it is feasible to collect comprehensive field data from an entire watershed using a statistically rigorous design with moderate effort. In addition, we propose an approach for integrating a broad suite of indicators to describe watershed condition. The goal of this project is to develop a standardized methodology of both remote-sensed (GIS) and field-based monitoring of watershed condition for application to watersheds with high fish (and other) values across the province.

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P9. The Bull Trout Recovery Monitoring and Evaluation Technical Group (RMEG). Marc Porter, *ESSA Technologies Ltd., Suite 600-2695 Granville St., Vancouver, BC. V6H 3H4, mporter@essa.com;* Darcy Pickard *dpickard@essa.com*

Four broad "recovery objectives" have been established for ESA listed Bull Trout (*Salvelinus confluentus*) under the USFWS Bull Trout Recovery Plan (USFWS 2002):

1. maintain current distribution of Bull Trout and restore distribution in previously occupied areas;
2. maintain stable or increasing trends in abundance;
3. restore and maintain suitable habitat conditions for all life-history stages and strategies; and
4. conserve genetic diversity and provide opportunity for genetic exchange.

Nested within general recovery objectives, quantitative "recovery criteria" have been established. These criteria will be assessed through a range of indicators. Some are indicators monitored routinely by fisheries agencies (e.g., number of adults); others are being developed within pilot studies (e.g., delineations of Bull Trout "patches" and assessments of occupancy, connectivity, etc.). Development of broad-scale monitoring strategies around these indicators will be essential for evaluating progress towards Bull Trout recovery across the Pacific Northwest, and evaluating the effectiveness of specific recovery actions. The Bull Trout Monitoring and Evaluation Technical Group (RMEG) is tasked with developing monitoring that can reliably inform evaluation of bull trout status and recovery objectives. The RMEG consists of federal/state biologists and academics with skills in population dynamics, char biology, biometrics, and experimental design. In addition to developing rigorous designs for monitoring ongoing RMEG activities include development of survival models for evaluating threats and extinction risks, analyzing the sensitivity of standard conservation tools (e.g. NatureServe) used to evaluate recovery status, and developing methods (e.g. GIS, genetic, habitat-based rules) to delineate Bull Trout Core Areas and local populations.

P10. Vertical Radar Surveys of Marbled Murrelets Used to Detect Flight Elevations at Winchie Creek, Vancouver Island. Andy Smith, *EDI Environmental Dynamics, Inc., # 208A 2520 Bowen Road, Nanaimo BC. V9T 3L3; asmith@edynamics.com;* Bernard Schroeder, *Bernard K. Schroeder Consulting, 351 Howard Ave, Nanaimo, BC V9R 3R8; bernard.schroeder@telus.net.*

Horizontal surveys using modified marine radar are traditionally used to estimate abundance, trajectory, and ground speeds of Marbled Murrelets (*Brachyramphus marmoratus*), but radar can also be oriented vertically to estimate flight heights. Vertical radar surveys were used to measure flight heights of Marbled Murrelets at a run-of-river hydropower project proposed by the Tla-o-qui-aht First Nation on a tributary of the Kennedy River on western Vancouver Island. The project requires a transmission line with a 374 m crossing of the Kennedy River that ranges from 62 to 87 m above the river surface. Over 300 Marbled Murrelets were detected using the Kennedy River corridor daily to access inland nesting sites, causing potential for collisions with the proposed transmission line. Using vertical surveys, 970 incoming and outgoing Marbled Murrelets were detected over two days in July, 2011. The lowest flight height was 99 m above the river surface, suggesting collision potential should be very low; however, the cloud ceiling was very high on both days. Pre-sunrise flight heights were lower (525 m ± 205.1 SD and 515 m ± 214.9 SD) than post-sunrise flight heights (710 m ± 174.4 SD and 715 m ± 210.7 SD). Flight heights observed were higher than reported elsewhere (mean = 246 m - Stumpf et al. 2010) in a location closer to the ocean with lower topographic relief. Marbled Murrelets may vary their flight heights according to variables such as topographic complexity, distance from ocean, light levels, and weather conditions when accessing and leaving nesting catchments.

P11. Diet and Foraging Ecology of the Racer (*Coluber constrictor*) from Central Washington State. Robert E Weaver, *Department of Biological Sciences, Central Washington University, 400 E University Way, Ellensburg WA 98926;weaverro@cwu.edu;* William H Clark, *Department of Math and Science, Western Wyoming Community College, 2500 College Drive, Rock Springs WY, 82902;* Daniel C McEwen, *Biosciences Department, University of Minnesota Moorhead 1104 S 7th Avenue, Moorhead MN, 56563*

The Racer (*Coluber constrictor*) is found throughout much of the United States, southern Canada, and south into Central America. This species is found in a variety of habitat types, and is largely considered a generalist predator on invertebrates and vertebrates. Here we present data on the diet and foraging ecology of *C. constrictor* from 2 sites within the shrub-steppe of central Washington State. We searched for snakes by hand from March-October during 2007-09. We recorded the sex, snout-vent length, and mass

of each snake, as well as cloacal and air temperature. Snakes were gently palpated for recently ingested meals and for fecal matter. Prey items and fecal matter were identified to the lowest possible taxonomic level, preserved, and stored in ethanol. We used Generalized Linear Models (GLM) to determine what biologically relevant interactions might occur between any of our explanatory variables and the most parsimonious model was selected using Akaikie Information Criteria (AICc). Information from these hierarchical models were used to create conditional logistic regression models to determine what influences diet choices for snakes. There were a total of 69.7% of snakes that had prey within their stomachs. Invertebrates were the preferred prey item (62.0%), primarily of the order Orthoptera (92% of identified invertebrates). Larger snakes were most probable to have vertebrate prey. Individual snakes with higher cloacal temperatures were most likely to have consumed Gartersnakes (*Thamnophis* spp.) as vertebrate prey, and the primary lizards foraged for were Western Skinks (*Plestiodon skiltonianus*).

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