Invasive Species Research Conference

TURNING SCIENCE INTO ACTION

CO-HOSTED BY:

THOMPSON RIVERS UNIVERSITY

iSC Invasive Species Council of BC

Conference Program

M. Herborg

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June 20 – 22 | Thompson Rivers University | events.BCinvasives.ca

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We would like to give special thanks to the Conference Partners, Funders and Sponsors.

Thompson Rivers University (TRU) – TRU's Kamloops campus is located on the traditional territory of the Secwepemc peoples, in British Columbia's southern interior. In the City of Kamloops, whose name is from the Secwepemc word for "meeting of the waters", the main campus overlooks the junction of the North Thompson and South Thompson rivers, from which the university gets its name. Faculty at TRU have broad interests in Invasive Species Biology. Research has ranged from mapping DNA across species to mapping ant colonies across landscapes. Species of interest have ranged from microbes to insects, fish, mammals and plants.

Invasive Species Council of BC (ISCBC) – ISCBC convened the first Invasive Plant Research Conference in 2011 which was deemed successful for both academic researchers and practitioners by linking science with operations. Based on the 2011 Research Conference, the BC Research Road Map was created to identify the future needs and priorities for invasive plant research relevant to BC. To build upon this work, TRU and ISCBC partnered to co-host the Invasive Species Research Conference, June 20 – 22, 2017 in Kamloops, BC.

CONFERENCE FUNDERS

Ministry of Forests, Lands and Natural Resource Operations

Natural Sciences and Engineering Research Council of Canada

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CONFERENCE PLANNING COMMITTEE

We would like to give a special thanks to Conference Planning Committee members who contributed a diversity of knowledge and expertise essential to the successfully planning and delivery of the Conference.

David Clements, *Trinity Western University*

Sharon Gillies, *University of the Fraser Valley*

Brian Heise, *Thompson Rivers University*

Matthias Herborg (Co-Chair), *Ministry of Environment*

Rob Higgins (Co-Chair), *Thompson Rivers University*

Duncan Knowler, *Simon Fraser University*

Val Schaefer, *University of Victoria*

Dominique Sigg, *Ministry of Environment*

Jacqueline Sorensen (Chair of Local Arrangements Committee), *Thompson Rivers University*

Catherine Tarasoff, *Agrowest Consulting and Thompson Rivers University*

PRESENTERS

Thanks to each and every presenter for taking the time to share their invasive species research at this Conference.

VOLUNTEERS

We would also like to thank TRU In-house Elder **Estella Patrick Moller** for her Blessing; **Dr. Alan Shaver,** *President and Vice Chancellor, Thompson Rivers University* and **Brian Heise,** *Chair, ISCBC* for their welcoming remarks and each of the the MCs, hosts and student volunteers for their valued contributions.

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Be Social

We are excited to be live-streaming the digital conversations that take place throughout the Conference. Join the conversation online, using:

#InvSpRes

Share the highlight of your day, something new you learned, or share photos or video on Twitter and Instagram!

3 Day Agenda

DAY 1 | Tuesday, June 20

VENUE ▸ **ROTUNDA**

7:45 am **REGISTRATION OPENS**

VENUE ▸ **MOUNTAIN ROOM**

8:45 am **WELCOME** | **Dr. Alan Shaver,** *President and Vice-Chancellor; Thompson Rivers University* and **Brian Heise,** *Chair; Invasive Species Council of BC*
BLESSING | TRU In-house Elder **Estella Patrick Moller**

9:10 am **KEYNOTE SPEAKER** | **Managing Invasives: Progress, Problems, and Polemics; Dr. Daniel Simberloff**

9:55 am **"HOT TOPIC" PRESENTATION** | Utility of unmanned aerial vehicles for mapping invasive plant species: a case study on Yellow flag iris *(Iris pseudacorus L.)*; **Garrett Whitworth**

10:20 am **REFRESHMENT BREAK**

VENUE ▸	MOUNTAIN ROOM	TERRACE ROOM
10:40 am	**SESSION 1: Ecological Restoration Following Invasion**	**SESSION 2: Social Aspects of Invasion**
10:40 am	Effects of fire and herbivore exclusion fencing on native and non-native plant populations in a Garry Oak Ecosystem on Salt Spring Island in British Columbia: A role for deer grazing in novel ecosystem management? **Jennifer Grenz**	Policy pitfalls and opportunities for marine invasive species management in Canada; **Natascia Tamburello**
11:00 am	Implementing and maintaining ecological restoration efforts in urban estuary and riparian environments: a case study of MacKay Creek in North Vancouver; **Julia Alards-Tomalin**	Socio-economic predictors of invasive plant species occurrence in urban green spaces of Metro Vancouver; **Woongsoon Jang**
11:20 am	Round Table: What additional research is needed on this topic?	Round Table: What additional research is needed on this topic?

VENUE ▸ **MOUNTAIN ROOM**

11:25 am **Lightning Talks – a series of rapid fire 5 minute research presentations**

11:30 am Examining soil legacy of Spotted knapweed; **Matthew Coghill**

11:35 am The effect of time since burning on stem density of Dalmatian toadflax *(Linaria dalmatica)*, Yellow toadflax *(L. vulgaris)*, and Spotted knapweed *(Centaurea maculosa)*; **Gabrielle Hindley**

11:40 am Assessing the effectiveness of fisheries compensation habitats for the Port Mann Highway 1 Improvement Project; **Stephanie Cavaghan**

11:45 am Drought and invasiveness on temperate grasslands in the Southern Interior of British Columbia; **Janelle Paulson**

	VENUE ▸ MOUNTAIN ROOM
11:50 am	Problematic persistence of common carp and innovative measures to eradicate from a pond environment; **Darryl Arsenault**
11:55 am	Effects of the invasive plant, Spotted knapweed *(Centaurea maculosa)*, on grassland arthropod communities and genomic barcoding solutions for ecosystem reclamation management; **Jordann Foster**
12:00 pm	Kootenay Boundary bullies: Protecting Northern leopard frogs through bullfrog eradication; **Morgan Sternberg**
12:05 pm	Comparing conventional and alternative control of *Linaria genistifolia ssp. Dalmatica* in a semi-arid grassland of British Columbia's southern interior; **Jacob Bradshaw**
12:10 pm	**LUNCH**

	VENUE ▸ MOUNTAIN ROOM	TERRACE ROOM
1:25 pm	**SESSION 3: New Approaches to Invasive Species Management**	**SESSION 4: Risk Assessment of Invasive Species**
1:25 pm	Potential for glyphosate resistance in Bohemian knotweed *(Fallopia x bohemica)*; **Matthew Strelau**	Assessing the risk of Pacific Fisheries Regulation Schedule VIII Species; **Thomas Therriault**
1:45 pm	Bacterial diversity and virus detection in the invasive Yellow crazy ant; **Meghan Cooling**	*Phragmites australis* niches for other biota are similar on three continents; **Erik Kiviat**
2:05 pm	Anti-Pd activity: Can environmental microorganisms be used against *Pseudogymnoascus destructans,* the causative agent of white-nose syndrome? **Naowarat Cheeptham**	Evaluating movement of marine infrastructure as a pathway of aquatic invasive species spread; **Josephine Iacarella**
2:25 pm	Round Table: What additional research is needed on this topic?	Round Table: What additional research is needed on this topic?
2:30 pm	**REFRESHMENT BREAK**	

2:50 pm	**SESSION 5: New Approaches to Invasive Species Management**	**SESSION 6: Risk Assessment of Invasive Species**
2:50 pm	Suppression of invasive Northern pike in Box Canyon Reservoir of the Pend Oreille River in northeast Washington State, USA; **Nick Bean**	Modeling the risks and damages from a "potential" invasive plant species: Yellow starthistle *(Centaurea solstitialis)*; **Sergey Tsynkevych**
3:10 pm	Puncturevine *(Tribulus terrestris)* control in the South Okanagan; **Ken Sapsford**	Assessing the risk of marine invasive species in the Bering Sea; **Amanda Droghini**
3:30 pm	Assessing benthic barriers vs. aggressive cutting as effective Yellow flag iris *(Iris pseudacorus)* Control Mechanisms; **Catherine Tarasoff**	Predicting progressive ecosystem-wide impacts of invasive mussel establishment in a large lake; **Patricia Woodruff**
3:50 pm	Northern pike invasion and suppression in the Columbia River; **Crystal Lawrence**	How important is seed production in the spread of Japanese knotweed *(Fallopia japonica)*? **Sharon Gillies**
4:10 pm	Under the cover of rock snot: understanding the effects of Didymo algae in Yukon; **Heather Milligan**	Introduced Yellow perch *(Perca flavescens)* in BC lakes: Feeding, movement and a possible control method; **Carmen Tattersfield**
4:30 pm	Round Table: What additional research is needed on this topic?	Round Table: What additional research is needed on this topic?
4:35 pm	**DAY ONE ADJOURNMENT**	

DAY 1 | Continued

VENUE ▸ **ROTUNDA**

4:45 pm	**Poster Presentations & Evening Reception**
7:00 pm	**Conclusion of Poster Presentations & Evening Reception**
	DINNER ON OWN
9:00 pm	OPTIONAL FIELD TRIP | Night Time Bat Observation (estimate 11:30 pm return to TRU). Meet at Campus Activity Centre entrance.

DAY 2 | Wednesday, June 21

VENUE ▸ **ROTUNDA**

8:30 am	**REGISTRATION OPENS**

VENUE ▸ **MOUNTAIN ROOM**

9:00 am	**WELCOME**
9:10 am	**KEYNOTE SPEAKER** | **Predicting Impact: A Challenge for Invasive Species Risk Assessment; Dr. Anthony Ricciardi**
9:55 am	**"HOT TOPIC" PRESENTATION** | Building DNA reference libraries to enable the development of eDNA metabarcoding tools for invasive species detection; **Cathryn Abbott**
10:20 am	**REFRESHMENT BREAK**
10:40 am	**SESSION 7: Molecular Approaches to Invasion Biology**
10:40 am	Development of an eDNA metabarcoding tool for detection of invasive freshwater fish in British Columbia lakes; **Davon Callander**
11:00 am	Invasive rat colonization history and movement dynamics in Haida Gwaii; **Bryson Sjodin**
11:20 am	Identifying marine invasive species from environmental DNA: a tool to inform the management of shellfish aquaculture movements. **Kristen Westfall**
11:40 am	Round Table: What additional research is needed on this topic?
11:45 am	**LUNCH**

	VENUE ▸ TERRACE ROOM
1:00 pm	**GUEST SPEAKER** | **Research Partnership Grant Opportunities; Pam Giberson,** *Natural Sciences and Engineering Research Council of Canada (NSERC)*
1:25 pm	**WORKSHOP** | Invasive Species Research Priorities and Connections; **Jodi Romyn**, *Invasive Species Council of BC (ISCBC)*
2:45 pm	**REFRESHMENT BREAK**

	VENUE ▸ STUDENT UNION LECTURE HALL	TERRACE ROOM
3:05 pm	**SESSION 8: Tracking invaders: Where are they?**	**SESSION 9: From just taking up space to an invasive meltdown**
3:05 pm	Columbia River Invasive Northern pike - Exploring movements through physical and chemical means; **Dan Doutaz**	Shared experience of invasive Grey squirrel management practice; **Craig Shuttleworth**
3:25 pm	White-nose syndrome in the west: updates and strategies; **Cori Lausen**	Changes in age structure and diet of invasive centrarchid fish populations under management by electrofishing; **Lungi Roberts**
3:45 pm	Occasional and established introduced ants in Washington and Oregon; **Laurel Hansen**	Exotic species replacement: a tale of two invasive mussels; **Lisa Jones**
4:05 pm	Round Table: What additional research is needed on this topic?	Round Table: What additional research is needed on this topic?
4:10 pm	**DAY TWO ADJOURNMENT**	
4:45 pm	OPTIONAL SOCIAL | Kamloops Wine Tasting Tour with Al Fresco Dinner	

DAY 3 | Thursday, June 22

8:30 am	**OPTIONAL FIELD TRIP** | Lac du Bois Grasslands Protected Area & Kenna Cartwright Park (estimated 1:00 pm return to TRU); Meet at Campus Activity Centre Entrance

Keynote Speaker Biographies & Abstracts

Managing Invasives: Progress, Problems, and Polemics

Dr. Daniel Simberloff, *University of Tennessee*

BIOGRAPHY

Daniel Simberloff is the Nancy Gore Hunger Professor of Environmental Studies at the University of Tennessee. He received his A.B. (1964) and Ph.D. (1968) from Harvard University and was a faculty member at Florida State University from 1968 through 1997, when he joined the Department of Ecology and Evolutionary Biology at the University of Tennessee. His publications number ca. 500 and centre on ecology, biogeography, evolution, and conservation biology; much of his research focuses on causes and consequences of biological invasions. His research projects are on insects, plants, fungi, birds, and mammals.

Daniel Simberloff is editor-in-chief of Biological Invasions, senior editor of the Encyclopedia of Biological Invasions (2012), author of Invasive Species: What Everyone Needs to Know (2013), and is a member of the editorial board for several other journals. He served on the United States National Science Board 2000-2006. In 2006 he was named Eminent Ecologist by the Ecological Society of America, in 2012 he won the Margalef Prize for research in ecology, and in 2015 he won the Wallace Prize of the International Biogeography Society. He is a member of the U.S. National Academy of Sciences and the American Academy of Arts and Sciences.

ABSTRACT

Modern invasion biology is a young field, beginning in the 1980s. Nevertheless, we now know of drastic impacts of hundreds of invaders. They eat native species, overgrow them, outcompete them, infect them, hybridize with them, and have myriad other impacts. Impacts affecting entire ecosystems have been increasingly documented, particularly as ecological research on aboveground-belowground interactions has increased. Despite this hecatomb, the past few years have seen several criticisms of the field of invasion biology and management. Among other bones of contention, critics charge that the field is infected with xenophobia, claim that the damage caused by biological invasions is overblown, and argue that, even if effects of biological invasions are substantial, we can't do much about the phenomenon in the face of globalization, so we shouldn't waste our resources trying. These criticisms are misguided. In particular, successful management projects (including eradications) are proliferating, with several evolving new approaches and ambitious goals.

Predicting Impact: A Challenge for Invasive Species Risk Assessment

Dr. Anthony Ricciardi,
Redpath Museum and School of Environment,
McGill University

BIOGRAPHY

Dr. Anthony Ricciardi is a professor of biology in the Redpath Museum and the School of Environment at McGill University, and a McGill Trottier Fellow in Science and Public Policy. For over 20 years, his research has examined the causes and consequences of biological invasions using field experiments, lab experiments, empirical modeling and meta-analysis.

Anthony is an editorial board member for the journal Biological Invasions and the journal Diversity and Distributions. From 2006 to 2016, he served on the scientific committee of the Canadian Aquatic Invasive Species Network – an NSERC research group that assessed the risks and mechanisms of invasion in Canada's lakes, rivers and coastal waters. In recent years, he and his students have sought to identify global patterns and mechanisms that explain variation in the colonization success and impacts of introduced freshwater fishes and invertebrates.

ABSTRACT

Alien species are invading ecosystems at increasing rates worldwide. Some of these invasions appear to have only minor ecological consequences, while others have had dramatic impacts – including habitat degradation, disruption of ecosystem services, and native species loss. Risk assessments tend to focus on accuracy in predicting whether a species will invade, rather than on the impact it may have after invasion. Predicting the impact of an invasion is a longstanding challenge that is complicated by at least four factors: First, an invader's impact may vary greatly over time and space under the influence of environmental conditions. Second, it may be altered by interactions with overlapping human-driven stressors (e.g. disturbance, climate change, other alien species). Third, indirect effects are often poorly understood and require careful experimentation to be recognized. Finally, impact data are lacking for most invasions. These constraints have hindered the development of risk assessment tools for anticipating and prioritizing invasion threats.

Nevertheless, there are some promising approaches and emerging methods toward developing a more predictive understanding of invader impact. The relationship of the invader to its physical and biological environment is a key element of these approaches, and studies that have explored this relationship have discovered patterns that explain spatial and temporal variation of impact. Identifying these patterns is the first step toward building predictive models that can allow managers to identify which alien species pose the greatest ecological threat and which habitats are at greatest risk of disruption – in advance of invasion.

Invasive Species Research Priorities and Connections Workshop

In addition to sharing invasive species research, The Invasive Species Research Conference provides a platform for networking and brings together invasive species researchers, practitioners and stakeholders. In advance of the Conference, input was collected on invasive species research priorities for BC and Western Canada through an online survey. Throughout the Conference participants will be asked for their input on what more research is needed within the Conference themes.

The Invasive Species Research Priorities and Connections Workshop, held with support from the Natural Sciences and Engineering Research Council of Canada (NSERC) and facilitated by ISCBC, will build upon the survey findings and the input from Conference participants. Together workshop participants will identify the priorities for invasive species research for BC and Western Canada and foster connections for future research partnerships.

Field Trips

Two optional field trips are included as part of the Invasive Species Research Conference.

JUNE 20TH, 9:00 PM – 11:30 PM

Bat Observation at Night

Participants will depart TRU by bus to a rural location, approx 20 mins from Kamloops, where a colony of bats lives. Participants will be able to see bats flying at dusk, and will observe experts mist-netting and measuring bats. Bat detectors on site will also enable participants to hear the echolocation calls of bats.

JUNE 22ND, 8:30 AM – 1:00 PM

Lac du Bois Grasslands Protected Area & Kenna Cartwright Park Day Field Trip

Grasslands cover less than 1% of BC, house more than 30% of BC threatened or endangered species, and represent the most endangered ecosystem in Canada.

Lac Du Bois is a provincially protected area of approximately 16,000 ha located just north of Kamloops. This area encompasses three types of grasslands communities and incorporates a complex range use tenure system.

Kenna Cartwright Park is one of the largest (800 ha) urban parks in North America. A diverse history of utilization combined with high levels of visitor use make management of invasive species in this park a complex task. A variety of management tools have been utilized in Kenna Cartwright Park, many with dramatic effect.

On this field tour we will visit Lac Du Bois and discuss the grassland community types as well as water conservation and utilization issues. After ‘setting the stage’ in Lac Du Bois, we will head to Kenna Cartwright Park to look at ‘management in action’. These efforts include tree canopy thinning, biocontrol, goats, and fire.

Tuesday Presentation Abstracts

9:55 AM – 10:20 AM, MOUNTAIN ROOM

Utility of unmanned aerial vehicles for mapping invasive plant species: a case study on Yellow flag iris *(Iris pseudacorus L.)*

Garrett Whitworth; *Thompson Rivers University*

Co-authors: John S. Church[2], Jackson Baron[3], Jacob L. Bradshaw[4], Catherine Tarasoff[5], David J. Hill[6]
Co-author Affiliations: [3,6] Department of Geography and Environmental Studies, Thompson Rivers University, V2C 0C8, Kamloops, BC, Canada. [2,4,5] Department of Natural Resource Science, Thompson Rivers University, V2C 0C8, Kamloops, BC, Canada.

This study investigates the utility of an off-the-shelf, consumer-grade unmanned aerial vehicle (UAV) for invasive species mapping in a lacustrine fringe environment. Specifically, this work sought to determine whether such a UAV would be capable of creating accurate maps of the extent of patches of an invasive plant, yellow flag iris *(Iris pseudacorus L.)*, more efficiently than could be accomplished by a traditional field survey, which is often considered in the literature to provide the most accurate maps. The study was conducted at two lakes in the central interior of British Columbia. The UAV used in this study was a DJI Phantom 3 Professional that can acquire images using the built-in 12.4 MP digital camera. This UAV was selected because it is representative of the type of aerial platform that is easily accessible to invasive plant managers in terms of cost, ease of use, and lack of legal restrictions. Three methods of mapping the yellow flag iris were compared: (1) field survey, (2) manual interpretation of the raw UAV-acquired imagery and the orthoimage created from these data, and (3) pixel-based classification of the orthoimage created from the UAV imagery using a random forest classifier. The results revealed that, at both lakes considered, manual interpretation of the UAV-acquired imagery produced the most accurate maps of Yellow flag iris infestation, with a false-positive and false-negative classification rate of less than 1%.

10:40 AM – 11:00 AM, MOUNTAIN ROOM

Effects of fire and herbivore exclusion fencing on native and non-native plant populations in a Garry Oak Ecosystem on Salt Spring Island in British Columbia: A role for deer grazing in novel ecosystem management?

Jennifer Grenz; *University of British Columbia*

Co-authors: Rebecca Robertson[2] and David R. Clements[3]
Co-author Affiliations: [2] Department of Biology, Trinity Western University 7600 Glover Rd., Langley, BC, Canada V2Y 1Y1, [3] Department of Biology, Trinity Western University 7600 Glover Rd., Langley, BC, Canada V2Y 1Y1

The impacts of an accidental fire and herbivory on plant communities within a Garry oak ecosystem in a section of Mount Maxwell Provincial Park on Salt Spring Island in British Columbia were evaluated. Garry oak ecosystems are one of Canada's most threatened habitats and provide specialized habitats for a number of plant species at risk. Frequent burning in this area by the Coast Salish prior to European settlement, played a vital role in the establishment of this novel ecosystem. Fire suppression after European settlement has enabled understory conversion of oak stands to coniferous forest. The purpose of this study was to better inform possible GOE restoration strategies such as the reintroduction of fire and installation of deer fencing. Over a three year period, plots within burned and unburned Garry oak savanna, with and without exclusion fencing were surveyed for plant species present and categorized as native or non-native. A MANOVA was used to evaluate the effect of each treatment of percent ground cover of native and non-native plants for each treatment year. ANOVA tests were used to examine specific interactions where significant overall effects were found.

Our research revealed a slight increase in the mean percent cover of non-native plants in the burned areas over the three year study period. Unburned unfenced areas had a greater percent cover of native vegetation suggesting that disturbances other than fire, such as herbivory by deer, may be effective in both preventing canopy closure, promoting native vegetation, preventing non-native vegetation from becoming highly invasive, and promoting the growth of Garry Oak seedlings.

10:40 AM – 11:00 AM, TERRACE ROOM

Policy pitfalls and opportunities for marine invasive species management in Canada

Natascia Tamburello; *ESSA Technologies*

Co-authors: Fiona Francis[2], Erica Olson[3]
Co-author Affiliations: [2] Department of Biological Sciences, Simon Fraser University, V5A 1S6, Burnaby, BC, Canada. [3] ESSA Technologies, #600 – 2695 Granville Street, Vancouver, BC, Canada

Haida Gwaii is one of the most ecologically and culturally important marine areas in Canada and provides important ecological, economic, and cultural values to local residents, other Canadians, and visitors from around the world. Because of its geographic isolation, Haida Gwaii supports a unique assemblage of plants and animals, including many rare and endemic species highly sensitive to disturbance. However, this region is also facing a mounting host of economic development and environmental pressures. Among these, species introductions are recognized as one of the most important threats to ecological integrity across the archipelago and particularly within the Gwaii Haanas National Park Reserve and Haida Heritage Site. Marine invasive species management is a nascent field on the Canadian West Coast, but past and present policy developments are paving the way for more rigorous management. This study aims to provide a unified foundation for future work through a comprehensive assessment of the regulatory and non-regulatory tools currently available for addressing marine invasive species in Canada, with a focus on Haida Gwaii. We conducted a policy analysis and expert interviews to highlight regulatory strengths and weaknesses in addressing different stages of invasion. Where gaps exist, we propose both regulatory and non-regulatory solutions drawn from best practices in other jurisdictions. This suite of options will lay a foundation for the Marine Plan Partnership and Council of the Haida Nation to consider in developing an invasive species management plan for the successful prevention, monitoring, and mitigation of marine species invasions in Haida Gwaii and beyond.

11:00 AM – 11:20 AM, MOUNTAIN ROOM

Implementing and maintaining ecological restoration efforts in urban estuary and riparian environments: a case study of MacKay Creek in North Vancouver

Julia Alards-Tomalin; *Echo Ecological Enterprises*

Co-authors: Tara Matthews[2], Deanna MacTavish[3]
Co-author Affiliations: [2,3] Echo Ecological Enterprises

Urban environments are often highly degraded and can benefit greatly from ecological restoration efforts. In recent years MacKay Creek estuary in North Vancouver, BC has undergone an incredible transformation from its previously highly degraded state. This area is an estuarine waterway that is utilized by salmonid species for spawning and rearing habitat. Ecosystems such as this are immensely important for the life cycle of many fish species, and also provide critical habitat for many types of waterfowl and terrestrial birds. Restoring these areas provides many species with the foothold they need to survive in the difficult urban environment. However, maintenance and monitoring is the only way to ensure the restoration stays on track and this can be difficult to ensure long-term. Without regular maintenance invasive plant species tend to overwhelm any restoration efforts in a matter of years and without monitoring there is no way to evaluate success. Ecological restoration is a difficult task with no easy answers. This talk will focus on the life of this project, how it has evolved over time and the successes and difficulties encountered in real-life ecological restoration of urban environments.

11:00 AM – 11:20 AM, TERRACE ROOM

Socio-economic predictors of invasive plant species occurrence in urban green spaces of Metro Vancouver

Woongsoon Jang; *Department of Forest Resources Management, University of British Columbia*

Co-author: Bianca N.I. Eskeson
Co-author Affiliation: Department of Forest Resources Management, The University of British Columbia, 2424 Main Mall, Vancouver, BC V6T 1Z4, Canada

This study was conducted to address the relation between socio-economic factors and invasive plant species occurrence in urban green spaces of Metro Vancouver, British Columbia. We used invasive plants inventory data in parks and natural areas acquired from the City of Surrey (surveyed in 2016) and the City of Coquitlam (surveyed in 2015). Four socio-economic variables were extracted from 2011 census data: median household income, population density, single-detached house density, and household expenditure on gardening. Ten other environmental/human variables (e.g., elevation, path and trail density) were obtained for each invasive plant observation point. Using an Inhomogeneous Poisson point process modelling approach, these socio-economic and environmental/human predictors were tested for the prediction of spatial density for three primary invasive plant species: English ivy, Japanese knotweed, and Lamium. In both cities, higher median household income related to higher spatial density of English Ivy and Japanese Knotweed. Higher population density increased English ivy's spatial density in Coquitlam. Spatial density of Lamium in Surrey and Coquitlam were higher in areas with higher household expenditure on gardening and single-detached house density, respectively. Results indicate that the set of spatial socio-economic predictors combined with other environmental/human predictors should be chosen for identifying primary management areas according to target species and site. This case study demonstrates a proper approach for analyzing presence-only field inventory data, the common data type collected by invasive plant species management agencies, and incorporating those data and available census data into a spatial modelling framework.

11:30 AM – 11:35 AM, MOUNTAIN ROOM

Examining soil legacy of Spotted knapweed

Matthew Coghill, *Thompson Rivers University*

Invasive plant species threaten native plant biodiversity and disrupt and diminish ecosystem function. In North America, Spotted knapweed *(Centaurea stoebe)* has spread across most of the Canadian provinces and American states within the past few decades. Spotted knapweed is able to produce thousands of seeds per square foot, and those seeds can persist in soils for years. The plant has both immediate and long-term effects on soil biology and chemistry. Immediate soil effects have been shown reduce native plant establishment and growth. Long-term or legacy effects exist in soils when spotted knapweed alters soil properties, which may persist even following physical eradication of live stems, thereby affecting establishment and restoration of future native plant communities. These legacy effects have not been studied in communities invaded by Spotted knapweed, and with the increasing threats harbored by this noxious weed it is important that we fill in this knowledge gap by studying the growth of native plants in knapweed-infested soil and experimenting with soil amendments to reduce the potential legacy effects of knapweed. My greenhouse study will investigate potential differences in growth of native plants grown alone and when planted with Spotted knapweed in soils taken from a variety of sites with and without knapweed invasion. In addition, I will determine the effectiveness of a locally produced fly ash, an activated carbon source, at reducing the soil legacy effects contributed by spotted knapweed. This work will contribute to a growing area of research focusing on invasive plant mitigation in North American grasslands.

11:35 AM – 11:40 AM, MOUNTAIN ROOM

The effect of time since burning on stem density of Dalmatian toadflax *(Linaria dalmatica)*, yellow toadflax *(L. vulgaris)*, and spotted knapweed *(Centaurea maculosa)*

Gabrielle Hindley; *Department of Environment, Simon Fraser University*

Parks often have multiple management goals. This is the case in Kenna Cartwright Park, Kamloops where goals include reducing fuel load and protecting biodiversity. Invasive plants pose a risk to native plant diversity. Within the park, Dalmatian toadflax *(Linaria dalmatica)*, Yellow toadflax *(Linaria vulgaris)*, and Spotted knapweed *(Centaurea maculosa)* are target invasive species due to their prevalence. Fire suppression has led to an increase in fuel load and greater fire risk. Since 2015, prescribed burning has been used to reduce the risk of interface fire, but fire can differentially affect native and invasive plants. If diversity and fuel management are both priorities for the Park, it is necessary to understand the effect of fire on the density of target invasive plants.

Areas of the park were burned in March 2015 and 2016. I will conduct post-burn surveys of stem density of the three target invasive plants within the burn areas compared to adjacent unburned areas. Burning of a third area is planned for 2017 where I will establish a before-after control-intervention experiment and measure stem density before and after burning in comparison to unburned areas. My objective is to help inform park management of the effects of fire on the density of the three invasive plants and determine whether burning is meeting the objective of reducing invasive density. The aim of these surveys will be to inform future burning and invasive species removal programs in the park and determine whether post-burn treatment of invasive plants is necessary.

11:40 AM – 11:45 AM, MOUNTAIN ROOM

Assessing the effectiveness of fisheries compensation habitats for the Port Mann Highway 1 Improvement Project

Stephanie Cavaghan; *Triton Environmental*

Co-authors: Michelle Dobson, B.A., E.Pt.[1]; **Adam Goodwin,** M.Sc., R.P.Bio.[1]; **Miranda Lewis,** M.Sc., E.Pt.[1,3]; **Jeff van den Eerenbeemt,** P. Eng., PMP[2]
Co-author Affiliations: [1] Triton Environmental Consultants Ltd.; [2] Transportation Investment Corporation; [3] Submitting Author;

The Transportation Investment Corporation (TI Corp) retained Triton Environmental Consultants Ltd. (Triton) to assess the effectiveness of constructed fisheries compensation habitats as per the DFO authorization for the Port Mann/Highway 1 Improvement Project. Triton assessed riparian vegetation, water quality, fish passage, presence, and abundance, at 14 compensation and 7 reference sites at regular intervals annually.

In spring 2016, 2 sites reached the end of their 5 year monitoring period, providing spawning and rearing habitat as required in the DFO authorization. The remainder of the sites are in various stages of the required 5 year monitoring period. Site successes include the provision of productive biogenic material and fish habitat, as well as contributing to the sustainability of key fisheries. Results indicate that riparian plantings are most successful if they are in proximity to established native vegetation. Fish presence and abundance varied across compensation sites, with fish access and water quality believed to be critical factors. TI Corp retained contractors to implement remedial site works, including removal of invasive plants using physical and chemical techniques as appropriate. The results from Triton's monitoring and implemented remedial actions help highlight challenges associated with fisheries habitat compensation within urban environments.

11:45 AM – 11:50 AM, MOUNTAIN ROOM

Drought and invasiveness on temperate grasslands in the Southern Interior of British Columbia

Janelle Paulson; *Thompson Rivers University*

Co-author: Lauchlan Fraser[2]
Co-author Affiliation: [2] Department of Natural Resource Science, Thompson Rivers University, V2C 5N3, Kamloops, BC, Canada.

Grasslands provide many ecosystem goods and services such as biodiversity, wildlife habitat, forage production, erosion control, pollination and carbon sequestration. However, grasslands in British Columbia are endangered ecosystems. They represent less than 1% of British Columbia's land base but provide habitat for more than 30% of BC's species at risk. Grasslands are further threatened due to land conversion, desertification, and the introduction of non-native invasive species. Future precipitation in Southern BC is predicted to be less in the summer and more in the winter. The combination of reduced summer rainfall and spring snowmelt can lead to more intense, prolonged drought. Over time these droughts may increase plant susceptibility to mortality creating spatial gaps in plant communities that allow for non-native species to readily invade. This project will investigate the invasiveness of non-native species when exposed to drought. A 1 in 100 year drought is simulated using rain-out shelters previously constructed in Lac du Bois Grasslands Protected Area, BC, Canada. At the end of the growing season, drought and control soils will be removed from the Lac du Bois sites, transferred to pots in the greenhouse and sown with native and non-native seeds. Plant biomass, plant diversity and seedling survival will be analysed. This project will further our knowledge on how our native grassland soils will be influenced when faced with drought and may provide a forewarning that new management practices may need to be implanted or increased to prevent further non-native invasion.

11:50 AM – 11:55 AM, MOUNTAIN ROOM

Problematic persistence of common carp and innovative measures to eradicate from a pond environment.

Darryl Arsenault; *Golder Associates Ltd.*

Co-author: Bobby Bedingfield
Co-author Affiliation: Golder Associates Ltd., Kelowna, BC

An opportunity for restoration of a stream containing rainbow trout in West Kelowna was complicated by the presence of common carp *(Cyprinus carpio)* in a dammed pond at the top end of the restoration area. The value of rainbow trout habitat creation would have been greatly decreased if the new pools and channels were occupied by the invasive carp, which had been stocked by well-meaning land owners. Not only are carp very fecund on the reproductive scale, they are very hardy and difficult to kill. Adult and juvenile carp were removed by dewatering and electroshocking on repetitive cycles. However, yearling carp were almost impossible to capture via conventional methods. Even when the pond was dewatered, the young fish could survive on the soft, muddy surface for longer than construction crews were able to wait. We will present a cost effective method for euthanization in shallow water conditions.

11:55 AM – 12:00 PM, MOUNTAIN ROOM

Effects of the invasive plant, Spotted knapweed *(Centaurea maculosa)*, on grassland arthropod communities and genomic barcoding solutions for ecosystem reclamation management

Jordann Foster; Science Department, *Thompson Rivers University*

Co-author: Lauchlan Fraser[1]
Co-author Affiliation: [1] Department of Natural Resource Science, Thompson Rivers University, V2C 0C8, Kamloops, BC, Canada.

British Columbia's (BC) grasslands are home to 30% of the province's species at risk and are one of Canada's most endangered ecosystems. In BC's interior, human activities such as mining, recreation, and farming are altering grassland ecosystems; leaving them susceptible to the colonization of non-native invasive species. Alterations to native plant communities and nutrient cycling, which can occur with the invasion of non-native plants, may alter the amount and quality of habitat available for animals at multiple trophic levels, including arthropods. Arthropods are diverse and contribute to energy flow and nutrient cycling and are therefore an important group to study as a way of determining the effects of changes to ecosystem functioning. Spotted knapweed *(Centaurea maculosa)*, a perennial forb native to Eurasia, is considered one of the most ecologically harmful invasive species in western North America. The objectives of my study are (1) to determine if Spotted knapweed is altering arthropod communities in grassland habitats; and (2) to DNA metabarcode specimens to test recent methodology which could be used to expedite site restoration efforts. To address these objectives, I will set up pitfall (ground insect) traps and Malaise (flying insect) traps at sites that are absent of and highly colonized by Spotted knapweed and DNA metabarcode all specimens collected. Research adding to our grassland species catalogue can be applicable to both invasive species conservation efforts and in helping to improve remediation efforts in disturbed grassland sites.

12:00 PM – 12:05 PM, MOUNTAIN ROOM

Kootenay Boundary bullies: protecting Northern leopard frogs through bullfrog eradication

Morgan Sternberg; *Central Kootenay Invasive Species Society*

Co-authors: Terry Anderson[2], Lindsay Anderson[2], Erin Bates[3], Jennifer Vogel[3], Khaylish Fraser[3], Irene Manley[4], Rob Fox[4], Marc-Andre Beaucher[5], Barb Houston[4]
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American bullfrogs *(Lithobates catesbeiana)* were first detected in BC's Kootenay Boundary region in 2015; sites were alarmingly close to the only three known Northern leopard frog (*Lithobates pipiens*; Rocky Mountain population) populations in BC. Bullfrogs are confirmed predators of Northern leopard frogs, which are designated as SARA Schedule 1 (endangered). Additionally, bullfrogs can transport dangerous diseases, have an extremely high fecundity, and have a history of general competitive exclusivity. Given these concerns, bullfrog eradication in the region was viewed as integral to the Northern leopard frog's successful recovery. Early Detection - Rapid Response (EDRR) procedures began in September 2015, with larger-scale efforts initiated in 2016. Increased targeted public education efforts led to a residential report and eventual capture of a bullfrog within the Creston Valley in 2016. As of 30 January 2017, this program has resulted in the successful control of 180 adults and 380 tadpoles/metamorphs in the Kootenay Boundary region. It is suspected that the first identified incursion site is still infested, but the extent of establishment is unknown. Also in question is the leading edge of incursion. Updates provided on 2017 EDRR efforts and preliminary results. Discussion on the observed indicative capabilities of surveillance methodologies, including song-meter analysis, auditory surveys, and environmental DNA (eDNA) analysis.

12:05 PM – 12:10 PM, MOUNTAIN ROOM

Comparing conventional and alternative control of *Linaria genistifolia ssp.* Dalmatica in a semi-arid grassland of British Columbia's southern interior.

Jacob Bradshaw; *Department of Natural Resource Sciences, Thompson Rivers University*

Manual removal and three herbicide treatments of Dalmatian toadflax were compared by collecting live and dead stem count in 6m by 6m replicates (n=30) during baseline, post-treatment and end-of-growing season assessments in 2016. Tordon 22K was applied at 213 g a.e. ha-1 picloram mixed with Agral 90 surfactant (0.025% by volume) using broadcast spraying, spot spraying and hand wicking (August 23rd). Treatment had a significant effect; broadcast and spot spraying provided the highest overall success resulting in mean stem counts of 1.7 ± 1.07 and 6.33 ± 2.67 at the end of the growing season, respectively. Wicking contained 61% of the live stems at the end of the growing season, relative to baseline, whereas spot spraying contained 31%. Broadcast spraying offered the greatest success in which survivorship was 13%. Only broadcast and spot spraying provide statistically significant reduction in vegetative stems from baseline to end-of-season; broadcast spraying contained zero stems in this life stage. Despite eliminating all stems at time of treatment, manual removal experienced high regrowth which resulted in statistical similarity to the control and appeared to encourage vegetative regrowth. Nearly all of the regrowth experienced in the control, manual removal, spot spraying and wicking at the end of the growing season were rosettes. Seedlings did not greatly contribute to reproduction in any treatments and were absent from broadcast spraying. For high density sites (>31 stems per square meter), broadcast spraying offers the greatest chance of success based on both success and efficiency.

1:25 PM – 1:45 PM, MOUNTAIN ROOM

Potential for glyphosate resistance in Bohemian knotweed *(Fallopia x bohemica)*

Matthew Strelau; *Department of Biology, Trinity Western University*

Co-authors: David Clements[2], Michael Bogress[3]
Co-author Affiliations: [2,3] Department of Biology, Trinity Western University, 7600 Glover Rd, V2Y 1Y1, Langley, BC, Canada.

Japanese knotweed, *Fallopia japonica*, is an East Asian perennial herb transported to North America approximately 100 years ago. The vigorous rhizome structure and astonishing rapid growth have presented a difficult invasive issue. Being male-sterile, the weed has only reproduced asexually in local locations. This invasive species is causing significant property damage and a detriment to local biodiversity. Through hybridization with the congeneric *Fallopia sachalinensis,* the offspring *(Fallopia x bohemica)* can produce viable seeds for long distance dispersal. The most widely applied herbicide for the control of knotweed is glyphosate. Due to heterosis and long-distance dispersal in this hybrid knotweed, there is potential for the development of herbicide resistance. Our study examined resistance and tolerance attributes in Bohemian knotweed. Seedlings were sprayed with glyphosate in a dose-response test. Initial tests revealed susceptible populations had a slightly more accurate binomial trend-line, whereas the potentially resistant population was faintly irregular to a second-degree polynomial. Further research involved an additional dose-response test, measuring the dry weight of the plants after treatment and statistically compared using an analysis of variance (ANOVA). Additionally, a dose-response curve will be compared using a log-logistic analysis. If resistance or even some degree of tolerance is discovered, this study will signify a need for caution in the use of glyphosate. More diverse control methods, utilising a variety of chemical treatments, mechanical removal, or biological control, must be considered when managing knotweed.

1:25 PM – 1:45 PM, TERRACE ROOM

Assessing the risk of Pacific Fisheries Regulation Schedule VIII Species

Thomas Therriault; *Fisheries and Oceans Canada, Pacific Biological Station*

Co-author: Janis L Webb
Co-author Affiliation: Fisheries and Oceans Canada, Pacific Biological Station

On June 17, 2015 the Aquatic Invasive Species Regulations under the Canadian Fisheries Act were posted in Canada Gazette Part II and are now in effect. The objectives of these Regulations are: 1) to prevent the introduction and spread of aquatic invasive species (AIS) in Canadian waters; 2) to avoid costs associated with the establishment of AIS; 3) to support management activities to control the spread of AIS once introduced into Canada; and 4) to fill regulatory gaps, and ensure a consistent national strategy for the management of AIS. Risk assessments formed the scientific underpinning for most species that ultimately were listed in the Regulations and it is expected they will play a prominent role in listing additional species in the future. The Pacific Fisheries Regulations (PFR) Schedule VIII lists species that are prohibited from live import into British Columbia (BC) but the rationale for the genesis of this list is unclear and confounded thereby requiring additional analyses to potentially add PFR Schedule VIII species to the AIS Regulations. Thus, to inform potential listing of these species in the federal AIS Regulations, we applied a screening-level risk assessment tool – the Canadian Marine Invasive Screening Tool (CMIST) – to assess the potential risk of species listed in PFR Schedule VIII. Although some of the highest risk species are in BC already, we identify additional species that are not yet known from BC and which should be priority species for monitoring/early detection. Results will be useful for future amendments to the AIS Regulations.

1:45 PM – 2:05 PM, MOUNTAIN ROOM

Bacterial diversity and virus detection in the invasive Yellow crazy ant

Meghan Cooling; *Victoria University of Wellington*

Co-authors: Ben Hoffmann[1], Monica Gruber[2], Alexandra Sébastien[3], Phil Lester[2]
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Populations of invasive species have been observed to decline, though the mechanisms behind such declines are rarely investigated. The microbial community living within insects can have significant impacts on their health and population dynamics and may be one such mechanism. We used Illumina sequencing to compare the bacterial communities and examine the presence of viruses in queens of the invasive Yellow crazy ant *(Anoplolepis gracilipes)* from populations in various stages of decline or expansion in Australia. Sequences with homology to the Dicistroviridae were present in queens from declining ant populations. This is the first such instance of sequence homology with a virus being found in the Yellow crazy ant. Overall, bacterial communities were not statistically different between the different population types. A number of possible mutualists were detected, along with several putative pathogens, including the entomopathogen, *Serratia marcescens*, the potential pathogen, *Candidatus Rhabdochlamydia*, and the reproductive parasite, *Candidatus Cardinium*. Our survey has identified several candidates for future study to identify potential microbial control agents, and which may be responsible for population declines of this invasive ant.

1:45 PM – 2:05 PM, TERRACE ROOM

Phragmites australis niches for other biota are similar on three continents

Erik Kiviat; *Hudsonia*

Common reed *(Phragmites australis)* is one of the most widely distributed, most abundant, and best-studied vascular plants worldwide but there has been no broad comparative analysis of reed-associated biota on different continents. A survey of observational data on (mostly terrestrial) organisms using *P. australis* reedbeds revealed ecological parallels among North America, Europe, and sub-Saharan Africa. I present examples for a selected group of 27 niches (i.e., features of the reed plant or reedbed used in particular ways by groups of organisms). Niches include animals eating particular portions of reed, birds roosting in reedbeds, and vines using reeds for support. These similarities in habitat functions in biogeographically distinct world regions suggest a fundamental character of reed ecological relationships related to the large size, extensive stands, high productivity, deep litter layers, and other traits of reed. The data also underline the biodiversity support functions of reed and their similarity among continents. Managers can consider reed niches and user guilds to design management approaches and predict outcomes of conservation, management, or other environmental changes affecting reedbeds, whether native or introduced, over-abundant or under-abundant.

2:05 PM – 2:25 PM, MOUNTAIN ROOM

Anti-Pd activity: Can environmental microorganisms be used against *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome?

Naowarat Cheeptham[*]; *Department of Biological Sciences, Thompson Rivers University*

Co-authors: Soumya Ghosh[1#], Robyn McArthur[1#], Cori Lausen[2]
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Pseudogymnoascus destructans (Pd), the fungus responsible for white-nose syndrome (WNS) in bats, has devastated North American bat populations over the last decade. To date, there have been a limited number of studies reporting anti-Pd activities of bacterial and fungal strains (Ex. *Rhodococcus rhodochrous* strain DAP96253) and chemical compounds such as terpeneless orange oil and trans, trans-farnesol. In our study, we collected mushrooms from the phylloplane, tree bark and several infected plant woods and leaves from Bush Lake and Timber Lake in BC. All of the collected samples were inoculated on Sabouraud dextrose agar (SDA) plates, which were placed at 25°C to promote fungal and bacterial growth. Morphologically distinguishable colonies were isolated for pure culture. These isolates were then tested for their inhibitory activity against Pd in vitro. For the anti-Pd bioassay, SDA medium was inoculated with a spore suspension (concentration 1.2x 106 spores/mL) of Pd strain M3906-2 by the seeded agar technique. The microbial isolates were then streaked on the seeded Pd agar plates, which were incubated for a period of 10 days at 15°C. Out of the 93 screened, we have obtained 30 bacterial isolates (B3, B10, B12, B13, B14, B19, B20, B21, B32, B34, B35, B36, B37, B38, B41, B47, B51, B53, B54, B55, B56, B70, B71, B77, B80, B81, B84, B86, B89, B90), as primarily confirmed by Gram-staining, that have exhibited anti-Pd activities in comparison to the positive controls (10% bleach and peroxigard) and negative control (sterile water). Additionally, the molecular identification by 16S nucleotide sequencing of these bacterial isolates that exhibited anti-Pd activities are under investigation. Given that these microbial isolates from the environment could be potential biocontrol agents for Pd, further studies on these metabolites and their structures are required to allow future implementation of a treatment originating from these microorganisms, especially in a Pd-infected cave.

2:05 PM – 2:25 PM, TERRACE ROOM

Evaluating movement of marine infrastructure as a pathway of aquatic invasive species spread

Josephine Iacarella; *Institute of Ocean Sciences, Ecosystem Sciences Division*

Co-authors: Anya Dunham[1], Ian Davidson[2]
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Marine infrastructure transfers – including floating marina docks, aquaculture gear, construction and drilling equipment, and navigational buoys – represent a pathway of introduction and spread of aquatic invasive species (AIS) that has received little or no attention. Infrastructure movement is a likely vector of AIS spread as (1) infrastructure residence time is often orders of magnitude higher than vessels (months to years) promoting build-up of biofouling organisms prior to translocation; (2) movements of infrastructure usually involve slow towing and little hydrodynamic stress to remove organisms during transit, and 3) anthropogenic structures serve as hotspots for a diverse range of AIS. We will map and measure standing stock of moveable infrastructure throughout British Columbia and adjacent waters, as well as document cases and patterns of infrastructure movements. The spread of AIS through aquaculture gear movement will be evaluated through questionnaires of industry stakeholders and mapping stock and equipment transfers in the region. In a case study, floating docks will be surveyed before, during, and after transfers to determine AIS abundance, richness, and condition throughout the vector process. Finally, predictions of marine AIS abundance and richness across the region will be tested through model selection to determine the drivers of AIS spread for this vector, and to identify specific management interventions that could reduce AIS spread throughout the NE Pacific and elsewhere.

2:50 PM – 3:10 PM, MOUNTAIN ROOM

Suppression of invasive Northern pike in Box Canyon Reservoir of the Pend Oreille River in northeast Washington State, USA

Nick Bean; *Kalispel Tribe of Indians*

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[2] Washington Department of Fish and Wildlife, Region 1 Fish Program, 2315 N. Discovery Place, 99216, Spokane Valley, Washington, USA

Northern pike are a relative newcomer to the list of non-native species in Washington State. Following their rapid expansion and successful establishment in the Pend Oreille River in northeast Washington State, concerns quickly arose regarding the potential impacts on local and regional recovery efforts for Westslope Cutthroat Trout and Endangered Species Act listed Bull Trout and the possible disastrous impacts to salmon and steelhead if established downstream in the Columbia River and its tributaries. The Kalispel Tribe of Indians and Washington Department of Fish and Wildlife responded by establishing a program to monitor and suppress the expanding population of Northern Pike in the 55-mile long Box Canyon Reservoir of the Pend Oreille River. To increase angler harvest we implemented an education and outreach effort and hosted several fishing derbies, while mechanically suppressing the population annually with gillnets. Spring gillnetting was the most effective method and in total, 17,159 Northern pike were removed from the core habitat areas. Spring Pike Index netting survey results in 2016 indicated the population abundance had been reduced by greater than 98% when compared to 2011 baseline abundance estimates. Although the project has largely been deemed a success, continued suppression will be necessary and efforts to monitor and control new populations downstream will be of the utmost importance. This presentation will focus on the impact of invasive Northern pike, the approach to controlling the population and the success of the various control and monitoring methods implemented to date on the Pend Oreille River.

2:50 PM – 3:10 PM, TERRACE ROOM

Modeling the risks and damages from a "potential" invasive plant species: Yellow starthistle *(Centaurea Solstitialis)*

Sergey Tsynkevych; *Department of Resource & Environmental Studies, Simon Fraser University*

Co-author: Duncan Knowler
Co-author Affiliation: Department of Resource & Environmental Studies, Simon Fraser University

Yellow starthistle *(Centaurea Solstitialis)* is an annual invasive weed introduced to Western United States from the Mediterranean region. It favours sunny areas and responds aggressively to human disturbances such as road development, tillage of the top soil for agriculture, firebreaks and animal grazing. It also benefits from longer growing seasons and increased levels of CO2 disproportionately more than native plants. Yellow starthistle (YST) is not yet known to occur in Canada but has been sighted in Washington and Idaho. We use a bioeconomic model augmented by a hazard function to mimic YST's invasion hazard, with or without the stimulating effects of climate change. We assume that there may be different probability distributions for invasion with climate change. A representative ranching operation is used as a study site with rangelands being the dominant type of land-use. Producers are assumed to maximise their profit subject to the probability of a YST invasion on rangelands. We use hazard rates and variables describing biological characteristics of YST, augmented by economic data from a ranch operation to estimate economic losses. Since the use of a representative ranch to derive economic losses includes only direct effects, this study will underestimate economic damages to society because we ignore other types of damages (e.g. biodiversity, ecoservices). We expect the modelling to confirm that economic damages are expected to arise with a warming climate and an expanded range. We conclude with a discussion of the policy implications of our research for addressing invading species risks prior to invasion, beginning with the cost-effectiveness advantages of early detection.

3:10 PM – 3:30 PM, MOUNTAIN ROOM

Puncturevine *(Tribulus terrestris)* Control in the South Okanagan

Ken Sapsford; *BC Ministry of Agriculture*

Co-author: Lisa K. Scott[2]
Co-author Affiliation: [2] Okanagan and Similkameen Invasive Species Society, Summerland, BC.

Puncturevine *(Tribulus terrestris)* was first recorded in Canada in the 1970's. In British Columbia it only occurs in the Okanagan and Similkameen Valleys, with the majority of the population in the South Okanagan near Osoyoos and Oliver but has been recorded as far north as Vernon. It is classified as a noxious weed for the Regional District of Okanagan-Similkameen. Puncturevine prefers dry, sandy or gravely soils and requires less water than most plants. The most distinguishing feature is its spiny seedpods that can damage the feet of humans, the mouths of grazing wildlife and domestic animals and they can also puncture bicycle tires. There is no herbicide registered for control of puncturevine at this time in Canada. Trials were established near Osoyoos in 2015 and Oliver in 2016 to evaluate a number of pre-emergent and post-emergent herbicides for puncturevine control. Pre-emerge products: Prism (rimsulfuron), Chateau (flumioxazin) and Sandea (halosulfuron) provided good suppression or control of puncturevine through part or all of the growing season in both 2015 and 2016. Alion (indaziflam) provided minimal control of puncturevine in the year of application but provided 100% control 12 months after application. In 2015 none of the post-emergent products tested provided control of puncturevine. In 2016 Clearview (aminopyralid + metsulfuron-methyl) and Overdrive (diflufenzopyr + dicamba) each provided season long control of puncturevine.

3:10 PM – 3:30 PM, TERRACE ROOM

Assessing the risk of marine invasive species in the Bering Sea

Amanda Droghini; *Alaska Center for Conservation Science, University of Alaska Anchorage*

Co-authors: Jesika Reimer[1], Aaron Poe[2], Anthony Fischbach[3], Bonnie Bernard[1], Jordan Watson[4], Alan Haynie[4]
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The Bering Sea generates half of the seafood harvest in the United States and sustains subsistence cultures for dozens of coastal Alaskan communities. While the Bering Sea's geographic isolation has kept species introductions relatively low, new patterns in global shipping traffic and an expanding human footprint may increase the risk of introductions. The region's climate has also changed, resulting in warmer water temperatures and decreased seasonal sea ice, both of which have historically acted as barriers to species' establishment. To assess the risk of invasive species to the Bering Sea, we developed a quantitative ranking system and applied it to 60 species listed as invasive in nearby ecoregions. We used this ranking system to identify species of greatest risk, based on biological characteristics, use of anthropogenic vectors, and predicted impacts on ecosystems and human communities. In addition, we used species-specific characteristics and shipping traffic data to identify regions in the Bering Sea that are most suitable for survival and establishment, and those that are most likely to experience future increases in propagule pressure. Lastly, we are developing outreach and engagement activities for local communities and the maritime industry to raise awareness and promote prevention and early detection. Our work, which includes a ranking system, a list of "greatest risk" species, spatial depiction of high-risk areas, and outreach efforts, is a useful model for managers across the Pacific Northwest to evaluate risk and raise awareness of marine invasive species.

3:30 PM – 3:50 PM, MOUNTAIN ROOM

Assessing benthic barriers vs. aggressive cutting as effective Yellow flag iris *(Iris pseudacorus)* control mechanisms

Catherine Tarasoff; *Thompson Rivers University*

Co-authors: Kailee Streichert[2], Wendy Gardner[3], Brian Heise[4], John Church[5], and Thomas G. Pypker[6]
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An experiment was initiated to study the effects of rubber benthic barriers vs. aggressive cutting on the invasive aquatic emergent plant, Yellow flag iris. Treatments were compared against a control at two locations within British Columbia, Canada (Vaseux Lake and Dutch Lake). Yellow flag iris response was significantly different between the two sites, but biologically the results were identical: the benthic barrier killed yellow flag iris rhizomes within 70 d of treatment. Over the extent of the research, at Vaseux Lake the effect of aggressive cutting was no different from the control, while aggressive cutting was statistically no different than the benthic barrier at Dutch Lake. Vegetation regrowth approximately 200 d after the benthic barriers were removed was not detected at either location.

3:30 PM – 3:50 PM, TERRACE ROOM

Predicting progressive ecosystem-wide impacts of invasive mussel establishment in a large lake

Patricia Woodruff; *Institute for the Oceans and Fisheries, University of British Columbia*

Co-authors: Villy Christensen[2], Brett van Poorten[3], Daniel Selbie[4], Matthias Herborg[5]
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Aquatic invasive species can impact whole freshwater ecosystems through a combination of competition and predation on various other species endemic to the system. Non-indigenous mussel species can affect water quality and have significant impacts on all trophic levels. These mussels have few natural predators, and generally provide poor nutritional value. Moreover, they are very efficient consumers, effectively removing planktonic algae and zooplankton from the top and mid depths of lakes. The presence of these mussels results in fouling of boats, water structures such as docks and pilings, and hydro power intakes. Recreational boaters act as vectors of introduction of aquatic invasive species to novel ecosystems through movements between affected and unaffected lakes. Zebra mussels can survive up to 30 days out of the water, and therefore transporting boats between waterbodies is one of the primary vectors for the spread of zebra mussels across North America. Shuswap Lake, BC has some of the highest use among recreational boaters in the province, with tens of thousands of boats present on the lake each summer. I will characterize the Shuswap Lake ecosystem, using EcoPath with EcoSim (EwE) and then simulate the effect of the introduction of an invasive mussel species on the ecosystem as a whole, and the sockeye salmon runs and predator abundance in particular. This research will look at the effect of an aquatic invasive species on the natural ecosystem and its potential far-reaching effects on the sockeye salmon fishery as well as the local trout and char recreational fisheries.

3:50 PM – 4:10 PM, MOUNTAIN ROOM

Northern pike invasion and suppression in the Columbia River

Crystal Lawrence; *Amec Foster Wheeler Environment & Infrastructure*

Co-authors: Jeremy Baxter
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Northern pike *(Esox lucius)*, a fish species endemic to northern regions of Canada, are a recent invader of the Columbia River system in both Canada and the United States. The presence of Northern Pike in the Canadian Columbia River was first recorded near Castlegar, BC in 2009. Northern Pike have the potential to significantly impact native fish populations and the recovery of species listed under the Species-at-Risk Act (SARA) through competition, predation and the introduction of disease. Following the discovery of Northern pike in the lower Columbia River, fisheries managers responded quickly with removal and research programs aimed at suppressing and evaluating the population. The response to the invasion came from various agencies, first nations, researchers and other stakeholders. An information review was conducted to compile information about current suppression efforts and knowledge gaps to help inform future suppression activities. Since the initial detection, strategies to inventory and suppress the non-native predator in the Canadian Columbia River have included gill-net suppression, an angler incentive/awareness program, unlimited daily quota angling regulation, acoustic telemetry, otolith geochemistry, eDNA, juvenile detection programs and aquatic invasive plant suppression. The rapid response following the initial discovery has successfully eliminated approximately 30 to 40% of the Northern pike population annually in the Canadian Columbia River and so far restricted the upstream invasion of the Arrow Lakes. Continuing on the successes of the response to date, stakeholders identified the need for a coordinated suppression program with long-term funding sources.

3:50 PM – 4:10 PM, TERRACE ROOM

How important is seed production in the spread of Japanese knotweed *(Fallopia japonica)*?

Sharon Gillies; *Biology Department, University of the Fraser Valley*

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Japanese knotweed was introduced as a female clone, the spread of this plant was considered to be limited to vegetative methods, such as fragmentation and by rhizomes. However, recent studies have shown that in Western North America considerable hybridization has occurred between Japanese knotweed and a related species Giant knotweed. The resultant hybrid Bohemian knotweed, shows greater variability than either parent. Seed production can be prodigious, and germination rates can reach as high as 100% in some populations. Dispersal from seed may become an important vector for knotweeds. Japanese knotweed has been shown to use allelopathy to inhibit germination of other plant seeds, but knotweed seed germination appears to be enhanced by knotweed leaf litter.

4:10 PM – 4:30 PM, MOUNTAIN ROOM

Under the cover of rock snot: understanding the effects of Didymo algae in Yukon

Heather Milligan; *Department of Environment, Yukon government*

Didymo algae (also known as Rock snot or *Didymosphenia geminata*) is a freshwater diatom that can form massive blooms in stream beds and impact fish habitat. Until recently, nuisance blooms were considered invasive in Canada; however, current evidence indicates the species is native and that blooms are associated with environmental changes and low phosphorus levels. The effects of these Didymo blooms to fish habitat are not well understood, especially in areas subject to sub-arctic climates. Beginning in 2015, the Yukon Department of Environment established a collection program for benthic invertebrates existing in habitats where Didymo blooms were present, with the intent of determining how fish prey species may be affected by Didymo occurrence. We collected invertebrates in Didymo affected and un-affected areas from seven streams in southern Yukon using a surber sampling methodology. Preliminary results indicate that there are no declines in species diversity associated with Didymo. Nevertheless, shifts in invertebrate community composition did occur and higher densities of chironomids in Didymo affected areas were observed. Our results help to reveal the effects of Didymo blooms on invertebrate communities in northern Canada.

4:10 PM – 4:30 PM, TERRACE ROOM

Introduced Yellow perch *(Perca flavescens)* in BC lakes: Feeding, movement and a possible control method

Carmen Tattersfield, *Thompson Rivers University*

Co-authors: Brian A. Heise[2]
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Yellow perch *(Perca flavescens)* is an invasive species in most areas of British Columbia, where its introduction has had deleterious effects on trout populations. We examined seasonal diet composition and basic movement patterns of perch to determine any differences in feeding and movement behaviours in novel habitat versus native habitat. Diet composition was studied during five seasonal sampling periods by counting and identifying items within perch stomachs. Diets were compared among lakes, among seasons and among size classes within each lake, using a multivariate analysis. Diet composition varied among lakes. Yellow perch did not consume juvenile fishes in several lakes, but rather, consumed large proportions of zooplankton. It is possible that diet composition of introduced yellow perch could be predicted based on presence or absence of predators and refugia for prey species.

Radio telemetry analysis showed yellow perch relatively close to shore during the summer season. In early spring, yellow perch were significantly farther from shore when ice was covering the lake and moved closer to shore as the ice receded. This coincided with the beginning of the spawning season at temperatures of 3.8 °C, the lowest end of the known spawning temperature range for this species.

We also investigated the use of artificial spawning substrates as a potential method of removing eggs to reduce spawning success and possibly limit population growth. The trials were successful; perch spawned multiple times on all artificial spawning substrates and eggs were removed from the lake.

Tuesday Poster Presentation Abstracts

Posters are listed in alphabetical order according to the presenter's last name.

Using statistical learning to evaluate environmental factors influencing GIS-based identification of Yellow flag iris

Jackson Baron; *Department of Geography and Environmental Studies, Thompson Rivers University*

Co-authors: David Hill, Catherine Tarasoff, Garrett Whitworth, Jacob Bradshaw
Co-author Affiliations: Department of Natural Resource Science, Thompson Rivers University, V2C 0C8, Kamloops, BC, Canada.

The integration of Unmanned Aerial Vehicles (UAVs) with traditional field-based methods of data collection can be used to improve the accuracy of detection for the invasive species Yellow flag iris *(Iris Pseudacorus)*, while providing more accurate ground-cover estimates and reducing the likelihood of failed detection. By generating orthomosaics from UAV images, GIS mapping can be used to manually digitize Yellow flag iris (YFI) locations, generating a more accurate depiction of YFI infestation than can be performed with GPS measurements alone. The error associated with off-site mapping limits the effectiveness of using UAVs as a standalone tool in invasive species mapping, however, by measuring the accuracy of detection in relation to the surrounding environmental features, areas that pose a higher risk of containing unidentified YFI can be classified for additional on-site analysis. By comparing GIS-based maps of YFI locations to ground truth field measurements, statistical learning methods can be applied to predict the likelihood of unidentified YFI in areas based on other environmental factors present. This study quantifies the effects that features such as YFI percent cover, water depth, etc. have on the detection accuracy of YFI at Cheam Lake. Future studies will expand this research to additional field sites.

Anti-Pd activity: Can environmental microorganisms be used against *Pseudogymnoascus destructans*, the causative agent of white-nose syndrome?

Naowarat Cheeptham[*]; *Department of Biological Sciences, Thompson Rivers University* and
Cori Lausen; *Wildlife Conservation Society Canada*

Co-authors: Soumya Ghosh[1#], Robyn McArthur[1#]
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Pseudogymnoascus destructans (Pd), the fungus responsible for white-nose syndrome (WNS) in bats, has devastated North American bat populations over the last decade. To date, there have been a limited number of studies reporting anti-Pd activities of bacterial and fungal strains (Ex. *Rhodococcus rhodochrous* strain DAP96253) and chemical compounds such as terpeneless orange oil and trans, trans-farnesol. In our study, we collected mushrooms from the phylloplane, tree bark and several infected plant woods and leaves from Bush Lake and Timber Lake in BC. All of the collected samples were inoculated on Sabouraud dextrose agar (SDA) plates, which were placed at 25°C to promote fungal and bacterial growth. Morphologically distinguishable colonies were isolated for pure culture. These isolates were then tested for their inhibitory activity against Pd in vitro. For the anti-Pd bioassay, SDA medium was inoculated with a spore suspension (concentration 1.2x 106 spores/mL) of Pd strain M3906-2 by the seeded agar technique. The microbial isolates were then streaked on the seeded Pd agar plates, which were incubated for a period of 10 days at 15°C. Out of the 93 screened, we have obtained 30 bacterial isolates (B3, B10, B12, B13, B14, B19, B20, B21, B32, B34, B35, B36, B37, B38, B41, B47, B51, B53, B54, B55, B56, B70, B71, B77, B80, B81, B84, B86, B89, B90), as primarily confirmed by Gram-staining, that have exhibited anti-Pd activities in comparison to the positive controls (10% bleach and peroxigard) and negative control (sterile water). Additionally, the molecular identification by 16S nucleotide sequencing of these bacterial isolates that exhibited anti-Pd activities are under investigation. Given that these microbial isolates from the environment could be potential biocontrol agents for Pd, further studies on these metabolites and their structures are required to allow future implementation of a treatment originating from these microorganisms, especially in a Pd-infected cave.

Invasive rat colonization history and movement dynamics in Haida Gwaii

Bryson Sjodin; *University of British Columbia Okanagan*

Co-authors: Robyn Irvine[1], Gregg Howald[2], Michael Russello[3]
Co-author Affiliations: [1] Gwaii Haanas National Park Reserve, National Marine Conservation Area Reserve and Haida Heritage Site, Parks Canada, 60 Second Beach Road, V0T 1S1, Skidegate BC, Canada; [2] Island Conservation, 2100 Delaware Ave., Suite 1, 95060, Santa Cruz, CA, USA; [3] Department of Biology, University of British Columbia, Okanagan Campus, 3427 University Way, V1V 1V7, Kelowna, BC, Canada

The Brown *(Rattus norvegicus)* and Black rat *(R. rattus)* are among the most invasive species globally. Through predation and competition, invasive rats reduce the biodiversity of native fauna. On Haida Gwaii, invasive rats have caused population declines in six seabird species. Eradications were conducted on several islands where important nesting sites for sea-birds exist. On the Bischof Islands, reappearance of rats post-eradication has been observed. The objectives of this research are to investigate population history and movement dynamics of invasive rats in Haida Gwaii. Presently, 551 Brown and Black rats have been sampled from eighteen islands, collected from 2008-2016. Pre- and post-eradication samples were collected from the Bischofs allowing for an explicit evaluation of re-emergence versus re-colonization in these locations. Genomic DNA was extracted from ear samples and used to conduct double digest restriction site-associated DNA sequencing using the Illumina HiSeq2500 PE125 platform. Single nucleotide polymorphisms (SNPs) were identified, genotyped, and used to assign individuals to species using a Bayesian clustering approach. Resulting SNP data will be analyzed using a series of population genetic and spatially-explicit analyses to determine the source of re-established populations and quantify the extent and direction of gene flow throughout the system. Genotypic data are being collected such that they offer full connectibility to a global SNP database of brown rats to infer potential sources of the populations in Haida Gwaii. Results of these analyses will help facilitate future eradications and provide useful insights to prevent the spread of rats elsewhere within the system.

Potential for glyphosate resistance in Bohemian knotweed *(Fallopia x bohemica)*

Matthew Strelau; *Department of Biology, Trinity Western University*

Co-authors: David Clements[2], Michael Bogress[3]
Co-author Affiliations: [2,3] Department of Biology, Trinity Western University, 7600 Glover Rd, V2Y 1Y1, Langley, BC, Canada.

Japanese knotweed, *Fallopia japonica*, is an East Asian perennial herb transported to North America approximately 100 years ago. The vigorous rhizome structure and astonishing rapid growth have presented a difficult invasive issue. Being male-sterile, the weed has only reproduced asexually in local locations. This invasive species is causing significant property damage and a detriment to local biodiversity. Through hybridization with the congeneric *Fallopia sachalinensis,* the offspring *(Fallopia x bohemica)* can produce viable seeds for long distance dispersal. The most widely applied herbicide for the control of knotweed is glyphosate. Due to heterosis and long-distance dispersal in this hybrid knotweed, there is potential for the development of herbicide resistance. Our study examined resistance and tolerance attributes in Bohemian knotweed. Seedlings were sprayed with glyphosate in a dose-response test. Initial tests revealed susceptible populations had a slightly more accurate binomial trend-line, whereas the potentially resistant population was faintly irregular to a second-degree polynomial. Further research involved an additional dose-response test, measuring the dry weight of the plants after treatment and statistically compared using an analysis of variance (ANOVA). Additionally, a dose-response curve will be compared using a log-logistic analysis. If resistance or even some degree of tolerance is discovered, this study will signify a need for caution in the use of glyphosate. More diverse control methods, utilising a variety of chemical treatments, mechanical removal, or biological control, must be considered when managing knotweed.

Comparing conventional and alternative control of *Linaria genistifolia ssp. Dalmatica* in a semi-arid grassland of British Columbia's southern interior

Jacob Bradshaw; *Department of Natural Resource Sciences, Thompson Rivers University*

Dalmatian toadflax is a major concern in disturbed areas of British Columbia's interior due to its ability to displace native vegetation. To investigate the most appropriate control method, including efficiency and scalability, a study was established in Kenna Cartwright Nature Park, Kamloops, BC in 2016. The study compared manual removal and three herbicide treatments (broadcast, spot spraying and wicking) by collecting live and dead stem count in 6m by 6m replicates (n=30). Tordon 22K was applied (213 g ae ha-1 picloram) mixed with Agral 90 surfactant (0.025% by volume). Treatment had a significant effect; broadcast and spot spraying provided the highest overall success resulting in mean stem counts of 1.7±1.07 and 6.33±2.67, respectively. These were also the only treatments to eliminate nearly all vegetative regrowth at the end of the growing season. Wicking offered the same overall success as spot spraying in reducing total live stems and may provide an option on low density sites. Although manual removal eliminated all plants at time of treatment, there was high regrowth which resulted in statistical similarity to the control. Only broadcast and spot spraying provide statistically significant reduction in vegetative stems from pre-treatment to end-of-season. For medium-high density sites (mean stem count 25.91m-2), broadcast and spot spraying offer the greatest chance of success based on both success and efficiency. This research highlights the importance of planning invasive plant management on small scales and provides land managers with multiple integrated management components to consider when removing Dalmatian toadflax from semi-arid grasslands.

Community dynamics and management of invasive perennial grasses using mowing and prevention of grazing in Garry oak meadows over 7 years

David Clements; *Trinity Western University*

Co-authors: Joy Marconato[1], Emily Gonzales[2]
Co-author Affiliations: [1] Department of Geography and Environment, Trinity Western University, V2Y 1Y1, Langley, BC, Canada; [2] Parks Canada, V6B 6B4, Vancouver, BC, Canada

Invasive perennial grasses such as *Anthoxanthum odoratum* degrade vulnerable Garry oak ecosystems in the North American Pacific Northwest. Previous research on the same site showed that a combination of mowing and grazing prevention reduced dominance of non-native grasses in this system. The previous research utilized 1x1m plots over 3 years; we scaled up the approach to utilize 5x5m plots over 7 years using four treatments: grazed/unmowed, grazed/mowed, ungrazed/unmowed, and ungrazed/mowed on a Salt Spring Island site. A yearly census was completed of the vegetation, followed by a single fall mowing. In June 2016 we harvested plants at ground level to analyze biomass trends. Trends in percent cover over the 7 years showed a decline in non-native perennial grasses (NNPG) with mowing but no increase in native perennial forbs (NPF). After 7 years, the dry weight of NNPG in ungrazed/mowed plots was still highest among the 3 largest plant categories, illustrating the inadequacy of a single mowing in the fall to control NNPG. There was less NNPG biomass in the grazed/mowed plots than in the ungrazed/mowed plots, but non-native annual grasses (NNAG) was higher in these plots. A holistic restoration effort would require more frequent mowing and extensive planting of native vegetation.

Pacific Northwest Garlic Wustard Working Group: Highlights from recent collaborations

Catherine MacRae on behalf of Michelle Delepine; *West Multnomah Soil & Water Conservation District*

Co-authors & Affiliations: ALASKA: Melinda Lamb (Juneau USFS), Brian Maupin (Southeast SWCD) BRITISH COLUMBIA: Becky Brown, Catherine MacRae (BC Ministry of Forests, Lands and Natural Resource Operations) OREGON: Chris Aldassy, Lucas Nipp, Jon Wagner (East Multnomah SWCD); Mitch Bixby (City of Portland, Bureau of Environmental Services); Michelle Delepine (West Multnomah SWCD); Dan Durphey, Theodore Orr (Umatilla Weed Control Program), Robert Emanuel (Clean Water Services); Sarah Hamilton (4-County CWMA); Vern Holm (Western Invasives Network); Jordan Kim, Kris Schaedel (Hood River SWCD); Sam Leininger, Jeff Lesh (Clackamas County SWCD); Bethany Lund (Tualatin SWCD); Christina Mead (Mt Hood National Forest, USFS); Glenn Miller, Beth Myers-Shenai (ODA); Charles Nappi (Portland Parks and Rec); Kyle Strauss (Strauss Ecological Services); Sam Whiteridge (Rogue Basin Watersheds); Lindsey Wise (iMap OR) WASHINGTON: Denielle Cowley, Mike Monfort, Kevin Tyler (Clark County Environmental Services); Greg Haubrich (WSDA); Frances Lucero, Ed McFarlin, Karen Peterson, Sasha Shaw, Maria Winkler (King County Noxious Weed Program); Kyle McKune, Clark Sexton, Aaron Yanez (WSDOT); Dan Sorensen (University of Washington); Emily Stevenson (Skamania County Noxious Weed Control Program); Angelica Velazquez (Cowlitz County Noxious Weed Control Board); Bill Wamsley (Lewis County Noxious Weed Board)

Invasive plant managers and field staff working on control of Garlic mustard *(Alliaria petiolata)* in Oregon, Washington, British Columbia and Alaska recently convened to share observations, identify challenges, discuss treatment strategies and refine methodologies. Through collective sharing of observed treatment successes and deficiencies, potential improvements to control methodologies were revealed. A composite, regional view of the current work being undertaken to combat Garlic mustard was also compiled. Developing a platform for future collaboration promotes timely sharing of key information and supports a region-wide effort to contain and decrease Garlic mustard presence in the Pacific Northwest.

Does seed source matter in grassland restoration?

Sabina Donnelly; *Department of Biological Sciences, Thompson Rivers University*

Co-authors: Dr. Lauchlan Fraser[2], Dr. Wendy Gardner[3]
Co-author Affiliations: [2,3] Department of Biology, Thompson Rivers University, V2C 0C8, Kamloops, BC, Canada

Natural grasslands in British Columbia (BC) are very important as they contain large amounts of biodiversity, and provide valuable ecosystem services. Due to human activities, grasslands are increasingly under threat from invasive species infestations. Restoring sites with vigorous native species after the removal of infestations decreases colonization opportunities for invasive seedlings. Seeds used in restoration can be sourced from a variety of climatic and edaphic conditions. This can be problematic as poorly adapted collections could offer diminished competitive ability against colonizing invasive species. The goal of the project was to evaluate the importance of local seed source during restoration practice. Seeds of bluebunch wheatgrass *(Pseudoroegneria spicata)*, Idaho fescue *(Festuca idahoensis)*, and needle-and-thread grass *(Hesperostipa comata)* were collected from ten populations extending from central BC to northern California. We established a common garden in Kamloops, BC to measure and compare plant morphological traits to determine if significant variation in physiological and resource-use strategy existed among populations. Our results indicate that there are underlying differences in growth and resource-use strategies among some populations of the species collected. Future work in delineating seed transfer zones of native species in BC appears to be a beneficial endeavour to improve seed source policy and restoration practice in our province.

St. John's Wort *(Hypericum perforatum)*: An investigative approach to biocontrol resistance

Kristi Gordon; *Department of Natural Resource Science, Thompson Rivers University*

St. John's wort *(Hypericum perforatum)* is a perennial plant native to Europe that can reproduce and spread aggressively, particularly in disturbed sites and rangelands. Recently, St. John's wort appears to be resurging on the landscape, and the biological control agents *(Chrysolina sp.)* are not performing as well as they have historically. The purpose of this research was to determine if there exists evidence of biocontrol resistance within a population of St. John's wort located in the West Kootenay region of British Columbia. Ten suspected resistant plants and ten susceptible plants were collected from the field. Leaves were randomly selected, and the number of dark coloured and translucent leaf glands (the locations of where the toxins hypericin and hyperforin accumulate) were tallied for each of the suspected versus susceptible plants. Further experiments included single-choice and no-choice tests. Our results indicate that the suspected resistant St. John's wort plants had greater densities of dark leaf glands ($p=.043$, $\alpha=.05$) and translucent leaf glands ($p=.001$, $\alpha=.05$). Although not significant, there appeared to be more leaves defoliated on the susceptible plants than the resistant plants in the single-choice test ($p=0.326$, $\alpha=0.05$). Additionally, 54.5% of the suspected resistant leaves weren't eaten, while 66.7% of the susceptible leaves were eaten in the no-choice test. The results of this research suggest that there may be resistance developing within certain populations of St. John's wort. This experiment should be repeated with more sites added to determine how widespread possible resistance may be across the province.

Decomposition rate analysis of Japanese knotweed

Shyna Kanda; *Biology Department, University of the Fraser Valley*

Co-authors: Sharon Gillies[2]
Co-author Affiliations: [2] Biology Department, University of the Fraser Valley, V2S 7M8, Abbotsford, BC, Canada

As an aggressive riparian invader in the Fraser Valley, Japanese knotweed *(Fallopia japonica)* thrives in riparian areas as it prefers moist soils with medium shading. To analyze the nature of this invasive plant, this study was conducted to measure decomposition rates of Knotweed leaf litter. Decomposition of leaf litter is a major source of nutrients; therefore, leaf litter is an effective parameter to study the quality of stream ecosystems. The quality of the leaves is also an important factor and is defined by its lignin content and overall leaf toughness. Leaf litter bags were placed in Upper and Lower Clayburn Creek, Abbotsford, BC to analyze the differences between the fresh (green) and senesced (yellow) Knotweed leaves. Lower sampling site is more impacted by human interference and there, yellow leaves decomposed faster compared with the green leaves. This might also be due to the different macroinvertebrate populations or water quality. This study can be helpful to monitor and maintain stream health and shed light on mechanisms for the removal of invasive plant species, such as Japanese knotweed.

Impacts of Cattle Grazing on the Proliferation of Foxtail Barley in Wet Meadow Rangeland Communities

Kaleb Ledoux; *Department of Biology, University of Winnipeg, MB*

Co-authors: Rafael Otfinowski[2], Jane Thornton[3]
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Hordeum jubatum (Foxtail barley), a native weedy grass found throughout the Prairie provinces, thrives in sites high in salinity and moisture, such as wet meadows, and poses a major health hazard to livestock. Although wet meadows provide valuable summer forage, uncontrolled grazing may contribute to the proliferation of foxtail barley and further threaten livestock. This study tests the hypothesis that low intensity, late season grazing will reduce the proliferation of foxtail barley and increase the productivity of wetland meadows. Between July and August 2016, early and late grazing treatments were crossed with two grazing intensities. Each paddock within the wet meadow was analyzed for forage productivity, soil properties, plant community composition, and vegetative cover of foxtail barley. Following the first year, 64 different species were identified in the area. Among them, foxtail barley covered 6-45% of sample quadrats and was found along most transects. Forage biomass ranged from 3,674 kg/ha in June to 3,579 kg/ha in July and consisted primarily of graminoids. Soils were clay loam and were high in salinity and organic matter. Based on early observations, early season, high intensity grazing shifted the plant community towards rushes and weedy forbs, however, grazing will continue for one more season to assess its full impacts on the plant community. As changing climates and flooding continue to impact the Prairie provinces, this study will contribute information regarding management of weedy species of wet meadows, as well as stewardship of healthy soils and diverse rangeland communities.

Efforts to assess and control aquatic invasive species in the Columbia River

Bronwen Lewis; *Okanagan Nation Alliance - Columbia Team*

Co-authors: Evan Smith[1]
Co-author Affiliations: [1] Okanagan Nation Alliance

The Columbia River near Castlegar, BC (Robson Reach) has become the receiving environment for a growing number of invasive aquatic species in the last 20 years. Invasive Eurasian watermilfoil (EWM) has been observed to increase coverage annually along the margins of the Columbia River downstream from Hugh L. Keenleyside Dam. The first invasive Northern pike (NP), a voracious predator, was captured from the Robson Reach in 2010 and now this species extensively uses the EVM beds as ambush cover habitat. NP are considered a serious threat to native fish species, having been observed to feed mainly feed on Mountain whitefish and Rainbow trout. To determine if NP were successful in spawning and hatching larvae in the Robson Reach, quatrefoil light traps and lighted minnow traps were deployed at approximately 2 week intervals after a spent female NP was removed from the river, but larval pike were not located at that time. In 2017, we have started a limited pilot program using two suppression methods to target the removal the EVM, both as an invasive and as NP habitat. The program will involve implementing a combination of geotextile barriers and scuba diver hand removal at selected sites of heavy EWM infestation. The geotextile barriers will lay on the river bottom for about 8 weeks to block sunlight and potentially kill the EVM root system. We will be monitoring the success of EWM depletion between the hand removal sites versus the geotextile barrier during the summer of 2017.

First report: spotted knapweed *(Centaurea maculosa L.)* resistance to auxinic herbicides

David Clements on behalf of Linda Hall; *Agricultural, Food and Nutritional Sciences, Faculty of Agriculture, Life and Environmental Sciences, University of Alberta*

Co-authors: Amy Mangin[1], Linda Hall[2]
Co-author Affiliations: [1,2] Agriculture Food and Nutritional Science, University of Alberta, Edmonton, AB

Spotted knapweed *(Centaurea maculosa L.)* is prohibited noxious, invasive species replacing native rangeland in the Pacific Northwestern United States, southern British Columbia and Alberta. This biennial or short-lived perennial that has been reported to establish a monoculture in poor range conditions in as little as one season. Chemical control of Spotted knapweed has been achieved primarily through application of auxinic herbicides. A population collected from an extensively managed land-base near Fernie, BC was reported to not respond to herbicides. To confirm if the population was resistant to herbicide and quantify level of resistance, this population was compared it to a susceptible (S) population collected in Vernon, BC. The Fernie population was highly resistant to both clopyralid and picloram with resistance ratios of >25,600 and 28, respectively. This is the first report of resistance in Spotted knapweed and the highest resistance to clopyralid reported in any species. Effective alternatives to chemical control must be developed to retard the spread of this invasive species.

Invasion meltdown, mycorrhizal fungi

Antreas Pogiatzis; *University of British Columbia, Okanagan Campus*

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The establishment of exotic invasive species is very common following the disturbance of natural habitats. Invaders may have significant impact on local communities and ecosystems, and it is believed that this often results in invasion meltdown (the establishment of multiple invading exotic species, and enhanced ecosystem degradation). In the Okanagan Valley, disturbed sites are typically occupied by combinations of multiple exotic species and usually include *Lepidium draba (Brassicaceae), Sisymbrium altissimum (Brassicaceae)* and *Bromus tectorum (Poaceae)*, among others. Interestingly, two of these species are in the Brassicaceae, a family which has been associated with the degradation of local arbuscular mycorrhizal fungi. In contrast, grasses are typically highly mycorrhizal. In this study, we will focus on the effects of individual and multiple invaders on the abundance of mycorrhizal fungi, and the consequences of such effects on the growth of local native plants.

Kootenay Boundary bullies: Protecting Northern leopard frogs through bullfrog eradication

Morgan Sternberg; *Central Kootenay Invasive Species Society*

Co-authors: Terry Anderson[2], Lindsay Anderson[2], Erin Bates[3], Jennifer Vogel[3], Khaylish Fraser[3], Irene Manley[4], Rob Fox 4, Marc-Andre Beaucher[5], Barb Houston[4]
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American bullfrogs *(Lithobates catesbeiana)* were first detected in BC's Kootenay Boundary region in 2015; sites were alarmingly close to the only three known Northern leopard frog (*Lithobates pipiens*; Rocky Mountain population) populations in BC. Bullfrogs are confirmed predators of Northern leopard frogs, which are designated as SARA Schedule 1 (endangered). Additionally, bullfrogs can transport dangerous diseases, have an extremely high fecundity, and have a history of general competitive exclusivity. Given these concerns, bullfrog eradication in the region was viewed as integral to the Northern leopard frog's successful recovery. Early Detection - Rapid Response (EDRR) procedures began in September 2015, with larger-scale efforts initiated in 2016. Increased targeted public education efforts led to a residential report and eventual capture of a bullfrog within the Creston Valley in 2016. As of 30 January 2017, this program has resulted in the successful control of 180 adults and 380 tadpoles/metamorphs in the Kootenay Boundary region. It is suspected that the first identified incursion site is still infested, but the extent of establishment is unknown. Also in question is the leading edge of incursion. Updates provided on 2017 EDRR efforts and preliminary results. Discussion on the observed indicative capabilities of surveillance methodologies, including song-meter analysis, auditory surveys, and environmental DNA (eDNA) analysis.

Fungal biofertilizers as a potential source of microbial invasion

Corrina Thomsen; *Department of Biology, UBC Okanagan*

Co-authors: Pat Bowen[2], Miranda Hart[3]
Co-author Affiliations: [2] Agriculture and Agri-Food Canada, Summerland Research and Development Centre, V0H 1Z0, Summerland, BC, Canada; [3] Department of Biology, University of British Columbia Okanagan, V1V 1V7, Kelowna, BC, Canada,

Invasive microbes have the potential to significantly alter native microbial communities, which play a key role in the nutrient cycling, productivity, and biodiversity of ecosystems. However, as they are much more difficult to track than larger organisms, we know very little about invasive microbes, except for major pathogens. The lack of data on the risk of microbial invasion has raised concerns over the commercial use of fungal "biofertilizers", when foreign arbuscular mycorrhizal fungal (AMF) isolates are added to agricultural fields for crop growth promotion or pathogen protection. In order to apply invasive species frameworks to the use of these biofertilizers, we need more information on persistence and spread of these species in the field. Here I focus on work currently being conducted in a long-term monitoring study. In 2013, grapevines were inoculated with a commercial biofertilizer containing the AMF isolate *Rhizophagus irregularis* DAOM 197198 near Kelowna, BC. From fall 2013-2016, soils were collected and DNA was tested for the presence of the commercial inoculant using a newly developed primer and probe specific to this isolate. Using this approach, we will track the establishment, persistence, and spread of this commonly used inoculant in a field setting, to determine the risk and rate of spread from the point of introduction.

Are biological control agents impacting Spotted knapweed in the Lundbom grasslands?

Susan Turner; *BC Ministry of Forests, Lands and Natural Resource Operations*

Co-author: Sheryl Wurtz[2]
Co-author Affiliation: [2] BC Ministry of Forests, Lands and Natural Resource Operations

Despite years of treatment of the invasive plant Spotted knapweed *(Centaurea biebersteinii)*, it still persists at many sites in British Columbia. On the grasslands of the Lundbom Commonage near Merritt, B.C., Spotted knapweed grows in dense patches, despite approximately twenty years of herbicide spraying and release of biological control agents. However, a 30 year study in Western Montana showed that seed head attacking biological control agents caused a landscape crash of Spotted knapweed on several sites (Story et al. 2008). Story et al. also proposed a seed bank threshold below which Spotted knapweed would collapse. Could the Lundbom Spotted knapweed infestation be on the verge of a similar decline? Plant, biological control and seed data was collected in the Lundbom and analyzed for comparison to the Montana study.

Wednesday Presentation Abstracts

9:55 AM – 10:20 AM, MOUNTAIN ROOM

Building DNA reference libraries to enable the development of eDNA metabarcoding tools for invasive species detection

Cathryn Abbott; *Pacific Biological Station, Fisheries and Oceans Canada*

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Environmental DNA (eDNA) metabarcoding has shown great potential for biodiversity assessments and early detection of invasive species from environmental samples. However, much of its success relies on the availability of validated and comprehensive DNA reference libraries, where unknown sequences can be taxonomically assigned by confidently matching them to reference sequences. Building high quality useable reference libraries requires a considerable amount of time and resources. Stringent quality control measures must be employed and each sequence needs to be traceable back through all steps in the workflow to the original, morphologically identified specimen. These practices are imperative for this approach to be used by government for regulatory purposes because results need to be legally defensible. An ideal reference library includes multiple gene markers and a wide diversity of both native and invasive species with sufficient species repetition – necessitating the need for collaboration. Here we will talk about a recent, large interdepartmental federal genomics project aimed at developing new multi-gene DNA sequence libraries for invasive species detection. Such projects dedicated to high quality reference sequence library building are necessary to support the success of future eDNA metabarcoding tools to detect and monitor high risk invasive species.

10:40 AM – 11:00 AM, MOUNTAIN ROOM

Development of an eDNA metabarcoding tool for detection of invasive freshwater fish in British Columbia lakes

Davon Callander; *Department of Fisheries and Oceans, Pacific Biological Station*

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Invasive freshwater fish species pose a major threat to freshwater ecosystems and fisheries in BC, including wild salmon populations. For example, Northern pike in the Columbia region may prey upon juveniles of native fish species and Yellow perch in the Thompson region may out-compete native species for food. Early detection of invasive species maximizes the chance for effective management intervention towards preventing or mitigating potentially severe negative impacts. Environmental DNA (eDNA) metabarcoding can be used to infer species presence/absence and is ideally suited for early detection of invasive species as they are expected to first be present in recipient ecosystems in low densities. Furthermore, eDNA metabarcoding can serve as a biodiversity monitoring tool to assess fish community assemblages. Here we present a field-based proof-of-concept study that tests a fish eDNA metabarcoding tool in BC lakes with known fish assemblages. Filtration method, intensity of sampling, collection depth, and other factors are being tested to develop an efficient approach to eDNA metabarcoding for fish detection in BC lakes. This tool will enable more effective monitoring and management of high risk invasive fish species in BC. Results of the field testing will be discussed within the context of widespread application of this metabarcoding tool for invasive species detection in BC.

11:00 AM – 11:20 AM, MOUNTAIN ROOM

Invasive rat colonization history and movement dynamics in Haida Gwaii

Bryson Sjodin; *University of British Columbia Okanagan*

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The Brown *(Rattus norvegicus)* and Black rat *(R. rattus)* are among the most invasive species globally. Through predation and competition, invasive rats reduce the biodiversity of native fauna. On Haida Gwaii, invasive rats have caused population declines in six seabird species. Eradications were conducted on several islands where important nesting sites for sea-birds exist. On the Bischof Islands, reappearance of rats post-eradication has been observed. The objectives of this research are to investigate population history and movement dynamics of invasive rats in Haida Gwaii. Presently, 551 Brown and Black rats have been sampled from eighteen islands, collected from 2008-2016. Pre- and post-eradication samples were collected from the Bischofs allowing for an explicit evaluation of re-emergence versus re-colonization in these locations. Genomic DNA was extracted from ear samples and used to conduct double digest restriction site-associated DNA sequencing using the Illumina HiSeq2500 PE125 platform. Single nucleotide polymorphisms (SNPs) were identified, genotyped, and used to assign individuals to species using a Bayesian clustering approach. Resulting SNP data will be analyzed using a series of population genetic and spatially-explicit analyses to determine the source of re-established populations and quantify the extent and direction of gene flow throughout the system. Genotypic data are being collected such that they offer full connectibility to a global SNP database of brown rats to infer potential sources of the populations in Haida Gwaii. Results of these analyses will help facilitate future eradications and provide useful insights to prevent the spread of rats elsewhere within the system.

11:20 AM – 11:40 AM, MOUNTAIN ROOM

Identifying marine invasive species from environmental DNA: a tool to inform the management of shellfish aquaculture movements.

Kristen Westfall; *Pacific Biological Station, Fisheries and Oceans Canada*

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There are over 100 marine invasive species from 11 phyla in BC coastal waters. Shellfish movements associated with aquaculture activities are a known vector for invasive species introduction and spread. There are five shellfish transfer zones in BC used to guide decision-making around shellfish movements, with the goal of minimizing the movements of pests. Environmental DNA (eDNA) metabarcoding uses next generation sequencing technologies to identify a subset or all species present in a complex sample. Here we employ the eDNA metabarcoding approach to identify marine invasive species. This novel tool will be used as a biosurveillance method to aid in decision-making, including around shellfish aquaculture movements in BC. This tool represents the first metabarcoding approach of its kind to identify marine invasive species in Canada and is specifically tailored to known and problematic species in BC coastal waters. Here we present data from the initial development stages, including marker identification and field sampling strategies. Marker identification proceeded with in silico analysis of suitable gene fragments to maximize taxonomic discrimination and amplification efficiency of target invasive species. Field sampling strategies included testing the effect of sampling intensity (spatial resolution) and frequency (temporal resolution) on invasive species detection. We also compared invasive species detection levels from eDNA (water samples) and bulk DNA extracted from targeted zooplankton samples. Results from this pilot project will be discussed within the objectives of tool development with suggestions for refinement to meet future project goals.

3:05 PM – 3:25 PM, STUDENT UNION LECTURE HALL

Columbia River invasive Northern pike – Exploring movements through physical and chemical means

Dan Doutaz; *Department of Natural Resource Sciences, Thompson Rivers University*

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Northern pike *(Esox lucious)* is a highly piscivorous invasive fish species in the Columbia River, posing a major threat to native fish communities through predation, competition and the introduction of a variety of diseases. The suspected source of the invasion is the Pend d'Oreille River, which flows northwest from Idaho through Washington and into the BC portion of the Columbia, yet no evidence has been found to support movement through the numerous hydroelectric facilities on the Pend d'Oreille. We investigated movements of Northern Pike in the Columbia and Pend d'Oreille Rivers through a combination of acoustic tagging and microchemical analysis of otoliths (inner ear bones), in an attempt to locate crucial habitat for pike in the BC portion of the Columbia River and determine the source population for the invasion.

3:05 PM – 3:25 PM, TERRACE ROOM

Shared experience of invasive Grey squirrel management practice

Craig Shuttleworth; *School of Environment, Natural Resources and Geography, Bangor University*

Co-authors: Dave Everest[2], Aileen Mill[3], Peter Robertson[3], Liz Halliwell[4], Karl Larson[5]
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Opportunistic blood sampling during the eradication of Grey squirrels *(Sciurus carolinensis)* from the island of Anglesey, Wales, (UK) revealed a progressive decline in rates of asymptomatic squirrelpox virus antibody infection presence within the residual populations. This virus is invariably pathogenic to native Red squirrels *(S. vulgaris)* and is currently perhaps the most significant factor in replacement by the congener. Successful Red squirrel population restoration across the 720km2 area led to natural colonisation of adjacent mainland forests where Grey squirrels are abundant. We highlight the inter-specific risk posed by this sympatricy, the threat to neighbouring island red squirrels by the presence of a permeable sea strait, and the logistical challenges of preventing, detecting and responding to island incursion by mainland Grey squirrels. Recent research has highlighted the potential role of Grey squirrels in the epidemiology of a range of rodent infections including adenovirus. The results of predictive models have also illuminated the potential for novel methods of intervention to manage such infections, whilst the application of transmission electron microscopy and polymerase chain reaction analyses has offered a combination of less or non-invasive means of determining population infection status. We describe the application of such techniques in current collaborative research to better understand the full impact of the Grey squirrel as an invasive species in Europe and North America.

3:25 PM – 3:45 PM, STUDENT UNION LECTURE HALL

White-nose syndrome in the west: updates and strategies

Cori Lausen; *Wildlife Conservation Society Canada*

When white-nose syndrome was confirmed in bats in Washington state in March 2016, a paradigm shift was called for in bat conservation and management in BC. Predictions by published disease spread maps are now obsolete, and imminent arrival of the invasive fungus *Pseudogymnoascus destructans* to BC is anticipated. In September 2016, biologists from across western Canada came together to produce an Action Plan that, if implemented in a timely fashion, may go a long way to mitigating the impacts that this disease is expected to have on the province in coming years. I provide updates on the disease, outline collaborations and campaigns that have evolved to respond to this issue, and provide an overview of the response/actions planned and underway, including efforts to reduce the risk of giant leaps of the fungus within the province.

3:25 PM – 3:45 PM, TERRACE ROOM

Changes in age structure and diet of invasive centrarchid fish populations under management by electrofishing

Lungi Roberts; *Department of Geography and Environment, Trinity Western University*

Co-authors: David Clements[2]
Co-author Affiliations: [2] Department of Geography and Environment, Trinity Western University

Aquatic invasive species pose a risk to freshwater ecosystems. Two key invaders in coastal British Columbia, *Micropterus salmoides* (Largemouth bass) and *Lepomis gibbosus* (Pumpkinseed sunfish) threaten many native species, including salmonids along B.C's coast. Large numbers of both species have been observed and monitored since 2009 in McMillan Lake on the campus of Trinity Western University, Langley, BC. In 2013, 2014, and 2015 electrofishing was conducted to cull invasives and collect fish life history data, yielding 579, 4520, and 1992 fish, respectively. More than 98% of the fish caught by electrofishing were non-native. Otolith analysis coupled with body length and gonad measurements allowed us to look at age-specific parameters, and stomach content analysis was used to examine diet preferences. Sunfish did not live past 3 years but bass reached 4 years, although sunfish matured earlier. The most prevalent and preferred prey for sunfish was damselfly larvae. Younger bass also preferred invertebrates but tended to be piscivorous by 2-years old, although there appeared to be a shift in the bass diet between 2014 and 2015 to insect feeding. This dietary shift coupled with the decline in total numbers caught in 2015, might signal a decline in invasive fish populations but on the other hand our observations show that both species have a high reproductive potential in the ideal breeding habitat of this shallow lake, and thus eradication by electrofishing and/or other means is a serious challenge.

3:45 PM – 4:05 PM, STUDENT UNION LECTURE HALL

Occasional and established introduced ants in Washington and Oregon

Laurel Hansen; *Biology Department, Spokane Falls Community College*

Reports by pest management professionals (PMPs) of stinging ants and invasive ants signaled public concern and the need for collection and identification of ants being treated in urban areas. A two-year survey was funded for collections by pest management professionals to collect and submit ants for identification. Over 1600 samples were submitted and identified. Samples included the most commonly controlled ants: 26% *Tapinoma sessile*, 28% *Camponotus spp*., 17% *Tetramorium caespitum, Formica spp.* 12%. Exotic ants submitted included: *Myrmica rubra, M. speciodes, Linepithema humile, Tapinoma melanocephalum, Technomyrmex difficilis, Hypoponera punctatissima, Monomorium pharaonis*. Sites of these ants were investigated and chiefly proved to be areas of temporary invasions. *M. rubra* has been established in one area for more than 25 years; *M. speciodes* was submitted from six areas in the Puget Sound area. Many of the other invasive species appear to be contained within zoos. Efforts are being made to educate PMPs to collect and submit ants encountered that are not part of their routine management.

3:45 PM – 4:05 PM, TERRACE ROOM

Exotic species replacement: A tale of two invasive mussels

Lisa Jones; *McGill University*

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The Zebra mussel *(Dreissena polymorpha)* and Quagga mussel *(D. bugensis)* have a similar life cycle, morphology and ecology, yet exhibit distinct patterns of invasion. The Zebra mussel is often first to invade a waterbody, whereas the Quagga mussel replaces the Zebra mussel over time, particularly in deeper waters. Few studies have examined mechanisms causing replacement of dominant invaders, even though such events may generate a new suite of impacts on the recipient community. We investigated patterns and mechanisms of replacement of the Zebra mussel by the Quagga mussel in a canal connected to the St. Lawrence River. Long-term monitoring showed that Quagga mussels have been dominant in the canal for several years and are larger and more abundant in the deeper areas than Zebra mussels ever were, but Zebra mussels persist at shallow depths. We tested the relative importance of life history and environmental factors in setting these patterns. We predicted that the Zebra mussel would be the superior colonizer following disturbance, whereas the Quagga mussel would eventually come to dominate as a superior competitor. We tracked the colonization and relative dominance of the mussels within two depth zones on the canal wall, over a three-year period following an initial experimental disturbance. Our findings suggest that patterns of mussel dominance can be explained by life history traits and an environmental gradient (turbidity). This study shows that mussel replacement can occur even in shallow systems, and the establishment of a dominant invader does not prevent subsequent incursion by a functionally-similar invader.

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