Garry oak ecosystems recovery team

Research Colloquium 2009 Proceedings

Pacific Forestry Centre
Canadian Forest Service
506 West Burnside Road
Victoria, BC, Canada

February 20th 2009

Table of Contents

Presenters' Contacts

Robin Annschild
Saltspring Island Conservancy
PO Box 722, Ganges, Salt Spring Island, BC V8K 2W3
250-538-0318 / robinannschild@saltspring.com

Jenny Balke
Denman Conservancy Association
P.O. Box 60, Denman Island, BC V0R 1T0
jbalke@island.net

Brenda Callan
Pacific Forestry Centre
Canadian Forest Service, Natural Resources Canada
506 West Burnside Road, Victoria, BC V8Z 1M5
250-363-0744 / bcallan@nrcan.pfc.gc.ca

Adolf and Oluna Ceska
P.O. Box 8546, Victoria, BC V8W 3S2
250-477-1211 / 250-216-1481 (mobile) / aceska@telus.net

Andrew Fyson
Denman Conservancy Association
P.O. Box 60, Denman Island, BC V0R 1T0
andyfys@hotmail.com

Susan Hannon
Reginald Hill, Salt Spring Island, BC
sue.hannon@ualberta.ca

Colin Huebert
Centre for Conservation Genetics, University of British Columbia
2424 Main Mall, Vancouver, BC V6T 1Z4
stereovision1@yahoo.com

Natalie Jones
Department of Integrative Biology, University of Guelph
Science Complex, Guelph, ON, N1G 2W1
njones@ouguelph.ca

Heather Kharouba
Department of Zoology, University of British Columbia
2370-6270 University Blvd., Vancouver, BC V6T 1Z4
604-827-3250 / kharouba@zoology.ubc.ca

Nicole Kroeker
Parks Canada, Western & Northern Service Centre.
2nd Floor - 711 Broughton St., Victoria, BC V8W 1E2
250-363-8563 / 250-363-8552 (Fax) / nicole.kroeker@pc.gc.ca

Tom Maertens
Tree Ring Lab, Department of Geography, University of British Columbia
1984 West Mall, Vancouver, BC Canada V6T 1Z2
604-827-5754 / maertens@forestmail.com

James Miskelly
Research Associate, Royal BC Museum
675 Belleville Street, Victoria, BC V8W 9W2
james.miskelly@gmail.com

Kristiina Ovaska
424 Viaduct Ave W, Victoria, BC V9E 2B7
250-727-9708 / kovaska@shaw.ca

Susan Pinkus
EcoJustice
131 Water Street, Suite 214, Vancouver, BC V6B 4M3
spinkus@ecojustice.ca

Hans Roemer
Roemer Field Botany Consulting
1717 Woodsend Drive, Victoria, BC V9E 1H9
250-479-6470 / hlroemer@shaw.ca

Lennart Sopuck
Biolinx Environmental Research Ltd
1759 Colburne Place, Sidney, BC V8L 5A2
250-656-8981 / biolinx@shaw.ca

Hiroshi Tomimatsu
Department of Botany, University of British Columbia
3529-6270 University Blvd., Vancouver, BC V6T 1Z4
604-827-3250 / htomi@interchange.ubc.ca

Non-Presenters' Contacts

Sally N. Aitken
Centre for Conservation Genetics, University of British Columbia
3041 - 2424 Main Mall, Vancouver, BC V6T 1Z4
604-822-6020 / 604-822-9102 (Fax) / sally.aitken@ubc.ca

Nicholas Conder
Pacific Forestry Centre
Canadian Forest Service, Natural Resources Canada
506 West Burnside Road, Victoria, BC V8Z 1M5
250-363-0634 / Nicholas.Conder@NRCan-RNCan.gc.ca

Ze'ev Gedalof
Department of Geography, University of Guelph
Guelph, ON N1G 2W1
519-824-4120 ext. 58083 / zgedalof@uoguelph.ca

Jessica Hellmann
Department of Biological Sciences, University of Notre Dame
107 Galvin Life Science Center, Notre Dame, IN 46556
574-631-7521 / hellmann.3@nd.edu

Shaun Hubbard
shaunalice@comcast.net

Andrew MacDougall
Department of Integrative Biology, University of Guelph
Science Complex, Guelph, ON, N1G 2W1
amacdo02@uoguelph.ca

Travis D. Marsico
Department of Biological Sciences, University of Notre Dame
107 Galvin Life Science Center, Notre Dame, IN 46556
574-631-0296 / tmarsico@biology.msstate.edu

Kirsten M. Prior
Department of Biological Sciences, University of Notre Dame
107 Galvin Life Science Center, Notre Dame, IN 46556
kprior1@nd.edu

Imre S. Otvos
Pacific Forestry Centre
Canadian Forest Service, Natural Resources Canada
506 West Burnside Road, Victoria, BC V8Z 1M5
250-363-0620 / Imre.Otvos@NRCan-RNCan.gc.ca

RARE SPECIES BIOLOGY

SURVEYS FOR THE ENDANGERED BLUE-GREY TAILDROPPER SLUG ON SOUTHERN VANCOUVER ISLAND

Kristiina Ovaska and Lennart Sopuck
Biolinx Environmental Research Ltd.

The Blue-grey Taildropper (Prophysaon coeruleum), one of four species of taildropper slugs known from British Columbia, is noted for its ability to excise the end of its tail if seized by a potential predator. This species is listed as Endangered by COSEWIC and is known from only six localities in Canada, all within the Capital Regional District (CRD) on the southern tip of Vancouver Island. Since 1999, we have conducted surveys for terrestrial gastropods, largely focusing on species at risk including the Blue-grey Taildropper. Surveys in CRD regional parks and Department of National Defense (DND) properties have shown that the slugs inhabit a variety of forest types, where they often occur in forest gaps or forest-meadow ecotones with dense shrub or herbaceous vegetation. Slugs were found in Garry oak woodlands at three of the six localities, occurring in moist depressions with dense herbaceous vegetation. The slugs are most active and easiest to detect in late fall, after rains have thoroughly moistened the ground and litter layer. They are patchily distributed within a very limited range, and hence local populations are vulnerable to extirpation from habitat loss or degradation, prolonged droughts, or stochastic events. Protection is best achieved by avoiding disturbance and trampling of natural vegetation and soils at occupied sites, and controlling the spread of invasive, introduced vegetation and exotic invertebrates that may compete with or prey on the Blue-grey Taildropper.

IMPACTS OF GRAZING BY FERAL SHEEP ON THE ENDANGERED YELLOW MONTANE VIOLET, *VIOLA PRAEMORSA*

Robin Annschild[1] and Dr. Hans Roemer[2]

[1]Saltspring Island Conservancy, [2]Roemer Field Botany Services

We are conducting a multi-year study designed to detect changes that may occur in the violet population upon exclusion of grazing by feral sheep in the Mt. Tuam Garry Oak Ecosystem, Salt Spring Island, British Columbia. Detailed mapping and counting of the Yellow Montane Violet population was completed in 2007, confirming this site, containing over 20 000 plants, as the second-largest population in Canada. Six 4m x 4m paired exclosures and controls were installed in May, 2007. Numbers of flowering, non-flowering and seedling Yellow Montane Violets were counted in each exclosure and control plot. Percent cover data for other species in each plot were collected in June when grasses are in flower. Expected Duration of Project: 2007-2011; Landowner: Transport Canada; Funder: Interdepartmental Recovery Fund, Government of Canada.

THE RESPONSE OF BUTTERFLY AND PLANT COMMUNITIES TO HUMAN DISTURBANCE IN THE GARRY OAK ECOSYSTEM

Heather Kharouba
Department of Zoology, University of British Columbia

Global species diversity is declining due to species extinctions likely caused by human activities. However, at regional and local scales, alpha-diversity is increasing, often leading to the homogenization of communities, or the increase in compositional similarity.

This process might be occurring in plant and butterfly communities within the Garry Oak ecosystem, given that it is extensively fragmented, heavily invaded by exotic plant species and contains many butterfly and plant species at risk.

This research sets out to examine whether there is any evidence of plant and butterfly homogenization within this ecosystem and whether these communities respond in similar ways to human disturbance.

We surveyed butterfly communities in 17 remnant Garry Oak habitat patches along the Saanich Peninsula in the summer of 2008. We tested the effects of road density (an index of human disturbance), while accounting for patch area and climate, on butterfly species richness, diversity and composition.

We detected no significant effect of road density on species richness or diversity but composition changed significantly along the road-density gradient. Based on patch-density estimates 42% of (5/12) species showed a significant response to road density; however, two species responded positively while three others responded negatively.

There was no evidence of homogenization in these butterfly communities. Further analyses will examine the relationship between individual butterfly species and road density, while exploring the relationship between butterflies and their host plants in these communities.

THE STATUS OF BRANDED SKIPPER BUTTERFLIES (*HESPERIA* SPP.) ON VANCOUVER ISLAND

James Miskelly
Royal British Columbia Museum

Branded skippers of the genus *Hesperia* are found on Vancouver Island in two habitats, Garry oak ecosystems and subalpine meadows. All branded skippers on Vancouver Island have previously been considered *Hesperia colorado oregonia*, which is found in dry grasslands on the west side of the Cascade Mountains from BC to northern California. Until recently, the scarcity of specimens from high elevations on Vancouver Island had prevented their scrutiny. In 2008, a series of specimens from high elevation was compared to specimens from low elevation for the first time. High and low elevation specimens differ significantly in colouration and size. The high elevation specimens are clearly *Hesperia comma*, which is common in subalpine and alpine areas across southern British Columbia. *Hesperia colorado oregonia* in British Columbia occurs only in Garry oak and associated ecosystems. Many historic populations are extirpated, and there may be as few as two extant populations in Canada.

CSPOTS AND GARRY OAK MEADOW RESTORATION

Jenny Balke and Andrew Fyson
Denman Conservancy Association

Taylor's checkerspot butterflies *Euphydryas editha taylori*, considered extirpated from Canada since 2001, were discovered on Denman Island in 2005. As a result, Denman Conservancy Association biologists, government staff and contractors have been studying the Checkerspot populations, affectionately known as Cspots. Studies comprise repeated transect counts, distribution surveys, habitat assessment and behavioural documentation. Most remarkably, Cspots on Denman are occupying and reproducing in substantial numbers in recent clear-cuts with associated shallow wetlands and in a wet meadow area of a 30 year old re-grown clear-cut. A few individual butterflies have been seen each year, in wet meadows in farms and other open sites. All life stages have been documented on Denman including mating, egg-laying, pre and post diapause larvae and pupae. In addition, studies have revealed larval food plants, *Veronica scutellata*, *V. serpilifolia*, *Plantago major* and *P. lanceolata*, as well as butterfly nectar species, most flowering plants, in the habitat in May and early June, when adults are flying.

The future of this federal Endangered species is uncertain. Given that clear-cuts on Denman will re-grow, presumably this species will be looking for its former home, in Garry oak meadows and vernal pools, previously maintained by First Nations. In 2008-9, the DCA began a Rare Meadow Stewardship project, funded by the federal Habitat Stewardship Program. Consequently, the DCA is designing Cspot-enhancement aspects of existing open-wet farm-meadows of land stewards. However, to ensure the long-term survival of the complex of Garry oak ecosystem species, one suggestion is for GOERT to support a coordinated approach, with community groups and biologists, for "coastal lawn conversion" to Garry oak meadows. A GOERT "Conversion Support Team" could supply advice on habitat selection and methods, as well as training, supervision and organizing bulk purchases of materials. GOERT has the potential to inspire the painstakingly slow restoration process, on a broad scale on the south coast, even at one small meadow, in each community, at a time.

THE ECOLOGICAL SIGNIFICANCE OF CLEISTOGAMY

Natalie Jones and Dr. Andrew MacDougall
Department of Integrative Biology, University of Guelph

Relatively few vascular plant species, including the endangered *Viola praemorsa* ssp. *praemorsa* of the Garry oak ecosystem (GOE) in Canada, exhibit cleistogamy, a flower dimorphism where individuals produce both facultatively outcrossing chasmogamous (CH) and obligately selfing cleistogamous (CL) flowers on the same individual. Cleistogamous flowers are reduced and self-fertilize in the bud. They do not bloom or reach anthesis and therefore cannot donate or receive pollen. One of the fundamental questions surrounding cleistogamy is its ecological significance and, in the context of *Viola praemorsa*, its possible role in driving or offsetting its rarity. On one hand, flower dimorphism may create flexibility, enabling flowers to produce progeny in the absence of pollinators or adverse environmental conditions. On the other hand the mixedmating system may be a hindrance as it divides resources and produces many genetically similar offspring.

With my research, I am exploring ecological significance of cleistogamy for *V. praemorsa*. I am especially interested in whether cleistogamy helps buffer this species from limitations of habitat loss and climatic variability that characterize the GOE or, alternatively, whether the resources required to produce two sets of flowers hinder its demographic performance. Specific issues I plan to address include pollen limitation, pollinator dynamics, the role of maternal effects and flower origin in recruitment (e.g., do CL seeds do better near the parent plant? Do CH seeds establish in a wider range of environments?), how weather impacts Viola phenology and the relationship between CH vs. CL flowering, and whether CH flowers are also self-compatible? My research will test basic principles regarding the ecological implications of cleistogamy, as well as providing insight on the possible management directions for protecting this species.

RARE PLANTS OF BEACON HILL PARK: THEIR DECLINE AND THEIR PROTECTION

Adolf and Oluna Ceska

Beacon Hill Park was granted to the City of Victoria in 1882. Major parts of its 154 acres (ca. 62.3 ha) have been developed (petting zoo, formal gardens, arboretum, groves of commemorative trees, several sports fields, etc.), and many parts have been negatively impacted by various events such as military camps and exercises, parades, and community celebrations. In spite of these impacts, there are some areas in Beacon Hill Park where several rare plant species still survive. Unfortunately, we have witnessed the decline and disappearance of several rare plant species. Lack of knowledge of precise locations and improper management have resulted in the extinction of several rare plants: the site of Nuttall's quillwort (*Isoetes nuttallii*) was destroyed when the depression where it grew was paved over in 1989-90, Prairie lupine (*Lupinus lepidus*) did not survive the burning of Scotch broom (*Cytisus scoparius*) on top of it in about 1994. The last single plant of Golden paintbrush (*Castilleja levisecta*) disappeared in 1993, and the last few clumps of Deltoid balsamroot (*Balsamorhiza deltoidea*) are still hanging on, currently being threatened by mowing on one side and encroaching snowberries on the other. From earlier disappearances, Scouler's catchfly (*Silene scouleri*) was last seen in the Beacon Hill Park in the late 1960's. Small spike-rush (*Eleocharis parvula*) and Rosy owl-clover (*Orthocarpus bracteosus*) were known in the Park only in the early 1900's.

To avoid further accidental destruction of rare plants, the park managers need to know the precise locations of all rare plants. Dr. Chris Brayshaw produced a map of rare plants in the Beacon Hill Park in the 1990s. In the spring of 2004 we were contracted by the Victoria City Park Department to conduct a detailed survey of rare plants in Beacon Hill Park north of Dallas Road. We estimated the populations of rare plants and determined GPS locations of their particular sites.

The major areas with larger accumulation of rare plants are:

- the grassy slope between the top (flag pole) and the “largest totem pole”;
- NW slope of the hill below the top; and
- the rocky ridge S of the Southgate Street, parallel to Douglas Street.

These areas require special attention by the park managers. Any major management decision at those particular areas should be done with rare plants in mind. Often a relatively small adjustment would enhance native plants: many populations of native plants increased when the mowing was deferred until after their main seed production time.

The following rare and uncommon plants still occurred in Beacon Hill Park in 2004: Dune bentgrass (*Agrostis pallens*), Slimleaf onion (*Allium amplectens*), Deltoid balsamroot (*Balsamorhiza deltoidea*), Short-stemmed sedge (*Carex brevicaulis*), Howell’s montia (*Montia howellii*), Graceful cinquefoil (*Potentilla gracilis*), Purple sanicle (*Sanicula bipinnatifida*), Poverty clover (*Trifolium depauperatum*), Howell’s triteleia (*Triteleia howellii*), Yellow montane violet (*Viola praemorsa*).

Park management decisions that put a priority on conservation of rare plants will help to ensure the survival of these threatened and endangered species.

CONSERVATION GENETICS OF GARRY OAK *(QUERCUS GARRYANA)*

Colin Huebert and Dr. Sally N. Aitken
Centre for Conservation Genetics, University of British Columbia

Although accounting for less than 0.3% of British Columbia's entire land coverage, Garry oak-associated ecosystems support tremendous biodiversity and are home to a large number of rare species in B.C. Populations have however been declining since European settlement. It is estimated that only 1-5% of pre-European Garry oak ecosystems remain uncompromised in B.C. today. However, species distribution models predict the area climatically appropriate for Garry oak to triple in B.C. by the 2080's. Using a common garden experimental design, data regarding growth and partitioning, bud phenology and cold hardiness were collected from 1700 individuals (15 populations) representing the species' entire range. Results indicate weak population differentiation for quantitative traits. However, significant genetic clines follow latitudinal gradients for height, germinant emergence and cold hardiness. Additionally, estimates of quantitative genetic variation (Q_{ST}) were low relative to published estimates of neutral molecular variation (G_{ST}), indicating weak divergent selection for this species. Results will be used to recommend seed-transfer guidelines and conservation strategies for current and future climates in B.C. and elsewhere.

THE GROWTH-CLIMATE RELATIONSHIP OF OREGON WHITE OAK (*QUERCUS GARRYANA*)

Tom Maertens and Dr. Ze'ev Gedalof
Department of Geography, University of Guelph

My thesis describes the growth-climate relationship of Oregon white oak, a foundation species in one of the most endangered habitat types in North America. These trees inhabit dynamic forest ecosystems in which climate is especially significant and expected to become increasingly important. In this study, we identified characteristic growth responses of Oregon white oak to its climate and assessed their geographic patterns.

We used dendroecological techniques to determine unique correlation functions for each of 18 climatically sensitive stands representing much of the geographic range of the species. Principal components analyses identified important associations between growth and climate. Over 110 years of analysis, 1896-2005, spring conditions have dominated the dendroclimatic response but other significant relationships occur throughout the year. A characteristic growth pattern is common to all stands, however the relative importance of climatic controls varies throughout the species' range. These results are crucial for the long-term management of Oregon white oak ecosystems and contribute to our understanding of vegetation dynamics.

Synthesis of findings
Correlations between the 18 Oregon white oak tree ring chronologies and their local climates are very similar, evidence that Oregon white oak responds coherently as a species. The growth-response of Oregon white oak trees is one dominantly controlled by spring conditions. A temporally complex growth-response to spring temperatures occurs, with trees at most sites responding positively to temperatures in April and May of the year prior to growth but negatively to maximum temperatures during June in the year that the ring is formed. A positive response to spring rainfall is consistent in stands throughout the range of the species. The strongest correlations found in this

study are the positive growth associations with soil moisture availability in winter, spring, and summer.

However, variability in growth-response to some climatic variables indicates that some Oregon white oak stands do not respond in the same way to all climatic forcings: differences in the timing, direction, and magnitude of growth-responses among stands to the same climatic factors indicate a mixed response. Spatial patterns include latitudinal gradients: stands at lower latitudes tend to respond more negatively to maximal temperatures and more positively to precipitation and soil moisture availability in fall, winter, and spring. Northern sites respond more positively to temperatures in winter. Longitudinal gradients in response reflect the influence of drier continental climates and extreme diurnal and seasonal variability: more easterly sites respond more positively to minimal temperatures in the spring and in the fall than other Oregon white oaks west of the Cascade Mountains. The radial-growth response reflects the interaction of local climate with the ecogeographic position of the stand, so suspected mechanisms vary by site.

POST-GLACIAL MIGRATION, LIMITATIONS TO POLEWARD RANGE EXPANSION, AND GROWTH RESPONSES TO FUTURE CLIMATES OF PLANTS IN THE GARRY OAK ECOSYSTEM

Travis D. Marsico

Department of Biological Sciences, University of Notre Dame, Doctor of Philosophy Thesis, Volunteered Paper

A key goal in ecology is to understand the factors limiting species' distributions. Important range-limiting factors are often difficult to generalize, however, because organisms have many different life-history traits, evolutionary histories, and diverse interactions with other species. Climate is often implicated as the most important range-limiting factor in modern species distributions. Yet many species are not or not yet exhibiting range changes associated with anthropogenic climate change. A potentially important non-climatic range-limiting factor is dispersal limitation. Recently, some researchers have concluded that dispersal limitation is likely as strong a range limiting factor as climate. One way to tackle the limits to generalization is to investigate range limiting factors and patterns of range shift for well-chosen taxa in a comparative fashion to glean general principles.

My research uses a comparative approach to investigate patterns of post-glacial colonization, factors involved in geographic range limitation, and species responses to future climates using genetic techniques, a field experiment, and a chamber experiment, respectively. All studies were conducted on species associated with the Garry oak ecosystem in the Pacific Northwest of North America and focused on four plant taxa: *Quercus garryana* var. *garryana*, the flagship species of the Garry oak ecosystem, and three *Lomatium* species, *L. dissectum* var. *dissectum*, *L. nudicaule*, and *L. utriculatum*.

An overall conclusion from this dissertation is that related, co-occurring species provide an appropriate comparison for determining species- and trait-based generalization. *Lomatium* chloroplast genetic data suggest that abundance is important in determining the ability of long-distance seed dispersal. The field experiment shows that dispersal limitation is currently important in determining range boundaries for species no matter their regional abundance. The field experiment also shows that closely related species may differ in their competitive abilities and responses to competitors/facilitators. My genetic survey on *Q. garryana* provides evidence that seed dispersal has been more limiting than pollen flow during post-glacial range expansion, even though refugial oak populations occurred near the ice sheet boundary. The chamber experiment provides evidence that some responses to global change will be unpredictable, making certain generalizations difficult. Given these findings, humans may consider accelerating species migration through purposeful translocation outside species' ranges to overcome dispersal barriers.

INVASIVE SPECIES EFFECTS

INTRODUCED PLANTS: JUST HOW EXOTIC ARE WE?

Dr. Hans Roemer
Roemer Field Botany Services

This presentation is made under the impression that the conservation-minded public, restoration groups, and even some ecological scientists are unaware of the full extent to which our plant communities have been invaded by exotic species.

The material presented here focuses on the Garry Oak and closely associated ecosystems. The author felt that he had a special opportunity to analyse introduced species levels, having collected hundreds of complete species lists (relevés) representing Garry oak and related plant communities, both in representative sites and in sites that harbor rare and endangered plant species.

The present analysis makes use of 31 data sets in the form of vegetation tables representing a total of 366 relevés, all taken in the dry parts of SE Vancouver Island. In a vegetation table the columns represent different sites and the rows represent species. To obtain the proportion of introduced species, their number is compared to the total number of species in each relevé. Percentages of introduced species are then averaged for each data set (table). Thus each percent figure is based on the number of relevés (columns) in the data set. These range between 4 and 40 in the current material.

Results presented here show that in herb/grass-dominated upland communities on SE Vancouver Island exotic species form from 16% to nearly 70% of the number of species when only vascular plants are considered. Five data sets (totaling about 80 relevés) specifically describe the best-preserved south-facing grass bald communities on the western periphery of the Garry oak ecosystem and these have averages of “only”19 to 40% exotic species. Ten data sets (144 relevés) describe rare and endangered plant sites in local protected areas and these have averages from 24 to 57% of exotic species. In one data set based on 12 relevés exotic species content by number of species was compared to exotic species content by bio-mass (here approximated by cover value). Introduced species were 64% by biomass/cover instead of 57 by number of species. This was in a yellow montane violet (*Viola praemorsa*) site which had many different introductions. Much higher exotic-content by cover or biomass would be expected where a single introduced species dominates. For another data set with 13 relevés the percentage derived for vascular plants only was compared to that derived after including bryophytes and lichens. Including the latter resulted in a decrease from 23.9% to 17.7% of exotics. Intuitively, one could assume that the species-richest plant communities would be the most pristine. However, in the utilized material there appeared to be no correlation between the number of species in a community and the % of exotics.

In summary, these results show that the least disturbed non-forested communities have 16-30%, average communities have 30-50% and many others, including most “Garry oak meadows”, have over 50% of exotic species.

Introduced Species – All sets of relevés, ranked by % introduced

Plant community or formation name, Location	average % intro vasc. spp	based on # of samples	average # of vascul. spp in comm.	year
Camas Grassland, Chemainus Valley grass bald	16	10	19.2	07
Danthonia-Eriophyllum-Allium (Grass Bald study, CWHxm)	19	11	33	96/97
Danthonia-Eriophyllum (Grass Bald study, CWHxm)	22	35	27	96/97
Lupinus lepidus Sites, Sooke Hills, vasculars only	23.9	13	15.2[1]	07
Aster curtus sites, Mill Hill	26	40	21.4	03-07
Danthonia-Mimulus (Grass Bald study, CWHxm)	28	17	28	96/97
Agrostis pallens sites, Mill Hill	31	9	13.6[1]	06-07
Meconella oregana sites, SE Vancouver Island, Saturna Island	33.7	17	19.5[1]	04
Sanicula bipinnatifida Sites, Mill Hill	36	23	18	03-07
Danthonia-Cynosurus-Eriophyllum (Grass Bald study, CWHxm)	37	7	27	96/97

Isoetes nuttallii sites, Mill Hill	39	4	16	07
Danthonia-Cynosurus (Grass Bald study, CWHxm)	40	12	25	96/97
Clarkia purpurea ssp. quadrivulnera sites, Mill Hill	46	15	20.4	03-07
G.O. Woodlands, Mill Hill, broom NOT removed	47.00	9	33.66	04
Allium amplectens sites, Mill Hill	47	6	20.8	05-07
Garry Oak – Snowberry polygon, Christmas Hill	47	7	13.7	05
G.O. Woodlands, Mill Hill, broom removed	47.78	9	34.55	04
Garry Oak – Grassland, Sutil Mtn., Galiano Island	48	7	19.3	04
G.O. Woodlands, Mill Hill, broom removed	49.11	9	29.44	06
Trifolium depauperatum sites, Mill Hill	49.2	5	27.6	07
G.O. Woodlands, Mill Hill, broom removed	50	9	30.66	03
GarryOak&Douglas-fir – Indian plum polygon, Christmas Hill	50	8	19.6	05
G.O. Woodlands, Mill Hill, broom NOT removed	51.11	9	30.55	03
Viola praemorsa sites, Mt. Tuam, provincial land	51.4	12	24.5	08
Orchardgrass Draws polygon, Christmas Hill	52	7	10.7	05
G.O. Woodlands, Mill Hill, broom NOT removed	52.55	9	26.78	06
Grass-herb on shallow soil polygon, Christmas Hill	54	11	15.7	05
Viola praemorsa sites, Mt. Tuam, federal land	55.8	12	27	08
Viola praemorsa sites, Mt. Tuam, Saltspring Island	57	12	29	07
Camas meadows, Greater Victoria	66	6	17	95
Tall grass polygon, S-slope Christmas Hill	67	6	17.8	05
	Total:	366		

1 These sites have a high bryophyte and lichen content

NOVEL SPECIES INTERACTIONS AS THE RESULT OF A SPECIES' RANGE EXPANSION: THE ROLE OF ENEMY-FREE SPACE IN CAUSING OUTBREAKS OF THE JUMPING GALL WASP, *NEUROTERUS SALTATORIUS*, IN ITS INVADED RANGE AND ITS IMPACTS ON NATIVE SPECIES

Kirsten M. Prior and Dr. Jessica J. Hellmann
Department of Biological Sciences, University of Notre Dame,
Volunteered Paper

Species ranges are changing in response to climate change and as they are relocated around the globe through trade and traffic. Novel species interactions occur as a result of these range changes. I am studying novel species interactions occurring as the result of a recent range expansion of the Jumping gall wasp, *Neuroterus saltatorius* (Hymenoptera: Cynipidae) on to Vancouver Island, B.C. This species is a specialist on *Quercus garryana* and its historical range occurs from north-western Texas to mainland Washington with the Juan de Fuca straight likely acting as a historical dispersal barrier. *N. saltatorius* was first observed just north of the city of Victoria in 1986 (Smith 1995, Duncan 1997). While *N. saltatorius* occurs at low non-damaging levels in its native range it occurs in much higher abundance on Vancouver Island, B.C. causing damage to *Q. garryana* leaf tissue in the form of foliar spotting or necrosis of continuous portions of the tissue. My research focuses on impacts of *N. saltatorius* on native species, and how changes in interactions with its predators (Hymenoptera: Chalcidoidea) between its native and invaded range contribute to its success on the Island.

The first portion of my research is concerned with the impact of outbreaking levels of *N. saltatorius* on *Q. garryana* and other herbivores that share this host plant. *Erynnis propertius* (Lepidoptera: Hesperiidae) is a specialist butterfly on *Q. garryana* that is of conservation concern. I collected leaves from trees with varying levels of gall wasp damage at two sites: Government House, Victoria, B.C. and Nature Conservancy Canada's Cowichan Valley Preserve, Duncan, B.C. I measured their foliar quality including: percent water, carbon : nitrogen and protein-binding capacity (*i.e.*, foliar tannins). So far, I have found that *N. saltatorius* decreases the foliar quality of leaves. In particular, high levels of gall wasp damage cause a loss of nitrogen, which is limiting to herbivorous insects. In addition, I set up a butterfly performance experiment at a site where *E. propertius* is not currently found (Government House) where I stocked enclosures with second-instar caterpillars. These enclosures were placed on trees with varying levels of damage. I found that performance (pupal volume and survivorship) were negatively affected by the level of damage caused by *N. saltatorius*. My research suggests that *N. saltatorius* is affecting the performance of *E. propertius* by indirectly causing changes to their shared host plant.

The second objective of my research is to identify what causes *N. saltatorius* to be more successful in its invaded range (Vancouver Island) than its native range (mainland Washington). One of the main hypotheses of invasion success is the 'enemy-release' hypothesis where an introduced species, or one that has undergone a range expansion, is likely to arrive in its new range without its full complement of enemies (*e.g.*, predators, parasites, pathogens). I am testing this hypothesis as a mechanism for success of *N. saltatorius* on the Island. First, I am taking a biogeographical approach by assessing *N. saltatorius* abundance and parasitoid abundance at multiple sites in its native range (Southern Puget Sound, WA) and in its invaded range (Vancouver Island, BC). After two years of surveys I have found that *N. saltatorius* occurs in higher abundance on the Island, so it is in fact outbreaking in its invaded range. In addition, I have found evidence for lower parasitism rates on the Island. These results are correlational, however, and do not speak to enemy reduction being the cause of outbreaks. To see if reduction causes host release I set up an enemy-exclusion experiment in 2008 at multiple sites in the native and invaded range. So far I have found that parasitism rates were higher in the controls in the native range (*i.e.*, controls measure background parasitism rates). In the spring of 2009 I will see if excluding parasitoids in the native range has a larger effect on the survivorship of *N. saltatorius* than excluding parasitoids in the invaded range does. If this is the case then we can conclude that *N. saltatorius* outbreaks are being influenced by a loss of enemies in their invaded range.

References

Duncan, R.W. (1997). Forest Pest Leaflet: Jumping Gall Wasp. Pacific Forestry Centre. Natural Resources Canada. Cat. No. Fo 29-6/80-1997E

Smith, J. (1995). Life history, survivorship, and parasitoid complex of the jumping gall wasp, *Neuroterus saltatorius* (Edwards) on Garry oak, *Quercus garryana* Douglas. Masters thesis, University of Victoria.

BIOLOGICAL CONTROL OF THE WINTER MOTH IN GREATER VICTORIA, BC

Dr. Imre S. Otvos and Nicholas Conder
Canadian Forest Service, Natural Resources Canada,
Volunteered Paper

The winter moth, *Operophtera brumata*, was accidentally introduced into British Columbia, probably during the 1970s. It was initially misidentified as the Bruce spanworm, *O. bruceata*, a native species that periodically caused noticeable defoliation of broadleaf trees in the Greater Victoria area. In the absence of the natural enemies, the winter moth populations increased explosively, and by 1977 this pest was defoliating approximately 120km^2 of southern Vancouver Island.

The preferred host of the winter moth is Garry oak, *Quercus garryana*, but it also defoliates other broadleaf shade trees along boulevards and on private property, as well as fruit trees. The rapid spread of the winter moth on southern Vancouver Island led to concerns that this insect might spread into the fruit growing areas in the Okanagan.

In Nova Scotia, where the winter moth was first introduced in the late 1940s, control was achieved by two of six parasitoids introduced from Europe, a parasitic fly (*Cyzenis albicans*) and a parasitic wasp (*Agrypon flaveolatum*). These two parasitoid species were introduced, both from Nova Scotia and from Europe, and were released over a 4 year period (from 1979-1982) at 33 locations in the Greater Victoria area. A total of 17,931 *C. albicans* and 10,641 *A. flaveolatum* were introduced during this time. Within 2 years of the cessation of these releases winter moth populations, and the defoliation they caused, were considerably reduced.

However, monitoring of both the winter moth and its parasitoids since the introductions has shown that percent parasitism of winter moth has fluctuated considerably over time. It has been hypothesized this is due to a couple of factors: soil condition changes due to drought or excessive rainfall during the time that fully fed larvae drop to the ground and pupate in the duff in May (reducing the host and parasitoid populations at the same time), or drought or excessive rainfall during parasitoid emergence the following spring (reducing parasitoid populations only). The use of *Bacillus thuringiensis* subsp. *kurstaki* (a biopesticide that affects many species of Lepidoptera) against the repeated introductions of gypsy moth may also have had an impact on the winter moth-parasitoid complex in the Greater Victoria area. The results obtained through this long-term monitoring program indicate the importance of monitoring classical biological control programs over an extended period of time.

"SUDDEN OAK DEATH": BIOLOGY AND STATUS IN BC RE IMPACT ON GARRY OAK ECOSYSTEMS.

Dr. Brenda Callan
Canadian Forest Service, Natural Resources Canada

Sudden oak death is the name of a disease associated with mortality of certain oak species and related plants in California since the mid-1990's. To date, millions of trees, including coast live oak (*Quercus agrifolia*) and tanoak (*Lithocarpus densiflorus*), have died, changing ecosystems and reducing property values. The causal agent is *Phytophthora ramorum*, a fungus-like organism. This pathogen has a very wide host range, and causes a variety of symptoms on many different plant genera and families. Most plant species endure minor, non-lethal, infections such as leaf spots or twig dieback. Only a few host species develop fatal trunk cankers. Most of the highly susceptible true oaks are red oaks, not white oaks such Garry oak. To date, establishment of *P. ramorum* in wildlands has been limited to coastal areas of California and southern Oregon, where the often foggy climate, highly susceptible oak hosts, and overstorey plants capable of producing high levels of inoculum, such as California bay laurel (*Umbellularia californica*), are present. *Phytophthora ramorum* has caused problems with importations of landscape plants, particularly of *Camellia, Rhododendron, Pieris, Kalmia and Viburnum*, which are popular landscape plants, and unfortunately also inoculum-producing hosts for this pathogen. Nursery imports to Canada from the United States and Europe areas are under strict regulation to prevent further introductions of this pathogen. Plant imports are been monitored for signs of *P. ramorum* since 2004, and infected plants have been discovered in BC several times. Once discovered, affected nurseries must undergo costly and time-consuming quarantine and eradication protocols. International research is underway to determine the geographical origin of this introduced pathogen; improvement of detection methods and monitoring will continue.

GENETIC STRUCTURE OF CAMAS (*CAMASSIA QUAMASH*) IN WESTERN NORTH AMERICA: POSTGLACIAL COLONIZATION AND TRANSPORT BY INDIGENOUS PEOPLES

Hiroshi Tomimatsu
Department of Botany, University of British Columbia

Recent human activities have spread many plant species extensively across the globe, yet it is relatively unclear how much historical human activities influenced plant dispersal. In western North America, *Camassia quamash* was one of the most important food plants for indigenous peoples, who transported its propagules either intentionally or accidentally. To investigate how human and natural dispersal have contributed to the current pattern of spatial genetic structure, we analyzed sequences of two noncoding regions of chloroplast DNA from 53 populations of *C. quamash* as well as 21 populations of the nonconsumed, but ecologically-similar plant *Zigadenus venenosus* as a control. Contrary to the expectation of presumed anthropogenic transport, *C. quamash* populations did not exhibit weaker genetic structure than *Z. venenosus* populations. We also failed to find convincing evidence for more-specific signatures of transport. Instead, our data showed strong effects of past glaciation and geographical barriers of the mountains in the Cascade Range, Olympic Peninsula, and Vancouver Island. West of the Cascades, the species appears to have largely migrated northward from a southern refugium after deglaciation, whereas few populations having a highly divergent haplotype may have survived beyond the glaciated zone in southwestern Washington. Our data suggest that, despite substantial ethnobotanical evidence for anthropogenic transport**,** the current pattern of genetic structure of *C. quamash* can be understood without invoking any presumed effects of indigenous activities.

RESTORATION

SEPARATING SCIENCE FROM POLITICS IN *SARA* RECOVERY PLANNING

Susan Pinkus
Ecojustice

Abstract not submitted.

GARRY OAK ECOSYSTEMS AND SPECIES AT RISK RECOVERY, GULF ISLANDS NATIONAL PARK RESERVE, BRITISH COLUMBIA

Nicole Kroeker
Parks Canada

Gulf Islands National Park Reserve protects some of Canada's most threatened natural regions including Garry oak and associated ecosystems. To enhance the national park reserve's ecological integrity, Garry oak ecosystem restoration and species at risk recovery efforts are underway. Recovery activities include exotic invasive plant species control using mechanical and chemical techniques; re-vegetation of treated areas using native plant species; exclusion of intense browsing and grazing pressure from deer and geese by fencing off an entire island located in the lagoon at Sidney Spit, Sidney Island; and a small-scale experimental translocation of golden paintbrush (*Castilleja levisecta*), an endangered plant species protected under the federal Species at Risk Act, to an islet in the Park Reserve.

A RESTORATION NEOPHYTE'S "NEED TO KNOW" LIST

Susan Hannon

I recently moved to a 3.5 acre piece of land in the Reginald Hill strata on Salt Spring Island. Our strata is situated in a Garry Oak Ecosystem and we have formed a vegetation committee with a goal to conserve and restore the ecosystem on our 60 acres of common land and to provide information to residents on conservation on their private holdings. We have done some self-education and have talked to some experts but have not settled on a management plan. Below I outline some of the areas that we neophytes would like advice on.

1. How do we get the best conservation "bang" for our time, energy and financial "buck"? What are the top priorities that will have the most impact on restoring the ecosystem?
   - Invasive plant control?
   - Girdling, limbing or topping Douglas-fir?
   - Replanting native species?
   - Controlling deer?

2. Invasive plant control: Which species should we remove and which should we ignore? How and when should they be removed? How should they be disposed of?

3. Where should Douglas-fir be managed (priority areas)? How (topping, limbing, girdling)? What time of year?

4. Which native species should we plant and where? Which ones require protection from deer? If we can't control deer herbivory without fencing, then is planting native species a waste of time? What species should be planted in disturbed sites (e.g. on septic fields, around houses, along driveways)?

5. How can we control the deer? What is the cheapest and most effective fencing? If fencing is too expensive, are there other types of deterrents (chemical, noise, light, water)?

6. Where can we apply for funding for more expensive management efforts (e.g. topping or limbing trees, fencing, purchasing native plants)?

7. Is there research that can be done while implementing a management plan that will help to answer questions of interest to GOERT?

DOUGLAS-FIR TREE REMOVAL: PERSONAL (NON-SCIENTIFC) OBSERVATIONS REGARDING A GARRY OAK HABITAT RESTORATION PROJECT, CADY MOUNTAIN, SAN JUAN ISLAND, WA

Shaun Hubbard
Volunteered Paper

Project Background:
The property, purchased in 2000, is comprised of 20 acres in the middle of San Juan Island. The property is on a south-facing slope and can be divided by micro-habitat types into thirds from top (north) to bottom (south) and ranging in elevation from approx. 600-400 feet. The top third is open grass meadow with a few Garry Oaks and minimal rock outcroppings; the middle third is mainly rock outcroppings, shrubs of Snowberry and Nootka Rose, wildflowers, Arbutus, Garry Oaks and ancient Douglas-firs; and the bottom portion is primarily a dense Douglas-fir forest with trees ranging in age from 300 to 20 years old. Our restoration project is concentrated in the top two sections of the property.

In 2003, we signed a Wildlife Habitat Improvement Project (WHIP) contract through the US Dept. of Agriculture, Natural Resources Conservation Service (NRCS). With this contract, we and several other private landowners on Cady Mt., agree to work (our own labor, or hired) on the restoration of the Garry Oak habitat using prescribed methods and within agreed-upon time frames. In turn we are reimbursed 75% of the maximum estimated costs in time and materials. We have renewed this contract each year since. I am happy it exists as it has provided many a learning opportunity and incentive for us to continue the restoration work. I must say, that our true help and inspiration has been, Thom Pence, a retired forester, whom we call the “Oak Guru”. He is the one who instigated the restoration project on all of Cady Mt. It really helps to have an enthusiastic and knowledgeable cheerleader nudging you along (and wielding a chainsaw).

We have learned that at the initiation of the project, it is a good idea to do an inventory of what is on the site. How many Garry Oaks, what percentage in firs, grasslands, etc. Where are the wildflowers? Do you want to keep brush corridors for wildlife? Then define your goal -- do you want ALL the land to go back to oak prairie/woodlands? In theory, one must remove all or most of the firs in order to restore the oak habitat, but we know that there is a difference among landowners' aesthetics -- some prefer to keep the fir trees for privacy, or sentimental value, or for reducing their carbon footprint. We have a smattering of ancient (300 year-old) Douglas-firs on our property that we will definitely keep, as well as those few with a diameter of 2 feet or more (future "ancients"). However, any large tree (except an "ancient") that endangers a specific oak tree by overcrowding is removed or girdled (we usually girdle those whose removal could damage the nearby oak).

Notes regarding Douglas-fir tree removal:
I would say that the fir removal is the first priority -- to free up the oaks from crowding, prevent seeding of future trees, and restore the habitat to its original Garry Oak ecosystem. We are experimenting with removal in addition to keeping some stands for privacy screens from neighbors. If you do keep some firs, then you must commit to diligence in watching for and removing any seedlings that appear (and they WILL appear!).

Removal of trees can be:
1. cutting them all down, all at once
2. girdling
3. limbing up
4. periodically thinning out a stand of trees

We have used all four methods, and in different combinations. We did not try topping -- it did not help the oaks regarding crowding, the remaining firs still produce seeds, and we felt it is not aesthetically pleasing.

The cutting-all-at-once seemed to disturb the soil in a way that invasives (predominately Canada and Bull Thistles, Hairy Cats Ears, Velvet Grass) came in quickly.

Because of the weedy results from the cutting-all-at-once, we decided to try a slower, gentler method. So, in one stand, we limbed up (6 ft.

plus) all the firs to allow light to enter into the middle of the stand of trees -- the theory being that native plants growing at the edges of the stand would grow in under the trees and strengthen the soil base to minimize the disturbance that would occur with future tree removal.

In this same stand, we are selectively removing trees, a few at a time each season over the years -- another way to be gentler on the earth.

Another reason for going slowly on this particular stand, is that we want to get used to the changing view. We had found that the removal-all-at-once method can be visually and emotionally disturbing, especially when previously hidden neighbors' homes became exposed to our view.

We are also experimenting with a stand of firs in which we limbed AND girdled. Girdling also allows the light to come in to the soil under the trees -- eventually. We girdled last spring and the firs are just now (a year later) appearing to be dying -- the needles have been dropping all along, but so slowly that it was not noticeable until now. We will probably wait another year before we remove these girdled trees. And we may remove them in stages vs. all at once -- it depends on how healed the base soil appears.

I have noticed in both the girdled/limbed and the limbed-only stands that there is a slow encroachment of plants coming in to the previously shaded areas, as we had hoped. There are native plants, grasses and wildflowers, HOWEVER...some thistles, Cat's Ears, and non-native grasses as well. Yet in my observations, the proportion is more in favor of the natives. This was not the case when we did the all-at-once fir removal when it was predominately weeds that came in. Another positive side to girdling is that the removal will be easier -- limbs will be lighter to haul. Some of the large girdled trees we have left standing as snags which provide woodpecker food – we have noted, however, that many of these girdled snags can easily break off at the girdle line, so leave them standing where they won’t cause harm should they fall. And if they do fall, or if you have some that you purposefully fell and left on site, these too can become helpful habitat as “nurse logs”.

Our fir removal has been done in fall or spring -- before or after the wildflower bloom. We often use handsaws vs. chainsaws for the smaller trees (to reduce fuel, pollution and noise). We burn fall's debris in the following spring, and spring's debris in the following fall. But we have waited even longer on some piles. Dry fuel at the base of the pile is important for a good burn.

To help Nature along, I have been sowing native Fescue seeds under the tree stands that we are working on. Our neighbor to the north has tried Fescue plugs. I think that plugs would do better with the head start they have (the plug experiment may be too new to evaluate). I am having to sow the seeds in repeated rounds (in the rainy seasons -- the areas are too far away from a water source to hand water) with minimal result, but I think it's important to keep trying to cover that bare ground as quickly as possible -- with the desired native plants. I would think that propagated native plants from one's own greenhouse would be of value here.

Regarding limb disposal: we have burned, we have chipped and we have had the brush piles hauled away to compost. We have also left some piles (admittedly from neglect), but they make good bird, wildlife and reptilian habitats. Just be sure they are not going to smother any fragile wildflower or rare plant sites. We buck up the logs for firewood that we have kept for our own use as well as given away to friends in need.

Burning: we pile the limbs on a bald rocky area to avoid heat damage to soil. And have the feeder piles situated near by. Of course you will follow your local fire district regulations and other safety precautions -- burn season, permit, water source nearby, safety clothing/helmet, shovels and rakes, etc. The burn goes fast if the pile has been drying for a season. Our concerns about burning are the addition of emissions to the atmosphere, and there is an unattractive burn scar left, but the mosses soon come in to heal the rock. Also, be sure your feeder piles are not on top of a fragile habitat. We recently had to move some piles because wildflowers were emerging beneath them before we could get around to burning.

Chipping: we did not find this successful for us only because we did not have a use for the chips. There is some debate as to whether the fir chips are good for the oak soil or not (I would like to know if there is any info on this), so I was hesitant to just scatter them on the ground. Some people love wood chips for paths and mulching, but we already have gravel paths and no garden to mulch.

Hauling Away: this method requires having a contractor that will haul away, and ideally put the debris to good use. In our case, a local company composts it for commercial sales. You need to have road access and then haul the piles to that road for pickup. This is hard work if you have steep terrain and no road close by. We found this was a costly method and will probably not do it again. The good thing is, the trucks can haul away the larger logs as well as the limbs, if you are in need of disposing of bigger material. I have to admit, it was a relief to have the piles just “disappear”!

All told, fir removal can be a daunting task, depending on the amount and size of trees, of course. But if you make a plan, take it slowly and have patience, it is very rewarding to see the oak savannah/prairie reveal itself -- and you can practically hear the oaks sigh with relief.

Reference: Harrington, Constance A.; Devine, Warren D., 2006. A practical guide to oak release. Gen. Tech. Rep. PNW-GTR-666. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Center. 28 p.