2005 ANNUAL REPORT

DEPARTMENT OF NATIONAL DEFENCE

ESAC

ENVIRONMENTAL SCIENCE ADVISORY COMMITTEE

CANADIAN FORCES BASE ESQUIMALT

National Defence / Défense nationale

Canada

Prepared on behalf of the Committee by:

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Cover Photos:

Top Left:
Bald Eagle (*Haliaeetus leucocephalus*)

Top Right:
Sharp-tailed Snake (*Contia tenuis*)

Bottom:
Rocky Point Bird Observatory Activities

Inset:
Red-winged Blackbird *(Agelaius phoeniceus)*

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EXECUTIVE SUMMARY

The Department of National Defence (DND) Environmental Science Advisory Committee (ESAC) for Canadian Forces Base (CFB) Esquimalt was established in 1994 as a multi-agency technical advisory committee. The committee reviews and recommends proposals from researchers and other interested parties who wish to carry out natural resources scientific research on CFB Esquimalt properties. Every year, ESAC collects, reports, and archives the findings of the research activities in a printed and web-based annual report. ESAC also acts as an advisory body to CFB Esquimalt on various environmental issues occurring on CFB Esquimalt properties, and serves as a gateway to a network of scientists accessible to Maritime Forces Pacific (MARPAC) staff.

In 2005, the Committee reviewed 25 proposals to conduct research and/or collection activities on CFB Esquimalt properties including the following studies:

- Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa*) and the Red-legged Frog (*Rana aurora*);
- Comparison of Gene Flow and Recruitment in Three *Lomatium* Species;
- Environmental Controls on Overstory Recruitment of Garry Oak (*Quercus garryana*) at Rocky Point;
- Western Redcedar (*Thuja plicata)*, Climate Change, and Implications for Management on Vancouver Island;
- Impact of Scotch Broom (*Cytisus scoparius*) on Rare Native Plants in Garry Oak Meadows Mediated through Soil Chemistry; and
- Wildlife Tree Stewardship Initiative: Bald Eagle (*Haliaeetus leucocephalus*) Nest Tree Monitoring at Canadian Forces Maritime Experimental Test Range (CFMETR).

Each proposal was reviewed by ESAC for scientific content and forwarded to Formation Risk Management Branch, Environment Office and to Base Operations, Range Control personnel to ensure that the proposed activities did not result in any adverse environmental effects or interfere with military operations and activities. Subsequently, recommended proposals were sent to the Base Commander for the final review, approval and issuing of the permit. Twenty-one ESAC research and collection permits were issued to individuals and organizations authorizing environmental research on CFB Esquimalt lands. A compilation of the scientific reports obtained from each of these authorized research projects as well as a summary of the Committee's activities conducted throughout the year are presented in this annual report.

In 2005, the "Environmental Assessment Project Evaluation Form" accompanied all ESAC research and collection applications. The project evaluation form enabled the Environment Office personnel to assess the environmental effects of the proposed research project according to the Canadian Environmental Assessment Act.

Where applicable, wildlife and sensitive ecosystem inventory data from 2005 ESAC research projects were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. This information combined with existing data was used to generate significant natural areas maps that are readily available to MARPAC personnel. ESAC research sites located on CFB Esquimalt properties were also added to the GIS database.

To facilitate sharing of research findings collected on CFB Esquimalt land in 2005, the Committee hosted its ESAC Annual Workshop on February 2nd, 2006 at the Pacific Forestry Centre, Victoria, B.C. Nine presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and ecosystem restoration were given to attendees from government and non-government organizations. The 2005 ESAC Annual Workshop boasted the highest turnout to date with over 70 individuals in attendance.

Permit P089-05. Wildlife Tree Stewardship Initiative: Bald Eagle (*Haliaeetus leucocephalus*) Nest Tree Monitoring at CFMETR (page 42).

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INTRODUCTION

Maritime Forces Pacific (MARPAC) constitutes Canada's Navy on the west coast. Her Majesty's Canadian Dockyard at Canadian Forces Base (CFB) Esquimalt is home to the Navy's Canadian Pacific Fleet. The role of CFB Esquimalt is to support the ships' personnel of the Canadian Pacific Fleet and other key military units.

MARPAC is one of the largest government organizations in the Pacific Region, with a work force of approximately 3700 military and 1900 civilians. With approximately 4200 hectares of land amongst 14 different municipalities and regional districts under its administration (Table 1), MARPAC has long acknowledged its responsibility to consider environmental impacts in the management of its training areas and in the planning and conduct of its activities. Efforts to minimize the adverse effects of training and operations, in conjunction with innovative management practices, will ensure continued protection and enhancement of the many significant natural areas and unique features located on CFB Esquimalt lands in British Columbia.

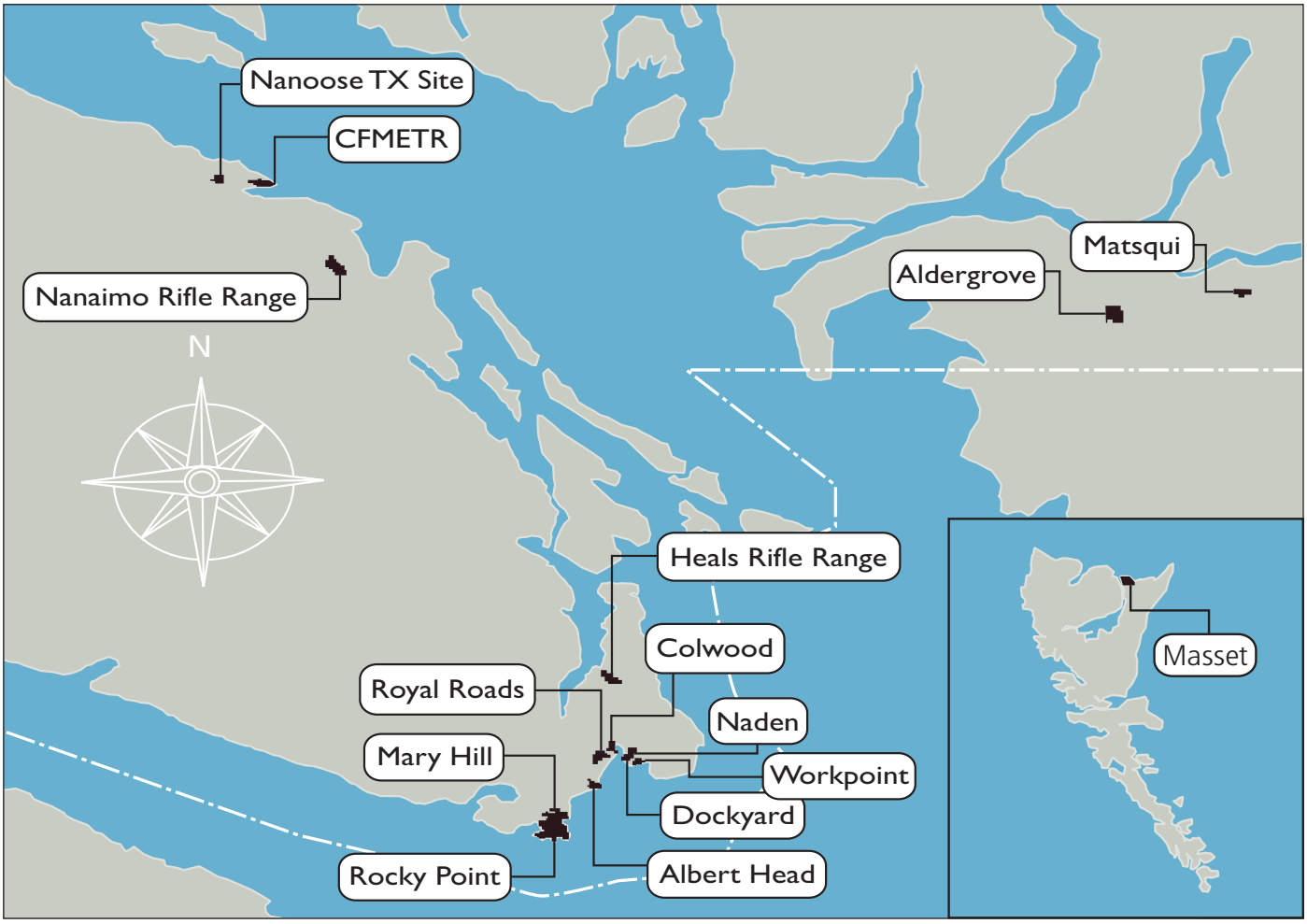
Over two-thirds of MARPAC lands are forested and minimal human disturbance makes them a refuge for various wildlife species. A number of CFB Esquimalt properties support remnants of sensitive ecosystems such as Coastal Douglas-fir forests and Garry oak meadows providing unique opportunities for scientists to conduct an array of environmental studies.

Table 1. CFB Esquimalt properties total area in hectares.

Albert Head	92.7
Aldergrove	514.0
Colwood	90.0
CFMETR / Nanoose Bay	288.4
Dockyard / Signal Hill / Yarrows	62.7
Heals Rifle Range	212.4
Mary Hill	178.1
Masset (Queen Charlotte Islands)	824.0
Matsqui	95.1
Naden	45.4
Nanaimo Rifle Range	351.0
Nanoose TX Site	105.0
Rocky Point	1078.0
Royal Roads	229.0
Work Point	66.0
TOTAL AREA	**4,231.8**

Permit P114-05. Environmental Controls on Overstory Recruitment of Garry Oak *(Quercus garryana)* at Rocky Point (page 74).

CFB ESQUIMALT PROPERTIES



BACKGROUND

Prior to 1994, research projects were undertaken by various individuals and organizations on CFB Esquimalt properties on an ad hoc basis. Consequently, the bulk of the research findings were not readily available to MARPAC personnel for use in environmental management and decision-making. The recognized need for a process to track the research activities and associated findings resulted in the formation of the DND Environmental Science Advisory Committee (ESAC) for CFB Esquimalt. Since the creation of the Committee, in 1994, ESAC has facilitated and coordinated over 100 environmental studies on CFB Esquimalt properties in conjunction with other environmental projects funded by DND.

The ESAC provides scientific advice within the context of MARPAC's overall Natural Resources Program. This program encompasses the management of natural resources on CFB Esquimalt lands including species-at-risk, sensitive ecosystems, forests, wetlands and riparian zones while ensuring sustainable military training and operations.

MEMBERS

ESAC is a multi-agency committee composed of two representatives from CFB Esquimalt (Formation Risk Management Branch and Base Construction Engineering Office) and one representative from each of the member agencies:

- **Canadian Forest Service**
- **Canadian Wildlife Service**
- **British Columbia Ministry of Forests**
- **University of Victoria**
- **Royal Roads University**

A complete list of ESAC members and contact information is located at the end of this report.

Permit P112-05. Comparison of Gene Flow and Recruitment in Three *Lomatium* Species (page 72).

ROLES AND RESPONSIBILITIES

Proposal Review and Tracking

The Committee's primary functions are to review, evaluate, and provide scientific expertise and advice to CFB Esquimalt on proposals received to conduct biological, environmental and archaeological studies on its properties. The Committee maintains a formal permitting system to facilitate tracking of proposals and permits to conduct research on CFB Esquimalt properties. Research activities requiring a permit include, but may not be limited to, the following: surveys and inventories; tagging and banding; collection of wildlife specimens; installation of scientific monitoring structures; observations; and photography. Individuals interested in conducting environmental studies on CFB Esquimalt properties can obtain more information by contacting a member of ESAC at (250) 363-2313.

Each research proposal is sent to and reviewed by ESAC. Subsequently, proposals are sent to the Formation Risk Management Branch, Environment Office and to Base Operations, Range Control personnel to ensure that the proposed activities will not result in any adverse environmental effects or interfere with military operations and activities. Lastly, each recommended proposal is sent to the Base Commander for final review, approval and permit issuance.

Reporting of Activities

As part of the reporting process, ESAC permit holders are required to submit a report describing the purpose, methodology and research findings obtained throughout the year. ESAC compiles these research reports and makes them available to all member agencies and other interested organizations through the production of an annual report.

To further promote sharing of information obtained through ESAC research projects, the Committee hosts an annual workshop. Additional information on ESAC, the annual workshop, and an archive of past annual reports are available on the ESAC website. The website (listed below) is updated regularly.
www.pfc.cfs.nrcan.gc.ca/programs/esac

Other Committee Activities

ESAC also acts as an advisory body to MARPAC by providing insight and advice on various environmental issues occurring on CFB Esquimalt properties. ESAC members also provide MARPAC personnel with the ability to connect with the broader scientific community regarding various ecological issues. In addition, the Committee oversees the activities of the Operating Committee for the Forest Canopy Research Station at Rocky Point.

ESAC ACTIVITIES IN 2005

Permit P003-05. Western Bluebird *(Sialia mexicana)* Nestbox Program at Rocky Point (page 20).

ADVISORY AND REPORTING ACTIVITIES

This year was the eleventh full year of activity for ESAC. The Committee met three times during 2005 to review project proposals and status, to plan reporting activities, and to provide advice to CFB Esquimalt on other environmental issues occurring on CFB Esquimalt properties.

The 2004 ESAC Annual Report was produced and 150 hard copies were distributed to ESAC permit holders, military bases across Canada, and other government and non-government agencies throughout British Columbia. The ESAC website was restructured with the intent of making it current and easier to use, including the addition of basic property maps for identifying locations of permitted projects. Active and/or archival ESAC projects can be queried by year, location or permit number; in addition, all ESAC Annual Reports from 1995 to 2004 are now available for downloading from the website.

The Environmental Assessment (EA) Project Evaluation Form, developed in 2004, accompanied all 2005 ESAC research and collection applications. This form proved to be extremely useful when screening proposals for activities that could trigger an environmental assessment. Requirements for project proponent liability insurance were studied and this will become a requirement for all projects in 2006.

The 2005 ESAC Annual Workshop, held on February 2nd, 2006 at the Pacific Forestry Centre, had the highest attendance to date. More than 70 individuals participated in the workshop. Nine presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and ecosystem restoration were given. Participants represented a wide variety of government, non-government and private organizations including the Department of National Defence, Natural Resource Canada, Environment Canada, British Columbia Ministry of Environment, Department of Fisheries and Oceans Canada, Royal Roads University, Camosun College, the Victoria Natural History Society, the Rocky Point Bird Observatory and the Wildlife Tree Stewardship Initiative.

Table 2. Number of environmental research proposals received and permits issued since 1995.

Year	Proposals	Permits
2005	25	21
2004	16	16
2003	26	24
2002	21	20
2001	14	14
2000	19	16
1999	25	25
1998	26	26
1997	24	24
1996	25	24
1995	22	20

RESEARCH AND COLLECTION ACTIVITIES

A total of 25 proposals were received and reviewed by ESAC. Of the 25 proposals, 21 permits were issued with 15 being renewals of projects begun in previous years. Table 2 shows the number of proposals received and permits issued annually since 1995.

The diversity of projects conducted in 2005 enhanced the knowledge and understanding of the wildlife and sensitive ecosystems occurring on CFB Esquimalt properties. In addition, research findings collected under the ESAC permits contributed to sound decision-making and environmental management by CFB Esquimalt personnel. The knowledge gained from these studies could also be applied, to varying degrees, in neighbouring and similar ecosystems under different jurisdictions, thus adding to the value of the research carried out on CFB Esquimalt properties. Table 3 lists all research and collection activities conducted in 2005 under the auspices of ESAC.

Permit P090-05. Distribution, Abundance and Adaptation of Butterflies at their Northern Range Limit (page 47).

Table 3. Summary of ecological research conducted under ESAC in 2005. Property abbreviations are listed below.

ESAC Permit Title	Project Leader	Permit #	Property
2005 Rocky Point Bird Observatory Society Activities	Kelly	P003-05*	AH, HRR, MH, RP, RR
Monitoring of Winter Moth (*Operophtera brumata*) and the Parasites Introduced for its Control	Otvos	P031-05*	NA
Purple Martin (*Progne subis*) Origins and Relationships	Finlay	P044-05*	CO
Wildlife Tree Stewardship Initiative: Raptor Nest Monitoring at Rocky Point, Albert Head and Colwood	Greenwood	P074-05*	RP, AH, CO
Garry Oak *(Quercus garryana)* Acorn Production Study	Courtin	P079-05*	CFMETR, MH, RP
Thermal Characteristics of Townsend's Big-eared Bat Roosts	Craig	P086-05*,**	MH
Royal Roads University - Microclimate Monitoring Station Upgrade at Rocky Point	Dushenko	P087-05*	RP (FCRS)
Pilot Monitoring Program for Plethodontid Salamanders on Vancouver Island, British Columbia	Paige	P088-05*	RP, RR
Wildlife Tree Stewardship Initiative: Bald Eagle (*Haliaeetus leucocephalus*) Nest Tree Monitoring at CFMETR	Gray	P089-05*	CFMETR
Distribution, Abundance and Adaptation of Butterflies at their Northern Range Limit	Hellmann	P090-05*	RP, CFMETR
Sharp-tailed Snake (*Contia tenuis*) Habitat Suitability and Monitoring Project on Federal Lands	Engelstoft	P100-05*	AH, CO, DY, NA, HR, MH, RP, RR, WP
The Late Prehistoric Mortuary Landscape of Southern Vancouver Island	Mathews	P104-05*	AH, MH, RP
Phantom Orchid (*Cephalanthera austiniae*) Inventory at Heals Rifle Range	Chatwin	P105-54*	HR
Impact of Scotch Broom (*Cytisus scoparius*) on Rare Native Plants in Garry Oak Meadows Mediated through Soil Chemistry	Shaben	P107-05*	RP, AH
Western Bluebird *(Sialia mexicana)* Nestbox Program at CFMETR	Chatwin	P108-05	CFMETR
Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa*) and Red-legged Frog (*Rana aurora*)	McKibbin	P109-05	ALD
Recovery Activities Benefiting the Oregon Spotted Frog (*Rana pretiosa*) at Maintenance Detachment Aldergrove	Haycock	P110-05	ALD
Comparison of Gene Flow and Recruitment in Three *Lomatium* Species	Marsico	P112-05	RP
Deer Dispersion and Population Dynamics at CFB Esquimalt - Dockyard	Fraker	P113-05**	DY, NA
Environmental Controls on Overstory Recruitment of Garry Oak (*Quercus garryana*) at Rocky Point	Gedalof	P114-05	RP
Western Redcedar (*Thuja plicata*), Climate Change, and Implications for Management on Vancouver Island	Seebacher	P115-05	RR

Properties: AH: Albert Head; **AL:** Aldergrove; **CFMETR:** Canadian Forces Maritime Experimental and Test Ranges; **CO:** Colwood; **DY:** Dockyard; **HR:** Heals Rifle Range; **MH:** Mary Hill; **MS:** Masset; **MT:** Matsqui; **NA:** Naden; **NT:** Nanoose TX Site; **RP:** Rocky Point (**FCRS** – Forest Canopy Research Station); **RR:** Royal Roads; **WP:** Work Point. * Renewed from previous years. ** Research project abandoned or postponed to 2006.

Rocky Point Forest Canopy Research Station.

ROCKY POINT FOREST CANOPY RESEARCH STATION

Constructed in 1994, the Forest Canopy Research Station at Rocky Point originally consisted of five old-growth Douglas-fir trees located in mature forest at the southern end of the property. Each of the five trees was originally fitted with platforms and rope and pulley systems, in addition to ladders leading to higher levels in the canopy. The canopy station stands 30 meters above the northern edge of a one hectare Ecological Monitoring and Assessment Network (EMAN) plot. An Environment Canada microclimate station originally configured to measure temperature and relative humidity within the canopy also supports the station. An Operating Committee is responsible for the station's maintenance, use and overseeing its operations.

Ownership and responsibility for the Rocky Point Forest Canopy Station has been held by Royal Roads University since 2002, as part of the university's efforts to monitor climate change and atmospheric transport of contaminants. Since this transfer, all sensors associated with the microclimate station have been recalibrated, and a new environmental sensing strategy for the site developed. This includes an aerial ladder installed between two trees to support temperature/relative humidity profiling within the canopy. Equipment at the site, including a data-logger and sensors, is powered by a solar panel supported on an 18-m tower on a knoll adjacent to the canopy station.

A safety inspection of the canopy trees completed in 2003 recommended a major upgrade of the canopy platforms and access system. Following a detailed assessment by the Operating Committee, the Department of National Defence approved of the terms of reference for the upgrade. The upgrade, as detailed below, commenced in August of 2005 and was completed early in 2006.

The platforms and rope-pulley systems were decommissioned from two of the five trees to leave a three-tree canopy system, which is easier to maintain. The decommissioning entailed removing all strapping, webbing, ladders and platforms. The original deadwood from the remaining trees was removed in a controlled manner to minimize the impact to the ground below; this removal benefits the trees' overall health, and makes them safe for access and use.

Once the deadwood was removed, the old platform systems were dismantled and the materials sorted for reuse in the structural upgrades. The upgrading started with the installation of aluminum ladder sections, bolted together from the ground up, by tying them to the trees with new tubular webbing using blocks to keep the ladders out from the tree. All of the old ratchet straps from the remaining platforms were removed and replaced. A single safety line tie-in for the three remaining trees was installed, running from the top platforms to the first platform. Access from the ground to the first platform was installed with a single line safety tie-in. Once a climber is on the first platform, only the one tie-in is required to access the higher platforms. All equipment haul lines and pulleys were replaced and safety cables were installed. Stainless steel ladder covers and locks were also installed to prevent unauthorized access and warning signs are to be posted.

Researchers accessing the canopy system will wear a full body safety harness and helmet and use a mechanical prussic (Petzl Shunt) on the safety line. Researchers will exit the station with a mechanical lowering device (Petzl Stop). These devices will ensure safety and reduce user error. A new revised safety protocol is currently being developed in response to these upgrades.

This work will facilitate the installation of the upgraded microclimate station equipment which will be fully operational by summer 2006.

GEOGRAPHIC INFORMATION SYSTEM

All wildlife monitoring sites, sensitive features and sensitive ecosystem inventory data collected from ESAC research projects in 2005 were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. These findings, combined with existing sensitive species and ecosystem data, were used to generate maps of significant sensitive and natural areas making this information readily available to MARPAC personnel. The information that populates these maps includes the location of species-at-risk, sensitive ecosystems, invasive shrub species, wetlands, riparian zones and archaeological features. The information available in the natural resources GIS database is utilized by MARPAC personnel when performing a wide variety of activities including the preparation of environmental assessments, environmental awareness and training, planning and designing construction engineering projects, and conducting military exercises. Selected GIS data were also made available to member or other agencies.

The locations of ESAC research sites were added to the GIS and subsequently delineated on property maps made available to CFB Esquimalt personnel to reduce conflicts with military training and activities; these maps are available on the ESAC website.

DEPARTMENT OF NATIONAL DEFENCE

ESAC

ENVIRONMENTAL SCIENCE ADVISORY COMMITTEE

CANADIAN FORCES BASE ESQUIMALT

SCIENTIFIC REPORTS

Research and Collection Activities Conducted in 2005

2005 Rocky Point Bird Observatory Society Activities

David Kelly

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Tel: (250) 658-8669 • Email: sdkelly@shaw.ca

Permit #: *P003-05*
Location: *Rocky Point and Royal Roads*
Start Date: *April 2005*
Completion Date: *31 December 2005*

1. MIGRATION MONITORING STATION
Project Leader: David Kelly
Location: Rocky Point

Introduction

During migration, the Rocky Point Bird Observatory (RPBO) is witness to impressive numbers of songbirds, vultures, raptors, and seabirds. Over the years, a remarkable 297 species have been recorded at the site. In addition, over eighty species breed (or are suspected of breeding) in the area. Typically, between 3000 to 4000 birds of 55 to 60 species are banded at RPBO each year (31,6240 birds of 93 species have been banded since 1994). RPBO's primary banding season runs from mid-July through October. The potential for bird studies at this site is considerable. Rocky Point is particularly suited for migration monitoring since human disturbance is minimal.

Study Area and Methodology

RPBO is located on the Department of National Defence land to the southwest of Victoria, B.C. Overlooking the Strait of Juan de Fuca, the unique geography and mixed forest here at the extreme southern end of Vancouver Island attracts both migrants and vagrant bird species. The monitoring operation covers an area about 9 km^2. The habitat consists of old growth Douglas-fir and Grand Fir stands, tidal flats, endangered Garry Oak forests, open meadow and riparian habitats. In 2005, mist nets were operated daily from 21 July to 18 October at Rocky Point following a standard methodology (Derbyshire 2005).

Results and Discussion

On October 18th, we completed the 12th season for fall migration monitoring at Rocky Point. Record numbers for many species were the story of the day. Our tally of 4625 birds banded is a new single season record for RPBO. Ruby-crowned Kinglets became the first bird at RBPO to reach 500 birds in a season and we ended up with a phenomenal 834. In addition, 16 species set single season banding highs: Downy Woodpecker, Willow Flycatcher, Chestnut-backed Chickadee, Winter Wren, Ruby-crowned Kinglet, Hermit Thrush, Yellow Warbler, Yellow-rumped Warbler, Black-throated Gray Warbler, MacGillivray's Warbler, Common Yellowthroat, Wilson's Warbler, Lincoln's Sparrow, White-crowned Sparrow, Dark-eyed Junco, and Purple Finch. Once again a bit perplexing, Chipping Sparrows appear to have departed early for the second year in a row and only two birds were banded. Also a bit sobering was the fact that Hammond's Flycatcher, Bewick's Wren, Bushtit, Song Sparrow, and even Brown-headed Cowbird were below their normal capture rates. Of interest was our earliest banding capture for Fox Sparrow on the opening day of the season.

On August 14, RPBO had its first banding record for California Quail with a family group of four. Note we now have a provincial permit which allows us to band this Gallinaceous species (Grouse and allies) for the first time. Among banding rarities, a Dusky Flycatcher, an American Redstart, two Northern Waterthrushes, a Swamp Sparrow, and three White-throated Sparrows were captured. An After Third Year (ATY) Northern Flicker re-trapped on August 7 was originally banded on July 21, 2001 as an After Hatch Year (AHY), so it is now at least 4 years, 2 months old. Another recapture of note was an After Second Year (ASY) Golden-crowned Kinglet caught on August 14; it was originally banded as a hatch-year (HY) on September 21, 2002 making it now at least 3 years, 2 months old (this is pretty old for a kinglet – the oldest on file at the Bird Banding Lab is only 5 years,

2005 Rocky Point Bird Observatory Society Activities

Barred Owl *(Strix varia)*

4 months!). For the third year in a row, we participated in Cam Finlay's hummingbird project, but only 15 Rufous Hummingbirds were banded. This is consistent with startlingly low numbers of this species reported on the south island all year.

Looking at the banding figures, during a 14-day stretch from September 9 to September 22, a total of 1619 birds were banded, and more than 100 birds were banded on each of 8 of those days (a new station record in a single season). To put these numbers in perspective, this two-week period represents ~35% of our total captures for the entire season. Furthermore, on September 17 a new single day station record was set when 208 birds were banded.

At first glance, the weather pattern appeared to be similar to last year. However, slightly lower temperatures and more precipitation earlier in the year may have helped some of our breeding species, both locally and further north. It was also definitely foggier and windier than normal in the Strait of Juan de Fuca, and that certainly hampered offshore observations and even census tallies on some days. Temperatures in October were pleasantly milder than normal, with very few mornings starting out below 5°C.

Among the rare birds recorded: Rocky Point's second-ever Clark's Nutcracker on August 10 (almost ten years since our last record), a Buff-breasted Sandpiper on August 19 (new record for RPBO checklist), our second American Redstart (a HY male) was banded on August 28, a Lewis's Woodpecker (September 6; only second record in recent years, as they historically bred here), an Ash-throated Flycatcher (also September 6; second site record), a Vesper Sparrow (September 14; second site record), a Clay-colored Sparrow (September 25; second site record), and a Tropical Kingbird on October 8 while no doubt "overdue" for the checklist was still welcome (#297 for our list). Early in the season a Parasitic Jaeger was seen offshore on July 22. Tufted Puffins were seen (from shore) on July 22 and 25, and again on August 2. While 1 to 3 Northern Waterthrushes are usually seen or captured at Rocky Point every fall, two banding records in a season is always a treat.

Other rarities included: a Wood Duck (September 11; only 9th site record), Nashville Warbler (September 22; remarkably the 11th record for the site), two Dusky Flycatchers (different birds on September 17 and 18; 11 records now for us), an immature Northern Goshawk was near the trailers at Cape Calver on October 29th, and in October at least two Barn Owls were heard in the evenings during owl banding (subsequently a predated specimen was found and these represent only our 6th and 7th records). Broad-winged Hawks put on an average showing this September, with approximately 10 individuals observed. The site year list finished with a respectable 198 species.

It will be very interesting to see if the high capture rates established over the last three seasons will continue next year. In addition, note there have been some changes to the order for our Top 10 banded list over the last two years, with the middle order showing a changing dynamic (e.g. only 115 birds separate the 4, 5, 6 order). Furthermore, the overall decline by Savannah Sparrow and Lincoln's Sparrow is of concern. Note that this Top 10 list represents ~58% of our total captures.

RPBO Top 10 (1994 – 2005)	
Ruby-crowned Kinglet	Orange-crowned Warbler
Pacific-slope Flycatcher	Yellow Warbler
Wilson's Warbler	Song Sparrow
Winter Wren	Fox Sparrow
Lincoln's Sparrow	Savannah Sparrow

2005 Rocky Point Bird Observatory Society Activities

Total Birds Banded from July 21 to October 18, 2005 The nonmenclature used follows the American Ornithologists' Union (1998, 2002)

SPECIES	# BANDED
California Quail	*4 (new to our banded list)*
Sharp-shinned Hawk	5
Cooper's Hawk	*1 (only our fifth ever banded)*
Sora	1 (our sixth ever banded, but first in 7 years in our nets)
Rufous Hummingbird	**15**
Downy Woodpecker	*4 (*new single season high; previous high 3 from 2004)*
Hairy Woodpecker	*1 (only our sixth ever banded)*
Northern Flicker	*3*
Willow Flycatcher	*79 (*new single season high; previous high 56 from tie in 2003 and 2004)*
Hammond's Flycatcher	**25 (lowest since 1999)**
Dusky Flycatcher	*1 (our fourth banding record, but 10th for station checklist)*
Pacific-slope Flycatcher	*317*
Hutton's Vireo	*8*
Warbling Vireo	22
Steller's Jay	14
Violet-green Swallow	1
Northern Rough-winged Swallow	1
Chestnut-backed Chickadee	*142 (*new single season high; previous high 93 from 2002)*
Bushtit	**30 (lowest since 2003)**
Red-breasted Nuthatch	4
Brown Creeper	*15*
Bewick's Wren	**24 (our lowest capture rate since 1997)**
House Wren	*30 (ties high set last year)*
Winter Wren	*294 (*new single season high; previous high 260 in 2000)*
Marsh Wren	*9*
Golden-crowned Kinglet	*146*
Ruby-crowned Kinglet	*834 (*new single season high; previous high 467 from 2004!)*
Swainson's Thrush	*89*
Hermit Thrush	*141 (*new single season high; previous high 139 in 2004)*
American Robin	*17*
Cedar Waxwing	*9*
Orange-crowned Warbler	*249*
Yellow Warbler	*310 (*new single season high; previous high 265 from 2004)*
Yellow-rumped Warbler	*81 (*new single season high; previous high 64 in 2003)*
Black-throated Gray Warbler	*8 (*new single season high; previous high 6 from 2001)*

(*Italics* indicates high/ **bold** for low vs. averages)

2005 Rocky Point Bird Observatory Society Activities

Total Birds Banded from July 21 to October 18, 2005

SPECIES	# BANDED
Townsend's Warbler	4
American Redstart	*1 (second station record; only third record for Victoria checklist!)*
Northern Waterthrush	*2 (our 10th and 11th banding records)*
MacGillivray's Warbler	*68 (*new single season high; previous high 48 from 2002)*
Common Yellowthroat	*118 (*new single season high; previous high 105 from 1998)*
Wilson's Warbler	*315 (*new single season high; previous high 257 from 1999)*
Western Tanager	*1 (only our fifth ever banded)*
Spotted Towhee	*121*
Chipping Sparrow	**2 (our lowest capture rate since 1996)**
Savannah Sparrow	96
Fox Sparrow	*185*
Song Sparrow	**127 (lowest since 2001)**
Lincoln's Sparrow	*199 (*new single season high; previous high 197 from 2004)*
Swamp Sparrow	1
White-throated Sparrow	3
White-crowned Sparrow	*121 (*new single season high; previous high 116 in 2004)*
Golden-crowned Sparrow	*112*
Dark-eyed Junco	*95 (*new single season high; previous high 88 in 2000)*
Red-winged Blackbird	4
Brown-headed Cowbird	**6 (lowest since 1997)**
Purple Finch	*16 (*new single season high; previous high a tie with 13 in 1998, 1999, and 2004)*
American Goldfinch	*109*
Total Number of Birds	**4625**
Total Species	**57**

(*Italics* indicates high/ **bold** for low vs. averages)

References

Derbyshire, Daniel. August 2005, ver. 1.42. Field Protocol for Migration Monitoring at Rocky Point Bird Observatory. RPBO, British Columbia.

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th ed. American Ornithologists' Union, Washington, D.C.

American Ornithologists' Union. 2002. Forty-third supplement to the American Ornithologists' Union Check-list of North American birds. Auk 119: 897-906.

2005 Rocky Point Bird Observatory Society Activities

2. BIRD BANDING WORKSHOP
Project Leaders: David Kelly and Ann Nightingale
Location: Royal Roads

Introduction

Much of the research on health and survival of avian species requires mist-netting and handling of individual birds. In Canada and the US, a significant portion of this work is done by volunteer naturalists and students who have little access to training prior to beginning field work. Since 2003, RPBO has been offering short training programs to introduce potential researchers and field assistants to techniques which emphasize safe handling of birds while accurately obtaining the data required for their research.

Study Area and Methodology

RPBO's training sessions take place on the Royal Roads University campus, utilizing net sites established for the Monitoring Avian Productivity and Survivorship program. Course participants also attend classroom sessions to learn methods for identifying and determining the age and sex of a wide variety of birds. In the classroom sessions, photographs and frozen specimens are used. In 2005, the workshop instructor was Peter Pyle, North America's leading authority on ageing and sexing of birds, and the author of the primary reference for banding stations throughout the continent. The workshop occurred from 25 March to 27 March 2005.

Results

Eighteen participants, from novice to experienced banders, attended the 2005 workshop. Although most of the students were from British Columbia, several participants, including two from Florida, traveled great distances to attend, reinforcing the value of such activities. Participants learned how to safely hold, measure and release captured birds.

During the mist-netting portion of the workshop, 93 birds of 9 species were captured and banded, providing ample opportunity for the students to begin to learn safe handling techniques. Birds were banded by holders of valid Canadian Wildlife Service permits, or by the students under the supervision of permitted banders, and the data collected was sent to Bird Studies Canada and the Canadian Wildlife Service.

Discussion

Several workshop participants have gone on to volunteer at banding operations, obtain work as field technicians or to establish banding stations. There is a clear need and interest for this kind of program, both from the perspective of the potential bird handlers and to ensure the safest and most accurate methodologies for working with birds in the hand.

References

Pyle, Peter. 1997. Identification Guide to North American Birds. Part I. Columbidae to Ploceidae. Slate Creek Press, Bolinas, CA.

3. MONITORING AVIAN PRODUCTIVITY AND SURVIVORSHIP
Project Leaders: Gabriel David and Ann Nightingale
Location: Rocky Point and Royal Roads

Introduction

The Monitoring Avian Productivity and Survivorship (MAPS) Program was created by the Institute for Bird Populations in 1989 to assess and monitor the vital rates and population dynamics of over 120 species of North American landbirds at more than 500 sites in order to provide critical conservation and management information on their populations. Since 2003, RPBO has contributed data from two DND sites: Rocky Point and Royal Roads University.

The purpose of the MAPS project at Royal Roads and Rocky Point is to inventory the breeding songbird populations using standardized methodology, and to record sightings of other species occurring at these locations to facilitate comparisons of populations and avian diversity at the two sites. The data is submitted to both Bird Studies Canada (banding data) and to the Institute for Bird Populations (banding, observation, breeding status, and habitat structure) to be made available to researchers and others.

Study Area and Methodology

MAPS monitoring was conducted at Royal Roads and Rocky Point, following the MAPS Manual Protocol (DeSante *et al*. 2005). Songbirds were captured in mist-nets and banded during standardized sampling sessions. The mist-nets are located in a variety of habitat types, at prescribed distances from each other. The area covered at each study site is approximately 8 acres (3.25 hectares). The sessions were conducted for a six hour period starting at sunrise, at each location, once per ten-day period from the beginning of June to the first ten days of August.

Results

Sampling was conducted between 3 June and 8 August (MAPS periods 4 to 10), resulting in each study site being sampled seven times—once in each 10 day MAPS period. Despite similar habitat, the Royal Roads site continued to have fewer birds and lower species diversity than that of Rocky Point: 163 individuals were banded of 25 species at Royal Roads, vs. 316 banded of 35 species at the Rocky Point site. This is consistent with the observations in both the preceding years of this project.

Species' breeding status was determined by observing the breeding condition of adults while in the hand, by the location of active nests, and by the formulae prescribed by the Institute for Bird Populations. 31 species were defined as breeding at the Royal Roads site and 38 species were defined at Rocky Point. These numbers are significantly higher than in 2004 (22 and 33 species respectively), largely due to the benefit of multiple years of data. Observations of birds also show a higher diversity at the Rocky Point site with 73 species observed vs. 65 species at Royal Roads.

Discussion

The MAPS protocol advises that a five to ten year period of data collection is required before meaningful analysis can be initiated; however, certain trends are already becoming evident. The Rocky Point site continues to be more productive both in terms of numbers of individuals and in confirmed breeders. There is considerable overlap in the species found at both sites, as would be expected with the similar habitat, but a few species are emerging as being more prevalent at one site over the other. As more years are dedicated to this project, and more data collected, conclusions may be able to be drawn regarding these differences and the general health of the breeding bird populations at both sites.

The program requires a considerable contribution of effort, exceeding 500 person hours including set-up, monitoring, and data management for the two Victoria locations.

References

DeSante, *et al*. 2005. MAPS Manual 2005 Protocol; Instructions for the Establishment and Operation of Constant-Effort Bird-Banding Stations as Part of the Monitoring Avian Productivity and Survivorship (MAPS) Program. The Institute for Bird Populations, Point Reyes Station, California.

Pyle, Peter. 1997. Identification Guide to North American Birds. Part I. Columbidae to Ploceidae. Slate Creek Press, Bolinas, CA.

2005 Rocky Point Bird Observatory Society Activities

4. NOCTURNAL OWL MONITORING PROJECT
Project Leader: Paul Levesque
Location: Rocky Point

Introduction

Forest dwelling owls are increasingly becoming a conservation concern in North America. As predators, the group feeds at high trophic levels, limiting population densities at the landscape level and making the owls susceptible to bioaccumulation of toxins. In British Columbia, five species of "small" owls are secondary cavity nesters, making them dependant on mature forests. Due to their nocturnal behaviour and remoteness of breeding areas, collecting population data for long term monitoring is often labor intensive and costly. The owl monitoring has proven to be successful for Northern Saw-whet Owls and to a lesser extent Barred Owls.

Study Area and Methodology

Owl monitoring at Rocky Point was conducted during the first six hours of darkness on 29 evenings, from 13 Sept. to 4 Nov., 2005. Six mist nets and an audio lure broadcasting Northern Saw-whet Owl calls were used to attract and capture migrating owls. Once captured, owls were removed from the nets, marked with aluminum leg bands, a series of morphometric measurement were collected, aged and then released.

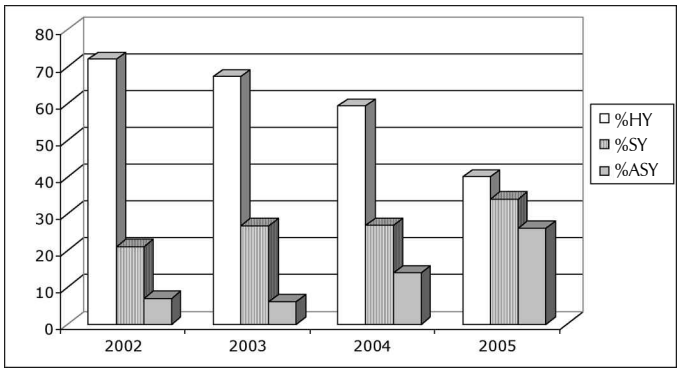
Results

During the fall of 2005, 77 Northern Saw-whet Owls and one Barred Owl were banded during 664 hours of mist netting. The capture rate of Northern Saw-whet Owls was 0.11 birds/net hour. The sex ratio was skewed towards females, with 79.2% being female, 7.8% male and 13.0% unknown sex. Of the 77 Northern Saw-whet Owls, 40% were hatch year, 34% second year and 26% after second year. Although capture rates were relatively low in 2005, the annual productivity (measured as the ratio of hatch year birds to adult birds) has continued to decrease since 2002 (Figure 1). The single Barred Owl capture was a hatch year male; this number is down from eight caught in 2004.

Discussion

Annual fluctuations in migrant Northern Saw-whet Owl numbers have been observed in eastern North America. However, this usually involves a pattern of several years with relatively stable numbers followed by an "irruptive event" where the number of birds captured increases by four fold or more.

Figure 1. Age structure of Northern Saw-whet Owls sampled during the fall at Rocky Point, 2002- 2005. The three age classes are HY: Hatch Year birds which are young of the year, SY refers to Second Year birds that are at least one year of age, and ASY are After Second Year birds that are at least two years of age.



Conclusions

The capture rate of Northern Saw-whet Owls at Rocky Point has been relatively consistent between 2002 and 2004; averaging 0.38 birds/net hour. The decrease in the 2005 capture rate to 0.11 birds/net hour may indicate that a relatively large population adjustment occurred sometime between the fall of 2004 and 2005. The fluctuations in numbers as noted above generally occur in an "irruptive event"; the bulk of the birds being hatch year females. In the years following the irruptive event, capture rates and age/sex structure generally return to normal (Brinker *et al*. 1997). Results from the owl monitoring at Rocky Point suggest that the population of Northern Saw-whet Owls migrating through coastal B.C. have population cycles that may differ from population dynamics elsewhere in North America.

References

Brinker, D. F., K. E. Duffy, D. M. Whalen, B. D. Watts and K. M. Dodge 1997. Autumn Migration of Northern Saw-whet Owls *(Aegolius acadicus)* in the Middle Atlantic and Northeastern United States: What Observations from 1995 Suggest. In Duncan J. R., D. H. Johnson and T. H. Nicholls, Eds. Biology and Conservation of Owls of the Northern Hemisphere: 2nd International Symposium; 1997 February 5-9; Winnipeg, MB. USDA Forest Service Gen. Tech. Rep. NC-190, Pp 74-89.

2005 Rocky Point Bird Observatory Society Activities

5. VICTORIA AND SOOKE CHRISTMAS BIRD COUNT
Project Leader: David Allinson
Location: Rocky Point, Mary Hill, Albert Head and Heals Rifle Range

Introduction

Since 1900, the Christmas Bird Count (CBC) has become an annual event attracting thousands of birders across North America to census winter bird populations within a local 24 km circle. Long-term trends are analyzed and compiled now for more than 1700 counts by the National Audubon Society and Bird Studies Canada. However, significant habitats found on Department of National Defence properties were usually off-limits to Victoria and Sooke CBC's compilers. For the third year in a row, ESAC Permit P003-05 provided access for members of the Victoria Natural History Society on the Victoria and Sooke CBC's into four key DND sites.

Study Area and Methodology

A winter bird survey was carried out in December 2005 at Albert Head, Heals Rifle Range, Mary Hill and Rocky Point. Albert Head and Heals Rifle Range were covered during the Victoria CBC on December 17th, 2005, while Rocky Point and nearby Mary Hill were covered during the Sooke CBC on December 26th, 2005.

Results and Discussion

In the past, the Albert Head site has proven to be rich in bird diversity with as many as 70 species using the area in winter both for shelter and feeding. In particular, terrestrial and pelagic species are well represented here. This year Albert Head produced 50 species, which is down from the previous two years, but not surprising given the cold and windy weather conditions. Total individuals recorded on the grounds were consistent with the previous two years. Highlights this year included locally uncommon winter birds such as Turkey Vulture, Peregrine Falcon, Spotted Sandpiper, Townsend's Solitaire, and Hermit Thrush. The Heals Rifle Range site is only one section within the Butchart Gardens-Northern Highlands sub-area within the Victoria CBC count circle. While an average number of species were recorded in 2005 (20), the number of individuals was quite low (86 birds within the range). Birds of interest recorded here included Cooper's Hawk, Barred Owl, and Lincoln's Sparrow. Albert Head and Heals Rifle Range combined for 56 species and 4339 individuals in total (representing 42% and 7% respectively of the total numbers recorded during the Victoria CBC). Note that the 2005 Victoria CBC managed to place second overall in Canada with 133 species (after setting a new Canadian record in 2004 with 154 species).

Rocky Point and Mary Hill – By comparing the results from these two subareas to the entire Sooke CBC, indicates their importance and significance. Mary Hill produced an impressive 28 species and three locally uncommon winter species were tallied there (Northern Pygmy-Owl, Turkey Vulture, and Hermit Thrush). Rocky Point produced 58 species, including Golden Eagle, Turkey Vulture, and Herring Gull. The two sites combined for 66 species and 5318 individuals. Unfortunately, for comparison the final figures for the Sooke CBC were not available at time of writing this report.

The 2005 CBC results from these four sites produced 75 species and 9657 individuals. It is quite evident that these sites are worth continued coverage to produce long-term trends.

My thanks to CBC compilers Ann Nightingale (Victoria) and Denise Gubersky (Sooke) for their assistance in preparing this report.

2005 Rocky Point Bird Observatory Society Activities

6. WESTERN BLUEBIRD NESTBOX PROJECT 2005

Project Leader: Naira Johnston
Location: Rocky Point

The Western Bluebird nest-box project succeeded in establishing ten sites on and around southern Vancouver Island in 2005. Of the ten sites, two were located on DND property, one at Rocky Point and one at CFMETR Nanoose. The other sites are located in three Victoria CRD Parks, on Salt Spring Island, Galliano Island, Mount Tzuhalem, and Mount Finlayson.

Six nest-boxes were affixed to trees in the 'west meadow' at Rocky Point. Nest-boxes were attached to trees in the open meadow using zap-straps. The zap-straps were nailed into the back of the boxes, then fastened around the trunk of the tree at eye level. Most of the boxes were oriented facing away from prevailing winds, which meant south-east facing. With time the zap-straps will degrade and eventually break so that no harm will be done to the growing trees.

Species recorded in and around the nest-boxes were House Wren and Chestnut-backed Chickadee. Western Bluebirds did not use any of the nest-boxes this year, however an estimated twelve birds were observed investigating the boxes at Rocky Point on 17 February, 2005. Over the season there were 8 sightings of Western Bluebird flocks in the Georgia depression (which includes the Olympic Peninsula), 4 of which occurred in the southern Vancouver Island/Gulf Island region.

Rocky Point is likely an important area to Western Bluebirds. Historically Rocky Point served as an overwintering site. It is believed that birds from the flourishing population at Fort Lewis, just south of Seattle Washington, are venturing northward and the large open meadows of Rocky Point offer a potentially important breeding opportunities in a strategic location. Consequently, we feel that it is important to maintain (and monitor) the nest-boxes at Rocky Point to accommodate the assumed expanding Washington Bluebird population.

A funding proposal for the 2006 season will be submitted to Ecoaction under the auspices of The Nature Conservancy whom are overseeing the project. The Rocky Point site requires little input due to the organized efforts and organization of the RPBO. The project is set to continue for several years with the guidance of Trudy Chatwin, Rare and Endangered Species Biologist for B.C. Ministry of the Environment. All data collected by the RPBO volunteers will be sent to Trudy.

7. QUANTIFYING THE QUALITY OF STOPOVER SITES DURING FALL MIGRATION

Project Leader: Dr. Lesley Evans Ogden, UBC Centre for Applied Conservation Research
Location: Rocky Point

Summary

Over the past two fall migration seasons Dr. Lesley Evans Ogden has been investigating the importance of high versus low elevation habitats as stopover sites for migrating birds. Little is known about the ecology of high elevation stopover sites, despite the fact that high elevation habitats represent approximately 50% of B.C. For long-distance migrants, mortality rates during migration are significantly higher than at any other time during the annual cycle, and successful refueling at stopover sites en route is crucial. During stopovers birds feed voraciously, accumulating fat which fuels onward migration. The rate at which birds can accumulate fat determines the length of time spent at a stopover site, the amount of fuel with which they depart, the speed of migration, and ultimately their chance of survival. RPBO is one of four B.C. sites (two high, two low) where I am investigating habitat quality by assessing physiological condition of birds. Analysis of plasma from a small blood sample taken from each bird provides an index of mass gain or loss. By amassing this information for all birds captured at each site, this fattening index provides an indicator of habitat quality. Laboratory work is in progress for samples collected in 2005, but for samples collected in 2004, triglyceride levels (an indication of fat gain) were significantly different between sites, and indicated that birds are fattening more quickly at high elevation sites. However, in terms of the ability to fatten, the measured plasma metabolites and visible fat scores of birds suggested that habitat quality at RPBO was superior to the low elevation research site (Maplewood Flats) in the Lower Mainland. Previous studies at high elevation in eastern North America suggested that high elevation sites were poor quality fall stopover sites, so the preliminary findings of this research imply that things may be quite different on the west coast. This research suggests that high elevation sites in B.C. are important stopover habitats and that conservation of such sites may be important to ensure healthy populations of migratory birds.

8. A PILOT STUDY TO DETECT WEST NILE VIRUS IN MIGRATORY BIRDS ON SOUTHERN VANCOUVER ISLAND, B.C.

Project Leader: Dr. Muhammad G. Morshed, B.C. Centre for Disease Control

Location: Rocky Point

Summary

A pilot study to detect West Nile virus in migratory birds was carried out on the southern tip of Vancouver Island, British Columbia in the summer of 2005. The main purpose for the study was to determine if birds migrating along the Pacific Flyway had any current or past infection with West Nile Virus in order to establish if the virus had reached British Columbia. There were 73 feather pulp specimens and 11 sera collected from 76 birds captured at the RPBO between July 25 and August 29, 2005. All the specimens were shipped to Zoonotic Diseases and Emerging Pathogens Laboratory, B.C. Centre for Disease Control, for testing. No West Nile virus RNA was detected in any of the 73 feather pulp specimens tested by Taqman Real Time Polymerase Chain Reaction (RT-PCR) and all serum tested to determine the antibody against West Nile virus were also negative.

We also retrieved 67 ticks (all *Ixodes auritulus*) from passerines captured at Rocky Point in 2005, in order to test for *Borrelia*; the causative agent of Lyme disease. Sixteen of the 67 ticks were alive; from those 16 we found 4 live cultures of *Borrelia spp*. Of the 51 dead ticks, three turned out to be PCR positive for *Borrelia*. Further work is underway to characterize these isolates.

Monitoring of Winter Moth *(Operophtera brumata)* and the Parasites Introduced for its Control

Imre S. Otvos

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Permit #: *P031-05*
Location: *Naden*

Start Date: *1 February 2005*
Completion Date: *31 December 2005*

Introduction

The winter moth *(Operophtera brumata)* is an introduced pest that originated in Europe, where it mainly attacks fruit and deciduous trees. It was first reported from Nova Scotia in 1949, and was first positively identified in the Victoria area in 1976. By 1977, this insect defoliated over 120 km^2 on southern Vancouver Island. Its principle host on southern Vancouver Island is the Garry Oak *(Quercus garryana)*, a unique tree with restricted distribution, that is the dominant species in a threatened habitat. In addition, the introduction of winter moth also posed a threat to the fruit growing regions of B.C.

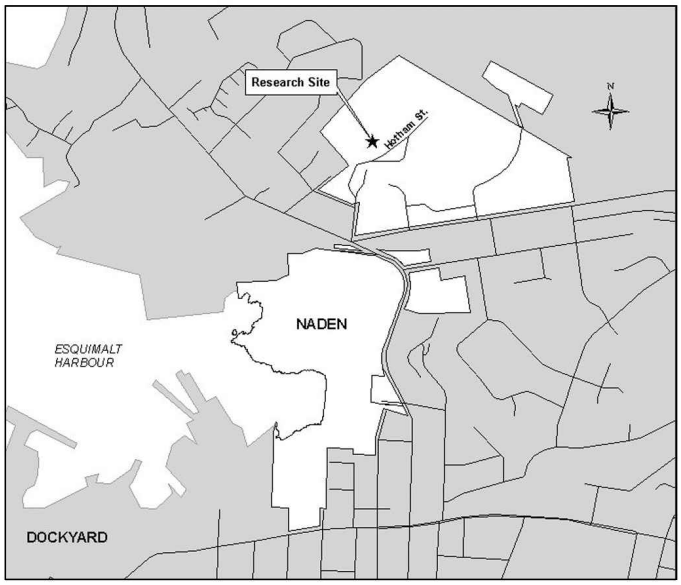
In the late 1950s and early 1960s, a highly successful biological control program was conducted in Nova Scotia, during which six parasitoid species (three parasitic wasps and three parasitic flies) were introduced from Europe. Of these six species, two species became established and were credited with controlling the winter moth in Nova Scotia. Following this example, in 1979, the Canadian Forest Service commenced introduction, both from Europe and from Nova Scotia, of the two natural enemies of winter moth that proved successful in Nova Scotia. These two natural enemies, a parasitic wasp, *Agrypon flaveolatum*, and a parasitic fly, *Cyzenis albicans*, were released over a four-year period at a total of 33 different locations in the Victoria area. One of these locations was located in a Garry oak meadow near the (now demolished) Officer's Mess on Hotham Street. Following the completion of the release program in 1982, a monitoring program was initiated at several Garry oak stands to track the success of the introduction of these natural enemies and the impact of the newly established parasitoid species. A prerequisite for conducting research at any DND property is to obtain a permit to collect the insects, and prepare an annual report.

The objective of this study is to monitor the population density of winter moth and determine percent parasitism by the introduced parasites at Hotham Street.

Study Area and Methodology

Two sampling methods were employed on the Naden property along Hotham Street (Figure 1) to monitor winter moth population and to measure the interaction between the host and the parasitoids.

Figure 1. Winter moth monitoring plot, Hotham Street, Naden, Victoria.



Monitoring of Winter Moth *(Operophtera brumata)* and the Parasites Introduced for its Control

Winter moth population density:

Winter moth population densities were determined by making collections of 20 branches from four randomly selected oak trees (five branches per tree) from several sampling locations, including the Naden site. Different trees were randomly selected for sampling every year at each of the permanent sample locations. Due to abnormally warm spring temperatures in 2005, branch samples, normally collected in early to mid May, were collected during the last week of April. The branch samples were collected when winter moth larvae had reached late 3rd or early 4th instar (when the larvae were still feeding). A pole pruner with a basket attached below the cutting head was used to collect each oak branch that had newly flushed leaf clusters. The branch, approximately 45cm long, was cut so that it fell into the basket, and any larvae that were dislodged were retained in the basket. The branch was then cut into smaller pieces and placed into a 20lb brown kraft paper bag along with the contents of the basket. The paper bag was then sealed, taken to the Pacific Forestry Centre and stored at -20˚C to kill the larvae and prevent discoloration of the larvae (discoloration would prevent accurate identification of the larvae) until the branches could be processed (i.e. counting the number of winter moth larvae, leaves and leaf clusters on each branch). Winter moth larval densities were expressed as the number of larvae per leaf or leaf cluster to monitor changes in the winter moth population over time.

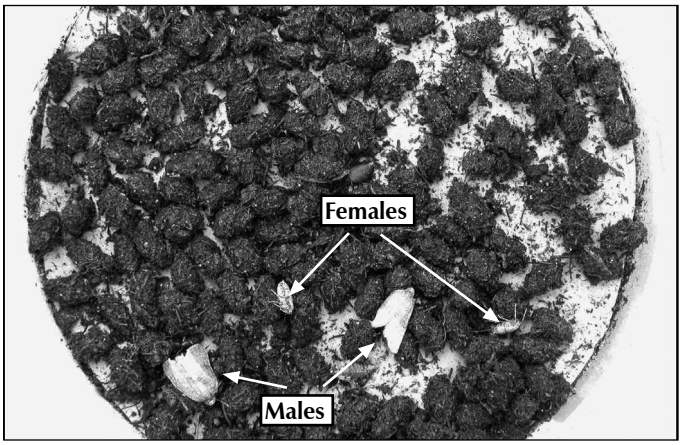
Percent parasitism:

Parasitoid populations were monitored by collecting mature larvae just before they dropped to the ground to pupate in the duff layer. The collected winter moth larvae were reared in cages in the laboratory on Garry oak branches, collected at other locations, until they dropped into the substrate (peat moss spread across the bottom of the cage) to pupate. This was necessary because the parasitoid larvae hatch and feed inside the host pupae, and cannot be identified until they complete development during the fall and winter months.

Trees were selected at random at the permanent sample location. A large (2m x 3m) white sheet was placed on the ground under the lower branches of the randomly selected trees, and a 2m pole was used to beat all the branches located over the sheet to dislodge the larvae from the lower branches of the tree. This procedure was repeated until either about 200 larvae were collected, or 1 hour of collecting larvae had passed. All of the larvae that had fallen on the sheet were collected and placed in a plastic bucket containing some oak foliage and a layer of moist peat moss in the bottom for the mature larvae to pupate in. Once the larval collection at the location was completed, a plastic lid with an 8 cm diameter hole cut in it (the hole covered with mesh) for aeration was placed on the bucket, and the insects were transported back to the Pacific Forestry Centre for rearing at room temperature.

The winter moth larvae were reared in these buckets until they spun down into the peat moss and pupated. Once the larvae finished pupating (at the beginning of June), the pupae were left undisturbed in the buckets for at least a week so the cuticle could harden and the cocoons containing the larvae could be handled without damaging them while they were being removed from the peat moss. The peat moss was removed from the buckets and sieves were used to separate the winter moth cocoons from the peat moss, frass and oak leaf debris. The cocoons were placed in large (150x20mm petri dishes) containing a layer of moist sand covered with a filter paper (Figure 2). The filter paper and cocoons were moistened regularly with a 1% sodium proprionate (anti-fungal) solution, as required, to prevent desiccation of the pupae in the cocoons. The pupae were reared at room temperature until mid-October, then transferred to a growth chamber set at 5-8˚C and reared until the spring, when the parasitoids will emerge. Adult moths started emerging around mid-November (Figure 2) and finished emerging in mid-December.

Figure 2. Winter moth adults emerging from cocoons after rearing in a petri dish. Note that the female moths have short, non-functional wings. Only the adult male moths can fly.



Monitoring of Winter Moth *(Operophtera brumata)* and the Parasites Introduced for its Control

Results

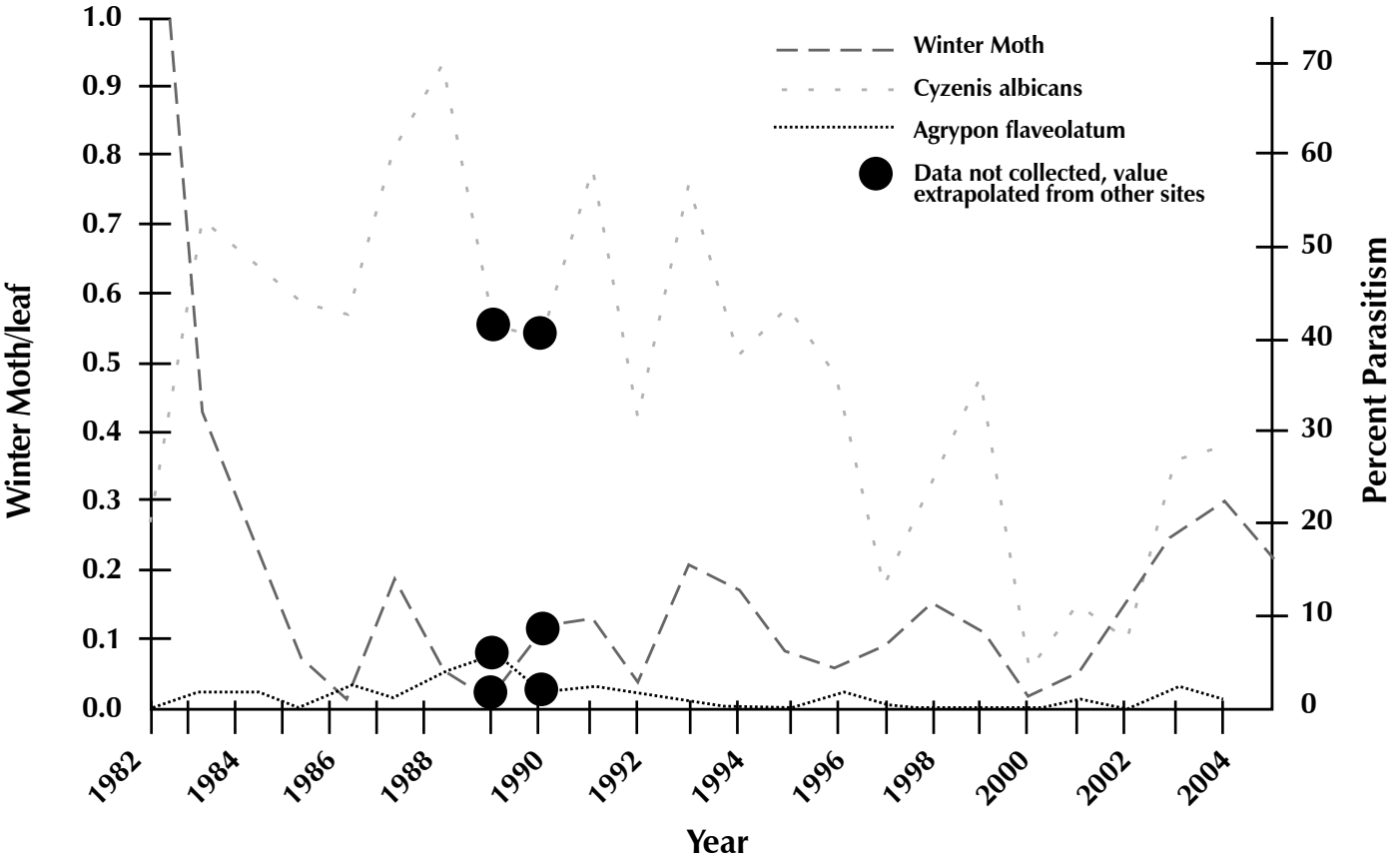
In 2005, at the Naden site (DND), winter moth population densities remained the same as in 2004, averaging 0.12 larvae per leaf. This was about half the overall average for the Greater Victoria area, which averaged 0.30 and 0.22 larvae per leaf in 2003 and 2004, respectively (Figure 3). The higher population densities in the Greater Victoria area caused some highly visible defoliation (damage) of the leaves. On the other hand, damage caused by the lower population densities at the Naden site could only be seen close up, the leaves having "shot-gun" type holes and no discoloration of the damaged leaves.

Percent parasitism by both parasitoid species, *Cyzenis albicans* and *Agrypon flaveolatum*, will be determined in the spring of 2006 when the overwintered parasitoid adults emerge.

Parasitism by the more important parasitoid, *Cyzenis albicans*, at the Naden site decreased from 21.2% parasitism in 2003 to 15.0% parasitism in 2004. We have no explanation for this decline. In the Greater Victoria area, percent parasitism by *Cyzenis albicans* remained at about the same level increasing slightly from an average of 26.7% in 2003 to 28.3% in 2004 (Figure 3).

The pattern of parasitism by the less important parasitoid, *Agrypon flaveolatum*, is more varied. It parasitized 0.5% of winter moth collected at the Naden site in 2003 (adults emerged in spring 2004), which is the first time this parasitoid had been collected at the Naden site since 1998. However, in 2004, *Agrypon flaveolatum* was not recovered at this site. This in itself was not unexpected, because parasitism by this parasitic wasp has been quite low at all six monitoring sites over the years. In the Greater Victoria area in 2003, parasitism by *Agrypon flaveolatum* averaged 1.8%, while in 2004 it averaged 1.0% (Figure 3).

Figure 3. Winter moth population density and percent parasitism at the Naden site, Victoria, B.C., from 1982-2005



Monitoring of Winter Moth *(Operophtera brumata)* and the Parasites Introduced for its Control

Discussion

Winter moth populations at the Naden site were lower in 2004 and 2005 than the regional average, but this is not unusual. Both winter moth and parasitoid population densities have been consistently lower at the Naden site than the overall host and parasitoid population levels for the Greater Victoria area since 1991. Winter moth populations during 2004 and 2005 were the highest recorded in the last 12 years.

Parasitism by *C. albicans* was also higher at both the Naden site (21.2% and 15.0%) and throughout Victoria as a whole (26.7% and 28.3%) for 2003 and 2004, respectively. In 2005, there was a slight decrease of winter moth populations in the Greater Victoria area, compared with the previous year, and the 2003 and 2004 data suggest that parasitism by *Cyzenis albicans* has stabilized at around 26-28%.

Parasitism by *Agrypon flaveolatum* was low in 2003 and 2004, and is likely to remain low (about 1%), as this parasitoid has never caused more than 6% parasitism in a single year in B.C. since its introduction 25 years ago.

At this time we cannot make any long-term predictions on winter moth populations and the associated parasitoids, except that it appears an equilibrium has been reached between the host and its introduced parasitoids. Most likely, the introduced parasitoids will never completely eliminate the winter moth. It is also likely that the current low fluctuations will increase in amplitude from time to time to the point where winter moth populations will temporarily "escape" from its parasitoids and cause light to moderate defoliation of Garry oak in localized areas in Greater Victoria.

In conclusion, monitoring of winter moth and its parasitoids show that the introductions of the two parasitoids, *Cyzenis albicans* and *Agrypon flaveolatum*, particularly the former, has resulted in control of the introduced winter moth in the Greater Victoria area. However, eradication programs conducted against both Asian and European strains of gypsy moth in recent years in the Greater Victoria area have made it difficult to predict with any certainty when, and at what host density levels, the winter moth and its parasitoids will reach an equilibrium. In these eradication programs, the bioinsecticide, *Bacillus thuringiensis subsp. kurstaki (Btk)*, a naturally occurring soil bacterium, is used. Although this bioinsecticide has a much narrower target range than chemical insecticides, it still affects a number of Lepidoptera species, including the winter moth. This was observed in the years following the eradication program. Therefore, it is important to continue monitoring these insects. Continued monitoring will not only reveal if the host-parasitoid complex has reached an equilibrium or not, but will also show how this equilibrium is affected by the periodic use of *Btk* to prevent the establishment of another invasive species, the gypsy moth (be that either the European or Asian strain), on the west coast.

The successful introduction of parasitoids and subsequent control of the winter moth in eastern (Nova Scotia), then western Canada (Victoria) has attracted international interest. As a result of this highly successful program, Dr. J. Elkinton, University of Massachusetts, initiated a parasitoids release program for control of winter moth in the eastern United States, where the winter moth was recently introduced and is causing significant damage in New England. Dr. Elkinton visited our laboratory in the spring of 2005 to learn about our sampling and successful rearing techniques, both for the winter moth and its parasitoids. In a cooperative project, about 1,000 parasitized winter moth pupae were shipped to the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Service (APHIS-PPQ) for rearing of the parasitoids for release in Massachusetts in 2005. A similar but larger shipment is planned for 2006. In both cases the winter moth obtained for shipment were not collected at the Naden site (DND), but at other locations in the Greater Victoria area, where parasitism is higher. We predict that the winter moth in the northeastern United States will also be controlled by the introduction of these two parasitoids. If this third program is successful, as predicted, it will confirm that classical biological control is still the best method for controlling this introduced, exotic pest.

Purple Martin *(Progne subis)* Origins and Relationships

Cam Finlay[1] and Laura Darling[2]

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Permit #: *P044-05*
Location: *Colwood*
Start Date: *12 April 2005*
Completion Date: *03 August 2005*

Introduction

The Purple Martin *(Progne subis)* is at the northwestern limit of its range in British Columbia, hence the low number of pairs and the red-listed designation provincially. In 1984, Purple Martin numbers decreased to less than five pairs in British Columbia. However, by 1995, in response to man-made nest boxes, the total number of known active Purple Martin nests in B.C. increased to 55 (B.C. Ministry of Environment, Lands and Parks, 1997).

In 2005, the Colwood site became one of 32 known colonies of man-made nest boxes in B.C., up from 26 colonies in 2004. Purple Martins in B.C. have been banded with individually numbered bands for the past nine years to determine inter-colony movements and relationships. The nest box colony at the Colwood site is one of the oldest and most productive of all B.C. colonies, with 47 nest boxes occupied out of a total of 62. The objectives for 2005, as part of an on-going nest box monitoring and maintenance program, were to continue banding nestlings in nest boxes; to monitor nest success and productivity; and to monitor for band returns, particularly looking for coloured bands on early returns at the beginning of the season.

Study Area and Methodology

At least 98 percent of all Purple Martin nestlings, produced at known breeding locations in B.C. in the past six years, have been banded with individually numbered coloured plastic and metal bands. These bands are visible and readable with a spotting scope, binoculars and a trained eye. In 2005, Martin colonies throughout southwestern B.C., including the Colwood site, were visited to identify individuals banded in B.C. in previous years. In addition, the number of eggs and/or nestlings were recorded in all accessible nest boxes. Productivity was determined for the whole colony on a per basis, and by nest box type. As in pervious years, adults captured incidentally on the nest were measured and those data were recorded.

Between April and August 2005, 20 visits were made to the Colwood site for observation purposes, to check nest boxes and to band nestlings. All band return records (re-sightings of identified individuals) were submitted to the banding office.

Results

In 2005, 158 nestlings were banded at the Colwood site, up from the 155 nestlings banded in 2004, and 115 in 2003. Of the 62 solid nest boxes at Colwood, 47 contained eggs or young averaging 4.1 young per pair. Thirty-five of the adult birds sighted had previously been banded at the Colwood site and re-observed at other colonies in British Columbia and Washington State. Of the 35 adult birds re-sighted, 13 had been banded at the Colwood site. One of the adult birds sighted at Colwood in 2005 had been banded at the site in 1998, making it seven years old. In addition, three returning birds had been banded at the Colwood site in 1999, two in 2000, 11 in 2003 and 18 in 2004. Twenty-two colour-banded Purple Martins, previously banded at the Colwood site, were sighted at other colonies in the province.

Purple Martin *(Progne subis)* Origins and Relationships

Discussion

Purple Martin nestlings, banded between 1997 and 2005, have been re-sighted at other locations (different from their natal colonies) including at colonies in Washington, Oregon and California. We suspect the B.C. colonies are part of a broader population that ranges from at least Oregon and possibility California north.

Purple Martin populations are increasing in B.C. and U.S. coastal states and their recovery appears to be related to the availability of man-made nest boxes. Our banding returns and DNA research suggest that the Colwood colony is increasing due to immigration of birds from further south in the United States. Preliminary results from DNA analyses indicates an absence of a genetic bottleneck and inbreeding. Instead, there is an extremely diverse genetic makeup due to the contributions made by birds from Washington, Oregon and possibly California.

In 2003, blood was collected from Purple Martins in California; this was the first Martin blood collection since 1999. DNA samples collected prior to 2004 have been analyzed and the analysis of these California samples has been completed. Final results are anticipated in early 2006. The DNA analyses are part of an overall study of the origin of the western Purple Martin including B.C., Washington, Oregon and California as well as various birds east of the Rockies including Alberta, Manitoba, Ontario and Pennsylvania. A clearer understanding of the relationship between the western and eastern Purple Martins is important for the management of this endangered western population.

Purple Martin *(Progne subis)*

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Wildlife Tree Stewardship Initiative: Raptor Nest Monitoring at Rocky Point, Albert Head and Colwood

Gwen Greenwood

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Permit #: *P074-05*
Location: *Rocky Point, Albert Head and Colwood*
Start Date: *01 January 2005*
Completion Date: *31 December 2005*

Introduction

The Bald Eagle Nest Tree monitoring program began on Vancouver Island in 2000 to establish a baseline measure of the success of nesting eagles and to monitor the stability of nest trees. The program also monitors the adaptability of the Bald Eagle (BAEA) to overall habitat changes.

Since 2002, similar monitoring persists under the Wildlife Tree Stewardship (WiTS) Initiative of the Vancouver Island Region of the Federation of B.C. Naturalists. Since its formation, WiTS has been continuously monitoring Bald Eagle nest trees as well as other raptor nests (e.g, Osprey and Red-tailed Hawk). The expansion of the program has augmented the focus to include community education, habitat protection and stewardship agreements.

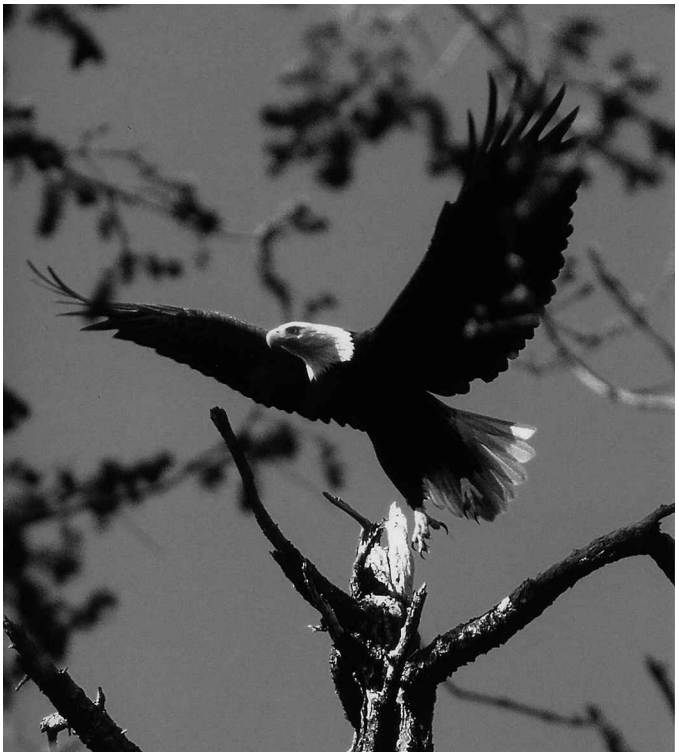
Bald Eagle nest trees at Rocky Point have been monitored since 2001. In 2003, Albert Head was added to the study and in 2004, nests were monitored at Colwood. It is anticipated that the monitoring will continue each year.

The monitoring on CFB Esquimalt property adds to our overall understanding of the productivity of the nests of these large raptors. In the Capital Regional District (CRD), WiTS has 33 volunteer monitors observing approximately 26 Bald Eagle territories, as well as other raptor nests.

The project is supervised by Kerri-Lynne Wilson (FBCN) and Karen Morrison and Terri Martin of the B.C. Ministry of the Environment.

Study Area and Methodology

In 2005, Bald Eagle and Osprey activity was monitored at Rocky Point and Colwood. No raptor activity was observed at Albert Head. Raptor nests were located by sound, with the use of binoculars and telescopes, and by careful observation of their activities. Nests were observed with binoculars and telescopes and all activity was documented. A Bald Eagle "territory" may be 500-1000 metres in radius and is defended for the purpose of hunting and breeding; it may consist of two or three nests in different trees and the nests could be used alternately. All documented raptor activities at Rocky Point and Colwood during 2005 are listed on the following page.



Bald Eagle *(Haliaeetus leucocephalus)*

Wildlife Tree Stewardship Initiative:
Raptor Nest Monitoring at Rocky Point, Albert Head and Colwood

Results

Rocky Point – 2005 Raptor Nest Monitoring Summary - Six Bald Eagle nest trees and one Osprey nest were monitored in 2005.

Nest ID	Tree /Class	Location	2005 Activity	Monitoring Observations
BALD EAGLE				
A (E102-007)	Fallen Douglas-fir	Fossil Point (located just off the East Perimeter Road)	Inactive	This nest tree was uprooted in a storm December 1999.
B (E102-008)	Douglas-fir, decay class 1	Fossil Point (located just off the East Perimeter Road)	Inactive	This nest fledged 1 young in 2001 and was inactive in 2002, 2003 and 2004. In the spring of 2005, nest activity was absent however the nest did appear larger. On May 26th, two adult eagles were observed perched in a Grand Fir adjacent to the nest tree. An adult eagle was also observed perched adjacent to the nest tree on June 29th. There was no eagle activity within the nest during both site visits and a second nest site was not detected. Nest activity and productivity remain unknown.
C (E102-005)	Douglas-fir, decay class 3	Church Hill, on the west side of Whirl Bay	Inactive	The age of this nest is unknown. Apparently the nest was active in 2000 (as reported by fishing boats); however the nest was not active in 2001, 2002, or 2003. The nest fledged one young in 2004. The nest was monitored three times in 2005. BAEA activity was not observed and grass was growing in the nest. Red-tailed Hawks were observed flying close to the nest.
D (E102-026)	Douglas-fir, decay class 2	West side of Church Hill	Inactive	The nest was first discovered in May 2002 and fledged two young. The nest was inactive in 2003; active in 2004 (produced two young) and inactive in 2005. The nest has deteriorated.
E (E102-027)	Douglas-fir, decay class 1-2	East side of Whirl Bay (approx. 70 m inside gate #10)	Inactive	The nest was observed in 2003 and fledged one young. The nest was inactive in 2004. In 2005, adult BAEA were observed flying in the vicinity (Church Island) however the nest was believed to be inactive.
F (E102-028)	Douglas-fir, decay class 4	West side of Church Hill	Active	The nest was discovered in 2003 with one adult sitting on the nest and one in the perch tree. The nest was inactive in 2004. On June 29th 2005, an adult BAEA was observed perched at the nest along with a young fledging.
OSPREY				
Platform Nest	Relocated nest on an alternate pole and platform	CFAD	Inactive	In 2003, the nest was built on a power pole. Once the young fledged, an alternate pole and platform were erected approx. 30 m from the original nest location. In 2004, three young fledged the nest. The Osprey pair returned in 2005 and attempted to rebuild a nest on the power pole. A second nest platform was erected; however, neither nest site was used for breeding.

Wildlife Tree Stewardship Initiative: Raptor Nest Monitoring at Rocky Point, Albert Head and Colwood

Colwood – 2005 Raptor Nest Monitoring Summary
Two Bald Eagle nest trees and one Osprey nest were monitored in 2005. Five site visits were made.

Nest ID	Tree /Class	Location	2005 Activity	Monitoring Observations
BALD EAGLE				
A (no # yet)	Douglas-fir, decay class 2	Northeast portion of the property; the nest is located near Bunker 48	Inactive	No activity was observed or heard at this nest site.
B (no # yet)	Fir, decay class 1	Located approximately 75 metres southwest of Bunker 44	Unknown	In March 2005, an adult BAEA was observed flying to the nest with grass. Subsequent BAEA activity was not observed. A few white feathers were observed in the nest however productivity is unknown.
OSPREY				
0101-004	Nest on a platform located on top of a Douglas-fir tree	Approx. 150 m from "F" Jetty	Active	Osprey activity was not observed in April-May 2005 however two young were observed at the nest site in August. An osprey nest in the Juan de Fuca playing field also produced one young this year, therefore it is apparent that these are two separate osprey territories.

Discussion

On Vancouver Island, Bald Eagle nest productivity has been lower in general, quite drastically in some areas, and moderately so in the CRD. Several nests with chicks fell out of poor quality trees in high winds during the spring of 2005.

Specifically on CFB Esquimalt land, observations of mature and immature Bald Eagles were somewhat lower and nest productivity appears to be down. However, this year has shown how secretive these large birds can be and how we, as monitors, can miss essential activity on our sporadic visits. Some nest sites are also very difficult to observe due to a distant vantage point and an increase in tree growth.

Conclusions

In 2005, there appears to have been only one active Bald Eagle nest at either Rocky Point and Colwood; and only a single juvenile fledged.

While the time spent monitoring has been comparable to previous years, this year's activity was either missed or there was an increase in nest failure (and was noted in many other nests in the CRD area). The availability of an adequate food supply is one concern, as is the number and quality of nest trees in general. The value of the protection the Department of National Defence has afforded these old growth trees at Rocky Point and Colwood is becoming more and more apparent and vital.

Garry Oak *(Quercus garryana)* Acorn Production Study

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Permit #: *P079-05*
Location: *CFMETR, Mary Hill and Rocky Point*
Start Date: *August 2005*
Completion Date: *31 December 2005*

Introduction

The purpose of the Garry Oak *(Quercus garryana)* Acorn Production Study is to determine how common good and bad acorn crops are, the variation in production between places and the environmental and biological factors that influence production. We want to understand the conditions contributing to both individual tree and stand level production including local and regional environmental factors, biological interactions and community succession. The Vancouver Island sites are especially important to the study as they are near the northernmost distribution limit of Garry oak. This report focuses on results from Vancouver Island.

Although Garry oak is widely distributed from southern California to Vancouver Island (Stein 1990), Garry oak ecosystems are rapidly disappearing or changing due to introduction of exotic species, fire suppression and land conversion for agricultural and urban uses (Reed and Sugihara 1987, Agee 1993, Bell and Papanikolas 1997, Ewing 1997, Chappell and Crawford 1997, Tveten and Fonda 1999). Acorns are a rich source of food for many mammals, birds and insects (Barrett 1979, Ryan and Carry 1995) and are important for oak regeneration and dispersal. The regularity of acorn crops, the age when acorns are first produced and the age of maximum acorn production are not known; although it is known that mature trees bear heavy crops on an irregular basis (Stein 1990). High variation in acorn production from year to year, and tree to tree is characteristic of oak species in general (Koenig 1980). There is little published information on acorn crop sizes in Garry oak.

The Garry Oak Acorn Production Study began in 1999, and the first samples on Vancouver Island were taken in 2001. Some Vancouver Island sites have now been monitored for five years. The study follows acorn production from Courtenay, Vancouver Island to northern California with the help of an extensive network of volunteers and cooperating agencies. In British Columbia, our cooperators are Paul Courtin of the B.C. Ministry of Forests, and Kevin Brown, a private contractor. The study is intended to be long-term, with data collection for a minimum of 10 years to allow for meaningful analysis of acorn production periodicity and climatic effects on acorn production. To assist our volunteers and inform the general public, we have created a website with background information, methods and forms used in the survey, and results of the survey - (www.fs.fed.us/pnw/olympia/silv/oak-studies/acorn_survey).

Study Area and Methodology

The number of trees monitored annually on or near Vancouver Island has grown from 54 in 2001 to 230 in 2005. Figure 1 shows the distribution of sample sites with 2005 mean acorn classes for selected sites. At each site 3-16 trees were selected for monitoring.

The acorn survey uses an ocular estimation method developed by Graves (1980) for surveys of oaks in California. Acorns are surveyed in August or September, depending on the site and acorn development. Acorn production is

Garry Oak *(Quercus garryana)* Acorn Production Study

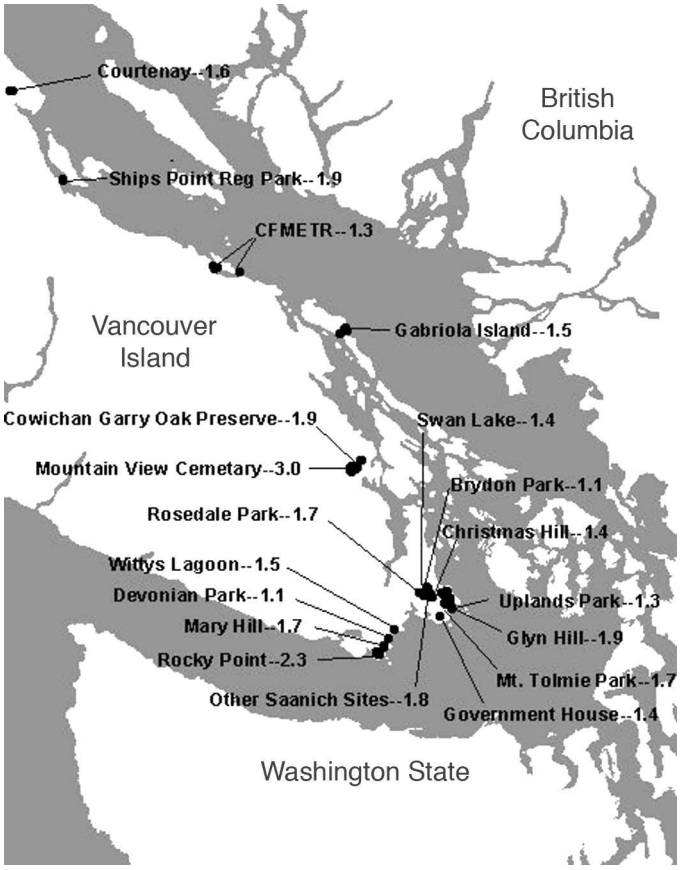
scaled with a 1 to 4 class system, with 1 indicating no acorns and 4 indicating a heavy crop. The method was designed for use with volunteers and tests have shown it to be reliable (Graves 1980). Mean acorn classes are used to indicate relative acorn production between sites, but acorn class increments are not equal. For example, in total acorn counts from a small sample of trees, class 3 trees averaged about 8 times as many acorns as class 2 trees.

Site data such as slope, elevation, aspect, and proximity to water are collected to characterize the physical setting of the tree as it affects tree vigour and acorn production. Also collected are data indicating anthropogenic practices such as irrigation and fertilization, and setting including urban or agricultural. Tree data including diameter at breast height (DBH), tree height, crown diameter, crown contact, and health code allow evaluation of the tree's vigour, size and competitive position. Annual precipitation data (Environment Canada 2005) for 2001-2003 were averaged for weather stations located closest to the sample sites to explore geographically based precipitation effects. Summarized data were not yet available for 2004-2005.

The Vancouver Island data were stratified into 8 analysis groups, including 3 groups based on tree or site conditions and 5 geographically based groups. The groups based on tree or site conditions (juvenile trees, wetland edge trees, and trees growing under cultivated conditions) are drawn from the other locations where such conditions exist. Thus, the geographic groups represent mature trees growing in more or less natural, upland conditions. The geographic groups include three DND properties (CFMETR, Rocky Point and Mary Hill) and two broader groups (northern and southern oak woodlands). The northern and southern oak woodlands are arbitrarily separated at the latitude of Duncan, with Duncan sites falling into the southern group. Rocky Point and Mary Hill, although separately reported, are examples of southern Vancouver Island oak woodlands, while CFMETR near Nanoose Bay would fall into the northern oak woodlands. Juvenile trees are trees with a diameter at 1.3 m (DBH) of less than 5 cm. Cultivated conditions include lawns, parks, gardens and pastures where irrigation, fertilization or stringent overstory or understory competition control are practiced.

Acorns at three DND properties were compared to each other and to other Vancouver Island sites using means and Kruskal-Wallis ANOVA ($p=0.05$). All statistical analysis was conducted with SAS Software (SAS 2002-2003) Comparisons were made on the basis of data collected from 2001 through 2005, but data were not collected in 2002 at CFMETR. Dunn tests were used to locate statistical differences among years or groups when ANOVA indicated significance. While acorn classes are not normally distributed, means of acorn classes increasingly approach a normal distribution as the sample size of the mean increases. Mean acorn classes for the 7 mature groups were modeled on DBH with linear regression. Pearson product moment correlation analysis was used to explore relationships between mean acorn production, site percent slope and mean tree measurements (DBH, height, crown width, and crown contact).

Figure 1. Sample sites on and near Vancouver Island and selected 2005 mean acorn classes.



Garry Oak *(Quercus garryana)* Acorn Production Study

Results

The largest acorn crop since 1999 occurred in 2004 (Figure 2). Large acorn crops were recorded from northern California to Vancouver Island that year. In general, most sites (except the very driest) averaged better production in 2004 than in the other years of the survey. Acorn production from Vancouver Island to southern Oregon fell sharply in 2005. On Vancouver Island, acorn production was significantly higher in 2004 overall and in the southern woodlands than in any other year. Acorn production was as high or higher in all other analysis groups in 2004 as in any other survey year (Table 1).

Figure 2. Mean acorn class for all Vancouver Island sites by year.

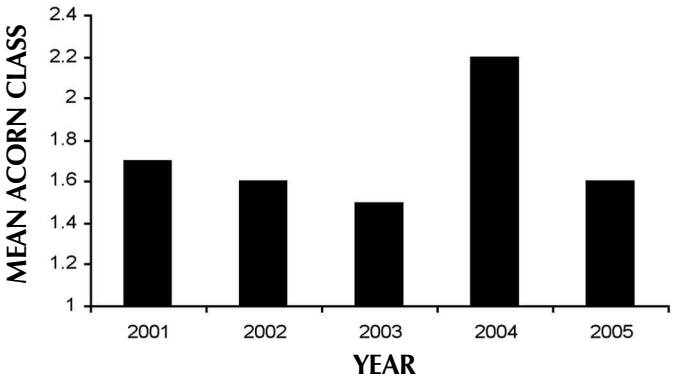


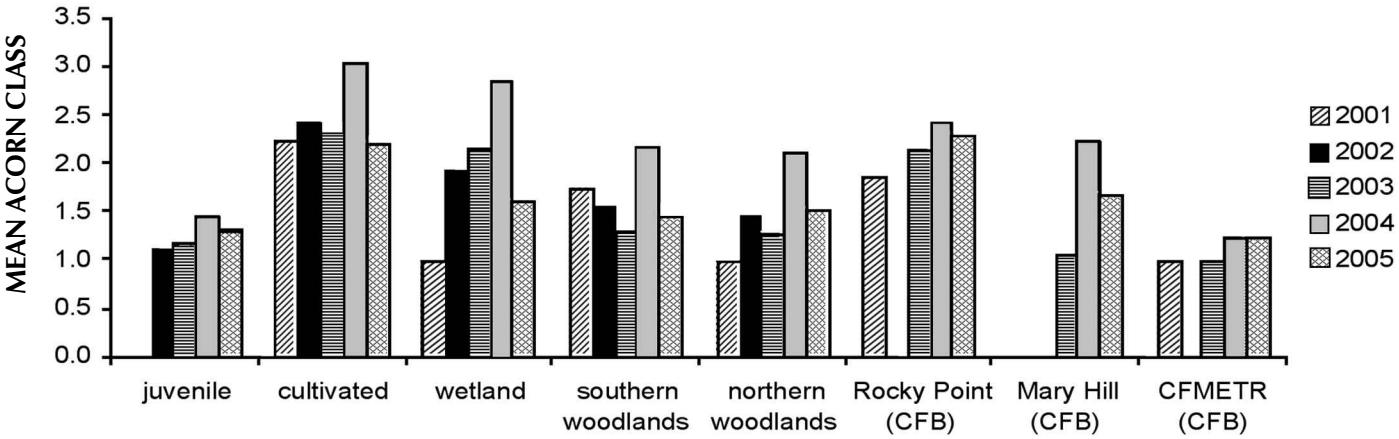
Table 1. Mean acorn codes by year for the eight analysis groups. Dunn Tests indicate the location of significant differences with unique letters. Letters in the year column indicate where analysis groups differ. Analysis group means were significantly different in all years; however the Dunn Test failed to locate differences in 2001. Letters in the Dunn Test column are presented in the order of the years to indicate where years differ (p=0.05).

Analysis Group	2001	2002		2003		2004		2005		Dunn Test (years)	All Years	
CFMETR	1.0			1.0	a	1.3	a	1.3	a	1.1	a	
Juvenile		1.1	a	1.2	a	1.5	a	1.3	a	1.3	a	
Northern woodlands	1.0	1.5	ab	1.3	ab	2.1	a	1.5	a	a,ab,a,b,ab	1.5	ab
Southern woodlands	1.7	1.6	ab	1.3	ab	2.2	ab	1.5	a	a,a,a,b,a	1.6	ab
Mary Hill				1.1	a	2.3	abc	1.7	ab	-,-,a,b,b	1.7	abc
Wetland edge	1.0	1.9	bc	2.2	bc	2.8	bc	1.6	ab		2.1	bc
Rocky Point	1.9			2.1	abc	2.4	abc	2.3	ab		2.2	abc
Cultivated	2.2	2.4	bc	2.3	c	3.0	c	2.2	b	ab,ab,ab,b,a	2.4	c
All groups	1.7	1.6		1.5		2.2		1.6		a,a,a,b,a	1.7	

Wetland associated sites and cultivated sites were the highest producing analysis groups (Figure 3). Cultivated trees produced significantly more than the northern and southern woodlands, juvenile trees or CFMETR. The lowest producing analysis groups are CFMETR and juvenile trees which were significantly lower producing than wetland associated sites or cultivated sites (Table 1).

Garry Oak *(Quercus garryana)* Acorn Production Study

Figure 3. Mean acorn classes for the eight analysis groups by year.



Large trees growing on flat sites tended to be the highest acorn producers. Among the mature analysis groups there were significant correlations between mean DBH and mean acorn class (r=0.93) and between percent slope and mean acorn class (r=-0.82). The mean DBH from each analysis group was a good predictor of mean acorn class over the 5 years of the study.

mean acorn class = -1.012 + 0.0631 * mean DBH

r2=0.86, $p<0.01$, p of intercept = 0.11

Correlations of mean acorn class with tree height, crown width, and percent crown contact were not significant.

Discussion

The DND sites encompass much of the productivity range within the larger Vancouver Island data set. Rocky Point and Mary Hill are representative of the south Vancouver Island analysis group and produce acorns similarly. One Rocky Point tree is in the wetland associated group and a moderately good producer. The CFMETR site at Nanoose Bay is the lowest producing site in the study. It includes trees growing on flat terrain (Wallis Point) and others on steep, rocky terrain (Nanoose Hill) - but acorn productivity has been low at both locales.

The 2005 acorn crop was smaller than that of 2004, and comparable to 2001-2003, suggesting that it was an average or poor year for acorns. Observations in Oregon and Washington suggest a comparable pattern. What is striking about the pattern to date on Vancouver Island is the lack of year-to-year variation in crop size other than in 2004 when the crop was quite large.

The year 2004 had the largest acorn crop so far in the survey from Vancouver Island, Washington and Oregon. In 2004, however, a rainy, cool period began in August. Normally, fall rains return in September or October as they did in all of the other survey years. Greater rainfall and cooler temperatures in August may have reduced drought stress, and promoted better acorn retention, which suggests the importance of summer moisture to acorn production.

Crown contact is a measure of crown competition with surrounding trees. The probability of acorn production decreases with increased crown contact (Peter and Harrington 2002). On average, the Vancouver Island sample has relatively low crown contact, suggesting that crown competition is of secondary importance to productivity in this sample. This was borne out by the lack of a significant correlation between crown contact and acorn production in this data set.

There was a strong association between tree size (DBH) and productivity, although there may be more than one reason for this. The very poor productivity of the juvenile

trees (<5 cm DBH) is clearly related to tree maturity. But, there was also a strong relationship between DBH and productivity among the mature trees. Age data for these trees were not available, so age cannot be ruled out as one factor. However, CFMETR soils are generally shallow and rocky (Paul Courtin pers. com.), precipitation was lower than in the other analysis groups and a portion of the site is quite steep—all factors that suggest drier conditions than elsewhere.

These trees also had the smallest average DBH among mature groups. The three highest producing groups (cultivated, wetlands and Rocky Point) appear to have greater access to water and had the largest diameters of the analysis groups. Trees growing at a wetland edge have an obvious source of water. Cultivated trees may be irrigated at some times in the summer, or have less competition from understory and other trees for soil resources, including water. Also many of the cultivated trees (and non-cultivated trees at Rocky Point) were in the Victoria area where precipitation, at least for 2001-2003, was higher than in most of the locations studied farther north. Thus, it is likely that at least some of the DBH difference is due to moister growing conditions as opposed to age, which resulted in faster growing trees, larger diameters and larger acorn crops.

Acorn production in a tree canopy relates both to the density of acorns in the canopy and the total canopy area. Thus a large tree with a light crop might out-produce a small tree with a heavy crop. Acorn classes relate to acorn density over the canopy, not absolute numbers of acorns borne by the canopy. The density of acorns increases with DBH, but larger diameter trees are also likely to have larger crown areas on which to bear acorns of whatever density. Crown size is a very important consideration where trees are well spaced, but there is still some question as to whether the collective crown area of smaller denser trees produces as well as larger crowned, more widely spaced trees. While there is a significant linear relationship between DBH and mean acorn class it should be remembered that acorn class is not a linear scale; in fact it more closely (but not exactly) resembles an exponential relationship. However, the implication is that acorn density increases considerably with tree diameter.

Conclusions

The Garry Oak Acorn Production Study is an ongoing study so the conclusions stated above are preliminary. However, it appears that the availability of summer moisture is especially important to acorn productivity. This is reflected in the high production of wetland edge sites and probably in the higher production of the cultivated trees. Summer moisture may be increased climatically, topographically (wetlands) or anthropogenically (irrigation and competition control). It appears that the large size of the 2004 crop was most likely due to high summer precipitation. On average, acorn crops on Vancouver Island have not shown much variation other than in 2004. Some sites appear to be better producers than others, and CFMETR was the lowest producing site, probably because of the extremely dry conditions. Juvenile trees (those < 5 cm DBH) produce few to no acorns; however, smaller diameter mature trees also tended to be poor producers (either due to age or site conditions that limit both size and acorn production).

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Table 2. Tree and site characteristics of the eight analysis groups sorted by the mean acorn class over all years. Mean annual precipitation for the period of 2001-2003 is given only for geographically based sites.

analysis group	DBH (cm)	height (m)	crown width (m)	crown contact trees	% crown contact	% slope	precip. (mm)	mean acorn class
CFMETR	34.5	10.8	8.7	1.5	26	30.1		1.1
juvenile	2.8	2.3	1.2	0.0	1	9.1	1010	1.3
northern woodlands	43.7	17.7	9.7	2.0	40	5.5	--	1.5
southern woodlands	40.3	12.3	8.7	1.0	20	9.7	1124	1.6
Mary Hill	41.9	9.8	8.5	1.6	37	19.1	1139	1.7
wetland edge	53.1	14.5	11.0	0.6	14	3.3	1134	2.1
Rocky Point	49.0	16.8	13.1	1.0	14	0.4	--	2.2
cultivated	50.6	14.4	9.9	1.3	39	3.4	1134	2.4
							--	

Royal Roads University - Microclimate Monitoring Station Upgrade at Rocky Point

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Permit #: *P087-05*
Location: *Rocky Point (Forest Canopy Research Station)*
Start Date: *January 2005*
Completion Date: *31 December 2005*

Introduction

This project involves the on-going enhancement of the microclimate monitoring station as part of the existing EMAN site and canopy station to access Rocky Point. This has included the installation of two towers and new solar panels to power the existing instrumentation and support the existing rain gauge; installation of soil moisture probes in the existing EMAN plots; and the set-up of a small storage shed to house some of the existing and future monitoring equipment from the elements. This information will be used to support other research activities relating to climate change and forest ecosystem response.

Forest Canopy Research Station - Rocky Point

Study Area and Methodology

The Forest Canopy Research Station, established in an old growth Douglas-fir forest, is located on the Rocky Point property situated at the extreme southern tip of Vancouver Island.

The general objective of this project has been to enhance the current capabilities of the existing microclimate monitoring station at Rocky Point for the purposes of downloading information from the datalogger on a regular basis using remote technology. Specific activities have included the following:

1. Installation of a solar panel and tower to provide an adequate power supply for additional station equipment installed there;
2. Installation of a second tower to more adequately support the deployment of the existing rain gauge at the site;
3. Set up of three soil moisture probes at selected locations in the adjoining EMAN site;
4. Installation of a small storage shed for the station equipment and the datalogger on the existing platform outside of the EMAN plot;
5. Equip the existing datalogger with a remote communications equipment to transmit data back to Royal Roads on a daily schedule.
6. Regular inspection and maintenance.

Royal Roads University - Microclimate Monitoring Station Upgrade at Rocky Point

Results

As reported in 2004, sensing levels were established at 10, 20 and 30 m elevations for temperature and relative humidity. A 3-metre tripod stand was installed within the salal ground cover to provide a sensing level at the surface of the vegetation cover. Three soil moisture probes were set up at three different profiles within the EMAN site. Two towers were set up on the rock outcrop adjoining the micro-climate tree. The larger tower was set at 19 metres, representing the top of the forest canopy. It was equipped with a 750 watt solar panel. The smaller tower was set at 10 metres high and was equipped with a tipping bucket rain gauge.

Delays were experienced in the work at the microclimate station this year (2005) due to the need for the canopy station upgrade, tree maintenance, and safety training which was not completed until the end of this reporting year. The sensors for installation were also not able to be purchased until 2006.

Discussion

The improvements, once complete will help to support the longer-term project of monitoring climate conditions and atmospheric pollutants (both local and long-range), as well as indicators of environmental health in temperate coastal forest ecosystems. The current upgrade has been slower than anticipated, contingent upon the availability of infrastructure funds, but will likely be completed by summer 2006. A quantum radiation sensor; temperature and relative humidity sensor and a wind speed and direction sensor will be attached to the first (19 m) tower stand in 2006. The second (10 m) tower will also be equipped with an antenna for cellular communication between Royal Roads and the data logger in 2006. The upcoming year should also see all the sensors installed, a new datalogger program written and data being sent directly to RRU. In addition, a lysimeter to measure water balance in the forest microclimate should be completed and installed ready for the winter rain.

A full ambient monitoring station at Christopher Point along the Strait of Juan de Fuca, located just southeast of the microclimate station, is near completion and should be fully operational by summer 2006.

Conclusion

This site constitutes the southern Vancouver Island node of the Georgian Basin, and is part of a larger global environmental monitoring network. The acquisition of data by the microclimate station situated by the EMAN site below the canopy station at Rocky Point will be an important component of this project. The station will also serve as an important vehicle for research, education and extension activities in the near future.

Pilot Monitoring Program for Plethodontid Salamanders on Vancouver Island, British Columbia

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Permit #: *P088-05*
Location: *Rocky Point, Royal Roads*
Start Date: *25 April 2005*
Completion Date: *31 December 2005*

Introduction

A pilot project was initiated in 2002 to monitor population trends of the Western Red-backed Salamander *(Plethodon vehiculum)* at two DND sites on southern Vancouver Island: Royal Roads and Rocky Point. The Western Red-backed Salamander is a terrestrial forest-dwelling salamander that is sensitive to changes in the moisture and temperature regimes on the forest floor. The pilot project followed the recommendations developed jointly by the Ecological Monitoring and Assessment Network (EMAN) and Parks Canada for a national monitoring program for plethodontid (terrestrial) salamanders. EMAN is a national network of long term monitoring and research sites that provide a national perspective on the health of Canadian ecosystems (Zorn *et al.* 2004). EMAN recommends monitoring a suite of integrated forest health indicators in addition to terrestrial salamanders. These indicators include: terrestrial vegetation, worm species richness, lichen abundance and diversity, annual decay rates, downed woody debris, exotic plant abundance, tree health, plant phenology, soil temperature and anuran abundance and phenology.

For more information about any of these indicators visit the EMAN web page at http://www.eman-rese.ca/.

The objectives of this project are: to test the national EMAN plethodontid salamander protocol for use in British Columbia; to collect baseline data in potential reference areas and for use in power analysis; and to collect long-term data on population trends of the Western Red-backed Salamander.

Study area

One of the study sites is in an old growth coniferous forest at Rocky Point. The other site is within a mature second-growth coniferous forest at the Royal Roads University. A total of 45 cover-boards (in three plots of 15 boards) were placed at each site in association with vegetation plots monitored by researchers from the Royal Roads University.

An additional monitoring plot was set up in June 2004 in Butterfield Park on the Saanich Peninsula. Butterfield Park is a small (5.3 ha) and more disturbed park than the DND sites. Sections of the park contain suitable habitat for the Western Red-backed Salamander. Exotic plant species such as daphne *(Daphne laureola)* and English ivy *(Hedera helix)* are prevalent but removal efforts are currently underway.

Methodology

Three plots were set up in December 2002 at Royal Roads and Rocky Point. Each plot consists of 15 cover boards installed around the perimeter of existing EMAN vegetation plots (20m x 20m), which is consistent with the national EMAN/Parks Canada monitoring protocol.

The cover boards are checked annually, ideally three or four times in both the fall and spring. The number of salamanders, their snout-to-vent length, weight and sex are recorded. In addition, other selected macro-invertebrates are also recorded.

Results

Captures of the Western Red-backed Salamander continued to increase at both Rocky Point and Royal Roads. The mean number of captures from spring counts was 10 in 2003 and 17.4 in 2004. Sampling was not completed in the spring of 2005. Means for fall data were 14.3 in 2004 and 25.5 in 2005. The number of captures continues to be higher at Royal Roads than at Rocky Point.

The Butterfield cover-boards were installed in the spring of 2004 and were not checked until 2005. Ten salamanders were recorded in 2005. Four Long-toed Salamanders *(Ambystoma macrodactylum)* were also found using the cover boards.

Pilot Monitoring Program for Plethodontid Salamanders on Vancouver Island, British Columbia

Table 1. Total captures and survey effort in 2005.

SITE	Plots #	ACO *#	Visits #	Total PLVE** #	Mean #
Rocky Point	3	45	1 spring	15	15
Royal Roads	3	45	2 fall	51	25.5
Butterfield	1	16	4 fall	10	2.5

*ACO = Artificial Cover Object **PLVE = Western Red-backed Salamander

Table 2. Demographic data from 2005.

SITE	Adults #				Juveniles #	Hatchling #	Escaped
	Total	Male	Female	Unknown			
Rocky Point	8	3	4	1	5	0	2
Royal Roads	37	20	10	3	13	0	1
Butterfield	7	5	1	1	3	0	0

Results for selected macro-invertebrates (molluscs, carabid beetles, and millipedes) are presented in Tables 3, 4 and 5. Macro-invertebrates were selected based on their use of cover-boards and ease of identification. Several are noted as potential indicator species.

Preliminary results suggest that the Pacific Banana slug *(Ariolimax columbianus)* is more common at Royal Roads than Rocky Point. To date the introduced Chocolate Arion slug *(Arion rufus)* was not found at the old forest site at Rocky Point. The Pacific Sideband snail *(Monadenia fidelis)* was not recorded at either Royal Roads or Rocky Point but is found at Butterfield Park.

Table 3. Total records for invertebrate species recorded at Royal Roads.

Year	Slugs		Snails			Millipede	Carabid beetle
	Ariolimax columbianus	*Arion rufus**	*Haplotrema vancouverense*	*Vespericola columbianus*	*Monadenia fidelis*	*Harpaphe haydeniana*	*Scaphinotus angusticollis*
2003	85	5	11	15	0	6	22
2004	84	6	24	16	0	4	38
2005	37	16	11	6	0	0	3

Table 4. Total records for invertebrate species recorded at Rocky Point.

Year	Slugs		Snails			Millipede	Carabid beetle
	Ariolimax columbianus	*Arion rufus**	*Haplotrema vancouverense*	*Vespericola columbianus*	*Monadenia fidelis*	*Harpaphe haydeniana*	*Scaphinotus angusticollis*
2003	18	0	16	12	0	17	20
2004	5	0	6	7	0	5	8
2005	0	0	2	1	0	1	4

Table 5. Total records for invertebrate species recorded at Butterfield.

Year	Slugs		Snails			Millipede	Carabid beetle
	Ariolimax columbianus	*Arion rufus**	*Haplotrema vancouverense*	*Vespericola columbianus*	*Monadenia fidelis*	*Harpaphe haydeniana*	*Scaphinotus angusticollis*
2005	1	1	11	3	2	0	10

*introduced species

Pilot Monitoring Program for Plethodontid Salamanders on Vancouver Island, British Columbia

The primary objectives of this project are to collect baseline data to enable the development of an efficient sampling design for monitoring terrestrial salamander populations and to monitor terrestrial salamander populations. This project also provides an opportunity to collect baseline data on the use of cover boards by selected macro-invertebrates. However, it is still too early to detect trends.

Cover boards typically continue to improve in effectiveness for the first year or two after installation, as more salamanders find them, and as the cover boards weather (Ovaska *et al*. 2003). Thus several years of sampling are required before trends can be reliably estimated.

Zorn *et al*. (2004) recommend that the first three or four years of data be used to establish baselines and provide information (i.e., coefficient of variation) to facilitate revisiting of survey parameters. A preliminary power analysis was conducted in 2002 and recommended annual sampling three or four times in the spring and fall for at least 15 years. Using an estimated coefficient of variation (CV) of 30% and an alpha level of 0.1, these survey parameters would enable detection of a 10% decline with 80% power (Ovaska *et al*. 2003). Another year of sampling is required before the power analysis can be revisited. If the CV is found to be lower than 30% it may be reasonable to reduce survey effort without compromising power to detect a change. A reduction in survey effort is desirable, because, for various reasons, it is often difficult to sustain long-term monitoring. It may be sufficient to monitor at one time of year, substantially reducing sampling effort. The spring is the preferred time of year as the salamander surface activity period is longer and more reliable (Ovaska *et al*. 2003).

Establishing baselines and long-term monitoring of populations is important to document trends because amphibian populations can rapidly decline, sometimes without notice (Stuart *et al*. 2004). Stuart *et al*. (2004) estimate declines in 43% of all amphibian species worldwide. Declines are attributed to overexploitation, habitat reduction and enigmatic agents, mainly climate and disease such as the chytrid fungus *(Batrachochytrium dendrobatidis)*. To date this pathogen was believed to be confined to aquatic species; however, the first record of an infected wild terrestrial salamander was recorded in 2004 (Cummer *et al*. 2005).

In addition to documenting declines, it also important to correlate cause of observed trends to raise awareness and prompt management action.

Observed population changes at Rocky Point and Royal Roads will be correlated with climatic and vegetation data collected at the EMAN plots.

Over time the results of this monitoring project will provide insight into population trends of terrestrial salamanders and other forest floor organisms. Data from this project will be submitted to a national database (SalamanderWatch) which is currently under development. In this way, data from studies can be pooled to document trends in British Columbia and Canada.

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Wildlife Tree Stewardship Initiative: Bald Eagle *(Haliaeetus leucocephalus)* Nest Tree Monitoring at CFMETR

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Permit #: *P089-05*
Location: *CFMETR*
Start Date: *01 January 2005*
Completion Date: *31 December 2005*

Introduction

As part of a larger project with over a decade of field work on Vancouver Island, the Wildlife Tree Stewardship Initiative (WiTS), which is made up of different naturalist groups, has been searching for, identifying and monitoring wildlife trees, particularly Bald Eagle (BAEA) nest sites. This past season, 19 volunteers from the Arrowsmith Naturalists (Federation of B.C. Naturalists) based out of the Parksville/ Qualicum Beach area, monitored or received reports from over 70 BAEA territories between Deep Bay and Nanoose Bay, Vancouver Island. The WiTS initiative aims to document wildlife usage and locations of wildlife trees to help conserve the remnant habitats of Vancouver Island's altered ecosystems.

Study Area and Methodology

Monthly site visits to CFMETR were made to observe BAEA activity in their territories. Nest trees were located and the base of the nest trees was visited to assess tree health and recent usage of the site. The location of the perch sites was also determined and visited when accessible. Other bird activity in the area was observed, identified and counted.

Results

Territory: E105-092 -Wallis Point (DND Ridge) - Perch area for several raptor species

The perch area was used by several Bald Eagle pairs in 2005. No nests have been found to date. Access to this particular territory was hindered due to difficult terrain with the absence of trails except for a few fire access roads. On each visit to CFMETR, various raptors were observed near the top of the ridge. Species observed include: Bald Eagle, Turkey Vulture, Red-tailed Hawk, Cooper's Hawk, Sharp-shinned Hawk, Common Raven and Northwestern Crow.

Territory: E105-124 – Mid-Nanoose Harbour (DND Tower East) – Not Active - Perch site

This old nest site has been used as a perch area by Bald Eagles for many years. The nest was last active circa 1993. The Bald Eagle pair has since moved to E105-300, approximately 500 m southwest. The old nest tree has yet to be identified, however, several Douglas-fir veteran trees are in the general area above the East Tower. The most likely nest tree is approximately 7 to 10 m high with a broken top and vast lateral branches close to the ground.

Territory: E105-125 -Wallis Point (DND campground) - Not Active

This Class 3 degraded Douglas-fir old nest tree is regularly used as a perch site by several Bald Eagle pairs and immature eagles were seen flying from Southey Isl., Ada Isl., Richards Pt. and two Fairwinds Golf Course territories to perch at this site throughout the year. Approximately in 1994, most of the original nest tree fell, however, a few large branches remain low on the stem. Nearby are two 'enhanced' Douglas-fir trees also used as perch sites and several other perch trees that afford good views of Brickyard Cove and adjacent small islands. This is a heavily forested area with minimal human activity.

Wildlife Tree Stewardship Initiative:
Bald Eagle *(Haliaeetus leucocephalus)* Nest Tree Monitoring at CFMETR

Territory: E105-300 – Mid-Nanoose Harbour (Ranch Point, 600 m East) – ACTIVE, however nest success is unknown.
Incubation occurred but chicks were not seen. A new nest approximately one kilometre northwest upslope on Notch Hill is suspected.

Date	BAEA Activity	Notes
February 12	No BAEAs seen at or near the nest tree. A BAEA pair was perched west and above West Wharf.	Nest in good condition, new sticks visible, white wash & prey items at the base of the nest tree.
March 12	One immature and one adult BAEA were observed in the perch tree 100 m East of the nest.	No new prey items were present at the base of the nest tree. Large forested areas adjacent to the nesting site were surveyed. No new nests were found however many other bird species were observed.
April 12	Incubation in progress. A second adult and one immature BAEA were observed flying together in the area.	Approximately 12 Turkey Vultures (TUVU) were observed in the area.
May 16	One adult BAEA was in the nest and the eggs have most likely hatched. Several adult and immature BAEAs as well as several TUVUs were flying overhead.	
June 11	No adult BAEAs were observed at the nest. One adult BAEA flew by from the perch area on the east side of the meadow. A possible chick was observed in the nest.	Minimal whitewash, a few feathers and feather/bone pellets were present at the base of the nest tree. BAEAs and TUVUs were flying overhead.
July 9	A variety of BAEA plumages were found at the nest site. A BAEA was perched close to shore approx. 300 m west of West Wharf in a Douglas-fir veteran tree below 'The Notch'. A BAEA pair (likely the nesting pair) tolerated two other BAEAs, one white-belly (1-2 y) and one immature (1 y), as they flew near the nest tree. No BAEAs were observed at the nest and no current year chicks were observed or heard throughout this site visit.	This site has been a favored perch site over the last three years. A new nest is suspected upslope. Minimum whitewash and no new prey items were observed at the base of the nest tree.
September 11	Two adult BAEAs circled overhead.	No whitewash or recent prey items were found in the area of the nest tree. Several TUVUs were observed overhead.
October 11 -15	One adult BAEA was perched 300 m north of the nest tree. A total of six BAEAs were observed on the property. At the Nanoose Bay Pentecostal Camp, two adult BAEAs were perched together in a Douglas-fir veteran tree upslope and approx. 300 m west of West Wharf, CFMETR.	No recent prey items or whitewash were present under the nest and perch areas.
November 12	Two adult BAEAs were perched and flying near the nest tree, one immature BAEA was flying overhead.	No whitewash or prey items were present under the nest or favored perch 15 m south of nest. New sticks are visible in the nest.
December 17	Three adult BAEAs were seen flying and perching in the area of the nest tree during the Christmas Bird Count.	Two Great-horned Owls were flying and calling, exhibiting strong territorial defense in the forested area 300 m north of the BAEA nest tree.

Wildlife Tree Stewardship Initiative: Bald Eagle *(Haliaeetus leucocephalus)* Nest Tree Monitoring at CFMETR

Territory: E105-045 - Richard Point Nanoose Harbour (DND Camp) – ACTIVE – one chick fledged sometime after July 9/05. This tree is likely the oldest and largest tree on CFMETR. The nest tree is a Class 1 / 2 Douglas–fir with strong nest supports.

Date	BAEA Activity	Notes
February 12	BAEA adults were observed at the favored perch tree 100 m south of the nest tree.	Whitewash and prey items were present at the base of the nest tree.
March 12	One immature BAEA was flying in the area around the nest tree.	New sticks were visible in nest and the nest appears to be solid and in good condition for this season.
April 12	Incubation in progress. A second adult BAEA was flying overhead.	Several Turkey Vultures were in the area.
May 16	The chicks hatched and an adult BAEA was in the nest guarding and watching. A second adult BAEA was perched 100 m south of the nest.	Several BAEA adults and Turkey Vultures were in the area.
June 11	One chick, approximately 5-6 weeks old, was in the nest.	Both adult BAEAs were in the favored perch 100 m south of the nest.
July 9	A large dark brown chick was ready to fledge and was vigorously flapping its wings.	One adult BAEA was in the favored perch 100 m south of the nest tree.
September 11	No BAEA were seen at or near nest tree.	No whitewash or prey items at the base.
October 11	No BAEA were seen at or near nest tree.	No whitewash or prey items at the base. One immature female Osprey (likely a migrant) was perching, flying and hunting in the area of the nest tree. A total of six adult BAEAs were observed over a four hour visit.
November 12		One adult BAEA was in the favored perch 300 m northeast of the nest. The nest tree and favored perch had no whitewash or prey items.
December 17	No BAEA were seen at or near nest tree.	No whitewash or prey items at the base of the nest tree or the favored perch 100 m south of the nest tree. Five adults and one immature BAEA were observed on the base during the Christmas Bird Count.

Discussion

Bald Eagle nest observations at CFMETR commenced in 2003. Since 2003, several new perch sites have been found as well as numerous new candidates for future nest trees. Familiarity with the areas monitored has increased, therefore allowing the monitoring team to devote more time to bird identification. Since 2004, all bird species seen and heard during the site visits were documented. These bird surveys have lead to a potential future initiative to perform broader bird surveys as well as breeding bird surveys at CFMETR. The mixed forests of CFMETR and the adjacent waters continue to be a rich food source and place of refuge for at least 11 Bald Eagle pairs, their offspring, and the many resident and migrant bird species co-existing in the area.

Conclusions

Due to the continued loss of wildlife habitat to forestry activities and urbanization on the East Coast of Vancouver Island, the preservation of the forest and shoreline of CFMETR and surrounding undeveloped lands is critical to current and future wildlife populations. Long-term limited access or no access to the general public is advised to allow areas for wildlife to exist with little human intervention.

References

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Wildlife Tree Stewardship Initiative:
Bald Eagle *(Haliaeetus leucocephalus)* Nest Tree Monitoring at CFMETR

CFMETR Christmas Bird Count - *The nonmenclature used follows the American Ornithologists' Union (1998, 2002).*

A winter bird survey was carried out on December 18th, 2005 at CFMETR. Two observers participated in a seven hour bird survey. All birds observed and heard in the area were identified and recorded. The following table lists the total number of birds and bird species observed at CFMETR during monthly site visits and the Christmas Bird Count (CBC) in 2005.

SPECIES	# of bird sightings in 2005 (excluding CBC)	# of bird sightings during the CBC
Canada Goose	168	108
Trumpeter Swan	15	18
American Wigeon		127
Mallard	21	63
American Green-winged Teal		12
Harlequin Duck	4	7
Surf Scoter	103	55
White-winged Scoter	29	14
Black Scoter	31	35
Bufflehead	38	28
Common Goldeneye	14	11
Barrow's Goldeneye	84	37
Common Merganser	47	18
Red-breasted Merganser	17	80
Ring–necked Pheasant		1
California Quail	1	
Pacific Loon	193	118
Common Loon	72	50
Pied-billed Grebe	2	1
Horned Grebe	26	30
Red-necked Grebe	12	10
Western Grebe		12
Brandt's Cormorant		2
Double-crested Cormorant	64	39
Pelagic Cormorant	85	62
Great Blue Heron	8	1
Turkey Vulture	31	
Osprey	1	
Bald Eagle - Adults	56	5
- Immatures	29	1
Sharp-shinned Hawk	3	2
Cooper's Hawk	2	2
Red-tailed Hawk	2	2
Merlin	1	
Peregrine Falcon		1
Killdeer		2
Black Oystercatcher	4	1
Black Turnstone		31
Surfbird		3
Long-billed Dowitcher	3	
Mew Gull	64	31
Ring-billed Gull	1	4
California Gull	5	11
Thayer's Gull	5	11
Western Gull		1
Glaucous-winged Gull	118	52
gull sp.	372	55

SPECIES	# of bird sightings in 2005 (excluding CBC)	# of bird sightings during the CBC
Pigeon Guillmot	2	2
Marbled Murrelet	13	3
Rock Pigeon	64	4
Band-tailed Pigeon	3	12
Great Horned Owl		2
Vaux's Swift	5	
Anna's Hummingbird		1
Belted Kingfisher	4	1
Red-breasted Sapsucker	1	1
Downy Woodpecker	2	4
Hairy Woodpecker	2	1
Northern Flicker	40	20
Pileated Woodpecker	8	3
Steller's Jay	3	
Northwestern Crow	116	90
Common Raven	22	4
Chestnut-backed Chickadee	84	53
Bushtit		2
Red-breasted Nuthatch	75	48
Brown Creeper	16	4
Bewick's Wren	4	1
Winter Wren	24	11
Golden-crowned Kinglet	26	25
Ruby-crowned Kinglet	63	10
Townsend's Solitaire		2
American Robin	486	890
Varied Thrush	12	105
European Starling	66	141
Hutton's Vireo	5	
Yellow-rumped Warbler	2	
Townsends's Warbler		3
Spotted Towhee	65	38
Chipping Sparrow	76	
Fox Sparrow	3	3
Song Sparrow	52	17
Golden-crowned Sparrow	3	3
White-crowned Sparrow	3	3
Dark-eyed Junco	374	132
Purple Finch	22	11
Red Crossbill	45	
Pine Siskin	16	
Total Species	**71**	**74**
Total Number of Birds	**3538**	**2804**

 # hours: 7
# of observers: 2
Distance (on foot): 4 km
Distance (by car): 19 km

Notes:
- Canada Geese, Trumpeter Swans, and dabbling and diving duck species were generally observed near the Oyster floats, at the head of Nanoose Bay (west of CFMETR) and scattered in deeper water.
- Low gull observations appear to be the norm for the mid-island region in 2005.
- The European Starling population has increased significantly in 2005.
- Purple Finches were the only winter finches observed in 2005.

Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit

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Permit #: *P090-05*
Location: *CFMETR and Rocky Point*
Start Date: *1 April 2005*
Completion Date: *1 August 2005*

Abstract

Researchers in the Hellmann Laboratory at the University of Notre Dame pursued a third consecutive year of study in Garry oak meadows at Rocky Point and CFMETR/Notch Hill. Seven objectives were pursued by graduate students, field workers, and Dr. Hellmann. These objectives included plant surveys, studies of caterpillar performance as related to local climate, weather monitoring, and genetic and phenological studies of key butterfly resources. All species are recorded during surveys, but experiments and plant studies focus on two focal butterflies: the Propertius skipper (*Erynnis propertius*) and Anise swallowtail (*Papilio zelicaon*). Results from field studies pursued in 2005 are summarized here. The first round of publications resulting from work at Rocky Point and CFMETR is expected within the next 12 months. Studies will continue in 2006.

Introduction

Studies conducted at ESAC sites during the spring of 2005 were a continuation of multi-year research on the butterfly and plant communities of Garry oak ecosystems. These studies take place at a number of sites on southeast Vancouver Island including Rocky Point and CFMETR. This research project was initiated in 2003 as a study focused on the abundance of butterfly populations along a latitudinal gradient. Since then, the program has expanded to include translocation studies that test the local adaptation of two focal butterfly species, analyses of the genetic differences of populations of two focal butterflies and of Garry oak, and surveys of vegetation that examine the dynamics, phenology, and abundance of plants important to butterfly species. After three years of study, a number of subprojects are near completion, and publication in scientific journals is expected within the next year. These include density estimates of *P. zelicaon* and *E. propertius*, translocation experiments of these two species within Vancouver Island, and genetic studies of gene flow in these taxa. Over the coming three years, however, new studies will be initiated, including comparisons of Vancouver Island populations with contrasting populations in the center of the study species' range (in southern Oregon).

Our research informs management and conservation by repeatedly monitoring population size, by uncovering the factors that predict butterfly abundance, and by identifying populations that are genetically distinct. The studies also are designed to test essential questions in global change biology. These questions transcend the particulars of Garry oak ecosystems: Will species shift their geographic distributions under climate change? Which species are likely to shift and which may be constrained – or possibly decline – under climate change? Garry oak ecosystems on Vancouver Island are ideal systems for the study of the impacts of climate change because they represent the edge of an ecoregion. Any range shifts that occur in Garry oak species will take place on Vancouver Island. Where geographic shifts are limited in some species, British Columbian land managers will need to take steps to conserve threatened species or foster their northward migration.

Here we outline studies pursued in the spring of 2005 and report the results of analyses completed by December 20, 2005. The following objectives were the focus of study this year: 1) butterfly surveys; 2) translocation experiment with butterfly caterpillars; 3) plant surveys; 4) incidental butterfly collecting for genetic analysis; 5) weather monitoring; 6) oak leaf collection for phenology, chemistry, and genetic analysis; and 7) damage assessment by oak defoliators.

Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit

Study Area and Methodology

Objectives 1-7 were pursued at both Rocky Point and CFMETR. Methods used to complete each objective are given below:

1) Transect lines were repeatedly walked, and all butterfly species observed along these lines were recorded. Effort spent walking transect lines was standardized by site size so that density comparisons can be made among study sites. This procedure was performed in 2003, 2004, and 2005 (see previous ESAC reports).

2) Eggs were collected from females at Rocky Point and CFMETR, and these eggs were placed in field enclosures. Eggs were either reared at Rocky Point and CFMETR or moved to other locations on Vancouver Island for rearing. In addition, some eggs from other locations were temporarily reared at Rocky Point and CFMETR. Caterpillars were repeatedly measured to calculate a growth rate for each enclosure. Eggs from other locations were removed at the end of July and eggs temporarily removed from Rocky Point and CFMETR were returned. This procedure was performed in 2004 and 2005 (see previous ESAC reports).

3) Transect lines were surveyed one time during the season for plant cover, abundance of camas and other nectar sources, number of *Lomatium* plants, and incidence of Garry oak. The abundance of nectar resources also was repeatedly assessed in subplots throughout the growing season. This procedure was performed in 2003, 2004, and 2005 (see previous ESAC reports).

4) Females that died during egg collection (objective #2) were collected in 2005 and are being used in genetic analyses that are ongoing in the Hellmann Lab at Notre Dame. These samples augment collections made in previous years (2003 and 2004). Samples were recently analyzed to assess genetic diversity within study populations using three mitochondrial genes (CO I, CO II, and ND5). Microsatellite markers are currently being developed to perform similar analyses but with greater statistical power.

5) Ambient temperature and rainfall were recorded in fifteen minute intervals from April through July, 2005. Weather also was monitored in 2003 and 2004 (see previous ESAC reports).

6) Three times during the study season, oak leaves were collected from 20 trees spread randomly across Rocky Point and CFMETR. These leaves were dried to measure water content and digested in the Lab at Notre Dame to study nutrient content. Material from the twigs of these leaf samples were used to assess genetic diversity using microsatellite markers in the Lab at Notre Dame. Samples also were collected at other study sites so that comparisons can be made of leaf chemistry, leaf phenology, and genetic composition. Chemical and genetic analyses are on-going. These procedures were initiated in 2005.

7) Oak leaves from collection trees (objective #6) were surveyed once at the end of the season for damage by herbivores. Percentage of leaf damage and classification of damage type (i.e., species causing damage) were recorded. Possible sources of damage include *Neuroterus saltatorius, Operophtera brumata,* and *Phylloxera glabra*. Other taxa, including *E. propertius*, forage on Garry oak but are not sources of major defoliation. Such species could be adversely affected by major defoliators. This procedure was initiated in 2005.

Top photo: A mid-instar Propertius Skipper *(Erynnis propertius)* caterpillar.

Bottom photo: Cages containing Anise Swallowtail *(Papilio zelicaon)* caterpillars in the field at CFMETR.

Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit

Results

1) Tables 1 and 2 show results from repeated butterfly surveys. Table 1 lists the accumulated species that have been observed at Rocky Point and CFMETR. The right-most column indicates if the species was observed in 2003, 2004, or 2005. Table 2 indicates the presence or absence of species on individual study days. A species is marked as "1" if it was observed on an individual day; the final row indicates the total number of individuals observed over the season. These data can be used to assess flight phenology and can be compared to previous years (2003 and 2004) to indicate changes in phenology and abundance. Relative abundance among years should be interpreted with caution, however, as survey effort varied somewhat among years.

Figure 1 is standardized for among-year variation in sampling intensity for the two focal study species, and this figure shows an estimate of seasonal density for *E. propertius* and *P. zelicaon* across three years of study. These data will be included in a paper currently in preparation that is slated for submission to a scientific journal within the coming months (Hellmann *et al*. in prep). At all sites studied by our group on Vancouver Island, 2004 had the highest density of both *E. propertius* and *P. zelicaon*.

Please also note an erratum in previous reports submitted by our group. We suspect that individuals reported in 2003 and 2004 as Western Meadow Fritillaries (Clossiana epithore) were, in fact, Mylitta Crescents (Phyciodes mylitta). Tables 1 and 2 reflect this correction.

2) Data from larval growth experiments at Rocky Point and CFMETR are shown in Figure 2. Though population size of butterflies was larger (and earlier) in 2004 than in 2005, our focal caterpillars grew faster in 2005 than in 2004 at CFMETR. These data were combined with similar data from other sites to determine if larval growth varies among sites as a function of climatic differences, location within a latitudinal gradient, and site of origin.

E. propertius: In both 2004 and 2005, we found no differences in larval growth among sites for *E. propertius* and no enhanced performance associated with being reared in a caterpillar's native site (data not shown). This result has two possible interpretations. First, caterpillars of this species could be exceptionally plastic showing equal capacity for growth in all environmental conditions. Second, caterpillars of this species could be adapted to the edge of their range as a whole such that their tolerance of conditions at the edge of the range is relatively high (where "edge" is represented by Vancouver Island as a whole). We will not be able to distinguish between these two explanations until we rear caterpillars in locations that are more-distinct than those conditions captured by Vancouver Island alone. Said differently, we need to rear caterpillars at significantly warmer, or more-central, locales in order to interpret the significance of the growth rate values observed on Vancouver Island. We hypothesize, however, that the second interpretation is the correct one as we do see differences in growth among years, suggesting that caterpillars of this species do show some responsiveness to variable climate.

P. zelicaon: In 2004 we found significant differences in larval growth rate among sites for *P. zelicaon* such that caterpillars reared in the warmest locations had significantly faster growth that individuals reared in cooler sites (data not shown). This suggests that this species benefits from warmer conditions such as those climates characteristic of the center of their range or that might occur under climate change. The contrast of this result with that for *E. propertius* suggests that the responses of the two species to warming could differ. (Again, however, further testing over a broader range of conditions is necessary for *E. propertius*.) In 2005, however, no significant difference was seen in growth rate among sites for *P. zelicaon* though sample size was lower than in 2004.

Larval data for the two focal species will be included in a paper currently in preparation that is slated for submission to a scientific journal within the coming months (Hellmann *et al*. in prep).

3) Data recorded from plant transects in 2005 are still being analyzed. However, we do have estimates for *Lomatium utriculatum* (a larval food source for *P. zelicaon*) at both Rocky Point and CFMETR. Though *L. utriculatum* grows in some areas of Rocky Point in relative abundance, it is uncommon in the majority of our butterfly survey areas.

Transect data showed that there were no *L. utriculatum* in 95 one-meter quadrats. Thus, we estimate that no *L. utriculatum* grow in our butterfly survey area of Rocky point. However, one *L. nudicaule* plant was observed in one quadrat. Since the *L. nudicaule* at Rocky Point all grows together in one large patch, direct counts of the population

were conducted and are estimated at 200 individuals. At CFMETR, ~128,200 plants (~4400 plants/ha) are estimated to occur based upon 534 one-meter quadrats placed systematically across the site at 30 meter intervals. These data along with other butterfly resource data collected at the sites will be compared with the abundance of our two focal butterflies to determine if any measures of habitat quality predict butterfly density. In 2003 and 2004, there were only a few occasions when plant values co-varied with butterfly population size. In 2004, for example, *E. propertius* was positively related to forbs coverage ($R2=0.58$, $p=0.10$) and inversely related to shrub cover ($R2=0.57$, $p=0.11$). Interestingly, the density of our focal species was not correlated with abundance of host or nectar plants in 2003 or 2004. We suspect that this will be the case in 2005 as well. This may be because study sites were selected for their overall high-quality; perhaps there is a minimum threshold of resource availability that is necessary. (One exception, however, is a site in central Victoria that has high quality but is devoid of many native butterfly species including *E. propertius*.) Butterfly diversity (at seven study sites) also was not correlated with plant characteristics in 2003 and 2004.

4) Analysis of genetic samples collected for *E. propertius* and *P. zelicaon* is proceeding at Notre Dame. A library enriched for microsatellites has been constructed for each species, and this library is currently being screened for suitable markers. Three mitochondrial genes (CO I, CO II, and ND5) also have been sequenced to identify genetic differences among sites. For *E. propertius*, individuals collected from Rocky Point and CFMETR were found to be similar to individuals collected from Mill Hill (owner: CRD Parks) and a site near Olympia, Washington (owner: Weyerhaeuser). For *P. zelicaon*, individuals collected from Rocky Point and CFMETR were similar to individuals from across the entire species range. The principle motivation for pursuing genetic studies at Rocky Point, CFMETR, and other sites is to examine gene flow from the center of our focal species' ranges toward the periphery of their distribution. Using mitochondrial genes, we found higher rates of gene flow in *P. zelicaon* than in *E. propertius* as we predicted based on differences in their morphology and life history. These data are currently being prepared for publication (Zakharov and Hellmann in prep a). Papers describing the primers that we discover for microsatellites in these species also are being prepared (Zakharov *et al*. in prep; Zakharov and Hellmann in prep b).

Recently, we discovered a highly-divergent form of mitochondrial DNA in some populations of *E. propertius* on Vancouver Island and in central Washington. It is premature to state the source of this haplotype, but we are pursuing additional sequencing studies to investigate its source.

5) Ambient temperature and rainfall were recorded in fifteen minute intervals from April through July, 2005. Figure 3a shows the average weekly daytime temperature (10:00-16:00) at Rocky Point and CFMETR from mid-May through mid-July in 2005. Rainfall data were collected in 2004 and 2005 using tipping-bucket event loggers (Figure 3b). 2005 was significantly wetter than 2004 at CFMETR. Rainfall data in 2005 at Rocky Point were lost due to a malfunctioning data-recorder.

6) Collected twigs have begun to be analyzed in the Lab at Notre Dame using microsatellite primers. An initial set of samples, not including Rocky Point, were used to compare allelic diversity of oaks in peripheral populations (Vancouver Island) and southern populations (southern Oregon). Initial results suggest that populations across the species range harbor a large amount of genetic diversity. Vancouver Island populations are similar to each other, but they differ in some alleles from southern populations. Leaf chemistry also is currently being analyzed in the lab at Notre Dame. Preliminary results indicate considerable differences across time in moisture content (Figure 4); trees at Rocky Point and CFMETR were not significantly different in moisture content than other sites, however. Data for nitrogen and phosphorous content are forth-coming. Any differences observed for oak chemistry among sites will be compared with the genetic data to see if chemical variation follows that of genetic variation.

7) Rocky Point and CFMETR have moderate rates of oak leaf damage due to dominant leaf defoliators (Figure 5). Data classified based on damage type are still being analyzed. One study location in Victoria is the only site that significantly deviates from others in total leaf damage. This site also has experienced defoliating outbreaks from tent caterpillars (*Malacosoma californicum pluviale*) in the past few years and is lacking a population of *E. propertius*.

Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit

Discussion

The studies described above form a multi-faceted program of research centered on butterfly population dynamics, the responsiveness of butterflies to climate and local factors, and studies of populations near the edge of their geographic range. Over the last two years, our work has grown from an exclusive focus on butterflies to greater consideration of plants. The work also has grown from exclusive field-based studies to include genetic and chemical analyses that take place in the Lab. Our work also offers a multi-year perspective, generating one of the most comprehensive and complete programs of Garry oak monitoring anywhere in British Columbia or western North America. The regional scope of our studies also offers individual land-owners perspective on how their site compares to other locales that contain a similar ecosystem or similar species.

A highlight of work to date is accumulated support for our hypothesis that butterflies with contrasting life history traits have differing population dynamics and responses to local climatic conditions at the edge of their range. We also have discovered differences in the flow of genes toward the edge of these species distributions and we have identified locations and regions that are genetically distinguished from other populations. These results will be published in scientific journals in the coming months. Other aspects of our program are just being initiated such as genetic and chemical analyses of Garry oak. Results from these projects will not be ready for publication until additional years of data are collected.

We aspire to continue collaboration with landowners and managers such as ESAC and DND to conserve butterfly species and manage their responses under climate change. To date we have presented results at the Garry Oak Ecosystems Research Colloquium and at the Invertebrate Species at Risk Symposium. Results also have been presented to the Program for Ecosystem Research at the US Department of Energy, a source of funds for the Hellmann research program. Research talks are planned at Michigan State University and at Oak Ridge National Laboratory. These presentations enhance the visibility of Garry oak ecosystems and ESAC.

Several aspects of our research at Rocky Point and CFMETR and other sites on Vancouver Island are nearing their conclusion. Other aspects are evolving and expanding. We anticipate continued research activities at Rocky Point and CFMETR over the coming years.

2005 Participants

Jessica Hellmann, principle investigator
Kirsten Prior, field crew leader
Travis Marsico, University of Notre Dame Ph.D. student
Shannon Pelini (formerly Gray), University of Notre Dame Ph.D. student
Vincent Hellmann, volunteer
Neil Vargas, University of Notre Dame undergraduate

Please do not use these data in any published form without prior written consent. These data were collected by Dr. Jessica Hellmann of the University of Notre Dame, Notre Dame, IN. Field activities in 2005 were supported by the US Department of Energy and the University of Notre Dame.

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Zakharov, E., and J. J. Hellmann. In preparation a. Characterization of microsatellite primers for *Erynnis propertius*.

Zakharov, E., and J. J. Hellmann. In preparation b. Phylogeography of two contrasting butterfly species.

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Table 1. List of species observed at Rocky Point (RP) and CFMETR either from quantitative butterfly surveys or from simple observations made while on-site. The codes 03, 04, and 05 in the right-most columns indicate the year in which a species was observed.

Code	Common name	Latin name	RP	CFMETR
EP	Propertius skipper	*Erynnis propertius*	*03, 04, 05*	*03, 04, 05*
PZ	Anise swallowtail	*Papilio zelicaon*	*03, 04*	*03, 04, 05*
SA	Spring azure	*Celastrina echo*	*03, 04, 05*	*03, 04, 05*
CW	Cabbage white	*Pieris rapae*	*03*	*03, 05*
GH	Grey hairstreak	*Strymon melinus*	*03, 04, 05*	*03, 04, 05*
SO	Sara's orangetip	*Anthocharis sara*	*05*	*03, 04, 05*
AW	Anglewing	*Polygonia spp.*		
MC	Mourning cloak	*Nymphalis antiopa*	*05*	*03, 05*
AS	Arctic skipper	*Carterocephalus palaemon*		
PC	Purplish copper	*Lycaena helloides*	*03, 05*	*03*
LA	Lorquin's admiral	*Limenitis lorquini*	*03*	*03*
RA	Red admiral	*Vanessa atalanta*		*03*
El	Elfin (Western or Moss')	*Incisalia iroides or Icisalia mossii*	*03, 04, 05*	*03, 04, 05*
MC	Mylitta Crescent ***	*Phyciodes mylitta*		*03, 04, 05*
Fr	Hydaspe/Zerene fritillary	*Speyeria hydaspe or Speyeria zerene*	*03, 04*	*03*
Sw	Swallowtail	*Papilio spp.*	*03, 05*	*03, 04, 05*
V	Vanessa	*Vanessa spp.*	*05*	*05*
Tort	California Tortoise Shell	*Nymphalis californica*		*05*
SwT	Western tiger swallowtail	*Papilio rutulus*	*03, 05*	*03, 04, 05*
SwP	Pale swallowtail	*Papilio eurymedon*	*03, 04*	*03, 04, 05*

All identifications made with the use of Guppy, C. S., and J. H. Shepard. 2001. The Butterflies of British Columbia. UBC Press.
*** Misreported in 2003 as Western meadow fritillary, *Clossiana epithore*

Table 2. Butterfly occurrence data for 2005 at Rocky Point (A) and CFMETR (B). Records of presence (indicated with "1") come either from quantitative butterfly surveys or from simple observations made while on site. Records of total observed abundance come from regular transect surveys of each study area.

A. Rocky Point

Date	EP	SA	GH	V	SO	MC	PC	El	Sw	TSw
4/20/2005	1	1	0	0	1	0	0	1	0	0
4/25/2005	1	1	1	1	0	0	0	1	0	0
5/1/2005	1	1	1	0	0	0	0	0	0	0
5/25/2005	1	1	0	0	0	0	1	0	0	0
6/9/2005	1	0	0	0	0	1	0	0	0	1
6/17/2005	0	0	0	0	0	0	0	0	0	1
6/23/2005	0	0	0	1	0	0	0	0	1	0
Total	20	23	3	6	1	1	1	2	1	2

B. CFMETR

Date	EP	PZ	SA	CW	GH	SO	MC	El	Sw	WSw	V	Cr	Tort	PSw
4/22/2005	1	0	1	1	1	0	1	0	0	0	0	0	0	0
4/28/2005	1	0	1	1	1	1	0	1	0	0	0	1	1	0
5/6/2005	1	1	0	0	1	1	1	1	0	0	0	0	0	0
5/24/2005	1	1	1	1	1	1	1	1	0	0	0	0	0	1
6/15/2005	1	0	0	0	0	0	0	0	1	1	0	0	0	0
6/21/2005	0	0	0	0	0	0	0	0	0	1	1	0	0	1
Total:	178	3	15	4	41	24	5	8	2	3	7	5	1	4

Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit

Figure 1. Plot of seasonal density estimates for *E. propertius* (A) and *P. zelicaon* (B) at Rocky Point and CFMETR.

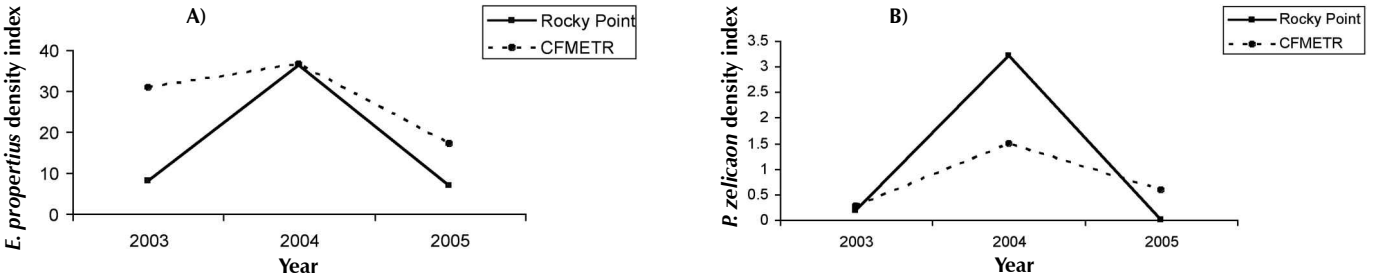


Figure 2. Average growth rate observed for *E. propertius* and *P. zelicaon* in translocation studies with caterpillars in 2004 and 2005 at Rocky Point (A) and CFMETR (B). Growth rate is determined by fitting experimental data with an exponential function; values reported are the exponent of that function.

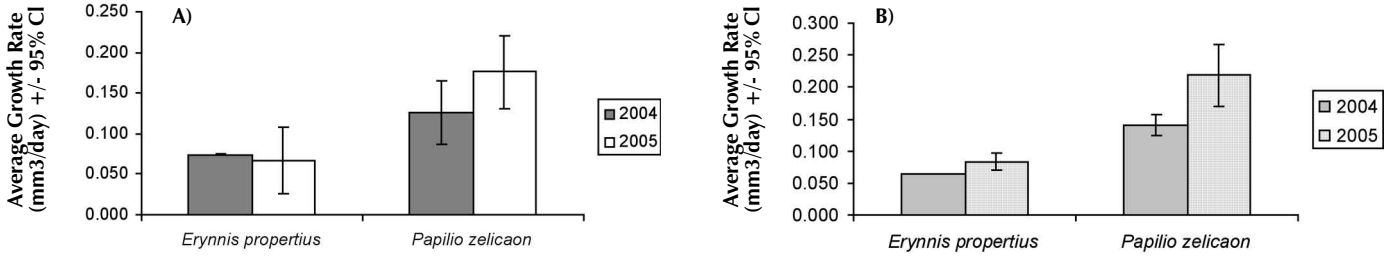


Figure 3. Mean weekly daytime temperature (10:00-16:00) in 15-minute intervals at Rocky Point (dashed line) and CFMETR (solid line) (A) and total seasonal rainfall recorded at Rocky Point and CFMETR (B).

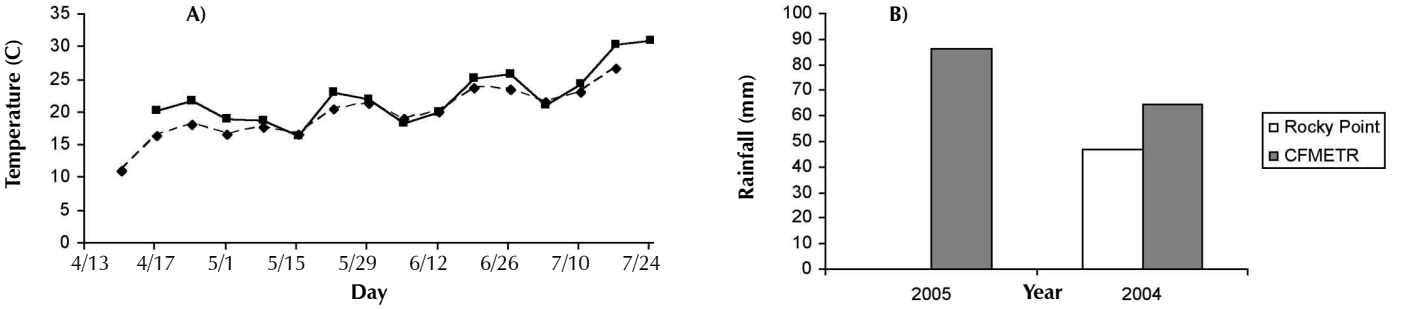


Figure 4. Average percent moisture of oak leaves by month at Rocky Point and CFMETR.

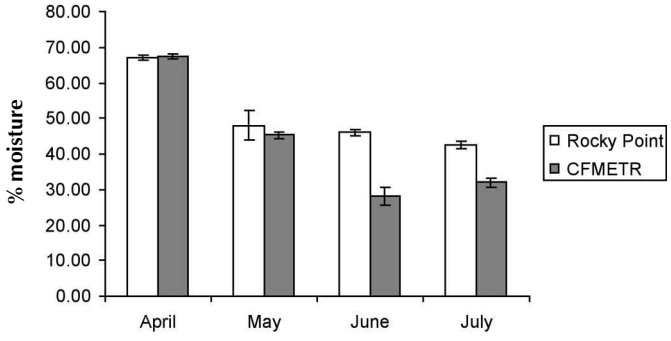
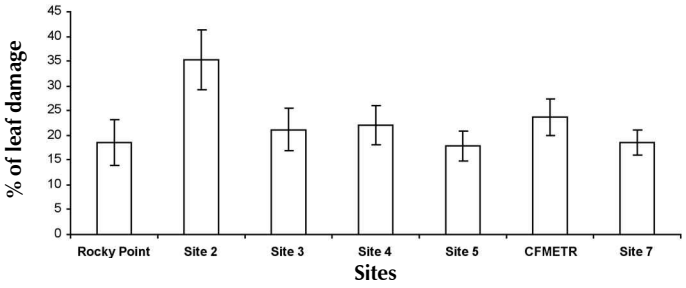


Figure 5. Plot of leaf damage recorded at Rocky Point, CFMETR, and other study sites on Vancouver Island listed south to north. Damage was assessed on leaves collected from trees once during the season.



Sharp-tailed Snake *(Contia tenuis)* Habitat Suitability and Monitoring Project on Federal Lands

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Permit #: *P100-05*
Location: *Rocky Point, Mary Hill, Albert Head, Dockyard, Heals Rifle Range*

Start Date: *01 March 2005*
Completion Date: *31 December 2005*

Introduction

The endangered Sharp-tailed Snake *(Contia tenuis)* is known from only a few localities on southern Vancouver Island and the Gulf Islands, British Columbia. Known Sharp-tailed Snake sites are generally small in spatial extent and the number of snakes appears to be correspondingly low. Since 2003, efforts to locate new populations of the Sharp-tailed Snake have resulted in the discovery of populations on Mary Hill and Heals Rifle Range, CFB Esquimalt lands. The objectives of this study are: to identify potential Sharp-tailed Snake habitat on DND properties; to conduct surveys for the species on identified sites; and to study habitat use and daily activity patterns of the Sharp-tailed Snake on Heals Rifle Range.

Study Area and Methodology

CFB Esquimalt monitoring sites included in this study are Rocky Point, Mary Hill, Albert Head, Heals Rifle Range and Dockyard. Other federal properties located on southern Vancouver Island and the Gulf Islands were also included in this study. In 2005, existing artificial cover objects were monitored at ten sites (Table 1). In addition, night searches were conducted; a harmonic direction finder system and experimental funnel trapping technique were utilized; and the prey base (slugs) was investigated at Heals Rifle Range.

In 2005, existing artificial cover objects on all federal properties were inspected between four and 22 times. The number of inspections varied according to site accessibility. A total of three night surveys were conducted at Heals Rifle Range during the summer.

The Sharp-tailed Snake habitat use is poorly understood, and the only current method to track Sharp-tailed Snake is using the Harmonic Direction Finder technique (Engelstoft *et al*. 1999). An Animal Care permit was obtained from wildlife veterinarian Dr. Helen Schwantje (BC Ministry of Water, Land and Air Protection). Dr. Schwantie's involvement provided the most up to date knowledge about reptile anesthesia to minimize any risk to the snake. A Species at Risk Act permit from the Canadian Wildlife Service was also obtained. Only one captured snake was suitable for the harmonic direction finder technique. The individual snake was kept in captivity for a few days to recover and then released at the same location where it was found. The snake will be tracked to observe its daily and yearly movement patterns and habitat use.

The funnel trapping technique was used at the Heals Rifle Range site to potentially increase Sharp-tailed Snake capture rates. A combination of natural barriers and drift fences were used in conjunction with funnel style traps. Drift fences provide a method of directing the movements of snakes towards a trap. A barrier to the snake's path will cause them to follow along the obstruction looking for an alternative route around it. The traps were made of a wire mesh in the shape of a cylinder with a funnel entrance constructed of the same material. One array of fences and funnel traps was installed on 25 August, 2005, and was kept open between 5 – 8 September and 17 – 22 October.

To compare the availability of potential prey for snakes in natural openings and the adjacent forest, we sampled gastropods (slugs and snails) using cardboard cover-objects along paired transect lines.

Sharp-tailed Snake *(Contia tenuis)* Habitat Suitability and Monitoring Project on Federal Lands

Results

In 2005, existing artificial cover object monitoring on each of the federal properties did not reveal any new Sharp-tailed Snake populations (Table 1). The most common reptiles encountered were the Alligator Lizard *(Elgaria coerulea*; 307 observations) and the Northwestern Garter Snake (*Thamnophis ordinoides*; 221 observations) (Table 1). Fifty per cent (n= 221) of all Northwestern Garter Snakes *(Thamnophis ordinoides)* were found on Heals Rifle Range and Mary Hill, where the Sharp-tailed Snake also occurs. We found the introduced European Wall Lizard *(Podarcis muralis)* on Heals Rifle Range for the first time in the fall of 2005. The initial release of that species occurred in that neighbourhood in the early 1970s (Allan *et al*. In Press) and the lizards have recently been noted to be expanding their range. The implications of the presence of the introduced lizards to the Sharp-tailed Snake are unknown.

There were 40 observations of Sharp-tailed Snakes in 2005, representing 14 individual snakes on Heals Rifle Range and 9 on Mary Hill. On Heals Rifle Range the observations occurred from 27 February to 13 August, whereas all the observations on Mary Hill were in the fall. All three observations on Heals Rifle Range were at night. Searches of the ground surface at night, away from the cover-objects, resulted in the finding of one Sharp-tailed Snake. Five individuals at Heals Rifle Range were recaptured 1 – 4 times in 2005; the longest straight-line distance between captures for these snakes was 31 m. The snakes were found in 8 small forest openings with average dimensions of 25.5 m x 24.7 m. The snakes used 18% of the 94 artificial cover objects present at this site.

We were able to follow one tagged snake with the harmonic direction finder for 5 weeks in June – July (Ovaska and Engelstoft 2005) . The snake moved within and among 3 forest openings and was always concealed, either within a downed log or underground. The straight line path of the snake was 56 m.

No reptiles were found in the traps. Of note is the fact that during this same period, no reptiles were encountered under the artificial cover objects either; that suggests that the snakes may have been inactive then. But none were found under artificial cover objects on the site during the trapping periods, which suggests that the snakes might have been inactive.

The potential prey species, a native slug called *Prophysaon foliolatum*, was relatively abundant in the openings occupied by Sharp-tailed Snakes.

Plans for 2006 include continuing monitoring of priority sites to locate the Sharp-tailed Snake, tracking more snakes with the harmonic direction finder to obtain information on habitat use, and continuing sampling of gastropod prey throughout the year to identify potential foraging areas.

Table 1. Summary of reptile observations under artificial cover objects on DND, Parks Canada and Coast Guard properties in 2005.

Location	Land ownership[1]	# of site	# visit	STS[2] obs	Indiv STS	NWGS[2]	WTG[2]	CGS[2]	ALI[2]	EWL[2]
Rocky Point	DND	11	9	0	0	6	0	0	7	0
Mary Hill	DND	6	11-14	15	9	68	2	0	180	0
Albert Head	DND	4	9	0	0	35	0	0	34	0
Dockyard	DND	1	4	0	0	1	0	0	0	0
Heals Rifle Range	DND	2	10-22	25	14	42	1	0	4	2
Roe Lake	PCA	2	8	0	0	50	8	4	2	0
Mt. Norman	PCA	4	9	0	0	1	0	0	14	0
Greenburn Lake	PCA	1	7	0	0	0	0	0	4	0
Prevost Island	PCA/CCG	4	5	0	0	13	0	0	12	0
Narvaez Bay	PCA	1	8	0	0	5	0	0	50	0
		36		40	23	221	11	4	307	2

[1] DND = Department of National Defence, PCA = Parks Canada Agency, CCG = Canadian Coast Guard

[2] Obs = observation, indiv = individual, STS = Sharp-tailed Snake, NWGS =Northwestern Garter Snake, WTG = Western Terrestrial Garter Snake, CGS = Common Garter Snake, ALI = Alligator Lizard, EWL = European Wall Lizard

Sharp-tailed Snake *(Contia tenuis)* Habitat Suitability and Monitoring Project on Federal Lands

We gratefully acknowledge the Interdepartmental Recovery Fund and the Endangered Species Recovery Fund for providing funding for our projects.

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Juvenile Sharp-tailed Snake *(Conita tenuis)*.

Identifying an individual Sharp-tailed Snake using a photo catalogue.

The Late Prehistoric Mortuary Landscape of Southern Vancouver Island

Darcy Mathews

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Permit #: *P104-05*
Location: *Rocky Point, Mary Hill, Albert Head*
Start Date: *July 2005*
Completion Date: *31 December 2005*

Introduction

In the face of death, mortuary rituals reassert and maintain the reality of the socially constructed world, bridging the supernatural and the mundane. The interrelationship between the cosmological and the everyday aspects of life allow mortuary rituals to serve as a complex and highly visible venue for the assertion of individual and group identities. Importantly, mortuary rituals have a material element. As an end goal, this research addresses the relationship between concepts of personal and group identity and the use of material culture in mortuary ritual.

Prior to European contact, the Straits Salish people, an ethnolinguistic group centred on present day Victoria in southwestern British Columbia, built a distinctive form of grave. The burial cairn, a phenomenon occurring 1500–1000 years before present, consists of an arrangement of rocks placed over the deceased. Cairns vary in form and distribution, often occurring in an array of shapes and sizes (Figure 1). Sites comprise as few as one and as many as 300 or more cairns. During the late nineteenth century, burial cairns in the Victoria area attracted international attention from early researchers but have received virtually no archaeological attention during most of the twentieth century. Recent research on burial cairns and mounds in the Fraser Valley on the mainland of British Columbia has begun to address the interpretive potential of these important features. Although there has been very productive work on similar mortuary features in Europe, burial cairn research in British Columbia is a remarkable but largely untapped avenue for exploration into the social aspects of Straits Salish life. Building on the proven method and theory of this earlier work, I recently documented the largest remaining burial cairn cemetery in British Columbia at Rocky Point outside of greater Victoria. Working with members of the Scia'new First Nation, I mapped and recorded almost 400 cairns at the Rocky Point site in great detail using a geographical information system. I hypothesize that the external attributes of the burial cairn – its location and shape – are important signifiers of the social identity of the person buried within. This approach is supported by Mytum (2004), who proposes that one of the most valuable aspects of burial memorials is that they are built within the context of social relationships and are designed to encapsulate aspects of the identity of the dead. By extension, burial cairns at the Rocky Point cemetery can be reasonably viewed as memorials, built to endure and presumably to express the identity of the deceased. Although burial cairns do not have written biographical text like Western headstones, the manner in which mortuary space is used – the style, material choice, size, and placement of cairns – has great interpretive potential to identify socially meaningful patterns.

The objective of this project is twofold. Firstly, collection of data on the physical form and spatial location of individual burial cairns is being undertaken. Patterns in cairn size, construction, and orientation, in addition to spatial analytical variables, may be reflective of underlying local social structures, such as group identity and status. Secondly, intersite landscape spatial data is being collected. The geographic layout of cairn sites in relation to each other and to the natural and cultural elements of the local landscape are informative regarding larger scale regional concepts of space and group identity.

Study Area and Methodology

The majority of the data was gathered at a large cairn site (designated DbRv-3) in the vicinity of Edye Point at Rocky Point. Interpretation of the data was facilitated by a spatial analysis using a Geographical Information System (GIS).

In order for the intrasite spatial analysis of DbRv-3 to be successful, it was necessary to first inventory the site with systematic pedestrian transects. A crew of 3–5 experienced archaeologists walked systematic transects with a 2-metre interval between surveyors, recording the location of each petroform feature with a Trimble back-mounted 4700 GPS

and a TSC1 data collector. The spatial data was imported into a geographic information system (ESRI ArcGIS 9.1).

For the analysis of individual cairns, a total of 18 analytical variables were collected, in addition to the production of photographs, and detailed diagrams of significant cairns. The metric attributes of each feature, information on the specific type, amount, shape, and size of the constituent rock, and the structure of each cairn were recorded on a standardized form. Some cairns required at least partial clearing of accumulated vegetal matter, particularly from invasive species such as Scotch broom and gorse. Cairns were otherwise not affected by the proposed research. This clearing substantially enhanced the amount of visible data and, therefore, the interpretative potential of the site.

GIS was instrumental as a means of data quantification and management, ensuring a high level of accuracy in mapping and analysis, and a method by which to group data. By using GIS as a management tool, mortuary features were quantified and reorganized and reassigned into analytical units based on quantifiable spatial and morphological attributes.

Results

Prior to this research, there had not been a comprehensive and encompassing examination of the spatial distribution of burial cairns in the Strait of Georgia, despite the fact that the cairns were one of the earliest types of archaeological sites studied in the region. Additionally, there had not been a comprehensive inventory of burial cairns in the Victoria region. From a cultural/historic perspective, this research generated a systematic and detailed survey of over 1400 hectares of land in Metchosin (and 20 km of shoreline), the largest systematic archaeological survey conducted in the Victoria area. In addition, over 600 cairns were inventoried, mapped, and entered into a GIS spatial database. Detailed analysis of the individual burial cairns at DbRv-3 at Rocky Point is approximately 90% complete.

Although the ongoing project is non-invasive, one cairn was destroyed by roots from a wind-fallen tree. Partial human remains were observed eroding out of the root mass. With permission from The Scia'new First Nation, the remains were systematically collected and analyzed on-site. The remains had been partially cremated and were likely those of a young adult. In addition to the human remains, burnt fish and water fowl bones, as well as butter clam shells, were associated with the cairn, suggesting a ritual feeding of the dead, which is still practiced by Salish peoples today. With participation of Elders from the Scia'new First Nation and representatives of the Department of National Defence, the remains were interred in a reconstructed cairn during a burial ceremony held the same day.

At this point in my research, the preliminary data analysis indicates that the socially and physically constructed burial cairn cemetery at Rocky Point is the local-level material record of an emerging concept of a shared Straits Salish social identity and, somewhat paradoxically, is simultaneously an expression of increasing social inequality within this group.

Discussion

This research explores ways in which social practices are linked to particular forms of relationships between peoples and to particular forms of power. Most themes of monumentality view burial cairns as indicators of social hierarchy and elite control of surplus non-elite labour, rather than as the outcome of processes that are characteristic of the changing relations and strategies between agents in society. This research proposes that the spatial distribution of burial cairns in the southern Strait of Georgia are material elements of a socially constructed landscape and can, therefore, be used to examine social relationships between peoples who constructed burial cairns. The mortuary landscape, as illustrated through burial cairn distribution, is the material process of a society constructing and interpreting the world around it.

Field research will continue in 2006. The aim of the research will continue to focus on gathering detailed information on individual cairn morphology from DbRv-3 and using this information to spatially and statistically test associations between individual cairns within the site, but also to test the spatial associations between DbRv-3 and other cairn sites and the natural landscapes of Rocky Point, Mary Hill, and Albert Head.

Conclusions

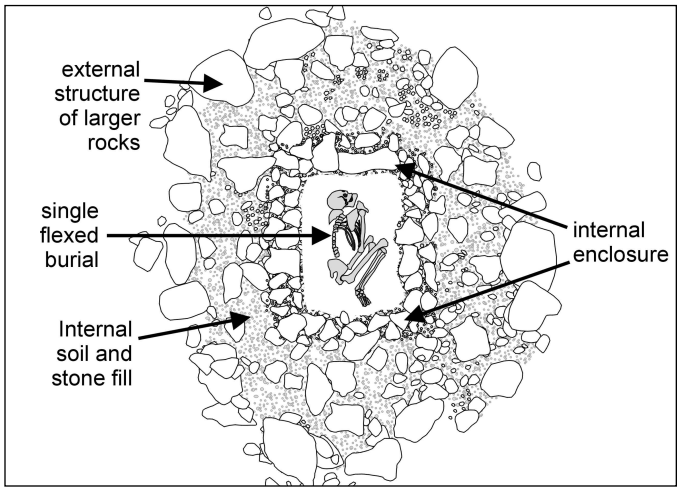
While spatial and morphological data are still being collected from burial cairns at DbRv-3, there are promising preliminary results suggesting evidence of discernable practices relating to emergent complexity in concepts of social identity (and increasing inequality) within precontact Straits Salish

The Late Prehistoric Mortuary Landscape of Southern Vancouver Island

communities. While these and other results are tentative pending further data collection and analysis, they suggest that the materiality and positioning of burial cairns has the interpretive potential to identify different social processes. By extension, the results also point to larger themes of group identity and the maintenance and contesting of societal structures, as they are materially expressed through the creation of the mortuary landscape at Rocky Point.

While this research demonstrates the interpretive potential of burial cairns as statements of social identity at the site-specific level, it is limited in scope to a single large site at Rocky Point. The success of this research encourages me to wonder what can be achieved by looking beyond the boundaries of the individual cairn site. For the next phase of research, I hypothesize that the use of mortuary space at multiple scales of interaction, from the village level to the region, is the material expression of emergent Straits Salish identities of simultaneous inclusion and exclusion. More specifically, funerals (and the resulting burial cairns) were an institution of ceremonial exchanges, a network that linked people from separate villages within the wider regional community. Together with marriage and the cultivation of other strategic social, economic, and political ties, I will argue that the practice of constructing cairns may have become ingrained in regional societal perceptions of identity. As Cannon (2002) states, "identities and relationships are preserved through spatial association and the perceptions this creates and sustains in the minds of survivors and future generations. Tombs and cemeteries become visible expressions of the stability and identity of the community". Burial cairns may have simultaneously provided a forum in which identity and inequality at the local kin or village-based level could be created, contested, and renegotiated. Being the largest and best-preserved burial cairn cemetery in British Columbia, the ongoing research at Rocky Point will form the theoretical and methodological stepping off point from which a regional analysis can be approached.

Figure 1. Generalized burial cairn structure. External structure based on observations of cairns at Rocky Point and internal structure based on cairns excavated by Harlan Smith (1901) from Greater Victoria.



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Phantom Orchid *(Cephalanthera austiniae)* Inventory at Heals Rifle Range

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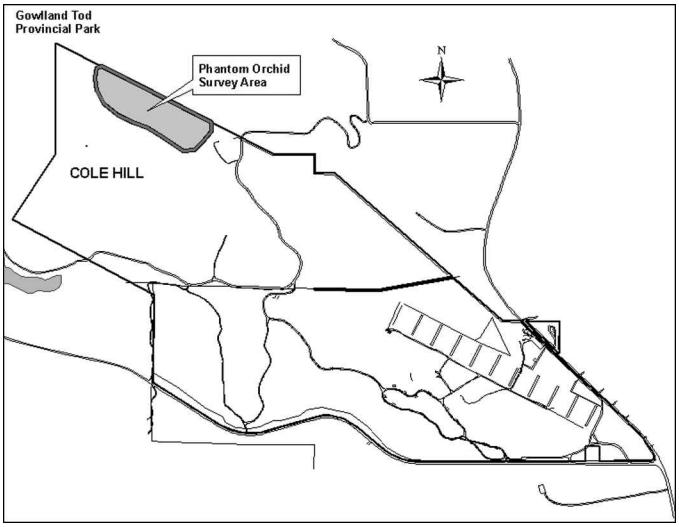
Permit #: *105-05*
Location: *Heals Rifle Range*
Start Date: *01 May 2005*
Completion Date: *18 July 2005*

Introduction

The Phantom Orchid *(Cephalantera austiniae)* is a rare white orchid that is restricted to few locations in the extreme southwest of British Columbia where it occurs in maturing forest on southern Vancouver Island, Salt Spring Island and the lower Fraser Valley. The Phantom Orchid is listed as Endangered by COSEWIC and a National Recovery Plan is in preparation for this species. One of the recommendations of the Phantom Orchid Recovery Team is to locate additional populations of the Phantom Orchid, hence the significance of this project.

Eight populations of Phantom Orchid have been observed in Gowlland Tod Provincial Park, adjacent to Heals Rifle Range. Phantom Orchids are visible and bloom only from the middle of June to the middle of July, so the search time is limited.

Figure 1. Survey area at Heals Rifle Range.



Study Area and Methodology

Most of the Gowlland Todd populations of Phantom Orchid occur in maturing mixed coniferous/deciduous forests with very limited understory, therefore search efforts were concentrated in this type of habitat (Figure 1). Survey sites encompassed open Douglas-fir, Maple/Dougals-fir, and Dry Arbutus-Ocean spray forests. The Phantom Orchid was not observed during the survey on June 30th 2005. A different area of Cole Hill was surveyed on July 7th, 2005 with no success of locating the Phantom Orchid. Other common orchid species and Indian pipe were observed.

Results

Further surveys around the northern portion of the Heals Rifle Range site are required before concluding whether or not Phantom Orchids occur on the site. Additional surveys are anticipated for 2006.

Phantom Orchid *(Cephalanthera austiniae)* in bloom at Gowlland Todd Provincial Park.

Impact of Scotch Broom *(Cytisus scoparius)* on Rare Native Plants in Garry Oak Meadows Mediated through Soil Chemistry

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Permit #: *P107- 05*
Location: *Rocky Point*
Start Date: *January 2005*
Completion Date: *October 2005*

Introduction

Scotch Broom *(Cytisus scoparius)* is a leguminous shrub and one of the primary plant invaders of the Garry Oak ecosystem. As is characteristic of legumes, Scotch Broom has a symbiotic association with nitrogen-fixing *Rhizobium* bacteria, which gives it an advantage over non-N-fixing plant species by allowing it to avoid the common problem of nitrogen limitation.

Invasion by Scotch Broom in Garry Oak habitat tends to result in a different diversity of plant species than in non-invaded Garry Oak habitat. This difference may be due to a number of factors such as an altered light regime, allelopathic chemicals, competition for water and a possible alteration of soil nutrient availability. In an effort to deduce the degree to which Scotch Broom alters the ecosystem via nitrogen fixation, we have investigated the diversity and abundance of plants associated with Scotch Broom-invaded Garry Oak habitat and contiguous un-invaded areas at Rocky Point while obtaining seasonal *in-situ* measurements of soil nutrient availability using ion exchange membrane probes.

The intent of this project is to determine if Scotch Broom increases the nitrogen budget of invaded Garry Oak communities through nitrogen fixation; and to determine if increased N has an effect on native plant populations in the Garry Oak ecosystems, either directly or indirectly (via competition with non-native grasses).

Study Area and Methodology

Five sites were chosen at Rocky Point representing contiguous Scotch Broom-invaded and un-invaded Garry Oak habitat in which to do the soil and plant surveys. All five sites represented deep soil Garry Oak and associated ecosystem habitat.

Plant surveys were conducted in May and June in both Scotch Broom-invaded and un-invaded plots at the five sites. Ten quadrats were surveyed using systematic 25 point estimates to acquire average leaf area indices for each species present in each quadrat, resulting in a total of twenty 0.25 m^2 quadrats per site (over-all total, 100 quadrats). Comparisons will be made between the two treatment types (Scotch Broom/no Scotch Broom) for diversity and abundance of native versus introduced plants, native versus introduced grasses, total diversity and introduced grass diversity.

Soil nutrient monitoring began in January 2005. Eight sets of ion exchange membrane probes (Plant Root Simulators (PRS)^{TM}) were inserted into the soil at each of the five sites; four sets in the Scotch Broom-invaded side and four sets in the un-invaded side. The probes were replaced every five weeks for four consecutive burial periods, ending in early June 2005. Plant-available nitrogen in the forms of ammonium and nitrate were quantified as a rate of availability in units of μg/10 cm^2/35 days.

A pairwise t-test was used to determine if there is a significant difference in rates of availability of nitrogen between Scotch Broom-invaded and un-invaded plots. Average Scotch Broom biomass was determined at each site by measuring two parameters on a sample of plants (width of stems at 5 cm from the soil surface and length of the longest stem) from ten, 1 m^2 plots per site. A random subsample of plants were weighed from each plot and used to develop a regression curve in order to predict the overall biomass of Scotch Broom. That would allow inter-site comparisons of Scotch Broom biomass.

Impact of Scotch Broom *(Cytisus scoparius)* on Rare Native Plants in Garry Oak Meadows Mediated through Soil Chemistry

Results

Plant survey data are currently being analyzed and therefore results are as yet unavailable.

Soil nutrient availability data has been analyzed and is shown in Figures 1 and 2. No significant difference was detected in levels of either nitrate (NO_3^-) (Figure 1) or ammonium (NH_4^+) (Figure 2) between Scotch Broom and no Scotch Broom plots for any of the burial periods. The biomass for each of the sites is listed in Table 1.

Table 1. Average initial Scotch Broom biomass for each site at Rocky Point, in kg/m^2.

Site	1	2	3	4	5
Biomass (kg/m^2)	3.02	1.63	0.27	2.35	2.72

Figure 1. Nutrient availability rates for NO_3^- for all four burial periods. n = 5 SE bars.

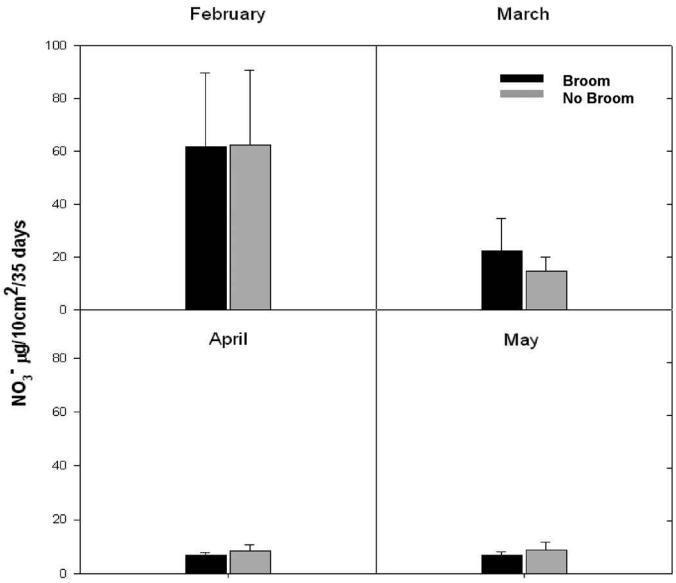
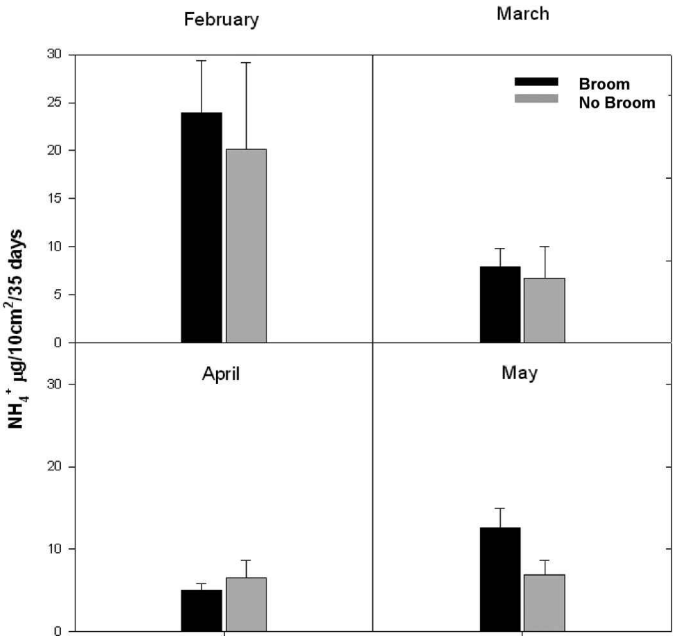


Figure 2. Nutrient availability rates for NH_4^+ for all four burial periods. n = 5 SE bars.



Pairwise t-tests showed that there was not a significant difference in levels of available nitrogen in between Scotch Broom and non-Scotch Broom plots.

Conclusion

It appears that there is no significant correlation between the presence of Scotch Broom and an increase in the availability of ammonium or nitrate as previously believed.

Western Bluebird *(Sialia mexicana)* Nestbox Program at CFMETR

Trudy Chatwin

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Permit #: *108-05*
Location: *CFMETR*
Start Date: *05 January 2005*
Completion Date: *30 September 2005*

Introduction

The Western Bluebird Nestbox Project at CFMETR is part of a larger project aimed at increasing the nesting opportunities for the Western Bluebird on southern Vancouver Island. Until the 1990's the Western Bluebird *(Sialia mexicana)* nested on Garry oak sites on southern Vancouver Island and the Gulf Islands. It is believed that cool springs and perhaps competition for nest sites with European Starlings *(Sturnus vulgaris)* caused extirpation of this species in the Georgia Depression. Our 'Bring back the Bluebird' project aims to revive the Western Bluebird Nestbox Program, organize a system of boxes and volunteer stewards and work towards the re-introduction of Western Bluebirds to the Georgia Depression. The CFMETR property in Nanoose is of special importance because birds have been historically recorded breeding in this area, and there is little competition from other avian species such as starlings and House Sparrows *(Passer domesticus)*. It is for this reason that CFMETR is of the utmost importance for this study.

The purpose of this project is to increase nesting opportunities for the Western Bluebird in and around southern Vancouver Island as well as obtain several years of nestbox monitoring data prior to species reintroduction.

Western Bluebird *(Sialia mexicana)* nest boxes.

Western Bluebird Nestbox Program at CFMETR

Study Area and Methodology

On January 31st 2005, six Western Bluebird nestboxes (Figure 1) were installed amongst Garry oaks on the south facing slope of Nanoose Hill. The boxes were spaced in pairs approximately 20 metres apart and positioned so as to be prominent to bluebirds flying by, but not obvious to walkers. The nestboxes were attached to Garry oak trees at about 1.4 metres height with zap-straps to avoid puncturing the tree bark. In addition to the six bluebird boxes at this site, a flicker box was placed in the area.

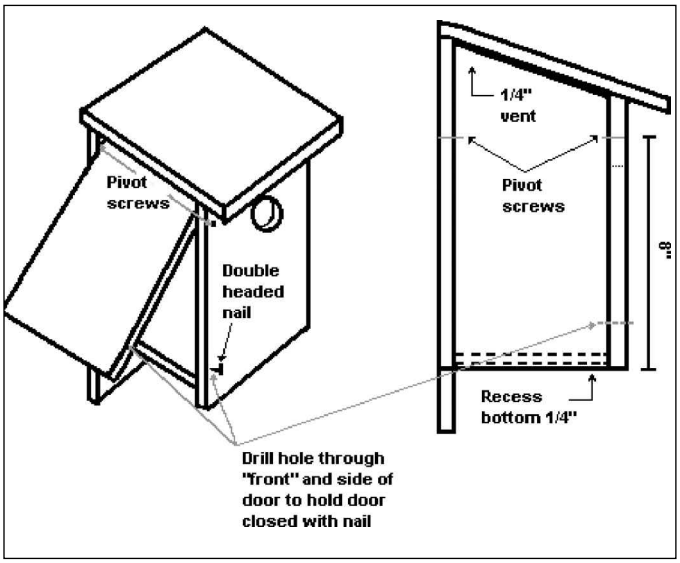
Results

Stewards, Guy Monty and Donna McKean, made 12 checks of the boxes from March 2005 to August 2005. No Western Bluebirds were observed; however, a Mountain Bluebird was observed in the spring.

The boxes were cleaned in November and December. Judging by the cob-webs over the entrance holes, it appeared that no other birds nested or entered the boxes. There was no evidence of any vandalism to the boxes. Providing that it is permitted, nestbox monitoring will continue through the spring and summer of 2006.

Steward/volunteer mounting a Western Bluebird (*Sialia mexicana*) nest box on a Garry oak tree at Nanoose Hill, CFMETR.

Figure 1. Western Bluebird Nestbox Design



Embryonic survivorship of the Oregon Spotted Frog *(Rana pretiosa)* and Red-legged Frog *(Rana aurora)*

René McKibbin

Royal Roads University c/o Canadian Wildlife Service
5421 Robertson Rd. Delta, BC V4K 3N2

Permit #: *P109-05*
Location: *Aldergrove*
Start Date: *1 March 2005*
Completion Date: *15 May 2005*

Introduction

The Oregon Spotted Frog *(R. pretiosa)* is a Pacific Northwest species (Corkran & Thoms, 1996). Since the 1990's, *R. pretiosa* was not found in any of the previous locations in British Columbia (Haycock, 1999). In British Columbia today, it occurs in three sites in the extreme southwest corner of the province: namely Maintenance Detachment (MD) Aldergrove, Mountain Slough in Agassiz and Maria Slough adjacent to Seabird Island (Haycock, 2000a).

R. pretiosa was designated "Endangered" in an emergency listing in November 1999 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Haycock, 2000b). The reason for the designation is the fact that it is reduced to only three isolated sites, each containing very low numbers of individuals and the species has been adversely affected by habitat loss due to urban expansion, agriculture, exotic competitors and exotic vegetation (COSEWIC, 2000).

The MD Aldergrove population, particularly, has shown a steady annual decline from 90 egg masses in 1997 to 33 egg masses in 2001 (Haycock, 2001). The reason for poor fecundity at MD Aldergrove is currently unknown. This study tested the hypothesis that water conditions correlate with embryonic survivorship of *R. pretiosa* in British Columbia, Canada.

Study Area and Methodology

Study Site:

The research was conducted at the Department of National Defence's MD Aldergrove (latitude 49° 0′ and longitude 122° 29″). The MD Aldergrove study site consisted of two sub sites, namely sub site A and B. Sub site A is a small, open wetland. Sub site B was altered in 2002 and now consists of a large body of open water.

Embryonic Survivorship of *R. pretiosa*:

To quantify the embryonic survivorship of *R. pretiosa* from early development through to hatching, sub-samples of egg masses (15-30) were placed in holding cages set up *in-situ* near the wild egg mass. Egg clumps were removed from different locations within masses to ensure sub-samples were taken from both the outside and inside of the egg mass. These enclosures exclude larger vertebrate predators and smaller invertebrate predators, except for bacteria and viruses (Harris & Bogart, 1997) (Figure 1).

Figure 1. Nytex holding cages.

The cages were made of Nytex which allowed for adequate water circulation and light penetration. The cages were attached loosely to small wooden dowels to ensure cages moved vertically with changes in the water depth to prevent dehydration. The cages were visited two times per week during the three to four week of development. Development was described using Gosner (1960) staging. Free swimming hatchlings were released at the wild egg masses.

Water Quality:

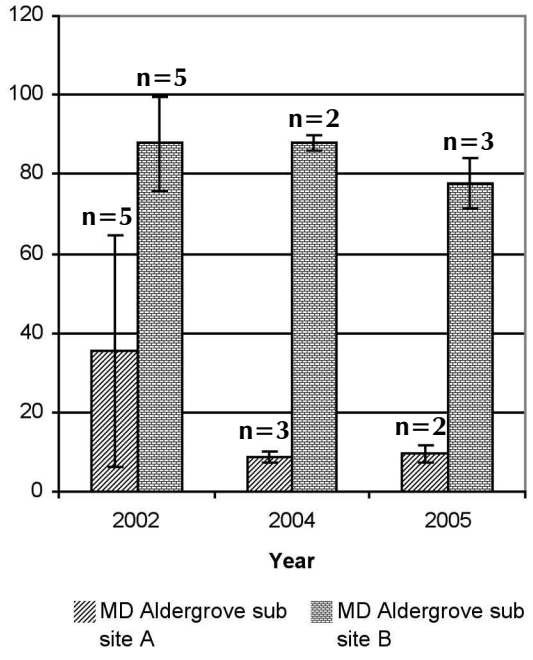
Water samples were collected for water chemistry, trace metal and bacterial coliform analyses. Water analysis was done by CANTEST and Pacific Environmental Science Center [PESC]. Water temperature was recorded with a Vee Gee brand minimum/maximum thermometer.

Results

Embryonic survivorship of *R. pretiosa*

During 2002, 2004 and 2005, the mean embryonic survivorship of *R. pretiosa* at MD Aldergrove sub site A ranged from 9% to 36%, and at sub site B it ranged from 78% to 88% (Figure 4).

Figure 4. Mean [± standard deviation (SD)] embryonic survivorship of *Rana pretiosa* at MD Aldergrove sub site A and B, BC, Canada during 2002, 2004 and 2005. n = number of cages.



Water Quality

Water chemistry: Most water chemistry parameters did not show a substantial change in concentration of more than an order of magnitude or at least 100% among study years. There were few differences in water chemistry among MD Aldergrove sub site A and sub site B. For parameters in which Canadian Water Quality Guidelines (CWQG) for the protection of freshwater aquatic life (Canadian Council of Ministers of the Environment [CCME], 2003) were available, only pH was below the CWQG range at MD Aldergrove sub site A and sub site B.

Trace metals: Most trace metals did not show a substantial change in concentration of more than an order of magnitude or at least 100% among study years (2004 and 2005). At sub site A, iron, silicon, cadmium, manganese and selenium were the only parameters to vary by at least 100% or up to an order of magnitude in concentration between years. At sub site B, aluminium, cadmium, manganese, nickel and selenium were the only parameters to vary by at least 100% or up to an order of magnitude between years.

Coliforms: Total coliforms at MD Aldergrove during 2002, 2004 and 2005 ranged from less than the MDL (< 1 col/100ml) to 370 col/100ml. Fecal coliforms ranged from less than the MDL (< 1 col/100ml) to 16 col/100ml within the MD Aldergrove sub sites. No CWQG guidelines currently exist for coliforms.

Water temperature: At MD Aldergrove sub site A, during 2005 the minimum water temperature ranged from 3 to 9˚C, the maximum water temperature ranged from 14 to 18˚C and the average water temperature ranged from 8 to14˚C. At MD Aldergrove sub site B, during 2005, the minimum water temperature ranged from 3 to 9˚C, the maximum water temperature ranged from 11 to 18˚C and the average water temperature ranged from 7 to 14˚C within MD Aldergrove sub site B.

Discussion

At MD Aldergrove sub site B, mean embryonic survivorship seems to be within the range reported by many studies of Ranids and salamanders in the wild (Licht 1974; McAlister & White 2001; Seigel, 1983) while embryonic survivorship at sub site A was far below average. *R. pretiosa* usually breed in February and March, soon after snow melt (Licht, 1971). The lethal thermal limits for young *R. pretiosa* embryos are about 6 – 28 °C (Licht, 1971). During this study, temperatures were within the temperature tolerance limits for *R. pretiosa* and low embryonic survivorship at sub site A is not due to temperature.

pH can have an influence on embryonic survivorship. Amphibians are most sensitive to low pH during the fertilization and embryonic development stage (Beattie *et al.*, 1992; Pierce *et al.*, 1984). Lethal and sub lethal effects of pH were usually observed at pH < 4.5 (Beattie *et al.*, 1992; Pierce *et al.*, 1984). In this study the lowest pH was

Embryonic survivorship of the Oregon Spotted Frog *(Rana pretiosa)* and Red-legged Frog *(Rana aurora)*

relatively high at pH 5.53, indicating pH was not a factor alone in hatching success.

Based on CWQG, there were no exceptionally high levels of trace metals at any of the sites and most of the trace metals were within the CWQG for aquatic life. CWQG are based on the most sensitive plant and animal species that occur in Canadian waters and the guidelines are expected to protect 100% of species in Canadian water, 100% of the time (CCME, 2003).

Conclusions

This research has indicated that water conditions do not likely significantly influence the embryonic survivorship of *R. pretiosa* at MD Aldergrove and therefore do not contribute to the low embryonic survivorship, population decline and potential extirpation at MD Aldergrove sub site A. However, due to the small number of egg masses oviposited at MD Aldergrove, the sample size is small which might have limited the analytical power. The fact that the species is endangered also limits the research that can be conducted on the species which makes it more challenging to provide recommendations.

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Recovery Activities Benefiting the Oregon Spotted Frog *(Rana pretiosa)* at Maintenance Detachment Aldergrove

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Permit #: *P110-05*
Location: *Maintenance Detachment Aldergrove*
Start Date: *28 February 2005*
Completion Date: *15 May 2005*

Introduction

With only three populations and an estimated total of approximately 378 breeding individuals in 2004, Oregon Spotted Frog (*Rana pretiosa*; OSF) is Canada's most endangered amphibian. It has disappeared from more than 70 per cent of its historic range (Hayes 1997) and Canadian populations account for less than 10 per cent of the species global distribution. The Canadian government's emergency listing of this species is a further indication of the species' extreme vulnerability. A recovery team was formed in 1999 and is developing a recovery plan for this species as well as implementing several recovery actions as per the draft recovery plan.

The Department of National Defence is undertaking recovery activities for the endangered OSF at Maintenance Detachment Aldergrove (MDA) which includes handling egg masses, larvae, juveniles, and adults. Handling of the OSF is necessary to conduct recovery activities such as processing of captive reared froglets, and other population augmentation and headstarting activities.

This project is a continuation of an ongoing recovery effort for the OSF. The population of OSF at MDA is small and declining. In the absence of recovery activities, the population is a candidate for extirpation. The affect of past captive rearing and headstarting programs must be monitored and the information gained from this monitoring must be applied to adaptively manage the overall recovery effort.

Handling of frogs is required while undertaking recovery activities. All of the activities undertaken throughout this project have been tested in small pilot projects before full scale implementation. Recovery activities for this project include: 1) Processing and release of juvenile frogs that have been overwintered and release of captive-reared froglets; and 2) Egg mass survey, trapping of juveniles and adults, protection of egg masses, partitioning of embryos for captive rearing, preservation of embryos for later genetic analysis, and larval head starting.

Study Area and Methodology

Study site:

The research was conducted in the large wetland in the south-central part of the Department of National Defence property known as Maintenance Detachment Aldergrove.

The marking of froglets is undertaken by individuals with significant experience. The methodology includes the best available technology with the primary objective of minimizing handling times and employing non-invasive techniques.

The field work for the projects to be undertaken occurs within the occupied site between February 28, 2005 – May 15, 2005.

Processing and release of juvenile frogs that have been overwintered:

Eighty-nine larvae and froglets were weighed, measured and marked (processed) at MVCBC in October 2004 after negative results were received of zoonotics testing from the Provincial pathologist. These froglets originated from embryos from MDA. Forty-five froglets and 9 larvae were placed into 10 – 4x4x2 holding pens for an overwintering study. The remaining froglets were released into the wild. The froglets and larvae in these holding pens must now be processed and released into the wild.

Recovery Activities Benefiting the Oregon Spotted Frog *(Rana pretiosa)* at Maintenance Detachment Aldergrove

Release of captive-reared froglets:

Captive-reared froglets, originating from egg masses laid at MDA and raised at the Greater Vancouver Zoo (GVZ), will be weighed, measured, marked, and toe samples prepared for zoonotics testing. Not more than twenty percent of the total number of froglets remaining in tubs will be tested for zoonotics at the Provincial Agriculture Canada pathology facility as advised by the pathologist. Testing is conducted for iridovirus, chytrid fungus, and various bacteria.

These froglets ranged in size from 19 mm snout-urostyle length (SUL) to 40 mm SUL and were weighed with a field balance and measured with digital calipers at the GVZ. Each froglet was individually marked using visual alphanumeric coded tags and elastomer dye. Processing occured at the GVZ. The release of the froglets was approved by the Department of National Defence and the Oregon Spotted Frog Recovery Team and was advised of the results of the pathological testing. When such release was approved, froglets were transported from the GVZ to MDA and released into 10 holding pens. The release into the holding pens was for acclimation only and occured when nighttime temperatures were above freezing. Holding pens consisted of 4x4x2 foot stainless steel frames that are covered with 5mm inert, UV-inhibited, plastic mesh. Ten holding pens were prepared in advance of the release with suitable vegetation. Suitable food was released into the pens from the surrounding wetlands by collecting insects using hand nets. Froglets were released from the holding pens into the wetland as early as the second week of March 2005 or as late as March 31, 2005, depending upon weather conditions.

Egg mass survey:

Oviposition (egg laying) habitat is described in detail by Haycock (1998, 1999, 2000, 2001, 2002). Oviposition microhabitats are located in seasonally inundated, warm shallows (McAllister and Leonard 1997). Oviposition locations are discovered through visual reconnaissance of known and potential habitats. We investigated known oviposition sites and walked the perimeter of the wetlands to survey for new oviposition sites. The locations of oviposition sites are recorded with a Global Positioning System and the number of egg masses was recorded.

Trapping of juveniles and adults:

Captive rearing of OSF started in 2003 and 200 larvae and 618 froglets were released into the wetland. Since males from this release would be sexually mature by the spring of 2005, we wished to monitor their fate by conducting a limited, rotating trapping period as described in further detail herein. Females mature in their third year and were not expected at oviposition sites.

In accordance with the SARA permit, trapping occurred after oviposition was complete and traps were set 10 metres from the centroid of the location where egg masses were deposited. In 2005, 100 nylon funnel traps were set in water not greater than 8 inches to avoid drowning frogs. Traps were checked five to seven times per week. In periods when traps could not be checked, traps were temporarily closed until trapping was resumed.

Table 1 lists the number of traps set at each location. Although the ditch south of the outflow tributary is not an oviposition site, it was of interest since frogs have been located there in the past.

Table 1. Number of traps set at locations.

Location	Number of Traps Set
Western Clusters - North	30
West of Western Clusters - South	15
Eastern Clusters - Pilot	50
Ditch south of outflow tributary	30
Total	**125**

As OSF were located in traps, the location was recorded. The frog(s) was transferred into a labeled zip lock bag and placed into a 5 gallon plastic bucket. Frogs were checked for the presence of fluorescing tags in specific body locations with amber glasses and UV light. They were weighed, measured and marked with the tagging system in place and immediately released into the wetland where they were captured. Maladies, if any, were noted. Information collected from adults contributes to our understanding of age, size at sexual maturity, body size at northern latitudes, population size and our captive rearing program. Information collected from juveniles, captured incidentally in traps, contributes to our understanding of age, size at sexual maturity, and the effectiveness of our captive rearing program. Other vertebrate and invertebrate species were removed from the traps and released.

Recovery Activities Benefiting the Oregon Spotted Frog *(Rana pretiosa)* at Maintenance Detachment Aldergrove

Population Size Range:

Population size range can be calculated from any range of estimates determined over time using the same methodology. For our purposes, our population size range is the minimum and maximum size of the population determined through a simple calculation using the egg mass census number (Nem).

Effective population size (Ne) is the size of a breeding population; a factor that can be determined by the number of parents. Although effective population size is defined in much more detail in calculations that consider population genetics, for our purposes, I base effective population size on the number of egg masses counted. Since Nem is equal to the number of breeding females in the population, I double the egg mass census number to arrive at an estimate of the total number of breeding individuals or Ne = 2 X Nem. Assumptions include: all egg masses in a population in a given year are located; females lay one, annual clutch of eggs; and, one male parented with one female.

Fecundity and Survivorship:

Egg masses were carefully transferred from the location of oviposition into a shallow plastic container. A digital photo of the egg mass was taken. In 2003, the egg mass was returned to its original location after the photo was taken, whereas in 2004 and 2005, the egg mass was retained in a 6 litre plastic container that allowed water to circulate and embryos were allowed to develop and hatch. At hatching, survivorship was tabulated by either taking another photograph and counting hatchlings, counting dead embryos by hand, or counting live embryos by hand – whichever method would result in the least amount of counting.

Protection of egg masses:

In 2001, a remote video camera recorded bullfrog (*Rana catesbeiana*) entering an oviposition site and consuming OSF as they emerged from their egg casings. Accordingly, bullfrogs must be excluded from preying on hatchlings. Egg masses were teased into shallow, 14 litre plastic containers at approximately Gosner stage 12. Plastic containers were prepared to receive one egg mass each by drilling two holes into the wall of two sides of the container to allow water exchange. The outer wall of the plastic container was covered with Nitex mesh and clear aquarium silicon was used to adhere the mesh to the wall. Embryos will hatch at Gosner stage 20-22, depending upon temperature. Plastic containers remained at the site where they were laid and were not disturbed during embryonic development.

Partitioning of embryos for captive rearing:

Once embryos hatched in the plastic containers, they were partitioned for captive rearing, head starting and release into the wild. For captive rearing, enough hatchlings were removed from each egg mass to equal the number required to populate twelve – 260 gallon tubs at a maximum density of one larva per two gallons of water. The total number of embryos required to achieve this density was 1560. Embryos were partitioned into plastic ziplock containers and transported to the husbandry facilities in a cooler.

Larval head starting:

Ten – 3x3x2 stainless steel framed holding pens covered with 2 mm inert, UV inhibited plastic mesh were prepared for *in situ* headstarting by populating the pens with suitable vegetation. Ten hatchlings were placed into each holding pen at the same time larvae were partitioned for captive rearing, for a total of 100 larvae. Larvae grazed on the algae on vegetation that has been placed into the pens and were counted and released into the wild May 15, 2005. The remaining larvae that had hatched in the plastic containers were released into the wild in the location of the original egg mass.

Results

Egg Mass Survey

As of March 29, 2005, there were seven egg masses deposited by Oregon Spotted Frog at Maintenance Detachment Aldergrove, approximately 70 per cent of the number of masses that were laid in 2004. Table 2 presents the number of egg masses located at each site and the date of first encounter. Table 3 represents the percent difference in egg masses encountered from 1997 and 2000-2005.

Recovery Activities Benefiting the Oregon Spotted Frog *(Rana pretiosa)* at Maintenance Detachment Aldergrove

Table 2. Number of egg masses located in 2005 and date of first encounter.

Location	Number of Egg Masses	Date of First Encounter
Eastern Clusters - Pilot	3	March 5, 2005
Western Clusters - North	2	March 7, 2005
West of Western Clusters - South	2	March 16, 2005
Total	**7**	

Table 3. Percent difference in egg masses encountered from previous years.

Year	Total # of Egg Masses	Effective Population Size	Percent Annual Change
1997	92	184	-
2000	29	58	-68%
2001	31	62	7%
2002	34	68	10%
2003	12	24	-65%
2004	10	20	-17%
2005	7	14	-30%

Population Size

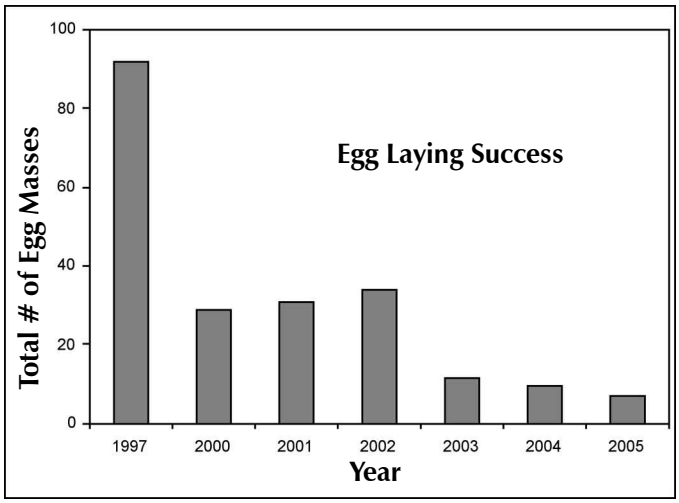
For our purposes, the population size range equals the effective population size. In 2005, the effective population size is 14 (Table 4). Since egg mass counts were initially undertaken in 1997, the population of OSF at MDA has consistently decreased (Figure 1).

Table 4. Number of egg masses and effective population size range.

Year	Total # of Egg Masses	Effective Population Size
1997	92	184
2000	29	58
2001	31	62
2002	34	68
2003	12	24
2004	10	20
2005	7	14

Recovery Activities Benefiting the Oregon Spotted Frog *(Rana pretiosa)* at Maintenance Detachment Aldergrove

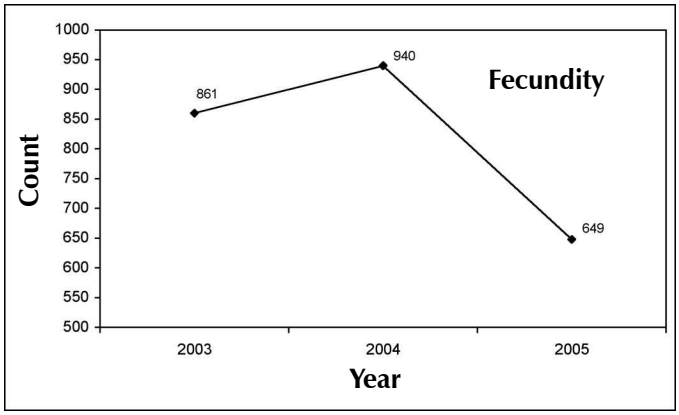
Figure 1. Egg laying success from 1997 and 2000 to 2005.



Fecundity

In 2005, the mean number of embryos counted from 26 egg masses was 649 (N=5) down from 940 (N=10) in 2004; and 861 (N=11) in 2003 (Figure 2).

Figure 2. Average Annual Fecundity (2003-2005)



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Comparison of Gene Flow and Recruitment in Three *Lomatium* Species

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Permit #: *P112-05*
Location: *Rocky Point*
Start Date: *15 July 2005*
Completion Date: *28 July 2005*

Introduction

This research project focuses on three *Lomatium* species, *Lomatium utriculatum, L. nudicaule,* and *L. dissectum var. dissectum*, which are restricted to Garry oak and associated ecosystems, and all share their northern range limit on southeast Vancouver Island. These species make an excellent model system for comparing the dynamics of species with differing traits in a phylogenetically conserved way. Important differences among these species are: overall abundance, local density, size, age of first reproduction, number of seeds produced, and size of seeds.

The three *Lomatium* species are possible food plants for Anise swallowtail *(Papilio zelicaon)*, a focal butterfly species studied by Dr. Jessica Hellmann, University of Notre Dame. Characteristics such as vegetative and flowering phenology may influence the usefulness of each species as a butterfly food source.

This research project combined with Dr. Hellmann's research on DND land has implications for land management on Vancouver Island by determining the limiting factors for plant species that act as food sources for butterflies. The purpose of this research project is to conduct seed production surveys for the *Lomatium* species growing at Rocky Point to understand how populations of each species grow and disperse at their northern limit.

Study Area and Methodology

This study was conducted in the Garry oak and associated ecosystems at Rocky Point. Surveys were composed of plots assessed at the time of seed ripening/dispersal to quantify plant abundance and the number of seeds produced per plant.

Fruit set was surveyed by counting the number of fruits (each fruit is two seeded in these species) produced by each individual of each *Lomatium utriculatum* inflorescence in randomly chosen 1 m^2 plots. Due to the clumped nature of the *L. nudicaule* plants, a representative random sample of 7 per cent of the population's inflorescences was assessed for successful fruit set. The methods described above were also pursued at seven other sites across southeast Vancouver Island for a total of eight sites.

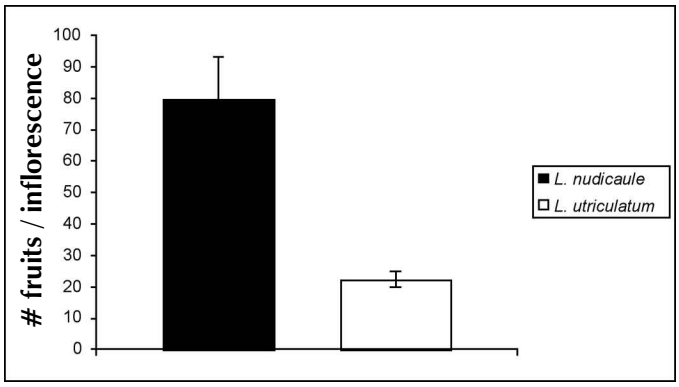
Results

Lomatium utriculatum is the first species to germinate and returns from dormancy as early as February. It was observed that *L. utriculatum* was flowering in early April at Rocky Point and that by early April unsuccessful fruiting attempts appeared, possibly due to a lack of pollinators that early in the season. Flowering continued through April, and some fruits developed in late May. *Lomatium utriculatum* fruits fully ripened by mid-June and subsequently senesced. *Lomatium nudicaule* was the last of the species to mature and senesce and was still flowering by the end of May with fruits not fully developed until July. *Lomatium nudicaule* plants also persisted much longer into the dry summer season than *L. utriculatum*.

Population abundances at Rocky Point are estimated to be: *L. nudicaule* $\sim$ 200 individuals; and *L. utriculatum* $>$5,000 individuals. Surveys of fruits set per inflorescence conducted at Rocky Point showed that *L. nudicaule* had a much higher number of successful fruits set per inflorescence than did *L. utriculatum* (Figure 1).

Comparison of Gene Flow and Recruitment in Three *Lomatium* Species

Figure 1. Number of successful fruits set per inflorescence from *Lomatium* plants at Rocky Point. Bars represent standard error.



Discussion

At Rocky Point, as is typical throughout many of the Garry oak meadows on Vancouver Island, *L. utriculatum* is a more abundant plant than *L. nudicaule*. *Lomatium nudicaule* is the larger of the two plants, so it is not surprising that *L. nudicaule* has the ability and therefore produces a greater number of successful fruits per inflorescence than its congener, *L. utriculatum*. On average, *L. nudicaule* at Rocky Point produced 3.5 times more fruits per inflorescence than did *L. utriculatum*, but it is interesting to note that *L. utriculatum* is at least 25 times more abundant at the site resulting in a much greater population fruit set from *L. utriculatum*.

Abundance and fruit set are two important aspects of species natural history, and differences found in these species may be informative in predicting the ability of the species to respond to global changes.

***Lomatium utriculatum* growing with *Plantago lanceolata*.**

Environmental Controls on Overstory Recruitment of Garry Oak *(Quercus garryana)* at Rocky Point

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Permit #: *P114-05*
Location: *Rocky Point*
Start Date: *1 August 2005*
Completion Date: *31 December 2005*

Introduction

Field investigations undertaken in 2003 and 2004 (Gedalof *et al*. 2004; Gedalof *et al*. in review) throughout southern Vancouver Island and the Gulf Islands revealed an alarming trend among a range of Garry oak *(Quercus garryanna)* associated ecosystems. At three sites where detailed stand structure and stand composition reconstructions were undertaken using dendrochronological techniques, no oak recruitment was found to have occurred in at least the last 50 years. At two of the sites (located in Beaumont Marine Park, and on Tumbo Island), no seedling establishment at all has occurred. At the third site (Rocky Point), abundant seedlings were observed, but there was no evidence of successful recruitment to the overstory. At Rocky Point, 678 seedlings were counted within the sample area, but only three saplings were found. In contrast, Douglas-fir *(Pseudotsuga menziesii)* appears to be regenerating very successfully; although only 53 Douglas- fir seedlings and 41 saplings were found suggesting that survival rates are generally high. Additionally, overstory recruitment of Douglas-fir has been fairly continuous over the last century. Preliminary results from the Nature Conservancy of Canada property at Elkington, and the B.C. Parks property at Burgoyne Bay, Salt Spring Island, suggest that seedlings are relatively common at both sites, but there are very few small oak trees and virtually no sapling-sized individuals. Additionally, conifer encroachment is occurring in portions of both Garry oak ecosystems, suggesting a dramatic change in stand structure and composition relative to recent centuries.

In light of these findings, it is important to identify the controls on seedling survival, and subsequent recruitment to the canopy. Fire has been identified as a factor in some studies (e.g. Agee 1996), and burning by first nations in Garry oak associated ecosystems is well documented (Turner 1999; White 1999; Williams 2000). However, recent experimental studies have failed to identify a robust link between fire and seedling establishment (Regan and Agee 2004). Similarly, the potentially confounding effects of competition and herbivory have not been adequately addressed. Lastly, no study to date has distinguished the relative importance of regeneration by sprouting versus seedling establishment (c.f. Agee 1996). Experiments initiated at Rocky Point in August 2005, will provide some insight into controls on seedling establishment (rather than sprouting), and the effects of non-fire controls on survival and recruitment to the sapling stage.

Study Area and Methodology

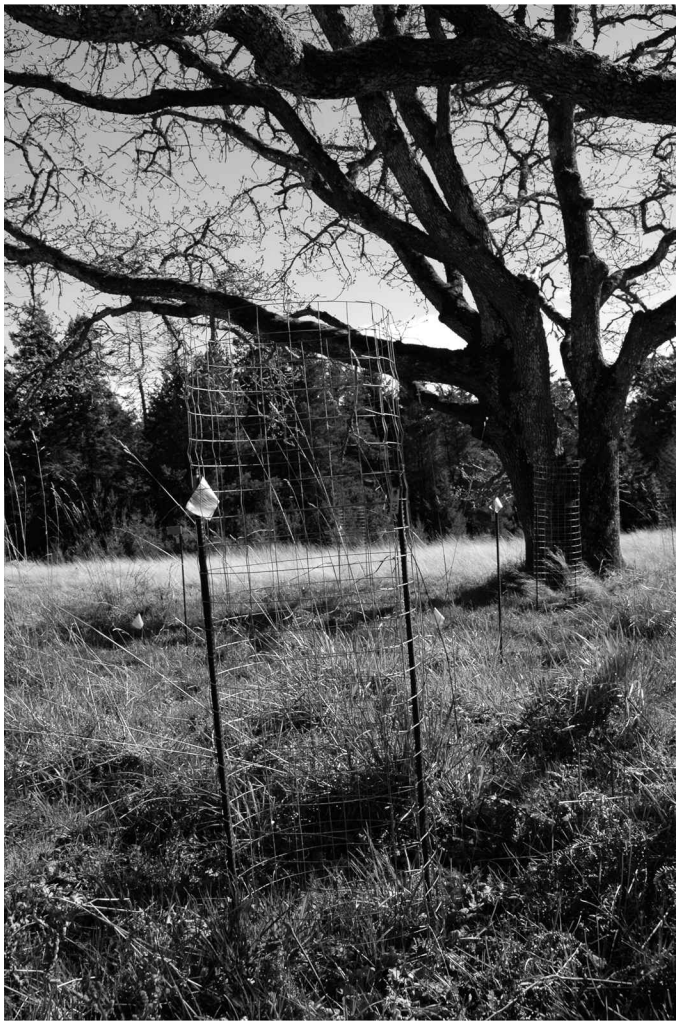
The study area is located in an area of transition from prairie to closed forest at Rocky Point. The site is generally flat, with only a few relatively small undulations (<1 m) in topography. The understory vegetation is composed primarily of introduced grasses, with coverage of approximately 30 percent Orchardgrass *(Dactylis glomerata)*, 30 percent colonial Bentgrass *(Agrostis capillaries)*, 20 percent Sweet Vernal Grass *(Anthoxanthum odoratum)*, and 20 percent Bracken Fern *(Pteridium aquilinum)*. The overstory is composed primarily of Garry oak, with some Douglas-fir, Grand fir *(Abies grandis)*, Arbutus *(Arbutus menziesii)*, and Lodgepole pine (*Pinus contorta* var. *contorta*) in the vicinity. Canopy closure is variable, but is less than 30 percent in the area where experimental treatments were applied.

One hundred seedlings were identified, and randomly assigned to a treatment type. To minimize biases due to seedling age, only seedlings with few leaves, and no obvious signs of resprouting were considered. Two treatment types, as well as their interaction, were targeted in this analysis. In order to assess the effect of browsing on seedling success, small circular exclosures were established around 20 seedlings. The exclosures are composed of wire fencing supported by re-bar, and are approximately 50 cm in diameter and 1 m in height. To assess the effect of

Environmental Controls on Overstory Recruitment of Garry Oak *(Quercus garryana)* at Rocky Point

competition with grasses, a small square of landscape cloth was placed around 20 seedlings to reduce competition for resources. To assess interactive effects, 20 seedlings had both treatments applied. Forty control seedlings were identified and marked for future identification. A photograph of the study site is shown in Figure 1. Seedling plots will be revisited annually to maintain treatment types, and to measure response variables. After three years, all materials will be removed. Response variables will be limited to non-invasive measurements, including stem height, number of leafs, and total leaf area. While it would be beneficial to also know the total above- and below-ground biomass, and rooting depth, conservation priorities take precedence.

Figure 1. Garry oak (*Quercus garryana*) seedling treatments at Rocky Point.



Results

No results are available at this time, as no seedling growth has occurred since installation of the treatments. Initial results will be provided in the 2006 annual report.

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Western Redcedar (*Thuja plicata*) Climate Change and Implications for Management on Vancouver Island

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Permit #: *P115-05*
Location: *Royal Roads*

Start Date: *22 July 2005*
Completion Date: *12 September 2005*

Introduction

Western Redcedar (WRC) *(Thuja plicata*) has been used for centuries by north Pacific coast aboriginal groups for clothing, shelter, tools and transportation. WRC is also an extremely valuable tree species for the British Columbia forest industry, and its wood is world renowned for beauty and decay resistance. WRC habitat is limited to the west coast of North America from northern California, to southeastern Alaska and, in the interior, from south-central B.C. into western Montana and northern Idaho (Minore 1983). The exponential increase in human population around the globe has increased greenhouse gases, pollution, and facilitated climate change. Palynological studies have shown major changes in historical distributions of forest ecosystems and individual species over time due to climate change (Overpeck *et al*. 1991). Between 10,000 and 6000 years BP, pollen of WRC was scarce, which corresponds to the warm and dry early Holocene xerothermic time period (Hebda and Mathewes 1984). Pollen studies have shown that WRC did not establish in B.C. until roughly the mid Holocene time period (5000-6000 years BP), which was known to be cooler and wetter than present (Hebda and Matthewes 1984; Wainman and Matthewes 1987; Hebda 1995; Brown and Hebda 2002). Apparently, WRC was not present in B.C. during very warm and dry periods, which supports the contention if current climate change leads to warming and drying, WRC will again shift in geographical distribution and change in abundance. Such geographic range shifts have significant implications for the WRC-based timber industry and for the ecology of west coast forests where this species currently plays a dominant role.

The term "forest dieback" has been used interchangeably with "forest decline" and is best referred to as "an episodic event characterized by premature, progressive loss of tree vigour and health over a given period without obvious evidence of a clearly identifiable causal factor" (Ciesla and Douaubauer 1994). Top crown dieback has recently been observed on WRC trees on the east coast of Vancouver Island (Andres, Courtin, Hebda, Heppner, Klinka, Wark, Zeglen personal communications May and June, 2005). Dr. Vladimir Krajina speculated on the causes of WRC top dieback and its tendency to develop multi-stemmed "candelabra" growth forms in very old trees as early as the 1960's, which he attributed to summer moisture stress (Kimmins, personal communication June 10, 2005). The cause and extent of western red cedar dieback will be the focus of this project.

This study will explore the potential effects of climate and subsidiary determinants on current western red cedar dieback, and explore forest management implications in the face of the potential shifts in site, geographical range and stem form of this species. Collaboration will be undertaken with the Galiano Island Conservancy Association, Royal Roads University, the B.C. Ministry of Forests and Range, and various forest harvesting companies.

Study Area and Methodology

Study sites are within the eastern part of Vancouver Island, from Campbell River south to Victoria, which lies in the dry rainshadow of the Olympic Mountains in Washington. As a result, Western Redcedar dieback will most likely be observed on this part of the island, although with future changing climate, the effects may be expressed more widely. Sites were selected in three of the drier biogeoclimatic subzones on the island (CDFmm, CWHxm, and CWHmm) with advice from local foresters.

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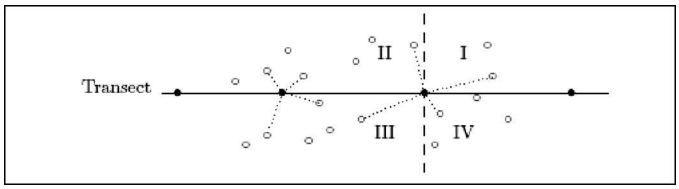
Sampling

This study was limited to sampling only second growth (50-100 years) forest stands due to the fact that the influence of typical "dead-topped" old WRC trees found on the north and west coast of the Island should be separated from the newly drought stressed trees. Sites were stratified by biogeoclimatic subzone, site series (wet sites versus dry sites within particular subzones) and age of stand. The design of the project should allow for comparison between and within study sites. A number of transects were created from east to west along the east coast of Vancouver Island to cover a moisture gradient and to see how WRC in different subzones are affected by climate. The first section of the project was to assess where most extensive WRC mortality/ dieback is occurring. Transects were established in a variety of subzones (from CDFmm, CWHxm1/2, to CWHmm1/2). Soil maps were used to assess sites most vulnerable to climate change (freely drained soils-gravelly-loamy sands, thin soils, low organic material). Over the summer of 2005, 16 sites were selected between Campbell River and Victoria, B.C. on the east coast of Vancouver Island. One of the sites chosen was at Royal Roads University which was located within the CDFmm southern subzone. The point-centered quarter method was employed by laying out a straight line roughly 200 m long with eight systematically spaced points along the center line . This method assumes that trees are randomly distributed within a stand. The distance between these points was set at 20 m within the stand in order to avoid double sampling of trees. At each sampling point, an imaginary line was drawn perpendicular to the starting line and within each segmented quarter, the closest WRC tree was measured (Figure 1).

Figure 1. Typical layout using the plot-centered quarter method in which a center transect is established, and random sampling points along this line are specified. At each sampling point, a perpendicular line is drawn to divide the world into four quarters (I, II, III, IV). Within each quarter, the closest red cedar tree is sampled (Mitchell 2001).



Two increment cores were taken from each WRC tree from either side of the tree. This added to a total of 32 trees sampled per plot on each, and 576 trees sampled in total over all sites.

Classification of tree dieback

In order to classify the extent of damage on a WRC crown, a general classification of damage was employed. A number of different methods were used to classify the extent of dieback.

1) Measurement of height to live crown subtracted from height to tree top will give an indication of the extent of dieback occurring on each tree. Using a vertex hypsometer, distance to crown top and distance to live crown top will be assessed.

2) Light meter (fish eye lens camera) was used to assess the amount of light filtering through the tree canopy (Astrup personal communication, June 17, 2005). The distance to the tree from the camera and the diameter at breast height was also recorded for each tree showing evidence of dieback. Fisheye photos were taken in areas where individual WRC crowns can be clearly distinguished in the picture. Photos must be taken during overcast days, or in early morning, or evening. The Gap Light Analyzer was used to assess the crown openness of each individual dieback tree (Canham 1988); (Fraser *et al*. 1997; Fraser *et al*. 2000). Trees may need to be stratified by age for this procedure.

3) A picture was taken of each tree and the extent of crown dieback assessed on a percentage loss of major branches (Brisco personal communication 2005 (Innes 1990). Trees are rated on a scale of 1-4 according to the amount of dieback in crown (0-25% dieback=4 good, 26-50%=3, 51-75%=2, 76-100%=1 poor).

All three methods will allow for each tree to be generally classified as healthy or stressed, and when linked with increment coring, and direct observation of the condition of each tree in different BEC subzones/ site series, soil types, aspect, elevation, tree age, proximity to roads, and harvesting regimes, the cause of stress may be assessed.

Increment coring

The main idea behind this portion of the project is to undertake a comparison of ring widths within a given BEC subzone in relation to changing historical climatic data. To test this hypothesis increment coring of surviving WRC trees must be completed

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along a transect (trees measured a given distance from the transect line) within dry to wetter subzones (east to west). The cores will be mounted, sanded, and measured for size of earlywood and latewood for each year (Microscope program-Steve Mitchell) to see how ring width changes over time. Once measurements are made, standardization to remove the growth function of each tree will be used (COFECHA, ARSTAN). Rings will then be related with past climate (Ministry of Environment climate records) with particular attention made to historical drought years. An index of summer drought may also be used, such as the 5 year cumulative summer moisture deficit, to assess its correlation to tree growth. It is expected that ring widths should correspond with past climate (narrower rings in drier years (last 2 years especially) and wider rings in wetter years).

Characteristics such as zone/subzone/site series, latitude/longitude, diameter at breast height (dbh), height, height to crown, age, density of stand (#stems/ha and basal area/ha using a prism), related tree species, plant associations (indicator species), exposure, aspect, slope, elevation, moisture regime, nutrient regime, successional stage, tree dominance, and proximity to major roads will also be measured. At each transect, a soil pit was dug (roughly 60cm-1m deep) to assess the soil condition. Depth of the LF and H layers was measured, and a 20x20 cm square sample of the LF layer was sampled for bulk density determination. Using a bulb planter, a known volume of humus was removed to determine bulk density. Finally, within each major horizon, a known volume of soil was sampled and field capacity and permanent wilting point was calculated. Supplementary soil information includes: soil texture, coarse fragment content, depth to water restricting layer, rooting depth, and mesoslope position.

ForWaDy

This model will be used to see how soil moisture and tree stress vary over time when connected to climate models. To assess tree moisture stress, the transpiration deficit index (TDI) will be measured for a stand. This index calculates the difference between the transpiration energy demand of the canopy in relation to the soil-limited actual canopy transpiration (Seely *et al*. 1997). This model was created to act as a submodel of the FORECAST forest ecosystem model (Kimmins *et al*. 1999). The model requires three main types of data: climate, vegetation, and forest floor/ soil data. The data requirements for these three main types are as follows:

Climate data (daily): Mean temperature; solar radiation; total precipitation; and snow fraction.
Vegetation data: Percent cover by conifers & hardwoods; conifer and hardwood leaf area index (LAI); rooting depths for canopy trees; and rooting depths for understory.
Forest floor and soil data: Litter mass per area; humus depth; depth of soil layers (rooting zone); soil texture class of each soil layer; and coarse fragment content of layers.

Preliminary Result
Fieldwork findings

Overall in the established transect at Royal Roads, no major WRC dieback was observed. However, there was some observed dieback on more exposed sites adjacent to roads or in clearings. Preliminary data analysis has been undertaken for each of the 16 sites including the Royal Roads University site. The following general information was observed with regards to the site (Table 1).

Table 1. Site Description

Date (Y/M/D) 05/07/22 / 05/09/12	Surveyors Tanya +Emily / Tanya + Rease
Location (lat/long)	N 48º25.965' W123º28.856'
Elevation (m)	164 m
BEC zone	CDF BEC subzone: mm BEC variant:
Site series	4
Aspect	South
Slope (%)	5
Mesoslope position (a=crest, b=mid-slope, c=toe)	B
Surface topography (a=smooth, b=slightly mounded, c=strongly mounded)	B
Moisture Regime	2-3
Nutrient Regime	Rich
Proximity to major road (m)	approx. 100 m off West Campus Road

In addition, the overall stand density from the site transect was 250 stems/hectare with the following species stand density values (Table 2):

Table 2. Average number of species per hectare found on the Royal Roads site

SPECIES	AVERAGE # SPECIES/ha
Cw (Western Redcedar)	100
Df (Douglas Fir)	50
Hw (Hemlock)	50
Gf (Grand Fir)	50

The following tree characteristics were measured on the transect (Table 3):

Table 3. Tree Survey Form: Point-centered quarter method

Point #	1		2		3		4		5		6		7		8
Dist. (m)	0		20		40		94		114		136		156		176
REDCEDAR SURVEY															
Height (m)															
Tree #1 BL	15.7	TL	22.7	BL	23.2	BL	19.4	BR	43.5	BR	17.5	BR	32.2	BR	(#030210) 18
Tree #2 TL	29.8	TR	21.8	BR	28	BR	29.6	BL	(#030102) 29	TR	44.4	TR	(#030212) 16.1	TL	15.3
Tree #3 TR	13.7	BL	31	TR	20.1	TR	27.5	TL	37.3	TL	38.2	TL	17.1	BL	(#030202) 21.5
Tree #4 BR	29.9	BR	27.1	TL	23.3	TL	21.3	TR	41.5	BL	47.3	BL	43.1	TR	18
Ht to live crown (m)															
Tree #1	4.2		7.7		4.9		8.9		14.6		12.4		18.8		3.7
Tree #2	3.2		5.8		8.9		4.4		10.9		20.6		3.2		5.2
Tree #3	5.6		7.6		12.4		13.4		10.4		19.9		9.1		5.7
Tree #4	7.8		4.5		6.9		7.3		20.3		8.7		14.3		3.8
DBH (cm)															
Tree #1	30.24		27.37		38.83		31.51		79.58		32.47		51.57		25.78
Tree #2	60.16		23.87		44.25		54.11		68.12		100.90		24.51		19.10
Tree #3	18.78		63.03		26.10		37.24		75.76		65.57		28.65		28.97
Tree #4	22.92		61.12		40.11		33.42		79.26		113.95		115.86		32.79
Dist. to tree from plot center (m)															
Tree #1	3.64		5.35		4.64		4.2		5		9.4		10.4		6.1
Tree #2	8.12		4.82		17.2		8.6		19.2		4		10.5		23.7
Tree #3	8.32		18.9		14.4		11.7		8.2		8.3		6.9		14.8
Tree #4	5.8		14.7		8.8		9.2		5.7		10		10.7		11
Dieback (%)															
Tree #1	0		0		0		0		0		0		0		0
Tree #2	0		0		0		0		0		0		0		0
Tree #3	0		0		0		0		0		0		0		0
Tree #4	0		0		0		0		0		0		0		0
Tree dominance (1=dominant, 2=co-dominant, 3=intermediate, 4=suppressed)															
Tree #1	4		3		3		4		2		4		3		4
Tree #2	2		3		3		3		3		2		4		4
Tree #3	4		2		3		4		2		2		4		4
Tree #4	3		2		3		4		2		2		2		4
Pest information (1=insect attack, 2=obvious rot/ pathogen, 3=harvesting damage)															
Tree #1	1								1				2		
Tree #2	1								1 ROTTEN PITH		1 ^ 2				
Tree #3					1		1		1 ROTTEN PITH		ROTTEN PITH		1		
Tree #4	1		ROTTEN PITH		1						1		2		

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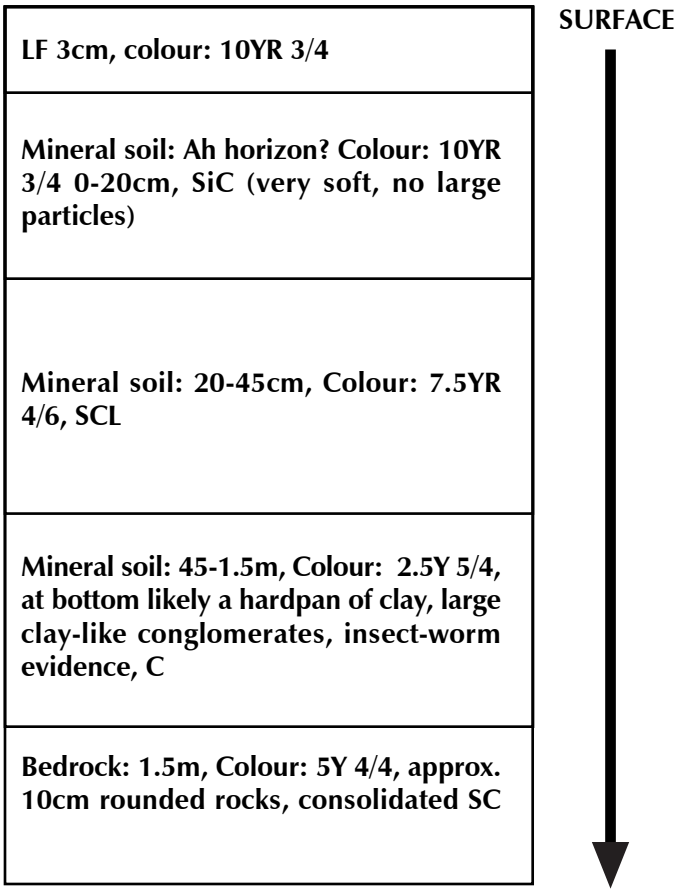
Understory vegetation was noted and the following major species were present: Vanilla leaf (*Achlys triphylla*); Fragrant bedstraw (*Galium triflorum*); Daphne (introduced); Holly (introduced); Swordfern (*Polystichum munitum*); Bunchberry (*Cornus canadensis*); Salal (*Gaultheria shallon*); Dull Oregon grape (*Mahonia nervosa*); Red huckleberry (*Vaccinium parvifolium*); and Trailing blackberry (*Rubus ursinus*). Based on the Land Management Handbook #28, the estimated understory foliage cover is 50% at this site (Green and Klinka 1994).

Four samples were removed for soil bulk density determination, which were sampled randomly around the main soil pit. The main soil pit was dug at a random location along the transect to classify the soil horizons, texture major horizons, and determine the depth to an impenetrable layer. In regards to the soil pit, the following soil profile was observed (Figure 2):

Figure 2. Soil profile observed



The litter layer was relatively thin, and a thick Ah horizon was underneath the litter material. The texture of the Ah horizon was silty clay therefore, very fine textured. Underlying the Ah, there was a B horizon which had a sandy clay loam texture. The deeper BC horizon was entirely composed of clay which was very dense and hard. Underlying this layer, there was a C horizon of parent material which had a sandy clay texture. In regards to soil bulk density (g/cm^3) values, the following table summarizes the results found for litter/ F layers, humus layers and top 10 cm mineral soil layers using the excavation method (Table 4).

Table 6. Bulk density values (g/cm^3)

Soil Layer	Bulk Density Value (g/cm^3)
Litter/ F 1	0.126641
Litter/ F 2	0.103797
Litter/ F 3	0.152863
Litter/ F 4	0.048708
Humus 1	0.376249
Humus 2	0.338675
Mineral 1	1.266856
Mineral 2	1.40984
Mineral 3	1.222056
Mineral 4	0.757662

At this stage of the analysis, the tree cores taken from the site have not yet been analyzed. The cores are currently being mounted and sanded in preparation for microscope analysis. In the coming months, ring widths for each core will be recorded and records of temperature and precipitation will be compared to the ring widths to determine if correlation exists between each of these variables. In addition, the moisture model, ForWaDy, which uses the soil information collected on site, will be used to calculate the transpiration deficit index (TDI) for the site to see whether or not the TDI values correspond to the observed tree ring widths. It is expected that sites with observed dieback should have higher TDI values compared to sites where red cedar appear healthy and no dieback is present. Once this analysis is completed for all 16 sites on eastern Vancouver Island, postulations for the cause of this dieback will be proposed. If all the analysis progresses as planned, this thesis will be defended in the fall of 2006.

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OUTLOOK FOR 2006

ESAC will continue to track and review research proposals and projects on CFB Esquimalt properties, sponsor the annual workshop, prepare an annual report and update the ESAC website.

In 2006, the ESAC website will continue to undergo several updates to ensure that information on current ESAC projects is readily accessible to MARPAC personnel. The ESAC Research and Collection Application Form along with Environmental Assessment Project Evaluation Form will be available for downloading from the website. In addition, the 2006 ESAC research and collection permit will include a liability clause which will require all persons requesting access to CFB Esquimalt land to have public liability insurance.

In addition, the Committee will confer on issues related to the upgrade and maintenance of the Rocky Point Forest Canopy Research Station and provide advice to MARPAC on environmental issues occurring on CFB Esquimalt properties. The Letter of Understanding for ESAC will be up for renewal in 2006 including a review of the Committee's Terms of Reference.

ACKNOWLEDGEMENTS

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- All 2005 ESAC permit holders for their cooperation and contribution to the knowledge of the environmental conditions, flora and fauna on CFB Esquimalt properties.
- The Canadian Forest Service – Pacific Forestry Centre for coordinating and hosting the annual workshop.
- All of the individuals who presented and attended the ESAC annual workshop in February 2006. Your attendance and participation are valued.

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