2006 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:
Sharp-tailed Snake (*Contia tenuis*)

Top Right:
Gum weed (*Grindelia integrifolia)*

Bottom:
Northern Pygmy-Owl (*Glaucidium gnoma)*

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# EXECUTIVE SUMMARY

The Department of National Defence (DND) Environmental Science Advisory Committee (ESAC) for CFB Esquimalt was established in 1994 as a multi-agency technical advisory committee that reviews and recommends proposals from researchers and other interested parties to carry out natural resources research on CFB Esquimalt properties. Every year, ESAC collects, reports, and archives the findings of the research activities in an 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 2006, the Committee reviewed twenty-two proposals to conduct research and collection activities on CFB Esquimalt properties including the following studies:

- Monitoring forest floor indicators: salamanders, slugs and snails;
- Local abundance, performance and adaptation of butterflies in Garry oak meadows;
- The mortuary landscape of southern Vancouver Island;
- Effects of browsing and competition on Garry oak (*Quercus garryana*) recruitment success;
- Western Bluebird nestbox program; and
- Landscape and environmental drivers of plant distribution in Garry oak ecosystems.

Each proposal was reviewed by ESAC for scientific content and forwarded to the MARPAC Formation Environment Office and to Range Control personnel to ensure that the proposed activities would not result in any adverse environmental effects or interfere with military operations and activities. Subsequently, each permit was sent to the Base Commander for final review, approval and permit issue. 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 2006, the "Environmental Assessment Project Evaluation Form" accompanied all ESAC research and collection applications. The project evaluation form assisted Formation Environment Office personnel in assessing the environmental effects of the proposed research project according to the Canadian Environmental Assessment Act.

Where applicable, wildlife and sensitive ecosystem inventory data findings obtained from 2006 ESAC research projects were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. This information, combined with existing environmental data, was used to generate 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 the sharing of research findings collected on CFB Esquimalt land in 2006, the Committee hosted its ESAC Annual Workshop on February 8th, 2007 at the Pacific Forestry Centre, Victoria, B.C. Ten presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and restoration were given to government and non-government organizations. The 2006 ESAC Annual Workshop boasted the highest turnout to date with over 70 individuals in attendance.

**Permit P089-06.** Wildlife Tree Stewardship Initiative: Bald Eagle Nest Tree Monitoring at CFMETR (page 43)

# TABLE OF CONTENTS

# 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 of the Canadian Pacific Fleet and other key military units.

MARPAC is one of the largest government organizations in the Pacific Region, with approximately 4,000 military and 2,800 civilians working at the base, which covers over 10 hectares. With approximately 4,200 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 B.C.

MARPAC properties, while utilized for a variety of military purposes, including industrial activities, training exercises, and communications infrastructure, are often relatively undisturbed by human impact. A number of CFB Esquimalt properties support remnants of sensitive ecosystems such as Coastal Douglas-fir forests and Garry Oak meadows and provide unique opportunities for scientists to conduct an array of environmental studies.

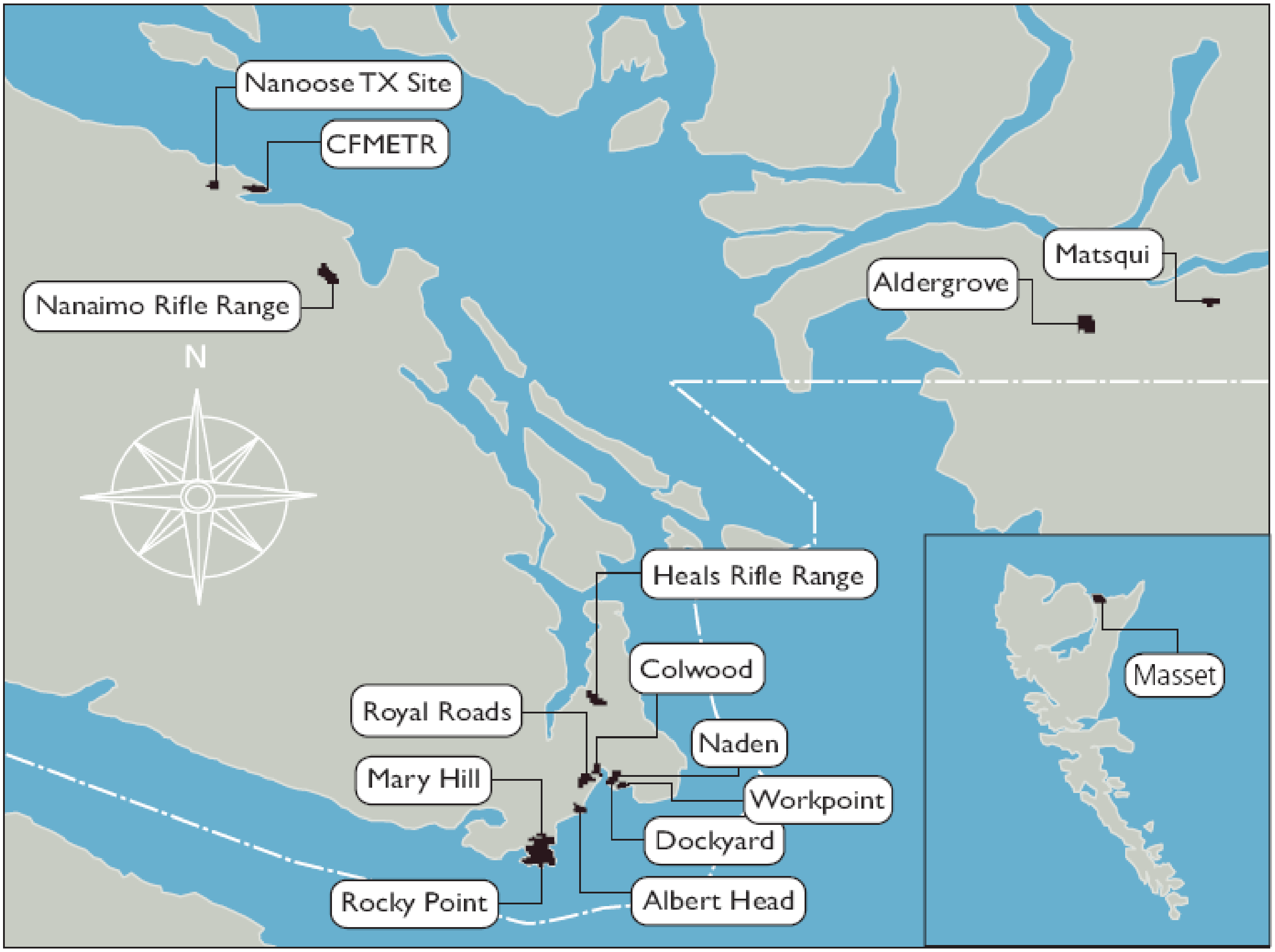
Table 1. CFB Esquimalt properties - total area in hectares

| | |
|---|---|
| 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 P116-06. Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems (page 71)

Permit P044-06. Purple Martin Origins and Relationships (page 25)

# CFB ESQUIMALT PROPERTIES




# BACKGROUND

Prior to 1994, research projects were undertaken by various individuals and organizations on CFB Esquimalt properties. Research was *ad hoc* and the findings were not readily available to MARPAC personnel for use in environmental management and decision making. The recognized need for a process to track 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 environmental studies on CFB Esquimalt properties in conjunction with other environmental projects funded by DND.

In 2006 the ESAC Letter of Understanding between DND CFB Esquimalt and member agencies, was renewed for another five-year period (2006-2011).

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 technical advisory committee composed of the following members:

- **CFB Esquimalt, Formation Safety and Environment**
- **CFB Esquimalt, Base Construction Engineering Office**
- **Canadian Forest Service, Natural Resources Canada**
- **Canadian Wildlife Service, Environment Canada**
- **British Columbia Ministry of Forests and Range**
- **University of Victoria**
- **Royal Roads University**

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

**Permit P116-06.** Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems (page 71)

# 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 and environmental studies on its properties. The committee maintains a formal permitting system to facilitate the 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: observations; photography; surveys and inventories; tagging and banding; collection of wildlife specimens; and installation of scientific monitoring structures. Individuals interested in conducting environmental studies on CFB Esquimalt properties can obtain more information by contacting a member of ESAC at (250) 363-0614.

Each research proposal is sent to and reviewed by ESAC. Subsequently, proposals are sent to the MARPAC Safety and Environment Office and Range Control personnel to ensure that the proposed activities do not result in any adverse environmental effects or interfere with military operations and activities. Lastly, each permit is sent to the Base Commander for final review, approval and permit issue.

## 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 the 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 direction and insight 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 for 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 2006

**Permit 114-06.** Environmental Controls on Overstory Recruitment of Garry Oak at Rocky Point (page 71)

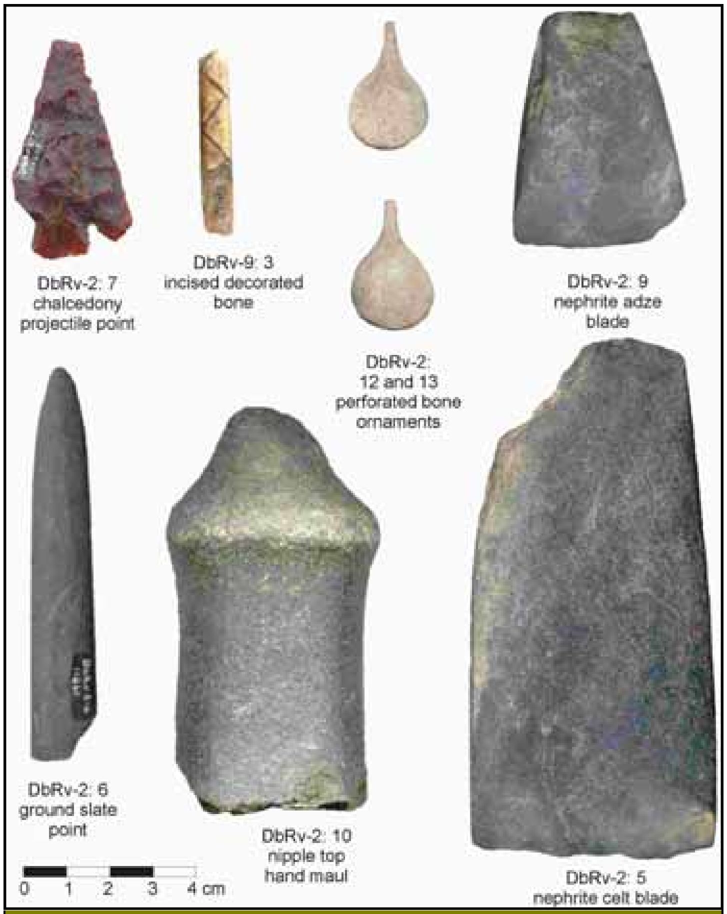
## ADVISORY AND REPORTING ACTIVITES

This year was the twelfth full year of activity for ESAC. The committee met three times during 2006 to review project proposals and status, plan reporting activities and advise CFB Esquimalt on other environmental issues occurring on CFB Esquimalt properties.

The 2005 ESAC Annual Report was produced and 150 hard-copy reports were distributed to ESAC permit holders, military bases across Canada, and other government and non-government agencies throughout B.C. The ESAC web-site was restructured with the intent of providing information on projects active in the current year. Active and/or archival ESAC projects can be queried by year, location or permit number. In addition, all ESAC Annual Reports from 1995 to 2005 are available for download from the website.

The Environmental Assessment (EA) Project Evaluation Form, developed in 2004-05, accompanied all 2006 ESAC research and collection applications. The Project Evaluation Form proved to be useful when screening proposals for potential activities that may trigger the environmental assessment process.

The 2006 ESAC Annual Workshop, was held February 8th, 2007 at the Pacific Forestry Centre. Ten presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and restoration were given. A wide variety of representatives were present, including the B.C. Ministry of Environment, 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.




**Permit P104-06.** The Mortuary Landscape of Southern Vancouver Island, B.C. (page 55)

**Permit P074-06.** Wildlife Tree Stewardship Program (page 29)

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

| Year | Proposals | Permits |
|---|---|---|
| 2006 | 22 | 21 |
| 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 22 proposals were received and reviewed by ESAC. Of the 22 proposals received, 21 permits were issued with 15 being renewals of previous years. Table 2 shows the number of proposals received and permits issued annually since 1995.

The diversity of projects conducted in 2006 enhanced the knowledge and understanding of the wildlife and sensitive ecosystems occurring on CFB Esquimalt properties. In addition, research findings collected under ESAC permits contributed to the sound decision making and environmental management by CFB Esquimalt personnel. The knowledge gained could potentially also be applied to 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 2006 under the auspices of ESAC.

Table 3. Summary of ecological research conducted under ESAC in 2006.

| ESAC Permit Title | Project Leader | Permit # | Property (Abbreviations Below) |
|---|---|---|---|
| 2006 Rocky Point Bird Observatory Society Activities | Paul Levesque | P003-06* | AH, HR, RP, RR |
| Monitoring of Winter Moth (*Operophtera brumata*) and the Parasites Introduced for its Control | Imre S. Otvos | P031-06* | NA |
| Purple Martin (*Progne subis*) Origins and Relationships | Cam Finlay | P044-06* | CO, RR |
| 2006 Gypsy Moth Survey | Douglas Kyle | P071-06 | CFMETR, DY, NT, RP, RR, WP |
| Wildlife Tree Stewardship Program (WiTS) | Gwen Greenwood | P074-06* | RP, AH, CO |
| Garry Oak (*Quercus garryana)* Acorn Production Study | Paul Courtin | P079-06* | CFMETR, RP |
| Royal Roads University Canopy and Microclimate Station - Continuing Upgrade | Bill Dushenko | P087-06* | RP (FCRS) |
| Forest Floor Monitoring on Vancouver Island, British Columbia | Kathy Paige | P088-06* | RP, RR |
| Bald Eagle Nest Tree Monitoring/Wildlife Tree Stewardship Initiative (WiTS) & Bird Counts | Sandra Gray | P089-06* | CFMETR |
| Distribution, Abundance, and Adaptation of Butterflies at their Northern Range Limit | Jessica Hellmann | P090-06* | RP, CFMETR |
| Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point | Darcy Mathews | P104-06* | AH, RP |
| Phantom Orchid Survey at Heals Rifle Range | Trudy Chatwin | P105-06* | HR |
| Western Bluebird Nestbox Project at CFMETR Nanoose Bay | Trudy Chatwin | P108-06* | CFMETR |
| Influence of Water Conditions on the Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa*) at Maintenance Detachment Aldergrove | Rene McKibbin | P109-06* | AL |
| Environmental Controls on Overstory Recruitment of Garry Oak at Rocky Point | Ze'ev Gedalof | P114-06* | RP |
| Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems | Patrick Lilley | P116-06 | AH, HR, RP, WP |
| Effects on Marine Foraging River Otters in the Puget Sound/Georgia Basin Region of Southeast Vancouver Island | Daniel Guertin | P117-06 | CO, RP, RR |
| Aldergrove Observation Wells | Gwyn Graham | P118-06** | AL |
| Distribution and Taxonomy of a Mushroom *Pholiota punicea* on Southern Vancouver Island | Adolf Ceska | P119-06 | AH, RP, RR, CFMETR. HR |
| Local Versus Regional Determinants of Community Composition in Garry Oak Ecosystem Patches | Joe Bennett | P120-06 | CFMETR |
| BC Coastal Waterbird Survey for Nanoose Harbour | Roger Taylor | P122-06 | CFMETR |

**Properties: AH:** Albert Head; **AL:** Aldergrove; **CFMETR:** Canadian Forces Maritime Experimental and Test Ranges; **CO:** Colwood; **DY:** Dockyard; **HR:** Heals Rifle Range; **NA:** Naden; **RP:** Rocky Point; (**FCRS**-Forest Canopy Research Station); **RR:** Royal Roads; **WP:** Work Point.

* Renewed from previous years ** Project was not initiated and omitted

Rocky Point Forest Canopy Research Station

**Permit P003-06.** Rocky Point Bird Observatory Society Activities (page 12)

## 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 the canopy, in addition to ladders leading to higher levels in the canopy. The canopy station towers over 30 m above the northern edge of a one hectare Ecological Monitoring and Assessment Network (EMAN) plot. The station has also been supported by an Environment Canada microclimate station originally configured to measure temperature and relative humidity within the canopy. An Operating Committee has been responsible for the station's maintenance, use and overseeing its operations.

Ownership and responsibility for the infrastructure at the Rocky Point Forest Canopy Research 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 has been developed. This has included 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 by a 20 m tower on a knoll adjacent to the canopy station.

A safety inspection of the canopy trees, completed in 2003, recommended a major upgrade and overhaul of the canopy platforms and access system. Following a detailed assessment by the Operating Committee of the work needed to complete this upgrade in 2004, approval of the terms of reference for completing this work was given by the Department of National Defence in early 2005.

The upgrade commenced in early August of 2005 and was completed in early 2006.

The platforms and rope-pulley systems were decommissioned from two of the five trees, leaving a three-tree canopy system which is easier to maintain. This included removing all strapping, webbing, ladders and platforms. The removal of the original deadwood from the remaining trees was conducted in a controlled manner to minimize the impact to the ground below. This removal will benefit the trees' overall health, as well as making them safe for access and use. Old platform systems were dismantled and the materials sorted for reuse.

The upgrading began with the installation of aluminum ladder sections, bolted together from the ground up to the trees with new tubular webbing and using blocks in order to minimize the impact of structures on the trees. 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 on the first platform, only the one tie-in is then needed to access the higher platforms. All equipment haul lines and pulleys were replaced and safety cables installed. Stainless steel ladder covers and locks were also installed to prevent unauthorized access and warning signs are posted.

Access is done by wearing a full-body safety harness and helmet using a mechanical prussic (Petzl Shunt) on the safety line. Exiting the station is done with a mechanical lowering device (Petzl Stop). These devices will ensure safety and reduce user error, and a new revised safety protocol is currently being developed for these upgrades.

This work has facilitated the installation of the upgraded microclimate station equipment which will be fully operational by summer 2007 (see report P087-06).

# GEOGRAPHIC INFORMATION SYSTEM (GIS)

All wildlife and sensitive ecosystem inventory data findings obtained from 2006 ESAC research projects were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. These results, combined with existing environmental data, were used to generate areas maps that are readily available to MARPAC personnel. Information presented on these maps includes the location of Species At Risk, sensitive ecosystems, wetlands and 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.

The location of each ESAC project research site was added to the GIS and subsequently delineated on property maps made available to CFB Esquimalt personnel to reduce interference with military training and activities. The latter maps are available on the ESAC website. Information from ESAC projects and other environmental projects were used to update the natural resources GIS layers.

**Permit P109-06.** Influence of Water Conditions on the Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa*) (page 63)

DEPARTMENT OF NATIONAL DEFENCE

ESAC

ENVIRONMENTAL SCIENCE ADVISORY COMMITTEE

CANADIAN FORCES BASE ESQUIMALT

# SCIENTIFIC REPORTS

## Research and Collection Activities Conducted in 2006

# 2006 Rocky Point Bird Observatory Society Activities

***Paul Levesque***

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*Telephone: (250) 337-1782 • Email: tuff-puffin@shaw.ca*

***Permit #:*** *P003-06*
***Location:*** *Albert Head, Heals Rifle Range, Rocky Point and Royal Roads University*

## 1. Bird Banding Workshops

**Project Leader:** Paul Levesque
**Location:** Royal Roads University
**Start Date:** 04 April 2006
**Completion Date:** 09 April 2006

### Introduction

The process of capturing wildlife and the marking and collecting of data and samples from individual birds require specialized training to ensure animal safety and successful research results. Since 2003, the Rocky Point Bird Observatory (RPBO) has been offering short training programs to teach the correct techniques in bird capture, banding, ageing, and in morphometric measurements. In 2006, the bird banding workshop was again offered to the public. The Canadian Wildlife Service (CWS) and RPBO also hosted an advanced banding workshop for B.C. members of the Canadian Migration Monitoring Network (CMMN).

### Study Area and Methods

The workshop consisted of lectures, lab sessions, and field work at Royal Roads University. For the field component, seven mist nets were used to capture songbirds that were used for live teaching demonstrations. In 2006, the workshop instructor was Peter Pyle, the author of the primary reference for banding projects in North America (Pyle 1997).

Bird banding at Rocky Point

### Results

Eighteen participants attended the public workshop, and fourteen participants took part in the CWS/CMMN advanced banding workshop. During the field component, eighty-nine birds comprising sixteen species were banded. Interestingly, ten of the birds captured were banded previously at Royal Roads; five birds were from previous banding workshops, and five birds had been banded during RPBO's Monitoring Avian Productivity and Survival (MAPS) project (from the summers of 2004 and 2005). Birds were banded by holders of valid Canadian Wildlife Service banding permits, or by the students under the supervision of permitted banders. The data collected were sent to the Canadian Wildlife Service. Detailed banding data are either available by request from RPBO, or via the CWS Bird Banding Office in Ottawa.

## Discussion

The bird banding workshop has been very successful in providing specialized training to people working on bird research projects throughout western North America. The Royal Roads site is an ideal location for the workshops.

## Conclusions

We plan to offer a bird banding workshop to the public in the spring of 2008. A number of RPBO's core volunteers have participated in these workshops, and as a result, they have enhanced their expertise as well as the quality of their commitment to the programs. Note that the CWS/CMMN advanced workshops are not held annually and the locations of the event varies each time.

## References

Pyle, P. 1997. Identification Guide to North American Birds, Part I. Bolinas, CA: Slate Creek Press.

**Canadian Bird Banding Office**
National Wildlife Research Centre
Canadian Wildlife Service
1125 Colonel By Drive (Raven Road)
Ottawa, Ontario
K1A 0H3
613-998-0524

http://www.cws-scf.ec.gc.ca/nwrc-cnrf/default.asp?lang=En&n=B197CA34-0

## 2. Nocturnal Owl Monitoring

**Project Leader:** Paul Levesque
**Location:** Rocky Point
**Start Date:** 20 September 2006
**Completion Date:** 31 October 2006

## Introduction

Forest dwelling owls are increasingly becoming a conservation concern throughout much of North America. As predators, the group feeds at high trophic levels, limiting population densities at the landscape level and making them susceptible to the bioaccumulation of toxins. In B.C., 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 labour-intensive and expensive. In the fall of 2002, an attempt was made to conduct monitoring by intercepting owls during fall migration at Rocky Point; this proved to be successful for Northern Saw-whet Owls and to a lesser extent Barred Owls.

## Study Area and Methods

Owl monitoring at Rocky Point was conducted during the first five hours of darkness for thirty evenings, from 24 September to 31 October 2006. Six mist nets and an audio lure broadcasting Northern Saw-whet Owl calls were used to attract and capture migrating owls. Once captured, the owls were removed from the nets, marked with aluminum leg bands, morphometric measurements were taken, the birds were aged, and then released.

## Results

During the 2006 study period, 296 Northern Saw-whet Owls and six Barred Owls were banded during 121 net hours (length of time nets were opened). The capture rate of Northern Saw-whet Owls was 0.41 birds/net hour. The capture rate was similar to the average from previous years, although it was significantly higher than what we encountered in 2005 (0.11 birds/net hour). Of the 296 Northern Saw-whet Owls banded, 86% were hatch year birds, 7% were second year, and 7% were after second year. Annual productivity (measured as the ratio of hatch year to adult birds) was the highest since monitoring began in 2002 (Figure 1). Five of the six Barred Owls captured in 2006 were hatch year birds; the remaining bird was the first adult Barred Owl captured since the program began in 2002.

## Rocky Point Bird Observatory Society Activities

Of note was the report of a bird found on 23 October, 2006 near Matador, Saskatchewan, that had been banded at Rocky Point on 27 September 2003. Matador is more than 1,150 km from Rocky Point.

### Discussion

The number of Northern Saw-whet Owls banded in 2006 increased greatly from the previous year. In 2005, only 78 Northern Saw-whet Owls were captured over the same number of net hours. The capture rate in 2005 was 0.11 owls/net hour. The higher rate in 2006 suggests that the breeding season had been very successful, as indicated by the fact that 86% of the birds captured were young of the year.

### Conclusions

This project produces invaluable information on Northern Saw-whet Owls and we intend on continuing the study in the fall of 2007.

### References

RPBO Website: http://www.rpbo.org/nswo.html

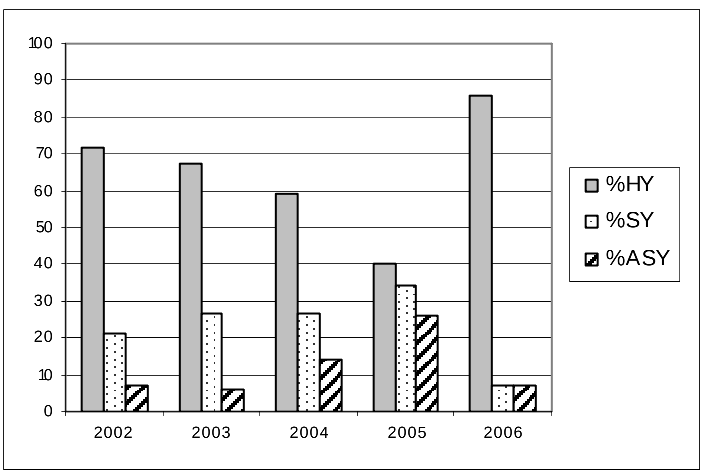


Figure 1. Age structure of Northern Saw-whet Owls sampled during the fall at Rocky Point, 2002-2006. The three age classes are: HY = Hatch Year birds (young of the year); SY = Second Year birds (at least one year of age); ASY = After Second Year birds (at least two years of age).

## 3. Christmas Bird Count

**Project Leader:** David Allinson
**Location:** Albert Head, Heals Rifle Range and Rocky Point
**Start Date:** 16 December 2006
**Completion Date:** 23 December 2006

### Introduction

Since 1900, the Christmas Bird Count (CBC) has been an annual event attracting thousands of birders across North America to census winter bird populations within a 24 km circle. Long-term trends are analyzed and compiled from more than 1800 counts across Canada by Bird Studies Canada. Until 2003, significant habitat types found on Department of National Defence properties were off-limits to Victoria and Sooke CBC compilers. For the fourth year in a row, ESAC Permit P003-06 provided access for members of the Rocky Point Bird Observatory and Victoria Natural History Society to three key DND sites for the Victoria and Sooke Christmas Bird Counts.

### Study Area and Methods

In 2006, bird surveys were conducted at Albert Head and Heals Rifle Range (on 16 December) and at Rocky Point (23 December). Total survey effort by property varied from less than two hours at Heals Rifle Range, to four hours at Albert Head and seven hours at Rocky Point. At each location, participants recorded the total number of birds observed by species.

### Results

Observers at Albert Head recorded sixty-four species and 20,687 individuals, seventy species and 10,880 individuals were found at Rocky Point and Heals Rifle Range produced a total of twenty-two species and 205 individuals. See Tables 1, 2 & 3 for details.

## Discussion

In the past, the Albert Head site supported high species richness (total number of species) with as many as ninety bird species using the area in winter both for shelter and feeding (*pers obs*.). Both terrestrial and pelagic species are well represented there. Species richness in 2006 was about average, but the numbers of individual birds was higher than normal. The increase in numbers may in part have been due to favourable weather conditions which allowed good visibility to census offshore seabirds. Because of the ideal conditions, an estimated 9,000 Mew Gulls and 7,500 Common Murres were tallied; these two species accounted for almost 80% of the total number of birds counted at Albert Head. Uncommon birds that were observed included: 365 Ancient Murrelets, 101 Bonaparte's Gulls, three Northern Shovelers, three Hermit Thrushes, two Turkey Vultures, one Merlin, one Peregrine Falcon, one Spotted Sandpiper and one Cassin's Auklet.

At Heals Rifle Range, species richness was consistent with prior results. However, the number of individuals rebounded from a low of eighty-six birds in 2005. Birds of interest observed included: six Hooded Mergansers, three Red-tailed Hawks, and one Lincoln's Sparrow.

The Rocky Point site again demonstrated its regional significance; the richness of species encountered represented almost 60% of the total Sooke CBC species tally (seventy of 118 species). In addition, Rocky Point contributed more than a third of the total individuals tallied on the Sooke CBC (10,880 out of 31,495). A number of uncommon birds or significant totals were recorded here: 650 Bonaparte's Gulls, thirty Black Oystercatchers, thirteen Harlequin Ducks, four Sharp-shinned Hawks, four Herring Gulls, one Turkey Vulture, one Peregrine Falcon, one Sanderling, and one Northern Shrike.

## Conclusions

The 2006 CBC results from these three sites produced a total of eighty-two species and 31,772 individuals (compared with seventy-five species and 9,657 individuals in 2005). It is quite evident that the continued monitoring of these sites is worthwhile as a means of determining long-term trends for wintering birds on southern Vancouver Island.

## Rocky Point Bird Observatory Society Activities

## References

Victoria Natural History Society Christmas Bird Count web site: http://www.vicnhs.bc.ca/cbc/

Bird Studies Canada National Christmas Bird Count web site: http://www.bsc-eoc.org/national/cbcmain.html

## Acknowledgements

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

Table 1. Albert Head Christmas Bird Count

| Species | # of sightings |
|---|---|
| Mallard | 22 |
| Northern Shoveler | 3 |
| Ring-necked Duck | 9 |
| Harlequin Duck | 3 |
| Surf Scoter | 28 |
| White-winged Scoter | 2 |
| Bufflehead | 33 |
| Common Goldeneye | 1 |
| Hooded Merganser | 4 |
| Common Merganser | 6 |
| Red-breasted Merganser | 19 |
| Pacific Loon | 1 |
| Common Loon | 1 |
| Horned Grebe | 4 |
| Red-necked Grebe | 5 |
| Western Grebe | 12 |
| Brandt's Cormorant | 575 |
| Double-crested Cormorant | 36 |
| Pelagic Cormorant | 12 |
| Great Blue Heron | 2 |
| Turkey Vulture | 2 |
| Bald Eagle | 9 |
| Red-tailed Hawk | 1 |
| Merlin | 1 |
| Peregrine Falcon | 1 |
| Spotted Sandpiper | 1 |
| Bonaparte's Gull | 101 |
| Mew Gull | 9000 |
| Thayer's Gull | 12 |

## Rocky Point Bird Observatory Society Activities

Table 1. continued

| Species | # of sightings |
|---|---|
| Glaucous-winged Gull | 2500 |
| Common Murre | 7500 |
| Pigeon Guillemot. | 4 |
| Marbled Murrelet | 2 |
| Ancient Murrelet | 365 |
| Cassin's Auklet (*) | 1 |
| Rhinoceros Auklet | 3 |
| Belted Kingfisher | 1 |
| Downy Woodpecker | 2 |
| Hairy Woodpecker | 1 |
| Northern Flicker | 7 |
| Steller's Jay | 4 |
| Common Raven | 6 |
| Chestnut-backed Chickadee | 45 |
| Bushtit | 13 |
| Red-breasted Nuthatch | 1 |
| Brown Creeper | 2 |
| Bewick's Wren | 2 |
| Winter Wren | 7 |
| Golden-crowned Kinglet | 95 |
| Ruby-crowned Kinglet | 4 |
| Hermit Thrush | 3 |
| American Robin | 47 |
| Varied Thrush | 14 |
| European Starling | 5 |
| Cedar Waxwing | 14 |
| Spotted Towhee | 29 |
| Fox Sparrow | 11 |
| Song Sparrow | 6 |
| Golden-crowned Sparrow | 15 |
| Dark-eyed Junco | 39 |
| Purple Finch | 5 |
| House Finch | 6 |
| Pine Siskin | 3 |
| House Sparrow | 19 |
| **Total Number of Birds** | **20687** |
| **Total Species** | **64** |

*# of observers: 3* *Date: 16 Dec 2006*
*# hours on foot: 4* *Distance (on foot): 5 km*

Table 2. Heals Rifle Range Christmas Bird Count

| Species | # of sightings |
|---|---|
| Canada Goose | 49 |
| Mallard | 16 |
| Bufflehead | 10 |
| Hooded Merganser | 6 |

Table 2. continued

| Species | # of sightings |
|---|---|
| Bald Eagle | 1 |
| Red-tailed Hawk | 3 |
| Glaucous-winged Gull | 58 |
| Northern Flicker | 6 |
| Pileated Woodpecker | 1 |
| Steller's Jay | 3 |
| Common Raven | 7 |
| Chestnut-backed Chickadee | 3 |
| Winter Wren | 1 |
| Ruby-crowned Kinglet | 2 |
| American Robin | 5 |
| Varied Thrush | 1 |
| European Starling | 5 |
| Fox Sparrow | 3 |
| Song Sparrow | 7 |
| Lincoln's Sparrow | 1 |
| Golden-crowned Sparrow | 11 |
| Dark-eyed Junco | 6 |
| **Total Number of Birds** | **205** |
| **Total Species** | **22** |

*# of observers: 2* *Date: 16 Dec 2006*
*# hours on foot: 1.75* *Distance (on foot): 3 km*

Table 3. Rocky Point Christmas Bird Count

| Species | # of sightings |
|---|---|
| Canada Goose | 2 |
| American Wigeon | 10 |
| Mallard | 6 |
| Ring-necked Duck | 3 |
| Harlequin Duck | 13 |
| Surf Scoter | 60 |
| Bufflehead | 270 |
| Common Goldeneye | 8 |
| Hooded Merganser | 14 |
| Common Merganser | 16 |
| Red-breasted Merganser | 2 |
| Pacific Loon | 2 |
| Common Loon | 3 |
| Horned Grebe | 1 |
| Red-necked Grebe | 15 |
| Western Grebe | 122 |
| Brandt's Cormorant | 1075 |
| Double-crested Cormorant | 125 |
| Pelagic Cormorant | 22 |
| Great blue Heron | 2 |
| Turkey Vulture | 1 |

**Table 3. continued**

| Species | # of sightings |
|---|---|
| Bald Eagle | 16 |
| Sharp-shinned Hawk | 4 |
| Red-tailed Hawk | 1 |
| Peregrine Falcon | 1 |
| Black Oystercatcher | 30 |
| Spotted Sandpiper | 1 |
| Black Turnstone | 8 |
| Sanderling | 1 |
| Wilson's Snipe | 1 |
| Bonaparte's Gull | 650 |
| Mew Gull | 300 |
| Herring Gull | 4 |
| Thayer's Gull | 2200 |
| Western Gull | 1 |
| Glaucous-winged Gull | 225 |
| Common Murre | 4575 |
| Pigeon Guillemot. | 6 |
| Marbled Murrelet | 4 |
| Ancient Murrelet | 24 |
| Belted Kingfisher | 2 |
| Downy Woodpecker | 5 |
| Hairy Woodpecker | 2 |
| Northern Flicker | 22 |
| Pileated Woodpecker | 2 |
| Northern Shrike | 1 |
| Steller's Jay | 4 |
| Northwestern Crow | 12 |
| Common Raven | 8 |
| Chestnut-backed Chickadee | 9 |
| Red-breasted Nuthatch | 1 |
| Brown Creeper | 3 |
| Bewick's Wren | 3 |
| Winter Wren | 17 |
| Marsh Wren | 1 |
| Golden-crowned Kinglet | 55 |
| Ruby-crowned Kinglet | 3 |
| American Robin | 33 |
| Varied Thrush | 10 |
| European Starling | 13 |
| Spotted Towhee | 5 |
| Savannah Sparrow | 2 |
| Fox Sparrow | 2 |
| Song Sparrow | 7 |
| Golden-crowned Sparrow | 2 |
| Dark-eyed Junco | 4 |
| Red-winged Blackbird | 7 |

**Table 3. continued**

| Species | # of sightings |
|---|---|
| Pine Siskin | 20 |
| Gull spp | 800 |
| Iceland Gull | 1 |
| **Total Number of Birds** | **10880** |
| **Total Species** | **70** |

| | |
|---|---|
| *# of observers: 3* | *Date: 23 Dec 2006* |
| *# hours on foot: 7* | *Distance (on foot): 8 km* |
| *# hours (by car): 0.5* | *distance (by car): 8 km* |
| *# hours (by boat): 1* | *distance (by boat): 10 km* |
| *# hours (owling): 1* | *distance (owling): 2 km* |

## 4. Fall Songbird Migration Monitoring

**Project Leader:** Paul Levesque
**Location:** Rocky Point
**Start Date:** 21 July 2006
**Completion Date:** 18 October 2006

### Introduction

The migration monitoring projects at Rocky Point collect data on population trends, and over time provide benchmark data for determining population changes at the landscape level. Data collected at Rocky Point cover coastal BC and Alaska, but when the data is combined with data collected from the other twenty-three banding station across Canada, the status of migrating songbirds can be assessed at a national scale. The fall migration monitoring of songbirds started in 1994 at Rocky Point; thus 2006 was the 13$^{th}$ year of monitoring.

### Study Area and Methods

The fall migration monitoring employed thirteen mist nets which were opened thirty minutes before sunrise and run for six hours each day between 21 July and 18 October. Birds captured in the mist nets were banded, sexed, aged, measured for a number of morphometric features, and released. Each day, a standardized census route was walked and general observations on all birds present in the area were recorded (Derbyshire 2000).

## Rocky Point Bird Observatory Society Activities

The 2006 fall migration monitoring project was the seventh year following a standardized monitoring protocol.

### Results

During the fall of 2006, monitoring was conducted on seventy-seven days between 21 July and 18 October. Overall 3,068 birds (comprising sixty species). The five most commonly banded species were: Ruby-crown Kinglets (398), Pacific-sloped Flycatchers (214), Golden-crowned Kinglets (201), Lincoln's Sparrows (174) and Wilson's Warblers (166). A number of birds uncommon on Vancouver Island were also banded, including White-throated Sparrows (3), Northern Waterthrushes (3), Swamp Sparrows (1) and Northern Pygmy-Owl (1). Although Northern Pygmy-Owls breed in most areas of Vancouver Island, this was only the third captured at Rocky Point (Murray 2006).

### Discussion

Trend analysis is currently being conducted by Bird Studies Canada on the "estimated totals" data collected at Rocky Point. The estimated totals are the result of combining the banding data and the observation data from the census. The maximum number for a given species each day is recorded as the estimated total. The trend analysis will be conducted on only the species of songbirds that are regularly recorded at Rocky Point (but seldom banded).

### Conclusions

Rocky Point Bird Observatory (RPBO) is one of twenty-three stations in the Canadian Migration Network (CMMN). The CMMN and Rocky Point Bird Observatory plan to continue to monitor songbird populations in 2007. Data collected by RPBO will be shared with Bird Studies Canada, the Canadian Wildlife Service and the Canadian Bird Banding Office.

The trend analyses being conducted by Bird Studies Canada will be available on the Bird Studies Canada website by the fall of 2007.

### References

Derbyshire, D. 2000. Field Protocol for Migration Monitoring at Rocky Point Bird Observatory, Version 1.42. Rocky Point Bird Observatory Society, Metchosin, B.C.
www.islandnet.com/~rpbo/protocol/protocol.html

Murray, J. 2006. Migration Monitoring at the Rocky Point Bird Observatory: Fall 2006. Rocky Point Bird Observatory Society, Metchosin, B.C.
www.islandnet.com/~rpbo/finalreport06.pdf

Common Yellowthroat (*Geothlypis trichas)*

## 5. Monitoring Avian Productivity and Survival

**Project Leader:** Paul Levesque
**Location:** Rocky Point and Royal Roads
**Start Date:** 07 June 2006
**Completion Date:** 08 August 2006

### Introduction

The Monitoring Avian Productivity and Survivorship (MAPS) project 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 across North America. The sites at Rocky Point and Royal Roads are two of four sites in B.C.

The purpose of the MAPS projects at Royal Roads and Rocky Point is to create an inventory of the breeding songbird populations using a standardized methodology, and to record sightings of other species at these locations in order to facilitate comparisons of populations and avian diversity between the two sites. The data are submitted to both the Canada Wildlife Service (banding data) and to the Institute of Bird Populations (banding, observation, breeding status, and habitat structure data).

### Study Area and Methods

MAPS monitoring was conducted at Royal Roads and Rocky Point, following the MAPS protocol (DeSante *et al*., 2005). Songbirds were captured in mist nets and banded during standardized sampling sessions. The mist nets were located in a variety of habitat types, at prescribed distances from each other. The area covered at each study site was approximately 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 tenth of August. The MAPS protocol requires a minimum of five years of data (to account for annual variation in populations) before trend analysis or site comparisons can be made.

### Discussion

Rocky Point continues to be more productive, in terms of the number of individuals and in species richness, than the Royal Roads site. As more years of data are collected, the MAPS project should prove to be a useful tool for measuring the effects of site management on songbird populations at the two sites.

### Conclusions

The MAPS monitoring project will not take place in 2007 due to funding constraints. It is hoped the MAPS project will be reinstated in the near future.

### References

DeSante, D.F., K.M. Berton, P. Velez, and D. Froehlick 2004. MAPS Manual 2004 Protocol. The Institute for Bird Populations, Point Reyes Station, CA. 67 pp.

## Rocky Point Bird Observatory Society Activities

### 6. Spring Songbird Monitoring

**Project Leader:** Paul Levesque
**Location:** Rocky Point
**Start Date:** 29 April 2006
**Completion Date:** 06 June 2006

### Introduction

The migration monitoring projects at Rocky Point collect data on population trends and over time provide benchmarks for determining population declines at the landscape level. Data collected at Rocky Point cover coastal B.C. and Alaska, but when the data is combined with data collected from the other twenty-three banding stations across Canada, the status of migrating songbirds can be assessed at a national scale.

In the past, most monitoring at Rocky Point has occurred during the fall migration period. By conducting migration monitoring in the spring, it was hoped that species with low encounter rates during the fall might be more abundant in the spring and provide a large enough sample size for trend analyses.

### Study Area and Methods

The spring monitoring used the same net locations at Rocky Point and followed the same methodology as during the fall migration monitoring (Derbyshire 2000). Thirteen nets were opened thirty minutes before sunrise and closed after six hours. Birds captured in the mist nets were banded, sexed, aged, measured for a number of morphometric features, and released.

### Results

Spring songbird monitoring was conducted on thirty-three days between 29 April and 6 June. A total of 764 birds (forty-two species) were banded. Capture rates were low, averaging 0.34 birds/net hr. In contrast, the fall monitoring averaged 0.7 birds/net hr.

Species that were notably more numerous than in the fall included: Rufous Hummingbirds (106), Cedar Waxwings (25), Red-winged Blackbirds (21) and Black-headed Grosbeaks (6). Two birds uncommon on Vancouver Island that were banded were the Dusky Flycatcher (1) and the Western Kingbird (1).

### Discussion

The spring migration monitoring at Rocky Point provided interesting insights into the seasonal movement of songbirds at the Rocky Point site, however the relatively low capture rates make it difficult to justify continuing the project. There were a number of species banded in the spring in numbers higher than the fall monitoring project, however all of these species, with the exception of the Black-headed Grosbeak, are banded in high enough numbers during the fall monitoring to conduct trend analyses.

### Conclusions

We are planning on continuing the spring monitoring program in 2007. Banding data were submitted to the Canadian Bird Banding Office, and banding data and bird observations were submitted to Canadian Wildlife Service.

### References

Derbyshire, D. 2000. Field Protocol for Migration Monitoring at Rocky Point Bird Observatory, Version 1.42. Rocky Point Bird Observatory Society, Metchosin, B.C. www.islandnet.com/~rpbo/protocol/protocol.html

## 7. Western Bluebird Nestbox Project

**Project Leader:** Tracy Anderson
**Location:** Rocky Point
**Start Date:** 29 April 2006
**Completion Date:** 06 June 2006

### Introduction

The Western Bluebird nestbox project established ten sites on southern Vancouver Island in 2005. Of the ten sites, two are located on DND property, one at Rocky Point and one at the Canadian Forces Maritime Experimental and Test Range (CFMETR). The other sites are located in three Capital Regional District (CRD) Parks, on Salt Spring Island, Galiano Island, Mount Tzuhalem, and Mount Finlayson.

### Study Area and Methods

Six nestboxes were affixed to Garry oak trees in the 'west meadow' near the Rocky Point Bird Observatory's banding area in 2005 (Johnston 2005). The nestboxes were monitored for bluebird activity over 10 days between late April and mid-June.

### Results

No Western Bluebirds were recorded in the nestboxes or at Rocky Point in 2006.

### Discussion

Western Bluebirds were extirpated from Vancouver Island; however, recent recovery efforts in Washington State have resulted in some success, and it is hoped that by providing nestboxes in suitable habitat on Vancouver Island a population will become established. In 2005, twelve Western Bluebirds were observed visiting the 'west meadow' nestboxes at Rocky Point between 16 to 23 February.

### Conclusions

We plan to maintain and monitor the nestboxes at Rocky Point again in 2007.

### References

Johnson, Naira. *Western Bluebird Nestbox Project 2005*. Environmental Science Advisory Committee, 2005 Annual Report.

Western Bluebird nestbox

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

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***Permit #:*** *P031-06*
***Location:*** *Naden*
***Start Date:*** *01 February 2006*
***Completion Date:*** *31 December 2006*

## Introduction

The objective of this study is to monitor winter moth population densities and determine percent parasitism by the two introduced parasitoid species in the Victoria area.

The winter moth, *Operophtera brumata* L., 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. Prior to 1976 it was assumed that the damage in the Greater Victoria area was done by the native Bruce spanworm, *O. bruceata,* a close relative of the winter moth. By 1977, this insect defoliated over 120 km$^2$ on southern Vancouver Island. Its principle host on Vancouver Island is the Garry oak, *Quercus garryana* Dougl., a unique tree with restricted distribution that is the dominant species in a threatened habitat. In addition, the introduction of the 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. Following this example, in 1979, the Canadian Forest Service commenced introduction, both from Europe and Nova Scotia, of the two parasitoids that proved successful in controlling the winter moth 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 thirty-three different locations in the Victoria area.

One of these locations was in a Garry oak meadow near the (now demolished) Officer's Mess at Naden. Following completion of the release program in 1982, a monitoring program was initiated at several Garry oak stands in the Greater Victoria area to track the success of the introduction of these natural enemies and the impact of the newly established parasitoid species.

## Study Area and Methods

Two sampling methods were employed to monitor the winter moth population and to measure the interaction between the host and the parasitoids in the Greater Victoria area (including Naden).

### *Winter moth population density*

Winter moth population densities were determined by collecting twenty branches from four randomly selected oak trees (five branches per tree). Trees that were randomly selected one year for sampling were, wherever possible, excluded from further sampling. Different trees were randomly selected for sampling every year at each of the permanent sample locations. The branch samples were collected in early to mid May when winter moth larvae had reached late 3$^{rd}$ or early 4$^{th}$ 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 (about 45 cm long) that had newly-flushed leaf clusters.

The branch 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 brown kraft paper bag along with the contents of the basket attached to the pole pruner. The paper bag was then sealed, taken to the Pacific Forestry Centre and stored at 20º C to kill and preserve the larvae until the branches could be processed. The number of winter moth larvae, leaves, and leaf clusters were counted 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 winter moth larvae and rearing them because both species of parasitoid larvae hatch and feed inside the host pupae, and cannot be identified until they complete development during the fall and winter months, after the host pupates.

Winter moth larval collections were made just before the caterpillars dropped to the ground to pupate in the duff layer. Trees were selected at random at the permanent sample location. A large (2 m X 3 m) white sheet was placed on the ground under the lower branches of the randomly selected trees, and a 2 m 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 about 200 larvae were collected, or one hour was spent collecting larvae, whichever came first. All the winter moth larvae that fell onto 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 larval collection at the location was completed, a plastic lid with an 8 cm diameter hole cut in it (the hole was covered with mesh) for aeration was placed on the bucket, and the insects transported back to the Pacific Forestry Centre for rearing at room temperature.

Once the winter moth larvae finished pupating (at the beginning of June), the pupae were left undisturbed in the buckets for at least a week so the cuticles could harden and the cocoons containing the pupae could be handled without damaging them. 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 (150 X 20mm) petri dishes containing a layer of moist sand covered with a filter paper. 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 5ºC and reared until the spring, when the parasitoids will emerge. Adult winter moths started emerging around mid-November and finished emerging by about mid-December.

## Results

In 2006, at Naden, winter moth population densities more than doubled, from an average of 0.12 larvae per leaf in 2005 to 0.27 larvae per leaf in 2006. This was about half the overall average for the Greater Victoria area, which averaged 0.22 and 0.41 larvae per leaf in 2005 and 2006, respectively. The higher population densities in the Greater Victoria area caused some defoliation (damage) of the leaves that was visible from a distance at some locations. On the other hand, in spite of the increased numbers of insects present at Naden, the damage caused by the winter moth could only be seen close up, the leaves having “shotgun” type holes and no discoloration of the damaged leaves.

Percent parasitism by both parasitoid species, *C. albicans* and *A. flaveolatum*, can only be determined in the spring of 2007 when the overwintered parasitoid adults will emerge. Therefore, only parasitism of winter moth in 2005 can be reported at this time.

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

Parasitism by the more important parasitoid, *C. albicans*, at Naden increased from 15.0% in 2004 to 36.2% in 2005. This is probably due, in part, to the higher population density of the host. In the Greater Victoria area, percent parasitism by *C. albicans* remained about the same, decreasing slightly from an average of 28.3% in 2004 to 25.0% in 2005.

The pattern of parasitism by the less important parasitoid, *A. flaveolatum*, is more varied. No *A. flaveolatum* were recovered at Naden in 2004. However, in 2005, this parasitic wasp parasitized 0.6% of winter moths collected at Naden (adults emerged in spring 2005), which is only the second time this parasitoid had been collected at Naden since 1998. 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 2004, parasitism by *A. flaveolatum* averaged 1.0%, while in 2005 it averaged 0.2%.

### Discussion

Winter moth populations at Naden were lower in 2005 and 2006 than the regional average, but this is not unusual. Both winter moth and parasitoid population densities have been consistently lower at Naden than the overall host and parasitoid population levels for the Greater Victoria area since 1991. Winter moth populations during 2006 were the highest recorded since 1983.

Parasitism by *C. albicans* increased at Naden (15.0% and 36.2%), but remained relatively stable throughout Victoria as a whole (26.7% and 28.3%) for 2004 and 2005, respectively. In 2006, there were significant increases in winter moth populations in the Greater Victoria area, compared with the previous year. However, the 2004 and 2005 data suggest that parasitism by *C. albicans* has stabilized at around 25-28%. Parasitism by *A. flaveolatum* was low in 2004 and 2005, 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. .

### Conclusions

Monitoring of the winter moth and its parasitoids in the Greater Victoria area shows that the introductions of the two parasitoids, *C. albicans* and *A. flaveolatum*, particularly the former, has resulted in control of winter moth in the area. However, eradication programs conducted against both Asian and European strains of gypsy moth in recent years 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*), was used. Although *Btk* has a much narrower target range than chemical insecticides, it still affects a number of Lepidoptera species, including the winter moth. 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 show if this equilibrium is affected by the periodic use of *Btk* to prevent the establishment of another invasive species, the gypsy moth.

The successful control of the winter moth in eastern (Nova Scotia) and western (Victoria) Canada has attracted international interest. As a result of these highly successful programs, Dr. J. Elkinton, University of Massachusetts, initiated a parasitoids release program in 2005 to control the winter moth in the eastern United States, where it was recently introduced and is causing significant damage in New England. In a cooperative project, over 2,000 parasitized winter moth pupae were shipped to the United States for rearing of the parasitoids for release in Massachusetts in 2005 and 2006. In both 2005 and 2006 the winter moth obtained for shipment were not collected at Naden, but at other locations (where parasitism is higher) in the Greater Victoria area. We predict that the winter moth in the northeastern United States will also be controlled by the introduction of these two parasitoids. Classical biological control is ecologically less disturbing and economically less expensive than the chemical control approaches routinely used in the past. If this third program is successful, as predicted, it will confirm that classical biological control is still the best method for controlling an introduced, exotic pest.

# Purple Martin (*Progne subis*) Origins and Relationships

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***Permit #:*** *P044-06*
***Location:*** *Colwood and Royal Roads University*
***Start Date:*** *12 April 2006*
***Completion Date:*** *30 August 2006*

## Introduction

Purple Martins (*Progne subis*) are at the northwestern limit of their range in B.C., hence the low number of pairs and their Blue-listed designation in B.C. In 1984, Purple Martin numbers had decreased to less than five known pairs in B.C. By 1995, in response to the availability of manmade nestboxes, the total number of known active Purple Martin nests in B.C. had increased to fifty-five (B.C. Ministry of Water, Land and Air Protection, 1997). For the past ten years Purple Martins in B.C. have been monitored systematically to document their abundance and production, and nestlings have been banded with individually numbered bands to determine inter-colony movements and relationships.

## Study Area and Methods

The Colwood site, located on southern Vancouver Island, is one of forty-five active nestbox sites in B.C. In 2006, Purple Martin colonies throughout southwestern B.C., including the Colwood and Royal Roads sites, were visited to identify individuals banded in B.C. and Washington in previous years. During each visit, the number of eggs and/or nestlings in all accessible nest boxes were recorded. Productivity was determined for the whole colony, on a per pair basis, and by nestbox type. As in previous years, adults captured incidentally on the nest were banded, measured and standard body measurements were recorded; the birds were then placed back in the nest boxes. In the past nine years, up to 98% of all nestlings produced at known breeding locations in B.C. have been banded with individually numbered coloured plastic and metal bands that can be read using binoculars or scopes.

## Results

In 2006 the nesting population exceeded 600 pairs in the Georgia Basin (up from 450 pairs in 2005). All observed nesting occurred in nestboxes (unpubl. data). The nestbox colony at the Colwood site is one of the oldest and most productive of all the colonies in B.C.

We received our permit on 4 May 2006, which meant that we were unable to check the boxes before that date to read the bands of early arrivals. The site was checked again on 12 May, 29 May, 10 June and 24 June, by which time up to ~100 martins were nesting at the colony. However, upon checking the boxes, only thirty-eight of a total of sixty-two available nestboxes showed any sign of nesting activity. Of these, twenty-nine had fully developed and undisturbed nests, but none of the nests had any eggs. In six boxes there were partial egg clutches and three boxes had young less than eight days old. When we returned three days later (17 July ) only twelve martins were in the area, and they were attending/feeding the nestlings at only three boxes . We returned on 26 July, and found that the three boxes that had young previously were now empty. We also checked the six boxes that contained eggs on 14 July and found that all of the eggs were cold (and not being tended); in other words, the colony had been abandoned.

## Purple Martin (*Progne subis*) Origins and Relationships

A review of the literature on martins nesting east of the Rockies suggested that the colony might have been predated by an owl, either a Great-horned Owl or a Barred Owl. In the east, the owls will land on a box at night, reach in with a foot, and extract any adults and nestlings present. Birds in the rest of the colony will explode from the boxes and will not return that night. The owls will continue this night after night until the site is abandoned. Such predation has been reported east of the Rockies but not on the west coast. We can not prove that owl predation caused the colony to abandon, but it does seem plausible.

As a consequence of the colony abandonment, there were no nestlings banded at the Colwood site in 2006; down from 158 nestlings banded in 2005 and 156 banded in 2004. We were able to read the coloured bands of fifteen adult birds. Four birds had fledged from Colwood and one had returned to nest there in 2005. The other eleven banded birds had fledged from five other colonies in the Strait of Georgia and two from Puget Sound, WA. Five of the eleven birds mentioned above had nested at Colwood in 2005 or earlier; two were banded as nestlings in 1998 and 1999. Those birds were eight and seven years old, respectively; most Purple Martins only live one to three years.

At the Royal Roads colony fifteen nestlings were banded five nests; two other nests had eggs but did not fledge young. No numbered colour bands were read.

### Discussion

Purple Martins banded at many B.C. colonies between 1997 and 2006 have been re-sighted at different colonies than their natal colonies in B.C., Washington, Oregon and California (during migration). We suspect the B.C. colonies are part of a much broader population that ranges from at least Oregon (and possibly California) north. Purple Martin populations are increasing in B.C. and in most American west coast states; this is likely linked to the availability of nestboxes. It is possible that the current population is derived from the few birds that adapted to man-made nestboxes in the province. However, our banding returns (as well as DNA analysis - see below) show that the Colwood population is supplemented by birds from the west coast of the USA as well as B.C. colonies to the north. Considering the nesting failure at Colwood this year, it will be interesting to see where the colonizers come from in 2007.

In 2003, blood was collected from Purple Martins in California for DNA analysis. All samples have now been analyzed; preliminary results indicate the absence of a genetic bottleneck or inbreeding. Instead, the DNA analysis indicates a genetically diverse population.

In 2006, blood samples were collected from birds in Colorado and Utah; those results will also be added to the DNA database. This DNA work is part of an overall study of the origin of western Purple Martins (B.C., Washington, Oregon, California, Colorado and Utah) plus birds from east of the Rockies (Alberta, Manitoba, Ontario and Pennsylvania). Understanding the relationship between the western and eastern populations is important for the conservation of this species.

## Plans for Next Season

For the 2007 season, we hope to obtain access to the colony by 1 April (first return in early April) in order to read coloured bands. That will allow us to determine if the birds have nested at Colwood previously or if the colony is being re-populated by the fledged young of previous years from Colwood or by birds from elsewhere. This is a unique opportunity to assess from where birds will come to nest at a colony abandoned in the previous year. In addition to looking for coloured bands on early returns at the beginning of the season, we will continue to band nestlings in nestboxes, to monitor nest success and productivity; and to monitor for band returns, as part of the larger Purple Martin monitoring program. We will carry out similar monitoring, nestling banding and band reading at the Royal Roads University colony.

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Purple Martin (*Progne subis*)

# 2006 Gypsy Moth Survey

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***Permit #:*** *P071-06*
***Location:*** *CFMETR, Colwood, Dockyard, Naden, Nanoose TX Site, Rocky Point, Royal Roads, Work Point*
***Start Date:*** *01 June 2006*
***Completion Date:*** *31 December 2006*

## Introduction

The Canadian Food Inspection Agency (CFIA) is responsible for surveying for the introduction of Quarantine pests. Every year the CFIA surveys for the Gypsy Moth (*Lymantria dispar*) by placing pheromone traps on a grid pattern in rural and urban areas in B.C. Legal Authority: Plant Protection Act, s.c. 1990, c.22 and Plant Protection Regulations, SOR/95-212. The directive, D-98-09 contains the plant protection requirements governing the movement within Canada, export from Canada to the United States and import into Canada of regulated articles which can harbour any stage of the North American gypsy moth. The pheromone traps (or delta traps) will be collected and the contents will be examined for gypsy moths. Locally, introductions will be followed by delimiting and egg mass surveys to confirm establishment.

## Study Area and Methods

Pheromone traps, which are specific to the gypsy moth, are placed in a grid pattern throughout urban and rural areas of the province. Traps are placed in June, and collected from mid September until the end of October. If the target insect is detected, then an egg mass search is conducted in the area. The pheromone traps are constructed of cardboard, coated with wax, and loaded with Tanglefoot glue. A pheromone string lure (500 milligrams (+) Disparlure) is stapled inside the trap. The lure attracts the male gypsy moth and the glue holds the moth for collection.

Trapped moths are identified and positive samples are sent for biotype confirmation. All trapped moth specimens of interest will be sent to the CFIA National Headquarters in Ottawa.

## Results

Thirty-one Gypsy Moth traps were placed on DND property. No male gypsy moths were caught in these traps.

## Discussion

Gypsy moths and egg masses were found in 2006 on properties adjacent to lands covered by this ESAC permit.

## Conclusions

Future annual gypsy moth surveys will be required, along with delimiting surveys, egg mass searching, and egg mass collection and destruction.

# Wildlife Tree Stewardship Program (WiTS)

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***Permit #:*** *P074-06*
***Location:*** *Colwood, Rocky Point, Albert Head*
***Start Date:*** *01 June 2006*
***Completion Date:*** *31 December 2006*

## Introduction

The Bald Eagle Nest Tree monitoring program began on Vancouver Island in 2000 to establish a baseline of the success of nesting eagles and to monitor the stability of nest trees. The program monitors how eagles can adapt to overall habitat changes.

Since 2002, the same monitoring continues to be done under the Wildlife Tree Stewardship (WiTS) program of the Federation of B.C. Naturalists (FBCN), and includes other raptor nests such as Osprey, Red-tailed Hawks, etc. The program has expanded to include most of Vancouver Island, the Gulf Islands and now parts of the southern Mainland, the focus increasingly being community education, habitat protection, and stewardship agreements. The project is supervised by Kerri-Lynne Wilson (FBCN) and Karen Morrison and Terri Martin (B.C. Ministry of Environment).

Rocky Point has been monitored since 2001; in 2003 Albert Head was added to the study and in 2004 nests were monitored at the Colwood site.

The monitoring on DND lands adds to an understanding of the productivity of nests of large raptors such as Bald Eagles, Osprey, Red-tailed Hawks, etc.

## Study Area and Methods

The areas studied in 2006 were Rocky Point and Colwood. Albert Head was monitored (from Albert Head Lagoon) but was not accessed this year, as little activity was observed by the monitoring from Albert Head Lagoon.

Nests are located by sound, with the use of binoculars and telescopes, and by generally observing activity.

The known nests were observed with binoculars and telescope and all activity was documented.

## Results

A summary of the monitoring efforts are presented in Tables 1 & 2.

Bald Eagle (*Hailaeetus leucocephalus*)

## Wildlife Tree Stewardship Program (WiTS)

Table 1. Rocky Point – 2006 Raptor Nest Monitoring Summary – Eight eagle nest trees and one Osprey nest were monitored in 2006.

| Nest ID | Tree/Class | Location | 2006 Activity | Monitoring Observations |
|---|---|---|---|---|
| **Bald Eagle** | | | | |
| A (E102-007) | Fallen Douglas-fir | Fossil Point, just off the East Perimeter Road in Polygon 119. | Inactive | This nest tree was uprooted in a storm in December 1999. |
| B (E102-008) | Douglas-fir, decay class 1 | Fossil Point, just off the East Perimeter Road in Polygon 119. | Inactive | This nest fledged 1 young in 2001 and has not been productive since. In 2003 the nest appeared to be disintegrating somewhat. In 2004 and 2005 activity was seen nearby but nest inactive and no other nest found. 2006 observations:<br>28 April - eagles heard but not seen. No activity at nest.<br>15 May - eagle perched nearby.<br>2 August - New nest (H) found on opposite side of road. |
| C (E102-005) | Douglas-fir, decay class 3 | Church Hill, South East in Polygon 6, on West side of Whirl Bay. | Inactive | This nest is of unknown age, apparently active in 2000 as reported by fishing boats but not active in 2001, 2002, or 2003. In 2004 1 young fledged. In 2005 and 2006 the nest was inactive and is deteriorating somewhat. Many whale watching boats were observed viewing the nest. |
| D (E102-026) | Douglas-fir, decay class 2 | Church Hill, Northwest side in Polygon 4. | Inactive | Nest first discovered in May 2002 and fledged 2 young that year. No activity seen at this nest in 2003. In 2004 fledged 2 young. In 2005 and 2006 the nest was inactive and growing grass. Nest is very difficult to see due to growing trees. |
| E (E102-027) | Douglas-fir, class 1-2 | Whirl Bay, in Polygon 14, approximately 70 m inside gate #10. | Inactive | Nest discovered from the top of Church Hill in April 2003 and 1 young fledged that year. In 2004 and 2005 no activity was seen or heard at this nest. 2006 observations:<br>28 April - no activity seen.<br>15 May- adult observed (from Church Hill) in nest with 2nd adult perched in same tree,<br>2 August- no activity seen. |
| F (E102-028) | Douglas-fir, decay class 4 | Church Hill, North West side in Polygon 4. | Inactive | Nest discovered in May 2003 with 1 adult sitting on nest and 1 in perch tree. No activity was seen on subsequent visits and the nest apparently abandoned. Base of tree was accessed in June 2003 by Art Robinson. In 2004 no activity was seen at this nest. In 2005 1 young fledged and nest appeared to be disintegrating. In 2006 no activity was observed. |
| G (E102-029) | Douglas-fir, decay class 2 | Whirl Bay, approx 20 m South of road. | Active | Reported to have been active and fledged at least 1 young in 2005 (Not seen by WiTS monitors until 2006).<br>2006 observations:<br>28 April - adult on nest.<br>15 May - no activity seen from road but observations from Church Hill showed adult in nest and 2nd adult perched nearby.<br>2 August - no activity seen or heard. |
| H (no E# yet) | Douglas-fir, class 2 | Fossil Point, approx 50 m to East side of E. Perimeter Road. | Active | Nest discovered Aug 2, 2006. 1 young observed in nest. Appears to be territory of nest 'B' pair. |

Table 1. continued

| Nest ID | Tree/Class | Location | 2006 Activity | Monitoring Observations |
|---|---|---|---|---|
| **Osprey** | | | | |
| Platform Nest | Relocated nest on an alternative pole and platform | Area B, CFAD | Inactive | One osprey nest was monitored at Rocky Point. While the nest was not in a tree, monitoring this nest activity may be of interest for any future mitigation and for territorial monitoring. This pair built their first nest in 2003 on top of a power pole in area 'B', approximately 150 m from the main gate. In 2003 2 young fledged. Subsequently an alternate nesting platform was erected with a 2nd one erected in 2005. In 2004 3 young fledged. In 2005 and 2006 no young fledged. |

Table 2. Colwood – 2006 Raptor Nest Monitoring Summary – two eagle nest tree and one osprey nest were monitored in 2006.

| Nest ID | Tree/ Class | Location | 2006 Ac-tivity | Monitoring Observations |
|---|---|---|---|---|
| **Bald Eagle** | | | | |
| A (E101-647) | Douglas-fir, decay class 2 | Two nests were found in this tree, located approx 6 meters to the West of the road, between Bunkers 45 and 48. | Inactive | In 2004, 2005, and 2006 - eagles were seen and heard nearby but no activity was observed at this nest. Old prey items were noted at base of tree. |
| B (E101-648) | Douglas-fir, class 1 | Tree located approx 75 meters SSW of Bunker 44. | Active | In 2004 and 2005 we were unable to detect activity at this nest, however eagles were heard and seen nearby. Very difficult to get good look at nest.<br>2006 observations:<br>5 May - 1 adult (possible brood patch observed) sitting beside nest.<br>2 June - 2 adults seen at nest. 2 subsequent visits showed no activity |
| **Osprey** | | | | |
| 0101-004 | Nest on a platform located at top of a Douglas-fir tree | approximately 150 meters NW of "F" Jetty, | Inactive | Inactive in 2004. In 2005 2 young fledged. In 2006 1 adult was seen nearby in May but nest appeared to be inactive. |

Wildlife Tree Stewardship Program (WiTS)

## Discussion

Observations at Rocky Point in 2006 resulted in many unanswered questions. Firstly, the two nests at Whirl Bay appear to have been active with two adults observed at two nest sites within 400 m of each other. This is not unprecedented but is a bit unusual as most territories will be between 500 to 1000 m apart. During the following visit no eagles were seen at either nest. It is unknown why this occurred; whether the eagles fledged early, or if there was a disturbance that prompted both nests to fail.

No eagle activity was seen during any visits on the West side of Church Hill. This lack of activity may be due to a disturbance in that area, although this study did not determine this.

## Conclusions

Our observations for Rocky Point in 2006 were somewhat limited due to study site constraints.

Nesting eagles are often very secretive and nest sites can be difficult to find in such a forested area. It appears that there are four separate territories at Rocky Point and our observations for 2006 would suggest that two nest sites failed, one site was inactive, and one site fledged an eaglet.

The Osprey were apparently in the area early in the year but did not nest.

Our plan for 2007 is to continue to study the same DND areas for nesting activity and productivity. This will complement our studies in the CRD area.

Findings for the CRD area (including DND land) for 2006 showed that twenty-three eaglets fledged from twenty-seven active territories. Fifteen of those territories failed or did not have eagles nesting within.

Many thanks to all who enable WiTS to carry on this study.

Bald Eagle on nest

# Garry Oak (*Quercus garryana*) Acorn Production Study

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***Permit #:*** *P079-06*
***Location:*** *CFMETR, Rocky Point*
***Start Date:*** *August 2006*
***Completion Date:*** *September 2006*

## Introduction

The purpose of the Garry Oak (*Quercus garryana*) Acorn Production Study is to determine how common good and bad acorn crops are and the factors that influence production. The regularity of acorn crops, the age when acorns are first borne on a tree, and the age of maximum production are not known, but mature trees bear heavy crops on an irregular basis (Stein 1990). High variation in acorn production is characteristic of oak species in general (Koenig 1980).

The Garry Oak Acorn Production Study began in 1999, and expanded to Vancouver Island in 2001. Data collection is planned for a minimum of 10 years to allow for meaningful analysis of acorn production periodicity and climatic effects on acorn production. Background information, methods, forms, and results are available on the project website (www.fs.fed.us/pnw/olympia/silv/oak-studies/acorn_survey).

Previous ESAC reports (PO79-02,03,04,05) focused on project scope and goals, early results, geographic variation in acorn production, and tree size relationships to acorn production. This report explores effects of annual climatic patterns on Vancouver Island acorn production.

## Study Area and Methods

The number of trees annually monitored on Vancouver Island has grown from 54 in 2001 to 227 in 2006. Three to sixteen trees at twenty-six sites were monitored from Courtenay to Victoria. Acorn production was ocularly scaled (1-4; 1= no acorns; 4 = a heavy crop) in August or September (Graves 1980). Mean acorn class was utilized to indicate relative acorn production between sites. Physical site data, proximity to water and anthropogenic practices (irrigation and fertilization) were also recorded.

Acorn production was reported for three DND sites from 2001-2006, and was additionally combined with data from all Vancouver Island sites to explore correlations between monthly temperature and precipitation with annual acorn production for the twelve months preceding each crop. The combined data were stratified into four groups (riparian, irrigated, Victoria, uplands). Trees at Rocky Point, Mary Hill and CFMETR (DND sites) grew in uplands, as did the Victoria group. The Victoria group was separated from the uplands group for two reasons: 1) it is the largest group of trees, and 2) Victoria has lower precipitation than any other area. Some irrigated trees were also fertilized. Other groups grew in more or less natural conditions.

## Garry Oak (*Quercus garryana*) Acorn Production Study

The precipitation or mean temperature from the Victoria International Airport (Environment Canada, 2006) was compared for each of twelve months prior to September with the mean group acorn abundance class using Spearman correlation analysis (SAS 2002) and declared statistical significance at $p$=0.1.

Of the DND sites, Rocky Point had five upland and one riparian trees. CFMETR had eight upland trees and Mary Hill sixteen upland trees; no riparian or irrigated trees were sampled at these sites. Within all of the Vancouver Island sites, there were eight irrigated trees and two riparian trees in 2001 and fifteen to seventeen thereafter. Also overall, there were twenty-two upland trees in 2001 and forty-one to seventy-four thereafter. In Victoria, there were nineteen upland trees in 2001, and 81 to 111 in 2002-2006.

### Results to Date

Acorn production at Rocky Point was higher than at Mary Hill or CFMETR (Figure 1). Among Vancouver Island sites, Rocky Point produces a high yield of acorns while CFMETR does not. Overall, acorn production on Vancouver Island was highest in 2004, followed by 2006 and lowest in 2003 and 2005 (Figure 1). The Rocky Point and CFMETR sites, however, were not lower in 2005 compared to other years, as was the case elsewhere.

There was a consistent pattern of monthly precipitation correlations with acorn production across analysis groups (Figure 2). Significant correlations were found in all seasons and were stronger than r = 0.7. The Victoria and upland groups had more significant correlations with precipitation than the irrigated and riparian groups.

Monthly temperature correlations with acorn production were less consistent than with precipitation (Figure 2). Significant correlations occurred in fall, winter and summer and were stronger than r = 0.7. Correlations with riparian trees were only significant in June and July and no other groups showed significant correlations at that time.

### Discussion

Correlation analysis may suggest, but does not establish, cause and effect relationships. It may suggest further research topics. The importance of summer soil moisture is suggested in several ways. Irrigated and riparian trees were the most productive groups. There were no significant positive correlations with precipitation in the irrigated or riparian groups. The driest group (Victoria) was positively correlated with August precipitation.

Positive correlation of the riparian group with June and July temperature suggests that cool summer temperatures may limit acorn productivity where water is not limiting. Positive October precipitation and temperature correlations suggest benefits to longer growing seasons, provided water is sufficient. These findings suggest mechanisms limiting the northern distribution of Garry oak.

Negative correlations with November temperature suggest entering winter dormancy before the coldest winter temperatures arrive is important. Warmer winter temperatures are associated with higher precipitation, thus the negative correlation with December precipitation suggests importance of maintaining cool conditions and thus dormancy. Also, the negative correlations in March and April with precipitation suggest that dry conditions are advantageous for pollination as was found by others (Cecich, 1997).

### Conclusions

Correlations of temperature and precipitation with acorn production vary seasonally during the twelve months preceding acorn fall. Correlations suggest long, warm, moist growing seasons and dry conditions during pollination benefit acorn production.

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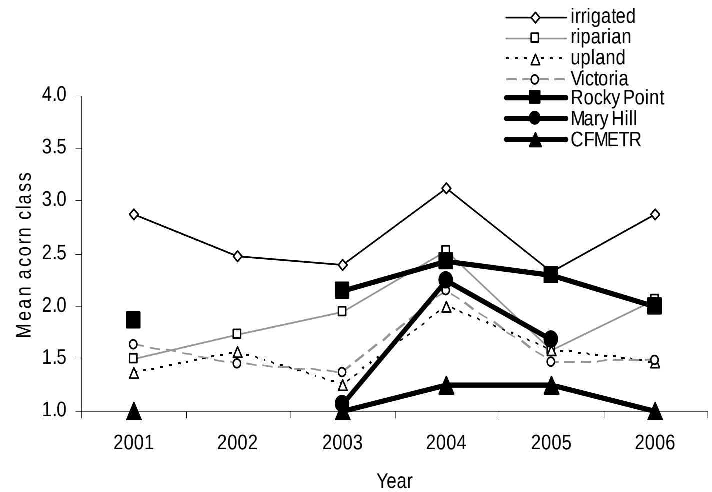
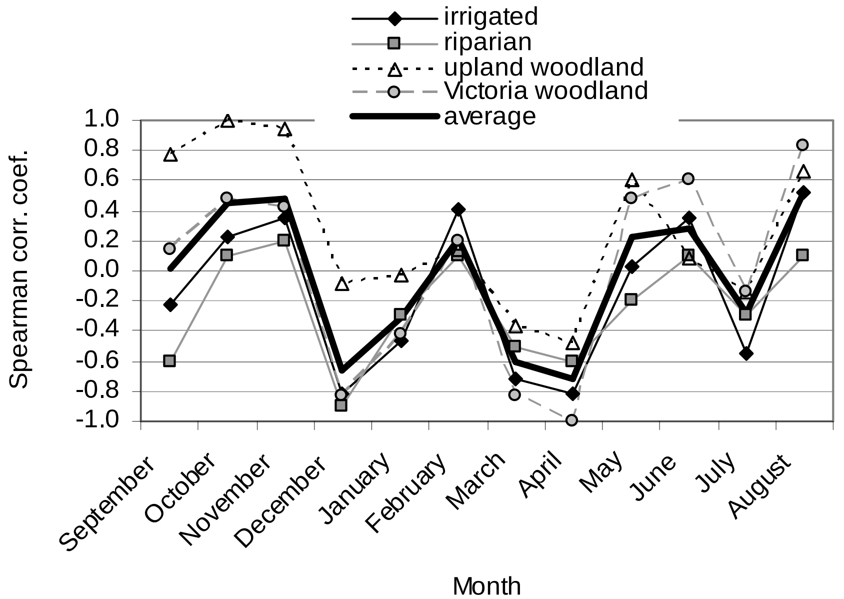



Figure 1. Acorn production at three DND sites and 4 analysis groups. The DND sites were not available for sampling in 2002. Mary Hill was not available in 2006.

Garry Oak (*Quercus garryana*) Acorn Production Study

## Precipitation Correlations




Significant points:

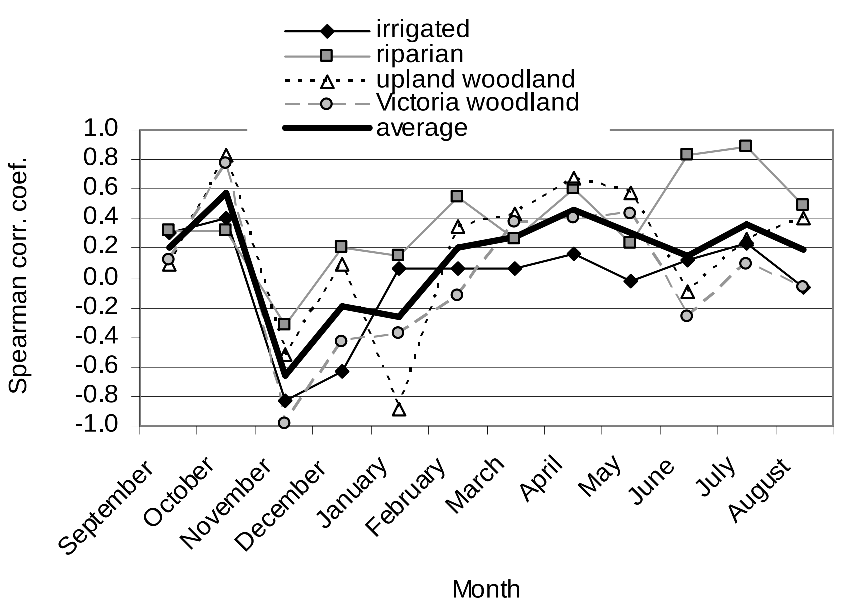
Irrigated: December, March, April

Riparian: December

Upland: September, October, November

Victoria: December, March, April, August

## Temperature Correlations




Significant points:

Irrigated: November

Riparian: June, July

Upland: October, January

Victoria: October, November

Figure 2. Correlations of oak analysis groups on Vancouver Island with precipitation and temperature for the 12 months preceding the acorn crop. Significant correlations are indicated to the right of each graph.

# Royal Roads University Canopy and Microclimate Station — Continuing Upgrading

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***Permit #:*** *P087-06*
***Location:*** *Rocky Point*
***Start Date:*** *January 2004*
***Completion Date:*** *December 2007*

## Introduction

This project involves an enhancement of the microclimate monitoring station as part of the existing Ecological Monitoring and Assessment Network (EMAN) site and canopy station at Rocky Point. This includes 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. Data gathered from the microclimate station will be used to support other research activities at Royal Roads University (RRU) as part of the university's effort to monitor atmospheric contaminants changes as a result climate change.

## Study Area and Methods

The main objective of this project was to enhance the current capabilities of the existing microclimate monitoring station at Rocky Point for the purposes of downloading atmospheric and ecological information using data loggers on a regular basis via remote technology. Activities completed include the following:

- Installation of a solar panel and tower to provide an adequate power supply for all monitoring equipment. The height of the tower was set at thirty metres, representing the top of the forest canopy and equipped with a 750 watt solar panel;
- Installation of a quantum radiation sensor, temperature and relative humidity sensor, and a wind speed and direction sensor on the thirty metre tower;
- Installation of temperature thermocouples within the study tree canopy;
- Installation of aspirated shields, at ten, twenty and thirty metres, on a cable ladder beside the study tree, to support temperature and relative humidity sensors;
- Installation of a tripod stand in the underbrush to support wind, temperature, relative humidity and quantum light sensors over the surface vegetation;
- Modification of the existing tipping bucket rain gauge by deploying it on a ten metre high tower to improve exposure;
- Installation of three soil moisture probes at selected locations in the adjoining EMAN site;
- Installation of a lysimeter to measure evapotranspiration rates including an extension of the existing boardwalk to the site of the lysimeter;
- Establishment of cellular communications with the data logging system;
- Installation of a small storage shed for the station equipment and the data logger on the existing platform outside of the EMAN plot; and
- Regular inspection and maintenance including tree pruning and upgrade/removal of tree platforms to focus on three sturdy trees.

## Royal Roads University Canopy and Microclimate Station – Continuing Upgrading

### Results

Installation of the data loggers and programming will be completed shortly. Following this, remote downloading of the data will commence. The following parameters will be monitored: temperature and relative humidity at the ten, twenty and thirty metre elevations of the canopy; sensing level within the salal ground cover using a three metre tripod stand designed to provide a sensing level at the surface of the vegetation cover; soil moisture at three different profiles within the EMAN site; and rainfall. The data will be stored in a database at RRU.

### Discussion

The data gathered through these activities will help to support the longer-term objective 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 and will be completed by March 2007. It is intended that the data gathered from the Canopy Station will complement information from two ambient air monitoring stations at Christopher Point and Royal Roads University. The Christopher Point Station is located along the Strait of Juan de Fuca, just southeast of the microclimate station. A Memoranudum of Understanding (MOU) has been established with DND in collaboration with Environment Canada, for the operation of the Christopher Point Station. The Royal Roads University Ambient station is situated on campus near the shore of Esquimalt Lagoon.

### Conclusions

The acquisition of data by the microclimate station situated near the EMAN site below the canopy station at Rocky Point and the two ambient air monitoring stations will serve as an important vehicle for research, education and extension activities in the future. The automated stations will support a number of valuable research and support functions including the following:

- Monitoring of local atmospheric conditions (wind, visibility, precipitation) in the Strait of Juan de Fuca, which will be valuable for navigation and other activities in the area;
- Assessing local and long-range air pollutants (i.e., metals, oxides, persistent organic contaminants, ozone, particulates) in different air masses in the southern Vancouver Island Region and the Georgia Basin;
- Providing valuable meteorological, climate and air chemistry data for regional (Capital Regional District), provincial (Ministry of Water Land and Air Pollution) and federal government departments (Environment Canada, Transport Canada and Department of National Defence); and,
- Operating as a node in a much larger atmospheric monitoring network in the Georgia Basin and B.C. for monitoring trans-boundary pollutant issues at the international level as part of the National Atmospheric Pollutants Surveillance (NAPS) program.

Methods are currently being developed for the collection of precipitation and air samples for additional laboratory analysis and characterization. These include the use of integrated passive air samplers with polyurethane foam disks operating over a four month period. Protocols are also currently being developed for sample screening for a range of Persistent Organic Pollutants (POPs) using a Varian Saturn 2200 Gas Chromatography/Mass Spectrometry facility at RRU. The screening will initially comprise pesticides (including DDT and its derivatives, chlordane and mirex), PCBs, dioxins and furans, and new generation pollutants (e.g., polychlorinated naphthalenes, halogenated diphenyl ethers, and chloroparaffins). Detected contaminants will serve as the focus for additional sampling to assess patterns of atmospheric POP distribution. Analyzing POPs in different types of samples from the atmosphere (i.e., particulates, precipitation, gas and aerosols) will provide an indication of how and in what form these contaminants move into temperate coastal ecosystems.

# Forest Floor Monitoring for the Western Red-backed Salamander (*Plethodon vehiculum*) on Vancouver Island, British Columbia

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***Permit #:*** *P088-06*
***Location:*** *Rocky Point, Royal Roads*
***Start Date:*** *April 2006*
***Completion Date:*** *December 2006*

## 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 (see Figure 1). 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 (Zorn *et al.*, 2004). EMAN is a national network of long term monitoring and research sites that provide a national perspective on the health of Canadian ecosystems.

The objectives of this project are:

1. Test the national EMAN plethodontid salamander protocol for use in B.C;

2. Collect baseline data in potential reference areas and for use in power analysis; and

3. Collect long-term data on population trends of the Western Red-backed Salamander.


Figure 1. Location of study sites on Vancouver Island

## Forest Floor Monitoring for the Western Red-backed Salamander (*Plethodon vehiculum*) on Vancouver Island, British Columbia

### Study Area and Methods

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 Royal Roads University. Three plots were set up in December 2002 at each site. Each plot consists of fifteen cover boards installed around the perimeter of existing EMAN vegetation plots (20 m x 20 m), which is consistent with the national EMAN/Parks Canada monitoring protocol. Each cover board consists of a five cm thick bottom board, covered by two 20.3 cm wide x 2.5 cm thick top boards (see Figure 2). All boards are 91.5 cm long. Top boards are separated from bottom boards by strips of cedar lath (Ovaska et al. 2003). Several boards required replacing in 2006 as a tree had fallen on two cover boards at Royal Roads and others at Rocky Point had rotted.

The cover boards are checked annually, ideally three 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 recorded (see Table 3). Macro-invertebrates were selected based on their use of coverboards and ease of identification (Ovaska et al. 2003).

### Results

In 2006, a total of 201 Western Red-backed Salamanders were captured (see Tables 1 and 2). The EMAN protocol does not recommend pooling data from spring and fall surveys. It also suggests that spring surveys may be more effective than fall surveys. The mean number of salamanders recorded per plot during the spring season at Royal Roads and Rocky Point are shown in Figure 3.

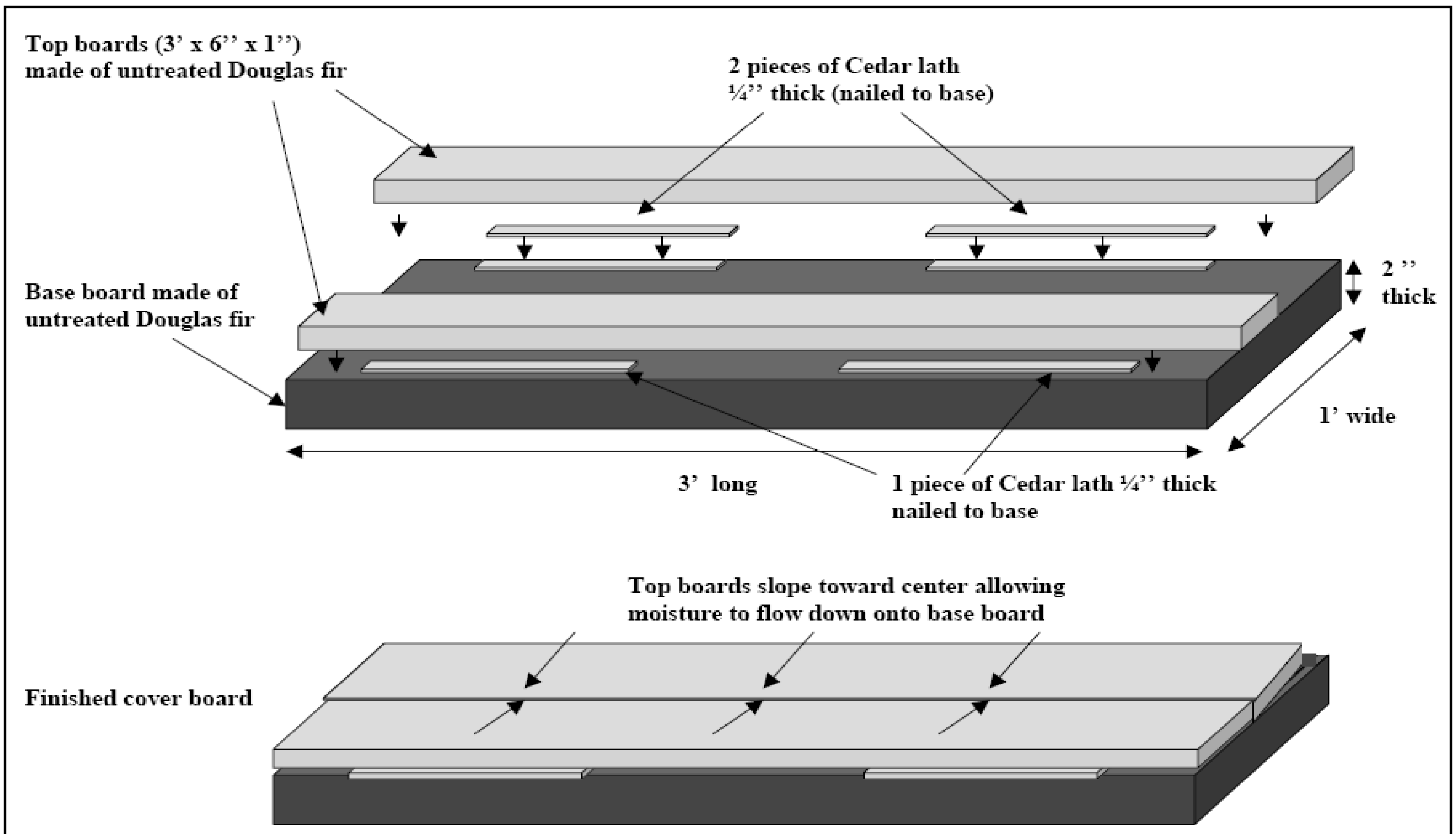


Figure 2. Illustration of cover board (from Ovaska *et al*. 2003)

Table 1. Total captures and survey effort in 2006

| Site | Plots # | Cover boards # | Plots surveyed # | Total salamanders # | Mean # per plot |
|---|---|---|---|---|---|
| Rocky Point | 3 | 45 | 6 | 54 | 9 |
| Royal Roads | 3 | 45 | 14 | 147 | 10.5 |

Table 2. Demographic data from 2006

| Site | Adults # | | | | # Juveniles | # Hatchlings | Escaped |
|---|---|---|---|---|---|---|---|
| | *Total* | *Male* | *Female* | *Unknown* | | | |
| Rocky Point | 25 | 9 | 16 | 0 | 28 | 0 | 1 |
| Royal Roads | 68 | 35 | 30 | 3 | 75 | 2 | 2 |

Table 3. Total records for invertebrate species recorded at Rocky Point (6 plots) and Royal Roads (14 plots) in 2006

| Site | Slugs | | Snails | | | Millipede | Carabid beetle |
|---|---|---|---|---|---|---|---|
| | *Ariolimax columbianus* | *Arion rufus** | *Haplotrema vancouverense* | *Vespericola columbianus* | *Monadenia fidelis* | *Harpaphe haydeniana* | *Scaphinotus angusticollis* |
| Rocky Point | 15 | 0 | 1 | 1 | 0 | 0 | 10 |
| Royal Roads | 94 | 13 | 14 | 6 | 0 | 1 | 15 |

*introduced species

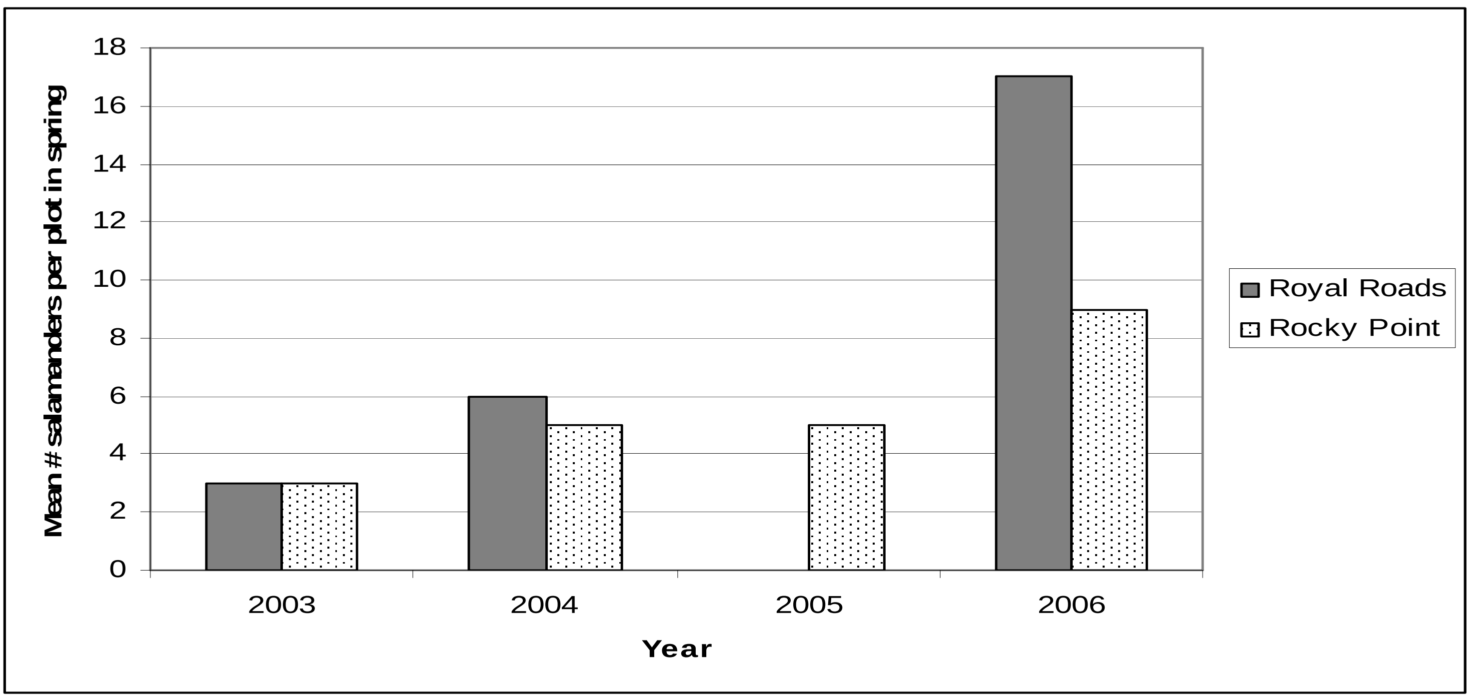


Figure 3. Mean number of Western Red-backed Salamanders per plot during the spring season at Rocky Point and Royal Roads between 2003 and 2006

# Forest Floor Monitoring for the Western Red-backed Salamander (*Plethodon vehiculum*) on Vancouver Island, British Columbia

## Discussion

Although it appears that Western Red-backed Salamanders are increasing, this is more likely due to a 'start up' effect. This is where the number of salamanders detected at the cover boards increases after the first year the cover boards are installed. The cover boards require time to become incorporated into the environment and salamanders take time to find them. Several more years of data collection are required to show a true trend. Ovaska *et al.* 2003 recommended at least fifteen years of monitoring with a review of sampling parameters every third year. Over the past three years, it has been difficult to meet the sampling requirements at both sites due to limited capacity. Statistical support will be sought in 2007 to look at options for changing sampling parameters and assistance with trend analysis.

## Conclusions

- Carl Schwarz and students with Simon Fraser University will be assisting with data analysis and making recommendations for improving sampling efficiency over the next year.
- Data from this project will be entered into the recently available EMAN spreadsheet for plethodontid salamanders. This Excel spreadsheet accompanies the national protocol. The spreadsheet includes automatic data calculations.
- Disease monitoring is becoming an important component of amphibian monitoring. The possibility of incorporating field tests for chytrid fungus (*Batrachochytrium dendrobatidis*) will be investigated.

## References

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# Bald Eagle Nest Monitoring/Wildlife Tree Stewardship (WiTS) & Bird Counts

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***Permit #:*** *P089-06*
***Location:*** *CFMETR*
***Start Date:*** *January 2006*
***Completion Date:*** *December 2006*

## Introduction

As part of a larger project, the Wildlife Tree Stewardship Initiative (WiTS), and with over a decade of field work on Vancouver Island, naturalist groups have been searching out, identifying and monitoring wildlife trees, especially those used as Bald Eagle nest sites. In 2006, eighteen members of the Arrowsmith Naturalists monitored eighty-two eagle territories, including 140 sites with current reports of wildlife activity, from Nanoose Bay to Deep Bay. The WiTS initiative aims to document wildlife usage and locations of wildlife trees to help conserve the remnant habitats on Vancouver Island's altered ecosystems.

## Study Area and Methods

Monthly site visits to CFMETR were made to observe Bald Eagle activity in their territories. Nest trees were located and the base of the nest trees were visited to assess tree health and recent usage of the site. The locations of perch sites were also determined and visited where possible. The average visit was three to four hours.

The survey areas were similar for each visit except for during the Christmas Bird Count (CBC) which resulted in more walking and driving with many short roadside stops. The CBC was conducted on 15 December 2006; during that event, two observers spent 7.5 hours counting and identifying all birds seen or heard during the twelve km of driving and an estimated 3.5 km of walking.

The CBC driving part of the methods involved making many short stops (five to ten minutes in duration) followed by scoping (for up to an hour) from each of the two wharves, as well as from several other locations that afforded good viewing.

## Results

### *Bald Eagle Nest Monitoring*

Nest E105-045: Richard Point Nanoose Harbour (DND Camp) - Active. 1 chick fledged after July 8/06. Summary of observations in Table 1.

Nest E105-092 Wallis Point (DND Ridge) - Regular perch area for many raptors. No known nests found to date due to difficult terrain & access.

Nest E105-124 Mid Nanoose Harbour (DND Tower E) - Not active. Old nest site, area used as perch site due to commanding view of large area. Eagle pair seen perched on top of East Tower numerous times. Turkey Vultures use this area frequently from April to August, many rocky outcroppings and potential nest area.

Nest E105-125 Wallis Point (DND) Not active. Old nest site used as regular perch area for several eagle pairs from surrounding territories. Still standing, dead top, no nest.

E105-300 Mid Nanoose Harbour (Ranch Point, 600m E) - Active, failed. Summary of observations in Table 2.

## Bald Eagle Nest Monitoring/Wildlife Tree Stewardship (WiTS) & Bird Counts

Table 1. Nest E105-045: Richard Point Nanoose Harbour (DND Camp)

| Date/2006 | Bald Eagle Activity | Notes |
|---|---|---|
| 11 March | Both adults calling to each other repeatedly over 1 hour from various sites near nest. | Much stick &/or egg adjustments by pair while in solid large nest structure. |
| 20 April | One adult incubating, 2nd adult in favored perch 100 m S. | |
| 25 May | One chick walking around nest calling frequently, both adults close by. | Many prey items at base of nest tree. |
| 10 June | One large active chick 6-8 weeks old, both adults close by. | |
| 8 July | One large very active chick ready to fledge, both adults on favored perch 100 m S. | |
| 14 October | No eagles near nest area. | |
| 14 November | Pair active on territory, perching & carrying sticks to known perch tree west & uphill of camp (possible new nest in construction?). | |
| 12 December | One adult & one immature in area of nest tree for over 2 hours, | Total of 25 eagles seen on CFMETR |

Table 2. E105-300 Mid Nanoose Harbour (Ranch Point, 600m E)

| Date/2006 | Bald Eagle Activity | Notes |
|---|---|---|
| 11 March | Both adults left meadow adjacent to nest as we approached, | New sticks visible, solid large nest structure. |
| 20 April | 1 adult incubating, 2nd adult 150 m W. | DND staff report “1 dead adult eagle found 13 April near administration building (~300 m NE of nest) under powerlines by pond. Carcass taken to MOE, Nanaimo." |
| 25 May | No eagles at nest. Eagle pair at top of E Tower. | Very quiet, likely failed. |
| 10 June | No eagles at nest. Pair flying & perching over wide area, minimally near nest & meadow. | |
| 8 July | Both adults on territory. | No prey items or whitewash under nest. |
| 14 October | No eagles near nest. | |
| 14 November | No eagles near nest. 3 adults very actively flying, chasing & diving on each other ~1 km E of nest toward Richard Pt. | |
| 12 December | No eagles near nest. 1 adult perched on barge anchored off West Wharf. | |

***Other Bird Species Observations and Christmas Bird Count***

A total of eighty-seven species were identified throughout 2006 (Table 3). A large number of gulls were observed over deep water or high overhead which made identification impossible.

The CBC resulted in a total of forty-eight species and 1,935 individuals recorded (Table 3). Many waterbird species and all raptors were observed from the scoping locations.

Some highlights of the CBC were:

- Two Trumpeter Swans identified in the pond by the administration building;

- A flock of eighty-three Barrow's Goldeneye were identified at both wharves;

- Diving ducks were present in good numbers, many in deeper waters out past Wallis Point;

- Eagle numbers, twenty-eight, were about average with a stack of eighteen identified at one point over The Notch;

- Three Cooper's Hawks, four Red-tail Hawks and one Merlin were identified;

- Three Band-tail Pigeons, seven Bushtits, and one Pine Grosbeak were observed.

## Discussion

This was the fourth year of nest monitoring and third year recording bird species at CFMETR. The identification challenge is ongoing and skilled birders willing to commit for the entire year have proven difficult to find. It is possible that many common resident species and spring and fall migrants were missed due to limited time and personnel on this project. The survey areas were similar for each visit (except CBC which resulted in more walking and driving with many short roadside stops). The mixed forests of CFMETR and waters around the base continue to be a rich food source and place of refuge for at least eleven known Bald Eagle pairs, their offspring and the many species of birds (residents and migrants) that were observed during the monthly surveys.

## Conclusions

Monitoring of Bald Eagle nests in 2007 will continue from Nanoose Bay to Deep Bay. However due to a lack of funding and volunteer support, the CFMETR site will not be studied. All WiTS data are stored at the Ministry of Environment, Nanaimo (contact Karen Morrison MOE for details). Limited data are available online at the Wildlife Tree Atlas website (www.shim.bc.ca/atlases/). Many of the Regional District of Nanaimo's Official Community Plan maps show many of the eagle nest locations.

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, Notch Hill and surrounding remaining 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 minimal disturbance from human activities.

## Bald Eagle Nest Monitoring/Wildlife Tree Stewardship (WITS) & Bird Counts

Table 3. Bird species observed at CFMETR in 2006

| Species | Number of Bird Sightings | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mar | Apr | May | June | July | Oct | Nov | Dec | CBC |
| Canada Goose | 2 | 3 | 8 | 19 | | 16 | 1 | | |
| Trumpeter Swan | | | | | | | | 2 | 2 |
| American Wigeon | | | | | | 2 | 30 | | |
| Mallard | 8 | 1 | 3 | | | | 29 | 3 | 15 |
| American Green-winged Teal | | | | | | 2 | | | |
| Harlequin Duck | 3 | | | | | 1 | | 6 | 13 |
| Surf Scoter | 8 | | | | | 207 | 18 | 43 | 18 |
| White-winged Scoter | | 12 | 6 | | | 124 | 6 | 7 | 20 |
| Black Scoter | | | | | | 25 | 125 | 6 | 6 |
| Bufflehead | 7 | 5 | | | | | 3 | 14 | 19 |
| Common Goldeneye | | | | | | | | 3 | |
| Barrow's Goldeneye | 26 | | | | | | | 15 | 83 |
| Common Merganser | 3 | | | | | | 5 | 26 | 7 |
| Red-breasted Merganser | 6 | 17 | 4 | | | | | 14 | 47 |
| California Quail | 17 | | 17 | | | | | | |
| Pacific Loon | 13 | 30 | 81 | | | 53 | 41 | 22 | 33 |
| Common Loon | 6 | 12 | 2 | | | 27 | 32 | 15 | 17 |
| Horned Grebe | 7 | 15 | | | | 33 | 21 | 11 | 24 |
| Red-necked Grebe | | | | | | 9 | | 3 | 4 |
| Double-crested Cormorant | 4 | 6 | 5 | | | 41 | 75 | 31 | 20 |
| Pelagic Cormorant | 3 | 19 | 6 | | | 67 | 46 | 62 | 72 |
| Great Blue Heron | | 2 | | | | 5 | | | |
| Turkey Vulture | | 8 | 5 | 12 | 6 | | | | |
| Osprey | | 1 | | | | | | | |
| Bald Eagle – Adults / Immatures | 6 / 4 | 11 / 2 | 6 / 3 | 7 / 4 | 5 / 1 | 1 / 0 | 8 / 0 | 14 / 11 | 18 / 10 |
| Sharp-shinned Hawk | | | | | | 1 | | 1 | |
| Cooper's Hawk | | | 1 | | | | 1 | | 3 |
| Red-tailed Hawk | 1 | 1 | | | | | 1 | 1 | 4 |
| Merlin | | | | | | | 2 | | 1 |
| Black Oystercatcher | | | | 3 | 6 | 6 | 4 | | |
| Black Turnstone | | | | | | 5 | 10 | | |
| Mew Gull | 5 | 13 | 18 | | | 101 | 29 | 9 | 18 |
| Ring-billed Gull | | | | 2 | | | | | |
| California Gull | | | | | | 3 | | | |
| Thayer's Gull | | | 6 | | | 8 | | 4 | 3 |
| Glaucous-winged Gull | 9 | 33 | 32 | 5 | 2 | 59 | 136 | 53 | 32 |
| Gull sp. | 57 | 25 | 15 | 11 | 4 | 70 | 26 | 80 | 109 |
| Pigeon Guillmot | | | 1 | | | | | | |
| Marbled Murrelet | | 24 | | | 6 | 2 | 2 | 2 | |
| Rock Pigeon | | 14 | 3 | | | | | 3 | |
| Band-tailed Pigeon | | 2 | | | | | | 4 | 3 |
| Vaux's Swift | | | | | 7 | | | | |
| Rufous Hummingbird | | 7 | 7 | 3 | | | | | |
| Belted Kingfisher | | 3 | | 1 | 3 | 5 | 3 | 2 | 1 |
| Downy Woodpecker | 1 | | | | | | | | 1 |
| Hairy Woodpecker | | 1 | | | | | | | |
| Northern Flicker | 10 | 15 | 9 | 3 | 3 | 36 | 32 | 21 | 38 |
| Pileated Woodpecker | 2 | 4 | | | | 2 | | 2 | 3 |
| Willow Flycatcher | | | 2 | 1 | | | | | |
| Steller's Jay | | | | | | | 2 | 1 | 2 |

| Table 3. continued | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Number of Bird Sightings** | | | | | | | | |
| | **Mar** | **Apr** | **May** | **June** | **July** | **Oct** | **Nov** | **Dec** | **CBC** |
| Northwestern Crow | 4 | 7 | 12 | 8 | 4 | 13 | 15 | 37 | 5 |
| Common Raven | 3 | 3 | 1 | 1 | | 3 | 3 | 2 | 3 |
| Violot Green Swallow | | | | 7 | 4 | | | | |
| Tree Swallow | | | 2 | 2 | | | | | |
| Chestnut-backed Chickadee | 24 | 19 | 4 | | 1 | 6 | 10 | 5 | 26 |
| Bushtit | | | | | | | | | 7 |
| Red-breasted Nuthatch | 12 | 8 | 7 | 22 | | 5 | | 3 | 2 |
| Brown Creeper | 2 | | 3 | 1 | | | | | 5 |
| Bewick’s Wren | 3 | | 2 | | | 1 | | | |
| Winter Wren | 5 | 1 | 2 | | 1 | 2 | 3 | 1 | 11 |
| Golden-crowned Kinglet | | 13 | | | | 16 | 33 | 5 | 37 |
| Ruby-crowned Kinglet | 23 | 13 | | | | 22 | | | 14 |
| Swainson’s Thrush | | | 14 | 7 | 3 | | | | |
| Hermit Thrush | 2 | | | | | | | | |
| American Robin | 52 | 110 | 56 | 32 | 4 | 505 | 785 | 1070 | 911 |
| Varied Thrush | | 1 | | | | 17 | | 10 | 110 |
| Cedar Waxwing | | | 2 | | | | | | |
| European Starling | 8 | 26 | 15 | 24 | 4 | 28 | 11 | 43 | 28 |
| Hutton’s Vireo | | | 1 | 1 | | | | | |
| Orange-crowned Warbler | | 4 | 2 | 6 | | | | | |
| Yellow-rumped Warbler | | 1 | 1 | | | | | | |
| Black-throated Gray Warbler | | 2 | 3 | 3 | | | | | |
| Western Tanager | | | 4 | 9 | | | | | |
| Black-headed Grosbeak | | | | 6 | | | | | |
| Spotted Towhee | 12 | 24 | 25 | 18 | 1 | 30 | 17 | 8 | 18 |
| Chipping Sparrow | | 11 | 36 | 34 | 5 | | | | |
| Fox Sparrow | 2 | | | | | | | 1 | |
| Song Sparrow | 2 | 4 | 17 | 12 | 6 | 14 | 5 | 4 | 7 |
| Golden-crowned Sparrow | | | | | | | | 2 | |
| White-crowned Sparrow | | 58 | 45 | 21 | 31 | 6 | | | |
| Dark-eyed Junco | 24 | 39 | 8 | 23 | 4 | 39 | 27 | 29 | 53 |
| Red-winged Blackbird | 1+ | 3 | 6 | 5 | | | | | |
| Pine Grosbeak | | | | | | | | | 1 |
| Purple Finch | 17 | 36 | 26 | 22 | 7 | | 6 | 5 | 16 |
| House Finch | | 30 | 31 | 22 | 23 | 44 | 6 | 7 | 3 |
| Red Crossbill | | | | 2 | | | | | |
| Pine Siskin | | | | | | | 275 | 95 | 32 |
| American Goldfinch | | 3 | 2 | | 1 | | | | |
| **Total Bird Species** | **38** | **47** | **46** | **33** | **23** | **42** | **38** | **47** | **48** |
| Other observations: | | | | | | | | | |
| Black-tailed Deer | 7 | 8 | 17 | 11 | 2 | 19 | 4 | 18 | 15 |
| Raccoon | | | | 2 | 1 | | | | |

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

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***Permit #:*** *P090-06*
***Location:*** *CFMETR and Rocky Point*
***Start Date:*** *01 April 2006*
***Completion Date:*** *01 August 2006*

## Introduction

During the spring of 2006 the Hellmann lab conducted research for the fourth consecutive year at two ESAC site: Rocky Point and CFMETR. These studies are a continuation of research on the butterfly and plant communities of Garry oak ecosystems. Initially the focus of the study was on the population dynamics and adaptation of *Erynnis propertius* and *Papilio zelicaon* along a latitudinal gradient across Vancouver Island. The study objectives have since been expanded to include studies of the range limitations of *Lomatium* spp., population variation in the genetics and nutrient chemistry of *Quercus garryana*, and the impacts and range expansion of the invasive gall wasp, *Neuroterus saltatorius*. *Lomatium* spp. and *Q. garryana* are host plants of our focal butterfly species, and the wasp potentially competes with *E. propertius* and other native oak feeders.

The 2006 study objectives were : 1) Measure the density and abundance of all butterfly species and their plant resources at the two study sites; 2) Record temperature and precipitation occurring during the butterfly season at both sites; 3) Perform larval growth experiments with *E. propertius* and *P. zelicaon* to examine variation among geographic locations in growth rate; 4) Sample *E. propertius* and *P. zelicaon* to quantify genetic variation among geographic locations; 5) Sample *Q. garryana* to measure host quality for *E. propertius* and to quantify genetic variation among geographic locations; 6) Perform an experiment with *Lomatium utriculatum*, *L. dissectum*, and *L. nudicaule* to examine germination success among sites, in the presence and absence of competition, and in the presence and absence of large herbivores; and 7) Quantify the extent of outbreak and oak leaf damage caused by *N. saltatorius*.

## Study Area and Methods

1) Transect lines were established in one Garry oak meadow at each of Rocky Point and CFMETR. These transects were repeatedly walked, and all butterfly species observed along the lines were recorded. Effort spent walking transect lines was standardized by meadow size so that density comparisons could be made among study sites. This procedure was also performed in 2003 to 2005. Detailed methods can be found in Hellmann et al. (in review).

2) Temperature was recorded in fifteen minute intervals and total rainfall was recorded from April through July. This procedure also was performed in 2003 to 2005. Detailed methods can be found in Hellmann et al. (in review).

3) Eggs were collected from female *E. propertius* and *P. zelicaon* butterflies at Rocky Point and CFMETR. These eggs were reared at either their natal site or translocated to one of three locations on Vancouver Island (edge of species' range) or three locations in southern Oregon (core of species' range). Eggs from these locations also were temporarily reared at Rocky Point and CFMETR. Caterpillars were repeatedly measured to capture growth rate in mesh enclosures. Larvae hatched from eggs from translocated to other sites on Vancouver Island were returned and released. Similar translocation experiments were performed in 2004 and 2005. Detailed methods can be found in Hellmann et al. (in review).

4) Females that died during egg collection were used in genetic analyses. These samples augment collections made from 2003 to 2005. Samples were recently analyzed to assess genetic diversity within study populations using three mitochondrial genes (CO I, CO II, and ND5) and a suite of microsatellite markers. Detailed methods can be found in Zakharov *et al*. (2007), Zakharov and Hellmann (2007), and Zakharov and Hellmann (in review).

5) Leaves of *Q. garryana* were collected at three time periods from 10 randomly chosen trees at Rocky Point and CFMETR. Leaves were dried to measure water content and digested in the lab to quantify nutrient content (C:N ratio). Material from the twigs of these leaf samples was also used to assess genetic diversity using microsatellite markers. Samples were collected at several other sites throughout the range of *Q. garryana* so that comparisons can be made of leaf chemistry, leaf phenology, and genetic structure over a large geographic area.

6) Seeds from *L. dissectum, L. nudicaule,* and *L. utriculatum* were collected and then experimentally planted at Rocky Point and nine other sites on Vancouver Island, including several sites outside the species' geographic range. Seeds were attached to color-coded toothpicks representing their sources and placed in one square metre field plots. One-quarter of the plots were caged to exclude herbivores (treatment 1), one-quarter of the plots had the competitors removed (treatment 2), one-quarter of the plots were both caged and had competitors removed (treatment 1 and 2), and one-quarter were unmodified (control). The performance of plants in study plots both inside (including Rocky Point) and outside the current range will be assessed in 2007 by the proportion of individuals that germinate at the planting sites. Comparisons will be made for each species within vs. outside the range boundary and across the three study species. Comparisons also will be made within species among source populations and among plot treatments.

7) Surveys were conducted at nine sites on Vancouver Island, including Rocky Point and CFMETR, to estimate the density and resultant damage caused by the invasive jumping gall wasp, *N. saltatorius*. Sites varied in their isolation from agricultural and residential development so that any correlation between wasp density and human land use could be detected. Second generation galls also were collected to assess rates of parasitism. Additional studies examining the parasitoid community of *N. saltatorius* and their effect on *E. propertius* will be pursued in 2007.

## Results

1) A total of eighteen species were observed during repeated butterfly surveys at Rocky Point and CFMETR (Table 1). To date, no COSEWIC or other exceptionally rare butterflies have been detected and additional survey years do not appear to reveal greater species diversity. Instead repeated surveys provide an increasingly accurate portrayal of flight phenology and relative species density.

2) Figure 2 shows the average daytime temperature and seasonal rainfall recorded at Rocky Point and CFMETR in 2006. As with butterfly surveys, additional years of weather sampling provide an increasingly accurate picture of the environmental conditions occurring during the flight season and caterpillar growing season. We are using these weather data to interpret results from larval experiments (Hellmann et al. in review) and to determine the relationship between weather conditions and flight season phenology (Prior and Hellmann in prep).

3) Data from larval growth experiments at Rocky Point and CFMETR are shown in Figure 3. These values 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 (Hellmann et al. in review).

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

Growth rates were similar among years within a species with the exception of faster growth in *E. propertius* in 2006 at Rocky Point and slightly faster growth in *P. zelicaon* at CFMETR in 2005 (Figure 3). In 2006, we translocated individuals from Vancouver Island, including Rocky Point and CFMETR, to the core of the species' range (southern Oregon). The data from this experiment are currently being analyzed and results are not yet available.

4) To enable analysis of genetic samples collected for *E. propertius* and *P. zelicaon*, a suite of microsatellite markers were created for each species. Fifteen polymorphic dinucleotide microsatellite loci were characterized for *E. propertius*. Of these, twelve were successfully amplified in related *Erynnis* species and eight loci were polymorphic in at least one other species (Zakharov *et al*. 2007). In *P. zelicaon,* seventeen microsatellite loci were identified, sixteen of which amplified successfully in other *Papilio* species (Zakharov and Hellmann 2007).

Three mitochondrial genes (CO I, CO II, and ND5) also were sequenced to identify genetic differences among sites. For *E. propertius*, individuals collected from Rocky Point and CFMETR were similar to individuals collected from Mill Hill, Victoria, B.C. and a site near Olympia, Washington. Rocky Point and CFMETR individuals were more distantly related to individuals collected from other locations throughout the species' range. Some individuals from Rocky Point also had a highly divergent mtDNA haplotype represented in few other sites across the range. This haplotype was more than 5% divergent from the dominant haplotype of *E. propertius*. For *P. zelicaon*, individuals collected from Rocky Point and CFMETR were similar to individuals from across the entire species' range. 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. More extensive results are reported in Zakharov and Hellmann (in review).

5) We developed ten microsatellite markers in the lab at Notre Dame, and these then were used to analyze the population structure of *Q. garryana* in the species' core (southern Oregon), in the greater Puget Sound region (mid-range), and its periphery (Vancouver Island). We found that the greatest amount of genetic diversity is contained within populations. Populations also significantly differ from each other in allele frequency, particularly across the two regions.

Data on the nutritional value and moisture content of *Q. garryana* leaves are currently being analyzed, but preliminary results suggest considerable differences across time in moisture content (Figure 4). Samples from sites located in southern Oregon had significantly more moisture than leaves collected from sites on Vancouver Island. Nitrogen (% dry weight) content also was marginally higher in samples from Oregon.

6) Results from the experiment with germination of three contrasting *Lomatium* spp. will not be available until after data are collected in 2007.

7) Density and damage estimates of *N. saltatorius* were higher at Rocky Point then at CFMETR, and damage levels at Rocky Point were similar to other sites on the Island that are surrounded by an urban matrix. Damage levels of *N. saltatorius* were also 95% higher on the island then in their native range (mainland Oregon and Washington). Collected galls still are being analyzed for parasitism in the lab at Notre Dame.

### Discussion

The above objectives comprise a multi-pronged approach to studying species at the edge of their geographic range. These include rare species (e.g., *E. propertius* and *L. dissectum*), common species (e.g., *P. zelicaon* and *L. utriculatum*), and invasive species *(N. saltatroius*). It is assumed that each of these taxa will shift northward due to climate change or human-mediated dispersal.

If shifts are possible, they will take place on Vancouver Island and the adjacent Gulf Islands as this region represents the northern range limit of all of the study species. By studying range boundaries at Rocky Point, CFMETR, and select other sites in the region, factors are being determined that might be important to the future occurrence of Garry oak ecosystem species.

Through the course of the butterfly studies, differences in the flow of genes throughout their geographic distributions have been determined and locations and regions that are genetically distinct from other populations have been identified. Specifically, populations of *E. propertius* at Rocky Point and other select other sites on Vancouver Island have very different mitochondrial haplotypes than other populations, including CFMETR. Further study is necessary to determine the origin of this haplotype, but it seems to be a case of historical interspecific gene flow (Zakharov and Hellmann in prep). Vancouver Island populations as a group also are genetically distinct from mainland populations according to both mtDNA and microsatellite markers (Zakharov and Hellmann in review). *P. zelicaon* also was differentiated at the edge of its range (Vancouver Island) relative to the core (mainland), but less differentiation was found within these two groups than observed for *E. propertius* (Zakharov and Hellmann in review).

Larval growth experiments in previous years involving translocations within sites on Vancouver Island (2004 & 2005; Hellmann et al. in review) also suggest that *E. propertius* individuals from Rocky Point grow significantly slower than individuals collected at other sites. This is likely because the climate at Rocky Point, though southerly on the Island, is cool compared to other Garry oak sites. Other than this difference at Rocky Point only, growth rates of *E. propertius* are relatively constant among source populations and rearing sites. In contrast, growth rates of *P. zelicaon* vary significantly among rearing sites as predicted by temperature and rainfall. The warmest sites (i.e., those most like the centre of the species' range) had the fastest rate of growth. Analysis of the 2006 larval experiment, involving translocation between Vancouver Island and southern Oregon, is on-going (Hellmann et al. in prep). A third, and final, experiment involving *E. propertius* and *P. zelicaon* larvae at Rocky Point, CFMETR , and other sites will take place in 2007. In this experiment, eggs will be collected from the field and transported to a series of growth chambers at Notre Dame where conditions similar to the range periphery and core will be simulated in a controlled environment.

Preliminary data also suggest that oaks in the centre of the species' range may be of higher nutritional quality for *E. propertius* and that conservation of individual oak populations is critical for preserving their genetic diversity due to high within-population diversity (Marsico and Hellmann in prep). Preliminary data of *N. saltatorius* suggests that outbreaks of this species still occur on the Island as damage rates there as whole are high relative to the species' native range. Damage rates also were high at sites within the greater Victoria region and some of the highest levels recorded were at Rocky Point. Further studies in 2007 will examine the parasitoid community infecting *N. saltatorius* and the effect of leaf damage on *E. propertius*.

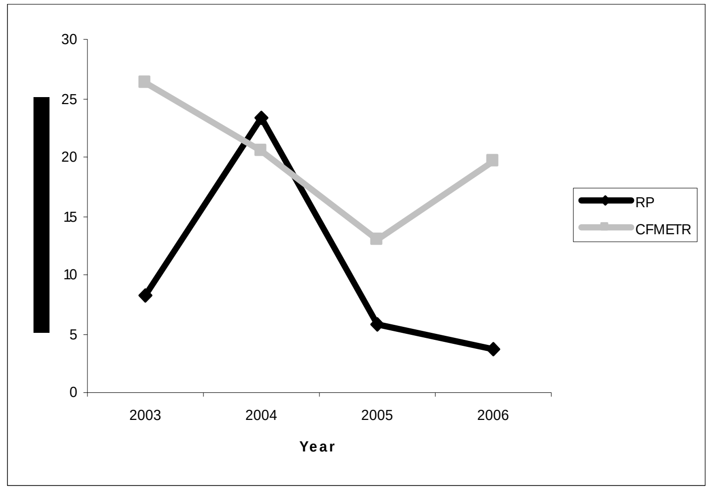
Finally, data collected from the *Lomatium* spp. experiment in 2007 will provide an additional picture of the limitation of Garry oak species, as well as the potential uniqueness of populations at Rocky Point and CFMETR in comparison to other sites. Note that the projects involving *Lomatium* spp. and *N. saltatorius* are Ph.D. projects executed by Travis Marsico and Kirsten Prior, respectively.

## Conclusions

To date, research at Rocky Point and CFMETR have generated four manuscripts and a number of other in-preparation manuscripts. In preparation manuscripts include: 1) an analysis of the genetic structure of *Q. garryana* (Marsico and Hellmann); 2) results of larval growth experiments at the edge vs. core of the species' ranges (Hellmann et al.);

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

3) an analysis of the life history of *E. propertius* at the edge of its geographic distribution (Prior and Hellmann); and 4) description of the historical interspecific hybridization in *E. propertius* (Zakharov and Hellmann). The studies with *Lomatium* spp. and *N. saltatorius* are expected to be published in coming years as well. Other aspects of the research pursued at Rocky Point and CFMETR (e.g., weather data) provide support and interpretation to several of the papers listed above. Methodological details beyond that presented here also can be found in these manuscripts. Data are available upon request to J. Hellmann.



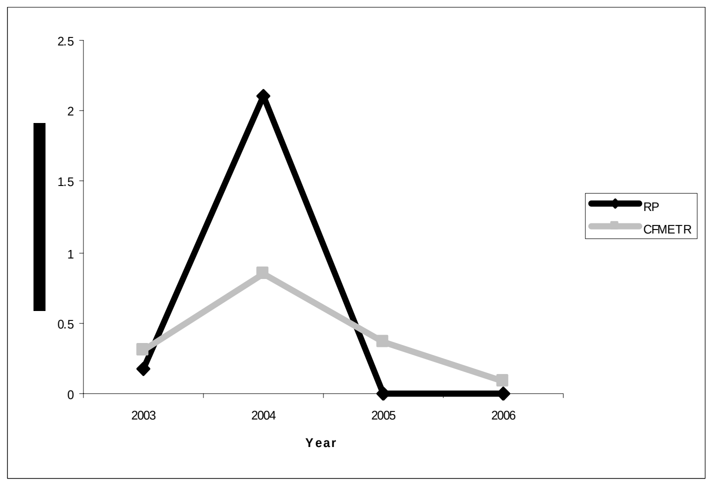




Figure 1. Seasonal density estimates for *E. propertius* (A) and *P. zelicaon* (B) at Rocky Point and CFMETR.

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Table 1. List of species observed at Rocky Point (RP) and CFMETR (CFM) either from quantitative butterfly surveys or from simple observations made while on-site. The codes 03, 04, 05, and 06 in the right-most columns indicate the year in which a species was observed.

| Code | Common name | Latin name | RP | CFM |
|---|---|---|---|---|
| EP | Propertius skipper | *Erynnis propertius* | 03, 04, 05, 06 | 03, 04, 05, 06 |
| PZ | Anise swallowtail | *Papilio zelicaon* | 03, 04 | 03, 04, 05, 06 |
| SA | Spring azure | *Celastrina echo* | 03, 04, 05, 06 | 03, 04, 05, 06 |
| CW | Cabbage white | *Pieris rapae* | 03, 06 | 03, 05, 06 |
| GH | Grey hairstreak | *Strymon melinus* | 03, 04, 05, 06 | 03, 04, 05, 06 |
| SO | Sara's orangetip | *Anthocharis sara* | 05, 06 | 03, 04, 05, 06 |
| MC | Mourning cloak | *Nymphalis antiopa* | 05 | 03, 05 |
| PC | Purplish copper | *Lycaena helloides* | 03, 05, 06 | 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, 06 | 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, 06 |
| 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*

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

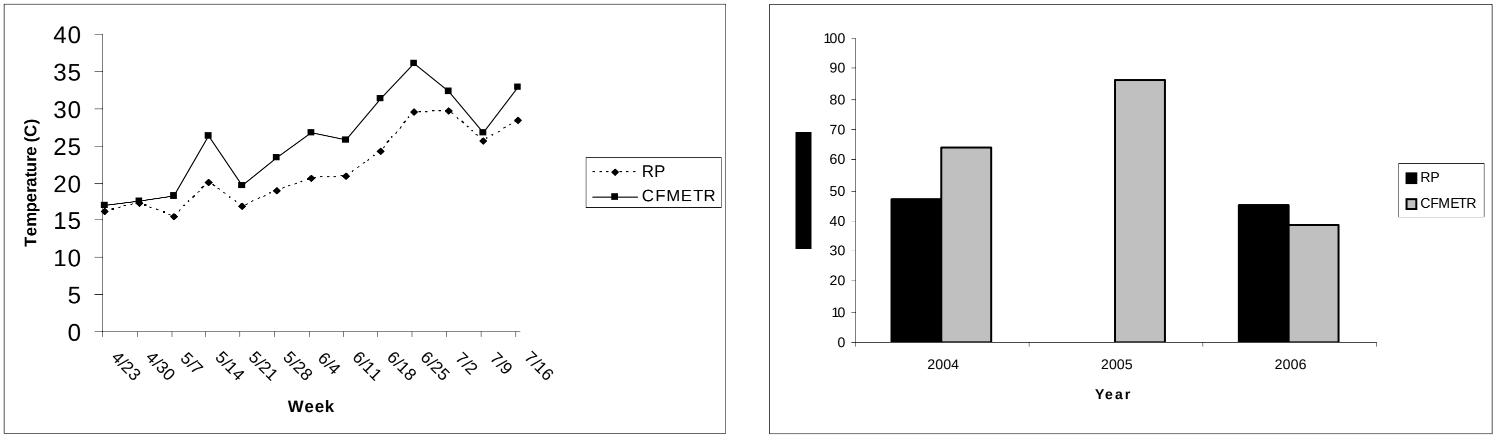



Figure 2. Mean weekly daytime temperature (10:00-16:00) in 15-minute intervals at Rocky Point (dashed line) and CFMETR (solid line) (A) and total seasonal rainfall recorded at Rocky Point and CFMETR (B).

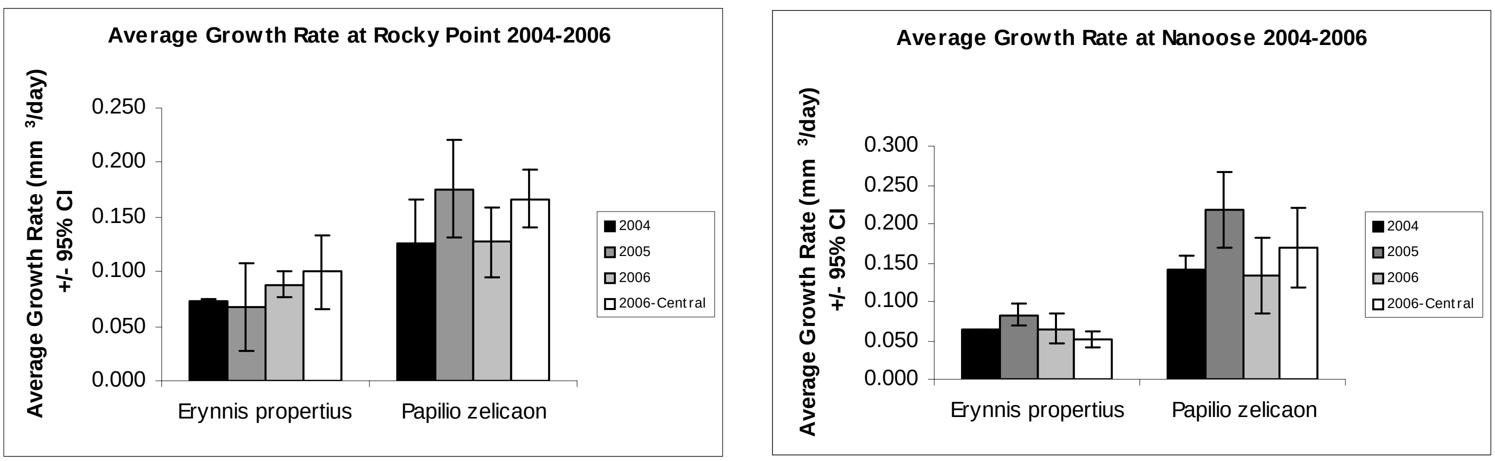
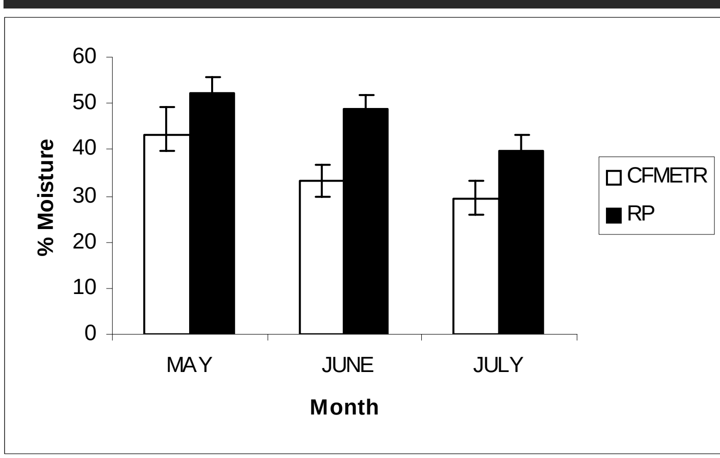



Figure 3. Average growth rate observed for *E. propertius* and *P. zelicaon* in caterpillar studies at Rocky Point (A) and CFMETR/Nanoose (B). "2004," "2005," and "2006" represent caterpillars reared at their native site. "2006-central" represents caterpillars from southern Oregon reared temporarily at Rocky Point (A) and CFMETR/Nanoose (B) and then removed. Growth rate is determined by fitting experimental data with an exponential function; values reported are the exponent of that function. Error bars shown represent 95% confidence intervals.




< Figure 4. Average percent moisture of oak leaves by month at Rocky Point and CFMETR. Error bars shown represent standard deviation.

# Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point, British Columbia

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***Permit #:*** *P104-06*
***Location:*** *Rocky Point*
***Start Date:*** *01 January 2006*
***Completion Date:*** *31 December 2006*

## Introduction

Prior to European contact, the Straits Salish people, an ethnolinguistic group centered on present day Victoria in southwestern B.C., built a distinctive form of grave. The burial cairn and mound, a phenomenon occurring 1500–1000 years before present (Thom 1995) consists of an arrangement of rocks and soil placed over the deceased. Cairns and mounds vary in form and distribution, often occurring in an array of shapes and sizes. Cairns are constructed primarily from stone, with only a minor or moderate amount of soil. Burial mounds are essentially burial cairns covered with a thick layer of soil. Burial cairn and mound 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 (Smith and Fowke 1901) 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 B.C. (Lepofsky *et al*. 2000) has begun to address the interpretive potential of these important features. Although there has been very productive work on similar mortuary features in Europe (Bradley 1998, Tuovinen 2002) burial cairn research in B.C. 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, a recent compilation was completed of the detailed examination of the largest remaining burial cairn cemetery in B.C. at the Department of National Defence, Rocky Point property (Figure 1). Working with members of the Scia'new First Nation, nearly 400 cairns were mapped in great detail at the Rocky Point site with a Global Positioning System (GPS).

It is hypothesized that the external attributes of burial cairns and mounds – their location and shape – are important signifiers of the social identity of the person buried within. Much like historic and contemporary Euro-Canadian grave markers say important things about the social affiliations of the dead (their relative socioeconomic standing, membership to special organizations such as the military, etc.) and how cemeteries are divided into sections, again based on attributes of the dead person's place in society, 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, intrasite landscape spatial data are 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.

# Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point, British Columbia

## Study Area and Methods

All of the data were gathered at a large cairn site (designated DbRv-3 in Figure 1) in the vicinity of Edye Point at Rocky Point. Interpretation of the data was facilitated through spatial analysis if the data in 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 three to five experienced archaeologists walked systematic transects with a two 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 were imported into a Geographic Information System (GIS) (Figure 2). This was largely completed by 2005.

For the analysis of individual cairns, a total of eighteen 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. This work was largely completed in 2006. Some cairns required at least partial clearing of accumulated vegetation, particularly from invasive species such as Scotch broom and gorse. Cairns were otherwise not affected by the 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 (Mathews 2006a). Additionally, there had not been a comprehensive inventory of burial cairns in the Victoria region. From a cultural history perspective, this research generated a systematic and detailed survey of over 1400 hectares of land in Metchosin (and twenty 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. This type of non-invasive detailed analysis of the individual burial cairns at DbRv-3 at Rocky Point is the first of its kind in the province, and possibly in North America.

My masters thesis, entitled "Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point, British Columbia" (Mathews 2006b) was successfully defended in the Department of Anthropology at the University of Victoria on August 25, 2006. During the analysis, six distinct types of features were identified by a statistical analysis of the materials used to build the burials, the shape and size of the cairn, and the amount of soil used to build them (Figure 3). Next, a spatial analysis was used to define seven distinct areas within the site. This was followed by an analysis of the distribution of these six types of cairns throughout the seven different areas. Distinct patterns were evident. This patterning indicates that certain types of cairns were restricted in terms of where they could be built. In other words, there were likely social rules in play that dictated who could be buried where. This patterning may be analogous to how contemporaraneous villages were laid out. Within villages, the people with the most social capital had their houses in the centre of the settlement with the progressively less influential and wealthy having their houses along the peripheries of the site. Within each household, wealthy or poor, there was also internal social stratification.

The distribution of burial cairns at Rocky Point likely may reflect this same patterning, with each of the seven areas likely representing the burial locality of separate households. Each type of cairn within each of these spatial clusters in turn may represent more individual identities.

At this point in my research, the 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. This research raises as many questions as it answers and is the impetus for a more detailed analysis of Rocky Point, as well as a number of other burial cairn sites throughout the Strait of Georgia area.

## Discussion

This research explores ways in which social practices are linked to particular forms of relationships between peoples and to particular forms of power. 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 2007. The aim of the research will continue to focus on gathering detailed information on individual cairn morphology from Rocky Point 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 and other DND properties, as well as at other non-DND properties throughout the Strait of Georgia and Puget Sound.

## Conclusions

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 further study to determine what can achieved by looking beyond the boundaries of the individual cairn site. For the next phase of research, it is hypothesized 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. 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 B.C., the ongoing research at Rocky Point will form the theoretical and methodological stepping off point from which a regional analysis can be approached. The regional analysis will focus on sites throughout the Strait of Georgia and Puget Sound.

*I am now a Doctoral candidate at the University of Victoria. I will continue pursuing this field of study. I am currently preparing a manuscript for publication based on the results of my master's thesis for an edited volume on Northwest Coast archaeology. The results of the doctoral dissertation, which I anticipate defending in 2010, will be the basis for a book and multiple articles on the burial cairns and mounds of Rocky Point. This resulting data will be curated with the Environmental Sciences Advisory Committee, The University of Victoria Archives, and the Royal British Columbia Museum.*

# Burial Cairn Taxonomy and the Mortuary Landscape of Rocky Point, British Columbia

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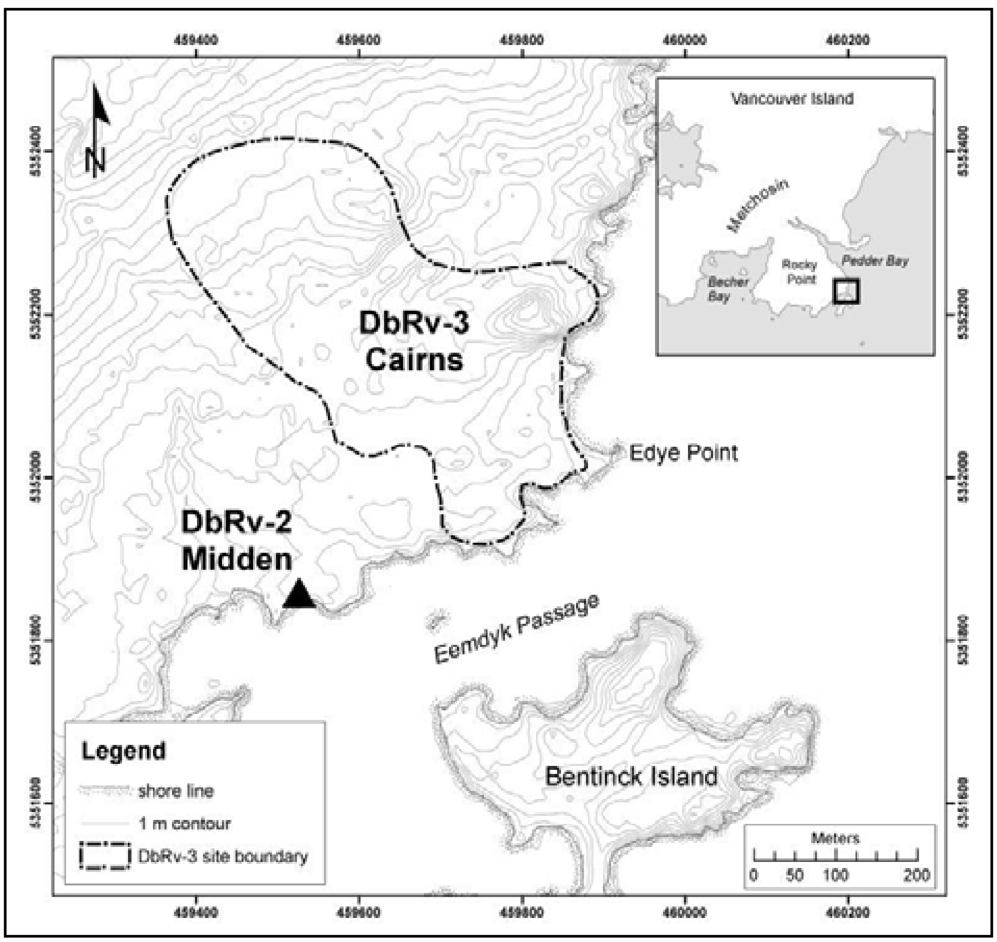
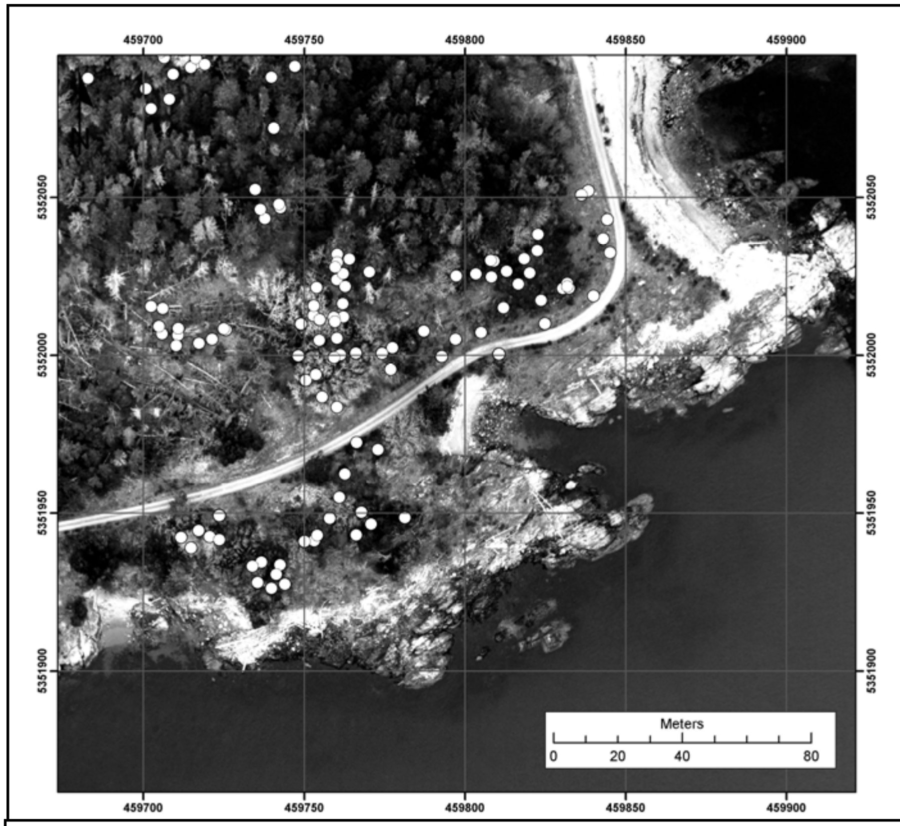
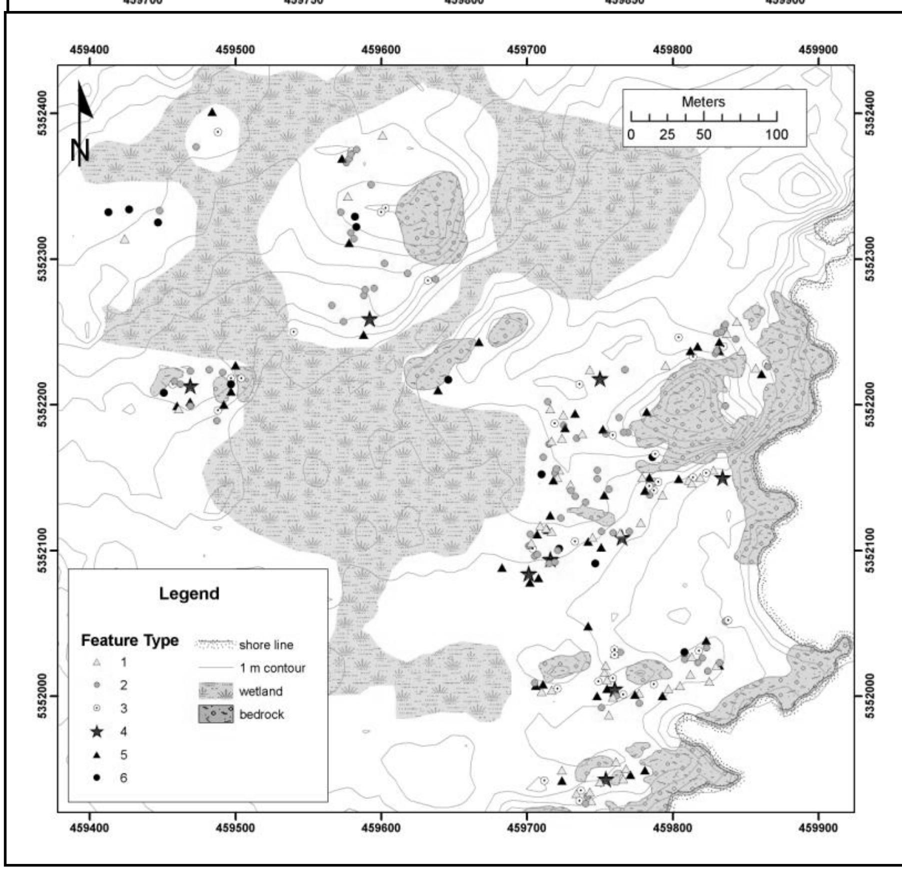



Figure 1: Location of DbRv-3, the Rocky Point Burial Cairn Cemetery




< Figure 2. Example of burial cairn density and distribution




< Figure 3. Distribution of cairns by type

# Phantom Orchid Survey At Heals Rifle Range

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***Permit #:*** *P105-06*
***Location:*** *Heal's Rifle Range*
***Start Date:*** *May 2006*
***Completion Date:*** *15 July 2006*

## Introduction

The phantom orchid (*Cephalantera austiniae*) is a rare white orchid that is restricted to a few locations in the extreme southwest of British Columbia where it occurs in maturing forest on southern Vancouver Island, Saltspring 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. If the phantom orchid occurs on federal land it would be automatically protected under the Species at Risk Act. One of the recommendations of the Phantom Orchid Recovery Team is to locate additional populations of the phantom orchid.

Over eight populations of phantom orchid were identifiedin the Gowlland Tod Provincial Park, which is adjacent to DND's Heals Rifle Range property. As such, this property was a logical area to search for the species. The phantom orchid is visible and blooms only from the middle of June to the middle of July, limiting the searching period.

## Study Area and Methods

Two search days were conducted on Cole Hill at Heals Rifle Range in 2005. In 2006 a search of different part of Cole Hill took place on 9 June; these search areas were mapped using a GPS.

## Results

No phantom orchids were found in 2006 on the single day of searching.

## Discussion

Due to the ephemeral nature of phantom orchids (they can go many years without flowering, then appear) and the short duration of our search, we could not definitively determine if phantom orchids occur at Heals Rifle Range.

## Conclusions

Due to our lack of success, and the difficulties making entry and permit arrangements, we have decided not to apply for a permit for 2007.

# Western Bluebird Nestbox Project at CFMETR, Nanoose Bay, B.C.

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***Permit #:*** *P108-06*
***Location:*** *CFMETR*
***Start Date:*** *02 June 2006*
***Completion Date:*** *31 December 2006*

## Introduction

The Western Bluebird Nestbox Project at CFMETR, in Nanoose Bay is part of a larger project aimed at increasing the nesting opportunities for the Western Bluebird on southern Vancouver Island and the Gulf Islands. Until the 1990s the Western Bluebird (*Sialia mexicana*) once nested on Garry oak sites on southern Vancouver Island and the Gulf Islands. It is believed that cool spring temperatures 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 Bluebird nestbox program, organize a system of boxes and voluntary stewards and work towards the re-introduction of Western Bluebirds to the Georgia Depression. Bluebird nestboxes are also monitored at Rocky Point under the Rocky Point Bird Observatory's permit. This report focuses only on the boxes at CFMETR in Nanoose Bay.

## Study Area and Methods

On 31 January 2005, six Western Bluebird nestboxes (Figure 1) and one flicker nestbox were affixed amongst Garry oaks on the face of Nanoose Hill. This work was completed with the assistance of Naira Johnston, University of Victoria Co-Op student and volunteer coordinator, and Guy Monty, volunteer steward. The boxes were spaced in pairs approximately twenty metres apart and positioned so as to be prominent to bluebirds flying by, but not obvious to individuals walking by.

## Results

In 2006 , Monty completed five checks of the boxes:

- 28 May 2006 - no evidence of birds using boxes and there were spider webs over the entrances;
- 26 June 2006 - no evidence of birds using boxes, spider webs present;
- 3 August 2006 - no evidence of birds using boxes, spider webs present;
- 18 October 2006 - mouse evidence in two boxes;
- December 2006 - Nanoose Christmas bird count – Owl feathers in the flicker box, but no evidence of nesting.

There was no evidence of vandalism to the boxes. All boxes were cleaned out after the end of the breeding season.

## Discussion

There was no Western Bluebird use of boxes in 2006. Nanoose Bay is near the northern limit of the Western Bluebird's range. It is more likely that Western Bluebirds will discover and occupy the Rocky Point Bluebird boxes before those at Nanoose Bay. However, public support for the 'Bring Back the Bluebird' project in Nanoose Bay is high, with volunteers building more than 50 boxes. The project will hopefully include installing additional boxes at CFMETR as it is the most likely site to attract Western Bluebirds in the Nanaimo area.

# Western Bluebird Nestbox Project At CFMETR, Nanoose Bay, B.C.

## Conclusions

"Bring Back the Bluebirds" is a long-term project. It is anticipated that Western Bluebirds from Fort Lewis, Washington will eventually reach Vancouver Island as a result of warming temperatures and expanding populations. Although the Western Bluebird boxes at CFMETR in Nanoose Bay were not occupied in 2005 or 2006, it is important to keep monitoring the boxes and to place a few more as Nanoose Hill represents an excellent potential site for the birds.

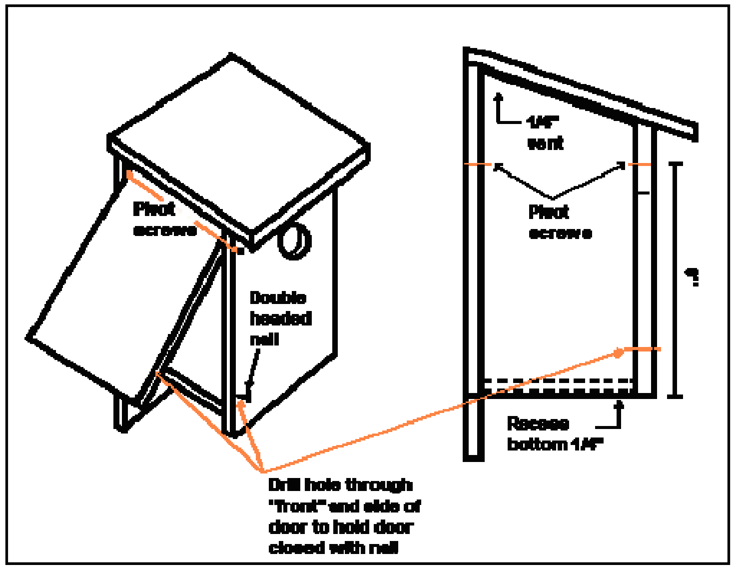


Figure 1. Western Bluebird nestbox design

# Influence of Water Conditions on the Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa)* at Maintenance Detachment Aldergrove

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***Permit #:*** *P109-06*
***Location:*** *CFMETR*

***Start Date:*** *01 March 2006*
***Completion Date:*** *15 May 2006*

## Introduction

*Rana pretiosa* is a Pacific Northwest species (Corkran & Thoms, 1996). Since the 1990s, *R. pretiosa* has not been found in any of the previous locations that it was known from in B.C. (Haycock, 1999). In B.C. today, it occurs at three sites in the extreme south-west 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 has been 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 ninety egg masses in 1997 to thirty-three egg masses in 2001 (Haycock, 2001). From 2004 to 2006 the number of egg masses at MD Aldergrove was between five and seven (unpublished data). 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 B.C.

## Study Area and Methods

### *Study Site*

The research was conducted at the Department of National Defence's MD Aldergrove proeprty (latitude 49° 0" and longitude 122° 29"). The MD Aldergrove study site consisted of three sub sites, namely Pipeline, Frog Restoration site (FRS) and 264th Street. Pipeline and 264th Street were connected and were open wetlands with a mix of open water and vegetation. FRS was altered in 2002 and now consists of a large body of open water with little vegetation in the littoral zone.

### *Embryonic survivorship of R. pretiosa*

The sub-sites were visited twice a week from the beginning of March to the beginning of April to locate egg masses. To quantify the embryonic survivorship of *R. pretiosa* from early development through to hatching, sub-samples of egg masses (fifteen to thirty eggs) 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, but do not exclude bacteria and viruses (Harris & Bogart, 1997) (Figure 1).

# Influence of Water Conditions on the Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa)* at Maintenance Detachment Aldergrove

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 period of development. Development was described using Gosner (1960) staging. Free swimming hatchlings were released at the wild egg masses site.

***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]. A minimum/maximum Vee Gee brand thermometer was installed where the egg masses were oviposited and current (temperature at time of survey), minimum and maximum water temperatures were recorded twice a week during the two to three weeks of egg development.

## Results

***Embryonic survivorship***

On 13 March, three adults were observed and on 27 March, one adult was observed. However, no *R. pretiosa* egg masses were oviposited at the pipeline sub site.

Three egg masses were oviposited at FRS. Embryonic survivorship was between 61% and 91%. Mean embryonic survivorship was 80% (SD ± 16). Two egg masses were oviposited at 264th Street. One cage was tipped over during the development period (possibly by a beaver) and eggs could have fallen out. The remaining cage had an embryonic survivorship of 39%.

***Water quality***

Water Chemistry

There were very few differences in water chemistry between FRS, Pipeline and 264th Street based on the water sample taken half way through the breeding period. At the sub-sites parameters including $SO_4$, Br, $NO_3$ and $PO_4$ were below method detection limit (MDL). At FRS $NO_2$ and $NH_3$ were also below MDL while at Pipeline Phos. 0-PO4 diss. was also below MDL.

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, none of the parameters exceeded the CWQG.

Trace metals

At FRS and Pipeline, bismuth and thallium were below MDL. In addition, at FRS, beryllium, cadmium and lithium were also below MDL and at Pipeline sulphur and molybdenum were below MDL. At 264th Street, sulphur, bismuth, cadmium and molybdenum were below MDL. For parameters in which CWQG (Canadian Council of Ministers of the Environment [CCME], 2003) were available, iron and copper exceeded the CWQG at FRS and Pipeline.

At FRS, exceeded the CWQG by a small degree while at Pipeline, chromium exceeded the CWQG by a small degree and aluminum exceeded the CWQG by a larger degree. At 264th Street iron exceeded the CWQG by a small degree and aluminum exceeded the CWQG by a larger degree.

Coliforms

Total coliforms at MD Aldergrove FRS was 360 col/100 ml, at Pipeline it was 57 col/100 ml and at 264th Street it was 76col/100 ml. Fecal coliform at FRS was below method detection limit while at Pipeline it was 47 col/100ml and at 264th Street it was 5 col/100 ml. No Canadian water quality guidelines (CWQG) currently exist for coliforms.

Water temperature

The minimum water temperature at FRS ranged from 3 to 6ºC while the maximum water temperature varied between 13 and 21ºC. Current water temperature ranged from 6 to 12ºC. The mean minimum water temperature for FRS during 2006 was 5ºC (SD ±1.23), the mean maximum water temperature was 16.4ºC (SD ±3.44) and the mean current water temperature was 10°C (SD ±2.55). Minimum water temperature at 264th Street was similar with minimum water temperature between 4 and 6ºC, maximum between 15 and 18ºC and current water temperature between 7 and 12ºC. Mean minimum water temperature at 264th Street was 5ºC (SD ± 1.26), mean maximum water temperature was 16ºC (SD ±1.41) and mean current water temperature was 10.4ºC (SD ±2.07).

## Discussion

At MD Aldergrove FRS, 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 264th Street was far below average. *R. pretiosa* usually breeds 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 264th Street is not likely due to temperature.

The pH, in combination with aluminum, can cause embryonic mortalities (Beattie and Tyler-Jones, 1992; Beattie *et al*., 1992 and Clark and LaZerte, 1985). These lethal effects were usually observed at a pH below 4.5 (Beattie and Tyler-Jones, 1992; Beattie *et al*., 1992; Clark & LaZerte, 1985). Given that in this study was not below pH 6.78, it is unlikely that the combination of pH and resulting aluminum concentrations would have any significant effect on embryonic survivorship observed in this study.

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 current 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. However, we need to continue this monitoring to ensure water conditions stay within the acceptable range for *R. pretiosa* and to monitor the long term embryonic survivorship of *R. pretiosa.*

# Influence of Water Conditions on the Embryonic Survivorship of the Oregon Spotted Frog (*Rana pretiosa)* at Maintenance Detachment Aldergrove

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

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***Permit #:*** *P114-06*
***Location:*** *Rocky Point*
***Start Date:*** *August 2005*
***Completion Date:*** *August 2008*

## Introduction

Field investigations undertaken in 2003 and 2004 (Gedalof *et al*. 2004; Gedalof *et al*. 2006) 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 fifty-three Douglas-fir seedlings were found, forty-one saplings were also 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 BC Parks property at Burgoyne Bay, Saltspring Island, suggest that seedlings are relatively common at both sites, but there are very few small oak trees and virtually no sapling-sized individuals (Smith, 2007). Additionally, conifer encroachment is occurring in portions of all observed 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 vs. 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 Methods

The study area is located in an area of transition from prairie to closed forest at DND Rocky Point property. The southeast corner of the sampling area is located at N 48° 19’ 28.5” W 123° 32’ 45.3” (horizontal accuracy ± 5 m). The site is generally flat, with only a few relatively small undulations (< one metre) in topography. The understory vegetation is composed primarily of introduced grasses [30% orchardgrass (*Dactylis glomerata*), 30% colonial bentgrass (*Agrostis capillaries*), 20% sweet vernal grass (*Anthoxanthum odoratum*)], with most of the remaining understory composed of bracken fern (*Pteridium aquilinum*)].

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

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% 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 twenty seedlings. The exclosures are composed of wire fencing supported by re-bar, and are approximately fifty centimetres in diameter and one metre in height. To assess the effect of competition with grasses, a small square of landscape cloth was placed around twenty seedlings to reduce competition for resources. To assess interactive effects, both treatments were applied to seedlings (Figure 1). Forty control seedlings were identified and marked for future identification. Seedlings were remeasured in August, 2006.

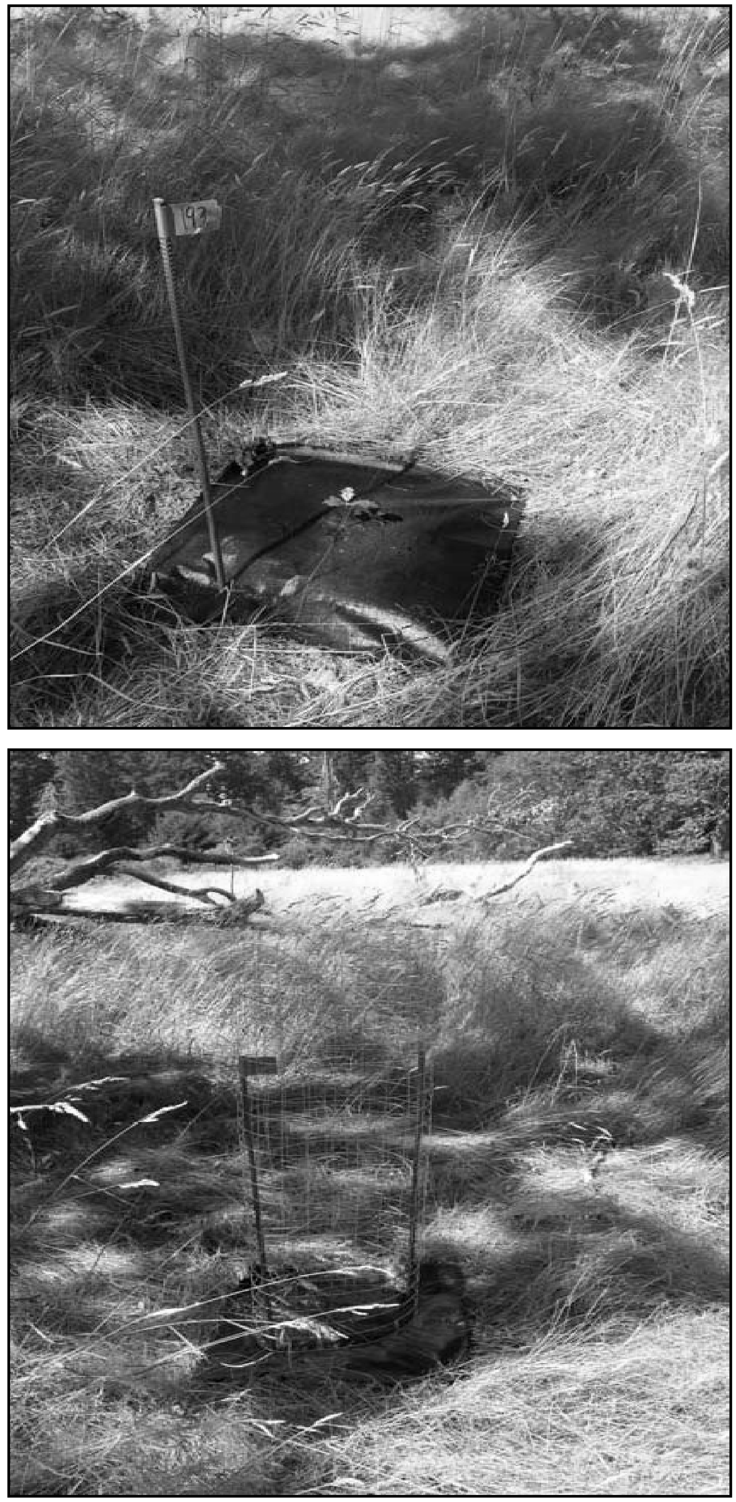

Figure 1. (Top) Landscaping cloth used to reduce competition with grasses;
(Bottom) Landscaping cloth and ungulate exclosure used to test for an interaction effect

## Results

Seedling mortality was high across treatment types (24%), with the lowest mortality occurring in seedlings with exclosures (10%), and the highest mortality in seedlings with landscape cloth (35%). Mortality in the control group was 20%, and in the interaction group was 35%. A difference of proportions test (Zar 1999) indicates that the following results are statistically significant; mortality was lower than average among seedlings with exclosures only, and mortality was higher than average among seedlings with landscaping cloth (regardless of whether an exclosure was present or not). There was no interaction effect.

## Discussion

The results to date suggest that herbivory by large ungulates plays a small but important role in reducing seedling survival rates for Garry oak. Competition with exotic vegetation for water or light does not appear to be limiting of itself. In fact, young seedlings appear to require the presence of vegetation. This result may be explained by the fact that seedlings have shallow root systems, and may experience moisture deficits without vegetation to shade them and reduce transpirative moisture losses (Cui and Smith, 1991). For this reason, seedlings may have different environmental limitations than mature trees do. In the context of the original research question, *Why is Garry oak failing to reproduce at Rocky Point*?, three possible explanations remain: (1) natural mortality combined with herbivory may be sufficient to make regeneration events extremely rare. This problem may be exacerbated by the introduction of livestock to many Garry oak meadows (e.g., cattle, horses, goats, sheep), as well as the elimination of large predators from most remaining Garry oak ecosystems; (2) Competitive effects may affect older seedlings disproportionately. As root systems grow, shade and moisture deficits may be more problematic to Garry oak seedlings; and (3) Exotic vegetation may have distinct effects on Garry oak seedlings that are not directly related to competition. For example, the invasive plant garlic mustard (*Alliaria petiolata*) has been shown to interfere with the the arbuscular mycorrhizal fungi required by many trees for vigorous growth and reproduction (Stinson *et al.,* 2006). If these effects are present in Garry oak ecosystems, the removal of immediately adjacent vegetation (as undertaken in this experiment) would not be a useful proxy for an uninvaded ecosystem, since the below-ground community remains fundamentally different and the seedlings may consequently be more susceptible to drought or nutrient deficiencies.

## Conclusions

The logical next step in these analyses involves the comparison of invaded and non-invaded Garry oak associated ecosystems with respect to their seedling survival. The ideal method of modifying these systems involves the application of grass-specific herbicides, since these do not affect native vegetation or disturb the soil. Unfortunately this is not possible at Rocky Point due to DND policies. Future plans for Rocky Point are restricted (at this time) to ongoing monitoring of seedlings, and a survey of oak seedlings to characterize the nature of safe sites. Consequently, future experiments are being undertaken at the Nature Conservancy of Canada Cowichan Oak Preserve, where exotic species eradication has been undertaken over the past several years, and reasonably intact native communities have been restored.

Results from research undertaken at Rocky Point has been presented in the previous year at the Garry Oak Ecosystems Recovery Team Research Colloquium (February, 2006; Victoria, B.C.), the 7th International Conference on Dendrochronology (June, 2006; Beijing, China), and the BC Protected Areas Research Forum (December, 2006; Victoria, B.C.). A publication from earlier research was published in the journal Northwest Science (Gedalof *et al.* 2006).

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

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# Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems

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***Location:*** *Albert Head and Rocky Point*
***Start Date:*** *March 2006*
***Completion Date:*** *December 2006*

## Introduction

Biodiversity conservation depends fundamentally on ecological research to understand the processes that produce and maintain patterns of diversity and how human impacts, such as habitat loss and climate change, may alter these patterns. While local environmental conditions are often thought to be the dominant determinants of plant community composition at a given location, there has been a recent recognition that regional processes, historical events and geographical circumstances interact with these local processes to determine species distributions (Ricklefs and Schluter, 1993). For example, when habitat is fragmented, the size of the remaining fragments and their spatial configurations can influence the relative frequencies of colonization and extinction (Fahrig, 2003).

On southeastern Vancouver Island, the endangered Garry oak ecosystem has been fragmented by urban development, agriculture and forestry, such that less than 10% remains in a near-natural state (Lea, 2006). Many of the remaining patches of this ecosystem exist as 'habitat islands' in parks and protected areas. These habitat patches are crucial reservoirs for the high plant species diversity characteristic of this ecosystem (Fuchs, 2001). Designing effective strategies to conserve species in the Garry oak ecosystem can benefit from a thorough understanding of how landscape context influences plant species distributions.

The initial stage of this study has two purposes:

1. To assess the relative contributions of local environmental factors (topography, soils) and landscape context (patch area, connectivity) as drivers of plant diversity and composition; and

2. To compare native and exotic species to look at whether exotic plant species show different responses to habitat fragmentation, which may indicate traits that facilitate their invasion or persistence in fragmented Garry oak habitats.

## Study Area and Methods

This study was conducted in forty-three Garry oak habitat patches distributed across the Greater Victoria area and the Saanich Peninsula (Figure 1). Sites were chosen to vary coarsely in their area, isolation, topography, tree cover and soil conditions. Two patches on CFB Esquimalt properties are part of the study: a small patch near the amateur radio station at Albert Head (ALBERT) and a patch at Rocky Point that encompasses the western half of Garibaldi Hill (GARIB-W). All other study patches are in provincial, regional or municipal parks or other protected areas.

In 2006, walking transect surveys were used to create vascular plant species lists (forbs, grasses, shrubs and trees) for all study patches. Each patch was surveyed at least two times, once in early spring (April 12 – June 5) and once in late spring/early summer (June 7 – July 27) to capture plants with early and later phenologies.

## Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems

Most plants were identified *in situ* although specimens were collected for some species requiring microscopic examination, comparison to herbarium records, or consultation with experienced botanists. A small percentage of species was eliminated from the study due to difficulties with detection (i.e. cryptic species), taxonomy, or short flowering time relative to the length of the survey periods.

Field collection of environmental data (soil depth, slope/ aspect, canopy cover and soil nutrients) took place from July – September 2006. Stratified random sampling points were generated in ArcView GIS 3.2 (Environmental Systems Research Institute, Redlands, CA) using the Department of Natural Resources (DNR) Random Sample Generator extension (Minnesota Department of Natural Resources, St. Paul, MN). Points were located in the field using a handheld Global Positioning System (GPS). At each sampling location, soil depth was determined by pushing a seventy cm small diameter steel probe to bedrock. Local slope and aspect were measured using a clinometer and compass. Canopy cover was assessed using a spherical densiometer. Soil moisture, initially of interest, was not sampled in 2006 due to difficulties with collecting comparable measurements across sites. At least thirty-two and no more than forty points were sampled in each patch. Means and variances were calculated to assess the average patch condition and within-patch heterogeneity for each parameter.

To assess soil nutrient differences among patches, at a stratified random subset of ten of the points above, a six cm diameter soil core was taken to ten cm depth. 120 ml of soil was collected from each core and combined into a single sample. These composite samples will undergo standard soil nutrient analysis in 2007.

Patch area was calculated by delineating study patches on digitized geo-referenced aerial photographs in ArcView. Additional predictor variables representing connectivity, topography, and climate will be derived from pre-existing GIS data layers in 2007.

Summary statistics for three measures of species richness (native, exotic and total) were calculated to compare diversity across study patches. Linear regression was used to examine the relationship of these three measures of species richness and patch size. In 2007, once all environmental and landscape context data have been prepared, stepwise multiple regression will be used to determine significant predictors of native, exotic and total species richness. Constrained ordination will be used to test for predictors of community composition and logistic regression will be used to test for predictors of individual species presence/absence.

### Results

Due to the ongoing nature of this project, only limited results for species richness and relationships to patch area, with a focus on the two patches on CFB Esquimalt properties, are presented at this time. A total of 271 plant species were recorded in the forty-three patches in 2006. Of the species detected, 153 species (56.5%) were native, 116 (42.8%) were exotic and two (0.7%) were of unknown origin. Table 1 shows patch areas, species richness (SR) and percentage of native species for the two patches on CFB Esquimalt properties with summary statistics for all patches for comparison. Full species lists for each site can be found in Appendix A. For ALBERT, native richness is below the mean native richness of all sites while exotic richness is above the mean value. Total richness is slightly lower than mean total richness for all sites. For GARIB-W, the reverse is true with the patch having higher than average native richness, lower than average exotic richness, and slightly higher than average total richness. ALBERT has lower native richness, higher exotic richness, and lower total richness than GARIB-W.

Figure 2 shows the relationship between native, exotic and total plant species richness and patch area (log transformed). The results show a positive significant correlation between patch size and all measures of species richness (Native SR: $R^2 = 0.165$, $p = 0.007$; Exotic SR: $R^2 = 0.313$, $p < 0.001$; Total SR: $R^2 = 0.694$, $p < 0.001$).

The $R^2$ values indicate that patch area is a strong predictor of total species richness, explaining almost 70% of the variation in the data. Patch area explains a greater proportion of variation in exotic richness (31.3%) than native richness (16.5%).

Data points for the two patches on CFB Esquimalt properties are indicated in Figure 2. Actual values can be compared to those predicted by patch area by examining their positions relative to the regression lines. ALBERT shows lower native richness, higher exotic richness and slightly higher total richness than is predicted by its area. On the other hand, GARIB-W shows higher native richness, lower exotic richness and lower total richness than is predicted by its area.

## Discussion

The relationships between total, native and exotic species richness and patch area shown in this study are what we would expect from island biogeography theory: larger patches should have a greater number of species. For ALBERT and GARIB-W, much of the variation between the mean values for all sites and values for these sites can be explained by patch size. The explanatory power of patch size is somewhat surprising, given the array of other factors thought to be important in this ecosystem. While some of these other factors will be examined in future work to see if they explain additional variation not explained by patch size, patch size appears to be a significant driver of overall plant diversity patterns at the patch scale.

Several factors could explain the deviations of actual native and exotic species richness from predicted richness for the two patches on CFB Esquimalt properties. As ALBERT is close to human development, the lower than predicted native species richness may be due to higher human disturbance. Similarly, the higher than predicted exotic species richness may be due to its proximity to exotic seed sources, which are often roadsides, gardens, and agricultural fields.

GARIB-W, on the other hand, is more isolated from human development and, thus, likely has been less disturbed historically. Also, due to its position on a hilltop away from development, GARIB-W is not as close to potential exotic seed sources. This contrast is also shown in comparing the proportion of natives at each site. GIS analysis of the landscape surrounding all study patches will be used to test these hypotheses.

## Conclusions

The strong relationship between species richness and patch area suggests that habitat fragmentation, particularly the size of remaining habitat fragments, is a significant driver of plant diversity patterns in this ecosystem. As such, landscape context should be an important consideration in conservation planning for this ecosystem. This research also suggests that, in the absence of detailed botanical surveys, predictive models could be used to help identify priority sites for biodiversity conservation and ecological restoration.

In addition to looking for other significant predictors of species richness and building predictive models incorporating all factors for both native and exotic species, future work will also look at species individually to examine whether particular life history traits, such as dispersal mode and degree of habitat specialization, confer certain advantages in the face of habitat fragmentation. The main project outcomes will be a completed Masters thesis as well as one to two articles in peer-reviewed scientific journals. Key findings will be submitted to the Garry Oak Ecosystems Recovery Team, regional and municipal land managers, and other interested parties.

## Acknowledgments

Thanks to Mark Vellend for supervision and advice. Thanks to Jen Muir for assistance in the field and Hans Roemer for help with difficult species identifications. Work is funded by a research grant from the National Sciences and Engineering Research Council (NSERC).

## Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems

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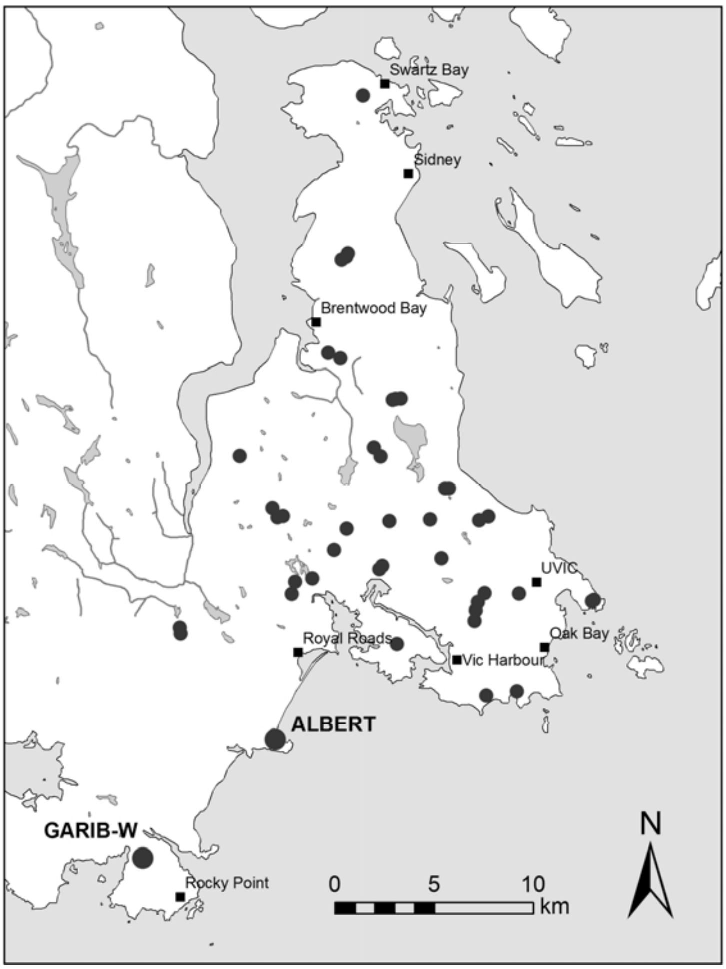


Figure 1. Map of Greater Victoria and the Saanich Peninsula showing locations of 43 patches included in the study. Two patches on CFB Esquimalt properties: GARIB-W at Rocky Point and ALBERT at Albert Head, are highlighted

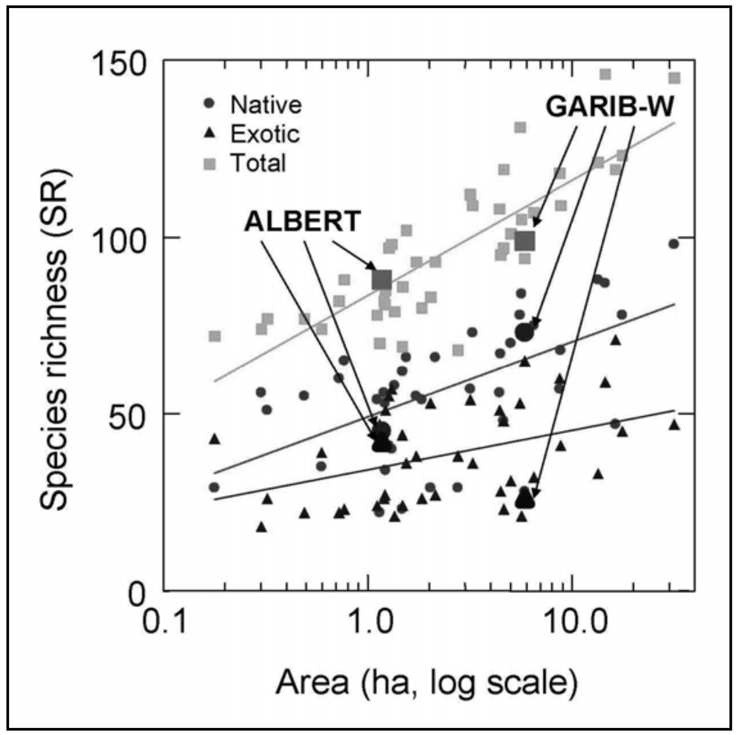


Figure 2. Relationship between native, exotic and total plant species richness and patch area (log scale) with data points for two patches on CFB Esquimalt properties highlighted

**Table 1.** Patch areas, species richness (SR), and percentage of native species data for Garry oak habitat patches on CFB Esquimalt properties included in the study with summary statistics from all study sites for comparison purposes

| | CFB Esquimalt sites | | All study sites (n = 43) | |
|---|---|---|---|---|
| | **ALBERT** | **GARIB-W** | **Range** | **Mean ± SD** |
| **Patch area (ha)** | 1.17 | 5.89 | 0.18 – 31.7 | 4.6 ± 6.1 |
| **Native SR** | 45 | 73 | 22 – 98 | 57.3 ± 19.3 |
| **Exotic SR** | 42 | 26 | 18 – 71 | 38.4 ± 14.0 |
| **Total SR** | 88 | 99 | 68 – 146 | 96.1 ± 19.8 |
| **% native spp.** | 51.1 | 73.7 | 29.8 – 80.7 | 59.1 ± 14.6 |

## Appendix A

Full species lists (ordered alphabetically by scientific name) for Garry oak habitat patches on CFB Esquimalt properties included in the study. An “X” indicates species was detected in the patch. Not all species found across all 43 study patches are listed.

| Scientific Name | Common Name(s) | Origin | ALBERT | GARIB-W |
|---|---|---|---|---|
| *Acer macrophyllum* | Bigleaf maple | N | X | X |
| *Achillea millefolium* | Yarrow | N | | X |
| *Agoseris grandiflora* | Large-flowered agoseris | N | | X |
| *Aira caryophyllea* | Silver hairgrass | E | X | X |
| *Aira praecox* | Early hairgrass | E | X | X |
| *Allium acuminatum* | Hooker's onion | N | | X |
| *Allium cernuum* | Nodding onion | N | | X |
| *Amelanchier alnifolia* | Saskatoon | N | | X |
| *Anthoxanthum odoratum* | Sweet vernalgrass | E | X | X |
| *Arbutus menziesii* | Arbutus | N | X | X |
| *Arctostaphylos columbiana* | Hairy manzanita | N | | X |
| *Arctostaphylos uva-ursi* | Kinnikinnick | N | | X |
| *Arrhenatherum elatius* | Tall oatgrass | E | X | |
| *Barbarea orthoceras* | American winter cress | N | | X |
| *Brodiaea coronaria* | Harvest brodiaea | N | X | X |
| *Brodiaea hyacinthina* | Fool's onion | N | | X |
| *Bromus carinatus/sitchensis* | Native brome sp. | N | X | X |
| *Bromus hordeaceus* | Soft brome | E | X | X |
| *Bromus rigidus* | Rip-gut brome | E | X | |
| *Bromus sterilis* | Barren brome | E | X | X |
| *Camassia sp.* | Camas sp. | N | X | X |
| *Cardamine oligosperma* | Few-seeded bitter-cress | N | X | |
| *Carex inops* | Long-stoloned sedge | N | X | X |
| *Cerastium arvense* | Field chickweed | N | X | X |
| *Cirsium brevistylum* | Short-styled thistle | N | | X |
| *Cirsium vulgare* | Bull thistle | E | X | |
| *Claytonia perfoliata* | Miner's-lettuce | N | X | X |
| *Collinsia parviflora* | Small-flowered blue-eyed Mary | N | X | X |
| *Cynosurus echinatus* | Hedgedog dogtail | E | X | |
| *Cystisus scoparius* | Scotch broom | E | X | X |
| *Dactylis glomerata* | Orchard grass | E | X | |

## Landscape and Environmental Drivers of Plant Distributions in Garry Oak Ecosystems

| Scientific Name | Common Name(s) | Origin | ALBERT | GARIB-W |
|---|---|---|---|---|
| *Danthonia californica* | California oat-grass | N | X | X |
| *Daphne laureola* | Spurge-laurel | E | X | |
| *Daucus carota* | Wild-carrot, Queen Anne's lace | E | X | |
| *Daucus pusillus* | American wild-carrot | N | | X |
| *Delphinium menziesii* | Menzies' larkspur | N | | X |
| *Dodecatheon hendersonii* | Broad-leaved shooting-star | N | X | X |
| *Elymus glaucus* | Blue wildrye | N | X | X |
| *Epilobium sp.* | Native willowherb sp. | N | | X |
| *Erodium cicutarium* | Common stork's-bill | E | X | X |
| *Erythronium oreganum* | White fawn lily | N | X | X |
| *Festuca idahoensis/rubra* | Native fescue sp. | N | X | X |
| *Galium aparine* | Cleavers | E | X | X |
| *Gaultheria shallon* | Salal | N | | X |
| *Geranium dissectum* | Cut-leaved geranium | E | X | X |
| *Geranium molle* | Dovefoot geranium | E | X | X |
| *Geranium robertanium* | Herb-robert | N | X | |
| *Geranium sp.* | Native geranium sp. | N | X | |
| *Gnaphalium sp.* | Cudweed sp. | N | X | X |
| *Goodyera oblongifolia* | Rattlesnake-plantain | N | | X |
| *Heuchera micrantha* | Small-flowered alumroot | N | X | X |
| *Hieracium albiflorum* | White hawkweed | N | | X |
| *Holcus lanatus* | Common velvet-grass | E | | X |
| *Holodiscus discolor* | Ocean spray | N | X | X |
| *Hypochaeris glabra* | Smooth cat's-ear | E | | X |
| *Hypochaeris radicata* | Hairy cat's-ear | E | X | X |
| *Ilex aquifolium* | English holly | E | X | |
| *Lactuca muralis* | Wall lettuce | E | X | X |
| *Lamium purpureum* | Red dead-nettle | E | X | |
| *Lepidium heterophyllum* | Smith's pepper-grass | E | X | |
| *Leucanthemum vulgare* | Oxeye daisy | E | X | |
| *Linanthus bicolor* | Bicolored flaxflower | N | | X |
| *Lithophragma parviflorum* | Small-flowered woodland star | N | X | X |
| *Lolium perenne* | Perennial ryegrass | E | X | |
| *Lomatium utriculatum* | Spring-gold | N | X | X |
| *Lonicera hispidula* | Hairy honeysuckle | N | X | |
| *Lotus micranthus* | Small-flowered lotus | N | | X |
| *Lupinus bicolor* | Lupine bicolor | N | X | |
| *Luzula multiflora* | Many-flowered wood rush | N | X | X |
| *Madia madioides* | Woodland tarweed | N | | X |
| *Madia sativa* | Chilean tarweed | E | X | X |
| *Mahonia aquifolium* | Tall oregon-grape | N | X | X |
| *Mahonia nervosa* | Dull oregon-grape | N | | X |
| *Matricaria discoidea* | Pineapple weed | U | X | |
| *Medicago arabica* | Spotted medic | E | X | |
| *Medicago lupilina* | Black medic | E | X | |
| *Melica harfordii* | Harford's melic | N | | X |
| *Melica subulata* | Alaska oniongrass | N | X | X |
| *Mimulus alsinoides* | Chickweed monkey-flower | N | X | X |
| *Moehringia macrophylla* | Big-leaved sandwort | N | | X |
| *Montia linearis* | Narrow-leaved montia | N | | X |
| *Montia parvifolia* | Small-leaved montia | N | X | X |
| *Myosotis discolor* | Common forget-me-not | E | X | X |

| Scientific Name | Common Name(s) | Origin | ALBERT | GARIB-W |
|---|---|---|---|---|
| *Nemophila parviflora* | Small-flowered nemophila | N | X | X |
| *Olsynium douglasii* | Satin-flower | N | | X |
| *Osmorhiza berteroi* | Mountain sweet-cicely | N | X | X |
| *Pachistima myrsinites* | Falsebox, mountain boxwood | N | | X |
| *Pinus contorta* | Shore pine | N | | X |
| *Piperia sp.* | Rein orchid sp. | N | | X |
| *Pityrogramma triangularis* | Goldenback fern | N | X | X |
| *Plantago lanceolata* | Ribwort | E | X | X |
| *Plectritis congesta* | Sea blush | N | | X |
| *Plectritis macroceras* | Long-spurred sea blush | N | X | X |
| *Poa pratensis* | Kentucky bluegrass | N | X | X |
| *Poa secunda* | Sandberg's bluegrass | N | | X |
| *Polypodium glycyrrhiza* | Licorice fern | N | X | X |
| *Polystichum sp.* | Sword fern sp. | N | X | X |
| *Pseudotsuga menziesii* | Douglas-fir | N | X | X |
| *Pteridium aquilinum* | Bracken fern | N | | X |
| *Quercus garryana* | Garry oak | N | X | X |
| *Rubus discolor* | Himalayan blackberry | E | X | |
| *Rubus laciniatus* | Evergreen blackberry | E | X | |
| *Rubus ursinus* | Trailing blackberry | N | X | X |
| *Rumex acetosella* | Sheep sorrel | E | X | X |
| *Salix sp.* | Willow sp. | N | X | X |
| *Sanicula crassicaulis* | Pacific sanicle | N | X | X |
| *Satureja douglasii* | Yerba buena | N | X | X |
| *Saxifraga integrifolia* | Grassland saxifrage | N | X | X |
| *Sedum spathifolium* | Broad-leaved stonecrop | N | X | X |
| *Senecio sylvaticus* | Wood groundsel | E | | X |
| *Silene gallica* | Small-flowered catchfly | E | | X |
| *Sonchus sp.* | Sow-thistle sp. | E | X | |
| *Spergularia rubra* | Red sand-spurry | E | X | |
| *Spiranthes romanzoffiana* | Hooded ladies' tresses | N | | X |
| *Stellaria media* | Common chickweed | E | X | X |
| *Symphoricarpus albus* | Common snowberry | N | X | X |
| *Teesdalia nudicaulis* | Shepherd's cress | E | X | X |
| *Trientalis latifolia* | Broad-leaved starflower | N | | X |
| *Trifolium dubium* | Small-hop clover | E | X | |
| *Trifolium willdenowii* | Tomcat clover | N | | X |
| *Ulex europaeus* | Gorse | E | | X |
| *Veronica arvensis* | Wall speedwell | E | X | |
| *Vicia hirsuta* | Tiny vetch | E | X | |
| *Vicia sativa* | Common vetch | E | X | X |
| *Vinca major* | Large periwinkle | E | X | |
| *Vulpia bromoides* | Barren fescue | E | X | X |
| *Vulpia myuros* | Rattail fescue | E | | X |
| | | **TOTAL NATIVE SPECIES** | **45** | **73** |
| | | **TOTAL EXOTIC SPECIES** | **42** | **26** |
| | | **TOTAL SPECIES OF UNKNOWN ORIGIN** | **1** | **0** |
| | | **TOTAL SPECIES** | **88** | **99** |

N = native species
E = exotic species
U = species of unknown origin

# Urbanization, Industrialization, and Environmental Contamination: Effects on Marine Foraging River Otters (*Lontra canadensis*) in the Puget Sound / Georgia Basin Region of Southeast Vancouver Island, British Columbia, Canada

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***Permit #:*** *P117-06*
***Location:*** *Albert Head, Colwood, Rocky Point, and Royal Roads*
***Start Date:*** *May 2006*
***Completion Date:*** *2008*

## Introduction

The transboundary Puget Sound – Georgia Basin (PS-GB), located in southwest B.C. and northwest Washington, is highly industrialized and home to approximately seven million people (Fraser *et al*., 2006). Persistent organic pollutants (POPs), such as polychlorinated biphenyls (PCBs), are widely distributed in the marine waters of the region, and elevated levels have been reported in invertebrates, fish, birds, and marine mammals (Elliott *et al*., 1996, Ross *et al*., 2004; Ross *et al*., 2000, Ikonomou *et al*., 2002). The river otter (*Lontra canadensis*) is an apex predator in nearshore marine zones of the Pacific Northwest and sensitive to environmental pollution (Ben-David *et al*., 2001, Ben-David *et al*., 2000, Bowyer *et al*., 2003). The river otter can serve as a useful indicator species for environmental degradation in nearshore marine regions because of its high trophic status and habitat preferences, yet little is known about its ecology in B.C.'s coastal ecosystems. The main goals of this study are: 1) to establish baseline information on abundance, distribution, and density of river otters in the PS-GB; 2) to determine pollutant burdens in coastal otters of the PS-GB; and 3) to determine principal prey species of coastal otters in the PS-GB. By combining these data, it is possible to examine river otter spatial and temporal landscape use, particularly of contaminated sites. Due to their high site fidelity, feeding strategies, and relatively long lifespan, otters represent an ideal species to monitor changes in pollutant levels in the marine ecosystem consequent to clean up efforts that are being proposed and are underway in the PS-GB.

Results of this study are important because there is a lack of information regarding the ecology of marine foraging river otters in the PS-GB, and as the human population of this region continues to encroach on wildlife habitat, increased stress in the form of urban and industrial pollution has the potential to jeopardize populations of river otters and other marine species.

### *Purpose and Goal*

The purpose of this project is to develop a wide-scale and cost efficient means of monitoring environmental contaminant levels in river otters using non-invasive techniques. Our goal is to conduct scientifically sound research in order to help conserve and enhance wildlife populations and their habitats in the waters of the Pacific Northwest and worldwide.

## Study Area and Methods

### *Overview*

Preliminary research conducted by the Canadian Wildlife Service (CWS), Delta, B.C. along the coastline of Vancouver Island and Burrard Inlet has shown that some river otter fecal samples contain toxin levels elevated above the critical level for biological effects in mustelids (Elliott, unpublished data).

# Urbanization, Industrialization, and Environmental Contamination: Effects on Marine Foraging River Otters (*Lontra canadensis*) in the Puget Sound / Georgia Basin Region of Southeast Vancouver Island, British Columbia, Canada

Samples of highest concern were collected from latrine sites in both Victoria and Esquimalt Harbours. It was therefore decided that the majority of our research efforts should be focused in the Greater Victoria area.

To systematically sample this area, the shoreline was divided into six sub-sampling areas (focal areas A, B, C, D, E, and F). Each focal area is a distinct survey area. When one focal area was being surveyed, no other focal area was visited. Each area was sampled by small inflatable craft provided by Environment Canada.

***Methods***

Latrine Surveys

The core study area of the Victoria region consisted of focal areas B, C, D, and E (totaling 62.5 km of shoreline), which included both Esquimalt and Victoria Harbours. Our DNA sampling efforts were only conducted in these areas. Focal areas A and F were considered periphery areas and were only sampled for contaminants. In all areas, river otter latrine sites were visited and the location of each site was recorded with a handheld GPS. Sites were defined as active latrines where otters deposited at least ten old or new scats.

Sample Collection

Each active latrine site within focal areas B, C, D, and E was visited for nine consecutive mornings during two sampling periods for a total of eighteen days. All old scats were marked with silver glitter upon initial visit to each site during each sampling period. It was decided that returning to sites in the early morning provided the best opportunity to obtain new scats in which the DNA had not yet been degraded by prolonged exposure to sunlight and high temperatures. All new scats deposited at latrine sites were inspected by the researcher before collection. All scats deemed fresh enough (characterized by a glossy appearance and strong smell) to yield DNA were given a number rank (1 to 5, 1 being the freshest) based on appearance and consistency. The scat was divided in half in the field, and one portion was collected in a 50 ml microcentrifuge tube, preserved in 100% ethanol, stored at 4ºC, and shipped to the University of Wyoming for DNA extraction and analysis. The remaining half of the scat samples found in regions B, C, D, and E were collected and preserved in acid-washed 50 or 100 ml glass jars and stored at -40ºC for contaminant analysis. Whole scats were also collected from focal areas A and F for contaminant analysis only.

DNA Analysis

DNA was extracted from all 802 fecal samples using Qiagen DNA stool mini kits. Current lab work is focusing on identifying individual genotypes at multiple hypervariable microsatellite loci specific to the river otter.

Dietary Analysis

Prior to DNA extraction, each fecal sample collected from focal areas B, C, D, and E was sieved through a fine-mesh stainless steel autoclavable sieve to remove all prey material. All hard prey remains removed from fecal samples were stored in individually labeled petri-dishes. One hundred (n=100) randomly chosen diet remains were shipped to Pacific Identification Inc., University of Victoria, B.C. for dietary analysis (33 from focal area B, 33 from focal areas C and D combined (neighboring Esquimalt and Victoria harbours), and 34 from focal area E. Dietary analysis will also be conducted on individuals identified by DNA fingerprinting with varying degree of contaminant concentrations.

Contaminant Analysis

Once DNA results are obtained, we will select which samples to have analyzed for contaminants. Samples analyzed for contaminants will only be from individuals identified by the fecal DNA analysis. Samples will be sent to the National Wildlife Research Centre (NWRC), Environment Canada, Ottawa, ON for fecal contaminant analysis.

## Urbanization, Industrialization, and Environmental Contamination: Effects on Marine Foraging River Otters (*Lontra canadensis*) in the Puget Sound / Georgia Basin Region of Southeast Vancouver Island, British Columbia, Canada

An important step to this project is validating the use of scat as an accurate measure of body contaminant concentrations. To do this, a map of all Vancouver Island traplines was obtained from the B.C. Ministry of Environment. Traplines consisting of a coastal boundary were selected and trapline owners were contacted by mail requesting their assistance with the project. Current trappers residing in Greater Victoria and those who possess legal trapping permits were also contacted. Individuals willing to participate in this portion of the study were asked to submit any skinned otter carcasses that were captured from the marine environment. Four B.C. trappers responded positively. A total of 22 river otter carcasses were obtained from trappers. Necropsies were conducted on all carcasses at the Environment Canada Pacific and Yukon Regional Office, Delta, B.C. Samples obtained included: left liver lobe, intestinal fecal remains, anal secretion from the anal gland, muscle from right hind leg, and one lower canine. Liver, fecal, and anal secretions will be analyzed for contaminants to determine the relationship between toxin levels stored in the various biological compartments. The lower canines will be used for aging. Each 20 g muscle sample will be sent to University of Wyoming for DNA analysis. Genetic results from these otters will serve as a reference for fecal genetic analysis.

## Results

### *Latrine Survey*

Surveys of the coastline in the Victoria region were conducted from 31 May – 22 August 2006. We surveyed approximately 86.5 km of linear shoreline and detected 165 active latrine sites, which represents a density of 1.89 latrines per km of shoreline. Latrines most often occurred at sites with large slabs of coastal bedrock (72% of sites) with some form of back vegetation. Much of the original forest has been lost along this coastline. Grasses, shrubs, and young deciduous trees accounted for 76% of the vegetation associated with latrines. During the summer sampling period, we observed 154 river otters. Observations included single animals, relatively large groups of 7-11 individuals, and one adult with two young pups. Many of these observations were likely repeat individuals.

### *Sample Collection*

Of the 165 total latrine sites, 87 were surveyed for fresh fecal sample collection along 62.5 km of linear shoreline. Each latrine site was visited for 9 consecutive days on 2 sampling occasions. Among those sites, 7,124 old and 2,681 new scats were counted. Based on these counts, fecal deposition rate is 42.24 feces per site for old scats and 1.77 fresh feces per day per site. These results suggest a high density of otters in the study area. A total of 802 fresh scats (<24 hours old) were collected for DNA analysis and 839 for contaminant analysis.

### *DNA Analysis*

Current lab work is focusing on identifying individual genotypes at multiple hypervariable microsatellite loci specific to the river otter. Results are pending.

### *Dietary Analysis*

Results are pending

### *Contaminant Analysis*

Results are pending

## Discussion

This is a multi-year study. Year 1 was focused on sample collection and preservation. Laboratory procedures are currently underway to analyze the fecal samples collected during the summer field season. DNA, contaminant, and prey identification results are pending. At this point, any logical interpretations of the study data cannot be made. All data will be reported upon completion of the study.

## Conclusions

### *Future Plans and Anticipated Timeline*

- September 2007 - Complete DNA analysis
- September 2007 - Send samples for contaminant analysis
- July/August 2007 - Sample collection for contaminants only
- April 2008 - Complete contaminant analysis
- April 2008 - Complete prey analysis
- September 2008 - Complete study

### *Related Studies*

River otter scat samples are also being collected along the coastline of Vancouver, B.C. and the San Juan Islands, WA, USA. Contaminant levels in river otter scats will be compared between these sites. This is a collaborative project between Simon Fraser University, Environment Canada, British Columbia Ministry of Environment, and UCDavis SeaDoc Society, Eastsound WA.

### *Anticipated Publications*

- One MSc thesis at Simon Fraser University, Burnaby, B.C.
- Peer reviewed scientific papers.

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# Local Versus Regional Determinants of Community Composition in Garry Oak Ecosystem Patches

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***Permit #:*** *P120-06*
***Location:*** *CFMETR*
***Start Date:*** *18 May 2006*
***Completion Date:*** *31 May 2006*

## Introduction

Very few intact remnants of Garry oak ecosystems now exist. These remnant patches are subject to a variety of stressors, including invasive species, habitat fragmentation, and lack of dispersal corridors. As the climate of Vancouver Island and the Strait of Georgia warms, the potential exists for Garry oak ecosystems to expand. However, it is unknown whether expansion would indeed occur, given current threats to the ecosystem and its discontinuous distribution. The long-term viability of current patches is also unknown, as is their vulnerability to current stressors such as invasive species.

Through an exploration of the environmental factors driving community dynamics in islands versus habitat patches, this project will answer some key questions regarding the drivers of community composition in Garry oak ecosystems. In addition, it will inform management decisions regarding how to best protect Garry oak ecosystems, as well as other fragmented ecosystems that are threatened by habitat loss and invasive species. Finally, it will add to the body of island biogeography theory, through comparisons of two different types of habitat "islands." There are a number of intact Garry oak ecosystems identified in DND properties, as such surveys on these properties were important for this study.

***Objectives***

The objectives for the project as a whole are as follows:

1) compare the flora of three "sets" of islands/islets on a North to South axis, from Nanaimo south to southern Puget Sound;

2) using previously-gathered data from locations outside and between the island sets, design transfer functions to infer biogeoclimatic drivers of Garry oak ecosystem floral components; and

3) perform experimental manipulations (in growth chambers and in field trial sites) to determine the role of local (e.g. soil) vs. regional (e.g. climate) factors in growth and establishment of Garry oak ecosystem components.

***Objectives for 2006 Season***

The 2006 season was the first for this project. The objectives were:

- confirm the practicality of the methodology;
- enumerate plant percent cover on sample plots in at least five mainland and island sites; and
- collect soil depth, slope, and aspect measurements on these sites observe trends to inform future sampling strategies.

# Local versus regional determinants of community composition in Garry Oak Ecosystem patches

## Study Area and Methods

Using a stratified random sampling pattern, one $m^2$ plots were established on 11 islands/islets and six mainland patches. Plots were marked in a way that does not interfere with DND activities, using buried spikes that can be located with a combination of GPS and a metal detector. These spikes will also be easily removed upon completion of the project. Percent cover of all vascular plants was surveyed, as was percent cover of mosses/lichens (as general groups), and slope, aspect and soil depth at each plot. Plot locations on mainland CFMETR are shown in Figure 1.

## Results to Date

Although insufficient data are available at this stage of the project to provide definitive conclusions, the following trends were obvious:

- Significantly higher diversity of both native and exotic plant diversity on mainland patches vs. islands;
- Significantly lower percent cover of native plants on mainland patches vs. islands;
- Apparent effect of soil depth on floral composition;
- No apparent effect of patch size, but an apparent (though as yet insignificant) effect of island size, whereby smaller islands have lower diversity.

Regarding DND properties in particular, the flora are not noticeably different from other sites that were sampled. There were no provincially or federally listed species found in the plots. It must be noted, though, that this does not mean that listed species are not present on DND properties. The chosen sampling technique is designed to measure dominance of common species, not presence and absence of all species.

Invasive plants are a problem in Garry oak ecosystems in general, and CFMETR is no exception. Indeed, the flora of Nanoose Hill appears to be dominated by invasive grasses (e.g. *Cynosrus echinata, Anthoxanthum oderatum, Bromus rigidis, B. sterilis)*. Some native plant species do exist on Nanoose Hill (e.g., *Castilleja hispida)*, however, the dominance of invasive species indicates that the environment there is conducive to the establishment and persistence of invasive grasses. In contrast, the flora of Winchelsea Island appears to be dominated by native species, especially in deeper soil areas.

## Discussion

The results of the 2006 season indicate a clear difference between island and mainland sites, in terms of diversity and dominance by native species. The dominance of invasives species on Nanoose Hill is particularly significant, since this represents one of the least disturbed and most intact Garry oak ecosystem remnants anywhere in Canada. Neither direct disturbance by humans nor fragmentation to small patch sizes are necessary for the promotion of invasibility in this ecosystem. It is unlikely that any specific DND activities would have promoted this situation; indeed, other sites (e.g. Mount Maxwell on Salt Spring Island) have similar species compositions.

Some taxa (e.g. *Camassia leichtlinii*) are more prevalent on island sites. A combination of dispersal limitation and competition may be part of the story. For example, some invasive species are not found on the islands probably because they have not yet dispersed to them. However, there are almost certainly other factors, since invasives (such as *Cynosurus echinata*) that dominate on some mainland sites are present on but do not dominate the islands. Herbivory may be an important contributing factor to the differences between islands and mainland sites. Nanoose Hill, for example, appears to have a large deer population, whereas the islands do not.

Local versus regional determinants of community composition in Garry Oak Ecosystem patches

## Conclusions

This study is in the early stages and further investigation is required before any conclusions can be made. Future plans include surveys on islands stretching from the San Juan islands to the Winchelsea group, as well as patches on Vancouver Island in the Victoria and Parksville areas. Survey activities on DND sites (including CFMETR and Rocky Point) are expected to continue in 2007.

Following analysis of 2007 field season results, further survey work may take place in 2008. In addition, experiments to test the mechanisms of dominance of island versus mainland plants will be conducted at a UBC common garden. The results of this study will eventually be compiled in J. Bennett's PhD thesis, and will be submitted as scientific papers to academic journals.

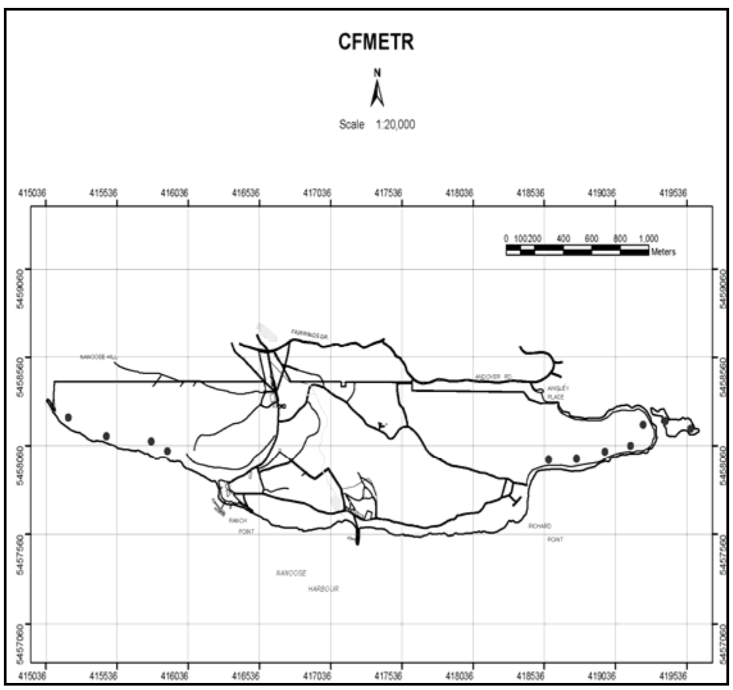
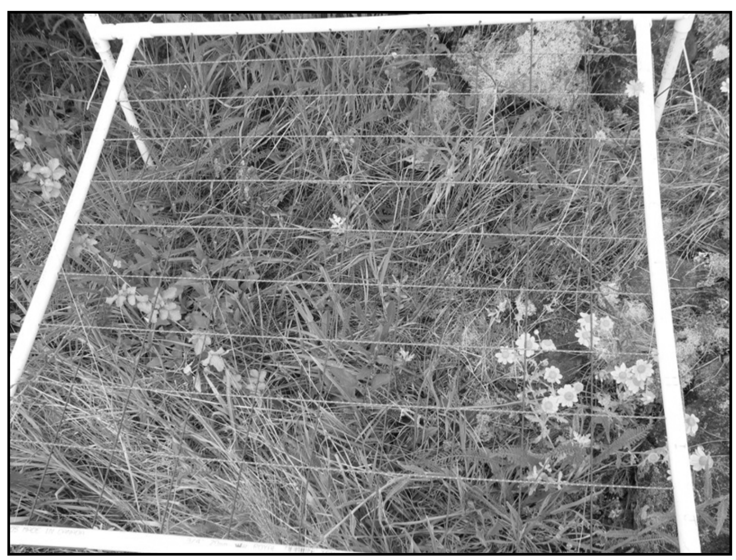



Figure 1. Mainland CFMETR property showing 2006 sample locations



Plots on Nanoose Hill (above) and Winchelsea Island (below).

# B.C. Coastal Waterbird Survey for Nanoose Harbour

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***Permit #:*** *P122-06*
***Location:*** *CFMETR*
***Start Date:*** *10 December 2006*
***Completion Date:*** *10 December 2006*

## Introduction

B.C.'s productive tidal and inshore marine habitats support some of the highest densities of seabirds, waterfowl, and shorebirds in the eastern North Pacific. Two-thirds of British Columbia's human population lives within the watersheds that empty into these habitats, and the number of people in the Georgia Basin area alone is projected to almost double in the first 20 years of the 21st century, potentially impacting coastal ecosystems. The B.C. Coastal Waterbird Survey (BCCWS) was established in 1999 to meet the need for monitoring coastal bird populations, and to better understand their responses to natural and human-induced environmental change. The BCCWS is a long-term, volunteer-based monitoring program, coordinated by Bird Studies Canada, with support from Environment Canada. Over 250 citizen scientists contribute over 1,000 person-days to the program each year, conducting standardized scientific surveys at an annual average of 180 locations. This is the only survey of its kind in the Pacific Northwest, and is an increasingly utilized resource by the region's conservation planners. The survey's objectives are: 1) to assess the size of non-breeding waterbird populations in coastal B.C., particularly the Georgia Basin; 2) to assess changes in numbers and distribution of coastal waterbirds; 3) to assess and monitor the importance of individual sites for waterbirds; and 4) to improve understanding of the ecology of these species, including responses to natural and human-induced change (e.g. habitat alteration).

## Study area and Methods

Each winter (from September to April inclusive), surveyors conduct complete counts of all visible birds within predefined sites, on or around the second Sunday of the month, and within approximately two hours of the high tide. Surveys continue from May through August at some sites. BCCWS site boundaries have pre-defined, mapped boundaries, average one to two km in length, and cover a variety of habitats (rocky shores, sandy beaches, saltmarshes, mudflats, and inshore waters). Data are submitted online or entered manually from standard recording forms, then error-checked prior to analysis and dissemination. The dataset is housed and managed by Bird Studies Canada within a Microsoft Access database, which contains all the surveyor, site, and individual survey details, in a series of related tables, using a standard coding system. Survey site polygons are stored as a digital GIS data layer.

Permit P122-06 provides access to shoreline in the CFMETR property. This access is important in that it allows the observers to survey waterbirds in the entire Nanoose Harbour sector, referred to as VINN2.

## Results

Table 1 lists the species and numbers of birds observed within Nanoose Harbour on 12 December 2006.

Table 1. Nanoose Harbour Observations

| Species | # of sightings |
|---|---|
| Common Loon | 10 |
| Pied-billed Grebe | 1 |
| Horned Grebe | 6 |
| Red-necked Grebe | 1 |
| Double-crested Cormorant | 4 |
| Pelagic Cormorant | 28 |
| American Wigeon | 1 |
| Mallard | 5 |
| Greater Scaup | 25 |
| Harlequin Duck | 4 |
| Surf Scoter | 51 |
| White-winged Scoter | 130 |
| Black Scoter | 20 |
| Bufflehead | 31 |
| Common Goldeneye | 11 |
| Barrow's Goldeneye | 42 |
| Common Goldeneye X Barrow's Goldeneye hybrid | 2 |
| Common Merganser | 2 |
| Red-breasted Merganser | 13 |
| Bald Eagle | 3 |
| Herring Gull | 2 |
| Thayer's Gull | 1 |
| Glaucous-winged Gull | 43 |
| Unidentified Gull species | 5 |
| Belted Kingfisher | 4 |
| Northwestern Crow | 35 |

## Discussion

Most of the birds listed in Table 1 were observed from other points around the bay but the observations from CFMETR were critical in order to get a complete survey of Nanoose Harbour. The only species unique to CFMETR were American Wigeon and Mallard. Most of the Barrow's Goldeneye were found near one of the jetties within CFMETR. Other than the apparent hybrid Common/ Barrow's Goldeneye there were no unusual bird sightings.

## Conclusions

At this stage it is not possible to draw any conclusions as we have only just begun conducting surveys of Nanoose Harbour and further investigation is required. It is expected however, that we will have a clearer picture of the waterbird populations and movements within the Nanoose Harbour area by the end of the winter survey period (April). Our intent is to continue this monitoring project for several years. All of the data will be entered into the BC Coastal Waterbird database accessed via the Bird Studies Canada web site.

## References

The B.C. Coastal Waterbird web site can be found at:

http://www.bsc-eoc.org/regional/bcwaterbirds.html

# OUTLOOK FOR 2007

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

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.

In 2007, the ESAC website will undergo updates with the intent of ensuring that all current information on ESAC projects is readily accessible for use by MARPAC personnel. The ESAC Research and Collection Application Form along with Environmental Assessment Project Evaluation Form will be available for download on the website.

# ACKNOWLEDGMENTS

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All 2006 ESAC permit holders for their cooperation and contribution to the knowledge of flora and fauna on CFB Esquimalt properties.

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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 2007. Your attendance and participation are valued.

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