2007 ANNUAL REPORT

DEPARTMENT OF NATIONAL DEFENCE

ESAC

ENVIRONMENTAL SCIENCE ADVISORY COMMITTEE

CANADIAN FORCES BASE ESQUIMALT

National Defence / Défense nationale

Canada

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Cover Photos:

Top Left: Garry oak acorns at Rocky Point.

Top Right: *Tubaria punicea*, a rare mushroom at the base of an arbutus tree.

Bottom: Oregon spotted frog at Aldergrove.

Photo Credits:

A. Ceska, R. McKibbin, A. Schiller, T. Cornforth, Wildlife Tree Stewardship Society, Canadian Forest Service, L. Schmidt, K. McKay, Royal Roads University, D. Mathews, Z. Gedalof, and J. Bennett.

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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 parties interested in carrying out natural resources research on CFB Esquimalt properties. Every year, ESAC collects, reports, and archives the findings of the research activities in a printed and web-based annual report. ESAC also acts as an advisory body to CFB Esquimalt on various environmental issues occurring on CFB Esquimalt properties, and serves as a gateway to a network of scientists accessible to Maritime Forces Pacific (MARPAC) staff.

In 2007, the Committee reviewed 18 proposals to conduct research and collection activities on CFB Esquimalt properties. Each proposal was reviewed by ESAC for scientific content and forwarded to the DND Formation Safety and Environment Branch, Environment Office and to Base Operations, 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. Fifteen 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.

Where applicable, wildlife and sensitive ecosystem inventory data obtained from 2007 ESAC research projects were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. This information, combined with existing sensitive 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 2007, the Committee hosted its ESAC Annual Workshop on February 7th, 2008 at the Pacific Forestry Centre, Victoria, B.C. Nine presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and restoration were given to personnel from government and non-government organizations. The 2007 ESAC Annual Workshop was very well attended with over 75 individuals present.

P074-07 Wildlife Tree Stewardship Program. Monitoring a Bald Eagle nest at Rocky Point.

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INTRODUCTION

Maritime Forces Pacific (MARPAC) constitutes Canada's Navy on the West Coast. Her Majesty's Canadian Dockyard at Canadian Forces Base (CFB) Esquimalt is home to the Navy's Canadian Pacific Fleet. The role of CFB Esquimalt is to support the ships 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 British Columbia.

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 which provide unique opportunities for scientists to conduct an array of environmental studies.

CFB Esquimalt's Rocky Point property supports a number of ecosystems, from wetlands and coastal bluffs to Garry oak meadows and Douglas-fir forests.

Table 1. CFB Esquimalt Properties
Area in hectares (ha)

Albert Head	93
Maintenance Detachment Aldergrove	514
Colwood	90
CFMETR	288
Dockyard/Signal Hill/Yarrows	63
Heals Rifle Range	212
Mary Hill	178
CFS Leitrim Detachment Masset (Queen Charlotte Islands)	824
Matsqui TX Site	95
Naden	45
Nanaimo Rifle Range	351
Nanoose TX Site	105
Rocky Point	1,078
Royal Roads	229
Work Point	66
TOTAL AREA	4,231

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 the research activities and associated findings resulted in the formation of the DND Environmental Science Advisory Committee (ESAC) for CFB Esquimalt. Since the creation of the Committee, in 1994, ESAC has facilitated and coordinated 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 years (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 Branch)
- CFB Esquimalt (Base Construction Engineering Office)
- Natural Resources Canada (Canadian Forest Service)
- Environment Canada (Canadian Wildlife Service)
- B.C. Ministry of Forests and Range
- University of Victoria
- Royal Roads University

A complete list of ESAC members in 2007 and contact information is located at the end of this report.

ROLES & RESPONSIBILITIES

Proposal Review & 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 visiting the ESAC website at: **http://cfs.nrcan.gc.ca/subsite/esac**

Each research proposal is sent to and reviewed by ESAC. Subsequently, proposals are sent to the Formation Safety and Environment office and to Base Operations, 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.

Permit Support

Once an ESAC permit is granted, the ESAC provides ongoing support to permit holders. ESAC facilitates a safety briefing for all permit holders who will be conducting activities in active training areas and ranges. The safety briefing is delivered by a DND Range Control Officer and ensures that each researcher is familiar with the potential hazards associated with working on DND properties. Specific safety information is provided about potential hazards, danger areas and emergency procedures. Restrictions and access control procedures are also explained.

In 2007 an environmental briefing was developed and delivered to ESAC permit holders in conjunction with the safety briefing. Each permit holder is provided with information and maps about sensitive environmental and cultural features for each property that they are permitted to access. Information about environmental requirements and restrictions, as well as wildlife considerations are provided.

The heavy winds of the winter of 2006/07 resulted in severe damage to the forested areas on some of the DND properties. DND coordinated with ESAC to identify areas that are used by ESAC researchers, and removed hazardous trees from those areas. A significant amount of effort was expended in 2007 to clear storm damage debris and fallen trees from trails used by ESAC permit holders, in order to ensure their safety.

Reporting Activities

As part of the reporting process, ESAC permit holders are required to submit a report on their activities and results, for the permit year. ESAC compiles these documents and makes them available to all member agencies and other interested organizations by way of the 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.

Other Committee Activities

ESAC 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 regarding various ecological issues. In addition, the Committee oversees the activities of the Operating Committee for the Forest Canopy Research Station at Rocky Point.

ESAC ACTIVITIES in 2007

Advisory & Reporting Activities

This year was the thirteenth full year of activity for ESAC. The Committee met three times during 2007 to review project proposals and status, plan reporting activities, and advise CFB Esquimalt on other environmental issues occurring on CFB Esquimalt properties.

The 2006 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 British Columbia. The ESAC website was updated to provide information on active projects. Archived ESAC projects can be queried by year, location or permit number and all ESAC Annual Reports from 1995 to 2006 are available to download from the website.

The 2007 ESAC Annual Workshop, held 7 February 2008 at the Pacific Forestry Centre, was the most attended to date with over 75 individuals present. Nine presentations, focusing on wildlife and sensitive ecosystem inventories, monitoring, and restoration were given. A wide variety of representatives were present, including the BC Ministry of Environment, Fisheries and Oceans Canada, Royal Roads University, Camosun College, the Victoria Natural History Society, the Rocky Point Bird Observatory, Natural Resources Canada, Department of National Defence, Capital Regional District, and the Wildlife Tree Stewardship Initiative.

Research & Collection Activities

A total of 18 proposals were received and reviewed by ESAC in 2007. Of the 18 proposals received, 15 permits were issued – with 13 being renewals of previous year's permits. Table 2 shows the number of proposals received and permits issued annually since 1995.

The diversity of projects conducted in 2007 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 sound decision-making and environmental management by CFB Esquimalt personnel. The knowledge gained from these studies could also be applied to neighbouring, 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 2007 under the auspices of ESAC.

Table 2. Number of Proposals Received and Permits Issued Since 1995

YEAR	PROPOSALS	PERMITS
2007	18	15
2006	22	21
2005	25	21
2004	16	16
2003	26	24
2002	21	20
2001	14	14
1999	25	25
1998	26	26
1997	24	24
1996	25	24
1995	22	20

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 a mature stand 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, as well as 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 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. The Forest Canopy Research Station operating protocol was revised in 2007 to address access control, liability issues, and safety officer and station inspection requirements.

Ownership and responsibility for the Rocky Point Forest Canopy Station has been held by Royal Roads University since 2002, as part of the University's efforts to monitor climate change and atmospheric transport of contaminants. Since this transfer, all sensors associated with the microclimate station have been recalibrated, and a new environmental sensing strategy for the site 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 an 18 m tower on a knoll adjacent to the canopy station. This work has facilitated the installation of the upgraded microclimate station equipment and was fully operational by summer 2007 (see report P087-07).

A safety upgrade was completed in 2006, and a new revised safety protocol has been developed for these upgrades.

Several trees came down in the winter storms of 2006-2007, and a few of them caused damage to or were considered a hazard to the canopy station. DND felled the hazard trees, and Royal Roads University is working to repair the damage to the station infrastructure.

Table 3. Summary of Research Projects Conducted Under ESAC in 2007

ESAC PERMIT TITLE	PROJECT LEADER (S)	PERMIT #	PROPERTY (Abbreviations are listed below)
2007 Rocky Point Bird Observatory Society Activities	P. Levesque A. Nightingale	P003-07*	AH, HR, RP, RR
Monitoring of Winter Moth and the Parasites Introduced for its Control	I. Otvos	P031-07*	NA
Purple Martin Origins and Relationships	C. Finlay	P044-07*	CO, RR
Wildlife Tree Stewardship Program (WiTS)	G. Greenwood	P074-07*	RP, AH, CO
Garry Oak (*Quercus garryana*) Acorn Survey	P. Courtin	P079-07*	CFMETR, RP
Microclimate Station Upgrade	M. Dodd	P087-07*	RP (FCRS)
Studies on the Dynamics of Butterflies and their Host Plants in Garry Oak Ecosystems	J. Hellmann	P090-07*	RP, CFMETR
The Strait of Georgia Mortuary Landscape Project	D. Mathews	P104-07*	AH, CO, RP
Monitoring of the Oregon Spotted frog (*Rana pretiosa)* at Maintenance Detachment Aldergrove	R. McKibbin	P109-07*	ALD
Garry Oak Ecosystem Dynamics: Controls on Overstorey Recruitment	Z. Gedalof	P114-07*	RP
Urbanization, Industrialization, and Environmental Contamination: Effects on Marine Foraging River Otters (*Lontra canadensis*) in Puget Sound/Georgia Basin Region of Southeast Vancouver Island	D. Guertin	P117-07**	RP, CO, RR
Local Versus Regional Determinants of Community Composition in Garry Oak Ecosystems	J. Bennett	P120-07*	AH, CFMETR, RP
BC Coastal Waterbird Survey for Nanoose Harbour	R. Taylor	P122-07**	CFMETR
Investigation for the Presence of the Rigid Apple Moss on DND Properties	T. McIntosh	P123-07	CFMETR, RP
Year-round Microclimates Experienced by Butterfly Larvae in Garry Oak Ecosystems	B. Sinclair	P124-07	RP

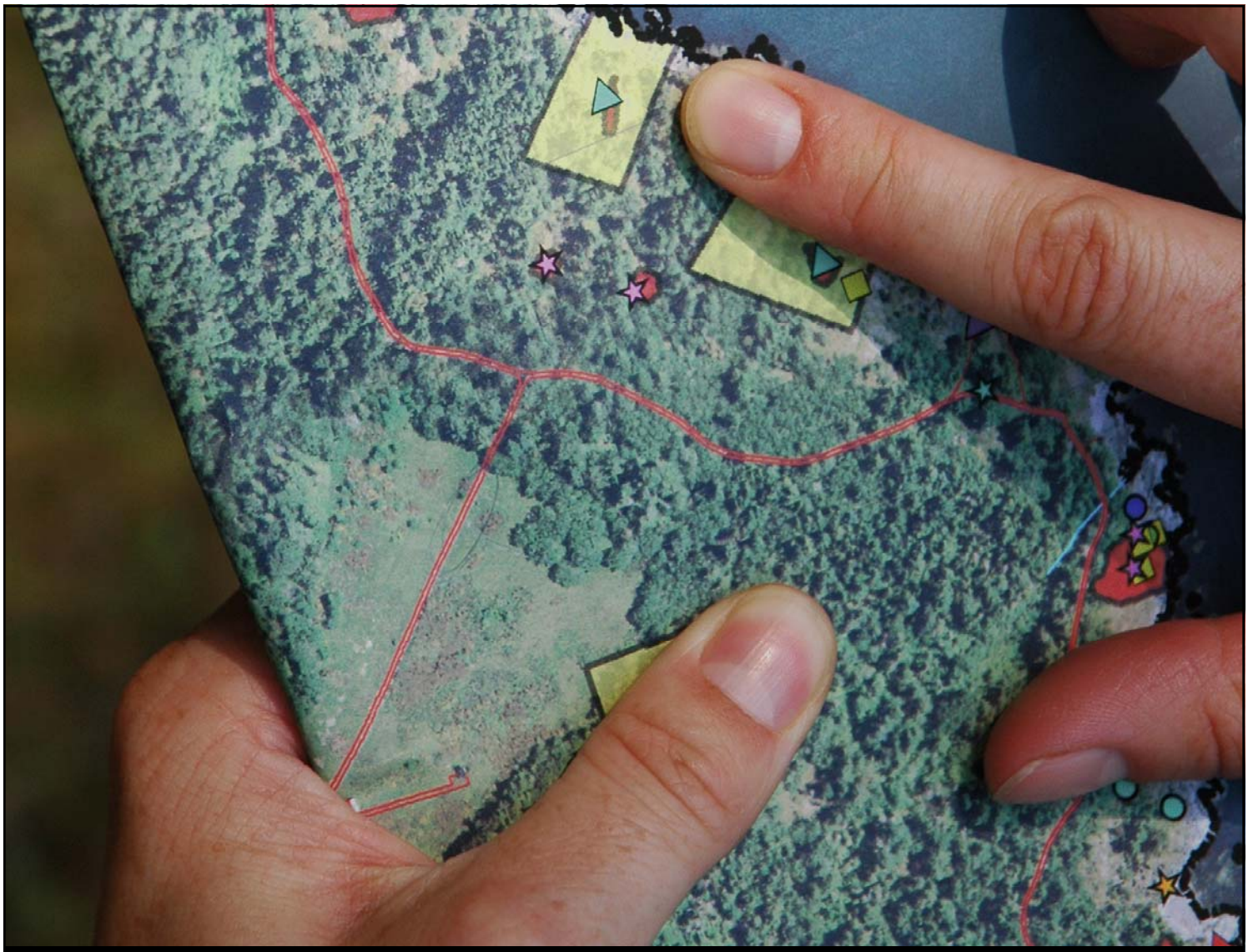
*** Renewed from previous years. ** Project was abandoned or postponed**

Properties: AH: Albert Head; ALD: 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.

Geographic Information System

All wildlife and sensitive ecosystem inventory data collected in 2007 were integrated into the CFB Esquimalt Natural Resources Geographic Information System (GIS) database. This information, combined with existing data, were used to generate sensitive and natural 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 locations of ESAC research sites were added to the GIS and subsequently delineated on property maps made available to CFB Esquimalt personnel to reduce any conflicts with military training and activities. Information from ESAC projects and other environmental projects were used to update the natural resources GIS layers.



CFB Esquimalt maintains an up-to-date database on the sensitive areas located on its properties. These areas are plotted on maps and provided to personnel to employ as a planning tool for exercises, operations, and development. Information from ESAC projects and other environmental projects are used to update the natural resources GIS layers.

Clockwise from top right: P114-07 Garry Oak Ecosystem Dynamics: Controls on Overstorey Recruitment; P074-07 Wildlife Tree Stewardship Program; P123-07 Investigation for the Presence of the Rigid Apple Moss on DND Properties; P003-07 2007 Rocky Point Bird Observatory Society Activities

DEPARTMENT OF NATIONAL DEFENCE

ESAC

ENVIRONMENTAL SCIENCE ADVISORY COMMITTEE

CANADIAN FORCES BASE ESQUIMALT

SCIENTIFIC REPORTS

Research and Collection Activities Conducted in 2007

2007 Rocky Point Bird Observatory Society Activities

Project Leader (s): Paul Levesque & Ann Nightingale
Organization(s): Rocky Point Bird Observatory Society
Address(es): 1721 Cultra Ave., Saanichton, BC V8M 1T1
Telephone: (250) 652-6450
Facsimile(s): (250) 652-6450
E-mail: motmot@shaw.ca
Website(s): http://www.islandnet.com/~rpbo
Permit #: P003-07
Location(s): Albert Head, Rocky Point
Start Date: February 2007
Completion Date: December 2007
Project Status: 1994—ongoing (original start date to anticipated completion date)

1. Christmas Bird Count Census

Project Leader(s): David Allinson
Location: Albert Head, Rocky Point
Start Date: 15 December 2007
Completion Date: 22 December 2007
Project Status: 2003—ongoing

Introduction

Since 1900, the annual Christmas Bird Count (CBC) has attracted thousands of birders across North America to census winter bird populations within a local 24- km circle. Long-term trends are analyzed and compiled now for more than 1800 counts across Canada by Bird Studies Canada. However, significant habitats found on Department of National Defence (DND) properties were historically off-limits to the Victoria and Sooke CBCs' compilers, with sporadic coverage beginning in the late 1980's and early 1990's. For the fifth year in a row, ESAC Permit P003-07 provided access for members of the Rocky Point Bird Observatory and Victoria Natural History Society into two key DND sites for the Victoria and Sooke Christmas Bird Counts.

Study Area and Methods

On the two Christmas Bird Count dates, participants completed bird surveys at two DND sites. Coverage consisted of four hours at Albert Head, and five hours at CFAD Rocky Point. Participants recorded not only species, but also counted all individual numbers observed and/or identified by voice.

Albert Head (sub-area 6) was covered during the Victoria Christmas Bird count on 15 December 2007, while Rocky Point (sub-area 5) was covered during the Sooke Christmas Bird Count on 22 December 2007.

Results

Albert Head recorded 46 species and 680 individuals, and Rocky Point tallied 73 species and 4320 individuals. For detailed results, see Table 1.

Discussion

In the past, the Albert Head site has proved to support many species of birds with as many as 90 species using the area in winter for shelter and/or for feeding (*D. Allinson, pers. obs.)* Both terrestrial and pelagic species are well represented here. Forty-six species of birds were found in 2007; that was well below normal (average number seen in winter is 63). In addition, the number of individual birds recorded was dramatically lower than previous counts. However, this was probably due to the adverse weather conditions (wind and rain) which created poor visibility to census offshore seabirds and undoubtedly kept many landbirds hidden from view.

The number of individual birds tallied at Albert Head in 2007 represented only 1% of the total recorded on the Victoria CBC. In comparison, 21% of the total birds counted in the 2006 Victoria CBC were seen at Albert Head.

Species richness at Albert Head still represented more than a third of Victoria's total species tally (46 out of 134 species) almost half of which were found in fewer than 50% of the 20 land-based count zones. Uncommon birds of interest included: Trumpeter Swan (*Cygnus buccinator*), Western Grebe (*Aechmophorus occidentalis*), Black Oystercatcher (*Haematopus bachmani*), Ancient Murrelet (*Synthliboramphus antiquus*), and Hermit Thrush (*Catharus guttatus*).

The Rocky Point sub-area again showed its significance and importance with its richness of species representing 63% of the total Sooke CBC species tally (73 out of 115 species). In addition, this sub-area accounted for 28% of the total number of individuals tallied on the entire Sooke CBC (4320 of 15,181). The proportion of total species and the total number of individuals counted in 2007 were similar to that noted in 2006 (60% and 32% respectively). A number of uncommon birds were found at Rocky Point, including: Long-tailed Duck (*Clangula hyemalis*), Turkey Vulture (*Cathartes aura*), Sharp-shinned Hawk (*Accipiter striatus*), Merlin (*Falco columbarius*), Peregrine Falcon (*Falco peregrinus*), Wilson's Snipe (*Gallinago delicata*), Red Phalarope (*Phalaropus fulicarius*), Northern Pygmy-Owl (*Glaucidium gnoma*), Marsh Wren (*Cistothorus palustris*), Cedar Waxwing (*Bombycilla cedrorum*), and Lincoln's Sparrow (*Melospiza lincolnii*).

Conclusions

The 2007 CBC results from these two key sites produced an overall total of 79 species and 5000 individuals, compared with 82 species and 31,772 individuals in 2006. While the number of species encountered in 2007 was very similar to the total observed in 2006, the overall count of individuals in 2007 was approximately 15% of what was seen the year before. No doubt the poor weather conditions on both counts in 2007 hindered both observers and bird behaviour keeping individual numbers well below normal. Because of the weather-induced variability, further study is warranted. Rocky Point Bird Observatory intends to continue conducting these annual counts, in order to be able to detect long-term trends for wintering birds on southern Vancouver Island.

Table 1. Christmas Bird Count Results

SPECIES	# OF INDIVIDUALS ROCKY POINT	# OF INDIVIDUALS ALBERT HEAD
Trumpeter Swan		1
Canada Goose	23	
American Wigeon	5	
Mallard	3	4
Ring-necked Duck	2	4
Harlequin Duck	3	4
Surf Scoter	70	50
White-winged Scoter	5	38
Long-tailed Duck	3	
Bufflehead	191	25
Common Goldeneye	17	
Hooded Merganser	10	2
Common Merganser	7	
Red-breasted Merganser	38	2
Red-throated Loon	3	
Pacific Loon	9	8
Common Loon	6	
Horned Grebe	2	10
Red-necked Grebe	17	3
Western Grebe	9	1
Brandt's Cormorant	27	4
Double-crested Cormorant	42	5

Table 1. Continued

SPECIES	# OF INDIVIDUALS ROCKY POINT	# OF INDIVIDUALS ALBERT HEAD
Pelagic Cormorant	55	3
Great Blue Heron	3	1
Turkey Vulture	2	
Bald Eagle	11	5
Black Oystercatcher		1
Sharp-shinned Hawk	1	
Merlin	1	
Peregrine Falcon	1	
California Quail	4	
Black Turnstone	20	
Wilson's Snipe	1	
Red Phalarope	6	
Mew Gull	285	100
Thayer's Gull	15	
Glaucous-winged Gull	285	120
Common Murre	2278	2
Pigeon Guillemot	4	7
Marbled Murrelet	16	
Ancient Murrelet	88	120
Rhinoceros Auklet	8	2
Northern Pygmy-Owl	1	
Barred Owl	1	
Belted Kingfisher	1	

Table 1. Continued

SPECIES	# OF INDIVIDUALS ROCKY POINT	# OF INDIVIDUALS ALBERT HEAD
Downy Woodpecker	2	1
Dark-eyed Junco	85	30
Hairy Woodpecker	3	
Northern Flicker	9	6
Steller's Jay	1	
Northwestern Crow	2	
Common Raven	8	
Chestnut-backed Chickadee	66	6
Bushtit	7	2
Red-breasted Nuthatch	5	
Brown Creeper	9	
Bewick's Wren	2	2
Winter Wren	19	6
Marsh Wren	1	
Golden-crowned Kinglet	169	20
Ruby-crowned Kinglet	5	10
Hermit Thrush		1
American Robin	64	5
Varied Thrush	8	11
European Starling	12	2
Cedar Waxwing	1	
Spotted Towhee	9	15
Fox Sparrow	2	9
Song Sparrow	8	3

Table 1. Continued

SPECIES	# OF INDIVIDUALS ROCKY POINT	# OF INDIVIDUALS ALBERT HEAD
Lincoln's Sparrow	1	
White-crowned Sparrow		1
Golden-crowned Sparrow	24	5
Red-winged Blackbird	1	
Purple Finch	1	3
House Finch		3
Red Crossbill	48	
Pine Siskin	250	
House Sparrow	12	3
Total Number of Species	73	46
	Date: 22 December 2007 Effort: # of observers: 4 # hours on foot: 5 Distance (on foot): 7 km # hours by car: 1 Distance (by car): 17 km # hours by boat: 1.5 Distance (by boat): 6 km # hours owling: 1.5 Distance (owling): 5 km	Date: 15 December 2007 Effort: # of observers: 4 # hours on foot: 4 Distance (on foot): 5 km

References

American Ornithologists' Union. 2007. Check-list of North American Birds (7th Edition, 48th supplement, July 2007) website: http://www.aou.org/checklist/index.php3

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 acknowledged for their assistance in preparing this report.

2. Western Bluebird Nestbox Project

Project Leader(s): Tracy Anderson
Location: Rocky Point
Start Date: February 2007
Completion Date: 11 April 2007
Project Status: 2005-2007
Transferring to ESAC Permit number P108 in 2008

Introduction

Western Bluebirds (*Sialia Mexicana*), regular breeders on southern Vancouver Island until the 1980's, are considered extirpated from Vancouver Island, and suffered serious population declines in coastal Washington State around the same time. In recent years, the species has been recovering in Washington, creating the possibility that some birds might travel northward as the population grows. In 2005, the Western Bluebird Nestbox Project established ten sites on southern Vancouver Island to provide nesting sites should Western Bluebirds return to the area. Of the ten sites, two were located on DND property, - one at CFAD Rocky Point and one at CFMETR Nanoose.

Study Area and Methods

Six nestboxes at Rocky Point were affixed to Garry oak trees in the 'west meadow' near the Rocky Point Bird Observatory's banding area in 2005 (Johnston 2005). The boxes were paired to allow for occupation of one box in each pair by another species while still providing several suitable nesting structures for the Western Bluebird.

Results

The Rocky Point boxes were checked and cleaned once in early February 2007 and were still firmly attached to the trees despite the winter storms. There was only one site visit conducted (on April 11th) to determine if any of the boxes contained nests. No Western Bluebirds were seen at the site on either visit. It is unknown if there were any late-nesters as the site was not visited after April.

During box cleaning and checking in 2008, any nests found will be identified to determine which species have used or are currently using them. Previously, the nestboxes at Rocky Point have been used by native bird species, notably the House Wren.

Discussion

Recent recovery efforts in Washington State have resulted in some success. The San Juan Islands Audubon Society, San Juan Preservation Trust, American Bird Conservancy, and Ecostudies Institute, have undertaken a five-year plan to reintroduce bluebirds to the San Juan Islands. A total of 90 breeding-aged birds are expected to be introduced into the study area. In 2007, eight pairs of Western Bluebirds were translocated from Fort Lewis to the meadows of the San Juan Islands. Although three pairs returned to Fort Lewis, one pair stayed and raised three young at this location. These are the first Western Bluebirds known to have been hatched on San Juan Island since 1965. Should this population become established, it will become the closest breeding population to our study area.

It is hoped that by providing nesting boxes in suitable habitat on Vancouver Island a population will become established, although this may not occur for several years. In 2005, 12 Western Bluebirds were observed visiting the 'west meadow' nestboxes at Rocky Point between February 16th and 23rd confirming the suitability of the habitat for attracting this species.

Other sites monitored under the Western Bluebird Nestbox project are located at Nanoose (CFMETR), Victoria CRD Parks, Salt Spring Island, Galiano Island, Mount Tzouhalem, and Mount Finlayson. Western Bluebirds did not nest at any of these sites in 2007.

As most recent Western Bluebird sightings in recent years have occurred early in the year, monitoring should include frequent visits in February and March to ascertain if Bluebirds are present, even if they do not remain to nest. As well, nestboxes need to be cleaned and maintained annually to ensure suitable nesting structures are available if the Washington population increases sufficiently to cause the 'overflow' to seek out potential nest sites on Vancouver Island. In addition, the annual nestbox maintenance provides an opportunity to determine if Western Bluebirds nested in the area after the monitoring in 2007 ended.

Conclusions

It may take a number of years before Western Bluebirds are re-established on Vancouver Island. As such, the nestboxes will be maintained and monitored at Rocky Point again in 2008, under the ESAC permit held by the Garry Oak Ecosystem Recovery Team.

References

Anderson, Tracy. 2006. Western bluebird nestbox project. Environmental Science Advisory Committee Annual Report, 2006.

Audubon Washington. 2007. Oh, those baby blues! Audubon Washington ENewswire, July 2007., http://wa.audubon.org/aboutus_ENewswire_July2007.html

Johnson, Naira. 2005. Western bluebird nestbox project 2005. Environmental Science Advisory Committee Annual Report, 2005.

Yakima Audubon Society. 2007. Western bluebirds returning to the San Juan Islands. Calliope Crier, February 2007:6.

Monitoring of Winter Moth and the Parasites Introduced for its Control

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Introduction

The objectives of this study are to monitor winter moth population densities and determine percent parasitism by the two parasitoid species introduced 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, the winter moth 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 winter moth also posed a threat to the fruit growing regions of B.C.

In the late 1950s and early 1960s, a highly successful biological control program was conducted in Nova Scotia, during which six parasitoid species (three parasitic wasps and three parasitic flies) were introduced from Europe. Of these six species, two species became established and were credited with controlling the winter moth in Nova Scotia. Following this example, in 1979, the Canadian Forest Service commenced introduction, both from Europe and from Nova Scotia, of the two parasitoids that had proven 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 33 different locations in the Victoria area. One of these locations was in a Garry oak meadow on the Naden base near the (now demolished) Officer's Mess on Hotham Street. Following the completion of the release program in 1982, a monitoring program was initiated at several Garry oak stands 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 winter moth population and to measure the interaction between the host and the parasitoids in the Greater Victoria area (including the DND Naden property) (Figure 1).

Winter moth population density:

Winter moth population densities were determined by collecting 20 branches from four randomly selected oak trees (five branches per tree). Trees that had been 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 3rd or early 4th instar (i.e., 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.

Figure 1. Winter moth monitoring plot, Naden, DND Esquimalt. The area containing sample trees is outlined in red.

The branch was then cut into smaller pieces and placed into a 20 lb brown kraft paper bag, along with the contents of the basket. The paper bag was then sealed, taken to the Pacific Forestry Centre, and stored at -20° C. This kills the larvae and prevents discoloration of the larvae (that would prevent accurate identification of the larvae) until the branches can be processed (i.e., counting the number of winter moth larvae, leaves, and leaf clusters on each branch). Winter moth larval densities were expressed as the number of larvae per leaf or leaf cluster to monitor changes in the winter moth population over time.

Percent parasitism:

Parasitoid populations were monitored by collecting mature 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 that could be reached with the pole to dislodge the larvae.

This procedure was repeated until about 200 larvae were collected, or 1 hour was spent collecting larvae, whichever came first. All the winter moth larvae that had fallen on the sheet were collected and placed in a bucket containing some oak foliage and a bottom layer of moist peat moss soil mixture for the mature larvae to pupate in.

Once larval collection at the location was completed, a lid with an 8 cm diameter hole cut in it for aeration (the hole was covered with mesh) 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 cuticle 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 20 mm) 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 5° C and reared until the spring, when the parasitoids would emerge. Adult winter moths started emerging around mid-November and finished emerging by about mid-December.

Results

At Naden, winter moth population densities averaged 0.27 and 0.14 larvae per leaf in 2006 and 2007, respectively. This was lower than the overall average for the Greater Victoria area of 0.41 and 0.26 larvae per leaf in 2006 and 2007, respectively. The higher population densities in the Greater Victoria area caused some visible defoliation of the leaves that in some locations was visible at a distance. On the other hand, because of the decreased numbers of insects present at Naden, the damage caused by the winter moth could only be seen close up, the leaves having "shot-gun" type holes and no discoloration of the damaged leaves.

Percent parasitism by parasitoid species, *Cyzenis albicans* and *Agrypon flaveolatum*, during the spring of 2007 will be determined in the spring of 2008 when the over wintered parasitoid adults will emerge. Therefore, only parasitism of winter moth during 2006 can be reported at this time.

Parasitism by the more important parasitoid, *Cyzenis albicans*, at Naden decreased slightly from 36.2% parasitism in 2005 to 29.9% in 2006. On the other hand, in the Greater Victoria area, percent parasitism by *Cyzenis albicans* increased from an average of 25.0% in 2005 to 38.6% in 2006. We are unable to explain this decline in percent parasitism by *C. albicans* at Naden at this time.

The pattern of parasitism by the less important parasitoid, *Agrypon flaveolatum*, was more varied. No *Agrypon flaveolatum* were recovered at Naden in 2006, compared to 2005, when this parasitic wasp parasitized 0.6% of winter moth collected. 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 2006, parasitism by *Agrypon flaveolatum* averaged 0.4%, double the levels that were recorded in 2005 (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* decreased at Naden (from 36.2% to 29.9%), but increased throughout Victoria as a whole (from 25.0% to 38.6%) for 2005 and 2006, respectively.

In 2007, there was a significant decrease in winter moth populations in the Greater Victoria area, compared with the previous year, and this is reflected in the increased presence of *Cyzenis albicans*, which exceeded 50% parasitism at some locations in the Greater Victoria area.

Parasitism by *Agrypon flaveolatum* was low in 2005 and 2006, and is likely to remain low (less than 1%), as this parasitoid has never caused more than 6% parasitism in a single year in B.C. since its introduction 25 years ago.

At this time we cannot make any long-term predictions on winter moth populations and the associated parasitoids, except that it appears equilibrium may have been reached between the host and its introduced parasitoids. These introduced parasitoids will likely not eliminate the winter moth. It is possible that the current low fluctuations will increase in amplitude from time to time to the point where winter moth populations will temporarily "escape" from its parasitoids and cause light to moderate defoliation of Garry oak in localized areas in the Greater Victoria area. It is not known what, if any, factors could disrupt this "natural balance" reached between the winter moth and its parasitoids.

Conclusions

Monitoring of the winter moth and its parasitoids in the Greater Victoria area shows that the introductions of the two parasitoids, *Cyzenis albicans* and *Agrypon flaveolatum*, have resulted in control of winter moth in the Greater Victoria area. However, both the recent drought (which makes the soil dry and hard, making it difficult for the mature larvae to burrow into the soil to pupate) and the eradication programs conducted against both Asian and European strains of gypsy moth in recent years in the Greater Victoria area have made it difficult to predict with any certainty when, and at what host density levels, the winter moth and its parasitoids will reach or stay in 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 equilibrium or not, it will also 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 Canada (Victoria) 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 of 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 22,000 parasitized winter moth pupae were shipped to the United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine Service (APHIS-PPQ) for rearing of the parasitoids for release in Massachusetts in 2005, 2006, and 2007. None of the winter moth that were collected and shipped to the United States were collected at Naden, but rather 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. If successful, it will confirm the hypothesis that classical biological control is an effective way to manage or even eliminate an introduced, exotic pest (DeBach, 1965).

References

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P031-07: Male and female winter moths (*Operophtera brumata* L.).

Purple Martin (*Progne subis*) Origins and Relationships

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Completion Date: 30 September 2007
Project Status: 1998—ongoing (original start date and anticipated completion date)

Introduction

Purple Martins (*Progne subis*) are at the northwestern limit of their range in British Columbia (B.C.), hence the low number of pairs and a Blue-listed designation in B.C. By 1984, Purple Martin numbers had decreased to less than five known pairs in the province. In 1995, as a response to the provision of man-made nestboxes for a decade, the total number of known active Purple Martin nests in B.C. increased to 55 (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 abundance and production. As well, nestlings have also 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 55 active nestbox sites in B.C. In 2007, 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 during previous years. Up to 98% of all nestlings produced at known breeding locations in B.C. in the past ten years have been banded with individually-numbered coloured plastic and/or metal bands that are visible with binoculars and readable with a spotting scope. In addition, the number of eggs and/or nestlings have been recorded in all of the nest boxes inspected. Productivity was determined for the whole colony, on a per pair basis, and by nestbox type. As in pervious years, all adults captured incidentally on the nest have been sampled - and standard body measurements recorded.

In 2007, eighteen visits were made to the Colwood and Royal Roads sites between March and September for observations, nestbox checks, and banding of nestlings. All band return records (re-sightings of identified individuals) were submitted to the banding office.

Results

For the second consecutive year no martin nestlings were fledged at the Colwood DND diving dock colony. Monitoring of this site began early this year with the first visit on 25 March. Subsequent visits on 6, 12, 15, and 18 April produced no sightings of martins. One adult male martin was seen flying by on 23 April but it did not stop. Small numbers of martins were at the colony on 28 April, 2, 5, 9, 13, 22, 29 May and 7 June. On 20 June and subsequent visits a maximum of eight martins were present at the colony. The boxes were checked 15 July and only three active nests (each with three or four eggs in them) were found; no martins were seen flying around the colony.

Another nest check took place on 1 August; again, we only found the three cold nests that were first noted on 15 July. Once again no martins were present around the colony. It appears that this colony was abandoned early in July in a repeat pattern of last year. Although it is speculation at this time, we suspect the cause of the colony failure was disturbance/ predation by an owl.

We will apply for a continuation of the ESAC permit for 2008 to conduct more observations, and perhaps we will install some electronic or camera surveillance in an attempt to determine the cause of the failure.

At the Royal Roads colony, eighteen nestlings fledged from six nests. Three of these were fostered into a late nest with three other nestlings of about the same age. They came from a drainage port on HMCS Vancouver tied up in Esquimalt Harbour and taken out to Wild ARC in Metchosin on 20 August. Due to diligent feeding by two juvenile parents, all six were flying by 6 September.

Discussion

Many of the Purple Martin nestlings banded at colonies between 1997-2007 have been re-sighted at different colonies other than their natal colonies in B.C., Washington, Oregon and even in California (during migration). We suspect the B.C. colonies are part of a much broader population that ranges north from at least Oregon and possibly California north. Purple Martin populations are on the increase in B.C. and most American west coast states (personal observation plus reports from Washington and Oregon). They appear to be increasing in association with the availability of man-made nestboxes. It is possible that the current population is derived from the few birds that adapted to man-made nestbox colonies in B.C. However, our banding returns and DNA analysis show that the Colwood population is augmented by birds from further south in the USA and from the more northern B.C. colonies. After the nesting failure this year it will be most interesting to see from where the new colonizers will come in 2008.

Following blood samples taken from Washington and B.C. in 1999 and California in 2003 which have now been analyzed and final results presented in late 2006, combined with banding returns, the western martins from California north appear to have an extremely diverse genetic makeup. The B.C. birds have an influx coming from the south out of Washington and probably from Oregon with no evidence of a genetic bottleneck. Also in 2006, blood samples were collected from birds in Colorado and Utah. These too were added to our DNA database. This DNA work is part of an overall study of the origin of western martins, including birds from B.C., Washington, Oregon, California, and now Colorado and Utah, plus birds from east of the Rockies, including Alberta, Manitoba, Ontario, and Pennsylvania. Establishment of the relationship between the western and eastern populations is important for the management of this at-risk species.

Conclusions

In 2008, we wish to obtain access to the colony by 1 April, since the martins tend to first return early in that month. This would allow us to read the coloured bands of returning adults in order to determine if the birds have previously nested at the Colwood site or if the colony is being re-populated by the young of last year or by birds from other areas. Since almost all martins fledged at the B.C. colonies in the past nine years have been banded, we will most likely know the origin of any new colonizer. This is a unique opportunity to assess the origins of re-colonizers and such information will be invaluable when developing management plans for the species. In addition to looking for coloured bands on early returns at the beginning of the season (assuming some birds will return since this has previously been such a successful colony), we will continue to band nestlings in nest nestboxes; to monitor nest success and productivity; and to monitor for band returns, as part of the on-going nest nestbox monitoring and maintenance program. We will carry out similar monitoring, nestling banding, and band reading sessions at Royal Roads University.

References

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P044-07: Male and female Purple Martins on a nest box.

Wildlife Tree Stewardship Program (WiTS)

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Project Status: 2001—ongoing (original start date and anticipated completion date)

Introduction

The Bald Eagle (*Haliaeetus leucocephalus*) 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 (*Pandion haliaetus*) and Red-tailed Hawks (*Buteo jamaicensis*). The program has expanded to include most of Vancouver Island, the Gulf Islands, the Southern Mainland, and the Okanagan, with the focus increasingly being community education, habitat protection, and stewardship agreements. The project is supervised by Kerri-Lynne Wilson (FBCN) and Karen Morrison (B.C. Ministry of Environment).

CFAD 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 our overall view of the productivity and proximity of the nests of large raptors such as Bald Eagles, Osprey, and Red-tailed Hawks, etc.

Study Area and Methods

The areas studied in 2007 were Rocky Point and Colwood. Albert Head was not accessed this year, as little activity was observed by the monitor from Albert Head Lagoon. We drive or walk the roads, stop and listen, observe general activity with the aid of binoculars and sound if searching for a new nest site.

For example, in order to locate the latest nest site, we heard an eaglet call and were able to find the nest by walking approx 10 metres toward the water from the road. The known nests are observed with binoculars and telescope and all activity is documented.

We leave the road only in order to view a nest that can't be seen clearly from the road or to climb Church Hill for observations from there. If a nest tree can be accessed easily it is sometimes helpful to check the base of the tree for prey items after nesting season is complete. This is rarely done at Rocky Point, as most trees are inaccessible. More information about the program can be found on the website: www.wildlifetree.org.

Our information goes to the B.C. Ministry of Environment and is also on "The Community Mapping Network" in our Wildlife Tree Atlas, which can be viewed at the following website:
http://www.shim.bc.ca/atlases/wits2/witsloginscreen.htm.

These data are available for research purposes and have been used by two students, one obtaining her masters degree and the other obtaining her doctorate degree. These data can be used to monitor trends on Vancouver Island, the Lower Mainland, and the South Okanagan. The information is also shared with an increasing number of municipalities to aid in community planning and habitat protection.

We are a large '"citizens science" project' with over 250 volunteers. Since DND lands are ideal habitat for eagle nest sites, these areas help to give us a more complete picture of the overall eagle productivity and adaptation to habitat changes.

Results

ROCKY POINT:
Eight Bald Eagle nest trees have been located and identified at CFAD Rocky Point.

I have divided this report into "territories." A "territory" for a pair of bald eagles is usually 500 m to 1000 m away from another breeding pair, is fiercely protected, and may contain several different nest trees. (The following "territories" are estimations displayed this way to prevent jumping back and forth in location.) As two pairs of adults have been observed in both nest "E" and nest "G" at the same time in 2006 and 2007 it is felt that although the two nests are only approximately 400 m apart, the two territories coexist and that likely nests "C" and '"G"' belong to the same pair.

One osprey nest was monitored at Rocky Point. While the nest is not in a tree, monitoring this nest activity may be of interest for any future mitigation and for territorial monitoring.

A summary of the monitoring efforts at Rocky Point are presented in Table 1.

Table 1. Rocky Point 2007 Raptor Nest Monitoring Summary

Nest ID	Tree/Class	Location	2007 Activity	Monitoring Observations
Bald Eagle				
Fossil Point Territory				
A (E102-007)	Fallen Douglas-fir	Fossil Point, located just off the East Perimeter Road in Polygon 119	Inactive	This nest tree was uprooted in a storm during December 1999.
B (E102-008)	Douglas-fir, decay class 1-2.	Fossil Point, just off the East Perimeter Road in Polygon 119	Inactive	This nest fledged one young in 2001 and has not been productive since.
H (no E # yet)	Douglas-fir, class 2	Fossil Point, approximately 50 metres to East side of E. Perimeter Rd.	Active	Nest discovered 2 August 2006 - one young observed in nest. 2007 - no eagles seen at or in nest on four visits, however, two adults heard on 12 April – one called from the nest. Each visit was for one hour at least but our timing may have just missed seeing or hearing other activity. Down and fresh lichen were observed on the nest with telescope on the nest and feathers were found near the tree. We considered this to still be an active nest.
Whirl Bay (Gate 10) Territory				
E (E102-027)	Douglas-fir, class 1-2	Whirl Bay, in Polygon 14, approximately 70 metres inside gate #10	Active	Nest discovered from the top of Church Hill in April 2003 - one young only. 2004 and 2005 - no activity seen or heard at this nest. 2006 - some activity, but no young. 2007 - two adults seen at nest during March, April and May visits. Subsequent visit in June, following underwater demolition testing in Whirl Bay, found one adult in nest tree and one eaglet in nest.

Table 1. Continued

Nest ID	Tree/Class	Location	2007 Activity	Monitoring Observations
Whirl Bay Shore/Church Hill East Territory				
'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 and apparently active in 2000 as reported by fishing boaters. It was not active in 2001, 2002, or 2003. Nest is deteriorating somewhat. 2004 - one young fledged. 2005 - 2007 - nest inactive - many whale watching boats observed viewing nest. However, on 6 June a pair of adults were perched in this tree.
'G' (E102-029)	Douglas-fir, decay class 2	Whirl Bay, approx 20 metres south of road.		2005 - reported to have been active and fledged at least one young. (Not seen by WiTS monitors until 2006.) 2006 - some activity, but no young. 2007 – nest fell during winter storms along with many nearby trees. 30 March – One adult in nest tree, small amount of nest material in tree, some branches broken - second adult flew into nest. 12 April – nest appears larger, no adults seen. 17 May and 18 June – no eagles seen or heard near this tree.
Church Hill West Territory				
'D' (E102-026)	Douglas-fir, decay class 2	Church Hill, north-west side in Polygon 4	Active	Nest first discovered in May 2002 and fledged two young that year. No activity seen at this nest in 2003. 2004 - fledged two young. 2005 and 2006 - nest inactive and growing grass and very difficult to see due to growing trees. 2007- 30 March, adult on nest, then exchanged with second adult. 12 April and 17 May, one adult seen on nest. 18 June, one adult perched near nest and one large brown eaglet in nest. Tree and nest very difficult to see.
'F' (E102-028)	Douglas-fir, decay class 4	Church Hill, north-west side in Polygon 4.	Inactive	Nest discovered in May 2003 with one adult sitting on nest and one in a perch tree. No activity was seen on subsequent visits - nest apparently abandoned. Base of tree was accessed in June 2003 by Art Robinson. 2004 - no activity seen at this nest. Only remnants of nest remain. 2005 - 2007 - no activity, very little nest material left in tree.
Osprey				
Platform nest	Relocated nest on an alternative pole and platform	Area B, CFAD	Active	This pair built their first nest in 2003 on top of a power pole in area '"B,"', approximately 150 metres from the main gate. 2003 - two young fledged. Subsequently, an alternate nesting platform was erected with a second one erected in 2005. 2004 - three young fledged. 2005 & 2006 - adults seen in vicinity but no young fledged. 2007 - 17 May, adult osprey seen in second platform. 18 June, one adult sitting on nest and one flying. Observers working on base felt there may have been two young osprey early in season, they may have been predated by eagles, no young fledged.

ALBERT HEAD:
The Albert Head site was not accessed this year as no activity was observed from Albert Head Lagoon.

COLWOOD:
In 2004 two Bald Eagle nest trees were located and subsequently monitored.

There are now two man-made Osprey nest platforms at the Colwood site. A new artificial structure with platform was erected 26 April near the West end of "D" Jetty, and replacing a nest being built on the decommissioned "Huron" (Guille 2007). These two platforms, although they are approximately. 400 metres apart, we believe may be in the territory of the same osprey pair. While a WiTS monitor was unable to observe the outcome of the breeding season for this pair, a DND employee did report that two young Osprey fledged from this new platform.

A summary of the monitoring efforts at Colwood is presented in Table 2.

Table 2. Colwood 2007 Raptor Nest Monitoring Summary

Nest ID	Tree/Class	Location	2007 Activity	Monitoring Observations
Bald Eagle				
'A' - (E101-647)	Douglas-fir, decay class 2	Approximately 6 metres to the west of the road, between Bunkers 45 and 48.	Inactive	Two nests were found in this tree. 2004, 2005, and 2006 - eagles seen and heard nearby but no activity at this nest. Old prey items at base of tree. 2007 - eagles nearby, this nest tree not active. The two nests in this tree appear to be deteriorating.
'B' - (E101-648)	Douglas-fir, class 1	Approximately 75 metres SSW of Bunker 44.	Active	2004 and 2005 - unable to detect activity at this nest, however eagles heard and seen nearby. Very difficult to get good look at nest. 2006 -some activity but no young. 2007 - 30 April, one adult left nest and second adult perched nearby. 31 May, calling heard as one adult flew over. 27 June, no activity observed. Two large branches have broken off above the nest and are hanging adjacent to it. Prey items found under nearby perch tree. We consider this nest to be active but productivity is unknown.
Osprey				
(0101-004)	Nest on a platform located at top of a Douglas-fir tree	Approximately 150 metres west of the Fuelling Jetty	Inactive	Last active in 2005 when two young fledged.
New platform nest	Relocated nest on a pole and platform.	West end of "D" Jetty		A DND employee reported that two young osprey fledged from this nest.

Discussion

We believe that there continued to be four active Bald Eagle territories at Rocky Point during the 2007 breeding season. Although our observations for the Fossil Point territory have not produced conclusive results, we are reminded again how secretive these large birds can be and how limited our visibility is in the tree canopy. Early activity was either heard or seen in two territories and the remaining two territories produced at least two eaglets. Several immature eagles were also observed flying during our visits.

The Osprey nest was active, although no young survived to fledge, and while Red-tailed Hawks were observed flying on most visits, a nest has not yet been found. Turkey Vultures (*Cathartes aura*) are also frequently seen.

Conclusions

Our plan for 2008 is to continue to study the same DND areas for nesting activity and productivity. This will complement WiTS studies in the CRD area and elsewhere in B.C., as can be seen at the following website:
http://www.shim.bc.ca/atlases/wits2/witsloginscreen.htm

Acknowledgements

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

References

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Garry Oak (*Quercus garryana*) Acorn Survey

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Start Date: January 2007
Completion Date: December 2007
Project Status: 2001—ongoing (original start date and anticipated completion date)

Introduction

High variation in acorn production from year to year, and tree to tree, is characteristic of oak species in general (Koenig 1980), but there is little published information on acorn crop variation or regularity in Garry oak (*Quercus garryana*) (Stein 1990). The purpose of the Garry Oak Acorn Production Study is to determine the spatial and temporal variation in acorn production and the factors that influence it. Annual acorn production is monitored from Vancouver Island to southern Oregon with the help of volunteers and cooperating agencies. To assist our volunteers and inform the general public, a website was created containing background information, the methods and forms used in the survey, and results: www.fs.fed.us/pnw/olympia/silv/oak-studies/acorn_survey.

Study Area and Methods

The number of trees monitored annually on or near Vancouver Island has grown from 54 trees in 2001 to 230 trees in 2005. In 2007, only 214 trees were monitored due to mortality (ten trees) and lack of access to one DND site (Mary Hill: 16 trees). The sample trees extend from Courtenay in the north to Rocky Point, southwest of Victoria.

We surveyed acorns in August or September and ranked acorn production on a scale from 1 to 4, with 1 indicating no acorns and 4 indicating a heavy crop (Graves 1980).

Acorns are a rich source of food for many mammals, birds, and insects and are important for oak regeneration and dispersal. But, Garry oak ecosystems from southern California to Vancouver Island are disappearing or changing due to introduction of exotic species, fire exclusion, and land conversion for agricultural and urban uses (Agee 1993, Bell and Papanikolas 1997, Chappell and Crawford 1997, Reed and Sugihara 1987, Tveten and Fonda 1999).

The Vancouver Island sites are important as they are near the northernmost distribution of Garry oak and may thus reveal important information about climatic limitations on Garry oak distribution. In this report, upland acorn production variability among DND and other Vancouver Island sites is evaluated and then compared to production in Oregon and Washington.

Acorn class increments are not equal. For example, in total acorn counts from a small sample of trees, class 3 trees averaged about eight times as many acorns as class 2 trees.

We selected 1092 upland trees in the acorn survey database from Vancouver Island, Oregon, and Washington that had not been irrigated or fertilized. All trees had a minimum of five annual observations between 2001 and 2007 – with the exception of Mary Hill which had only three years of data. These data were stratified into four geographic analysis groups: Vancouver Island (n = 177), Washington Puget-Willamette Trough (n = 768), Oregon Puget-Willamette Trough (n = 67), and Eastside (eastern Cascade Mountains and eastern Columbia Gorge, n = 79).

The analysis groups were further stratified into geographic subgroups. The Vancouver Island subgroups included the three DND properties (CFMETR, Rocky Point, and Mary Hill) and two broader groups (northern and southern oak woodlands). The northern and southern oak woodlands were arbitrarily separated at the latitude of Duncan, with Duncan sites falling into the southern group.

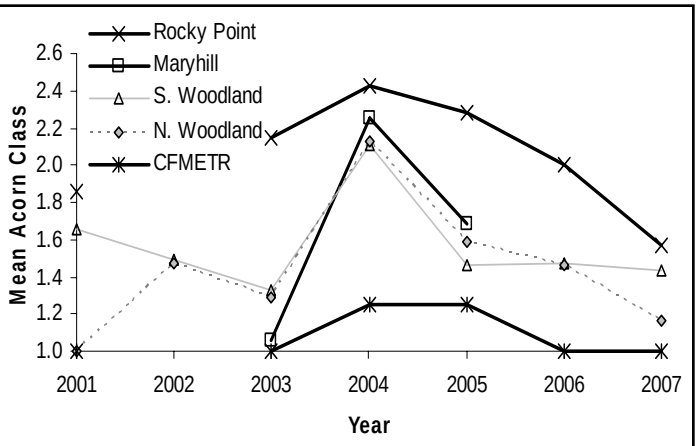

Figure 1. Mean annual acorn classes for the Vancouver Island subgroups.

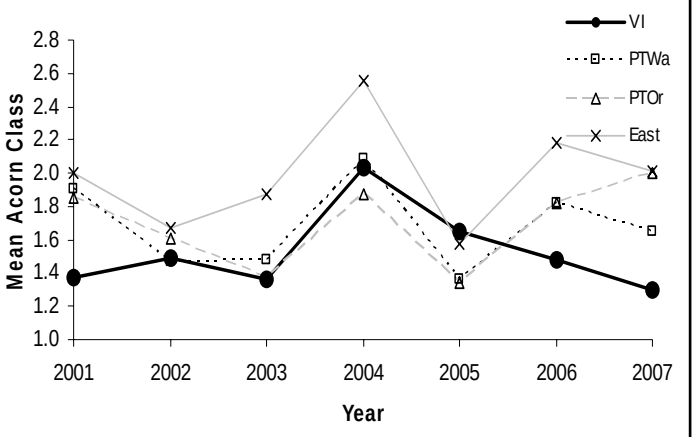

Figure 2. Mean annual acorn classes for the analysis groups (VI = Vancouver Island, PTWa = Puget Trough Washington, PTOr = Puget Trough Oregon, East = Eastside and eastern Columbia Gorge).

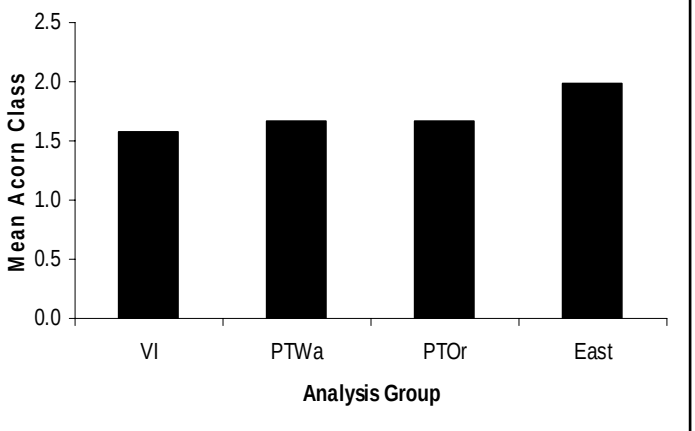

Figure 3. Mean acorn classes over all years for the analysis groups (VI = Vancouver Island, PTWa = Puget Trough Washington, PTOr = Puget Trough Oregon, East = Eastside and eastern Columbia Gorge).

Rocky Point and Mary Hill, although reported on separately, are examples of southern Vancouver Island oak woodlands, while CFMETR near Nanoose Bay would fall into the northern oak woodlands. Sample sizes were: CFMETR – 8, Mary Hill – 16, Rocky Point – 7, northern woodlands – 24, southern woodlands – 122.

Farther south, there were eight Eastside subgroups, seven Oregon Puget-Willamette Trough subgroups, and nine Washington Puget-Willamette Trough subgroups consisting of individual stands or collections of similar stands. Trees in the heavily-sampled glacial outwash plains of the South Puget Sound region were divided into three subgroups to avoid giving this region too much weight. These groups were: Fort Lewis – 344 trees, Lakewood – 198 trees, and Olympia – 84 trees. Other subgroups included three to 27 trees (mean = 11).

Statistical analysis was conducted with SAS Software (SAS 2002-2003) and significance was declared at $p = 0.05$. Parametric ANOVA was used to compare means when Q-Q plots indicated that the assumption of normality was satisfied, otherwise non-parametric Kruskal-Wallis ANOVA was used. Acorn classes are not normally distributed, but means of acorn classes increasingly approach a normal distribution as the sample size of the mean increases.

Acorn production among Vancouver Island subgroups was compared with Kruskal-Wallis ANOVA since these tree-level means were not normally distributed. Significantly different subgroup distributions were located with a Dunn test. Acorn production among analysis groups was compared with parametric ANOVA of subgroup means as these means were normally distributed. Significantly different analysis group means were located with Tukey's HSD test.

Results

Rocky Point was the highest Vancouver Island acorn producer and CFMETR the lowest (Figure 1). Over the entire acorn survey (2001-2007), both Rocky Point and Mary Hill produced significantly more acorns than CFMETR. However, when only acorn data for 2003 through 2005 were compared (the only years with data for all subgroups in all years) the difference was marginal ($p = 0.07$).

Acorn production peaked in 2004 in all analysis groups (Figure 2) and dropped for one or more years thereafter, although not all annual comparisons were significant. Eastside acorn production was significantly higher than Vancouver Island production in 2001, 2004, and 2007, but over all years there was no significant difference among analysis groups (Figure 3).

Discussion

On Vancouver Island, upland northern woodland and southern woodland acorn production was similar, exclusive of the DND sites, however the Rocky Point and Mary Hill DND sites (both southern woodlands) produced more heavily than the CFMETR site (a northern woodland). Thus, southern trees may be more productive than northern trees, but the difference is minimal.

Vancouver Island acorn production appears to be lower and less variable than acorn production on upland sites to the south, although the difference was only significant with the Eastside subgroup in some years. Peter and Courtin (2006) suggested that long, warm, moist growing seasons and dry spring conditions benefit acorn production. Thus, the tendency for acorn production to increase to the south of Vancouver Island and especially east of the Cascade Mountains may reflect warmer summers and drier springs in those areas.

Conclusions

Vancouver Island trees, especially northern trees, may be somewhat less productive than Eastside trees to the south. This difference in productivity may relate to climatic differences, especially spring and summer moisture and temperature conditions.

We plan to continue acorn surveys for at least three more years, as each year's data adds clarity to the geographic and climatic relationships to acorn production. We expect this study will result in publications describing geographic and temporal masting patterns, and the effects of weather, habitat, and competition on acorn production in Garry oak. Data for this study are maintained at the USDA Pacific Northwest Forestry Sciences Laboratory in Olympia, WA.

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Microclimate Station Upgrade

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Location(s): Rocky Point
Start Date: February 2007
Completion Date: December 2007
Project Status: 2004—ongoing (original start date and anticipated completion date)

Introduction

This project involves the continuous improvement and maintenance and measurements at the microclimate monitoring station located at the existing Ecological Monitoring and Assessment Network (EMAN) site and canopy station at Rocky Point. Equipment installed at the site includes:

- A 30-m tower with a 750-watt solar panel that powers the existing instrumentation;
- A small storage shed that houses some of the existing and future monitoring equipment and protects them from the elements is also available on site;
- Tipping bucket rain gauge deployed on a 10-m high tower to improve exposure;
- A quantum radiation, temperature, and relative humidity sensor and a wind speed and direction sensor on the 30-m tower;
- Temperature thermocouples within the study tree canopy;
- Aspirated shields, at 10, 20, and 30 m on a cable ladder beside the study tree, to support temperature and relative humidity sensors; and
- Three soil moisture probes at selected locations in the adjoining EMAN site.

Data gathered from the microclimate station will be used to support other research activities at Royal Roads University as part of the university's effort to monitor atmospheric contaminants changes as a result of climate change.

Study Area and Methods

The main objective of the project was to maintain and complete the installation of the infrastructure at Rocky Point for the purposes of monitoring atmospheric and ecological information using data loggers on a regular basis via remote technology as well as provide maintenance of the canopy station. Activities completed this year included:

- Improvements in communication reliability between the data logger and Royal Roads polling system by installing and upgrading a CDMA cellular antenna system;
- Monitoring of the sensors on the study tree;
- Purchasing and delivery of materials on site to extend the boardwalk to the new locations for the lysimeter and tripod tower, that are located within the salal (*Gaultheria shallon*) vegetation area, as well as fix any sections damaged during severe winter storms;
- Design and development of a lysimeter to measure evapotranspiration rates for installation on the site; and
- Inspection of the site.

Results

Installation of the data loggers and programming has been completed. The data logger is operational and it is sending data on a routine basis to a server at Royal Roads. The sensors currently operational include the nine temperature sensors in the study tree – located at three elevations, and the soil moisture probes.

Operation of the remaining sensors will only require their installation, running of signal cables, and the re-programming of the data logger to accept the new variables. The tall tower was also extended this past year to 30 m to reach the top of the canopy (great view). The tripod tower is also ready to accept sensors. Data from this site for the period 07/2006 to 12/2007 are stored at Royal Roads University and are available on request from the project leader.

Discussion

The current upgrade has been slower than anticipated due to financial constraints and it is anticipated that the installation of the lysimeter and boardwalk improvements will be completed in the summer of 2008. The strapping on all study trees needs adjustment and maintenance and it is anticipated that this will also be performed over a similar time frame. The aerial ladder will need some maintenance since it was damaged in last winter's wind storm. Additional work is also required to make the monitoring data publicly available via an interactive website.

Conclusions

It is intended that the data gathered from the Rocky Point Canopy Station and the microclimate monitoring 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 monitoring station. A memorandum of understanding for its operation has been established with DND in collaboration with Environment Canada. The Royal Roads University Ambient station is situated on campus near the shore of Esquimalt Lagoon. These facilities will serve as important vehicles for research, education, and extension activities in the future including public outreach on air quality management in the Capital Regional District and beyond.

P087-07: Forest Canopy Research Station infrastructure at Rocky Point.

Studies on the Dynamics of Butterflies and their Host Plants in Garry Oak Ecosystems

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Location(s): Rocky Point, CFMETR
Start Date: 01 April 2007
Completion Date: 01 August 2007
Project Status: 2003—2009 (original start date and anticipated completion date)

Introduction

Our research, initiated in 2003, addresses the factors that limit the distribution and abundance of several insect species and their host plants in Garry oak (*Quercus garryana*) ecosystems. The following objectives were the focus of study this year: I) examine the factors that limit butterfly distributions specifically in *Erynnis propertius* and *Papilio zelicaon;* II) explore if differing abundances of related *Lomatium* species may lead to different abilities for a range shift under climate change; and III) quantify the extent of outbreaks and investigate the mechanisms enabling outbreaks of the jumping gall wasp, *Neuroterus saltatorius*, a species that recently expanded its range from mainland Washington (WA) to Vancouver Island (VI). Our research informs management and conservation by repeatedly monitoring butterfly population size, uncovering the factors that predict the abundance of butterflies and the gall wasp, and by identifying populations that are genetically and functionally distinct in *E. propertius*, *P. zelicaon* and *Lomatium* spp.

Study Area and Methods

Part I: *Erynnis propertius* and *P. zelicaon* eggs were collected from multiple sites in core (Oregon [OR]) and peripheral (VI) areas of their geographic distributions, including CFMETR and Rocky Point. Eggs were transported to the University of Notre Dame (UND) where they were placed in environmental growth chambers under treatments of climate and host plant.

The climate (temperature) treatment had two levels: core and peripheral. The host plant treatment had two levels for *Erynnis propertius*: core and peripheral populations of Garry Oak. The host plant treatment for *Papilio zelicaon* had three levels: *Lomatium utriculatum*, *L. nudicaule,* and non-native *Petroselinum crispum*. Larval size and survivorship were recorded weekly for individual larvae.

Each temperature treatment was replicated twice. Experimental conditions were set to values determined from long term temperature data (1997-2006). Temperature was adjusted in two week intervals to reflect seasonality. Cages were checked routinely to ensure that all caterpillars had a constant food source.

For each species, a three-way General Linear Model was used to determine the effect of source region, host plant, and temperature on survivorship and growth. To meet the assumptions of normality, data for both species were arcsine-square root transformed.

Part II: Seeds from each of three *Lomatium* species (*L. dissectum*, *L. nudicaule*, and *L. utriculatum*) were collected from Rocky Point and nine other sites across VI in 2006. Seeds were attached to colour-coded toothpicks representing their sources. Six planting sites (three within the species range [one of which is Rocky Point] and three beyond the range boundary) were chosen to receive the collected seeds. These sites span 5-160 km across VI.

The two planting regions represent two treatment levels in the experiment: inside the historic geographic ranges of the three plant species and outside these ranges. The outside-range sites receive 50% more precipitation and on average have 50 more days below freezing annually than sites inside the range. A total of 120 study plots (20, 1m^2 plots in each of six sites) were assessed in June, 2006 for composition of vegetation before plot manipulations. Then, one of four treatment combinations was applied to each plot. One-half of the plots were caged to exclude herbivores and one-half of the plots had competitors removed. Plots were replicated five times at each site, and sites were replicated three times within each study region.

Plots were scored for germination and establishment in 2007 and will be reassessed for survival in 2008. To determine factors involved in establishment of the study species, a three-factor ANOVA with region, disturbance/competition, and herbivory as treatment effects was used to analyze germination data from 2007. Additionally, a single -factor ANOVA was used to compare overall germination differences across species.

Part III: Assessments of foliar damage on Garry oak caused by the Jumping gall wasp, *N. saltatorius*, were conducted at Rocky Point, CFMETR, and 19 other sites in both the gall wasp's native range, southern Puget Sound, WA, and its invaded range, San Juan Islands, WA and VI. At each site, 150 trees were chosen randomly for assessment. Each tree was assigned to one of the following damage categories: low (if the majority of leaves had < 25% of their total green area covered with *N. saltatorius* damage), moderate (25%-75%), and high (> 75%). This sampling protocol enables comparison of gall damage between native and non-native regions and quantifies regional differences in the size and impact of gall wasp populations.

In addition to damage assessments, over 24,000 galls of *N. saltatorius* were collected from leaves at Rocky Point, CFMETR, and 20 other sites in WA (i.e., native range) and British Columbia (BC) (i.e., invaded range). These collections occurred four times between 21 June and 29 July 2007. Each gall was enclosed in a gelatin capsule. Capsules are currently housed in growth chambers at UND to capture parasitoid wasps as they emerge. Parasitoid wasps will be identified to genus or species where possible. This sampling protocol enables comparison of parasitism rates, parasitism phenology, and parasitoid species richness in sites where the gall wasp historically occurred (i.e., WA) and where it recently expanded (i.e., VI). Specifically, this method enables us to perform a correlative assessment of whether a possible cause for the success of *N. saltatorius* on VI is due to reduced top-down control by parasitoid wasps (superfamily Chalcidoidea).

To further investigate the role of parasitoids in determining the density of *N. saltatorius* populations, a parasitoid exclusion experiment was conducted at Rocky Point and four other sites on VI (i.e., the invaded region) and at four sites in WA (i.e., the native region). Seven paired control and exclusion replicates were deployed at Rocky Point on 8 June and at all other sites between 5 June and 11 June 2007. Each paired replicate was placed on a single tree. The exclosures were designed to prevent parasitoid wasps from accessing *N. saltatorius* galls, and controls were designed to allow parasitoid wasps access to galls. Galls were collected from each paired replicate and are currently being housed in petri dishes in greenhouses at UND. Galls will be dissected in the spring of 2008 to assess adult gall survivorship. If gall wasps are outbreaking on VI due to a reduction in top-down control by parasitoids, we expect that our experimental reduction of this parasitism will increase gall wasp survivorship, more so than in the wasp's native range.

Results

Part I: Temperature had a significant effect on survivorship for both *E. propertius* and *P. zelicaon*, yielding higher survivorship in the warmer conditions that simulate the species' range core (Table 1). *E. propertius* individuals performed equally well on Garry Oak from OR and VI (Table 1). *P. zelicaon* individuals collected from VI had lower survivorship on two host plant species, *L. utriculatum* and *P. crispum*, than did caterpillars from OR (Figure 1). *P. zelicaon* caterpillars from VI, however, did significantly better on *L. nudicaule,* the less common of the two native species.

Table 1. Table 1. ANOVA table for survivorship to pupation of *E. propertius* and *P. zelicaon.*

Species	***Erynnis propertius***			***Papilio zelicaon***		
Source	df	F	p	df	F	p
Temperature	1	10.328	0.012	1	20.119	0.001*
Source	1	2.109	0.184	1	1.780	0.207
Host plant	1	2.086	0.187	2	7.268	0.009*
Temp. x Source	1	2.565	0.148	1	1.608	0.229
Temp. x Host plant	1	3.138	0.114	2	0.330	0.725
Source x Host plant	1	0.315	0.590	2	7.345	0.008*
Temp. x Source x Host plant	1	0.414	0.538	2	2.021	0.175
Error	8			12		

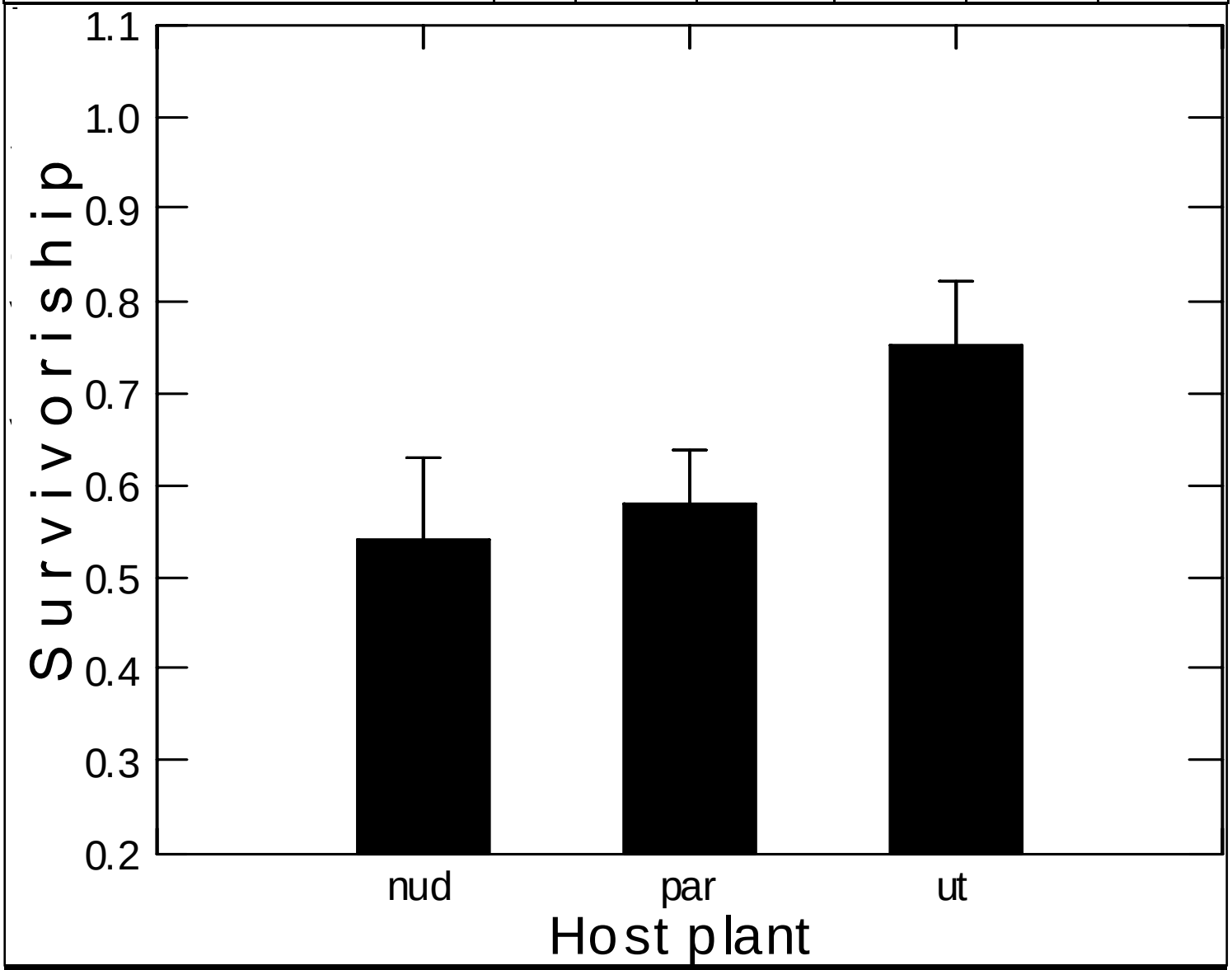

Figure 1. Plot of host plant vs. survivorship of *P. zelicaon.* "nud" represents *L. nudicaule*, "par" is *P. crispum*, ands "ut" represents *L. utriculatum*. Error bars denote standard error.

Caterpillars from OR had substantial mortality when fed this same hostplant. Overall, survivorship of both regional groups was highest on *L. utriculatum*.

Part II: The rarest species, *L. dissectum*, had lower rates of germination than *L. utriculatum* and *L. nudicaule* (ANOVA: df = 2, 359, F = 25.69, p < 0.001, Tukey post-hoc all three species differ). Within species, we found that a treatment of initial disturbance before planting significantly interacted with planting region for both *L. nudicaule* (ANOVA: df = 1, 119, F = 12.00, p = 0.001) and *L. dissectum* (ANOVA: df = 1, 119, F = 15.18, p < 0.001). The direction of this interaction, however, was different between species. *Lomatium utriculatum* germinated best with no initial soil disturbance, independent of planting location. The herbivore treatment did not have a significant effect on germination, and germination rates outside the current species range did not differ significantly from those within the range boundaries for all three species.

Part III: Rocky Point has a high proportion of trees (64%) in the moderate to high damage categories for *N. saltatrois* and is one of the most damaged sites by *N. saltatrois* surveyed in this study (Figure 2a). Rocky Point has damage levels that are comparable to oak meadows that are set in and surrounded by urban areas (Figure 2a, white bars). CFMETR has the second -lowest proportion of trees in the moderate to high damage categories (41%) in BC (Figure 2a). Damage levels are, for the most part, higher in BC then they are in WA. In comparison to values recorded in WA, the gall wasp's native range, these data suggest that *N. saltatorius* occurs at high abundances where it has recently expanded.

As of 20 August 2007, 2,065 parasitoid wasps had emerged from field-collected galls. CFMETR has similar parasitoid emergence rates (10.3%) to other sites in BC and the San Juan Islands, WA (Figure 2b). Emergence rates from Rocky Point could not be calculated as capsules containing galls from this site were damaged in the greenhouse at UND. There are higher parasitoid emergence rates in galls collected from the southern Puget Sound, WA, than in galls from other regions (Figure 2b), suggesting that parasitoid rates are higher in the native range than in the invaded range and may play a role in limiting the abundance of *N. saltatrois*.

As of December, 2007, data from the experiment of parasitoid reduction had not yet been analyzed.

Discussion:

Part I: Our results from caterpillar growth experiments support the prediction that populations perform best in conditions found at the core of their geographic distributions. This also suggests that individuals collected from the periphery, VI, may perform better under climate change, possibly resulting in population increases that may enable poleward range shifts. Differences in performance among host plants for caterpillars of *P. zelicaon* suggests that populations from OR are more generalized with respect to host plant species than populations on VI. As well, *L. nudicaule* may have a chemical profile that reduces caterpillar survivorship. It is possible, though further experiments would be needed to test this conjecture, that caterpillars from VI have evolved the ability to detoxify *Lomatium utriculatum* at a cost of a reduction in their ability to effectively use other host plant species.

Part II: We found that all three species of *Lomatium* germinate as well outside their current range distribution as they do inside their range boundary. Therefore, we conclude that limitations in seed dispersal may be the primary factor limiting the establishment of new, poleward populations in these plants. This implies that populations could be purposefully established outside the current range boundary to facilitate poleward range expansion in anticipation of climate change.

High germination rates in the undisturbed plots outside the species' range indicate that natural competitors may facilitate germination by moderating abiotic conditions. It is important to note that while a herbivore effect was not observed in 2007, none was anticipated at the germination stage, as the plants were still small. Herbivory will be better assessed in 2008 with survivorship. Yet, current results suggest that region-level differences in seed predation, moisture levels, and the freeze/thaw cycle outside the current range do not limit germination in the study species.

We also observed differences in germination among species, with the rarest species showing the lowest proportion of germination.

Fewer propagules, coupled with poorer germination, could compound the effects of rarity in establishing new populations of *L. dissectum*.

Part III: We found that damage levels are higher and parasitoid abundances are lower in invasive *N. saltatorius* populations on VI than in native areas of WA. This suggests that outbreaks of *N. saltatorius* in BC could be a result of release from parasitoid control relative to native sites in WA. Additional analysis of data experimental data collected on *N. saltatroius* in 2007 is still needed.

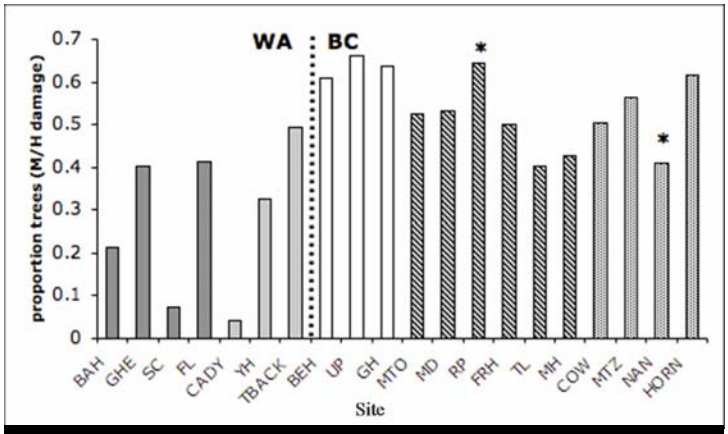

Figure 2a. Proportion of *Q. garryana* trees that have moderate to high levels of foliar damage caused by *N. saltatorius*.

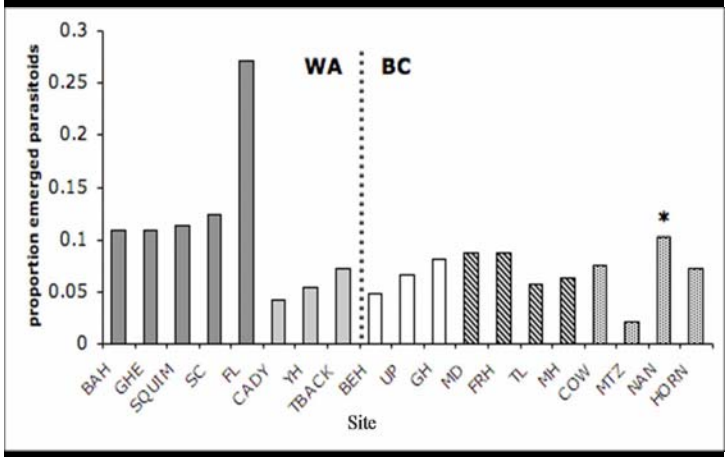

Figure 2b. Proportion of *N. saltatorius* that emerged as of 20 Aug. 2007 from galls of *N. saltatorius* collected in 2007 from sites in southern Puget Sound (dark grey) WA, San Juan Islands (light grey), WA, and VI, BC. Of the VI sites, white bars are urban sites in Victoria, diagonally hatched bars are non-urban sites, and speckled bars indicate sites further to the north. Rocky Point (RP) and CFMETR (NAN) are marked with asterisks.

Conclusions

The following publications have resulted from our work at Rocky Point and CFMETR:

Zakharov, E. V., and J. J. Hellmann. 2008. Genetic differentiation across a latitudinal gradient in two co-occurring butterfly species: revealing population differences in a context of climate change. Molecular Ecology 17: 189-208.

Zakharov, E. V., J. J. Hellmann, and J. Romero-Severson. 2007. Microsatellite loci in the Propertius duskywing, *Erynnis propertius* (Lepidoptera: Hesperiidae), and related species. Molecular Ecology Notes 7: 266-268.

Zakharov, E. V., and J. J. Hellmann. 2007. Characterization of 17 polymorphic microsatellite loci in the Anise swallowtail, *Papilio zelicaon* (Lepidoptera: Papilionidae), and their amplification in related species. Molecular Ecology Notes 7: 144-146.

Hellmann. J.J, Pelini, S.L, Prior, K.M., and Dzurisin, J.D.K. The adaptation of two butterfly species to the edge of their range and the effect of edge adaptation under climate change. Oecologia. In review.

Prior, K.M, and Hellmann, J.J. The ecology and life history of an oak-feeding butterfly (*Erynnis propertius*). The Canadian Entomologist. In review.

Marsico, T., Hellmann, J.J., and Romero-Severson, J. Patterns of postglacial seed dispersal and contemporary pollen flow in *Quercus garryana* (Fagaceae): a baseline for predicting future response to climate change. Journal of Biogeography. In review.

In the coming years we anticipate continued monitoring and experimental research on *E. propertius, P. zelicaon, Lomatium spp.*, and *N. saltatorius* at Rocky Point and CFMETR.

The Strait of Georgia Mortuary Landscape Project

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Start Date: 12 April 2007
Completion Date: 31 December 2007
Project Status: 2004—2009 (original start date and anticipated completion date)

Introduction

Prior to European contact, the Straits Salish people, an ethnolinguistic group centered on present day Victoria in southwestern British Columbia, 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 (Figure 1). 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 British Columbia (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 British Columbia is a remarkable but largely untapped avenue for exploration into the social aspects of Straits Salish life. Building on the proven method and theory of this earlier work, I recently completed a detailed examination of the largest remaining burial cairn cemetery in British Columbia at the Department of National Defence Rocky Point property (Figure 2). Working with members of the Scia'new First Nation, I mapped and recorded almost 400 cairns in great detail using a geographical information system.

I hypothesize 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.

Figure 1. Example of burial cairns at Rocky Point.

The geographic layout of cairn sites in relation to each other and to the natural and cultural elements of the local landscape are informative regarding larger scale regional concepts of space and group identity.

Study Area and Methods

Ongoing data collection has been undertaken at a large cairn site (designated DbRv-3) in the vicinity of Edye Point at Rocky Point, as well as at other mortuary sites on that property and at Albert Head and Colwood. Baseline data, consisting of cairn locations only, were collected at Mary Hill before access to that property was restricted. Interpretation of the data was facilitated by a spatial analysis using a Geographical Information System (GIS).

In order for the intrasite spatial analysis of burial cairn sites to be successful, it was necessary to first inventory the properties with systematic pedestrian survey. A crew of three to five experienced archaeologists walked systematic transects with a 2-metre interval between surveyors, recording the location of each petroform feature with a Trimble back-mounted 4700 GPS and a TSC1 data collector. The spatial data were imported into a GIS (geographic information system).

For the analysis of individual cairns, a total of 18 analytical variables were collected, in addition to the taking of photographs, and the drawing of 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 vegetal matter, particularly from invasive species such as Scotch broom and gorse. Cairns were otherwise not altered 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 culture history perspective, this research generated a systematic and detailed survey of over 1400 hectares of land in Metchosin (and 20 km of shoreline), the largest systematic archaeological survey conducted in the Victoria area (Mathews 2006b). 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.

Analysis to date has identified six distinct types of features (Figure 3). Concurrently, a spatial analysis defined seven distinct areas within the site (Mathews 2006b). Analysis of the distribution of the six types of cairns throughout the seven different areas identified distinct patterns. This patterning indicates that certain types of cairns were restricted in terms of where they could be built. The distribution of burial cairns at Rocky Point likely may reflect the burial locality of separate households.

Discussion

The 2007 field season was abbreviated due to time necessary for the completion of doctoral coursework and comprehensive examinations. The 2008 field season will be the primary year in which field data will be collected. The aim of the research will continue to focus on gathering detailed information on individual cairn morphology from Rocky Point, Albert Head, and Colwood and using this information to spatially and statistically test associations between individual cairns and the spatial associations between cairn sites and the natural landscapes of DND properties, as well as at other non-DND properties throughout the Strait of Georgia and Puget Sound.

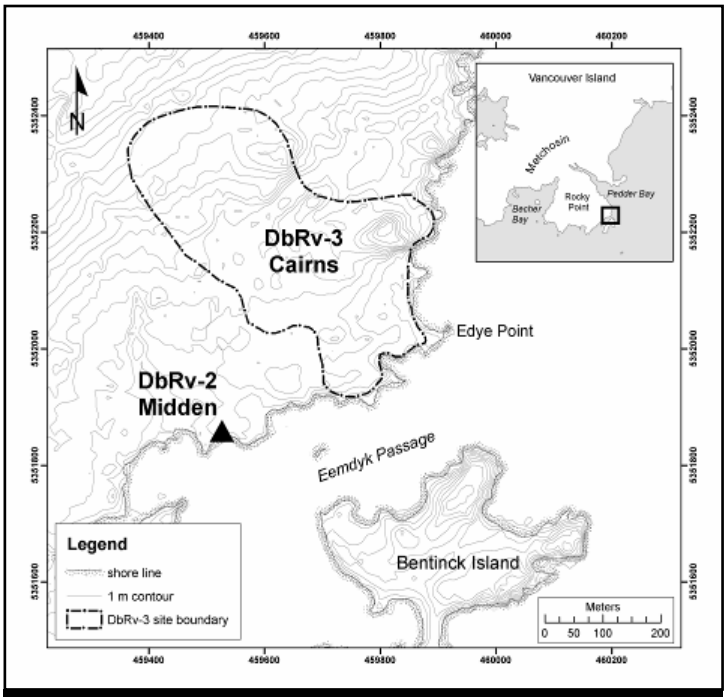

Figure 2. Location of DbRv-3, The Rocky Point cairn cemetery.

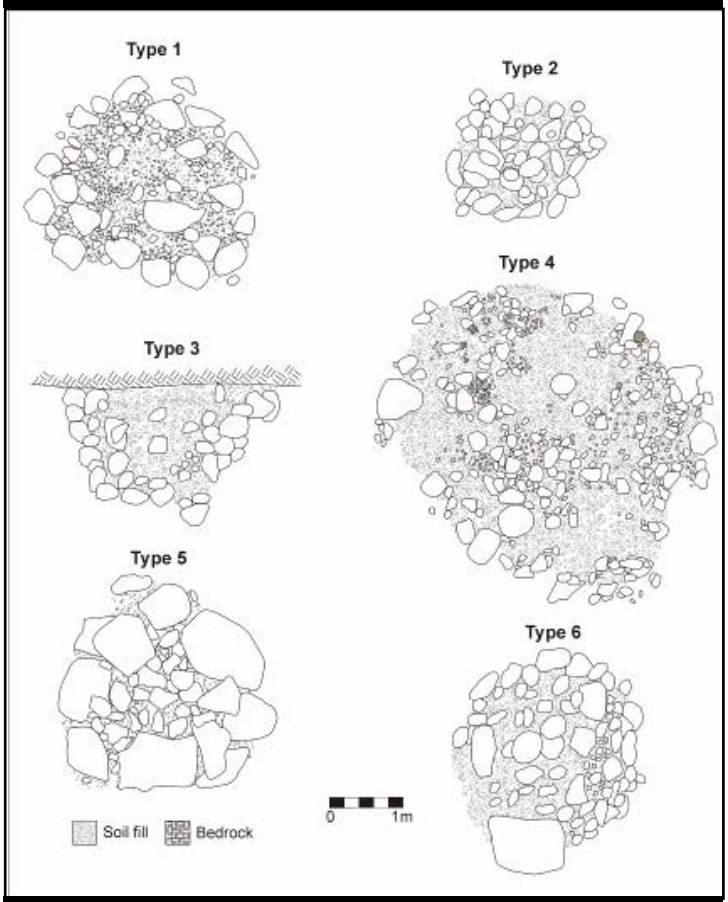

Figure 3. Cairn types at DbRv-3, Rocky Point.

Conclusions

I hypothesize that the use of mortuary space at multiple scales of interaction, from the village level to the region, is a snap-shot in time of Straits Salish social relationships — presenting an unparalleled opportunity for archaeologists to investigate, in unusually good detail, a pivotal time in this pre-contact society (Mathews 2006b). Burial cairns and the funerals during which they were built acted as 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 argue that burial cairns may have simultaneously provided a forum in which identity and inequality at the local kin or village-based level could be created, contested, and renegotiated. Being the largest and best-preserved burial cairn cemetery in British Columbia, the ongoing research at Rocky Point will form the theoretical and methodological stepping -off point from which a regional analysis can be approached. The regional analysis will focus on sites throughout the Strait of Georgia and Puget Sound.

The results of the doctoral dissertation resulting from this research, which I anticipate defending in 2010, will be the basis for a book and multiple articles on the burial cairns and mounds of the Strait of Georgia. This resulting data will be curated with the Environmental Sciences Advisory Committee, The University of Victoria Archives, and the Royal British Columbia Museum for access by future researchers and resource managers.

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Monitoring of the Oregon Spotted frog (*Rana pretiosa)* at Maintenance Detachment Aldergrove

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Start Date: 02 February 2007
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Project Status: 2005 - ongoing (original start date and anticipated completion date)

Introduction

R. pretiosa (the Oregon Spotted frog) is a Pacific Northwest species (Corkran & Thoms 1996). In B.C. today, it occurs in three sites in the extreme southwest corner of the province: namely Maintenance Detachment (MD) Aldergrove, Mountain Slough in Agassiz, and Maria Slough adjacent to Seabird Island (Haycock 2000a).

R. pretiosa was designated as "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 of its reduced to only three isolated sites, each containing very low numbers of individuals and because the species has been adversely affected by habitat loss due to urban expansion, agriculture, exotic competitors, and exotic vegetation (COSEWIC 2000).

The MD Aldergrove population, particularly, has shown a steady annual decline from 90 egg masses in 1997 to 33 egg masses in 2001 (Haycock 2001). The goals of the study are to determine the number of egg masses oviposited at MD Aldergrove and their embryonic survivorship; to increase the breeding population by captive rearing programs; and to determine the survivorship of adults previously reared at the breeding facilities and released at MD Aldergrove.

Study Area and Methods

Study Site

The research was conducted at the Department of National Defense's MD Aldergrove facility (latitude 49° 4' and longitude 122° 29'). The MD Aldergrove study site consisted of three sub- sites; these were Pipeline, Frog Restoration Site (FRS), and 264th. Pipeline and 264th are connected and are 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

No embryonic survivorship study was done during 2007.

Captive rearing

No egg masses were collected and no captive rearing was done.

Oregon spotted frog trapping

Forty collapsible minnow traps were put out between 20 March and 11 May 2007 at the FRS at known Oregon Spotted Frog oviposition sites. Traps were put out on Tuesday mornings and checked on Wednesday, Thursday, and Friday mornings. Traps were removed from the wetland after being checked on Friday mornings. Traps were moved to a new location within the FRS every week. A GPS reading was taken at each trap and traps were put out in numerical order to ensure all traps were checked at each visit.

If an amphibian was caught, the species and sex (if possible) were recorded and mass, snout-vent-length, and total lengths (for salamanders only) were recorded. To avoid salamanders from drying out, they were placed in a Ziploc bag with water while measurements were taken. Disposable gloves were worn at all times.

A Stowaway® "tidbit" thermometer was placed in the water where amphibian trapping was done. Water temperature was recorded every 60 minutes between 24 April and 11 May 2007.

Results

Embryonic survivorship and captive rearing

Surveys for egg masses were conducted at the three sub -sites during March and April 2007. No egg masses were found and therefore no embryonic survivorship was done.

Oregon spotted frog trapping

As indicated in Table 1, six amphibian species were caught during trapping, including *Pseudacris regilla* (Pacific Tree Frog), *Ambystoma gracile* (North-western Salamander), *Taricha granulosa* (Rough-skinned Newt), *Lithobates catesbeianus* (Bullfrog), *Rana aurora* (Red-legged Frog) and *R. pretiosa* (Oregon spotted frog). The one Oregon Spotted Frog that was captured was a male, weighing 9.5 g and the snout-vent-length (SVL) was 47.05 mm. It had green elastomer dye marking on the left foot. The North-western Salamander was the most common species caught.

Table 1. Number of amphibians trapped at MD Aldergrove during April and May 2007.

	# per species							
Date	*Pseudacris regilla*	*Ambystoma gracile*	*Taricha granulosa*	*Lithobates catesbeianus*	*Rana aurora*	*Rana pretiosa*	total per trap night	# per trap
20-Mar-07	8	5	9	1	0	1	24	0.83
21-Mar-07	6	3	0	0	0	0	9	0.31
22-Mar-07	2	5	2	0	0	0	9	0.31
25-Apr-07	0	19	1	2	0	0	22	0.59
26-Apr-07	0	8	0	5	0	0	13	0.34
27-Apr-07	0	6	1	1	0	0	8	0.20
2-May-07	1	8	0	0	0	0	9	0.23
3-May-07	0	5	1	1	0	0	7	0.18
4-May-07	1	7	0	2	0	0	10	0.25
9-May-07	0	8	2	2	1	0	13	0.33
10-May-07	0	14	1	2	0	0	17	0.43
11-May-07	1	4	0	3	1	0	9	0.23
Total	**19**	**92**	**17**	**19**	**2**	**1**	**150**	

Discussion

R. pretiosa usually breeds in February and March, soon after snow melt (Licht 1971). The lethal thermal limits for young *R. pretiosa* embryos are approximately less than 6°C and greater than 28°C (Licht, 1971). During this study, temperatures were within the temperature tolerance limits for *R. pretiosa.*

During 2006, Oregon Spotted frogs captive reared at the Greater Vancouver Zoo, were marked with green elastomer dye on the left foot (Hawkes 2006). The Oregon Spotted frog captured was therefore an individual reared at the Greater Vancouver Zoo during 2006 and released in the fall of 2006.

Conclusion

No Oregon Spotted Frog egg masses were located during 2007 and only one individual was caught during the amphibian trapping. However, Oregon Spotted Frogs take two to three years to breed and individuals that were released from the captive rearing facilities during 2005 and 2006 can still breed in future years. Surveys will therefore continue to determine whether Oregon Spotted Frogs are still present at MD Aldergrove.

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Garry Oak Ecosystem Dynamics: Controls on Overstory Recruitment

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Project Status: 2005 - 2008 (original start date and anticipated completion date)

Introduction

Field investigations undertaken in 2003 and 2004 (Gedalof *et al*. 2004, 2006) throughout southern Vancouver Island and the Gulf Islands revealed an alarming trend among a range of Garry oak (*Quercus garryana*) 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 overstorey. At Rocky Point, 678 seedlings were counted within the sample area, but only three saplings were found. In contrast, Douglas-fir (*Pseudotsuga menziesii*) appears to be regenerating very successfully: although only 53 Douglas-fir seedlings were found, 41 saplings were also found – suggesting that survival rates are generally high. Additionally, overstorey recruitment of Douglas-fir has been fairly continuous over the last century. Preliminary results from the Nature Conservancy of Canada property at Elkington, near Duncan, and the B.C. 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. 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 Ammunition Depot Rocky Point. The southeast corner of the sampling area is located at N 48° 19' 28.5" by W 123° 32' 45.3" (horizontal accuracy ± 5 m).

The site is generally flat, with only a few relatively small undulations (<1 m) in topography. The understorey vegetation is composed primarily of introduced grasses, with coverage of approximately 30 percent orchardgrass (*Dactylis glomerata*), 30 percent colonial bentgrass (*Agrostis capillaries*), 20 percent sweet vernal grass (*Anthoxanthum odoratum*), and 20 percent bracken fern (*Pteridium aquilinum*). The overstorey is composed primarily of Garry oak, with some Douglas-fir, grand fir (*Abies grandis*), arbutus (*Arbutus menziesii*), and lodgepole pine (*Pinus contorta* var. contorta) in the vicinity. Canopy closure is variable, but is less than 30 percent in the area where experimental treatments were applied.

One hundred seedlings were identified, and randomly assigned to a treatment type. To minimize biases due to seedling age, only seedlings with few leaves, and no obvious signs of resprouting were considered. Two treatment types, as well as their interaction, were targeted in this analysis. In order to assess the effect of browsing on seedling success, small circular exclosures were established around 20 seedlings. The exclosures are composed of wire fencing supported by re-bar, and are approximately 50 cm in diameter and 1 m in height. To assess the effect of competition with grasses, a small square of landscape cloth was placed around 20 seedlings to reduce competition for resources. To assess interactive effects, 20 seedlings had both treatments applied (Figure 1a and 1b). Forty control seedlings were identified and marked for future identification. Seedlings were remeasured in August 2006.

Results

Seedling mortality has been high across all treatment types (32 percent after two years), with the lowest overall mortality occurring in the control group (28 percent), and the highest mortality in seedlings with landscape cloth (45 percent) (Figure 2). Mortality in the exclosure group was 30 percent, and in the interaction group was 30 percent. A difference of proportions test (Zar 1999) indicates that the only statistically significant effect is that mortality was higher than average among seedlings with landscaping cloth (regardless of whether an exclosure was present or not). These results differ from the 2006 results in two important fashions (Table 1): First, mortality across all treatment types was lower.

This observation may be due to the fact that these seedlings are one year older, and are therefore larger and presumably have a deeper, more extensive root system buffering them against adverse effects. Alternatively, it may be due to the anomalous wet weather conditions during summer, 2007. Secondly, seedling mortality from 2006 to 2007 was highest among the exclosure treatment. The cause for this change is unclear, although a surprising number of small rodent holes were visible within the exclosures, suggesting that these animals may be using the exclosures for protection from their own predators and are having an adverse effect on the seedlings.

Figure 1a. Landscaping cloth used to reduce competition with grasses effect.

Figure 1b. Landscaping cloth and ungulate exclosure used to test for an interaction effect.

Regardless of the cause, the net effect has been an equalizing of the differences between treatment types in terms of mortality.

Table 1. Proportional seedling mortality.

Treatment	N	Mortality (2006)	Mortality (2007)	Total Mortality
Control	40	0.20	0.09	0.28
Mulch	20	0.35	0.15	0.45
Exclosure	20	0.10	0.22	0.30
Both	20	0.35	-0.08	0.30
All Mulch	40	0.35	0.04	0.38
All Excl.	40	0.23	0.07	0.30
All	100	0.24	0.11	0.32

Discussion

The results to date suggest that herbivory by large ungulates plays a relatively minor role in reducing seedling survival rates for Garry oak. Competition with exotic vegetation for water or light also 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, including the effects of herbivory from all sources, may be sufficient to make regeneration events extremely rare. This problem may have been exacerbated in recent decades by the introduction of livestock to many Garry oak meadows (e.g., cattle, horses, goats, and 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. (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 disrupt 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 non-invaded 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 steps in these analyses involves the comparison of invaded and non-invaded Garry oak associated ecosystems with respect to their seedling survival, and the comparison of seedling survival rates in soils with intact and disrupted mycorrhizal communities. Because the ideal method of modifying these systems involves the application of herbicides and fungicides, since these treatments do not affect native vegetation or disturb the soil, these experiments can not be undertaken at Rocky Point due to current DND policies. 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. While the effect of these actions on seedling survival rates is not yet known, reasonably intact native understorey communities have been restored.

Two experiments have been undertaken to date, though only preliminary results are available. In the first experiment, soil moisture was monitored through one growing season in invaded and non-invaded oak associated ecosystems. It appears that exotic plant communities exploit soil moisture more efficiently and later in the summer than native plant communities do, bringing them into more direct competition with oak seedlings. In the second experiment, native and exotic oak associates were seeded in individual pots in a growth chamber, and their weekly soil moisture use was determined using a lysimeter. This experiment showed that most exotic plant species emerge earlier, and remain metabolically active longer than most native oak associates. They are also able to produce more than one seed crop per year when water is not a limiting factor. Future work will examine the growth of oak seedlings in the presence and absence of ectomycorrhizal fungi, and the effect of exotic plant species on ectomycorrhizal abundance.

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.

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P114-07: Measuring Garry oak seedling leaves at Rocky Point.

Local Versus Regional Determinants of Community Composition in Garry Oak Ecosystems

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Location(s): Rocky Point, CFMETR
Start Date: 11 May 2007
Completion Date: 28 May 2007
Project Status: 2006 – 2010 (original start date and anticipated completion date)

Introduction

This study is a biogeographic comparison of "mainland" (i.e., Vancouver Island) versus island patches of the Garry Oak Ecosystem (GOE). Island biogeography theory (e.g. MacArthur and Wilson 1967; Whittaker and Fernandez-Pelacios 2007) contains specific predictions regarding the number and characteristics of organisms inhabiting islands versus contiguous swaths of mainland habitat. Island biogeography theory has also been used to develop predictions regarding communities inhabiting fragmented habitats on mainlands, treating patches as pseudo-islands. However, due to a paucity of appropriate study areas, very few analyses have directly compared true islands with habitat patches of the same ecosystem type. A combination of geography and recent habitat fragmentation makes the GOE of southern Vancouver Island an ideal area for such a comparison.

As is well-known among those working in GOE patches, there are many general and patch-specific threats to the ecosystem. A clear and quantitative understanding of the drivers of species composition in GOE patches, in terms of cover and identity of native versus introduced species, is necessary to guide stewardship efforts. Such an understanding would help to preserve patches that are relatively intact, and could guide remedial action on degraded patches.

A comparison of islands and mainland patches (of which the latter have significantly higher dominance and diversity of introduced species) will help to understand drivers of community composition.

This study compares the floristic composition of GOE patches on islands versus Vancouver Island in order to address the theoretical and practical issues outlined above. The work on DND sites forms a small but necessary part of this study, which involves surveys of GOE patches from the southern San Juan Islands (and the southern tip of Vancouver Island) north to the Parksville area.

Study Area and Methods

In year one (2006), 1-m^2 plots were established at a consistent aerial coverage on GOE patches at CFMETR. Plots were located at 100m, 50m, or 25m nodal points using a Global Positioning System (GPS). Initial surveys of flora were done in the plots and the following environmental measurements taken: slope, aspect, canopy cover, and soil depth.

In year two (2007) some plots at CFMETR were re-visited, and new plots in different locations (including additional plots at CFMETR and plots at Rocky Point) were established. Plots were surveyed as above; plot locations are indicated in Figures 1 and 2. Small (approximately 10 g) soil samples were collected for nutrient analyses, to be done at a future date.

In addition, full surveys of vascular plants were conducted for Garry oak meadows at Wallace Point, Wallace Point Island, and Nanoose Peninsula. These surveys were conducted by walking transects 5 -10 m apart along the lengths of the meadows. For both full and plot-based surveys, plants that could not be identified *in situ* were collected, unless there was a possiblity that they could be federally or provincially listed species.

Results

Full surveys at CFMETR patches found that approximately 40% of the flora of each patch was composed of introduced species. This percentage corresponds broadly to other study sites that have seen some anthropogenic influence. Island sites (e.g. in the Winchelsea Group and the San Juan Islands) tend to have lower numbers and dominance of introduced species. Among the native species at CFMETR, a single species at risk (*Allium geyerii*; BC Red List) was found on Wallace Point Island.

Plot-level surveys at CFMETR reflected similar patterns. The average percent cover of introduced species in plots on DND sites (24%) is comparable to that of "mainland" (Vancouver Island) sites across the study area (25%). (Note that the remainder of the percent cover was made up of duff, rock, etc.) The average percent cover of native species in plots on DND sites (26%) was somewhat lower than that on mainland sites across the study area (35%). The pattern of percent cover on Wallace Point Island (31% introduced; 26% native) reflects that of mainland sites, and not island sites, which across the study area showed higher percent cover of native species (>50% on average).

Discussion

Despite putative protection from human disturbance, DND sites did not show a greater percent cover or richness of native species than did sites with less stringent protection. This pattern is interesting from a theoretical and practical standpoint: it indicates that present human disturbance may be less important in driving species invasion than other factors.

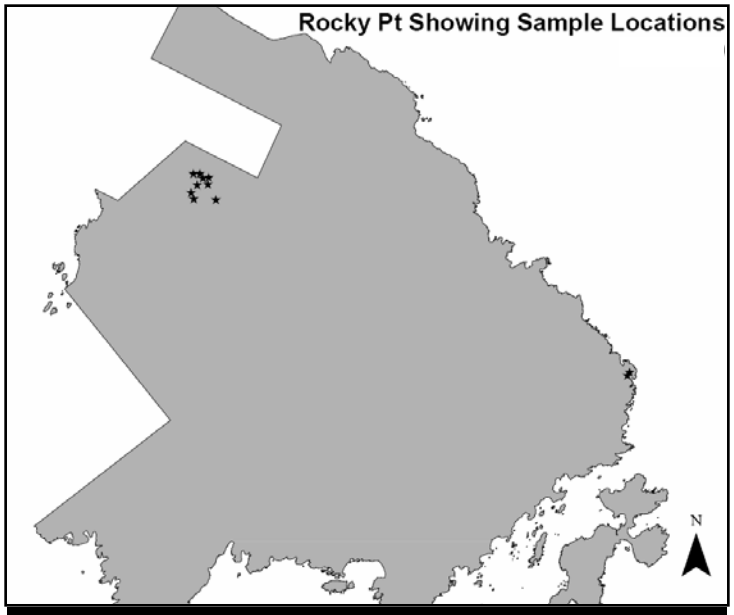

Figure 1. Map of Rocky Point showing 2007 sample locations.

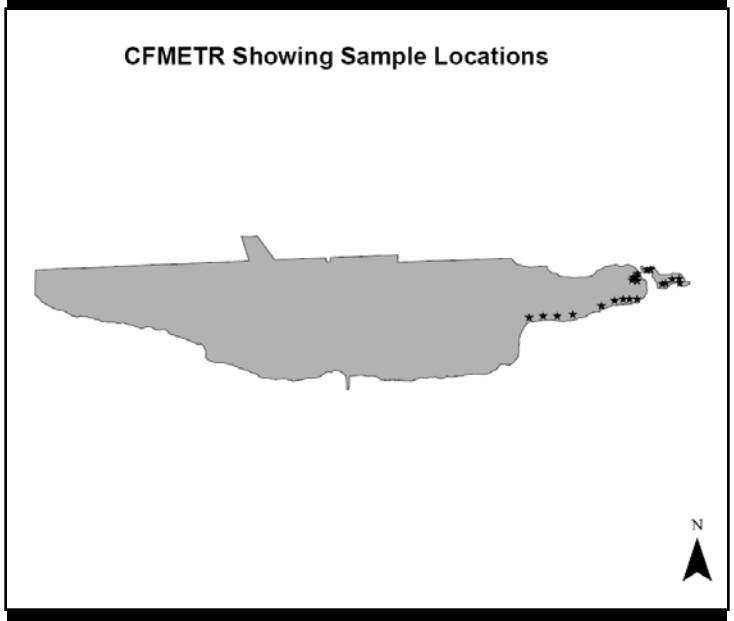

Figure 2. Map of CFMETR showing 2007 sample locations.

Some of these factors include the following: past land use history; (Nanoose Peninsula was apparently once farmed); herbivory by deer (Nanoose Peninsula is obviously heavily browsed); and status as "mainland" sites (islands are obviously more protected from invasive propagules, and Wallace Point Island is joined to the mainland at low tide).

Current land use may also be a factor; evidence of recent campsites was found on Wallace Point Island.

Lack of protection from invasive propagules does not mean that DND sites are not useful for the maintenance of the endangered GOE. A number of rare species apparently occur on the CFMETR property, and on another site (Rocky Point) many rare species have been found by other researchers. As areas that are currently isolated from heavy human use, these sites represent important baselines for the study of processes affecting GOE plant communities.

Conclusions

Too few DND sites exist to point to statistically significant patterns with respect to other GOE sites. However, DND sites are very useful for this broader study. Future plans include additional surveys in 2008 (possibly on DND sites), followed by data analysis and publication of results. Publications will examine the following issues: climatic influences on ecosystem components; island/mainland biogeographic comparisons; a comparison of spatial and environmental influences at different scales in this ecosystem; and models predicting species occurrences to assist remedial efforts. These publications will form the bulk of my Ph.D. thesis. Raw data and detailed statistics will be contained in thesis appendices.

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MacArthur, R.H., and Wilson, E.O. 1967. The theory of island biogeography. Princeton University Press., Princeton, NJ.

Whittaker, R.J., and Fernandez-Pelacios, J.M. 2007. Island biogeography – ecology, evolution, and conservation, 2nd ed. Oxford University Press. Oxford, UK.

P120-07: View of Wallace Point Island from Wallace Point at CFMETR.

Investigation for the Presence of the Rigid Apple Moss on DND properties

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Permit #: P123-07
Location(s): CFMETR, Rocky Point
Start Date: 07 June 2007
Completion Date: 31 December 2007
Project Status: 2007 - 2009 (original start date and anticipated completion date)

Introduction

The largest known Canadian populations of the rigid apple moss (*Bartramia stricta)* are found on DND properties near Victoria and Nanaimo, British Columbia. The intention of the 2007 work was to inventory previously unsurveyed areas on DND properties for this species in order to more fully understand its distribution on these properties. At Rocky Point, I proposed to search for the moss a few areas that had not been investigated as a follow-up to an initial survey in March 2007 (McIntosh 2007). I also proposed to survey a few recently discovered populations at CFMETR near Nanoose Bay (Fairbarns 2007). I also planned to measure some population attributes for the rigid apple moss such as size of patches and number of fruiting bodies (sporophytes). Surveys like these add significant data to our understanding of this rare moss.

Study Area and Methods

At Rocky Point, accessible outcrop communities on the eastern side of Rocky Point were to be surveyed for appropriate habitats for the rigid apple-moss. If populations were found, their locations were to be recorded using a GPS unit and photographs taken of the patches and habitat. Detailed habitat and population notes were to have been completed. At CFMETR, new populations of this moss were to be surveyed.

Results

Because of time constraints, surveys of the Rocky Point property could not be completed in 2007 but will be in 2008 (a new ESAC permit has been issued for this work).

Discussion

Although this study was not completed, an initial search for the rigid apple moss on unsurveyed portions of Rocky Point was done in March 2007 (McIntosh 2007). The moss was not found at that time, but it was discovered that there may be more appropriate habitat for it in other areas of Rocky Point (thus an application was made to re-visit Rocky Point). Also, I assisted Matt Fairbarns in a rare plant project in early 2007 at CFMETR. Part of his project was to investigate the distribution of the rigid apple moss (Fairbarns 2007).

Conclusions

Future plans: The survey of the Rocky Point property will be completed in 2008. An attempt will be also be made to visit other potential sites for this moss including a reported site on Lasqueti Island as well as a small outcrop area on private land outside DND property near Rocky Point (the rigid apple moss had been reported from there as well but is now listed as extirpated from the site).

References

Fairbarns, M. 2007. Survey for *Meconella oregana* (white meconella), Canadian Forces Maritime Experimental and Testing Ranges (CFMETR), April-June 2007. Report submitted to Natural Resources Canada, Pacific Forestry Centre.

McIntosh, T. T. 2007. Report on a search for the rigid apple moss on DND Property, Rocky Point, Vancouver Island, March 28 - 29, 2007. Contract report prepared for the Canadian Forest Service, Victoria, B.C.

Year-round Microclimates Experienced by Butterfly Larvae in Garry Oak Ecosystems

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Start Date: 23 July 2007
Completion Date: 31 December 2007
Project Status: 2007—ongoing (original start date and anticipated completion date)

Introduction

This project addresses the impacts of overwintering conditions and climate change on the biology of species at the edge of their geographic range. It is complementary to, and conducted in consultation with, Dr. Jessica Hellmann at University of Notre Dame., Indiana. The overall goals of the project are to determine the effects of microclimatic conditions on the energy utilization, survival, and subsequent reproductive potential of overwintering individuals of the butterflies *Errynis propertius* and *Papilio zelicaon*. Physiological work is being conducted in the laboratory in London, Ontario, using larvae collected for other purposes by Dr. Hellmann's group, and these physiological data will be interpreted in light of long-term microclimate temperature recordings. The primary questions to be addressed using microclimate temperature data collected from Rocky Point and other locations on Vancouver Island are as follows:

1. to what extent is reproductive output determined by energy consumption during the overwintering period;
2. what is the relative importance of temperature conditions in fall and winter in determining energy reserves remaining for spring reproduction in these species; and
3. is there a risk of mortality for these species due to low temperature exposures of short or long duration?

This information will be interpreted in light of other microclimate stations (to be established in Oregon and elsewhere on Vancouver Island) and physiological information in order to address the main question of the study. That question is: do overwintering conditions, whether through mortality or energy expenditure, determine the northern geographic limit for these species?

Overall, this study will provide important information for ongoing studies on the flora and fauna of the Garry oak ecosystem, provide information for future conservation and management of the butterfly species, and it will address a number of knowledge gaps concerning the effects of changing winter conditions on insect population biology.

This research is supported by the National Science and Engineering Research Council of Canada (NSERC), the Canadian Foundation for Innovation (CFI), the Ontario Research Foundation, and The University of Western Ontario.

Study Area and Methods

Microclimate temperature recording stations have been established in Garry oak meadows at Rocky Point in close proximity to transects used for on-the-wing butterfly surveys carried out by Dr Hellmann.

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Each microclimate station consists of four iButton DS1921 or DS1922 dataloggers, which make time-stamped temperature recordings at one- hour intervals. The data loggers at each station were deployed in two pairs – two were affixed to a branch in the canopy at 1.8 to 2 m height (representative of 'leaf temperature', experienced by growing caterpillars and by caterpillars overwintering in leaf rolls that do not drop to the ground), while two were anchored to tent pegs and placed in the leaf litter directly below the canopy data loggers to provide temperature measurements representative of overwintering habitat in the leaf litter. This configuration was also used at two other sites in Garry oak meadows on Vancouver Island and at two sites in Oregon. The level of replication within and between locations was necessary to allow a determination of the variability of temperature conditions both among and within sites.

Overall, this study will provide important information for ongoing studies on the flora and fauna of the Garry oak ecosystem, provide information for future conservation and management of the butterfly species, and it will address a number of knowledge gaps concerning the effects of changing winter conditions on insect population biology.

This research is supported by the National Science and Engineering Research Council of Canada (NSERC), the Canadian Foundation for Innovation (CFI), the Ontario Research Foundation, and The University of Western Ontario.

Data download and maintenance was achieved by downloading the dataloggers on-site using a laptop computer.

Results

Caroline Williams and Kirsten Prior visited Rocky Point on 22 October 2007, deploying dataloggers at four stations. We do not anticipate a return visit to download data until 2008.

Discussion

Because this project is in its early stages, we do not have any data to discuss.

Conclusions

We have successfully established microclimate temperature monitoring sites at Rocky Point, as well as at two other Vancouver Island locations and two locations in Oregon. As an adjunct to this project, we have taken delivery of larvae and pupae of the study species, and are preparing to begin a respirometry study of metabolism and metabolic rate, which will be completed in the early part of 2008.

Future plans include the download and maintenance of the data loggers (with the hope that this will become a long-term monitoring project), and the expansion of physiological studies to include cold and heat tolerance and performance of adults emerging from larvae or pupae reared under climatic conditions which simulate climate change scenarios.

Taxonomy and Distribution of a Mushroom, *Tubaria punicea*, on Southern Vancouver Island

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Location(s): Albert Head, Colwood, Heals Rifle Range, Rocky Point
Start Date: March 2006
Completion Date: December 2006
Project Status: 2005—ongoing (original start date and anticipated completion date)

Introduction

In December 2001, while working on a COSEWIC update on Macoun's meadowfoam (*Limnanthes macounii*), we found a peculiar, deep red mushroom in a dying arbutus (*Arbutus menziesii*) stump. We identified this fungus as *Naucoria vinicolor*. We consulted our find with mycologists associated with the Pacific Northwest Key Council (PNKC) and none of them had ever seen this species. We kept looking for this species in winters of 2002 through 2004 without any luck.

In December 2005, we found this fungus again, this time on a private property on Skirt Mountain in Victoria that we were assessing for an environmental report. There were three arbutus trees that had this fungus growing on their base. We notified members of the South Vancouver Island Mycological Society about our find and asked them for their help to find more sites with this peculiar fungus. Dr. Jim Ginns, retired mycologist from the main Canada mycological herbarium in Ottawa, forwarded my appeal to his colleagues, some of whom were just working on a paper that dealt with this group of fungi. For this particular fungus, they have only two old collections and they obviously needed more material for their study.

Based on the requests from P. Brandon Matheny and his colleagues, we obtained an ESAC permit to search for this fungus on DND properties.

Study Area and Methods

From our previous mycological surveys at Rocky Point (1) and consulting work at Heals Rifle Range, as well as from other floristic works on DND properties, we concentrated our search to the DND properties on southern Vancouver Island where we knew of extensive stands of arbutus of varying ages. Knowing the ecology and phenology of this fungus, we searched for it at eroded bases of *Arbutus menziesii* trees. We timed our search for late December and early January.

Results

In winter 2005/2006 we found eight sites with this fungus, five of which were on DND properties. We collected enough material from a relatively wide area (Cobble Hill to Rocky Point) that enabled our colleagues to study the morphology of this fungus. One of us (Oldriska Ceska) has been invited to be a co-author of a paper that would clarify the taxonomy of this group of mushrooms. The authors of the paper (2) concluded that the fungus we found should be called *Tubaria punicea* (A.H. Sm. & Hesler) Ammirati, Matheny, et P.-A. Moreau, and that taxon is different from what used to be called *Naucoria vinicolor* (our original identification). Our material collected within this permit was crucial to this taxonomical decision, since Brandon Matheny and his collaborators had only two old collections of this species that were not suitable for their DNA analyses.

Our surveys continued in the following winter of 2006/2007. Several volunteers took part in those surveys for new sites, and they found eight new sites and extended the known distribution of this fungus from Rocky Point in Metchosin to Little Mountain near Parksville. All these searches were either on private properties, parks, or Crown land. We now know this fungus from more non-DND sites than sites on DND properties. The results of those surveys are in Table 1.

For the phenological observations we involved a number of volunteers who visited the *Tubaria punicea* sites in Metchosin, Mill Hill Regional Park, or on Observatory Hill. *Tubaria punicea* was first seen fruiting on October 24, 2006 (Mill Hill), and fruiting continued until January 6, 2007 (Metchosin). There was a second flush of this fungus at the end of March (March 25, 2007 in Langford and March 28, 2007 on Observatory Hill). This second fruiting was suspected to be triggered by the abnormally high precipitations in March.

The investigation of arbutus trees on southern Vancouver Island yielded 13 sites with *Tubaria punicea*, five of which were on DND properties (Table 1). A total of 40 arbutus trees were observed to have *T. punicea* and GPS coordinates were recorded.

Discussion

Taxonomical studies done on the collections from the DND properties on southern Vancouver Island showed that the fungus called *Pholiota punicea* should be placed into the genus *Tubaria*. Originally, this fungus was known from very few collections and the material available for the study before our DND survey cast some doubts about the distinction between this fungus that is specific to arbutus and the more ubiquitous *Naucoria vinicolor*. The material collected from the DND properties played a significant role in solving this taxonomical puzzle.

The DND properties, due to their variety of habitats that include old growth forests and late successional stages, are important treasure-troves of many rare and uncommon organisms. The DND areas are ideal as a source of study material for broad-scale studies.

Because of the access restrictions, however, there are many difficulties in planning long-term monitoring studies that require repeated visits of the sites.

In our case, we made an effort to find our study object outside DND properties, and with the help of several research volunteers we succeeded in finding this fungus on several sites outside DND lands.

In spite of the fact that we added quite a few sites (Table 1) to those known from the DND lands, *Tubaria punicea* is still rare. The Committee On the Status of Endangered Wildlife In Canada (COSEWIC) that oversees the listing of rare organisms still has not listed a single fungus as rare in Canada. *Tubaria punicea* would be an ideal species for such a listing; however, 'official' rare status for this species is unlikely unless COSEWIC changes the criteria for the listing that apply for animals and vascular plants, mosses and lichens, as they are not suitable for fungi.

References

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2. Matheny, P. Brandon, Else C. Vellinga, Neale L. Bougher, Oldriska Ceska, Pierre-Arthur Moreau, Maria Alice Neves, Joseph F. Ammirati. 2007. *Taxonomy of displaced species of* Tubaria. *Mycologia* 99(4): 569-585.

Table 1. Sites with *Arbutus menziesii* trees on southern Vancouver Island that yielded the *Tubaria punicea*: (DND properties are in **bold** face font.)

Site	2005 - 2006	2006 - 2007	TOTAL
Albert Head	**1 tree**	**1 tree**	**1 tree**
Cobble Hill	2 trees	9 trees	9 trees
Heals Rifle Range	**2 trees**	**5 trees**	**5 trees**
Langford Glenshire Drive	-	3 trees	3 trees
Little Mtn. Near Parks-ville	-	1 tree	1 tree
Mary Hill	**2 trees**	**??**	**2 trees**
Metchosin Private Property 1	-	3 trees	3 trees
Metchosin Private Property 2	-	4 trees	4 trees
Mill Hill CRD Park	-	1 tree	1 tree
Miniskirt Mtn	2 trees	-	2 trees
Observatory Hill	2 trees	7 trees	7 trees
Rocky Point	**1 tree**	**2 trees**	**2 trees**
Colwood	**2 trees**	**3 trees**	**3 trees**

Permit P119-06: *Tubaria punicea* are associated with *Arbutus menziesii* trees.

OUTLOOK

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 2008, 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 and other interested parties.

ACKNOWLEDGEMENTS

Maritime Forces Pacific, CFB Esquimalt and ESAC would like to thank:

- All 2007 ESAC permit holders for their cooperation and contribution to the knowledge of flora, fauna, and ecology on CFB Esquimalt properties;
- Special thanks to Michael Dunn, Canadian Wildlife Service alternate representative, for your contributions to ESAC;
- The Canadian Forest Service – Pacific Forestry Centre for coordinating and hosting the annual workshop;
- All of the individuals who presented at and/or attended the ESAC annual workshop in February 2008. Your attendance and participation are valued.

Paintbrush flowering at Ballenas Island.

LIST OF ENVIRONMENTAL REPORTS FOR 2006-2007

Reports in 2007

Biolinx Environmental Research Ltd. December 2007. Surveys for the blue-grey taildropper sulg (*Prophysaon coeruleum*) on federal lands on southern Vancouver Island, BC, fall 2007. Biolinx Environmental Research Ltd., Sidney, BC. 21p + appendices.

Englestoft, C. March 2007. Sharp-tailed snake inventory and populations monitoring on DND, NRC, and Parks Canada properties on southern Vancouver Island and southern Gulf Islands. Alula Biological Consulting. Victoria, B.C. 63p.

Fairbarns, M. March 2007. Demographic and phenological patterns of *Microseris bigelovii* (coast microseris): interim report March 2007. Aruncus Consulting. Victoria, B.C. 12p.

Fairbarns, M. March 2007. Population restoration studies of plant species at risk: interim report March 2007. Aruncus Consulting. Victoria, B.C. 13p.

Formation Risk Management Branch - CFB Esquimalt. Maritime Forces Pacific State of the Environment Annual Report. 2006/07. Victoria, B.C. 30p.

Lilley, P.L. 2007. Determinants of native and exotic plant species diversity and composition in remnant oak savannas on southeastern Vancouver Island. M.Sc. Thesis. University of British Columbia, Vancouver, British Columbia, Canada. 86p + appendices.

McIntosh, T. March 2007. Report on a search for the rigid apple moss on DND property, Rocky Point, Vancouver Island. Biospherics Environmental Inc. Vancouver, B.C. 14p + appendices.

Robinson, A. and N. Kroeker. March 2007. Background information for a five-year vegetation management plan for invasive shrub species on DND Properties, CFB Esquimalt, Victoria, BC. Natural Resources Canada, Canadian Forest Service. Victoria, B.C. 32p + appendices.

Robinson, A. and A. Schiller. March 2007. A five-year vegetation management plan for invasive shrub species on DND Properties, CFB Esquimalt, Victoria, BC. Natural Resources Canada, Canadian Forest Service. Victoria, B.C. 21p + appendices.

Yazvenko, S. September 2007. Survey for phantom orchid at Heals Rifle Range, Saanich Peninsula, BC. LGL Limited Environmental Research Associates. Sidney, BC. Report submitted to Natural Resources Canada, Pacific Forestry Centre. 19p.

Zakharov, E. V., J. J. Hellmann, and J. Romero-Severson. 2007. Microsatellite loci in the Propertius duskywing, *Erynnis propertius* (Lepidoptera: Hesperiidae), and related species. Molecular Ecology Notes 7: 266-268.

Zakharov, E. V., and J. J. Hellmann. 2007. Characterization of 17 polymorphic microsatellite loci in the Anise swallowtail, *Papilio zelicaon* (Lepidoptera: Papilionidae), and their amplification in related species. Molecular Ecology Notes 7: 144-146.

Reports in 2006

Byrne, L. March 2006. Adaptive management of species at risk in the Garry oak ecosystem: Interim Report 2005-06. Natural Resources Canada, Canadian Forest Service. Victoria, B.C. 30p + appendices.

Englestoft, C. March 2006. Sharp-tailed snake inventory and habitat use assessment on federal lands on southern Vancouver Island and southern Gulf Islands. Alula Biological Consulting. Victoria, B.C. 45p.

Fairbarns, M. March 2006. Demographic and phenological patterns of *Microseris bigelovii* (coast microseris): interim report 2006. Aruncus Consulting. Victoria, B.C. 12p.

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Fairbarns, M. March 2006. Survey for species at risk on Department of National Defence lands on Vancouver Island: Work Point (Golf Hill), Mary Hill, Albert Head, CFMETR, South Ballenas Island. Aruncus Consulting. Victoria, B.C. 18p.

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Gedalof, Z, M. Pellatt and D.J. Smith. 2006. From prairie to forest: three centuries of environmental change at Rocky Point, Vancouver Island, British Columbia. Northwest Science 80(1): 34-46.

Matheny, P.B., E.C. Vellinga, N.L. Bougher, O. Ceska, P. Moreau, M.A. Neves, J.F. Ammirati. 2007. Taxonomy of displaced species of *Tubaria*. Mycologia 99(4): 569-585.

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Mathews, D. 2006. Ancient cities of the dead revisited: early burial cairn investigation in Victoria. The Midden 38 (1): 14-20.

Robinson, A. March 2006. Preparing for interface fires: forest management recommendations for CFB Esquimalt. Natural Resources Canada, Canadian Forest Service. Victoria, B.C. 23p + appendix.

Robinson, A. and N. Kroeker. March 2006. A five-year vegetation management plan for invasive shrub species on DND Properties, CFB Esquimalt, Victoria, BC. Natural Resources Canada, Canadian Forest Service. Victoria, B.C. 30p + appendices.

Shaben, J. October 2006. Scotch broom (*Cytisus scoparius*) and soil nitrogen: ecological implications. M.Sc. Thesis, University of British Columbia, Vancouver, BC. 84p + appendices.

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