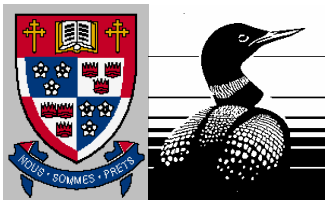
# ANNUAL REPORT of the
# CENTRE FOR WILDLIFE ECOLOGY

## 2006-2007


**Department of Biological Sciences**
**Simon Fraser University**

**http://www.sfu.ca/biology/wildberg/index.html**

**Dr. Ron Ydenberg, Director**

# TABLE OF CONTENTS

**I. HISTORY ..... 3**
**II. MISSION STATEMENT ..... 3**
**III. PERSONNEL ..... 4**
A. RESEARCH TEAM ..... 4
1. Faculty and Research Associates ..... 4
2. Research Group ..... 4
B. STEERING COMMITTEE ..... 5
**IV. INTRODUCTION ..... 6**
**V. THE CWE IN ACTION ..... 6**
A. THE TRIANGLE ISLAND SEABIRD RESEARCH STATION ..... 6
B. INTEGRATED SHOREBIRD RESEARCH ..... 7
C. THE MARBLED MURRELET PROJECT ..... 8
D. SEA DUCK ECOLOGY ..... 9
E. HERON WORKING GROUP ..... 13
G. ECOLOGICAL PHYSIOLOGY ..... 14
I. POPULATION ECOLOGY OF LANDBIRDS ..... 16
**VI. CONFERENCES ..... 18**
**VII FUNDING ..... 18**
**VIII. PUBLICATIONS ..... 24**
A. Papers in Refereed Journals ..... 24
B. Book Chapters or Conference Proceedings ..... 29
C. Other Publications ..... 29
D. Theses ..... 29

## I. HISTORY

Under the Migratory Birds Convention and Canada Wildlife Acts, the mandate of the Canadian Wildlife Service is to protect and conserve migratory bird populations. In the 21st century, this historical mandate is broadening to encompass other environmental concerns such as species at risk, biodiversity, sustainability and endangered habitats. To meet these broad and varied responsibilities, Environment Canada depends on sound science, and participates in cooperative ventures. In 1993, the Natural Sciences and Engineering Research Council of Canada, Simon Fraser University, and Environment Canada signed a ten year agreement to create the NSERC/CWS Chair in Wildlife Ecology at SFU. The Centre for Wildlife Ecology (CWE) described here is a revised administrative structure based on the Chair, formed after the retirement in 2002 of the original chairholder, Professor Fred Cooke.

## II. MISSION STATEMENT

The mission of the Centre for Wildlife Ecology (CWE) is to foster high quality graduate training and research, conduct basic and applied research in wildlife ecology, and to provide knowledge and personnel that will help Environment Canada and other agencies meet the challenges of conservation in the 21st century. The central concept is to foster synergy between the mission-oriented research and management policies of the Canadian Wildlife Service (CWS) and the basic research agenda of the University. Information, ideas, expertise, resources and opportunity flow back and forth across this interface, giving government agencies access to a broad base of science capability that helps inform policy and decision making, while the university and its faculty and students benefit from enhanced opportunities for research and application of the ideas their disciplines generate.

# III. PERSONNEL

## A. Research Team

### *1. Faculty and Research Associates*

| *Name* | *Position* |
|---|---|
| Ron Ydenberg | Director, Professor |
| Tony Williams | Professor |
| David Green | Associate Director, Assistant Professor |
| Dov Lank | University Research Associate / Adjunct Professor |
| Dan Esler | University Research Associate / Adjunct Professor |
| Mark Hipfner | University Research Associate / CWS Biologist |
| Doug Bertram | CWS Biologist / Adjunct Professor |
| Sean Boyd | CWS Research Scientist |
| Rob Butler | CWS Research Scientist / Adjunct Professor |
| Bob Elner | CWS Research Scientist |
| John Elliott | CWS Research Scientist |
| Barry Smith | CWS Research Scientist / Adjunct Professor |
| Fred Cooke (retired) | Emeritus Chairholder |

### *2. Research Group*

| ***Postdoctoral Fellow*** | ***PhD (in progress)*** | ***MSc (in progress)*** | ***Staff*** |
|---|---|---|---|
| Sophie Bourgeon | Kathy Brodhead | Samantha Franks | Monica Court, CWE Admin. Asst. |
| Tomohiro Kuwae | Lindsay Farrell | Dan Guertin | Connie Smith, CWE Research Tech |
| Caz Taylor | Joel Heath | Dong Han | Jeanine Bond, Sea Duck Res. Asst. |
| Yuri Zharikov | Sarah Jamieson | Megan Harrison | Tyler Lewis, Sea Duck Res. Asst. |
| | Oliver Love | Sofi Hindmarch | Glen Keddie, Res. Assist. |
| | Heather Major | Iain Jones | |
| | | Peter Katinic | |
| | | Vera Klein | |
| | | Lauren Kordonowy | |
| | | Erika Lok | |
| | | Josh Malt | |
| | | Kyle Morrison | |
| | | Sam Quinlan | |
| | | Michael Silvergieter | |
| | | Marc Travers | |
| | | Emily Wagner | |
| | | Ivy Whitehorne | |
| ***Visitors*** | ***PhD( defended)*** | ***MSc (defended)*** | |
| Sue McRae | Andrea Pomeroy | Courtney Albert | |
| Who-seng Lee | | Eric Davies | |
| Kimi Jaatinen | | Molly Kirk | |
| | | Sunny LeBourdais | |
| | | Holly Middleton | |

## B. Steering Committee

| *Name* | *Position* | *Affiliation* |
|---|---|---|
| Elizabeth Elle | Assistant Professor | *SFU* |
| Arne Mooers | Assistant Professor | *SFU* |
| Robert Elner | Head, Migratory Birds Conservation | *CWS* |
| David Green | CWE faculty (non-voting) | *SFU* |
| Kristina Rothley (SFU alternate) | Assistant Professor | *SFU* |
| Paul Kluckner | Regional Director, ECB PYR | *CWS* |
| Barry Smith | Research Scientist | *CWS* |
| Tony Williams | CWE faculty (non-voting) | *SFU* |
| Ron Ydenberg | CWE Director (non-voting) | *SFU* |

## IV. INTRODUCTION

The aim of this Annual Report is to give an overview of our activities, outline the progress on new and continuing projects, describe the personnel involved, and to give some indication of our scientific and community involvement. Previous Annual Reports are available from the CWE. Contact us via our website

http://www.sfu.ca/biology/wildberg/index.html

or contact Ron Ydenberg at ydenberg@sfu.ca.

The past year was the CWE's 14th, and as this report details, our record of accomplishment in training students, publishing papers, and attracting funding has been sustained. The coming year will be the 5th and last of our current agreement with Environment Canada, and a major focus of the coming months will be renewal. To that end, I want to draw attention to a companion document to this report. In that document we examine each of our major projects from the perspective of Environment Canada's goals, asking how they further EC's policy objectives and priorities. (I note here that the organization of projects differs slightly from that presented below.) This document will form an important part of the renewal process, and will help us set objectives for the next agreement.

Finally, I want to acknowledge the continued contributions of Monica Court and Connie Smith to the production of this document, and in countless other ways during the past year. As our new Administrative Assistant, I'm sure Monica found the past year a challenge, but handled it with grace and aplomb. Connie not only provided a steady hand on the tiller down in our 'temporary' accommodations in the old Cooke lab, but has also overseen the plans for our new quarters, which will hopefully become available later this year. My abiding thanks to both of you.

## V. THE CWE IN ACTION

The accounts that follow give brief overviews of the major projects run by the CWE. More detail is available on our website (http://www.sfu.ca/biology/wildberg/index.html). Publications and theses are listed at the end of this report. The personnel also can be contacted via the website.

### A. The Triangle Island Seabird Research Station

Coastal British Columbia supports large populations of many species of seabirds, for which the Pacific and Yukon Region of the Canadian Wildlife Service has stewardship responsibility. The Triangle Island Seabird Research and Monitoring Station was established in 1994 as a centre for research devoted to understanding seabird biology, aimed particularly at identifying and understanding environmental and demographic causes of population change so as to recommend appropriate conservation actions. The Anne Vallée Ecological Reserve on Triangle Island supports the largest and most diverse seabird colony in BC, including the world's largest population of Cassin's Auklets, BC's largest populations of Tufted Puffins and Common Murres, and a large population of Rhinoceros Auklets, among others. As part of the Scott Island Group, Triangle Island is recognized as an Important Bird Area (IBA). Moreover, waters around the Scott Islands are being developed as a Marine Wildlife Area (MWA) under the Canada Wildlife

Act, to protect critical habitat for the millions of seabirds that depend on these waters through the year.

Our ongoing investigations examine breeding propensity and chronology, reproductive performance, nestling diet and development, parental foraging and provisioning patterns, attendance patterns, and adult survival, among other topics. Of particular interest is the issue of how climate-induced fluctuations in the timing and availability of marine prey populations affect seabird reproduction and survival.

The 2006 season*:* We opened our research station on Triangle Island for year 13 on 28 March 2006, with continued logistical support from the Canadian Coast Guard. Scientific research was conducted under the direction of Mark Hipfner. Mark, Valerie Labrecque, Jennifer Greenwood, and Joanna Smith led the field crew at various times in the summer. We maintained our time series focus on Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin, Common Murre, Pelagic Cormorants, Glaucous-winged Gulls and Black Oystercatchers, coupled with graduate student research (see below).

After the disastrous 2005 seabird breeding and post-breeding seasons, which attracted considerable media attention over the winter, the much less dramatic 2006 season was very welcome. At Triangle Island, timing and success of breeding both were very close to long-term averages in all seabird species, and in the case of both Cassin's Auklets and Rhinoceros Auklets, very close to values predicted from environmental variables.

**Graduate students:**

In June 2006, Jessica Beaubier defended her MSc thesis investigating linkages between ocean climate, forage fish energetics, and seabird breeding success. In January 2007, Eric Davies defended his MSc thesis at SFU, investigating the foraging ecology of Triangle's alcids using stable isotope analysis. Finally, Kyle Morrison began his MSc at SFU, co-supervised by David Green, spending the months of July and August on Triangle Island. Kyle's thesis will investigate survival and colony attendance patterns in Tufted Puffins in relation to age and gender.

## B. Integrated Shorebird Research

Shorebirds are among the most highly migratory of all birds. Populations of many species travel half the globe in the course of their annual migrations. The Canadian Wildlife Service has an historical, mandated responsibility for the conservation of migratory birds. Great concern has been raised about apparent population declines of many species over the past two decades. The CWE is studying two small calidrid sandpipers - western sandpipers and dunlin - to better understand these apparent declines.

The majority of the world's 3.5 – 4.0 million Western Sandpipers stop briefly to refuel in Boundary Bay or on Robert's Bank during their annual northward migration, providing a thrilling sight for local residents. A good fraction of the species population also stops over on southward migration, following a flight over the Gulf of Alaska. Because of this, the species is ranked in the highest priority class in the draft BC-Yukon region CWS Shorebird Management Plan. Local information on shorebird usage, including western sandpipers and dunlin, contributed towards Environment Canada's submission in response to proposals to enlarge the Coal Port facility on

Robert's Bank. Since its inception in 1993, the CWE has nurtured the development of the Western Sandpiper Research Network as a platform for research on a hemispheric scale that can address this issue. CWS staffers Rob Butler, Bob Elner, and Barry Smith are active in this group, which includes CWE staff Ron Ydenberg, Dov Lank, and Tony Williams. Our multifaceted research is documenting and modeling the factors controlling the population size, migratory routes and timing, ecological relationships with predators and prey, habitat use, and physiological ecology of this long-distance, Neotropical migrant. We have pursued and aided fieldwork at three breeding sites, several migration locations, and four wintering sites. We have organized ten workshops to help keep researchers in touch, and we run a list-server for this purpose. Our integrated approach allows us to examine how factors at one location affect events at another. How do events in the wintering grounds, migration sites, and breeding grounds interconnect? Where are population bottlenecks? Of direct conservation concern is the consequence of the removal or deterioration of one or more locations on survival and reproduction. As a result of our work, the Western Sandpiper is now the best-studied sandpiper in the Western Hemisphere.

Highlights from the past year: In March 2006, Dov Lank organized and chaired the Western Sandpiper Symposium at the first "Shorebird Science in the Western Hemisphere" meeting in Boulder Co. In December 2006, timed to combine with the annual CWS Shorebird Committee meeting at the Pacific Wildlife Research Centre (PWRC), we held a Western Sandpiper work-shop at SFU attended by more than 40 researchers, including many of the CWS committee members. PhD student Andrea Pomeroy completed her PhD thesis on western sandpiper behaviour at stopovers sites. Sarah Jamieson continued her research on the breeding biology of dunlin. New MSc student Samantha Franks started her project on southward migration stopover behaviour of continental-migrating western sandpipers and other calidrid species in Kansas, with assistance from 1996 graduate from the CWE, Brett Sandercock, now at Kansas State University. Postdoctoral researchers Caz Taylor and Yuri Zharikov continued their projects. Dr. Taylor is creating an individual-based model of Western Sandpiper migration, which may be expanded to more of the annual cycle. Dr. Zharikov, who is based at the PWRC in Delta, is studying the winter ecology of shorebird use, particularly dunlin, on Robert's Bank. Ron Ydenberg and co-authors submitted a commentary highlighting potential effects of predation danger on migration strategies to the Journal of Avian Biology. Dov Lank and Yuri Zharikov are collaborating with a radio-tracking study of habitat use by dunlin in the Skagit Delta in Washington State, initiated by Gary Slater, from the Ecostudies Institute and Ruth Milner, Washington Fish and Wildlife. The study borrows approaches used in the Fraser River delta by earlier CWE students. We continued to collaborate with radio-tracking studies organized by Dr. Pat Baird (California State University at Riverside) and Dr. Nils Warnock (PRBO Conservation Sciences). Additional collaborators included: Dr. Ryan Norris, at the University of Guelph, who is testing novel approaches towards identifying winter locations based on feather composition; Dr. Abby Powell and Audrey Taylor, at the University of Alaska, who are looking at physiological measures associated with migrant habitat use; graduated PhD student Guillermo Férnandez, now at the Universidad Nacional Autónoma de México in Mazatlan; and Dick Dekker, who is examining local raptor-dunlin interactions. The past year was productive from a publication point of view, with 17 papers published or in press.

## C. The Marbled Murrelet Project

This ground-breaking and high profile project examining the biology of the threatened and elusive marbled murrelet continues for its thirteenth year. Dov Lank, Josh Malt, and Mike

Silvergeiter continued with the project throughout the year. Dr. Kris Rothley and her MREM graduate student Jenn Barrett continued their work; MREM student Rebecca Harrold also spent a term working on this project. The SFU team worked closely with Louise Waterhouse from the BC Ministry of Forests and other murrelet researchers in government, industry, and academia, including Peter Arcese (UBC) and Alan Burger (UVic).

Dov Lank continued to serve on the Canadian Marbled Murrelet Recovery Team, which is headed by former CWE staff member Doug Bertram. This participation enables the results of the CWE's research to be rapidly assimilated into evolving policy guidelines for management of this threatened species, under the protection of the federal Species at Risk Act and Provincial Identified Wildlife Management Strategy. Through the Recovery Team, Lank participated in rewriting the federal recovery strategy and action plans. He also reviewed the USFWS's paper on trends of Marbled Murrelet populations in Alaska and BC, part of a process stimulated by proposals to de-list the species south of the US-Canadian border.

MSc student Josh Malt will defend his thesis at the beginning of April 2007. His project is primarily an experimental examination of the magnitude of "edge effects" on the probability of nest survivorship. This topic remains controversial in BC, and has substantial management implications. Jeanine Bond, a CWE MSc graduate, and Mike Silvergeiter managed complex and demanding operations at field sites on Vancouver Island and inland from Squamish, conducting the final year of fieldwork in the edge effects study. MREM student Rebecca Harrold and Dr. Kris Rothley have develop preliminary landscape-level models of nest predation danger based on Josh's initial results, and this will be tested and modified with the additional data.

Silvergeiter's thesis will focus on stand-level habitat characteristics, utilizing data collected in previous years, including some he gathered while working as an undergraduate two years ago. MREM student Jenn Barrett, from the Resource Management Department at SFU, is using data collected in previous years to jointly model marine and terrestrial effects on habitat usage and nesting success, following up on work begun by Elsie Krebs. Yuri Zharikov's second major paper, looking at landscape-level effects on forest habitat usage and nesting success, was accepted by the Journal of Applied Ecology.

As the year closed, our findings were being communicated to interested parties. The CWE organized, co-sponsored and chaired a workshop in Nanaimo in January, co-sponsored with the provincial Ministries of Forest and of the Environment, on techniques for assessing nesting habitat quality. A report from the conference is being published in LINK, the forestry extension publication. Funding for the past and future years has come from the Provincial Forest Science Program, six forest companies, and from an NSERC-CRD grant awarded at the close of 2005.

## D. Sea Duck Ecology

The sea duck research group, led by Dan Esler, conducts a broad range of studies addressing factors affecting population dynamics of sea ducks. Much of the work is conducted along the Pacific coast from Alaska to Mexico, including a concentration in British Columbia. All studies are collaborative ventures with federal agencies, including the Canadian Wildlife Service, U.S. Geological Survey, and the U.S. Fish and Wildlife Service. We also collaborate with universities throughout North America. Details of each project are presented in an updated web site (http://www.sfu.ca/biology/wildberg/CWESeaducksfolder/CWESeaducks/index.html) and are

described in brief below.

*1. Chronic Effects of the Exxon Valdez Oil Spill on Sea Ducks* – This long-term program continues to evaluate the progress of population recovery of sea ducks (harlequin ducks and Barrow's goldeneye) from the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska. At this stage, most efforts are directed towards analysis and publication of data collected over the 11 years of the project. However, we continue to collect new data on the degree and duration of oil exposure that sea ducks are experiencing. In addition, new funding from the Exxon Valdez Oil Spill Trustee Council will be used to construct a population model that will allow evaluation of the relative effects of acute mortalities immediately after the spill and mortalities related to chronic exposure to oil over the subsequent 18 years. Collaborators on the project include U.S. Geological Survey, U.S. Fish and Wildlife Service, and Oregon State University.

*2. Scoter Interactions with Shellfish Aquaculture in Coastal British Columbia* – This work, part of the Sustainable Shellfish Aquaculture Initiative, was conducted in close collaboration with the Canadian Wildlife Service. The research was designed to evaluate mechanisms by which shellfish aquaculture might affect, positively or negatively, wintering surf and white-winged scoters. Funding was provided by an NSERC Strategic Grant to Leah Bendell-Young et al., the Canadian Wildlife Service, Ducks Unlimited, and the Sea Duck Joint Venture. Many CWE personnel were involved in this multi-faceted project, including Dan Esler, Sean Boyd, Ron Ydenberg, Ramūnas Žydelis, Sam Iverson, Deb Lacroix, and graduate students Tyler Lewis and Molly Kirk.

Data collection for this project was completed in 2005 and we are in the analysis and write-up phases, with 8 papers already published and many others in review or preparation. Both Tyler and Molly have graduated and have done a great job getting their work into the primary literature.

The findings of this project have been encouraging from the perspective of scoter conservation. Using a suite of metrics (habitat use, changes in abundance, survival, foraging behaviour, and habitat quality), we determined that shellfish aquaculture had either neutral or beneficial effects on scoters, depending on the location, type of aquaculture, and prey type. These findings have been used by the industry and regulators to help chart a sustainable course for BC's coastal environments.

*3. Behavioural, Distributional, and Physiological Responses of Scoters to Herring Spawn* – Many birds are known to aggregate at sites where Pacific herring spawn in the spring. However, the importance of this phenomenon, in terms of the numbers of species and individuals that use this ephemeral food resource and in terms of the benefits conferred by foraging on spawn, has not previously been addressed. In direct collaboration with the Canadian Wildlife Service and the University of Wyoming, we have been collecting data to address these issues. We have found that the largest and most predictable herring spawn sites in the Strait of Georgia are used by hundreds of thousands of individuals of many species. Surf scoters show a particularly strong response; CWE MSc students Molly Kirk and Erika Lok have used radio and satellite telemetry to show that nearly all surf scoters that winter or migrate through coastal BC utilize herring spawn. Collaborator and PhD candidate (UWyo) Eric Anderson has been tracking changes in mass and condition of scoters in association with herring spawn, using stable isotopes and fatty acids to determine sources of lipid reserves. CWE MSc student Tyler Lewis demonstrated that surf and white-winged scoters dramatically decreased their foraging effort during herring spawn,

suggesting that they were easily able to meet maintenance and lipid acquisition costs when foraging on the abundant spawn.

*4. Staging Habitats of Spring-migrating Surf Scoters* – As part of a collaborative project investigating Surf Scoter spring migration ecology, Erika Lok (CWE MSc student) is using a combination of satellite telemetry, radio-telemetry, aerial surveys, and existing GIS habitat data to investigate habitat use of Surf Scoters along the northern BC coast and southeast Alaska during spring. Funded by the Sea Duck Joint Venture (U.S. Fish and Wildlife Service) and working with research partners from Canadian Wildlife Service, U.S. Geological Survey, and the Washington Department of Fish and Wildlife, Erika is identifying important spring habitats based on the location of marked scoters from throughout the Pacific wintering range, including Baja California Mexico, San Francisco Bay, Puget Sound, and British Columbia. Satellite telemetry, VHF telemetry and survey data collected during springs of 2005 and 2006 indicate that Surf Scoters are using specific staging sites within Southeast Alaska during migration, and that herring spawn events are likely an important habitat attribute of these sites. Erika is currently analyzing data and writing her thesis, with an intent to graduate in early fall 2007.

*5. Habitat Use by Sea Ducks in SE Alaska –* This newly funded project (Sea Duck Joint Venture; U.S. Fish and Wildlife Service) uses aerial survey data collected throughout southeast Alaska to analyze distribution and habitat use by wintering sea ducks. Combining the spatially explicit survey data with habitat attributes in GIS is allowing us to evaluate species-habitat relationships at a broad scale. This work is being done by SFU (REM) MSc candidate Dora Repard in collaboration with Kris Rothley (SFU-REM), U.S. Geological Survey researchers (Jerry Hupp), and U.S. Fish and Wildlife biologists (Jack Hodges, Debbie Groves, and Bruce Conant).

*6. Harlequin Duck Conservation Research* - The CWE and Canadian Wildlife Service have had long-standing conservation concerns and research interests regarding harlequin ducks in the Strait of Georgia. Past studies have resulted in an unprecedented understanding of ecology and demography of a seaduck.

During the summers of 2003 and 2004, we conducted studies of harlequin ducks breeding on streams in the southern Coast Mountains of British Columbia, and we are now finishing write-up of reports and papers. This project was funded in part by BC Hydro's Bridge-Coastal Fish and Wildlife Restoration Program and was led by Dan Esler and Ron Ydenberg. CWE MSc students Jeanine Bond, who completed her degree in December 2005, and Sunny LeBourdais, who graduated in summer 2006, were the workhorses on the project. This research was designed to determine factors affecting distribution and productivity, including abiotic habitat features, presence of fish and invertebrates, and strategies of nutrient acquisition and allocation by females for egg production. Our results indicate that some abiotic features (e.g., slope) are important predictors of harlequin duck occurrence and density, and that fish may have a negative influence, perhaps as a result of their influence on behaviour (and subsequently availability to ducks) of aquatic insects. Female harlequin ducks acquire egg resources entirely from breeding streams, although nutrients acquired on coastal wintering sites may be important for other reproductive stages. Final results of this work will be summarized in a final report for BC Hydro, are available in the theses of Jeanine Bond and Sunny LeBourdais, and are appearing in journal publications.

*7. Black Scoter Reproductive Energetics* – In collaboration with the U.S. Geological Survey (Paul Flint), we are addressing nutrient acquisition and allocation strategies of female black scoters for meeting costs of reproduction. Despite clear declines in numbers of Black Scoters breeding in

tundra habitats of Alaska, the mechanisms underlying population change are uncertain. Waterfowl ecologists and managers increasingly recognize the influence of spring energy management strategies on productivity, and ultimately population dynamics, of waterfowl. Therefore, we are quantifying the timing and locations at which female black scoters acquire nutrients and energy for subsequent investment into reproduction, with the intention of identifying habitats and annual cycle stages that are particularly important for management consideration. Field collections for this work have been completed, as has sample preparation for stable isotope analysis. Body composition analysis and stable isotope analysis will be occurring soon, and we are looking forward to learning what the data have to say.

*8. Latitudinal Variation in Wintering Ecology of Surf Scoters* – Tens of thousands of surf scoters winter along the west coast of Baja California, which represents the southern extent of their wintering range, yet we know very little about their wintering ecology (e.g., movements, foods, habitats used) in the region. In contrast to more northern wintering sites, our preliminary observations indicate that Surf Scoters in Mexico appear to have a different diet, exert greater foraging effort, and have a disproportionately higher number of females and juveniles in the population. We are using telemetry to study the ecology of Surf Scoters wintering in Baja California and gain a more complete delineation of the winter population structure, specific migration routes and patterns, and breeding distribution of scoters in the Pacific Flyway. In February 2006 and November 2006, we captured Surf Scoters in Bahia San Quintin and Bahia Ojo de Libre, Baja California, Mexico and deployed both satellite and radio transmitters to obtain spatial and temporal movement patterns of this wintering population, foraging effort information, habitat use, survival, and population delineation. This effort is led by CWE PhD candidate Kathy Brodhead, in collaboration with U.S. Geological Survey (David Ward) and local universities.

*9. Barrow's Goldeneye Population Delineation* – In collaboration with Sean Boyd of the Canadian Wildlife Service, we are using satellite telemetry to evaluate population structure, movements, site fidelity, and habitat use of Barrow's goldeneyes in British Columbia. Twenty males were marked at Riske Creek in May 2006, and ten males and ten females were marked in Indian Arm on the coast during December 2006. We intend to deploy more radios over the next 2 years, to mark all age and sex cohorts at different annual cycle stages. This work will have important implications for understanding population level effects of factors at different annual cycle stages (e.g., oil pollution on coastal wintering areas, changes to interior breeding areas) and will provide the first insights into migratory connectivity for the species. To date, we have learned that males from Riske Creek undergo extensive northward molt migrations, some as far north as the Beaufort Sea. Also, wintering areas of these males range from southeast Alaska to the Strait of Georgia, suggesting that local breeding populations are constituted from birds from numerous wintering sites.

*10. Offshore Wind Farms and Effects on Sea Ducks* – The CWE has been identified as a collaborator and national lead on research efforts by the Canadian Wildlife Service to evaluate effects of offshore wind turbine arrays on wintering and migrating sea ducks. To date, the only offshore wind farm proposed for Canada is in Hecate Strait near Haida Gwaii (Queen Charlotte Islands). We have laid the groundwork for participating in research in the region by hosting workshops, conducting extensive literature reviews, interacting with European researchers with experience in this area, visiting the site to meet with local interests, interacting with the proponent, and collaborating with the U.S. Fish and Wildlife Service to conduct aerial surveys. The full extent of CWE research on this topic remains to be seen.

*11. Foraging Strategies of Arctic Wintering Common Eiders* - Sea ice conditions in Hudson Bay are important to the winter ecology of Common Eiders. CWE PhD student Joel Heath has conducted field work in the Belcher Islands, Nunavut, to determine how wintering common eiders adjust their foraging behaviour in response to different environmental and physiological constraints, in order to balance their energy budgets in mid-winter. These results are indicating the importance of considering factors operating across multiple time scales, and are providing insight into potential impacts of environmental change in sea ice habitats, and elucidating recent mortality events. This project is being conducted in collaboration with Grant Gilchrist of the Canadian Wildlife Service and the Sanikiluaq Hunters and Trappers Association and will provide important information to facilitate informed co-management strategies.

## E. Heron Working Group

The Great Blue Heron, the largest heron of North America, is widely distributed in Canada but the estimated 1500 pairs of coastal British Columbia Great Blue Herons are distinct from herons elsewhere in Canada. The coastal birds are non-migratory and remain isolated year round from heron populations that migrate. This isolation has led to the adaptation of several unique features such as a darker plumage pattern. Due to these differences the local Pacific Great Blue Heron has been given a unique subspecies classification, *Ardea herodias fannini*. This subspecies, which is currently blue-listed by the British Columbia Ministry of Environment, has been investigated by a team of researchers from the CWE and CWS for several years.

In 2006/2007 CWS scientists Rob Butler and Barry Smith continued to investigate local heron nesting strategies, habitat use and population dynamics with students from the CWE. It has been observed that the overall reproductive success and number of Great Blue Herons in the Georgia Basin has decreased over the last decade and a high level of colony abandonment has occurred. This trend is thought to be the result of a combination of predation by bald eagles and human disturbance at colonial nest sites. Pacific Great Blue herons utilize a number of nesting strategies in Coastal British Columbia. Many pairs choose to nest in large colonies, some nest in small colonies, and many others choose to nest individually.

In the past year Barry Smith and Jamie Kenyon, a former CWE MSc student who defended in April of 2005, have collaborated to publish work stemming from Jamie's thesis. Jamie and Barry developed ecological models that examine the possible role of foraging site quality and predation risk in determining the population dynamics of coastal herons in BC. In addition, Jamie's thesis pioneered a methodology for identifying colony locations from foraging ground observations that increased the number of known colonies and the overall population estimates in the study area.

Iain Jones, a current MSc student with the CWE, has continued to work with Rob Butler, examining the role that predation risk plays in determining colony site selection by closely studying the behavioural and spatial relationship between coastal herons and their primary predator, the bald eagle. Paradoxically, it seems that a large proportion of herons are choosing to nest colonially near active eagle nests. The working hypothesis is that herons may benefit from being near one eagle nest by gaining territorial protection from other intruding eagles. In utilizing this strategy herons may manage their predation risk as bald eagle populations continue to recover from previous lows. Very little is known about eagle territoriality or foraging ecology

on the B.C. coast, but their propensity to defend their nest site from other eagles is a key assumption in the predator protection hypothesis.

Iain carried out a successful field season in 2006. He measured the propensity of Bald Eagles to defend their nests sites through both field observation and field experimentation within the Fraser River Basin. He also carried out observational case studies at several key sites where large heron colonies have taken up residence with an actively nesting pair of Bald Eagles, measuring the rates at which resident bald eagles defended the colonies from other predators and at which they utilized the herons as prey themselves. Iain conducted heron and eagle reproductive success surveys throughout the region contributing to the long term datasets that exist for these species at CWS. He is utilizing these datasets to examine how closely heron reproductive success and spatial distribution are correlated to eagle nesting location and reproductive success.

Currently Iain is analyzing his findings and writing his thesis that will likely be defended in September. His analyses thus far have supported the predator protection hypothesis as an explanation for heron habitat selection where this associative nesting behaviour is occurring in the Georgia Strait Basin.

## G. Ecological physiology

The main aims of CWE's research in ecological physiology are three-fold: 1) to obtain a better understanding of the fundamental mechanisms underlying individual and population-level variation in physiological traits in order to provide a solid basis for predicting how animals might respond to environmental change, 2) to determine more meaningful intra-specific measures of body condition, quality and individual health for birds, and 3) to develop and apply new physiological approaches and techniques to conservation biology and ecotoxicology. We approach these aims through a combination of studies on basic physiology, often using tractable model systems (e.g. zebra finches) as well as free-living birds (starlings, western sandpiper), coupled with more applied, and more specific, goal-orientated projects (e.g. addressing current endocrine disrupter and ecotoxicological problems). The following projects are on-going in the Williams' lab at present:

1. **Reproductive ecology and physiology**:

a) Oliver Love (PhD) is close to completing his thesis on the interaction between corticosterone, reproduction and environmental stress in European starlings (*Sturnus vulgaris*). Specifically, he is examining the adaptive role of corticosterone in mediating reproductive 'decisions' in females and the consequences of this on offspring phenotype. Maternal corticosterone transferred to the yolk may act as a hormonal cue of maternal condition to the developing embryo enabling mothers to fine-tune the quantity and quality of offspring to prevailing environments;

b) Emily Wagner (MSc) is close to completing her thesis on anemia and reproductive effort in zebra finches (*Taeniopygia guttata*). She has fully characterised hematological changes during egg-laying, confirmed that these are hormone- (estrogen) dependent, and developed hormonal methods for the direct manipulation of anemia. Since anemia can be a common symptom associated with disease or toxicological challenge this work will also be of applied interest;

c) Lauren Kordonowy (new MSc student) will be investigating the role of estrogens in hormonally-mediated maternal effects on egg production, offspring sex ratio and offspring

phenotype in European starlings;

d) Sophie Bourgeon (new post-doctoral fellow) will be investigating causal links between immunosuppression and oxidative stress in breeding birds using experimental manipulation of antioxidants in European starlings (*Sturnus vulgaris*); she has also developed assays for oxidative stress and total antioxidant capacity;

e) Marc Travers (new MSc student) will investigate how variation in clutch number (due to predation events) affects clutch size, and the physiological basis of cost of reproduction in free-living song sparrows on Vancouver Island, BC; this project is a collaboration with Drs. Liana Zanette and Mike Clinchy (University of Western Ontario);

f) Dong Han (new MSc student) will be bringing molecular tools to bear on inter-individual variation in reproductive physiology, specifically measuring ovarian vitellogenin receptor expression in relation to reproductive effort, and developing an ELISA for apo VLDL II (an improved yolk precursor assay).

2. **Plasma metabolites as indicators of physiological state and "condition"**: We have continued to extend the application of plasma metabolite analysis for the assessment of fattening rate, general condition, and the relative quality of habitats or sites used by migratory birds, in a wide variety of collaborative studies: a) habitat use over the whole migratory route in western sandpipers (with Drs. Nils Warnock, PRBO Conservation Science, Mary Ann Bishop, Prince William Sound Science Center, and John Takekawa, USGS; see Williams et al. in press); b) habitat use in pre-migratory staging areas for shorebirds in Alaska (with Audrey Taylor and Drs. Abby Powell and Rick Lanctot, University of Alaska Fairbanks); c) altitudinal habitat use in migratory passerines in the Lower Mainland (with Drs. Lesley Evans-Ogden, NSERC PDF at UBC and Kathy Martin); d) plasma metabolites in relation to incubation intensity in different populations of king eiders (with Rebecca McGuire and Dr. Abby Powell, University of Alaska, Fairbanks); e) yolk precursor analysis in relation to migration, timing of arrival and onset of reproduction in snow geese in the high-Arctic (with Dr, Joel Bêty, Universite de Rimouski; f) yolk precursor analysis in relation to stable isotope signatures in marbled murrelets (with Drs Ryan Norris, University of Guelph and Peter Arcese, UBC); g) yolk precursors and migration in surf scoters in California and Alaska (with Matt Wilson and Dr. John Takekawa, USGS); and h) yolk precursors and breeding propensity in lesser scaup (with Kate Martin and Dr. Mark Lindberg, University of Alaska, Fairbanks).

3. **Impact of use of MSMA (monosodium methanearsonate) for bark beetle control on cavity-nesting birds in B.C. forests.** Courtney Albert completed her MSc on the effects of MSMA on adult and nestling birds (in collaboration with Drs. John Elliott and Christy Morrissey of Environment Canada, and Dr. William Cullen, UBC). Zebra Finches were exposed to this pesticide at doses similar to those found in bark beetle samples from MSMA stands of trees treated in the southern interior of British Columbia. Adults showed high excretion (>90%) of arsenic but also dose-dependent accumulation of arsenic in blood and tissues, and significant weight loss occurred in the two highest dose groups. Nestlings were generally much more sensitive than adults with high mortality at >36 ug/g bw/day. At lower doses nestlings showed few negative effects of MSMA in terms of general health but did show decreased growth relative to controls. These results have been submitted for publication and were provided to MOF.

4. **E-Bird: an NSERC-funded Network on avian reproduction and environmental change: integrating ecology and physiology**. NSERC funding (to TDW) has supported a Canadian component of, and Canadian participation in, this international research network, with partners in the USA and Europe funded by NSF and ESF respectively

http://www.sfu.ca/biology/faculty/williams/ebird/. Major activities supported by this grant were 1) attendance at small international workshops, of which there have been three (Holland 2004, Seattle 2005, Vancouver 2006) and a final larger meeting (Glasgow, UK 2006); 2) attendance at small technical meetings, and 3) support for Canadian graduate students and post-docs wanting to make interdisciplinary, international lab exchanges. We organised a 4-day workshop on individual variation at SFU in March 2006 which was attended by 75 researchers, with two days focus on climate change. A total of 13 Canadians attended the fourth and final meeting in Glasgow in November 2006. Associated with this meeting we also ran a 2-day technical meeting with the aim of providing postgraduates and early-stage post-docs with the intellectual, practical and networking skills to establish interdisciplinary collaborations and which focused on the research of students who have benefited from E-Bird funding support. So far we have provided funding for more than 30 Canadian graduate students and post-docs to attend the workshops or for international lab exchanges. We have had a proposal for a theme issue of *Philosophical Transactions of the Royal Society* accepted for publication in 2008 which will contain 14 synthesis papers summarising the concepts discussed at each of the three E-bird workshops. E-Bird will likely become a Standing Committee or research coordination committee as part of the International Ornithological Congress that will further the development of this international group. Finally, E-Bird activities indirectly lead to TDW being invited to participate in a successful $9.3M CFI New Opportunities application to build AFAR, an Advanced Facility for Avian Research, at the University of Western Ontario campus (see, http://publish.uwo.ca/~smacdou2/afar.htm).

## I. Population ecology of landbirds

CWE's research on landbirds is coordinated by David Green and addresses two key questions in avian ecology and conservation. Firstly, we are interested in how migratory strategies of individual birds influence their fitness and the demography of populations. This question is addressed using two model systems; American dippers within the Chilliwack River watershed, and yellow warblers that breed in Revelstoke but overwinter in the neotropics. Secondly, we are interested in how anthropogenic changes to the landscape influence habitat selection, breeding performance and survival of threatened landbirds in British Columbia. Projects with this focus include a study examining how water use decisions by BC Hydro influence the breeding performance and survival of Yellow warblers in riparian habitat, a study examining habitat selection and reproductive success in the provincially threatened Brewer's sparrow, and a study examining how changes in agricultural practices in the Fraser Valley influence the foraging ecology productivity and survival of barn owls.
We briefly describe these studies below:

*Migratory behaviour and population demography of American dippers*

We have studied dippers in the Chilliwack River Valley, BC since 1999. The majority of dippers, in this and other populations, make seasonal movements between low elevation wintering grounds on large rivers and breeding grounds on higher elevation tributaries. However some individuals do not undergo this seasonal migration and remain on permanent territories year round. We are currently using morphometric data, mark-recapture analysis and radiotelemetry to investigate whether migratory/sedentary behaviour is associated with distinct morphological and physiological traits, and to examine how variation in migratory behaviour influences natal philopatry, recruitment, survival and reproductive success of American dippers. Analysis of the long-term data set conducted by Elizabeth Gillis (submitted to Ecology) suggests that sedentary

individuals have higher reproductive success but lower survival than migrants. Ivy Whitehorne therefore initiated an MSc project in 2006 examining whether the higher survival of migrants is due to their lower reproductive effort or because not having to defend a breeding territory in the winter improves their ability to deal with fluctuations in prey availability. Holly Middleton defended her MSc examining variation in dispersal strategies and juvenile survival in Dec 2006. She found that juveniles begin to disperse soon after fledging, but that delayed dispersal increases the probability that juveniles recruit into the breeding population. Intriguingly, variation in dispersal behaviour is linked to both parental behaviour (whether they renest) and fledgling traits (early foraging behavior).

*Migratory behaviour and reproduction in Yellow warblers*

We have studied the breeding biology of Yellow warblers, a declining songbird dependant on riparian habit, in Revelstoke since 2004. Sam Quinlan, an NSERC Industrial student supported by BC Hydro, has used information that can be obtained from hydrogen isotope ratios in feathers to determine where yellow warblers molt and over-winter. In 2007 he will defend his thesis that examines how molt and migratory strategies influence the survival and subsequent reproductive success of birds that return to their breeding grounds in Revelstoke. This work will provide considerable insight into migratory connectivity of Yellow warblers and the importance of carry-over effects during the winter period on subsequent productivity.

*Water use decisions and the demography of a riparian dependant songbird*

Human activities have caused a dramatic loss in the amount of riparian habitat in North America and this habitat loss is linked to population declines of many riparian dependant songbirds. Prevention of further declines will require an understanding of how to minimize human impacts on these bird populations along with informed restoration efforts. Yellow warblers have been identified by Partners in Flight as a focal species that could be used to evaluate the health of riparian habitat within BC. We established a marked population of Yellow warblers in three riparian habitat types within the drawdown zone of Upper Arrows Lake Reservoir, near Revelstoke, in 2004. We examined how local and landscape level habitat characteristics, including those associated with management of water levels in the Columbia River, influence habitat selection and breeding performance of Yellow Warblers in 2005 and 2006. We have shown that Yellow warblers prefer riparian habitat associated with large cottonwoods, with high densities of willow and non-willow shrubs, and avoid patches of riparian habitat that is not contiguous with deciduous forest (Quinlan and Green 2006, 2007). We have also demonstrated that concerns about the use of bird densities as a method of evaluating the efficacy of restoration efforts are warranted since densities do not always predict productivity. These results will be used to guide riparian restoration efforts in the Revelstoke and Kinbasket area.

*Habitat selection mechanisms in Brewer's sparrow*

The Brewer's sparrow is a provincially red-listed species that is restricted to the sagebrush steppe, an ecosystem type that is under intense pressure from agricultural and residential development. Research on Brewer's sparrows was initiated by the Canadian Wildlife Service (Pam Krannitz, Nancy Mahony, Kathy Martin) in 1997 and extended to include multiple sites within the Okanagan in 2003. Megan Harrison, an MSc student supervised by David Green and Pam Krannitz (CWS) has developed a research proposal that will extend previous work and examine the role of habitat metrics and conspecifics on settlement patterns. This research will commence in April 2007 and has the potential to improve habitat selection models that currently do not accurately predict the species' distribution, and explain why apparently suitable habitat is

not occupied.

*Impacts of changing agricultural land use on the distribution and breeding performance of barn owls*

Land used for agriculture provides habitat for a diversity of wildlife. However, the intensification of agricultural practises, increased use of pesticides and encroachment of urban centres have been linked to the widespread decline of many species associated with agricultural land in Europe. Less is known about the extent to which recent changes to agricultural land use and practices in the Fraser Valley have impacted wildlife. We have therefore initiated a project that will 1) examine how changes to farm structures and agricultural land have impacted the distribution of barn owls over the last decade, 2) investigate how land use patterns influence the foraging ecology and breeding performance of barn owls and 3) evaluate the extent to which barn owls are exposed to rodenticides. This project will be conducted by an MSc student, Sofi Hindmarch, and is a collaboration with Elsie Krebs and John Elliott of the Canadian Wildlife Service, and Markus Merkens of Delta Farmland and Wildlife Trust. This research will be used to promote agricultural practices that have positive effects on wildlife in an agricultural landscape.

## VI. CONFERENCES

*Offshore Wind Farms and Birds* – Dan Esler organized this conference which was held in Delta in February 2006, and was attended by federal and provincial agency folks, industry, consultants, and academics.

*Western Hemisphere Shorebird Science* - In December 2006 the CWE hosted the 10$^{th}$ Western Sandpiper Workshop. CWE members at the meeting participated in further organizational discussions for the Shorebird Research Group of the Americans and a potentially broader Western Hemisphere Shorebird Group.

*Environmental Change and Avian Reproduction* – E-BIRD (see G.4 above) and CWE organised a 2-day workshop on environmental change focusing on Canada and avian/mammalian population responses in March 2006 which was attended by 75 researchers from academia, non-government and provincial/federal government agencies.

## VII FUNDING

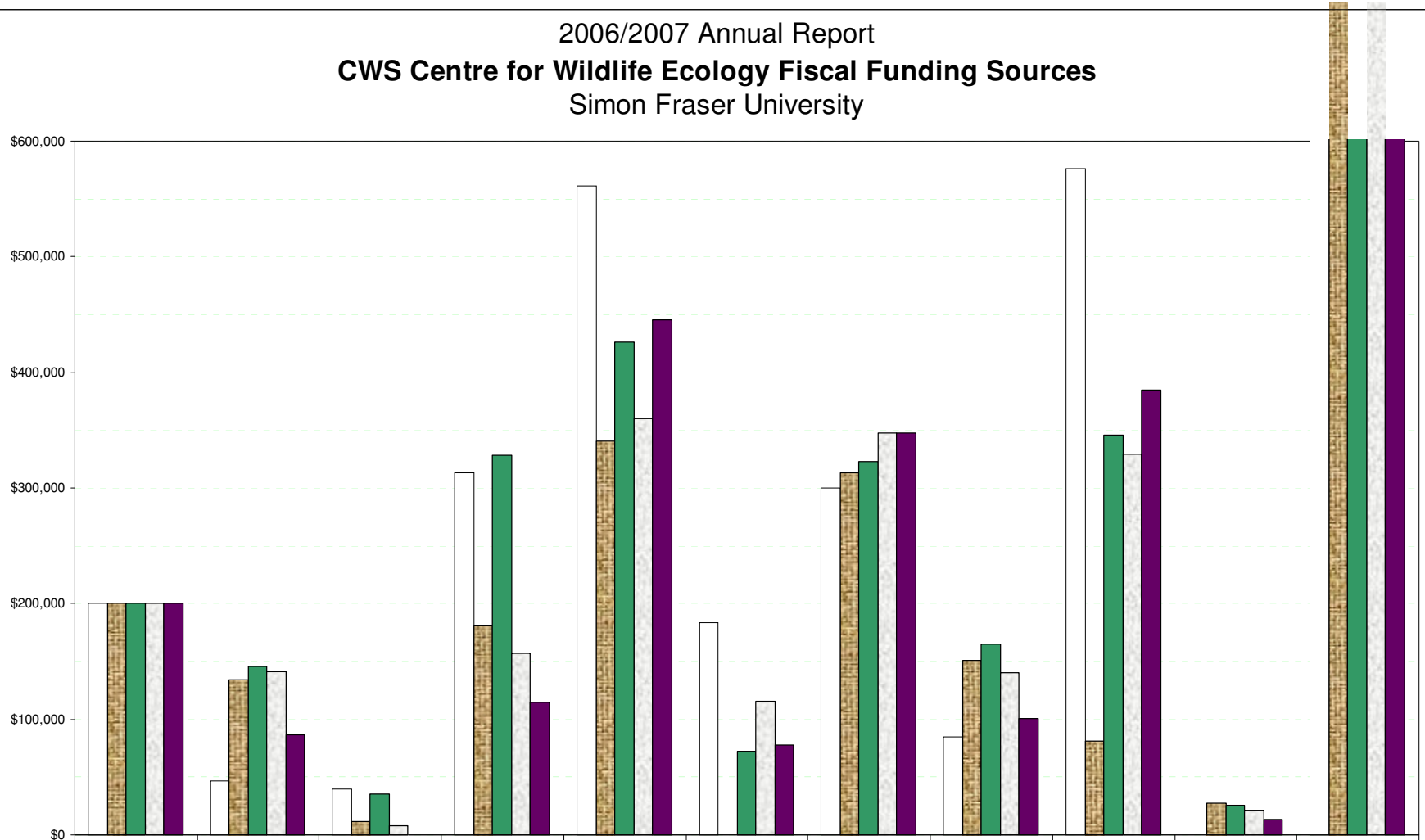
Budget
1 April 2006 to 31 March 2007 was the fourth year of the current five-year agreement between Simon Fraser University (the Centre for Wildlife Ecology) and Environment Canada (the Canadian Wildlife Service PYRC). This Contribution Agreement provides $200,000 annually as core support for the research activities of the Centre for Wildlife Ecology.

The chart has been revised from the format of previous years to compare revenue projections (formulated for this third agreement) to actual revenue from Environment Canada, SFU and other industrial, provincial, federal and international sectors.

2006/2007 Annual Report

## CWS Centre for Wildlife Ecology Fiscal Funding Sources

Simon Fraser University




| | EC/Core | Other EC | Other Fed Gov't | Prov Gov't | NSERC | Industry | SFU Faculty | SFU Other | Int'l (Cdn$) | Other | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Projections | 200,000 | 47,000 | 40,000 | 313,115 | 561,181 | 183,898 | 300,000 | 85,000 | 576,141 | 0 | 2,306,335 |
| 2003/2004 | 200,000 | 134,500 | 11,195 | 180,843 | 340,846 | 0 | 313,242 | 150,630 | 81,611 | 27,143 | 1,440,010 |
| 2004/2005 | 200,000 | 145,526 | 35,373 | 327,958 | 426,332 | 72,750 | 323,250 | 165,242 | 345,550 | 25,600 | 2,067,581 |
| 2005/2006 | 200,000 | 140,818 | 8,035 | 156,825 | 359,600 | 116,000 | 347,257 | 140,110 | 329,218 | 21,600 | 1,819,463 |
| 2006/2007 | 200,000 | 86,540 | 0 | 114,660 | 445,417 | 77,500 | 347,257 | 100,500 | $384,697 | 12,993 | 1,769,564 |

Category for Chart

# Centre for Wildlife Ecology Annual Financial Report

2006/2007 Fiscal Year

**1 April 2006 - 31 March 2007**

| | | | |
|---|---|---|---|
| | | **Scbolaships, Fellowships, Grants for Students** | |
| | | PhD | |
| Northern Scientific Training Program | | Sarah Jamieson | $3,040 |
| Northern Scientific Training Program | | Joel Heath | $3,953 |
| SFU Fellowships etc | | Joel Heath, Sarah Jamieson, Andrea Pomeroy | $25,500 |
| NSERC PGS-03 | | Lindsay Farrell | $7,000 |
| Travel Award Grad Studies - International Travel | | Lindsay Farrell | $6,000 |
| SFU Fellowships etc | | Heather Major | $6,000 |
| | | M Sc | |
| SFU Fellowships etc | | Kyle Morrison - CD Nelson Entrance Scholarship | $18,000 |
| NSERC RGS-M | | Samantha Franks | $17,300 |
| NSERC - PGS-M | | Molly Kirk | $8,650 |
| NSERC - Industrial | | Sam Quinlan | $21,000 |
| NSERC - PGS-M | | Ivy Whitehorne | $17,300 |
| NSERC CGS-M | | Megan Harrison | $11,667 |
| SFU Fellowships etc | | Iain Jones TA, GF | $10,500 |
| SFU Fellowships etc | | Mike Silvergieter TA | $3,500 |
| SFU Fellowships etc | | Megan Harrison | $7,000 |
| International | | Sofi Hindmarch | $12,000 |
| | | **General Funding for CWE** | |
| EC/Core | | EC/CWS Annual Chair Funding 1 April 06 to 31 March 07 | $200,000 |
| SFU | Ydenberg RC | SFU Dean of Science: Contribution to Centre for Wildlife Ecology (2nd of 5 yrs) | $30,000 |

| | | | |
|---|---|---|---|
| SFU | SFU | SFU Contribution to Faculty Salaries (Ydenberg Williams Green) | $347,257 |
| Other EC | Hipfner M | Science Horizon - Recovery of nocturnal Burrow-Nesting Seabirds following eradication of non-indigenous predators in BC - Haida Gwaii | $7,590 |

**Generated Research Funding**

**Aquaculture**

| | | | |
|---|---|---|---|
| NSERC | Bendell-Young L | NSERC Strategic Grant "Towards a Sustainable Shellfish Aquaculture Industry" (5th of 5 yrs) | $56,000 |

**Barrows Goldeneye**

| | | | |
|---|---|---|---|
| International | Ydenberg RC, Ost M | Riske Creek Project (2nd of 3 years) | $12,986 |

**Ducks**

| | | | |
|---|---|---|---|
| International | Esler D | US Fish & Wildlife: Sea Duck Joint Venture (2nd of 3 years) | $39,191 |
| International | Esler D | US Fish & Wildlife: Sea Duck Joint Venture (1st of 3 years) | $29,536 |
| International | Esler D | USGS - Female Black Scoters (1st of 2 years) | $25,194 |
| International | Esler D | USGS - Exxon/Harlequin Duck (1st of 3 years) | $87,192 |
| International | Esler D | USGS - FOIA | $4,527 |
| Other EC | Esler D, Boyd S | EC: Marine Bird Conservation (2nd of 5 years) | $35,000 |
| Other EC | Esler D | Wind Farms | $7,700 |
| Other EC | Esler D | Wind Farms (1st of 3 years) | $14,000 |

**Land Birds**

| | | | |
|---|---|---|---|
| Provincial | Green DJ | BC Hydro Columbia Basin Fish & Wildlife contribution Program: Evaluating the health of riparian habitats: The role of habitat structure in nest site selection and breeding success of yellow warblers in the Revelstoke Reach, BC | $18,135 |

| | | | |
|---|---|---|---|
| Other EC | Green DJ | Science Horizon - Song Bird Habitat Use and Migration Monitoring | $9,000 |
| | | **Marbled Murrelets** | |
| Provincial | Lank DB | Forest Science Program - Mamu - Edge Effects | $75,000 |
| Provincial | Lank DB | Forest Science Program - Mamu - Critical Habitat | $21,525 |
| Industry | Lank DB | Interfor - Mamu (NSERC match) | $52,500 |
| Industry | Lank DB | Interfor - Mamu (not NSERC match | $25,000 |
| NSERC | Lank DB | NSERC CRD (2st of 3 years) | $67,500 |
| | | **Physiological Ecology** | |
| NSERC | Williams TD | NSERC Special Research Opportunity Program (SRO) :"Avian reproduction and environmental change: integrating ecology and physiology" (3rd of 3 yrs) | $58,700 |
| | | **Triangle Island** | |
| Other EC | Hipfner MJ | Environment Canada - Science Horizons: "Demography and Post-Breeding Dispersal of Common Murres Breeding at Triangle Island" | $9,000 |
| | | **Western Sandpipers** | |
| International | Ydenberg RC, Baird P | US Army Corps of Engineers: Multinational Study of Neotropical Migrants: The Western Sandpiper as model. | $107,360 |
| Other EC | Ydenberg RC, Butler R | CWS: Western Sandpipers Equipment: | $4,250 |
| International | Taylor | Caz Taylor NSF postdoctoral funding (2/3 years?): modeling sandpiper migration | $57,950 |
| | | **Dunlin** | |
| NSERC | Zharikov | Yuri Zharikov's NSERC postdoc (2/2): Modelling shorebird use of intertidal habitat+C155 | $40,000 |
| International | Lank DB | Seadoc Society: Stable isotope analyses of Dunlin diet in the Skagit River Delta. | $8,761 |
| | | **NSERC** | |
| NSERC | Green DJ | NSERC Individual Research Grant - Dispersal and migration behaviour of birds in natural and modified landscapes (3nd of 5 years) | $22,000 |

| | | | |
|---|---|---|---|
| NSERC | Lank DB | NSERC Individual Research Grant - Maintaining variation in ecologically significant traits in birds (4rd of 4 years) | $24,000 |
| NSERC | Williams TD | NSERC Individual Research Grant- "Physiology of life-histories: egg size and number and costs of reproduction" (4th of 4 yrs) | $43,000 |
| NSERC | Ydenberg RC | NSERC Individual Research Grant - "Predation danger and the annual cycle of migrants (2st of 5 yrs) | $51,300 |
| | | Grand Total | $1,769,564 |
| | | SFU In-Kind | $116,678 |

## VIII. PUBLICATIONS

This list reflects those publications produced since our last report (publications that were "in press" or "submitted" for the last report are included and have been updated). We continue to publish very actively, with 29 publications in press and 30 submitted. Over the past year, one Doctoral and five Masters students successfully defended their theses. Most of our publications relate to the research carried out in the main CWE programs and most refer to work carried out in the Pacific Northwest. We are however interacting with scientists throughout Canada and beyond and some of our publications reflect this.

### A. Papers in Refereed Journals

**In press:**

Ball, J.R., D. Esler and J.A. Schmutz. In press. Proximate composition, energetic value, and relative abundance of prey fish from the inshore eastern Bering Sea: implications for piscivorous predators. Polar Biology.

Breuner, C.W., S.E. Lynn, G.E. Julian, J.M. Cornelius, B.J. Heidinger, O.P. Love, R.S. Sprague, H. Wada and B.A. Whitman. In press. Plasma binding globulins and the acute stress response. Horm. Met. Res.

Evans Ogden, L.J., D.B. Lank and S. Bittmann. In press. Use of agricultural land by shorebirds with special reference to the Fraser River Delta. Can. J. Plant. Sci.

Fernandez, G. and D.B. Lank. In press. Variation in the wing morphology of western sandpipers (*Calidris mauri*) in relation to sex, age and annual cycle. Auk.

Gorman, K.B., D. Esler, P.L. Flint and T.D. Williams. In press. Nutrient reserve dynamics during egg production by female Greater Scaup (*Aythya marila*): relationships with timing of reproduction. Auk.

Heath, J.P., H.G. Gilchrist and R.C. Ydenberg. In press. Can diving models predict patterns of foraging behaviour? Diving by common eiders in an arctic polynya. Anim. Behav.

Hipfner, J.M., M.R. Charete and G.S. Blackburn. In press. Subcolony variation in breeding success in Tufted Puffins, its association with foraging ecology, and its implications. Auk 124.

Iverson, S.A. and D. Esler. In press. Survival of female harlequin ducks during wing molt. J. Wildl. Manage.

Jamieson, S.E., H.G. Gilchrist, F.R. Merkel, A.W. Diamond and K. Falk. In press. Endogenous reserve dynamics of Northern Common Eiders wintering in Greenland. Polar Biology.

Jamieson, S.E., H.G. Gilchrist, F.R. Merkel, K. Falk and A.W. Diamond. In press. An evaluation of methods used to estimate carcass composition of Common Eiders. Wildl. Biol.

Kenyon, J.K., B.D. Smith and R.W. Butler. In press. Can redistribution of breeding colonies on a landscape mitigate changing predation danger? J. Avian Biol.

Lewis, T.L., D. Esler and W.S. Boyd. In press. Foraging behaviours of Surf and White-winged Scoters in relation to clam density: inferring food availability and habitat quality. Auk 125.

McKinney, M.A., L.S. Cesh, J.E. Elliott, T.D. Williams, D.K. Garcelon and R.J. Letcher. In press. Brominated flame retardants and halogenated phenolic compounds in North American west coast Bald Eaglet (*Haliaeetus leucocephalus*) plasma. Env.Tox. Chem.

Merkel, F.R., S.E. Jamieson, K. Falk and A. Mosbech. In press. The diet of Common Eiders wintering in Nuuk, southwest Greenland. Polar Biology.

Merkel, F.R., A. Mosbech, C. Sonne, A. Flagstad, K. Falk and S.E. Jamieson. In press. Local movements, home ranges and body condition of Common Eiders wintering in Southwest Greenland. Ardea.

Middleton, H.A., D.J. Green and E.A. Krebs. In press. Fledgling begging and parental responsiveness in American dippers (*Cinclus mexicanus*). Behaviour.

Miller, E.H., J. Williams, S.E. Jamieson, H.G. Gilchrist and M.L. Mallory. In press. Allometry, variation, and bilateral asymmetry of an internal sexually-selected structure: The vocal tract of Common Eiders (*Somateria mollissima*) and King Eiders (*S. spectabilis*). J. Avian Biol.

Mulcahy, D.M., K.A. Burek and D. Esler. In press. Histology of fabric collars from percutaneous antennas on intracoelomic radio transmitters implanted in harlequin ducks. Journal of Avian Medicine and Surgery 19.

Nicholls, J.A., A.A. Austin, D.C. Pavlacky and D.J Green. In press. Characterisation of polymorphic microsatellites in the logrunner *Orthonyx temminckii* (Aves: Orthonychidae). Mol. Ecol. Notes.

Norris, D.R., D.B. Lank, J. Pither, D. Chipley, R.C. Ydenberg and T.K. Kyser. In press. Trace element profiles as unique identifiers of western sandpiper (*Calidris mauri*) populations. Can. J. Zool.

Regehr, H.M., M.S. Rodway, M.J.F. Lemon and J.M. Hipfner. In press. Recovery of the Ancient Murrelet colony on Langara Island, British Columbia, following eradication of introduced rats. Marine Ornithol.

Rowland, E., O.P. Love, J.J. Verspoor and T.D. Williams. In press. Manipulating maternal quality reveals developmental sensitivity in the smaller sex of a passerine bird. J. Avian Biol.

Salvante, K.G. In press. Techniques for the study of integrated immune function in birds. Auk.

Salvante, K.G., G. Lin, R.L. Walzem and T.D. Williams. In press. What comes first, the zebra finch or the egg? Temperature-dependent reproductive, physiological and behavioural plasticity in egg-laying zebra finches. J. Exp. Biol.

Taylor, C.M. and D.R. Norris. In press. Predicting conditions for migration: effects of density dependence and habitat quality. Biol. Let.

Verspoor, J., O. Love, O. Rowland, E. Chin and T.D. Williams. In press. Sex-specific development of avian flight performance under experimentally altered rearing conditions. Behav. Ecol.

Wagner, E.C. and T.D. Williams. In press. Experimental (anti-estrogen mediated) reduction in egg size negatively affects offspring growth and survival. Physiological and Biochemical Zoology.

Williams, T.D., N. Warnock, J. Takekawa and M.A. Bishop. In press. Flyway scale variation in plasma triglyceride levels as an index of refueling rate in spring migrating Western Sandpipers. Auk.

Zharikov, Y., D.B. Lank and F. Cooke. In press. Influence of landscape structure on nest site selection and breeding success in a threatened Alcid, the marbled murrelet: management implications. J. Appl. Ecol.

**Submitted**

Addison, B. Submitted. Different shell traits of the marine mussel *Mytilus trossulus* (Gould 1850) mediate predation risk by crabs and seastars. J. Shellfish Res.

Addison, B., Z.M. Benowitz-Fredricks, J.M. Hipfner and A.S. Kitaysky. Submitted. Two species of oceanic birds that lay single-egg clutches do not adjust yolk androgens to environmental conditions. Gen. Comp. Endocrinol.

Addison, B., A.S. Kitaysky and J.M. Hipfner. Submitted. Sex allocation in the single-chick broods of rhinoceros auklets: test of environment, mate quality and female condition hypotheses. Behav. Ecol.

Albert, C.A., T.D. Williams, V. Lai, W.R. Cullen, C.A. Morrissey and J.E. Elliott. Submitted.

Dose dependant uptake, elimination and toxicity of monosodium methanearsonate (MSMA) in adult Zebra Finches (*Taeniopygia guttata*). Env.Tox. Chem.

Arcese, P., A.E. Burger, C.L. Staudhammer, J.P. Gibbs, E. Selak, G.D. Sutherland, J.D. Steventon, S.A. Fall, D.F. Bertram, I.A. Manley, S.E. Runyan, W.L. Harper, A. Harfenist, B.K. Schroeder, D.B. Lank, S.A. Cullen, J.A. Deal, D. Lindsay and G. Jones. Submitted. Monitoring designs to detect population declines and identify their cause for the Marbled Murrelet. Can. J. For. Res.

Ball, J.R., J.A. Schmutz and D. Esler. Submitted. Pre-fledging survival of Red-throated Loons in Alaska in response to variation in energy consumption and parental attendance. Avian Cons. Ecol.

Bond, J.C., D. Esler and K.A. Hobson. Submitted. Isotopic evidence for sources of nutrients allocated to clutch formation by harlequin ducks. Condor.

Bond, J.C., D. Esler and T.D. Williams. Submitted. Breeding propensity of harlequin ducks *Histrionicus histrionicus* estimated using yolk precursors and radio telemetry. Auk.

Davies, W.E. Submitted. Taking stable isotopes into the field: methods for calculating field-based discrimination factors. Oecologia.

Evans Ogden, L.J., S. Bittmann, D.B. Lank and F.C. Stevenson. Submitted. Factors influencing use of farmland habitat by shorebirds wintering in the Fraser River Delta, Canada. Agric., Ecosys. Environ.

Fernández, G.J. and D.B. Lank. Submitted. Sex differences of non-breeding western sandpipers (*Calidris mauri*) in foraging behavior and susceptibility to interference. Ibis.

Gillis, E.A., D.J. Green, C.A. Morrissey and H.A. Middleton. Submitted. Reproduction and survival of migratory and sedentary American dippers: implications for the evolution of migration. Ecology.

Gorman, K.B., D. Esler and T.D. Williams. Submitted. Plasma yolk precursor dynamics during egg production by female Greater Scaup (*Aythya marila*): characterization and indices of reproductive state. Physiological and Biochemical Zoology.

Gurd, D.B., D. Kinakin, D. Siu, J. Chandler and M. Mo. Submitted. Estimating local species richness from historical range maps: how robust are methods to errors in species' distributions? Global Ecol. Biogeogr.

Hipfner, J.M., and J.L. Greenwood. Submitted. Breeding biology of the Common Murre at Triangle Island, British Columbia, 2002-2006. Northwestern Naturalist.

Hipfner, J.M., J. Dale and K.J. McGraw. Submitted. Variation in yolk carotenoid profiles in a marine bird community: links to foraging strategies and breeding success. J. Anim. Ecol.

Kirk, M., D. Esler and W.S. Boyd. Submitted. Variation in morphology and availability of mussels in an aquaculture-modified landscape: implications for molluscivorous sea ducks. Mar. Ecol. Prog. Ser.

Love, O.P., K.E. Wynne-Edwards, L. Bond and T.D. Williams. Submitted. Within- and among-clutch variation in levels of yolk corticosterone in the European starling. Hormones and Behavior.

Malt, J.M. and D.B. Lank. Submitted. Temporal dynamics of edge effects on nest predation risk on the marbled murrelet. Biol. Conserv.

Merkel, F.R., A. Mosbech, S.E. Jamieson and K. Falk. Submitted. The diet of King Eiders wintering in Nuuk, Southwest Greenland. Polar Biology.

Mulcahy, D.M. and D. Esler. Submitted. Survival of captive and free-ranging harlequin ducks (*Histrionicus histrionicus*) following surgical liver biopsy. Journal of Avian Medicine and Surgery.

Nilsson, P.B., T.E. Hollmen, S. Atkinson, K.L. Mashburn, P.A. Tuomi, D. Esler, D.M. Mulcahy

and D.J. Rizzolo. Submitted. Effects of ACTH, capture, and short term confinement on corticosterone concentrations in harlequin ducks (*Histrionicus histrionicus*). Comparative Biochemistry and Physiology Part A.

Pomeroy, A.C., D.A. Acevedo Seaman, R.W. Butler, R.W. Elner, T.D. Williams and R.C. Ydenberg. Submitted. Management implications of feeding-danger tradeoffs in site selection by migrants. J. Appl. Ecol.

Reneerkens, J., J.B. Almeida, D.B. Lank, J. Jukema, R.B. Lanctot, R.I.G. Morrison, W.I.C. Rijpstra, D. Schamel, H. Schekkererman, J.S. Sinninghe Damsté, P.S. Tomkovich, D.M. Tracy, I. Tulp and T. Piersma. Submitted. Parental role division predicts avian preen wax cycles: a comparative study of sandpipers. Ibis.

Salvante, K.G., F. Vézina and T.D. Williams. Submitted. Evidence for within-individual energy reallocation in cold-challenged, egg-producing birds. J. Exp. Biol.

Schamber, J.L., D. Esler and P.L. Flint. Submitted. Evaluating the validity of using unverified indices of body condition. Ecology.

Waterhouse, F.L., A. Donaldson, D.B. Lank, P.K. Ott and E.A. Krebs. Submitted. Using air photos to interpret quality of Marbled Murrelet nesting habitat in British Columbia. B.C. J. Environ. Manag.

Ydenberg, R.C., R.W. Butler and D.B. Lank. Submitted. Effects of predator landscapes on the evolutionary ecology of routing, timing and molt by long-distance migrants. J. Avian Biol.

Zera, A.J., L.G. Harshman and T.D. Williams. Submitted. Evolutionary endocrinology: the developing synthesis between endocrinology and evolutionary genetics. Ann. Rev. Ecol. Evol. System.

**2007**

Addison, B., R.C. Ydenberg and B.D. Smith. 2007. Tufted puffins (*Fratercula cirrhata*) respond to predation danger during colony approach flights. Auk 124**:** 63-70.

Gorman, K.B., P.L. Flint, D. Esler and T.D. Williams. 2007. Ovarian follicle dynamics of female Greater Scaup during egg production. J. Field Ornithol. 78**:** 64-73.

Gurd, D.B. 2007. Predicting resource partitioning and community organization of filter-feeding dabbling ducks from functional morphology. Amer. Nat. 169**:** 334-343.

Lewis, T.L., D. Esler and W.S. Boyd. 2007. Effects of predation by sea ducks on clam abundance in soft-bottom intertidal habitats. Mar. Ecol. Prog. Ser. 329**:** 131-144.

Lewis, T.L., D. Esler and W.S. Boyd. 2007. Foraging behaviours of surf scoters and white-winged scoters at spawning sites of Pacific herring. Condor 109**:** 216-222.

Major, H.L., I.L. Jones, M.R. Charette and A.W. Diamond. 2007. Variations in the diet of introduced Norway rats (*Rattus norvegicus*) inferred using stable isotope analysis. J. Zool., Lond. 271**:** 463-468.

Mathot, K., B.D. Smith and R.W. Elner. 2007. Latitudinal clines in food distribution correlate with differential migration in the western sandpiper. Ecology 88**:** 781-791.

Ost, M., C.W. Clark, M. Kilpi and R. Ydenberg. 2007. Parental effort and reproductive skew in coalitions of brood-rearing female common eiders. Am. Nat. 169.

Salvante, K.G., G. Lin, R.L. Walzem and T.D. Williams. 2007. Characterization of VLDL particle size diameter dynamics in relation to egg production in a passerine bird. J. Exp. Biol. 210**:** 1064-1074.

Zimmerman, K. and J.M. Hipfner. 2007. Egg size, eggshell porosity, and incubation period in the marine bird family Alcidae. Auk 124**:** 307-315.

**2006**

Acevedo Seaman, D.A., C.G. Guglielmo, R.W. Elner and T.D. Williams. 2006. Landscape-scale physiology: Site differences in refueling rates indicated by plasma metabolite analysis in

free-living migratory sandpipers. Auk 123**:** 563-574.
Bond, J.C. and D. Esler. 2006. Nutrient acquisition by female Harlequin Ducks prior to spring migration and reproduction: evidence for body mass optimization. Can. J. Zool. 84**:** 1223-1229.
Esler, D., S.A. Iverson and D.J. Rizzolo. 2006. Genetic and demographic criteria for defining population units for conservation: the value of clear messages. Condor 108**:** 481-484.
Falk, K., F.R. Merkel, K. Kampp and S.E. Jamieson. 2006. Embedded lead shot and infliction rates of Common Eiders *Somateria mollissima* and King Eiders *S. spectabilis* wintering in southwest Greenland. Wildl. Biol. 12**:** 257-265.
Fernandez, G.J. and D.B. Lank. 2006. Sex, age, and body size distributions of Western Sandpipers during the nonbreeding season with respect to local habitat. Condor 108**:** 547-557.
Gjerdrum, C., G.M. Yanega and D.F. Bertram. 2006. Bill harnesses on nestling Tufted Puffins influence adult provisioning behaviour. J. Field Ornithol. 77**:** 329-334.
Gurd, D.B. 2006. Filter-feeding ducks (*Anas*) can actively select particles by size. Zool. 109**:** 120-126.
Heath, J.P. 2006. Quantifying temporal variability in population abundances. Oikos 115**:** 573-581.
Heath, J.P., H.G. Gilchrist and R.C. Ydenberg. 2006. Regulation of stroke pattern and swim speed across a range of current velocities: diving by common eiders wintering in polnyas in the Canadian Arctic. J. Exp. Biol. 209**:** 3974-3983.
Hipfner, J.M., A.J. Gaston and B.D. Smith. 2006. Regulation of provisioning in the Thick-billed Murre (*Uria lomvia*). Can. J. Zool. 84**:** 931-938.
Iverson, S.A., W.S. Boyd, D. Esler, D.M. Mulcahy and T.D. Bowman. 2006. Comparison of the effects and performance of four radio transmitter types for use with scoters. Wildl. Soc. Bull. 34**:** 656-663.
Iverson, S.A. and D. Esler. 2006. Site fidelity and the demographic implications of winter movements by a migratory bird, the harlequin duck. J. Avian Biol. 37**:** 219-228.
Kenyon, J.K. 2006. Use of vanishing bearings to locate new wading bird colonies. Waterbirds 29**:** 203-210.
Major, H.L., I.L. Jones, G.V. Byrd and J.C. Williams. 2006. Assessing the effects of introduced Norway rats (*Rattus norvegicus*) on reproductive performance and survival of Least Auklets (*Aethia pusilla*). Auk 123**:** 681-694.
Merkel, F.R., K. Falk and S.E. Jamieson. 2006. Impact on body condition of embedded lead shot in Common Eiders *Somateria mollissima*. J. Wildl. Manage. 70**:** 1644-1646.
Morgan, T.C., C.A. Bishop and A.M. Bezener. 2006. Temporal fluctuations in abundance of Brown-headed Cowbirds and their hosts in riparian habitat in the Okanagan Valley, British Columbia, Canada. J. Field Ornithol. 77**:** 444-451.
Muzaffar, S.B., R.C. Ydenberg and I.L. Jones. 2006. Avian influenza: an ecological and evolutionary perspective for waterbird scientists. Waterbirds 29**:** 243-257.
Niehaus, A.C. and R.C. Ydenberg. 2006. Ecological factors associated with the breeding and migratory phenology of high-latitude breeding western sandpipers. Polar Biology DOI**:** 10.1007/s00300-006-0154-1.
Norris, D.R. and C.M. Taylor. 2006. Predicting the consequences of carry-over effects on migratory populations. Biol. Let. 2**:** 148-151.
Pomeroy, A.C., R.W. Butler and R.C. Ydenberg. 2006. Experimental evidence that migrants adjust usage at a stopover site to trade off food and danger. Behav. Ecol. 17**:** 1041-1045.
Rodway, M.S. 2006. Have winter spacing patterns of Harlequin Ducks been partially shaped by sexual selection? Waterbirds 29**:** 415-426.

Sydeman, W.J., R.W. Bradley, P. Warzybok, C.L. Abraham, J. Jahncke, K.D. Hyrenbach, V. Kousky, J.M. Hipfner and M.D. Ohman. 2006. Planktivorous auklet *Ptychoramphus aleuticus* responses to ocean climate 2005: Unusual atomspheric blocking? Geophysical Research Letters 33, L22S09, DOI**:** 10.1029/2006GL026736.

Vézina, F., J.R. Speakman and T.D. Williams. 2006. Individually-variable energy management strategies in relation to energetic costs of egg production. Ecology 87**:** 2447-2458.

White, A.F., J.P. Heath and B. Gisborne. 2006. Seasonal timing o f Bald Eagle attendance and influence on activity budgets of Glaucous-winged Gulls in Barkley Sound, British Columbia. Waterbirds 29**:** 497-500.

Zydelis, R., D. Esler, W.S. Boyd, D. Lacroix and M. Kirk. 2006. Habitat use by wintering surf and white-winged scoters: effects of environmental attributes and shellfish aquaculture. J. Wildl. Manage. 70**:** 1754-1762.

## B. Book Chapters or Conference Proceedings

Dale, J. In press. Intraspecific variation in bird colors. In: *Bird Coloration, Function and Evolution*, Hill, G.E.and K.J. McGraw, eds. Cambridge: Harvard University Press.

Galdikas, B.M. and W.E. Davies. In press. Orangutan reproductive strategies: players, tactics and games. In: *All apes, great and small*, eds.: Springer-Verlag.

Ydenberg, R.C. In press. Provisioning. In: *Foraging*, Stephens, D.W., J. Brownand R.C. Ydenberg, eds. Chicago: University of Chicago Press.

Ydenberg, R.C., D.W. Stephens and J. Brown. In press. Foraging: an overview. In: *Foraging*, Stephens, D.W., J. Brownand R.C. Ydenberg, eds. Chicago: University of Chicago Press.

Gilchrist, H.G., J.P. Heath, L. Arragutainaq, G.J. Robertson, K. Allard, S. Gilliland and M. Mallory. 2006. Combining science and local knowledge to study common eider ducks wintering in Hudson Bay. In: *Climate change: linking traditional and scientific knowledge*, Riewe, R. and J. Oakes, eds., pp. 284-303. Winnipeg: Univ. Manitoba Aboriginal Issues Press.

Stephens, D.W., J. Brown and R.C. Ydenberg. In press. Foraging. Chicago: University of Chicago Press.

Lank, D.B. and S. Nebel. 2006. Cross-cutting research on a flyway scale - beyond monitoring. In: Waterbirds Around the World, Boere,G.C., C.A.Galbraith and D.A. Stroud, eds. pp. 107-112. Edinburgh: TSO Scotland Ltd..

## C. Other Publications

Green, D.J. and S. Quinlan. 2007. Evaluating the health of riparian habitats: water use decisions, density and breeding performance of Yellow Warblers in Revelstoke Reach, B.C. Report to: Columbia Basin Fish and Wildlife Compensation Program, BC. pp.

## D. Theses

Davies, W.E. 2007. Reproductive foraging ecology of five sympatrically breeding Alcid seabirds. MSc, Simon Fraser University, Burnaby. pp.

Albert, C.A. 2006. Uptake, elimination and toxicity of an arsenic-based pesticide in an avian system. MSc, Simon Fraser University, Burnaby. pp.

Kirk, M. 2006. Movement and foraging behaviours of Surf Scoters wintering in habitats modified by shellfish aquaculture. MSc, Simon Fraser University, Burnaby. pp.

LeBourdais, S.V. 2006. Harlequin duck (*Histrionicus histrionicus*) density on rivers in south-western British Columbia in relation to food availability and indirect interactions with

fish. MSc, Simon Fraser University, Burnaby. pp.
Middleton, H.A. 2006. Post-fledging behaviour and dispersal in American dippers. MSc, Simon Fraser University, Burnaby. pp.
Pomeroy, A.C. 2006. Feeding and predation danger tradeoffs in stopover site usage by Western Sandpipers (*Calidris mauri*). PhD, Simon Fraser University, Burnaby. pp.
Salvante, K.G. 2006. What comes first, the Zebra Finch or the egg? Resource allocation during avian egg production. PhD, Simon Fraser University, Burnaby. pp.