ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY

2015-2016

Department of Biological Sciences
Simon Fraser University

http://www.sfu.ca/biology/wildberg/NewCWEPage/CWEnewTestHome.htm

Dr. Ronald C. Ydenberg, Director

TABLE OF CONTENTS

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 and Climate Change 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 and Climate Change 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 Environment and Climate Change Canada (Canadian Wildlife Service, CWS, and Science and Technology, S&T) 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, Associate Professor
Dov Lank	University Research Associate / Adjunct Professor
Dan Esler	USGS Scientist / Adjunct Professor
Mark Hipfner	ECCC Research Scientist / Adjunct Professor
Doug Bertram	ECCC Research Scientist
Christine Bishop	ECCC Research Scientist / Adjunct Professor
Sean Boyd	ECCC Research Scientist / Adjunct Professor
Rob Butler	ECCC Research Scientist Emeritus/ Adjunct Professor
Bob Elner	ECCC Research Scientist Emeritus/Adjunct Professor
John Elliott	ECCC Research Scientist / Adjunct Professor
Rhonda Millikin	ECCC Head, Population Assessment/Adjunct Professor
Fred Cooke (retired)	Emeritus Chairholder

2. Research Group

Postdoctoral Fellows	***PhD (in progress)***	***MSc (in progress)***	***Staff***
Tom Flower	Marie-Hélène Burle	Seth Bennett	Kathryn Coukell, CWE Admin. Asst.
Cailin Xu	Allison Cornell	Chloe Boyton	Connie Smith, CWE Research Tech
	Philina English	Danielle Dagenais	
Undergrads	David Hope	Eveling Fernandez	***Visitors***
Jeremiah Kennedy	Richard Johnston	Cybele Heddle (MET)	Pat Baird
	Emily McAuley	Matthew Hepp	Lia Hemerik, Univ. Wageningen
	Michal Pavlik	Olga Lansdorp	Roxana Torres, UNAM (Mexico)
	Marinde Out	Lauren MacFarland	
	Sarah Thomsen	Spencer Morran (MET)	
	Simon Valdez	Mitchell Serota	
	Jeff Yap	Megan Willie	
	PhD(defended)	***MSc (defended)***	
	Birgit Schwarz	Annie Ellison	
		Maria Yu (MET)	

B. Steering Committee

Name	*Position*	*Affiliation*
Robert Elner	Emeritus Scientist	*EC*
David Green	CWE faculty (non-voting)	*SFU*
Mark Hipfner	Research Scientist	*EC*
Elsie Krebs	Research Manager, Western Canada	*EC*
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/NewCWEPage/CWEnewTestHome.htm

or contact Ron Ydenberg at ydenberg@sfu.ca.

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 (address above). Publications and theses are listed at the end of this report. The personnel also can be contacted via the website.

A. Species at Risk

1. Marbled Murrelet (Threatened, COSEWIC)

SFU's research on threatened Marbled Murrelets continues to address issues of direct conservation and management concern for this listed species. This project examining the biology of the threatened and elusive marbled murrelet, started by CWE chair emeritus Fred Cooke, continued for its 21th year lead by Dov Lank, addressing evolving questions of management interest for this threatened species.

In addition to participation on the Canadian Marbled Murrelet Recovery team, Lank continued an analysis of the extensive radar traffic rate data sets that have been gathered in BC to address: (1) The utility of several methods of habitat suitability classification as predictors of local traffic rates during the breeding season, and (2) The magnitude of fragmentation effects on traffic rates, as an index of local breeding population size. These are designed to contribute towards a provincial review of these issues put together by Alan Burger.

A new initiative by CWE PDF Tom Flower addresses nest predation patterns by Stellar's Jays in the context of differences in forest configurations, edge types, and landscapes relevant to nesting murrelets, as defined by earlier research by Lank and MSc student Josh Malt. Tom established a tame population of Jays in the UBC experimental forest and is conducting studies of nest predation rates at that site.

The CWE facilitated a radiotracking study by ECCC's Doug Bertam *et al*. in association with proposed LNG facility construction near Kitimat BC, published in Marine Ornitology.

2. Eastern WhipPoorWill (Threatened, COSEWIC)

The Eastern WhipPoorWill was designated as a Threatened species by COSEWIC in 2009. Philina English, a PhD candidate co-supervised by Dr David Green and Joe Nocera (Ontario

Ministry of Natural Resources), is examining how land use change and diet impact the distribution, abundance and breeding performance of Eastern WhipPoorWill in Ontario. She has demonstrated 1) that changes in the distribution of whippoorwill from the first and second Ontario Breeding Bird Atlas are not explained by increases in forest cover as forests regrow on abandoned agricultural land, 2) population declines over the last century are associated with changes in the nitrogen isotope signatures in winter grown and breeding ground tissues that reflect changes in their diet, and 3) prey abundance (beetle and moths) predicts the presence and abundance of whippoorwills at two spatial scales (the regional and local). In collaboration with Mike Cadman (CWS), she has used geolocators to determine the migration routes of whippoorwills breeding at three sites, (QUBS in the Frontenac arch, Torrance Barrens Dark Sky Reserve in the southern Muskoka, and Long Point on Lake Erie. She has submitted the first Chapter of her thesis (1 and 3 above) to Landscape Ecology and will defend her thesis in the coming year.

3. Lewis's Woodpecker (Threatened, COSEWIC)

Lewis's Woodpecker was designated as a Threatened species by COSEWIC in 2010. Lauren MacFarland, an MSc student in the Green lab co-supervised by Nancy Mahony (EC), will defend a thesis examining the habitat specific demography of Lewis's woodpeckers in the Summer 2016. She has demonstrated consistent differences in the productivity of Lewis's woodpeckers in riparian cottonwoods, open ponderosa pine and burned habitat within the Okanagan. Her analyses suggest these differences can be attributed to differences in the number of cavities available as nest-sites, rather than differences in the community of secondary cavity nesters (native and non-native), or differences in prey availability. Using a long-term Lewis's woodpecker nest monitoring dataset she has also demonstrated that there are annual and regional differences in the loss and re-use of nest cavities among habitat types that need to be investigated further.

4. Yellow-breasted Chat (Endangered, COSEWIC)

Tim Forrester (MSc 2015) investigated how restoration efforts in riparian habitat within the Okanagan influenced the abundance and demography of chats and other riparian dependent songbirds over the last decade. His work, conducted in collaboration with Dr. Christine Bishop (EC) demonstrated that restoration efforts have led to an increase in the abundance of yellow-breasted chats, and that pairs in newly occupied habitat have similar productivity to other pairs. However, restoration efforts for chats did not lead to significant increases in the abundance of other riparian dependent songbirds. The first chapter of his thesis has been submitted for publication in Restoration Ecology.

5. Scripp's Murrelet (Vulnerable, IUCN)

Santa Barbara Island in the Channel Islands California provides breeding habitat for 20% of the world's population of Scripps murrelets (global population = 2800 pairs). Scripp's murrelets on Santa Barbara may be depredated by barn owls, but barn owls also prey on deer mice that are known to be a major cause of egg failure. Management of barn owls may therefore have unexpected and unintended consequences for murrelets. Sarah Thomsen (PhD student in the Green lab) used data collected from 2010-2014 to show that barn owls can have both direct (negative) and indirect (positive) effects on Scripp's murrelets. She has submitted chapters of her thesis to Ecology and Global Change Biology and hopes to defend her thesis in 2016..

6. Tuamotu Sandpiper (Endangered, IUCN)

The CWE is lending its expertise in shorebird biology to support a conservation project on the highly endangered Tuamotu Sandpiper, in partnership with the USF&WS (Rick Lanctot, Alaska region), Island Conservation, the French Polynesian Regional Division for the Environment (DIREN), a local ornithological NGO (the Society of Polynesian Ornithologists, SOP-MANU), and the Critical Ecosystems Partnership Fund (CEPF), administered by Conservation International.

Once widespread across the South Pacific, this species is now found on only 4 atolls, with a world population of ca. 1200 individuals. PhD student Marie-Hélène Burle has spent >16 months over 4 field seasons conducting the first study of the species' biology. Her information on habitat usage, diet, and social behaviour is being used to support reintroduction planning for the species onto atolls where rats have been or will be removed, in addition to documenting fascinating novel adaptations by an arctic bird to a tropical environment.

7. Cassin's Auklet (Special Concern, COSEWIC) - see Section V.D.1, Coastal Studies of Seabirds.

B. Human Impacts on Birds

1. Contaminants and Toxicology

a. Barrow's Goldeneye Exposure to Contaminants in British Columbia

In collaboration with partners including Environment Canada, Stantec, and USGS, MSc student Megan Willie is conducting a project to evaluate variation in cytochrome P4501A induction, as a measure of exposure to hydrocarbons, in wintering Barrow's goldeneyes. Goldeneye samples were collected in the Douglas Channel area of north coastal BC in April 2014 and mussel samples were collected in those same sites the following summer. Both goldeneye and mussel samples were collected in Burrard Inlet in 2015. Megan is defending her thesis in April 2016, and her results indicate that the mussel-goldeneye food chain offers a sensitive, multi-trophic level system for evaluating hydrocarbon contamination. This is useful for monitoring chronic pollution and for determining effects and recovery from larger releases.

b. Developmental neurotoxicity of mercury in birds

Maria Yu (MET student) and Margaret Eng (post-doc) published results of a study on effects of in ovo dosing of mercury (Hg) via egg injection in the zebra finch, a model passerine with small egg size (1 g). Experimental work confirmed a dose-dependent effect on hatching success, i.e. embryotoxicity, at ecological relevant Hg levels. However, in ovo exposure to Hg had no detectable longer-term post-hatching effects on chick mass, hematological traits, male courtship song quality, mating behavior in both sexes, or female reproductive performance. This work was extended by Spencer Morran (MET student) who is investigating effects of Hg exposure during the post-hatching (chick) phase only. A third, new, MET student (Cybele Heddle) will complete this 5-year project by looking at the combined effects of embryonic and nestling Hg exposure.

c. Assessment of in vivo effects of Chemical Management Plan (CMP) priority chemicals in passerines

Margaret Eng (PhD 2013) continued to work as a post-doc in the Williams' Lab collaborating with Environment and Climate Change Canada scientists including John Elliott, Robert Letcher, Christine Bishop, Doug Crump and Stephanie Jones, and other toxicologists (e.g. Ken Drouillard, Windsor) on ECCC-funded projects. These included a) assessment of metabolism and effects of organic flame retardants in birds, using the zebra finch as a model passerine species.; b) focusing on compounds identified as priorities for assessment by the CMP, including organophosphorous (e.g. TBOEP) and novel brominated (e.g. TBBPA-BDBPE) flame retardants, which are increasing in production and use following the regulation of the PBDE flame retardants, and have been detected in avian wildlife; c) an experimental field study using egg injections in gray catbirds to verify predictions based on genotyping of the aryl-hydrocarbon receptor (AhR) that the catbird is highly sensitive to dioxin-like compounds; and d) on-going surveillance and monitoring of CMP priority compounds in the key bio-indicator species, the European starling (*Sturnus vulgaris*) through egg collection and contaminant analysis at several sites in the Lower Mainland.

2. Reservoirs and Water Use

a. 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. CWE, working in collaboration with BC Hydro and Cooper-Beauchesne and Associates, has examined how reservoir operations on the Columbia River between 2004-2015 impact the population dynamics of yellow warblers, a species identified by Partners in Flight as a focal species for riparian habitat. Most recently, Matt Hepp (MSc candidate) has developed an individual based model using detailed data on arrival dates, clutch and brood sizes, daily nest survival, and re-nesting probabilities to examine how different reservoir water use decisions influence productivity on the breeding grounds. He estimated that reservoir operations reduce productivity (fledglings per female per year) by 25%. However, this underestimates the impact of reservoir operations as he also found that post-fledging survival was far lower in territories inundated by water than in territories not impacted by rising reservoir water levels. Matt will defend his thesis and submit his two chapters for publication in 2016.

3. Agricultural Effects

a. Fragmentation, edge effects of orchards and vineyards and the distribution and abundance of songbirds in shrub-steppe habitat in the Okanagan.

Habitat loss alters the configuration of the remaining habitat patches, increasing the ratio of edge: core habitat, and alters the composition of the landscape surrounding remnant patches. Elly Knight (MSc 2013) examined how loss of habitat in the Okanagan due to agricultural and urban development influences the composition of the avian community within shrub-steppe habitat adjacent to orchards and vineyards. She found that bird communities differed in edge and core habitat primarily due to the presence of generalist species that used adjacent agricultural habitat (Knight et al. 2016). Shrubsteppe songbird nest densities were also lower in edge than interior habitat. Nest success, however, was only lower in edge habitat adjacent to orchards. (Knight et al. 2014). This project was conducted in collaboration with Dr. Nancy Mahony.

b. Use of vineyards by bats in the Okanagan Valley

British Columbia's South Okanagan has an expanding wine industry and supports the greatest diversity of bats in Canada. CWE MSc student Danielle Dagenais has been studying the use of vineyards by bats in the South Okanagan Valley to assess the amount of foraging habitat available to bats in this fragmented landscape. Using a radar-acoustic system, designed by CWE Adjunct Professor Rhonda Millikin, she assessed bat movements in the South Okanagan to determine if vineyards provide habitat for bats. She surveyed bat activity in six matched pairs of vineyards and adjacent natural sagebrush habitats. By evaluating the characteristics of radar tracks and combining radar and acoustic data, she compared bat activity over the habitats. Target parameters (height, speed, and relative size measured as Signal-to-Noise ratio) had similar distributions in both habitats. There was no statistical difference between habitats in mean target track length per unit area or in the mean number of acoustic "individual bat passes", nor did these measures differ between surveys in early (bat pregnancy), middle (lactation) and late summer (pup fledging). Her results suggest that the usage by bats of vineyards and natural habitats is similar. Her results will help with the conservation and management of bats in the Okanagan. The data can be incorporated into management strategies with viticulturists to enhance bat habitat in the area while also potentially reducing pest management costs. Danielle plans to defend her thesis in April 2016.

c. Breeding phenology and productivity of an invasive, agricultural specialist, the European starling

European starlings are an invasive species of considerable economic importance because of their agricultural and urban impact (as well as being the focal species for Environment Canada's terrestrial contaminant monitoring under the Chemical Management Plan). However, they are also agricultural specialists associated with less-intensive pasture (short mown or grazed fields), and are dependent on one main prey type (Tipulid larvae or leatherjackets – another introduced pest species) for successful reproduction. As such they could be a useful monitoring species for changes in agricultural land-use and intensification. Our long-term study of the ecological physiology of European starlings marked its 14th year at two sites in the Fraser Valley: Langley (140 nest boxes) and Glen Valley (60 nest boxes); funded largely from sources outside of CWE.

In 2015 we established a NSERC-funded automated radio-tracking system with 5 radio towers to track birds 24/7 during breeding in order to monitor their movement ecology and habitat use. Our current focus continues to be on the broader ecological and agricultural context of reproduction, measuring prey (Tipulid sp.) density in fields, prey composition of diet, foraging (using radio tracking) during chick provisioning, and physiological determinants of chick quality at fledging, in relation to breeding success and physiological condition. An example of the potential importance of this work was the appearance in 2015 of a "novel" prey item (soldier flies) which accounted for 60% of prey items fed to chicks, having never been recorded in the diet in the past 15 years. We are monitoring the impact of introduction of this nutritionally low-quality prey item has on starling breeding productivity. This work involves Allison Cornell (PhD) and Mitchell Serota (MSc) and an army of undergraduate students (several funded by Under-graduate Student Research Awards).

d. Landscape-level determinants of breeding distribution, productivity and foraging in Barn Swallows and Tree Swallows

Farmland and grassland bird species, including aerial insectivores, have been declining for decades in Europe and North America. Recent studies have cast doubt on the idea that there is a single, global cause for all population declines, e.g. there is only weak cross-correlation in

population trajectories in co-occurring aerial insectivore species. This suggests there are highly variable, and complex, spatio-temporal patterns of population change perhaps related to region-specific environmental conditions (e.g. climate, land use). In 2015 we completed a third field season studying breeding phenology and productivity of two co-occurring aerial insectivores, barn and tree swallows, at 11 sites (livestock, arable, non-agriculture) in the Metro Vancouver region. Specific objectives are to, a) assess effects of livestock presence, and non-agricultural and agricultural land use on breeding density and breeding success; b) to measure the abundance, diversity, and phenology of aerial arthropods in the different swallow breeding habitats, and c) study the potential of Grassland Set-Asides to provide high quality feeding habitat for Barn Swallows within an agricultural landscape. In addition, in 2015 we extended this project to look at post-fledging habitat use in juvenile birds using radio-tracking. This work is a collaboration with Nancy Mahony (Environment Canada), Bob Clarke (EC) and David Bradley (Bird Studies Canada) and currently involves two MSc students, Olga Lansdorp and Chloe Boynton.

C. Declining Avian Populations

1. Migratory Shorebirds

Populations of many species of shorebirds travel half the globe in the course of their annual migrations. Concern has been raised about apparent population declines of many species over the past two decades. The CWE is studying small calidrid sandpipers – principally Western and Least sandpipers, and Dunlin - to better understand the causes of these apparent declines.

Since its inception in 1993, the CWE has nurtured the development of the Western Sandpiper Research Network, including current CWE staff Ron Ydenberg, Dov Lank, and Tony Williams, EC's Barry Smith, and retirees Bob Elner and Rob Butler, as a platform for research on a hemispheric scale that can address migratory bird issues. We now cooperate with ECCC's Mark Drever (Delta), whose remit includes shorebird issues, and with Bird Studies Canada representatives. The CWE maintains substantial science capacity for this group of birds. 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 these long-distance Neotropical migrants. We have pursued and aided fieldwork at three breeding sites, several migration locations, and five wintering sites.

a. Shorebird Breeding Biology

CWE PhD student Birgit Schwarz defended her PhD addressing the population structure of Western Sandpipers, using nuclear and mitochondrial population genetics from breeding and non-breeding grounds, and studies of song structure, in January 2016. Birgit documented a weak pattern of isolation by distance among Western sandpiper breeding populations, and little migratory connectivity. Her findings are consistent with earlier studies by CWE PhD Samanatha Franks based on stable isotope data that suggested little connectivity.

In 2015 the CWE completed its field participation in the Arctic Shorebird Demographic Network, an arctic-wide collaborative program that includes over a dozen sites in Alaska and arctic Canada utilizing comparable protocols; the CWE contributed primarily at Nome, AK. By the end of the year, 5 highly collaborative manuscripts dealing with: breeding phenology relative to food supplies, changes in phenology between the mid-1990s and 2010s, migration patterns based on geolocator tracks from >140 Semipalmated sandpipers, the effects of geolocators on individual

survivorship, and a review of incubation strategies of biparental species were in progress utilizing information obtained at Nome.

Graduated MSc student Willow English prepared a MS on the effects of exclosures on nest success rates of incubating red-neck phalaropes, based on the Nome data from the 1990s and the 2010s.

b. Non-breeding biology

PhD student Richard Johnson, from Colombia, conducted a final field season examining non-breeding flight performance and aspects of the community ecology of wintering shorebirds in large riverine/estuary systems in southern Colombia. Richard prepared his first MS, describing factors influencing the location of roost sites for Whimbrils.

Eveling Tavera Fernandez, from Peru, conducted another successful field season at the end of 2014-spring 2015, capturing and resighting non-breeding shorebirds at Paracas, Peru, and submitted her first potential thesis manuscript, describing pre-migratory preparation and moult patterns of Semipalmated sandpipers. At the end of 2015, she returned to Peru for an additional field season involving local radiotracking and continued mark-resighting.

c. Population Biology

EC-sponsored PDF Cailin Xu's paper modeling population fluctuations of Pacific and Atlantic dunlin, based on a 35-year time series of Christmas Bird Counts, with respect to environmental variation and density dependent annual growth rates, was published. The analysis implies that substantial annual mortality is associated with storm systems during southward migration.

A second paper using these CBC Dunlin data was submitted for publication. The study shows how changes in regional distribution change from year to year in with respect to total population size and changes in falcon numbers (Ydenberg, Xu and Lank and former CWE staff Jenn Barret and visiting student Michiel Faber).

A third highly collaborative paper addresses issues related to perceived Semipalmated sandpiper population changes, which has been of substantial concern, particularly in eastern Canada. This study brings together morphological data suggesting that wing lengths of semipalmated were longest around 1980 and have become smaller since that time. These data suggest alternative explanations for the population significance of changes in morphometrics previously reported at the Bay of Fundy. Authors and collaborators are CWE's Lank, Xu, Ydenberg plus ECCC staff members Cheri Gratto-Trevor, Paul Smith Julie Paquet, Christian Friis, retired ECCC biologists Guy Morrison and Peter Hicklin, plus several students and other academics.

A methodological paper designed to improve estimates of apparent survivorship by incorporating dispersal information, generated when former CWE Postdoc Caz Taylor was in Vancouver, was finally published, together with Lank and former CWE student and continued collaborator Brett Sandercock.

2. Neotropical Migrant Passerines

CWE initiated a long-term study on yellow warblers that migrate between western Canada and Mexico/Central America in 2004. This research conducted in collaboration with Dr. Elsie Krebs

(EC) takes a whole life cycle approach and includes work on the breeding grounds in Inuvik, NT, and Revelstoke, BC, on migration and on the wintering grounds in Jalisco, Mexico. Anna Drake (PhD 2013) investigated the relative importance of breeding conditions, winter conditions, and migration on the demography of Yellow warblers using the western flyway. She found that conditions on the wintering grounds did not explain variation in annual survival, and winter habitat use did not have a large effect on the subsequent reproductive success of birds breeding in Revelstoke or Inuvik (Drake et al. 2013, 2014a, 2014b). Breeding phenology of yellow warblers in Revelstoke and Inuvik is more likely to result from differences in the intrinsic quality of individuals than a carry-over effect of winter habitat use (Jones et al. 2014). Conditions during fall migration, however, had large effects on arrival dates, productivity and annual survival of yellow warblers (Drake et al. 2014a).

Simon Valdez completed his fieldwork in Mexico in 2015 and is currently writing up his thesis. Preliminary analysis suggests 1) the breeding origins of female yellow warblers influences winter habitat use in Mexico, and 2) winter habitat use influences the condition, departure dates and winter survival of Yellow warblers in Jalisco, Mexico.

Michal Pavlik initiated his PhD on this project that will 1) examine how wind conditions on migration interact with condiionson the breeding grounds to determine the timing of breeding and local productivity, 2) use the long-term data collected from 2005-2007 to examine how mortality rates vary across the annual cycle, and 3) determine if factors that explain vital rates at the local scale predict regional variation in population dynamics.

3. Sea Ducks

<u>*Barrow's Goldeneye Population Delineation*</u> – In collaboration with Sean Boyd of Environment Canada, we are using satellite telemetry to evaluate population structure, movements, site fidelity, and habitat use of Barrow's goldeneyes in western North America. Goldeneyes have been marked at a breeding site (Riske Creek, BC), 5 wintering sites (Indian Arm, BC; Douglas Channel, BC; Prince William Sound, Alaska; Juneau, Alaska; and Kachemak Bay, Alaska), and a molt site (Cardinal Lake, Alberta). 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.

4. Aerial Insectivores

See section V.A.2. Eastern WhipPoorWill *(Threatened, COSEWIC).*
See section V.B.3.d. Landscape-level determinants of breeding distribution, productivity and foraging in Barn Swallows and Tree Swallows.

D. Coastal Ecology

1. Coastal Studies of Seabirds

Coastal British Columbia supports large populations of many species of seabirds, for which Environment Canada has an important stewardship responsibility. The Triangle Island Seabird Research and Monitoring Station was established in 1994 as a centre for research devoted to understanding seabird ecology, aimed particularly at identifying and understanding environmental and demographic causes of population change so as to recommend appropriate conserva-

tion 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 throughout the year.

Our ongoing investigations examine breeding propensity and chronology, reproductive performance, nestling diet and development, parental foraging and provisioning behaviour, 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 2015 season*:* We opened the research station on Triangle Island for year 22 on 1 April 2015, and made two separate trips out there (1 April to 20 May, and 22 June to 5 July). Scientific research was conducted under the direction of Mark Hipfner, and the field crew consisted of Mark, **Catherine Jardine** (Bird Studies Canada, Delta), **Jim Lamont** (Volunteer, Ottawa), **Mark Maftei** and **Britney Niedzielski** (Environment Canada, Delta), **Marinde Out** (PhD Candidate, Simon Fraser University), **Katharine Studholme (**PhD Candidate, Dalhousie University, Halifax) and **Sandra Valderrama** (Volunteer, Vancouver). We maintained our time series focus on Cassin's Auklets, Rhinoceros Auklets, and Black Oystercatchers, and banded Fox and Song sparrows for a third year.

The 2015 season was very unusual in terms of ocean conditions - conditions the oceanographers have dubbed "The Blob", characterized by a huge mass of anomalously warm surface water in the North Pacific. In the fall and winter of 2014-2015, Cassin's Auklets suffered through a severe mass mortality event, with record high deposition of beach-cast birds from California to British Columbia (including, sadly, a couple of old-timers banded on Triangle). Cassin's Auklet was recently designated a species of "Special Concern" by COSEWIC, mainly as a result of the CWE research program on Triangle Island. But surprisingly, given the warm ocean, breeding success was close to average for Cassin's Auklets on Triangle in 2015. The Blob had stronger effects on Rhinoceros Auklets and Tufted Puffins, both of which had poor breeding seasons.

In 2015 we also completed the eighth year of a project to band Rhinoceros Auklets at the large colonies at Pine Island (Central Coast) and Lucy Island (North Coast); we also visited Moore Island (Central Coast) and Cleland Island (Clayoquot Sound), as well as SGang Gwaay (Haida Gwaii), in 2015. The objectives of this research are to obtain estimates of adult survival rates to enable us to assess the potential effects of mortality in gill-net fisheries on local populations; to quantify variation in this species' diet and productivity; and to quantify spatial and temporal variation in diets of Pacific sandlance and Pacific herring, both of which are key prey species for piscivorous seabirds on BC colonies. And in 2015, we also continued collaborative projects to (1) quantify the consumption of salmon, especially Fraser River sockeye, by seabirds; and (2) deploy GLS tags on Cassin's and Rhinoceros auklets in order to track migratory routes and delineate habitats of importance during their annual cycle. The salmon project is being done in collaboration with Fisheries and Oceans Canada, and the GLS tagging is being done in collaboration with a large number of research groups from California to Alaska, in support of ongoing Environmental Assessments along BC's Central and North Coasts.

2. Coastal Usage by Migratory Shorebirds

The majority of the world's three and a half to four 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. Much 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. Each winter, the Fraser River Delta (FRD) hosts the most northerly wintering population of Pacific Dunlin – some 30,000-50,000. Local information on shorebird habitat usage, including western sandpipers and dunlin, contributes information useful for ECCC's environmental assessments as Port of Vancouver operations continue and expand.

David Hope, who obtained an MSc at the CWE, continued his PhD student in 2015 studying stopover strategies of southward migrating western sandpipers. In collaboration with Bird Studies Canada, he organized volunteers to survey shorebird site and habitat utilization throughout the Salish Sea. This work puts the relative importance of migratory stopover sites into regional perspectives and addresses hypotheses examining the environmental causes responsible for changes in habitat usage.

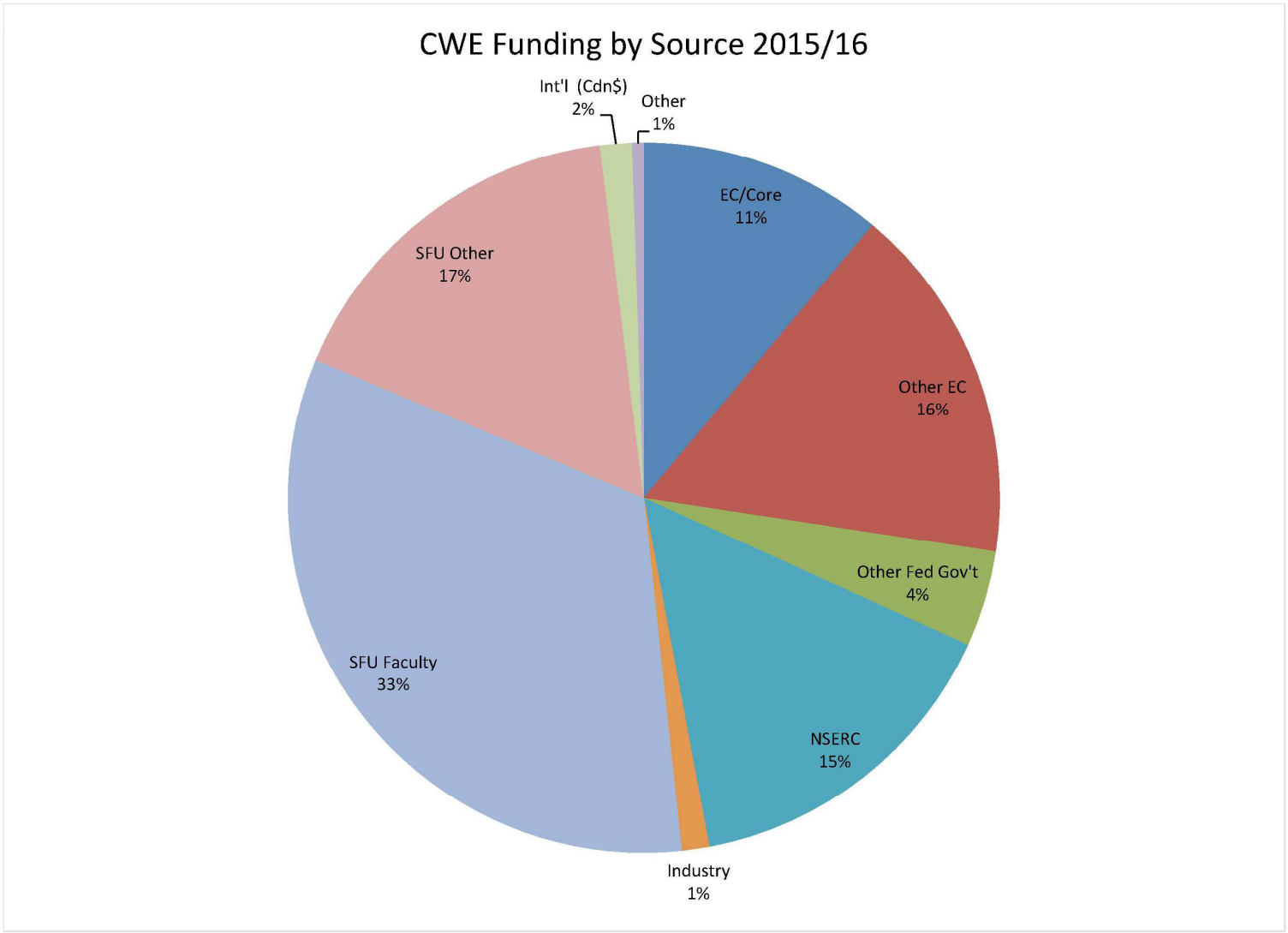
Visiting Dutch student Florian Reurink completed his study analyzing flight speeds of Dunlin among 4 foraging locations in the delta with different prey availabilities, testing a hypothesis derived from patch choice theory. This work was recently published in Behavioural Ecology.

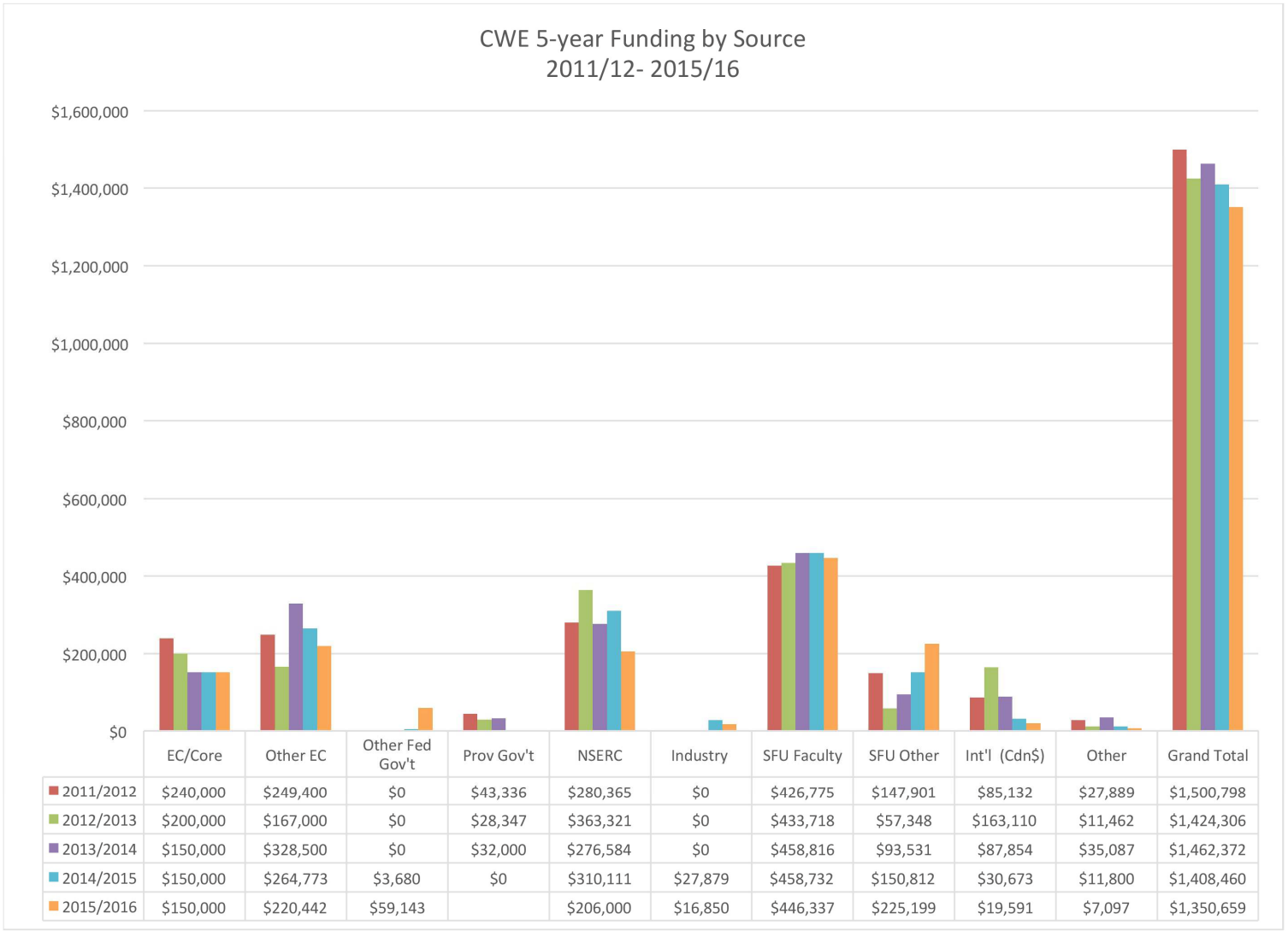
Several CWE-ECCC-contributed papers documenting biofilm usage in the Fraser River delta were published, including one by 2013 PhD graduate Ariam Jiménez, now a professor at the University of Havana.

VI FUNDING

2015-2016 was the third year of a five year funding agreement between the Simon Fraser University (Centre for Wildlife Ecology) and Environment Canada (Science and Technology Division) that supplies $150,000 per year for CWE research in priority coastal, riparian and grassland ecosystems in British Columbia.

The 5 year chart compares revenue projections (formulated for this agreement) to actual revenue from Environment Canada, SFU and other industrial, provincial, federal and international sectors.


CWE Funding by Source 2015/16
Int'l (Cdn$)
2%
Other
1%
EC/Core
11%
Other EC
16%
Other Fed Gov't
4%
NSERC
15%
Industry
1%
SFU Faculty
33%
SFU Other
17%



	EC/Core	Other EC	Other Fed Gov't	Prov Gov't	NSERC	Industry	SFU Faculty	SFU Other	Int'l (Cdn$)	Other	Grand Total
2011/2012	$240,000	$249,400	$0	$43,336	$280,365	$0	$426,775	$147,901	$85,132	$27,889	$1,500,798
2012/2013	$200,000	$167,000	$0	$28,347	$363,321	$0	$433,718	$57,348	$163,110	$11,462	$1,424,306
2013/2014	$150,000	$328,500	$0	$32,000	$276,584	$0	$458,816	$93,531	$87,854	$35,087	$1,462,372
2014/2015	$150,000	$264,773	$3,680	$0	$310,111	$27,879	$458,732	$150,812	$30,673	$11,800	$1,408,460
2015/2016	$150,000	$220,442	$59,143		$206,000	$16,850	$446,337	$225,199	$19,591	$7,097	$1,350,659

1 April 2015 - 31 March 2016

Scholarships, Fellowships, Grants for Students

PhD

NSERC	David Hope	NSERC IPS - NSERC contribution (Summer, Fall)	$10,000	
Industry	David Hope	NSERC IPS - Industry contribution (Summer, Fall)	$4,000	
SFU Fellowships etc	Marie-Helene Burle	TA (Fall, Spring)	$9,514	
SFU Fellowships etc	Allison Cornell	TA (Fall), GF (Spring)	$13,225	
SFU Fellowships etc	Philina English	TA (Fall, Spring), Travel award (Summer, Spring)	$13,078	
SFU Fellowships etc	Emily Missyabit McAuley	SFU Aboriginal Community Engagement (Summer, Fall), GF (Fall), Travel award (summer)	$12,000	
SFU Fellowships etc	Richard Johnson	TA (Spring), GF (Fall)	$10,601	
SFU Fellowships etc	Marinde Out	TA (Fall)	$5,413	
SFU Fellowships etc	Sarah Thomsen	GF (Summer, Fall), PRS (Spring), Travel award (Summer)	$19,750	
SFU Fellowships etc	David Hope	GF (Spring), Travel award (Fall)	$7,000	
SFU Fellowships etc	Eveling Tavera	GF (Fall), Travel award (Fall)	$7,000	
SFU Fellowships etc	Marie Helene Burle	TA (Fall, Spring)	$9,514	
SFU Fellowships etc	Simon Valdez	Provost International Fellowship (Summer, Fall), GF (Spring)	$10,167	
SFU Fellowships etc	Jeff Yap	TA (Summer), GF (Fall)	$14,537	
International	Simon Valdez	CONACYT	$16,141	(US $12810)
Other	David Hope	Bird Studies travel support	$297	
Other	Sarah Thomsen	World Seabird Conference	$1,800	
Other	Emily Missyabit McAuley	Irving K. Barber BC Aboriginal Student Award (2015/16 acad. Year)	$5,000	

M Sc

NSERC	Megan Willie	NSERC IPS - NSERC contribution (Summer, Fall)	$10,000	
NSERC	Michal Pavlik	NSERC IPS - NSERC contribution (Summer, Fall, Spring)	$15,000	
Industry	Megan Willie	NSERC IPS - Industry contribution (Summer, Fall)	$4,000	
Industry	Michal Pavlik	NSERC IPS - Industry contribution (Summer, Fall, Spring)	$6,000	
SFU Fellowships etc	Michal Pavlik	Entrance Scholarship (Summer, Fall, Spring)	$5,000	
SFU Fellowships etc	Seth Bennett	TA (Fall, Spring)	$11,400	
SFU Fellowships etc	Olga Lansdorp	TA (Fall)	$5,700	

SFU Fellowships etc	Spencer Morran	TA (Spring), GF (Fall)	$12,200
SFU Fellowships etc	Mitchell Serota	TA (Fall), GF (Spring), GIRTA (Spring)	$16,200
SFU Fellowships etc	Lauren MacFarland	Travel Award (Summer)	$500
SFU Fellowships etc	Megan Willie	GF (Spring), Travel Award (Summer)	$6,700
SFU Fellowships etc	Cybele Heddle	TA (Fall)	$5,700
Other EC	Lauren MacFarland	CWS (Fall), Travel support (Fall)	$7,500

General Funding for CWE

EC/Core	EC	EC Annual Chair Funding (3/5 yrs)	$150,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg Williams Green)	$446,337
SFU	SFU	SFU VPR: Contribution to CWE	$5,000
Other Federal	Lank	Canada Summer Jobs	$2,873
International	Lank	Travel grant, U. of Oulu, Finland	$3,450

Conference Funding

SFU - VPR & Dean of Science	Williams	International Ornithological Congress 2018-B	$25,000

Generated Research Funding

Species at Risk

Other Federal	Green DJ	Science Horizons: Measuring Survival and Impacts of Development on Species at Risk Birds and their Communities in Stressed Ecosystems	$12,000
Other Federal	Flower	Banting Postdoctoral Award (1/2 yrs)	$44,270

Human Impact on Birds

Industry	Green DJ	BC Hydro/ Cooper Beauchesne and Associates Ltd.	$2,850
Other EC	Willams TD / Elliott J	Research on developmental neurotoxicity of methyl mercury in birds (4/5 yrs)	$25,000

Declining Avian Populations

Other EC	Mahony, N	Swallow Project: Field Season In-Kind Support (with TD Williams)	$25,942
Other EC	Mahony, N	Swallow Project: MOTUS equipment (with TD Williams)	$20,000

Coast Ecology

Other EC	Hipfner MJ	Wildlife Research Division (A-base)	$52,000

Other EC	Hipfner MJ	Canadian Wildlife Service (Protected Areas)	$50,000
Other EC	Hipfner MJ	Canadian Wildlife Service (Marine Tanker Safety Phase 1b)	$30,000
Other EC	Hipfner MJ	Canadian Wildlife Service (Marine Tanker Safety Phase 2)	$10,000

NSERC

NSERC	Green DJ	Overwintering ecology, migration strategies and demography of migratory birds (2/5 yrs)	$27,000
NSERC	Lank D	Maintenance of ecological polymorphism by frequency-dependent selection (2/5 yrs)	$27,000
NSERC	Ydenberg RC	NSERC Individual Research Grant - "Predation danger in the ecology of migration" (1/5 yrs)	$32,000
NSERC	Williams TD	Physiological Adaptations for Breeding in Birds (4/6 yrs)	$60,000
NSERC	Elliott J	Investigating sources, transport, accumulation and effects of persistent contaminants in urban environments using a top predator as indicator (5/5 yrs)	$25,000

Grand Total	$1,350,659
SFU In-Kind	$120,000

VII. 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 actively. One PhD and two MSc students supervised by CWE faculty 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. Books or Book chapters

Williams, T.D. and T.G.G. Groothuis. 2015. Egg quality, embryonic development and post-hatching phenotype: an integrated perspective. In: *Nests, Eggs and Incubation*, Deeming, C. and S.J. Reynolds, eds. Oxford: Oxford University Press.

B. Papers in Refereed Journals or Books

In press:

Kouwenberg, A.-L., J.M. Hipfner, D.W. McKay and A.E. Storey. In press. Corticosterone levels in feathers and blood of a colonial seabird are affected by year-round variation in environmental conditions. Marine Biol. 163.

2016:

Cornell, A. and T.D. Williams. 2016. Individual quality and double-brooding in a highly synchronous songbird population. Auk 133**:** 251-260.

Cuthbert, R.J., R.M. Wanless, A. Angel, M.-H. Burle, G.M. Hilton, H. Louw, P. Visser, J.W. Wilson and P.G. Ryan. 2016. Drivers of predatory behavior and extreme size in house mice *Mus musculus* on Gough Island. J. Mammal. 97**:** 533-544 DOI: http://dx.doi.org/10.1093/jmammal/gyv199.

Küpper, C., M. Stocks, J.E. Risse, N. dos Remedios, L.L. Farrell, S.B. McRae, T.C. Morgan, N. Karlionova, P. Pinchuk, Y.I. Verkuil, A.S. Kitaysky, J.C. Wingfield, T. Piersma, K. Zeng, J. Slate, M. Blaxter, D.B. Lank and T. Burke. 2016. A supergene determines highly divergent male reproductive morphs in the ruff. Nature Gen. 48**:** 79-86,doi10.1038/ng.3443.

Tucker, S., J.M. Hipfner and M. Trudel. 2016. Size- and condition-dependent predation: a seabird disproportionately targets substandard juvenile salmon. Ecology 97**:** 461-471.

Uher-Koch, B.D., D. Esler, S.A. Iverson, D.H. Ward, W.S. Boyd, M. Kirk, T.L. Lewis, C.S. VanStratt, K.M. Brodhead, J.W. Hupp and J.A. Schmutz. 2016. Interacting effects of latitude, mass, age, and sex on winter survival of Surf Scoters (*Melanitta perspicillata*): implications for differential migration. Can. J. Zool. 94**:** 233-241.

2015

Crossin, G.T., A. Takahashi, K.Q. Sakamoto, P.N. Trathan and T.D. Williams. 2015. Habitat selection by foraging macaroni penguins is correlated with hematocrit, an index of aerobic condition. Mar. Ecol. Prog. Ser. 530**:** 163-176.

Davis, M.L., J.E. Elliott and T.D. Williams. 2015. Spatial and temporal variation in the dietary ecology of the Glaucous-winged gull *Larus glaucescens* in the Pacific Northwest. Marine Ornithol. 43**:** 189-198.

Dekker, D. and M.C. Drever. 2015. Kleptoparasitism by Bald Eagles (*Haliaeetus leucocephalus*) as a factor in reducing Peregrine Falcon (*Falco peregrinus)* predation on Dunlin (*Calidris alpina*) wintering in British Columbia. Can. Field Nat. 129**:** 159-164.

Elliott, J.E., J. Brogan, S.L. Lee, K.G. Drouillard and K.H. Elliott. 2015. PBDEs and other POPs in urban birds of prey partly explained by trophic level and carbon source. Sci. Total Environ. doi**:**

10.1016/j.scitotenv.2015.04.008.
Fowler, M.A. and T.D. Williams. 2015. Individual variation in parental workload and breeding productivity in female European starlings: is the effort worth it? Ecol. Evol. 5**:** 3585-3599, , doi: 10.1002/ece3.1625.
Green, D.J., I.B.J. Whitehorne, H.A. Middleton and C.A. Morrissey. 2015. Do American dippers obtain a survival benefit from altitudinal migration? PLoS One 10**:** e0125734.
Jardine, C.B., A.L. Bond, P.J.A. Davidson, R.W. Butler and T. Kuwae. 2015. Biofilm consumption and variable diet composition of western sandpipers (*Calidris mauri*) during migratory stopover. PLoS One 10**:** e0124164. doi: 10.1371/journal.pone.0124164.
Mallory, M.L., C.M. Little, E.S. Boyd, J. Ballard, K.H. Elliott, H.G. Gilchrist, J.M. Hipfner, A. Petersen and D. Shutler. 2015. Leucocyte profiles of Arctic marine birds: correlates of migration and breeding phenology. Conservation Physiology 3**:** cov028 doi 10.1093/conphys/cov028.
Miller, A., J.E. Elliott, K.H. Elliott, M.F. Guigueno, L.K. Wilson, S. Lee and A. Idrissie. 2015. Brominated flame retardant trends in aquatic birds from the Salish Sea region of the west coast of North America, including a mini-review of recent trends in marine and estuarine birds. Sci. Total Envir. 502**:** 60-69.
Ottenburghs, J., R.C. Ydenberg, P. Van Hooft, S.E. Van Wieren and H.H.T. Prins. 2015. The Avian Hybrids Project: gathering the scientific literature on avian hybridization. Ibis 157**:** 892-894.
Reurink, F., N. Hentze, J. Rourke and R. Ydenberg. 2015. Site-specific flight speeds of nonbreeding Pacific dunlins as a measure of the quality of a foraging habitat. Behav. Ecol. doi**:** 10.1093/beheco/arv223.
Steenweg, R., H.L. Hennin, J. Bêty, H.G. Gilchrist, T.D. Williams, G.T. Crossin and O.P. Love. 2015. Sources of diel variation in energetic physiology in an Arctic-breeding, diving, seaduck. Gen. Comp. Endocrinol. 216**:** 39-45.
Taylor, C.M., D.B. Lank and B.K. Sandercock. 2015. Using local dispersal data to reduce bias in annual apparent survival and mate fidelity. Condor 117**:** 598-608.
van Oort, H., D.J. Green, M. Hepp and J.M. Cooper. 2015. Do fluctuating water levels alter nest survivorship in reservoir shrubs? Condor 117**:** 376-385.
Webster, K.H., K.E. Harr, D.C. Bennett, T.D. Williams, K.M. Cheng, F. Maisonneuve and J.E. Elliott. 2015. Assessment of toxicity and coagulopathy of brodifacoum in Japanese quail and testing in wild owls. Ecotoxicol. 24**:** 1087-1101.
Williams, T.D. and M.A. Fowler. 2015. Individual variation in workload during parental care: can we detect a physiological signature of quality or cost of reproduction? J. Ornithol. 156**:** S441-S451.
Xu, C., J. Barrett, D.B. Lank and R.C. Ydenberg. 2015. Large and irregular population fluctuations in migratory Pacific (*Calidris alpina pacifica*) and Atlantic (*C. a. hudsonica*) dunlins are driven by density-dependence and climatic factors. Pop. Ecol. 57**:** 551-567.

Submitted:

Forrester, T., C.A. Bishop and D.J. Green. Submitted. Temporal variation in the abundance, richness, and breeding performance of riparian birds in response to habitat restoration in British Columbia, Canada. Restoration Ecol. (submitted Mar 2016)
Thomsen, S.K. and D.J. Green. Submitted. The landscape of fear determines how marine predators become terrestrial prey on an oceanic island. Ecology. (submitted Feb 2016)

C. Theses

Schwarz, B. 2016. Population structure in Western Sandpipers (*Calidris mauri*): variation in genes, morphology and vocalizations in a migratory shorebirds. PhD, Simon Fraser University, Burnaby.
Ellison, A.M. 2015. Acute but not chronic effects of predator presence on song sparrow (*Melospiza melodia*) singing behaviour. MSc, Simon Fraser University, Burnaby.
Yu, M. 2015. Assessment of embryotoxicity, post-hatch development, and long-term effects on behavior and

reproduction in zebra finches (*Taeniopygia guttata*) following in ovo methylmercury exposure. MET, Simon Fraser University, Burnaby.