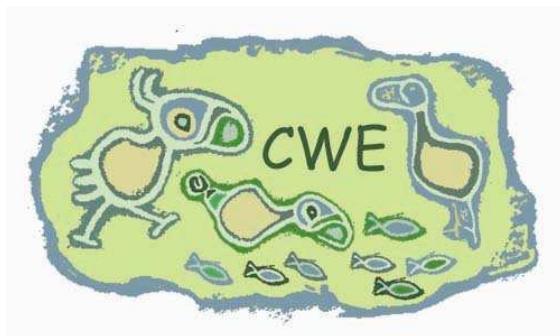


**ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY
2014-2015**



Environnement
Canada
Environment
Canada

**Department of Biological Sciences
Simon Fraser University**

<http://www.sfu.ca/biology/wildberg/NewCWEPage/CWEnetTestHome.htm>

Dr. Ronald C. Ydenberg, Director

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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 Environment 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	EC Research Scientist / Adjunct Professor
Doug Bertram	EC Research Scientist
Christine Bishop	EC Research Scientist / Adjunct Professor
Sean Boyd	EC Research Scientist / Adjunct Professor
Rob Butler	EC Research Scientist Emeritus / Adjunct Professor
Bob Elner	EC Research Scientist Emeritus/Adjunct Professor
John Elliott	EC Research Scientist / Adjunct Professor
Rhonda Millikin	EC Head, Population Assessment / Adjunct Professor
Fred Cooke (retired)	Emeritus Chairholder

2. Research Group

<i>Postdoctoral Fellows</i>	<i>PhD (in progress)</i>	<i>MSc (in progress)</i>	<i>Staff</i>
Margaret Eng	Marie-Hélène Burle	Seth Bennett	Kathryn Coukell, CWE Admin. Asst.
Melinda Fowler	Allison Cornell	Danielle Dagenais	Connie Smith, CWE Research Tech
Cailin Xu	Philina English	Annie Ellison	
	David Hope	Eveling Fernandez	
	Richard Johnston	Matthew Hepp	
<i>Undergrads</i>	<i>Emily McAuley</i>	<i>Olga Lansdorp</i>	<i>Visitors</i>
Michael Arbeider	Michal Pavlik	Lauren MacFarland	Pat Baird
Kate Gibson	Marinde Out	Spencer Morran (MET)	Bart Steen
Jeremiah Kennedy	Birgit Schwarz	Mitchell Serota	
Jessica Leung	Sarah Thomsen	Megan Willie	
Rowan Rampton	Simon Valdez	Maria Yu (MET)	
Daniel Tan	Jeff Yap		
Margot Webster			
Kenny Wong	<i>PhD(defended)</i>	<i>MSc (defended)</i>	
	Heidi Currier	Jason Brogan	
	Kristen Gorman	Tim Forrester	

B. Steering Committee

<i>Name</i>	<i>Position</i>	<i>Affiliation</i>
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 ground-breaking and high profile project examining the biology of the threatened and elusive marbled murrelet, started by CWE chair emeritus Fred Cooke, continued for its 20th year lead by Dov Lank, addressing evolving questions of management interest for this threatened species.

A major activity in 2014 involved supporting the CWS-led revision of a Marbled Murrelet recovery strategy by the Canadian Marbled Murrelet Recovery Team. The 'SFU' nesting data gathered by Cooke's crews were invoked as the 'best available information' in multiple contexts. Lank participated in a series of team meetings and contributed analyses towards dealing with questions of critical habitat definitions.

The second major activity was continued 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.

A new initiative was started through recruiting PDF Tom Flower, who will start at SFU in 2015, to work on nest predation patterns by corvids 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.

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 plans to write and defend her PhD thesis in 2015.

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), completed a second year of fieldwork examining the habitat specific demography of Lewis's woodpeckers in 2014. She has demonstrated consistent differences in the productivity of Lewis's woodpeckers in riparian cottonwoods, open ponderosa pine and burned habitat within the Okanagan. Preliminary analyses suggest these differences can be attributed to differences in the predator communities within these habitats, rather than differences in the community of secondary cavity nesters (native and non-native), or differences in prey availability. Lauren is currently using a long-term Lewis's woodpecker nest monitoring dataset to examine differences in the loss and re-use of nest cavities among habitat types.

4. *Yellow-breasted Chat* (Endangered, COSEWIC)

Tim Forrester (MSc 2014) 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.

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 plans to use population models to assess how direct and indirect effects combine to influence murrelet populations.

6. *Tuamotu Sandpiper* (Endangered, IUCN)

Tuamotu Sandpiper Conservation: 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 >15 months over 3 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.

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 and Stantec, 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. A second year of work is planned for 2015 in Burrard Inlet.

b. Developmental neurotoxicity of mercury in birds

Margaret Eng (post-doc) and Maria Yu (MET student) developed and validated methodologies for 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. A new MET student (Spencer Morran) is now developing and validating tests for memory and learning to investigate specific neurotoxic effects.

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

Margaret Eng (PhD 2013) continued to work as a post-doc in the Williams' Lab collaborating with Environment Canada scientists including John Elliott, Sean Kennedy, and Kim Fernie, and other toxicologists (e.g. Ken Drouillard, Windsor, researchers at Patuxent) on CMP-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 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 dosing study using egg injections in European starlings to verify

predictions based on genotyping of the aryl-hydrocarbon receptor (AhR) that the starling is highly sensitive to dioxin-like compounds (Eng et al., 2014, ET&C 33:2753); 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 Summer/Fall 2015.

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. in prep). 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

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. The Okanagan Valley is the second largest wine producing region and supports the highest diversity of bats in Canada; yet no Canadian studies have looked at the use of vineyards by aerial foraging bats. Danielle used a radar-acoustic system, designed by CWE Adjunct Professor Rhonda Millikin, to assess bat movements in the South Okanagan and to determine if vineyards provide habitat for bats. She surveyed six sites, each containing a natural and vineyard plot, and recorded thousand of individual bat passes during the 2012 breeding season. The acoustic data recorded 11 different bat species in both plots, with up to seven different species active during a given night. The mean number of passes per minute was 2.6 times greater in the natural plots than the vineyards; but owing to two nights of intense bat activity in one vineyard during the peak lactation period, there was no statistical difference in mean number of bat passes

between natural and vineyard plots. This indicated that lactating females will take advantage of vineyards during a time of high energy demand when prey is available. In addition, feeding buzzes were recorded in four vineyard plots indicating that bats are feeding in vineyards.

The radar data is presently being analyzed and co-located with the acoustic data to determine the percentage of bat tracks recorded in a given night. Time of call and distance to nearest track is being used to identify bat track parameters. Preliminary results indicate that approximately 1/3 of detected tracks are associated with bat activity, with a large proportion of tracks resulting from insect activity. Following this analysis, the radar tracks will be imported in ArcMap 10.2 to determine what percentage of the radar-defined bat track length is associated with vineyard and natural habitat.

The acoustic data indicates that vineyards provide foraging habitat for bats in the South Okanagan. This, combined with the radar data, can 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.

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

Our long-term study of the ecological physiology of European starlings marked its 13th 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. We are currently focusing 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. This work involves Allison Cornell (PhD), Melinda Fowler (post-doc), a new MSc (Mitchell Serota) and an army of undergraduate students (several funded by Undergraduate Student Research Awards).

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

In collaboration with Nancy Mahony (Environment Canada), Olga Lansdorp (MSc student) completed a second field season with data collection 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 3) study the potential of Grassland Set-Asides to provide high quality feeding habitat for Barn Swallows within an agricultural landscape. In addition, in collaboration with Bob Clarke (EC) and David Bradley (currently, Bird Studies Canada) we attached geolocators to 30 TRES to determine the location of their wintering grounds.

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 recent 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 EC'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. We have organized twelve workshops to help keep researchers in touch, and we run a list-server for this purpose.

a. Shorebird Breeding Biology

Lank co-supervised the final season of demographic research on nesting shorebirds with respect to environmental factors, near Nome Alaska, together with collaborator Brett Sandercock, a CWE alumnus who is now a professor at Kansas State University, primarily funded by NSF and the Alaska Department of Fish and Game. Several CWE graduate students participated in the study, which focuses on how the demography of Western and Semipalmated sandpipers may have changed since Sandercock's PhD work at the site in the 1990s. The site's data contributes towards 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 ADSN's goal is to obtain demographic parameters for use in shorebird population modeling. Lank also co-authored a study quantifying the opportunity cost of incubation by a small male calidrid, the Temminck's stint.

CWE MSc student Willow English published a paper on sex ratios of eggs laid by Red-necked phalaropes, from her MSc completed in spring 2014. Sarah Jamieson (PhD CWE 2009) published her final thesis paper with Ydenberg and Lank, relating the duration of parental care to migration strategies of sympatric dunlin and Western sandpipers.

b. Non-breeding biology

MSc student Richard Johnson, from Colombia, conducted a productive 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 transitioned to the PhD program early in December 2014. Eveling Tavera Fernandez, from Peru, began as a new MSc student in May 2014, and conducted another successful field season at the end of 2014- spring 2015. Eveling organized a shorebird banding project in Peru, and has discovered that both eastern and western populations of Semipalmated Sandpipers winter in Peru, arriving on different schedules.

c. Migratory Connectivity Project

Birgit Schwarz, a PhD student is addressing population structure using genetic analyses and song, co-supervised by Darren Irwin at UBC. She completed four thesis chapters and expects to finish her degree early in 2015.

As part of the 4th and final year of our collaborative breeding study at Nome, several geolocators

were recovered from Western and Semipalmated sandpipers, demonstrating a non-stop flight from Alaska to, and wintering at, the Fraser River delta and elsewhere.

d. Population Biology

EC-sponsored PDF Cailin Xu modeled population fluctuations of Pacific and Atlantic dunlin, based on a 35-year time series of Christmas Bird Counts, with respect to environmental variation. The analysis implies that substantial annual mortality is associated with storm systems during southward migration. A second paper by Ydenberg, Xu and Lank is examining changes in regional distribution in the CBC data in the context of changes in danger regimes over the past 30 years.

Xu, Lank and Ydenberg also address issues related to Semipalmated Sandpiper population changes, which have been of substantial concern, particularly in eastern Canada. In collaboration with EC staff members Cheri Gratto-Trevor, Paul Smith and Julie Paquet, and retired biologists Guy Morrison and Peter Hicklin, they brought together morphological data suggesting that wing lengths of semipalmated were longest around 1980 and have become smaller since that time. These data are useful in interpreting the population significance of large changes in wing lengths reported at migration sites at James Bay and the Bay of Fundy.

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) and Jorge Rivera (UNAM, Mexico) 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). More recently, Amber Richmond (Honours 2014) has demonstrated that migration effects on survival are best explained by variation in average windspeed in April/May that alter flight costs, rather than the number of storm events during migration, or rainfall effects on the condition of stopover habitat in southern USA.

Simon Valdez completed the fieldwork for his PhD in Spring 2015. His thesis will examine 1) whether the natal origins of yellow warblers influences winter habitat use in Mexico, and 2) evaluating how winter habitat (riparian habitat, agricultural habitat and coastal scrub/mangroves) influences the territorial behavior (float vs hold a permanent territory), condition, departure dates and winter survival of Yellow warblers in Jalisco, Mexico.

3. Sea Ducks

Barrow's Goldeneye Population Delineation – 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 biology, aimed particularly at identifying and understanding environmental and demographic causes of population change so as to recommend appropriate conservation actions. The Anne Vallé Ecological Reserve on Triangle Island supports the largest and most diverse seabird colony in BC, including the worlds largest population of Cassins Auklets, BCs 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 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 2014 season: We opened our research station on Triangle Island for year 21 on 23 April 2014, and made two separate trips (23 April to 23 May, and 20 June to 4 July). Scientific research was conducted under the direction of Mark Hipfner, and the field crew consisted of Mark, **Michael Arbeider** (BSc Candidate, Simon Fraser University, Burnaby), **Catherine Jardine** (Bird Studies Canada, Delta), **Claire Mussells** (EC, Delta WRD), **Katharine Studholme** (PhD Candidate, Dalhousie University, Halifax) and **Sarah Thomsen** (PhD Candidate, Simon Fraser University). We maintained our time series focus on Cassin's Auklets, Rhinoceros Auklets, and Black Oystercatchers, and banded Fox and Song sparrows for a second year.

The 2014 season was a strange year in terms of ocean conditions. It began cold, but by mid- to-late summer the northwestern Pacific Ocean had reached record high temperatures. The cold, early-season conditions were favourable for Black Oystercatchers, which bred at high density, and for Cassin's Auklets, which bred early and on time to match biomass peaks of their most

important prey, the copepod *Neocalanus cristatus*. Conditions were less than ideal for other species such as Rhinoceros Auklets and especially Tufted Puffins, which had a very poor breeding season.

In 2014 we also completed the seventh 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 SGang Gwaay in 2014. The objectives of the work are to obtain estimates of adult survival rates at these colonies to enable us to assess the potential effects of mortality in gill-net fisheries on local populations; to quantify geographic and yearly variation in this species' diet and productivity; and to quantify spatial and temporal variation in diets of Pacific sandlance, a key prey species for Rhinoceros Auklets at all BC colonies. And in 2014, we also continued a collaborative project to quantify the consumption of salmon, especially Fraser River sockeye, by seabirds; and completed the second year of a project to deploy GLS and GPS tags on Rhinoceros Auklets in order to track migratory routes and delineate habitats of importance during their annual cycle. This research is 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 Environment Canada's environmental assessments as Port of Vancouver and ferry operations continue and expand.

David Hope, who obtained an MSc at the CWE, continued his PhD student in 2014 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. Hope published the second chapter from his MSc thesis, looking at changes in stopover behaviour throughout the summer as predation danger changed.

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. Another visiting Dutch student, Bart Steen, followed up on this study by conducting similar observations on Western Sandpipers foraging at Boundary Bay. Ariam Jiménez returned to Cuba after completing his PhD examining biofilm use by migrants in the Fraser Delta, supervised by Bob Elner and Ron Ydenberg. The first paper from his PhD was published in Estuarine, Coastal and Shelf Science in 2014.

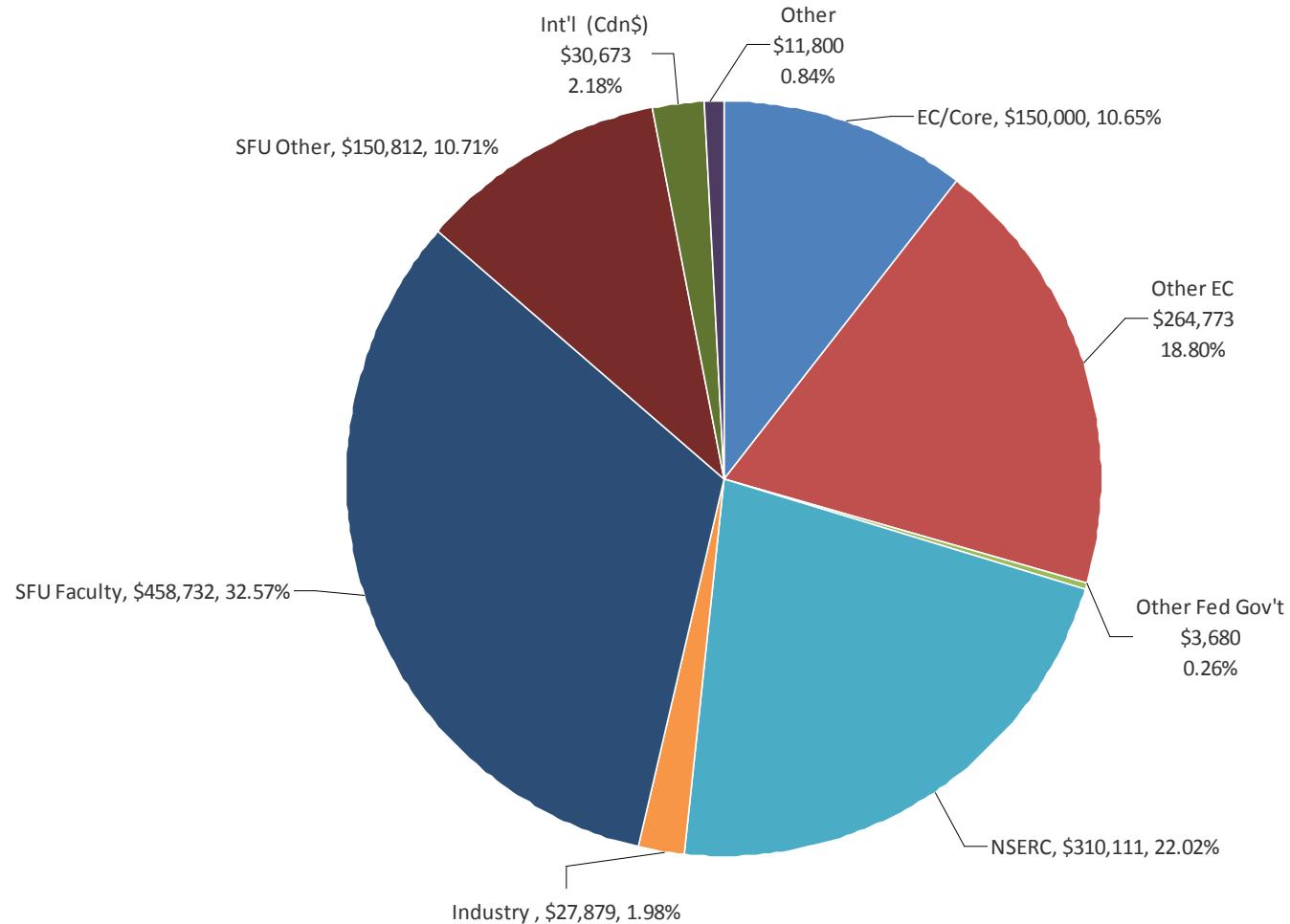
VI FUNDING

2014-2015 was the second year of a five year funding agreement between the Simon Fraser University (Centre for Wildlife Ecology) and Environment Canada (Science and Technology

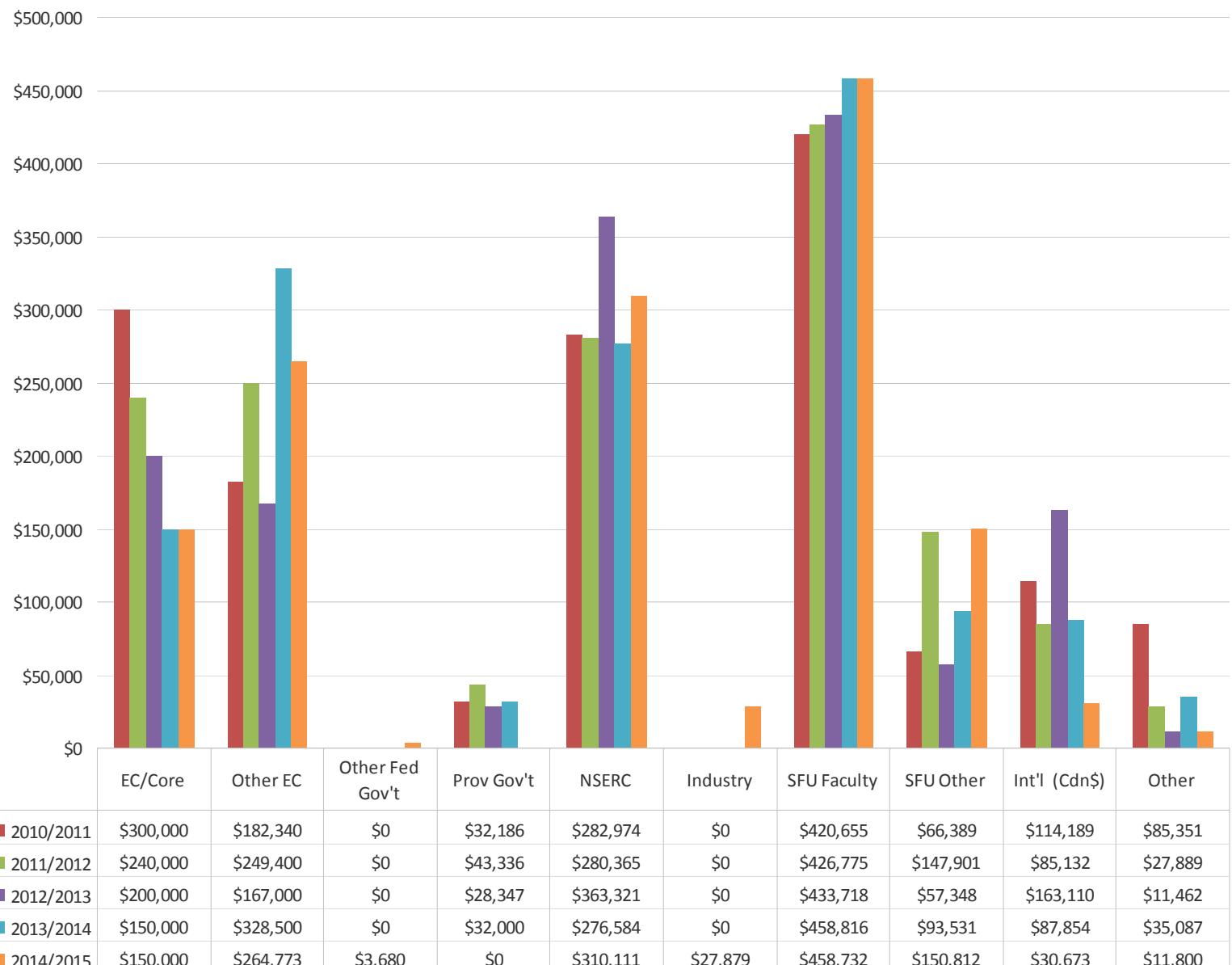
Division) that supplies \$150,000 per year for CWE research in priority coastal, riparian and grassland ecosystems in British Columbia.

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 Sources 2014/2015



CWE 5-year Funding by Source
2010/11 - 2014/15



Centre for Wildlife Ecology Annual Financial Report

1 April 2014 - 31 March 2015

Scholarships, Fellowships, Grants for Students

PhD

Category for Chart			
NSERC	David Hope	NSERC IPS - NSERC contribution (Summer, Fall, Spring)	\$15,000
Industry	David Hope	NSERC IPS - Industry contribution (Summer, Fall, Spring)	\$6,000
SFU Fellowships etc	Marie-Helene Burle	TA (Fall, Spring)	\$10,826
SFU Fellowships etc	Allison Cornell	TA (Fall) + Travel Award (x2)	\$7,725
SFU Fellowships etc	Philina English	GF (Fall), TA (Spring) + Travel Award	\$11,343
SFU Fellowships etc	Emily Missyabit McAuley	TA (Fall), GF (Spring), SFU Aboriginal Community Engagement Award (Summer, Fall), SFU Aboriginal Student Bursary (Spring)	\$18,613
SFU Fellowships etc	Richard Johnson	GF (Fall)	\$6,250
SFU Fellowships etc	Marinde Out	GF (Fall), TA (Spring)	\$12,975
SFU Fellowships etc	Sarah Thomsen	TA (Spring)	\$5,413
SFU Fellowships etc	Simon Valdez	Provost International Fellowship	\$5,500
International	Simon Valdez	CONACYT	\$23,827 (US \$19,215)
International	Eveling Tavera	GIRTA	\$6,250
Other	Philina English	J. Nocera, Trent U (Summer)	\$8,000
Other	Emily Missyabit McAuley	Indspire	\$3,800

M Sc

NSERC	Meghan Willie	NSERC IPS - NSERC contribution (Summer, Fall, Spring)	\$15,000
NSERC	Michal Pavlik	NSERC IPS - NSERC contribution (Fall, Spring)	\$10,000
Industry	Meghan Willie	NSERC IPS - Industry contribution (Summer, Fall, Spring)	\$6,000
Industry	Michal Pavlik	NSERC IPS - Industry contribution (Fall, Spring)	\$4,000
Industry	Meghan Willie	Stantec Travel Award	\$250
SFU Fellowships etc	Michal Pavlik	Entrance Scholarship (Fall, Spring)	\$4,000
SFU Fellowships etc	Mitchell Serota	Entrance Scholarship (Fall)	\$6,667
SFU Fellowships etc	Anne Ellison	GF (Fall), TA (Spring)	\$11,950
SFU Fellowships etc	Tim Forrester	TA (Fall)	\$5,700
SFU Fellowships etc	Seth Bennett	GF (Fall)	\$6,250
SFU Fellowships etc	Matt Hepp	TA (Fall, Spring) + Travel Award	\$11,750
SFU Fellowships etc	Olga Lansdorp	GF (Fall) + Travel Award	\$6,750
SFU Fellowships etc	Lauren MacFarland	GF (Fall) + Travel Award	\$6,700

SFU Fellowships etc	Danielle Dagenais	TA (Spring) + Travel Award	\$6,200
SFU Fellowships etc	Meghan Willie	Travel Award	\$500
SFU Fellowships etc	Spencer Morran	TA (Fall)	\$5,700
Other EC	Lauren MacFarland	Environment Canada (Summer)	\$7,073
Other EC	Tim Forrester	Environment Canada (Summer)	\$6,700
Other EC	Seth Bennett	CWS (Spring)	\$6,500

General Funding for CWE

EC/Core	EC	EC Annual Chair Funding (2/5 yrs)	\$150,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg Williams Green)	\$458,732
Other Federal	Lank	Canada Summer Jobs	\$2,300

Generated Research Funding

Species at Risk

Industry	Lank	Coastal Forest Products Association for Endangered Species research on Marbled Murrelet	\$2,500
International	Green DJ; Thomsen S	Montrose/NFWF	\$596

Human Impact on Birds

Industry	Green DJ	BC Hydro/ Cooper Beauchesne and Associates Ltd.	\$9,129
Other EC	Willams TD / Elliott J	Research on developmental neurotoxicity of methyl mercury in birds (3/5 yrs)	\$25,000

Declining Avian Populations

Other EC	RC Ydenberg	Postdoctoral Contribution (3/3 yrs)	\$25,000
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Coastal Ecology

Other EC	Hipfner MJ	Wildlife Research Division	\$71,500
Other EC	Hipfner MJ	Canadian Wildlife Service	\$123,000
Other Federal	D. Green/S. Bennet	NSTP - Provisioning and productivity in the Black Oystercatcher	\$1,380

NSERC

NSERC	Green DJ	Overwintering ecology, migration strategies and demography of migratory birds (1/5 yrs)	\$27,000
NSERC	Lank D	Maintenance of ecological polymorphism by frequency-dependent selection (1/5 yrs)	\$27,000
NSERC	Ydenberg RC	NSERC Individual Research Grant - "Predation danger and the annual cycle of migrants (5/5 yrs)	\$50,000
NSERC	Williams TD	Physiological Adaptations for Breeding in Birds (3/5 yrs)	\$60,000
NSERC	Williams TD	Physiological Adaptations for Breeding in Birds (3/3 yrs)	\$40,000
NSERC	Williams TD / Ydenberg RC / Green DJ	Automated radio tracking system for avian studies	\$41,111
NSERC	Elliott J	Investigating sources, transport, accumulation and effects of persistent contaminants in urban environments using a top predator as indicator (4/5 yrs)	\$25,000
Grand Total			\$1,408,460
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 with 9 publications out in 2015 through April, 4 publications in press and 5 submitted. Two 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. In press. Egg quality, embryonic development and post-hatching phenotype: an integrated perspective. In: *Nests and Eggs*, Deeming, C. and S.J. Reynolds, eds. Oxford: Oxford University Press.

B. Papers in Refereed Journals or Books

In press:

- Green, D.J., I.B.J. Whitehorne, H.A. Middleton and C.A. Morrissey. In press. Do American dippers obtain a survival benefit from altitudinal migration? *PLoS One*.
- van Oort, H., D.J. Green, M. Hepp and J.M. Cooper. In press. Do fluctuating water levels alter nest survivorship in reservoir shrubs? *Condor*.
- Webster, K.H., K.E. Harr, D.C. Bennett, T.D. Williams, K.M. Cheng, F. Maisonneuve and J.E. Elliott. In press. Assessment of toxicity and coagulopathy of brodifacoum in Japanese quail and testing in wild owls. *Ecotoxicol.*
- Williams, T.D. and M.A. Fowler. In press. Individual variation in workload during parental care: can we detect a physiological signature of quality or cost of reproduction? *J. Ornithol.*

2015

- Currier, H.A., R.J. Letcher, T.D. Williams and J.E. Elliott. 2015. Assessment of effects of the polybrominated diphenyl ether BDE-47 on growth, development, and reproductive success in Zebra Finches. *Bull. Environ. Contamin. Toxic.* 94: 140-145.
- Ellison, A.M., J. Watson and E. Demers. 2015. Testing problem-solving in turkey vultures (*Cathartes aura*) using the string-pulling test. *Anim. Cognit.* 18: 111-118.
- Farrell, L.L., C. Küpper, T. Burke and D.B. Lank. 2015. Major breeding plumage color differences of male ruffs (*Philomachus pugnax*) are not associated with coding sequence variation in the melanocortin-1 receptor (MC1R) gene. *Journal of Heredity* 106: 211-215.
- Hennin, H.L., P. Legagneux, J. Béty, T.D. Williams, H.G. Gilchrist, T.M. Baker and O.P. Love. 2015. Pre-breeding energetic management in a mixed-strategy breeder. *Oecologia* 177: 235-243.
- Jiménez, A., R.W. Elner, C. Favaro, K. Rickards and R.C. Ydenberg. 2015. Intertidal biofilm distribution underpins differential tide-following behavior of two sandpiper species (*Calidris mauri* and *Calidris alpina*) during northward migration. *Estuar. Coast. Shelf Sci.* 155: 8-16.
- Perfito, N., D. Guardado, T.D. Williams and G. Bentley. 2015. Social cues regulate reciprocal switching of hypothalamic Dio2/Dio3 and the transition into final follicle maturation in European starlings (*Sturnus vulgaris*). *Endocrinol.* 156: 694-706.
- Ryan, C.P., A. Dawson, P.J. Sharp and T.D. Williams. 2015. Uncoupling variation in clutch size and plasma prolactin using experimental egg removal. *Gen. Comp. Endocrinol.* 213: 1-8.

- Si, Y., Q. Xin, W.F. de Boer, P. Gong, R.C. Ydenberg and H.H.T. Prins. 2015. Do Arctic breeding geese track or overtake a green wave during spring migration? *Sci. Rep.* 5: 8749.
- Williams, T.D., S. Bourgeon, A. Cornell, L. Ferguson, M.A. Fowler, R.B. Fronstin and O.P. Love. 2015. Mid-winter temperatures, not spring temperatures, predict breeding phenology in the European starling *Sturnus vulgaris*. *Royal Soc. Open Sci.* 2: 140301.

2014

- Currier, H.A., R.J. Letcher, T.D. Williams and J.E. Elliott. 2014. An assessment of in ovo toxicity of the flame retardant 1,2-dibromo-4-(1,2-dibromoethyl) cyclohexane (TBECH) in the Zebra Finch. *Bull. Environ. Contamin. Toxic.* 91: 455-459.
- Dekker, D. 2014. The effect of water diversions and drought in the drying-up of Beaverhills Lake, a 140 km² Ramsar wetland in central Alberta. *Nat. Areas J.* 34: 346-352.
- Drake, A.E.G., C.A. Rock, S.P. Quinlan, M. Martin and D.J. Green. 2014. Wind speed during migration influences the survival, timing of breeding, and productivity of a Neotropical migrant, *Setophaga petechia*. *PLoS One* 9: e97152.
- Eng, M.L., J.E. Elliott, S.P. Jones, T.D. Williams, K.G. Drouillard and S.W. Kennedy. 2014. Amino acid sequence of the AhR1 ligand-binding domain predicts avian sensitivity to dioxin like compounds: in vivo validation in European starlings. *Env. Tox. Chem.* 33: 2753-2758.
- Eng, M.L., J.E. Elliott and T.D. Williams. 2014. An assessment of the developmental toxicity of BDE-99 in the European starling using an integrated laboratory and field approach. *Ecotoxicol.* 23: 1505-1516.
- Eng, M.L., T.D. Williams, R.J. Letcher and J.E. Elliott. 2014. Assessment of concentrations and effects of organohalogen contaminants in a terrestrial passerine, the European starling. *Sci. Total Environ.* 473-474: 589-596.
- English, W.B., D. Schamel, D.M. Tracy, D.F. Westneat and D.B. Lank. 2014. Sex ratio varies with egg investment in the red-necked phalarope (*Phalaropus lobatus*). *Beh. Ecol. Sociobiol.* 68: 1939-1949 DOI 10.1007/s00265-014-1800-1.
- Evers, D.C., J.A. Schmutz, N. Basu, C.R. DeSorbo, J. Fair, C.E. Gray, J.D. Paruk, M. Perkins, K. Regan, B.D. Uher-Koch and K.G. Wright. 2014. Historic and contemporary mercury exposure and potential risk to Yellow-Billed Loons (*Gavia adamsii*) breeding in Alaska and Canada. *Waterbirds* 37: 147-159.
- Hemerik, L., M. van Opheusden and R. Ydenberg. 2014. Ashmole's Halo as the outcome of a predator-prey game. *Marine Ornithol.* 42: 125-136.
- Hindmarch, S., E.A. Krebs, J. Elliott and D.J. Green. 2014. Urban development reduces fledging success of Barn Owls in British Columbia, Canada. *Condor* 116: 507-517.
- Hipfner, J.M. and M. Galbraith. 2014. Diet of the Pacific sand lance (*Ammodytes hexapterus*) in the Salish Sea in the 1960s. *Can. Field Nat.* 128: 57-62.
- Jamieson, S.E., R.C. Ydenberg and D.B. Lank. 2014. Does predation danger on southward migration curtail parental investment by female western sandpipers? *Anim. Migr.* 2: 34-43.
- Katinic, P.J., D.A. Patterson and R.C. Ydenberg. 2014. Thermal regime, predation danger and the early marine exit of sockeye salmon (*Oncorhynchus nerka*) in Copper Creek, Haida Gwaii. *J. Fish Biol.* DOI: 10.1111/jfb.12596.
- Knight, E.C., N. Mahony and D.J. Green. 2014. Crop type influences edge effects on the reproduction of songbirds in sagebrush habitat near agriculture. *Avian Cons. Ecol.* 9: 8. <http://dx.doi.org/10.5751/ACE-00662-090108>.
- Miller, K.M., A. Teffer, S. Tucker, S. Li, A.D. Schulze, M. Trudel, F. Juanes, A. Tabata, K.H. Kaukinen, N.G. Ginther, T.J. Ming, S. Cooke, J.M. Hipfner, D.A. Patterson and S.G. Hinch.

2014. Infectious disease, shifting climates and opportunistic predators: cumulative factors potentially impacting declining wild salmon populations. *Evol. Appl.* 7: 812-855 DOI: 10.1111/eva.12164.
- Ryan, C.P., A. Dawson, P.J. Sharp, S.L. Meddle and T.D. Williams. 2014. Circulating breeding and pre-breeding prolactin and LH are not associated with clutch size in the Zebra Finch (*Taeniopygia guttata*). *Gen. Comp. Endocrinol.* 202: 26-34.
- Schmutz, J.A., K.G. Wright, C.R. DeSorbo, J. Fair, D.C. Evers, B.D. Uher-Koch and D.M. Mulcahy. 2014. Size and retention of breeding territories of yellow-billed loons (*Gavia adamsii*) in Alaska and Canada. *Waterbirds* 37: 53-63.
- St. Clair, C.T., P. Baird, R.C. Ydenberg, R. Elner and L.I. Bendell. 2014. Trace elements in Pacific Dunlin (*Calidris alpina pacifica*): patterns of accumulation and concentrations in kidneys and feathers. *Ecotoxicol.* DOI 10.1007/s10646-014-1352-.
- Thomsen, S.K., C.E. Kroeger, P.H. Bloom and A.L. Harvey. 2014. Space use and home range size of Barn Owls on Santa Barbara Island. *Monogr. W. North Amer. Natural.* 7: 339-347.
- Tissier, M.L., T.D. Williams, S. Zahn, S. Massemin and F. Criscuolo. 2014. Maternal effects underlie ageing costs of growth in the zebra finch (*Taeniopygia guttata*). *PLoS One* 4.21: DOI: 10.1371/journal.pone.0097705.
- Uher-Koch, B.D., D. Esler, R.D. Dickson, J.W. Hupp, J.R. Evenson, E.M. Anderson, J. Barrett and J.A. Schmutz. 2014. Survival of surf scoters and white-winged scoters during remigial molt. *J. Wildl. Manage.* 78: 1189-1196.
- Verkuil, Y.I., C. Juillet, D.B. Lank, F. Widemo and T. Piersma. 2014. Genetic variation in nuclear and mitochondrial markers supports a large sex difference in lifetime reproductive skew in a lekking species. *Ecol. Evol.* DOI: 10.1002/ece3.1188.
- Wagner, D.N., D.J. Green, J.M. Cooper, O.P. Love and T.D. Williams. 2014. Variation in plasma corticosterone in migratory songbirds: a test of the migration-modulation hypothesis. *Physiol. Biochem. Zool.* 87: 695-703.
- Wagner, D.N., D.J. Green, M. Pavlik, J. Cooper and T.D. Williams. 2014. Physiological assessment of the effects of changing water levels associated with reservoir management on fattening rates of neo-tropical migrants at a stopover site. *Conservation Physiology* 2: cou017 doi:10.1093/conphys/cou017.
- Warren, J.M., K.A. Cutting, J.Y. Takekawa, S.E. De La Cruz, T.D. Williams and D. Koons. 2014. Previous success and current body condition determine breeding propensity in lesser scaup: evidence for the individual heterogeneity hypothesis. *Auk: Ornithol. Advances* 131: 287-297.

Submitted:

- Gorman, K.B., K.E. Ruck, S.E. Stammerjohn, H.W. Ducklow, T.D. Williams and W.R. Fraser. Submitted. Regional variation in reproductive isotopic niche among *Pygoscelis* penguins in relation to Southern Ocean sea ice: evidence for food-web match-mismatch. *Ecol. Monogr.*
- Gorman, K.B., S.L. Talbot, G.K. Sage, S.A. Sonsthagen, T.D. Williams and W.R. Fraser. Submitted. Population genetic structure and gene flow of Adelie penguins (*Pygoscelis adeliae*) breeding west of the Antarctic Peninsula. *Antarct. Sci.*
- Taylor, C.M., D.B. Lank and B.K. Sandercock. Submitted. Using local dispersal data to reduce bias in apparent survival and mate fidelity. *Condor*.
- VanStratt, C.S., D. Esler, D.H. Ward, K.M. Brodhead, B.D. Uher-Koch and J.W. Hupp. Submitted. Latitudinal variation in foraging effort of wintering surf scoters. *Condor*.
- Xu, C., J. Barrett, D.B. Lank and R.C. Ydenberg. Submitted. 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.*

C. Theses

- Forrester, T. 2015. Species richness, abundance and reproductive responses of riparian birds to habitat restoration in the Okanagan valley. MSc, Simon Fraser University, Burnaby. pp.
- Gorman, K. 2015. Integrative studies of southern ocean food-webs and *Pygoscelis* penguin demography: mechanisms of population response to environmental change. PhD, Simon Fraser University, Burnaby. pp.
- Brogan, J. 2014. Sources and effects of persistent organic pollutants and flame retardants in Cooper's hawks of Vancouver, British Columbia. MSc, Simon Fraser University, Burnaby. pp.
- Currier, H. 2014. Exposure of brominated flame retardants and their associated effects on the growth and development and the breeding success in two avian models: the zebra finch and the European starling. PhD, Simon Fraser University, Burnaby. pp.