ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY

2018-2019

Department of Biological Sciences
Simon Fraser University

http://www.sfu.ca/biology/wildberg/NewCWEPage/CWEnewTestHome.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 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. That agreement has expired, but The Centre for Wildlife Ecology (CWE) as described here continues work with ECCC and with other agencies, on a range of issues pertaining to wildlife and other environmental sciences.

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
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	Richard Johnston	Rachel Canham	Kathryn Coukell, CWE Admin. Asst.
Tanya Brown	Mason King	Gwyn Case	Connie Smith, CWE Research Tech
	Emily McAuley	Jo Enns	
	Michal Pavlik	Tess Forstner	***Visitors***
Undergrads	Marinde Out	Sonya Pastran	Pat Baird
Ellery Hardy	Florian Reurink	Elizabeth Ruberg (MET)	Joachim Bertrands
	Eveling Tavera Fernandez	Catherine Villeneuve	Lina Giraldo Deck
	Simon Valdez	Kristen Walters	Jasmine Loveland
		Lena Ware	Enver Ortiz
			Stephanie Roilo
	PhD(defended)	***MSc (defended)***	
	David Hope	Seth Bennett	
	Jeff Yap	Alice Domalik	
		Kate Fremlin	

B. Steering Committee

Name	*Position*	*Affiliation*
Robert Elner	Emeritus Scientist	*ECCC*
David Green	CWE faculty (non-voting)	*SFU*
Mark Hipfner	Research Scientist	*ECCC*
Elsie Krebs	Research Manager, Western Canada	*ECCC*
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 direct conservation and management issues for this listed species. This project was started by CWE chair emeritus Fred Cooke in 1994 and continued through the present by David Lank.

Lank took on MSc student Sonya Pastran to analyze Marbled Murrelet transect data gathered for the past 21 years by the Laskeek Bay Conservation Society, which has now received funding from ECCC under the Ocean Protection Plan. Pastran conducted a full season of fieldwork during the summer of 2018 prior to starting her MSc in Sept 2018. The project involves: creating a spatially-explicit database for seabird sightings over the full period, which is largely completed; assembling relevant environmental variable, both static and dynamic to compare with historical seabird distributions, and obtaining 2 years' data on local environmental variables to assess with respect data gathered in 2018 and 2019. The work also includes an experiment to determine whether seabirds avoid areas with coastal raptors. They appear to do so, and Pastran's poster describing the results of her 2018 experiments won a 'Best MSc Student Paper' award at the Pacific Seabird Group's meeting this year. Mark Drever of ECCC is on Pastran's committee. Pastran and Lank participated in several OPP planning sessions, and Pastran has contributed the recent Laskeek Bay data to the Emergency Response Database being assembled by ECCC staff.

Lank continued as a member of the Canadian Marbled Murrelet Recovery team, but this was minimally active during 2019. A technical paper arising from the development of the original Canadian Marbled Murrelet Recovery plan, co-authored by Lank, was published in the BC Journal of Ecosystem Management.

2. Eastern WhipPoorWill (Threatened, COSEWIC)

The Eastern WhipPoorWill was designated as a Threatened species by COSEWIC in 2009. Philina English addressed identified knowledge gaps for this species in her PhD thesis that was defended in April 2017. She 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 re-grow on abandoned agricultural land (English et al. 2017a), 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 (English et al 2018a), and 3) moth abundance has a positive influence on daily chick survival rates (English et al. 2018b). In collaboration with Mike Cadman (CWS), she also 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 (English et al 2017b).

3. 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. Sarah Thomsen explored the direct and indirect interactions between barn owls, deer mice and Scripp's murrelets, and evaluated management options for this vulnerable species in her PhD thesis that was defended in July 2017. This work has now been published in Ecology (Thomsen and Green 2017), Proceedings of the Royal Society (Thomsen et al 2018) and Global Change Biology (Thomsen and Green 2019).

4. Northern Goshawk (Threatened, COSEWIC)

The Northern Goshawk was designated as a Threatened species by COSEWIC in 2000. The Northern Goshawk is a forest raptor whose preference for breeding within late successional forest has placed it at risk from habitat loss and fragmentation, primarily due to timber harvest. Several knowledge gaps persist surrounding goshawk biology, particularly the amount, composition, and configuration of foraging habitat most beneficial to goshawk productivity. Gwyn Case (MSc student) initiated a research project that will be conducted in collaboration with FLNROD to quantify goshawk diet, examine how landscape-level forest structure relates to diet, and assess the role of diet and landscape-level forest structure on nest occupancy and reproductive success of goshawks. This project will fill substantial knowledge gaps related to this species at risk and inform habitat protection decisions in the province.

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

6. Barn Swallow (Threatened, COSEWIC) - see Section V.B.3.b., Landscape-level determinants of breeding distribution, productivity and foraging in Barn Swallows and Tree Swallows

B. Human Impacts on Birds

1. Contaminants and Toxicology

a. Developmental neurotoxicity of mercury in birds

We have completed this 5-year study. Cybele Heddle (MET student) graduated and is currently working as an Environmental Toxicologist, with SLR, Vancouver. Final papers from this project are submitted and in review.

b. Chronic toxicity of petroleum hydrocarbons and other contaminants in seabird sentinel species

This research focuses on investigating the toxicity of petroleum, specifically oil sands bitumen products, to birds on the Pacific north-west coast. We propose the development of novel approaches to assess toxicity from chronic exposure to petroleum hydrocarbons and other contaminants. Collaborators at National Wildlife Research Centre (NWRC), Ottawa have developed gene arrays of two wildlife indicator species, the Rhinoceros Auklet and Double-crested Cormorant for the purposes of assessing the effects of a range of environmental contaminants, primarily oil derived hydrocarbons, halogenated hydrocarbons, and heavy metals. These species have been selected by both ECCC Canadian Wildlife Service (CWS) and Wildlife and Landscape Science Directorate (WLSD) managers as the bio-indicators of choice in relation to baseline measurements for the NGP (Northern Gateway Pipeline). The Rhinoceros Auklet (RHAU) is also one of our ECCC (Environment and Climate Change Canada) long term contaminant seabird monitoring species for the west coast. This work is funded under the Ocean Protection Plan and is a collaboration with Dr. John Elliott (ECCC).

c. Avian dilbit toxicity studies

An initiative to increase transport of an unconventional crude petroleum known as diluted bitumen (dilbit) from the Port of Vancouver will increase the risk of a major oil spill and chronic small-scale discharges. Crude petroleum is toxic to birds, yet no published scientific studies of the effects of dilbit on birds yet exist. This pilot research will establish methods for evaluating the toxicity of dilbit to birds and bird embryos, as well as establish the range of doses at which sub-lethal effects occur. Initially this projects will have two components including, i) an oral toxicity test in adult zebra finches, and ii) a chicken embryo toxicity test (i.e. using fertile, developing eggs). The tests will yield methods for future research and some data on physiological and gene expression endpoints for dilbit toxicity. Depending on the results of these initial experiments we intend to undertake more detailed experiments, for example, looking at effects of dilbit in females and in breeding zebra finches. This work is funded under the Ocean Protection Plan and is a collaboration with Dr. John Elliott (ECCC).

d. Biomagnification of legacy and emergent persistent organic pollutants in a food-web of an avian top predator, the Cooper's hawk

The CWE continues to collaborate with Dr John Elliott (ECCC, SFU Adjunct Professor) on studies examining the exposure and impact of persistent organic pollutants (POPs) on wildlife. Kate Fremlin, who is working on a Doctoral degree in the School of Resources and Environmental Management at SFU, will continue her work on this project by developing a bioaccumulation model that can be used to predict what new commercial chemicals will do in terrestrial food-webs. She will also have more wildlife samples analysed for perfluroalkyl substances and cyclic

methylsiloxanes to expand and improve the current data set from her MSc. Kate and colleagues recently submitted a manuscript on bioaccumulation and biomagnification of PBDEs to the journal Chemosphere.

2. Reservoirs and the impact of Water Use Decisions on Riparian Birds

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 2004-2017 impact the population dynamics of yellow warblers, a species identified by Partners in Flight as a focal species for riparian habitat. The final component of this project, an individual based model will examine how different reservoir water use decisions influence productivity on the breeding grounds.

3. Agricultural Effects

a. 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 16th year at our Langley field site (140 nest boxes). Basic monitoring was conducted in 2018.

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

This project – a collaboration with Dr. Nancy Mahony, ECCC - was completed in 2018. Chloe Boynton (MSc) is currently working as a Migratory Bird Management Biologist with Canadian Wildlife Service. One paper will be submitted shortly and two more are in preparation from this project.

C. Declining Avian Populations

1. Migratory Shorebirds

Concern has been raised about apparent population declines of many species of shorebirds over the past two decades. The CWE and its ECCC associates have consistently contributed novel research findings addressing potential causes of these apparent declines. We have cooperated particularly closely with ECCC's Mark Drever (Delta), Keith Hobson (Saskatoon), and with ECCC emeritus Bob Elner, as well as Bird Studies Canada local representatives.

a. Shorebird Breeding Biology

Current and former CWE members contributed to four 2018 publications arising from their participation in the Arctic Shorebird Demographic Network, a collaborative program that includes over a dozen sites in Alaska and arctic Canada utilizing common protocols, including contributions from ECCC staff members Grant Gilchrist, Jennie Rausch, and Paul Smith. These publications address effects of environmental conditions and seasonal trends on breeding success and adult survivorship, and the extent to which these data can provide information on population trends. This last paper, which is in large measure the culmination of this extensive work, was under development during the end of 2018 and a draft has been completed by April 2019.

b. Non-breeding biology

PhD student Richard Johnson, from Colombia, completed his Ph.D thesis entitled "The influence of predation danger on the distribution of nonbreeding shorebirds in a tropical estuary system", in late winter 2019. During 2018, he published the first chapter of the thesis, assessing the relative importance of isolation, danger, and foraging locations as predictors of roost sites used by Whimbrils in the large tropical delta he studied on the Pacific coast of Columbia. In other chapters completed by the end of the year, Johnson concluded from analysis of 5 years of survey data that environmental predation danger overrides food abundance as a priority for most overwintering shorebirds in this tropical delta. Additional chapters highlight species differences in distributional patterns with respect to body size, foraging mode, and experimental measures of escape performance. Richard obtained a prestigious postdoctoral position in a new "Coastal Solutions Fellows Program'', which aims to pair early career shorebird biologists, coastal engineers, and others to create practical management plans for neotropical coastal areas. Lank participated in workshops in Panama early in 2018, and previously in Peru in 2017 at which this program was partially developed.

Eveling Tavera Fernandez, Ph.D student from Peru, obtained substantial new funding from the US Neotropical Migratory Bird program to continue her shorebird banding and resighting field seasons in Peru throughout 2018, including both activities in autumn 2017-spring 2018 and autumn 2018-spring 2019, and resighting 'oversummering' birds in between. She has collaborated with ECCC staff member Mark Drever to produce mark-recapture estimates of seasonal and annual survivorship of small shorebirds, based on her current datasets. She is involved with the generation of a Peruvian Shorebird Conservation plan, and is the chair of the Western Hemisphere Shorebird Group. The CWE hosted a 6-week visit by Eve's field manager Enver Ortiz, during which time we completed a paper on shorebird ectoparasite prevalence in Peru.

c. Migration Biology

PhD student Dave Hope finished his PhD e in December 2018, focused on factors affecting habitat use by migratory shorebirds, and how these factors affect the interpretation of shorebird counts at migration sites. An analysis of Atlantic Canada Shorebird Surveys showed that Semipalmated sandpipers steadily shifted their stopover site usage toward larger sites between 1974 and 2015). This work was done in cooperation with ECCC's Paul Smith (Ottawa). Surveys of the northbound passage of Western sandpipers and Dunlins along the Pacific Flyway show an advance in migration timing at southern, but not northern sites (1985 – 2016), an analysis done with ECCC staff Mark Drever and others.

Hope developed a model of mortality-minimizing decisions made by southbound Western sandpipers moving through a landscape with large and small stopover sites, and used the model to simulate counts that would be observed under different scenarios of population change and habitat usage, each leaving distinct `fingerprints' of outcomes. Simulated outcomes were compared to counts made over five years by citizen-scientists across the Salish Sea region, work coordinated in association with Bird Studies Canada staff, and the Migratory Shorebird Network headquartered at Point Blue Conservation Sciences. The results support the hypothesis that inter-annual variation in the passage timing of peregrine falcons strongly affect the distribution of sandpipers across small and large stopover sites. Other scenarios appeared less parsimonious.

Each of these approaches demonstrated that the behavioural response of shorebirds to landscape-level conditions affects counts strongly enough that the accuracy of estimated population trends can be poor. Caution should be exerted when using migratory counts to generate trends in populations.

Hope presented his findings at the Salish Sea Ecosystem Conference 2018 in Seattle, CRIMBI meetings in Bellingham, at the PWRC in Delta.

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 (ECCC) 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. The 2017 field season in Revelstoke completed the field component of this project.
Simon Valdez (PhD candidate) is currently investigating the non-breeding portion of the yellow warbler life cycle; he will defend his PhD in the coming year. He has demonstrated that the breeding origins of female yellow warblers influences winter habitat use in Mexico (Valdez-Juarez et al. 2018), and 2) that winter habitat use influences the condition and winter survival of Yellow warblers in Jalisco, Mexico (Valdez-Suarez et al. 2019). Michal Pavlik (PhD candidate) is currently examining 1) how wind conditions on migration influence the physiology of warblers on their arrival on the breeding grounds, 2) how conditions on migration interact with conditions on the breeding grounds to determine the timing of breeding and local productivity, 3) how mortality rates vary across the annual cycle, and 4) the importance of density-dependent and density-independent process for population dynamics.

3. Aerial Insectivores

The widespread population declines of this guild has led to the suggestion that declines may be due to changes in the abundance and/or availability of their insect prey. Long-term declines in insect abundance have been documented in Europe but similar data is lacking fro North America. Challenge experiments, that were a common tool used to test foraging theory in the 1990's provide a potential alternative approach to evaluating changes in prey availability; if prey availability has decreased parents over the last three decades we would expect to see concomitant changes in the ability of parents to meet the challenge of provisioning experimentally enlarged brood sizes. In 2017 and 2018, Catherine Villeneuve, repeated a brood manipulation on tree swallows in Creston BC that was previously conducted in 1994/5. She found that delivery rates to the nest were lower in 2018/19 than 1994/5 because load sizes at each delivery are reduced. Her work illustrates the potential for re-purposing behavioral studies on foraging behavior to

investigate long-term changes in insect abundance in the absence of long-term monitoring data. See also section V.B.3.b. Landscape-level determinants of breeding distribution, productivity and foraging in Barn Swallows and Tree Swallows.

See also section V.A.2. Eastern WhipPoorWill *(Threatened, COSEWIC).*

D. Coastal Ecology

1. Coastal Studies of Seabirds

Mark Hipfner (Environment and Climate Change Canada, Delta – Wildlife Research Division), the Scientific Director of the Triangle Island Seabird Research Station, and reports that summer 2018 marked the 25th year – a quarter century - of operation of the CWE's seabird research and monitoring program on Triangle Island. The 2018 field crew consisted of David Bradley (Bird Studies Canada), Amos Chow (ECCC, Delta – Canadian Wildlife Service), Nik Clyde (ECCC Delta - WRD), Alice Domalik (ECCC Delta – WRD, and MSc Candidate, CWE), Andrew Huang (ECCC, Delta – CWS), Kevin Kardynal (ECCC, Saskatoon – WRD), Mason King (PhD Candidate, CWE), Elsie Krebs (ECCC, Delta – WRD), Greg McLelland (ECCC, Delta – CWS), Megan Ross (ECCC, Delta – WRD), and Ken Wright (ECCC, Delta – WRD), in addition to Hipfner. As in past years, the Triangle crew monitored breeding chronology, breeding success and nestling diet in Cassin's Auklet *Ptychoramphus aleuticus*, Rhinoceros Auklet *Cerorhinca monocerata*, and Black Oystercatcher *Haemotopius bachmani*. The crew also took soil cores and collected vegetation and insect samples for stable isotope analysis for a project investigating the dynamic relationship between seabird populations and vegetation patterns on the island.

Research also continued on several other major Rhinoceros Auklet colonies in BC - in 2018, we visited Pine Island, Lucy Island, and (for the first time, at least for this purpose) Cleland Island. The primary objective of this program, which was initiated in 2006, is to study the effects of oceanographic variation on multiple trophic levels – the diets of the auklets and of their major fish prey, Pacific sand lance *Ammodytes personatus* and Pacific herring *Clupea pallasii*. We continue to collaborate on this research with researchers in Washington State, and with Fisheries and Oceans Canada in Nanaimo. The field crew for the BC portion of the work consisted of Isabelle Cellier (ECCC, Delta – CWS), Clyde, Domalik, Hipfner, Agathe Lebeau (ECCC, Delta – CWS), and Ross. While on the auklet colonies, we also deployed GPS tags on Rhinoceros Auklets for a study of at-sea distributions and habitat selection being led by Domalik, whose MSc is co-supervised by Hipfner and David Green (CWE, SFU); collected eggs and prey samples for a contaminants study being led by King, whose PhD is co-supervised by John Elliott (ECCC, Delta – Wildlife Toxicology Division) and Tony Williams (CWE, SFU); completed the seventh year of a project investigating the consumption of salmon *Oncorhynchus* spp. by seabirds in BC waters, in collaboration with Strahan Tucker (DFO, Nanaimo - PBS); and completed the tenth year of a project investigating the ingestion of microfibres/microplastics by forage fish, in collaboration with Moira Galbraith (DFO, Sidney - Institute of Ocean Sciences).

2. Coastal Ecology of Barrow's Goldeneye

Barrows goldeneye are a sea duck with a discrete western and eastern population. The majority of the larger western population winters along the Pacific, and breeds in the interior of British Columbia, Alberta and the Northwest Territories. Recent efforts, led primarily by ECCC, have focused on using satellite telemetry to determine linkages among breeding, molting and wintering

areas. These data have been used to describe the broad movements of Barrows Goldeneye throughout their annual cycle. However, the spatial scale and spatial/temporal resolution of this dataset can also be used to address research priorities of the federal Ocean Protection Plan and identified information needs of the Sea Duck Joint Venture. Tess Forstner (MSc candidate), in collaboration with Sean Boyd (ECCC) and Megan Willie (ECCC) is using the extensive satellite telemetry dataset to examine latitudinal variation in the timing of discrete stages of the annual cycle and assess the degree of migratory connectivity between wintering populations across the western range. She will also use the data to identify when and where wintering sea ducks would be sensitive to anthropogenic activities on the Pacific coasts.

3. Movement Ecology of Black Oystercatchers

CWE has initiated a new long-term study on the movement ecology and habitat use of the Black Oystercatcher, an indicator species for rocky intertidal habitat in the Pacific Northwest. This project is a collaboration involving federal agencies in BC (ECCC and Parks Canada) and Alaska (USGS and US National Parks Service) with assistance from non-governmental organisations in BC (Laskeek Bay Conservation Society and Rainforest Conservation Society). Fieldwork initiated in spring 2019 by Lena Ware (MSc candidate) will use detailed satellite telemetry data to define the movement and habitat use of black oystercatchers in relation the tidal and diurnal light cycle at different stages of the year. Her project will support the ECCC mandate, under the federal Ocean Protection Plan, to conduct research and monitoring in order to improve management of the coastal waters of the Pacific coast. Future work will assess the drivers of migration in Alaskan oystercatchers and assess how Alaskan migrants interact and shape the habitat selection of BC residents during the winter months.

4. Coastal Usage by Migratory Shorebirds

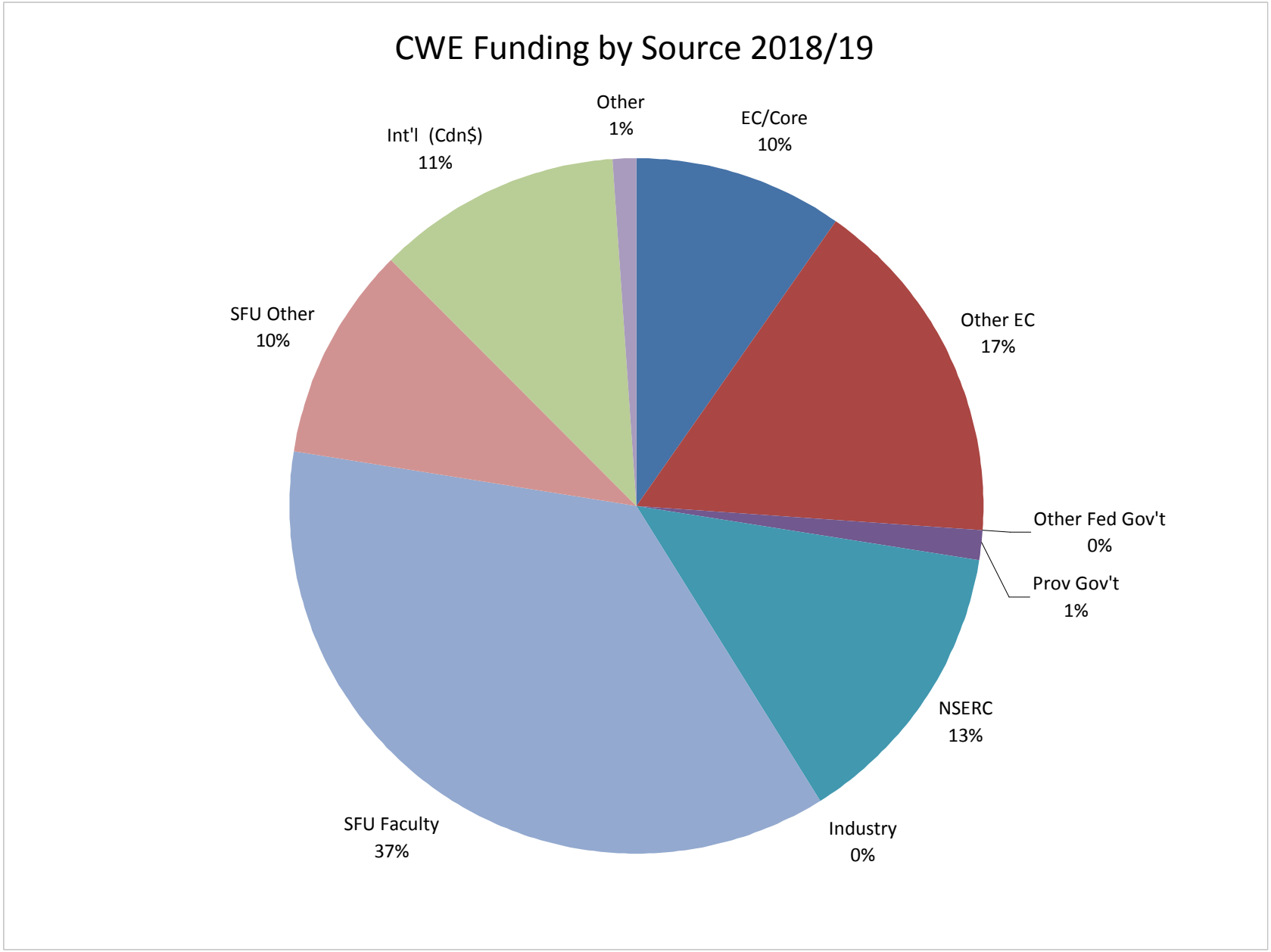
The majority of the world's three and a half to four million Western Sandpipers stop briefly to refuel in Boundary Bay or on Robert's Bank during their annual northward migration, providing a thrilling sight for local residents. Much of the species' population also stops over on southward migration, 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. 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.
MSc student Rachel Canham completed her thesis and defended early in 2019. Her work focused on biofilm production and grazing by migrant Western Sandpipers on Robert's Bank. Rachel measured biofilm concentration and grazing intensity on transects and concluded that found the total accumulation during tidal periods matched that removed by sandpipers during grazing visits. During the higher-intensity (10 – 100 fold, based on daily sandpiper counts) northward migration, biofilm concentration increased and grazing decreased with proximity to the shoreline. In contrast, during southward migration biofilm was uniformly high. A danger manipulation experiment supported a trade-off with biofilm concentration: grazing declined with danger, but less so where biofilm is higher. Together the results indicate that dynamic trophic interactions between danger, sandpipers and biofilm create spatial patterns in biofilm concentration.

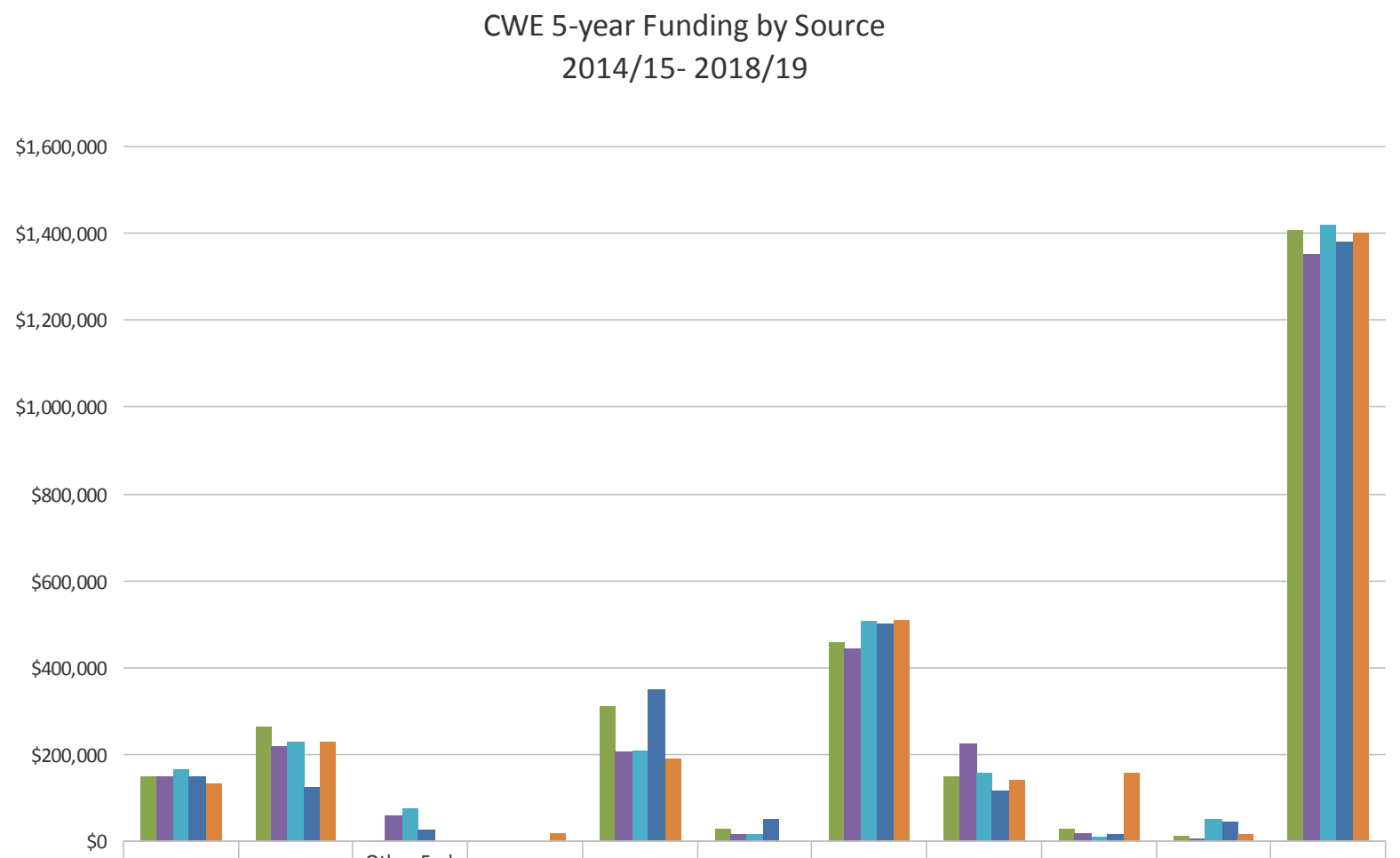
Florian Reurink started his PhD project, following up on work done in collaboration with Ron Ydenberg during his MSc program at Wageningen University. His previous work used flight behavior of birds to make predictions about energy intake rate in birds. Shorebird food availabil-

ity is time consuming and expensive to assess empirically, and these studies are testing a the potential for a behavioural measure to provide a simpler index of shorebird food availability. Behavioural ecological theory predicts that birds should adjust their foraging flight speed to the conditions in the habitat, where flight speed should increase with increased energy intake. The results from Florian's MSc work matched the predictions from the theory very well, and the Ph.D. further tests the applicability of this approach. In collaboration with ECCC's Rhonda Millikin and Ecotrack, Reurink has developed algorithms for quantifying flight speeds of dunlin and western sandpipers using a mobile radar system. Reurink and visiting MSc student Joachim Bertrand (Wageningen University, Netherlands), collected foraging flight speeds of dunlin over the course of the winter, testing the prediction that speeds would decrease as resources were depleted over the course of the winter, which was found to be the case. Reurink's research continues with planned collection of flight speeds of migrating western sandpipers at multiple sites in the Salish Sea, allowing him to look at inter- and intra-site differences.
Ydenberg continued to develop theory focusing on shorebird responses to changes in danger from increasing raptor populations over the past 30 years, and the effects these can have on shorebird populations and interpretations of census data. He and Lank are exploring contrasting directional effects on wing lengths of Western and Semipalmated sandpipers during the 1980s, following up on Lank's paper in 2016 on this subject.

VI FUNDING

In 2018-2019 the contract between the Simon Fraser University (Centre for Wildlife Ecology) and Environment and Climate Change Canada (Science and Technology Division) was renewed for three years. This grant 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 2018/19
Other
1%
EC/Core
10%
Int'l (Cdn$)
11%
SFU Other
10%
Other EC
17%
Other Fed Gov't
0%
Prov Gov't
1%
NSERC
13%
SFU Faculty
37%
Industry
0%



	EC/Core	Other EC	Other Fed Gov't	Prov Gov't	NSERC	Industry	SFU Faculty	SFU Other	Int'l (Cdn$)	Other	Grand Total
2014/2015	$150,000	$264,773	$3,680		$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
2016/2017	$168,500	$228,250	$73,975		$208,667	$16,300	$506,394	$156,750	$9,805	$51,001	$1,419,641
2017/2018	$150,000	$125,000	$25,235		$350,923	$51,800	$500,148	$117,694	$16,700	$44,281	$1,381,781
2018/2019	$135,000	$230,333	$1,520	$19,541	$188,667	$-	$510,633	$139,218	$158,478	$16,293	$1,399,681

1 April 2018 - 31 March 2019

Scholarships, Fellowships, Grants for Students

Description	Name of person	Notes	Amounts
		PhD	
SFU Fellowships etc	David Hope	TA (Fall)	$5,744
SFU Fellowships etc	Jeff Yap	TA (Summer)	$5,744
SFU Fellowships etc	Eveling Tavera	TA (Fall)	$7,136
SFU Fellowships etc	Mason King	GF (Fall)	$6,500
SFU Fellowships etc	Richard Johnson	GF (Fall)	$6,500
SFU Fellowships etc	Florian Reurink	Graduate Dean's Entrance Scholarship (Summer, Fall, Spring)	$21,000
Other	David Hope	Salish Sea Ecosystem Conference	$293
International	Eveling Tavera	NMBCA	$143,030
International	Eveling Tavera	Amer Ornithol Soc Conference	$629
International	Eveling Tavera	CONCYTEC (Peru) for AOS Conference	$2,993
		M Sc	
NSERC	Lena Ware	NSERC CGS-M (Fall, Spring)	$11,667
SFU Fellowships etc	Seth Bennett	TA (Summer)	$4,689
SFU Fellowships etc	Sonya Pastran	TA (Summer)	$5,819
SFU Fellowships etc	Catherine Villeneuve	GF (Summer)	$6,500
SFU Fellowships etc	Elizabeth Ruberg	GF (Fall)	$6,500
SFU Fellowships etc	Catherine Villeneuve	TA (Fall)	$6,051
SFU Fellowships etc	Alice Domalik	GF (Fall)	$6,500
SFU Fellowships etc	Joanna Enns	TA (Fall)	$2,526
SFU Fellowships etc	Tess Forstner	TA (Fall)	$6,051
SFU Fellowships etc	Sonya Pastran	TA (Fall)	$6,051
SFU Fellowships etc	Joachim Bertrands	TA (Fall)	$4,689
SFU Fellowships etc	Rachel Canham	TA (Spring)	$6,051
SFU Fellowships etc	Tess Forstner	GF (Spring)	$6,500
SFU Fellowships etc	Sonya Pastran	Travel Award For Seabird Meeting	$500
SFU Fellowships etc	Joachim Bertrands	Travel Award for Seabird Meeting	$500
Other EC	Alice Domalik	EC contract (Summer)	$7,000
Other EC	Tess Forstner	EC contract (Fall)	$7,333
Other EC	Kate Fremlin	EC contract (Summer)	$7,000
Other EC	Sonya Pastran	ECCC / Ocean Protection Plan	$28,000
Other	Sonya Pastran	Society of Canadian Ornithologists	$2,000
Other	Kristen Walters	Hancock Fdn (Summer)	$7,000
Provincial	Gwyn Case	FLNROD (Fall, Spring)	$19,541
		General Funding for CWE	
EC/Core	EC	EC Annual Chair Funding (1/3 yrs)	$135,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg Williams Green)	$510,633

Conference Funding

Other Funding

Other Federal	Lank	Canada Summer Jobs	$1,520
International	Lank	Max Plank Collaborative Agreement	$11,825
Other	Ydenberg	Echotrack	$7,000
SFU Other	Green	Ecological Restoration Supervision	$1,000

Species at Risk

Green - FLNROD			$0
Ydenberg - ECCC (Green)			$0
Williams	Chair's support		$16,667

Human Impact on Birds

Declining Avian Populations

Coast Ecology

Other EC	Hipfner MJ	Wildlife Research Division (A-base)	$30,000
Other EC	Hipfner MJ	Canadian Wildlife Service (Protected Areas)	$25,000
Other EC	Hipfner MJ	WRD (Ocean Protection Plan)	$75,000
Other EC	Hipfner MJ	Climate Change Action Plan	$25,000
Other EC	Hipfner MJ	STAGE	$26,000

NSERC

NSERC	Green DJ	Overwintering ecology, migration strategies and demography of migratory birds (5/5 yrs)	$27,000
NSERC	Lank D	Maintenance of ecological polymorphism by frequency-dependent selection (5/5) yrs)	$27,000
NSERC	Ydenberg RC	NSERC Individual Research Grant - "Predation danger in the ecology of migration" (4/5 yrs)	$32,000
NSERC	Williams TD	NSERC Individual Research Grant "Diet or exercise? How do birds cope with transitions in workload associated with parental care or fledging?"(1/5yrs)	$55,000
NSERC	Elliott J	Investigating sources, transport, accumulation and effects of persistent contaminants in urban environments using a top predator as indicator (3/5 yrs)	$36,000

Grand Total	$1,399,681
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. Two PhD students and three 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. PAPERS IN REFEREED JOURNALS OR BOOKS

Books and Book Chapters

Mathot, K.J., T. Piersma and R.W. Elner. 2018. Shorebirds as integrators and indicators of mudflat ecology. In: *Mudflat Ecology*, Beninger, P., eds., pp. 309-338. Cham: Springer.

Williams, T.D. 2018. Overview (wild birds). In: *Encyclopedia of Reproduction*, Knobil, E.and J.D. Neill, eds.: Elsevier Press.

Williams, T.D. 2018. Nutrition and reproduction, birds. In: *Encyclopedia of Reproduction*, Knobil, E.and J.D. Neill, eds.: Elsevier Press.

In press:

Grishchenko, M., H.H.T. Prins, R.C. Ydenberg, M.E. Schaepman, W.F. de Boer and H.J. de Knegt. In press. Landuse change and the migration geography of Greater White-fronted geese in European Russia. Ecosph.

Pakanen, V.-M., D. Blomqvist, T. Breiehagen, L.-Å. Flodin, O. Hildén, D.B. Lank, M. Larsson, T. Lislevand, K. Nuotio, H. Pehlak, A. Pauliny, A. Rönkä, N. Rönkä, D. Schamel, M. Soikkeli, R.L. Thomson, D. Tracy, P. Tomkovich, T.a. O. and K. Koivula. In press. Low frequencies of supernormal clutches in the Southern Dunlin and the Temminck's Stint. Ardea.

Studholme, K.R., J.M. Hipfner, A.D. Domalik, S.J. Iverson and G.T. Crossin. In press. Year-round tracking reveals the existence of multiple migratory tactics in Cassin's Auklet, a sentinel North Pacific seabird. Mar. Ecol. Prog. Ser.

Tavera, E.A., D. Minaya, E. Ortiz Lopez, O.J. Iannacone and D.B. Lank. In press. Cleaner in the tropics? Chewing lice occurrence, host specificity and diversity in non-breeding shore-birds in Perú. Wader Study. i

Vitousek, M.N., M.A. Johnson, C.J. Downs, E.T. Miller, L.B. Martin, C.D. Francis, J.W. Donald, M.J. Fuxjager, W. Goymann, M. Hau, J.F. Husak, B.K. Kircher, R. Knapp, L.A. Schoenle and T.D. Williams. In press. Macroevolutionary patterning in glucocorticoids suggests different selective pressures shape baseline and stress-induced levels. Amer. Nat.

2019:

Bos, D., E. Wymenga, R.C. Ydenberg and E.E. van Loon. 2019. De muskusrat op zijn retour. De Levende Natuur 120**:** 51-55.

Hipfner, J.M., D.F. Bertram and M.C. Drever. 2019. Limited consequences of infestation with a

blood-feeding ectoparasite for the nestlings of two North Pacific seabirds. J. Avian Biol. 50**:** 10.1111/jav.01927.

Macfarland, L., N.A. Mahony, M. Harrison and D. Green. 2019. Habitat-mediated breeding performance of Lewis's Woodpeckers (*Melanerpes lewis*) in British Columbia. PLoS One 14**:** e0212929.

O'Hara, P.D., S. Avery-Gomm, J. Wood, V. Bowes, L. Wilson, K.H. Morgan, W.S. Boyd, J.M. Hipfner, J.-P. Desforges, D.F. Bertram, C. Hannah and P.S. Ross. 2019. Seasonal variability in vulnerability for Cassin's auklets (*Ptychoramphus aleuticus*) exposed to microplastic pollution in the Canadian Pacific region. Sci. Total Environ. 649**:** 50-60.

Serota, M.W. and T.D. Williams. 2019. Adjustment of total activity as a response to handicapping during parental care in European starlings (*Sturnus vulgaris*). Anim. Beh. 148**:** 19-27.

Valdez-Juarez, S.O., E.A. Krebs, A.E. Drake and D.J. Green. 2019. Assessing the effect of seasonal agriculture on the condition and winter survival of a migratory songbird in Mexico. Conserv. Sci. Pract. 1**:** e19. https://doi.org/10.1111/csp2.19.

Williams, T.D., A. Cornell, G. Gillespie, A. Hura and M.W. Serota. 2019. Effects of an introduced, novel prey on diet and reproduction in the diet-specialist European Starling (*Sturnus vulgaris*). Can. J. Zool. 97**:** 225-231.

2018:

Burger, A.E., F.L. Waterhouse, J.A. Deal, D.B. Lank and D.S. Donald. 2018. The reliability and application of methods used to predict suitable nesting habitat for Marbled Murrelets. J. Ecosystems & Manag. 18**:** 1-18 doi: 10.22230/jem.2018v18n1a593.

Casagrande, S., L.Z. Garamszegi, W. Goymann, J. Donald, C.D. Francis, M.J. Fuxjager, J.F. Husak, M.A. Johnson, B. Kircher, R. Knapp, L.B. Martin, E.T. Miller, L.A. Schoenle, M.N. Vitousek, T.D. Williams and M. Hau. 2018. Do seasonal glucocorticoid changes depend on reproductive investment? A comparative approach in birds. Integrative and Comparative Biology 58**:** 739-750.

Domalik, A.D., J.M. Hipfner, K.R. Studholme, G.T. Crossin and D.J. Green. 2018. At-sea distribution and fine-scale habitat use patterns of zooplanktivorous Cassin's auklets during the chick-rearing period. Marine Biol. 165**:** 177. https://doi.org/10.1007/s00227-018-3434-8.

Ellison, A.M. and R. Ydenberg. 2018. Risk allocation: Acute and chronic predator exposure have contrasting effects on song sparrow (*Melospiza melodia*) singing behaviour. Can. J. Zool. DOI**:** 10.1139/cjz-2018-0147.

Eng, M.L., V. Winter, J.E. Elliott, S.A. MacDougall-Shackleton and T.D. Williams. 2018. Embryonic exposure to environmentally relevant concentrations of a brominated flame retardant reduces the size of song-control nuclei in a songbird. Develop. Neurobiol. 78**:** 799-806.

English, P.A., J.J. Nocera and D.J. Green. 2018. Nightjars may adjust breeding phenology to compensate for mismatches between moths and moonlight. Ecol. Evol. 8**:** 5515-5529. doi:10.1002/ece3.4077.

Fowler, M.A., M. Paquet, V. Legault, A.A. Cohen and T.D. Williams. 2018. Physiological predictors of reproductive performance in the European Starling (*Sturnus vulgaris*). Frontiers in Zoology 15**:** 45.

Francis, C.D., J. Donald, M.J. Fuxjager, L.Z. Garamszegi, W. Goymann, M. Hau, J.F. Husak, M.A. Johnson, B. Kircher, R. Knapp, L.B. Martin, E.T. Miller, L.A. Schoenle, M.N. Vitousek, T.D. Williams and C.J. Downs. 2018. Metabolic scaling of stress hormones in ver-

tebrates animals. Integrative and Comparative Biology 58**:** 729-38.

Gaglio, D., R.B. Sherley, T.R. Cook, P.G. Ryan and T. Flower. 2018. The costs of kleptoparasitism: a study of mixed-species seabird breeding colonies. Behav. Ecol. doi**:** 10.1093/beheco/ary050.

Garamszegi, L.Z., J. Donald, C.D. Francis, M.J. Fuxjager, W. Goymann, M. Hau, J.F. Husak, M.A. Johnson, B. Kircher, R. Knapp, L.B. Martin, E.T. Miller, L.A. Schoenle, M.N. Vitousek and T.D. Williams. 2018. Species-specific means and within-species variance in glucocorticoid hormones and speciation rates in birds. Integrative and Comparative Biology 58**:** 763-776.

Hennin, H.L., C.J. Dey, J. Bêty, H.G. Gilchrist, O. Legagneux, T.D. Williams and O.P. Love. 2018. Higher rates of prebreeding condition gain positively impacts clutch size: A mechanistic test of the condition- dependent individual optimization model. Funct. Ecol. 32**:** 2019-2028.

Hepp, M., L. Ware, H. van Oort, S.M. Beauchesne, J.M. Cooper and D.J. Green. 2018. Post-fledging survival and local recruitment of a riparian songbird in habitat influenced by reservoir operations. Avian Cons. Ecol. 13**:** 12. Doi: 10.5751/ACE-01190-130112. published June 2018.

Hipfner, J.M., M. Galbraith, S. Tucker, K.R. Studholme, A.D. Domalik, S.F. Pearson, T.P. Good, P.S. Ross and P. Hodum. 2018. Two forage fishes as potential conduits for the vertical transfer of microfibres in Northeastern Pacific Ocean food webs. Env. Poll. 239**:** 215-222.

Hipfner, J.M., E.K. Lok, C. Jardine, K.R. Studholme, A.C. Lebeau, K.G. Wright, S.A. Trefry, M.C. Drever and G. Jones. 2018. Beach-cast debris surveys on Triangle Island, British Columbia, Canada indicate the timing of arrival of 2011 Tohoku tsunami debris in North America. Mar. Pollut. Bull. 136**:** 407-413.

Hope, D.D., M.C. Drever, J.B. Buchanan, M.A. Bishop, G. Matz and M.J.F. Lemon. 2018. Trends in timing of spring migration along the Pacific Flyway by Western Sandpipers and Dunlins. Condor 120**:** 471-488.

Johnston-González, R. and E. Abril. 2018. Predation risk and resource availability explain roost locations of Whimbrel *Numenius phaeopus* in a tropical mangrove delta. Ibis doi**:** 10.1111/ibi.12678.

Jones, T., J.K. Parrish, W.T. Peterson, E.P. Bjorkstedt, N.A. Bond, L.T. Ballance, V. Bowes, J.M. Hipfner, H.K. Burgess, J.E. Dolliver, K. Lindquist, J. Lindsey, H.M. Nevins, R.R. Robertson, J. Roletto, L. Wilson, T. Joyce and J. Harvey. 2018. Massive mortality of a planktivorous seabird in response to a marine heatwave. Geophysical Research Letters 45**:** 3193-3202. https://doi.org/10.1002/2017GL076164.

Kwon, E., W.B. English, E.L. Weiser, S.E. Franks, D.J. Hodkinson, D.B. Lank and B.K. Sandercock. 2018. Delayed egg-laying and shortened incubation duration of Arctic-breeding shorebirds coincide with climate cooling. Ecol. Evol. 8**:** 1339-1351. Doi: 10.1002/ece3.3733.

Martin, L.B., M.N. Vitousek, J.W. Donald, T. Flock, M.J. Fuxjager, W. Goymann, M. Hau, J.F. Husak, M.A. Johnson, B. Kircher, R. Knapp, E.T. Miller, L.A. Schoenle, T.D. Williams and C.D. Francis. 2018. IUCN conservation status does not predict glucocorticoid concentrations in reptiles and birds. Integrative and Comparative Biology 58**:** 800-813.

Morran, S.A.M., J.E. Elliott, J.W. Young, M.L. Eng, N. Basu and T.D. Williams. 2018. Ecologically-relevant exposure to methylmercury during early development does not affect adult phenotype in zebra finches (*Taeniopygia guttata*). Ecotoxicol. 27**:** 259-266.

Nelson-Flower, M.J., T.P. Flower and A.R. Ridley. 2018. Sex differences in the drivers of reproductive skew in a cooperative breeder. Molec. Ecol. 27**:** 2435-2446. https://doi.org/10.1111/mec.14587.

Nelson-Flower, M.J., E.M. Wiley, T.P. Flower and A.R. Ridley. 2018. Individual dispersal delays in a cooperative breeder: Ecological constraints, the benefits of philopatry and the social queue for dominance. J. Anim. Ecol. 87**:** 1227-1238.

Studholme, K.R., J.M. Hipfner, L.M. Romero, B.M. Gormally, S.J. Iverson and G.T. Crossin. 2018. Egg size is independent of variation in pre-breeding feather corticosterone in Cassin's Auklets during favorable oceanographic conditions. Gen. Comp. Endocrinol. 268**:** 64-70. https://doi.org/10.1016/j.ygcen.2018.07.019.

Thomsen, S.K., D.M. Mazurkiewicz, T.R. Stanley and D.J. Green. 2018. El Nino/Southern Oscillation-driven rainfall pulse amplifies predation by owls on seabirds via apparent competition with mice. Proc. Roy. Soc. B 285**:** 20181161.

Valdez-Juarez, S.O., A. Drake, K.J. Kardynal, K.A. Hobson, E.A. Krebs and D.J. Green. 2018. Use of natural and anthropogenic land cover by wintering yellow warblers: the influence of sex and breeding origin. Condor 120**:** 427-438. doi: 10.1650/CONDOR-17-180.1.

van den Top, G.G., J.D. Reynolds, H.H.T. Prins, J. Mattson, D.J. Green and R.C. Ydenberg. 2018. From salmon to salmonberry: The effects of salmon-derived nutrients on the stomatal density of leaves of the nitriphillic shrub *Rubus spectabilis*. Funct. Ecol. 32**:** 2625-2633. https://doi.org/10.1111/1365-2435.13202.

Vitousek, M.N., M.A. Johnson, J.W. Donald, C.D. Francis, M.J. Fuxjager, W. Goymann, M. Hau, J.F. Husak, B.K. Kircher, R. Knapp, L.B. Martin, E.T. Miller, L.A. Schoenle, J.J. Uehling and T.D. Williams. 2018. HormoneBase, a population-level database of steroid hormone levels across vertebrates. Nature Sci. Data 5**:** 180097.

Weiser, E.L., R.B. Lanctot, S.C. Brown, H.R. Gates, R.L. Bentzen, M.L. Boldenow, J.A. Cunningham, A. Doll, T.F. Donnelly, W.B. English, S.E. Franks, K. Grond, P. Herzog, B.L. Hill, S. Kendall, E. Kwon, D.B. Lank, J.R. Liebezeit, J. Rausch, S.T. Saalfeld, A.R. Taylor, D.H. Ward, P.F. Woodard and B.K. Sandercock. 2018. Effects of leg flags on nest survival of four species of Arctic-breeding shorebirds. J. Field Ornithol. 89**:** 287-297. DOI: 10.1111/jofo.12264.

Williams, T.D. 2018. Physiology, activity and costs of parental care in birds [Invited commentary]. J. Exp. Biol. 221**:** doi:10.1242/jeb.169433.

Yap, K.N., M. Dick, C.G. Guglielmo and T.D. Williams. 2018. Effects of experimental manipulation of hematocrit on avian flight performance in high and low altitude conditions. J. Exp. Biol. 221**:** jeb191056.

Zhang, Y., K.N. Yap, T.D. Williams and D.L. Swanson. 2018. Experimental increases in foraging costs affect pectoralis muscle mass and myostatin expression in female, but not male, zebra finches (*Taeniopygia guttata*). Physiol. Biochem. Zool. 91**:** 849-858.

2017

Cornell, A. and T.D. Williams. 2017. Variation in developmental trajectories of physiological and somatic traits in a common songbird approaching fledging. J. Exp. Biol. 220**:** 4060-4067.

Crossin, G.T., R.A. Phillips, C.R. Lattin, L.M. Romero, X. Bordeleau, C.M. Harris, O.P. Love and T.D. Williams. 2017. Costs of reproduction and carry-over effects in breeding albatrosses. Antarct. Sci. 29**:** 155-164.

Davis, M.K., J.E. Elliott and T.D. Williams. 2017. Glaucous-winged Gulls (*Larus glaucescens*) as indicators of chemical contaminants in the Canadian Pacific marine environment: evidence from stable isotopes. Arch. Envir. Contam. Toxicol. 73**:** 247-255.

Dehn, M.M., R.C. Ydenberg and L.M. Dill. 2017. Experimental addition of cover lowers the perception of danger and increases reproduction in meadow voles (*Microtus pennsylvani-*

cus). Can. J. Zool. 95**:** 463–472 dx.doi.org/10.1139/cjz-2016-0169.

Eng, M.L., C.A. Bishop, D. Crump, S.P. Jones, T.D. Williams and K.G. Drouillard. 2017. The catbird is the new chicken: high sensitivity to a dioxin-like compound in a wildlife species. Env. Sci. Technol. 51**:** 5252-5258.

Eng, M.L., R.J. Letcher, T.D. Williams and J.E. Elliott. 2017. In ovo tris(2-butoxyethyl) phosphate concentrations significantly decrease in late incubation after a single exposure via injection, with no evidence of effects on hatching success or latent effects on growth or reproduction in zebra finches. Env.Tox. Chem. 36**:** 83-88.

Fowler, M.A. and T.D. Williams. 2017. A physiological signature of 'cost of reproduction' associated with parental care. Amer. Nat. 190**:** 762-773.

Gibson, K.F. and T.D. Williams. 2017. Intraclutch egg size variation is independent of ecological context among years in the European starling *Sturnus vulgaris*. J. Ornithol. 158**:** 1099-1110.

Gorman, K.B., S.L. Talbot, S.A. Sonsthagen, G.K. Sage, M.C. Gravely, W.R. Fraser and T.D. Williams. 2017. Population genetic structure and gene flow of Adélie penguins (*Pygoscelis adeliae*) breeding throughout the western Antarctic Peninsula. Antarct. Sci. 29**:** 499-510.

Killen, S.S., R. Calsbeek and T.D. Williams. 2017. The ecology of exercise: mechanisms underlying individual variation in behavior, activity, and performance: an introduction to symposium. Integrative and Comparative Biology 57**:** 185-194.

Yap, K.N., O.R. Kim, K.C. Harris and T.D. Williams. 2017. Physiological effects of training for increased foraging effort in a small passerine. J. Exp. Biol. 220**:** 4282-4291.

Yu, M.S., M.L. Eng, T.D. Williams, M.F. Guigueno and J.E. Elliott. 2017. Assessment of neuroanatomical and behavioural effects of in ovo methylmercury exposure in zebra finches (*Taeniopygia guttata*). Neurotoxicol. 59**:** 33-39.

Reports

Bertram, D.F., C.L.K. Robinson, M. Hennekes, M. Galbraith, N. Dangerfield, S. Gauthier and K. Woo. 2017. Plastic ingestion by Pacific Sand Lance (*Ammodytes personatus*) in the Salish Sea. In: *2016 Salish Sea Toxics Monitoring Review: A Selection of Research*, James, C.A., J. Lanksbury, D. Lester, S. O'Neill, T. Roberts, C. Sullivanand J. West, eds. Tacoma, WA: PSEMP Toxics Work Group.

Submitted:

Hipfner, J.M., M. Galbraith, D.F. Bertram and D.J. Green. Submitted. Basin-scale oceanographic processes, zooplankton community structure, and the diet and reproduction of a sentinel North Pacific seabird over a 22-year period. Prog. Oceanogr.

Hipfner, J.M., D. Shervill, A.D. Domalik, D.F. Bertram, M.J.F. Lemon, M.S. Rodway, C. Smith and S.A. Hudson (Trefry). Submitted. Longevity in the Rhinoceros Auklet. Marine Ornithology. Marine Ornithol.

Ydenberg, R.C., B. Leyland, J.M. Hipfner and H. Prins. Submitted. Testing hypotheses about the relation between salmonberry (*Rubus spectabilis* L.) expansion and the decline in the number of seabirds breeding on Triangle Island, British Columbia. Marine Ornithology. Marine Ornithol.

B. THESES

Bennett, S.G. 2018. Wintering and breeding distributions of Black Oystercatchers (*Haematopus bachmani*): long-term trends and the influence of climate. MSc, Simon Fraser University, Burnaby.

Domalik, A.D. 2018. At-sea distribution and foraging ecology of two North Pacific seabirds revealed through GPS tracking. MSc, Simon Fraser University, Burnaby.

Fremlin, K. 2018. Trophic magnification of legacy persistent organic pollutants and emergent contaminants within a terrestrial food-web of an avian apex predator, the Cooper's Hawk (*Accipiter cooperii*). MSc, Simon Fraser University, Burnaby.

Hope, D.D. 2018. The role of adaptive behaviour in migratory counts of shorebirds. PhD, Simon Fraser University, Burnaby.

Yap, K.N. 2018. Physiological basis of aerobic capacity and workload ability in birds. PhD, Simon Fraser University, Burnaby.