

**ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY
2021-2022**



Environment and
Climate Change Canada
Environnement et
Changement climatique Canada

**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

<i>Name</i>	<i>Position</i>
Ron Ydenberg	Director, Professor
Tony Williams	Professor
David Green	Associate Director, 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

<i>Postdoctoral Fellows</i>	<i>PhD (in progress)</i>	<i>MSc (in progress)</i>	<i>Staff</i>
	Josh Allen	Hannah Hall	Sadika Jurvic, CWE Admin. Asst.
	Kirk Hart	Jessie Kemp	Connie Smith, CWE Research Tech
	Brett Hodinka	Catherine Lee-Zuck	
	Kate Fremlin	Katie Leonard	
	Mason King	Cole Rankin	
	Michal Pavlik	Hannah Roodenrijs	
	Florian Reurink	Rachel Sullivan-Lord	
<i>Undergrads</i>	<i>PhD(defended)</i>	<i>MSc (defended)</i>	<i>Visitors</i>
Ellery Hardy		Gwen Case	Joshua McInnes
Jonson Lee		Jo Enns	
		Lena Ware	

B. Steering Committee

<i>Name</i>	<i>Position</i>	<i>Affiliation</i>
Robert Elner	Emeritus Scientist	<i>ECCC</i>
David Green	CWE faculty (non-voting)	<i>SFU</i>
Mark Hipfner	Research Scientist	<i>ECCC</i>
Elsie Krebs	Research Manager, Western Canada	<i>ECCC</i>
Tony Williams	CWE faculty (non-voting)	<i>SFU</i>
Ron Ydenberg	CWE Director (non-voting)	<i>SFU</i>

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.

MSc student Sonya Pastran published a paper from her 2020 MSc thesis describing marine habitat usage by Marbled Murrelets in Leskeek Bay, Haida Gwaii, using transect data gathered for the past 22 years by the Leskeek Bay Conservation Society and additional data gathered during 2 years of her fieldwork during the summers of 2018 and 2019, funded largely by ECCC through the Ocean Protection Plan. ECCC's Mark Drever was a co-author on the paper. Sonya's MSc research also included an experiment to determine whether seabirds avoid areas with coastal raptors. They appear to do so, and a second paper from her MSc is in progress, with Ydenberg as a collaborator.

Sonya completed a manuscript analyzing VHF radiotracking data gathered by the CWE during the late 1990s from Marbled Murrelets in Desolation and Clayoquot Sounds. Lank provided archival data to ECCC for these analyses and guided the analysis and writing.

Lank continues as a collaborator on an analysis of the use of lidar to evaluate forest murrelet nesting habitat suitability, lead by Louise Waterhouse, BC Ministry of Forests, Lands, and Natural Resource Operations, and UBC's Nicholas Coops. Lank continued as a member of the Canadian Marbled Murrelet Recovery team, but this was minimally active during 2021.

2. Northern Goshawk (Threatened, COSEWIC)

The Northern Goshawk (*Accipiter gentilis laingi*) was designated as a Threatened subspecies by COSEWIC in 2000. The Northern Goshawk *laingi* subspecies 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. Management actions are hampered by knowledge gaps surrounding the breeding season diet and foraging ecology of goshawks in coastal British Columbia. Gwyn Case conducted an MSc, defended in July 2021, that quantified goshawk diet using a combination of nest cameras, prey remains and regurgitated pellets, and investigated the link between dietary variation and goshawk reproductive success. She found that although goshawks consumed 33 different prey species *Tamiasciurus* squirrels made up the majority of their diet. Diet composition differed slightly between the coastal and transition zones but did not influence productivity. The major chapter of her thesis is being prepared for publication in Raptor Research. Gwyn also conducted a pilot study of goshawk breeding season movement using GPS-UHF transmitters that is being used to determine whether further telemetry based research on goshawk movements is warranted.

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

B. Human Impacts on Birds

1. Contaminants and Toxicology

a. Persistent pollutant monitoring and transcriptomic effects in marine bird sentinel species

Marine birds are exposed to a broad and increasing number of anthropogenic chemical contaminants. Accordingly, the eggs of seabirds such as the rhinoceros auklet are routinely collected for long-term contaminant monitoring by Environment and Climate Change Canada (ECCC). Inside of such eggs, the developing embryos may be sensitive to maternally transferred contaminants, but inferring whether measured contaminant concentrations may result in adverse effects in wild species faces uncertainty. We are implementing molecular tools that measure mRNA transcription in marine bird embryos to better quantify how adverse effects in the organism correlate with measured contaminant residue generated by National Wildlife Research Centre (NWRC) lab services for 94 persistent organic pollutants and mercury. These gene transcript-based approaches are novel in their application to monitoring the effects of industrial contaminants or other potential environmental disasters like oil spills in marine birds. This project lead by Mason King (PhD) in collaboration with researchers including Dr. John Elliott (ECCC PWRC), Dr. Vicki Marlatt (SFU), Dr. Amy Lee (SFU), and Doug Crump (NWRC) is using a combination of qPCR gene arrays and RNA Seq tools in two wildlife indicator species, the rhinoceros auklet and double-crested cormorant. These species have been selected by both ECCC Canadian Wildlife Service (CWS) and Wildlife and Landscape Science Directorate (WLS) managers as the bio-indicators of choice in relation to baseline measurements for past major national projects. This work is being funded under the Ocean Protection Plan and has produced data presented at several scientific meetings to date.

b. Avian dilbit toxicity studies

A national pipeline project to increase transport of an unconventional crude petroleum known as diluted bitumen (dilbit) from the oil sands region to the Port of Vancouver will increase the risk of a major oil spill and chronic small-scale discharges. We recently published three major reviews summarising the effects of petroleum toxicity in wildlife and identifying research needs on unconventional crude petroleum such as dilbit (King et al. 2021; Ruberg et al. 2021a,b). We found that crude petroleum is toxic to birds, yet no published scientific studies of the effects of dilbit on birds yet exist. We have three major components to our dilbit work: a) experimental work on effects of dilbit on physiology and health using adult zebra finches as a model system (work lead by Elizabeth Ruberg, MSc); b) experimental work on toxicity of dilbit to bird embryos via shell oiling in chicken and double-crested cormorant embryos (i.e. using fertile, developing eggs) lead by Mason King (PhD), and c) effects of external (feather oiling) and internal dilbit exposure on flight dynamics of free-living rhinoceros auklets (lead by Catherine Lee-Zuck, MSc). This work is funded under the Ocean Protection Plan, TransMountain Pipeline Expansion wildlife impacts research funding, and is a collaboration among Dr. John Elliott

(ECCC PWRC), Dr. Kyle Elliott (McGill), Dr. Vicki Marlatt (SFU), Doug Crump (NWRC), and Dr. Gregg Tomy (University of Manitoba). This year we published two papers on our laboratory studies with dilbit in zebra finches (Ruberg et al. 2022) and chicken/cormorant embryos (King et al. 2022), which together constitute the first published papers on the effect of oil sands bitumen products on avian wildlife.

c. Glaucous-winged gulls and the health of the Salish Sea

In the second year of this collaborative project, 150 adult glaucous-winged gulls were caught in January-February 2021 at coastal sites throughout the Salish Sea. Blood samples were obtained for assessment of physiological health, contaminant burdens, *Toxoplasma gondii* infections, and dietary stable-isotope analysis. Additionally, 17 adult gulls were not blood sampled, but instead received a GPS tag to provide fine-scale data on movement patterns and habitat use. This project is a collaboration between Dr. Mark Hipfner from the Wildlife Research Division (WRD) of Environment and Climate Change Canada (ECCC); also an Adjunct Professor at SFU and member of the CWE, Dr. Tony Williams and M.Sc. candidate Hannah Hall from the CWE, wildlife veterinarian Dr. Amy Wilson, and Dr. Theresa Burg from the University of Lethbridge. The project also involves researchers from the Ecotoxicology and Wildlife Health Division of ECCC, and Fisheries and Oceans Canada. All data are being uploaded to a shared, accessible database (with Allison Patterson) to ensure common approaches to movement analysis across different species. This work will help identify the most important seabird areas to inform decision making in event of an oil spill crisis. (See additional details - Section V.D.1, Coastal Studies of Seabirds.)

2. 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 20th year at our Langley field site (140 nest boxes) in 2021. In addition to basic monitoring of timing of laying and breeding productivity a current focus is on habitat use and foraging behaviour during chick rearing using GPS units and accelerometers. In the context of climate warming, we are re-visiting the relationship between temperature and laying date, and whether this is mediated by effects of temperature on invertebrate prey as well as looking at social factors.

b. Aerial insectivores

In 2021 we published two papers from previous research on tree swallows and barn swallows in the Lower Mainland. One was a large-scale, collaborative analysis using breeding bird survey data and breeding performance data collected at field sites in three regions across Canada (including BC with Nancy Mahony, Olga Lansdorp and Chloe Boynton) to examine long- and short-term barn swallow population trends in Canada, differences in breeding performance across regions, if average breeding performance measures or colony size predicted regional population growth rates and if local breeding performance is driven by density dependence and/or recruitment (Put et al. 2021). The second paper examined breeding productivity and phenology in relation to habitat, weather, and insect availability for co-occurring tree and barn swallows over four years on the southern coast of British Columbia, Canada (Boynton et al. 2021).

3. *Urban ecology and bird collisions with windows*

CWE, in collaboration with Elizabeth Gow and Krista De Groot (ECCC), has initiated a research project focusing on bird communities in the urban environment, under the supervision of Dr. David Green. The first project, initiated by Vanessa Hum (new MSc candidate), extends work on bird collisions on university campuses in BC by examining seasonal variation in collisions/mortality and species specific vulnerability to window collisions on SFU campus. Vanessa will also examine how architectural and landscape features influence bird-window collision risk. Future work on mitigation efforts will be conducted in collaboration with SFU Facilities.

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 closely with ECCC's Mark Drever (Delta), Keith Hobson (Saskatoon), and with ECCC emeritus Bob Elner, as well as Bird Studies Canada local representative David Bradley

a. Shorebird Breeding Biology

In 2021, current and former CWE members contributed to an additional publication arising from their participation in the Arctic Shorebird Demographic Network, a collaborative program that included 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. The 2021 paper utilized data gathered by the group to model levels of invertebrate biomass phenology in the arctic, an important variable for shorebird breeding ecology.

Dov Lank closed down his 35-year breeding population of captive ruff sandpipers by sending remaining birds to collaborators in Germany and North Carolina. He continues to work on papers on ruffs with students from the Max Planck Institute and others.

b. Non-breeding biology

Eveling Tavera Fernandez, Ph.D student from Peru, defended her PhD thesis in March 2020, with ECCC's Mark Drever on her graduate committee. Eve published a first paper from the thesis considering the fitness consequences of over-summering in Peru by juvenile and adult sandpiper, with Lank and Ydenberg. She is now working with ECCC's Kristy Gurney on shorebird breeding phenology. She is involved with the generation of a Peruvian Shorebird Conservation plan, and is the chair of the Western Hemisphere Shorebird Group.

Lank and Ydenberg are coauthors along with CWE PhD student Richard Johnston and former ECCC scientist Rob Butler on a paper published in ACE-EOC describing the formation and initial results of a hypothesis-driven hemispheric-wide network to monitor shorebird populations along the Pacific coast, with particular emphasis on Western sandpipers and Pacific dunlin.

c. Migration Biology

Lank co-authored a paper focusing on stopover behaviour of migrant Semipalmated sandpipers with respect to weather, seasonal timing and migration routes, based on reanalysis of data collected in 1977.

Ydenberg continued to develop theory focusing on shorebird responses to changes in danger from increasing raptor populations over the past 40 years, and the effects these can have on interpretations of census data and actually on population growth rates. He submitted a paper quantifying the seasonal change in predation danger to migrant raptors as a function of the timing of arctic spring. He, Lank, and Eveling Tavera submitted an opinion paper exploring the consequences of these interactions. Ydenberg and Lank submitted a second MS contrasting directional effects on wing lengths of Western and Semipalmated sandpipers during the 1980s, testing the hypothesis that differences in the relative

importance of resident versus migratory raptors could explain the contrasting trends. Ydenberg continues to develop a model of the population consequences of predation danger induced alterations in the propensity to migrate versus over-summer, which he believes could account for much of the reported population declines of shorebird species

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. Michal Pavlik (PhD candidate) is using the long-term dataset to 1) assess how conditions on migration interact with conditions on the breeding grounds to determine the timing of breeding and local productivity, 2) estimate true survival using a spatial-CJS model and 3) determine mortality rates across the annual cycle. The first chapter of his thesis demonstrates that female warblers initiate the transition to a reproductive physiology while still on migration despite the energetic demands of this stage of the annual cycle. The second chapter that will soon be submitted for publication shows how strong cross winds during spring migration can both delay arrival on the breeding grounds, and increase the number of days between arrival and egg-laying with negative effects on productivity.

D. Coastal Ecology

1. Coastal Studies of Seabirds

Mark Hipfner (ECCC-WRD and Adjunct at CWE) reports that summer 2021 marked the 28th year of operation of the Centre for Wildlife Ecology's seabird research program on Triangle Island. The 2021 field crew consisted of Alice Domalik, Josh Green and Sarah Hudson. The research program in 2021 was severely restricted due to COVID-19, but the field crew was able to obtain information on growth rates and diets of nestling Cassin's Auklets *Ptychoramphus aleuticus* and Rhinoceros Auklets *Cerorhinca monocerata*, adding to long-term datasets on those species. The crew also deployed GPS tags on 10 breeding Tufted Puffins *Fratercula cirrhata*, obtaining complete (24 h) tracks for six birds. As in 2019, foraging areas for puffins were largely contained within the boundaries of the Scott Islands marine National Wildlife Area.

Research also continued on other major Rhinoceros Auklet colonies in 2021. Hipfner, Nik Clyde, Kristina Hick and Vivian Pattison (all ECCC, Delta – WRD) visited Pine Island off BC's Central Coast; Hipfner, Pattison and Ken Wright (all ECCC, Delta – WRD) along with CWE PhD candidate Kirk Hart, visited Lucy Island off BC's North Coast; and Mark Maftai (Raincoast Education Society, Tofino) visited Cleland Island off the west coast of Vancouver Island. The main goal of this program, which started in 2006, is to study the effects of oceanographic variation across multiple trophic levels – the diets fed to nestling auklets and the diets of their major fish prey, the Pacific sand lance *Ammodytes personatus* and Pacific herring *Clupea pallasii*. Field crews also deployed GPS tags on a total of 36 Rhinoceros Auklets on Pine and Lucy islands, obtaining 26 complete tracks. While on the colonies we also completed the ninth year of a project investigating the consumption of Pacific salmon *Oncorhynchus* spp. by seabirds in BC waters, in collaboration with Strahan Tucker (Fisheries and Oceans Canada (DFO), Nanaimo – Pacific Biological Station); and completed the 13th year of a project investigating the ingestion of microplastics by forage fish, in collaboration with Moira Galbraith (DFO, Sidney - Institute of Ocean Sciences).

In addition to the summer field work, there was winter field work completed in January and February

2021. Tony Williams and CWE MSc candidate Hannah Hall, assisted by Clyde, Domalik, Green, Hipfner, Hudson, Pattison, along with Elsie Krebs and Anneka Vanderpass (both ECCC, Delta), trapped Glaucous-winged Gulls *Larus glaucescens* around the BC portion of the Salish Sea (Strait of Georgia, Juan de Fuca Strait) for a study of food-web contamination and its implications for the physiological health of gulls that spend winter in the region. GPS tags were deployed on 17 of the gulls, to assess habitat use in winter, including the extent to which the gulls feed at landfills. (See also Section V.B.1.c, Glaucous-winged gulls and the health of the Salish Sea.)

2. Coastal Ecology of Barrow's Goldeneye

Barrow's Goldeneye is 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 2021) used the extensive satellite telemetry dataset to show that adult Barrow's Goldeneye had a high degree of migratory connectivity (Forstner et al. 2022). Tess also found that the movement of first-year birds aligned with that of older birds suggesting that regional sub-populations functioned as discrete units and should be managed independently. Jesse Kemp (a new MSc candidate in Fall 2021) has used the same dataset to show how spring temperature and the timing of ice melt and ice up impact the timing of migration. Future work, in collaboration with Sean Boyd (ECCC) and Megan Willie (ECCC) will identify when and where wintering sea ducks would be sensitive to anthropogenic activities on the Pacific coasts.

3. Movement Ecology of Black Oystercatchers

In 2019 CWE 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 (see <https://davidgreensfu.com/m3bloy/>). 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 Education Society). Fieldwork was initiated in BC in Spring 2019 and Alaska in Summer 2019. Lena Ware (MSc 2021) used the detailed data from 20 birds deployed with ARGOS satellite tags to define the movement and habitat use of black oystercatchers in relation the tidal and diurnal light cycle throughout the year.

In summer 2021 the Black Oystercatcher research team searched for nest sites, resighting banded birds, and collected blood samples and potential prey items for stable isotope analyses, in Pacific Rim National Park Reserve and Gwaii Haanas National Park Reserve and Haida Heritage Site. This project is led by David Green and MSc Candidate Hannah Roodenrijs (CWE, SFU), and in 2021 was supported by Clyde, Domalik, and Maftai (all ECCC). In addition, Kathryn Hargan and MSc Candidate Alex Zvezdin (Memorial University of Newfoundland, St. John's) collected cores from the bottom of a small pond on S'Gang Gwaay, in GHNPR, for assessment of decadal to centurial trends in seabird populations at this UNESCO World Heritage Site.

Ongoing satellite data supports 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. Currently, Cole Rankin and Hannah Roodenrijs are examining the drivers of variation in the migratory strategies of oystercatchers and examining site and regional differences in morphology and foraging ecology of oystercatchers in BC and Alaska.

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.

Recent CWE alumni Rachel Canham and Dave Hope published an analysis with Mark Drever (ECCC) and Scott Flemming (CWS) showing marked drops in local use of the Fraser River delta by northward migrating Western sandpipers (-54% between 1990 and 2020), and dunlin (-31%), controlling for several environmental variables. They attribute this to a broader population decrease in Pacific flyway populations, rather than to local factors.

Florian Reurink continued 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. Assessing shorebird food availability empirically is time consuming and expensive, and these studies are testing the potential for using behavioural models to predict net energy intake rates from behavioural measures in the field. Behavioural ecological theory predicts that birds should adjust their foraging flight speed and power expenditure to various conditions in the habitat, where flight power expenditure should increase with increased energy intake. The results from Florian's MSc work matched the predictions from the theory well, and the Ph.D. further tests the applicability of this approach. Reurink has combined various behavioral adjustments from well established theories into a single model, allowing for more accurate predictions across a variety of conditions. Net energy intake rates have been predicted for wintering dunlin and migrating western sandpipers using flight speed estimates from a mobile radar system used in collaboration with EchoTrack (with Dr. Rhonda Millikin, ECCC-Emeritus). These field estimates are used for a qualitative test of the model predictions, while a feeding experiment with Steller's jays is used as a quantitative test of the model. Reurink continued to implement the various behavioral theories into his model while finalizing his analysis of flight speed estimates from dunlin and western sandpipers as well as his feeding experiment with Steller's jays. He expects to defend his thesis in April 2022.

VI FUNDING

Fiscal year 2021-2022 marked the first year of a two year contract between the Simon Fraser University (Centre for Wildlife Ecology) and Environment and Climate Change Canada (Science and Technology Division). This grant supplied \$115,000 in 2021-2022, and will supply \$180,000 in 2022-2023 for CWE research in priority coastal, riparian and grassland ecosystems in British Columbia.

1 April 2021 - 31 March 2022

Scholarships, Fellowships, Grants for Students

<u>Description</u>	<u>Name of person</u>	<u>Notes</u>	<u>Amounts</u>
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PhD

SFU Fellowships etc	Allen, Josh	TA (Fall 2021), GF (Spring 2022)	\$18,076
SFU Fellowships etc	Fremlin, Katharine	GF (Summer 2021, Spring 2022)	\$10,500
SFU Fellowships etc	Hodinka, Brett	Dean's Entrance Scholarship (Summer 2021, Fall 2021, Spring 2022; TA (Spring 2022)	\$25,620
SFU Fellowships etc	King, Mason	GF (Fall 2021)	\$7,000
SFU Fellowships etc	Reurink, Florian	GF (Summer 2021, Fall 2021)	\$14,000

M Sc

SFU Fellowships etc	Enns, Joanna	GF (Spring 2022)	\$7,000
SFU Fellowships etc	Hall, Hannah	GF (Fall 2021)	\$7,000
SFU Fellowships etc	Kemp, Jessica	TA (Spring 2022)	\$6,426
SFU Fellowships etc	Lee-Zuck, Catherine	GF (Summer 2021, Fall 2021)	\$9,700
SFU Fellowships etc	Leonard, Kathryn	GF (Fall 2021)	\$7,000
SFU Fellowships etc	Linton, Anna	TA (Spring 2022)	\$6,426
SFU Fellowships etc	Rankin, Cole	TA (Fall 2021); GF (Spring 2022)	\$12,178
SFU Fellowships etc	Roodenrijs, Hannah	GF (Fall 2021)	\$7,000

General Funding for CWE

ECCC/Core	ECCC	EC Annual Chair Funding (1/2 yrs)	\$115,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg, Williams Green)	\$582,559

Conference Funding

SFU Fellowships	Hodinka, Brett	TMRA Spring 2022	\$500
eBerg	Rankin, Cole	PEEC Spring 2022	\$150
eBerg	Roodenrijs, Hannah	PEEC Spring 2022	\$150

Other Funding

Federal government	Williams	ECCC	\$36,750
Federal government	Green	ECCC	\$49,200

NSERC

	Green DJ	Overwintering ecology, migration strategies and demography of migratory birds	\$47,000
Federal government			
Federal government	Ydenberg RC	NSERC Individual Research Grant - "Predation danger in the ecology of migration" (4/5 yrs)	\$28,000
Federal government	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
Federal government	Elliott J	Investigating sources, transport, accumulation and effects of persistent contaminants in urban environments using a top predator as indicator (3/5 yrs)	\$37,000
		Total funding:	<u>1,089,235</u>
	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 despite working remotely, and having our fieldwork severely restricted this past year because of the Covid-19 pandemic. 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

In press

- Crossin, G.T., R. Filgueira, K.R. Studholme and J.M. Hipfner. In press. Phenological cues to breeding and the differential response of Pacific auks to variation in marine primary production. *Mar. Ecol. Prog. Ser.*
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