ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY

2022-2023

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

Name	*Position*
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
Fred Cooke (retired)	Emeritus Chairholder

2. Research Group

Postdoctoral Fellows	***PhD (in progress)***	***MSc (in progress)***	***Staff***
	Josh Allen	Raven Barbera	Sadika Jungic, CWE Admin. Asst.
	Kirk Hart	Genavieve Desjardin	Connie Smith, CWE Research Tech
	Brett Hodinka	Vanessa Hum	
	Kate Fremlin	Jessie Kemp	
	Michal Pavlik	Catherine Lee-Zuck	
	Sherry Young	Anna Linton	
		Andrew Racz	
		Cole Rankin	
		Hannah Roodenrijs	
		Rachel Sullivan-Lord	
Undergrads	***PhD(defended)***	***MSc (defended)***	***Visitors***
Franknel Pabai	Mason King	Hannah Hall	Joshua McInnes
	Florian Reurink	Katie Leonard	Neena Pradel

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 Murrelets (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.

Former CWE MSc student Sonya Pastran published a paper summarizing VHF radiotracking data gathered by the CWE during the late 1990s from Marbled Murrelets in Desolation and Clayoquot Sounds, working with ECCC staff EA Krebs and DF Bertram. Lank provided archival data to ECCC for these analyses and guided the analysis and writing. Sonya also completed and has now submitted a paper to the Bulletin of the Wildlife Society based on experimental chapter of her MSc thesis examining the effects of eagles on Marbled Murrelet census data.

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 2022.

2. Northern Goshawks (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. This work has been submitted for publication in *Raptor Research*.

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 using 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 is a collaboration between Tony Williams, Mason King (former PhD student, now post-doctoral collaborator), Dr. John Elliott (ECCC PWRC), Dr. Vicki Marlatt (SFU), Dr. Amy Lee (SFU), and Doug Crump (NWRC). It focuses on 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 (WLSD) 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 numerous publications and presentations to date.

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

We are in the 4th year of this collaborative project, capturing and blood sampling adult glaucous-winged gulls during the winter season in January-March at coastal sites throughout the Salish Sea. Blood samples are obtained for assessment of physiological health, contaminant burdens, *Toxoplasma gondii* infections, and dietary stable-isotope analysis. Additionally, adult gulls that are not blood sampled receive GPS tags 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), Dr. Tony Williams and Hannah Hall (ex-MSc, now employed by ECCC) from the Centre for Wildlife Ecology at Simon Fraser University (SFU), 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 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.

Winter fieldwork was also completed in January to March of 2023 for a study mainly focusing on food-web contamination and its implications for the physiological health of gulls that spend winter in the Salish Sea. Domalik, Hipfner, Hudson, Pattison, along with Hannah Hall, Anneka Vanderpas, Sarah Popov, and Guy St. Amour trapped Glaucous-winged Gulls *Larus glaucescens* in the Salish Sea. For outgroups, the crews also sampled on the west (Tofino and Ucluelet area) and north (Port Hardy) coasts of Vancouver Island, in the vicinity of Prince Rupert off the North Coast, and in Haida Gwaii. In 2023, the gull crew was joined by Neena Pradal, a French graduate student who is studying age-related

variation in health parameters in the Williams' lab to complete her MSc research internship at Université Paul Sabatier and Ecole Nationale vétérinaire de Toulouse. And lastly, Domalik, Pattison and Vanderpas deployed GPS tags on 10 California Gulls *Larus californicus*, to assess habitat use in winter, and movements between the Pacific coast and inland breeding areas. A particular focus of this program is to assess the gulls' reliance on the herring spawn events in the Salish Sea.

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 22th year at our Langley field site (140 nest boxes) in 2023. 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.

3. Bird Collisions with Windows

CWE, in collaboration with Elizabeth Gow and Krista De Groot (ECCC), has initiated a research program focusing on bird communities in the urban environment. The first project, initiated by Vanessa Hum (MSc candidate), extends work on bird collisions with windows on university campuses in BC by examining seasonal variation in collisions/mortality and species-specific vulnerability to window collisions on SFU campus. Vanessa is also examining how architectural and landscape features influence bird-window collision risk. Future work on mitigation efforts will be conducted in collaboration with SFU Facilities. The second project, to be conducted by Triana Hohn (MSc candidate) will examine how urbanisation influences the demography and movement of spotted towhees in the lower mainland.

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

a. Shorebird Breeding Biology

Eveling Tavera Fernández, who graduated from SFU with her PhD in 2020, is now working with ECCC's Kristy Gurney on a paper about shorebird breeding phenology with Lank and other CWE

alumni as coauthors, through their participation in the Arctic Shorebird Demographic Network. She is involved with the generation of a Peruvian Shorebird Conservation plan, and is the chair of the Western Hemisphere Shorebird Group.

Lank continues to work on papers on the breeding biology of ruff sandpipers with students from the Max Planck Institute and others.

b. Migration and Non-breeding biology

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 published 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 published 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

c. Archiving Historical Morphometric data

Lank initiated a project to archive and make public historical morphological datasets for Western and Semipalmated Sandpipers, and Dunlin, collected primarily in North America over the past 70 years. Scott Flemming is cooperating with this on the ECCC side. The project is sponsored and supported by a graduate student internship for University of Saskatchewan MS student Katlin McCallum, funded by the Living Data Project of the Canadian Institute of Ecology and Evolution (https://www.ciee-icee.ca/ldp.html). Over 30 researchers have contributed datasets thus far, including many former CWE students and ECCC staff including Paul Smith, Jennie Rausch, Scott Flemming, and retirees Cheri Gratto-Trevor, Guy Morrison, Rob Butler, Bob Elner, Peter Hicklin and Gary Kaiser.

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. Michal Pavlik (PhD candidate) is using the long-term dataset (2004-2017) to assess how conditions on migration interact with conditions on the breeding grounds to determine the timing of breeding and local productivity, and estimate true survival using a spatial-CJS model and 3) determine mortality rates across the annual cycle. The first chapter of his thesis, published in Physiological and Biochemical Zoology (Pavlik et al 2021) 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 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. The final chapter illustrates how sex differences in dispersal can bias estimates of annual survival; annual apparent survival of males is higher than females while true survival of males and females does not differ. Michal will defend his thesis in September 2023.

D. Coastal Ecology

1. Coastal Studies of Seabirds

Mark Hipfner (ECCC – WRD and adjunct at CWE) reports that summer 2022 marked the 29th year of operation of the Centre for Wildlife Ecology's seabird research program on Triangle Island. The 2022 field crew consisted of Hannah Avenant, Alice Domalik, Josh Green, Sarah Hudson, Hipfner, Vivian Pattison, and Eric Wagner. The research program in 2022 was designed to collect information on growth rates and diets of nestling Cassin's Auklets *Ptychoramphus aleuticus* and Rhinoceros Auklets *Cerorhinca monocerata*, adding to long-term datasets for those species. Other projects included deploying GPS tags on 6 breeding Tufted Puffins *Fratercula cirrhata*, and 10 Rhinoceros Auklets, as part of a larger, multi-year program to assess how effectively the boundaries of the Scott Islands marine National Wildlife Area envelop key foraging areas for seabirds in the region; and determining numbers, types, and source countries of derelict fishing gear found on beaches in Triangle Island's South Bay.

Research also continued on other major Rhinoceros Auklet colonies in 2022. Hipfner and Pattison, along with Andrew Huang and David Dickinson, visited Pine Island off BC's Central Coast; Hipfner, Pattison, Elsie Krebs, Patrick O'Hara and PhD Candidate Kirk Hart (Simon Fraser University, Burnaby) visited Lucy Island off BC's North Coast; and Mark Maftei visited Cleland Island off the west coast of Vancouver Island. The main goal of this program, which was started in 2006, is to study 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 and Pacific herring. Field crews also deployed GPS tags on 7 Rhinoceros Auklets on Lucy Island. While on the colonies we also completed the tenth year of a project investigating the consumption of Pacific salmon spp. by seabirds in BC waters, in collaboration with Strahan Tucker (DFO); and completed the 14th year of a project investigating the ingestion of microplastics by forage fish, in collaboration with Moira Galbraith (DFO).

2. Movement Ecology of Gulls in the Salish Sea (see Section V.B.1.b.)

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. This work was recently published in Ecology and Evolution (Ware et al. 2023). Hannah Roodenrijs (MSc 2023) used morphometric and diet data to show that there are differences in the morphology of birds from BC and Alaska that are consistent with Allen's rule, but that the relatively large sex differences in bill-length are not associated with resource partitioning by males and females. Cole Rankin (MSc candidate) has used the tracking data to assess hypotheses for the partial migration of black oystercatchers in Alaska. Cole will defend his MSc in August 2023. Ongoing work is now assessing how environmental conditions influence the diet and survival of individuals. This project 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.

4. 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. The spatial scale and spatial/temporal resolution of this dataset has been 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). Jesse Kemp (PhD candidate) found that Barrow's Goldeneye refine decisions regarding the timing of migration based on spring temperature on the wintering grounds and the timing of ice melt on the breeding grounds (Kemp et al. in press). Finally, the tracking data provides no evidence to support the hypothesis that male-biased juvenile dispersal can explain the genetic structure in the mitochondrial DNA and panmixia in the autosomal DNA of Barrow's Goldeneye (Forstner et al, submitted to Movement Ecology).

5. 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. Roberts Bank, on the Fraser River estuary near Vancouver, Canada, is the site of a port facility built in the 1960s. The major obstacle to environmental approval of a proposed expansion to accommodate container traffic has been the possible impact on western sandpipers (*Calidris mauri*) that migrate through the estuary both north- and southbound. These waders graze on biofilm - 'transient epibenthic' mats that form in the upper intertidal (at ~3.2m Datum and higher) as 'epipelic' microorganisms, predominantly diatoms, migrate to the sediment surface to photosynthesize during diurnal low tides. The microorganisms occur in a thin (< 2 mm) layer, suspended with detritus and sediment in a matrix of polymers (EPS, for extracellular polymeric substances).

Roberts Bank is used intensively by migrant western sandpipers, and biofilm forms a major component of their diet. Grazing involves rapid pecking-like motions during which the bill tip opens and the tongue dabs the sediment surface. The density of chlorophyll-*a* (Chl-*a*) can be easily measured, and provides a convenient proxy measure for the amount of biofilm. Chl-*a* density begins each diurnal emersion at the same low level as the mudflat surface is exposed by the falling tide, and increases steadily until the tide rises.

The CWE has been examining the trophic interactions between biofilm, sandpipers and falcons for several years now. In past studies we have documented a strong gradient of increasing biofilm density toward the shoreline at our study site on Roberts Bank. In spring 2023 graduate student Andrew Racz and undergraduate honours student Franknel Pabai conducted weekly sampling of biofilm levels to determine if the gradient is an inherent attribute of the site (e.g. settling of fine sediments), or is caused by the foraging of sandpipers.

VI FUNDING

Fiscal year 2022-2023 marked the final 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 $180,000 in 2022-2023 for CWE research in priority coastal, riparian and grassland ecosystems in British Columbia.

1 April 2022 - 31 March 2023

Scholarships, Fellowships, Grants for Students

Description	Name of person	Notes	Amounts
PhD			
SFU Fellowships etc	Allen, Josh	GF Spring 2023	$7,000
SFU Fellowships etc	Fremlin, Katharine	NSERC 2022/2023; GF Summer 2022	$24,500
SFU Fellowships etc	Hodinka, Brett	GDES 2022/2023; TA Spring 2023	$25.620
SFU Fellowships etc	Young, Sherry	GF Fall 2022; TA Fall 2022, Spring 2023	$22,152
M Sc			
SFU Fellowships etc	Barbera, Raven	GF Fall 2022	$7,000
SFU Fellowships etc	Hum, Vanessa	GF Fall 2022	$7,000
SFU Fellowships etc	Kemp, Jessica	NSERC 2022/2023	$17,500
SFU Fellowships etc	Linton, Anna	TA Fall 2022	$6,426
SFU Fellowships etc	Racz, Andrew	TA Fall 2022	$6,426
SFU Fellowships etc	Rankin, Cole	TA/GF Spring 2023	$13,426
SFU Fellowships etc	Roodenrijs, Hannah	GF Fall 2022	$7,000
SFU Fellowships etc	Young, Sherry	GF Fall 2022; TA Fall 2022, Spring 2023	$22,152
		Total funding:	**$166,202**

General Funding for CWE

ECCC/Core	ECCC	EC Annual Chair Funding (2/2 yrs)	$180,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg, Williams Green)	$595,503
		Total funding	**$775,503**

Conference Funding - Students

SFU Fellowship	Allen, Josh	TARA	$700
SFU Fellowship/eBERG	Barbera, Raven	TARA, PEEC	$1486
SFU Fellowships/eBerg	Hodinka, Brett	TARA, PEEC	$870

SFU Fellowships/eBerg	Desjardin, Genavieve	TARA,PEEC	$870
eBerg	Hum, Vanessa	PEEC	$170
eBerg	Kemp, Jesica	PEEC	$170
eBerg	Linton, Anna	PEEC	$170
eBerg	Racz, Andrew	PEEC	$170
eBerg	Rankin, Cole	TARA, PEEC	$870
eBerg	Sullivan-Lord, Rachel	PEEC	$170
eBerg	Young, Sherry	PEEC	**$170**
		Total Funding	**$5816**

Other Funding

Federal government	Williams	ECCC	$8,800
Federal government	Ydenberg/Green	ECCC	$25,000
		Total funding	**$22,800**

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 (4/5 yrs)	$37,000
		Total NSERC	**$167,000**

TOTAL FUNDING $1,137,321

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. 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. PAPERS IN REFEREED JOURNALS OR BOOKS

In press

Canham, R.E., J. Rourke and R.C. Ydenberg. In press. The exploitation of biofilm by migrant western sandpipers (*Calidris mauri*). Heliyon.

Ware, L., J.M. Hipfner and D.J. Green. In press. Satellite telemetry reveals habitat selection decisions by Black Oystercatchers across seasonal, diel, and tidal cycles. Ecol. Evol.

2023

de Jong, J.F., L. Iacolina, H.H.T. Prins, P. van Hooft, R.P.M.A. Crooijmans, S.E. van Wieren, J.V. Baños, E. Baubet, S. Cahill, E. Ferreira, C. Fonseca, P.M. Glazov, I.J. Turinek, V.M. Lizana Martín, A. Náhlik, B. Pokorny, T. Podgórski, N. Šprem, R. Veeroja, R.C. Ydenberg and H.-J. Megens. 2023. Spatial genetic structure of European wild boar, with inferences on late-Pleistocene and Holocene demographic history. Heredity 130**:** 135-144.

Grishchenko, M., R.C. Ydenberg and H.H.T. Prins. 2023. Large-scale reduction in the extent of agriculture around stopover sites of migratory geese in European Russia between 1990 and 2015. Diversity 15**:** 447. https://doi.org/10.3390/d15030447.

King, M., J. Elliott, I. Idowu, G. Tomy and T. Williams. 2023. Polycyclic aromatic compound and trace metal element residues in *Mytilus* mussels at marine wildlife hotspots on the Pacific coast of Canada. Env. Poll. 316(2)**:** 120624 https://doi.org/10.1016/j.envpol.2022.120624.

Shimabukuro, U., A. Takahashi, J. Okado, N. Kokubun, J.B. Thiebot, A. Will, Y. Watanuki, B. Addison, S. Hatch, J.M. Hipfner, L. Slater, B.A. Drummond and A.S. Kitaysky. 2023. Across the North Pacific Ocean, dietary-induced stress of breeding rhinoceros auklets increases with high summer Pacific Decadal Oscillation index. Mar. Ecol. Prog. Ser. 708:177-189.

Tolliver, J.D.M., K. Kupan, D.B. Lank, S. Schindler and C. Kupper. 2023. Fitness benefits from co-display favour subdominant male–male partnerships between phenotypes. Anim. Behav. 197**:** 131-154.

2022

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