ANNUAL REPORT of the
CENTRE FOR WILDLIFE ECOLOGY

2020-2021

SFU

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, 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***
None (CoVid)	Josh Allen	Gwyn Case	Sadika Jurvic, CWE Admin. Asst.
	Kirk Hart	Jo Enns	Connie Smith, CWE Research Tech
	Brett Hodinka	Hannah Hall	
	Mason King	Catherine Lee-Zuck	
	Michal Pavlik	Katie Leonard	
	Florian Reurink	Cole Rankin	
		Hannah Roodenrijs	
		Lena Ware	
			Visitors
Undergrads	***PhD(defended)***	***MSc (defended)***	None (CoVid)
None (CoVid)	Emily McAuley	Tess Forstner	
		Robert Kesic (MET)	
		Sonya Pastran	

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.

MSc student Sonya Pastran completed her analysis of the local distributions of Marbled Murrelets, using transect data gathered for the past 22 years by the Laskeek Bay Conservation Society. Pastran conducted full seasons of fieldwork during the summers of 2018 and 2019, funded largely by ECCC through the Ocean Protection Plan. Sonya completed her MSc and graduated in October 2020. Her major findings on marine habitat usage are presented in a paper accepted by Ornithological Applications. Mark Drever of ECCC was on Pastran's committee and is a co-author on this 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 is currently working with ECCC's Doug Bertram, analyzing VHF radiotracking data gathered during the late 1990s by the CWE in Desolation and Clayoquot Sounds. Lank provided archival data to ECCC for these analyses.

Lank provided ground survey data gathered during the 1990s to an effort to validate 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 2020–2021.

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 (MSc student) initiated a research project to quantify goshawk diet and investigate potential links between dietary variation and goshawk reproductive success in 2019 and will defend her thesis in summer 2021. 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. Gwyn also conducted a pilot study of goshawk breeding season movement using GPS-UHF transmitters that will be extended into 2023/24 with funding provided by the Habitat Conservation Trust Fund. This project led by Melanie Wilson (FLNRORD, Surrey) will fill substantial knowledge gaps related to this species at risk and inform habitat protection decisions in the Province.

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. 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 being led by Mason King (PhD student), funded under the Ocean Protection Plan and is a collaboration with Dr. John Elliott (ECCC) and Dr. Vicki Marlatt (SFU).

b. 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. We have three major components to this study: a) experimental work on effects of dilbit on physiology and health using adult zebra finches as a model system (work lead by Elizabeth Ruberg); 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 and is a collaboration with Dr. John Elliott (ECCC) and Dr. Kyle Elliott (McGill).

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

In the second year of this collaborative project, 150 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, and stable-isotope analysis. In addition, a further 17 adult gulls 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), Dr. Tony Williams and M.Sc. candidate Hannah Hall from the Centre for Wildlife Ecology at Simon Fraser University (SFU), 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.

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 shows that managing reservoir operations by delaying when the reservoir fills by approximately 2 weeks would increase the productivity of yellow warblers (the average number of independent young produced) by 36%. This research and the code for the model was published in the open-access journal PLoS ONE in February 2021.

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 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.

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 2020–2021, current and former CWE members contributed to two additional publications 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 final major paper published combines data on fecundity and survivorship to generate models of population trend for 6 species of shorebirds nesting in the Canadian arctic was published in The Condor/Ornithological Applications. This large study generally estimated stable population growth rates, and confirms that annual adult survival rates strongly influence shorebird demographics. A second paper utilized data gathered by the group to model levels of invertebrate biomass phenology in the arctic, an important variable for shorebird breeding ecology.

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 oversummering 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 alone 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.

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, that was recently published in Physiological and Biochemical Zoology, 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.

D. Coastal Ecology

1. Coastal Studies of Seabirds

CWE Research Associate Dr. Mark Hipfner reports that the regular field activities on seabird colonies in British Columbia in summer 2020 were cancelled due to CoVid-19. In winter 2020 (January, February), Hipfner, Nik Clyde, Anneka Vanderpass, Joshua Green (all ECCC-WRD, Delta, BC) and Hannah Hall (CWE MSc candi-

date) completed the first season of a new research project investigating movements and health status in relation to diet of Glaucous-winged Gulls wintering in the BC sector of the Salish Sea. This project is funded through the TMX-PIER program of ECCC, and involves deploying GPS tags and collecting blood, feather and prey samples from across the region for measurements of C, N, and H stable isotope ratios, as well as a suite of physiological traits and contaminant levels. Collaborators on the project include Tony Williams (SFU), and John Elliott and Keith Hobson (ECCC).

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 2021) used the extensive satellite telemetry dataset to describe the migratory connectivity of Barrow's Goldeneye and latitudinal variation in the timing of spring and fall migration. Jesse Kemp (a new MSc candidate in Fall 2021) will use the same dataset to examine how 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

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 (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 candidate) used the detailed data from 20 birds deployed with ARGOS satellite tags to define the movement and habitat use of black oyster-catchers in relation the tidal and diurnal light cycle throughout the year. Her thesis that will be defended in Fall 2021 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. Incoming MSc. students Cole Rankin and Hannah Roodenrijs will examine the drivers of variation in the migratory strategies of oyster-catchers and assess how morphology and competitive interactions between migrants and residents shape the 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.

Graduated MSc student Rachel Canham published a paper from her 2019 MSc thesis validating the use of

footprints as a measure of mudflat usage by foraging shorebirds.

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 (Rhonda Millikin). 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.

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 submitting a paper exploring 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.

VI FUNDING

Fiscal year 2020-2021 marked the conclusion of the current three year contract between the Simon Fraser University (Centre for Wildlife Ecology) and Environment and Climate Change Canada (Science and Technology Division). This grant supplied $135,000 per year for CWE research in priority coastal, riparian and grassland ecosystems in British Columbia.

1 April 2020 - 31 March 2021

Scholarships, Fellowships, Grants for Students

Description	Name of person	Notes	Amounts
		PhD	
SFU Fellowships etc	Allen, Josh	TA (Fall 2020, Spring 2021)	$13,389
SFU Fellowships etc	Fremlin, Katharine	PGS NSERC (2021); GF (Spring 2021)	$14,000
SFU Fellowships etc	Hart, Kirk	GF (Fall 2020)	$7,000
SFU Fellowships etc	Hodinka, Brett	Dean's Entrance Scholarship (Fall 2020, Summer 2020, Spring 2021)	$21,000
SFU Fellowships etc	King, Mason	GF (Fall 2020); President's PhD Award (Spring 2021)	$14,000
SFU Fellowships etc	Reurink, Florian	Dean's Entrance Scholarship (Fall 2020, Summer 2020, Spring 2021)	$21,000

M Sc

SFU Fellowships etc	Enns, Joanna	GF (Fall 2020)	$7,000
SFU Fellowships etc	Forstner, Tess	TA (Spring 2021)	$7,509
SFU Fellowships etc	Hall, Hannah	Salish Sea Gull Project (Summer 2020); GF (Fall 2020)	$14,000
SFU Fellowships etc	Robert Kesic	MITACS RTA (Summer 2020); TA (Spring 2021); GF (Fall 2020)	$19,288
SFU Fellowships etc	Lee-Zuck, Catherine	GF (Fall 2020)	$7,000
SFU Fellowships etc	Leonard, Kathryn	TA (Fall 2020)	$6,288
SFU Fellowships etc	Leonard, Kathryn	GF (Fall 2020, Spring 2021)	$14,000
SFU Fellowships etc	Pastran, Sonya	GF (Summer 2020); Laskeek Project Funding	$14,000
SFU Fellowships etc	Roodenrijs, Hannah	GF (Spring 2021)	$7,000
SFU Fellowships etc	Ware, Lena	GF (Fall 2020)	$7,000

General Funding for CWE

EC/Core	EC	EC Annual Chair Funding (3/3 yrs)	$135,000
SFU	SFU	SFU Contribution to Faculty Salaries (Ydenberg Williams Green)	$548,053

Conference Funding

SFU Fellowships etc	Allen, Josh	TMRA Summer 2020	$500

Other Funding

Federal government	Williams	ECCC	$73,300
Federal government	Elliott, Williams, Ydenberg	COVID Relief	$19,200

NSERC

NSERC	Green DJ	Overwintering ecology, migration strategies and demography of migratory birds (5/5 yrs)	$47,000
NSERC	Ydenberg RC	NSERC Individual Research Grant - "Predation danger in the ecology of migration" (4/5 yrs)	$28,000
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)	$37,000

Grand Total	$1,136,527
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 being unable to conduct any fieldwork this year. One PhD student, two MSc and one MET 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

Williams, T.D., S. McWilliams, J.A. Clarke, E. MacDougall-Shackleton, S. MacDougall-Shackleton, F. Bonier and C. Eliason, eds. 2020. *What Is a Bird?* Princeton: Princeton University Press, 368 pp. ISBN: 9780691200163.

Crossin, G.T. and T.D. Williams. 2021. Using physiology to infer the reproductive status and breeding performance of cryptic or at-risk bird species. In: *Conservation physiology: applications for wildlife conservation and management*, Madliger, C., C.E. Franklin, O.P. Loveand S.J. Cooke, eds. Oxford: Oxford University Press.

2021

Hepp, M., E. Palsson, S.K. Thomsen and D.J. Green. 2021. Predicting the effects of reservoir water level management on the reproductive output of a riparian songbird. PLoS One 16**:** e0247318. https://doi.org/10.1371/journal.pone.0247318.

King, M.D., J.E. Elliott and T.D. Williams. 2021. Effects of petroleum exposure on birds: A review. Sci. Total Environ. 755(Part 1)**:** 142834. published on 10 Feb 2021.

Roques, S., D.B. Lank, E. Cam and R. Pradel. 2021. More than just refuelling: lengthy stopover and selection of departure weather by sandpipers prior to transoceanic and transcontinental flights. Ibis 163**:** 519–535 doi:.10.1111/ibi.12891.

Shaftel, R., D.J. Rinella, E. Kwon, S.C. Brown, H.R. Gates, S. Kendall, D.B. Lank, J.R. Liebezeit, D.C. Payer, J. Rausch, S.T. Saalfeld, B.K. Sandercock, P.A. Smith, D.H. Ward and R.B. Lanctot. 2021. Predictors of invertebrate biomass and rate of advancement of invertebrate phenology across eight sites in the North American Arctic. Polar Biology 44**:** 237-257.

2020

Beninger, P.G. and R.W. Elner. 2020. On the tip of the tongue: natural history observations that transformed shorebird ecology. Ecosph.**:** Article ID: ECS23133.

Bos, D., E. van Loon and R. Ydenberg. 2020. A large-scale experiment to evaluate control of invasive muskrats in The Netherlands. Wildl. Soc. Bull. 44**:** 314-322.

Boynton, C., N. Mahony and T.D. Williams. 2020. Post-fledging habitat use and survival of Barn Swallows (*Hirundo rustica*). Condor 122: duz067.

Canham, R. 2020. Comparison of shorebird abundance and foraging rate estimates from footprints, fecal droppings and trail cameras. Wader Study 127**:** 37-42. doi: 10.18194/ws.00170.

Criscuolo, F., R. Torres, S. Zann and T.D. Williams. 2020. Telomere dynamics from hatching to sexual maturity and the multivariate egg. J. Exp. Biol. 223**:** jeb232496. [featured article in 'Inside JEB'].

Davidson, S.C. and a. others. 2020. Ecological insights from three decades of animal movement tracking across a changing Arctic. Science 370**:** 712-715.

De Jong, J., P. van Hooft, H.-J. Megens, R. Crooijmans, G.A. De Groot, J. Pemberton, J. Huisman, L. Bartos, L. Iacolina, S. van Wieren, R. Ydenberg and H.H.T. Prins. 2020. Fragmentation and translocation distort the genetic landscape of ungulates: a case study of red deer of the Netherlands. Frontiers Ecol. Evol. 8**:** 365. https://doi.org/10.3389/fevo.2020.535715.

Forrester, T.R., D.J. Green, R. McKibbin, M. Bezener and C.A. Bishop. 2020. Riparian habitat restoration increases the availability and occupancy of Yellow-breasted Chat territories but brood parasitism is the primary influence on reproductive performance. Condor: Ornithological Applications 122**:** duaa038.

Giraldo-Deck, L., W. Goymann, I. Safari, D. Dawson, M. Stocks, T. Burke, D. Lank and C. Kuepper. 2020. Development of intraspecific size variation in black coucals, white-browed coucals and ruffs from hatching to fledging. J. Avian Biol. 51**:** e02440.

Gutowsky, S.E., J.M. Hipfner, M. Maftei, W.S. Boyd, M. Auger-Méthé, D.J. Yurkowski and M.L. Mallory. 2020. First insights into Thayer's Gull *Larus glaucoides thayeri* migratory and overwintering behavior along the Pacific coast of North America. Marine Ornithol. 48**:** 9-16.

Heddle, C., J.E. Elliott, T. Brown, M. Eng, N. Basu, M. Perkins and T.D. Williams. 2020. Continuous exposure to mercury during embryogenesis and chick development affects later survival and fertility of zebra finch (*Taeniopygia guttata*). Ecotoxicol. 29**:** 1117-1127. https://doi.org/10.1007/s10646-019-02074-6.

Hipfner, J.M., M.M. Prill, K.R. Studholme, A.D. Domalik, S. Tucker, C. Jardine, M. Maftei, K.G. Wright, J.N. Beck, R.W. Bradley, R.D. Carle, T.P. Good, S.A. Hatch, P. Hodum, M. Ito, S.F. Pearson, N. Rojek, L. Slater, Y. Watanuki, A. Bindoff, G.T. Crossin, M.C. Drever and T.M. Burg. 2020. Geolocator tagging links distributions in the non-breeding season to population genetic structure in a sentinel North Pacific seabird. PLoS One 15**:** e0240056.

Hodinka, B.L. and N.T. Ashley. 2020. Effect of sleep loss on executive function and plasma corticosterone levels in an arctic-breeding songbird the Lapland longspur (*Calcarius lapponicu*s). Hormones Behav. 122**:** 104764.

Injaian, A.S., C.D. Francis, J.Q. Ouyang, D.M. Dominoni, J.W. Donald, M.J. Fuxjager, W. Goymann, M. Hau, J.F. Husak, M.A. Johnson, B.K. Kircher, R. Knapp, L.B. Martin, E.T. Miller, L.A. Schoenle, T.D. Williams and M.N. Vitousek. 2020. Baseline and stress-induced corticosterone levels across birds and reptiles do not reflect urbanization levels. Conservation Physiology 8**:** coz110; doi:10.1093/conphys/coz110.

Jubinville, I., C. Harvey-Clark, T.D. Williams, P.N. Trathan and G.T. Crossin. 2020. Trade-off between aerobic performance and egg production in migratory macaroni penguins. Comp Biochem Physiol A Mol Integr Physiol. 247**:** 110742.

Lowney, A.M., T.P. Flower and R.L. Thomson. 2020. Kalahari skinks eavesdrop on sociable weavers to manage predation by pygmy falcons and expand their realized niche. Behav. Ecol. 31**:** 1094-1102. https://doi.org/10.1093/beheco/araa057.

McFarlane Tranquilla, L., J.L. Ryder, L. Blight, P.D. O'Hara and D.B. Bertram. 2020. Nightly colony attendance patterns of provisioning Cassin's Auklet *Ptychoramphus aleuticus* are consistent and synchronous. Marine Ornithol. 48**:** 263-272.

Monlish, D.A., Z.J. Greenberg, S.T. Bhatt, K.M. Leonard, M.P. Romine, Q. Dong, L. Bendesky, E.J. Duncavage, J.A. Magee and L.G. Schuettpelz. 2020. TLR2/6 signaling promotes the expansion of premalignant hematopoietic stem and progenitor cells in the NUP98-HOXD13 mouse model of MDS. Exp. Hematol. 88**:** 42-55.

Reiter, M., E. Palacios, D. Eusse, R. Johnston, P. Davidson, D. Bradley, R. Clay, K. Strum, J. Chu, B.

Barbaree, C. Hickey, D. Lank, R. Ydenberg, M. Drever and R. Butler. 2020. A monitoring framework for assessing threats to non-breeding shorebirds on the Pacific coast of the Americas. Avian Cons. Ecol. 15**:** 7. https://doi.org/10.5751/ACE-01620-150207.

Rennie, I.R.F., D.J. Green, E.A. Krebs and A. Harfenist. 2020. High apparent survival of Leach's Storm Petrels *Oceanodroma leucorhoa* in British Columbia. Marine Ornithol. 48**:** 133-140.

Schnurr, P.J.D., M.C., Elner, R.W., Harper, J. and M. Arts. 2020. Peak abundance of fatty acids in intertidal biofilm coincides with Northward migration of shorebirds. Frontiers Mar. Sci. 7**:** Article 63.

Tavera, E.A., G.E. Stauffer, D.B. Lank and R.C. Ydenberg. 2020. Oversummering juvenile and adult Semipalmated Sandpipers in Perú gain enough survival to compensate for foregone breeding opportunity. Movement Ecol. 8**:** 42. https://movementecologyjournal.biomedcentral.com/articles/10.1186/s40462-020-00226-6. published on line 27 Oct 2020.

Weiser, E.L., R.B. Lanctot, S.C. Brown, H.R. Gates, J. Bêty, M.L. Boldenow, R.W. Brook, G.S. Brown, W.B. English, S.A. Flemming, S.E. Franks, H.G. Gilchrist, M.-A. Giroux, A. Johnson, S. Kendall, L.V. Kennedy, L. Koloski, E. Kwon, J.-F. Lamarre, D.B. Lank, C.J. Latty, N. Lecomte, J.R. Liebezeit, R.L. McGuire, L. McKinnon, E. Nol, D. Payer, J. Perz, J. Rausch, M. Robards, S.T. Saalfeld, N.R. Senner, P.A. Smith, M. Soloviev, D. Solovyeva, D.H. Ward, P.F. Woodard and B.K. Sandercock. 2020. Annual adult survival drives trends in Arctic-breeding shorebirds but knowledge gaps in other vital rates remain. Condor 122**:** duaa026.

2019:

Criscuolo, F., A. Cornell, S. Zahn and T.D. Williams. 2019. Oxidative status and telomere length are related to somatic and physiological maturation in chicks of European starlings (*Sturnus vulgaris*). J. Exp. Biol. 222**:** jeb204719.

Laine, V., I. Verhagen, A.C. Mateman, A. Pijl, T.D. Williams, P. Gienapp, K. van Oers and M.E. Visser. 2019. Exploration of tissue-specific gene expression patterns underlying timing of breeding in contrasting temperature environments in a song bird. BMC Genomics 20**:** 693.

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. 2019. Low frequencies of supernormal clutches in the Southern Dunlin and the Temminck's Stint. Ardea 107**:** 61-74.

Schnurr, P.J., Drever, M.C., Kling, H., Elner, R.W. and M. Arts. 2019. Seasonal changes in fatty acid composition of estuarine intertidal biofilm: implications for western sandpiper migration. Estuar. Coast. Shelf Sci. 224**:** 94-107.

Studholme, K.R., J.M. Hipfner, A.D. Domalik, S.J. Iverson and G.T. Crossin. 2019. Year-round tracking reveals the existence of multiple migratory tactics in Cassin's Auklet, a sentinel North Pacific seabird. Mar. Ecol. Prog. Ser. 619**:** 169-185.

Verhagen, I., V.N. Laine, A.C. Mateman, A. Pijl, R. de Wit, B. van Lith, W. Kamphuis, H.M. Viitaniemi, T.D. Williams, S.P. Caro, S.L. Meddle, P. Gienapp, K. van Oers and M.E. Visser. 2019. Fine-tuning of seasonal timing of breeding is regulated downstream in the underlying neuroendocrine system in a small song bird. J. Exp. Biol. 222**:** jeb202481.

Ydenberg, R.C., E.E. van Loon, D. Bos and H. van Hemert. 2019. Damage to dykes and levees in The Netherlands is extensive and increases with Muskrat (*Ondatra zibethicus*) density. Lutra 62.

Submitted:

Domalik, A.D., M. Maftei, K.G. Wright, S.A. Hudson and J.M. Hipfner. Submitted. Migration and winter habitat use of Glaucous-winged Gulls Larus glaucescens breeding on Triangle Island,

British Columbia. Waterbirds.
Fremlin, K.M., J.E. Elliott, P.A. Martin, T. Harner, A. Saini and F.A.C. Gobas. Submitted. Fugacity based trophic magnification factors characterize bioaccumulation of cyclic methyl siloxanes within an urban terrestrial avian food web: Importance of organism body temperature. Env. Sci. Technol.
Kuwae, T., Elner, R.W., Amano, T. and M.C. Drever. Submitted. Human-intervention in intertidal flat ecosystems: seven ecologically-based technical attributes for shorebird recovery. Ecol. Solutions Evidence.
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. Submitted. Across the North Pacific Ocean, dietary-induced stress of breeding rhinoceros auklets increases with high summer Pacific Decadal Oscillation index. Mar. Ecol. Prog. Ser.
Tate, H.M., K.R. Studholme, A.D. Domalik, M.D. Drever, L.M. Romero, B.M.G. Gormally, K.A. Hobson, J.M. Hipfner and G.T. Crossin. Submitted. Physiological response to "The Blob" differs between two sentinel North Pacific seabirds. Conservation Physiology.

B. THESES

Forstner, T. 2021. Migratory connectivity and spatio-temporal aspects of Pacific Barrow's goldeneye (*Bucephala islandica*) migration. MSc, Simon Fraser University, Burnaby. pp. defended on 12 Jan 2021.
Kesic, R. 2020. The continuing persistence and biomagnification of DDT and metabolites in American robin (*Turdus migratorius*) fruit orchard food chains. MET, Simon Fraser University, Burnaby. pp. defended 14 Dec 2020.
McAuley, E.M. 2020. Disentangling the effects of biogeoclimatic factors and local stressors on breeding harlequin duck presence and abundance using field surveys, MaxEnt, and stable isotope turnover models. PhD, Simon Fraser University, Burnaby. pp. defended 10 Dec 2020.
Pastran, S. 2020. Marine habitat preferences of Marbled Murrelet in Haida Gwaii, BC. MSc, Simon Fraser University, Burnaby. pp. defended 30 Oct 2020.