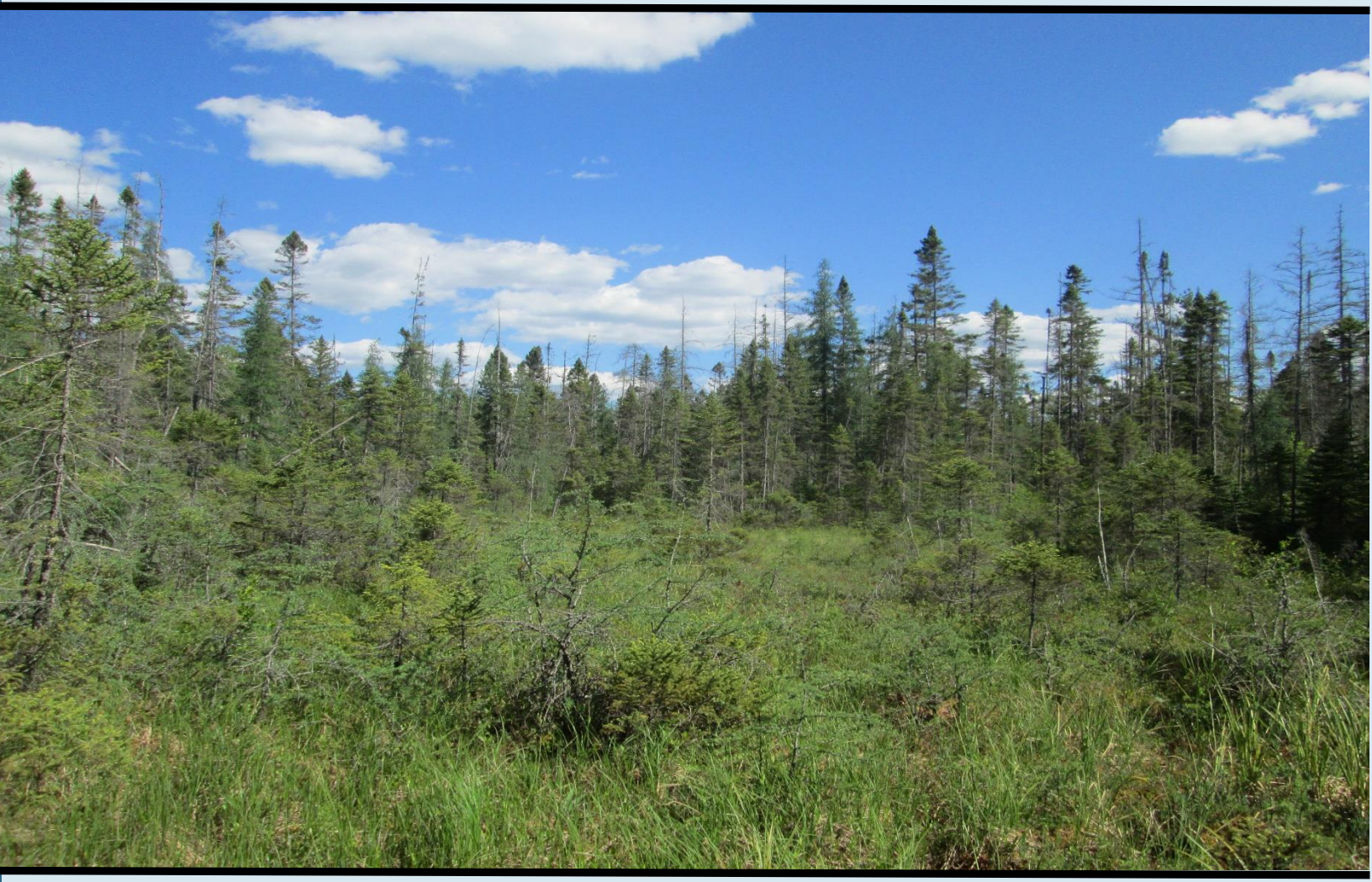
NEW YORK COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT



2018 Annual Report

The New York Cooperative Fish and Wildlife Research Unit works closely with our cooperators to conduct research that guides management of fish and wildlife resources in New York State and beyond.

Front cover photo: Study site from the Adirondack moose study.

New York Cooperative Fish and Wildlife Research Unit

2018 ANNUAL REPORT

211 Fernow Hall
Cornell University
Ithaca, NY 14853

Phone: 607-255-2839
Fax: 607-255-1895
http://www.coopunits.org/New_York/

Cooperators:

U.S. Geological Survey
Cornell University
New York State Department of Environmental Conservation
U.S. Fish and Wildlife Service
Wildlife Management Institute

TABLE OF CONTENTS

INTRODUCTION

The Cooperative Research Units (CRU) program was established in 1935 as a cooperative partnership between the Federal and State biological resource agencies and Land Grant universities to conduct research on managing wildlife populations and habitats, train wildlife managers, and disseminate information to management agencies. Seventy-five years later, the mission of the program remains unchanged. Now with 40 Units in 38 states, the CRU program employs over 100 scientists that conduct research on natural resource issues of importance to State and Federal agencies and other organizations, teach graduate-level courses at their host universities, and conduct workshops and short courses for their cooperators and other partners.

The New York Cooperative Fish and Wildlife Research Unit was established in 1961 under the leadership of Dr. Daniel Thompson. Originally established as a separate wildlife unit, the fishery unit was added in 1963 and led by Dr. Alfred Eipper. In 1984, the units were combined and led through 2008 by Dr. Milo Richmond. Dr. Angela Fuller became the new Assistant Unit Leader-Wildlife in 2009, and assumed the Unit Leader position in 2014

We look forward to continuing our research collaborations in cooperation with our partners at Cornell University, the New York State Department of Environmental Conservation, U. S. Geological Survey, U.S. Fish and Wildlife Service, Wildlife Management Institute, and other organizations.

This annual report provides an overview of the research, teaching, and technical assistance activities of the New York Cooperative Fish and Wildlife Research Unit.

The Scientists and Staff of the
New York Cooperative Fish and Wildlife Research Unit

PROGRAM STATEMENT

The New York Cooperative Fish and Wildlife Research Unit, one of 40 in a national Cooperative Research Units program, was established for the purpose of enhancing the management of this nation's natural resources. The mission of the program is to conduct research on natural resource questions, contribute to graduate education by engaging graduate students in research projects and teaching graduate-level courses, provide technical assistance and consultation on natural resource issues, and provide continuing education for natural resource professionals. The Unit is a partnership among the U.S. Geological Survey, the New York State Department of Environmental Conservation, Cornell University, the U.S. Fish and Wildlife Service, and the Wildlife Management Institute. The mission of the Unit is to conduct and facilitate applied and basic research in fish and wildlife management among state and federal natural resource agencies, non-governmental organizations, and university faculty and staff on topics of mutual concern. The three Unit research scientists are aided by a highly motivated group of graduate students and research affiliates who conduct scientific research and understand the need for application and dissemination of research results. Particular attention is given to the natural resource problems and issues of the Northeastern states, with New York as the focal point, but we also work on national and international conservation issues. Our research focuses on how spatial and temporal variation in environmental and habitat characteristics influence habitat selection, movements, and population ecology of fish and wildlife. When appropriate, we promote the principles and use of structured decision making to guide management and research, and apply methods of adaptive management as a framework to reduce the pervasive uncertainties that complicate natural resource management and policy decisions.

Approved: September 18, 2012

COOPERATORS AND PERSONNEL

COORDINATING COMMITTEE

U.S. Geological Survey

MIKE TOME, Eastern Supervisor, Cooperative Research Units, Leetown Science Center, 11649 Leetown Road, Kearneysville, WV 25430

New York State Department of Environmental Conservation

ANTHONY WILKINSON, Director, Division of Fish, Wildlife, and Marine Resources, 625 Broadway, Albany, NY 12233

Cornell University

PATRICK SULLIVAN, Chair, Department of Natural Resources, Fernow Hall, Cornell University, Ithaca, NY 14853

AMY MCCUNE, Senior Associate Dean, College of Agriculture and Life Sciences, Roberts Hall, Cornell University, Ithaca, NY 14853

U.S. Fish and Wildlife Service

DEBORAH ROCQUE, Deputy Regional Director, Science Applications, U.S. Fish and Wildlife Service, Northeast Regional Office, 300 Westgate Center Dr., Hadley, MA 01035

DAVID STILWELL, Field Supervisor, U.S. Fish and Wildlife Service, New York Field Office, 3817 Luker Rd., Cortland, NY 13045

Wildlife Management Institute

SCOT WILLIAMSON, Northeast Regional Representative and Vice-President, Wildlife Management Institute, 69 Clinton Avenue, St. Johnsbury, VT 05819

UNIT PERSONNEL

Scientists

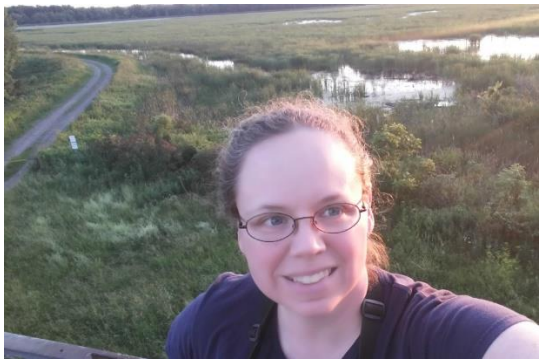
ANGELA K. FULLER, UNIT LEADER, WILDLIFE

SURESH SETHI, ASSISTANT LEADER, FISHERIES

Staff

MELANIE MOSS
ADMINISTRATIVE ASSISTANT

KELLY PERKINS
RESEARCH SUPPORT SPECIALIST



Postdoctoral Scientists

BEN AUGUSTINE

JENNIFER BRAZEAL

JENNIFER PRICE TACK

COLLABORATORS

Tom Bell, New York State Department of Environmental Conservation
Carrie Brown-Lima, Cornell University
Lance Clarke, New York State Department of Environmental Conservation
Evan Cooch, Cornell University
Mike Connerton, New York State Department of Environmental Conservation
Jennifer Dean, New York Natural Heritage
Daniel Decker, Cornell University
Duane Diefenbach, Pennsylvania Cooperative Fish and Wildlife Research Unit
Bistra Dilkina, University of Southern California
Glen Dowell, Cornell University
Jim Eckler, New York State Department of Environmental Conservation
James Farquhar, New York State Department of Environmental Conservation
Alex Flecker, Cornell University
Jacqui Frair, SUNY Environmental Science Forestry
Dave Garshelis, Minnesota Department of Natural Resources
Isaac Goldstein, Wildlife Conservation Society
Carla Gomes, Cornell University
Miguel Gomez, Cornell University
Matthew Hare, Cornell University
Brad Harris, Alaska Pacific University
Fred Henson, New York State Department of Environmental Conservation
Steve Heerkens, New York State Department of Environmental Conservation
Amanda Higgs, New York State Department of Environmental Conservation
Lisa Holst, New York State Department of Environmental Conservation
Phil Hulbert, New York State Department of Environmental Conservation
Jeremy Hurst, New York State Department of Environmental Conservation
Steve Hurst, New York State Department of Environmental Conservation
Dan Isermann, Wisconsin Cooperative Fisheries Research Unit
Randy Jackson, Cornell University
Kathryn Jahn, U.S. Fish and Wildlife Service
Paul Jensen, New York State Department of Environmental Conservation
Steve Joule, New York State Department of Environmental Conservation
Karim Kassam, Cornell University
Arthur Kirsch, New York State Department of Environmental Conservation
Clifford Kraft, Cornell University

Heidi Kretser, Wildlife Conservation Society
Brian Lantry, U.S. Geological Survey Lake Ontario Biological Field Station
Chris Legard, New York State Department of Environmental Conservation
Steve Lapan, New York State Department of Environmental Conservation
Wes Larson, Wisconsin Cooperative Fisheries Research Unit
James Lassoie, Cornell University
Jesse Lepak, NY Sea Grant
Sean Madden, New York State Department of Environmental Conservation
Jennifer Miller, Panthera, Cornell University and University of Cape Town
Steve Morreale, Cornell University
Web Pearsall, New York State Department of Environmental Conservation
Rich Pendleton, New York State Department of Environmental Conservation
Manuel Peralvo, CONDESAN
Aaron Rice, Cornell University
Amanda Rodewald, Cornell University
Daniel Rosenblatt, New York State Department of Environmental Conservation
J. Andrew Royle, Patuxent Wildlife Research Center
Lars Rudstam, Cornell University
Mike Schiavone, New York State Department of Environmental Conservation
Krysten Schuler, Cornell University
Michael Schwartz, USDA Forest Service
William Siemer, Cornell University
Richard Stedman, Cornell University
Jim Stickles, New York State Department of Environmental Conservation
Josh Stiller, New York State Department of Environmental Conservation
Patrick Sullivan, Cornell University
Theodore Toombs, Environmental Defense Fund
Mike Wasilco, New York State Department of Environmental Conservation
Brian Weidel, U.S. Geological Survey Lake Ontario Biological Field Station
Steven Wolf, Cornell University

EDUCATION

GRADUATE STUDENTS

TAYLOR BROWN, M.S. and Ph.D., Natural Resources, (ADVISOR: SETHI)

KIMBERLY FITZPATRICK, Ph.D., Natural Resources, (ADVISOR: SETHI)

ABRAHAM FRANCIS, M.S, Natural Resources, (ADVISOR: FULLER)

SANTIAGO GARCIA, Ph.D., Natural Resources, (ADVISOR: FULLER)

ROBERT MÁRQUEZ, PH.D., NATURAL RESOURCES, (ADVISOR: FULLER)

MATTHEW PAUFVE, M.S., NATURAL RESOURCES (ADVISOR: SETHI)

SCOTT SMELTZ, PH.D., NATURAL RESOURCES, (ADVISOR: SETHI)

VANESSA SPRINGER, M.S., Natural Resources, (ADVISOR: FULLER)

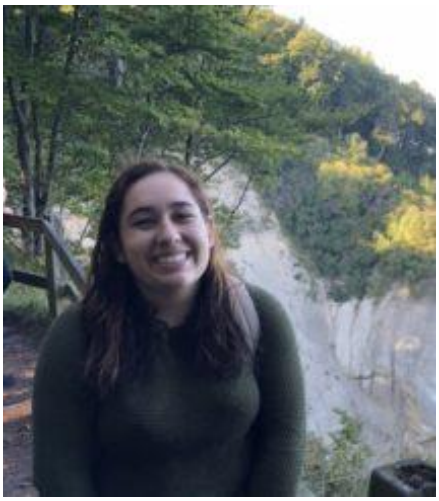
CAT SUN, PH.D., Natural Resources, (ADVISOR: FULLER)

ALEC WONG, M.S., Natural Resources, (ADVISOR: FULLER)

UNDERGRADUATE STUDENTS AND DORIS DUKE CONSERVATION SCHOLARS

READ BARBEE

VIVIAN GARCIA



JAILENE HILDAGO

NIKI LOVE

MADDIE HOLDEN

Brianna Mims

Sabrina Molyneaux

Jessie Phillips

Jeremy Pustilnik

Amairani Tovar

Sarah Scott-Cruz

RESEARCH
CURRENT PROJECTS

Leveraging partial identity information to advance noninvasive genetic, remote camera, and bioacoustics sampling of animal populations and improve conservation decision making

INVESTIGATORS: Angela Fuller (NYCFWRU)

J. Andrew Royle (USGS Patuxent)

POST DOC: Ben Augustine (Cornell)

SPONSORS: Atkinson Center, Cornell University

STARTED: March 2018

Ben Augustine, Postdoctoral Scholar

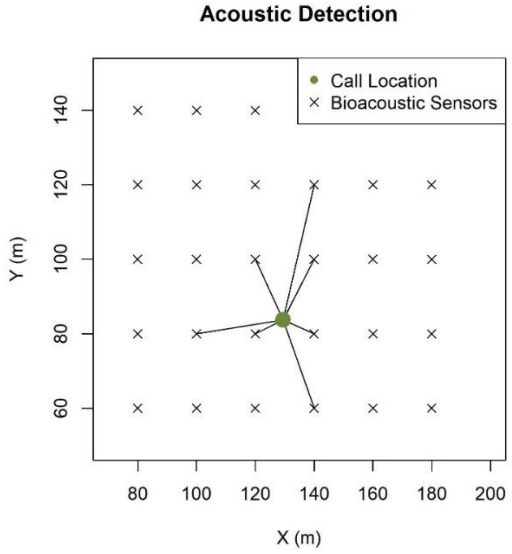
Over the past two decades, new technologies have affected the way we study and understand animal populations. New, noninvasive methods for monitoring wildlife species such as genetic data from hair or scat samples, remote cameras, and bioacoustic monitoring, have allowed researchers to collect more abundant data than was previously possible. However, to reliably estimate population parameters relevant to conservation decisions such as population density and growth rates, individuals must be individually identifiable which is only possible for a small subset of species for which individual identities are easily determined such as the flank patterns of tigers seen in photographs or species that yield high quality DNA samples. The vast majority of noninvasive applications do not always provide an unambiguous determination of individual identity.

While many of these noninvasive detections do not provide *complete* individual identities, they often provide information that allow for a *partial* identification—information that is currently rarely used and that can lead to large improvements in estimation efficiency and reduced bias. Examples of partial identification are single flank photographs in a remote camera study where a photograph event of both flanks is required for a complete identity and incomplete DNA samples in a study that requires a full DNA sample. Due to the importance of estimates of population density and growth rates for conservation decisions and the utility of noninvasive methods for collecting data on wildlife species, statistical models that use encounter data with partial individual identity are a critical need for the vast number of species that are not easily identifiable.

Over the past year, we have developed estimation methods for the following partial identity applications. 1) Density estimation using incomplete genotypes that allows for samples that contain genotyping errors. Currently, incomplete and potentially erroneous samples are discarded, despite the

fact that they contain abundant information about individual identity, density, and other ecological parameters of interest. We are applying this model to a fisher data set from New York where we are able to use 420 hair samples, rather than the original 287, and increase the precision of density estimates. 2) Density estimation from camera trap photographs that do not require individual identities to be assigned. Current methods for identifying individual animals from photographs require certain individual identity assignments, but for species without unambiguous individual markings, the potential for error is high. We allow for density estimation by classifying bear face regions into binary values of "marked" or "unmarked" and apply this to an Andean bear data set from Ecuador. 3) Density estimation from bioacoustic detectors. Current methods for estimating density from bioacoustics detectors are limited, requiring perfect individual identity assignments or restrictive assumptions. We developed a method to estimate density using an array of bioacoustics detectors that uses the spatial information in estimated call locations to group calls to individuals or groups of individuals and estimate their density. We are applying this method to a population of Gibbons in Borneo.

Above: A fisher hair snare from the 2013 – 2015 survey in NY. The barbs placed around the bait snag hair samples, which are genotyped to provide complete or partial individual identities.



Above: A conceptual illustration of how bioacoustics calls can be localized by detection at multiple bioacoustics detectors.

Left: An Andean bear camera trap capture event from one of the more identifiable bears photographed in Ecuador in 2016.

Project Title: Fisher and Marten Occupancy, Density, and Interspecific Interactions in New York

INVESTIGATORS: Angela Fuller (NYCFWRU)

Paul Jensen (NYSDEC)

POST DOC: Jennifer Brazeal (Cornell)

SPONSORS: New York State Department of Environmental Conservation

STARTED: September 2018

Jennifer Brazeal, Postdoctoral Researcher

Fisher (*Pekania pennanti*) and marten (*Martes americana*) are two forest-dwelling carnivore species that are found in New York, where they occur in sympatry with other carnivore species, such as bobcats (*Lynx rufus*) and coyotes (*Canis latrans*). Because they occupy a high trophic level, they can have significant impacts on ecological communities, and are of high economic and recreational value as furbearing species. Both fishers and martens can be sensitive to over-harvesting, as they occur naturally at low densities, and it is therefore important to carefully monitor and regulate their trapping seasons and the status of their populations to ensure sustainable numbers. Their distributions overlap in the Adirondack region, though fisher also occur more broadly throughout eastern New York, and have recently expanded their range across the southern tier of western and central New York.

From 2013 to 2015, Angela Fuller, Dan Linden, and the New York Department of Environmental Conservation (NYDEC) collaborated on a winter camera and hair snare survey of fisher in the western and central southern tier of New York to estimate occupancy and density of fishers in New York. As a result of these surveys, NYDEC opened conservative trapping seasons in select wildlife management units previously closed to trapping. In order to determine the current status of fisher populations in the southern tier of New York, and monitor for any response to the recent management change, we collaborated with the NYDEC to design and implement a 2019 winter camera and hair snare survey in the southern tier of New York. Beginning in December, 2018, NYDEC began the first round of surveys, which will include 585 sites across 5 Regions, including 464 paired hair snare and camera sites and 121 camera only sites. These data will allow for estimation of both

occupancy and density of fisher. Using the camera data from 2013-2015, we are also developing a multi-species occupancy model that will explore occupancy and interspecific interactions of fisher, bobcat, and coyotes.

Concurrently, we are working with Paul Jensen at the NYDEC to evaluate the status of marten populations in New York using a variety of data sources, which we plan to incorporate into an integrated population model. These data include live trapping and non-invasive sampling (hair snare and camera) from 2015-2017, telemetry data from 2007-2012, and age-structured harvest data from 2003-2015. We will additionally develop a multi-species occupancy model to explore interactions between coyote, fisher and marten in the Adirondack regions.

Above: Coyote photo from the 2013-2015 fisher camera survey.

Above: Fisher photo from the 2013-2015 fisher camera survey.

Above: Bobcat photo from the 2013-2015 fisher camera survey.

Quantifying coregonine habitat use across space and time to inform assessment and restoration

INVESTIGATORS: Suresh Sethi (NYCFWRU)

Lars Rudstam (Cornell)

Brian Weidel (USGS Lake Ontario Biological Station)

STUDENTS: Taylor Brown

SPONSORS: EPA Great Lakes Restoration Initiative

USGS Great Lakes Science Center

STARTED: June 2018

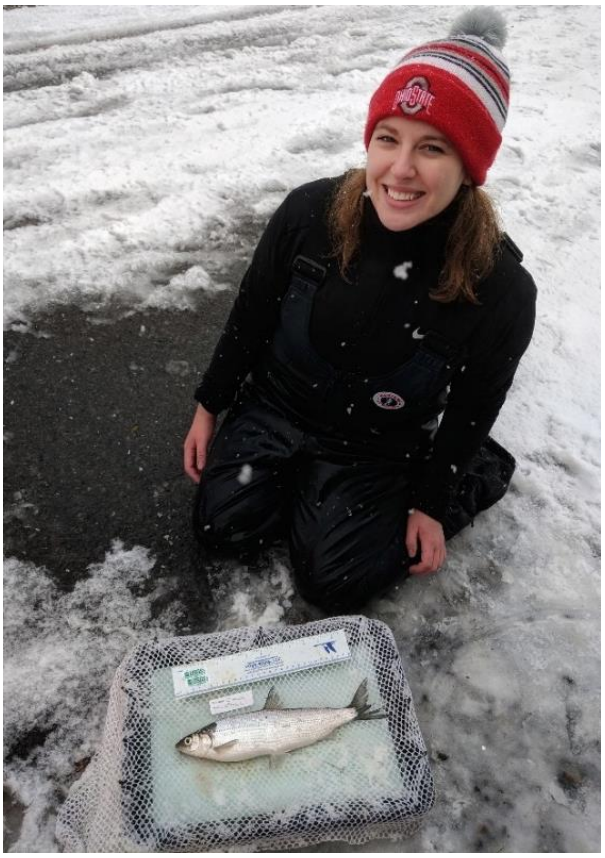
Taylor Brown, M.S./Ph.D. Student

Coregonines (*Coregonus* spp.) in the Laurentian Great Lakes were historically the major component of native fish communities and commercial fisheries. In Lake Ontario, only remnant populations of Cisco (*C. artedi*) and Lake Whitefish (*C. clupeaformis*) endured through the impacts of overfishing, habitat degradation, and invasive species. Due to their significance both ecologically as a forage base for piscivorous fishes and societally as a recreational and commercial fishery, there is a rapidly growing management interest in rehabilitating coregonine populations within Lake Ontario and broadly across the Great Lakes. However, Lake Ontario lacks a formal, lake-wide coregonine survey and, consequently, little is known about contemporary population dynamics. A deeper, mechanistic understanding of coregonine ecology is needed to develop effective management and monitoring actions. For this project, we are quantifying patterns and drivers of coregonine spatial distributions among Lake Ontario habitats and across life-history stages in collaboration with a group of federal (USGS, USFWS, Department of Fisheries and Oceans Canada), state (NYSDEC), and provincial (Ontario Ministry of Natural Resources and Forestry) biologists.

In 2018, as part of the EPA Cooperative Science and Monitoring Initiative, spatially-extensive field surveys were conducted to quantify lake-wide spatiotemporal variability in coregonine habitat use and to evaluate the efficacy of potential targeted assessment programs. Historical and contemporary spawning habitats were surveyed to determine which habitats currently support coregonine populations

and to identify potential biotic and abiotic drivers of coregonine presence and relative abundance among habitats. Surveys were conducted during both the larval emergence period (April through May) using ichthyoplankton tows and when adult coregonines are staging to spawn (November through December) using horizontal gillnets. From July through September, pelagic Cisco space use as a function of stratification and thermocline characteristics was investigated using hydroacoustics, midwater trawls, and vertical gill nets in the eastern basin. These projects contribute to an improved understanding of coregonine population dynamics in Lake Ontario, how these populations may respond to future ecological pressures or management actions, and what factors need to be considered for designing an effective annual coregonine assessment program.

Above: Cisco collected during a midwater trawl survey on the *R/V Ontario Explorer*, September 2018. Below: Taylor Brown with Cisco.



Lake Ontario Salmonid Management Risk Assessment: Refinement of Predator/Prey Models

INVESTIGATORS: Suresh Sethi (NYCFWRU)

STUDENTS: Kimberly Fitzpatrick

SPONSORS: New York State Department of Environmental Conservation

STARTED: August 2017

Kimberly Fitzpatrick, Ph.D. Student

Sustaining populations of salmon in Lake Ontario requires mangers to balance the abundance of stocked and naturally reproducing predators with the availability of prey, primarily Alewife. These management strategies may benefit from an increased understanding of predator-prey relationships and identification of key information needs. In conjunction with lake managers, we aim to improve the understanding of predator-prey population dynamics and develop pertinent support tools for Lake Ontario salmon management.

We are building upon on previous Great Lakes predator management efforts by updating existing predator-prey models for Lake Ontario and incorporating more recent data. The model will combine elements of population dynamics, bioenergetics, and foraging arena models to simulate predator-prey dynamics. The updated model will then be tested under different scenarios in order to design management strategies that are robust to uncertainty. These test scenarios will include situations that Lake Ontario managers have highlighted as being important (e.g. Alewife year-class failures, increased abundance of predators) or are based off of predator-prey dynamics seen in other Great Lakes populations (e.g. runaway naturalized predator reproduction). Finally, we will use the model to identify key data needs and cost-effective approaches to improve decision support for salmon management strategies in Lake Ontario.

In 2018, we began to work on the predator-prey model that will form the foundation for this research. Given its importance as the hallmark recreational fishery in Lake Ontario, we focused our efforts on developing a population dynamics model for Chinook Salmon. We worked closely with NYSDEC, USGS, and Ontario Ministry of Natural Resources and Forestry to ensure that the model represents both key observed population dynamics while

providing pertinent information to managers. Moving forward, we will work on developing and incorporating a population dynamics model for Alewife and integrating estimates of Alewife consumption by other predators from existing models (e.g. Lake Trout).

Right: Salmon jumping at Salmon River Hatchery (Altmar NY) during the spawning run in October 2018.

Above: Fitzpatrick, K.B. (center) and USGS and NYSDEC researchers workup gillnets during sampling survey. November 2018.

3rd NY Breeding Bird Atlas Design

INVESTIGATORS: Angela Fuller (NYCFWRU)

J. Andrew Royle (USGS)

STAFF: Kelly Perkins (Cornell)

STARTED: April 2018

New York will hold its third Breeding Bird Atlas in 2020-2025 to collect data on bird distributions and status within the state. Lack of a formal survey design and documentation of atlasing effort limited inference on trends of avian distributions in New York in the previous atlases. The current atlas will use data collected in eBird to model changes in species occupancy with subsequent atlases. We acquired the eBird reference dataset for the Western Hemisphere (bird data) and spatial reference dataset (background environmental covariate data) from Cornell Lab of Ornithology and began the process of assembling and filtering the necessary data to simulate power to detect trends under various design options within an occupancy framework.

Spatial Risk Mapping: A Tool to Plan and Implement Human-Andean Bear Conflict Mitigation in Western Ecuador

INVESTIGATORS: Angela Fuller (NYCFWRU)

Richard Stedman (Cornell)

STUDENTS: Santiago Garcia, Ph.D.

SPONSORS: SENESCYT

STARTED: February 2019

Santiago Garcia, Ph.D. Student

The loss of tropical forests worldwide has induced rapid and widespread extinction across many plant and animal species, many of them poorly known to science. This loss of forest cover also affects the function of ecosystem services and human populations that rely on them for subsistence. The cloud forests of Northwest Pichincha are within the Tropical Andes hotspot, one of the most important biodiversity hotspots globally.

The process of forest loss involves dynamic and complex interactions spanning social, environmental and economic realms. These socio-ecological systems involve intimate linkages between humans and nature, emphasizing that humans must be seen as a part of, not apart from, nature. Understanding how these processes affect natural resources is a challenge that involves identification of factors that may trigger these interactions and how interactions impact ecosystems.

Over the past 20 years, communities inside the Andean Bear Corridor in the Northwest Pichincha region have become a model for how communities may transition from unsustainable practices to sustainable economies. The presence of Andean bears (*Tremarctos ornatus*) in this area presents both conservation challenges and opportunities. Within the corridor, bears have come into conflict with humans, so it is vital to identify actions that help mitigate risks to both humans and bears. We propose to identify key conservation values in the landscape of the Andean Bear corridor, as well as to measure levels of tolerance towards Andean bears. We will link this information to the results of a previous study on bear abundance in the corridor to create a risk map of conflict

between communities and the Andean bear. This risk map will help communities and decision-makers to design mitigation measures that help generate better management strategies as well as creating policies to support Andean bear conservation.

Andean bear (*Tremarctos ornatus*)

Santiago Garcia

Conservation and Management of Andean Bears from Regional to Local Scales: Occupancy, Density, Connectivity, and Threats.

INVESTIGATORS: Angela Fuller (NYCFWRU)
Dave Garshelis (MN Dept. of Natural Resources)
Isaac Goldstein (Wildlife Conservation Society)

STUDENTS: Robert Márquez

SPONSORS: Andean Bear Conservation Alliance
Wildlife Conservation Society

STARTED: September 2017

Robert Márquez, Ph.D. Student

The Andean bear is the only extant species of bear in South America and is considered threatened across its range due to habitat loss, fragmentation, and illegal hunting. In Colombia, Ecuador, and Peru, non-protected areas have historically had human presence/activity. Consequently, Andean bear populations in this region are exposed to high levels of fragmentation, and to a diverse degree of human related threats, including retaliatory hunting as a result of human-bear conflict.

In this study we seek to understand the relationship of Andean bear with threats and environmental variables for informing management decisions. We are interested to 1) evaluate the relationship between real/perceived damage caused by Andean bears, farmers' attitudes about bears, and bear killing; 2) Evaluate landscape factors and species threats that contribute to regional occupancy of Andean bears. In order to reach these objectives, we are a) Evaluating the effect of husbandry practices and environmental variables on damage caused by Andean bears in Colombia and Peru, b) evaluating the effect of damage caused by Andean bears and socio-economic factors on the attitudes of local residents in Colombia and Peru, c) evaluating the effect of human attitudes, norms, and context on human behavior regarding hunting in Colombia and Peru, d) evaluate occupancy of Andean bears in Colombia, Ecuador and Peru.

Cisco Spawning Habitat in the Great Lakes

INVESTIGATORS: Suresh Sethi (NYCFWRU)

Brian Lantry (USGS)

STUDENTS: Matthew Paufve, M.S.

SPONSORS: EPA Great Lakes Restoration Initiative

STARTED: August 2016

Matt Paufve
M.S. Student

We have been studying the spawning habitat used by cisco (Coregonus artedi), a native prey fish in the Great Lakes. This species was once a prominent component of the lake ecosystems, but populations collapsed in the mid-1900s and cisco remain locally extirpated or in remnant populations in the Great Lakes. Rehabilitation of cisco populations is a management priority in the region, prompting questions about whether the availability of suitable spawning habitat could be preventing population growth and expansion.

To address this question and inform management actions targeting cisco, we characterized spawning habitat use in three known spawning areas—at Elk Rapids in Grand Traverse Bay, Lake Michigan, Thunder Bay, Lake Superior, and Chaumont Bay, Lake Ontario. In 2016, 2017, and 2018, we worked with tribal, federal, and state agencies to sample across ranges of habitat types for cisco eggs. Our results are currently being analyzed, but suggest that as a species, cisco have a broad spawning habitat niche, but individual spawning stocks appear to have specific habitat preferences that vary between stocks.

We recently published a paper on a controlled field experiment in which we evaluated the efficiency of our egg sampling pump, and we are currently analyzing data for a second methods-focused manuscript describing how egg diameter can be used to identify the species of eggs.

Above: Live Cisco egg from Thunder Bay Lake Superior.

Left: Egg sampling on Thunder Bay, Lake Superior.

Below: Egg pumping Chaumont, Lake Ontario.

Spatial Optimization of Invasive Species Management in New York

INVESTIGATORS: Angela Fuller (NYCFWRU)
Carrie Brown-Lima (NYISRI)
Jennifer Dean (NYSHP)

POST DOC: Jennifer Price Tack, Ph.D.

SPONSORS: New York State Department of Environmental Conservation

STARTED: September 2017

Jennifer L. Price Tack, Postdoctoral Researcher

Jennifer Price Tack is a postdoctoral research associate working with NYSDEC and leaders from the 8 NY Partnerships for Regional Invasive Species Management (PRISM). Her work is supported by the NY Invasive Species Research Institute (NYSRI), and was funded using Environmental Protection Funds. She is developing a tool that builds on the work of NY Heritage Program, DEC, and others to help invasive species managers optimize management actions based on species and areas statewide, with flexibility to tailor actions at the regional level.

Efficiently optimizing the management of invasive species is a complex problem involving hundreds of species across large landscapes. Species exhibit a wide range of biological characteristics, impacts to valued goods and services, and varying treatment options. Although there have been advancements in models informing the management of invasive species to reduce their impacts, few approaches are available that address the issue of spatially optimizing the allocation of treatments among multiple species that explicitly considers difficult tradeoffs. Structured decision making provides a framework for informing such complex decisions that is robust, transparent, and values-focused. Jennifer's projects demonstrates how structured decision making can be used to aid invasive species management decisions, and present a novel decision tool that mangers can use to identify where and which treatments to apply for multiple invasive species that accounts for species-specific impacts, invasive pathways, and treatment feasibility. We are applying our approach to the management of invasive species in New York, considering alternatives for prevention, surveillance, control, and no direct action.

Jennifer reviewed relevant literature and tools related to prioritizing and optimizing invasive species management decisions. She attended several meetings with NY invasive species

managers and stakeholders, including meetings with the NYS Invasive Species Committee, Invasive Species Advisory Council, NYS Heritage Program, and PRISM leaders. She has also been working with Jennifer Dean and others from NYS Heritage Program to utilize iMapInvasives observations of invasive species for prioritizing spatial distribution of management funds.

Above: PRISM leaders and stakeholders participate in a structured decision-making workshop.

Over the past year Jennifer has led or co-led (with Dr. Angela Fuller) several in-person SDM workshops to identify objectives, management alternatives, and elicit model parameter values from stakeholders. Jennifer has further led numerous remote meetings to continue working with species specialist groups to elicit parameter values (i.e. probability of management mitigating negative impacts, cost of management). She has been developing a state-dependent decision model, such that the alternatives under consideration for a spatial unit depends on whether the block is infested, un-infested high risk, or un-infested low risk. She is working with collaborators from Cornell's computer science department to optimize the large spatial problem using mixed-integer linear programming. Once the model is developed, she will be working with collaborators from NatureServe and the NY Natural Heritage Program to integrate the tool into iMapInvasives and develop a user-friendly interface such that managers can utilize the tool without the need of a computer programmer.

Above: PRISM leaders completing group elicitation work.

Above: Jennifer Price Tack leading an elicitation workshop with the PRISM leaders.

How many cooks in the kitchen? Evaluating the potential of DNA mixture models to infer counts from fish and wildlife genetic samples

INVESTIGATORS: Suresh Sethi (NYCFWRU)

Wes Larson (WICFRU)

Dan Isermann (WICFRU)

SPONSORS: USGS

STARTED: August 2016

We assessed whether DNA mixtures can count the number of yellow perch (Perca flavescens) in bass stomachs.

In many field-based genetics sampling occasions for fish and wildlife species, collection of tissue, fluid, hair, or feces samples occurs on a mix of individuals combining into a single sample specimen. In most scenarios, these DNA mixtures are either a nuisance for a given sampling design such as with genetic mark recapture studies, or the information contained in the DNA mixture is not fully utilized and is instead condensed down into presence/absence information only. In this project, we seek to extend methods developed in forensic criminology to estimate the number of individuals that contribute to a DNA mixture to identify novel applications for fish and wildlife management. If successful in development of these techniques, we envision applicability to a wide range of fish and wildlife ecology applications, including assessing fish diet compositions and taking eDNA species sampling beyond presence-absence to count-based inference, among other uses. In 2018, we completed a suite of simulation, laboratory, and field trials to demonstrate the use of DNA mixture tools. We showed how our new DNA mixture estimator could accurately enumerate prey fish in predatory fish stomachs, providing improved tools for analysts studying diet composition of fish. Our work was completed this year and led to a publication at *Methods in Ecology and Evolution*, a top journal in quantitative ecology. The techniques we've introduced are already making their way into other research projects including using eDNA tools to identify invasive fish in the Northeast U.S.

Project Assessment of the viability of active versus passive acoustic technology for assessment of schooling pelagic fish stocks

INVESTIGATORS: Suresh Sethi (NYCFWRU)

Aaron Rice (Cornell)

Pat Sullivan (Cornell)

Lars Rudstam (Cornell)

Rod Fujita (EDF)

High biodiversity of pelagic fish species in the Visayan Sea.

SPONSORS: Atkinson Center for a Sustainable Future

STARTED: August 2017

Schooling pelagic forage fish stocks such as alewife, mackerel and sardines provide large sources of biomass for top predator fish and for directed fishery harvests. Yet these populations are characterized by high recruitment variability, patchy distributions, and erratic phenology, making collection of stock assessment information necessary for sustainable fisheries management challenging. Acoustics technology has rapidly advanced and may provide novel tools to assess sardine biomass. In this collaboration we seek to evaluate the potential for active and passive acoustics tools for the assessment of schooling pelagic fish, using sardine as a case study.

While targeted at sardine stocks as a case study, insights from this project comparing active versus passive acoustics fish population assessment will be useful for a wide range of freshwater and marine schooling pelagic stocks. In 2018, we conducted field trials in the Philippines. We successfully deployed both active and passive acoustic sound gear to assess pelagic schooling fish stocks. Initial results indicate that schooling sardines do in fact make passively detectable sounds, suggesting combinations of passive and active acoustic sound gear could be used in combination to survey patchy pelagic stocks at broad spatial scales.

Invasive round goby ecology in Finger Lakes

INVESTIGATORS: Suresh Sethi (NYCFWRU)

Jesse Lepak (NY Sea Grant)

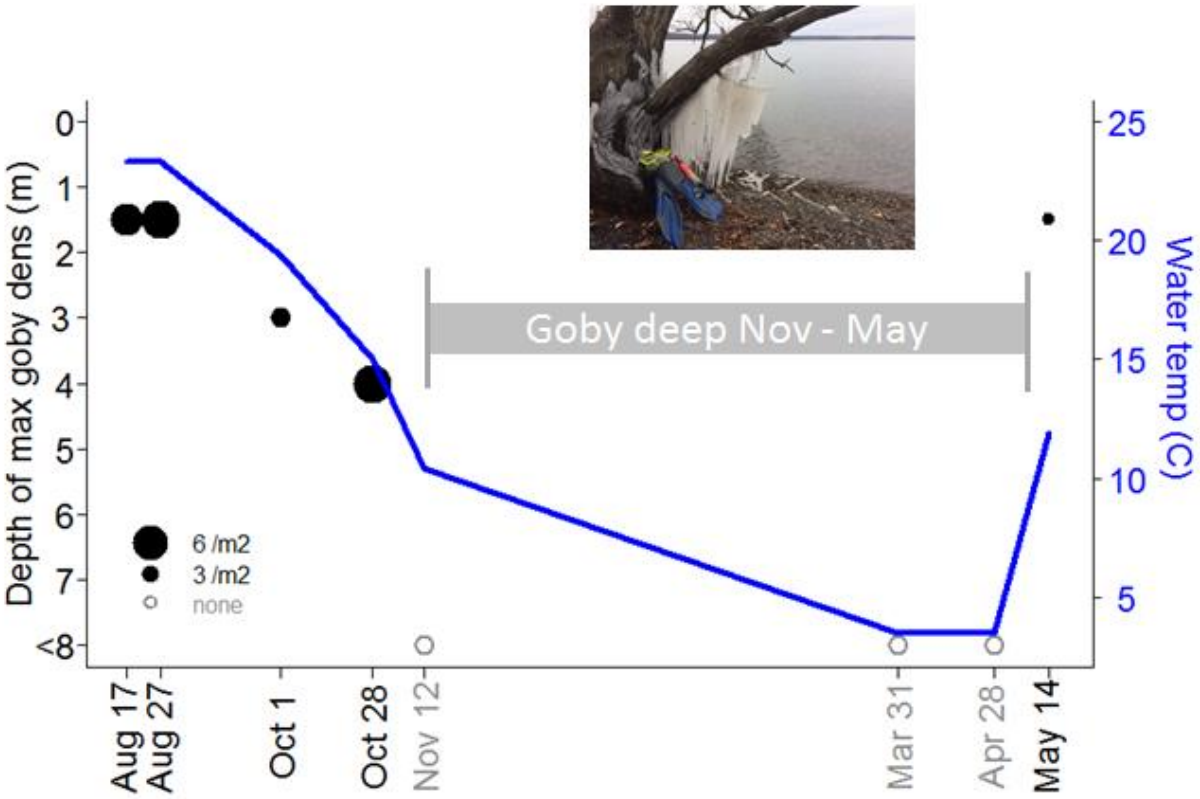
Aaron Rice (Cornell)

STUDENTS: Advanced Fisheries Research Methods Course, 2017

SPONSORS: New York State Department of Environmental Conservation

STARTED: August 2017

A relatively recent arrival to the region, round goby (*Neogobius melanostomus*) are now found throughout the Great Lakes basin. The species may negatively impact native fish species in the Great Lakes basin waters via habitat and food competition, and by predation on native fish eggs and larvae. Conversely, gobies prey on invasive *Dreissenid* mussels and themselves may be viable prey for adult native and target gamefish species. Information on the distribution and ecology of goby is a top priority for understanding ecosystem-level impacts from this rapidly expanding invader. Providing a mesocosm for Great Lakes systems, in this project we are analyzing a data set using benthic videography and sound recording to assess the distribution and biomass of round goby in heavily infested Cayuga Lake. In 2017, we used this research as a class project for Suresh's 'Advanced Fisheries Methods' graduate course. Students from the Department of Natural Resources and Ecology and Evolutionary Biology collaborated to conduct summer and winter field sampling in Cayuga Lake. Results have indicated round goby occupy a narrow summer niche in depths above ~50' but then move offshore and disperse in winter. We completed winter sampling and a project write up on this work in 2018. The efforts have led to engagement with Finger Lakes fishermen and managers, and have spurred research efforts in other NY inland waters. The class report is currently being considered for peer-review publication. We hope results will provide useful information to understand the scope for trophic interactions from round goby in invaded Great Lakes inland waters.



Above: Round goby are at high densities in the summer at shallow depths in Cayuga Lake but then move offshore during the winter. Data are from snorkel surveys at Long Point State Park.

Reintroduction of Cisco (*Coregonus artedi*), to Keuka Lake

INVESTIGATORS:	Suresh Sethi (NYCFWRU)
	Web Pearsall (NYSDEC)
	James McKenna (USGS Tunison)
	Grant Schoolten (USGS Tunison)
STUDENTS:	TBD
SPONSORS:	New York State Department of Environmental Conservation, USFWS (in-kind), USGS
STARTED:	August 2018

Above: NY State Department of Environmental Conservation collaborators release juvenile Cisco to Keuka Lake in October 2018.

Cisco were formerly a native fish community member to Keuka Lake; however, this species was extirpated sometime in the late 20th century. Recently, Keuka Lake has undergone lake-wide changes that have led to a dramatic reduction in a replacement forage base, alewife (Alosa pseudoharengus). In an effort to promote lake resiliency, we are collaborating with the NY State Department of Environmental Conservation to reintroduce a self-sustaining population of Cisco to provide a resilient, oligotrophic-adapted forage species. Working with USGS Tunison, we are deploying small acoustic tags to monitor the fate of stocked juvenile Cisco. Future work may also investigate other novel population assessment techniques, leveraging opportunity to deploy complementary fish assessment technology such as active acoustic tags and eDNA sampling.

Ultimately, this project will provide survival information for stocked coregonids, useful for informing native fish species restoration in the Finger Lakes, and providing insight to guide stocking more broadly in the Great Lakes. This project is intended to include a MS student at Cornell in the future.

Above: A sample of juvenile cisco fitted with small acoustic tags are staged for deployment in Keuka Lake, October 2018.

Managing for long term sustainability of seafood production from bottom tendered wild capture fisheries: evaluating tradeoffs between spatial closures versus gear modification

T. Scott Smeltz
Ph.D. Student

INVESTIGATORS: Suresh Sethi (NYCFWRU)
Pat Sullivan (Cornell)
Miguel Gomez (Cornell)
Brad Harris (Alaska Pacific University

STUDENTS: T. Scott Smeltz, Ph.D.

SPONSORS: Atkinson Center for a Sustainable Future
The Groundfish Forum At-Sea Processors
National Marine Fisheries Service, NOAA

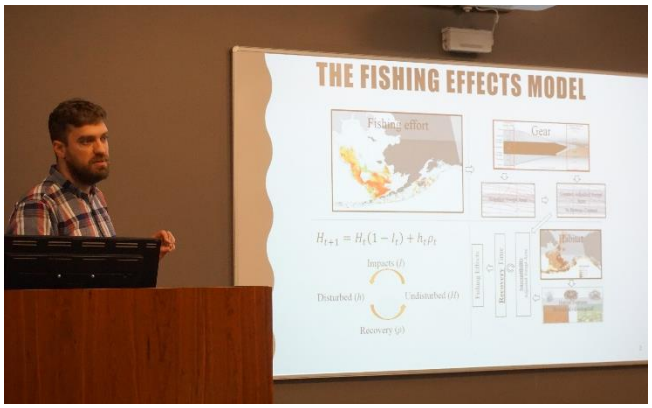
STARTED: January 2017

Twenty percent of global wild capture seafood production – 32 million metric tons per year – is harvested using bottom-tendered fishing gear such as trawls and dredges with potential to impact seafloor ecosystems. The cumulative impact of fishing gear-seafloor interactions is variable, ranging from ephemeral disturbances in fast-recovering systems, to long-term physical changes to benthic communities. Seafloor impact management is currently a major regulatory issue affecting the long term sustainability of seafood production from bottom-tendered fishing gear fisheries.

To help fisheries managers make better informed habitat-related decisions, we developed the Fishing Effects model, a quantitative tool to assess habitat impacts from fishing at seascape scales. The model produces high resolution spatiotemporal estimates of habitat disturbance using data on fishing locations, gear characteristics, and habitat distributions. The model has been adopted by both the North Pacific and New England Fisheries Management Councils for their Essential Fish Habitat (EFH) review. Protection of EFH is a provision of the Magnuson-Stevens Act – the primary law regulating fisheries management in the United States -- that requires U.S. federal fisheries managers to consider habitat impacts when managing for sustainable fisheries.

Now that the model has been developed and implemented in United States federal fisheries, we are turning our efforts to a global perspective. We are currently implementing the Fishing Effects model worldwide to make the first global

estimates of habitat impacts from commercial fishing. Ultimately, our goal is to assess the "habitat cost" of wild caught marine seafood and use this information to improve management for sustainable food production from the world's oceans.



Above: Scott giving a presentation on the Fishing Effects model to members of the fishing industry at the Fish Innovation and Sustainable Harvest Workshop in Seattle, WA.

Left: Scott helping with the Alaska Department of Fish & Game to stock salmon at the Homer Spit in Homer, AK.

Right: Scott getting hosed off after a muddy Razor Clam survey in Clam Gulch, AK.

Integrated Population Modeling of Black Bears in New York

INVESTIGATORS: Angela Fuller (NYCFWRU)
Matthew Hare (Cornell)
Jeremy Hurst (NYSDEC)

STUDENTS: Catherine Sun, Ph.D.

SPONSORS: New York State Department of Environmental Conservation

STARTED: August 2014

Catherine Sun, Ph.D. Student

This project seeks to 1) provide rigorous, non-harvest based estimates of population distribution and dynamics of black bears across New York to understand and anticipate the spatial patterns of black bear range expansion in New York, and 2) provide recommendations for long-term, large-scale monitoring approaches to inform bear management. 2018 marks the 4th year of this project.

In 2018, Cat completed work on the integrated population model and simulations that she developed in 2017 that unites systematic and opportunistic data to estimate parameters including population density, growth, survival, and recruitment rates. The model framework is flexible in order to accommodate a variety of datasets, including noninvasive spatial capture recapture, camera trapping, radiotelemetry, citizen science data, as well as harvest and hunter surveys. The simulations considered a range in the quality and quantity of systematic spatial capture-recapture and opportunistic occupancy data, and showed that bringing together multiple datasets can increase the spatial and temporal extent of population inference as well as the precision and accuracy of parameter estimates. The simulation results offer inroads into developing multi-method sampling approaches that are cost-efficient for large-scale, long-term population monitoring.

Cat also conducted the final season of summer data collection across the Southern Black Bear Range (NYSDEC Regions 3,4,7,8, and 9) on DEC and private land. Based on the success in 2017 of adding sites to increase the number of hair samples and spatial recaptures of individuals, she collaborated with regional DEC biologists

and technicians to monitor 238 research sites that consisted of trail cameras and barbed wire hair snares. Bears were detected by 58% of the trail cameras and at 45% of the hair snares, which yielded a total of 1,908 hair samples. Genetic analysis and individual identification of the hair samples, conducted by Wildlife Genetics International in Canada, revealed 568 detections of 290 individual bears. These data will be analyzed in an integrated model to estimate black bear population density and patterns of distribution across the Southern Black Bear Range.

The iSeeMammals program continued to collect citizen science data on black bears across New York State. iSeeMammals enlists members of the public to collect and submit data when bears or bear signs (e.g., scat, tracks, hair, and markings) are observed as one-off instances, or from hikes or trail cameras. As a result of continued multimedia outreach efforts, including workshops, lectures, interviews, and press releases, an additional 399 users registered with iSeeMammals during the first 10 months of 2018, building on the 712 who registered in 2017. iSeeMammals will continue to collect black bear data, with possibilities of expanding it to study and monitor other wildlife species.

Above: Eli Fry (L, foreground) and Bob Benson (R, foreground) practice setting up a barbed wire hair snare while other NYSDEC biologists look on from the background.

Right: Black bear on trail camera at a research site (in Region 3).

Methodologies for abundance estimation of moose (*Alces alces*) and other rare species.

INVESTIGATORS: Angela Fuller (NYCFWRU)

Jeremy Hurst (NYSDEC)

STUDENTS: Alec Wong, M.S.

SPONSORS: New York State Department of Environmental Conservation

STARTED: August 2015

Alec Wong
M.S. Student

The recolonization of moose in the Northeast US has seen generally steady growth in most states following extirpation from their range in the 1860s due to unregulated hunting and forest loss. Moose expanded back into their former range from populations in Maine in 1950, and eventually returned to New York in the 1980s. Current population estimates suggest that the New York population has not seen the same rate of increase as the rest of the Northeast states, with estimates of moose abundance ranging from 500-1000 individuals (for comparison, the neighboring Vermont contains an estimated 3000-4000 moose).

Two surveys were performed in the Adirondack Park, New York, designed for genetic spatial capture-recapture (SCR) analysis to estimate moose abundance. Scat detection dogs were utilized to detect moose feces along roughly 70-3km transects in various habitats and management regimes.

We discovered that Adirondack moose could not be identified from their scat, an unprecedented result that appears specific to the region, having controlled for several factors in handling, extraction of DNA, and processing of the samples. A modified SCR survey protocol was developed and implemented to increase data collection efficiency, but with genetic extraction failing again for the second survey, a new methodology was required to estimate moose population abundance.

Using the data we collected – GPS-logged movement of detection dogs, and location of scats – and spatially-varying covariates, we developed a new analytical framework that estimates animal population size without the need for genetic identity, or marks of any sort. This method models scat "population dynamics" over time, incorporating removal by our crew and

deposition by moose as a function of time. Having estimated rate of scat deposition, total scat abundance is estimated as the ratio of scat deposition rate to defecation rate, proportional to the area considered.

We estimate that there are approximately 600 moose in the Adirondack Park of New York (95% CI: 368, 850). The best-supported model did not have any spatial covariate effects, but models with covariate effects supported a hypothesis of habitat use to mitigate thermal stress. Moose scat deposition rates were correlated with higher elevation, higher latitude, and higher use of conifer and wetland habitat relative to deciduous forest. This carries implications that moose may distribute themselves farther north or higher in elevation in the event of hotter summers and warmer winters, as heat stress is a factor in all seasons.

Above right: Field work collecting moose scat. Below: The moose team, including Dr. Angela Fuller (top right), Alec Wong (2nd in top right) with technicians and scat dog team.

PUBLICATIONS AND PRESENTATIONS

JOURNAL ARTICLES

Agha, M., Todd, B.D., **Augustine, B.C.**, Lhotka, J.M., Fleckenstein, L.J., Lewis, M., Patterson, C., Stringer, J., and Price, S.J. 2018. Gap-based silviculture provides suitable thermal environments for a terrestrial reptile. Wildlife Research 42:72-81.

Augustine, B.C., Royle, J.A., Kelly, M.J., Satter, C.B., Alonso, R.S., Boydston, E.E., and Crooks, K.R. 2018. Spatial capture-recapture with partial identity: an application to camera traps. Annals of Applied Statistics 12:67-95.

Calvert, J., C. McGonigle, **S.A. Sethi**, B. Harris, R. Quinn, J. Grabowski. 2018. Dynamic occupancy modelling of temperate marine fish in area-based closures. Ecology and Evolution 8:10192-10205.

Decker, D.J., J.F. Organ, A.B. Forstchen, M.V. Schiavone, and **A.K. Fuller**. 2018. Wildlife management is science based. Myth or reality? The Wildlife Professional July/August 2018: 30-32.

Fitzpatrick, K.B. and T.M. Neeson. 2018. Aligning dam removals and road culvert upgrades boosts conservation return-on-investment. Ecological Modelling 368:198-204.

Miller, J.R.B., R.T. Pitman, G.K.H. Mann, **A.K. Fuller**, G.A. Balme. 2018. Lions and leopards coexist without spatial, temporal or demographic effects of interspecific competition. Journal of Animal Ecology. https://doi.org/10.1111/1365-2656.12883

Murphy, S.M., **Augustine, B.C.**, Carrollo, E., Petrullo, A., Adama, J. R., Waits, L.P., and Cox, J.J. 2018. Integrating multiple genetic detection methods to estimate population density of social and territorial carnivores. Ecosphere, 9:e02479.

Murphy, S.M., Hast, J.T., **Augustine, B.C.,** Weisrock, D.W., Clark, J.D., Kocks, D.M., Ryan, C.,Sajecki, J.L., and Cox, J.J. 2018. Early genetic outcomes of American black bear reintroductions in the Central Appalachians, USA. Ursus.

Neeson, T.M., P.J. Doran, M.C. Ferris, **K.B. Fitzpatrick**, M. Herbert, M. Khoury, A.T. Moody, J. Ross, E. Yacobson, P.B. McIntyre. 2018. Conserving rare species can have high opportunity costs for common species. Global Change Biology 24:3826-3872.

Price Tack, J.L., McGowan, C.P., Ditchkoff, S.S., Robinson, O.J. 2018. A population model and decision-making framework for managing hunter populations. Human Dimensions and Wildlife.

Royle, J.A., **A.K. Fuller**, and C. Sutherland. 2018. Unifying population and landscape ecology with spatial capture-recapture. Ecography 40: doi: 10.1111/ecog.03170. https://onlinelibrary.wiley.com/doi/abs/10.1111/ecog.03170&lt

Sethi S.A., C. Bradley, F. Harris. 2018. Separate tagging versus capture impacts on chum salmon (Oncorhynchus keta) freshwater spawning migration travel time performance. Fisheries Management and Ecology 25: 296-303.

Shi, Q., R. Garcia, A. Flecker, **S.A. Sethi**, C. Gomes. 2018. Efficiently optimizing for dendritic connectivity on tree-structured networks in a multi-objective framework. Conference on Computation and Sustainable Society 2018.

Sun, C., A. K. Fuller, and J. E. Hurst. 2018. Citizen science data enhance spatio-temporal extent and resolution of animal population studies. bioRxiv:352708.

Sutherland, C., **A.K. Fuller**, J.A. Royle, and S. Madden. 2018. Large-scale variation in density of an aquatic ecosystem indicator species. Scientific Reports. https://rdcu.be/WcKBWolf, N., B.P. Harris, N. Richard, **S.A. Sethi**, K. Lomac-Macnair, L. Parker. 2018. High-frequency aerial surveys inform the seasonal distribution of Cook Inlet beluga whales. Wildlife Society Bulletin 42: 577-586.

Wong, A., A.K. Fuller, and J.A. Royle. 2018. Adaptive sampling for spatial capture-recapture: An efficient sampling scheme for rare or patchily distributed species. bioRxiv 357459; doi: https://doi.org/10.1101/357459.

Wu X., J. Gomes-Selman, Q. Shi, X. Yexiang, R. Garcia, E. Anderson, **S.A. Sethi**, S. Steinschneider, A. Flecker, C. Gomes. 2018. Efficiently approximating the pareto frontier: hydropower dam placement in the Amazon basin. Proceedings of the Thirty-Second AAAI Conference on Artificial Intelligence.

TECHNICAL OR POPULAR ARTICLES

PNN and WCS (**R. Marquez**). 2018. Estrategy for the Andean bear conservation in the National Natural Park of Colombia (Estrategia de conservación del oso andino en los Parques Nacionales Naturales de Colombia).

Price Tack, J.L., Simmons, W, Bowe, Audrey, Brown-Lima, C. 2018. Warming waters: implications for invasive species in the Northeast. Regional Invasive Species & Climate Change (RISCC) Management. https://ecommons.cornell.edu/handle/1813/57590

Sun. C., A. K. Fuller, J. E. Hurst, and D. Nelson. iSeeMammals: citizens helping with black bear research. The Conservationist Magazine. pp 11-13. February 2018 Issue, Vol 72(4).

PRESENTATIONS AND SEMINARS

Almeida, R. *et al.* (**S.A. Sethi** 6th). Dams and greenhouse gases: Is hydropower a green alternative in the Amazon? Congreso AQUATROP, Quito, Ecuador. July 2018.

Augustine, B.C., J.A. Royle, **A.K. Fuller,** and M.J. Kelly. 2018. Leveraging partial identity information in density estimation. New York Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, Albany, NY.

Brazeal, J.L. and **A.K. Fuller.** 2018. Southern Zone Fisher Survey Design. New York State Department of Environmental Conservation Fisher Organizational Meeting, Ithaca, NY.

Brazeal, J.L. and **A.K. Fuller.** 2018. Multispecies Occupancy of Carnivores in New York. New York Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting, Albany, NY.

Brown, T.A., L.G. Rudstam, **S.A. Sethi**, and B.C. Weidel. Quantifying coregonine spatial ecology to support native fish management in Lake Ontario. New York Cooperative Fish and Wildlife Research Unit Annual Coordinating Committee Meeting. Albany, NY. December 2018.

Fitzpatrick, K.B., S.A. Sethi. 2018. Predator-prey population dynamics model for Chinook Salmon management in Lake Ontario. Cornell Department of Natural Resources Research Symposium. Ithaca, NY. January 18, 2018.

Fitzpatrick, K.B., S.R. LaPan, L.G. Rudstam, P.J. Sullivan, B.C. Weidel, **S.A. Sethi.** 2018. Predator-prey population dynamics model for Lake Ontario salmon management. New York Chapter of the American Fisheries Society Annual Meeting. Cooperstown, NY. February 8, 2018.

Flecker, A. *et al*. (**SA Sethi** 4th). Damming the Amazon: evaluating tradeoffs between hydropower and ecosystem services using a computation sustainability approach, Society for Freshwater Science, Detroit, MI. May 2018.

Fuller, A.K. Panelist: Science in an unstable world: confronting old divides and the future of natural resources. Cornell University. January 19, 2018.

Fuller, A.K. Invited seminar. Functional connectivity conservation: linking Andean bear conservation and landscape-scale decision making. University of Maine. 29 October, 2018.

Lepak J. *et al*. (**SA Sethi** 2nd). The role of invasive Round Goby in the Great Lakes basin, NY Chapter American Fisheries Society, Cooperstown, NY. Feb. 2018.

Marquez, R. 2018. Oportunidades y retos para la conservación del oso andino en la región Chingaza, at the V Colombian Zoology Congress in Bogotá, Colombia.

Marquez, R. 2018. Estrategias complementarias de manejo para la conservación del oso andino en el Parque Nacional Natural Chingaza, at the V Colombian Zoology Congress in Bogotá, Colombia.

Marquez, R. 2018. Interacciones entre el oso andino y la gente, después de los acuerdos de paz, at the V Colombian Zoology Congress in Bogotá, Colombia.

Marquez, R. 2018. Importancia de las áreas núcleo para la conservación del oso andino en Colombia: solapamiento con especies amenazadas, at the V Colombian Zoology Congress in Bogotá, Colombia.

Neeson, T.M., (**Fitzpatrick, K.B. 4th**). 2018. Conserving rare species can have high opportunity costs for common species. Society for Freshwater Science Annual Meeting. Detroit, MI. May 24, 2018.

Paufve, M.R., Sethi, S.A., Lantry, B.F., Jonas, J.L., O'Neill, P., Chiodo, A., Berglund, E.K., Yule, D.L., Rudstam, L.G., Weidel, B.C., Furgal, S., Karboski, C.T. Characterizing spawning and incubation habitat of Cisco (*Coregonus artedi*) in the Great Lakes. Cornell Department of Natural Resources Research Symposium. Ithaca, NY. January 18, 2018.

Paufve, M.R., Sethi, S.A., Lantry, B.F., Jonas, J.L., Yule, D.L., Berglund, E.K., Connerton, M. R., Gorsky, D., Chalupnicki, M., Weidel, B.C., Furgal, S., Karboski, C.T., Biesinger, Z., Castiglione, C., O'Neill, P., Chiodo, A., Rudstam, L.G. Characterizing spawning and incubation habitat of Cisco (*Coregonus artedi*) in the Great Lakes. New York Chapter of the American Fisheries Society Annual Meeting. Cooperstown, NY. February 6, 2018.

Paufve, M.R., Sethi, S.A., Lantry, B.F., Jonas, J.L., Yule, D.L., Berglund, E.K., Connerton, M., O'Neill, P., Chiodo, A., Furgal, S., Weidel, B.C., Rudstam, L.G. Characterizing spawning and incubation habitat of Cisco (*Coregonus artedi*) in the Great Lakes. International Association for Great Lakes Research Annual Meeting. Scarborough, Ontario, Canada. June 17, 2018.

Price Tack, J.L., **Fuller, A.K.**, Brown-Lima, C.J., Dean, J., Shi, Q., and C.P. Gomes. Spatial Optimization of Invasive Species Management in New York. Cornell Department of Natural Resources Graduate Student Symposium (Ithaca, NY, January 2018).

Price Tack, J.L., **Fuller, A.K.**, Brown-Lima, C.J., Dean, J., Shi, Q., and C.P. Gomes. Spatial Optimization of Invasive Species Management Using Structured Decision Making. The Wildlife Society 25th Annual Conference (Cleveland, OH, October 2018).

Price Tack, J.L., Fuller, A.K., Brown-Lima, C.J., Dean, J., Shi, Q., and C.P. Gomes. Spatial Optimization of Invasive Species Management Using Structured Decision Making. NAISMA-UMISC Joint Conference (Rochester, MN, October 2018).

Price Tack, J.L., Simmons, W., Bowe, Audrey, Brown-Lima, C. Warming waters: implications for invasive species in the Northeast. 2nd Annual Regional Invasive Species & Climate Change (RISCC) Management Symposium.

Rose, C. *et al.* (**SA Sethi** 4th). Monitoring survival of trawler deck-released pacific halibut using satellite reporting accelerometer tags, Alaska Marine Science Symposium, Anchorage, AK. Jan. 2018.

Sethi, S.A. Life history informed watershed connectivity restoration: win-win investments into salmon ecology, Alaska Pacific University, Anchorage, AK. Jan. 2018 (Invited).

Sethi S.A. *et al*. Regional and local drivers combine to structure mussel growth and mortality, Alaska Marine Science Symposium, Anchorage, AK. Jan. 2018.

Sethi, S.A. *et al*. Rapid response for invasive waterweeds in temperate lakes: assessment of collateral ecological impacts from herbicide treatments, NY Chapter American Fisheries Society, Cooperstown, NY. Feb. 2018.

Sethi S.A. *et al.* DNA mixtures for ecology, Western Division American Fisheries Society, Anchorage, AK. May 2018.

Sethi S.A. *et al.* Rapid response for invasive waterweeds in high latitude systems: assessment of collateral impacts from herbicide treatment, Western Division American Fisheries Society, Anchorage, AK. May 2018.

Sethi, S.A. *et al.* (**Fitzpatrick, K.B.** 7th, **Paufve, M.** 10th, **Perkins, K.** 11th). Characterizing the ecological niche of invasive round goby in inland lakes, International Association for Great Lakes Research, Toronto, Canada. June 2018.

Sethi, **S.A.,** A. Subalusky, E. Anderson. Rapid establishment of a novel social-ecological system: narco hippos in the Magdalena, TWS-AFS Ecosystem Synthesis Working Group, Seattle, WA. Nov 2018.

Sethi, S.A., et al. (**Fitzpatrick, K.B.** 7th, **Paufve, M.** 10th, **Perkins, K.** 11th). 2018. The role of invasive Round Goby in the Great Lakes basin: habitat use and standing stock biomass in a recently invaded deep inland lake. New York Chapter of the American Fisheries Society Annual Meeting. Cooperstown, NY. February 8, 2018.

Shi Q. *et al*. (**SA Sethi** 2nd), Fisheries connectivity optimization under Amazon hydropower proliferation, Computation Sustainability Net working group on Amazon Dams annual meeting, Miami, FL. Mar. 2018.

Shi, Q. *et al.* (**S.A. Sethi** 4th). Efficiently optimizing for dendritic connectivity on tree-structured networks in a multi-objective framework. Conference on Computing & Sustainable Societies, Menlo Park, CA. June 2018.

Smeltz, T. S. Assessing and managing fishing impacts on benthic habitats. Presentation at the Fisheries Innovation and Sustainable Harvest (FISH) Workshop. Seattle, WA. December 2018.

Smeltz, S., **S.A. Sethi**, B Harris. A seascape scale fishing impacts model to assess tradeoffs between spatial closures and gear modifications, Alaska Marine Science Symposium, Anchorage, AK. Jan. 2018.

Smeltz, T. *et al*. (**SA Sethi** 2nd). A seascape scale fishing impacts model to assess tradeoffs between spatial closures and gear modifications, Western Division American Fisheries Society, Anchorage, AK. May 2018.

Smeltz, T. *et al.* (**S.A. Sethi** 2nd). Seascape-level fishing impacts modeling to assess tradeoffs between spatial closures and gear modifications, International Council for Exploration of the Sea FTFB Working Group, Hirtshals, Denmark. June 2018.

Springer, V.L, A.K. Fuller, and E.G. Cooch. Spatial co-occurrence of Andean bears with puma and domestic dogs in Ecuador. The Wildlife Society 25th Annual Conference, Cleveland, OH. 9 October, 2018.

Sun, C.C., J.E. Hurst, and **A.K. Fuller**. 2018. Estimating black bear population dynamics to inform large scale management. New York Cooperative Fish and Wildlife Research Unit Coordinating Committee Meeting. Ithaca, NY.

Sun, C.C. 2018. Black Bears and Citizen Science in Catskills, New York. Catskill Environmental Research & Monitoring Conference. Highmount, NY.

Sun, C.C., **A.K. Fuller**, J. A. Royle. 2018. Population Level Inferences Improve with Integration of Opportunistic Presence-Absence Data and Systematic Capture-Recapture Data. The Wildlife Society 25th Annual Conference. Cleveland, OH. 9 October, 2018.

Sun, C.C., **A.K. Fuller**, J. Hurst. 2018. Black bear research and management in New York with iSeeMammals: a citizen science initiative. Northeast Association of Fish and Wildlife Agencies Annual Conference. Burlington, VT.

Sun, C.C., **A.K. Fuller**, J. Hurst. 2018. Black bear research and management in New York with iSeeMammals: a citizen science project. The New York Wildlife Society Annual Meeting. Kingston, NY.

Sun, C.C., **A.K. Fuller**, J. Hurst. 2018. Black bear research and management in New York with iSeeMammals: a citizen science project. Graduate Student Association Symposium, Department of Natural Resources, Cornell University. Ithaca, NY.

Sun, C.C. 2018. Black Bears and Citizen Science in New York. 26th Annual Genesee Land Conservancy Landowner Workshop. Mt. Morris, NY.

Sutherland, C., J.A. Royle, and **A.K. Fuller**. Statistical inference about landscape connectivity from animal telemetry data. The Wildlife Society 25th Annual Conference, Cleveland, OH. 10 October, 2018.

Ulin, K.E., L.Z. Almeida, D.A. Dippold, **T.A. Brown**, E.A. Marschall, and S.A. Ludsin. Validating daily otolith increment deposition in aquarium-reared juvenile walleye, Sander vitreus. Division of Wildlife – OSU Annual Research Review. Columbus, OH. December 2018.

Walsh, P. *et al*. (**SA Sethi** 2nd), Estimating denning date of wolves with daily movement and GPS location fix failure, Alaska Chapter of the Wildlife Society, Anchorage, AK. Mar. 2018.

Wong, A., A. K. Fuller, J.A. Royle. Modeling point pattern data from GPS logs of mobile detectors. The Wildlife Society 25th Annual Conference, Cleveland, OH. 9 October, 2018.

Wong, A., **A. Fuller**, and J.A. Royle. 2018. Novel application of adaptive sampling principles to spatial capture-recapture. 2018. International Statistical Ecology Conference, St. Andrews, Scotland

Wong, A., **A. Fuller**, J.A. Royle. J. Hurst. 2018. Obstacles to genetic analysis of moose using fecal samples Northeast Association of Fish and Wildlife Agencies Annual Conference. Burlington, VT.

THESES & DISSERTATIONS

Springer, V.L. 2018. Occupancy and co-occurrence of carnivores in the Ecuadorian Andes. M.S. Thesis, Cornell University, Ithaca, NY. (Advisor: Fuller)

Wong, A. 2018. Methodologies for abundance estimation of moose (*Alces alces*) and other rare species. MS Thesis, Cornell University, Ithaca, NY. (Advisor: Fuller)

COURSES TAUGHT & GUEST LECTURES

Fitzpatrick, K.B. Guest Lecture: Chinook Salmon in the Great Lakes, friend or foe? First-year Writing Seminar: Special topics in Natural Resources (NTRES 1200). November 4, 2018.

Fuller, A.K. Topics in Design and Analysis of Camera Trapping Studies, Spring 2018.

Fuller, A.K. Structured Decision Making for Natural Resource Management. Guest lecture in Principles and Practices of Applied Wildlife Science (NTRES 4280/6280).

Fuller, A.K. 5-day Spatial Capture-Recapture Workshop. Alaska Department of Fish and Game and U.S. Fish and Wildlife Service. Juneau, Alaska. August 13-17, 2018.

Fuller, A.K. 3-day Structured Decision Making Workshop of Elk Management in Alberta. Alberta Environment and Parks. Canmore, Alberta. August 1-3, 2018.

Fuller, A.K. 2-day Structured Decision Making Workshop. Alberta Environment and Parks. Canmore, Alberta. July 30-31, 2018.

Fuller, A.K. Moose Scenario Planning Workshop, Minnnowbrook Conference Center. June 29-30, 2018.

Fuller, A.K. 4-day Spatial Capture-Recapture Workshop. Banff Center for the Arts, Banff, Alberta, Canada. March 12-15, 2018.

Marquez, R. 2018. Monitoreo y manejo de poblaciones de oso andino, at the II National Congress of Wildlife Management and IV Ecuadorian Mastozoology Congress in Quito, Ecuador.

Marquez, R. 2018. Alianzas para la investigación, monitoreo y manejo de las poblaciones de oso andino, at the Simposio sobre investigación y monitoreo de fauna en Parques Nacionales Naturales de Colombia - V Colombian Zoology Congress in Bogotá, Colombia.

Price Tack, J. 2018. Building Shiny Apps in R. November 2018. Data Science. Faculty: Nina Overgaard Therkildsen.

Sethi, S. Controversial Conservation Topics (NTRES 6140), Fall 2018.

Sethi, S. 2018. Guest lecture, "As if it wasn't already hard enough: dealing with imperfect detection in ecological data," Alaska Pacific University Summer Field Course.

Sun, C. Guest lecture NTRES 3400 "Molecular Tools for Ecology, Conservation, & Natural Resource Management," Spring 2018.

Sun, C. and A. Wong. Instructors for NTRES 6940: The fundamentals of R, Fall 2018.

ACTIVITIES

TECHNICAL ASSISTANCE AND OUTREACH

Angela Fuller

Developed and implemented a camera-trap survey design for New York State Department of Environmental Conservation to estimate occupancy of fishers in southern New York.

New York Breeding Bird Atlas Design and Analysis Team – simulation study for occupancy and power analyses for integrating eBird with atlas effort.

Guide New York State Department of Environmental Conservation in a Structured Decision Making Process Regarding Waterfowl Season Setting.

Robert Marquez

In Bolivia, I held a Monitoring Program Development Workshop in July focused on WCS's Greater Madidi Tambopata Landscape Program, involving WCS researchers of Bolivia and Peru, and researchers of other relevant organizations involved in the study and conservation of Andean bears. I also taught an Introduction to Occupancy Workshop for regional university students in July as part of the Bolivia Mastozoological Congress.

In Colombia, I taught an analysis and synthesis training in July, which included representatives from the Colombian National Park System and the Autonomous Regional Corporations of the Oriental Mountain Range of Colombia. I also taught a Monitoring Program Development Workshop session at the Hermosas National Natural Park in July with the National Park Unit. Finally, I held an Introduction to Occupancy workshop for the Diagnosis and Management of Andean Bear Populations, providing examples from the Central mountain range, in August with staff from the National Natural Parks of Colombia, the Regional Environmental Organization of Tolima (CORTOLIMA), and university students.

In Ecuador, I organized an analysis and synthesis training in September with representatives from the Ministry of Environment (Paisaje Vida Silvestre Project) and WCS Ecuador program.

Matt Paufve

Workshop: Identifying Research Priorities for Cisco Restoration in Lake Ontario. Cornell Biological Field Station, Bridgeport, NY. May 31, 2018.

Suresh Sethi

Participated in two 1-day research consultations with NY DEC senior fisheries staff to identify research needs for Finger Lakes fisheries assessment and management, Rome Hatchery, Rome NY.

Assisting in the design, implementation, and monitoring of Cisco, *C. artedi*, reintroduction into Keuka Lake. A joint collaboration with Region 8 DEC, USGS Tunison, and the NYCFWRU.

Ongoing assistance with NY Dept. of Environmental Conservation Regions 7-8 with design and evaluation of a forage fish gillnet-based survey for the Finger Lakes.

Ongoing assistance with shortnose sturgeon research for the NY State Hudson River Estuary program.

TRAINING

Jennifer Brazeal

Advanced Occupancy Modeling Course. Blacksburg, VA. 22-26 October 2018.

Taylor Brown

Workshops with the Cornell Statistical Consulting Unit: Nonparametric Statistical Methods, Multimodel Inference and Model Selection.

Jennifer Price Tack

Decision analysis: Elicitation and Facilitation at the National Conservation Training Center (2018): Attended in a 1-week workshop to learn and practice elicitation and facilitation techniques needed to lead groups through the structured decision-making process.

SERVICE

Ben Augustine

Reviewer for Biological Conservation, Biometrics, Conservation Biology, Ecology, Journal of Fish and Wildlife Management, and Methods in Ecology and Evolution.

Kimberly Fitzpatrick

Department of Natural Resources Graduate Student Assembly, Treasurer

Angela Fuller

Student and Postdoc Engagement Committee, Atkinson Center for a Sustainable Future (October 2018 - Present)

Advisory Board, Atkinson Center for a Sustainable Future (June 2014 - Present)

Department of Natural Resources Executive Committee (January 2014 - Present)

Doris Duke Conservation Scholars Program (January 2014 - Present)

Faculty Fellow, Atkinson Center for a Sustainable Future (January 2014 - Present)

Cornell University Integrated Deer Research and Management Program Committee (April 2012 - Present)

Chair, Faculty Advisory Board, Atkinson Center for a Sustainable Future (September 2018 - September 2019)

Search Committee, Senior Director of Strategic Partnerships, Atkinson Center for a Sustainable Future (July 2018 - November 2018)

Vice Chair, Faculty Advisory Board, Atkinson Center for a Sustainable Future (September 2017 - September 2018)

USGS Research Grade Evaluation Panel (2018)

Scientific Advisory Committee, Andean Bear Conservation Alliance, (October 2018 - Present)

Chair, The Wildlife Society Nominating Committee (to nominate candidates for President of the society), The Wildlife Society, (October 2018 - August 2019)

TWS Nominating Committee, Northeast Representative, The Wildlife Society, (August 2016 - October 2018)

Associate Editor, PLoS ONE (September 2018 - Present)

Guest Editor, Journal of Applied Ecology, Ecological Society of America (September 2018)

Advisory Board, New York State Invasive Species Research Institute (April 2018 - Present)

Chair, New York State Breeding Bird Atlas Design and Analysis Committee (April 2018 - Present)

Co-Chair, Sampling Design Committee, New York Mammal Atlas (March 2018 - Present)

New York Mammal Atlas Steering Committee (January 2018 - Present)

Associate Director, Computational Sustainability Research Network (January 2016 - Present)

Women in Science - USGS (May 2015 - Present)

Suresh Sethi

Faculty Fellow, Atkinson Center for a Sustainable Future (2016-2021)

Lake Ontario Technical Committee (2016-present)

International Council for Exploration of the Sea: Fish Technology and Fish Behavior Working Group (2016-present)

Associate Editor, Journal of Fish and Wildlife Management (2013-present)

USGS Research Grade Evaluation Panel (2018)

Joint AFS-TWS Ecosystem Transformation Synthesis Team member (2018-2020)

Matt Paufve

Department of Natural Resources Graduate Student Assembly, President
Cornell Student Subunit of the American Fisheries Society, President

Kelly Perkins

NY Mammal Atlas Steering Committee

NY Breeding Bird Atlas Steering Committee

NY Breeding Bird Atlas Science Committee

NY Breeding Bird Atlas Methods Committee

Reviewer for PLOS ONE

Scott Smeltz

Alaska Department of Fish & Game annual Razor Clam survey. Ninilchik, AK.

Alaska Department of Fish & Game salmon stocking. Homer, AK.

Catherine Sun

Joint Diversity Initiative Report (US Fish and Wildlife Service, The Wildlife Society): 2018-2019

New York Chapter of The Wildlife Society Communications, Newsletter Chair: 2018-2020

AWARDS & RECOGNITION

Kimberly Fitzpatrick

Charles Standley Memorial Award for Outstanding Publication by a Graduate Student. Department of Geography and Environmental Sustainability, University of Oklahoma. March 2018.

Catherine Sun

Cornell University CALS Alumni Association Research Grant ($750): 2018

Best Student Presentation Award at the 25th Annual Wildlife Society Conference, October 2018

PRESS

Robert Marquez

El sendero del oso. Revista Don Juan. http://www.revistadonjuan.com/historias/el-sendero-del-oso-cronica-sobre-la-importancia-del-oso-de-anteojos+articulo+16882937

Catherine Sun

Television Interview by Hudson Valley News 12, July 26, 2018. (http://hudsonvalley.news12.com/clip/ 14519093/ researchers-black-bear-population-on-the-rise-in-ny).

Edwards, L. Article. "Spot black bears – and their debris – and help science". Times Union June 27, 2018.

HISTORY

New York Cooperative Wildlife Research Unit (established 1961)

Unit Leaders

Daniel Q. Thompson, 1961-75
Milo E. Richmond, 1975-77 (acting), 1977-1984

Assistant Unit Leaders

Milo E. Richmond, 1968-1975
Richard A. Malecki, 1978-84

New York Cooperative Fishery Research Unit (established 1963)

Unit Leaders

Alfred W. Eipper, 1963-75
John G. Nickum, 1975-76 (acting), 1977-80
Steven P. Gloss, 1980-84

Assistant Unit Leaders

Henry A. Regier, 1964-66
Clarence A. Carlson, Jr., 1966-72
John G. Nickum, 1973-75
Steven P. Gloss, 1978-80

New York Cooperative Fish and Wildlife Research Unit (combined 1984)

Unit Leaders

Milo E. Richmond, 1984-2008 (wildlife)
William L. Fisher, 2008-2013 (fisheries)
Angela K. Fuller, 2014 to present (wildlife)

Assistant Unit Leaders

Steven P. Gloss, 1984-87 (fisheries)
Richard A. Malecki, 1984-2008 (wildlife)
Mark B. Bain, 1991-2003 (fisheries)
Angela K. Fuller, 2009-2014 (wildlife)
Mitchell J. Eaton, 2011-2013 (ecology)
Suresh A. Sethi, 2016-present (fisheries)