Linking Nutrient Flow to Avian Community Composition in the Frank Church Wilderness

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Abstract

This project will start a projected long-term survey and monitoring program for the birds of the Frank Church Wilderness to document the current diversity of birds and to establish a baseline against which future changes can be measured. We will measure levels of nutrient (xanthophylls) within avian tissues to look for the presence of a marine-derived nutrient (astaxanthin) as a biomarker linking terrestrial food webs to annual salmonid fish migration. We will collect genetic and study skin samples of birds for inclusion into the Idaho Museum of Natural History to document for posterity the current Frank Church Wilderness avian biodiversity.

Background Information

The Frank Church River of No Return Wilderness is an important biological asset to Idaho and to the nation. The stream ecology, salmonid fishes, terrestrial mammal ecology, herpetological communities, and geology of the wilderness have received substantial scientific attention over the past 10-60 years. Unfortunately, the avian community of the Frank Church Wilderness has received surprisingly little scientific attention. Without well designed surveys documenting the current avian community composition, forthcoming impacts to the avian community from climate change, loss of tropical wintering habitat, disease, and other known threats will be difficult to document and remediate.

The Frank Church Wilderness offers an unusually good opportunity to study broad scale food web linkages due to its substantial ecological connection to Pacific marine ecosystems through annual runs of salmonid fishes carrying marine-derived nutrients deep into the Idaho wilderness. Birds are major participants in terrestrial food webs and are excellent study organisms for food webs due to their visibility and their high metabolic rate and mobility which drive their ability to locate and exploit nutrient rich ecological niches.

A class of nutrients known as ***xanthophyll*** has the potential to be an excellent biomarker of nutrient and energy flow from marine ecosystems to inland terrestrial ecosystems. Xanthophyll is produced by plants and consumed by animals. Xanthophyll moves intact through food webs in association with lipids. One form of xanthophyll known as ***astaxanthin*** is produced only by marine algae and is transported into terrestrial ecosystems within the tissues of migrating salmonids. A closely related form of xanthophyll known as ***lutein*** is produced by terrestrial plants and enters terrestrial food webs through animal herbivory (both insect and vertebrate). Relative levels astaxanthin and lutein within avian tissues can be measured using High Performance Liquid Chromatography (HPLC) and mass spectrometry.

Birds breeding in the Frank Church Wilderness along streams that have runs of salmonid fishes will have access to both marine-derived and terrestrially-derived xanthophyll through the consumption of stream emergent insects and terrestrial insects as well as through other food web pathways. Breeding birds sequester high concentrations of xanthophyll into their reproductive tissues. (The yellow color of bird egg yolks is due to the presence of concentrated xanthophyll, for example.) The Idaho State University Analytical Center housed in the Department of Pharmacy and directed by Dr. James Bigelow, has the analytical capability and availability to perform HPLC and mass spectrometry on avian tissues and I have secured an agreement from Dr. Bigelow to carry out the analyses in the facility.

Lastly, without representation of the current avian community in museum collections, the future opportunity to answer as yet unformulated questions about the birds of central Idaho will be lost. For example, there will be no record of the current genetic composition of bird species occurring in the wilderness. As Curator of Birds for the Idaho Museum of Natural History, I can confirm that the area is poorly represented in any museum collection within Idaho and that I regularly receive out-of-

state scientific inquiries for specimens from central Idaho – specimens which, in fact, do not exist. The region is only lightly represented in major national collections.

Objectives and Methods

This project has three immediate objectives of (1) establishing a baseline survey of birds breeding within and near riparian zones within the wilderness, (2) using HPLC analysis of avian lipids to assess the relative abundance of a marine-derived nutrient pigment (astaxanthin) and a terrestrially-derived nutrient pigment (lutein) to verify nutrient transfer between marine and interior terrestrial ecosystems, and (3) to gather genetic samples and study skins (from birds collected for tissue analysis) into the Idaho Museum of Natural History as important reference material for the State of Idaho. An additional objective (4) of this study is to initiate a long-term bird monitoring program within the wilderness through surveys and bird banding activities. (5) Also, this project will train a graduate student in the area of conservation research from both ecosystem (energy and nutrient flow) and physiological (xanthophyll sequestration into tissues) perspectives.

(1) Working with a graduate student, we will conduct visual and bird-song point-count surveys of the birds breeding within and adjacent to riparian zones during spring migration and breeding season. We will attempt to conduct these surveys such that they complement the biodiversity surveys of a biodiversity research team headed by Dr. Colden Baxter, Idaho Statue University. We also will use focused mist-netting to capture and band passerine birds from both migratory and nonmigratory species. These activities will substantially increase the body of information on avian composition of the wilderness area and also will allow us to identify candidate species for tissue analyses.

(2) Under state and federal permits and with approval from the Idaho State University Animal Care and Use Committee, we will collect a subset of birds from non-threatened species for tissue analysis for the presence or absence of astaxanthin (indicting marine-derived source) and lutein

(indicating terrestrially derived source). Male and female birds will be captured with mist nets, sacrificed, and tissue samples from reproductive tracts and lipid depots will be collected. Birds require high concentrations of xanthophyll pigments to form viable eggs and birds also use xanthophylls in many other ways (plumage coloration, for example). Hence, we are certain to detect xanthophylls in avian tissues. Looking for marine-derived xanthophylls within tissues of birds breeding in the interior west will be ground breaking and we cannot predict the outcome with certainty. We hypothesize, however, that gonadal tissues from birds breeding along streams with ocean-run fish will contain astaxanthin as well as lutein whereas birds breeding along streams without ocean run fish will not contain a significant astaxanthin signature. Presence of astaxanthin will indicate that marine-derived energy (lipids) and nutrients (astaxanthin) are moving from the Pacific to the interior of Idaho and entering terrestrial food webs.

(3) We will begin to build a representative sample of the wilderness bird community through our handling of birds (see (1) and (2), above). Small samples of blood (1-3 drops) from all birds captured in mist nets will be taken to begin to build a genetic representation. From the humanely sacrificed birds used in tissue analyses, we will also make study skins for inclusion into the Idaho Museum of Natural History collection. (Bone will also be made available to the museum's osteology collection and we will also solicit interest in liver and other organ tissue samples for ecotoxin examination.) It is essential that Idaho's birds become better represented in museum collections if Idaho is to have baseline information to understand future changes as major environmental perturbations occur.

(4) I am seeking to begin annual surveys and capture and banding activities in the wilderness, ideally using the Taylor Ranch facilities as a base. The current project would represent the initiation of that longer-term work. The work of Dr. Wayne Minshall on the wilderness streams clearly

demonstrated the importance of gathering baseline data in wilderness settings against which future, unexpected changes can be compared. Multiple years of surveys and bird banding would begin to establish a similar kind of reference for the bird community.

(5) This project will provide substantial scientific training for a graduate student. As threats to biodiversity increase, need for detailed scientific understanding ecosystems increases. Conservationists in the coming decades will need more than natural history knowledge and rhetorical skills. They will need to be able to recognize biodiversity value but also to understand how the ecosystems which sustain biodiversity function. We will need conservationists who are highly trained scientists.

The graduate student completing this project will have an excellent understanding of avian community composition, ecosystem linkages through nutrient and energy flow, and will know how to analyze and assess technical data. My preference would be to direct this project to a PhD student (Pamela O'Hearn, Idaho resident, recent MS graduate from ISU, substantial management agency experience). Alternatively, the project could be directed to an exceptionally skillful MS student.

Justification

Idaho's wilderness bird diversity faces multiple serious threats from forces such as climate change and disease that cross boundaries demarcating wilderness protection. This project will begin to establish baseline data on Frank Church Wilderness bird communities against which forthcoming change can be measured and will open the way for early recognition of deleterious change. Beneficial and important ecological effects also move across wilderness boundaries. This study seeks to confirm and quantify the transport of energy and nutrients from marine-ecosystems into the terrestrial Idaho wilderness. Demonstrating linkages like this is necessary to formulate long-term, large-scale protection of wilderness biodiversity. Lastly, this project will document and archive Idaho wilderness's avian diversity as it exists early in the 21st century for the benefit of the future citizens of Idaho.

Budget

This is a newly formulated project and this proposal is the first directed at accomplishing these important objectives. I am in the process of developing and submitting complementary proposals seeking operating funds as follows:

Support for undergraduate assistants	1900
Mist nets, portable poles, bands, color bands, banding tools, miscellaneous notebooks, etc.	5000
Laptop for field use	1800
Specimen preparation	2000
Taylor Ranch fees	1300
Travel	750
Peterson Birds Songs, MP3 format and players	250
GPS	250
Bird bags, calipers, Pesola scales, etc.	500
Blood sample kits	300
Total additional funds sought	**$14,050**

ABBREVIATED CURRICULUM VITAE
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PRESENT POSITIONS

Idaho State University - Assistant Professor of Biology & Graduate Faculty Member
Idaho Museum of Natural History - Curator of Birds

My research program centers on the reproductive biology of birds and their conservation and restoration within historic ranges. I am carrying out a suite of studies on wild and captive birds that investigate the role of diet on fecundity, effects of predation threat and uncertainty on parental incubation decisions, effects of cryptic sexual selection on reproductive physiology and behavior, and modifications of restoration strategies to account for physiological and behavioral reproductive traits. I have been deeply involved in two native bird restoration projects for the state of Nevada (mountain quail and Columbian sharp-tailed grouse) in cooperation with federal and state agencies, non-governmental conservation groups, and universities. My research on the relationship between dietary consumption of plant carotenoid pigments and steroid-mediated reproductive performance provides a link between habitat conditions and annual fecundity. With graduate students, I am exploring the relationship between predation risk and incubation strategies in greater sage grouse and American coots. Most recently, my work with graduate students is contributing to an exciting new area of cryptic sexual selection in birds, namely morphological and behavioral asymmetries associated with gametic transfer. I advise and support graduate students at the Ph.D. and M.S. levels and serve on graduate committees. I teach graduate and upper-division undergraduate courses in Ornithology, Animal Behavior, Environmental Physiology, and Conservation Biology.

EDUCATION

Ph.D. Ecology, Evolution, and Conservation Biology, University of Nevada, Reno, 1997.
Dissertation: *Mountain Quail Reproduction and Restoration in the Great Basin.*

M.S. Biology, University of North Dakota, 1991. Thesis: *The Effect of Clutch Size on Prolactin, Testosterone, and Incubation Persistence in Male Wilson's Phalaropes.*

B.S. Wildlife Management, University of Minnesota, St. Paul, 1985.

RECENT AND CURRENT RESEARCH PROJECTS

Current **Cryptic sexual selection in chukar -** investigating relative composition and performance of left versus right testes in male chukar.

Current **Incubation response of experimental partial clutch loss in American coots -** measuring the parental response to reduced fitness potential of continued parental investment by experimentally reducing clutch size through the removal of random eggs within synchronous and asynchronous clutches.

Current **Linking habitat quality to sage grouse fecundity -** investigating mechanisms by which degradation of sagebrush steppe plant communities and changes in nest-predator communities lead to reduced reproduction and recruitment in sage grouse populations. This project uses remote videography to

directly document predator x grouse interactions at the nest and to make fine-scale measurements of grouse incubation behavior.

Current **Sage grouse use of threetip sagebrush communities -** changing fire regimens are altering remaining sagebrush communities in the intermountain west, with threetip sagebrush *(Artemesia tridentata tripartita)* often replacing big sagebrush following burns. This project seeks to measure the degree to which threetip sagebrush communities are suitable for sage grouse reproduction relative to mountain big sagebrush communities.

1998-03 **Restoration of mountain quail to the northern Great Basin -** I established a new breeding population in the northern Great Basin within the species' historic range. I have also established a second population in northeastern Nevada through 2003. I am seeking to restart this project working with management agencies in both Nevada and Idaho.

1999-02 **Restoration of Columbian sharp-tailed grouse to Nevada -** I carried out the first reintroduction attempts and participated in developing a long-term restoration strategy for Nevada. First release occurred April 1999. Currently, a small but fragile population has been established in the Snake Mountains of northeastern Nevada. This project also led to a new technique being developed for identifying the presence of spermatozoa within live female grouse using a minimally invasive technique.

RECENT PEER-REVIEWED PUBLICATIONS

Coates, P. S., and D. J. **Delehanty** . *In press*. Using movement patterns of sharp-tailed grouse to guide release site selection. Wildlife Society Bulletin.

Elphick, C. S., J. M. Reed, and D. J. **Delehanty** . *2006*. Applications of Reproductive Biology to Bird Conservation and Population Management. *In* B. G. M.Jamieson (ed.). *Reproductive Biology and Phylogeny of Birds*. Science Publishers, Enfield, New Hampshire, USA.

Coates, P. S., and D. J. **Delehanty** . 2006. Effect of capture date on nest-attempt rate of translocated sharp-tailed grouse. Wildlife Biology.

O'Hearn, P. P., L. M. Romero, R. Carlson, and D. J. **Delehanty** . 2005. Effective subcutaneous implantation of radio-transmitters into the furcular cavity of chukar. Wildlife Society Bulletin 33: 1033-1046.

Delehanty , D. J., and P. P. O'Hearn. 2005. Behavioral and morphological asymmetries in chukar copulation. Journal of Avian Biology 36(4): 276-279.

Coates, P. S., and D. J. **Delehanty** . 2004. The effects of raven removal on sage grouse nest success. Proceedings from the 21st Vertebrate Pest Conference, Visalia, California, March 1-5, 2004.

Delehanty , D. J., S. S. Eaton, and T. G. Campbell. 2004. From the field: Mountain quail fidelity to guzzlers in the Mojave Desert. Wildlife Society Bulletin 32:588-593.

Delehanty , D. J., and N. C. Turek. 2003. Using wing plumage to determine age of mountain quail. North American Bird Banding 28(3):116-120.

Delehanty , D. J. 2000. Reproductive effort of female mountain quail induced by dietary xanthophyll. Page 125 *in* L. A. Brennan, W. E. Palmer, L. W. Burger, Jr., and T. L. Pruden (eds.). Quail IV: Proceeding of the Fourth national Quail Symposium. Tall Timbers Research Station, Tallahassee, FL.