

Academic Affairs Division – Spring 2014 Proposals
CSU RSCA (Research, Scholarship and Creative Activity) Program
Award period: 7/1/14 – 6/30/15

Personal Information

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Project Title Trash Birds? An examination of foraging on human refuse by western gulls

Project Abstract (not to exceed 100 words)

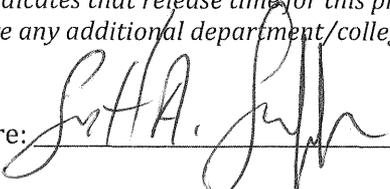
This study compares the foraging ecology of western gulls breeding at Año Nuevo Island (ANI), and subsidized by a landfill, to gulls breeding at Southeast Farallon Islands (SEFI), off San Francisco. We will examine movement patterns and activity budgets of GPS-tracked gulls while simultaneously collecting wet diet, feathers, and blood to quantify the frequency of human foods and garbage as well as exposure to pathogenic bacteria and harmful contaminants (e.g., heavy metals, organopollutants). Given the proximity of each colony (nearshore – ANI vs. offshore – SEFI), we predict that gulls from ANI will experience greater risks from exposure to human refuse. +

Name(s) of Co-PI(s) (if any): None

Funding requested:

- 0.2 release time for Spring 2015
 up to \$5,000 in RSCA-related expenses

My signature below indicates that release time for this project has not been funded by another source and that this project will not require any additional department/college/unit resources not specified in this proposal.

Applicant's signature:  Date: 04/29/14

My signature below indicates that I have read this proposal. If funded, this faculty member will be released for the work requested.

Department Chair/Director's signature:  Date: 4-29-14

Dean's signature:  Date: 4/29/14

**Submit complete application (Cover Page, Budget Form and Narrative – see
General Description and Instructions) with original signatures to
the Office of Graduate Studies & Research, in care of Jeanine Jones, ADM 223, 0025
by 5:00 p.m. on Tuesday, April 29, 2014.**

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BUDGET FORM FOR CSU RSCA PROPOSALS – Spring 2014

WHAT FUNDING ARE YOU REQUESTING? SELECT ONE OF THE FOLLOWING:

- 0.2 release time for Spring 2015
 up to \$5,000 in RSCA-related expenses

IF YOU ARE REQUESTING RSCA-RELATED EXPENSES, PLEASE ITEMIZE YOUR BUDGET:

Equipment and Supplies

(Please itemize, including shipping charges and sales tax.)

Equipment 13 GPS data loggers at \$50/unit + tax Total \$710.13

Supplies Tape, glue, and heat shrink tubing at \$150.77 Total \$ 534.23
Materials to make 3 carpet nooses at \$163.88
Wetsuit for PI to drive inflatable boat at \$180.26
Coveralls for working in colony at \$39.33

Travel

(Please describe trip(s) and itemize estimated costs.)

Gas for inflatable boat at \$50

Total \$ 50.00

Student Assistants

(Please specify the number of undergraduate and graduate students, the number of hours and the hourly rate.)

100 hours at \$15/hour for a graduate student assistant = \$1500

Total \$ 1,500.00

Other expenses

(Please describe/itemize)

Laboratory analyses = \$2200

Total \$ 2,200.00

GRAND TOTAL: \$ 4,994.36

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Project Title

Trash Birds? An examination of foraging on human refuse by western gulls

Statement of Need and Rationale

Reports from the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program have demonstrated significant reductions in many populations of mid- and upper-trophic level organisms, including western gulls (*Larus occidentalis*), which have been adversely impacted by human-related activities. One aspect that may have both positive and negative affects on gull populations includes the production of human garbage that can serve as a resource. However, studies of refuse in gull diets have had conflicting results, where refuse increases breeding success in some populations and decreases it in others¹⁻⁶. A possible cause for a decrease is increased exposure to contaminants, such as trace elements or organic pollutants, and harmful bacteria, such as *Clostridium botulinum*, a paralytic, often fatal, disease of birds⁷. Among wild populations, seabirds are especially vulnerable to sub-lethal affects of contaminants because they are generally long-lived which means they bioaccumulate toxins throughout their life and have little opportunity to 'shed' the contaminants. Seabirds are predators that also feed at the top of their food web⁸⁻¹¹ where biomagnification processes of some compounds (e.g. Hg, PCB) concentrate dramatically up the trophic web¹²⁻¹⁵. Currently, most studies involving gulls have relied upon direct observations of birds returning from garbage heaps or researchers quantifying garbage in the diets. Almost nothing is known about the general movement patterns of gulls using tracking tags, because previous devices were too heavy. The technology has dramatically improved and GPS tags are smaller, cheaper, and more powerful than before.

This project characterizes both intrinsic and extrinsic factors that influence western gull population growth at two central California coast breeding colonies. One population is stable and known to exploit human refuse at a nearby landfill whereas another population breeds on an island further off the coast with limited access to human refuse, and is declining. We will evaluate the behavior, distribution, activity budgets, and diets of each population to determine if colony-specific factors influence population demography; specifically whether human refuse forms an important source of food for the gulls and if so, what potentially harmful effects exist by using this resource. This information will enhance our understanding of ecosystem health and potentially provide greater clarity to those factors that contribute to overall breeding performance of two contrasting gull colonies off California.

Scope of Work and Methods

Approximately 30 adult western gulls from Año Nuevo Island (ANI; at Año Nuevo State Park, north of Santa Cruz) and 30 adult gulls at Southeast Farallon Islands (SEFI; off San Francisco) will be caught late in the incubation period, and equipped with small, GPS data loggers (~15g, IgotU GT-120, MobileAction Technology, Taiwan) that record high spatio-temporal movements and activity patterns during a foraging trip. Each bird will be banded and upon completion of a foraging bout, 2 mL of blood will be sampled for sex determination, stable isotope analysis to approximate diet, and contaminant exposure. Body contour feathers will also be sampled for stable isotope and contaminant analyses. Swabs will be collected using sterile cotton-tipped applicators from the inside and outside the mouth, from head, throat, and body feathers, and cloaca for bacterial analyses. Gulls regularly regurgitate when handled so we will obtain

opportunistic wet diet samples. Each nest will be marked and followed for the remainder of the breeding period and compared to another 20-30 nests of undisturbed control nests. Fledgling success will be compared between our disturbed nests and the controls.

Energy density of the gull's diets will be measured using a bomb calorimeter at San Jose State University (SJSU). Hard parts from pellets and regurgitations (e.g. bones, otoliths) will be used to determine the species present in the gulls' diet.

Isotope analysis will be used to compare the ratios of $^{13}\text{C}/^{12}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$ that will be used to estimate the location (terrestrial/freshwater vs marine) and trophic level, respectively that the gulls are using. Feathers can be used to determine the gulls diet when the feathers were being formed, which will give us an idea of the gulls diet earlier in the season than the blood analysis which captures diet data for the prior 1-5 weeks.

Contaminants will also be investigated in blood and feathers by Mass Spectrometry (ICP- and GC-MS). The considered trace elements will encompass essential (copper, zinc, selenium, iron, manganese, cobalt, nickel, arsenic), and non-essential elements (cadmium, mercury, lead, silver), the last being highly toxic and known to disrupt essential element metabolism. Target organic pollutants will include organochlorine pesticides (DDT, DDD, DDE, dieldrin, lindane, hexachlorobenzene), PCBs (polychlorinated biphenyls), and PBDEs (polybromodiphenylethers) which are known to be highly toxic for seabirds and to accumulate in their tissues. Sub-lethal effects of contaminants will be apprehended through the expression of key genes involved in mitochondrial and lipid metabolisms, defense against oxidative stress, detoxification and DNA repair system. RNA extractions will be performed from remaining blood not used for isotopic or contaminant measurements. Gene expressions will be studied by quantitative real-time PCR.

Microbial sample analyses will be performed in the lab of Dr. Cleber Ouverney and his team at SJSU. Molecular culture-independent methods will be used to characterize the abundance in cell/ml (confocal laser scanning fluorescence microscopy) and diversity (Illumina next generation sequencing of 16S rDNA gene using universal primers) for all samples. In addition samples will be prepared for isolation in pure culture of *Clostridium botulinum*, associated with avian botulism.^{7, 16-17}

Plan for Dissemination and Future Applications

This project has several important applications for conservation. For example, determining a putative cause for the SEFI population decline is important for the conservation of the species. The suspected cause of the decline is diet but this will be the first study that attempts to compare diet and foraging ecology between SEFI and a relatively stable population on ANI.

Although some studies have dealt with the effects of contaminants on seabirds, **few have evaluated the impacts on wild birds by the use of sensitive biomarkers such as genetic ones.** This study will benefit general knowledge of contaminant effects on bird breeding ecology, provide expertise on this subject, and help to determine concentration thresholds of toxic compounds and to develop accurate genetic biomarkers that may be used as early warning of toxic impact on bird populations. This project will then allow the development of tools to evaluate risks for populations. In addition, few studies of such scope have incorporated bacteria data, especially using next generation sequencing to study microbial composition associated with numerous body sites of a bird community.

The work on this project will undoubtedly form part or all of a Masters thesis of a student in my lab at SJSU. Thus, the results will be disseminated through a thesis but I expect the student to present their findings at a conference in the future as well as a formal publication in a peer-reviewed journal.

Western gulls breed at colonies in Southern California and Oregon. Therefore, my colleagues at UC Santa Barbara and Oregon State University have future plans to submit a large multi-institute, multi-year and site, proposal. We have identified at least three funding sources including California and Oregon Sea Grant Colleges, the National Science Foundation, and the Environmental Protection Agency. We believe the broad integrative approach to this question will be attractive to these funding agencies.

Budget Justification

Funds are requested to provide expendable field supplies, logistical costs, laboratory analyses, and an hourly wage for a student field assistant. Because I maintain a research appointment at UC Santa Cruz, I am able to use their facilities and boats at *almost* no cost. I am required to cover the cost of fuel for the boat and all researchers must wear wetsuits during transit to ANI (CA. 10 minutes) from the mainland. Thus, I am requesting funds to cover fuel costs and a new wetsuit for PI Shaffer who operates the boat. The tracking work requires GPS loggers and materials to temporarily attach the loggers to the gulls as well as materials to catch the birds. So, I am requesting approximately \$450 for tape, glue, heat shrink tubing for tag attachment and fishing line and hardware cloth to make carpet nooses. I have a limited number of GPS loggers from another project that I can dedicate to this research effort but will require additional tags to cover deployments at both locations so I am requesting funds to purchase 13 additional GPS loggers. I have an existing collaboration with Point Blue Conservation Science, who manages logistics at the Farallon Islands. Consequently, transportation costs for a student and myself to the island as well as living costs on the island will be covered by Point Blue.

Funds are requested to pay a graduate student up to 100 hours at \$15 per hour to assist with the field/laboratory research. It is likely that all or part of this project will constitute the student's Masters thesis.

Finally, I am requesting funds to help offset the costs of the laboratory analyses that will be performed in the labs of Drs. Brandon White (contaminants) and Cleber Ouverney (microbial) at SJSU. The analyses performed will require the mass spectrophotometer in SJSU's proteomics facility and DNA sequencing for evaluating bacterial diversity.

References

1) Pierotti R, Annett C (2001). Marzluff JM, Bowman R, Donnelly R (Eds.), *Avian Ecology and Conservation in an Urbanizing World*. Norwell: Kluwer Academic Publishers, pp 307-330; 2) Annett CA, Pierotti R (1999). *Ecology* 80, 288-297; 3) Hunt Jr GL (1972). *Ecology* 53, 1051-1061; 4) Belant JL, et al. (1998). *Landscape Urban Plann* 43, 11-19; 5) Watanuki Y (1992). *Condor*, 159-171; 6) Brousseau P, et al. (1996). *Colonial Waterbirds*, 22-30; 7) Yule AM, et al. (2006). *J Wildl Dis* 42, 479-493; 8) Burger J (1993). *Rev Environm Toxicol* 5, 203 - 311; 9) Burger J, Gochfeld M (2000). *Sci Tot Environ* 257, 37-52; 10) Hunter BA, Johnson JG (1982). *Oikos* 38, 108-117; 11) van Straalen NM, Ernst E (1991). *Oikos* 62, 255-256; 12) Dawson A (2000). *Ecotoxicology* 9, 59-69; 13) Lucia M, et al. (2010). *Ecotoxicology* 19, 163-170; 13) Scheuhammer AM (1987). *Environ Pollut* 46, 263-295 14) Verreault J, et al. (2004). *Environ Health Perspect* 112, 532-537; 15) Dewar ML, et al. (2013). *MicrobiologyOpen* 2, 195-204; 16) Ryu H, et al. (2012). *Appl Environ Microbiol* 78, 1909-1916.