



Exxon Valdez Oil Spill Trustee Council

Long-Term Research and Monitoring, Mariculture, Education and Outreach

Annual Project Reporting Form

Project Number: 22220111-I

Project Title: Ecological interactions between Pacific herring and Pacific salmon in Prince William Sound, Alaska

Principal Investigator(s): Peter S. Rand and Rob Campbell, PWSSC; Kristen B. Gorman, UAF; Ron Heintz, SSSC

Reporting Period: February 1, 2022 – January 31, 2023

Submission Date (Due March 1 immediately following the reporting period): March 1, 2023

Project Website: <https://gulfwatchalaska.org/>

Please check all the boxes that apply to the current reporting period.

Project progress is on schedule.

Project progress is delayed.

All field work, lab analysis, and reporting were delayed one fiscal year because of delays in the release of funding. The project will continue as outlined in the proposal beginning in *Exxon Valdez* Oil Spill Trustee Council (EVOSTC) FY23.

FY22-FY26 project milestones and tasks table from the original proposal has been updated below to indicate the tasks that were delayed (**D**) and rescheduled (**R**). Tasks that remain unchanged from the proposal are labeled “X”. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

We postponed all planned field work and analysis of field data (Milestones 2 and 3) until FY23 through a no-cost extension.



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Milestone/Task	FY22				FY23				FY24				FY25				FY26			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 1. Retrospective analysis on salmon-herring co-occurrence and interactions in PWS (Objective 1)																				
Obtain additional data from past studies in PWS	D	D					R	R												
Summarize/analyze data			D	D	D				X	X	X	X	R	R	R	R				
UAF Masters student					D	D	D	D	X	X	X	X	R	R	R	R				
Milestone 2. Conduct Field Surveys and Lab Work (Objectives 2 & 3)																				
Hiring field/lab techs - PWSSC	D	D		R	X	X			X	X			X	X			X	X		
Hiring field/lab techs - SSSC													X	X			X	X		
Purchase equipment/supplies/prep	D	D	R	R	X	X			X	X			X	X			X	X		
PWS offshore surface trawl survey		D				X				X				X				X		
PWS bay purse seine survey						X	X			X	X			X	X			X	X	
PWSSC lab work and working with lab contractors (plankton, diets, stomach DNA, salmon isotopes, salmon otoliths, salmon calorimetry, VEN sampling)			D	D	D		X	X	X		X	X	X		X	X	X		X	X
UAF lab work (herring and salmon isotopes, bulk and CSIA)							X	X	X		X	X	X		X	X	X		X	X
SSSC lab work (herring and salmon diets)							X	X	X		X	X	X		X	X	X		X	X
UAF Masters student					D	D	D	D	X	X	X	X	R	R	R	R				



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	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone 3. Annual Data Analysis (Objectives 2 & 3)																				
Analyze results from PWS trawl survey				D	D	D			X	X	X		X	X	X		X	X	X	
Analyze results from PWS purse seine survey									X	X	X		X	X	X		X	X	X	
Milestone 4. Data Analysis, modeling, synthesis (synthesis of all Objectives 1-4)																				
Synthesize field data, develop; bioenergetic model simulations, and forecast model development (support from PWSSC postdoc, funded separately)																			X	X
Reporting																				
Annual reports					X				X				X				X			
Deliverables																				
Peer reviewed paper												D				X				R
Data posted online					D				X				X				X			

Budget reallocation request.

Personnel changes.

1. Summary of Work Performed:

Due to the later than expected arrival of funding, the field work and associated data collections was delayed until May 2023. However, in FY22 principal investigators (PIs) spent some time attending the Gulf Watch Alaska-Long-Term Research and Monitoring (GWA-LTRM) PI meeting in Cordova, AK (Nov 2022) and the Alaska Marine Science Symposium (Jan 2023), in addition to searching for individuals who will be involved in the project (University of Alaska Fairbanks [UAF] graduate student and Prince William Sound Science Center [PWSSC] field/lab



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technician) and planning for field work scheduled to begin in spring 2023. We have also begun the process of acquiring needed equipment (trawls, field sampling supplies, etc.), applying for collection and Institutional Animal Care and Use Committee (IACUC) permits, and establishing a co-op agreement with the Alaska Department of Fish and Game (ADF&G).

2. Products:

Popular articles:

Rand, P., and K. Gorman. 2022. New study to investigate interactions between Pacific herring and pink salmon. Delta Sound Connections 2022-2023. <https://pwssc.org/wp-content/uploads/2022/06/DSC-2022-WEB.pdf>

3. Coordination and Collaboration:

The Alaska SeaLife Center or Prince William Sound Science Center

Two PIs on this project are staff at the PWSSC.

EVOSTC Long-Term Research and Monitoring Projects

This project is part of the Herring Research and Monitoring component of the GWA-LTRM program. We intend to collaborate with Dr. Paul Hershberger on the disease sampling in this project (Dr. Hershberger is the PI on a related, Herring Disease Program, project 22120111-E).

EVOSTC Mariculture Projects

None

EVOSTC Education and Outreach Projects

We intend to engage in outreach through PWSSC on this project, including articles in Delta Sound Connections and the PWSSC newsletter (Breakwater).

Project PIs have participated in meetings with members of the CORaL network funded by EVOSTC to evaluate ways the programs can work together on outreach activities.

Individual EVOSTC Projects

None



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Trustee or Management Agencies

We are working with ADF&G on a co-op agreement to allow us to charter the *R/V Solstice* and to have juvenile pink salmon otoliths examined to determine origin in the ADF&G Cordova Otolith Lab.

Native and Local Communities

None

4. Response to EVOSTC Review, Recommendations and Comments:

May 2021 EVOSTC Science Panel Comment: This 5-year proposal is intended to provide information that can be used to examine whether increased production of pink salmon in PWS is constraining herring stock recovery. It responds to a suggested area of interest in the FY22-31 Invitation for Proposals: *An examination of the role of hatchery-produced pink salmon, wild pink salmon, on herring ecology in PWS and the Gulf of Alaska*. The PIs propose to test three hypotheses: (1) foraging pink salmon and herring are commonly co-located; (2) pink salmon can consume a large biomass of herring, and (3) herring and pink salmon selectively consume similar prey items that are in limited supply.

As a result of this research, the PIs intend to provide: (1) a synthesis of existing data that identifies where, when, and at what life stages pink salmon and herring might be interacting in PWS; (2) new data describing juvenile pink salmon and juvenile herring diet composition including isotopic analysis; and (3) estimates of the potential number of larval herring consumed by juvenile pink salmon. Diets are planned to be examined using traditional gut analysis and stable isotope analysis (SIA). These diet data will be used for bioenergetic modeling, as well as isotopic analysis to determine whether or not (and presumably, the degree to which) pink salmon are directly consuming herring.

The proposed work was relatively well presented, although improvements can be made. For instance, the use of hypotheses, objectives, components, and results/products were sometimes confusingly presented and it was not always clear how they relate to one another. Although a study involving all life stages is proposed, the PIs anticipate interactions to be most likely between emigrating juvenile pink salmon and larval and/or juvenile herring. As a result, descriptions of those analyses are more fully described. In a revision, the Science Panel expects more explanations throughout the proposal. In some places, clarity is compromised by syntax errors and unnecessary brevity. For instance, the first hypothesis confusingly states “Foraging pink salmon, and herring that are suitably sized for consumption, are commonly co-located.” As



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another example, hypothesis 2 states “pink salmon can consume a significant biomass of herring.” “Significant” could mean ‘large or substantial’ or statistically significant but even so this might not be biologically meaningful at the ecosystem level. A reverse case might also hold so that modest consumption might have ecologically significant (or ecologically meaningful) effects. On page 7, it is not clear to us how objectives 2 and 4 differ. These are just a few examples that should be addressed in a revision.

PI Response: The proposal has gone through an extensive revision in being merged with another project initially proposed by PI Rand. In working through the revision, we focused our efforts on clarifying the language so as to avoid brevity and include details so as to be specific about our hypotheses and methods. The revision was a useful exercise for all PIs, Rand, Campbell, Heintz and Gorman, to discuss the proposal details and work towards a clear and integrated project that meets the initial objectives of both studies. The integrated proposal retains this project number (22220111-I). Because the proposal revisions are so extensive, we do not refer to proposal sections and page numbers in our comment responses.

May 2021 EVOSTC Science Panel Comment: In a revised proposal, we recommend consideration of the merits of polymerase chain reaction (PCR) for diet analysis. The Panel also raised some questions that could be addressed in a revised proposal. For instance, how synchronous is the release from the hatcheries? Is it spread over many weeks or months? It would seem that hatchery release patterns and their timing would be important to the degree of overlap with herring.

PI Response: We agree with the comments by the Science Panel. In the revised proposal, we merged our study with that of Rand et al. and now include DNA barcoding in diet work. Our initial budget cap limited us on several fronts including employing DNA-based diet work, in addition to conducting significant fieldwork. The new project allows for synergies between both studies including the use of DNA-based diet studies and conducting more fieldwork. We added details about the timing of sampling relative to hatchery releases of pink salmon in PWS.

May 2021 EVOSTC Science Panel Comment: There are obvious overlaps between this proposal and proposal 22220111-L (Rand, Campbell & Groner). For example, this proposal plans to undertake bioenergetic modeling to determine the extent to which juvenile pink salmon consume larval herring. This proposal plans the bioenergetic modeling to provide initial estimates of herring consumption by pink salmon. Whereas the other proposal would be able to further refine these estimates by considering consumption differences between odd and even years that vary in pink salmon run strengths. We consider the more thorough consideration of consumption differences in odd versus even years of higher value (as described in proposal 22220111-L). Given this, if both proposals are funded, the provision of initial estimates of herring consumption



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in this proposal would seem to be unnecessary if examined more completely in proposal 22220111-L. Other areas of overlap should be addressed, as well.

PI Response: Yes, this is why we decided to combine efforts into one proposal. Again, the initial budget cap on our smaller proposal dictated that we could not complete multiple years of field collections. By combining efforts with Rand et al. we are now in the position to work on a more detailed bioenergetic model that is outlined in the proposal.

May 2021 EVOSTC Science Panel Comment: We strongly recommend that the PIs of both herring-pink salmon interaction studies consider merging efforts into one, well-organized, comprehensive proposal. By combining the two, some cost savings and efficiencies may be realized. A combined proposal can still include separate research components conducted by a different set of co-PIs, as appropriate. But the relationships among these components can be articulated into a well-organized and sound proposal. If this recommendation is disregarded and two separate revised proposals are submitted in August, we expect to see that overlap between proposals is eliminated and the relationships of one proposal to the other is very clearly stated in both proposals. The last alternative (not preferred by the Panel) is two competing proposals, which will likely result in one or the other being recommended for funding.

PI Response: We understand the concerns of the Science Panel on overlaps between the two projects. In response, we have combined our efforts into one large proposal that continues to meet the initial objectives of both studies.

September 2021 EVOSTC Science Panel Comment: This proposal aims to resolve long-standing questions about the roles that pink salmon and Pacific herring play in each other's population dynamics in PWS. The PIs propose retrospective analyses and field studies over a 6-year period including (1) analyses of co-occurrence in nearshore and offshore habitats, (2) evidence of predation by each species on the other, (3) competition for dietary resources (using visual examination of stomach contents, DNA barcoding, bulk and compound-specific carbon and nitrogen stable isotope techniques, and examination of age-0 herring and juvenile pink salmon body condition), (4) prevalence of a key pathogen, viral erythrocytic necrosis, (5) development of a bioenergetic model to estimate the predatory demand of pink salmon on larval herring in southwestern PWS, a major migratory pathway for salmon, (6) construction of a model to explain variation in marine survival of PWS pink salmon, and (7) a development of a model to forecast PWS pink salmon returns. The proposal lays out five clear hypotheses and an associated list of objectives. Scientific methods are clearly described and justified. The proposed research builds on existing datasets already produced by EVOSTC: SEA, APEX, GWA, HRM, and other sources (ADF&G, NSF, NOAA, NPRB, and NCEAS). Coordination and collaboration with other EVOSTC components are well described.



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This project should, once and for all, establish the role of pink salmon in regulating Pacific herring production in PWS and develop tools for predicting pink salmon marine survival. The potential role of pink salmon on herring in PWS is palpable, as PWS is home to the largest pink salmon hatchery system in the world and the herring stock is depressed. If there is an effect of hatchery pink salmon, this is the place to look. In addition to considering the role of pink salmon on herring, the PIs will also examine the opposite effect of age-1+ (juvenile and adult) herring feeding on pink salmon fry. The proposed research will also help address how these past and future environmental changes, such as marine heat waves, can affect populations dynamics of herring and pink salmon.

We are excited about this new proposal, which combines proposals 22220111-I and 22220111-L. The PIs have joined forces and taken our previous comments seriously and produced a very well written proposal. Co-PIs Rand and Campbell, as well as Heintz and Gorman, have each worked together on related herring research in the past. Collectively, they form a strong research team.

PI Response: Thank you for your follow-up comments. We are pleased with our project team and look forward to beginning work.



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5. Budget:

EXXON VALDEZ OIL SPILL TRUSTEE COUNCIL
PROGRAM BUDGET PROPOSAL AND REPORTING FORM

Budget Category:	Proposed FY 22	Proposed FY 23	Proposed FY 24	Proposed FY 25	Proposed FY 26	5-YR TOTAL PROPOSED	ACTUAL CUMULATIVE
Personnel	\$112,299	\$201,472	\$206,654	\$185,064	\$182,478	\$887,967	\$48,137
Travel	\$11,223	\$15,539	\$14,459	\$11,998	\$10,764	\$63,983	\$4,615
Contractual	\$65,706	\$98,644	\$100,119	\$98,774	\$97,674	\$460,917	\$2,706
Commodities	\$12,050	\$4,250	\$4,250	\$4,250	\$3,250	\$28,050	\$654
Equipment	\$22,000	\$22,775	\$23,913	\$2,000	\$0	\$70,688	\$5,100
Indirect Costs (varies by proposer)	\$7,755	\$22,032	\$22,218	\$16,441	\$13,723	\$82,168	\$520
SUBTOTAL	\$231,033	\$364,711	\$371,613	\$318,527	\$307,888	\$1,593,773	\$61,732
General Administration (9% of subtotal)	\$20,793	\$32,824	\$33,445	\$28,667	\$27,710	\$143,440	N/A
PROJECT TOTAL	\$251,826	\$397,535	\$405,058	\$347,194	\$335,598	\$1,737,212	
Other Resources (In-Kind Funds)	\$0	\$0	\$0	\$0	\$0	\$0	

COMMENTS:

This is the combined budget for the individual Rand and Campbell, Gorman, and Heintz budgets that follow. Rand and Campbell are associated with Prince William Sound Science Center (PWSSC), Gorman is affiliated with the University of Alaska Fairbanks (UAF), and Heintz is affiliated with the Sitka Sound Science Center (SSSC). This form contains the summary information only. Detail by year for each PI/organization can be found in the following four worksheets.

FY22 expenses for this project are less than originally anticipated because delays in the release of funds resulted in field work for the project being delayed by one year.

FY22-26	Project Number: 22220111-I Project Title: Trophic Interactions PI(s): Rand & Campbell (PWSSC), Gorman (UAF), & Heintz (SSSC)	SUMMARY TABLE
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Pete Rand requested a no-cost extension to delay all survey work and associated laboratory analysis costs for one year. Some salary was drawn for Pete Rand to begin cruise planning for 2023, contribute to a search for a UAF graduate student and PWSSC research technician, engage in some early outreach efforts, coordinate work with other EVOSTC project PIs and contracted labs, and manage purchases of equipment and supplies needed for the work. We put an initial down payment on a surface trawl and have acquired a quote for a Methot trawl to collect plankton and micronekton. We plan to complete these purchases in early 2023. Work will continue as proposed in the EVOSTC 2023 fiscal year.



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Kristen Gorman used budget for travel in the current fiscal year to attend the GWA-LTRM PI meeting in Cordova, Alaska (Nov 2023) and the Alaska Marine Science Symposium (Jan 2023). Other expenses included AMSS registration, and some small laboratory and office supplies needed for field season preparation.