ATTACHMENT C ***EVOSTC Annual Project Report Form***

Form Rev. 10.3.14

1. Program Number: *See*, Reporting Policy at III (C) (1).

12120114-128102

2. Project Title: *See*, Reporting Policy at III (C) (2).

Long-term Monitoring: Synthesis and Conceptual Modeling - Conceptual Ecological Modeling

3. Principal Investigator(s) Names: *See*, Reporting Policy at III (C) (3).

Tuula E Hollmen (Principal Investigator)

Suresh A Sethi (Collaborator)

4. Time Period Covered by the Report: *See*, Reporting Policy at III (C) (4).

February 1, 2014-January 31, 2015

5. Date of Report: *See*, Reporting Policy at III (C) (5).

March 1, 2015

6. Project Website (if applicable): *See*, Reporting Policy at III (C) (6).

www.gulfwatchalaska.org

7. Summary of Work Performed: *See*, Reporting Policy at III (C) (7).

A general conceptual synthesis model for Gulf Watch Alaska program was developed during the first phase of the modeling project. In the current reporting period, work has focused on four areas:

1. Publishing results from the first two years of method development and modeling.
2. Development of a framework and working groups for a suite of submodels to explore and represent key hypotheses relating to the components of our program: environmental drivers, nearshore, pelagic, and lingering oil.
3. Development of visual aids to represent ecosystem structure and monitoring efforts related to the program components.
4. Development of a framework to consider monitoring priorities and management relevance to assist long term programmatic planning efforts.

Our first manuscript based on conceptual modeling development for Gulf Watch Alaska program was submitted in 2014 and is currently in revision to address reviewer comments. Development and refinement of a semi-quantitative expert knowledge rating tool was presented at the Alaska Marine Science Symposium in January 2015. Details about these publications and presentations are given in section 9.

Our conceptual modeling continues with development of a series of sub-models to explore hypotheses among the key program components: nearshore (Sub-model 1), pelagic (Sub-models 2, 3), and environmental drivers (Sub-model 4).

Sub-model 1: Key Trophic Linkages in Nearshore Northern Gulf Ecosystems

The benthic nearshore model will examine the impact of changes in invertebrate prey fields on consumers of interest as measured by a suite of behavioral and demographic performance metrics. The overall goals of the modeling effort are to organize understanding about trophic linkages in the nearshore system, and the strength of relationships between invertebrates and consumers of interest, provide semi-quantitative simulation models to forecast consumer population outcomes/effects on consumer performance metrics

resulting from changes in invertebrate prey fields, identify data gaps, and prioritize research to fill data gaps. A unique aspect of this modeling approach is that considerable empirical, quantitative information exists on diet compositions for the consumers of interest and energetic requirements may also be available for consumer taxa. We have developed the predator response metrics and prey data input framework. Prey data compilation is in progress.

Sub-model 2: Ecological Linchpin with Forage Fish Abundance

This conceptual sub-model focuses on the dynamics of a suite of forage fishes found in the Northern GOA. The sub-model examines linkages among forage fish prey, a suite of selected forage fish species, and higher trophic species populations. Salmon and other pelagic, marine forage fishes such as capelin, sand lance, and herring play important roles in the marine food web as predators, competitors, and prey. These connections, when examined through functional groups or shared similarities (i.e. examining loss of shared prey items across multiple species) can provide unique insights into food web dependencies and future management considerations. The working group of experts is identified and planning for a modeling workshop is in progress.

Sub-model 3: Top-down Control with Humpback Whale Predation

Much speculation regarding controlling factors for schooling and highly fecund fishes, such as Pacific herring, has focused on bottom up factors including availability of prey and suitable habitat. An alternative hypothesis with supporting evidence suggests that increasing predator populations may be acting as a top down controlling agent for these fish. This conceptual sub-model explores the relationships between humpback whale prey types and seasonal patterns that can lead to a better understanding of the influence that predation may have on suppressed, economically important fisheries. Current understanding about the processes affecting herring-whale dynamics in the Northern GOA was explored in a sub-model exercise rating properties of linkages in a zooplankton-herring-whale sub-model system. The pelagic team has explored movements and distribution of humpback whales in Prince William Sound, represented in a conceptual model.

Sub-model 4: Bottom-up Control with Environmental Forcing on Plankton Populations

This conceptual sub-model focuses on plankton production and the various environmental conditions that are thought to act as drivers of primary and secondary production in the northern GOA. Levels of primary production are related to nutrient availability and solar input. Factors that influence these aspects include levels of stratification and mixing related to freshwater input, wind mixing, topography, and upwelling of nutrients. The sub-model will explore ecosystem responses to changing climate and, because plankton production is a primary source of energy conversion for higher trophic levels, the sub-model will have key ties to other models addressing higher trophic levels and associated management needs for coastal communities. A working hypothesis relating to effect so potential pathways of effect of water stratification on phytoplankton bloom has been visualized in a conceptual model template.

Development of visualization tools continued. We have developed a graphic template for visual representation of Gulf of Alaska ecosystem in program Adobe Illustrator. The template may be modified to provide visualization tools for Gulf Watch program components (environmental drivers, nearshore, pelagic, lingering oil). We used the template to develop a visual representation of the nearshore ecosystem component and the environmental drivers component. We also developed a visual representation of the submodeling plan within the framework of the general ecosystem model developed based on input from Gulf Watch Alaska principal investigators.

Structured decision support tools are used to develop an adaptive framework to guide monitoring efforts in long term, and link monitoring efforts with management objectives. We develop decision models to identify a suite of potential scenarios and impact pathways, and construct an adaptive framework to guide scientific study and monitoring efforts to support management of resources based on indicators of change. The framework will offer adaptive guidance to monitoring data collection, based on learning contribution by the monitoring conducted by the Gulf Watch Alaska program. Our conceptual modeling efforts will contribute to the development of the adaptive framework by characterizing current understanding of linkages between drivers and responses, and predicted effects and indicators of change. Input from scientific experts and resource managers will be incorporated into the framework. We will develop the structure and template for

the adaptive framework using conceptual and decision modeling tools during 2015-2016, and the process will form a planning tool and framework for the program over the next two decades.

Deliverable/Milestone	Status
Continue development of conceptual models (component submodels, management applications, stakeholder objectives)	In progress. Framework for nearshore model developed, data input in progress. Concepts for models on management applications in development. Framework for considering long term monitoring priorities in development.
Continue development of interactive data visualization tools	In progress. Conceptual model based visualization tools for nearshore and environmental drivers components developed.
Attend annual PI meetings and Alaska Marine Science Symposium	Completed, November 2014 and January 2015. Presented a project update at Alaska Marine Science Symposium.

8. Coordination/Collaboration: *See,* Reporting Policy at III (C) (8).

A. The current goals of the conceptual modeling effort focus on development of submodels representing components and integrated hypotheses about ecosystem dynamics in our study area in the Gulf of Alaska. The process of developing component submodels involves close internal coordination and collaboration within and among Gulf Watch program components. Forage fish submodel will also involve coordination and collaboration between eth two programs.
B. Current coordination is focusing on collaboration within Gulf Watch Alaska program and between Gulf Watch Alaska and Herring Research Program.
C. Current coordination is focusing on collaboration within Gulf Watch Alaska program and between Gulf Watch Alaska and Herring Research Program.

9. Information and Data Transfer: *See,* Reporting Policy at III (C) (9).

- Conference presentation: Hollmen, TE and Sethi SA. Conceptual models are flexible tools for research planning, prioritization, and communication. Alaska Marine Science Symposium, Anchorage, Alaska January 2015.
- Manuscript in revision: Conceptual ecological models to synthesize, organize, and prioritize research in socioecological systems.
- Data and/or information products developed during the reporting period: Visualization of submodel structure, nearshore ecosystem submodel, and environmental drivers submodel.

10. Response to EVOSTC Review, Recommendations and Comments: *See,* Reporting Policy at III (C) (10).

N/A

11. Budget: *See,* Reporting Policy at III (C) (11).

There is a difference of >10% from the amount proposed and the amount spent to date for several categories of this project. This is due to differences in personnel costs expended as contracts, and there is lag in the sum total due to university invoicing cycles. Also, we are recruiting a postdoc to work with us, so all carryover is anticipated to be expended in personnel over the next two years.