Update Report

Period 2/1/2013 - 1/31/2014

Project R/LME/N-6 - Fish Aquaculture Simulation Model and GIS Validation and Adaptation for Government Management Use

STUDENTS SUPPORTED

No Students Reported This Period

CONFERENCES / PRESENTATIONS

Rensel, J.E., D.A. Kiefer and F.J. O'Brien (2013) Computer Software Tools for Sustainable Site Selection and Operation of Fish Mariculture. International conference "Monitoring and Management of Red Tides Conference". ICM Events. Dubai, United Arab Emirates. Nov. 10, 2013
, public/profession presentation, 130 attendees, 2013-11-10
Rensel, J.E. (2013) Evaluation of Mussel-oyster-salmon IMTA in Puget Sound using stable isotope tracing. World Aquaculture Society Semi-Annual Meeting, Open Ocean Aquaculture session. Nashville, TN. Feb. 24th 2013. Available at http //www.aquamodel.net/Downloads/World%20Aquaculture%20Society%20Fish%20Shellfish%20IMTA%20stable%20isotopes.pdf, public/profession presentation, 80 attendees, 2013-02-24
Rensel, J.E. (2013) Validation study of AquaModel fish farm simulation software. World Aquaculture Society Semi-Annual Meeting, Aquaculture Modeling session. Nashville, TN. Feb. 23, 2013. Available at http //www.aquamodel.net/Downloads/World%20Aquaculture%20Society%20Modeling%20session.pdf, public/profession presentation, 35 attendees, 2013-02-23
Rensel, J.E. (2013) Review of proposed National Science and Engineering Research Council Industrial Chair for Net Pen Modeling Research. Dalhousie University, Halifax Nova Scotia. 9-10 Aug. 2013

, public/profession presentation, 20 attendees, 2013-08-06
Rensel, J.E. (2013) Myths, realities and trends of computer modeling of Aquaculture. World Aquaculture Society Semi-Annual Meeting, Open Ocean Aquaculture session. Nashville, TN. Feb. 22, 2013. Available at http //www.aquamodel.net/DownloadsWorld%20Aquaculture%20Society%20Open%20Ocean%20session.pdf

, public/profession presentation, 50 attendees, 2013-02-22
Rensel, J.E. (2013) AquaModel Simulation of Fish mariculture, _water and sediment effects in near and far fields. NOAA Honolulu Office. Inter-agency Open Ocean Aquaculture Monitoring Group. Honolulu, Hawaii. Feb.15, 2013.
, public/profession presentation, 40 attendees, 2013-02-15
Rensel, J.E. (2013) Aquaculture Management Tools and Modeling. Washington Department of Ecology and NOAA Seminar. Manchester WA Aquaculture Research Station.

Manchester, WA. March 19, 2013., public/profession presentation, 60 attendees, 2013-03-19
Rensel, J.E. (2013) Aquaculture Management Tools and Modeling. Department of Ecology and NOAA Aquaculture Management Seminar. Washington Department of Ecology Headquarters, Olympia, WA. Feb. 10, 2013. Available at https //www.youtube.com/watch?v=qkl28cuVv0k&list=PL8BmI4b96dKZ5rdChrLsl-e5fxeGMHsLA&index=4

, public/profession presentation, 100 attendees, 2013-02-10

ADDITIONAL METRICS

K-12 Students Reached	Acres of degraded ecosystems restored as a result of Sea Grant activities
Curricula Developed	Resource Managers who use Ecosystem-Based Approaches to Management
Volunteer Hours	HACCP - Number of people with new certifications
Cumulative Clean Marina Program - certifications	

PATENTS AND ECONOMIC BENEFITS

No Benefits Reported This Period

TOOLS, TECH, AND INFORMATION SERVICES

Description		Developed	Used	Names of Managers	Number of Managers
AquaModel Software, various 2013-2014 executable updates	Actual (2/1/2013 - 1/31/2014)	1	1	Dr. Ken Riley, National Ocean Service, NOAA, Beaufort N.C. Dr. James Morris, National Ocean Service, NOAA, Beaufort N.C. Dr. Carol Price, National Ocean Service, NOAA, Beaufort N.C. Dr. Shawn Robinson, Department of Fisheries and Oceans, N.B. (NOT COUNTING - Dr. Jon	4
	Anticipated (2/1/2014 - 1/31/2015)	0	0		

Grant, Dalhousie University, Halifax Dr. Theirry Chopin, University of New Brunswick)

HAZARD RESILIENCE IN COASTAL COMMUNITIES

No Communities Reported This Period

ADDITIONAL MEASURES

Safe and sustainable seafood

Number of stakeholders modifying practices
Actual (2/1/2013 - 1/31/2014)
Anticipated (2/1/2014 - 1/31/2015)

Number of fishers using new techniques
Actual (2/1/2013 - 1/31/2014)
Anticipated (2/1/2014 - 1/31/2015)

Sustainable Coastal Development
Actual (2/1/2013 - 1/31/2014)
Anticipated (2/1/2014 - 1/31/2015)

Coastal Ecosystems
Actual (2/1/2013 - 1/31/2014)
Anticipated (2/1/2014 - 1/31/2015)

PARTNERS

Partner Name Canada Fisheries and Oceans, type Government, scale International

Partner Name Dr. David Fredriksson, U.S. Naval Academy, type Academic Institution, scale Federal or National

Partner Name Dr. James Morris, NOAA, National Ocean Service, Beaufort, N.C., type Government, scale Federal or National

Partner Name Instituto de Fomento Pesquero (Chilean Research Agency), type Government, scale International

Partner Name National Ocean Service, Aquaculture Modeling Division, type Government, scale Federal or National

Partner Name Professor Jon Grant, Dalhousie University, Halifax New Brunswick, type Academic Institution, scale International

Partner Name Sweeney International Management Corp., type Industry and Business, scale International

Partner Name University of New Brunswick, type Academic Institution, scale International

IMPACTS AND ACCOMPLISHMENTS

Title A Washington Sea Grant-supported simulation model is evaluating fish-farming sites

and environmental effects

Type impact

Relevance, Response, Results Relevance Net-pen fish farming might do much to meet the growing demand for seafood, and U.S. waters are well suited to it. But no commercial-scale operations have been permitted in the U.S. exclusive economic zone, and few operate in state waters. Washington communities have questioned their environmental effects, raising concerns about harm to native species, view impairment, and waste accumulation. When farms are sited where currents are insufficient to assimilate it, waste can damage benthic and aquatic habitats. But no adequate modeling tool that accounts for both these habitats has been available to help government and industry managers anticipate these effects and evaluate prospective farm sites. Response With funding from a national strategic initiative, this Washington Sea Grant-supported project is using AquaModel, a geospatial software system to evaluate fish-farm sites and determine their environmental carrying capacity. The system simulates the siting, operational and environmental conditions of individual or multiple net-pen fish farms in coastal and ocean waters. Using field projects in British Columbia, Puget Sound, Nova Scotia, the Gulf of Maine and Hawaii, researchers are examining relationships between these conditions and fish-farm effects to validate AquaModel and refine its accuracy. Results NOAA's National Ocean Survey is using AquaModel as a primary tool to assess existing marine fish farms. Initial testing of the model with data from British Columbia and Hawaii shows remarkable fidelity to observed benthic and water column parameters including respective sediment-sulfide and organic carbon conditions.

Recap Washington Sea Grant-supported research improved and validated the first successful modeling tool for evaluating net-pen aquaculture siting and environmental effects.

Comments Primary Focus Area LME (SSSS) Secondary Focus Area COCC (SCD) State Goals Support conservation and sustainable use of living marine resources through effective and responsible approaches, tools, models and information for harvesting wild and cultured stocks and preserving protected species (SSSS Industry). Assist coastal communities and marine-dependent businesses in planning and making decisions that provide local and regional economic benefits, increase resilience and foster stewardship of social, economic and natural resources (SCD Inter-relation)

Related Partners

PUBLICATIONS

Title AquaModel Web Site

Type Computer software Publication Year 2013 Uploaded File none URL http //www.aquamodel.org

Abstract An on line web site was developed, posted and updated during the project period that included information regarding AquaModel improvements related to model validation.

See www.AquaModel.org

Citation www.AquaModel.org

Copyright Restrictions + Other Notes

Journal Title none

Title AquaModel Help File

Type Handbooks, Manuals, Guides/Aids Publication Year 2013 Uploaded File none URL not applicable

Abstract A 300 page help file now included with AquaModel was developed and improved during this time period. The manual helps users with explicit instructions for designing their own model applications with step by step narratives. It includes both AquaModel instructions and the underlying EASy (Environmental Assessment System) GIS system. The manual is in final stages of preparation as of this writing (March 2014).

Citation Not applicable

Copyright Restrictions + Other Notes Copyright protected.

Journal Title Not applicable

OTHER DOCUMENTS

No Documents Reported This Period

LEVERAGED FUNDS

Type influenced Period 2013-12-01 2014-01-31Amount $6154

Purpose Open Ocean Fish Farm AquaModel Validation

Source NOAA Office of Aquaculture

UPDATE NARRATIVE

Uploaded File Rensel_7985_update_nar....7.pdf

2013 Progress Report to Washington Sea Grant

Project : R/LME/N-6 - *Fish Aquaculture Simulation Model and GIS: Validation and Adaptation for Government Management Use*

Principal Investigator: Jack Rensel Ph.D. System Science Applications Inc.

Project Starting Date: October 2012

Progress Report Time Period: Feb. 1, 2013 to January 31, 1014

Overview

The overall goal of this project is to validate AquaModel software as a tool for government use in managing net pen aquaculture siting and operational environmental effects. In the U.S., NOAA has recently decided that net pens can be used to sustainably provide high quality seafood protein, after conducting an extensive literature survey and review[1]. Prior to the development of AquaModel, there were no such models available for fish aquaculture that performs adequately for a variety of flow and fish culture conditions.

The model produces estimates of water column and sea bottom (benthic) effects. Both require validation for use in diverse U.S. and overseas ecoregions. The project proposal and the prior progress report give more information regarding the model construction and prior applications. Model overview, prior technical reports and publications may be found at www.AquaModel.org.

Table 1 provides the status of the three field projects we have been using for validation as data sources and two alternates. We only intend to use three of five, but are providing the list to show that we have backup options. Because the U.S. lags the rest of the world both in aquaculture fish production and related environmental research, we are by necessity working with collaborators in other countries and helping NOAA with regard to its goals in the U.S.

Location	Data Type	Setup	Collaborator
British Columbia [2/]	Benthic	Completed	Department of Fisheries & Oceans
Nova Scotia	Benthic	Starting now	Dalhousie Univ. & Cooke Aquaculture
Gulf of Maine	Water Column	Well underway	Dr. David Fredriksson, Naval Academy
Puget Sound	Water Column	Underway	Rensel Associates, WDOE data
Offshore Kona Hawaii	Benthic	Well underway	NOAA Office of Aquaculture

British Columbia

In our first (three month) and second (2012) progress reports we described our ongoing modeling of a published[2] fish farm effects record in British Columbia. The setup for this evaluation is completed and initial testing of the elaborate data inputs show remarkable fidelity to the observed conditions for sediment sulfides. At this point we are redesigning the sediment sulfide calculation algorithms to reduce

[1] Sears, C.S. and J.A. Morris. 2013. Marine Cage Farming and the Environment. NOAA Technical Memorandum NOS NCCOS 164.

[2] Data from Chamberlain, J. & D. Stucchi. 2007. Simulating the effects of parameter uncertainty on waste model predictions of marine finfish aquaculture. Aquaculture 272: 296-311 and unpublished data from British Columbia DFO officials.

temporal variation and tune the submodel to the observed results. We expect to wrap up this project within the next few months by using an AquaModel utility we devised to allow users to alter all factors involved in fish culture on a daily or more frequent basis. This utility involves use of spreadsheets termed “events files” that alow the user to override the normal AquaModel system that provides optimum feed amounts with an optional percent waste feed designation.

A goal of AquaModel use is to allow users to site and configure fish farms by predicting site carrying capacity so that governments can limit fish farm production to avoid adverse changes. Many North American salmon farms operate this way, but only got there through trial and error, realignment, reconfiguration and shifting of location on a trial and error basis. AquaModel seeks to provide a more economical and sustainable approach. The results of this project will be included in a series of publications we are planning.

Nova Scotia

This project is just beginning and is a replacement for promised model validation project in the initial proposal that involved an official in the Canadian Dept. of Fisheries and Oceans in New Brunswick who was unable to fulfill his written commitment. As a result of this delay, I have arranged for a Nova Scotia project replacement and proposed to Washington Sea Grant a six month contract extension. A great deal of unpaid time has gone into setting up this project, including a week of preparation and another week of travel to Saint John, New Brunswick to give a plenary talk at an Integrated Multitrophic Aquaculture (IMTA) meeting and to host an AquaModel training workshop for government, industry and academic participants from Dalhousie University and University of New Brunswick. The travel and meeting hosting expense was paid by the Dr. Thierry Chopin of the Canadian IMTA Network (CIMTAN) University of New Brunswick as there is a high interest in the region for the use of AquaModel. Moreover, there are several researchers and companies there involved in basic and applied researchers who want to collaborate. One of the companies has consultants who have collected high quality fish farm monitoring data that they have agreed to share with us. The advantages of these data involve the quality, frequency and concurrent parameters that were collected both before and after fish farm placement and operation. We have verbally heard that the data transfer has been approved and expect to begin work on this around April 6th. These data include concurrent sediment total organic carbon and sulfides as well as current meter and farm operational records of very high quality.

Puget Sound

In routine performance monitoring for the Department of Ecology, I collected several sets of data around several fish farms to examine dissolved oxygen and nitrogen flux. Some of these data were previously published in the State of Washington Programmatic EIS on floating aquaculture that I helped prepare with a commercial contractor (Parametrix Inc.) and others. These data are useful to estimate net pen dissolved oxygen reduction and dissolved nitrogen increases downstream of salmon farms that can be compared to model predictions. As we already have a very well established Atlantic salmon physiology submodel that has been used and tested for accuracy of growth, we will apply AquaModel to these farm sites that I examined several years ago. University of Washington Oceanography Routine Chemistry Laboratory performed the highly replicated dissolved nitrogen sample analysis. The data has been worked up into a format suitable for comparing results to model performance. When the data were collected, fish farms were smaller than now, and great care was taken to wait until flow through the cages was unidirectional and approximating a pipeline. With current meter data, the measured concentrations were converted to flux estimates for comparison to model estimates.

Gulf of Maine (Validation without fish & possible Far Field NPZ project)

We have completed an assessment of how AquaModel deals with boundary input condition in a project with and without fish stocked in virtual cages in the Gulf of Maine. This work was done by Dr. David Fredriksson in partnership with Dr. Rensel using the extensive database developed from studies in the

field by the University of New Hampshire at the Isle of Shoals net pen and now mussel farm site. This work was necessary to see how AquaModel conditions inside the modeling domain varied compared to the boundary input conditions. Mostly this was done without fish and we found no unexpected changes. We are examining the possibility of using the same type of analysis in a much larger area of the Gulf of Maine to assess the use of AquaModel's native NPZ (nitrogen/phytoplankton/zooplankton) submodel. This work is possible if we can find a suitable 3D circulation model to apply, such as a FVCOM model developed at UMASS Dartmouth. We are investigating the possibility using the output from that model at to power AquaModel to test the NPZ model.

Offshore Kona Hawaii (Backup Project)

An additional alternative study site of an existing offshore fish farm near Kona, Big Island of Hawai'i is underway and can be considered as a backup project for the Sea Grant project. We have collected two months of current meter data at the site, located over 200' (61m) of depth off the west shore of the "Big Island". Five years of total organic carbon sediment data and fish stocking data are also available. This is a high current site in deep water with a coarse substrate seabottom but representative of the type of open ocean site that NOAA is particularly interested in evaluating. Some minor separate funds are available for this work through the NOAA Office of Aquaculture. This study may be considered a companion project for the Sea Grant project but the efforts we are doing in both definitely overlap.

Software Modifications

Extensive software modifications to AquaModel have been made during the project reporting period to facilitate model validation and the goals of this project. These include an all new user options interface to streamline, embellish and simplify setting up and interpreting projects. Other improvements include additional of user controls that AquaModel to input precise and complex farm operations such as moving fish among pens, harvesting, mortality accounting, adding new cages, fluctuating feed rates, etc. This utility is essential for adapting the model to each new Ecoregion in the U.S. or overseas and to account for differences among cultured species. We recommend use the built-in automated operation and optimum feed use system for most applications, but for more complex simulations, the tools are now available and working.

Problems Encountered

No insurmountable problems were encountered during this reporting period. Approximately 20 versions of EASy/AquaModel were issued in 2013 to fix bugs, add new utilities and improve the system. Software updates were shared with collaborators including NOAA-NOS, Canadian DFO staff and Chilean government and their consultants.

Out Reach Activities

Dr. Rensel traveled extensively in the U.S., the Arabian Peninsula, Chile and eastern Canada during 2013 giving nine separate presentations and seminars at scientific meetings and special events, as reported in the Sea Grant on line reporting system. Dr. Kiefer and Dr. Rensel gave a 4 day training workshop in Vina del Mar, Chile to 18 scientists from the Chilean Government and this led to a forthcoming contract to apply AquaModel there, after further validation testing sponsored by the Chilean Government. We expect the contract to be let in spring 2014.

Changes in Direction

No change in direction has been made since this research began, although as discussed above, we have had to add a replacement study sites as data from an initially planned location was not delivered as promised by a collaborator. This is not a disadvantage, as the replacement site (Nova Scotia) data is much better for model validation and worth the wait.