EVOS ANNUAL PROJECT REPORT

All recipients of funds from the *Exxon Valdez* Oil Spill Trustee Council must submit an annual project report in the following format by September 1 of each fiscal year for which project funding is received, with the exception of the final funding year in which a final report must be submitted. Satisfactory review of the annual report is necessary for continuation of multi-year projects. Failure to submit an annual report by September 1 of each year, or unsatisfactory review of an annual report, will result in withholding of additional project funds and may result in cancellation of the project or denial of funding for future projects.

PLEASE NOTE: Significant changes in a project's objectives, methods, schedule, or budget require submittal of a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.

Project Number: 040699

Project Title: Biophysical Observations aboard Alaska Marine Highway System Ferries

PI Name: Edward D. Cokelet, Calvin W. Mordy and W. Scott Pegau

Time Period Covered by Report: 1 September 2004-30 September 2005

Date of Report: 30 September 2005

1. **Work Performed:** *Summarize work performed during the reporting period, including any results available to date and their relationship to the original project objectives. Describe and explain any deviation from the original project objectives, procedural or statistical methods, study area, or schedule. Also describe any known problems or unusual developments, and whether and how they have been or can be overcome. Include any other significant information pertinent to the project.*

The Alaska Coastal Current (ACC) is important because it flows along the continental shelf of the Gulf of Alaska carrying the river runoff, nutrients and plankton that fuel this rich ecosystem. The goal of this project is to design, build, install, operate and maintain an oceanographic observation system aboard the Alaska state ferry *Tustumena* to measure the near-surface water properties of the ACC. System design, construction and installation were completed in FY04.

The ferrybox system began operation on 15 September 2004. Figure 1 shows a temperature map during the first 4 days of measurements. Movies of temperature and salinity composed of a sequence of maps like this covering the first year of operation are available on our web site at **www.pmel.noaa.gov/foci/GEM/alaska_ferry/GEM_data.html**.

Figure 2 shows a time series of near-surface ocean temperature from 15 September 2004 to 15 September 2005 as measured along *Tustumena*'s track. The thirty-day-smoothed (blue line) annual cycle of cooling and warming sets the overall pattern. Superimposed high-frequency variations (red line) come from spatial differences along the track as the ship moves between

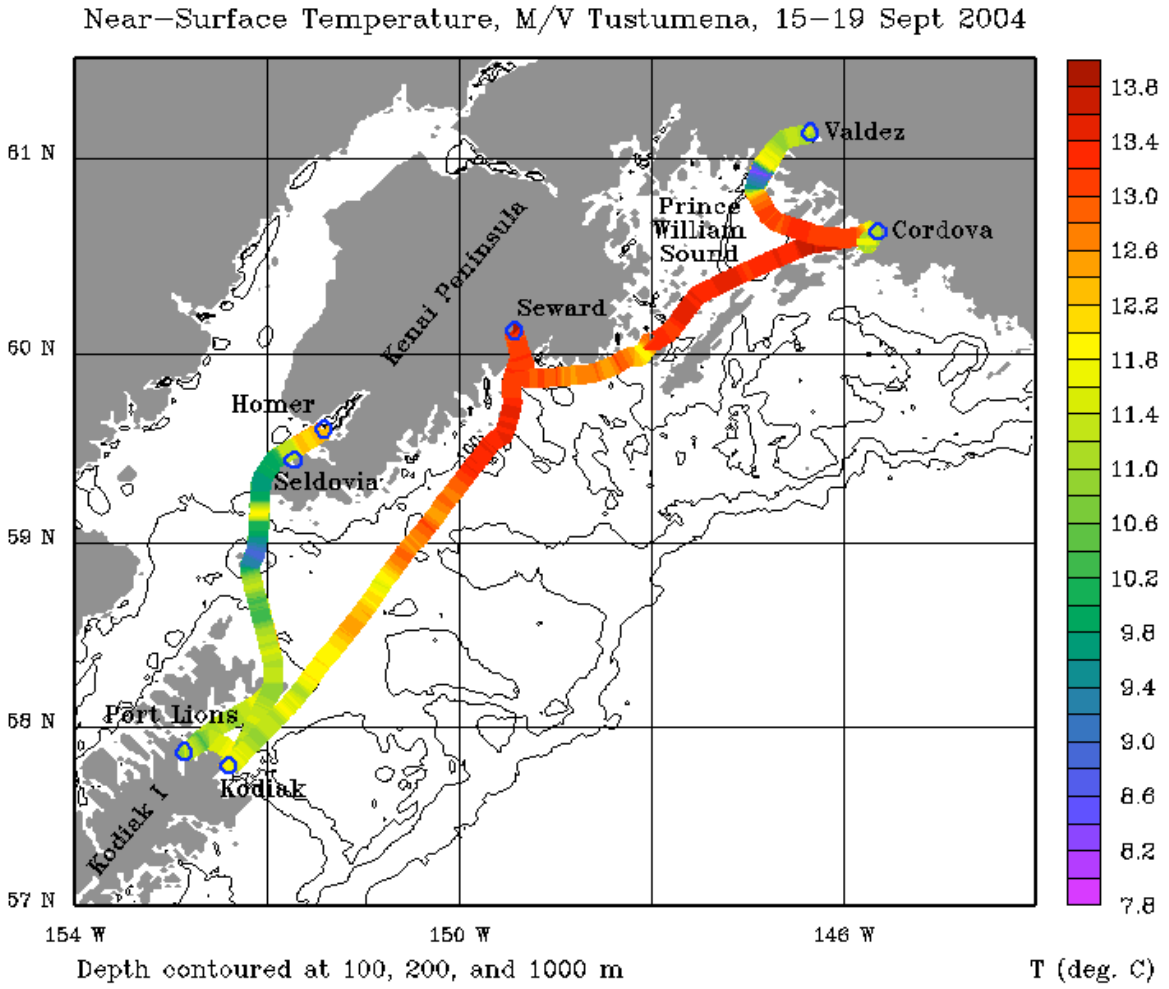

Figure 1. Near-surface ocean temperature along *Tustumena*'s ship track in the Gulf of Alaska.

confined and open water. Temperature extremes occur in bays such as Kachemak Bay (near Homer), Resurrection Bay (near Seward) and Prince William Sound. Sheltered from winds and subject to freshwater inflow and ice from rivers and glaciers, confined surface waters can cool in winter to form ice, or warm in summer in thin, stratified layers.

Figure 3 showing time series of near-surface ocean salinity measured along the *Tustumena*'s track is dominated by high-frequency variations (blue line) due to spatial differences as the ship moves between bays and the open ocean. Fresher surface water occurs near river mouths and

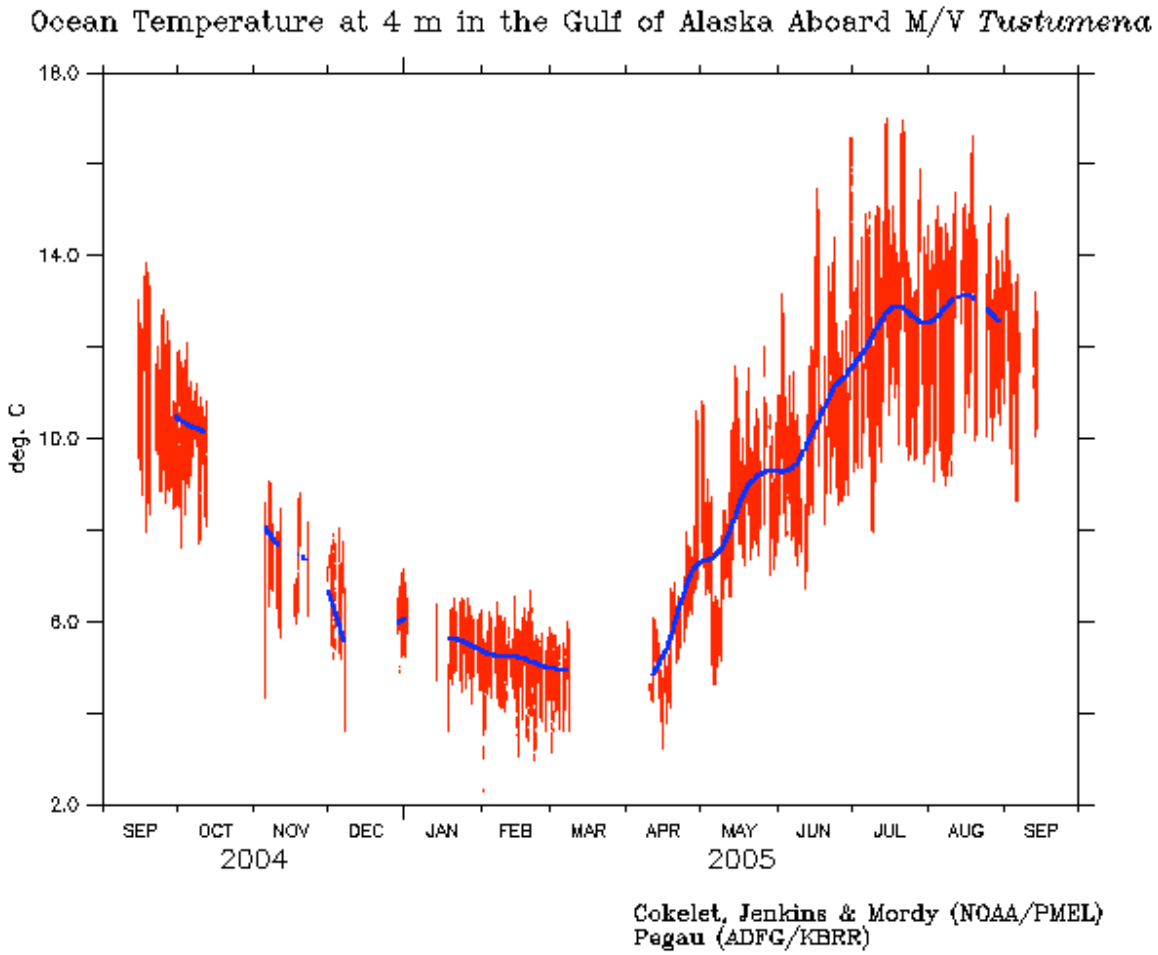

Figure 2. The annual cycle of near-surface ocean temperature in the Gulf of Alaska.

glaciers when temperatures are warm enough for melting. During winter, salinity variability is reduced because freezing binds the fresh water into ice.

The ferrybox project has been very successful. We achieved our objectives and more. One enhancement has been the Iridium satellite-telephone delivery of data. We originally proposed to put our data onto the ship's computer network to be downloaded automatically when *Tustumena* entered port. However the Alaska Marine Highway System's network became unavailable to us because of additional passenger manifest requirements imposed by Homeland Security rules. Therefore by enhancing technology under development at NOAA/PMEL, we designed a system to download the oceanographic data hourly via Iridium satellite telephone. This gives near-real-time access to the data and removes dependence on proximity to land. It also provides a two-way system whereby we can change the sampling program with the ship still at sea.

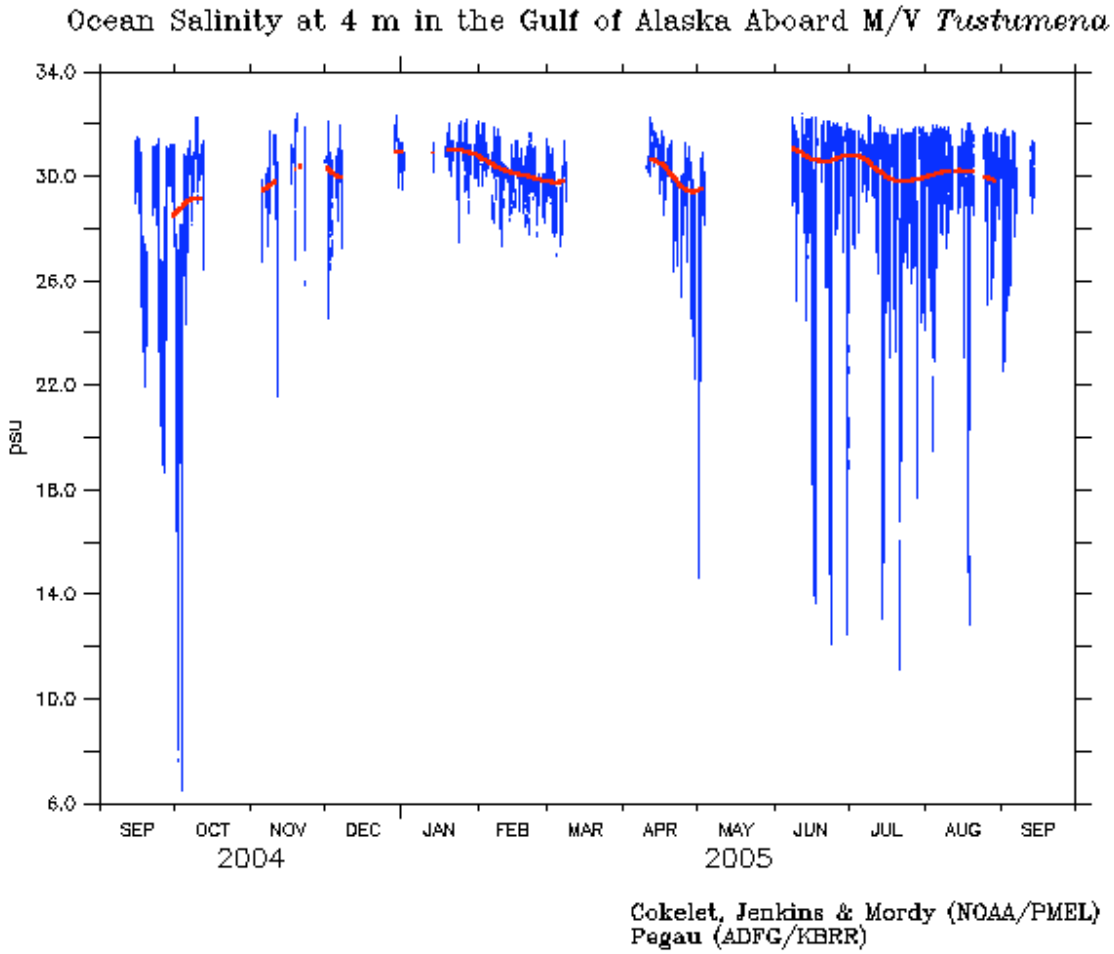

Figure 3. The annual cycle of near-surface ocean salinity in the Gulf of Alaska.

We have encountered and solved two main problems since beginning operation – bubbles and fouling. Air bubbles entered the system especially when the ship backed down in port or operated in heavy seas. We added two air vents with float valves to the plumbing and re-plumbed the intake line to promote bubble rise and expulsion.

We designed for fouling from marine organisms by incorporating an along-flow sequence of finer and finer screens and filters. Some require weekly hand cleaning and others are back-flushed automatically. However we encountered chemical fouling, too. This was new to the oceanographic community because we employed a new type of instrument – an optical nitrate sensor. These instruments rely upon the backscatter of ultraviolet light to measure the concentration of dissolved nitrate – a nutrient essential for phytoplankton growth. Our sensor would fail after a day of operation when the backscattered signal became too small. This posed a mystery because the sensor optics looked clean to the naked eye. The instrument manufacturer

could provide little useful guidance. One of us arranged to give a presentation at the American Society of Limnology and Oceanography (ASLO) summer meeting where an international group of ferrybox researchers gathered. A few researchers had encountered the same problem, and German colleagues came up with a solution. It turns out that rust in the water aboard ship combines with organic molecules to produce an iron-organic film that coats the optical sensor. The film is only a few molecules thick, but it is sufficient to attenuate the ultraviolet light and render the measurement useless. They solved the problem by cleaning with oxalic acid. We have instituted a weekly cleaning procedure, and our nitrate sensor began to work. We are embarking on a auxiliary measurement program to calibrate it against a chemically based sensor and water samples.

2. **Future Work:** *Summarize work to be performed during the upcoming year, if changed from the original proposal. Describe any proposed changes in objectives, procedural or statistical methods, study area, or schedule. [**PLEASE NOTE**: Significant changes in a project's objectives, methods, schedule, or budget require submittal of a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.]*

Future work will be performed as originally proposed. We plan another year of observations.

3. **Coordination/Collaboration:** *Describe efforts undertaken during the reporting period to achieve the coordination and collaboration provisions of the proposal, if applicable.*

No specific coordination/collaboration provisions were mentioned in the proposal other than that amongst the proposers at NOAA/PMEL, Kachemak Bay Research Reserve and the University of Washington/JISAO. However, one justification of this research as cited in the original EVOS request for proposals is to provide measurements to which numerical model results can be compared. Preliminary comparison has begun between these measurements and the GLOBEC Northeast Pacific Regional Ocean Model System (ROMS).

4. **Community Involvement/TEK & Resource Management Applications:** *Describe efforts undertaken during the reporting period to achieve the community involvement/TEK and resource management application provisions of the proposal, if applicable.*

The Alaska Marine Highway System has cooperated with the project by granting permission to install instruments on the ferry *Tustumena*. AMHS Port Engineering staff and the ship's captains and crew assisted in various ways and have hosted us during system maintenance. A computer display in *Tustumena*'s passenger lounge gives project background, acknowledges EVOS/GEM and shows maps of the ship's position and oceanographic variables measured underway. Seward Ship's Drydock made some plumbing modifications this year.

5. **Information Transfer:** *List (a) publications produced during the reporting period, (b) conference and workshop presentations and attendance during the reporting period, and (c) data*

*and/or information products developed during the reporting period. [**PLEASE NOTE:** Lack of compliance with the Trustee Council's data policy and/or the project's data management plan will result in withholding of additional* project funds, cancellation of the project, or denial of funding for future projects.]

(a) Publications – none to date.
(b Conference and workshop presentations:

"GEM Biophysical Observations Aboard an Alaska State Ferry" by E. D. Cokelet, A. J. Jenkins, W. S. Pegau, C. W. Mordy and M. E. Sullivan, presented at the Marine Science in Alaska 2005 Symposium, 24-26 Jan 2005, Anchorage, AK.

"GEM Biophysical Observations Aboard an Alaska State Ferry" by E. D. Cokelet, A. J. Jenkins, W. S. Pegau, C. W. Mordy and M. E. Sullivan, presented at the NOAA/FOCI seminar series, 16 Feb 2005, Seattle, WA.

"Biophysical Observations Aboard an Alaskan State Ferry" by E. D. Cokelet, A. J. Jenkins, W. S. Pegau, C. W. Mordy and M. E. Sullivan, at the ASLO Summer Meeting 2005, 19-24 June 2005, Santiago de Compostela, Spain.

(c) Data and/or information products – see web site www.pmel.noaa.gov/foci/GEM/alaska_ferry

6. **Budget:** *Explain any differences and/or problems between actual and budgeted expenditures, including any substantial changes in the allocation of funds among line items on the budget form. Also provide any new information regarding matching funds or funds from non-EVOS sources for the project. [**PLEASE NOTE:** Any request for an increased or supplemental budget must be submitted as a new proposal that will be subject to the standard process of proposal submittal, technical review, and Trustee Council approval.]*

Expenditures were in line with the projected budget. Some unbudgeted plumbing modifications were needed this year to reduce air-bubble infiltration.

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SUBMIT ANNUAL REPORTS ELECTRONICALLY TO brenda_ramos@evostc.state.ak.us. THE REPORTS WILL BE POSTED ON THE TRUSTEE COUNCIL'S WEB SITE AND SHOULD ALSO BE POSTED ON THE PI'S WEB SITE. The subject line of the e-mail transmitting the report must include the project number and the words "annual report" (e.g., "035620 Annual Report"). Electronic reports must be submitted either as an Acrobat Portable Document Format (PDF) file or word processing document (Microsoft Word 2000 for Windows or lower or WordPerfect 9.0 or lower) with any figures and tables imbedded. Acrobat PDF 4.0 or above file format must be used, preferably in 'formatted text with graphics' (called "PDF normal" under Acrobat PDF 4.0) format. Minimally, "PDF searchable image" (called "PDF original image with hidden text" under Acrobat PDF 4.0) may be used if pre-approved by the Trustee

Council Office. In either case, the PDF file must not be secured or locked from future editing, or contain a digital signature from the principal investigator.