EVOSTC ANNUAL PROJECT REPORT

Recipients of funds from the *Exxon Valdez* Oil Spill Trustee Council must submit an annual project report in the following format by **Sept. 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). **Please help ensure that continued support for your project will not be delayed by submitting your report by Sept. 1. Timely receipt of your report allows more time for court notice and transfer, report review and timely release of the following year's funds.**

Satisfactory review of the annual report is necessary for continuation of multi-year projects. Failure to submit an annual report by **Sept. 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: 10100132A

Project Title: Prince William Sound Herring Survey: Plankton and Oceanographic Observations

PI Name: Robert W. Campbell

Time period covered: Oct 1.2011 – Sept. 1 2012

Date of Report: August 20, 2012.....

Report prepared by: Robert W. Campbell

Project website (if applicable): .....

Work Performed: *Summarize work performed during the reporting period, including any results available to date and their relationship to the original project objectives. Explain deviations 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.*

Cruises were conducted in September and November 2011, and April, May, June, July and August 2012; on most cruises the standard cruise track (fig. 1) was followed. At each station, a CTD cast was done, water filtered for chlorophyll-a analysis and water samples collected for nutrient analysis, and a plankton net tow done. CTD data is available shortly after each cruise following some semi-automated processing routines, and zooplankton taxonomy and chlorophyll-a analysis are currently up-to-date.

In order to put the data collected under this project into context, we have been working to pull together data from prior work in the region. Hydrographic data (pressure, temperature and salinity) have been compiled from a variety of sources, including the National Oceanographic Data Center (most data prior to 1980) and databases compiled by the Institute of Marine Science at the University of Alaska Fairbanks and by the Prince William Sound Science Center (including the CTD data collected during prior EVOSTC funded projects, most notably the SEA project data). Most data were not provided with any indication of data quality, and data were checked with automated routines for physically unrealistic values, and also checked by eye. Of 9695 total casts, the best temporal resolution was within central PWS (fig. 2), which contained a subset of 190 casts (inside the red box, fig. 2). The complete records of temperature and salinity in the surface layer (top 100 m) are shown below (fig. 3).

This time series could charitably be called patchy (with the notable exception of the SEA years and the past two years), but is a 35 year record of depth-specific hydrographic data in the region. To deal with gaps in the time series, the annual progression of surface temperature (2 m depth) was modeled as a simple sine function:

$$T(t) = y_0 + a \sin\left[\frac{2\pi t}{b} + c\right] \qquad (1)$$

Where T is temperature, t is time, and y_0, a, b, and c are fitted parameters. The parameter a varies with the amplitude of the sine function (larger numbers indicate higher temperatures), and b and c vary with phase (the timing of the peak). Using the entire data record, the fit to the model is quite good (r^2=0.91, fig. 4), this can be considered a composite "annual cycle", from which we may examine departures of individual observations.

Having fit all the data to the sine model, we then fit the model to each individual year in the dataset, using only years that had >5 casts done within the year. This permits us to create time series of the model parameters (fig. 5), which indicate how individual years differ from the composite annual cycle. The time series of the fitted parameters (fig. 5) show a trend, although a linear fit did not describe the data particularly well. However, the model shows an increase in the amplitude parameter over time, indicating an increase in peak temperature. The phase parameters also indicate a shift towards later timing in recent years. Substituting in the parameters from the linear fits suggests that from 1976 to 2011, surface temperature increased by 0.7°C, and the timing of peak temperature has shifted from August 25 to Sept. 9, a difference of 15 days.

A similar treatment has also been done with surface salinity. Salinity does not fit a simple sine curve, so a second order sum-of-sines model was used instead:

$$S(t) = \sum_{i=1}^{2} a_i sin[2\pi b_i t + c_i] \qquad (2)$$

Where S is salinity, t is time, and a, b and c are fitted parameters. This model fits the data reasonably well (r^2=0.75, fig. 6), but has a much larger number of parameters, which are not easily interpretable or sensible as a time series. Assuming that the model represents the annual cycle of surface salinity, the deviation of individual data points (i.e. the residuals) may be used to examine how individual time points differed from the composite annual cycle over time (fig. 7). Most differences appear to have occurred during summer (June-Sept.), with fresher than normal conditions in the early 90's and more saline conditions more recently. This may be a reflection of changes in the circulation in central PWS (which is driven by freshwater inputs and tides.

Most recently, we have been able to obtain databases from UAF that contain the zooplankton taxonomy data from the collections made during the SEA project; those data will be directly comparable to the zooplankton data collected by this project. The databases are not in an immediately accessible format - the software used to create the database is no longer maintained, so we must first interpret the data files we have received into a format that may be used to query the data. It is our hope that that interpretation may be done as part of the data rescue activities of the LTM project.

Deviations to objectives, methods, study area or schedule

No deviations have been made from the objectives, methods or study area. The project is slightly behind schedule in terms of the analysis of 2012 nutrient samples, we prioritized catching up on the backlog of zooplankton and chlorophyll samples and have let the nutrient samples accumulate (they are stable indefinitely in the freezer). A Capillary Electrophoresis unit was purchased for nutrient analysis in 2012, and we are currently developing the nutrient

analysis protocol. Once the instrument is set up, we will be able to process the samples very quickly, in a matter of weeks.

Problems and developments

The PWSSC research vessel New Wave was in the shipyard for a refit and repower in early 2012, and was back in the water in April, when the first cruise of the year was done. This was later than expected or desired, but the soonest possible start given a very extensive refit, and a difficult winter (aka "Snowpocalypse"). The refit vessel has been performing very well (all cruises so far have gone very smoothly), and is considerably more efficient and reliable.

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

No changes are planned to the objectives outlined in the proposal. We will continue to play catch-up on the analysis of nutrient samples into the upcoming year and will continue to prioritize samples that are required for other subcomponents of the herring and LTM projects.

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

Joint cruises were done with Evelyn Brown ("PWS herring survey: Sound Wide Juvenile Herring, Predator, and Competitor Density via Aerial Surveys") in July and August. A custom camera mount was installed aboard the New Wave, to ground truth aerial observations of fish schools. Plankton and environmental (temperature, salinity, chlorophyll-a and turbidity) data has also been passed on to the energetics group supervised by Ron Heinz ("PWS Herring Survey: Predictors of Winter Performance in YoY Herring from PWS") as soon as possible following the joint cruises.

Although not in the proposal, there has also been coordination with other projects as well. A group from Texas A&M was assisted with benthic sampling in Simpson Bay (the bay chosen for more intensive study by the herring project) in July 2012. Herring collections and some whale observations were also done with JJ Vollenweider from the Heintz energetics group in July 2012. Water samples for CO2 analysis have been collected for researchers at the Ocean Acidification Research Center at UAF.

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.

Results and updates from this first year's work have been disseminated in articles in the local paper, on local radio, and updates to the PWSSC blog, in coordination with Scott Pegau's outreach activities.

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. ***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.*

No publications were submitted during the reporting period; as outlined in the proposal, the intention is to have another annual cycle covered before beginning a full analysis. Data is being archived in a consistent format and is available to all members of the project. Some preliminary results of the analysis of the hydrographic data presented here was presented at the Alaska Marine Science Symposium in January 2012.

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.
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.*

There have been no significant differences or problems between actual and budgeted expenditures, beyond delays in charging some of the salary allocations. We will work to address those delays as quickly as possible. The Alaska Ocean Observing System (AOOS) has shared some ship time with the project.

We can accept your annual report as a digital file (Microsoft Word or WordPerfect), with all figures and tables embedded. Acrobat Portable Document Format (PDF) files (version 4.x or later) are also acceptable; please do not lock PDF files or include digital signatures.

Please submit reports electronically in ProjectView or by email to catherine.boerner@alaska.gov. Also, please be sure to post your annual report on your own website, if you have one.

We appreciate your prompt submission of your annual report and thank you for your participation.

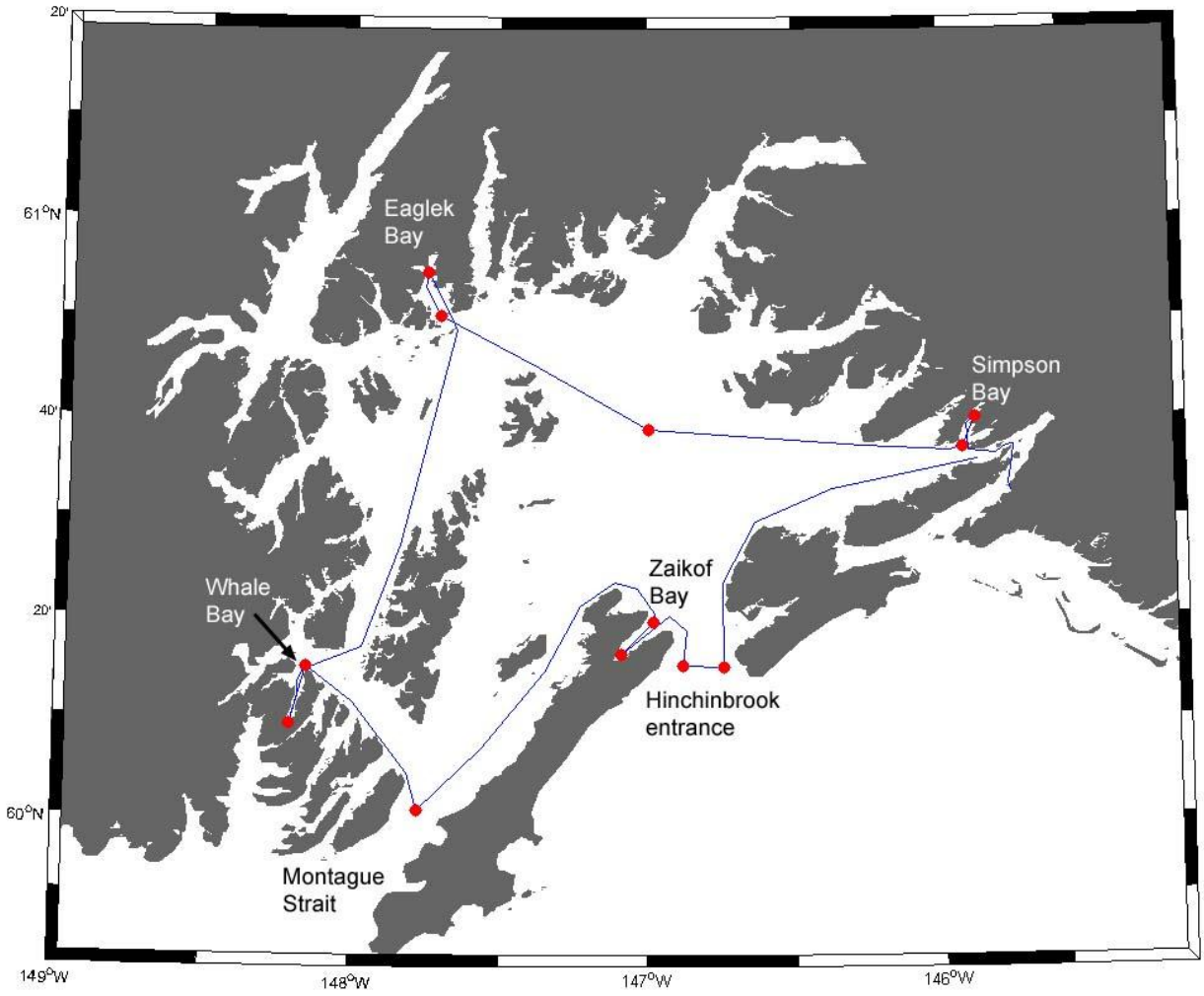

Figure 1: The standard cruise track, the route is generally done clockwise to be able to pick favorable weather in Hinchinbrook Entrance. Two stations are done in each of the SEA bays, one at the head, one at the mouth. Additional stations are done on the west and east sides of Hinchinbrook Entrance, in Montague Strait, and in central PWS.

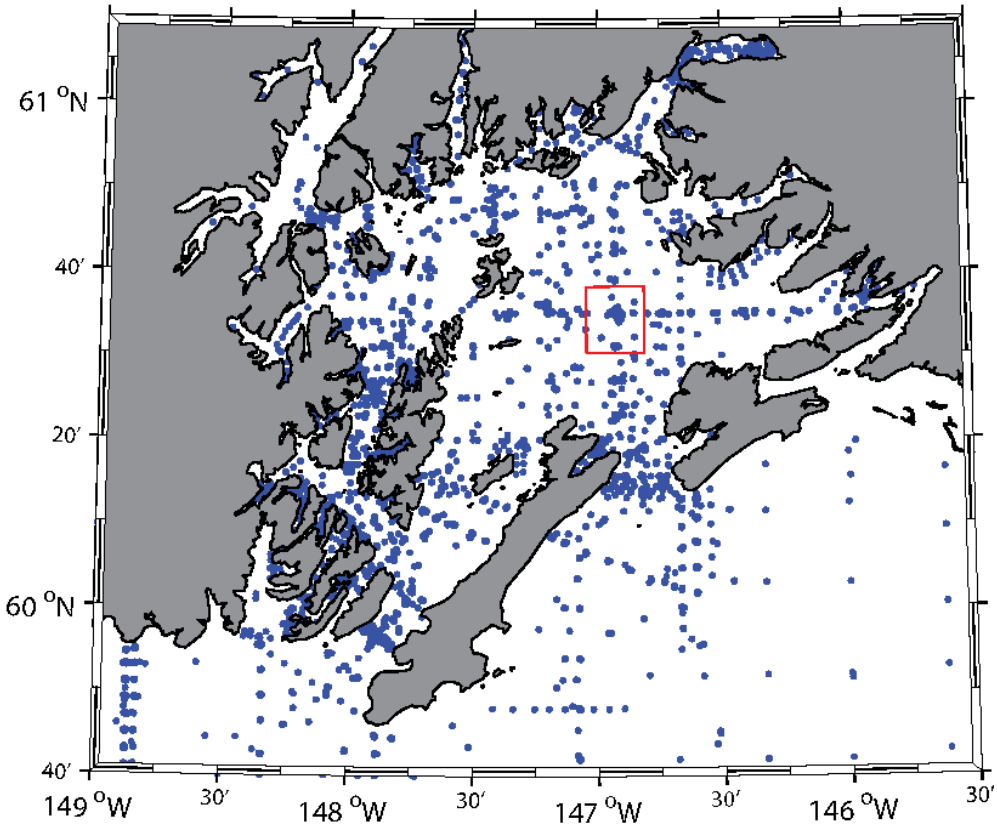

Figure 2: Positions of CTD casts in the PWS region, all years.

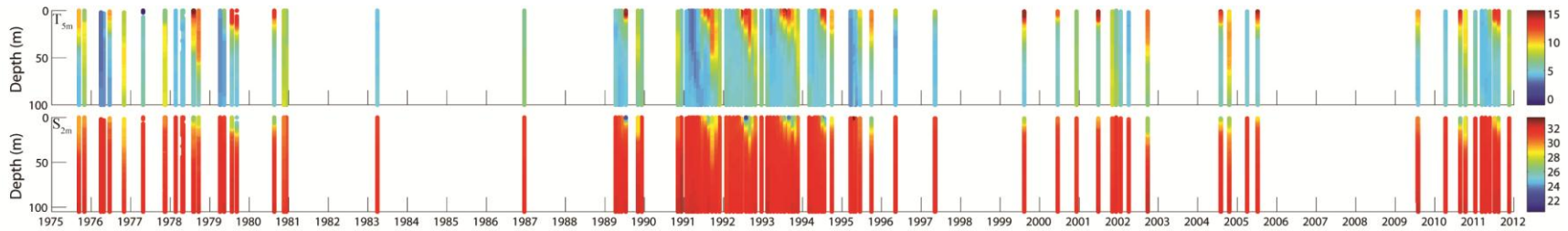

Figure 3: Time series of temperature (top, ^{o}C) and salinity (bottom) by depth in central PWS (defined by the red box in fig. 2).

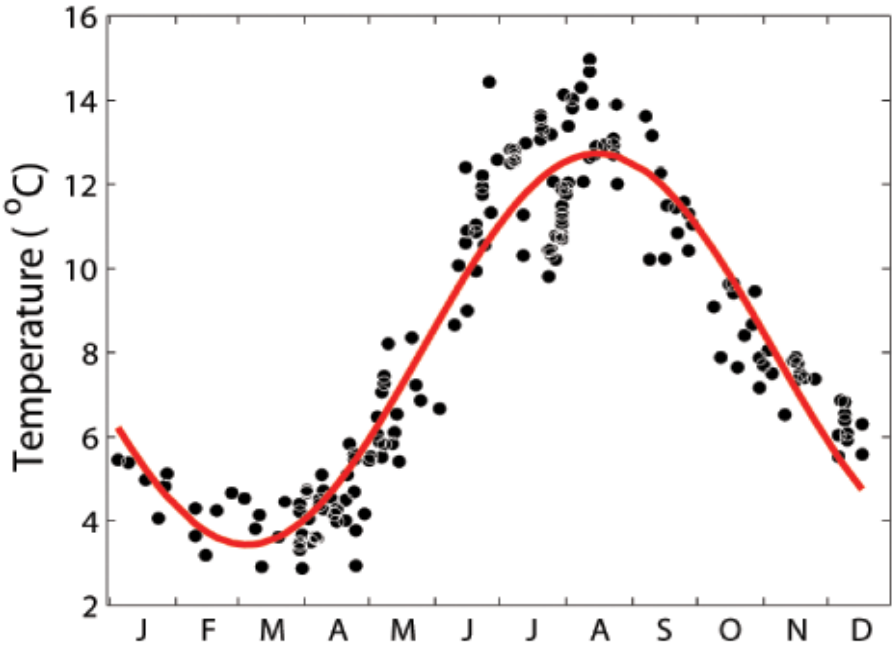

Figure 4: Time series of surface temperature (2 m depth) in central PWS, using all data in the database (i.e. combining all the data into a composite "annual cycle"), and the fit from the sine model (eq. 1, red line).

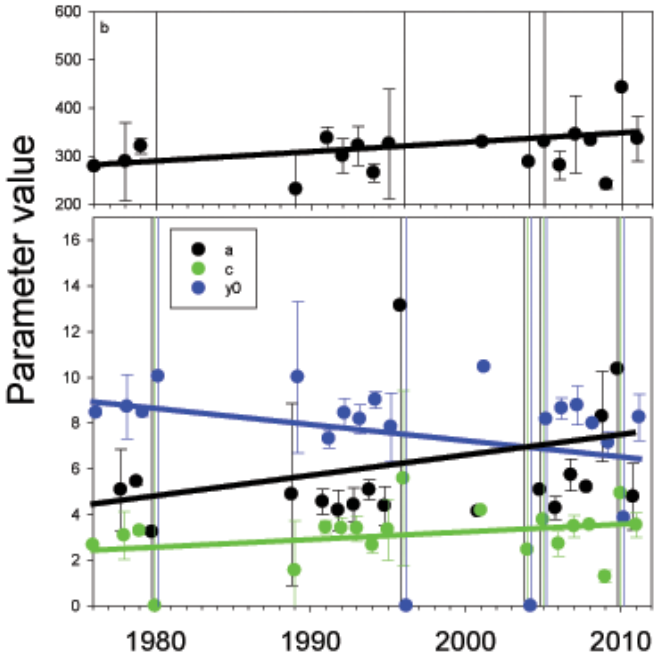

Figure 5: Time series of parameters from the sine model (eq. 1), as estimated by fitting each year to the model. Parameter b is broken out into its own panel (top) to facilitate better scaling. Bars indicate 95% confidence intervals of the parameter estimates.

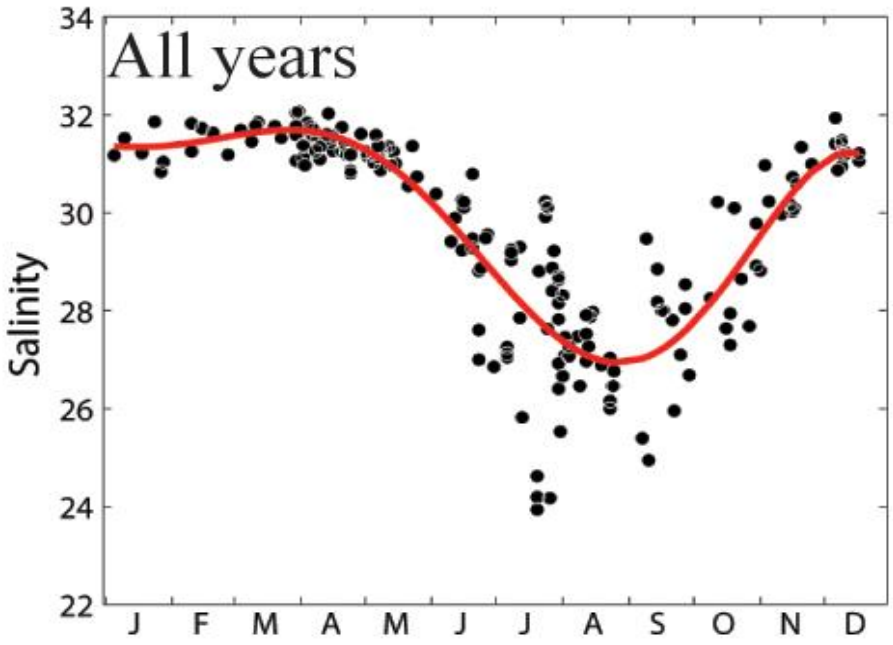

Figure 6: Time series of surface salinity (2 m depth) in central PWS, using all data in the database (i.e. combining all the data into a composite "annual cycle"), and the fit of the sum-of-sines model (eq. 2, red line)

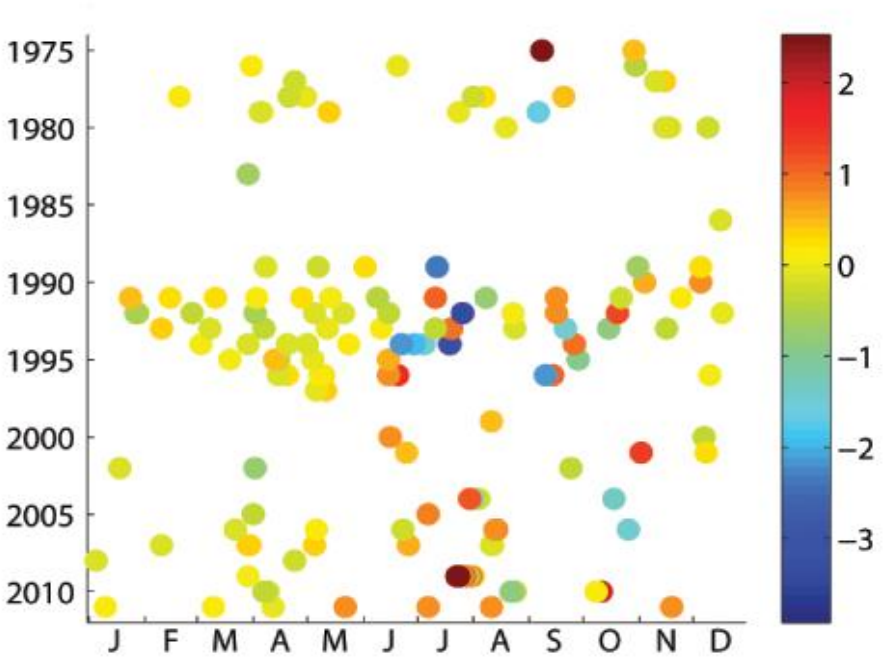

Figure 7: Heat map of the deviation of individual observations of surface salinity from the sum-of-sines model (eq. 2, fig. 6). Hot colors indicate positive deviations ("saltier"), and cold colors indicate negative deviations ("fresher").