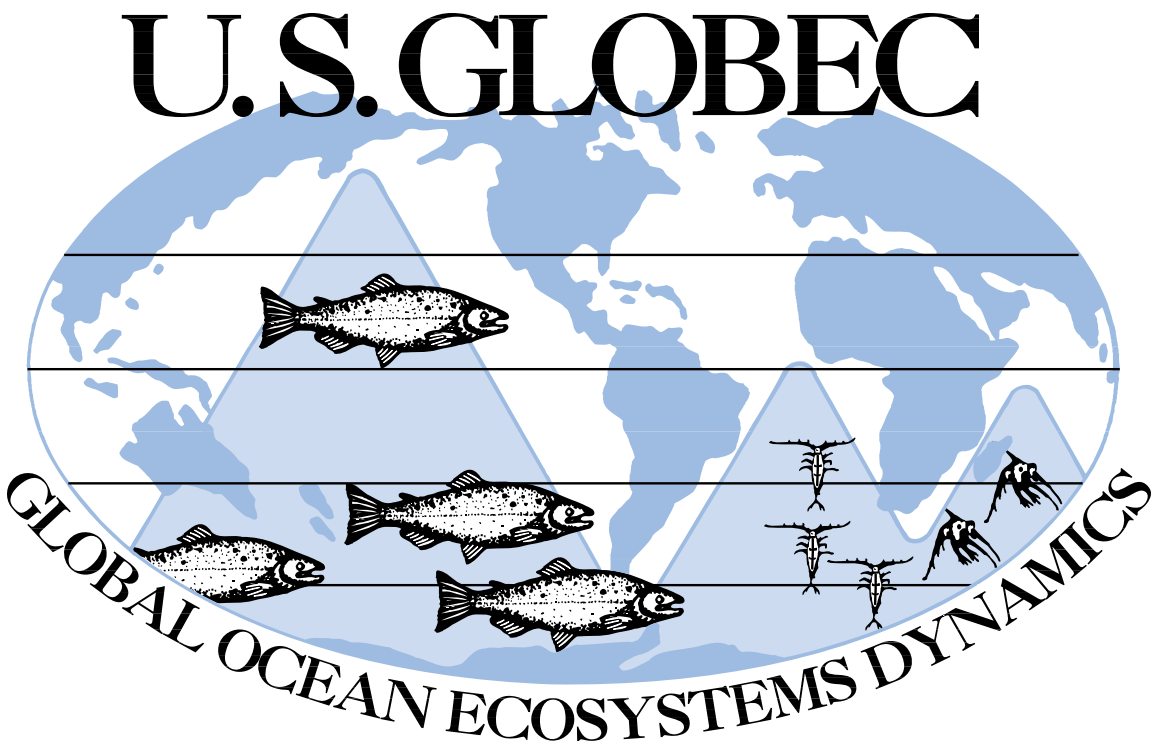

A Component of the U.S. Global Change Research Program

A Coordinated Response to the ENSO 1997-98 with Emphasis on Ecological Impacts

Summary of a Meeting held July 11, 1997 in San Francisco

U.S. Global Ocean Ecosystems Dynamics

July 1997

Executive Summary

Since the early 1980's, there has been marked improvement in remote sensing and modeling of El Niño's, such that it can be stated with some certainty that an El Niño will occur in 1997-1998. The evidence available to date suggests that it may be as strong or stronger than the 1982-83 El Niño. A group of oceanographers, representing a number of west coast programs, and variety of disciplines, met to develop a coordinated response of the research community to examine the propagation and impacts of this El Niño along the Pacific coast of the U.S. and Canada. The goal was to 1) provide a summary of ongoing and newly funded research/monitoring along the Pacific coast; 2) identify critical types of observations or specific regions where data are missing (gaps); and 3) provide guidance for filling those gaps. **Two major goals of an enhanced monitoring program on the west coast are 1) to document the alongshore response of ocean conditions as the El Niño propagates northward along the Pacific coast of North America; and 2) to document the impacts of the anomalous conditions associated with a major El Niño on the nearshore, coastal ecosystem of the Northeast Pacific.** Many of the research programs along the west coast are not directed specifically at El Niño; however, a major 1997-1998 El Niño would impact ocean conditions and ecological interactions along much of the west coast. Small changes in focus, perhaps accompanied by small, incremental enhancements of funds, could dramatically improve sampling at sites along the coast likely to be impacted by El Niño. However, in no respect should these changes be viewed as altering the fundamental long-term missions/goals of these established programs.

Four general needs of a coordinated ENSO monitoring effort are: 1) increased sampling of subsurface observations; 2) broader sampling of ocean chemistry and biology, including nutrients and multiple trophic levels; 3) sampling at many locations along the west coast, at as high a frequency as affordable; and, 4) establishment of a more effective communication network to coordinate the many sampling and monitoring activities that occur along the west coast.

Generally, we are much better placed presently to document the physical manifestation of El Niño conditions along the west coast than we are for biological aspects of the ecosystem. The network of observation sites, including moorings, NDBC buoys off California, tide gauges and shore temperature stations at a number of locations, and survey transects and grids in place now is nearly capable of documenting the physical manifestation of an El Niño as it propagates poleward along the North American west coast. If the network is supplemented in a few sites by a) beginning programs earlier than their intended starts, b) continuing existing programs beyond their scheduled completion, or c) augmenting existing programs, physical aspects of this prospective ENSO will be recorded satisfactorily. The coastwide sampling outlook is not as favorable for nutrient and biological variables. As for the physics, some improvement in chemical and biological sampling could be obtained by beginning projects prior to their official start dates. However, some regions do not have ongoing or planned sampling of biology at all, nor are there research cruises ongoing to which additional biological sampling could be added. In other regions it might be possible to obtain additional biological sampling for minimal cost, because research cruises are already taking place for other reasons.

I. Background and Goals

In 1982-83, the largest short-term climate anomaly of the 20th century occurred, when a massive El Niño created warm temperatures and deeper thermoclines along most of the coast of North America, from the equator to the northern Gulf of Alaska. At the time, El Niño prediction and precursors were unreliable, and the El Niño occurred unexpectedly. Consequently, with little warning, the research community along the Pacific Coast, were unable to mobilize effectively to document the propagation of the El Niño conditions from the tropics to the extratropics and the effects of the El Niño on the ocean ecosystem. In the 15 years since the 1982-83 El Niño, great progress has been made in forecasting the development of El Niño conditions. Much of this progress is due to three major developments: 1) greatly expanded satellite remote sensing capability; 2) improved ocean and atmospheric monitoring Pacific-wide, but especially along the equator (TOGA-TAO array) where the El Niño conditions are forced and first evident; and, 3) improved coupled atmospheric-ocean modeling that can project temperature and ocean conditions 3 to 12 months ahead. Because of this progress, we can state with some certainty that an El Niño will occur in 1997-1998. Moreover, the evidence available to date, suggests that this El Niño may be as strong or stronger than the 1982-83 event. Also, anomalously warm ocean temperatures and high sea levels along the Pacific coast of North America during March-June 1997 are likely due to local phenomena (anomalous Ekman pumping and local winds), rather than the emerging El Niño. The consequences of warmer, less productive conditions associated with a major El Niño, on top of already anomalous conditions, could be disastrous for the marine life of the region.

Given the likelihood of a major El Niño propagating to the northern Pacific extratropics in the fall 1997 to summer 1998 period, a group of researchers from the west coast met in San Francisco for a one day workshop to discuss how to develop a coordinated response to examine the propagation and impacts of this El Niño event along the Pacific coast of the U.S. and Canada. Appendix 1 list the researchers who attended the workshop. Table 2 provides the workshop agenda.

Two major goals of ENSO 97-98 Research

(1) Document the alongshore response of ocean conditions as the El Niño propagates northward along the Pacific coast of North America--ideally to distinguish locally forced from remotely forced changes. Critical to this goal are measurements of surface, and **subsurface**, conditions at many sites along the coast.

(2) Document the impacts of the anomalous conditions associated with a major El Niño on the nearshore, coastal ecosystem of the Northeast Pacific—response variables might include the distribution (perhaps northward shifts; range extensions; exotics) of species, and the production of the ecosystem at several trophic levels (primary, secondary, fish, birds, etc.).

II. Ongoing or Planned Monitoring of Ocean Conditions along West Coast

Three speakers described the large scale view of ENSO and the impacts of El Niño on the ocean ecosystems of high latitudes.

Using a computer animation, Howard Freeland provided an overview of the high-latitude ocean conditions from 1981 to the present, and used the 1983 and 1992 El Niño events as examples to demonstrate the impacts of El Niño on temperatures in the North Pacific. For both of those El Niño's, SST off of British Columbia were ca. 2-2.5°C above normal. Long-term records of nutrient concentrations along Line P, from the Strait of Juan de Fuca to Station P, show that the region of low wintertime nitrate concentration has expanded further offshore in recent decades. This has occurred independently of El Niño's and may be a response to the longer term "regime shift" that occurred in the North Pacific. The significance of the lower wintertime nitrate concentrations is that springtime primary production reduces the concentration to limiting levels over a much larger region of the North Pacific now than in earlier periods. Changes in the thermal structure and mixed layer depth associated with the El Niño at mid-to-high latitudes could reduce production even further.

Biological impacts of the 1983 El Niño were large. For instance, during non-El Niño conditions, 80% of Fraser River Sockeye salmon normally return via the southern route around Vancouver Island, BC. During the 1983 El Niño however, ca. 80% of the salmon returned by the northern route. Moreover, during the warm conditions of the early 1990s, mackerel populations were much further north than usual. Mackerel are predatory on essentially everything that they can physically consume. Mackerel sampled from Barkley Sound in the 1990's had 5-8 juvenile salmon in their guts. Survival and return of salmon from hatchery releases in western Canada declined from ca. 5% (before the warm 1990's) to ca. 0.02%--a major decline.

Ed Harrison provided an overview of the large scale temporal-spatial developments of the last four major El Niños (1977, 1983, 1988, 1992). It is clear that the different ENSO's have different temporal-spatial SST anomalies, and that there is no single "typical El Niño".

Tim Liu showed a sequence of images (and a movie) from the NASA Scatterometer that indicated two marked events of westerly winds in the western equatorial Pacific in the last few months, and showed how those anomalous winds resulted in a wave of sea level (from TOPEX) and sea surface temperature anomalies (from AVHRR) that progressed from west to east along the equator in the Pacific.

Mark Abbott noted the need for broad and expansive spatial coverage--both from satellites and in situ observations, especially subsurface)--to document the progression of El Niño conditions from the eastern tropical Pacific to the extratropics in the Northern Hemisphere.

Tom Powell described briefly the projects (PI's and titles) that were funded recently by NSF and NOAA to begin the U.S. GLOBEC NEP program. Three in particular are relevant to monitoring ocean conditions:

1) Strub et al: Remote sensing of the Northeast Pacific: retrospective and concurrent time series analysis using multiple sensors on multiple scales

2) Weingartner et al.: Physical-chemical structures, primary production and distribution of zooplankton and planktivorous fish on the Gulf of Alaska shelf: a GLOBEC monitoring proposal

3) Smith et al.: Pilot monitoring off Oregon for climate change studies in the Eastern North Pacific. More specific details about these projects is provided below.

Powell emphasized that efforts to provide more comprehensive and coordinated sampling of the impending ENSO by NEP-GLOBEC were not a redirection to become an "ENSO impacts" program. The mission of the NEP program is to sample the physics and biology of the region at ALL space and time scales. El Niño is a dominant signal in the spectrum, and the program should, to the extent feasible, prepare to sample the one expected later this year and next. Similar arguments hold for other supported science programs (PNCERS, etc.) in the region--namely, that **these programs are not detouring from their fundamental goals** to study El Niño.

Tom Weingartner provided additional details about their recently funded U.S. GLOBEC monitoring project on the Gulf of Alaska shelf (the Gulf of Alaska (GAK) line off Seward). Their project will be sampling the hydrography, velocity fields, nutrients, phytoplankton, zooplankton and fish along the GAK line on six cruises per year--determined to coincide roughly with biological seasonality (e.g., spring bloom, salmon outmigration, etc.). Sampling will occur from very near shore to ca. 150 km off shore. Sampling is not scheduled to begin until March of 1998, and the question arose--Is there some way to begin the funding early to enable sampling the fall and winter conditions this year prior to the projected arrival of the peak of the El Niño conditions? According to Weingartner, shiptime is available. It was also noted that eddies are spawned off Yakutat and Sitka and propagate westward in strong El Niño years. It might be possible to use the TOPEX altimeter to track these eddies if they form this year.

Jack Helle reviewed the data collection/surveys that are being conducted by the Ocean Carrying Capacity (OCC) program. Although the abundance (catch) of salmon is at historic highs in Alaska in recent years, the individual weights of the fish in 1994 have declined (long-term trend) ca. 40% (in some species and stocks) from the sizes caught in the early 1970's. Interestingly, the size of the 1995 and 1996 fish are significantly larger than the 1994 fish, raising the question of why--perhaps there has been another "regime shift"? The OCC program will be conducting surface trawling, using a chartered trawler, from mid-July to mid-August in 1997, 1998 and 1999. Trawling is done from Dixon entrance westward to the Aleutians. Similar trawling was done last year. This year, CTD's and plankton sampling will be done in addition to the trawling. In addition to this offshore sampling, the RV John Cobb will conduct fish and plankton sampling in inshore regions of southeast Alaska.

Howard Freeland briefed the group on sampling that is ongoing in Canada. First, he noted that DFO-AES (Department of Fisheries and Oceans-Atmospheric Environment Service) has 16 buoys that have been collecting data routinely--some for as long as ten years. That data is made available in near real time via a web site (http://www.ios.bc.ca/ios/osap/dispwx.htm). The La Perouse program off Vancouver Island will continue to sample south of Barkley Sound, which includes three current meter moorings, CTD survey cruises every 6 weeks, and zooplankton sampling. Adding phytoplankton sampling to the program is being considered. The Institute of Ocean Sciences will continue its approximately quarterly monitoring of hydrography and nutrients along Line P with cruises in Aug-Sept 97 and February 98. The use of aircraft to drop AXBT's once per month along Line P is under consideration. David Welch has a cruise that will sample out to Stn Papa, then north along 145°W to Alaska. There may also be two moorings deployed along 145°W near the Alaskan shelf by the Canadians. These could be moved to offshore of the GAK (Seward) line if it were clearly advantageous to do so.

Barbara Hickey discussed a variety of programs that are conducting minimal sampling along the Washington coast. The MacArthur is conducting CTD/ADCP surveys during the summers of 1995-98 along the northern coast of Washington as part of the Olympic Sanctuary program. A single mooring was deployed in the coastal zone off Willapa Bay for a year as part of an EPA/Sea Grant project, but there are no moorings there now. There was additional sampling and moorings in the estuary. A single mooring will be deployed off Willapa Bay for the Pacific Northwest Coastal Ecosystem Research Program (PNCERS) next spring, but could be deployed sooner if additional funds became available. PNCERS will deploy moorings off Grays Harbor, WA and Coos Bay, OR in 1998 and 1999, but they will be located in fairly shallow water (ca. 50 m isobath). There will also be additional sampling conducted within the estuaries during that period. If additional funds were made available, it might be possible to deploy the coastal moorings sooner--perhaps as early as this fall--to capture the signal of the El Niño as it progresses northward.

Mike Kosro described the sampling that Bill Peterson has been conducting along the Newport, OR line since May 1996. Using a small vessel (daytrips only) zooplankton (vertical and surface horizontal tows) and hydrography have been sampled ca. every other week. The stations are located 1, 3, 5, 10, and 15 miles from shore. According to Peterson, the spring transition in 1997 occurred early, upwelling was strong, the spring bloom was large, and zooplankton populations were abundant--until May. In May, there were strong and consistent anomalous southwesterly winds, and upwelling shut down (and hasn't resumed in any significant way). By mid-June, zooplankton populations were extremely low. Local populations of the common murre have crashed; few chicks fledged this spring, and adults are starving and washing up on beaches. This happened also last year, when upwelling was also poor. The lack of zooplankton in the nearshore will certainly provide for hard times and poor survival of Oregon coastal coho salmon this year. It is important to note that none of this is directly caused by the El Niño, the effects of which are unlikely to have been felt yet at Oregon latitudes, but rather are caused by locally-driven phenomena (e.g., anomalous winds; no upwelling). The cumulative impacts from an El Niño superimposed on the already poor conditions could be disastrous for nearshore marine species.

Kosro (and later Jeff Paduan) showed surface velocity data sets from high-frequency (HF) shore-based radars, which could provide surface current data at 1-2 km resolution out to 40-50 km from shore. It was noted that there are now three HF radar systems that will (or could be) sampling the nearshore current fields from just north of Point Conception (Libe Washburn), Monterey Bay (Paduan), and Newport, OR (Kosro). Both Kosro and Paduan showed how the HF radar data agreed reasonably well with satellite observations of ocean features collected simultaneously, and with time series observations obtained from moorings located within the field-of-view of the radar.

Jane Huyer and Bob Smith described the monitoring transects that U.S. GLOBEC has recently funded. Transect lines will be sampled quarterly (January, March, August and November) for hydrography, currents, chlorophyll and zooplankton. Sampling could begin as early as September/November 1997 if shiptime could be funded (the ship is available). Current plans are for multiple transect lines--a northern line at Newport, OR and a southern line off Coos Bay, OR. This GLOBEC project has arranged with NSF for two days of ship time in September to do the line off Newport. Ship time would be available in November to do the Newport, Coos Bay, and an additional northern California transect, if funds were available.

Francisco Chavez briefed the group on the sampling that is being conducted at three stations every three weeks by MBARI in Monterey Bay and slightly further offshore. In addition, there are two permanent moorings; one is at the mouth of the bay in 1000 m of water, and the second 20 km further offshore (in 1800 m of water). The hydrography, ADCP, nutrients and chlorophyll from the Monterey Bay dataset, which encompass the period from 1989 to present, indicate that nearshore data from within the Bay are not sufficient to document and describe the impacts of El Niño's (a point noted also by Mark Abbott from satellite observation analysis) because the nearshore zone can remain relatively unaffected while regions further from shore are altered dramatically. To adequately document El Niño impacts, additional data from further offshore are needed. Toward that end, MBARI is supporting three large-scale monitoring cruises in 1997. The MBARI survey grid is centered on CalCOFI transect line 67, and extends 400 km offshore. Three cruises will occur next year as well. The MBARI large-scale cruises contain little physical oceanography, and that aspect of central California monitoring needs additional resources. Moreover, this MBARI effort lacks a higher trophic level component (zooplankton, etc.), other than presently unfunded efforts "piggy-backed" on cruises in the region. Jeff Paduan also noted that there are a number of other research cruises in the region that could complement the seasonal coverage, including a Naval Post-Graduate School education/teaching cruise (July 1997), a Monterey Bay Marine Sanctuary cruise (August 1997), and a NAVOCEANO cruise (September 1997), if they were coordinated properly.

Marlene Noble described the USGS moorings in northern/central California. Currently, there are efforts in two regions: a transect extending across the shelf from Santa Cruz (3 moorings with current meters, thermistors, and sediment traps), and a planned deployment of three moorings on the slope off San Francisco (near Farallon Islands). The former are scheduled to be pulled in August 1997, but if there is a strong desire, could be redeployed at the same location (or nearby) to provide current records prior to and during the El Niño.

Figure 1 shows a summary of some of the observation programs in place now or that will be implemented in the near future to monitor ocean conditions along the Pacific coast of North America. Each observational program is depicted by letter; the observations being made at each site are summarized in Table 1.

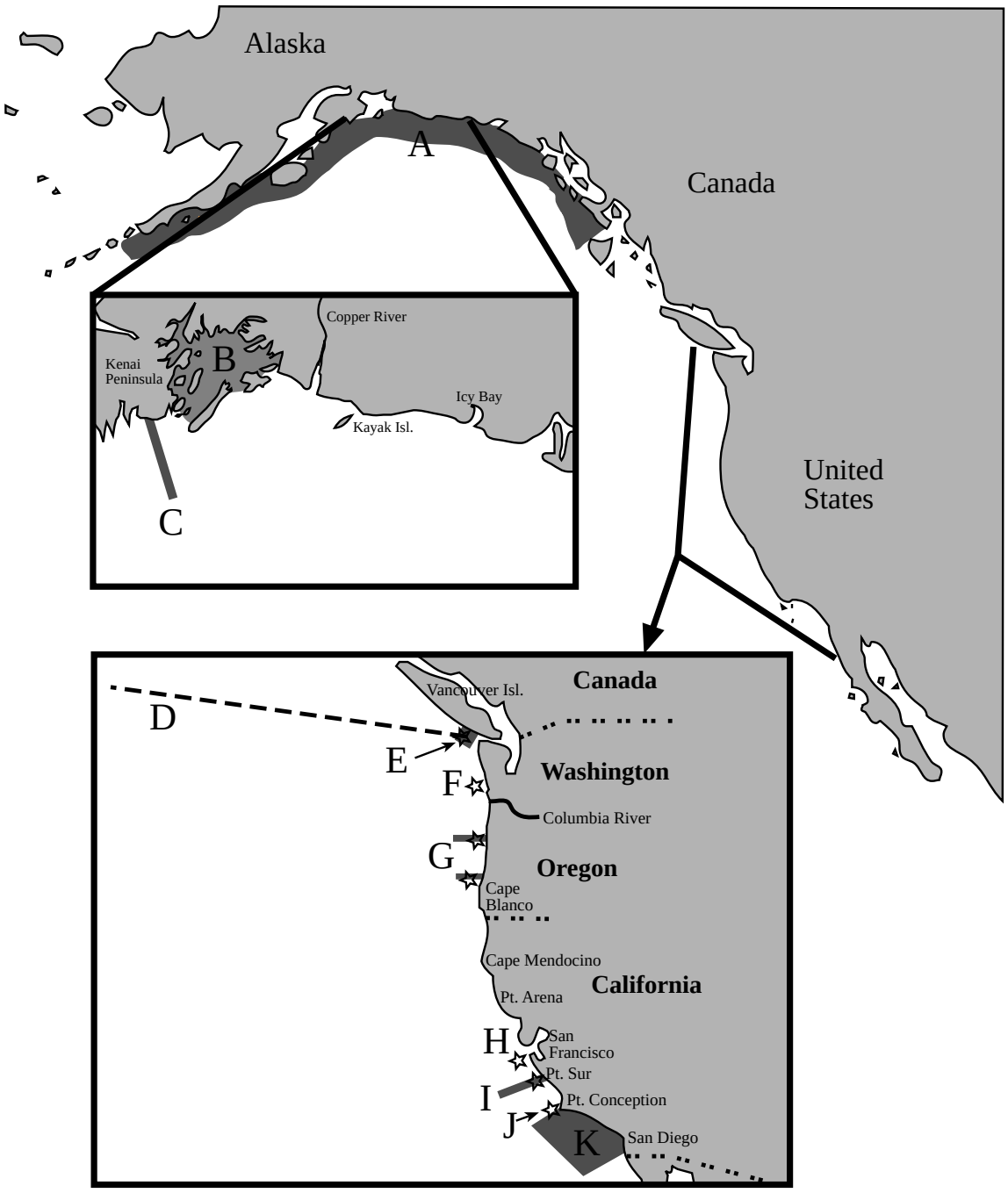

Figure 1. Locations of selected observation programs along the Pacific coast of North America. A-K identify specific programs (see Table 1 and text for additional details). Stars indicate locations with moorings. Shaded lines indicate offshore extending transects. Shaded regions indicate locations with survey grid sampling.

Table 1. Selected observational programs along the Pacific coast of North America.

Identifier in Figure 1	Program/PI's	Frequency of Sampling	Observations	Missing Obs./Needs
A	OCC/Helle et al.	annual survey in mid-July to mid-August	juvenile salmon trawling, zooplankton, CTD, diet composition	chlorophyll, nutrients, ADCP, hi-freq. acoustics
B	EVOS SEA/Cooney et al.	productive season cruises; one mooring?	CTD, zooplankton, juvenile salmon, chlorophyll	
C	GLOBEC/Weingartner et al.	6X/year along GAK line	hydrography, ADCP, nutrients, chlorophyll, zooplankton, hi-freq. acoustics, trawling	doesn't begin till March 1998; need earlier start, preferably November 97
D	Line P/Freeland	quarterly cruises	CTD, ADCP, nutrients, chlorophyll, zooplankton?	
E	La Perouse/Canada	CTD survey every 6 weeks; several moorings	CTD, zooplankton	nutrients, chlorophyll
F	PNCERS/Hickey	nearshore moorings off Gray's Harbor, Willapa Bay (and maybe Coos Bay, OR)	temperature, currents	phytoplankton, zooplankton; needs to begin before scheduled 1998 start
G	GLOBEC/Smith et al.	5X/year, Newport and Coos Bay; moorings	CTD, nutrients, ADCP, chlorophyll, zooplankton	juvenile salmon trawling; need earlier start
	NMFS/Peterson	biweekly cruises nearshore at Newport	CTD, zooplankton, chlorophyll, nutrients	fish
H	USGS/Noble	3 moorings on shelf off Santa Cruz	currents, temperature, ADCP, sediment traps	scheduled to end in August 1997; need turnaround and redeployment for another year
I	MBARI/Chavez et al.	3 cruises per year to 400 km offshore; nearshore moorings	CTD, ADCP, nutrients, chlorophyll	zooplankton; offshore mooring; additional fall 1997 cruises; better physical observations
J	MMS/Winant	12 moorings N and S of Pt. Conception	currents at several depths; temperature, salinity	scheduled to end in October 97; need some turned around and redeployed for another year
	MMS/Washburn	HF coastal radar	surface water velocities out to 40-50 km off Pt. Conception	
K	CalCOFI/Hayward et al.	quarterly survey cruise	CTD, nutrients, chlorophyll, ADCP, zooplankton	

III. A Coordinated ENSO Monitoring Effort

A. General Needs

Several general needs were identified as crucial in implementing a coordinated effort to document the impact of the El Niño.

1) increased emphasis on subsurface (to 500 m) observations--RATIONALE: satellite remote sensing provides a lot, but it cannot provide the subsurface data needed to examine changes in mixed layer depths, nutrient concentrations, etc. that could result from an ENSO event; many of these observations are very important to the biology.

2) more emphasis on ocean biology, especially the concentration and distribution of nutrients and phytoplankton and the abundance, species composition and distribution of zooplankton--RATIONALE: biological and chemical variables are difficult to sample remotely (unlike moored physics platforms), and therefore, usually very undersampled relative to physics.

3) need routine sampling at many locations along the west coast, at as high a frequency as affordable, to document the propagation of changes in physical structure and the impacts on the marine populations of the El Niño event--RATIONALE: thorough spatial and temporal sampling will be required in order to distinguish changes in the ecosystem that are locally forced (e.g. local winds/upwelling) from remotely forced (El Niño)

4) more effective communication network is needed to coordinate the host of sampling and monitoring activities that occur along the west coast. At the least, a web page and listserver need to be established to ensure communication. The web page should be capable of handling near-real time data from diverse sources including satellites, shore stations, and remote buoys. Some of this is available already at JPL or other sites, but other data sources/types are not available electronically.

B. Particular Needs

The network of observation sites, including moorings, NDBC buoys off California, tide gauges and shore temperature stations at a number of locations, and survey transects and grids in place now is capable of documenting the physical manifestation of an El Niño as it propagates poleward along the North American west coast--**IF** ALL of the observations documented in Figure 1 and Table 1 are obtained concurrently (i.e., be in the water) between now (July 1997) and September 1998. Unfortunately, several of the efforts (esp. C, F and G) are not scheduled to begin until early or late next year (thus missing the early stages of the predicted El Niño), and several other efforts (esp. H and J) are scheduled to conclude between August and November 1997 (missing most of the event entirely). For the former, to the extent that it is feasible, survey cruises or mooring deployments should begin now--before the El Niño's impacts are felt along the coast. For the latter, efforts are needed to retrieve, service and redeploy for another year some of the moored platforms—hopefully in the same location with similar sensors at the same depths as previously deployed—so that pre-El Niño and El Niño conditions are observed.

The coastwide sampling outlook is not as favorable for nutrient and biological variables. As for the physics, some improvement in chemical and biological sampling could be

obtained by beginning projects prior to their official start dates (e.g., C, G). Some regions do not have ongoing or planned sampling of biology (e.g., F, H, J), nor are there research cruises ongoing which could accommodate additional biological sampling. However, in other regions it might be possible to obtain additional biological sampling (esp. zooplankton) for minimal cost, because research cruises are already taking place (e.g., I).

Considering the sampling that is occurring already, we see the following immediate needs (letter identifiers refer to sites in Figure 1 and Table 1):

1) the region between Coos Bay, OR and Santa Cruz, CA has no ongoing monitoring of physics or biology

2) juvenile salmon, and fish more generally, are better sampled in the northern region (via efforts A, B and C) than further south (except for maybe K); fish sampling should be done off Oregon

3) high frequency acoustics--useful for sampling both fish and euphausiids, the latter a target species in the U.S. GLOBEC program--are used only in efforts B and C; some hi-frequency acoustic sampling on transects off Oregon would be useful

4) nutrient sampling is spotty, being good in efforts C, D, G (part), and I, but absent elsewhere.

5) some efforts (esp. moorings) will provide good data on ocean physics, but ocean chemistry and biology are undersampled or unsampled (e.g., F, H, J).

6) zooplankton sampling is needed at more sites, especially at D (if not done already), F, and I

7) observations are needed (or should be continued) at open ocean sites, like HOT and Stn PAPA, that have existing long-term records that include prior El Niño events

8) establish the electronic communication resources (web pages, listserver, etc.) for timely communication of data (some near-real time) on ocean conditions (physics and biology) and ancillary data.

IV. Rapid Response Funding Opportunities

Judy Gray, NOAA's U.S. GLOBEC program coordinator noted that all of NOAA's U.S. GLOBEC funds for NEP research were committed. Kendra Daly noted that although there were no additional funds available in GLOBEC on the NSF side either, there were two funding possibilities elsewhere in NSF. First, there is a regular NSF proposal deadline on August 15, to which additional work in the NEP could be proposed. However, the nature of the review process for regular proposals would provide delays such that it would be unlikely that the funds would be available prior to the arrival of the El Niño. Alternatively, NSF has SGER grants--Small Grants for Exploratory Research. Up to ca. 5% of NSF core funds can be spent on discretionary funds for rapid response events. SGER grants are not to exceed $100K, and the duration of the award is usually one, but can be for up to two years. SGER grants undergo an accelerated review process, and thus, might provide funds in time to implement additional sampling of the El Niño. SGER proposals are submitted to individual programs (e.g., Biological Oceanography) and should be brief (2-5 pages), including a clear rationale for the

urgency of the proposed research, the nature and significance of its potential impact on the field, and why the SGER grant would be a suitable means of supporting the research.

Appendix 1.-- Workshop Participants

Mark Abbott
Oregon State University
mark@oce.orst.edu

Hal Batchelder
Univ. California, Berkeley
halbatch@socrates.berkeley.edu

Steve Bollens
San Francisco State Univ.
sbollens@sfsu.edu

Mary-Elena Carr
Jet Propulsion Lab.
mec@pacific.jpl.nasa.gov

Francisco Chavez
Monterey Bay Aquarium Research Inst.
chfr@mbari.org

Kendra Daly
National Science Foundation
kdaly@nsf.gov

Elizabeth Dobbins
Univ. California, Berkeley
ldobbins@zanclopus.biol.berkeley.edu

Howard Freeland
Institute of Ocean Sciences
hjfree@ios.bc.ca

Judith Gray
NOAA Coastal Ocean Program
jgray@cop.noaa.gov

Ed Harrison
Pacific Marine Environmental Lab.
harrison@pmel.noaa.gov

John Helle
Alaska Fisheries Science Center
jhelle@abl.afsc.noaa.gov

Barbara Hickey
Univ. of Washington
bhickey@u.washington.edu

Jane Huyer
Oregon State University
ahuyer@oce.orst.edu

David Johnson
NOAA Coastal Ocean Program
djohnson@cop.noaa.gov

Mike Kosro
Oregon State University
kosro@oce.orst.edu

Tim Liu
Jet Propulsion Lab.
liu@pacific.jpl.nasa.gov

Marlene Noble
U.S. Geological Survey
marlene@octopus.wr.usgs.gov

Jeff Paduan
Naval Post-Graduate School
paje@mbari.org

Thomas Powell
Univ. California, Berkeley
zackp@socrates.berkeley.edu

Robert Smith
Oregon State University
rsmith@oce.orst.edu

Mark Stacey
Univ. California, Berkeley
mstacey@sagitta.biol.berkeley.edu

Tom Weingartner
Univ. of Alaska, Fairbanks
weingart@ims.alaska.edu

Appendix 2. -- Workshop Agenda

Informal ENSO response meeting.
11 July 1997. Westin Airport Hotel, San Francisco, CA

8:30	Welcome. Review agenda. Introduction. Aims.	T. Powell
8:45	Overview.	H. Freeland
9:05	Overview continued.	E. Harrison
	Individual presentations. Interest and capabilities. Each presentation should be 10 minutes, with 5 minutes for questions.	
9:15	GLOBEC Northeast Pacific monitoring.	T. Powell
9:30	NASA satellite observations.	T. Liu
9:45	West coast satellite observations.	M. Abbott
10:00	BREAK	
10:30	Gulf of Alaska.	T. Weingartner
10:45	Southern Alaska region	J. Helle
11:00	Queen Charlotte Is., Vancouver Is. coasts	H. Freeland
11:15	Washington coast.	B. Hickey
11:30	Oregon coast. I.	M. Kosro
11:45	Oregon coast. II./N. Calif.	A. Huyer/R. Smith
12:00	LUNCH	
	Individual presentations (continued).	
1:00	Central Calif./Monterey Bay	S. Bollens/F. Chavez/J. Paduan
1:15	USGS Work in Northern/Central California	M. Noble
1:30	Comments on Individ. presentations. Other regions, e.g., comparisons to open ocean regimes, etc. "Open Mike".	
	Agency perspectives. Facilities and resources.	
1:45	NSF NOAA NASA	K. Daly J. Gray/D. Johnson M-E. Carr
2:15	Discussion. Focus: what is needed for coordination?	
2:45	BREAK	
3:15	Discussion. Coordination needs (continued).	

4:00 Assignments. An incomplete list might include (but is not limited to) the following.

Writing tasks, if any? Individual written items?

Collective written materials?

Ship, facilities coordination?

Inter-calibration, -comparison of collected data?

Communication: e-mail, web-site(s?), other?

Additional People and groups to be included in future activities?

Future meetings?

Other?

5:00 ADJOURN