Gulf of the Farallones and Cordell Bank
National Marine Sanctuaries
Fort Mason, Building 201
San Francisco, CA 94123
tel: 415 561-6622
fax: 415 561-6616

26 June 2006

TO: Commanding Officer
NOAA Ship McARTHUR II

SUBJECT: **Cruise Instructions for AR-06-09**
Gulf of the Farallones National Marine Sanctuary
Sanctuary Ecosystem Assessment Surveys
Cruise dates: 10-20 July 2006

Project: Sanctuary Ecosystem Assessment Surveys – Upwelling, Pycnocline, Bathymetry and Trophic Interactions in the Northern and Central California Sanctuaries.

Signatures:

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Jan Roletto
Research Coordinator
Gulf of the Farallones
National Marine Sanctuary

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Rear Admiral Richard R. Behn
Director, Marine Operations Center

POINT OF CONTACT

Jan Roletto
Research Coordinator
Gulf of the Farallones National Marine Sanctuary
Fort Mason, Bldg. 201, San Francisco, CA 94123
TEL: (415) 561-6622 ext. 207
CELL: (415) 987-0412
FAX: (415) 561-6616
E-mail: Jan.Roletto@noaa.gov

1.0 OVERVIEW OF OPERATIONS

Scientists affiliated with Gulf of the Farallones National Marine Sanctuary (GFNMS), Cordell Bank National Marine Sanctuary and PRBO Conservation Science will conduct a multi disciplinary investigation aimed at linking physical and biological processes occurring within and adjacent to the GFNMS. This study will be conducted aboard the NOAA vessel McARTHUR II from 10 July 2006 through 20 July 2006.

The AR 06-09 cruise will consist of one leg:

1. Prepare vessel dockside in San Francisco Bay, location TBD (8 & 9 July);
2. Depart and test operations and sampling gear, transit to night time sampling area (10 July);
3. Sample night and day operations, begin in northern Cordell Bank area, move north to potential sanctuary expansion area, called "The Football," sample Cordell Bank to the Gulf of the Farallones region and return to replicate sampling across Cordell Bank. (July 11-20).
4. Demobilize ship in San Francisco Bay and media tour of ship. Dockside location to be determined (July 21).

The operations plan at sea can only be considered a guide as to how the chief scientist expects the study to progress. The operations schedule may be altered depending on weather and local conditions.

OPERATING AREA

Northern California, from the area north of Bodega Canyon, locally known as The Football (38° 26.4', -123° 38.8') south to the area locally known as Deep Reef (37° 19.7', -122° 30.3').

The area of operation will extend from the southern portion of the Gulf of the Farallones off of Deep Reef (37° 19.7', -122° 30.3') to The Football (38 ° 26.4', -123° 38.8'). Sampling will extend from three miles off the coast out to the continental shelf break, approximately 50 miles offshore. Operations will include daytime wildlife observations using standardized strip transect methods. Daytime and night time quantification of zooplankton and fish using EK 60 echosounder (using three different frequencies 38 kHz, 120 kHZ and 200 kHz), continuous collection of surface temperature and salinity using on board SCS, oblique tows with simple hoop net, hand-held phytoplankton net, and CTD data collection at selected stations. Nighttime operations will include tucker trawls and CTD data collection.

2.0 SCIENTIFIC GOALS AND OBJECTIVES

The primary goal of the research cruise is to investigate the relationship between distinct hydrographic features and the distribution and abundance of marine organisms at several trophic levels. This will incorporate study of transport and retention mechanisms and upwelling dynamics operating in the Gulf of the Farallones and Cordell Bank areas. We will test the hypothesis that timing, intensity, and duration of upwelling influences the distribution, abundance, growth and reproductive dynamics of euphausiids, thus affecting the distribution

and abundance of krill predators in the region. We predict that intense wind-driven upwelling provides conditions conducive for *Euphausia pacifica* (the more oceanic species) to move onto to the continental shelf where they become abundant and available to predators during late winter and spring. As the upwelling relaxes into the summer, *E. pacifica* moves offshore where it is less available to predators, and *Thysanoessa spinifera* (the more coastal species) becomes the dominant euphausiid in shelf waters and predator diets. This hypothesis is important because there is evidence that suggest that oceanographic conditions influences the availability of krill to upper trophic level predators, affecting their timing of breeding, reproductive success, as well as their overall abundance and distribution in the region. This cruise is one of a series that will be conducted from April 2005 to September 2008, to determine how event scale, seasonal and interannual variability in upwelling parameters (timing, intensity, amplitude, flow) affects krill and krill predator-prey dynamics in these marine sanctuary waters.

The objectives of this cruise are to:

I. Investigate the relationship between distinct hydrographic features and the distribution and abundance of marine organisms at several trophic levels in three West Coast National Marine Sanctuaries:
   a. Cordell Bank National Marine Sanctuary (CBNMS);
   b. Gulf of the Farallones National Marine Sanctuary (GFNMS); and
   c. Northern portion of the Monterey Bay National Marine Sanctuary (MBNMS).

II. Investigate areas of potential sanctuary expansion, as proposed by Congresswoman Lynn Woolsey.

III. Test the hypothesis that as bathymetry becomes shallower so does the thermocline and halocline, resulting in increased densities of primary and secondary productivity and foraging diving seabirds.

IV. Provide training to GFNMS staff in the areas of bird and marine mammal data collection and management, use of data collection software consistent with NMFS, SEEBIRD data base, use of EK 60 and data interpretation and data management, and logistics of net tow sampling efforts.

V. Development of Teacher At Sea tasks and products for the National Marine Sanctuary, web based, Expedition “blog”.

The secondary objective is to provide training to new sanctuary staff in the areas of bird and marine mammal data collection and management, use of EK 60 and data interpretation and data management, logistics of net tow sampling efforts and integration of West Coast regional sampling techniques and the use of the data base software SEEBIRD, consistent with National Marine Fisheries Service CSCAPE program.

In order to detect areas of ecological significance we propose to examine spatial and temporal relationships between predator-prey aggregations and oceanographic features. We hypothesize that the distribution and abundance of marine birds, mammals, and zooplankton in the Gulf of the Farallones and Cordell Bank regions are determined by bathymetric and hydrographic features and can be predictable in space and time. Physical oceanographic processes may increase foraging opportunities for upper trophic level predators by enhancing the availability of prey at predictable locations. Specifically, we predict that density of foraging birds and mammals will be greater in areas where physical oceanographic processes enhance zooplankton

availability. The goal of our study is to identify such persistent locations of predator and prey aggregations and potential areas of high trophic transfer in the Gulf of the Farallones, Cordell Bank and Monterey Bay National Marine Sanctuaries. Once established, these ecological relationships will be used to identify areas of ecological significance.

The chief scientist is authorized to alter the scientific portion of this cruise plan with the concurrence of the commanding officer, provided that the proposed changes will not:

- Jeopardize the safety of personnel or the Ship;
- Exceed the time allotted for the cruise;
- Result in undue additional expense; or
- Change the general intent of the cruise.

2.1 Specific objectives include:

2.1.1 Sample different water masses that characterize the Gulf of the Farallones and Cordell Bank hydrographic regions.
2.1.2 Describe community composition and abundance of phytoplankton, zooplankton, seabird and marine mammal populations associated with each of these water masses, to identify areas of ecological significance.
2.1.3 Investigate the diel migratory behavior and distribution relative to hydrographic features of euphausiids (*Thysanoessa spinifera* and *Euphausia pacifica*) and quantify distribution, abundance, and size and age class of krill using acoustic technique in comparison with trawl and surface net technique.
2.1.4 Identify diel distribution and abundance of phytoplankton, zooplankton, seabirds and marine mammals between Bodega Canyon, Cordell Bank, Gulf of the Farallones, and the Farallon Escarpment.
2.1.5 Assess current structure and stratification of the water column above and adjacent to the Football, Bodega Canyon, Cordell Bank, the area west of Point Reyes, the Farallon Escarpment, and the Deep Reef area for evidence of retention eddies and fronts.
2.1.6 Test the hypothesis that as bathymetry becomes shallower so does the thermocline and halocline, resulting in increased densities of primary and secondary productivity and foraging diving seabirds.
2.1.7 Provide field training for new sanctuary staff to: improve skills and learn alternative sampling design for bird and marine data collection and management, use of EK 60 and data interpretation and data management, logistics of net tow sampling efforts and use of NMFS field data management software, SEEBIRD.
2.1.8 Develop concise Teacher At Sea tasks and products for the National Marine Sanctuary, web based, Expedition “blog”.
2.1.9 Collection of phytoplankton samples for Department of Public Health, Harmful Algal Bloom – Biotoxin Monitoring Program.

3.0 ITINERARY

8 July 06	Arrive in San Francisco Bay, location Pier 15/17	San Francisco, Pier 15/17
8-9 July 06	Prepare ship for data collection, IT links	Connect ship's GPS and data downloads to scientific support computers, Ben Saenz (PRBO) to wire EK 60 computer with capability for down load, check storage capacity, hardwire if necessary. Saenz shall work with the field operations officer and oceanographic technician. Matt Ong and Jamie Hall to wire Nobletech laptop to be located in dry lab space to ship's IT GPS system. They will also set up IT system for data logging system on observation-flying bridge Matt Ong to set up IT system for data downloads during cruise to CPU in dry lab and set up data transfer to mainland for NMSP Expedition web site. Set up other computers and A/V equipment in dry lab, load Tucker trawl, hoop and phytoplankton nets, CTD, sampling supplies and personnel gear. Install observation chairs and waterproof computer housing on flying bridge.
10 July 06	Depart SF Bay, on station for night time samples by 2000	Science staff boards morning of July 10 for early afternoon departure. Orientation meeting with science staff. Transit to nighttime operations in Cordell Bank region, test sampling gear and data entry programs, safety procedures while in transit, and begin nighttime vertical krill sampling at 20:00.
11 -13 July 06	Cordell Bank Grid	Sample night and day operations. Acoustic and bird and mammal sampling; Tucker trawls, CTD, hoop net, phytoplankton
14-18 July 06	The Football to Deep Reef	Sample night and day operations. Acoustic and bird and mammal

	sampling; Tucker trawls, CTD, hoop net, phytoplankton; The Football to Cordell Bank to Rittenberg Bank to the Farallones to Deep Reef
19 July 06 Cordell Bank Grid (Repeat)	Repeat Cordell Grid; Sample night and day operations. Acoustic and bird and mammal sampling; Tucker trawls, CTD, hoop net, phytoplankton
20 July 06 Weather Day	Weather Day or daytime sampling krill at Cordell Bank, collection of underwater sounds via hydrophone, return to SF Bay Pier 30/32, time TBD
21 July 06 Demobilize ship and possible media interviews and tour	San Francisco Bay, dockside location Pier 30/32

Meetings:

Orientation Meeting:
The field operations officer will hold an orientation meeting for the scientific party at the beginning of cruise, prior to arriving on station.

Daily Safety and Operation Meetings:
Daily safety and operation meetings will be held between representatives of the Ship and the scientific party to evaluate the progress of the mission and implement schedule changes if deemed necessary. "Sewage runs" outside the sanctuaries will be planned and scheduled during these meetings. The daily meetings:

- Safety Meeting, as needed, 0750-0800
- Plan of the Day meeting, 24-hour cycle, Chief Scientist and FOO, 1500-1530
- Science Staff meeting, 1900

4.0 CONTACT PERSONNEL

Scientific Operations: Jan Roletto, Research Coordinator
Gulf of the Farallones National Marine Sanctuary
Fort Mason, Bldg. 201
San Francisco, CA 94123
(415) 561-6622 ext. 207/ Fax (415) 561-6616
cell ph # 415-987-0412
email Jan.Roletto@noaa.gov

Ship Operations: ENS Stephen Barry
PH: (206) 553-4469/ FAX:(206) 553-5448
Stephen.Barry@noaa.gov
foo.mcarthur@noaa.gov
206-553-4468
Cellular: 206-669-4437 (Voice)/ 206-499-6949 (CO)
Ship phone in ship yard: 206-623-1635 ext.825 or 364

5.0 OPERATIONAL PLANS

The following plans can only be considered a guide as to how the chief scientist expects the studies to progress, without being able to predict weather, operation and schedule problems, and/or equipment failure.

During the course of the cruise, we will be sampling nine transect lines positioned in and adjacent to the Gulf of the Farallones, Cordell Bank, and Monterey Bay National Marine Sanctuaries. Nine nights and nine days will be spent sampling the area for marine birds, mammals, and the biological and physical characteristics of the water column. The exact days and sampling locations will depend on sea conditions and also will be selected to minimize run times. The ship board EK 60 and thermosalinograph will run continuously during the cruise. A DVD will record the images from the towed camera sled and habitat and macrofauna will be annotated during side-scan, ground turthing, portion of the cruise.

5.1 Bird, Mammal and Krill Sampling

We will count marine birds and mammals from the flying bridge of the ship (eye height = 14.4 m above the sea surface) while cruising at 10 knots (minimum of 5 knots, 10 knots is optimal speed) using standardized strip transect survey methods. Other data to be collected include sea turtle counts, location of front and convergent zones, vessel activities, location and relative size of drift algae, relative abundance of jellyfish-type organisms. Birds (and pinnipeds, otters, turtles, fronts, marine debris, jellies, and drift algae), will be counted by an independent observer, counting continuously along predetermined survey lines (Table 1, Figs 1, 2 and 3) during daylight hours, at sea state of Beaufort 4 or less, in a 300-m arc from directly ahead of the vessel to 90° off the side with best visibility (i.e. lowest glare). Cetaceans and vessels will be counted by a second observer, in an 800 m arc from directly ahead of the vessel to 90° on both sides. Data will be logged into a Husky Hunter16 portable computer (using the FLOCK data logging program) and a Dell PC laptop (using the SEEBIRD data logging program). Birds et al. will be binned into three stratified, 100 m zones out to 300 m from the ship. Cetaceans and vessels will be binned into eight stratified, 100 m zones out to 800 m from the ship. Assistance in spotting vertebrates is allowed by the secondary observer or the recorder. The scheduled primary (bird or cetacean) observer shall determine if observation count shall be entered into count database or comments.

Seabird and cetacean behaviors shall be recorded. See below for definitions. Two data management software packages will be used in order to ascertain which is most consistent with

the majority of other similar science programs within NOAA. Data management software packages include FLOCK and SEEBIRD. Seabird and marine mammal behaviors will be recorded as flying, milling, sitting on the water, and feeding. GFNMS staff will observe and be trained on the transect data entry and data management procedures used by PRBO Conservation Science team, e.g. FLOCK.

To sample along the Cordell Bank Grid (Figure 1) or if surface swarms of euphausiids/feeding auklets are encountered during the day, the vessel will start and stop frequently and may abandon the bird and mammal transect line, to sample prey using a shallow tucker trawl. Bird and mammal counts shall continue while the vessel is in motion at speeds 10-5 knots; noting when the vessel is at optimal sampling speed at 10 knots, slowing or speeding up to optimal speed. Observations shall be discontinued while at speeds of <5 knots. Bridge shall communicate with observers when vessel is at or below 5 knots, speeding or slowing to/from optimal observation speed of 10 knots, and on sampling station. It is estimated that sampling with the CTD is approximately 40 minutes, sampling with the hoop net is 20 minutes, and sampling with a shallow Tucker trawl is <40 minutes. Net tow speeds should be approximately 2 knots, depending on tides and ship's capabilites.

We will collect conductivity, temperature, and depth data using a Sea-Bird Electronics SBE 19*Plus* SEACAT Profiler equipped with a WET Labs WETStar fluorometer at predetermined stations (Tables 2 & 3, Figs 1 and 2). We will also collect continuous underway data on surface temperature, salinity and fluorescence using instruments installed in the sea-chest of the ship while cruising along predetermined survey lines (Table 1, Figs 1, 2 and 3).

We will quantify the distribution and abundance of euphausiids using the ship's SIMRAD EK60 echosounder along predetermined survey lines (Table 1, Figs 1, 2 and 3). Data will be collected at three different frequencies (38 kHz, 120 kHz, and 200 kHz). Sampling will be done during the day and night, under calm conditions and cruising at 10 knots to minimize noise from surface bubbles and waves.

We will sample euphausiids in the water column using tucker trawls. We will deploy the net at fixed stations (Table 4 and Figure 2) and at targets of opportunity that will be chosen on site, using the EK 60 for identifying targets of interest. Also, if surface swarms of euphausiids are encountered during the day, the vessel will abandon the track line to sample prey using a shallow tucker trawl.

We will sample the zooplankton community in the upper 50-m of the water column using oblique tows with a hoop net at predetermined stations (Tables 2 & 3, Figs 1 and 2).

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD. A maximum of 5 samples will be collected throughout the cruise.

Definitions and Sampling Terminology

"Help" is defined when the non-primary person observes birds, mammals, vessel, etc. when primary person does not see it. Recorder takes first recording cue from primary observer and primary observer directs data input to recorder.

Flight direction for birds, swimming direction for cetaceans and activity for vessels are to be recorded. These are:
(1) Feeding/actively fishing
(2) Traveling non-directionally; i.e., milling or circling
(3) Traveling directionally
(4) Sitting on the water/at surface

Front and convergence zone definition: a front is a well-defined line visible for at least one km. The ship (observation platform) must cross the front and data is entered as the ship crosses. Record bearing, relative to the ship bow, 270 to 360 degrees or 0 to 90 degrees. Front bearings are recorded the same as bird and cetacean flight and swimming directions. Example of a front is the San Francisco Bay fresh water plume.

We will record vessel type activity and direction of travel for the following vessel types:
Commercial
- Tanker
- Container/Bulk Carrier
- Whale watch
- Passenger/Cruise liner
- Tug
- Tug & barge

Fishing:
- Party fishing (6 or more passengers)
- Crab pots/lobster pots (note lights pointed at back deck)
- Gillnet (deeper than 60 fathoms)
- Squid Purse seiner (note lights pointed at water)
- Herring Purse seiner
- Long-liner (set lines)
- Salmon troller/hook and line (stick boat, note if stick up or out)
- Rockfish hook and line (can appear as party boat w/fewer people, fewer rod Holders, look for blue commercial sticker, jigging)
- Trawler/ Stern dragger
- Troller (not a stick boat)
- Urchin diver

Recreational:
- Powerboat
- Powerboat (sport fishing)
- Sailboat
- Sailboat under power
- Kayak
- Winder surfer

Parasailer/kite surfboard
Ecotourism diving/cage dive boat
Jet ski
Government: (Note approximate size)
USCG
Military
CDFG
NMSP
USFWS – Farallon Patrol volunteer note type of vessel from above list
Research/academic
Unidentified/Other (describe in comments)

5.2 Itinerary

Day 1 (July 10)
Daytime: Embark. Orientation meeting with science staff. Transit to nighttime operations in Cordell Bank region, test sampling of gear and safety procedures while in transit. On station to begin nighttime sampling by 2000.

Nighttime: Krill vertical migration (Line 5, west)
We will start at the western end of line 5 (Table 1, Figure 2). Survey will begin after sunset (~20:00). We will survey a short (10 km; 1000 to 100 m) transect segment recording T/S (thermosalinograph) and EK 60 acoustics while underway at 10 knots. We will survey back and forth along this transect for about 8 times (until 04:00 July 12). Upon completion of survey we will head directly to the northern end of line C.

Day 2 (July 11)
Daytime: Cordell Bank Grid (Line C)
We will start at the northern end of line C heading south (Table 1, Figure 1). Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots (5 knots minimum speed). Survey along line C will be interrupted for CTD casts and hoop net tows as indicated (Table 2, Figure 1). Upon completion of survey we will turn around 180° to start another transect.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

During the cruise the Teacher At Sea (TAS) shall develop a daily log, to be summarized for the post-cruise description. The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. The daily log shall include one to two images and/or videos depicting the daily scientific tasks and natural resources of the sanctuaries. The daily log shall also include staff interviews, an excel table

listing the seabird and marine mammals sightings, beginning and end coordinates of the bird and mammal transects and coordinates of sighting highlights. The Chief Scientist shall review the daily log and images, as they are completed and summary document to be compiled by the TAS. The Chief Scientist will prep and condense the daily logs for electronic transmission from the vessel to Sanctuary technicians for mapping and posting on the national Expedition web page. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Cordell Bank Grid (Line C)
We will start at the southern end of line C heading north (Table 1, Figure 1). Survey will begin at or prior to 19:00, recording T/S, and acoustics while underway at 10 knots. Survey along line C will be interrupted for CTD casts and hoop net tows as indicated (Table 2, Figure 1). Upon completion of survey we will head directly to the northern end of line D.

Day 3 (July 12)
Daytime: Cordell Bank Grid (Line D)
We will start at the northern end of line D heading south (Table 1, Figure 1). Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along line C will be interrupted for CTD casts and hoop net tows as indicated (Table 2, Figure 1). Upon completion of survey we will head directly to the western end of line 5.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Krill vertical migration (Line 5, west)
We will start at the western end of line 5 (Table 1, Figure 2). Survey will begin after sunset (~20:00). We will survey a short (10 km; 1000 to 100 m) transect segment recording T/S and acoustics while underway at 10 knots. We will survey back and forth along this transect for about 8 times (until 04:00 July 14). Upon completion of survey we will head directly to the northern end of line B.

Day 4 (July 13)
Daytime: Cordell Bank Grid (Line B)
We will start at the northern end of line B heading south (Table 1, Figure 1). Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along line C will be interrupted for CTD casts and hoop net tows as indicated (Table 2, Figure 1). Upon completion of survey we will start krill sampling.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Tucker trawls - Extended Grid North (Line 14 and Targets of Opportunity)
We will sample krill both acoustically and with Tucker trawls within the extended grid comprised between 'The Football', line 14, and Cordell Bank, Line 11. The Tucker net will be deployed to capture targets identified by the acoustic system (EK 60) while cruising at 10 knots. We will deploy the Tucker net at 3 fixed stations along line 14 (Table 4) and 3 targets-of-opportunity, as identified on the EK 60, depending on distance between stations and depth of targets. Upon completion we will head directly to the western end of line 14.

Day 5 (July 14)
Daytime: The Football - Extended Grid North (Lines 12, 13, 14)
We will start at the western end of line 14 (Table 1, Figure 2). The extended north section of the grid will consist of transects 14, 13, and 12. Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 5-10 knots. Survey along line 14 will be interrupted for CTD casts and hoop net tows as indicated (Table 3, Figure 2). If auklets foraging on surface swarms of euphausiids are encountered during survey, the vessel will abandon the track line to sample prey in the vicinity of auklets using a shallow tucker trawl. Vessel shall take an oblique course, returning to 10 knots and predetermined transect line. Upon completion of Line 12 we will start krill sampling, regardless of time (daylight).

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Tucker trawls – Cordell-PRBO Northern Section (Line 2 and Targets of Opportunity)
At approximately 19:00, we will begin a zigzag search, starting at Line 12 moving towards Line 2, sampling krill both acoustically and with tucker trawls within the northern section of the Farallones-PRBO grid. The tucker net will be deployed to capture targets identified by the acoustic system while cruising at 10 knots. We will deploy the net at 3 fixed stations along line 2 (Table 4) and 3 targets of opportunity depending on distance between stations and depth of targets. Upon completion we will head directly to the western end of line 11.

Day 6 (July 15)
Daytime: Cordell-PRBO Northern Section – Lines 11, 1, 2

We will start at the western end of line 11 from the extended grid (Table 1, Figure 2 and 3). The northern section of the grid will consist of transects 11, 1, and 2. Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along Line 2 will be interrupted for CTD casts and hoop net tows as indicated (Table 3, Figure 2). If auklets foraging on surface swarms of euphausiids were encountered during survey, the vessel will abandon the track line to sample prey in the vicinity of auklets using a shallow tucker trawl. Vessel shall take an oblique course, returning to 10 knots and predetermined transect line. Upon completion of survey we will start krill sampling.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Tucker trawls – Rittenberg Bank - PRBO Central Section (Line 4 and Targets of Opportunity)

At approximately 19:00, we will begin a zigzag search, starting at Line 2 moving towards Line 4, sampling krill both acoustically and with tucker trawls within the central section of the PRBO grid. The tucker net will be deployed to capture targets identified by the acoustic system while cruising at 10 knots. We will deploy the net at 3 fixed stations along line 4 (Table 4) and 3 targets of opportunity depending on distance between stations and depth of targets. Upon completion we will head directly to the eastern end of line 3.

Day 7 (July 16)

Daytime: Rittenberg Bank -PRBO Central Section – Lines 3, 4

We will start at the eastern end of line 3 (Table 1, Figure 2 and 3). The central section of the grid will consist of transects Line 3 and 4. Survey will begin prior to or at 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along line 4 will be interrupted for CTD casts and net tows as indicated (Table 3, Figure 2). If auklets foraging on surface swarms of euphausiids are encountered during survey, the vessel will abandon the track line to sample prey in the vicinity of auklets using a shallow Tucker trawl. Vessel shall take an oblique course, returning to 10 knots and predetermined transect line. Upon completion of survey we will start krill sampling.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will

be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Tucker trawls – Farallones-PRBO Southern Section (Line 6 and Targets of Opportunity)
At approximately 19:00, we will begin a zigzag search, starting at Line 4 moving towards Line 6, sampling krill both acoustically and with tucker trawls within the central section of the PRBO grid. The tucker net will be deployed to capture targets identified by the acoustic system while cruising at 10 knots. We will deploy the net at 3 fixed stations along line 6 (Table 4) and 3 targets of opportunity depending on distance between stations and depth of targets. Upon completion we will head directly to the eastern end of Line 5.

Day 8 (July 17)
Daytime: Farallones-PRBO Southern Section – Lines 5, 6
We will start at the eastern end of line 5 (Table 1, Figure 2). The southern section of the grid will consist of transects 5 and 6. Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along line 6 will be interrupted for CTD casts and net tows as indicated (Table 3, Figure 2). If auklets foraging on surface swarms of euphausiids are encountered during survey, the vessel will abandon the track line to sample prey in the vicinity of auklets using a shallow Tucker trawl. Vessel shall take an oblique course, returning to 10 knots and predetermined transect line. Upon completion of survey we will start krill sampling.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Tucker trawls - Extended Grid South (Line 10 and Targets of Opportunity)
At approximately 19:00, we will begin a zigzag search, starting at Line 6 moving towards Line 10, sampling krill both acoustically and with tucker trawls within the southern section of Gulf of the Farallones region. We will sample krill both acoustically and with tucker trawls within the extended grid comprised between Southeast Farallon Islands and "Deep Reef." The tucker net will be deployed to capture targets identified by the acoustic system while cruising at 10 knots. We will deploy the net at 3 fixed stations along line 10 (Table 4) and 3 targets of opportunity depending on distance between stations and depth of targets. Upon completion we will head directly to the western end of line 10.

Day 9 (July 18)
Daytime: Deep Reef - Extended Grid South – Lines 8, 9, 10
We will start at the western end of line 10 (Table 1, Figure 2 and 3). The extended south section of the grid will consist of transects 8, 9 and 10. Survey will begin before 07:00 AM, recording T/S, acoustics, and marine birds/mammals while underway at 10 knots. Survey along line 10 will be interrupted for CTD casts and net tows as indicated (Table 3, Figure 2). If auklets foraging on surface swarms of euphausiids are encountered during survey, the vessel will abandon the track line to sample prey in the vicinity of auklets using a shallow Tucker trawl. Upon completion we will head directly to the northern end of line C.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site.

Nighttime: Transit only.

Day 10 (July 19)
Daytime: Cordell Bank Grid (Line C)
We will start at the northern end of line C heading south (Table 1, Figure 1). Survey will begin at or prior to 07:00, recording T/S, acoustics, and marine birds/mammals while underway at 5-10 knots. Survey along line C will be interrupted for CTD casts and net tows as indicated (Table 2, Figure 1). Upon completion of survey we will turn around 180° to start another transect.

If opportunity allows while on station conducting a CTD cast, we will use a hand held phytoplankton net to collect samples for California State Department of Health Harmful Algal bloom program. This shall be coordinated with the OOD.

Nighttime: Cordell Bank Grid (Line C)
We will start at the southern end of line C heading north (Table 1, Figure 1). Survey will begin before 07:00 PM, recording T/S, acoustics, while underway at 5-10 knots. Survey along line C will be interrupted for CTD casts and net tows as indicated (Table 2, Figure 1). Upon completion of survey we will get ready to sample krill at Cordell Bank.

Day 11 (July 20) WEATHER DAY
This day is reserved for completing tasks that were not possible during previous survey days due to inclement weather.

Once sampling has been completed or nearly completed, collection of underwater sounds. Three science personnel, will board a RHIB, move away from the ship to reduce ship noise. During recording, RHIB's engine will be off. The collection of the sounds will be via a hand-held hydrophone. We will attempt to record 30 to 45 minutes of sounds in an area of high cetacean presence or near the subtidal area, 300-500 feet offshore from the Farallon Islands. Sea state must be Beaufort 2 or less.

During the cruise the Teacher At Sea (TAS) shall develop a daily log, to be summarized for the post-cruise description. The TAS shall work with the Chief Scientist to produce a daily log summarizing scientific tasks, life on a research vessel, and daily scientific findings. The daily log shall include one to two images and/or videos depicting the daily scientific tasks and natural resources of the sanctuaries. The daily log shall also include an excel table listing the seabird and marine mammals sightings, beginning and end coordinates of the bird and mammal transects and coordinates of sighting highlights. The Chief Scientist shall review the daily log and images, as they are completed and summary document to be compiled by the TAS. The Chief Scientists will prep and condense the daily logs for electronic transmission from the vessel to Sanctuary technicians for mapping and posting on the national Expedition web page. It is expected that Expedition updates will be transmitted from the ship every two to three days for posting on the National Expedition web site. The final cruise summary for the national web site shall be completed just prior to the end of the cruise. The Chief Scientist shall review the final Post-Project Description and revise and post final report to the national web site. Post cruise report shall include sample area maps or coordinates when maps are not available, data summary tables, and videos when possible.

6.0 SCIENTIFIC PERSONNEL

6.1 The Chief Scientist is authorized to revise or alter technical portions of the instructions provided that, after consultation with the Commanding Officer, it is determined that proposed changes will not: 1) jeopardize the safety of personnel or the ship; 2) exceed the time allotted for the project; 3) result in undue additional expense; or 4) alter the general intent of the cruise instructions.

6.2 All scientific personnel must have a Health Services Questionnaire reviewed by the ship's medical officer before embarking.

6.3 All potential participants are listed. At any given time, the scientific team aboard the McARTHUR II will not exceed 14 people. The Chief Scientist will provide the Commanding Officer with a personnel list at least three days before embarking.

6.3.1 Participating Institutions:

- Gulf of the Farallones National Marine Sanctuary (GFNMS), Fort Mason, Building 201, San Francisco, CA 94123
- Cordell Bank National Marine Sanctuary, P.O. Box 159, Point Reyes Station, CA 94950
- Point Reyes Bird Observatory (PRBO), 3820 Cypress Dr., #11, Petaluma, CA 94954
- Farallones Marine Sanctuary Association, P.O Box 29386, San Francisco, CA 94129

6.3.2 Science Team

Name	**Title**	**Sex**	**Nationality**	**Affiliation**
Jan Roletto	Chief Scientist	F	US	GFNMS
Michael Carver	Scientist	M	US	CBNMS
Dru Devlin	Teacher At Sea	F	US	FMSA
Jamie Hall	Scientist	M	US	GFNMS
Jaime Jahncke	Co-PI	M	US	PRBO
Carol Keiper	Scientist	F	US	PRBO
Derek Lee	Scientist	M	US	PRBO
Shannon Lyday	Scientist	F	US	GFNMS
Carol Preston	Teacher At Sea	F	US	GFNMS
Ben Saenz	Scientist	M	US	PRBO
Mary J Schramm	Teacher At Sea	F	US	GFNMS
Sophie Webb	Scientist	F	US	PRBO

Emergency Contact information in Appendix I.

6.3.3 Berthing Plan

02-35-1	01-34-2
S Jan Roletto KEY:6 PHONE:	S Michael Craver (night) S Jaime Jahncke (night) KEY:15 PHONE:
01-14-4	01-29-1
S SCIENCE C GVA - male KEY:9 PHONE:	S Sophie Webb (day) S Carol Keiper (day) KEY:14 PHONE:
01-21-2	1-22-3
S MJ Schramm (day/night) S Dru Devlin (day/night) KEY:11 PHONE:	S Derek Lee (day) S Jamie Hall (night) S Ben Saenz (night)
01-27-2	

S	Shannon Lyday (day)	S	
S	Carol Preston (night/day)	KEY:44	PHONE:
	KEY:13 PHONE:		

The Chief Scientist or her representative will submit a berthing plan for the scientific complement prior to the cruise and will work with the FOO on any changes needed during the cruise.

7.0 DATA RESPONSIBILITIES

7.1 Data and Samples

7.1.1 The Chief Scientist is responsible for the data quality, disposition and archiving of data and samples collected aboard ship in association with achievement of the primary cruise goal and objectives. As the representative of the cruise sponsor, the Chief Scientist is also responsible for the dissemination of copies of these data to participants on the cruise and to any other requesters.

7.1.2 The Commanding Officer will give the Chief Scientist a single copy of all data collected by the ship's personnel. This data transfer will be documented on NOAA form 61-29, Letter Transmitting Data. The Chief Scientist will provide the Commanding Officer with a list of all data collected by the scientific party.

7.1.3 The Commanding Officer is responsible for all data collected for ancillary projects until those data have been transferred to the project's principal investigator or their designee. Data transfers will be documented on NOAA form 61-29. Copies of ancillary project data will be provided to the chief scientist when requested.

7.2 Records and Reports

7.2.1 Marine Operations Abstract (MOA). McARTHUR II's officers will maintain a MOA during the cruise. All times should be recorded as Greenwich Mean Time (GMT). The ship's position will be entered for all operations, and otherwise every 30 minutes or when changing course or speed. Other forms required by the chief scientist for each of the operations will be integrated into the MOA. The Commanding Officer will give the Chief Scientist a copy of the MOA upon completion of the cruise. MOA shall be marked for the following events: deployment of nets – Tucker trawl closing of net one and net two, hoop net deployment and depth, phytoplankton net deployment, deployment of CTD, deviation from transect lines. Scientific Computing System shall log the following data every 6 seconds: date, GMT, Lat. degree Lat. min as decimal minutes, Long. degree, Long. min as decimal minutes, depth, of water, turbidity (If possible), temperature, salinity, conductivity. If possible SCS shall also record all data from the EK 60, all frequencies in use. If this is not possible then science personnel

shall provide hardware to record data from EK 60 output. Data from EK 60 shall be continuously collected during cruise transects for bird, mammal and krill transects, while ship is underway. Ben Saenz shall work with FOO and oceanographic technician.

7.2.2 The Commanding Officer and the Chief Scientist will complete a cruise report within 30 days of completing the cruise (PMC OPORDER 1.3). The Chief Scientist will, in addition, submit a Ship Operations Evaluation form through his parent organization to the Office of NOAA Corps Operations.

8.0 EQUIPMENT

8.1 Supplied by the Scientific Party

(a) hoop net
(b) Tucker trawl with sliding messengers for ~>3/8" wire
(c) flow meters for plankton nets (2)
(d) SeaBird SBE19 CTD with Wetstar fluorometer
(e) sample jars (quart mason)
(f) Formalin with MSDS safety sheets
(g) Dissecting equipment, sample supplies
(h) Chemical spill clean up kit
(i) Time depth recorder
(j) Sample sieves and buckets
(k) Binoculars
(l) Computers
(m) Video camera, tapes, CDs and DVD+RW disks
(n) Conducting wire signal
(o) Laptops with Nobletech positioning software, SEEBIRD and FLOCK, CPU
(p) rechargeable batteries
(q) Flying bridge chairs

8.2 Supplied by McARTHUR II

(a) A-frame and winch with ~>3/8" diameter wire
(b) Starboard hydro winch
(c) Inclinometer
(d) EK-60 depth sounder with wiring to connect to VCR or other computer
(e) Thermosalinograph interfaced with computer and GPS
(f) Freezer space for one dozen water samples (one quart jar = sample)
(g) Position logs
(h) Bathymetric and navigation equipment
(j) Daily satellite image of sea surface temperature (to be determined)
(k) 110V outlet on flying bridge

(l) IT cabling for connection to CPU in dry lab to flying bridge data loggers to ship's GPS

9.0 ADDITIONAL INVESTIGATIONS AND PROJECTS

9.1 No ancillary projects are anticipated.

10.0 MISCELLANEOUS

10.1 Navigational Control: Standard CA code GPS will be used for positioning except as otherwise provided for by the scientific party.

10.2 Meals: Requests for meals for nighttime staff shall be coordinated with FOO during Plan of the Day meetings.

10.3 A pre-cruise meeting between the Chief Scientist, the Commanding Officer and their respective staffs will be held prior to commencement of operations to identify operational and logistic requirements.

10.4 A post-cruise debriefing will be held between the Chief Scientist and the commanding Officer. If serious problems are identified, the Commanding Officer shall notify the marine center by the most direct means available. The Chief Scientist shall document identified problems in the Ship Operations Evaluation Form.

10.5 The Chief Scientist is responsible for complying with NC Instruction 6280B, Hazardous Materials and Hazardous waste Policy, Guidance, and Training, this includes the requirement for the Chief Scientist to:

a. Provide a spill kit sufficient to deal with whatever chemicals are brought aboard by the scientific team, and appropriate neutralizing agents.

b. At the end of the cruise, remove all scientific team hazardous materials and waste.

c. Provide the Commanding Officer a copy of the MSDS for all chemicals brought aboard. By federal law, the ship may not sail without a complete inventory of MSDS and appropriate neutralizing agents, buffers, and/or absorbents in amounts adequate to address spills of a size equal to the amount of chemicals brought aboard. All HAZMAT shall have a MSDS provided to the ship ECO, and shall be accounted for throughout the mission and removed from the ship upon completion of the mission. See attached pdf file for formalin.

10.6 The Chief Scientist will bring aboard any permits required to conduct these operations.

10.7 If rain prevents seabird observations from the flying bridge, space will be provided in the bridge if it does not interfere with the ship's operations.

11.0 COMMUNICATIONS

11.1 McARTHUR II will communicate daily, Monday through Friday, with the Pacific Marine Center. Normally this will be via message, but radio contact will be maintained when possible. Digital images and text will be transferred via ship's email to GFNMS office on daily basis

11.2 Because scientific staff must sometimes communicate with other research vessels, commercial vessels, and shore-based NOAA facilities, the Chief Scientist or a designee may request the use of radio transceivers aboard the vessel.

11.3 Scientific staff may use McARTHUR's iridium phone when out of standard cellular phone range. The Chief Scientist will provide the Commanding Officer with payment information for the charges.

Table 1. List of start and end position of transects.

Grid	Line	Station	Latitude	Deg	Min	Longitude	Deg	Min
Cordell Bank	A	1	38.211586	38	12.6952	-123.626976	-123	37.6186
	A	11	37.776011	37	46.5607	-123.484847	-123	29.0908
	B	1	38.222819	38	13.3692	-123.571608	-123	34.2965
	B	11	37.787179	37	47.2307	-123.429779	-123	25.7868
	C	1	38.234027	38	14.0416	-123.516223	-123	30.9734
	C	11	37.798322	37	47.8993	-123.374695	-123	22.4817
	D	1	38.245209	38	14.7126	-123.460822	-123	27.6493
	D	11	37.809439	37	48.5663	-123.319595	-123	19.1757
	E	1	38.256366	38	15.3820	-123.405405	-123	24.3243
	E	11	37.820531	37	49.2319	-123.264478	-123	15.8687
PRBO Survey	1	W	38.130400	38	7.8240	-123.532000	-123	31.9200
	1	E	38.139900	38	8.3940	-123.192000	-123	11.5200
	2	W	38.046100	38	2.7660	-123.563000	-123	33.7800
	2	E	38.056800	38	3.4080	-123.183000	-123	10.9800
	3	W	37.964500	37	57.8700	-123.503000	-123	30.1800
	3	E	37.975000	37	58.5000	-123.123000	-123	7.3800
	4	W	37.882000	37	52.9200	-123.475000	-123	28.5000
	4	E	37.892500	37	53.5500	-123.095000	-123	5.7000
	5	W	37.801300	37	48.0780	-123.384000	-123	23.0400
	5	E	37.814500	37	48.8700	-122.879000	-122	52.7400
	6	W	37.722100	37	43.3260	-123.233000	-123	13.9800
	6	E	37.734300	37	44.0580	-122.748000	-122	44.8800
	7	W	37.641500	37	38.4900	-123.131000	-123	7.8600
	7	E	37.653200	37	39.1920	-122.648000	-122	38.8800
Deep Reef	8	W	37.542294	37	32.5377	-123.078543	-123	4.7126
	8	E	37.553870	37	33.2322	-122.594659	-122	35.6795
	9	E	37.455240	37	27.3144	-122.508383	-122	30.5030
	9	W	37.444014	37	26.6408	-122.991647	-122	59.4988
	10	W	37.344754	37	20.6852	-122.942026	-122	56.5215
	10	E	37.355778	37	21.3467	-122.459391	-122	27.5635
Football	11	W	38.209024	38	12.5414	-123.522737	-123	31.3642
	11	E	38.217982	38	13.0789	-123.202748	-123	12.1649
	12	W	38.286271	38	17.1763	-123.562580	-123	33.7548
	12	E	38.295949	38	17.7570	-123.219381	-123	13.1629
	13	E	38.373870	38	22.4322	-123.236216	-123	14.1730
	13	W	38.363005	38	21.7803	-123.617836	-123	37.0701
	14	W	38.440631	38	26.4379	-123.646111	-123	38.7667
	14	E	38.451584	38	27.0950	-123.264098	-123	15.8459

Table 2. List of CTDs and hoop net tow stations in the Cordell Bank grid.

Line	Station	Latitude	Deg	Min	Longitude	Deg	Min	CTD	Net
A	1	38.211586	38	12.6952	-123.626976	-123	37.6186		
A	2	38.168036	38	10.0822	-123.612689	-123	36.7613		
A	3	38.124484	38	7.4690	-123.598418	-123	35.9051		
A	4	38.080931	38	4.8558	-123.584163	-123	35.0498		
A	5	38.037376	38	2.2425	-123.569926	-123	34.1956		
A	6	37.993819	37	59.6292	-123.555705	-123	33.3423		
A	7	37.950261	37	57.0157	-123.541500	-123	32.4900		
A	8	37.906701	37	54.4021	-123.527312	-123	31.6387		
A	9	37.863140	37	51.7884	-123.513141	-123	30.7884		
A	10	37.819576	37	49.1746	-123.498986	-123	29.9391		
A	11	37.776011	37	46.5607	-123.484847	-123	29.0908		
B	1	38.222819	38	13.3692	-123.571608	-123	34.2965	X	X
B	2	38.179262	38	10.7557	-123.557351	-123	33.4410		
B	3	38.135704	38	8.1422	-123.543110	-123	32.5866	X	X
B	4	38.092144	38	5.5287	-123.528886	-123	31.7332	X	
B	5	38.048583	38	2.9150	-123.514678	-123	30.8807	X	X
B	6	38.005020	38	0.3012	-123.500487	-123	30.0292	X	
B	7	37.961455	37	57.6873	-123.486313	-123	29.1788	X	X
B	8	37.917889	37	55.0733	-123.472155	-123	28.3293	X	
B	9	37.874320	37	52.4592	-123.458013	-123	27.4808	X	X
B	10	37.830751	37	49.8450	-123.443888	-123	26.6333		
B	11	37.787179	37	47.2307	-123.429779	-123	25.7868	X	X
C	1	38.234027	38	14.0416	-123.516223	-123	30.9734	X	X
C	2	38.190464	38	11.4278	-123.501996	-123	30.1198		
C	3	38.146899	38	8.8139	-123.487786	-123	29.2671	X	X
C	4	38.103332	38	6.1999	-123.473592	-123	28.4155	X	
C	5	38.059764	38	3.5859	-123.459414	-123	27.5649	X	X
C	6	38.016195	38	0.9717	-123.445253	-123	26.7152	X	
C	7	37.972624	37	58.3574	-123.431109	-123	25.8665	X	X
C	8	37.929051	37	55.7430	-123.416981	-123	25.0188	X	
C	9	37.885476	37	53.1286	-123.402869	-123	24.1722	X	X
C	10	37.841900	37	50.5140	-123.388774	-123	23.3264		
C	11	37.798322	37	47.8993	-123.374695	-123	22.4817	X	X
D	1	38.245209	38	14.7126	-123.460822	-123	27.6493	X	X
D	2	38.201639	38	12.0984	-123.446625	-123	26.7975		
D	3	38.158068	38	9.4841	-123.432445	-123	25.9467	X	X
D	4	38.114495	38	6.8697	-123.418281	-123	25.0969	X	
D	5	38.070921	38	4.2552	-123.404134	-123	24.2480	X	X
D	6	38.027345	38	1.6407	-123.390003	-123	23.4002	X	
D	7	37.983767	37	59.0260	-123.375888	-123	22.5533	X	X

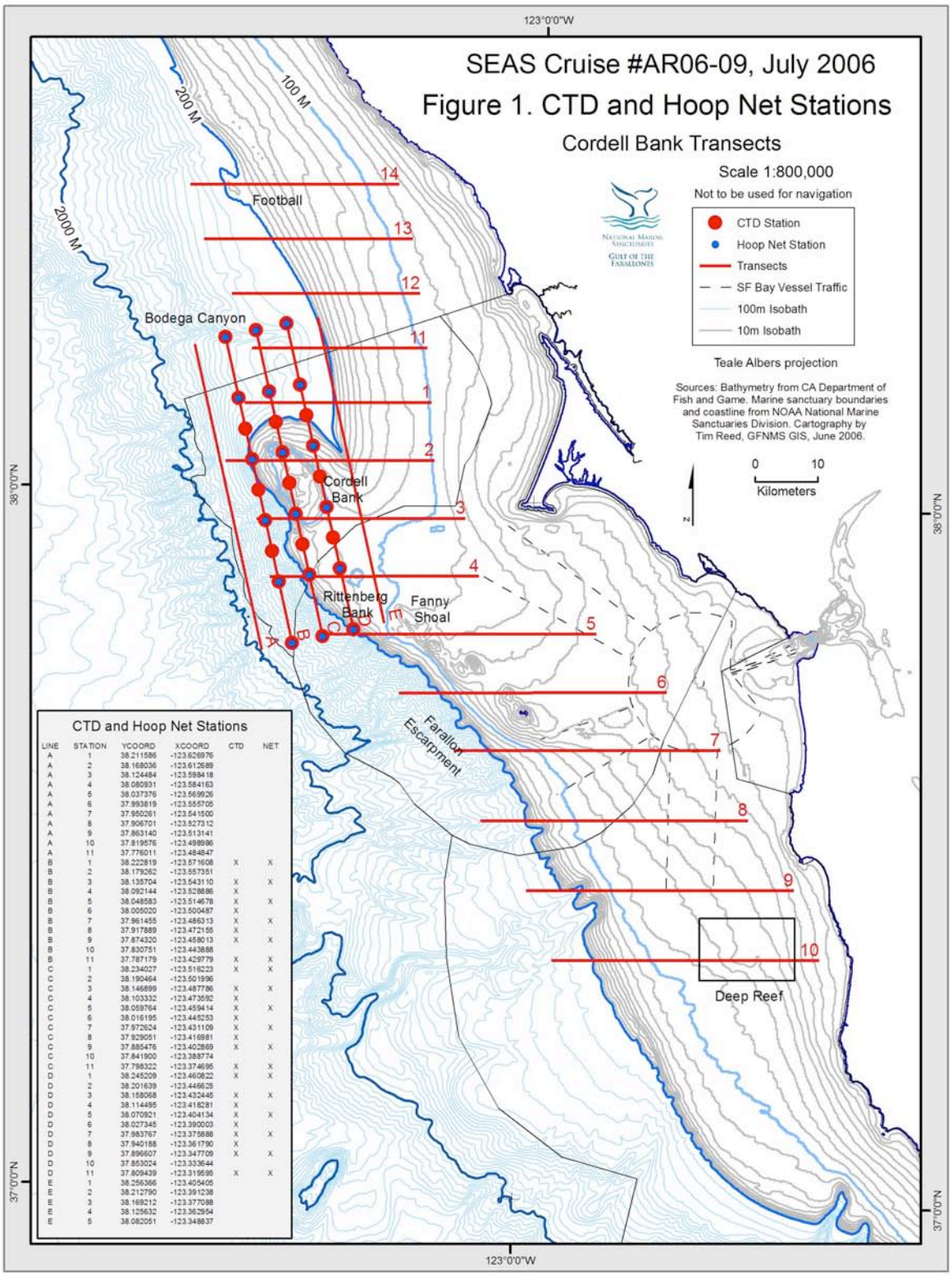
D		8	37.940188	37	56.4113	-123.361790	-123	21.7074	X	
D		9	37.896607	37	53.7964	-123.347709	-123	20.8625	X	X
D		10	37.853024	37	51.1814	-123.333644	-123	20.0186		
D		11	37.809439	37	48.5663	-123.319595	-123	19.1757	X	X
E	1		38.256366	38	15.3820	-123.405405	-123	24.3243		
E	2		38.21279	38	12.7674	-123.391238	-123	23.4743		
E	3		38.169212	38	10.1527	-123.377088	-123	22.6253		
E	4		38.125632	38	7.5379	-123.362954	-123	21.7772		
E	5		38.082051	38	4.9231	-123.348837	-123	20.9302		
E	6		38.038469	38	2.3082	-123.334736	-123	20.0842		
E	7		37.994885	37	59.6931	-123.320652	-123	19.2391		
E	8		37.951299	37	57.0780	-123.306584	-123	18.3950		
E	9		37.907712	37	54.4627	-123.292532	-123	17.5519		
E	10		37.864122	37	51.8473	-123.278497	-123	16.7098		
E	11		37.820531	37	49.2319	-123.264478	-123	15.8687		

Table 3. List of CTDs and hoop net tow stations in the extended PRBO survey grid.

Line	Station	Latitude	Deg	Min	Longitude	Deg	Min	CTD	Net
2	W	38.046100	38	2.7660	-123.563000	-123	33.7800	X	X
2	WM	38.047448	38	2.8469	-123.515175	-123	30.9105	X	X
2	M	38.048781	38	2.9269	-123.467652	-123	28.0591	X	X
2	ME	38.051448	38	3.0869	-123.372606	-123	22.3564	X	X
2	EX	38.054124	38	3.2474	-123.277803	-123	16.6682	X	X
2	E	38.056800	38	3.4080	-123.183000	-123	10.9800	X	X
4	W	37.882000	37	52.9200	-123.475000	-123	28.5000	X	X
4	WM	37.883340	37	53.0004	-123.427641	-123	25.6585	X	X
4	M	37.884643	37	53.0786	-123.380078	-123	22.8046	X	X
4	ME	37.887248	37	53.2349	-123.284951	-123	17.0970	X	X
4	EX	37.889874	37	53.3924	-123.189975	-123	11.3985	X	X
4	E	37.892500	37	53.5500	-123.095000	-123	5.7000	X	X
6	W	37.722100	37	43.3260	-123.233000	-123	13.9800	X	X
6	WM	37.723398	37	43.4039	-123.185281	-123	11.1169	X	X
6	M	37.724604	37	43.4762	-123.137815	-123	8.2689	X	X
6	ME	37.727017	37	43.6210	-123.042883	-123	2.5730	X	X
6	EX	37.730659	37	43.8395	-122.895442	-122	53.7265	X	X
6	E	37.734300	37	44.0580	-122.748000	-122	44.8800	X	X
10	W	37.344754	37	20.6852	-122.942026	-122	56.5215	X	X
10	MW	37.345935	37	20.7561	-122.894539	-122	53.6723	X	
10	M	37.347027	37	20.8216	-122.847304	-122	50.8382	X	
10	ME	37.349210	37	20.9526	-122.752835	-122	45.1701	X	X
10	EX	37.352494	37	21.1496	-122.606113	-122	36.3668	X	
10	E	37.355778	37	21.3467	-122.459391	-122	27.5635	X	X
14	W	38.440631	38	26.4379	-123.646111	-123	38.7667	X	X
14	MW	38.442011	38	26.5207	-123.598032	-123	35.8819	X	
14	M	38.443376	38	26.6026	-123.550257	-123	33.0154	X	
14	ME	38.446106	38	26.7664	-123.454708	-123	27.2825	X	X
14	EX	38.448845	38	26.9307	-123.359403	-123	21.5642	X	
14	E	38.451584	38	27.0950	-123.264098	-123	15.8459	X	X

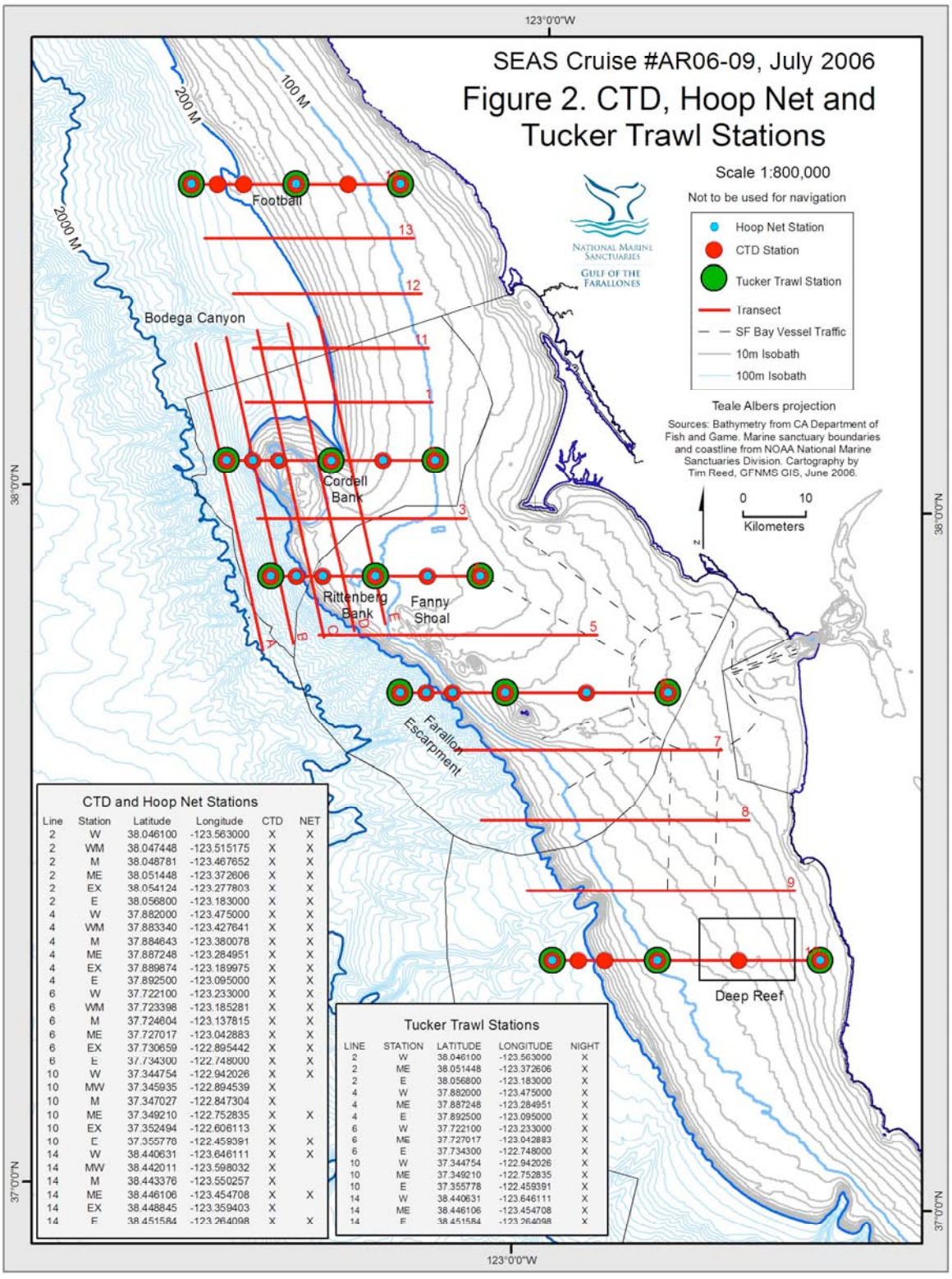
Table 4. List of sampling stations for Tucker trawls in the extended PRBO survey grid.

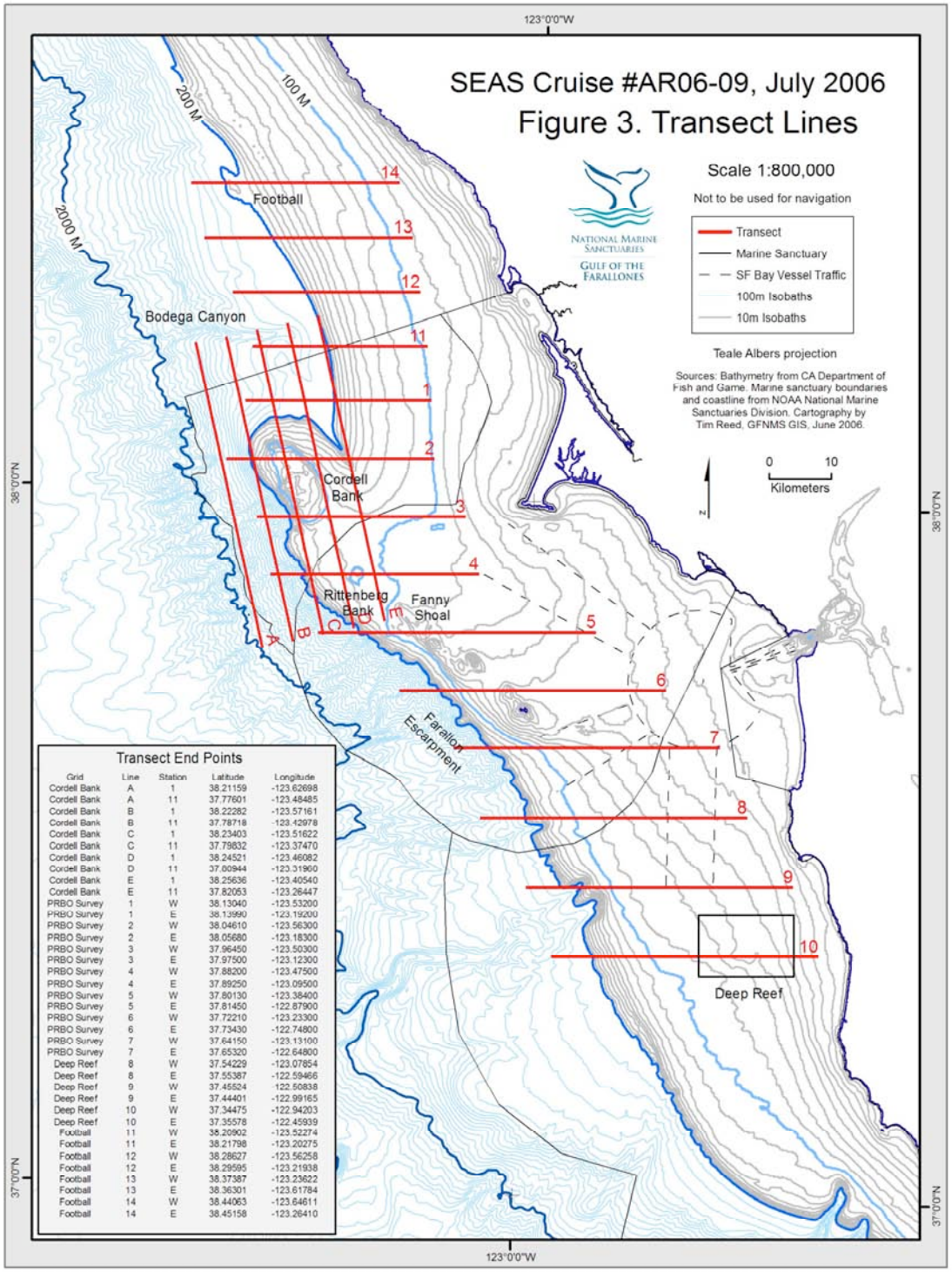
Line	Station	Latitude	Deg	Min	Longitude	Deg	Min	Night
2	W	38.046100	38	2.7660	-123.563000	-123	33.7800	X
2	ME	38.051448	38	3.0869	-123.372606	-123	22.3564	X
2	E	38.056800	38	3.4080	-123.183000	-123	10.9800	X
4	W	37.882000	37	52.9200	-123.475000	-123	28.5000	X
4	ME	37.887248	37	53.2349	-123.284951	-123	17.0970	X
4	E	37.892500	37	53.5500	-123.095000	-123	5.7000	X
6	W	37.722100	37	43.3260	-123.233000	-123	13.9800	X
6	ME	37.727017	37	43.6210	-123.042883	-123	2.5730	X
6	E	37.734300	37	44.0580	-122.748000	-122	44.8800	X
10	W	37.344754	37	20.6852	-122.942026	-122	56.5215	X
10	ME	37.349210	37	20.9526	-122.752835	-122	45.1701	X
10	E	37.355778	37	21.3467	-122.459391	-122	27.5635	X
14	W	38.440631	38	26.4379	-123.646111	-123	38.7667	X
14	ME	38.446106	38	26.7664	-123.454708	-123	27.2825	X
14	E	38.451584	38	27.0950	-123.264098	-123	15.8459	X



CTD and Hoop Net Stations

LINE	STATION	YCOORD	XCOORD	CTD	NET
A	1	38.211586	-123.626976		
A	2	38.168036	-123.612689		
A	3	38.124484	-123.598418		
A	4	38.080931	-123.584163		
A	5	38.037376	-123.569926		
A	6	37.993819	-123.555705		
A	7	37.950261	-123.541500		
A	8	37.906701	-123.527312		
A	9	37.863140	-123.513141		
A	10	37.819576	-123.498986		
A	11	37.776011	-123.484847		
B	1	38.222819	-123.571608	X	X
B	2	38.179262	-123.557351		
B	3	38.135704	-123.543110	X	X
B	4	38.092144	-123.528886	X	
B	5	38.048583	-123.514678	X	X
B	6	38.005020	-123.500487	X	
B	7	37.961455	-123.486313	X	X
B	8	37.917889	-123.472155	X	
B	9	37.874320	-123.458013	X	X
B	10	37.830751	-123.443888		
B	11	37.787179	-123.429779	X	X
C	1	38.234027	-123.516223	X	X
C	2	38.190464	-123.501996		
C	3	38.146899	-123.487786	X	X
C	4	38.103332	-123.473592	X	
C	5	38.059764	-123.459414	X	X
C	6	38.016195	-123.445253	X	
C	7	37.972624	-123.431109	X	X
C	8	37.929051	-123.416981	X	
C	9	37.885476	-123.402869	X	X
C	10	37.841900	-123.388774		
C	11	37.798322	-123.374695	X	X
D	1	38.245209	-123.460822	X	X
D	2	38.201639	-123.446625		
D	3	38.158068	-123.432445	X	X
D	4	38.114495	-123.418281	X	
D	5	38.070921	-123.404134	X	X
D	6	38.027345	-123.390003	X	
D	7	37.983767	-123.375888	X	X
D	8	37.940188	-123.361790	X	
D	9	37.896607	-123.347709	X	X
D	10	37.853024	-123.333644		
D	11	37.809439	-123.319595	X	X
E	1	38.256366	-123.405405		
E	2	38.212790	-123.391238		
E	3	38.169212	-123.377088		
E	4	38.125632	-123.362954		
E	5	38.082051	-123.348837		


SEAS Cruise #AR06-09, July 2006
Figure 2. CTD, Hoop Net and Tucker Trawl Stations
Scale 1:800,000
Not to be used for navigation
Hoop Net Station
CTD Station
Tucker Trawl Station
Transect
SF Bay Vessel Traffic
10m Isobath
100m Isobath
Teale Albers projection
Sources: Bathymetry from CA Department of Fish and Game. Marine sanctuary boundaries and coastline from NOAA National Marine Sanctuaries Division. Cartography by Tim Reed, GFNMS GIS, June 2006.
0 10
Kilometers
123°0'0"W
38°0'0"N
37°0'0"N
200 M
100 M
2000 M
Football
Bodega Canyon
Cordell Bank
Rittenberg Bank
Fanny Shoal
Farallon Escarpment
Deep Reef
CTD and Hoop Net Stations
Line Station Latitude Longitude CTD NET
2 W 38.046100 -123.563000 X X
2 WM 38.047448 -123.515175 X X
2 M 38.048781 -123.467652 X X
2 ME 38.051448 -123.372606 X X
2 EX 38.054124 -123.277803 X X
2 E 38.056800 -123.183000 X X
4 W 37.882000 -123.475000 X X
4 WM 37.883340 -123.427641 X X
4 M 37.884643 -123.380078 X X
4 ME 37.887248 -123.284951 X X
4 EX 37.889874 -123.189975 X X
4 E 37.892500 -123.095000 X X
6 W 37.722100 -123.233000 X X
6 WM 37.723398 -123.185281 X X
6 M 37.724604 -123.137815 X X
6 ME 37.727017 -123.042883 X X
6 EX 37.730659 -122.895442 X X
6 E 37.734300 -122.748000 X X
10 W 37.344754 -122.942026 X X
10 MW 37.345935 -122.894539 X
10 M 37.347027 -122.847304 X
10 ME 37.349210 -122.752835 X X
10 EX 37.352494 -122.606113 X
10 E 37.355778 -122.459391 X X
14 W 38.440631 -123.646111 X X
14 MW 38.442011 -123.598032 X
14 M 38.443376 -123.550257 X
14 ME 38.446106 -123.454708 X X
14 EX 38.448845 -123.359403 X
14 E 38.451584 -123.264098 X X
Tucker Trawl Stations
LINE STATION LATITUDE LONGITUDE NIGHT
2 W 38.046100 -123.563000 X
2 ME 38.051448 -123.372606 X
2 E 38.056800 -123.183000 X
4 W 37.882000 -123.475000 X
4 ME 37.887248 -123.284951 X
4 E 37.892500 -123.095000 X
6 W 37.722100 -123.233000 X
6 ME 37.727017 -123.042883 X
6 E 37.734300 -122.748000 X
10 W 37.344754 -122.942026 X
10 ME 37.349210 -122.752835 X
10 E 37.355778 -122.459391 X
14 W 38.440631 -123.646111 X
14 ME 38.446106 -123.454708 X
14 E 38.451584 -123.264098 X



Transect End Points

Grid	Line	Station	Latitude	Longitude
Cordell Bank	A	1	38.21159	-123.62698
Cordell Bank	A	11	37.77601	-123.48485
Cordell Bank	B	1	38.22282	-123.57161
Cordell Bank	B	11	37.78718	-123.42978
Cordell Bank	C	1	38.23403	-123.51622
Cordell Bank	C	11	37.79832	-123.37470
Cordell Bank	D	1	38.24521	-123.46082
Cordell Bank	D	11	37.80944	-123.31900
Cordell Bank	E	1	38.25636	-123.40540
Cordell Bank	E	11	37.82053	-123.26447
PRBO Survey	1	W	38.13040	-123.53200
PRBO Survey	1	E	38.13990	-123.19200
PRBO Survey	2	W	38.04610	-123.56300
PRBO Survey	2	E	38.05680	-123.18300
PRBO Survey	3	W	37.96450	-123.50300
PRBO Survey	3	E	37.97500	-123.12300
PRBO Survey	4	W	37.88200	-123.47500
PRBO Survey	4	E	37.89250	-123.09500
PRBO Survey	5	W	37.80130	-123.38400
PRBO Survey	5	E	37.81450	-122.87900
PRBO Survey	6	W	37.72210	-123.23300
PRBO Survey	6	E	37.73430	-122.74800
PRBO Survey	7	W	37.64150	-123.13100
PRBO Survey	7	E	37.65320	-122.64800
Deep Reef	8	W	37.54229	-123.07854
Deep Reef	8	E	37.55387	-122.59466
Deep Reef	9	W	37.45524	-122.50838
Deep Reef	9	E	37.44401	-122.99165
Deep Reef	10	W	37.34475	-122.94203
Deep Reef	10	E	37.35578	-122.45939
Football	11	W	38.20902	-123.52274
Football	11	E	38.21798	-123.20275
Football	12	W	38.28627	-123.56258
Football	12	E	38.29595	-123.21938
Football	13	W	38.37387	-123.23622
Football	13	E	38.36301	-123.61784
Football	14	W	38.44063	-123.64611
Football	14	E	38.45158	-123.26410

Appendix I

Emergency Contact Information

Michael Carver	Haley Mears 510 932 7050 M, Clare Carver 707 815 1766 M,
Dru Devlin	Emergency Contact/Next of kin: Donald J. Ayoob, spouse, Home: 650 -726-6021, Work: 415-904-5609
Jamie Hall	Judith Novak 415-561-6622 ext. 200
Jaime Jahncke	Ellie Cohen 415-254-3727
Carol Keiper	Judith Novak 415-561-6622 ext. 200
Derek Lee	Ellie Cohen 415-254-3727
Shannon Lyday	Judith Novak 415-561-6622 ext. 200
Carol Preston	Cell: 415-999-7503
Jan Roletto	John DeFiore, 650-796-2071 or Joyce Fauknor 650-364-8862
Ben Saenz	Ellie Cohen 415-254-3727
Mary Jane Schramm	Margaret Zeh (sister) 407-645-2390
Sophie Webb	Mary Nisbit/Tim Sheils 415-868-9895/0203, Michelle Hester 650-996-4002; Patrick Webb 212-924-6875