UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Fisheries Center
8604 La Jolla Shores Drive
La Jolla, California 92037

21 March 2007

FINAL CRUISE REPORT

Ship Name: NOAA Ship *David Starr Jordan*

Cruise Numbers: OMAO DS-06-05, SWFSC Marine Mammal Cruise Number: 1630

Cruise Dates: 28 July through 07 December 2006

Project: *Stenella* Abundance Research Project (STAR)

Sponsor: NOAA Fisheries, Southwest Fisheries Science Center (SWFSC) Protected Resources Division (PRD)

Chief Scientist: Dr. Lisa T. Ballance, SWFSC (858) 546-7173, Lisa.Ballance@noaa.gov

Clearance Countries:
Mexico, Guatemala, El Salvador, Honduras, Nicaragua, Costa Rica, Panama, Ecuador, Colombia, Peru, and France (Clipperton Island)

Foreign Participants:
Instituto Nacional de la Pesca (INP), Mexico; Instituto Nacional de Ecología (INE), Mexico; Universidad del Valle de Guatemala (Dra. Lucía Gutiérrez), Guatemala; Institut français de recherche pour l'exploitation de la mer (IFREMER), France; Ministerio de Ambiente y Energía (MINAE), Costa Rica; Instituto del Mar del Peru (IMARPE), Peru

Itinerary:

28 JUL	San Diego, CA/Acoustic calibration			
LEG 1:	29 Jul	Depart San Diego, CA	14 Aug	Arrive Mazatlán, Mexico
LEG 2:	17 Aug	Depart Mazatlán, Mexico	04 Sep	Arrive Puntarenas, Costa Rica
LEG 3:	08 Sep	Depart Puntarenas, Costa Rica	27 Sep	Arrive Puerto Quetzal, Guatemala
LEG 4:	03 Oct	Depart Puerto Quetzal	22 Oct	Arrive Acapulco, Mexico
LEG 5:	25 Oct	Depart Acapulco, Mexico	15 Nov	Arrive Manzanillo, Mexico
	15 Nov	Depart Manzanillo, Mexico	19 Nov	Arrive Manzanillo, Mexico
LEG 6:	22 Nov	Depart Manzanillo, Mexico	22 Nov	Arrive Manzanillo, Mexico
	25 Nov	Depart Manzanillo, Mexico	07 Dec	Arrive San Diego, CA
			07 Dec	Acoustic calibration

CRUISE DESCRIPTION AND OBJECTIVES:
The STAR 2006 cruise surveyed marine mammals and their habitat in the eastern tropical Pacific Ocean (ETP). The primary objective was to assess the status of dolphin stocks which have been taken as incidental catch by the yellowfin tuna purse-seine fishery. An ecosystem approach was used. Research on

physical and biological oceanography (dolphin habitat), mid trophic-level fishes and squids (dolphin prey), seabirds, marine turtles, and other cetaceans (dolphin commensals, competitors, and predators) was conducted. This cruise was a continuation of a multi-year study with previous cruises in 1986-1990, 1998-2000, and 2003 using a multidisciplinary approach.

Visual observations of cetaceans, seabirds, and sea turtles, their taxonomic composition, group size and geographic location were recorded. Photographs of cetaceans were taken for delineation of stocks and identification of individuals, and projectile biopsies were collected to study geographic stock structure and phylogenetic relationships. Sonobuoys recorded vocalizations of cetaceans. Sea turtles were tagged, measured and had blood samples taken. Thermosalinograph, fluorometer, XBT, and CTD measurements logged the oceanographic properties of the survey area. Manta and bongo net tows and dipnet sampling collected surface and midwater invertebrates and ichthyoplankton.

The STAR 2006 cruise was a two-ship project. Activities of the other vessel, NOAA Ship *McArthur II*, are covered in a separate report.

Study Area:
The eastern tropical Pacific Ocean (ETP). Tracklines covered are shown in **Figure 1.**

I. OPERATIONS

1. CETACEAN RESEARCH

Visual watches were conducted by observer teams on the flying bridge during all daylight hours (from sunrise to sunset), unless weather prohibited this activity.

1.1 Cetacean Survey - Line-transect survey methods were used to collect abundance data. At the beginning of each day search effort started on the trackline. The *Jordan* traveled at 10 knots (through the water) along the designated trackline. While on search effort, if the ship's speed through the water deviated from this by more than one knot, the bridge personnel notified the mammal team on watch or the Cruise Leader. A daily watch for cetaceans was maintained on the flying bridge during daylight hours (approximately 0600 to 1800) by six mammal observers. Each observer worked in 2-hour rotations, staffing each of the following three stations on the flying bridge for 40 minutes: a port side 25x150 binocular station, a center line data recorder position, and a starboard 25x150 binocular station. (SAME)

1.1.1 Logging of Data - A log of observation conditions, watch effort, sightings, and other required information were entered into a computer that was hooked up to the ship's Global Positioning System (GPS, for course, speed and position information) and SCS (for weather and heading information). An “independent observer” kept a separate watch of animals sighted during the cetacean survey operations to be compared later with the observer team’s data. (SAME)

1.1.2 Breaking Trackline - Upon sighting a cetacean school or other feature of biological interest, the Cruise Leader or cetacean observer team on watch requested that the vessel be maneuvered to approach the school or feature for investigation. When the ship approached a school of dolphins, the observers made independent estimates of school size. Biopsy and photographic operations commenced from the box, based on directions from the Cruise Leader or Senior Marine Mammal Observers. In some instances, the Cruise Leader requested the deployment of a small boat for biopsy, photographic or other operations (see 3.0). It was occasionally necessary to divert the ship’s course from the established trackline during regular effort due to glare or adverse sea conditions. Under these circumstances, the ship was diverted up to 30 degrees from the established course. This deviation was continued until the ship was 10nm from the trackline, at which point the ship turned back toward the trackline.

1.1.3 Dive-Interval Studies - Sightings of deep-diving whales prompted dive-interval studies at the discretion of the Cruise Leader. The collection of dive-interval data was necessary to produce sightability correction factors for those species that spend a considerable amount of time diving. The Cruise Leader or observer team on watch directed the vessel during these observations.

1.1.4 Resuming Effort - When the observers completed operations for the sighting, the ship resumed the same course and speed as prior to the sighting. If the pursuit of the sighting took the ship more than 10 nm from the trackline, the observers were notified. The Cruise Leader or Senior Marine Mammal Observers often requested that, rather than proceeding directly toward the next waypoint, the ship take a heading back toward the trackline.

1.2 Biopsy Sampling - Biopsy samples for genetic analyses of cetaceans were collected on an opportunistic basis. Necessary permits were present on the vessel. The animals sampled were approached by the research vessel during normal survey operations, approached the vessel on their own, or approached by a small boat. Samples were collected from animals within 10 to 30m of the bow of the vessel using a dart fired from a crossbow or rifle. With the exception of the small boat and safety gear, all necessary equipment was furnished and deployed by the scientific party.

1.3 Photography - Photographs of cetaceans were taken on an opportunistic basis. These were

used to study social behavior and movement patterns of identified individuals, and to study geographic variation. Necessary permits were present on the vessel. The animals photographed were approached by the research vessel during normal survey operations, approached the vessel on their own, or approached by a small boat. With the exception of the small boat and safety gear, all necessary equipment was furnished by the scientific party.

1.4 Passive Acoustics

1.4.1 Sonobuoys - Sonobuoys were deployed periodically from NOAA Ship *David Starr Jordan* or a small boat on an opportunistic basis at the discretion of the Cruise Leader. With the exception of the small boat and safety gear, all necessary equipment was supplied and operated by scientific personnel.

1.4.2 Bow Hydrophone - A hydrophone mounted on the bow was often activated by scientific personnel at the discretion of the Cruise Leader. All of the necessary equipment was supplied and operated by scientific personnel.

1.5 Aerial Photogrammetry - During Leg 5, the ship conducted coordinated operations with a NOAA Twin Otter aircraft operating out of airports along the west coast of Mexico (mainly Acapulco). The ship deployed and retrieved 50' sections of PVC pipe that were used to calibrate the radar altimeter on the aircraft. This operation required approximately one hour, and the pipes were attended by the ship's small boat at least 100 yards away from the ship. The small boat drifted alongside the pipes to ensure they were straight. Communications between the ship's scientific party and the aircraft was via Iridium phones at long range and VHF at short range. On days with excellent weather (Beaufort 2 and below) the aircraft flew to the vessel area to collect vertical photographs of schools detected from the ship and also attempted to locate schools in the ship's immediate vicinity. Data from the images will be used to calibrate observer estimates of school size and to estimate calf production for populations sampled. During days of ship/aircraft operations, school size calibration took precedence over line transect sampling. The ship/aircraft coordinated operations used 11 of the 12 days allocated. The Cruise Leader coordinated communications with the aircraft and kept the Command and Operations Officer informed of daily operations planning.

1.6 Salvage of Cetaceans - Cetacean body were salvaged on an opportunistic basis at the discretion of the Cruise Leader. This included whale and dolphin teeth, bones, and carcasses. When this occurred, scientific freezer space was used to store the cetacean body parts. Permits to salvage and import cetacean parts were present on the vessel. These permits were valid in US territorial waters and on the high seas only. All cetacean specimens obtained will be archived at the SWFSC but may be released on loan to recognized research institutions according to existing guidelines.

2. Ecosystem Studies

2.1 Oceanography - Oceanographic sampling was conducted by the Oceanographers and other designated scientists. A chronological record of oceanographic and net tow stations was kept by the ship (Marine Operations Log) with dates and times in GMT. The ship provided a printed and electronic copy of the marine operations log (with the cruise Weather Log and SCS data) to the Chief Scientist at the completion of the cruise.

2.1.1 ADCP -The Oceanographer conducted a test at the beginning of the cruise and periodically thereafter to determine if the ship’s ADCP causes any interference with the EK500 signal. If interference was observed, the ADCP remained off unless required by the ship’s Command. If the ADCP

was used, complete system settings were provided by the Oceanographer, and included 5-minute averaging of currents, AGC, and four beam returns in 60 8-meter bins.

2.1.2 Thermosalinograph Sampling - Ship personnel provided and maintained a thermosalinograph (TSG), which was calibrated and in working order, for continuous measurement of surface water temperature and salinity. A backup unit (calibrated and in working order) was also provided by ship personnel and remained aboard during the cruise. The SCS served as the main data collection system for the TSG. The Oceanographer provided the ship's Operations Officer and Electronics Technician with detailed SCS acquisition information. The SCS data acquisition was stopped and restarted weekly by the Electronics Technician so data files could be backed up and checked for errors. All SCS and raw data were provided to the SWFSC Oceanographer following each leg of the cruise.

2.1.3 Filtering Water Samples - Concurrent with squid sampling and dipnetting, small samples of particulate organic matter (POM) and zooplankton were collected by the visiting scientist in charge of squid sampling. One hour prior to the evening CTD, seawater was collected from the ship's uncontaminated seawater system, pre-filtered to remove large particles, and placed in a 10L carboy filtration system. The water was left for at least three hours to filter on to 25mm glass fiber filters. The glass fiber filters were stored frozen. For zooplankton collection, seawater collected from the sea surface was poured over a homemade nitex filter and stored frozen.

2.1.4 XBT Drops - Three XBT drops per day occurred at approximately 0900, 1200 and 1500 hours local ship time, or as requested by the Cruise Leader. The XBTs were provided by the Southwest Fisheries Science Center; the launcher and computer were provided by the ship. If the vessel was already stopped at the scheduled launch time, the drop was delayed until the ship was again underway. The scientist performing the drop would contact the bridge prior to deploying the XBT to ensure the vessel would move within half an hour. If the vessel would not move within half an hour, the drop was delayed or canceled at the discretion of the Cruise Leader.

2.1.5 Surface Water Samples - A surface water sample for chlorophyll *a* analysis and a bucket temperature were collected by the Cruise Leader at approximately 0900, 1200, 1500, and 1800 hours local ship time daily.

2.1.6 Argo Buoy Deployments - Fifteen Argo buoys were deployed by scientific personnel to improve coverage in the eastern tropical Pacific Ocean; seven on *David Starr Jordan* and eight on *McArthur II*. Argo is a major contributor to the WCRPs Climate Variability and Predictability Experiment (CLIVAR) and to the Global Ocean Data Assimilation Experiment (GODAE). The Argo array is part of the Global Climate Observing System/Global Ocean Observing System GCOS/GOOS.

The times and locations of the deployments were determined by the Cruise Leader in consultation with the Command. Buoys were deployed off the stern by a member of the scientific party after notifying the Deck Officer. The buoys were loaded in San Diego and secured in a weather protected area and stored horizontally at all times.

2.1.7 Underway pCO_2 System - The Pacific Marine Environmental Laboratory's underway pCO_2 system measured the partial pressure of CO_2 in the air and surface water while the ship was underway. The pCO_2 values, along with wind data, temperature, and salinity are used to calculate the flux of CO_2 at the air-sea interface. The system required 3 liters of seawater per minute and determined CO_2 content with a Licor infrared detector. Equipment maintenance included: daily verification that the system was operating correctly, e-mail transmission of CO_2 data to PMEL, and replacement of magnesium perchlorate desiccant every 3 days.

2.1.8 CTD - The main SeaBird CTD system was provided, maintained, and operated by the scientific party. The collection of CTD data, samples, and their processing were conducted by the scientific party. The crew of the vessel operated all deck equipment and was responsible for the termination (and any necessary reterminations) of the CTD cable pigtail (provided by the scientific party) to the conducting cable of the winch. The ship provided a complete backup system, consisting of a frame with weights, a 12-place rosette with bottles, a deck unit, and a SeaBird 9/11+ CTD with conductivity and temperature sensors. All instruments, their spares, and spare parts provided by the ship were maintained in working order and, if applicable, had current calibrations (within the previous 12 months). We used both primary and backup conductivity and temperature sensors during our casts; conducting CTD casts with two temperature and salinity sensors provided immediate feedback about the performance of the sensors and the validity of the data. To ensure longevity of the CTD and Bottles, the CTD was rinsed completely with fresh water after every cast. Afterwards, the oceanographer covered and secured the CTD and rosette.

2.1.8.1 - Initial CTD Cast for Each Leg - We requested an additional CTD cast on the first evening of oceanographic operations for each leg of the cruise. This cast was used to test the agreement among salinity samples collected from all CTD bottles. For this cast, a maximum depth of 700m was needed; all bottles were fired at this depth. The rate of CTD ascent and descent for this cast was 60m per minute. The oceanographer required extra time to take salinity samples from all bottles before the regular CTD cast was conducted: 30 minutes for the cast, 15 minutes for the sampling, and 15 minutes to prepare the CTD for the regular evening cast.

2.1.8.2 CTD Stations - Weather permitting, two CTD stations were occupied each night; an evening cast and a pre-dawn cast. CTD data and seawater samples were collected using a SeaBird 9/11+ CTD with rosette and Niskin bottles fitted with silicone tubing and o-rings (supplied by the scientific party). All casts were to 1000 m, with the descent rate at 30m/min for the first 100m of the cast, then 60m/min after that, including the up cast between bottles. Bottle samples were collected from 12 standard depths (0, 20, 40, 60, 80, 100, 120, 140, 170, 200, 500, and 1000 m). From each cast, chlorophyll samples were collected from all depths $\leq$ 250m, and processed on board. The 265ml chlorophyll samples were filtered onto GF/F filters, placed in 10ml of 90% acetone, refrigerated for 24 hours, and then analyzed on a Turner Designs model 10AU field fluorometer. Salinity samples (from all 12 Niskin bottles) were taken only from casts where bottle tripping errors were found. Analysis was done by the oceanographer. Cast times were subject to change since sunrise and sunset varied during the cruise. Additional CTD stations were requested by the Cruise Leader in areas of special interest.

2.1.8.3 Pre-dawn Cast - The morning cast began approximately 1-1/2 hours prior to sunrise. The exact starting time was determined the evening before by the Operations Officer or Deck Officer. The schedule was subject to modification by the Oceanographer. Samples for chlorophyll were collected as detailed above.

2.1.8.4 Evening Cast - An evening CTD cast was conducted no earlier sooner than one hour after sunset. The exact time was determined by the Deck Officer (by 1800 local ship time that day). Chlorophyll samples were collected as detailed above.

2.1.9 Buoys - The ship was not required to approach oceanographic buoys to repair or maintain scientific instruments for the Tropical Atmosphere Ocean (TAO) project during the cruise.

2.2 Prey Fishes and Squids

2.2.1 Acoustic Backscatter - The scientific EK-500 depth sounder was operated, at 38, 120, and 200 KHz, and interfaced to a data acquisition system to estimate micronekton biomass between

0 and 500 m. The vessel's EQ-50 depth sounder was used at the discretion of the Commanding Officer, but normally remained off while underway in deep waters. The ship informed the Cruise Leader of any use of the vessel's EQ-50, as it interferes with the signals received on the scientific EK-500. Use of the scientific EK-500 was continuous or at the discretion of the Cruise Leader.

2.2.2 Net Sampling - Net tows were conducted by the scientific party with the assistance of a winch operator from the vessel. The net tow schedule varied by leg.

2.2.3 Dipnetting - Concurrent with the evening CTD station, dipnetting for surface fauna was conducted by scientific personnel for one full hour from the starboard side of the ship. This station began no sooner than one full hour after sunset. One or more deck lights were necessary to illuminate the water surface in the area of dipnet sampling. Samples were preserved, labeled, and stored in the vessel's freezer. Surplus samples of any species of fishes, cephalopods, and crustaceans, were labeled and frozen for the Food-web Isotope Project. Scientists collected surface fauna for aquarium tanks on board. All live organisms were donated to the Scripps Aquarium upon return to San Diego.

2.2.4 Collection of Squid - Concurrent with the evening CTD station and dipnetting, two species of cephalopods, *Dosidicus gigas* and *Sthenoteuthis oualaniensis*, were collected in the evening using attracting lights and handline jigs. They were collected along the Pacific Coast of Mexico (off the Pacific Coast of the Baja Peninsula, Central Coast, and Gulf of Tehuantepec), El Salvador, Costa Rica Dome, and Ecuador. A total of 30 *D. gigas* were caught at each of the stations in the areas described above. *S. oualaniensis* (n = 30) were collected only if *D. gigas* were found in the same area. Juvenile squid swimming at the surface were collected with dip nets. Squids were labeled (ship, date, GPS position, and time). During Legs 1 and 2, squids were weighed, sexed, and measured by the visiting scientist in charge of squid sampling. Gill and muscle tissue samples, the complete beak, and stomachs were saved for processing later. Gill samples were stored in 95% ethanol in 1.5ml plastic vials; muscle tissues, beaks, and stomachs were kept frozen at -20°C. Squid with mantle lengths less than 30 cm were kept frozen intact. During Legs 3 through 6, all specimens were frozen intact as soon as possible and labeled (ship, date, time, and latitude and longitude position).

In areas not mentioned above, squids of all species with mantle sizes 35cm or less were collected opportunistically during dipnetting, labeled (ship, date, time, position), and frozen whole for the Food-web Isotope project. Two specimens per species per sampling location were sufficient.

2.2.5 Manta Tow - A surface manta net tow was conducted for fifteen minutes immediately following the evening CTD station and dipnetting. The manta tow was conducted in the dark; hence, the deck lights were turned off for the duration of the tow. The net was deployed from the starboard hydro winch when working; otherwise, the port winch was utilized. While at-sea, samples were preserved in formalin, labeled, and stored in containers provided by the SWFSC. Average completion time for the entire procedure was 30 minutes.

2.2.6 Bongo Tow - An oblique bongo tow was conducted for 15 minutes (45 minute station time), to a depth of 200m (wire out 300m on starboard hydro winch) immediately following the manta tow. The Bongo net has 505µm mesh on the starboard side, and 333µm mesh on the port side. Two cod ends were used on the bongo tow. The samples were preserved in formalin or frozen (isotope analysis), labeled and stored in containers provided by the SWFSC while at-sea.

2.2.6.1 Samples for Leatherback Turtle Diet Isotope Project and the Inter-American Tropical Tuna Commission Food-web Isotope Project - The contents of the second cod end (333 µm mesh) bongo tow were collected, placed in whirl-packs, labeled, and stored frozen for later stable isotope analysis. Samples were separated twice a week with gelatinous samples specifically stored

for the Turtle Diet Isotope Project. J. Seminoff (SWFSC) and R. Olson (IATTC) provided supplies to label and store these samples.

2.2.7 Collection of Fish - Fish were collected on an opportunistic basis at the discretion of the Cruise Leader. While underway, trolling gear was used when conditions permitted. While stationary, hook-and-line gear was used. Fish were measured, sexed, and stomach contents were examined and recorded by scientific personnel. The stomach with contents intact, a piece of liver, and a core of white muscle were removed from each scientifically caught fish and stored frozen for the Food-web Isotope Project (R. Olson, IATTC, will provide supplies and instructions). The Cruise Leader was responsible for the disposition of the catch, in accordance with NOAA Administrative Order 202-735B, dated January 9, 1989. All flyingfish specimens that landed on the decks were collected by the scientific party and frozen. Individuals who found flyingfish on deck notified Robert Pitman or the flyingfish team leader.

2.2.8 Collection of Jellyfish samples - Jellyfish and other gelatinous plankton were collected opportunistically for leatherback turtle dietary studies. Jellyfish were collected using dip nets, during scheduled bongo and manta tows, opportunistically from the surface, or from the small boat. Jellyfish and gelatinous plankton on the CTD were collected upon its retrieval. Samples were frozen for future stable isotope analysis.

2.3 Seabird Research - Weather permitting, visual surveys for seabirds were conducted by seabird observers from the flying bridge during all daylight hours (sunrise to sunset).

2.3.1 Seabird Survey - Visual surveys of seabirds were conducted from the flying bridge during daylight hours by two seabird observers. A log of visibility conditions, effort, sightings, and other required information were entered into a computer interfaced with the ship's GPS (for course, speed, and position information) and SCS (for weather and heading information). All science computers were connected to the same ship's GPS. Seabird observers used 7x50 handheld and 25x150 binoculars.

2.3.2 Seabird Collection - Two shotguns and ammunition were used to collect seabirds on an opportunistic basis. A small boat was required for specimen collection. Necessary permits were present on the vessel. Weapons and ammunition were turned over to the Commanding Officer immediately upon boarding and stored in the gun locker.

2.3.3 Seabird Colony Censuses - Nesting site surveys were conducted by the scientific party at locations to be determined by the Cruise Leader. The vessel's small boat was required for transporting observers to and from nesting sites for ground counts (on foot) of the seabird colonies. Clipperton Island was surveyed on this cruise. This survey was visual only, no collection occurred. All necessary permits were aboard the vessel.

2.3.4 Seabird Diet Study, Malpelo Island, Colombia - On Leg 3, three scientists studied the Nazca Booby diet; one of the scientists was a Colombian national who spent several months conducting seabird research on the island previously. The drop-off at Malpelo occurred on the afternoon of the third day out of Costa Rica and the pickup occurred on the afternoon of the eight day. The scientific party carried an iridium phone with them on the island to communicate with the ship. Scientists caught up to 300 individuals and collected regurgitations (n=90) from the birds. Birds were measured and weighed, and then released unharmed. The vast majority of regurgitation samples collected on Malpelo Island remained on the island as part of its ecosystem. Representative parts of the regurgitations were retained (e.g. otoliths, squid beaks) and may be sent to the Colombian Marine Natural History Museum (MHNMC in Spanish; see www.invemar.org.co, http://www.invemar.org.co/). No birds were collected on Malpelo.

2.4 Marine Turtle Research - A visual survey for marine turtles was conducted by the mammal and seabird observers on the flying bridge during all daylight hours. Data were recorded in both mammal and seabird databases. Marine turtles were captured from a small boat on an opportunistic basis at the discretion of the Cruise Leader. Regularly, turtles were measured, weighed, flipper tagged, and a small amount of blood or skin was collected for genetic and stable isotope analysis, or hormonal studies. All turtles were released unharmed. At the discretion of the Cruise Leader, three turtles were fitted with a satellite transmitter and released. The transmitter was attached to the carapace with fiberglass resin. Also at the discretion of the Cruise Leader a stomach lavage was performed on selected turtles. With the exception of the small boat and safety gear, all necessary equipment was supplied and operated by the scientific party. All necessary permits were aboard the vessel.

3. Small Boat Work

A small boat was necessary for biopsy sampling, photography, seabird collection, island surveys, and marine turtle work. Deployment was requested by the Cruise Leader on an opportunistic basis, including multiple times in a single day, provided the Commanding Officer concurred that operating conditions were safe. Unless the Commanding Officer allowed otherwise, the small boat remained within sight and radio contact at all times while deployed. The small boat returned to the ship immediately when recalled by the CO, OOD, or Cruise Leader. With the exception of the small boat and required safety gear, all necessary equipment was furnished by the scientific party.

4. Transit at Night

When scientific operations were completed for the night, the ship resumed course along the trackline, at a speed determined by the Cruise Leader, until it was necessary to stop for the morning (pre-dawn) CTD station. Generally, the ship transited between 50 and 100 nm per night. The Cruise Leader determined the nightly transit length on a daily basis.

II. SCIENTIFIC PERSONNEL

1. Chief Scientist - The Chief Scientist for STAR 2006 was Dr. Lisa T. Ballance. In addition to her Chief Scientist duties, she was Cruise Leader for three legs: Leg 2 aboard NOAA Ship *McArthur II* and Legs 4 and 5 aboard NOAA Ship *David Starr Jordan*.

1.1 Participating Scientists - Participating scientists are listed in the tables below by leg.

Leg 1: San Diego, California to Mazatlán, México

Name	Position	Affiliation
Robert Pitman	Cruise Leader	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
Iliana Ruiz-Cooley	Visiting Scientist	New Mexico State University
Manuel Inclan	Official Foreign Observer	Country of México
Mark Harris	Teacher-at-sea	ARMADA

Leg 2: Mazatlán, México to Puntarenas, Costa Rica

Name	Position	Affiliation
Robert Pitman	Cruise Leader	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
Iliana Ruiz-Cooley	Visiting Scientist	New Mexico State University
Juan Francisco Córdova Soriano	Official Foreign Observer	Country of El Salvador
Christian Naranjo	Official Foreign Observer	Country of Ecuador

Leg 3: Puntarenas, Costa Rica to Puerto Quetzal, Guatemala

Name	Position	Affiliation
Robert Pitman	Cruise Leader	NOAA Fisheries / SWFSC
Tim Gerrodette	Cruise Leader/Visiting Scientist	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
L. Ignacio Vilchis	Graduate Student	Scripps Inst. Oceanography
Mateo Lopez-Victoria	Official Foreign Observer	Country of Colombia
Anna Núñez Pereligina	Official Foreign Observer	Country of Panamá

Leg 4: Puerto Quetzal, Guatemala to Acapulco, México

Name	Position	Affiliation
Lisa Ballance	Cruise Leader	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
Robert Pitman	Visiting Scientist	NOAA Fisheries / SWFSC
L. Ignacio Vilchis	Graduate Student	Scripps Inst. Oceanography
Carl Safina	Visiting Scientist	Blue Ocean Institute

Leg 5: Acapulco, México to Manzanillo, México

Name	Position	Affiliation
Lisa Ballance	Cruise Leader	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
L. Ignacio Vilchis	Graduate Student	Scripps Inst. Oceanography
Nicholas Kellar	Visiting Scientist	NOAA Fisheries / SWFSC
Jeremy Rusin	Visiting Scientist	NOAA Fisheries / SWFSC
Tony Gaston	Visiting Scientist	Canadian Wildlife Service

Leg 6: Manzanillo, Mexico to San Diego, California

Name	Position	Affiliation
Sarah Mesnick	Cruise Leader	NOAA Fisheries / SWFSC
Juan Carlos Salinas	Senior Mammal Observer	AFL
Cornelia Oedekoven	Senior Mammal Observer	AFL
Gary Friedrichsen	Marine Mammal ID Specialist	NOAA Fisheries / SWFSC
Ernesto Vasquez	Mammal Observer	AFL
Adam Ü	Mammal Observer	NOAA Fisheries / SWFSC
Laura Morse	Mammal Observer	NOAA Fisheries / SWFSC
Richard Pagen	Senior Bird Observer	NOAA Fisheries / SWFSC
Chris Cutler	Bird Observer	NOAA Fisheries / SWFSC
Candice Hall	Oceanographer	AFL
Lindsey Peavey	Turtle Handler	Volunteer / SWFSC
Marisa Trego	Visiting Scientist	AFL
Lisa Schwarz	Visiting Scientist	University of Montana
Jessica Kondel	Visiting Scientist	NOAA Fisheries
Juan Manuel Gutierrez	Official Foreign Observer	Country of México

III. RESULTS

The area surveyed is shown in Figure 1; the data collected are summarized in the following tables:

Table 1. Cetacean sightings and behavioural data

Table 2. Cetacean biopsy samples

Table 3. Number of cetacean schools or individuals photographed

Table 4. Acoustic recordings

Table 5. Photogrammetry efforts by the aerial photogrammetry team

Table 6. Environmental data

Table 7. Cephalopod samples

Table 8. Seabird sightings

Table 9. Marine turtle sightings and sampling efforts

IV. DISPOSITION OF DATA

All data are currently being analyzed. The final data reports will be completed by February 2008. Marine mammal data were delivered to Dr. Tim Gerrodette, NOAA Fisheries / SWFSC, for analysis and distribution. Passive acoustic data were delivered to Dr. Jay Barlow, NOAA Fisheries / SWFSC, for analysis and distribution. Acoustic backscatter data were delivered to Dr. David Demer, NOAA Fisheries / SWFSC, for analysis and distribution. Oceanographic data were delivered to DR. Paul Fiedler, NOAA Fisheries / SWFSC, for analysis and distribution. Biopsy samples were delivered to Dr. Barbara Taylor, NOAA Fisheries / SWFSC, for analysis and distribution. Aerial photogrammetry data were delivered to Wayne Perryman, NOAA Fisheries / SWFSC, for analysis and distribution. Ecosystem data (seabirds, turtles, net samples) were delivered to the Chief Scientist, Dr. Lisa Ballance, NOAA Fisheries / SWFSC, for analysis and distribution.

Prepared by: _____ Date: 30 Mar 07
Annette E. Henry
Survey Coordinator

_____ Date: 30 Mar 2007
Dr. Lisa T. Ballance, Chief
Chief Scientist, STAR 2003

Approved by: _____ Date: 3/30/07
Dr. Stephen B. Reilly
Director, Protected Resources Division

_____ Date: 4/2/7
Dr. William W. Fox, Jr.
Director, NOAA Fisheries - SWFSC

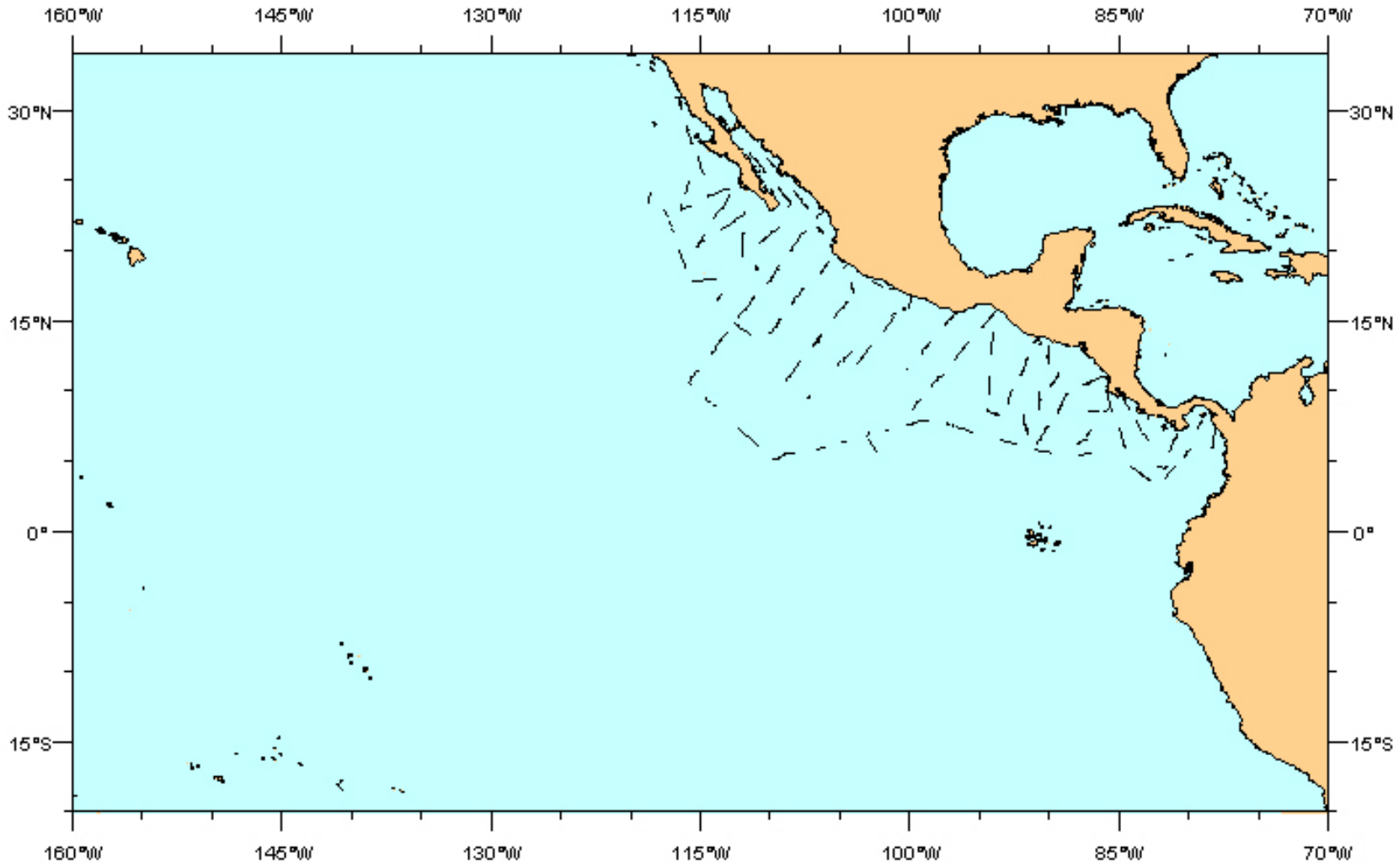

Figure 1. Trackline surveyed while on effort aboard NOAA Ship *David Starr Jordan* during STAR 2006.

Table 1. Summary of cetacean sightings during STAR 2006 aboard NOAA Ship *David Starr Jordan.* Behavioural data were collected on each sighting of small cetaceans.

Species or taxon	**Leg 1**	**Leg 2**	**Leg 3**	**Leg 4**	**Leg 5**	**Leg 6**	**Total**
Mesoplodon peruvianus	1	0	0	2	10	2	15
Stenella attenuata (offshore)	9	12	4	8	8	8	49
Stenella longirostris (unid. subsp.)	4	2	1	0	0	0	7
Stenella attenuata graffmani	0	0	13	1	0	0	14
Stenella longirostris orientalis	0	6	0	3	6	1	16
Stenella coeruleoalba	12	40	31	7	0	5	95
Steno bredanensis	11	7	6	5	17	2	48
Delphinus delphis	28	4	37	10	4	2	85
Tursiops truncatus	17	7	25	19	3	5	76
Grampus griseus	14	2	3	1	7	2	29
Feresa attenuata	0	0	1	0	2	1	4
Pseudorca crassidens	1	0	0	0	3	1	5
Globicephala macrorhynchus	3	0	6	0	0	0	9
Orcinus orca	1	0	3	1	3	1	9
Physeter macrocephalus	7	0	0	0	0	1	8
Kogia sima	5	0	2	2	14	2	25
Ziphiid whale	3	3	2	1	8	2	19
Mesoplodon sp.	2	1	3	0	7	1	14
Ziphius cavirostris	1	1	4	1	4	0	11
Berardius bairdii	8	0	0	0	0	0	8
Balaenoptera sp.	8	0	0	0	0	2	10
Balaenoptera acutorostrata	0	0	0	0	0	1	1
Balaenoptera edeni	2	0	0	3	0	0	5
Balaenoptera physalus	8	0	0	0	0	0	8
Balaenoptera musculus	24	0	2	3	1	0	30
Megaptera novaeangliae	0	2	5	0	0	0	7
Unid. dolphin	21	3	13	2	7	4	50
Unid. small whale	4	2	3	0	2	1	12
Unid. large whale	3	1	1	1	1	3	10
Kogia sp.	1	0	1	0	0	0	2
Stenella attenuata (unid. subsp.)	0	0	0	0	3	0	3
Unid. cetacean	0	1	0	0	0	0	1
Unid. whale	2	0	0	0	0	0	2
Balaenoptera borealis/edeni	5	0	1	0	1	0	7
Unid. small delphinid	7	23	22	9	29	11	101
Unid. medium delphinid	2	4	7	4	12	1	30
Unid. large delphinid	0	2	0	1	1	0	4
Total	**214**	**123**	**196**	**84**	**153**	**59**	**829**

Table 2. Cetacean biopsy samples collected during STAR 2006 aboard NOAA Ship *David Starr Jordan*.

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Stenella attenuata	12	0	0	9	78	11	110
Stenella longirostris sub sp.	0	21	4	0	0	0	25
Stenella attenuata graffmani	0	0	21	6	0	0	27
Stenella longirostris orientalis	6	0	0	2	54	11	73
Stenella coeruleoalba	1	0	1	0	0	0	2
Steno bredanensis	0	3	4	4	0	2	13
Delphinus delphis	15	0	3	1	0	0	19
Tursiops truncatus	13	11	18	6	0	10	58
Feresa attenuata	0	0	0	0	0	1	1
Pseudorca crassidens	0	0	0	0	0	1	1
Globicephala macrorhynchus	8	10	43	1	0	0	62
Orcinus orca	0	0	1	6	9	6	22
Physeter macrocephalus	8	0	0	0	0	0	8
Balaenoptera edeni	3	0	0	1	0	0	4
Balaenoptera musculus	8	0	1	0	0	0	9
Megaptera novaeangliae	0	0	2	0	0	0	2
Unid. small dolphin	0	0	0	0	2	0	2
Total	**74**	**45**	**98**	**36**	**143**	**42**	**438**

Table 3. Number of cetacean schools or individuals photographed during STAR 2006 aboard NOAA Ship *David Starr Jordan.*

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Stenella attenuata (offshore)	7	3	1	4	14	4	33
Stenella longirostris (unid.)	3	2	1	0	0	0	6
Stenella attenuata graffmani	0	0	10	1	0	0	11
Stenella longirostris orientalis	0	4	0	4	16	3	27
Stenella coeruleoalba	2	4	5	0	0	1	12
Steno bredanensis	3	4	1	3	1	3	15
Delphinus delphis	10	1	18	1	1	1	32
Tursiops truncatus	9	3	20	2	0	3	37
Grampus griseus	5	1	1	0	1	2	10
Feresa attenuata		0	1	0	2	1	4
Pseudorca crassidens		0	0	0	0	4	4
Globicephala macrorhynchus	1	1	9	1	0	0	12
Orcinus orca		0	4	9	24	10	47
Physeter macrocephalus	3	17	0	0	0	1	21
Kogia sima		0	0	0	0	1	1
Ziphiid whale	1	0	0	0	1	0	2
Berardius bairdii	3	0	0	0	0	0	3

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Balaenoptera acutorostrata	0	0	0	0	0	1	1
Balaenoptera edeni	1	0	0	2	0	0	3
Balaenoptera physalus	2	0	0	0	0	0	2
Balaenoptera musculus	11	4	3	3	1	1	23
Megaptera novaeangliae	0	1	5	0	0	0	6
*Stenella attenuata (*unid.)	1	0	0	0	0	0	1
Balaenoptera borealis/edeni	5	0	1	0	0	0	6
Total	**67**	**45**	**80**	**30**	**61**	**36**	**319**

Table 4a. Number of sighted cetacean groups per leg for which acoustic recordings were obtained using a bow hydrophone on NOAA Ship *David Starr Jordan* during STAR 2006, listed in order of the number of recordings obtained. A total of 52 cetacean schools were detected and recorded using the bow hydrophone.

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Tursiops truncatus	5	1	4	0	2	0	12
Stenella attenuata	3	0	5	1	1	0	10
Steno bredanensis	1	3	0	1	0	0	5
Delphinus delphis	2	0	2	0	0	0	4
Stenella longirostris	3	0	1	0	0	0	4
S. attenuata, S. longirostris (mixed)	1	0	0	0	2	0	3
Orcinus orca	0	0	1	0	2	0	3
Feresa attenuata	0	0	0	0	1	1	2
Globicephala macrorhynchus, T. truncatus (mixed)	1	0	1	0	0	0	2
Pseudorca crassidens	0	0	0	0	1	1	2
S. attenuata, T. truncatus (mixed)	1	0	0	0	0	0	1
Grampus griseus	1	0	0	0	0	0	1
T. truncatus, S. bredanensis (mixed)	0	0	1	0	0	0	1
Stenella coeruleoalba	0	0	1	0	0	0	1
Balaenoptera acutorostrata	0	0	0	0	0	1	1
Total	18	4	16	2	9	3	52

Table 4b. Number of cetacean schools recorded with sonobuoys on NOAA Ship *David Starr Jordan*.

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Opportunistic Sonobuoy Station	0	0	0	0	0	7	7
Orcinus orca	0	0	2	1	3	1	7
Balaenoptera musculus	1	0	1	0	1	0	3
Berardius bairdii	1	0	0	0	0	0	1
Globicephala macrorhynchus, Tursiops truncatus (mixed)	0	0	1	0	0	0	1
Balaenoptera edeni/borealis (unidentified)	0	0	1	0	0	0	1
Balaenoptera acutorostrata	0	0	0	0	0	1	1
Total	2	0	5	1	4	9	21

Table 5a. Photogrammetry effort for STAR 2006; data collected from deHavilland Twin Otter fixed-wing aircraft. DSJ: *David Starr Jordan*; MAC: *McArthur II*. Each ship was allocated one leg (12 flight days) to complete calibration; calibrations recorded include schools photographed, not necessarily final number used, and include partial calibrations (observations with < 6 observers).

Ship	Days			Flight		No. schools photographed	No. schools photographed for calibration
	Flown	lost	% flown	hours	hours/day		
1-DSJ	11	1	92	56.3	5.1	40	28
2- MAC	8	4	67	44.0	5.5	35	15
Total	**19**	**5**	**79**	**100.3**	**5.3**	**75**	**43**

Table 5b. Schools photographed by the aerial photogrammetry team during STAR 2006.

Species or taxon	Leg 1	Leg 2	Total
Stenella attenuata	0	4	4
Stenella longirostris	3	4	7
Mixed schools: *S. attenuata* and *S. longirostris*	25	9	34
Stenella coeruleoalba	0	0	0
Delphinus. Sp	4	10	14
Other small cetaceans	3	4	7
Unid. small cetaceans	0	1	1
Total small cetaceans	**35**	**32**	67
Large whales (*B. edeni*)	1	0	1
Beaked whales	4	3	7
Total sightings photographed	**40**	**35**	**75**

Table 6a. Dipnet samples collected during STAR 2006 aboard NOAA Ship *David Starr Jordan.*

Description	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
No. of stations occupied	16	18	19	17	16	10	96
No. of fish collected	309	703	829	483	223	134	2,681

Table 6b. Summary of environmental data collected during STAR 2006 aboard NOAA Ship *David Starr Jordan*.

Operation	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
CTD Casts	28	24	36	38	33	20	127
Salinity	30	24	28	26	24	16	94
Surface chlorophyll	45	54	46	68	44	40	198
CTD chlorophyll	269	218	330	346	320	190	1,186
XBT	44	55	54	51	40	43	188
CTD Casts	28	24	36	38	33	20	127

Table 7. Cephalopods collected during STAR 2006 aboard NOAA Ship *David Starr Jordan*. Note: squid species labeled as "unidentified" will be identified at a later date.

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
D. gigas	73	8	0	0	0	0	81
Argonauta sp.	1	0	0	0	0	0	1
Onychoteuthis	1	2	0	0	0	0	3
S. oualaniensis	3	82	0	0	0	0	85
Unidentified	1	1	263	109	108	30	512
T. rhombus	0	3	0	0	0	0	3
Mixed *D. gigas/S. oualaniensis*	0	0	0	0	0	0	0
Total	**79**	**96**	**263**	**109**	**108**	**30**	**685**

Table 8. Seabirds sighted during STAR 2006 aboard NOAA Ship *David Starr Jordan.*

Common Name	Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Albatrosses	Diomedeidae	5	0	0	0	0	1	6
Shearwaters	Puffinus spp.	50	461	245	181	208	142	1,287
Petrels	Pterodroma spp., Fulmarus spp.	118	572	147	407	57	22	1,323
Skuas	Catharactidae	5	4	2	2	3	0	16
Cormorants	Phalacrocoracidae	14	0	0	0	0	0	14
Storm-Petrels	Oceanitidae	2,485	457	333	511	324	211	4,321
Tropicbirds	Phaethontidae	22	14	30	13	14	14	107
Boobies	Sulidae	253	400	449	281	513	231	2,127
Frigatebirds	Fregatidae	31	17	32	4	4	5	93

Common Name	Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Phalaropes	Phalaropodidae	161	112	136	81	989	170	1,649
Jaegers	Stercorariidae	15	21	50	31	49	31	197
Gulls	Larus spp.	69	0	21	17	19	44	170
Terns	Sterna spp., Gygis spp., Chlidonias spp., Anous spp.	188	606	189	519	234	145	1,881
Auks	Alcidae	14	0	0	0	0	0	14
Total		**3,430**	**2,664**	**1,634**	**2,047**	**2,414**	**1,016**	**13,205**

Table 9a. Summary of marine turtle sightings during STAR 2006 aboard NOAA Ship *David Starr Jordan*.

Species or taxon	Leg 1	Leg 2	Leg 3	Leg 4	Leg 5	Leg 6	Total
Lepidochelys olivacea	32	12	81	38	150	37	350
Caretta caretta	8	0	0	0	0	0	8
Eretmochelys imbricata	0	0	1	0	0	0	1
Total	**40**	**12**	**82**	**38**	**322**	**37**	**360**

Table 9b. Summary of marine turtle samples collected during STAR 2006 aboard NOAA Ship *David Starr Jordan*.

Species	Skin	Blood	Scute	Lavage	Other	Total
Lepidochelys olivacea	565	1,233	346	41	44	2,229
Caretta caretta	15	28	8	0	1	52
Eretmochelys imbricata	2	4	1	0	2	9
Total	**582**	**1,265**	**355**	**41**	**47**	**2,290**