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OCTOBER 2012

2004 SURVEY OF ROCKFISHES IN THE SOUTHERN CALIFORNIA BIGHT USING THE COLLABORATIVE OPTICAL-ACOUSTIC SURVEY TECHNIQUE

Edited by
David A. Demer

NOAA-TM-NMFS-SWFSC-497

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center

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2004 Survey of Rockfishes in the Southern California Bight using the Collaborative Optical–Acoustic Survey Technique

COAST04

Report of the data collection, preliminary analysis, and tentative conclusions for the COAST surveys aboard NOAA RV *David Starr Jordan* and CPFV *Outer Limits*, October 2004 through May 2005

Edited by
David A. Demer

January 2012

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Background
Marine sportfishing in Southern California is a huge industry that must be monitored and managed by non-lethal fish surveying techniques if it, and the associated rockfish stocks, are to be maintained. Statewide, thousands of marine sportfishing anglers purchase tickets to board Commercial Passenger Fishing Vessels (CPFV) and also contribute to the tourism businesses in the region. Of the nearly 300 operated CPFVs statewide, approximately two thirds operate from harbors in the Southern California Bight (SCB). Meanwhile, the stocks of lingcod and six rockfish species, including four that are important to California anglers and commercial fishermen (*Sebastes paucispinis*, *S. pinniger*, *S. entomelas* and *S. levis*), are estimated at or below 25% of their pristine levels, and have been declared overfished by the Pacific Fisheries Management Council (PFMC). In response, two Marine Conservation Areas (MCAs) were recently created in the SCB. The State and Federal MCAs in southern California cover approximately 5,600 square-n.mi., which provide critical habitat for nearly 60 rockfish species (Love et al 2002). Because numerous species of rockfish coexist in these areas, residing near or on the seabed at depths of approximately 80 to 300 m, and are low in numerical-density, there are many survey challenges. To overcome these obstacles, a combination of survey equipment is required.

The first challenge is to identify the essential habitat for these rockfishes, thus reducing the necessary survey area. This can be done with a combination of multi-beam sonar, multi-frequency echosounders, and underwater cameras deployed from a remotely operated vehicle (ROV). Multi-frequency echosounders and underwater cameras can then be used to acoustically survey the rockfishes in their habitat, visually identify the mixture of species and their sizes, and estimate rockfish distributions and abundances, by species. The Southwest Fisheries Science Center (SWFSC) is developing this non-lethal, non-extractive survey technique to use in cooperation with the CPFV fleet. While these instruments and their associated data analysis techniques have proven utilities for estimating fish biomass, mapping bathymetry, and visually observing seabed terrain and fish species, respectively, many of the techniques must be adapted or redesigned specifically for studies of rockfishes.

Objectives
Initial rockfish studies were conducted from November 2003 through April 2004 from the CPFV *Outer Limits.* The research objective was to develop a survey technique that combines multi-beam sonar measurements for habitat characterization, multi-frequency echosounder measurements for mapping rockfish aggregations and facilitating remote taxa identification, and ROV-based video observations for validation of the acoustical habitat classification, identification of the mixture of species, and estimation of their size distributions. The field efforts focused on the characterizing rockfish 1) acoustical spectral signatures; 2) site fidelity; 3) diel behaviors; and 4) variability of their mixed species assemblages.

The goals of the investigation detailed in this report were to refine and apply the Collaborative Optical–Acoustic Survey Technique (COAST) to assess the distributions and abundances of rockfishes in the SCB, by species. Ultimately, this information will be combined with measures of the rockfish recruitment processes and the dispersion or redistribution of recruits from protected to harvested areas. The collective knowledge will provide a basis for a longer-term and broader spatial-scale assessment of rockfishes and assure the effectiveness of the protected areas in the SCB.

Description of operations

The rockfishes in selected areas of the Cowcod Conservation Area (CCA) were mapped using a combination of multiple-frequency echosounders deployed from NOAA Research Vessel *David Starr Jordan* or CPFV *Outer Limits* and an ROV equipped with high-resolution video and still cameras deployed from *Outer Limits*. These areas were selected from the results of the 2003/2004 pilot survey and the collective records from multiple fishing masters in the commercial fleet (courtesy of Ken Franke). The total proposed trackline, with 0.2 n.mi. transect spacing (0.1 n.mi. for smaller sites), totals approximately 2,654 n.mi. As most rockfishes rise above the seabed only during daylight hours, echosounder surveys were conducted between sunrise and sunset (approximately 1400 to 0100 GMT, 0700 to 1800 PST, or 11 hours per day off daylight savings time or approximately 1245 to 0245 GMT, 0545 to 1945 PST, or 13.5-14 hours per day; PST=GMT-7 hrs. during daylight savings), at a nominal speed of 5-10 kts.

Summary of results

The principal objective was to develop an acoustical-optical survey method for estimating the distributions and abundances of rockfishes, by species, throughout the SCB. Acoustic-optical surveys were conducted in the SCB from October 2004 through May 2005. Data from these surveys have been analyzed, and preliminary results show interesting trends in fish populations and promising accordance between acoustic-optical and assessment estimates.

Target strength measurements from OL0505 and previous cruises (OL1705-1707 from October 2003 to May 2004) were combined to create a dataset of *TS* of 45 rockfishes (data not shown here). This was an effort to identify *TS* versus acoustic frequency and fish size for a few species. The variability of *TS* measurements made on live, hooked fish was high. Consequently, more precise *TS* measurements of rockfishes need to be made in a hyperbaric chamber to investigate *TS* versus frequency, pressure, fish species and size.

Ultimately, this information will be combined with measures of the rockfish recruitment processes, and the dispersion or redistribution of recruits from protected to harvested areas. The collective knowledge will provide a basis for a longer term and broader spatial-scale assessments of rockfishes and assure the effectiveness of the protected areas in the SCB. Survey and analysis methods continue to be refined.

Scientific personnel

David Demer	SWFSC	Acoustic Engineer
John Butler	SWFSC	Research Fisheries Biologist
Deanna Pinkard	SWFSC	Research Fisheries Biologist
Scott Mau	SWFSC	Research Fisheries Biologist
Lara Asato	SWFSC	Acoustic Technician
David Murfin	SWFSC	Electrical Engineer
Michael Wilson	SWFSC	Biological Technician

Thomas S. Sessions SWFSC Acoustic Technician

Cruise reports

1. Multi-frequency and multi-beam echosounder surveys, submitted by David A. Demer, Lara Asato, and Thomas S. Sessions

1.1 Objectives

The main objective was to develop an acoustical-optical survey method into a standard for estimating rockfish dispersion and abundance by species in the Southern California Bight (SCB). This was to be accomplished by:

1) identifying and mapping the biotic and abiotic habitat that is available for rockfishes in the SCB;

2) acoustically surveying the rockfish habitat using multi-frequency echosounders mounted on the hull of a ship;

3) apportioning the integrated volume backscattering coefficients to rockfish and non-rockfish using multi-frequency algorithms;

4) optically surveying fish and seabed types in the rockfish habitat using cameras mounted on a remotely operated vehicle (ROV);

5) apportioning the acoustically estimated rockfish biomass to species using the optically measured species mix and dispersion;

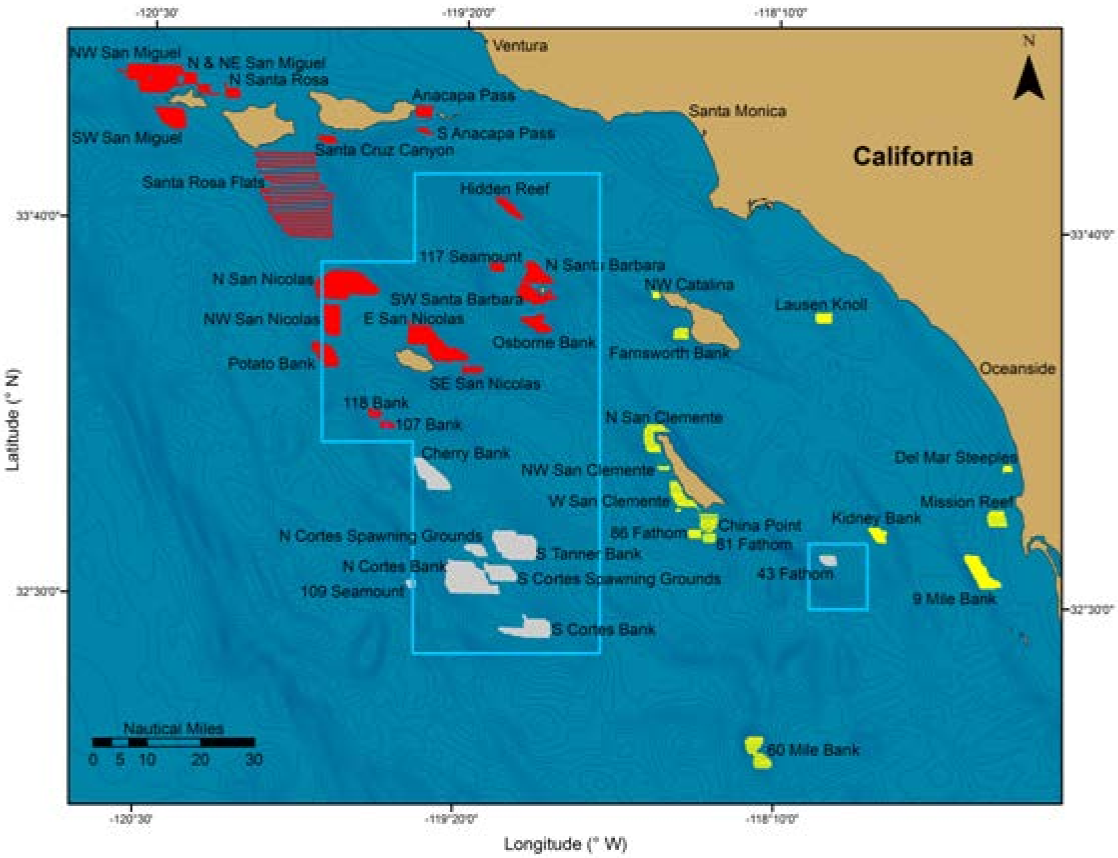
6) mapping the acoustically derived abundances of rockfishes in the SCB, by species; and

7) examining the depth distributions of rockfishes and behaviors of cowcod and other species of concern.

1.2 Accomplishments

Combined acoustic-optical surveys were conducted in the SCB from October 2004 through May 2005 (**Fig. 1.1**). Data from these surveys have been analyzed, and preliminary results show interesting trends in fish populations and promising accordance between acoustic-optical and assessment estimates. Efforts to refine the method have been focused on refining acoustic detections and classifications of rockfishes and their seabed habitats. The progress and results thus far have been extremely encouraging. Ultimately, this information will be combined with measures of the rockfish recruitment processes and the dispersion or redistribution of recruits from protected to harvested areas. The collective knowledge will provide a basis for a longer-term and broader spatial-scale assessments of rockfishes and assure the effectiveness of the protected areas in the SCB. Survey and analysis methods continue to be refined.

Figure 1.1. Collaborative Optical–Acoustic Survey Technique (COAST) survey plan. The Cowcod Conservation Area (CCA) is outlined in light blue. The survey waypoints and track lines are also in gray for the DSJ04 (October 2004) cruise, red for the DSJ0502 (February 2005) cruise and yellow for the OL0505 (May 2005) cruise.



1.3 Methods

Throughout the COAST survey, acoustical volume backscattering strengths (S_v; dB re 1 m) and target strengths (*TS*; dB 1 m^2) were measured continuously by four echosounders (Simrad EK60) configured with 38, 70, 120, and 200 kHz hull-mounted transducers. The transducers, each with 7º beamwidths, were mounted at a depth of approximately 3.7 m on the NOAA Ship *David Starr Jordan* and 1.1 m on the CPFV *Outer Limits*. Additionally, an 18 kHz echosounder with an 11º-beamwidth transducer was used during one cruise leg on *Outer Limits* (designated OL0505), in May 2005.

On *David Starr Jordan*, synchronized pulses of 256 µs were transmitted downward every second and received with bandwidths of 3.675, 6.163, 8.710, and 10.635 kHz, respectively. On *Outer Limits*, synchronized pulses of 512 µs were transmitted downward every 2 s, received with bandwidths of 1.749, 3.275, 4.687, 5.557, and 5.972 kHz, respectively. Data were stored in “raw” data format. These data were averaged every 1 m in range and stored in the “EK500” data format. Data corresponding to ranges of 500 m beneath the transducers were recorded in both formats on computer hard disk and backed-up to external USB V2.0 hard disk and DVD+R media. Data were processed with Echoview V3.30.58.03, and distribution maps were created with ArcGIS/Map 9.0.

Except for the echosounders being used for these surveys, all other echosounders and sonars operating at or near the survey frequencies were secured during all survey operations. On *David Starr Jordan*, this included the ship's 150 kHz broad bandwidth ADCP, 200 kHz Doppler speed log, Wesmar 160 kHz sonar, and 200 kHz Skipper echosounder. The 50 kHz ES60 navigation echosounder was synchronized with the EK60s to reduce interference with the survey measurements. On *Outer Limits*, the ship's Wesmar 160 kHz sonar, and 38/200 kHz Furuno navigation echosounder were secured. Despite these measures, appreciable noise degraded the echograms at all four or five frequencies when surveying in inclement weather and swell.

In each of the areas, a three-dimensional (3-D) seabed was visualized by interpolating the seabed detections from the 38 kHz echosounder to render a surface. Empirical relationships between the S_v at four frequencies (38, 70, 120, and 200 kHz) were used to remotely identify and separate the scatterer taxa (i.e., large fish, small fish, and zooplankton). The rockfish were thus extracted from the echograms and their 3-D distributions were overlaid on the 3-D rendering of the seabed (e.g., **Fig. 1.2**). Additionally, the integrated volume backscattering coefficients (s_A; m^2/nm^2) attributed to rockfishes, and the area backscattering coefficients (s_a; m^2/m^2) attributed to three seabed classifications were mapped in plan view (e.g., **Figs. 1.3 and 1.4**, respectively). The acoustically-derived maps of bathymetry and seabed-classifications (e.g., sloped or soft, $0.0<s_a<0.07$; hard with relief, $0.071< s_a <0.14$; and hard and flat, $0.141< s_a <2.0$) were used to direct the ROV for optical spot-validation of seabed types (e.g. sand, mud, cobble/rubble, low relief, low relief with sand, high relief, high relief with sand, and rocky vertical face), using still and video cameras. High resolution underwater video and still-camera images were obtained with the ROV to characterize the fish species and their sizes and validate the acoustical seabed classifications.

At the conclusion of each survey segment or day, a CTD (Seabird Electronics 19plus) was deployed in the area to within 5 m of the seabed. For each deployment, the CTD was submerged to a depth of nominally 3 m for 2 min; then beginning at the surface, the CTD was cast to within 5 m of the seabed at 60 m/min, and then retrieved at the same rate on *David Starr Jordan*. On *Outer Limits*, the CTD was manually deployed on a line. Thus, temperature, salinity, and sound speed profiles were recorded at one or more positions within each survey location. If daytime, the ship then transited to the next cruise segment and began surveying until it was completed, or until sunset. At night, the ship either 1) transited to the next survey segment; or 2) anchored or hove to, and was staged to begin the next echosounder survey segment at sunrise.

On *David Starr Jordan* cruises, the temperature and salinity of the surface waters (3 m depth) were continuously measured using the ship's Seabird thermosalinograph and the Scientific Computing System (SCS). These data were automatically merged with the time and position data from the ship's GPS and logged by computer each minute.

David Starr Jordan **Leg I (DSJ04)**

Calibration: On 19 October 2004, from approximately 1030-1630 PST, during hours of morning slack tide, the ship anchored off Shelter Island (32º 43.262'N/117º 12.470'W) for echosounder calibration experiments.

Departure: A storm front hit San Diego on 20 October 2004, and the ship departed from San Diego, California at 0900 on 21 October 2004.

Forty-Three Fathom Bank: The ship proceeded directly to the first waypoint of the Forty-Three Fathom Bank survey area. The survey began at 2021 GMT (1421 PST), continued at a speed of nominally 10 kts, and was completed at 0058 (1858). From 0116-0122, a CTD (1) was cast to 95 m at 32º 38.807'N/117º 58.325'W. Information about the distribution and relative abundance of acoustically surveyed rockfish was relayed by cell phone from *Jordan* to Dr. John Butler aboard *Outer Limits*. ROV surveys were then conducted for video verification of species.

South Cortes Bank: The survey began on 22 October 2004 at 1402, continued at a speed of nominally 10 kts, and was completed on 23 October 2004 at 0041 (GMT). The area was surveyed from northwest to southeast to allow the ROV survey to commence as soon as possible following the acoustical observations in the area. The ROV is most effective when assisted by the prevailing current. From 0116-0122, a CTD (2) was cast to 85 m at 32º 25.419'N/119º 01.946'W. Information about the distributions of rockfishes was relayed by VHF radio to Dr. John Butler aboard the *Outer Limits*. ROV surveys were then conducted for video verification of species.

North Cortes Bank: The survey began on 23 October 2004 at 1402 and was completed on 27 October 2004 at 0134 (GMT). Again, the area was surveyed from northwest to southeast. On 26 October, a storm front approached and the seas grew to 2+ m swells. Intermittently, the ship speed was slowed from 10 to 7 kts to reduce bubble induced noise on the echograms. Four CTD casts (3, 4, 5 and 6) were made in the area, one each evening: CTD 3: 0140-0143 on 24 October at 32º 35.778'N/119º 18.428'W; CTD 4: 0145-0156 on 25 October at 32º 33.051'N/119º 17.611'W; CTD 5: 0138-0145 on 26 October at 32º 31.200'N/119º 15.000'W; and CTD 6: 0215-0222 on 27 October at 32º 29.775'N/119º 10.353'W. Information about the rockfish distribution was relayed by VHF radio to Dr. John Butler aboard the *Outer Limits*. In the northern half of the area, ROV surveys were conducted for video verification of species. On the morning of 26 October, the team aboard the *Outer Limits* curtailed ROV operations due to weather conditions and returned to San Diego.

Northern Cortes Spawning Grounds: The survey began on 27 October 2004 at 1413, continued at a speed of nominally 10 kts to the east and 7 kts to the west, due to swell conditions, and was completed on 27 October 2004 at 1737 (GMT). The area was surveyed from northwest to southeast. From 0424-1735, a CTD (7) was cast to 170 m at 32º 38.874'N/119º 15.224'W. Information about the rockfish distribution was relayed to Dr. John Butler at SWFSC, by email.

Southern Cortes Spawning Grounds: The survey began on 27 October 2004 at 1832, continued at a speed of nominally 10 kts to the east and 7 kts to the west, due to swell conditions, and was completed on 28 October 2004 at 1114 (GMT). The area was surveyed from northwest to southeast. Four short transect lines in the southwestern part of the planned grid were not completed during daylight. From 0134-0155, a CTD (8) was cast to 230 m at 32º 35.858'N/119º 10.302'W. Information about the rockfish distribution was relayed to Dr. John Butler at SWFSC, by email.

South Tanner Bank: The survey began on 28 October 2004 at 1418, continued at a speed of nominally 10 kts, and was completed on 29 October 2004 at 2020 (GMT). The area was surveyed from northwest to southeast. From 0144-0148 on 28 October, a CTD (9) was cast to 65 m at 32º41.25’N/119 08.36’W.

109 Bank/Seamount: The survey began on 29 October 2004 at 2248, continued at a speed of nominally 10 kts, and was completed on 30 October 2004 at 0027 (GMT). The area was surveyed with a 0.1 n.mi. line spacing by first surveying from north to south with 0.2 n.mi. transect spacing, then from south to north with parallel transects offset by 0.1 n.mi.. From 0148-0152 on 30 October, a CTD (10) was cast to 256 m at 32º33.70’N/119 30.12’W. There were no communications with *Outer Limits*.

Cherry Bank: The survey began on 30 October at 1522. Military exercises were being conducted near the survey area, so communications with Fleet Control were required. The survey continued at a speed of nominally 10 kts, and was completed on 31 October at 0057 (GMT). From 0125-0129 on 31 October, a CTD (11) was cast to 125 m at 32º53.50’ N/119 26.00’ W. Again, there were no communications with *Outer Limits*.

***David Starr Jordan* Leg II (DSJ0502)**

Calibration: On 5 February 2005 from approximately 1631 to 2330 GMT, *Jordan* anchored off San Miguel Island (34º 00.5401’N/120º 19.860’W) for echosounder calibration experiments. Inclement weather and initial technical difficulties resulted in an extended calibration period. The 120 kHz transducer (ES70-7C) was wired out of phase and corrected before a second set of calibrations were performed on the same day at both 256 and 1024 µs pulse durations.

On 10 February 2005 from 0047 to 0146 GMT, while the ship was drifting off San Miguel Island (34º 00.86’N/120º 35.78’W) in calm weather and seas, the calibration sphere was lowered to approximately a depth of 20 m over the port side of the boat with a fishing rod to acquire further calibration data to be examined upon conclusion of all surveys.

A post-cruise calibration was performed while anchored in San Diego Bay (32º 43.3’N/117º 11.6’W) on 22 February 2005 from 1600 to 2358 GMT at both 256 and 1024 µs pulse durations.

Ultimately, the EK60 system was calibrated a total of seven times: five times for 256 µs pulses, and twice for 1024 µs pulses. The latter pulse duration was used during DSJ0501 (CalCOFI).

Departure: The ship’s departure from San Francisco, California was delayed due to vessel-equipment problems. The vessel therefore reached Santa Barbara, California to retrieve the acoustic scientific party at 1800 on 4 February 2005. The ship began transit to San Miguel Island ca. 1900 on 4 February 2005.

Southwest San Miguel Island: The ship proceeded directly to the first waypoint of the San Miguel Island survey area. The survey began at 1458 GMT (0658 PST) on 5 February 2005, continued at speeds ranging from 6 to 10 kts, and was completed at 0139 GMT (1739 PST) on 6 February 2005. From 0151-0202, a CTD was cast to 90 m at 34º 0.160’N/120º 26.170’W.

ROV surveys were conducted at San Miguel Island on 4 February 2005. *Outer Limits* left San Miguel Island on 5 February 2005, due to high winds and conditions. ROV surveys resumed at San Nicolas Island, where conditions were more favorable.

Northwest San Miguel Island: Initial acoustic surveys began at 1517 GMT on 7 February 2005, and ended that day at 0117. Transects continued 8 February 2005 from 1500 to 0042 GMT. The last section of this site was completed on 9 February 2005, from 2201 GMT to 2357. Ship speeds were consistently near 10 kts. GPS positions of fish schools were relayed to the crew of *Outer Limits*, who steamed back to San Miguel Island for ROV surveys. A CTD cast was made near this site on 10 February 2005 at 0430 GMT (34° 6.3'N/120° 26.7'W).

North Santa Rosa Island: Acoustic surveys were conducted on 9 February 2005 from 1456 to 1654 GMT. Ship speed ranged from 10-11 kts. Survey locations were relayed to John Butler for ROV surveys.

Northeast San Miguel Island: Acoustic surveys were conducted on 9 February 2005 from 1741 to 1911 GMT. Ship speed ranged from 10-11 kts.

North San Miguel Island: Acoustic surveys were conducted on 9 February 2005 from 1917 GMT to 2124 GMT. Ship speed ranged from 10-11 kts.

Santa Cruz Canyon: Acoustic surveys were conducted on 10 February 2005 from 1551 to 1732 GMT. Ship speed ranged from 10-11 kts. Data were processed quickly and positions were relayed to Dr. John Butler aboard *Outer Limits*. Note: high densities of rockfishes were observed in areas between Santa Cruz Canyon to South Anacapa Pass (33° 57.010'N 119° 37.770'W).

Southeast Santa Rosa Island: The captain of *David Starr Jordan* considered surveys at this site to be hazardous, due to shallow and uncharted waters.

South Anacapa Pass: Acoustic surveys were conducted on 10 February 2005 from 1912 to 2111 GMT. Ship speed ranged from 6-10 kts. Ship speed was reduced temporarily at 1935 GMT to fix engine problems.

Anacapa Pass: Acoustic surveys were conducted on 10 February 2005 from 1912 to 2111 GMT. Ship speed ranged from 6-10 kts.

East San Nicolas Island: Acoustic surveys were conducted on 11 February 2005 from 1528 to 2343 GMT; 12 February 2005 from 0110 to 0145 GMT and 1450 to 2327 GMT; and on 13 February 2005 from 0004 to 00120 GMT. Ship speed ranged from 6-11 kts. On 11 February at 1923 GMT, the ship veered slightly off course to avoid an underwater obstruction. On 12 February 2005, there were two periods of slow ship speeds while the crew performed maintenance checks. A CTD was cast on 12 February 2005 at 0212 GMT (33° 19.810'N/119° 28.810'W). A second CTD was cast on 13 February 2005 at 0144 (33° 14.910'N/119° 22.130'W), but there were problems with the up-cast data.

North San Nicolas Island: Acoustic surveys were conducted on 13 February 2005 from 1450 to 2335 GMT; and on 14 February 2005 from 0010 to 0206 GMT and 1454 to 1727 GMT. Ship speed ranged from 10-11 kts. A CTD was cast on 13 February 2005 at 1329 GMT (33° 28.5'N/119° 45.9'W). The preliminary results of the CTD down-cast seemed problematic, but the up-cast appeared to be correct.

Northwest San Nicolas Island: Acoustic surveys were conducted on 14 February 2005 from 1800 to 2357 GMT; and on 15 February 2005 from 0009 to 0149 GMT. Ship speed ranged from 10-11 kts. The last seven transects were not completed due to time constraints. A CTD was cast on 13 February 2005 at 0902 GMT (33° 14.6'W/119° 50.4'N). The preliminary results of the CTD down-cast seemed problematic, but the up-cast appeared to be correct.

107 Bank: Acoustic surveys were conducted on 15 February 2005 from 1451 to 1700 GMT. Ship speed ranged from 9-11 kts.

118 Bank: Acoustic surveys were conducted on 15 February 2005 from 1743 to 2006 GMT. Ship speed ranged from 10-11 kts.

Potato Bank: Acoustic surveys were conducted on 15 February 2005 from 2105 to 2359 GMT; and on 16 February 2005 from 0016 to 0142 GMT and 1443 to 1753 GMT. Ship speed ranged from 9-11 kts. A CTD was cast on 15 February 2005 at 0204, but the results were problematic. The CTD was repaired and another cast was made on 16 February 2005 at 1358 GMT (33° 15.9'W/119° 49.8'N).

Santa Rosa Flats: Acoustic surveys were conducted on 16 February 2005 from 1957 to 2331 GMT; on 17 February 2005 from 0024 to 0130 GMT and 0142 to 2333 GMT; and on 18 February 2005 from 0031 to 0133 GMT and 1439 to 1854 GMT. Ship speed ranged from 9-11 kts. A CTD cast was made on 16 February 2005 at 0159 GMT (33° 40.0'N/119°59.3'W).

Hidden Reef: Acoustic surveys were conducted on 18 February 2005 from 2216 to 2352 GMT, and on 19 February 2005 from 0000 to 0139 GMT. Ship speed ranged from 9 to 10 kts. A CTD was cast on 19 February 2005 at 0153 (33° 42.1'N/119° 7.4'W).

117 Seamount: Acoustic surveys were conducted on 19 February 2005 from 1457 to 1646 GMT. Ship speed ranged from 9-10 kts. A CTD was cast on 19 February 2005 at 1522 GMT (33° 32.4'N/119° 12.8'W).

North Santa Barbara Island: Acoustic surveys were conducted on 19 February 2005 from 1726 to 2355 and completed on 20 February at 0023 GMT. Ship speed ranged from 9 to 10 kts. A CTD cast was made on 20 February 2005 at 0159 GMT (33° 30.2'N/119° 3.9'W).

Southwest Santa Barbara Island: Acoustic surveys were conducted on 20 February 2005 from 1432 to 2335 GMT. Ship speed ranged from 8 to 11 kts. The ship veered off course for several brief periods to launch the small boat for diving activities.

Osborne Bank: Acoustic surveys were conducted on 20 February 2005 from 2351 to 2355 GMT; and on 21 February from 0000 to 0134 GMT. Surveys continued on 21 February 2005 from 1434 to 1754 GMT. Ship speed ranged from 9 to 10 kts. A CTD was cast on 21 February 2005, but was abandoned due to equipment failure.

Southeast San Nicolas Island: Acoustic surveys were conducted on 21 February 2005 from 1943 to 2336 GMT. Ship speed ranged from 9 to 10 kts.

Outer Limits Leg III

Calibration: On 4 May 2005 from approximately 1552 to 2030 GMT, the ship anchored at Nine Mile Bank (32º 34.570'N/117º 21.650'W) for echosounder calibration experiments. The calibration sphere was initially lowered to approximately 20 m (130 m seabed depth). Inclement weather resulted in an extended calibration period and eventually up to 15 lbs of weight needed to be added to the calibration bridle. Five frequencies (18, 38, 70, 120 and 200 kHz) were calibrated with the 70 and 200 kHz initially showing irregular beam patterns, most likely due to the lack of sufficient data points in certain quadrants. A second set of calibrations of the 70 and 200 kHz was within acceptable limits. A survey of the Nine Mile Bank was attempted at the conclusion of the calibration, but all channels showed excessive noise at speeds above 5 kts, particularly while transiting into the west swell. The 70 kHz was consistently the noisiest of all frequencies, for almost all survey sites. The Nine Mile Bank survey was prematurely stopped and the ship returned to Seaforth Marina, Mission Bay, San Diego.

EK60 echosounder troubleshooting: From 4 to 6 and 9 to 10 May, multiple experiments were conducted on *Outer Limits* to identify the source of bubble noise at speeds above 5 kts. SCUBA divers were used to video tape the underside of the vessel while underway. The following sources of noise were suspected: bubbles caused by cavitation or entrainment by the transducer pod (positioned mid-ship fore-aft, and outboard starboard) or the stainless steel "bubble dam"; or the transducer pod depth.

At Nine Mile Bank on 5 May 2005, removal of the dam did not reduce the noise. On 6 May 2005, there was poor visibility in the Mission Bay Channel and in deeper water on *The Yukon* outside of Mission Bay. It was clear that noise in the echograms was modulated by swell direction, and ship speed and draft. On 9 May, *Outer Limits* was dry-docked and the transducer pod was lowered an additional 5 in. to an approximate depth of 3.5 ft. (1.1 m) or approximately 1.5 ft. (0.5 m) above the keel depth. The increased transducer depth did reduce the noise when surveying into the swell from 5 kts to 7 to 8 kts. Also, full fuel tanks and a full live well on the aft deck served to reduce the noise. Nevertheless, the noise persisted when transiting down swell at even 3 to 4 kts. Consequently, the remainder of the survey was conducted at an average speed of 5 to 6 kts.

ROV dive and *TS* measurements: On 5 May 2005, a second unsuccessful attempt was made to survey Nine Mile Bank at speeds above 5 kts. In lieu of the acoustic survey, an ROV transect (32º 47.146'N/117º 21.598'W) was conducted at Nine Mile Bank, at a seabed depth of 92.2 m, from 1630 to 1845 GMT. Additional *TS* measurements were made of two live vermillion rockfish (*Sebastes miniatus*) and one flag rockfish (*Sebastes rubrivinctus*).

Departure: The ship departed from Seaforth Marina, Mission Bay, on 10 May 2005 at 2125 GMT. After testing the performance of the repositioned transducer pod, the vessel proceeded to Del Mar Steeples.

Del Mar Steeples: The ship proceeded directly to the first waypoint of the Del Mar Steeples survey grid. The survey began at 2315 GMT on 10 May 2005, continued at speeds ranging from 4 (down swell) to 8 kts (up swell) with an overall mean of 5 to 6 kts, and was completed at 0238 GMT on 11 May 2005. Pulses of 512 µs duration were transmitted every 2.0 s. All transects were surveyed during daytime except the transect between waypoints 01 to 02. From 0309 to 0324 GMT, a CTD was cast at 32º 55.822'N/117º 18.593'W to a depth of 80 m.

Northwest Catalina Island: Acoustic surveys with 0.1 n.mi. transect spacing were conducted on 11 May 2005 from 1301 to 1643 GMT. Pulses of 512 µs were transmitted every 1 s (this survey only). Ship speed ranged from 3 to 7 kts with a mean of approximately 5 kts. At the conclusion of the acoustic survey, a CTD was cast to 80 m at 33° 28.071'N/118° 37.201'W from 1653 to 1703 GMT.

Farnsworth Bank: A second survey near Catalina Island was also performed on 11 May 2005 from 1811 GMT to 2303 GMT. From 1811 to 1829 GMT, pulses were transmitted every 1 s. From 1830 to 2303 GMT, pulses were transmitted every 2 seconds (after a satellite conference call with David Demer). Also, there was a course correction early in the survey to avoid colliding with a sailing vessel. A CTD was cast at 33° 20.708'N/118° 31.143'W on 11 May to a depth of 50 m from 2326 to 2333 GMT. Ship speeds ranged from 4.2 to 7.0 kts.

West San Clemente Island: Acoustic surveys were conducted from 1343 GMT on to 0040 GMT 13 May 2005. Ship speed ranged from 3 to 8 kts.

Northwest San Clemente Island: On 13 May 2005, surveys continued on the northwest bank, transiting from south to north, from 0058 to 0224 GMT. Ship speed ranged from 4.5 to 7.5 kts. A CTD was cast to a depth of 90 m at 32° 55.678'N/118° 34.404'W from 0231 to 0238 GMT.

Acoustic surveys on the northwest bank continued at 5 to 8 kts on 13 May 2005 from 1313 to 2024 GMT when the Navy directed the survey to end. The echograms recorded from 1305 to 1836 and 1840 to 2027 GMT on 13 May, during navy operations, showed two distinctly different echosounder detected seabeds. Also, the data for these echograms include inaccurate latitude and longitude data (each differing by a few minutes). Oddly, the GPS positions were displayed and accurately recorded manually in the logbook during the survey.

The remaining upper portion of Northwest San Clementine was surveyed on 14 May 2005 from 1240 to 1814 GMT, in the north to south direction (opposite of the previous survey of the site). At the beginning of the survey, excessive noise on the 200 kHz was caused by interference from the ship's echosounder. It was secured at 1246 GMT.

The problem area between waypoints 73 (32° 58.787'N/118° 38.171'W) and 125 (32° 56.469'N/118° 36.297'W) was re-surveyed in a north to south direction from 2133 on 25 May 2005 to 0229 GMT on 26 May 2005. The transect between waypoints 129 and 130 was not conducted because the transect would not have been completed during daylight hours. A final CTD was cast at 32° 56.793'N/118° 35.481'W to a depth of 120 m (line out) from 0239 to 0246 GMT. The current was strong and the seabed depth was 105 m.

North San Clemente Island: After being instructed by the Navy to depart the Northwest San Clemente site, the northern most site was surveyed between 13 May 2005 at 2112 and 14 May 2005 at 0220 GMT. Ship speed ranged from 4.5 to 8.7 kts. Half of the transect between waypoints 29 and 30, closest to Castle Rock, was deemed a navigational hazard and was therefore not surveyed. Due to the relatively shallow depths and expanse of kelp beds, it is probably not rockfish habitat. A CTD was cast (33° 03.038'N/118° 37.152'W) to a depth of 67 m (line out) in a strong current from 0225 to 0231.

57 Fathom Reef: Acoustic surveys were conducted on 14 May 2005 from 2009 to 2055 GMT. Transects were spaced 0.1 n.mi. Ship speed ranged from 4 to 7 kts. A CTD was cast to a depth of 120 m at 32° 48.008'N/118° 31.556'W during 2101 to 2113 GMT.

China Point Reef: The first part of the site was surveyed on 14 May 2005 at 2148 to 15 May at 0238 GMT. Ship speed ranged from 4.8 to 6.8 kts. A CTD was cast to a depth of 50 m at 32° 45.979'N/118° 24.462'W during 0252 to 0257 GMT. The remainder of the site was surveyed on 15 May 2005 from 1310 to 1615 GMT.

San Clemente Island 86 Fathom Bank: Acoustic surveys were conducted on 15 May 2005 from 1625 to 2018 GMT. Ship speed ranged from 4 to 6 kts. The noise was excessive on the 70 and 120 kHz echosounders due to the swell direction and half-full fuel tanks. The live well tank was filled with 400 gals of seawater and the noise was reduced, into the swell, at a slightly faster ship speed. A CTD was cast to a depth of 160 m (line out) at 32° 43.490'N/118° 27.419'W, in a strong current during 2041 to 2054 GMT. These data were considered relevant for China Point Reef, 86 Fathom Bank, and the 81 Fathom Bank.

San Clemente Island 81 Fathom Bank: Acoustic surveys were conducted from 15 May 2005 at 2108 to 16 May 2005 at 0040 GMT. Ship speed ranged from 5 to 6 kts. At the conclusion of this survey, the ship returned to port in Seaforth Marina, Mission Bay.

60 Mile Bank: Acoustic surveys were conducted on 18 May 2005 at 1255 to 19 May 2005 at 0250 GMT; and on 19 May 2005 from 1600 to 1726 GMT. To optimize surveying time, ship speed was increased in areas with seabed depth greater than 500 m. Throughout the survey, ship speed ranged from 3 to 8 kts. On 19 May 2005 at 0030 GMT, the ship began a transect below the intended transect. The error was immediately corrected and the ship was on the correct course at 0032 GMT. A CTD was cast in a very strong current to a depth of 180 m (line out) at 31° 01.148'N/118° 12.552'W on 19 May 2005 during 0312 to 0320 GMT. The last transect (waypoints 117 to 118), mostly deeper than 500 m depth, was excluded due to time constraints.

Kidney Bank: Acoustic surveys were conducted from 19 May 2005 at 2252 to 20 May 2005 at 0236 GMT. Ship speed ranged from 4.2 to 7.1 kts. A CTD was cast in a strong current to a depth of 180 m (line out) at 32° 44.474'W/117° 47.934'N) on 20 May 2005 during 0252 to 0300. At the conclusion of the cast, the ship returned to Seaforth Marina, Mission Bay.

Mission Beach Reef: Acoustic surveys were conducted from 23 May 2005 from 1517 to 2345 GMT. Ship speed ranged from 5 to 7 kts. A CTD was cast to a depth of 70 m (line out) at 32° 46.823'N/117° 20.642'W on 24 May 2005 from 0001 to 0007. The CTD was soaked on the starboard side but, due to the direction of the strong current, was recast on the port side. At the conclusion of the cast, the ship returned to Seaforth Marina, Mission Bay.

Nine Mile Bank: *Outer Limits* departed Seaforth Marina later than originally planned. Acoustic surveys were conducted from 24 May 2005 at 1354 to 25 May 2005 at 0305 GMT. Ship speed ranged from 4 to 6.6 kts. The transects between waypoints 116 and 115 and 119 and 120 were not completed due to a lack of daylight. Halfway through the former transect, a CTD was cast in a slight current to a depth of 120m (line out) at 32° 34.144'N/117° 21.661'W on 25 May during 0305 to 0315 GMT. At the conclusion of the cast, the ship returned briefly to Seaforth Marina, Mission Bay, to change crew members before transiting to Lasuen Knoll.

Lasuen Knoll: Acoustic surveys were conducted on 25 May 2005 from 1245 to 1537 GMT. Ship speed ranged from 5.3 to 6.5 kts. A CTD was cast in a slight current to a depth of 110 m at 33° 24.049'N/118°00.242'W on 25 May 2005 during 1552 to 1603 GMT.

43 Fathom Bank: Acoustic surveys were conducted on 26 May 2005 from 1344 to 1717 GMT. A CTD was cast to a depth of 120 m (line out) at 33° 42.1'N/119° 7.4'W on 26 May 2005 during 1723 to 1730 GMT. At the conclusion of the cast, the ship returned to Seaforth Marina, Mission Bay.

1.4 Preliminary results

Only the preliminary analysis of acoustic data collected from *Jordan* and *Outer Limits* are presented here. The ultimate analysis which combines these data with those collected with the ROV aboard *Outer Limits* will be presented elsewhere.

David Starr Jordan Leg I (DSJ04)

Calibrations: The calibrations were performed in the protected waters of the San Diego Bay due to the cruise schedule and the weather conditions. For calibrating, the sphere must be positioned in a far-field range (R) of the transducers ($R_{far\text{-}field} \sim d^2 f/c$, where d is the diameter of the transducer aperture, f is the frequency, and c is the sound speed). For the 38 kHz transducer, this range is about 4 m. Optimally, calibrations should be performed at more than twice this range. Fortunately, the pre-cruise calibrations were consistent with the post-cruise calibration sphere measurements made at larger ranges. However, it was only determined after the initial calibration and the DSJ04 cruise that quadrant 1 of the ES70-7C was wired out of phase. In the future, calibrations should be performed in protected waters at least 20 m deep (e.g., in the lee of San Clemente Island).

Table 1.1. Summary of pre-survey EK60 calibrations on F/V *David Starr Jordan*.

Standard	38.1 mm diameter tungsten-carbide sphere			
Location	32º 43.262' N/117º 12.470' W			
Water Depth	~12.5 m (~9 m below transducers)			
Sphere Range	~6 m			
Temperature	19.2 ºC			
Salinity	33.2 PSU			
	38 kHz	**70 kHz***	**120 kHz**	**200 kHz**
Test Mode (dB)	-64	-64	-64	-64
Noise (dB)	-144	-158	-135	-125
α (dB/km)	7.5	21.1	43.5	69.63
Pulse duration (μs)	256	256	256	256
Transducer Gain (dB)	24.13	21.46	21.49	25.67
Sa corr. (dB)	-1.06	-0.78	-0.64	-0.40
*Determined post-cruise, quadrant 1 of the ES70-7C was wire out of phase.				

Table 1.2. Planned survey areas with their approximate distances and durations, and their actual beginning and ending dates and times (GMT=+7 hrs. PST on daylight savings). The total surveyed track lines for the DSJ04 cruise were 872 n.mi. of the entire surveyed Southern California Bight for October 2004 to May 2005 (2654 n.mi.).

Survey Order	Survey Area	Distance (n.mi.)	Time (Days)	Begin Date	Begin Time	End Date	End Time
1	Forty-Three Fathom Bank	37.5	0.2	211004	2021	211004	0058
2	South Cortes Bank	93.7	0.5	221004	1402	231004	0041
3	North Cortes Bank	375.5	3.5	231004	1402	271004	0134
4	Northern Cortes Spawning Grounds	26.4	0.2	271004	1413	271004	1714
5	Southern Cortes Spawning Grounds	57.6	0.3	272004	1832	281004	0114
6	South Tanner Bank	167.1	1.8	281004	1418	291004	2020
7	109 Seamount	17.4	0.1	291004	2248	301004	0027
8	Cherry Bank	96.3	1.0	301004	1522	311004	0057

<u>Forty-Three Fathom Bank:</u> Rockfish were very densely aggregated on the rocky peak of the bank and on some flanks, notably to the southeast. There appears to be an association between the acoustically identified rocky seabed and the locations of the rockfishes.

<u>South Cortes Bank:</u> Consistent with the small area of acoustically identified rocky seabed, there were relatively few fish observed at this location. The fish present were spread over most of the area, with minor aggregations observed in the shallowest regions.

<u>North Cortes Bank:</u> Most of the rocky seabed with fish was mapped in the northwestern area of the bank. There, the densest fish aggregations were mapped on the peaks of the rocky seabed. There was a large area of rocky seabed in the southeastern portion of the bank which did not have much fish.

<u>Northern Cortes Spawning Grounds:</u> This entire area was covered with moderately dense aggregations of fish. Interestingly, the acoustical seabed-classification algorithm did not indicate rocky seabed over most of this area. This area appears to be anomalous. The seabed-type and fish species in this area, in particular, should be characterized with the ROV video.

Southern Cortes Spawning Grounds: Low- to moderately-dense aggregations of rockfishes covered the two ridges in this area. No fish were mapped in the deeper area between. The acoustical seabed classification indicated rocky substrates on the eastern ridge and in the southern two-thirds of the deeper area between the ridges. This area also appears to be anomalous. Again, the seabed and fish species in this area should be well characterized with the ROV video.

South Tanner Bank: The densest aggregations of fish were mapped on the shallow rocky areas to the northwest of the bank. Much of the rocky seabed acoustically identified on the eastern fourth of the bank did not contain fish.

109 Bank/Seamount: This area was colder and less saline than the coastal waters encountered in the other areas. Moderately dense aggregations were mapped above the primary peak and the two minor flanking peaks comprising the seamount. The acoustical seabed classification shows rocky seabed beneath the fish, as well as much of the area void of fish. This area will be very difficult to study with the ROV due to the hazards of abundant abandoned fishing gear.

Cherry Bank: Large portions of the center and fringes of the bank were acoustically classified as rocky seabed. These areas, especially the rocky peaks, generally correlated with the distribution of moderate and very dense fish aggregations.

Figure 1.2. 43 Fathom Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

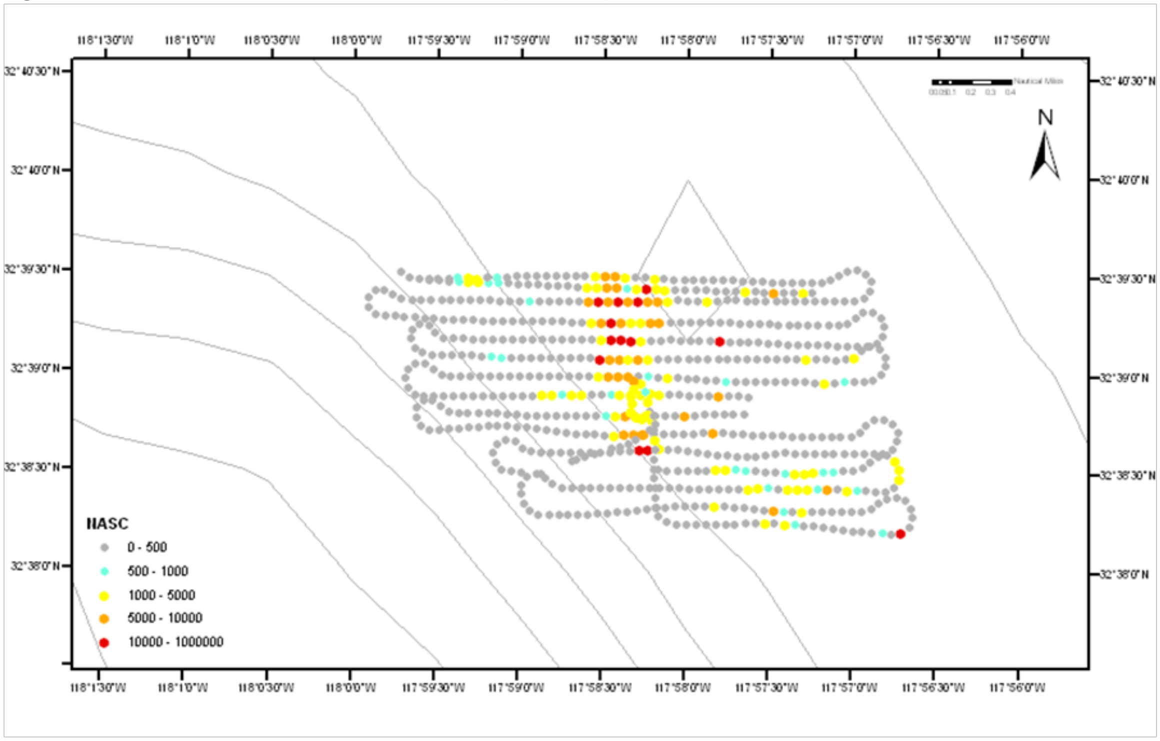


Figure 1.3. 43 Fathom Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

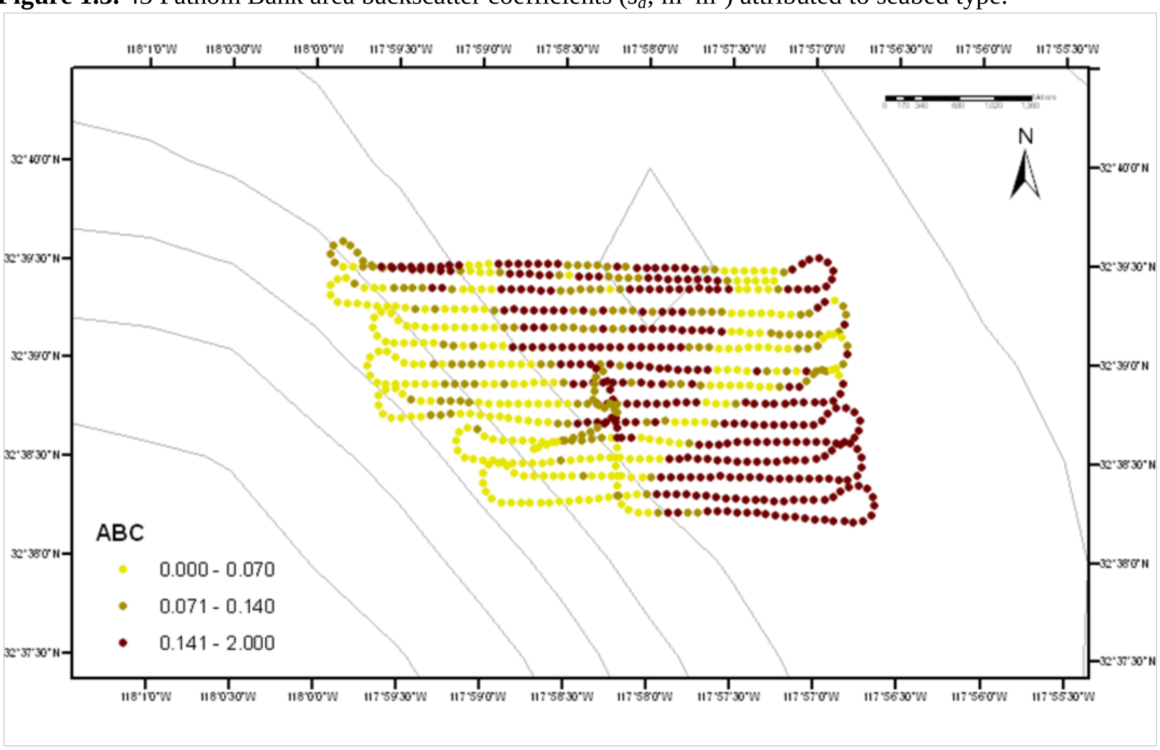


Figure 1.4. 43 Fathom Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

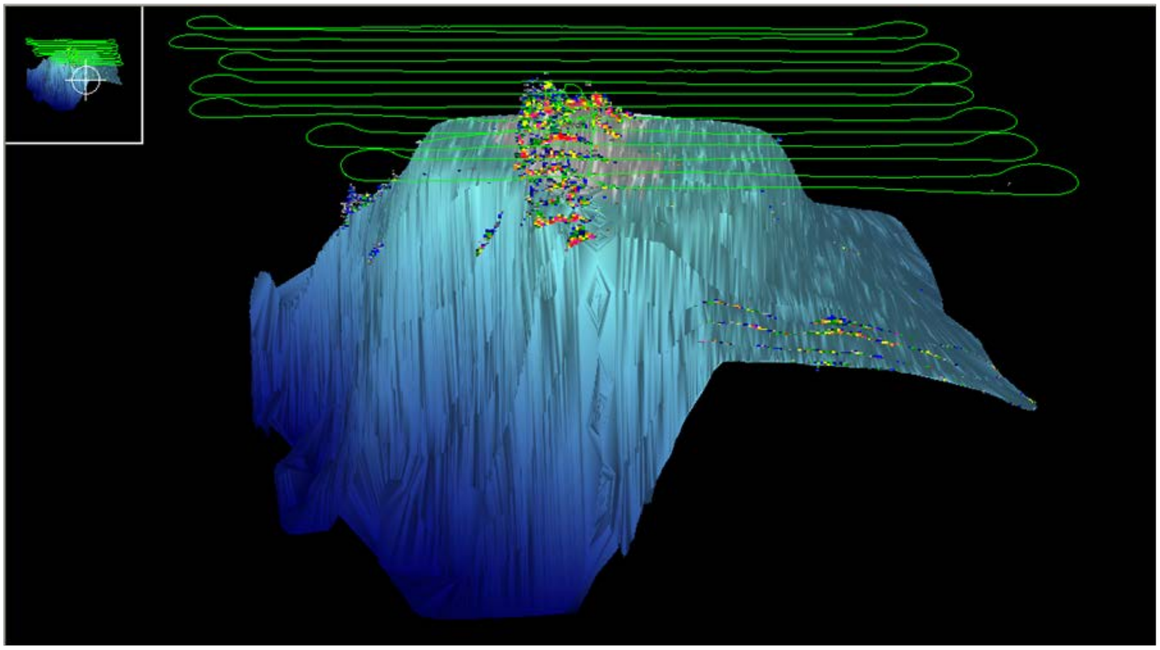


Figure 1.5. North and South Cortes Bank and South Cortes Spawning Grounds distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

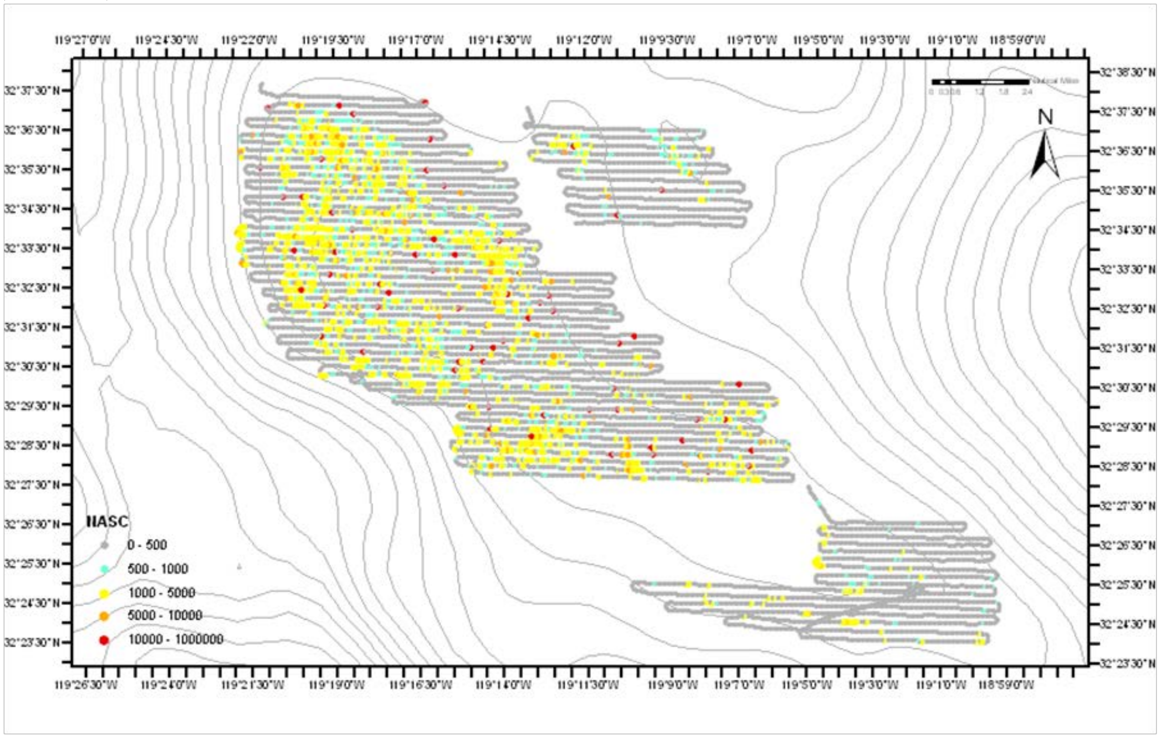


Figure 1.6. North and South Cortes Bank and South Cortes Spawning Grounds area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

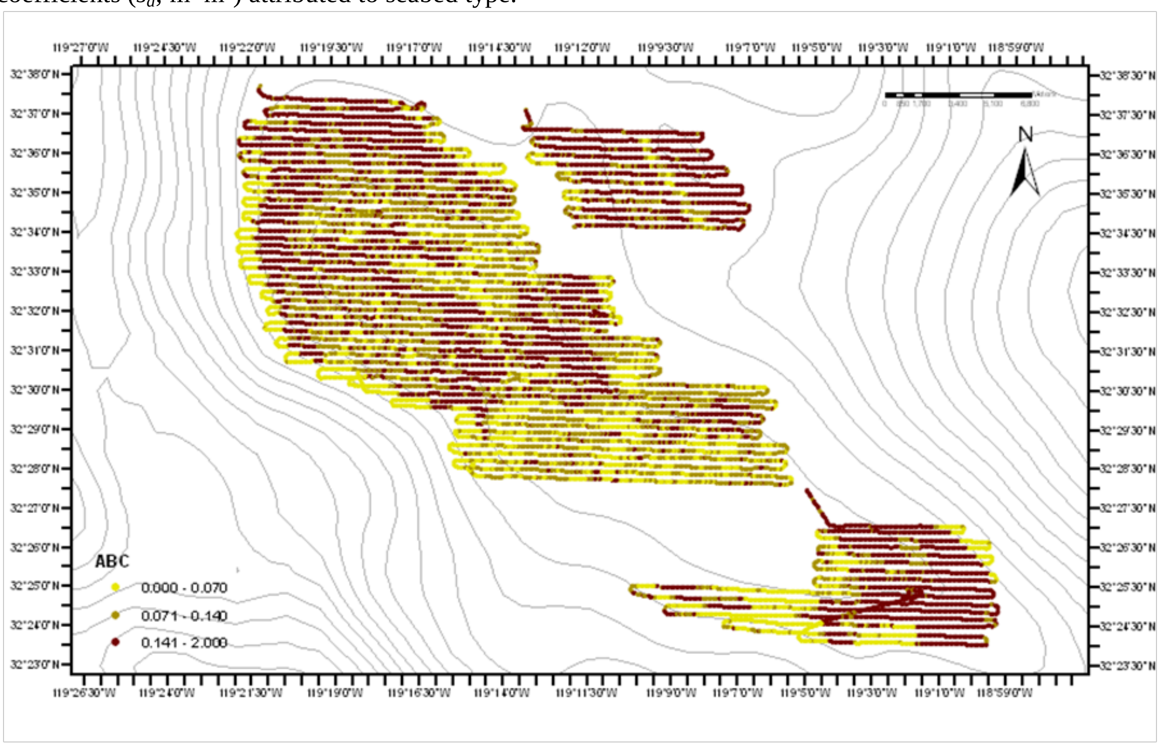


Figure 1.7. South Cortes Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

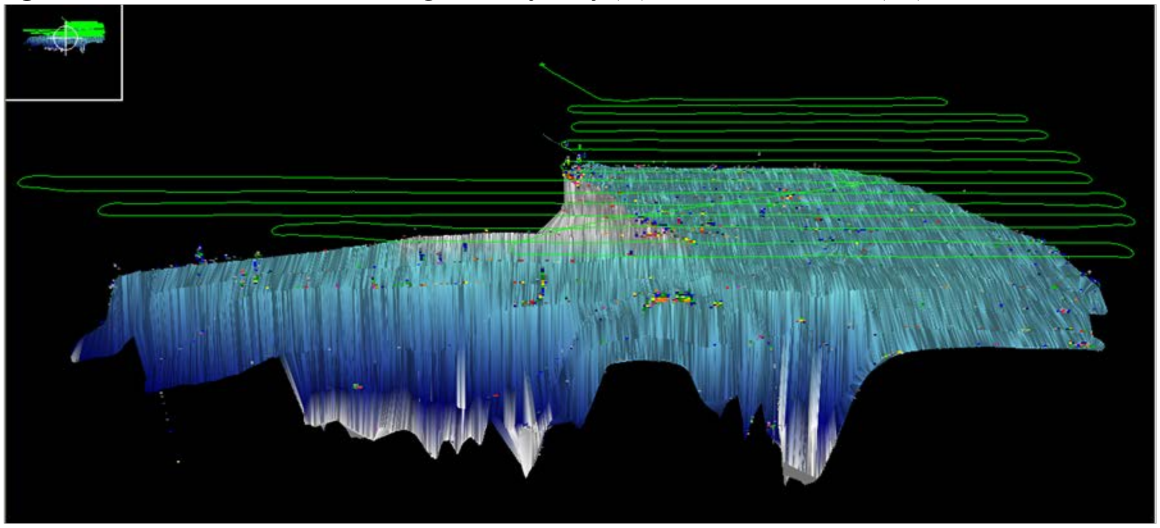


Figure 1.8. North Cortes Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

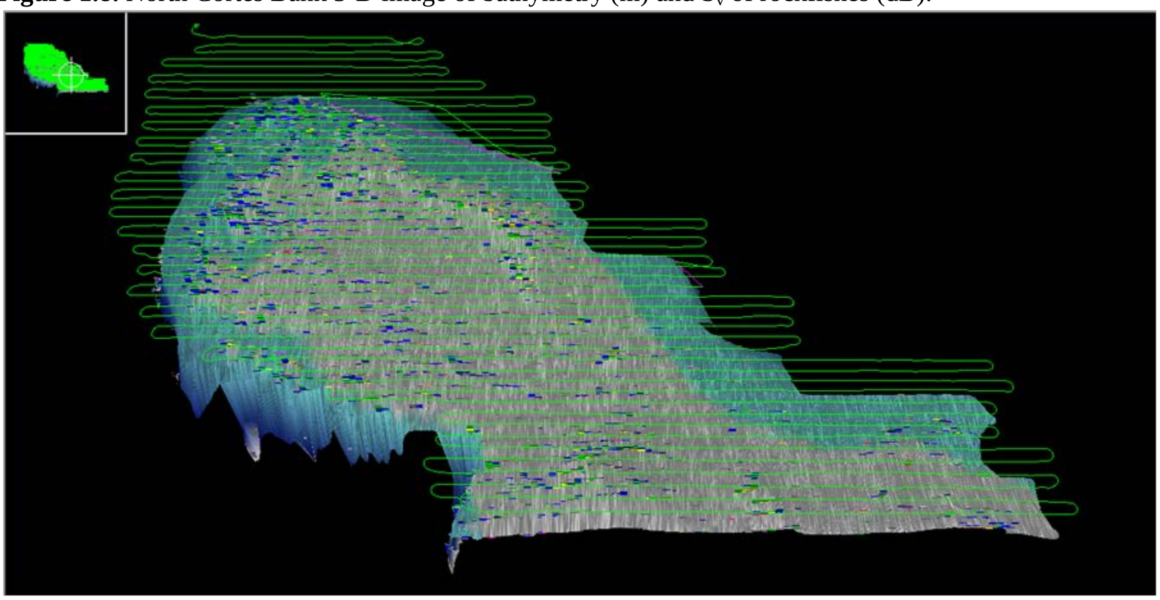


Figure 1.9. South Cortes Spawning Grounds 3-D image of bathymetry and rockfishes.

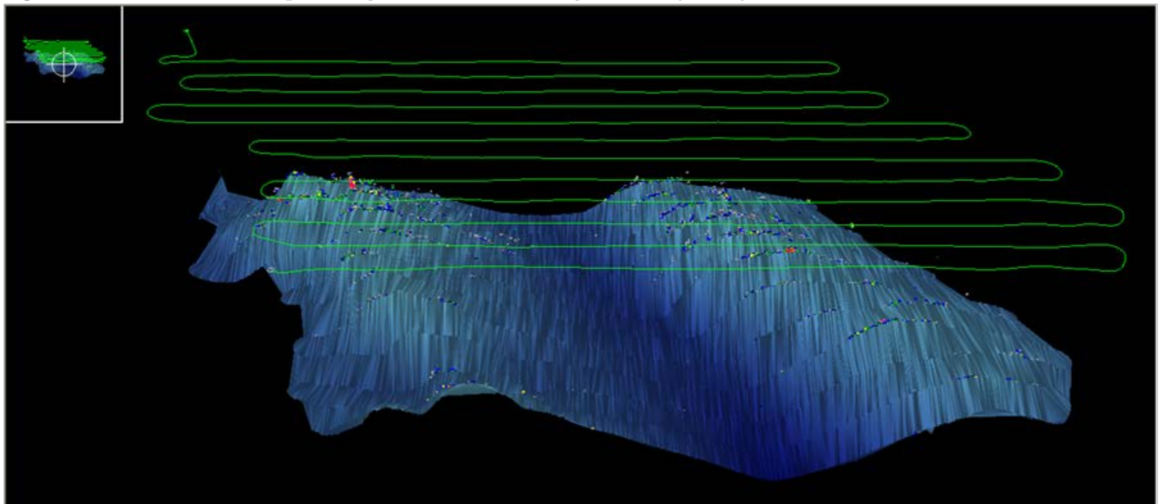


Figure 1.10. North Cortes Spawning Ground and South Tanner Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

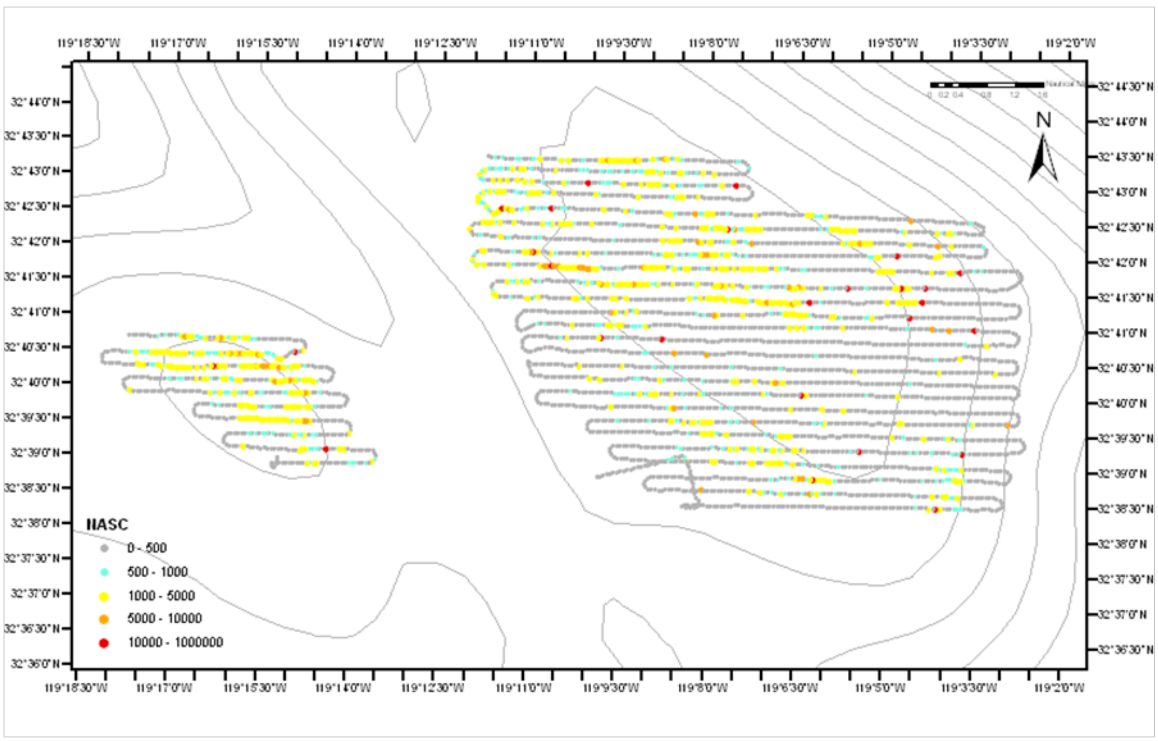


Figure 1.11. North Cortes Spawning Ground and South Tanner Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

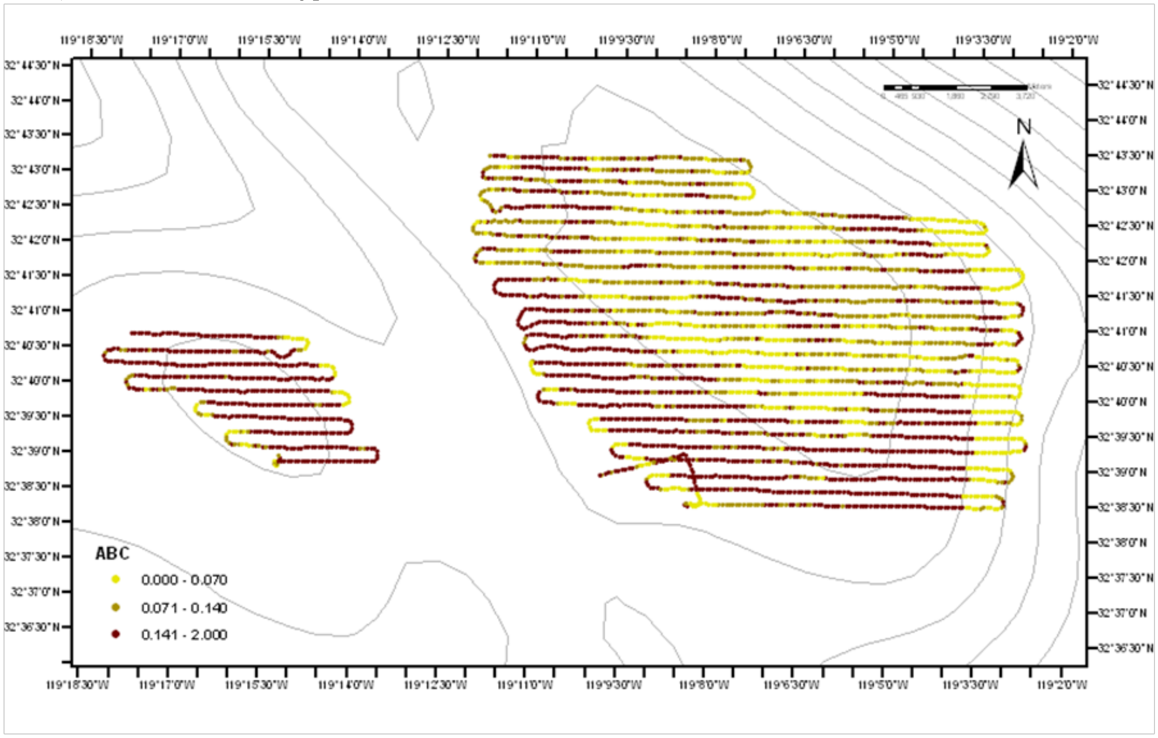


Figure 1.12. North Cortes Spawning Grounds 3-D image of bathymetry (m) and S_v of rockfishes (dB).

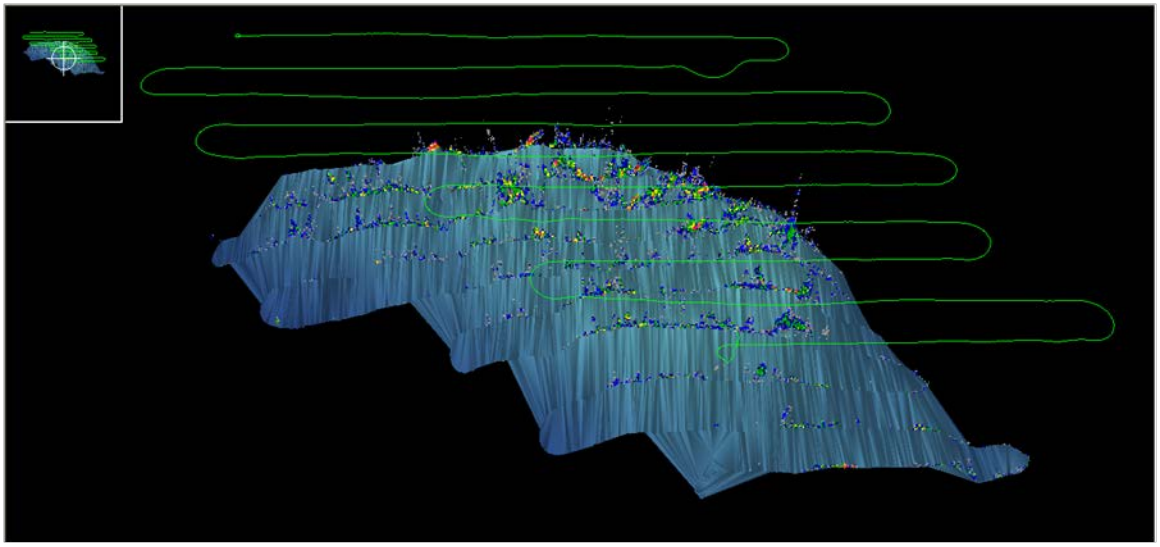


Figure 1.13. South Tanner Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

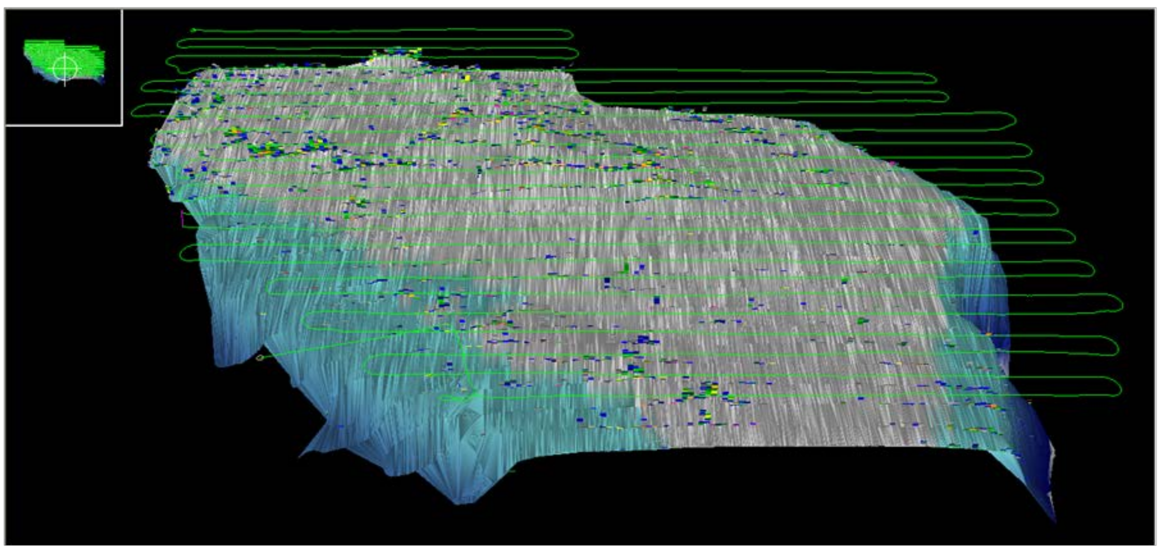


Figure 1.14. 109 Seamount distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

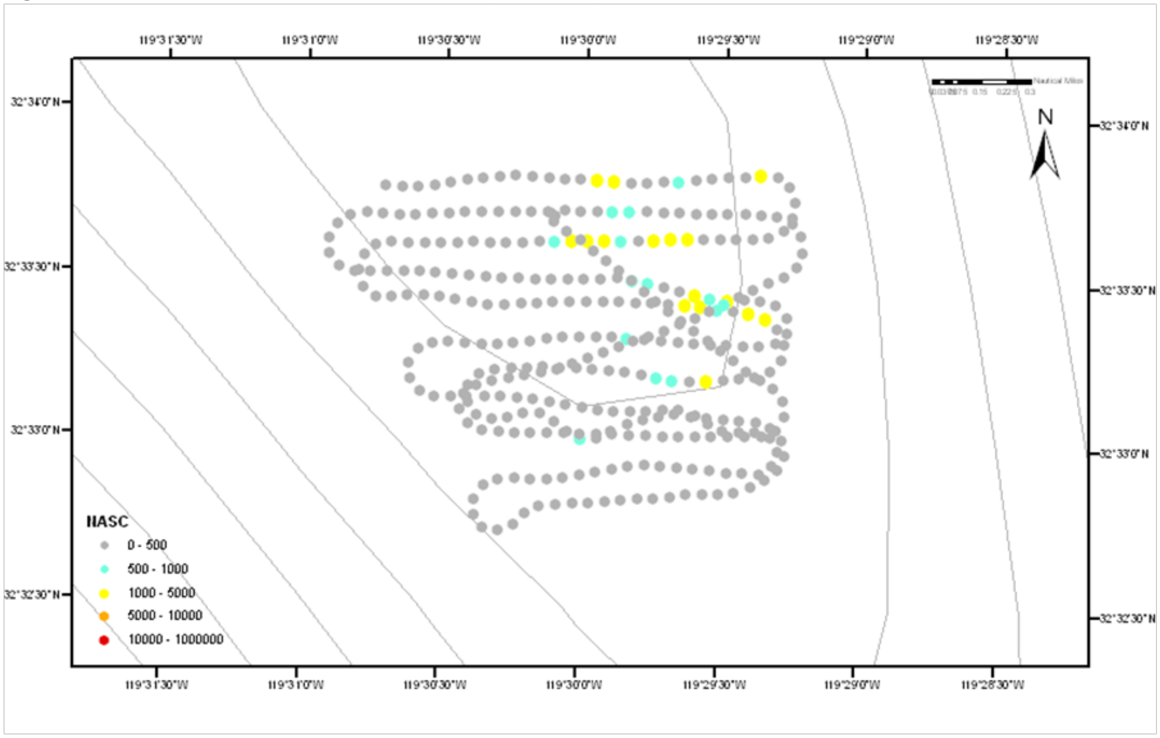


Figure 1.15. 109 Seamount area backscatter coefficients (s_a; m^{2}/m^2) attributed to seabed type.

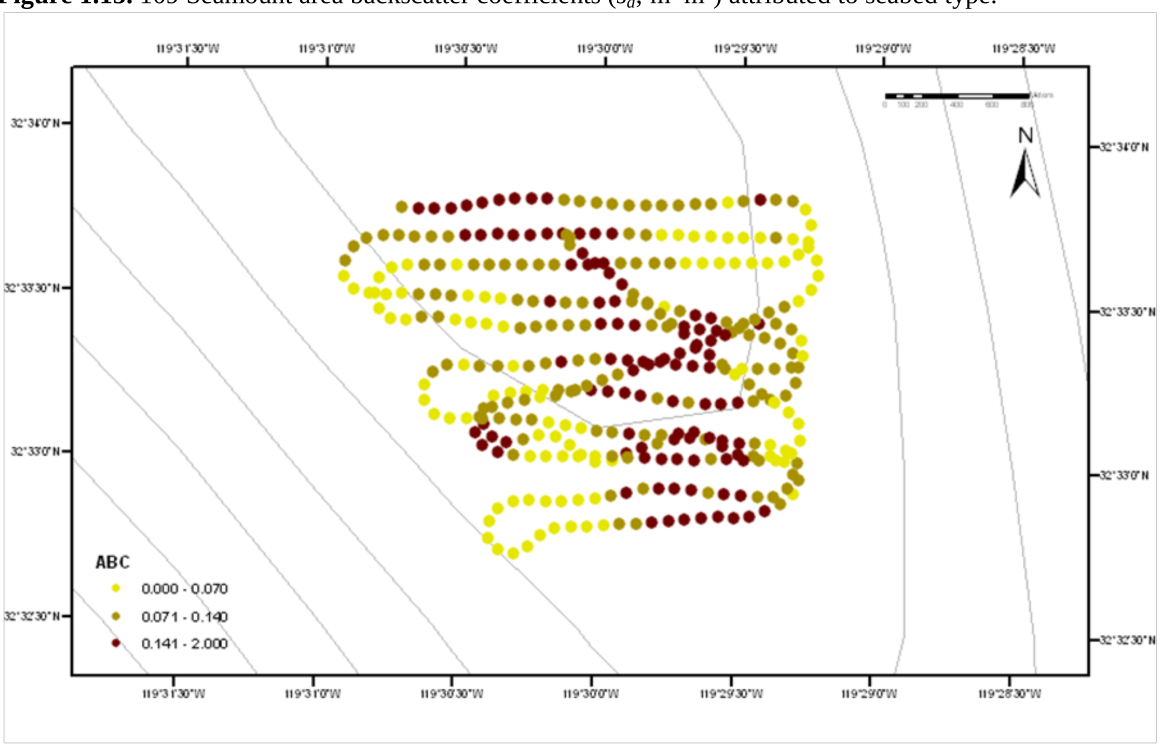


Figure 1.16. 109 Seamount 3-D image of bathymetry (m) and S_v of rockfishes (dB).

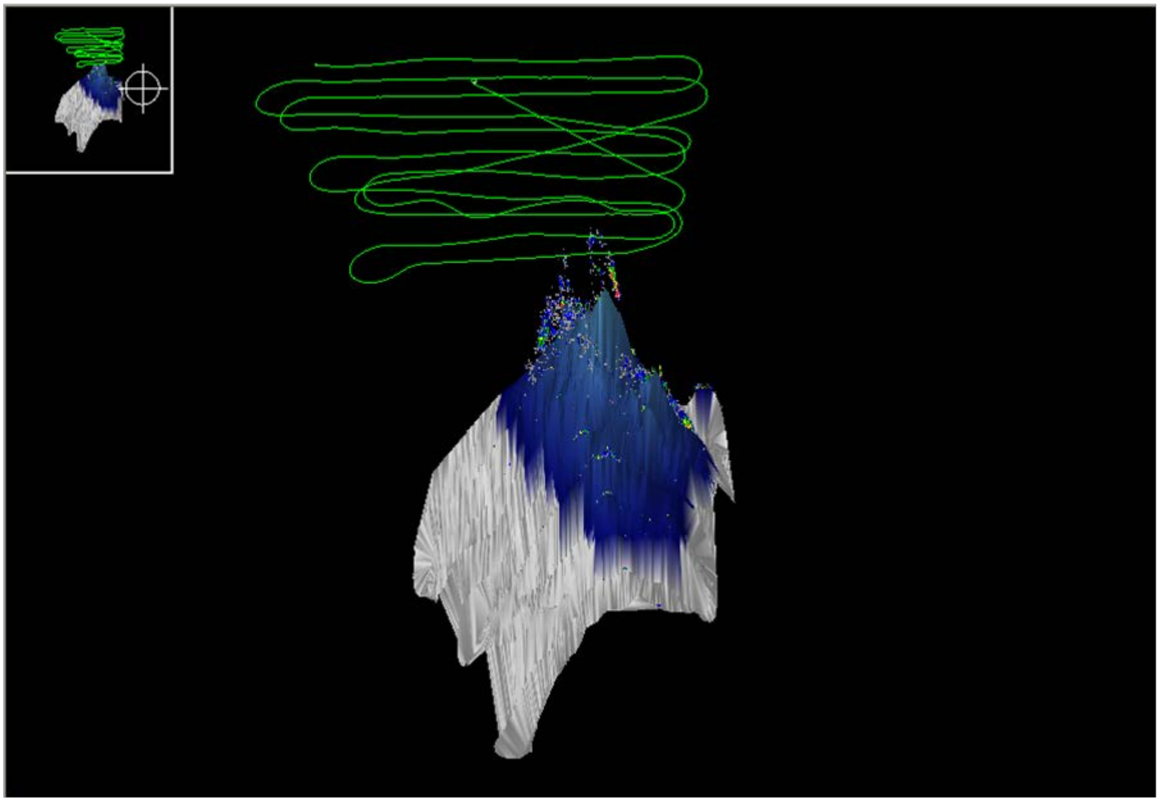


Figure 1.17. Cherry Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

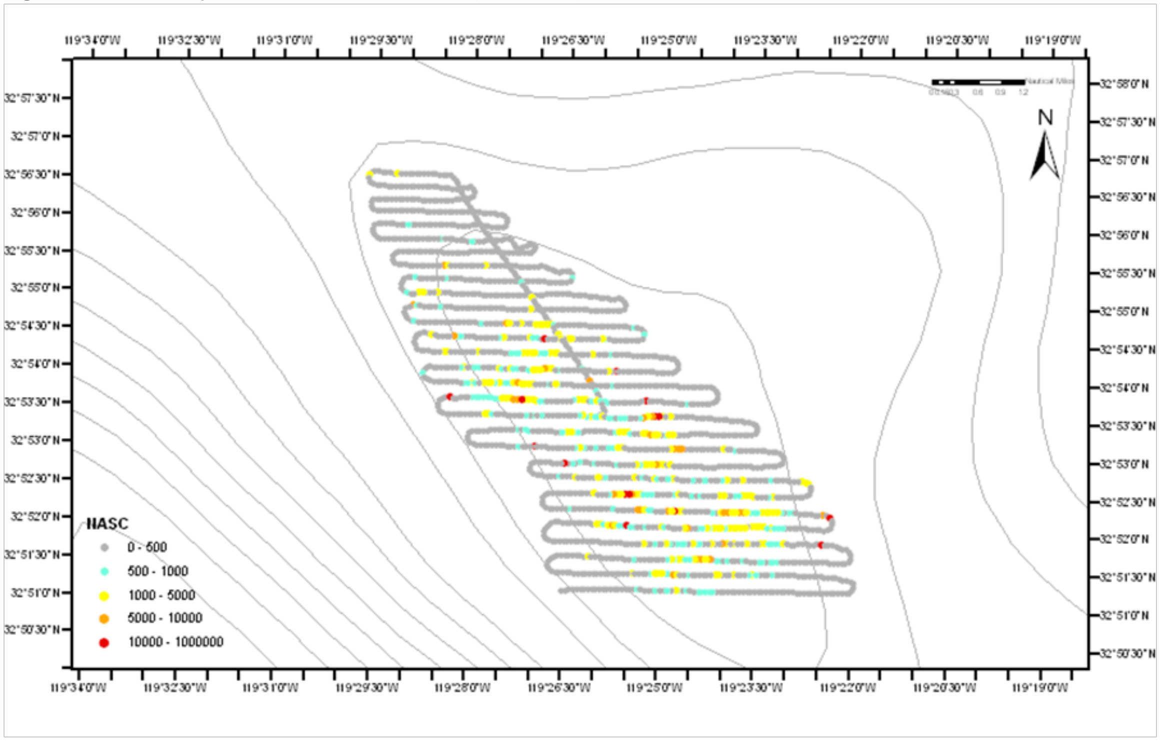


Figure 1.18. Cherry Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

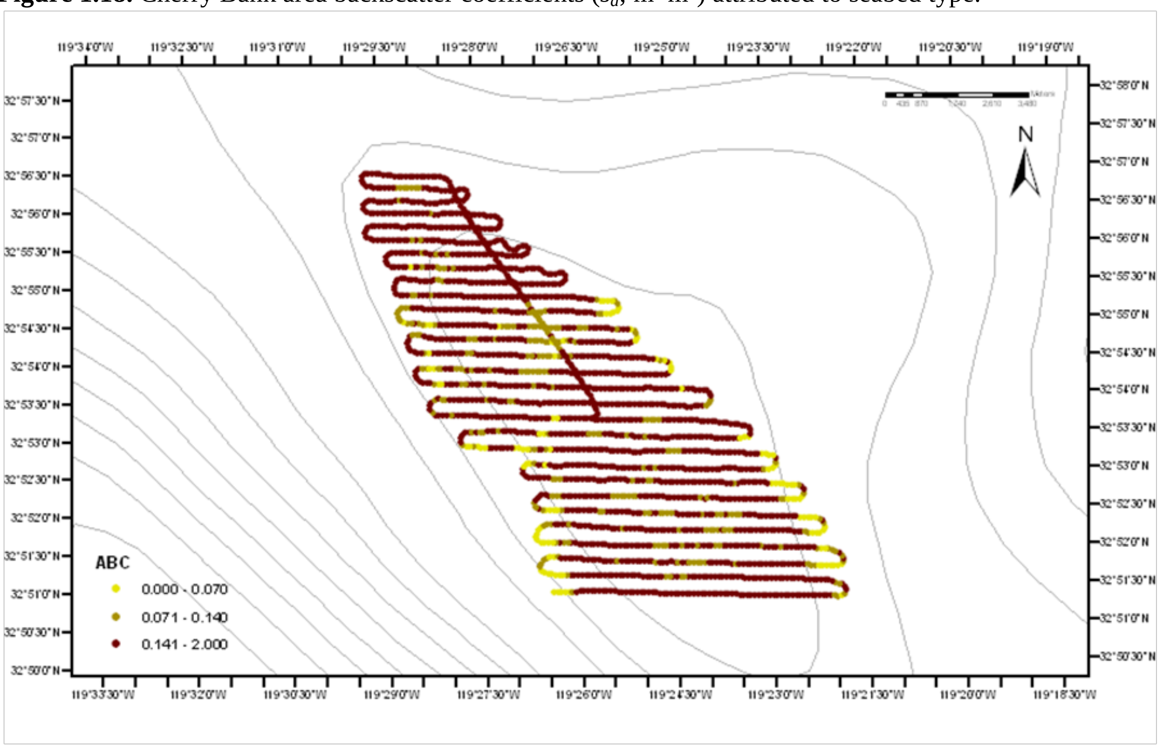
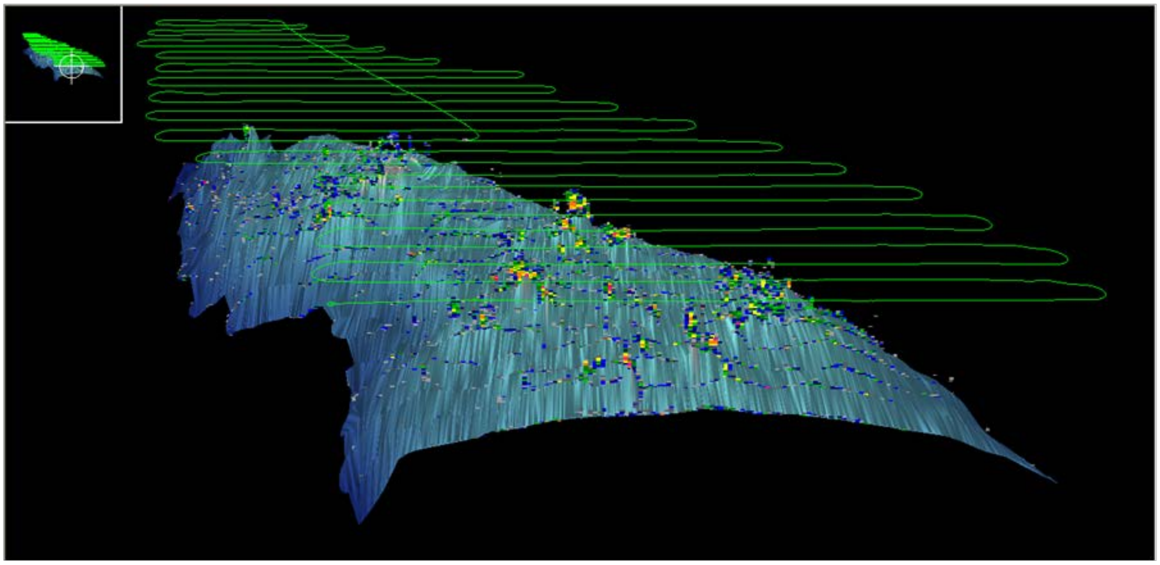


Figure 1.19. Cherry Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

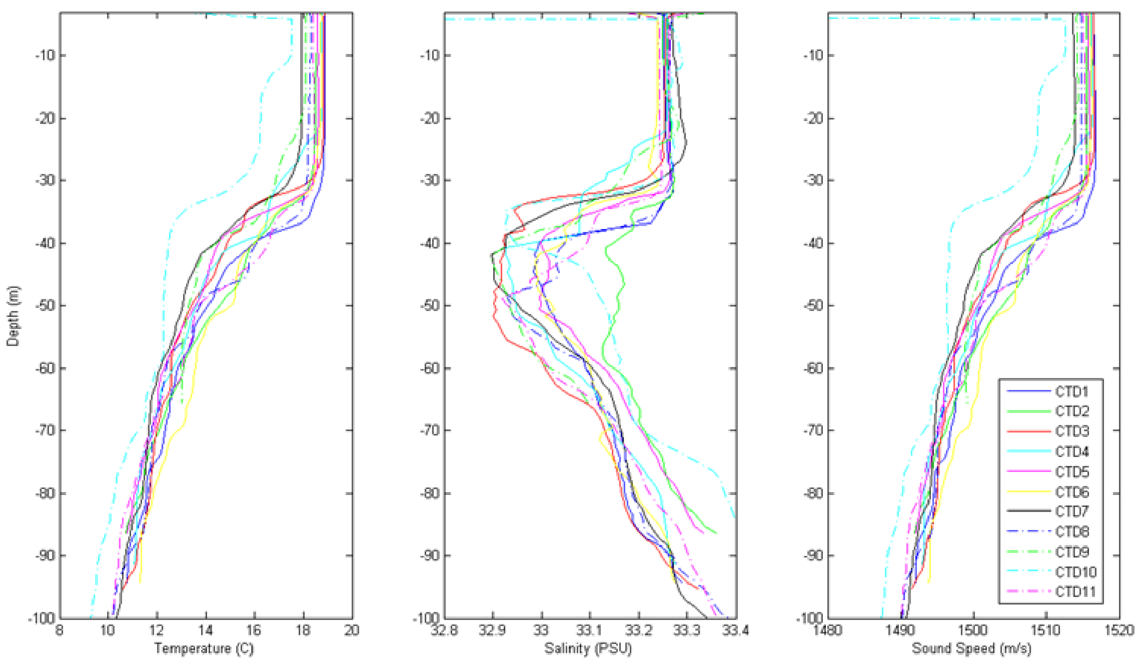


<u>CTD Results:</u> The most western CTD station (109 Seamount; CTD 10), is colder and fresher than the coastal water encountered elsewhere.

Table 1.3. CTD casts for DSJ04.

	Location	**Date**	**Latitude**	**Longitude**	**Maximum Depth (m)**
1	43 Fathom Bank	211004	32º 38.807'N	117º 58.325W	95
2	South Cortes Bank	231004	32º 25.419'N	119º 01.946W	85
3	North Cortes Bank A	241004	32º 35.778'N	119º 18.428W	95
4	North Cortes Bank B	251004	32º 33.051'N	119º 17.611W	90
5	North Cortes Bank C	261004	32º 31.200'N	119º 15.000W	85
6	North Cortes Bank D	271004	32º 29.775'N	119º 10.353W	95
7	North Cortes Spawning Grounds	271004	32º 38.874'N	119º 15.224W	170
8	South Cortes Spawning Grounds	281004	32º 35.858'N	119º 10.302'W	230
9	South Tanner Bank	281004	32º41.25'N	119 08.36'W	65
10	109 Seamount	301004	32º33.70'N	119 30.12'W	256
11	Cherry Bank	311004	32º53.50'N	119 26.00' W	125

Figure 1.20. Processed CTD down-cast profiles for DSJ04.



David Starr Jordan Leg II (DSJ0502)

Calibrations: The first set of calibrations was performed in open water south of San Miguel Island, but conditions were suboptimal. It was determined after the first set of calibrations that quadrant 1 of the ES70-7C was wired out-of-phase (**Table 1.4A**). After rewiring the ES70-7C, the second and third calibrations were performed for 256 and 1024 µs pulse durations, respectively (**Table 1.4A**). A fourth set of experiments was performed with the calibration sphere hanging from a fishing pole (**Table 1.4B**). Post-cruise, a fifth set of experiments was performed in the protected waters of the San Diego Bay (**Table 1.4C**).

Table 1.4A. Summary of pre-survey EK60 calibrations on 5 February 2005.

Standard	38.1 mm diameter tungsten-carbide sphere			
Location	34º 0.540’N/120º 19.86’W			
Water Depth	~42.5 m (~39 m below transducers)			
Sphere Range	~20 m			
Temperature	13.92 ºC			
Salinity	33.1 PSU			
	38 kHz	**70 kHz**	**120 kHz**	**200 kHz**
Test Mode (dB)	-64	-64	-64	-64
Noise (dB)	-142	-155	-154	-142
A (dB/km)	8.56	21.98	39.87	58.45
Experiment #1	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	256	256	256	256
Transducer Gain (dB)	23.04	20.63*	20.65	25.55
Sa corr. (dB)	-0.03	-0.70*	-0.59	-0.03
* Erroneous due to 1 quadrant wired out of phase.				
Experiment #2	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	256	256	256	256
Transducer Gain (dB)	23.52	22.30	21.11	25.88
Sa corr. (dB)	-0.96	-0.71	-0.60	-0.41
(Results used in survey)				
Experiment #3	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	1024	1024	1024	1024
Transducer Gain (dB)	24.57	25.31	26.59**	25.54
Sa corr. (dB)	-0.57	-0.36	0.00**	-0.23
** Gain value suspect due to low number of data points.				

Table 1.4B. Summary of mid-survey EK60 calibrations on 10 February 2005.

Standard	38.1 mm diameter tungsten-carbide sphere			
Location	34º 00.86’ N/120º 35.78’ W			
Water Depth	~404.5 m (~401 m below transducers)			
Sphere Range	~18.5 to 21.5 m			
Temperature	14.2 ºC			
Salinity	33.1 PSU			
Experiment #4	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	256	256	256	256

Transducer Gain (dB)	23.52	22.3	21.11	25.88
Sa corr. (dB)	-0.96	-0.71	-0.60	-0.41
Calibration performed with sphere suspended from a single monofilament line.				

Table 1.4C. Summary of post-survey EK60 calibrations on 22 February 2005.

Standard	38.1 mm diameter tungsten-carbide sphere			
Location	32º 43.3' N/117º 11.6' W			
Water Depth	~13.5 m (~10 m below transducers)			
Sphere Range	~7.5 m			
Temperature	15.5 ºC			
Salinity	32.26 PSU			
Experiment #5	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	256	256	256	256
Transducer Gain (dB)	24.43	25.98	21.60	25.28
Sa corr. (dB)	-1.07	-0.71	-0.45	-0.41

Table 1.5. Planned survey areas with their approximate distances and durations, and their actual beginning and ending dates and times (GMT=+7 hrs. PST on daylight savings). The total surveyed track lines for the DSJ0502 cruise were 1263 n.mi. of the entire surveyed Southern California Bight for October 2004 to May 2005 (2654 n.mi.).

Survey Order	Survey Area	Distance (n.mi.)	Time (Days)	Begin Date	Begin Time	End Date	End Time
1	Southwest San Miguel Island	88	0.9	060205	1458	070205	0119
2	Northwest San Miguel Island	203	2	070205	1517	090205	2357
3	North Santa Rosa Island	16	0.2	090205	1456	090205	1654
4	Northeast San Miguel Island	24	0.2	090205	1741	090205	1911
5	North San Miguel Island	17	0.2	090205	1917	090205	2124
6	Santa Cruz Canyon	13	0.1	102505	1551	100205	1732
7	South Anacapa Pass	10	0.1	100205	1912	100205	2111
8	Anacapa Pass	40	0.4	100205	2136	110205	0021
9	East San Nicolas Island	174	1.7	110205	1528	130205	0120
10	North San Nicolas Island	134	1.3	130205	1450	140205	1727
11	Northwest San Nicolas Island	75	0.8	140205	1800	150205	0149
12	107 Bank	15	0.2	150205	1451	150205	1700
13	118 Bank	17	0.2	150205	1743	150205	2006
14	Potato Bank	67	0.7	150205	2105	160205	1753
15	Santa Rosa Flats	168	1.7	160205	1957	180205	1854
16	Hidden Reef	23	0.2	180205	2216	190205	0139
17	117 Seamount	13	0.1	190205	1457	190205	1646
18	North Santa Barbara Island	61	0.6	190205	1726	200205	0023
19	Southwest Santa Barbara Island	51	0.5	200205	1432	200205	2312
20	Osborne Bank	37	0.4	200205	2351	210205	1754
21	SE San Nicolas Island	17	0.2	210205	1943	210205	2336

<u>Southwest San Miguel Island:</u> Virtually no rockfish were mapped in this area. The few fish schools that were present were in the shallow, rocky, northeastern portion of the survey. The seabed classification algorithm revealed mostly sandy seabed, with several small rocky areas. The presence of fish was generally related to rocky areas. The survey was shortened due to time constraints and the absence of fish schools.

Northwest San Miguel Island: Modest numbers of rockfish were detected at all areas of this site. There was a strong relationship between rocky seabed and the presence of rockfish.

North Santa Rosa Island: Relatively low numbers of rockfish were observed at this site. Areas that indicated the presence of rockfish were in rocky or an intermediate region of rocky and sandy seabed.

Northeast San Miguel Island: Slightly higher s_A for rockfish were observed in the southeast quadrant of the survey site in areas with a mix of rocky and sandy seabed.

North San Miguel Island: As with the northwest site, modest numbers of rockfish were mapped throughout most of this site in areas of rocky seabed.

Santa Cruz Canyon: This site included high rockfish densities, particularly on the southern section of the bank and along a ridge line that extended north to south.

South Anacapa Pass: For a small site, most of the South Anacapa Pass survey area was productive. Rocky and intermediate areas of rock and sand were highly associated with rockfish aggregations.

Anacapa Pass: Most of Anacapa Pass is flat and rocky. However, only the eastern areas of the pass were observed to have moderate numbers of rockfishes.

East San Nicolas Island: The eastern sites of San Nicolas Island were only moderately productive compared to the northwestern sites. Large sections of East San Nicolas were sandy. Rockfishes were largely associated with rocky areas and rock ridges.

North San Nicolas Island: The sites surrounding San Nicolas Island were among the most productive. North San Nicolas is an expansive flat area, predominantly rocky. Highest numbers of rockfishes were along the edges of the shelf, and in the northwestern area of the survey site.

Northwest San Nicolas Island: The mid-portion of the northwestern San Nicolas site was extremely productive. Like the north site, was predominantly rocky seabed.

118 and 107 Banks: Moderate densities of rockfishes were mapped around the summits of these small rocky areas. In comparison, the 107 Bank to the south and east of the 118 Bank had higher densities of rockfishes.

Potato Bank: The most productive site of the cruise was this rocky site to the west of San Nicolas.

Santa Rosa Flats: Few numbers of rockfish were observed throughout most of this large, rocky survey site except in the northeastern corner.

Hidden Reef: This narrow ridge of relatively rocky and mixed seabed had low densities of rockfishes.

117 Seamount: This rocky outcropping to the west of Santa Barbara Island had virtually no rockfishes.

North Santa Barbara Island: This site was fairly productive, particularly in the northeastern section likely with rocky seabed. The flatter southeastern portion was likely sandy and had lower rockfish densities.

Southwest Santa Barbara Island: The western area to the south of Santa Barbara Island was flat, rocky, and had moderately high rockfish densities.

Osborne Bank: Osborne Bank, to the south of Santa Barbara Island, had dense schools of rockfishes at the summit of the northeastern peak and along the broad flank from northwest to southeast. Most of the rockfishes were associated with areas having intermediate s_a values.

Southeast San Nicolas Island: This small site of predominantly rocky seabed had more fish than East San Nicolas.

Figure 1.21. Southwest San Miguel Island distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

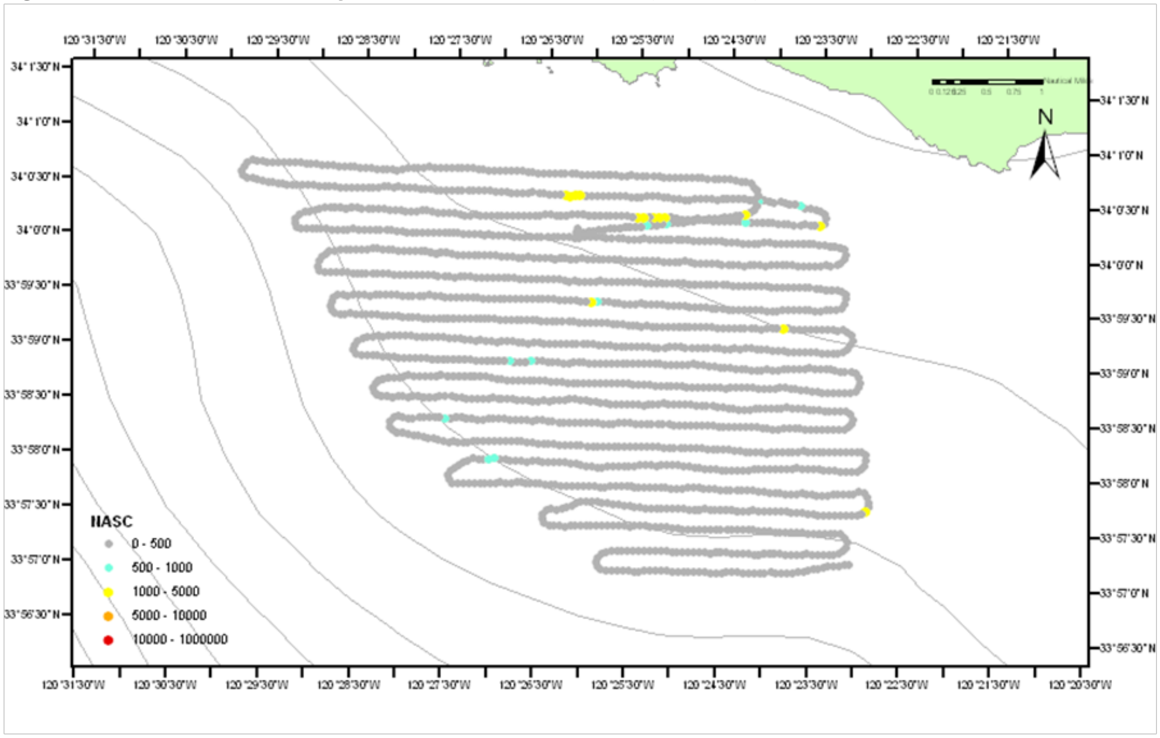


Figure 1.22. Southwest San Miguel Island area backscatter coefficients (s_a; m^{2}/m^2) attributed to seabed type.

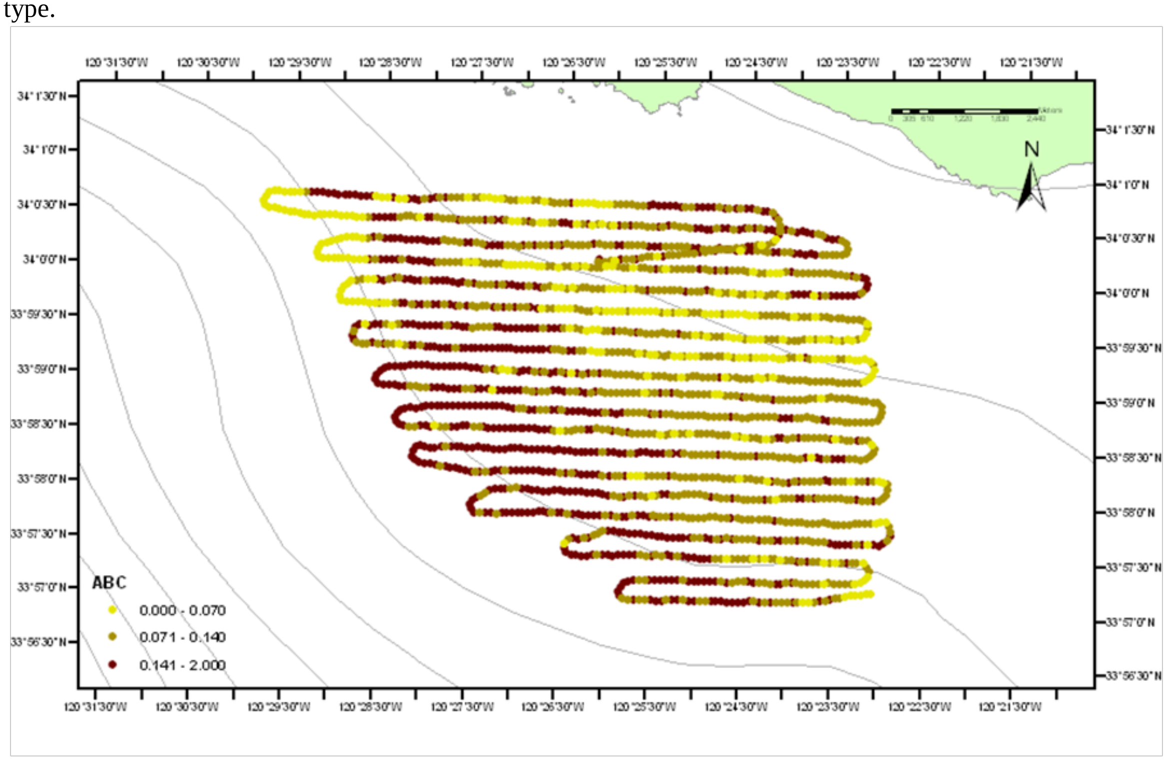


Figure 1.23. Southwest San Miguel Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

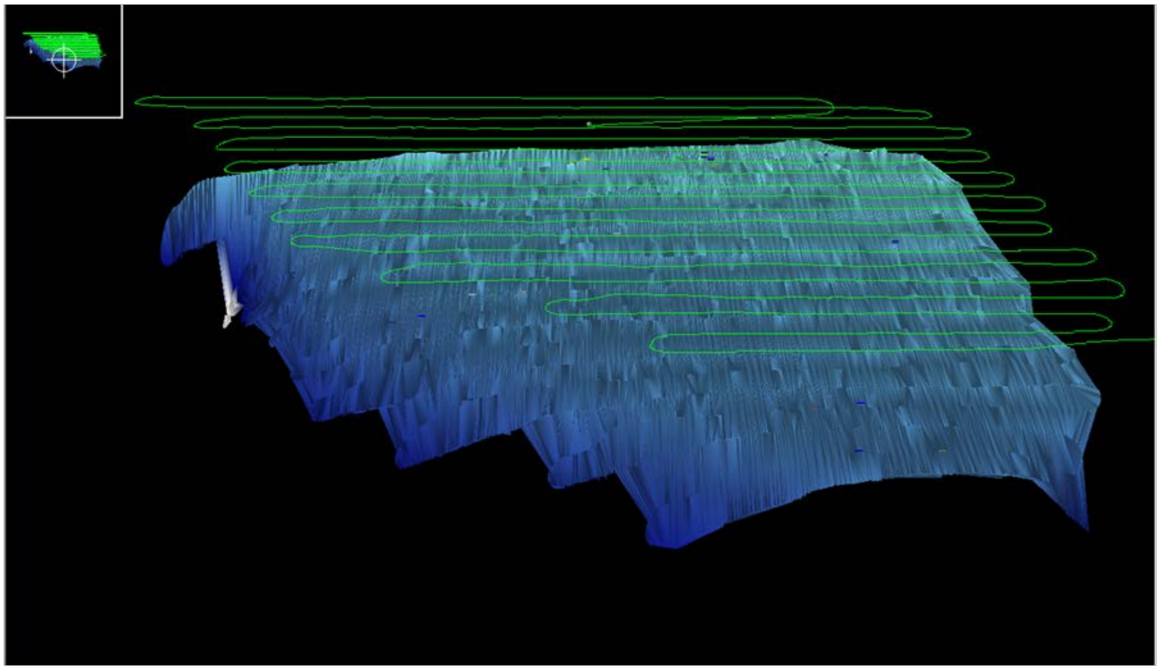


Figure 1.24. Northwest, North and Northeast San Miguel Island distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

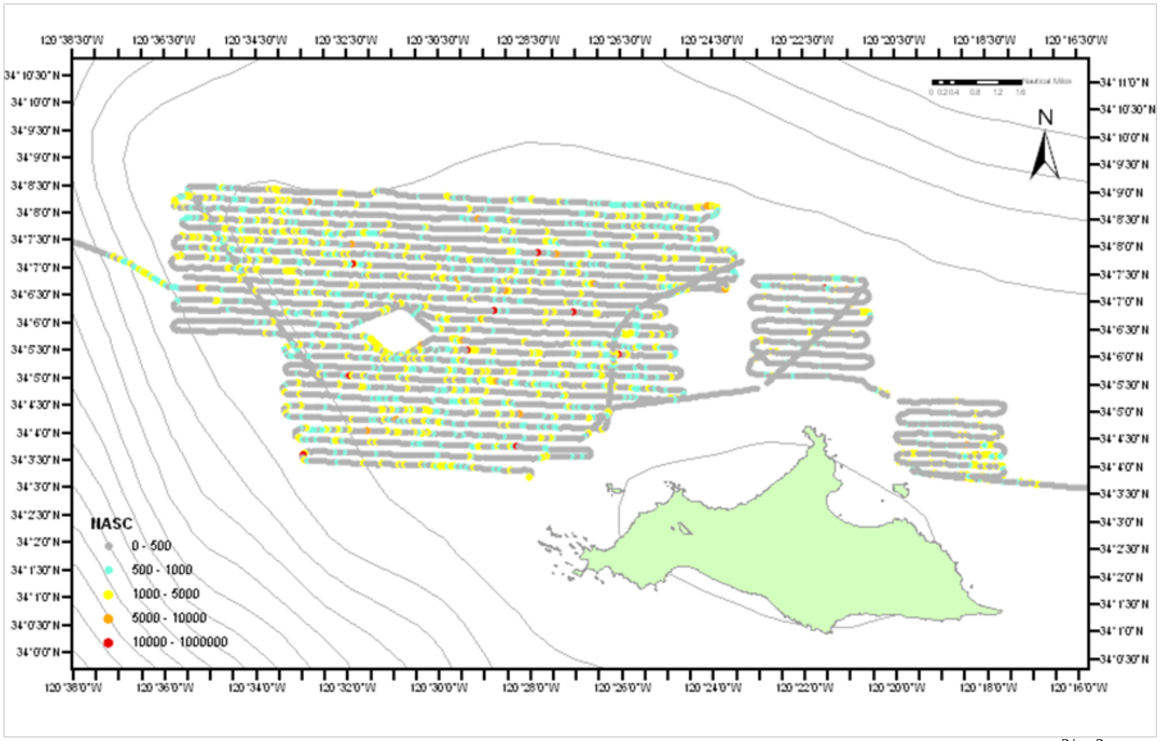


Figure 1.25. Northwest, North and Northeast San Miguel Island area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

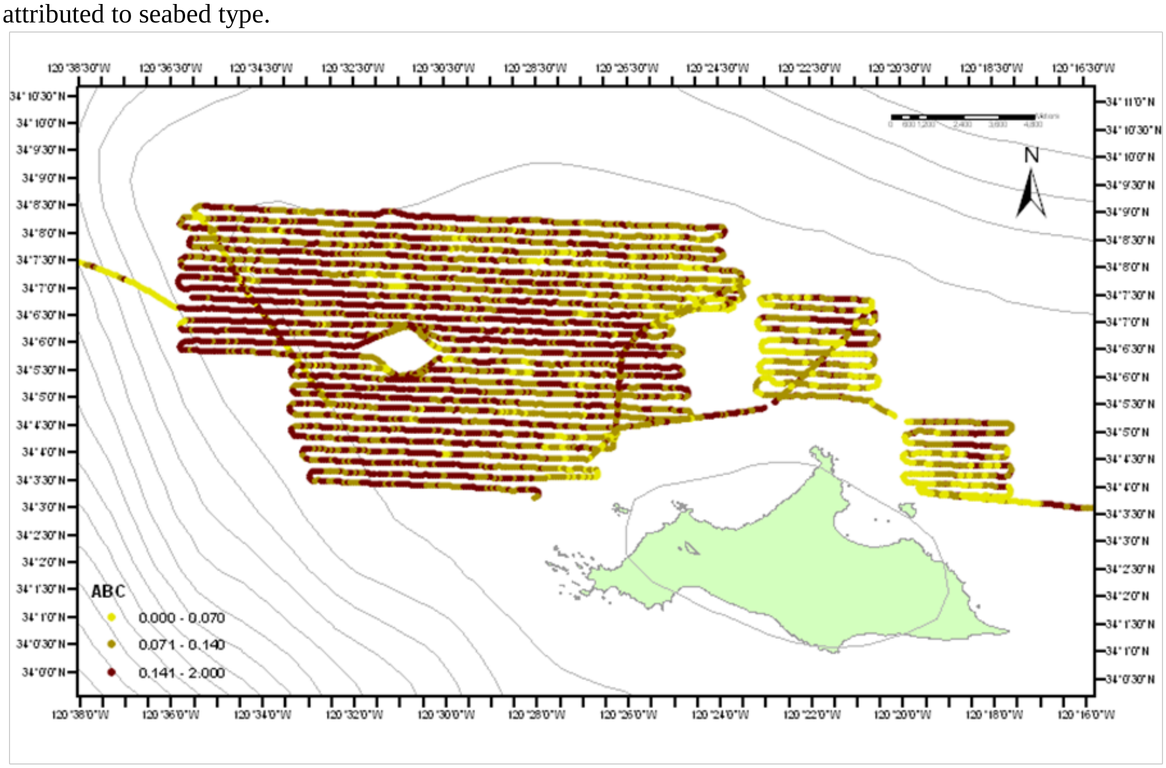


Figure 1.26. Northwest San Miguel Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

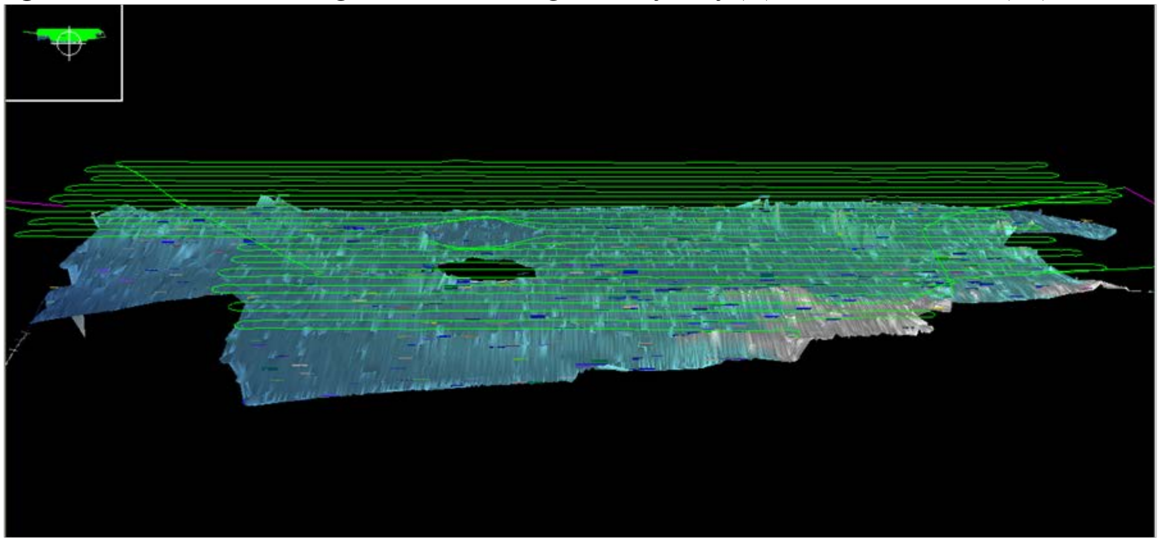


Figure 1.27. North San Miguel Island 3-D image of bathymetry and rockfishes.

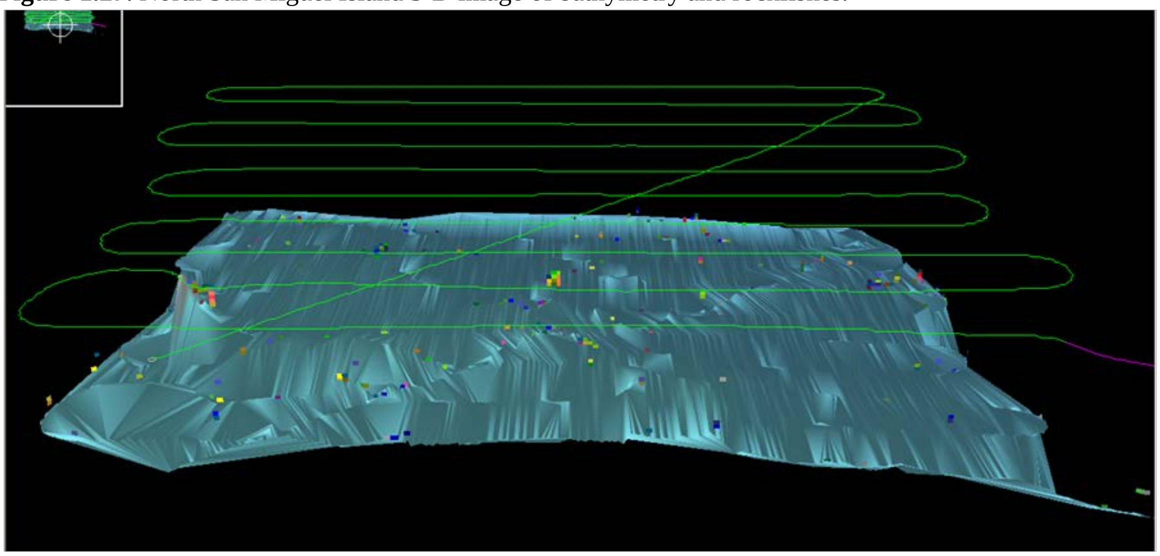


Figure 1.28. Northeast San Miguel Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

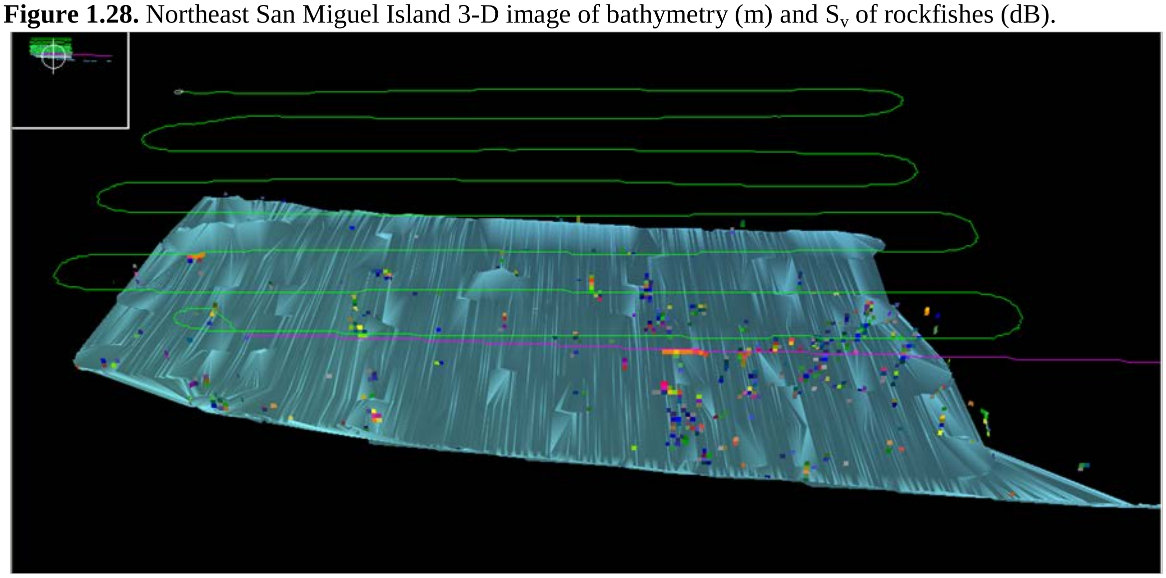


Figure 1.29. North Santa Rosa Island distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

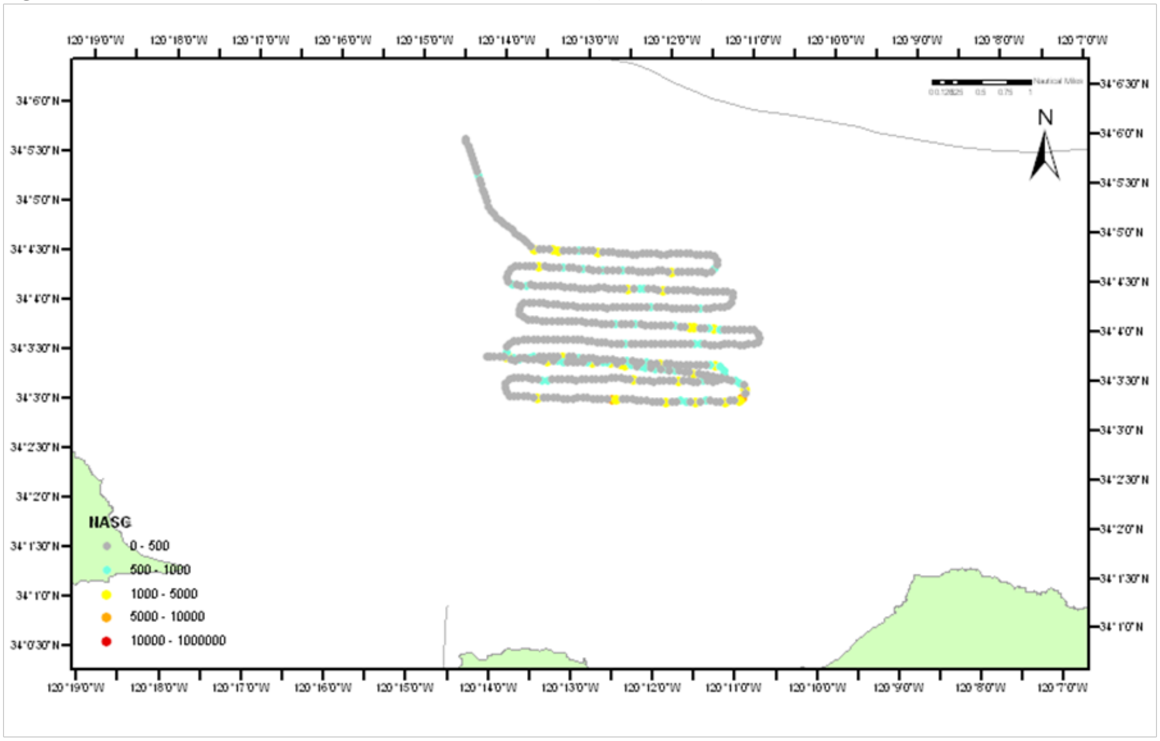


Figure 1.30. North Santa Rosa Island area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

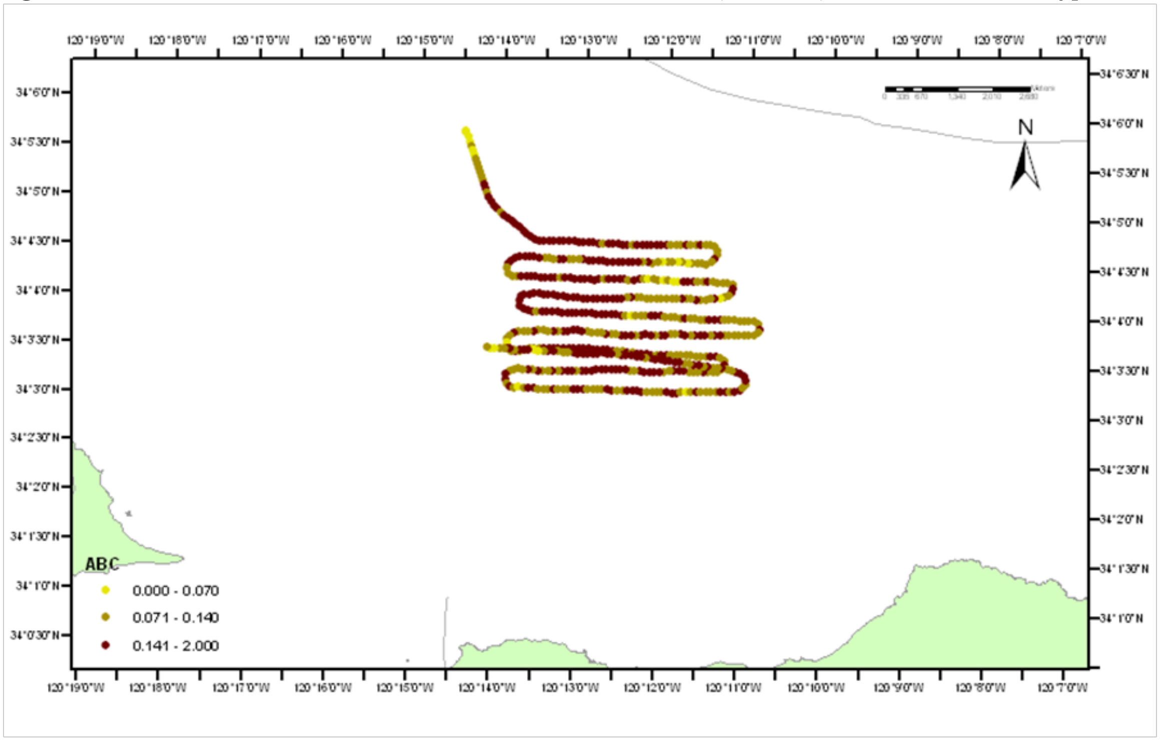


Figure 1.31. North Santa Rosa Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

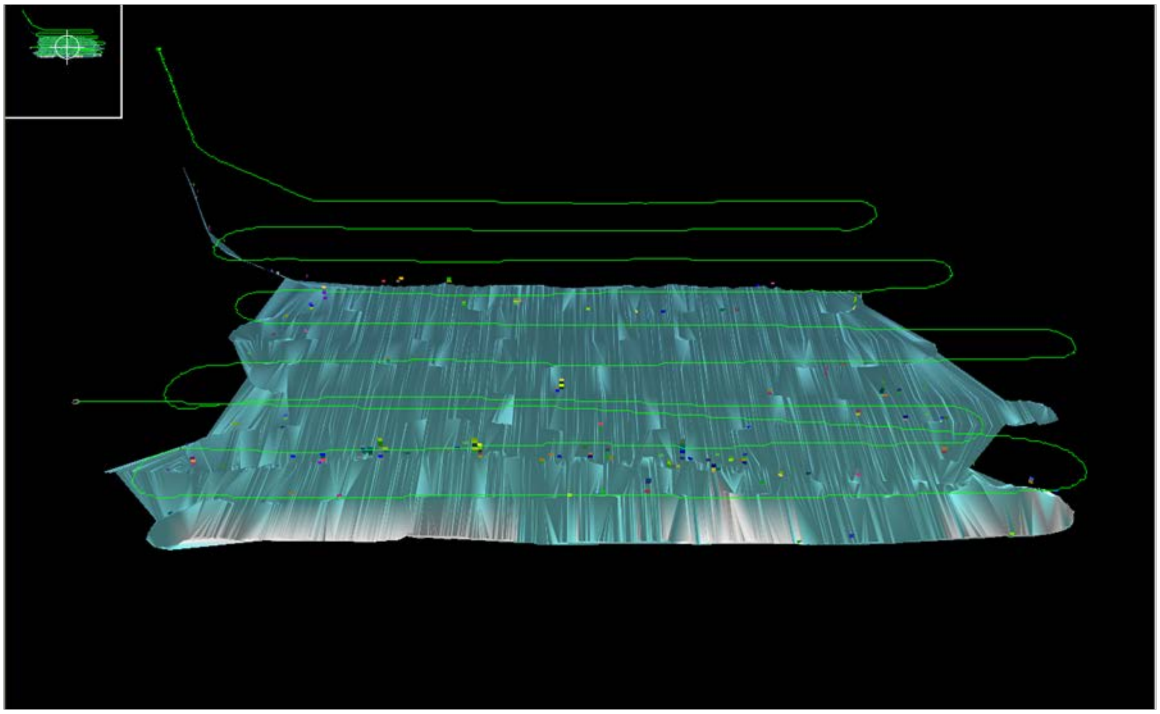


Figure 1.32. Santa Rosa Flats and Santa Cruz Canyon distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

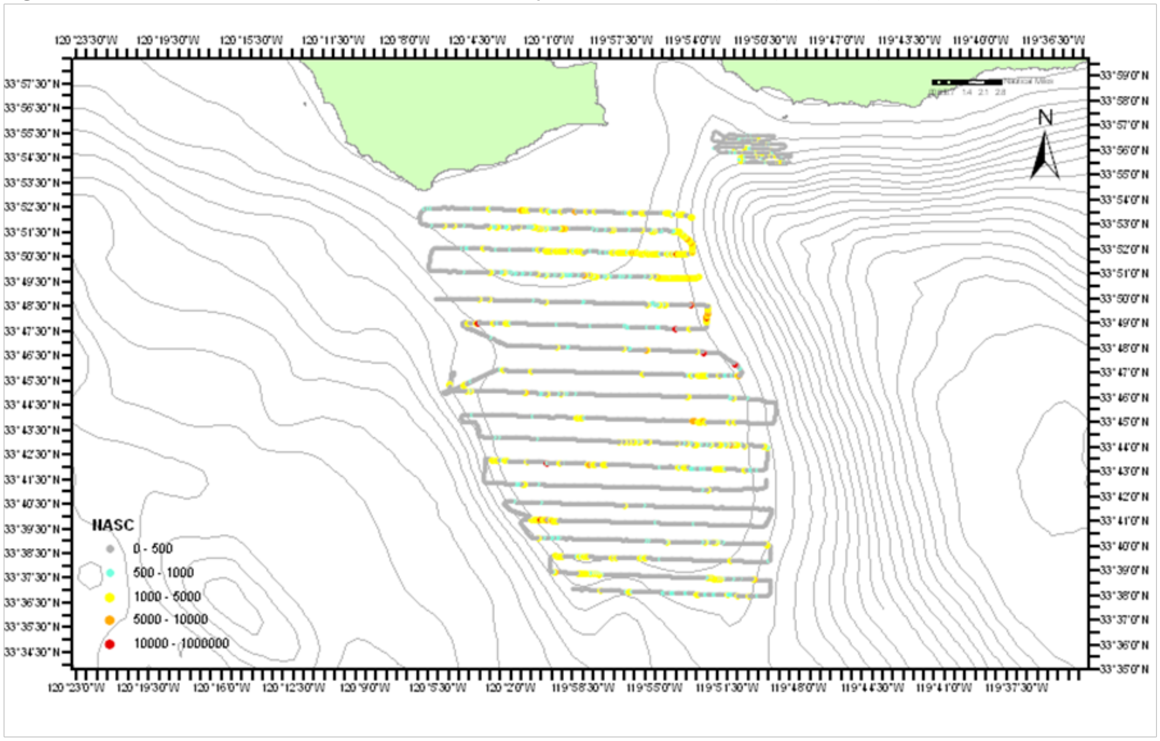


Figure 1.33. Santa Rosa Flats and Santa Cruz Canyon area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

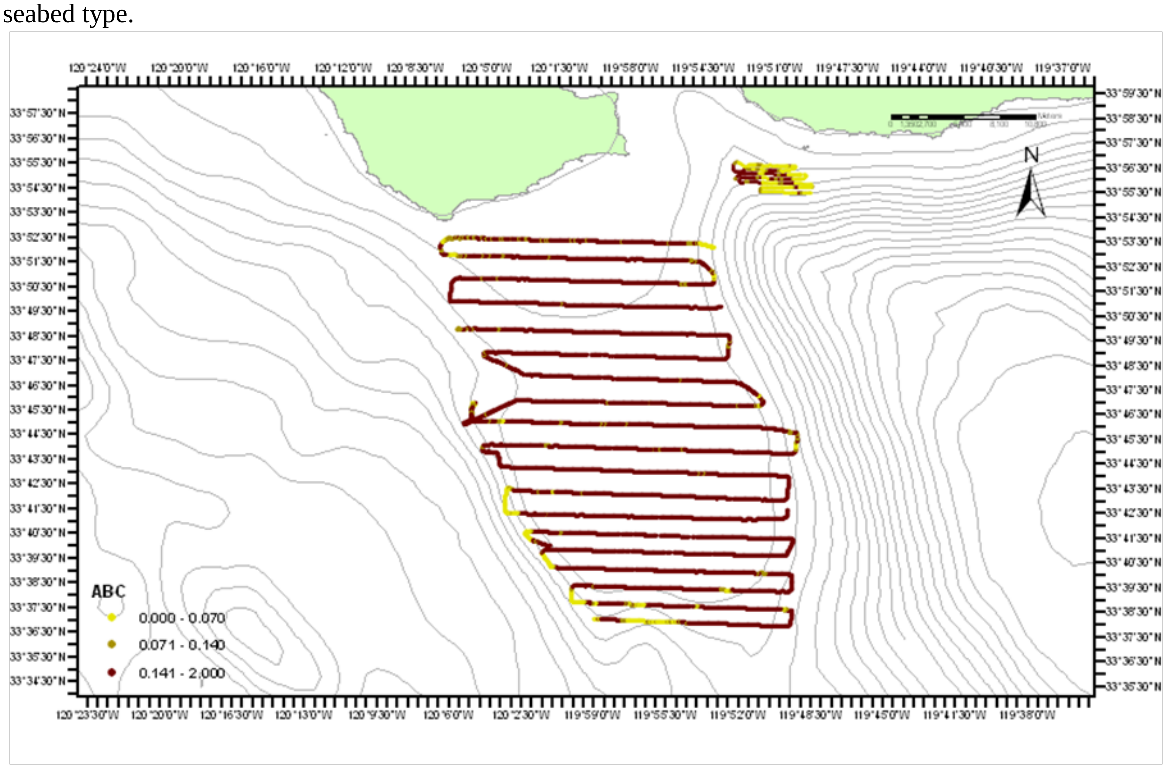


Figure 1.34. Santa Rosa Flats 3-D image of bathymetry (m) and S_v of rockfishes (dB).

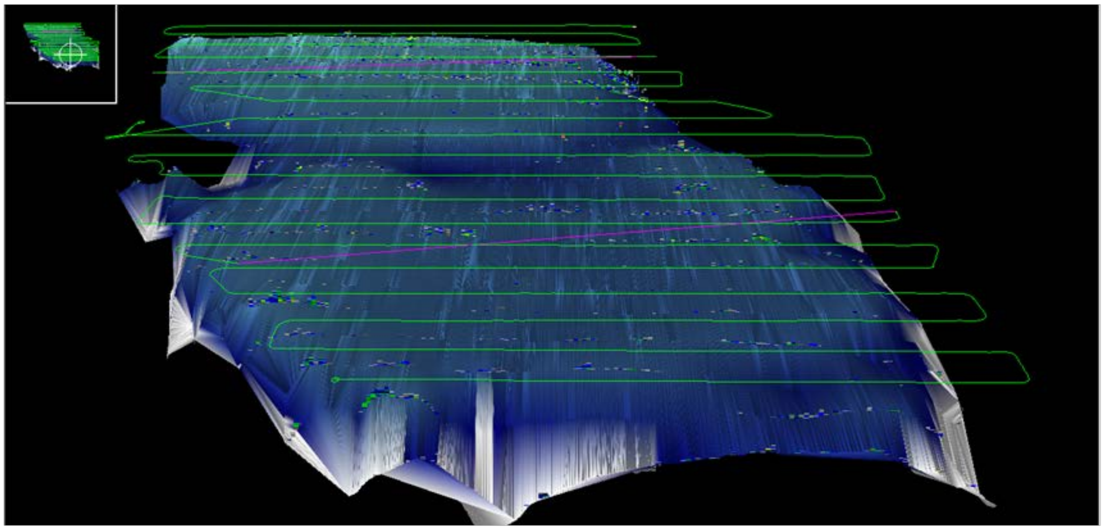


Figure 1.35. Santa Cruz Canyon 3-D image of bathymetry (m) and S_v of rockfishes (dB).

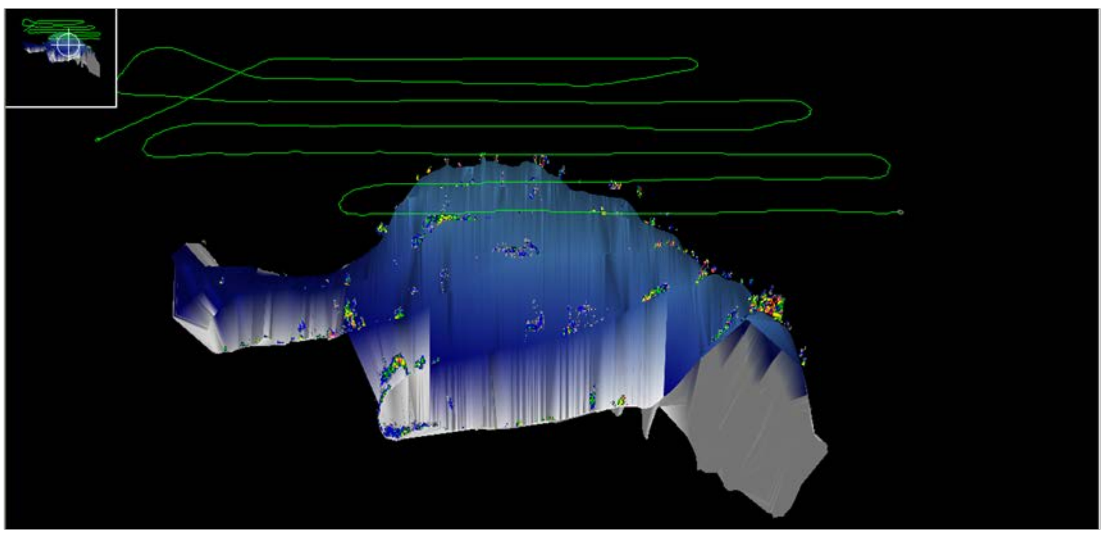


Figure 1.36. Anacapa Pass and S Anacapa Pass distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

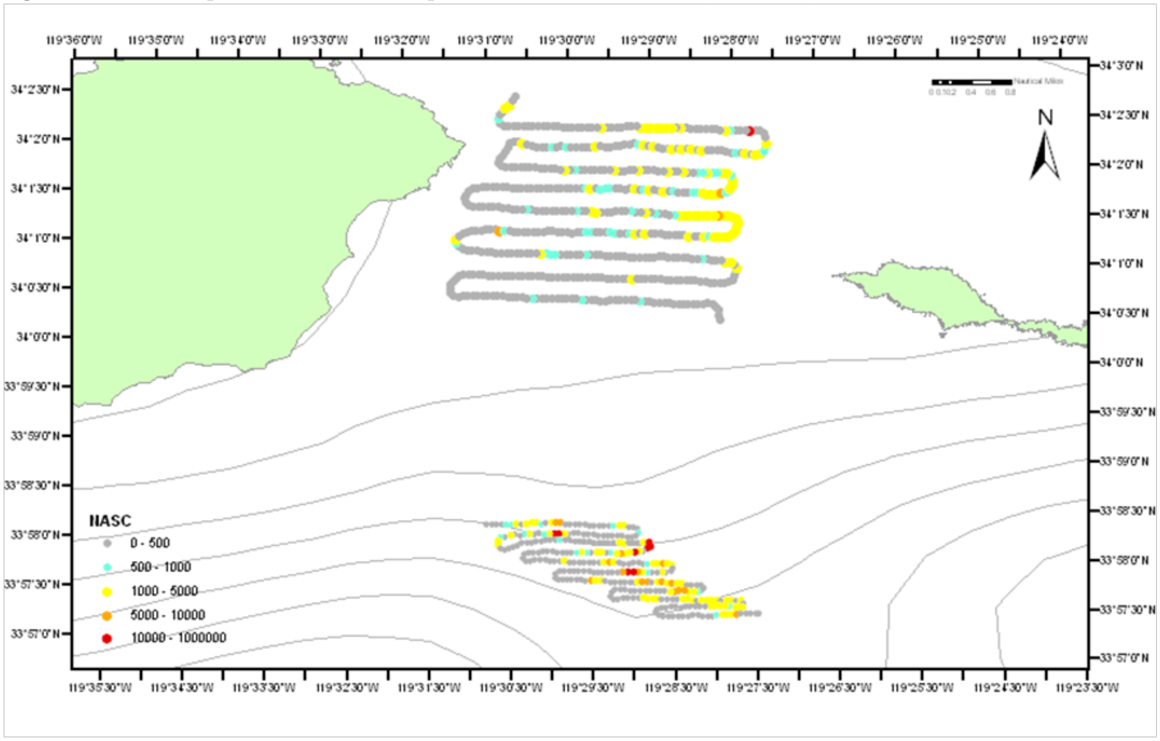


Figure 1.37. Anacapa Pass and South Anacapa Pass area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

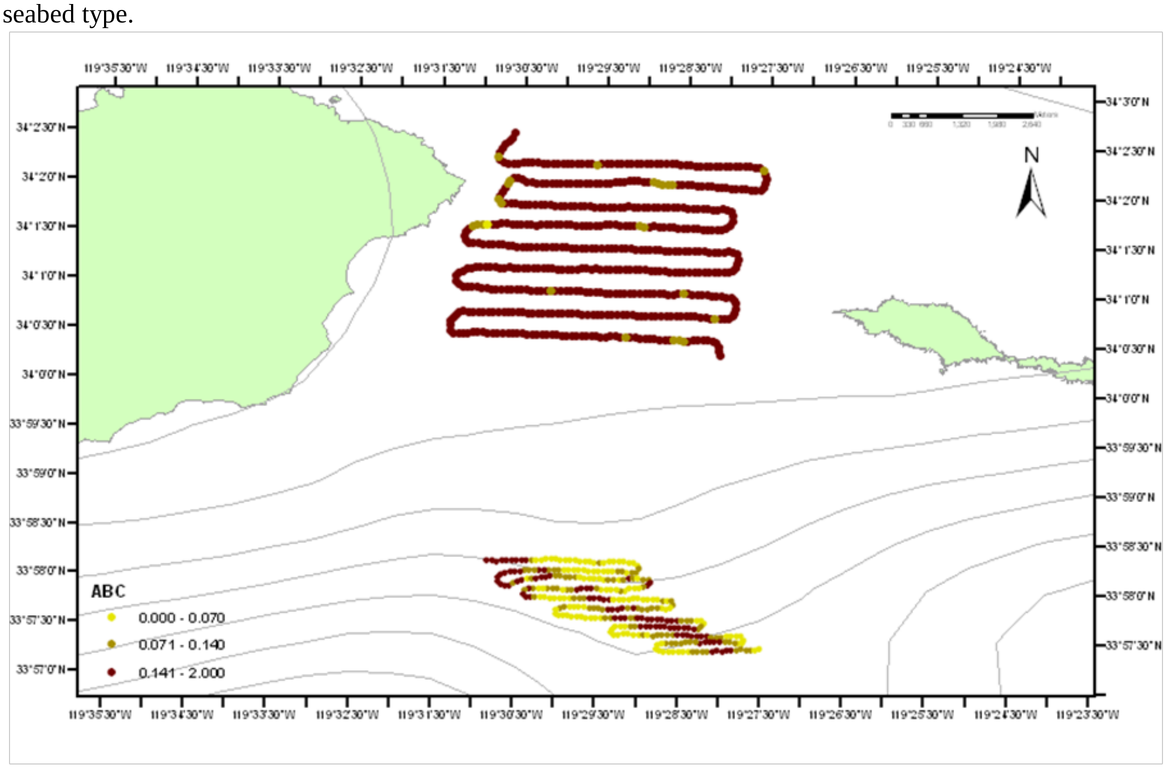


Figure 1.38. Anacapa Pass 3-D image of bathymetry (m) and S_v of rockfishes (dB).

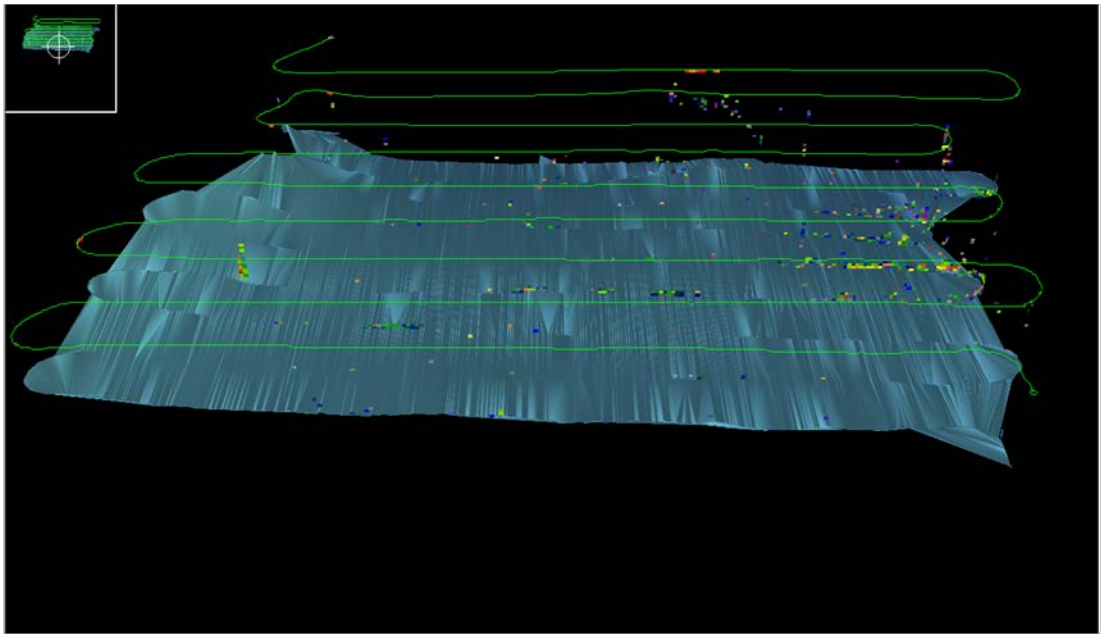


Figure 1.39. S Anacapa Pass 3-D image of bathymetry (m) and S_v of rockfishes (dB).

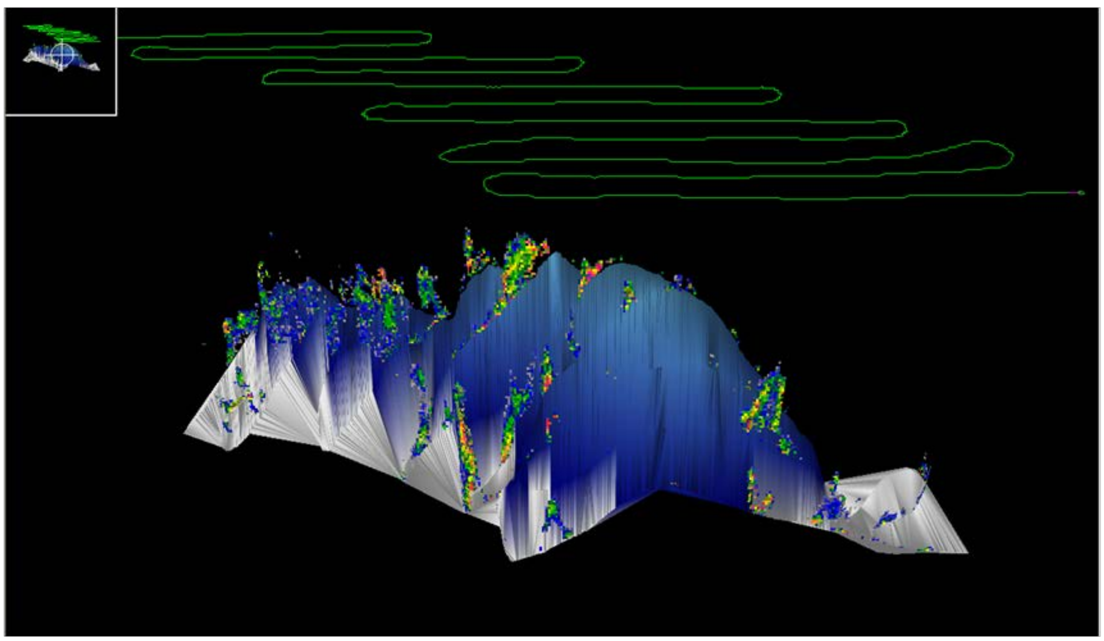


Figure 1.40. East and Southeast San Nicolas Island distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

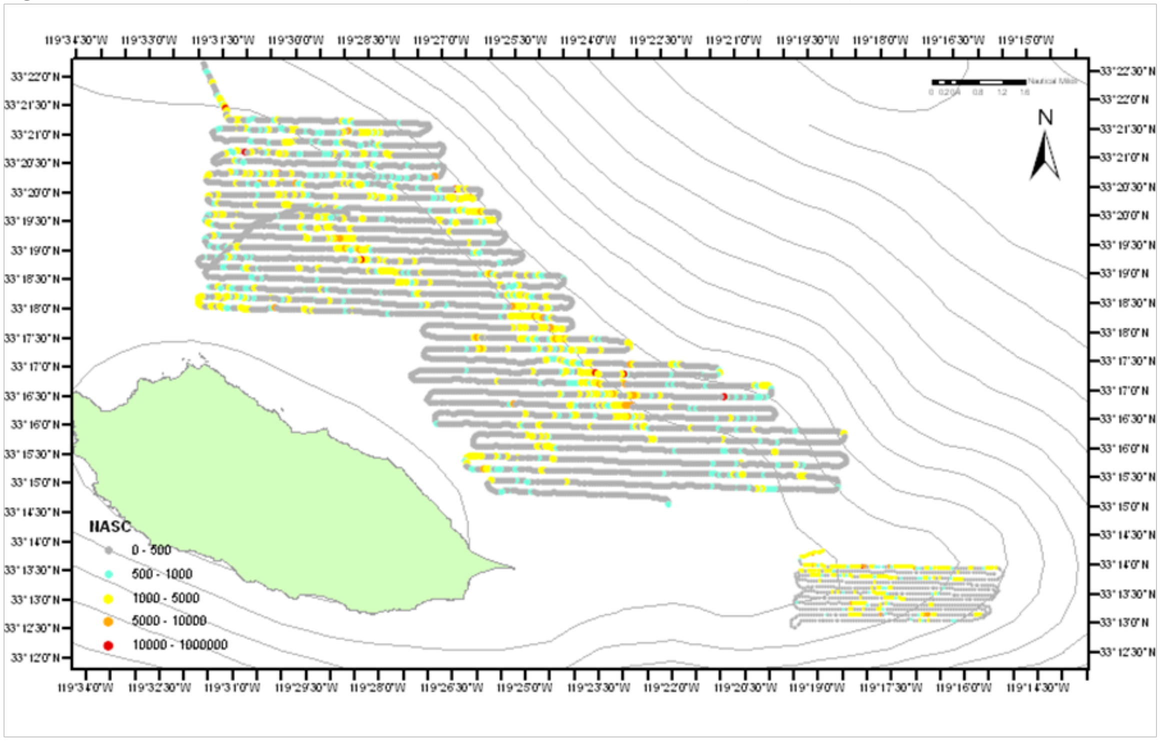


Figure 1.41. East and Southeast San Nicolas Island area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

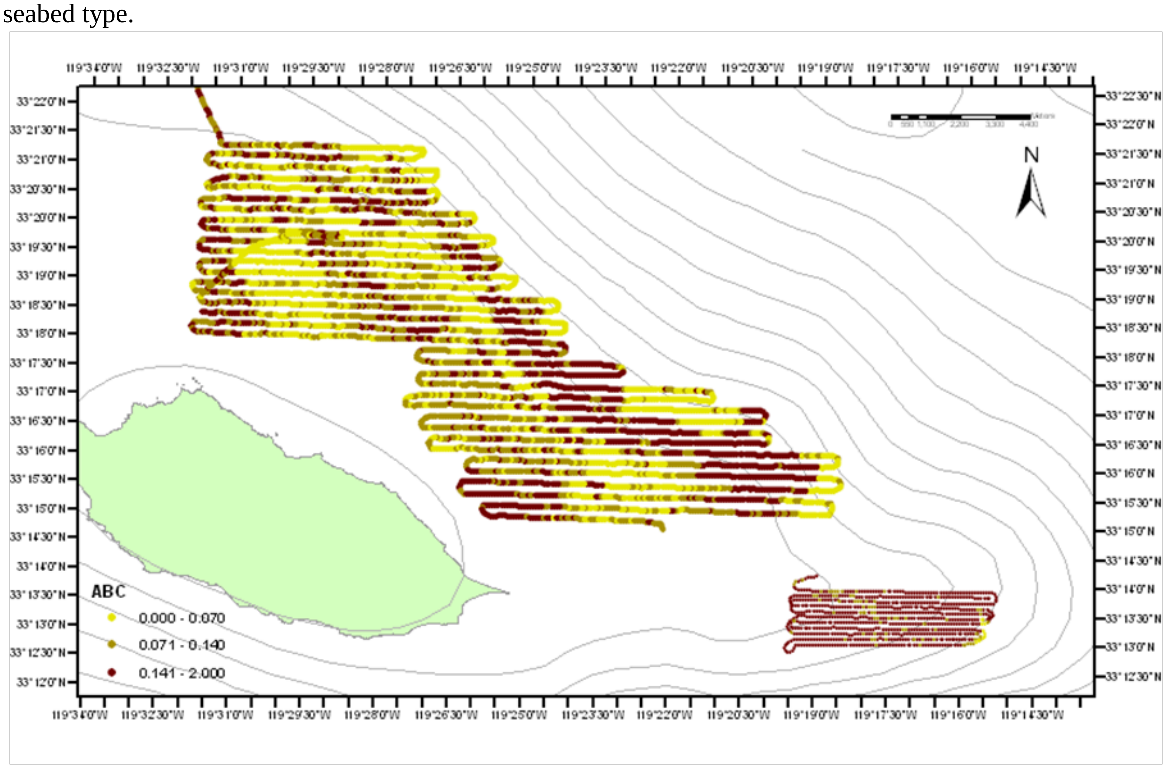


Figure 1.42. East San Nicolas Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).. View is southward.

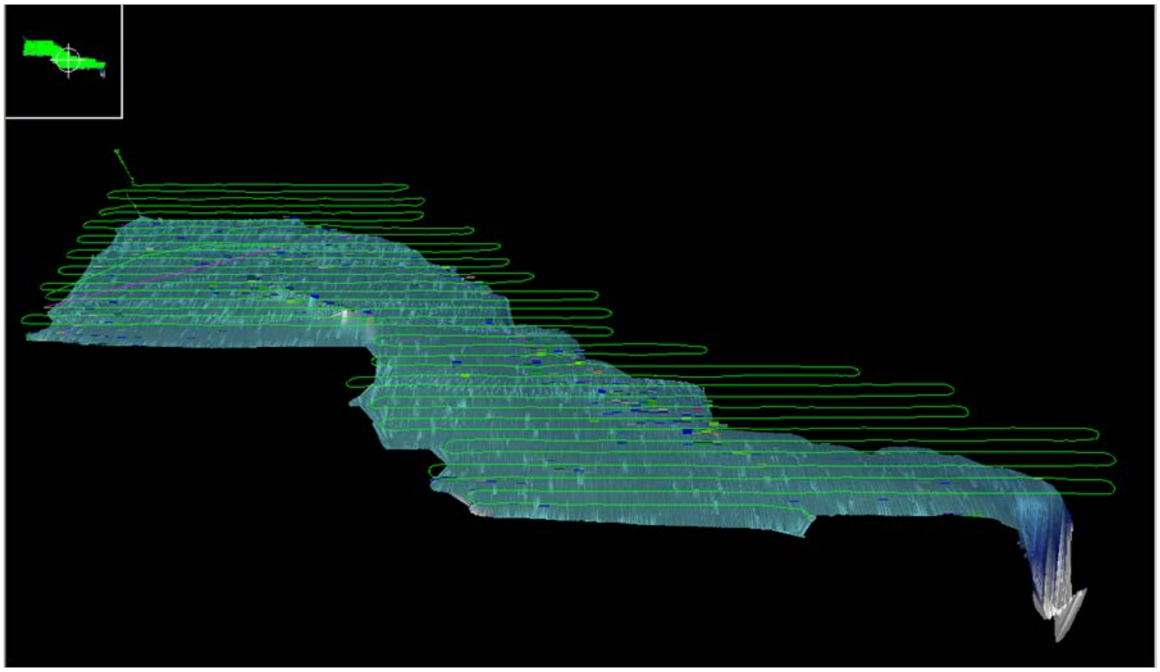


Figure 1.43. Southeast San Nicolas Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

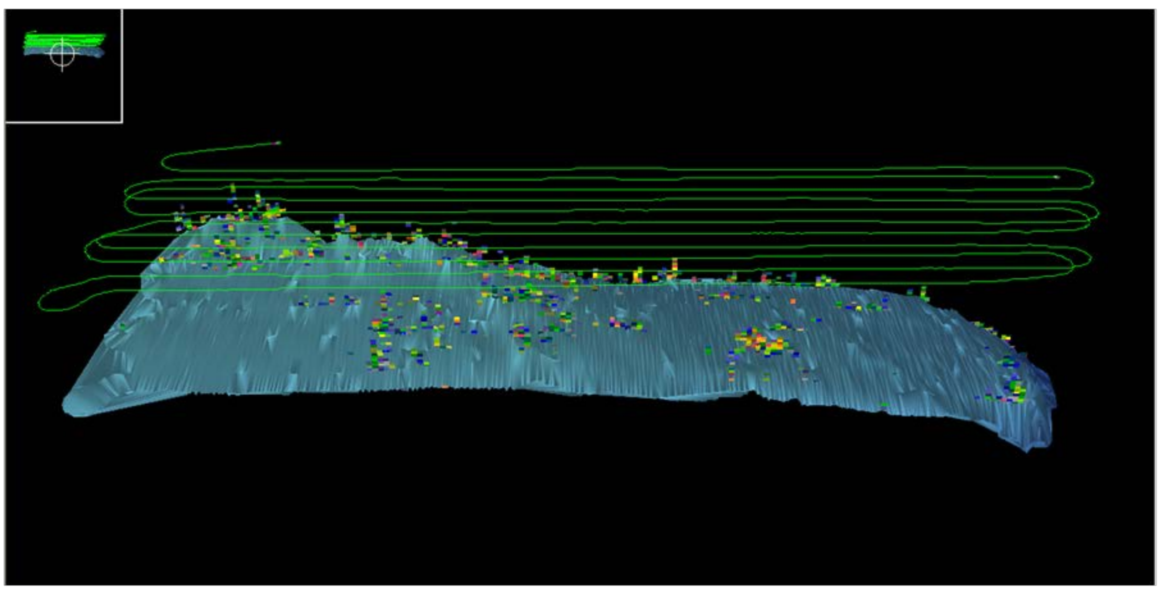


Figure 1.44. North and Northwest San Nicolas Island and Potato Bank distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

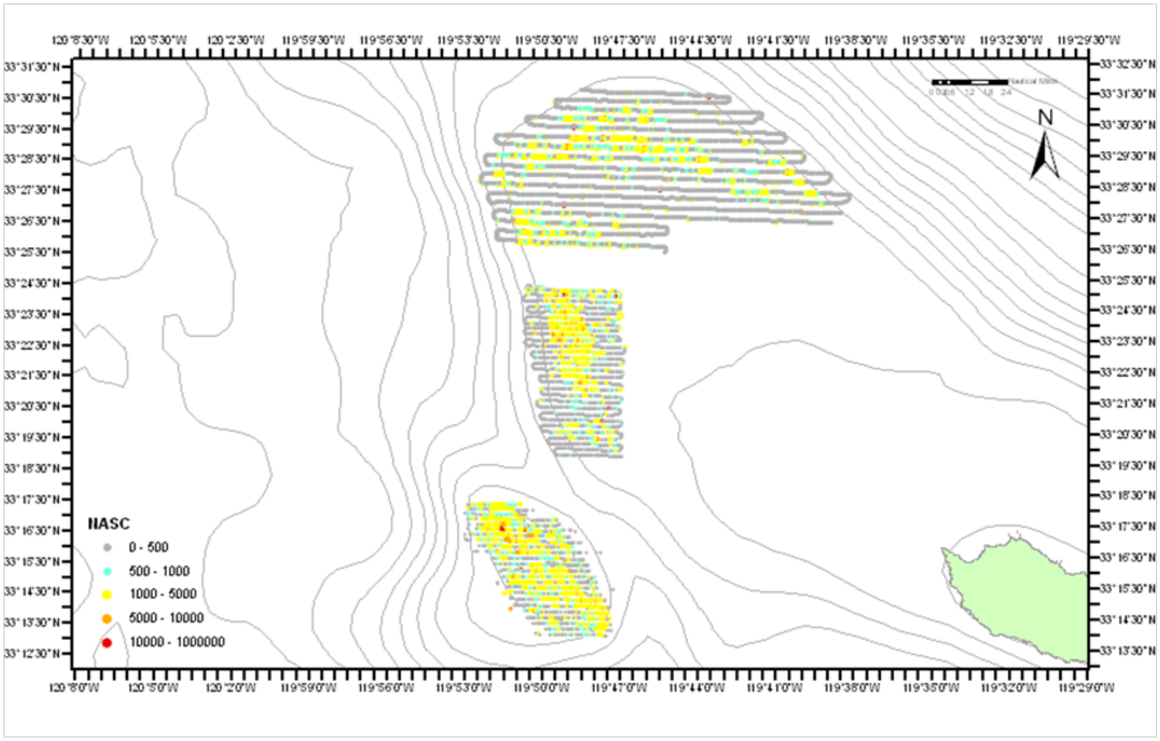


Figure 1.45. North and Northwest San Nicolas Island and Potato Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

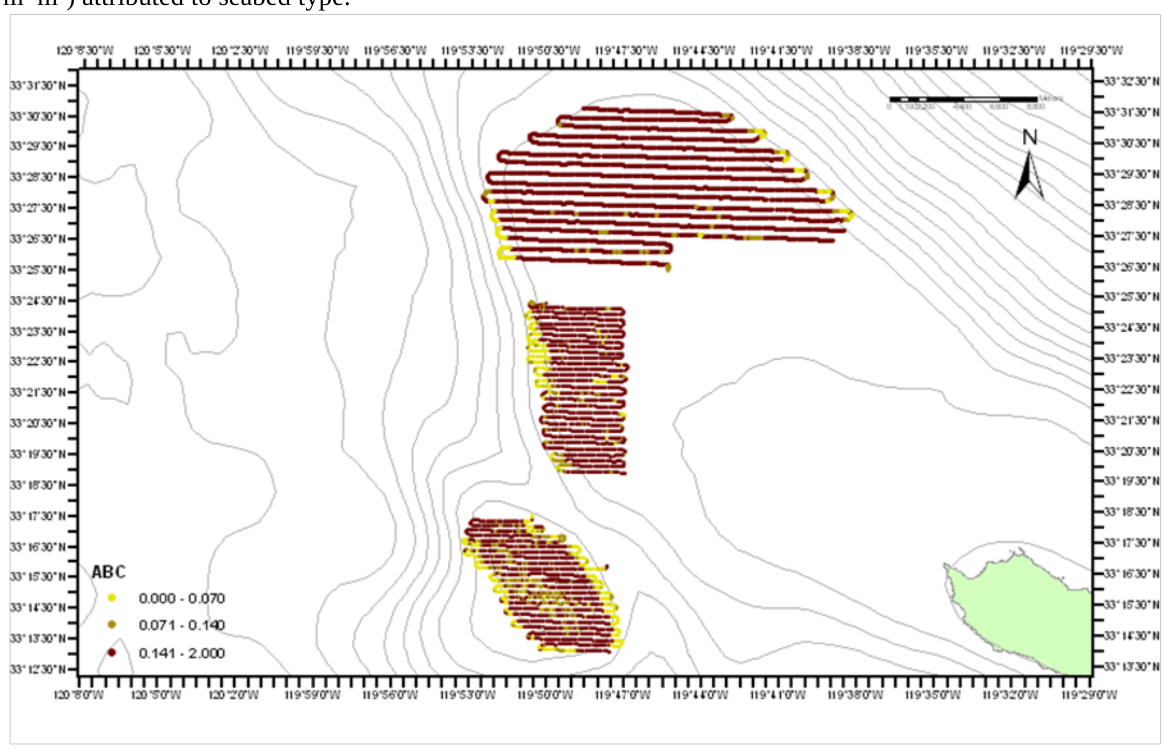


Figure 1.46. North San Nicolas Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

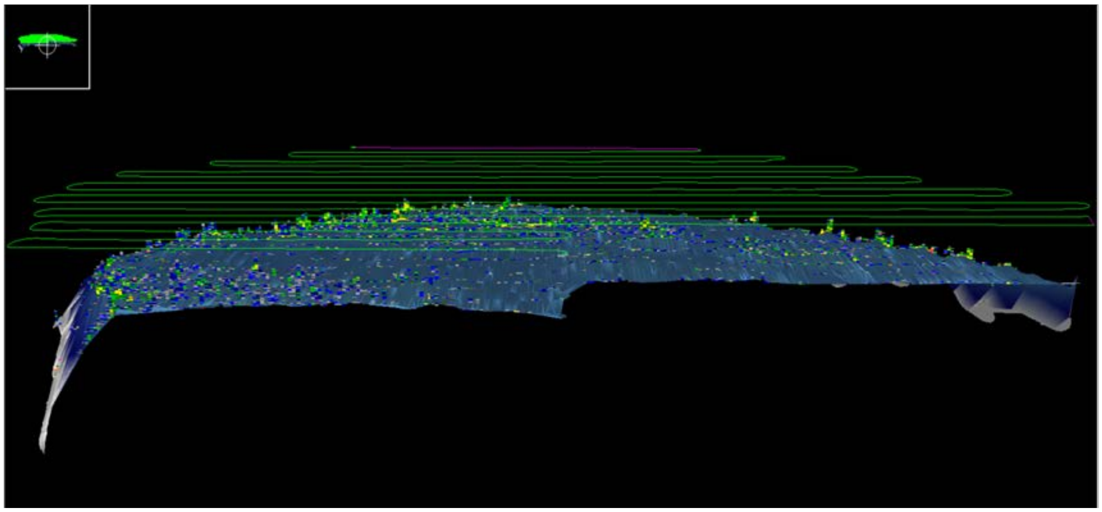


Figure 1.47. Northwest San Nicolas Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

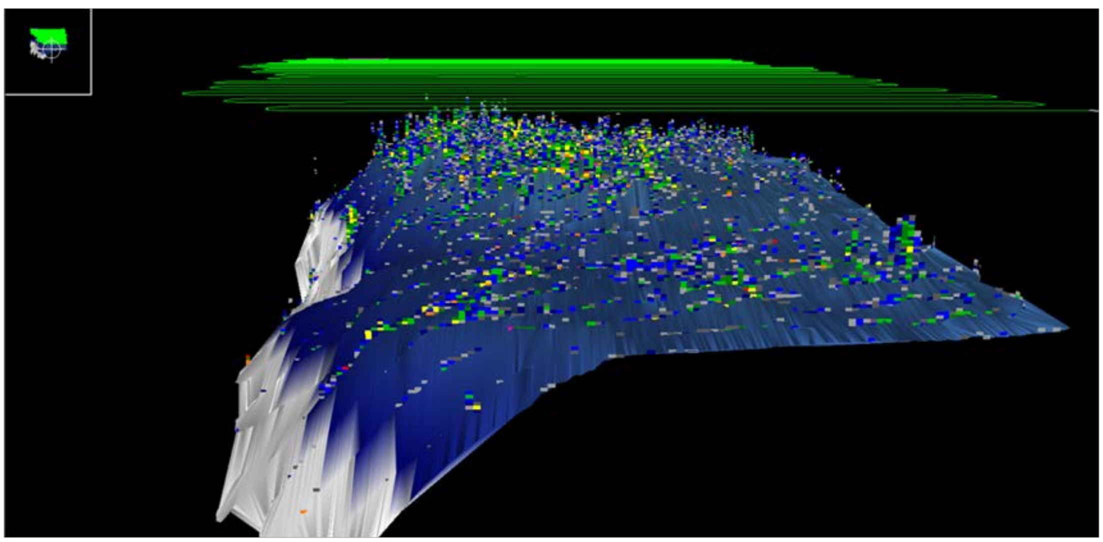


Figure 1.48. Potato Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

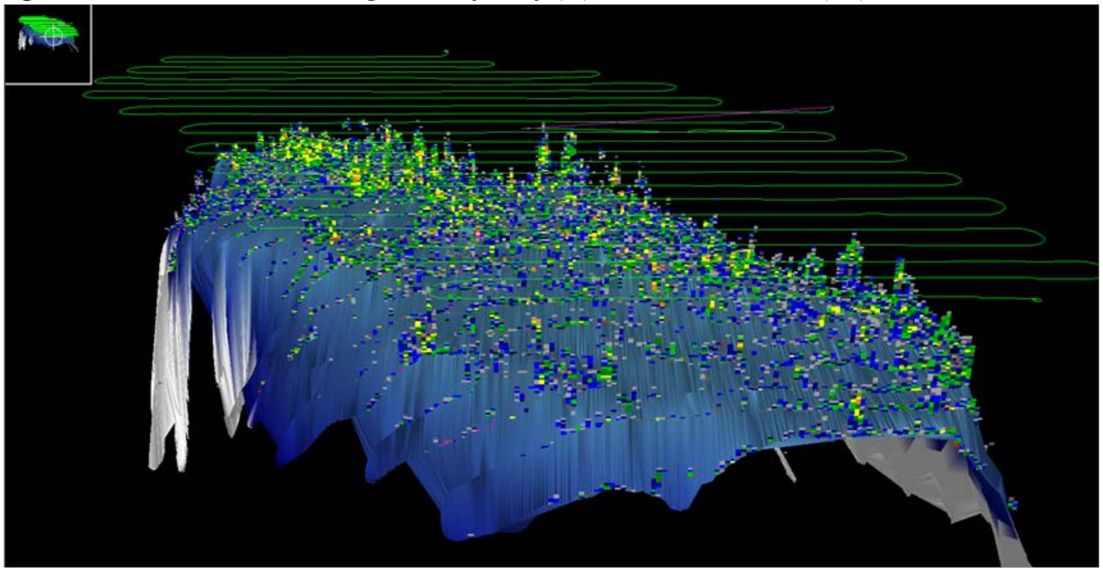


Figure 1.49. Hidden Reef distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

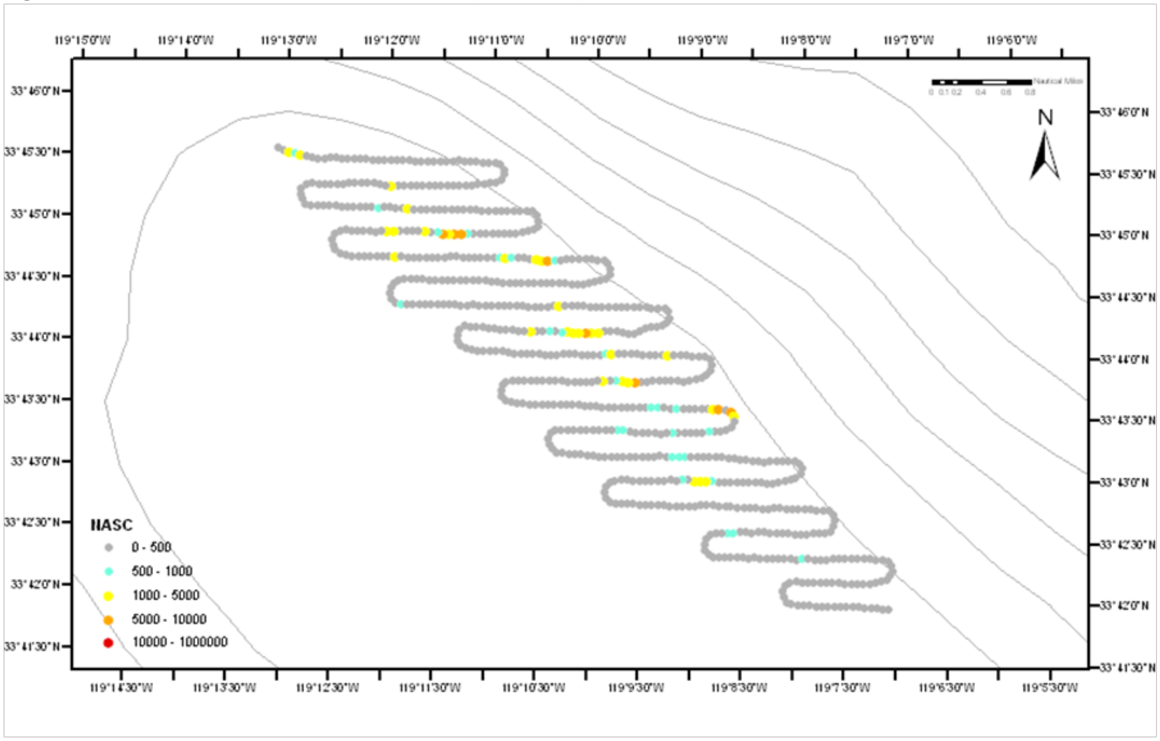


Figure 1.50. Hidden Reef area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

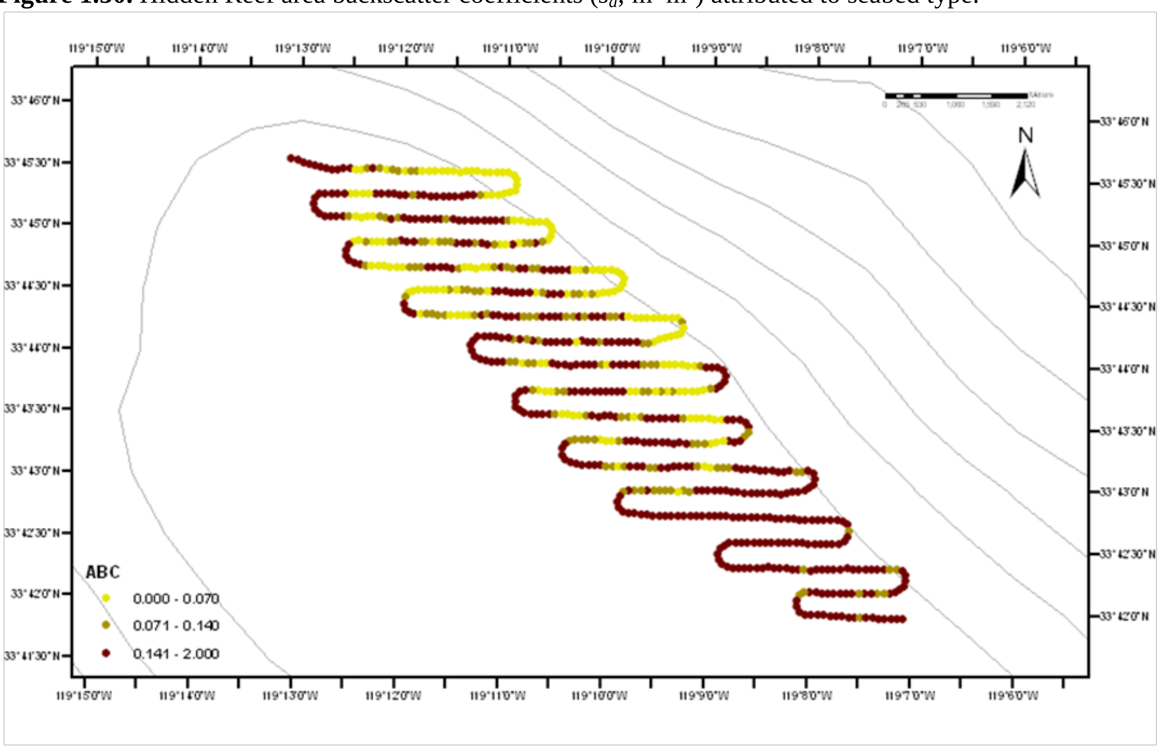


Figure 1.51. Hidden Reef 3-D image of bathymetry (m) and S_v of rockfishes (dB).

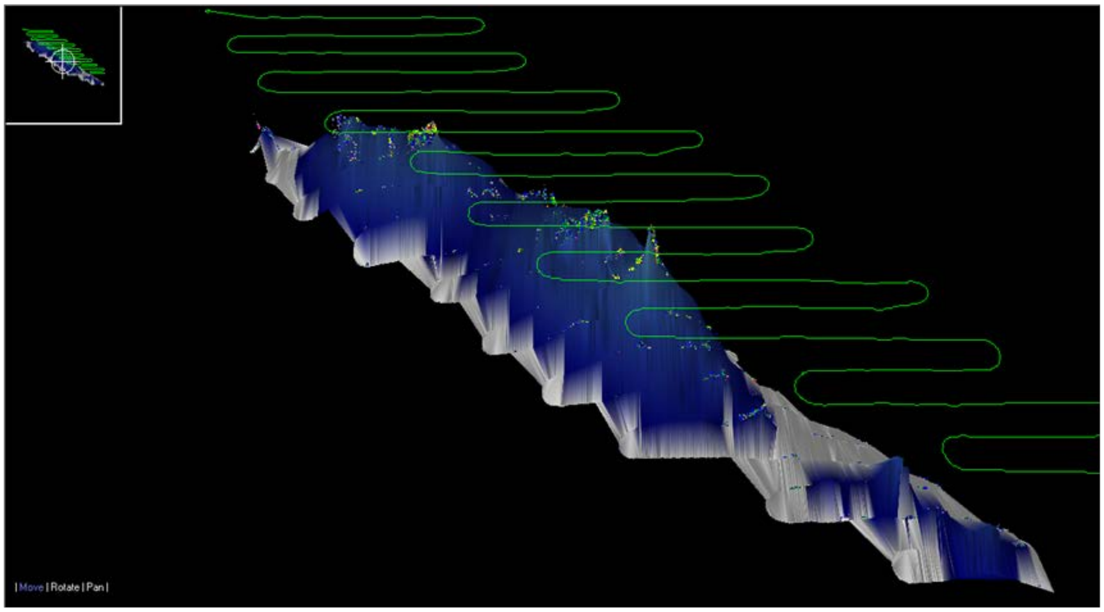


Figure 1.52. North and Southwest Santa Barbara Island, 117 Seamount and Osborne Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

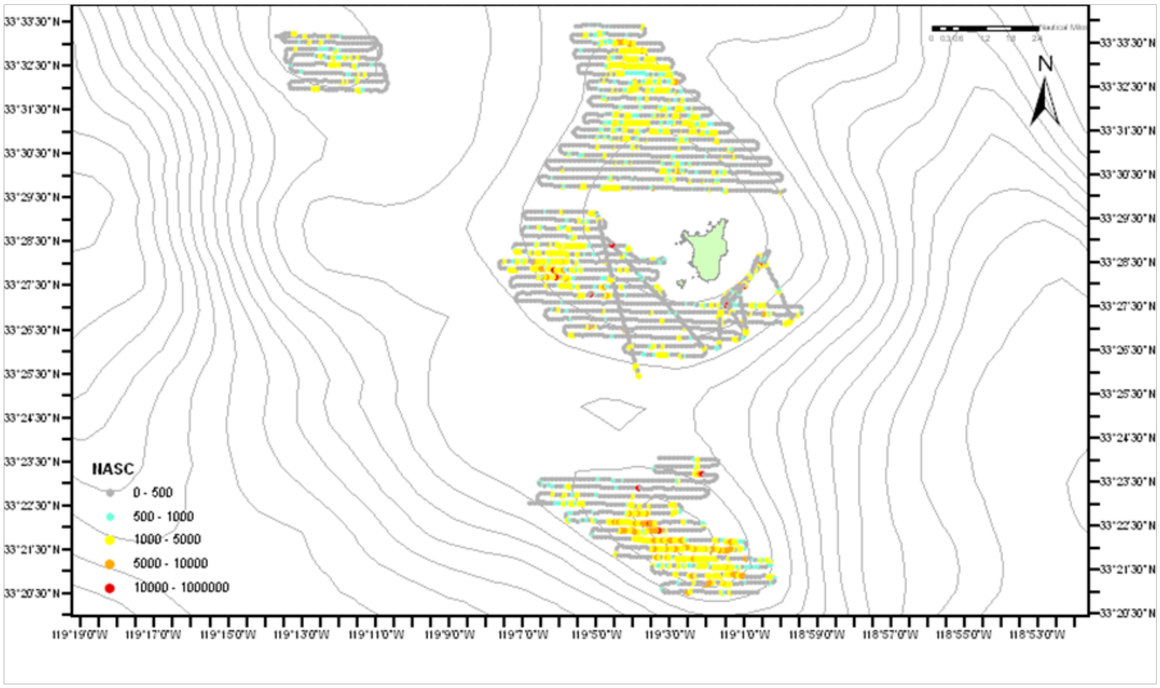


Figure 1.53. North and Southwest Santa Barbara Island, 117 Seamount and Osborne Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

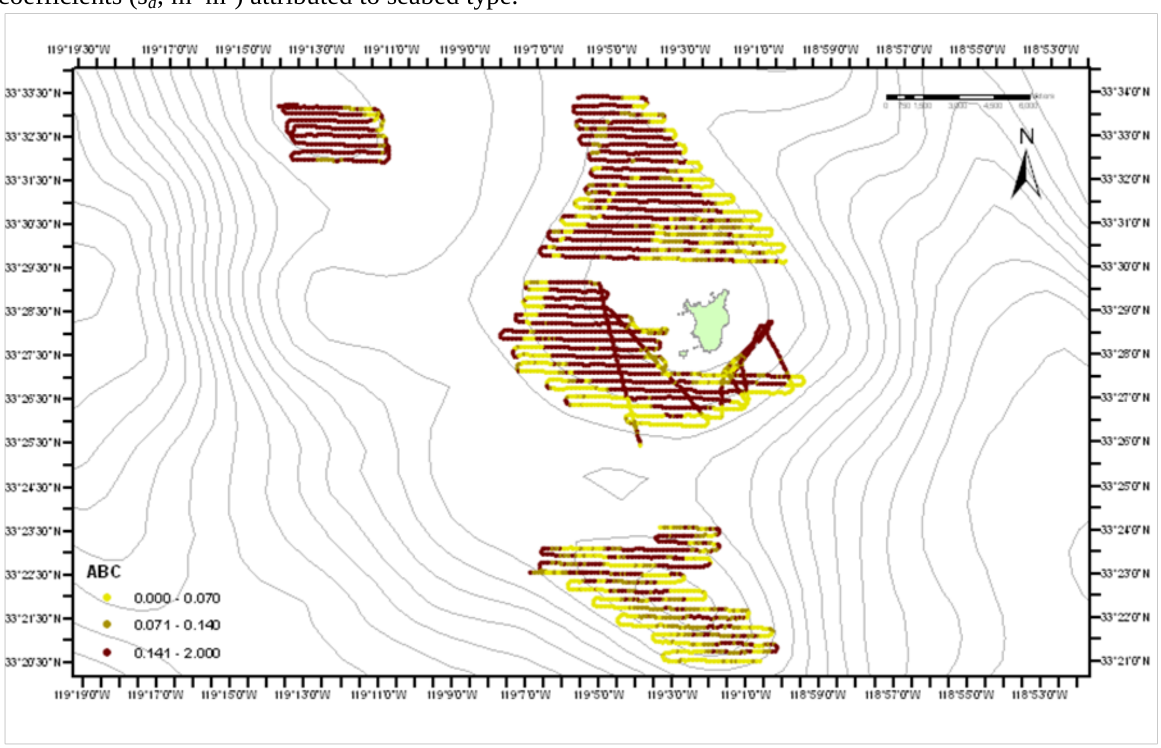


Figure 1.54. North Santa Barbara Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

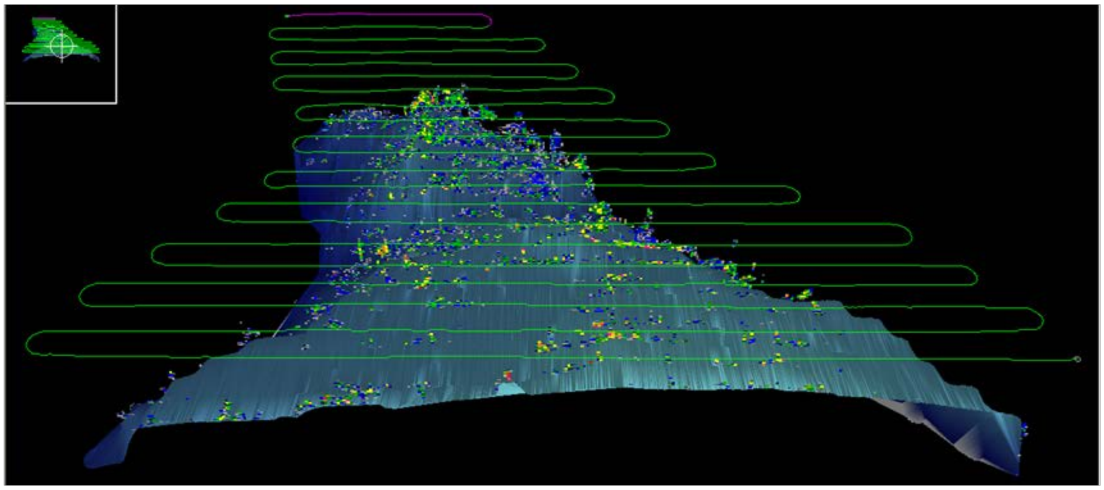


Figure 1.55. Southwest Santa Barbara Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

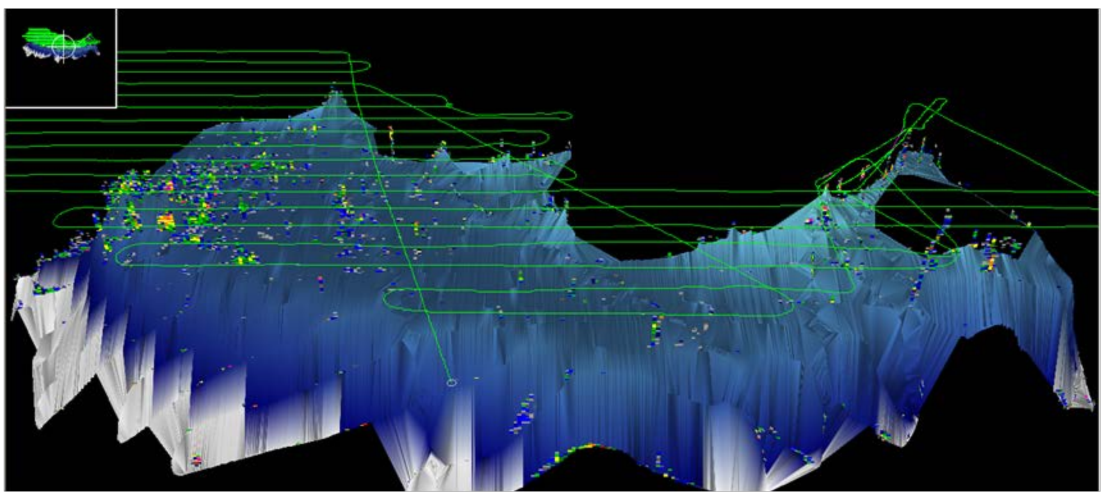


Figure 1.56. 117 Seamount 3-D image of bathymetry (m) and S_v of rockfishes (dB).

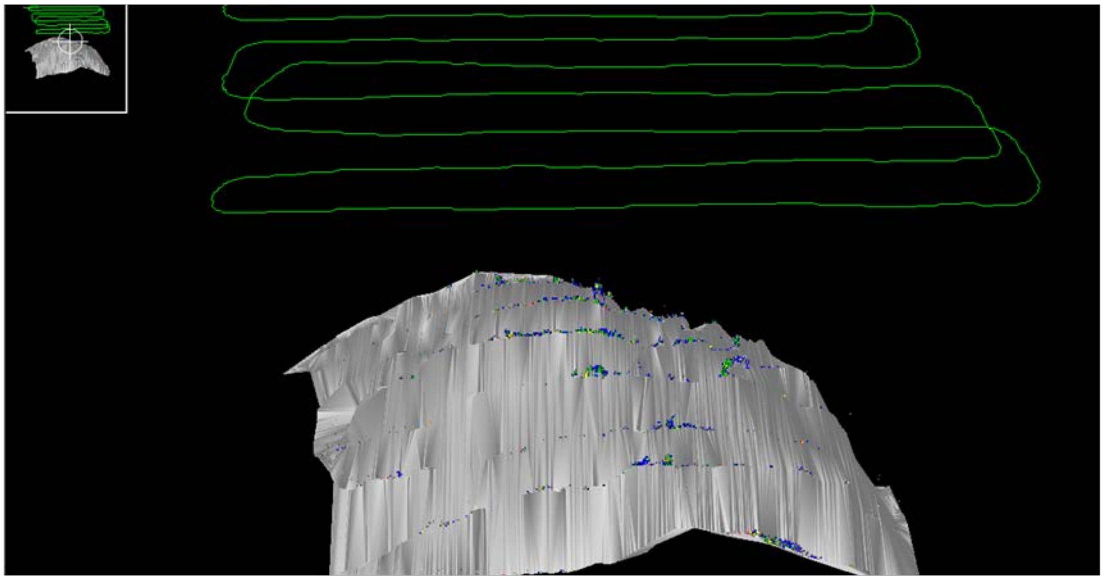


Figure 1.57. Osborne Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

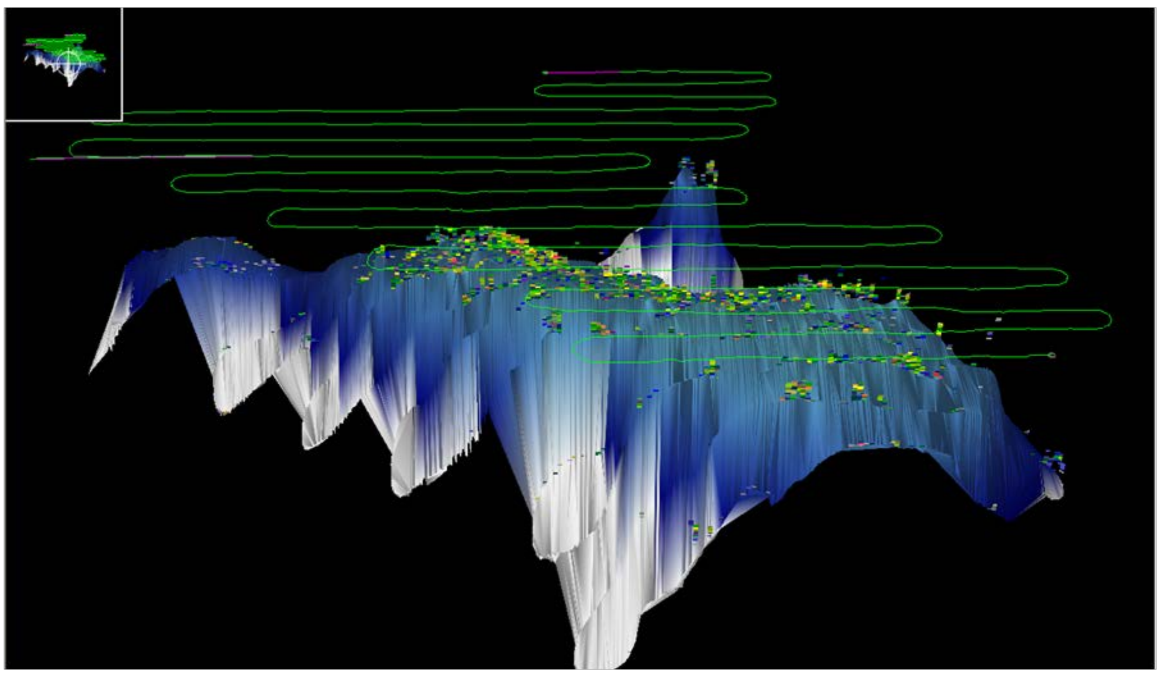


Figure 1.58. 118 and 107 Banks distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

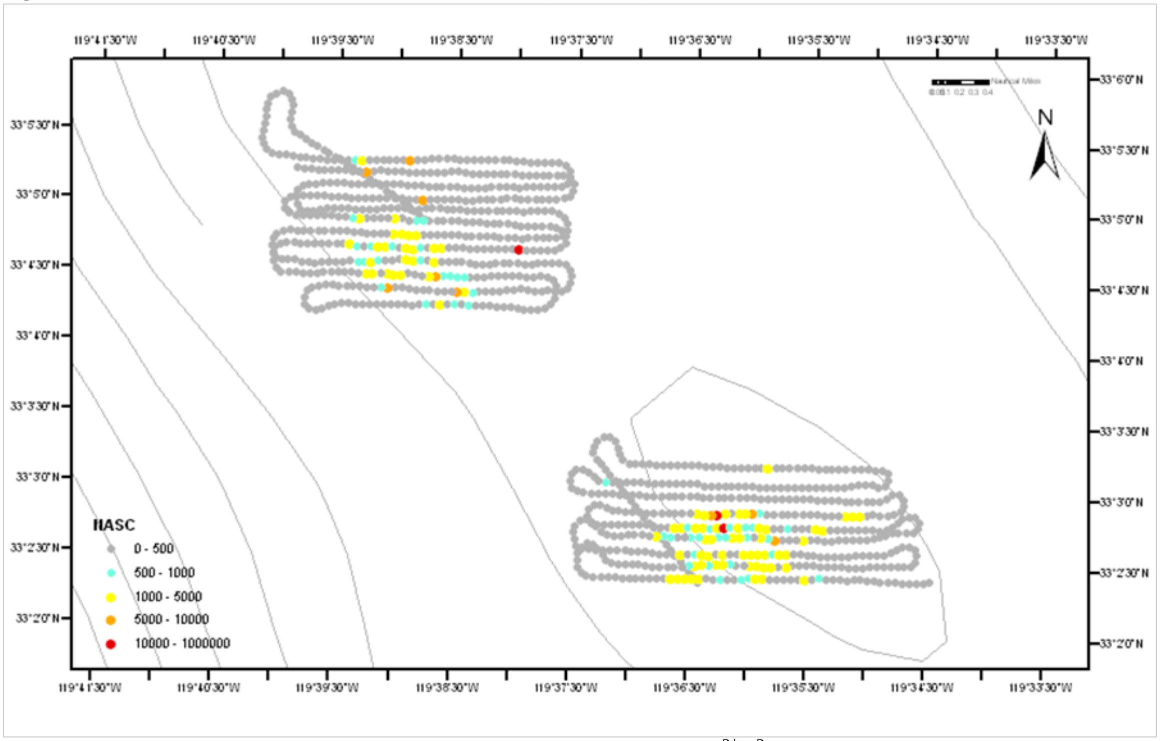


Figure 1.59. 118 and 107 Banks area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

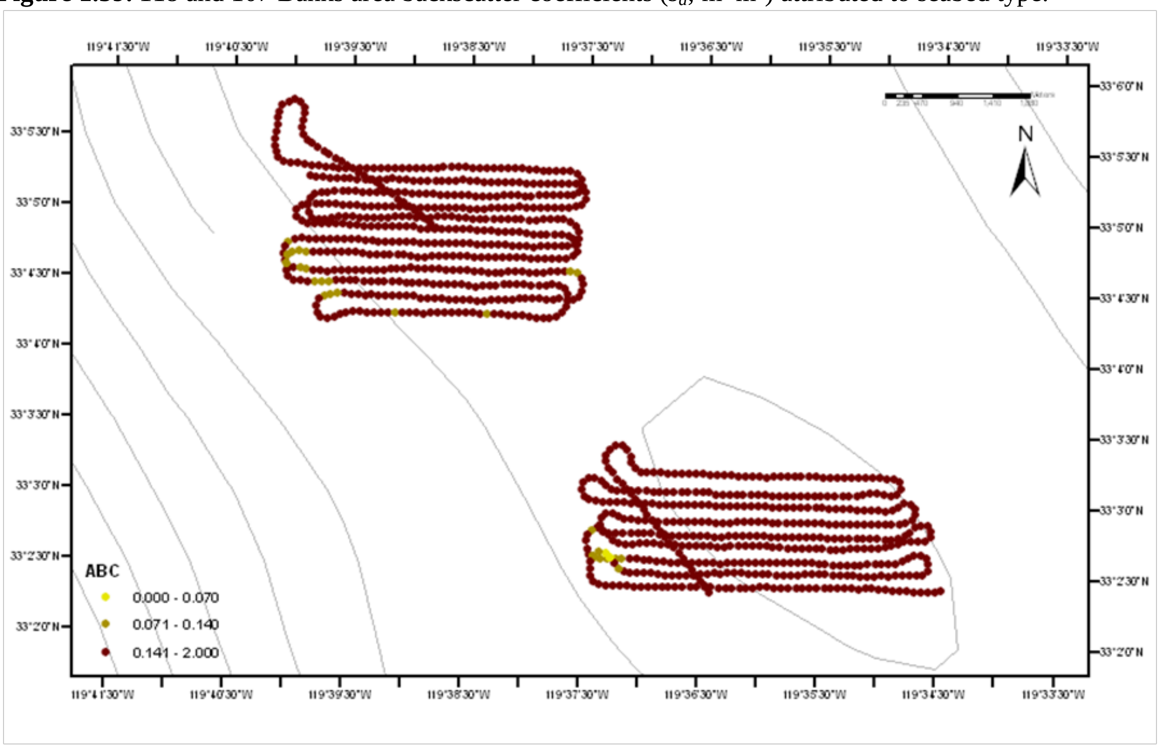


Figure 1.60. 118 Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

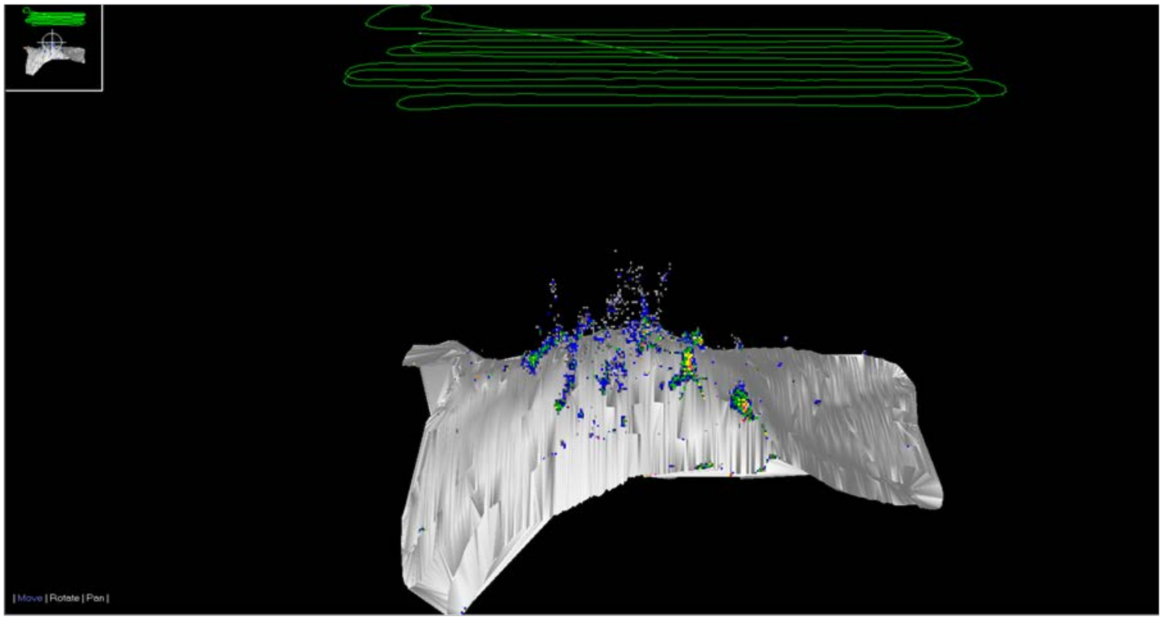
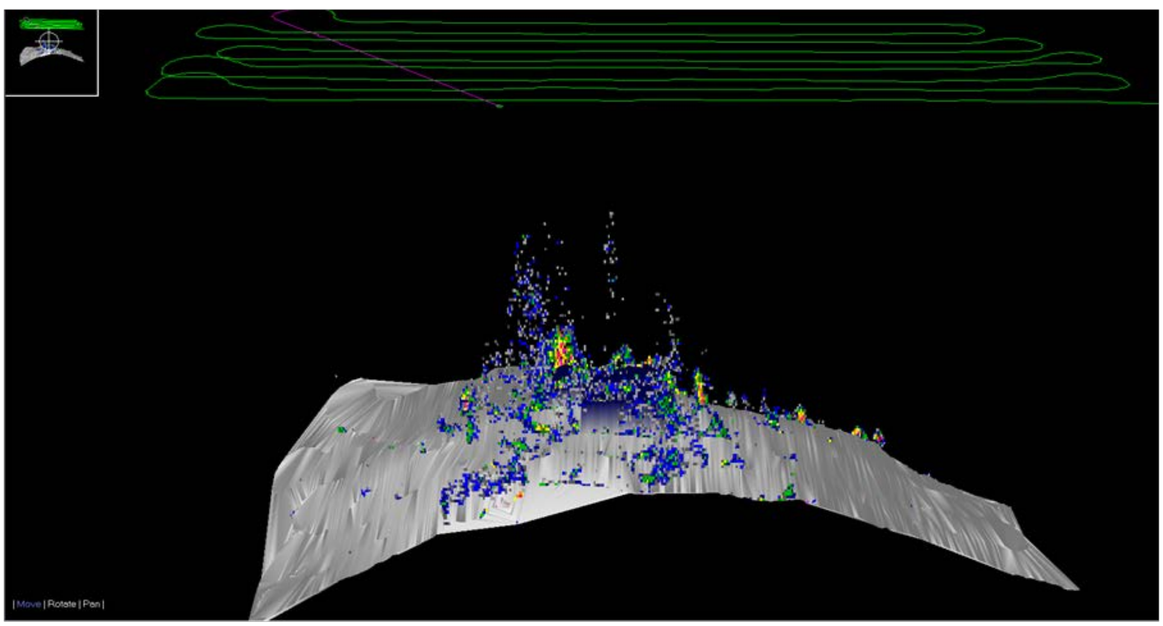


Figure 1.61. 107 Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

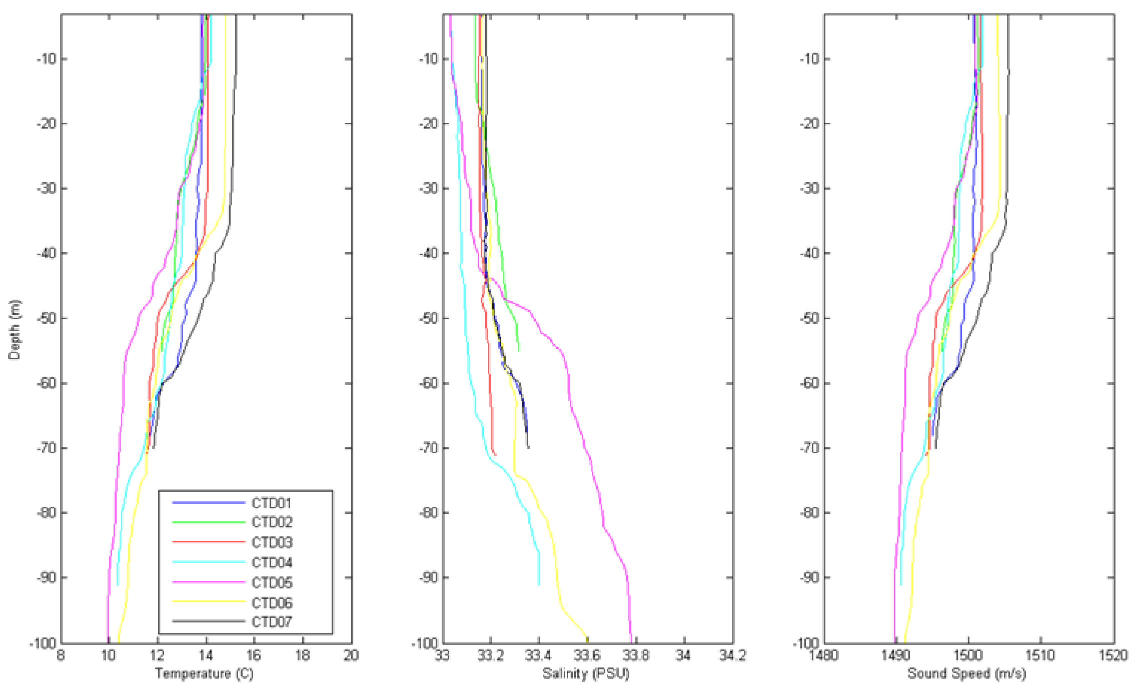


CTD Results: Based on only seven successful casts, the oceanographic conditions appear to be similar throughout the northern Channel Islands. The water temperatures were slightly warmer near the more protected Santa Barbara Island.

Table 1.6. CTD casts for DSJ0502. The Seabird 911plus (CalCOFI) had pump problems and either the down-cast or the entire cast produced poor data. Only seven sites had usable data (in bold print). CTD data was provided and processed by Dave Griffith, SWFSC.

CTD No.	Location	Date	Latitude	Longitude	Maximum Depth (m)
1	Southwest San Miguel Island	070205	34º 0.160'N	120º 26.170'W	90
2	Northwest San Miguel Island	090205	34° 6.3'N	120° 26.7'W	55
3	East San Nicolas Island	120205	33° 19.810'N	119° 28.810'W	70
4	East San Nicolas Island	130205	33° 14.910'N	119° 22.130'W	45
5	North San Nicolas Island	130205	33° 28.5'N	119° 45.9'W	105
6	Northwest San Nicolas Island	130205	33° 14.6'N	119° 50.4'W	105
7	Potato Bank (pump failure)	160205			90
8	Potato Bank	160205	33° 15.9'N	119° 49.8'W	90
9	Santa Rosa Flats	170205	33° 40.0'N	119°59.3'W	120
10	Hidden Reef	190205	33° 42.1'N	119° 7.4'W	160
11	117 Seamount	190205	33° 32.4'N	119° 12.8'W	250
12	North and SW Santa Barbara Island	200205	33° 30.2'N	119° 3.9'W	70
13	Osborne Bank (pump failure)	210205	33° 22.8'N	119° 5.4'W	145

Figure 1.62. Processed CTD up-cast profiles for DSJ0502. Note: the conductivity sensor did not appear to be responsive during the CTD03 cast at E. San Nicolas Island.



Outer Limits Leg I

Calibrations: The calibrations were performed in open water at Nine Mile Bank but conditions were suboptimal and thus took longer than usual to calibrate all five frequencies at 502 µs pulse durations (**Table 1.7**).

Table 1.7. Summary of pre-survey EK60 calibrations on 4 May 2005.

Standard	38.1 mm diameter tungsten-carbide sphere				
Location	32º 034.570' N/117º 21.650' W				
Water Depth	~131.1 m (~130 m below transducers)				
Sphere Range	~20 m				
Temperature	17.1 ºC				
Salinity	33.2 PSU				
	18 kHz	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Test Mode (dB)	-64	-64	-64	-64	-64
Absorption coeff. (dB/km)	2.03	7.92	21.60	42.41	65.29
Experiment 1	**18 kHz**	**38 kHz**	**70 kHz**	**120 kHz**	**200 kHz**
Pulse duration (µs)	512	512	512	512	512
Transducer Gain (dB)	20.87	23.41	26.43	26.63	28.94
Sa corr. (dB)	-0.48	-0.76	-0.51	-0.43	-0.62

Table 1.8. Planned survey areas with their approximate distances and durations, and their actual beginning and ending dates and times (GMT=+7 hrs. PST on daylight savings). The total surveyed track lines for the OL0505 cruise were 519 n.mi. of the entire surveyed Southern California Bight for October 2004 to May 2005 (2654 n.mi.). Only a section of Northwest San Clemente Island (SCI) was repeated on May 26, 2005.

Survey Order	Survey Area	Distance (n.mi.)	Time (Days)	Begin Date	Begin Time	End Date	End Time
1	Del Mar Steeples Reef	16	0.4	100505	2315	110505	0239
2	Northwest Catalina Island	14	0.2	110505	1307	110505	1643
3	Farnsworth Bank	26	0.5	110505	1811	110505	2303
4	West San Clemente Island	55	1.1	120505	1343	130505	0040
5	Northwest San Clemente Island (+Repeat SCI)*	67 27.5	1.3 0.5	130505 140505 260505	0058 1240 1344	130505 140505 260505	2024 1814 1717
6	North San Clemente Island	26	0.5	130505	2112	140505	0220
7	57 Fathom Reef	4	0.1	140505	2009	140505	2055
8	China Point Reef	40	0.8	140505	2148	150505	1615
9	SCI 86 Fathom Bank	19	0.4	150505	1625	150505	2018
10	SCI 81 Fathom Bank	17	0.3	150505	2108	160505	0040
11	60 Mile Bank	69	1.4	180505	1255	190505	1726
12	Kidney Bank	17	0.3	190505	2252	200505	0236
13	Mission Beach Reef	49	1.2	230505	1517	230505	2345
14	Nine Mile Bank	67	1.3	240505	1354	250505	0250
15	Lasuen Knoll	15	0.3	250505	1245	250505	1537
16	43 Fathom Bank	18	0.4	260505	1344	260505	1717

Del Mar Steeples: The seabed classification algorithm revealed a predominantly rocky seabed at the flatter, middle and eastern portions of this site. Note that the sandy, western side also correlates with those areas of the bank that were dropping off into deeper water which may need further algorithm refinement. Few rockfish were mapped throughout the entire bank. In the western region of the bank, virtually no rockfishes were acoustically detected.

Northwest Catalina Island: This site was replete with rockfish towards the mid-section of the bank. The presence of fish was generally related to a mixture of all three categories of acoustic backscatter and is probably a mix of rocky and sandy areas.

Farnsworth Bank: Similar to Northwest Catalina Island, large numbers of rockfishes were concentrated towards the middle of the site around the shallower peaks in areas of mixed seabed types.

West San Clemente Island: Moderate densities of rockfishes were observed along the eastern edge of the site in shallower areas of a mixed seabed types.

Northwest San Clemente Island: As with the West San Clemente Island site, the highest rockfish densities were mapped along the shallower eastern edge of the bank, mostly in the north. The rockfishes were generally associated with mixed seabed types.

North San Clemente Island: Large densities of rockfishes were observed throughout one-third of the site in the shallower areas of mixed seabed types.

57 Fathom Reef: This site had high densities of rockfishes over most of the shallower middle portions south of West San Clemente. Areas with rockfishes were likely rocky or a mix of seabed types.

China Point Reef, 86 and 81 Fathom Banks: All three of these sites, clustered at the southern tip of San Clemente Island, had dense aggregations of rockfishes associated with the shallow ridges aligned north to south in the middle of each site. Again, these high rockfish densities appear to be associated with a mixture of seabed types.

60 Mile Bank: This deeper bank had high densities of rockfishes, mostly concentrated in the northeastern portion of the bank. The shallower southern portion of the bank, likely a mixture of rocky and sandy seabed, had slightly lower rockfish densities.

Kidney Bank: As observed in earlier surveys of this area, this bank was mostly devoid of rockfishes. Interestingly, the crew of *Outer Limits* indicated that they had previously experienced good fishing in this area. Most of this small bank appears to be flat, with a shallow rocky area at the north end.

Mission Beach Reef: This mostly flat site close to San Diego has a mixture of seabed types and moderate rockfish densities.

Nine Mile Bank: This mostly rocky site close to Mission Bay had low to moderate rockfish densities.

Lasuen Knoll: This small area had moderate rockfish densities associatef with with a rocky area in the east and a mixed seabed in the west.

43 Fathom Bank: High densities of rockfishes are consistently mapped at this site, predominately above the rocky plateau and extending to the edge of the bank in the southwest.

Figure 1.63. Del Mar Steeples distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

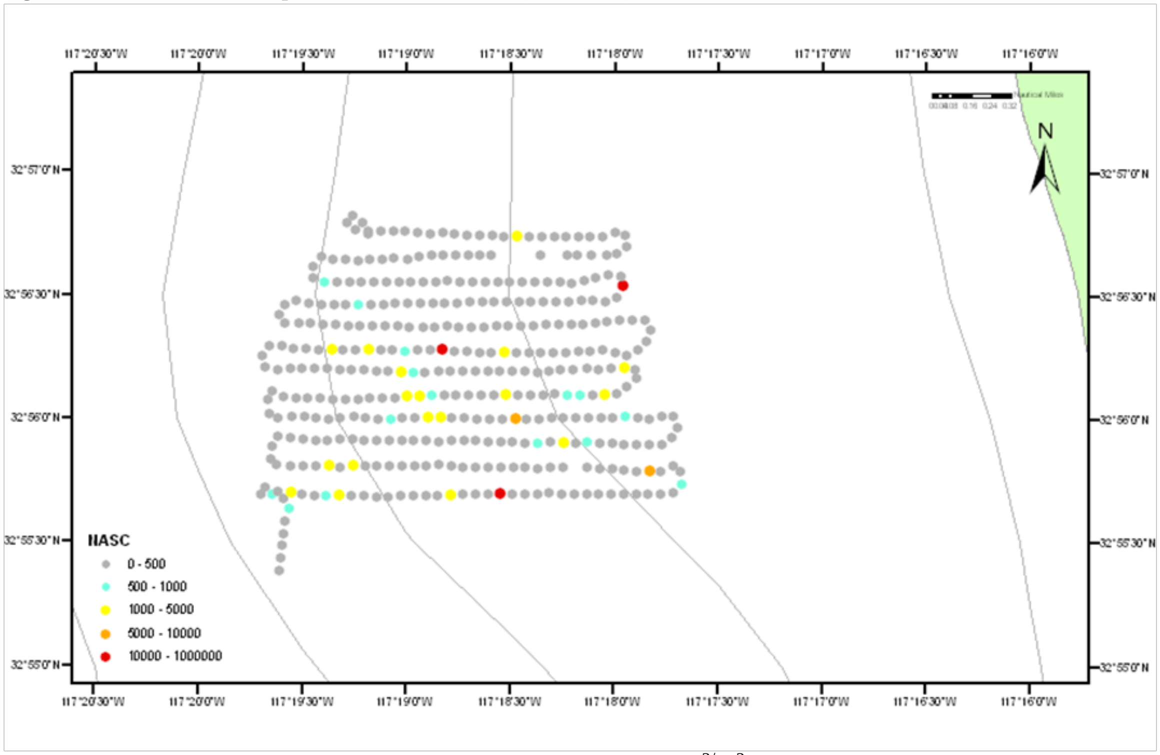


Figure 1.64. Del Mar Steeples area backscatter coefficients (s_a; m^2/m^2) attributed to seabed type.

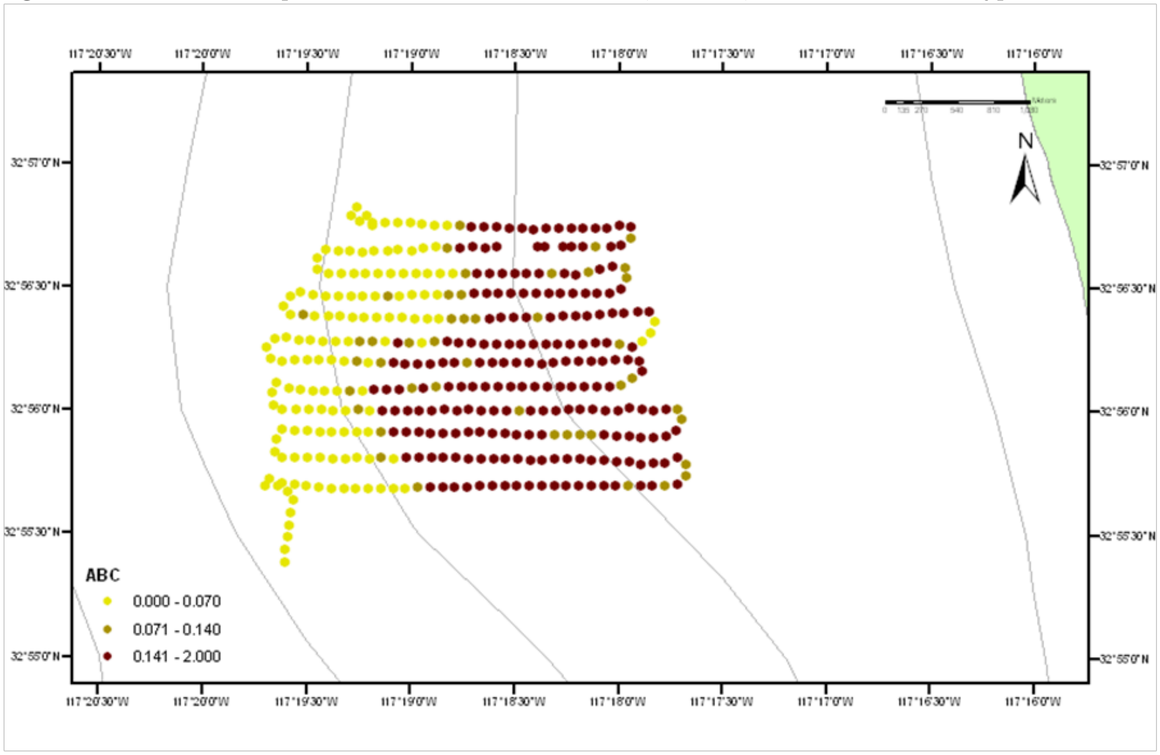


Figure 1.65. Del Mar Steeples 3-D image of bathymetry (m) and S_v of rockfishes (dB).

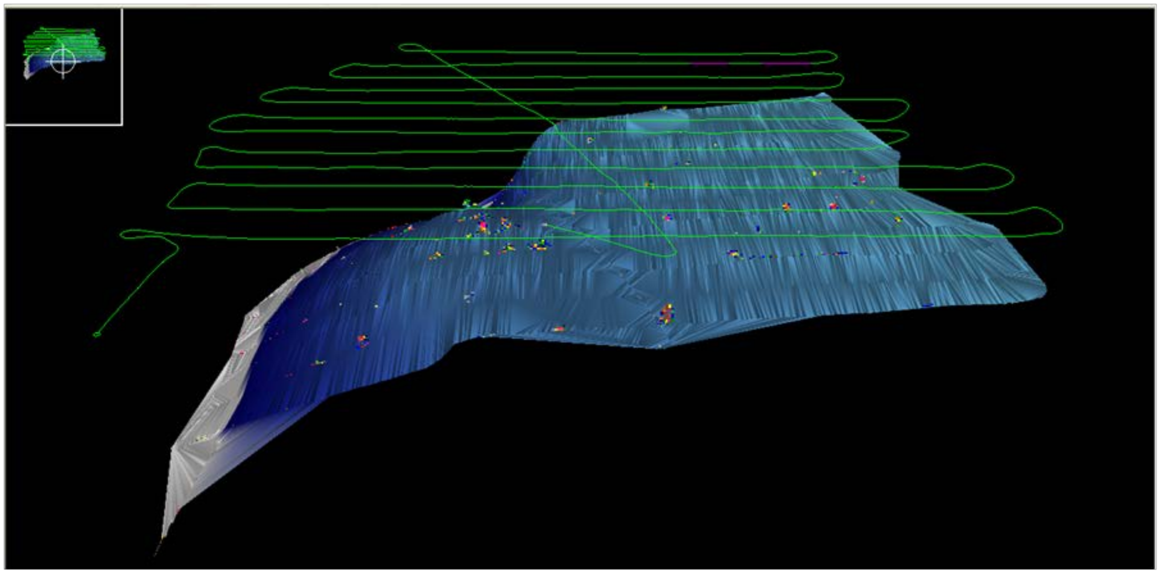


Figure 1.66. Northwest Catalina Island distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

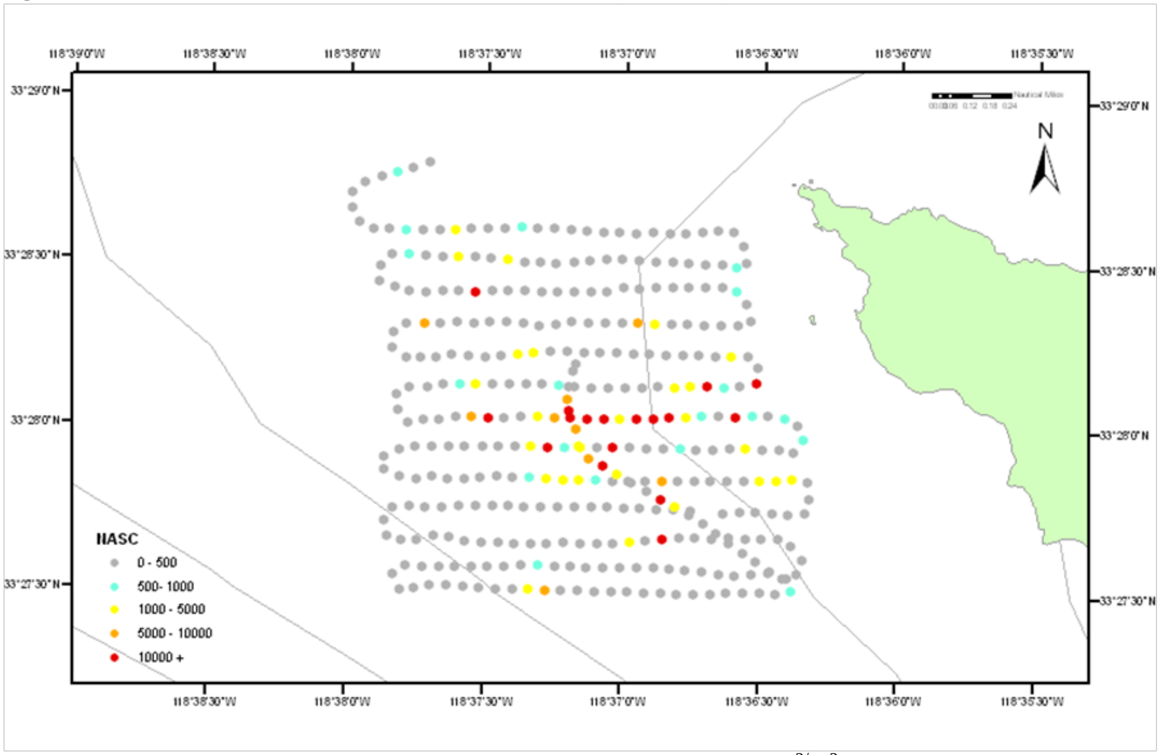


Figure 1.67. Northwest Catalina Island area backscatter coefficients (s_a; m^2/m^2) attributed to seabed type.

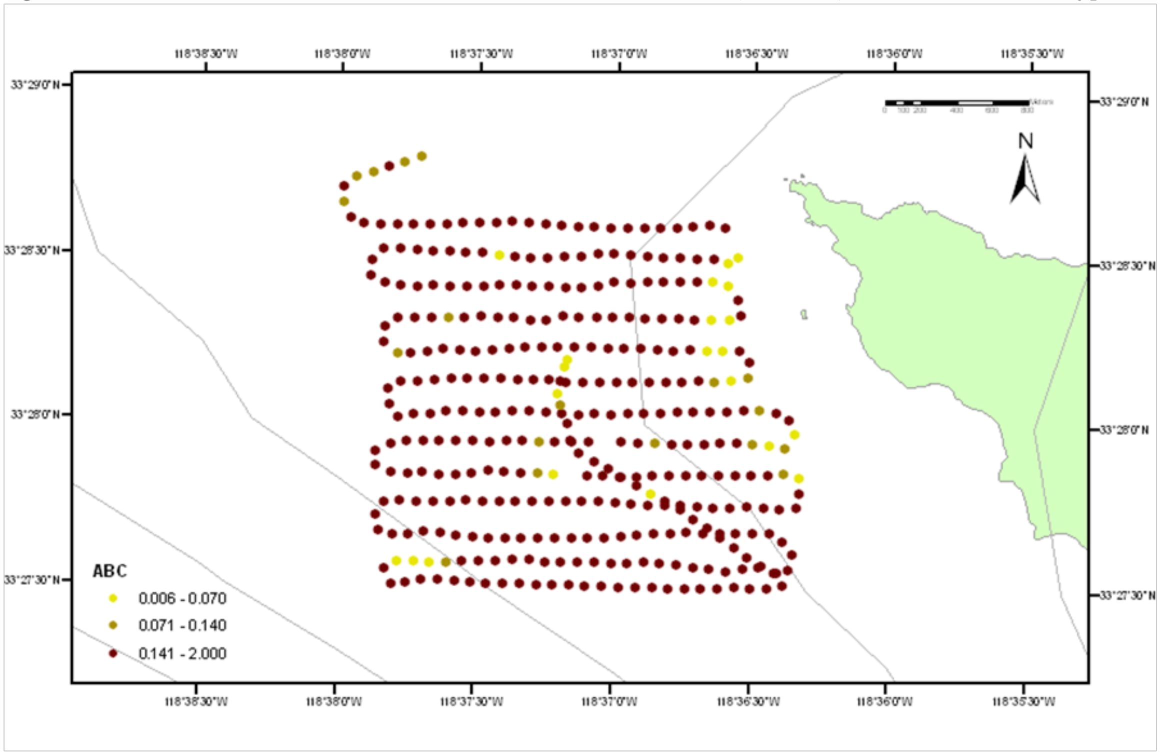


Figure 1.68. Northwest Catalina Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

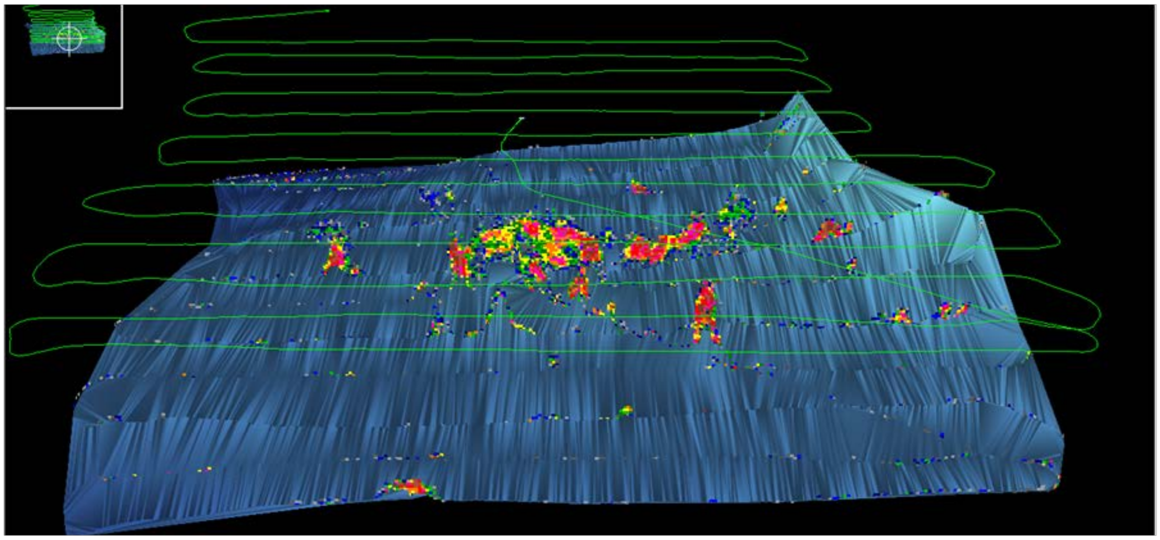


Figure 1.69. Farnsworth Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

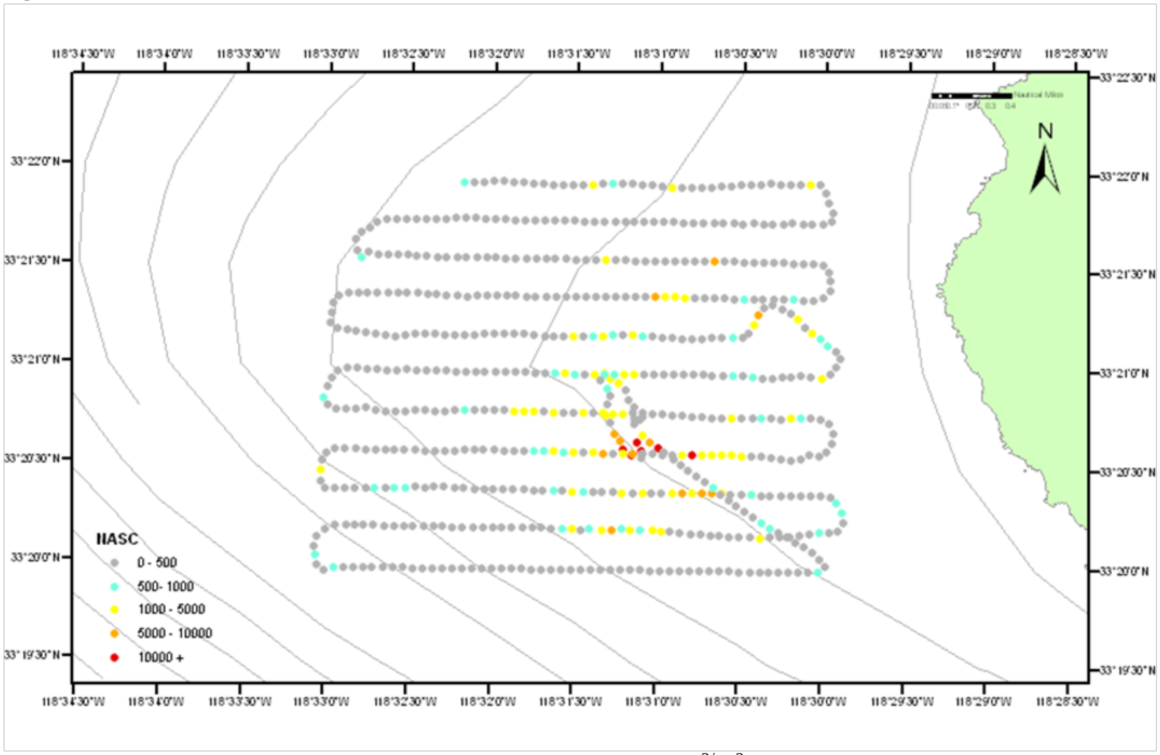


Figure 1.70. Farnsworth Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

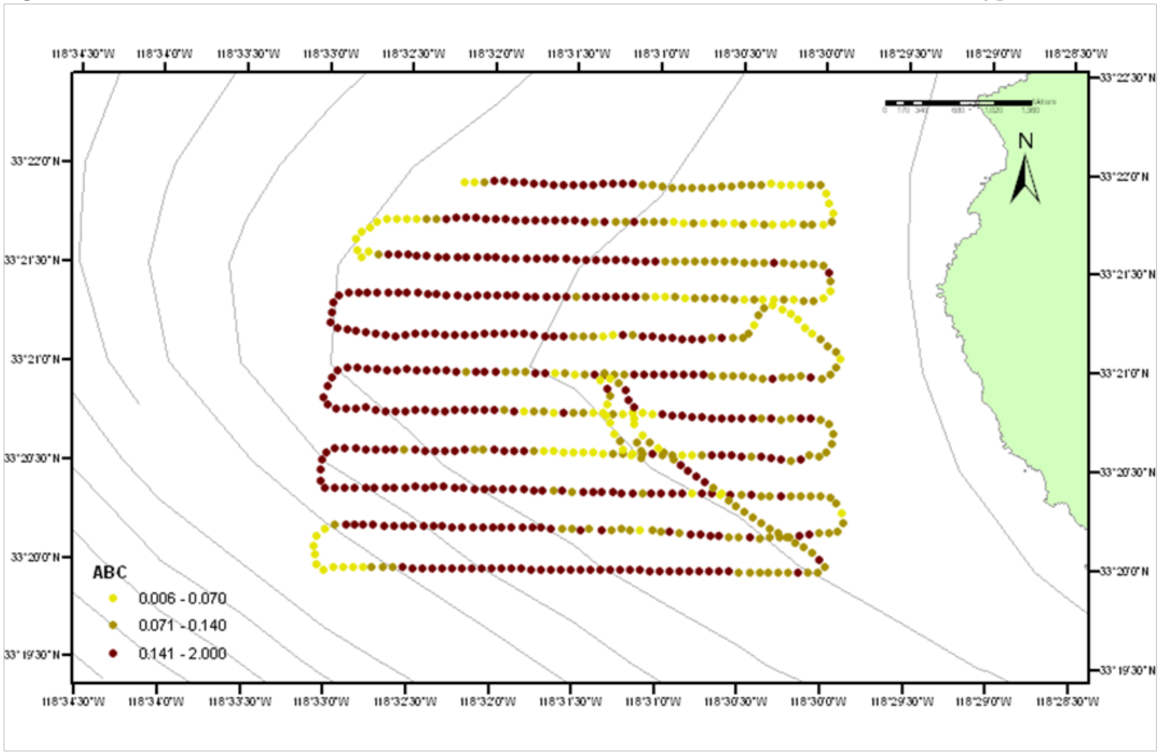


Figure 1.71. Farnsworth Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

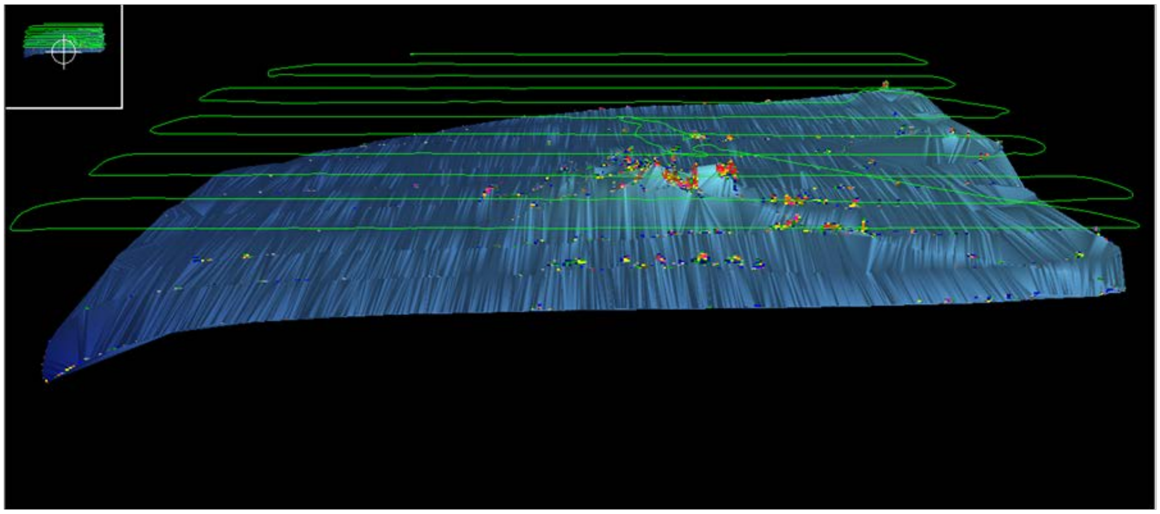


Figure 1.72. West San Clemente Island and 57 Fathom Bank distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

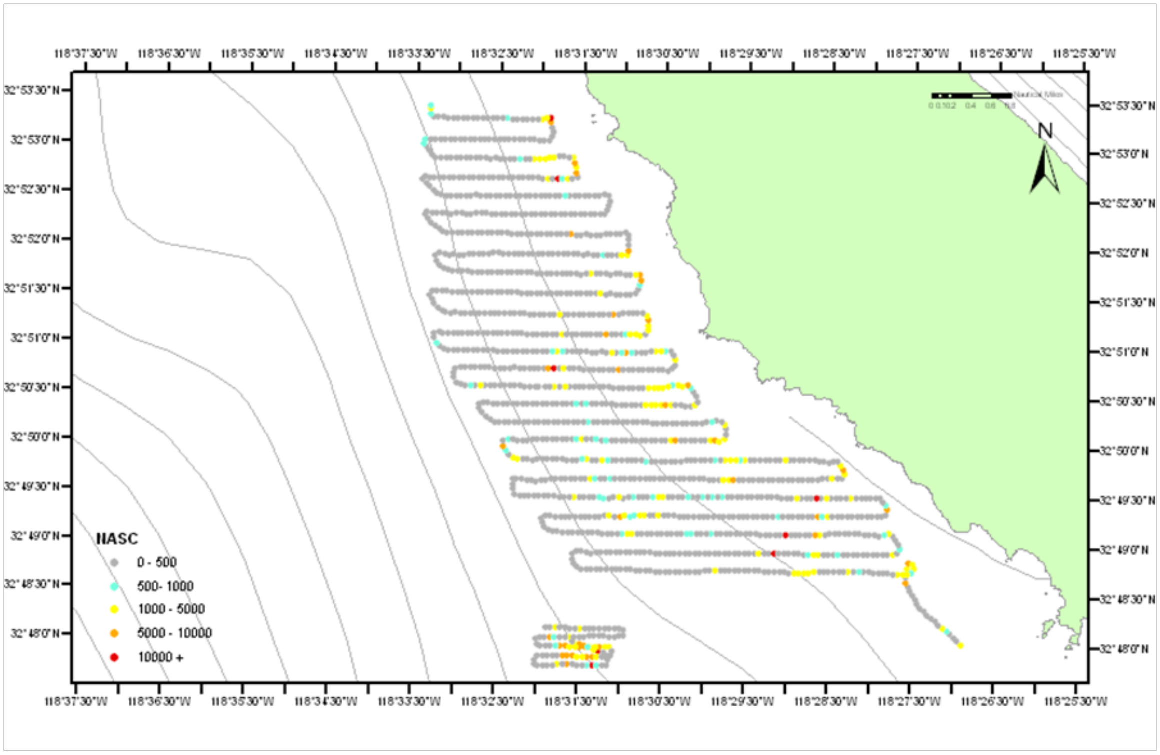


Figure 1.73. West San Clemente Island and 57 Fathom Bank area backscatter coefficients (s_a; m^2/m^2) attributed to seabed type.

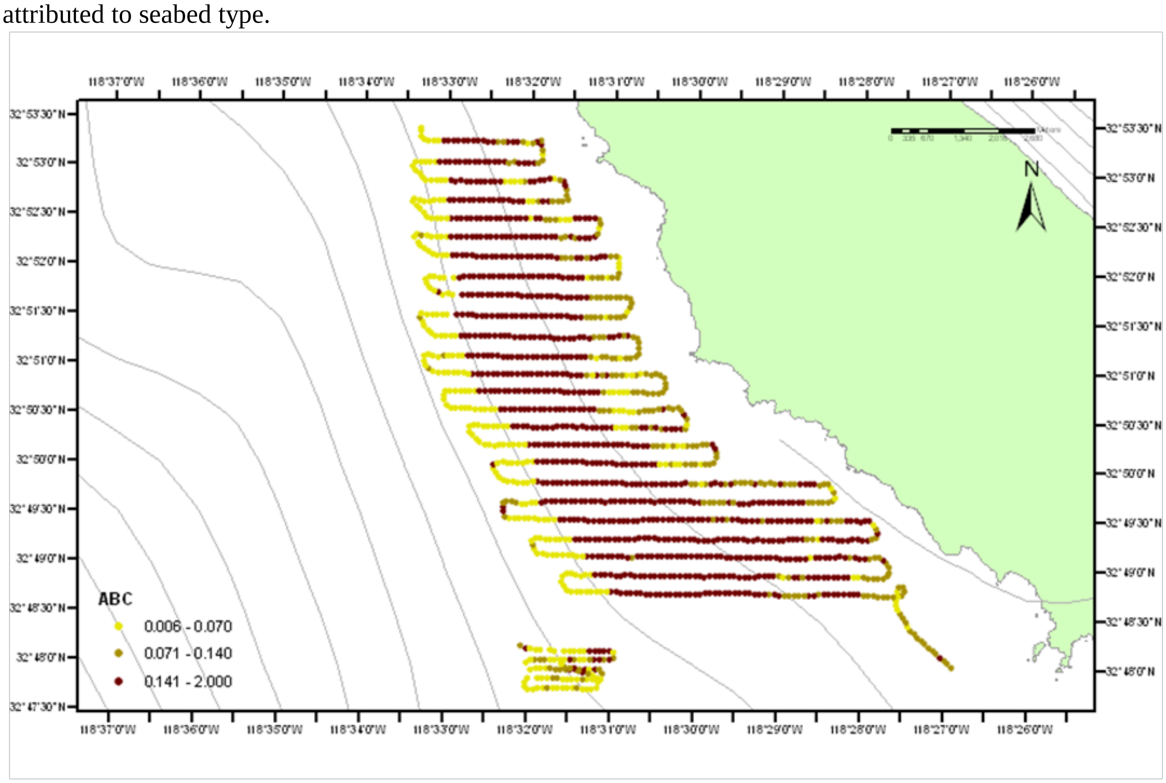


Figure 1.74. West San Clemente Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

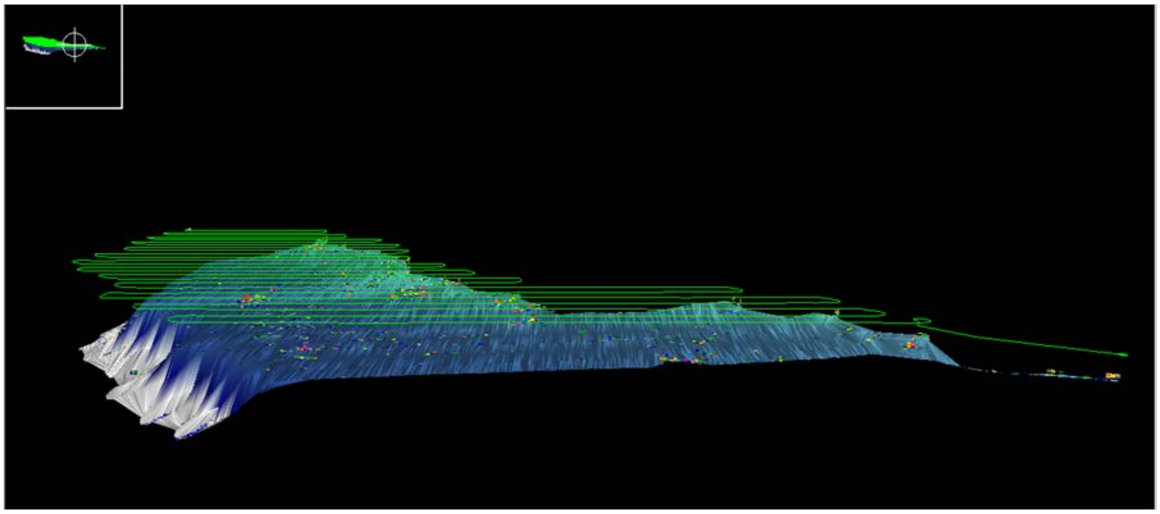


Figure 1.75. 57 Fathom Reef 3-D image of bathymetry (m) and S_v of rockfishes (dB). View is southward.

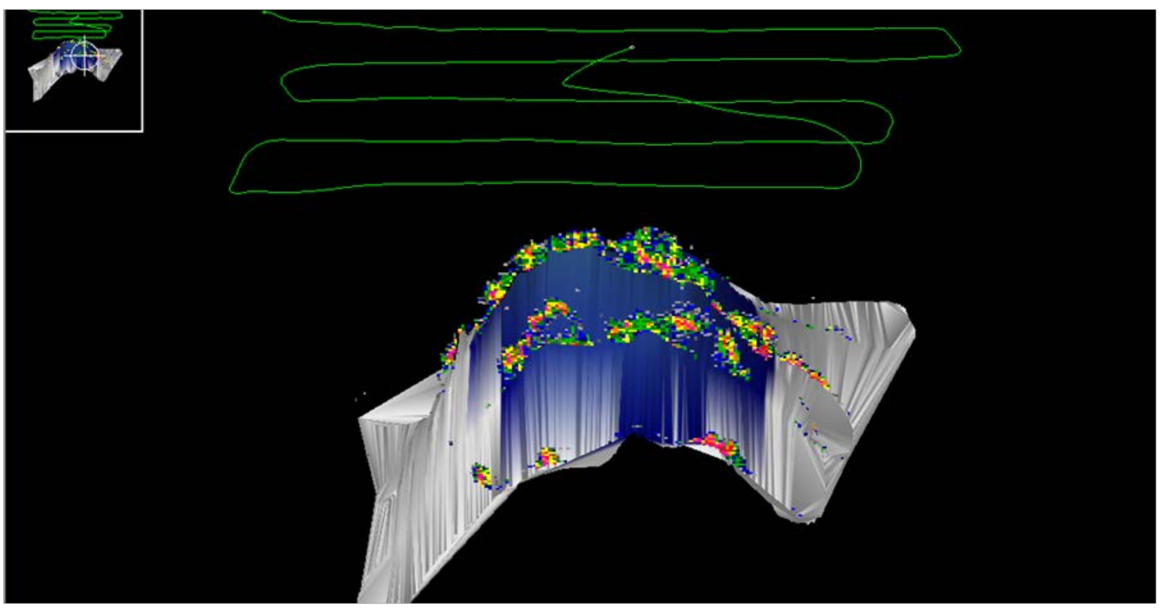


Figure 1.76. North and Northwest San Clemente Island distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

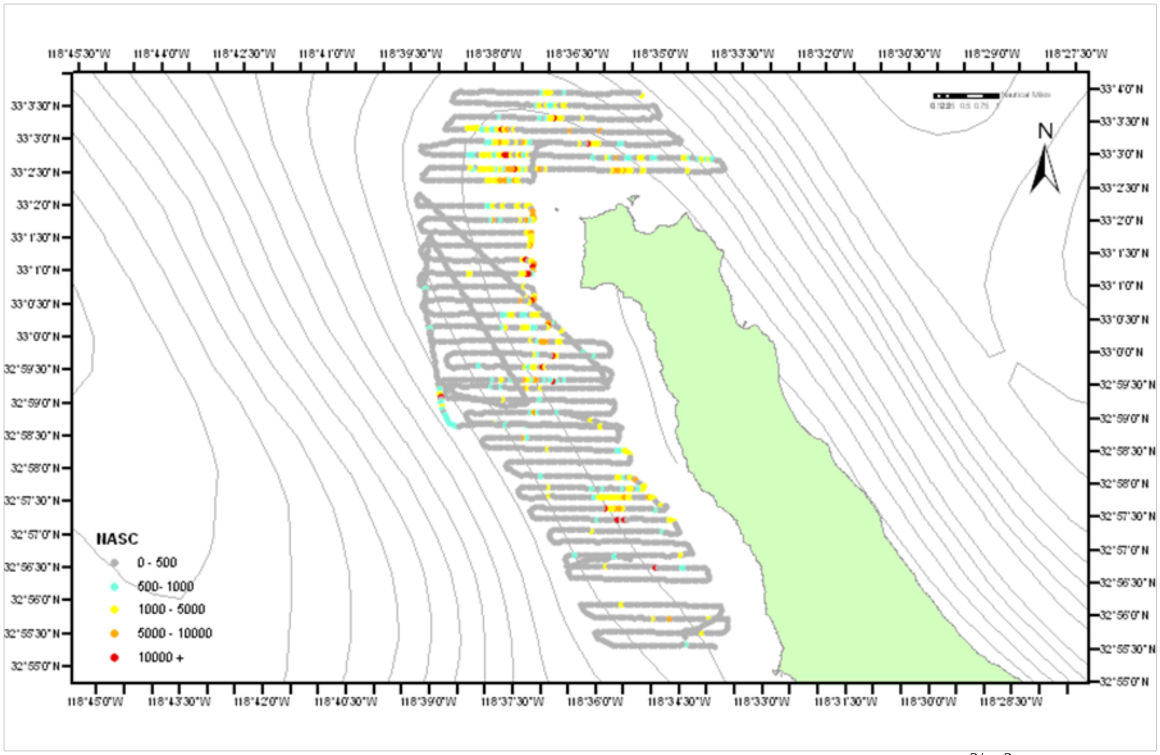


Figure 1.77. North and Northwest San Clemente Island area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

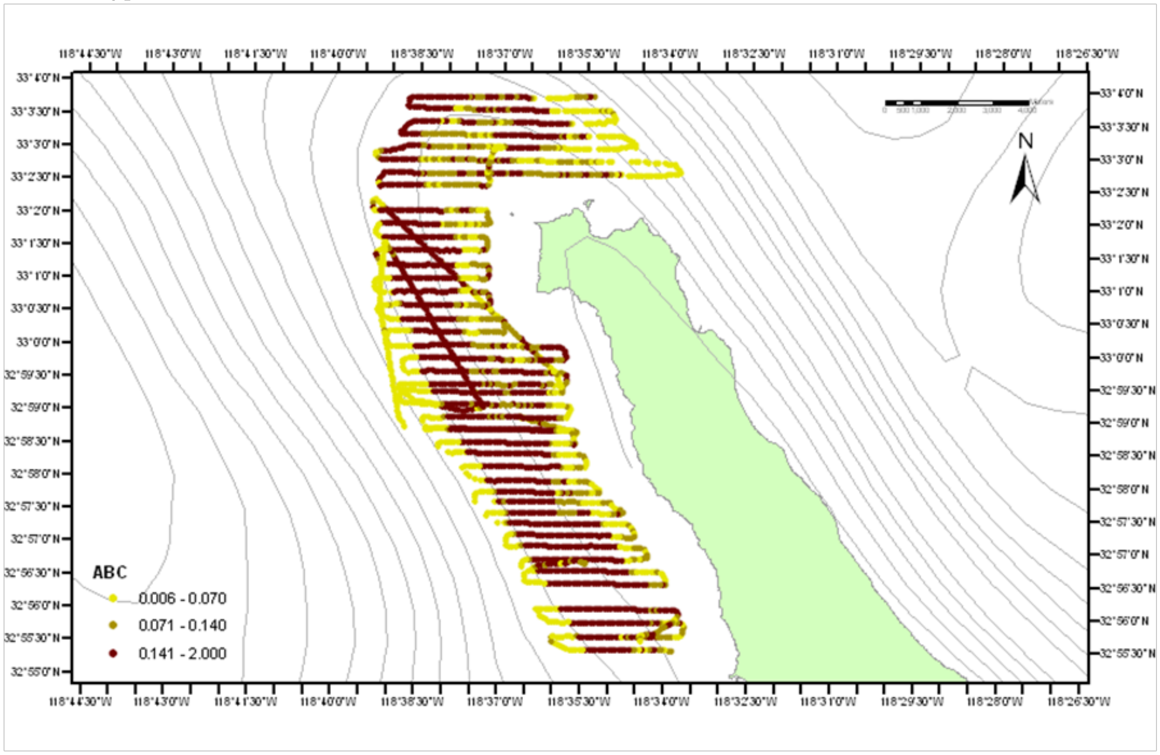


Figure 1.78. North San Clemente Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

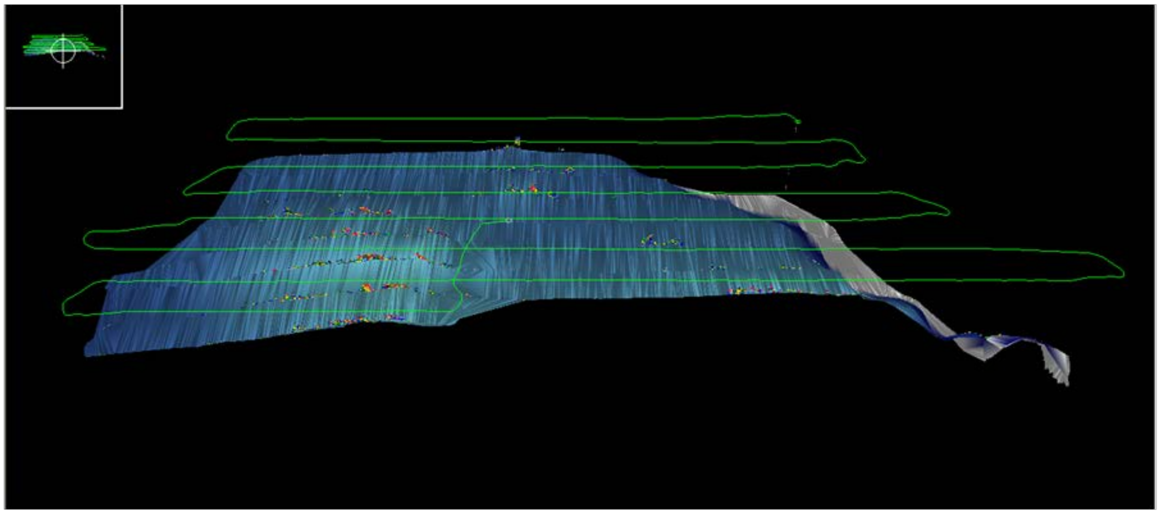


Figure 1.79. Northwest San Clemente Island 3-D image of bathymetry (m) and S_v of rockfishes (dB).

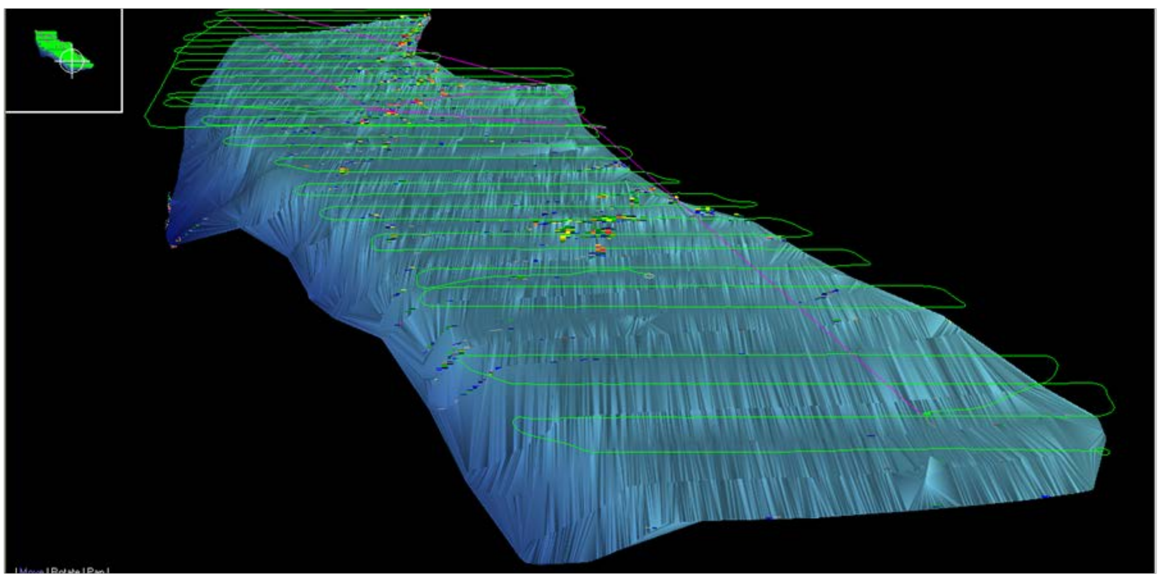


Figure 1.80. China Point Reef, 86 and 81 Fathom Banks distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

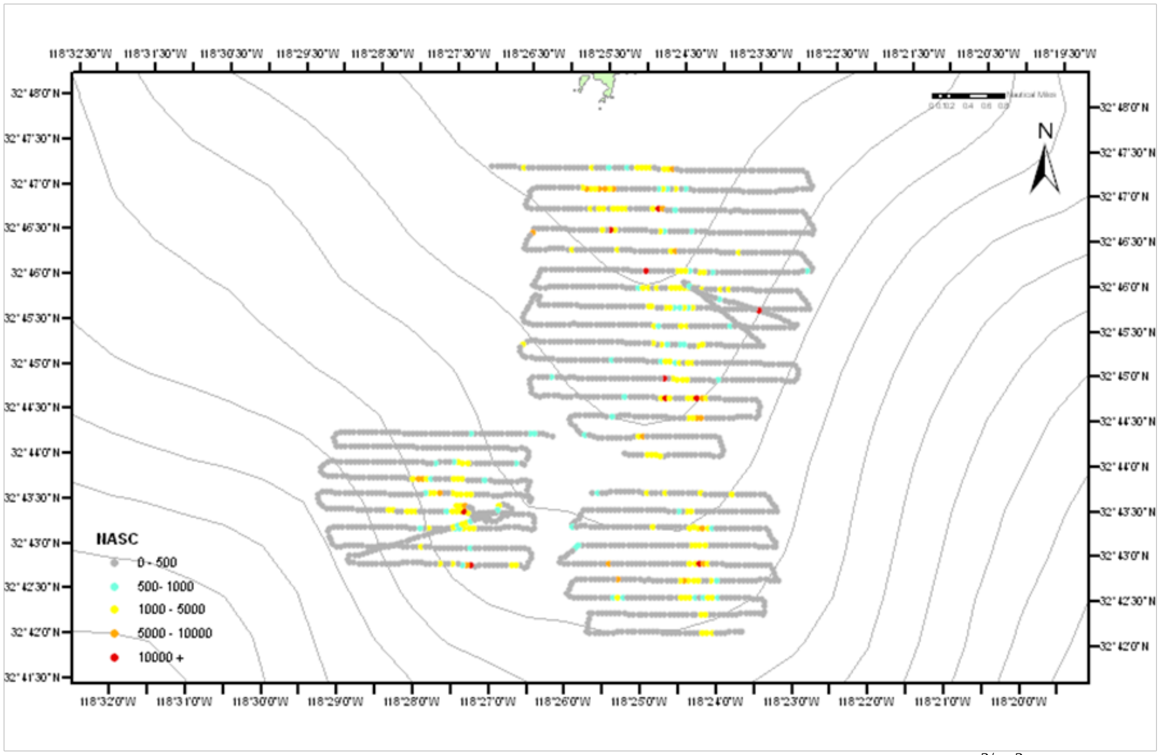


Figure 1.81. China Point Reef, 86 and 81 Fathom Banks area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

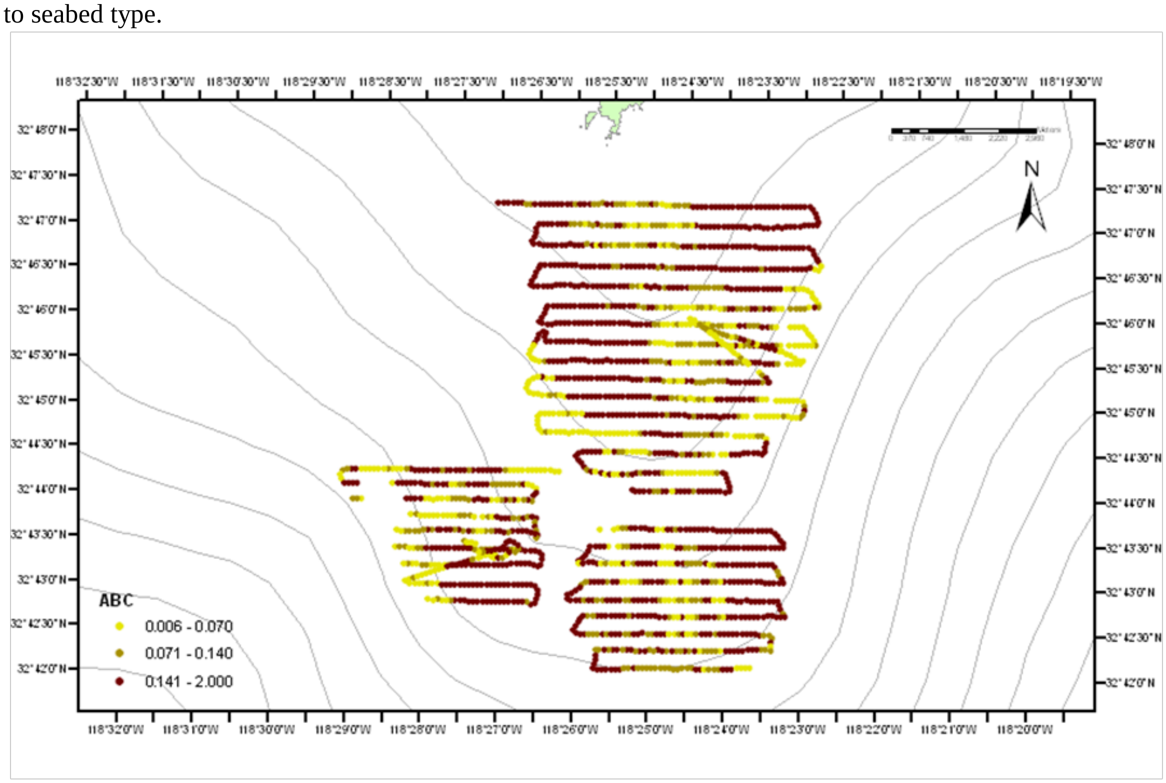


Figure 1.82. China Point Reef 3-D image of bathymetry (m) and S_v of rockfishes (dB).

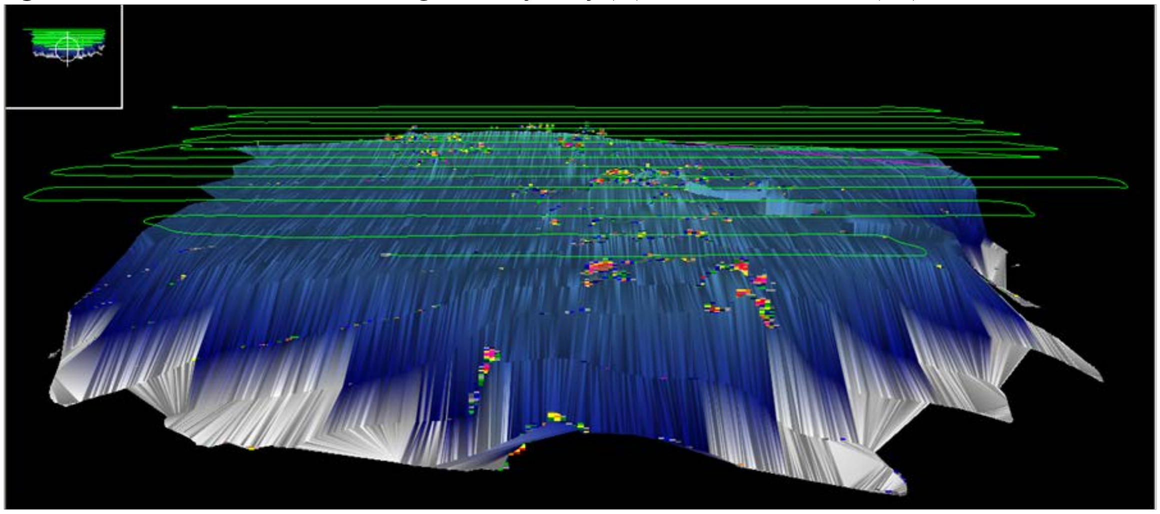


Figure 1.83. 86 Fathom Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

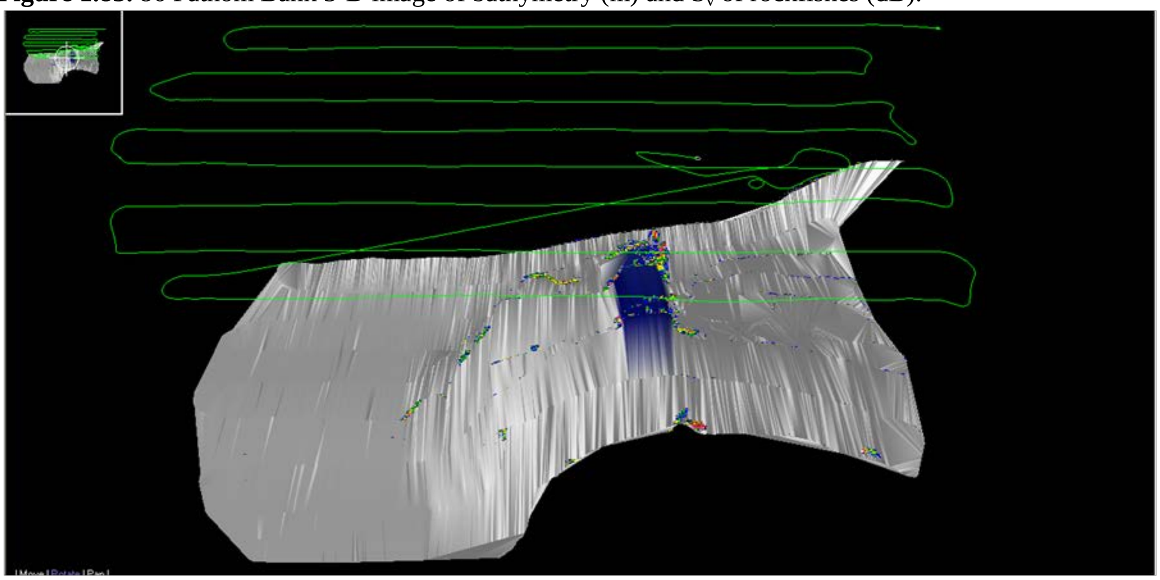


Figure 1.84. 81 Fathom Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

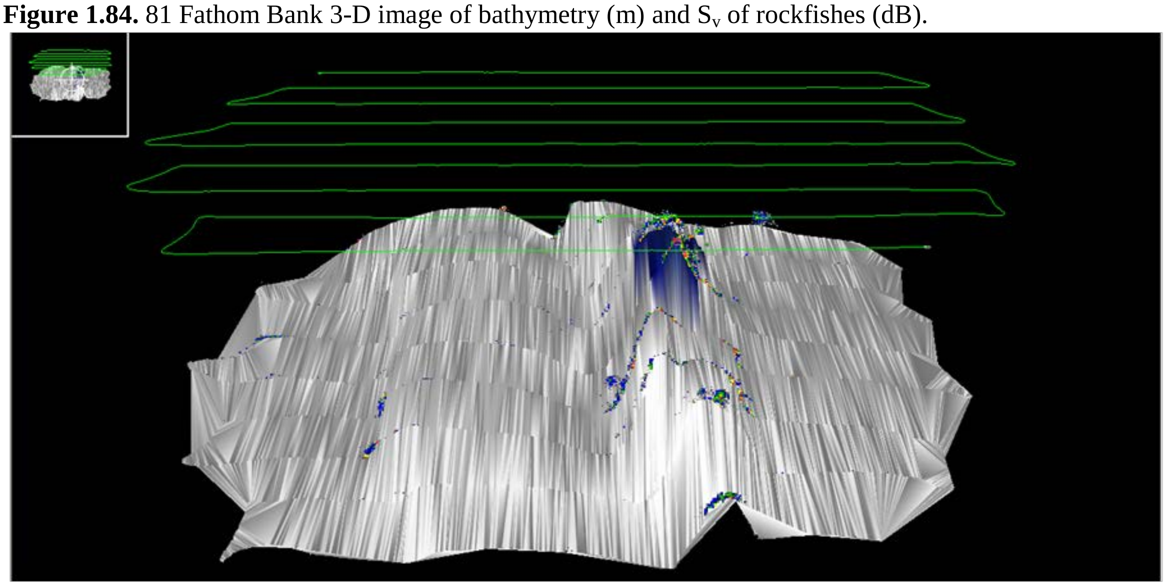


Figure 1.85. 60 Mile Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

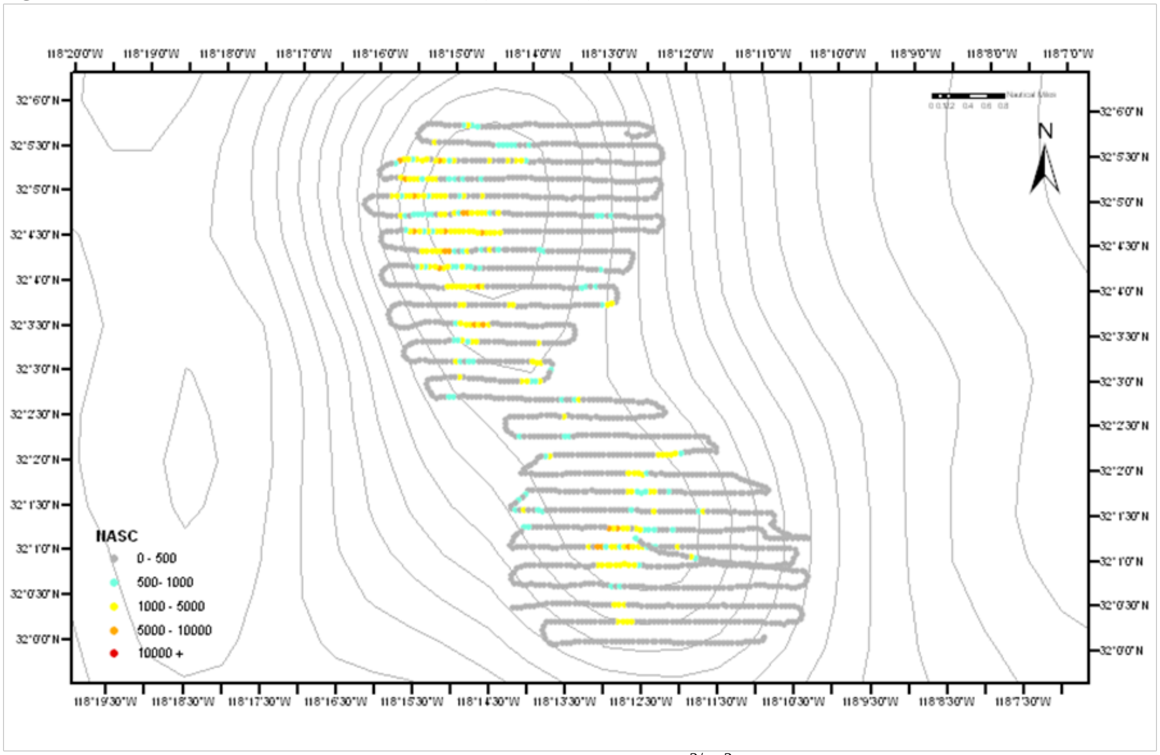


Figure 1.86. 60 Mile Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type. Note: the seabed classification of the southern end of the bank is incompletely mapped because the depth was greater than the recorded depth, 500 m.

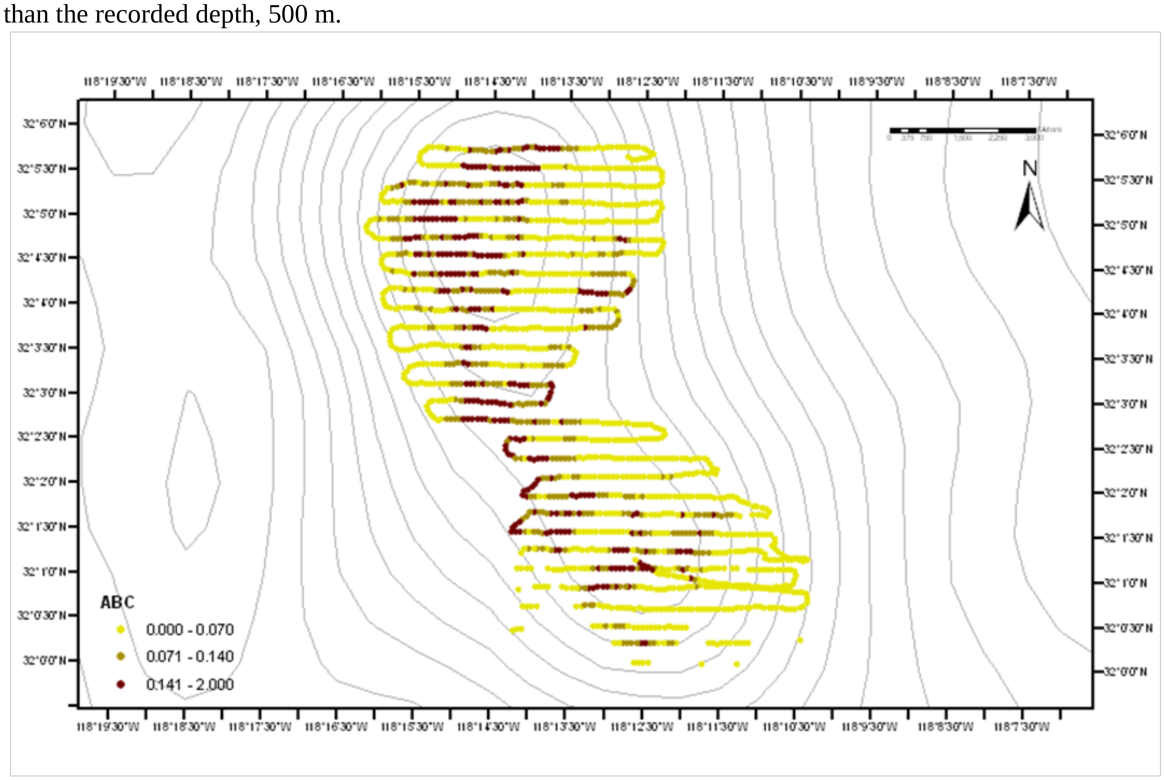


Figure 1.87. 60 Mile Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

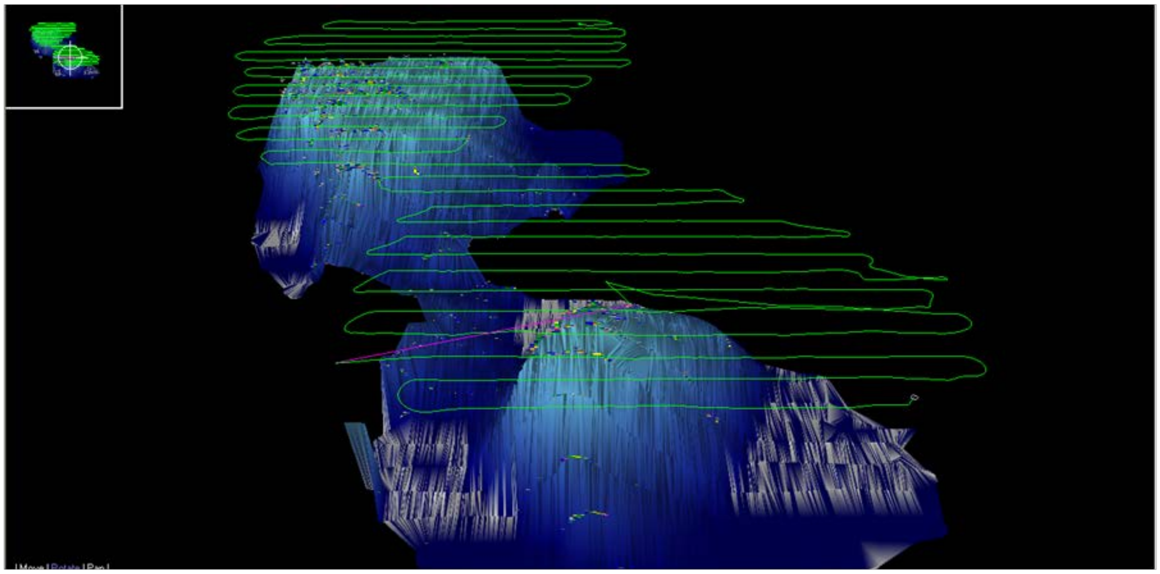


Figure 1.88. Kidney Bank distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

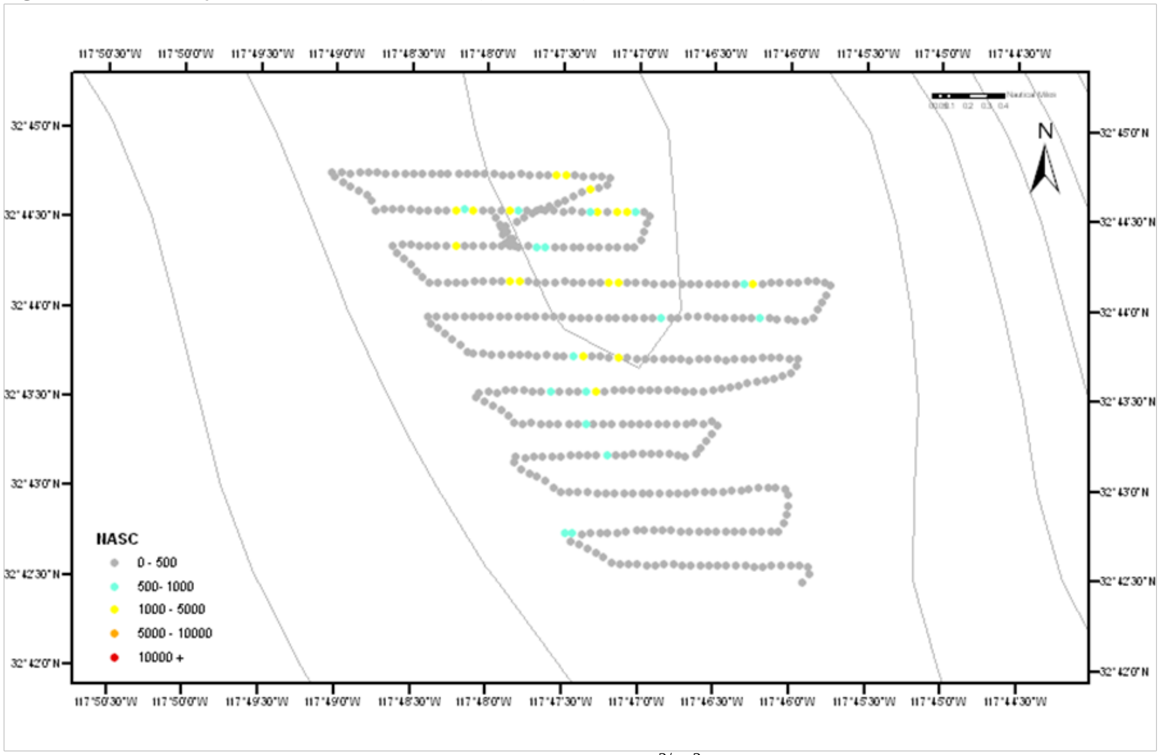


Figure 1.89. Kidney Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

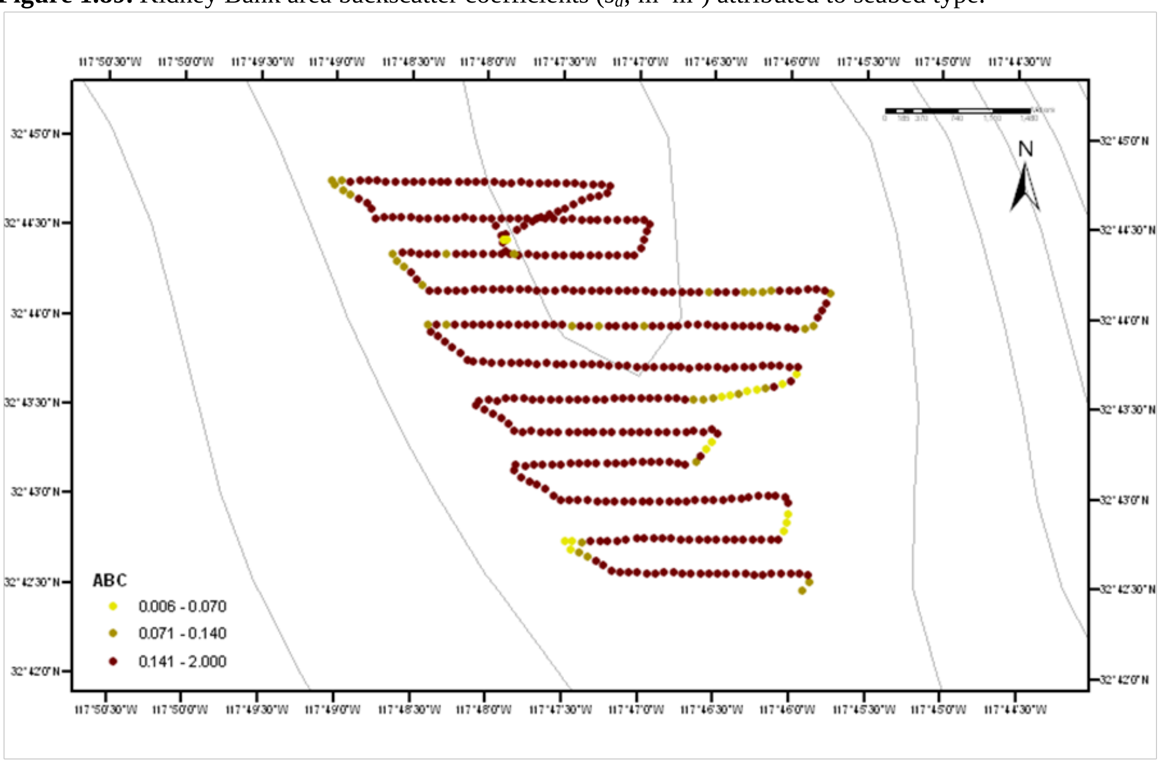


Figure 1.90. Kidney Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

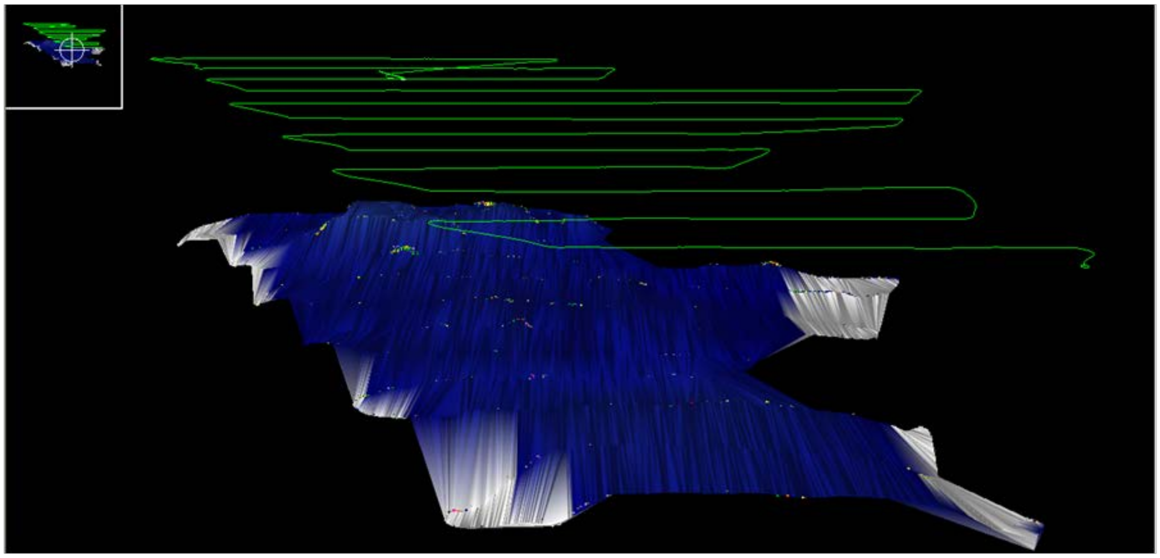


Figure 1.91. Mission Beach Reef distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

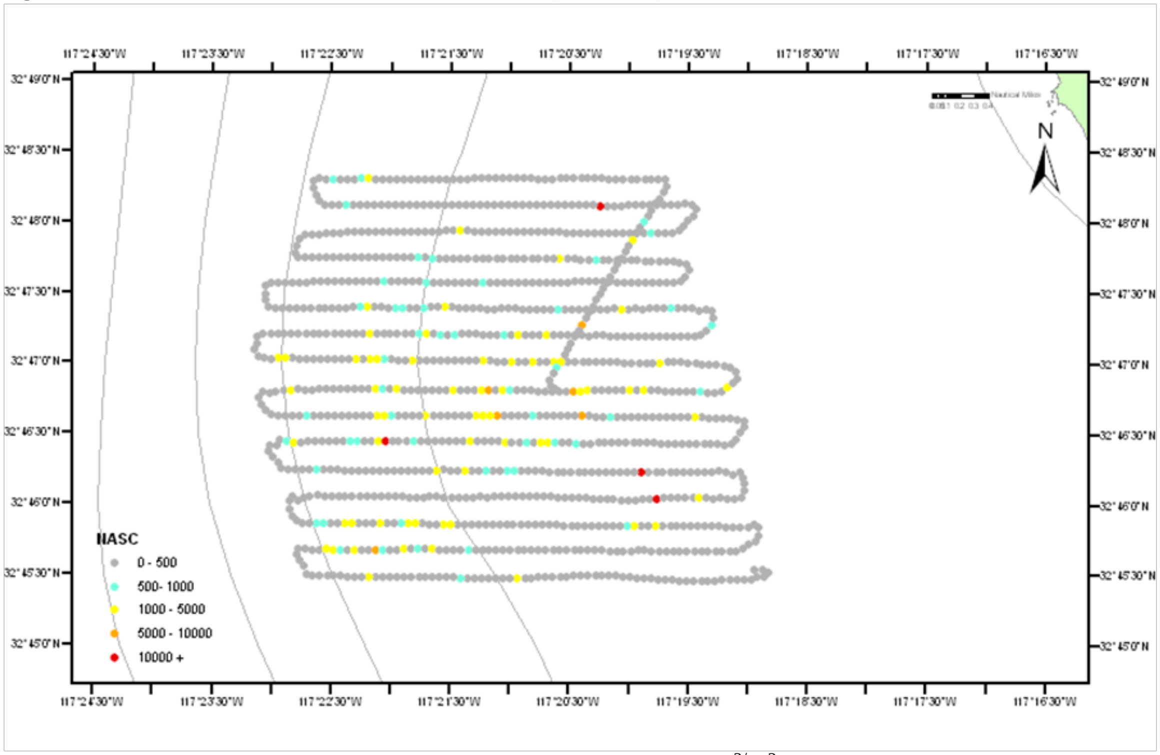


Figure 1.92. Mission Beach Reef area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

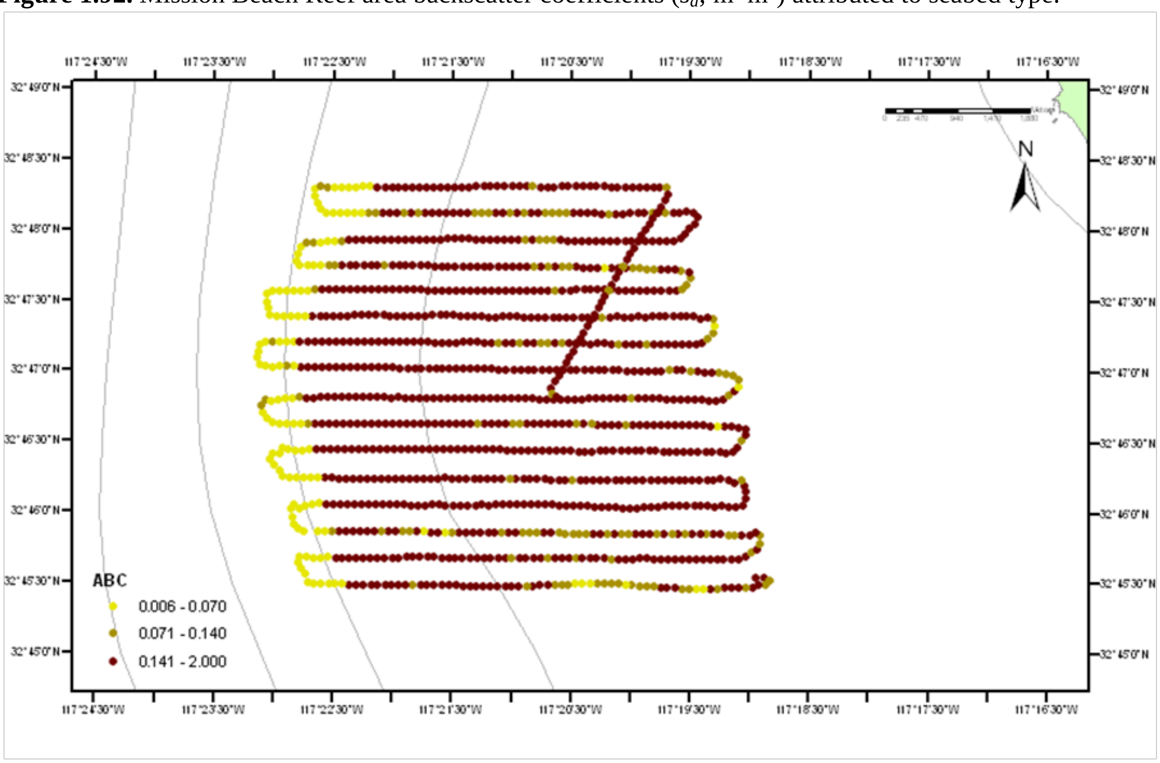


Figure 1.93. Mission Beach Reef 3-D image of bathymetry (m) and S_v of rockfishes (dB).

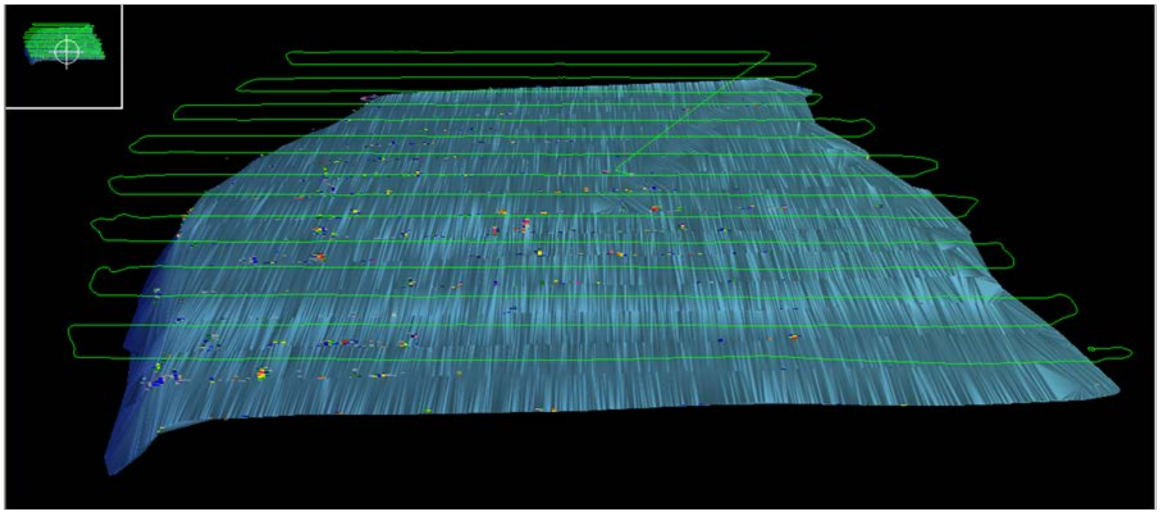


Figure 1.94. Nine Mile Bank distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

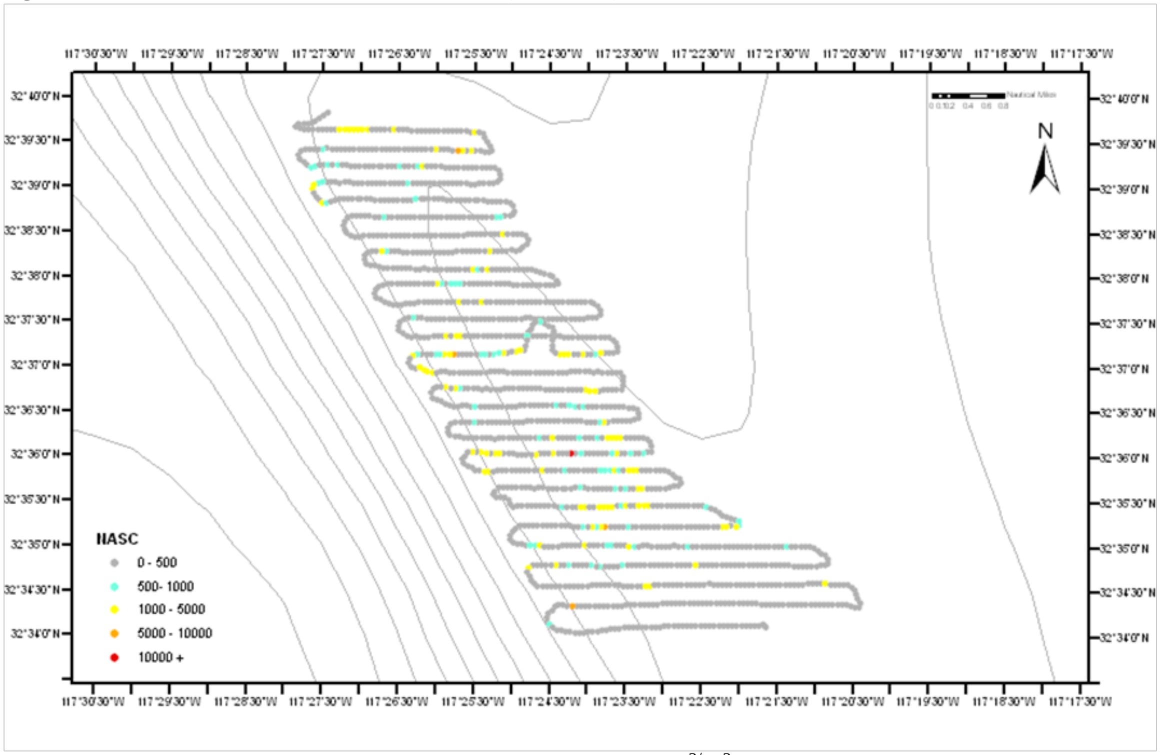


Figure 1.95. Nine Mile Bank area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

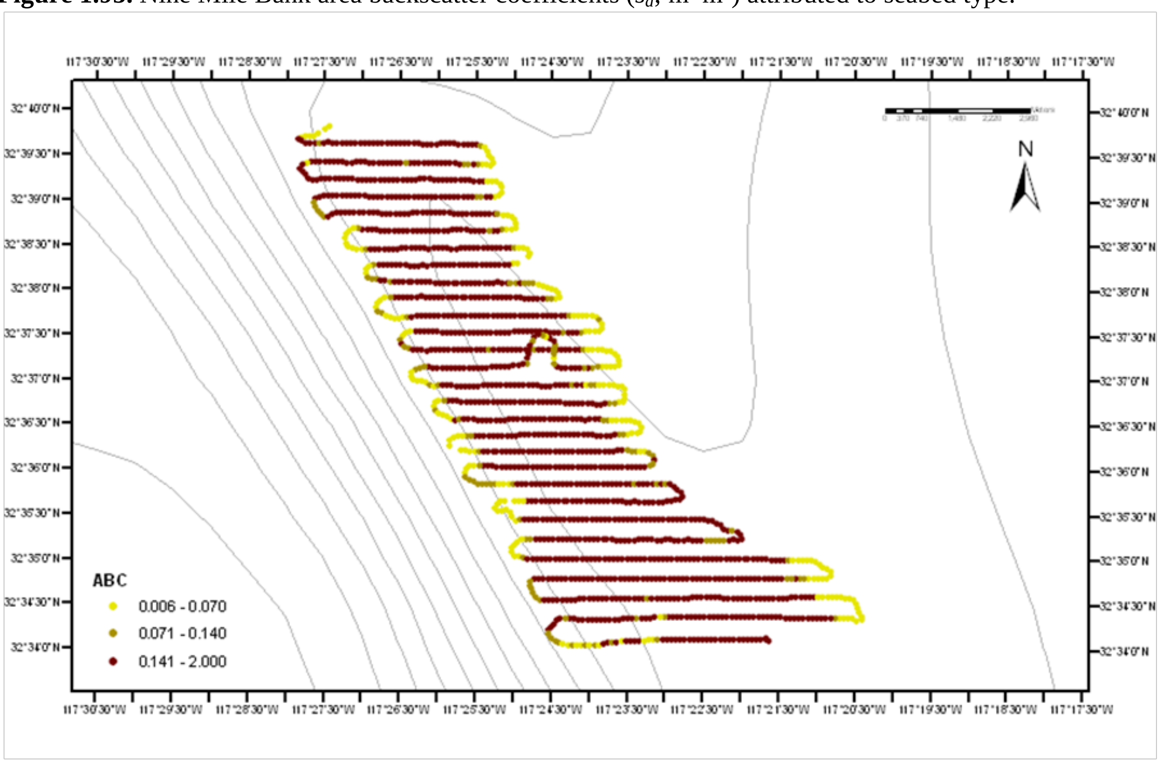


Figure 1.96. Nine Mile Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).

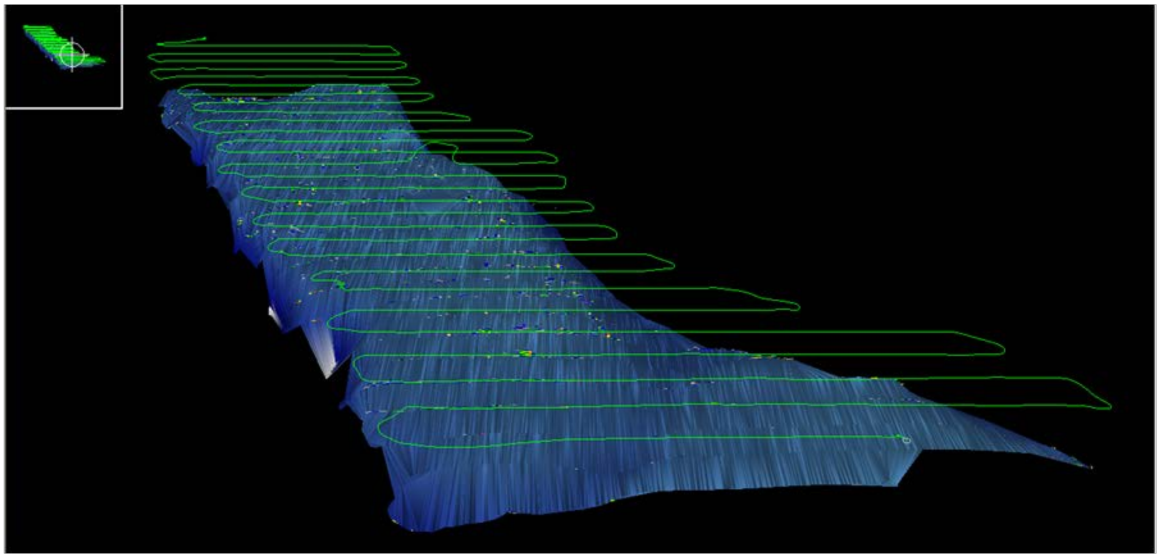


Figure 1.97. Lasuen Knoll distribution of s_A (m^2/n.mi.^{2}) attributed to rockfishes.

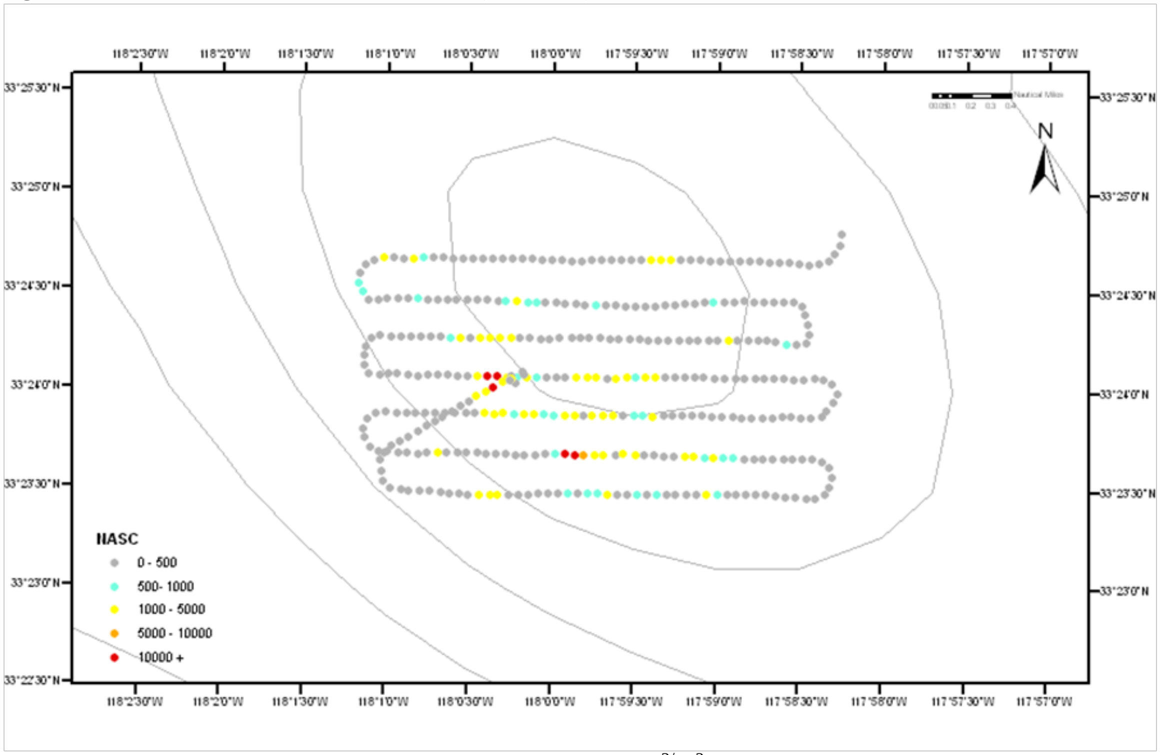


Figure 1.98. Lasuen Knoll area backscatter coefficients (s_a; $m^{2/}m^2$) attributed to seabed type.

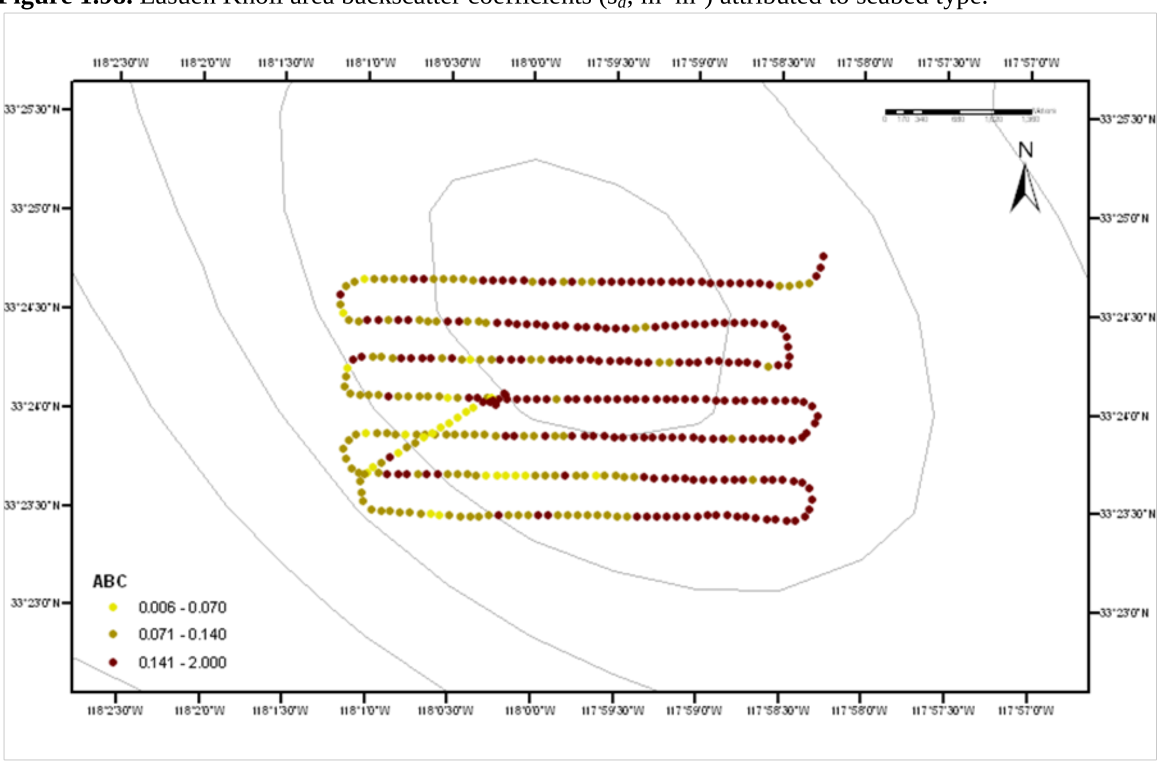


Figure 1.99. Lasuen Knoll 3-D image of bathymetry (m) and S_v of rockfishes (dB).

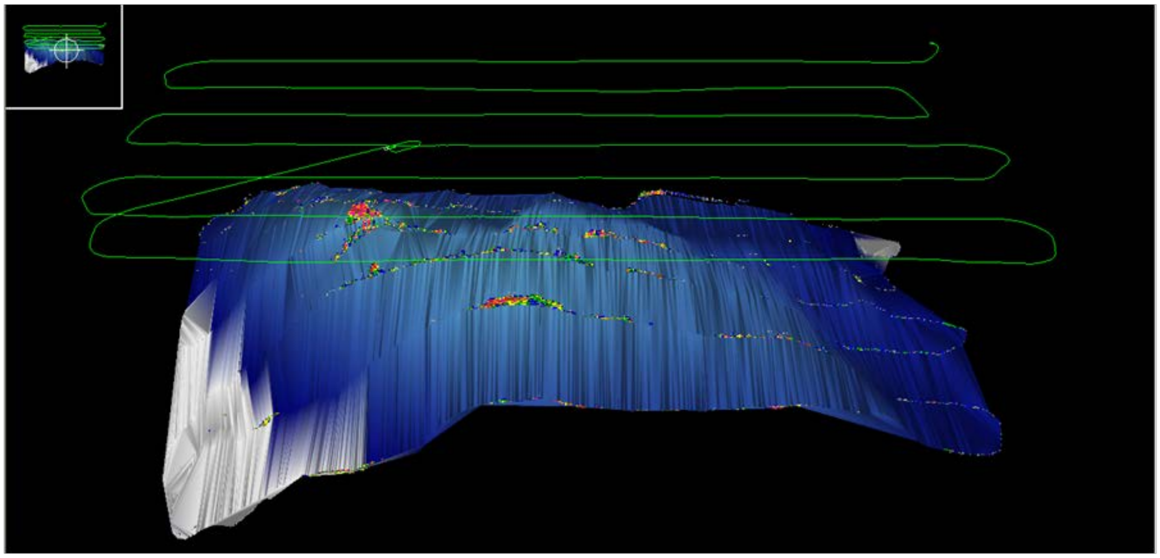


Figure 1.100. 43 Fathom Bank distribution of s_A ($m^2/n.mi.^2$) attributed to rockfishes.

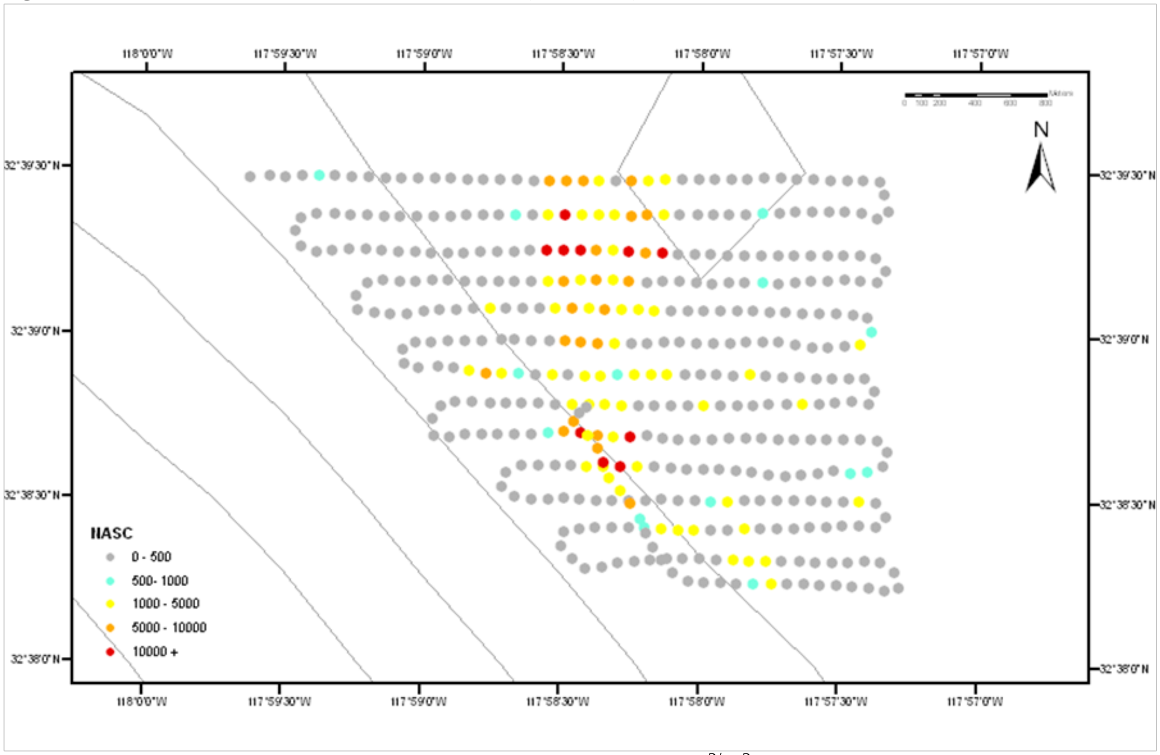


Figure 1.101. 43 Fathom Bank area backscatter coefficients (s_a; m^{2}/m^2) attributed to seabed type.

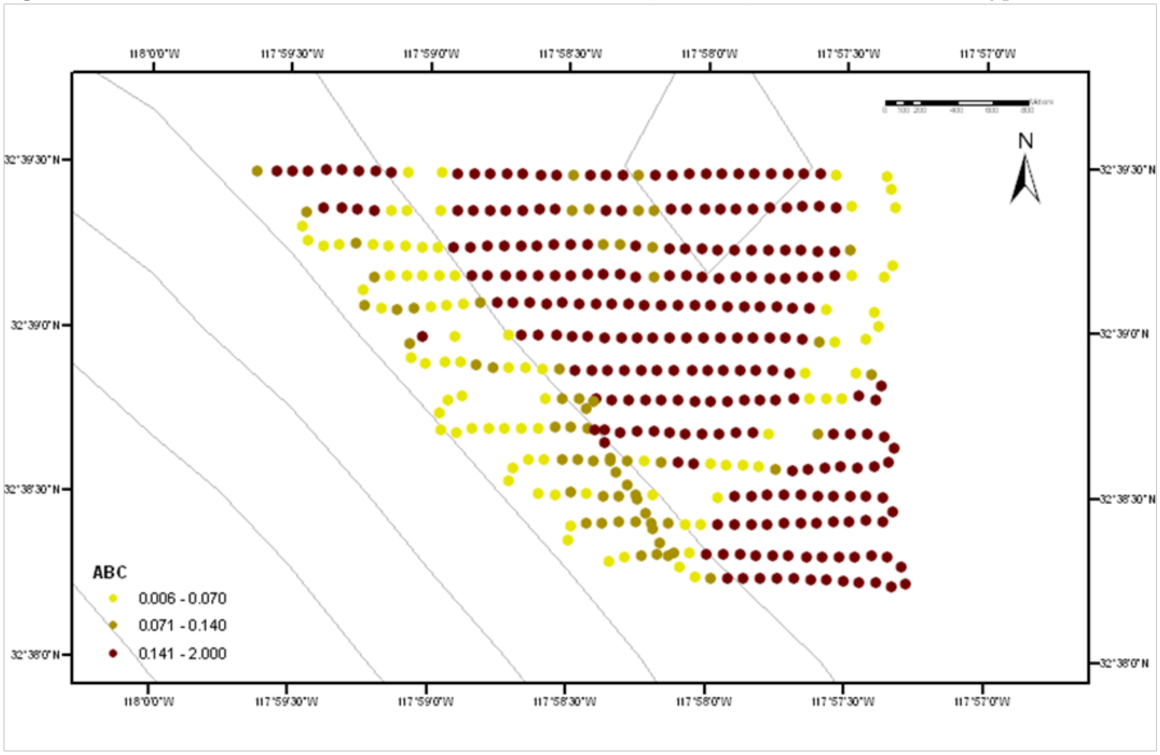
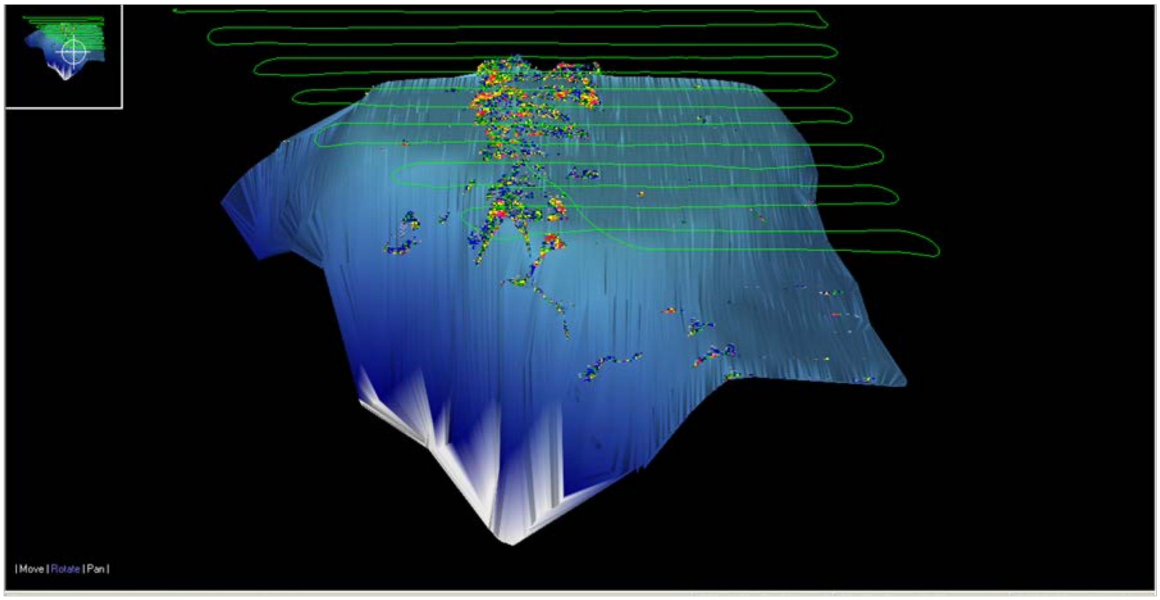


Figure 1.102. 43 Fathom Bank 3-D image of bathymetry (m) and S_v of rockfishes (dB).



Target strength results: *TS* measurements were recorded for a single flag (*Sebastes rubrivinctus*) and two vermillion (*Sebastes miniatus*) rockfishes at Mission Beach Reef on 5 May 2005. Fish were captured on hook and line, identified on deck, and then submerged to 80 m depth using a weight below the hooked fish. The fish were gradually brought back to the surface as *TS* measurements were made at 18, 38, 70, 120 and 200 kHz. Total and fork lengths (*FL*) were measured upon the second retrieval.

Table 1.9. Mean target strength measurements versus fish length (*L*) and acoustic frequency (*f*), recorded on 5 May 2005 at Mission Beach Reef. The measurements were fit the following model using non-linear least squares fit (Matlab 9.0 CFTool GUI): *TS*=20*Log(*L*; m)-a*Log(1+Depth/10)-b.

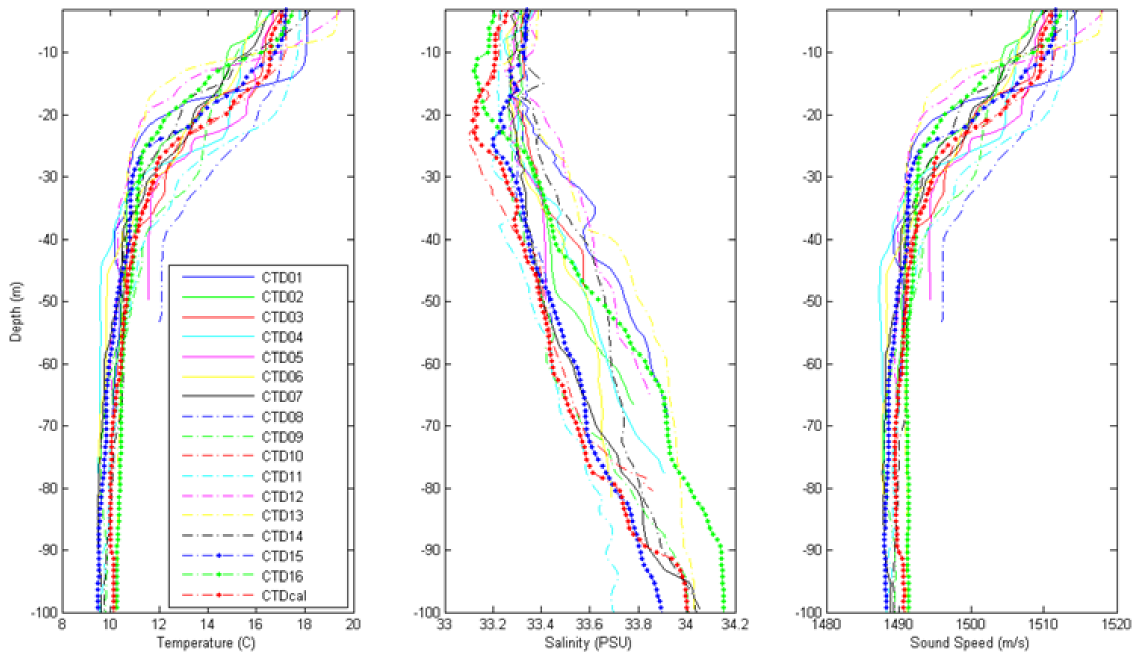
Fish	Species	*L* (cm)	*f* (kHz)	Mean *TS*	SD	n	a*	b*	R2	RMSE
1	Vermillion	40	18	-29.520	-28.38	103	1.851	12.40	0.01641	6.958
1	Vermillion	40	38	-27.982	-28.02	84	1.656	10.42	0.00549	5.471
1	Vermillion	40	70	-29.033	-28.35	116	2.305	10.71	0.01551	5.305
1	Vermillion	40	120	-29.468	-28.92	97	2.584	10.63	0.01992	4.780
1	Vermillion	40	200	-35.248	-34.22	155	1.959	17.08	0.01525	4.833
2	Flag	28	18	-32.327	-31.37	167	-0.075	9.89	0.00007	5.734
2	Flag	28	38	-31.986	-30.62	109	0.734	8.83	0.00192	5.438
2	Flag	28	70	-32.074	-29.47	167	-0.719	11.18	0.00222	5.850
2	Flag	28	120	-30.601	-28.80	123	-0.950	9.46	0.00419	5.169
2	Flag	28	200	-36.908	-34.29	253	-0.112	14.61	0.00010	4.937
3	Vermillion	48	18	-28.384	-25.44	189	0.963	17.29	0.00466	7.205
3	Vermillion	48	38	-28.120	-26.79	104	-3.678	23.68	0.09904	6.772
3	Vermillion	48	70	-32.074	-29.47	200	3.345	12.79	0.05865	5.707
3	Vermillion	48	120	-27.937	-26.41	139	2.744	12.17	0.04873	4.960
3	Vermillion	48	200	-33.895	-32.57	238	3.367	17.04	0.08268	4.647

<u>CTD Results:</u> CTD profiles of the nearshore sites demonstrated higher surface temperatures and more pronounced thermoclines compared to the offshore areas or the sites on the west side of the Channel Islands.

Table 1.10. CTD casts during OL0505.

	Location	Date	Lat	Lon	Maximum Depth (m)
1	Del Mar Steeples	110505	32º 55.822'N	117º 18.593'W	68
2	Northwest Catalina Island	110505	32º 28.071'N	118º 37.201'W	67
3	Farnsworth Bank	110505	32º 20.708'N	118º 31.143'W	48
4	Northwest and West San Clemente Island	130505	32º 55.678'N	118º 34.404'W	72
5	North San Clemente Island	140505	33º 03.038'N	118º 37.152'W	50
6	Northwest San Clemente Island	140505	32º 59.097'N	118º 37.381'W	81
7	57 Fathom Bank	140505	32º 48.008'N	118º 31.556'W	111
8	China Point Reef	150505	32º 45.979'N	118º 24.462'W	54
9	SCI 86 and 81Fathom Banks	150505	32º 43.490'N	118º 27.419'W	117
10	60 Mile Bank	190505	31º 01.148'N	118º 12.552'W	80
11	Kidney Bank	200505	32º 44.474'N	117º 47.934'W	130
12	Mission Beach Reef	240505	32º 46.823'N	117º 20.642'W	66
13	Nine Mile Bank	250505	32º 34.144'N	117º 21.661'W	112
14	Lasuen Knoll	250505	33º 24.039'N	118º 00.270'W	120
15	Northwest San Clemente Island (repeated)	260505	32º 56.793'N	118º 35.481'W	101
16	43 Fathom Bank	260505	32º 38.738'N	117º 58.457'W	104

Figure 1.103. Processed CTD down-cast profiles for OL0505.



Estimates of rockfish distributions and abundances: Coastal pelagic species are generally epipelagic (e.g. located within c. 70 m of the sea-surface) and rockfish are generally demersal (e.g. located within c. 30 m of the seabed). In this case, the volume backscattering coefficients (s_V) in the filtered 38 kHz echogram within 30 m of the seafloor were considered to be from rockfishes and their s_V values were integrated over that depth range and averaged over 0.05 n.mi (92.6 m) trackline distances. The integration range above the seabed was modified in a few instances to reject scatter from pelagic schools that extended closer than 30 m to the seabed, or include scatter from a demersal aggregation that extended higher into the water column.

The integrated s_V (s_A; m^2 $n.mi.^{-2}$) was then apportioned to the various species present within each of the 39 areas using the optically estimated proportions of each species. For seven areas (86 Fathom Bank, Anacapa Pass, North San Miguel Island, North San Nicolas Island, Northeast San Miguel Island, Northwest San Clemente Island, and South Cortes Spawning Grounds), there were no optical measurements; in these cases, the s_A values were apportioned using the proportions of species from the closest sites with ROV samples.

Figure 1.104. Preliminary acoustic-optical estimates of rockfish densities in 45 sites in the Southern California Bight during 2004/5.

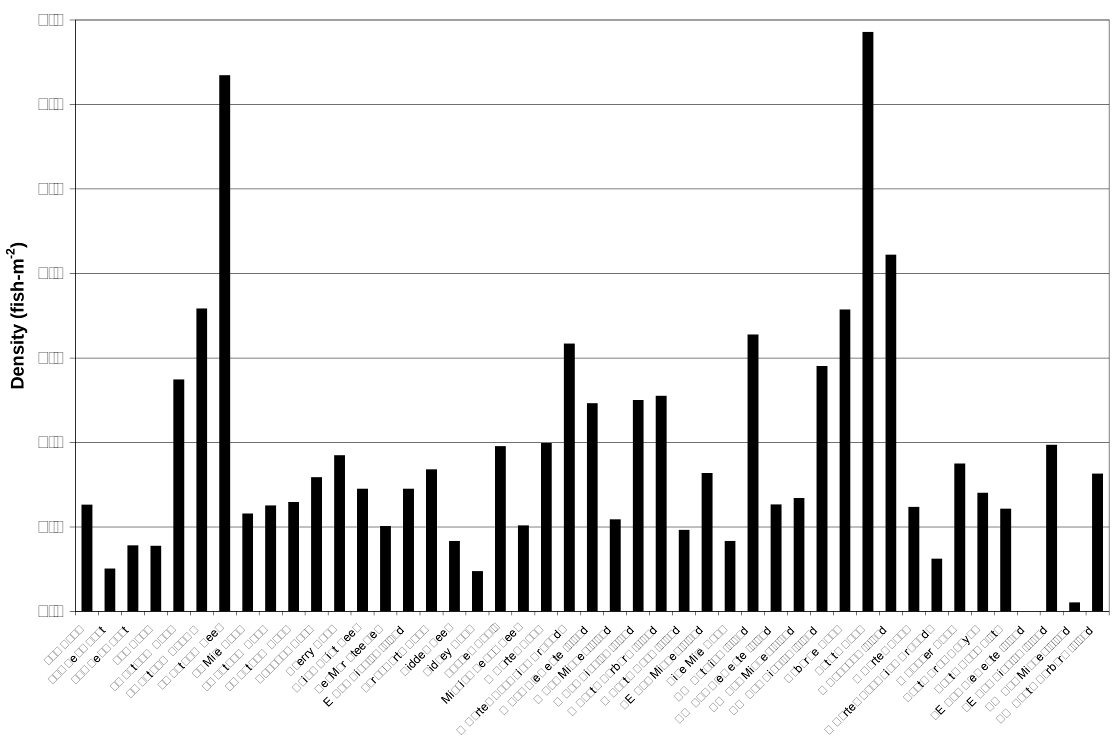


Table 1.11. Preliminary estimates of rockfish densities and numbers for each of 44 survey areas throughout the Southern California Bight. The 43 Fathom Bank was surveyed at the beginning of Leg I and end of Leg III for comparison.

Survey_Area	Mean_NASC ($m^2/n.mi.^2$)	ESDUs (0.05 n.mi.)	Distance (n.mi.)	Area ($n.mi^2$)	Number of fish	Density ($fish/m^2$)
107 Bank	367.1	476	24	5	4096474	0.25091
109 Seamount	146	346	17	3	1183941	0.09976
117 Seamount	226.1	400	20	4	2120387	0.15455
118 Bank	224.9	552	28	6	2909616	0.15368
43 Fathom Bank	800.6	749	37	7	14057639	0.54720
43 Fathom Bank 2	1046.8	416	21	4	10208175	0.71544
57 Fathom Reef	1854.6	96	5	1	4173636	1.26754
60 Mile Bank	336.5	1692	85	17	13347664	0.23000
81 Fathom Bank	364.4	416	21	4	3553298	0.24903
86 Fathom Bank	376.3	498	25	5	4392539	0.25716
Anacapa Pass	462	532	27	5	5761755	0.31576
Cherry Bank	538.5	1926	96	19	24313365	0.36805
China Point Reef	422.2	994	50	10	9838789	0.28858
Del Mar Steeples	293.5	380	19	4	2614388	0.20059
E San Nicolas Island	422.1	3847	192	38	38062768	0.28847
Farnsworth Bank	489.5	625	31	6	7172373	0.33458
Hidden Reef	241.5	694	35	7	3929371	0.16508
Kidney Bank	136.7	447	22	4	1432037	0.09340
Lasuen Knoll	569.6	369	18	4	4927318	0.38932
Mission Beach Reef	295.2	1081	54	11	7479695	0.20173
N Cortes Bank	580.8	8061	403	81	109757662	0.39698
N Cortes Spawning Grounds	925	527	26	5	11427085	0.63218
N San Clemente Island	718.7	582	29	6	9805698	0.49122
N San Miguel Island	315.9	520	26	5	3850988	0.21592
N San Nicolas Island	729.5	3038	152	30	51955380	0.49861
N Santa Barbara Island	744	1442	72	14	25148430	0.50847
N Santa Rosa Island	280	514	26	5	3373970	0.19138
NE San Miguel Island	476.5	398	20	4	4445686	0.32567
Nine Mile Bank	241.2	1483	74	15	8386396	0.16487
NW Catalina Island	956.4	358	18	4	8026709	0.65369
NW San Clemente Island	367.9	1881	94	19	16221558	0.25143
NW San Miguel Island	390.5	4805	240	48	43987758	0.26690
NW San Nicolas Island	847.8	1723	86	17	34242355	0.57942
Osborne Bank	1042.9	1036	52	10	25327629	0.71278
Potato Bank	2004.6	1356	68	14	63721739	1.37008
S Anacapa Island	1233.1	306	15	3	8845234	0.84276
S Cortes Bank	359.8	2005	100	20	16909799	0.24589
S Cortes Spawning Grounds	180.1	1152	58	12	4863567	0.12309
S Tanner Bank	509.9	3342	167	33	39946225	0.34849
Santa Cruz Canyon	408.4	385	19	4	3685521	0.27910
Santa Rosa Flats	353.1	4414	221	44	36541517	0.24136
SE San Nicolas Island	574.3	801	40	8	10784041	0.39252
SW San Miguel Island	28.9	1791	90	18	1215128	0.01978
SW Santa Barbara Island	474.9	1647	82	16	18334528	0.32456
W San Clemente Island	437.6	1302	65	13	13356435	0.29909

Figure 1.105. Preliminary acoustic-optical estimates of rockfish abundances in the SCB for 28 species during 2004/5. The error bars (CV=30%) were estimated from repeated acoustic surveys of the 43 Fathom Bank. Total abundance of cowcod (*Sebastes levis*) and bocaccio (*Sebastes paucispinis*) were estimated to be 600,000 ± 180,000 fish, and 4.5 ± 1.35 million fish, respectively. For comparison, the estimated 2005 total biomass of age 1+ bocaccio is 8561 metric tons (MacCall, 2005). The estimated 2005 total biomass of age 1+ cowcod is 478-710 metric tons (Piner *et al.*, 2005).

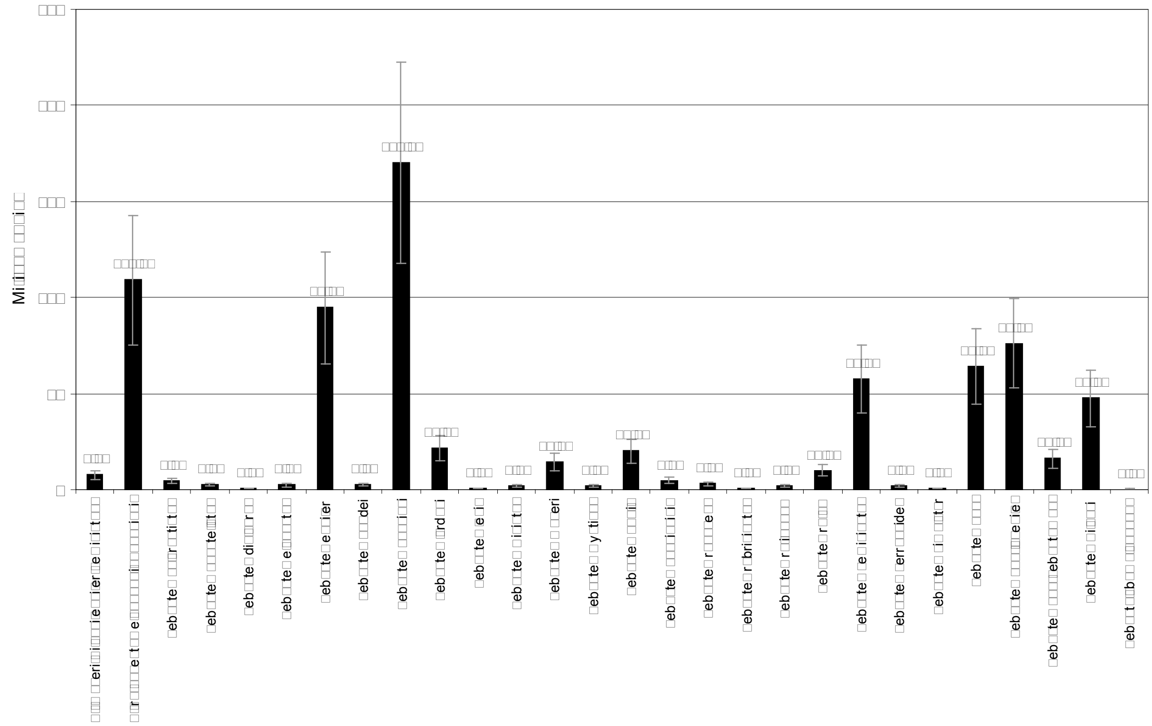


Figure 1.106. Dispersions of cowcod (*Sebastes levis*) in the Southern California Bight during 2004/5. The cowcod conservation areas are indicated (light blue lines).

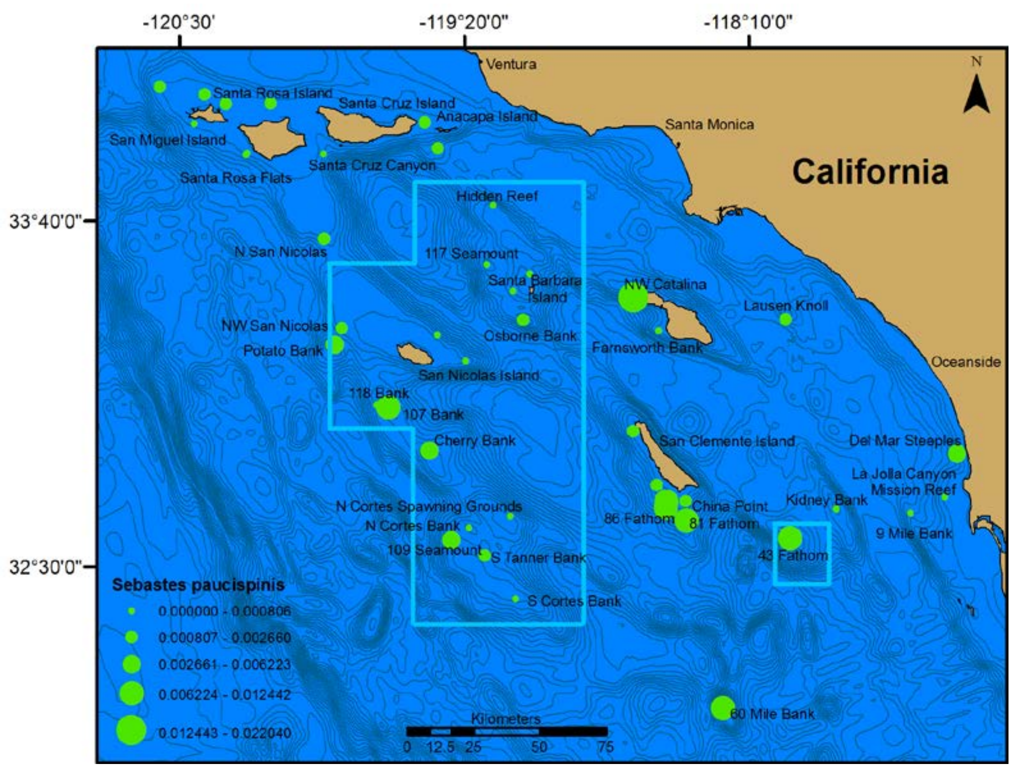
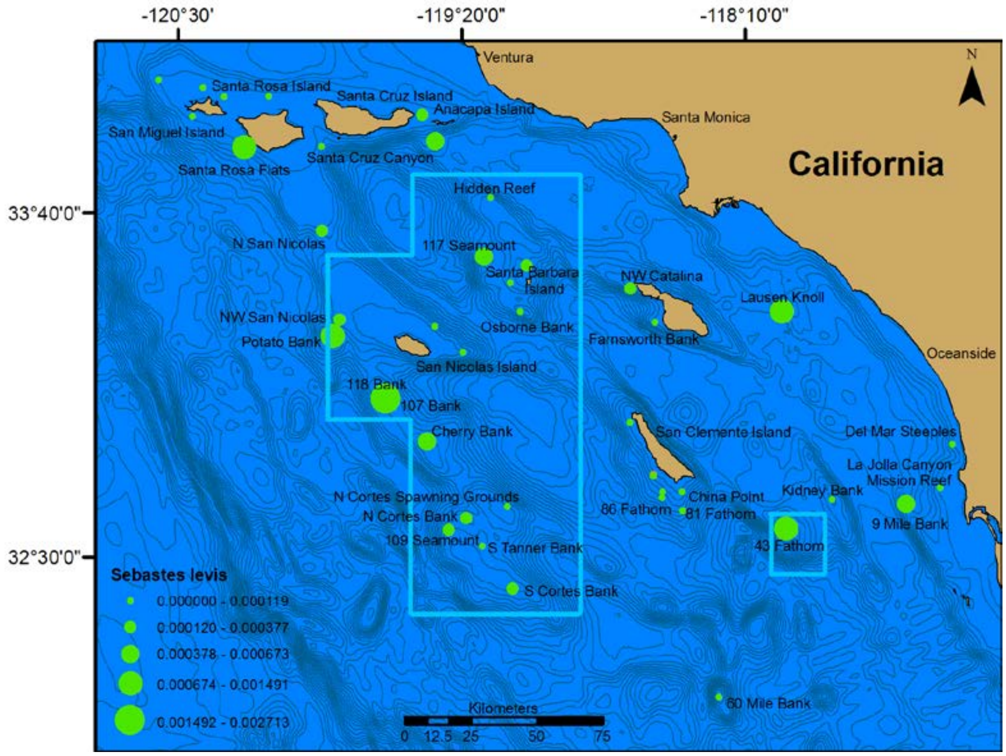


Figure 1.107. Dispersions of bocaccio (*Sebastes paucispinis*) in the Southern California Bight during 2004/5. The cowcod conservation areas are indicated (light blue lines).



1.5 Tentative Conclusions

Rockfishes in the SCB persistently associate with certain seabed types and features and may ascend up to 50 m off the seabed during daytime. This behavior makes at least some rockfish species available to acoustic daytime sampling with multi-frequency echosounders. The multiple-frequency acoustic backscatter information can be used to generate maps of rockfish densities and the seabed. These maps may be used to direct underwater optical sampling. The optical samples identify the species which comprise the acoustic backscatter and their sizes. These data may be combined to estimate rockfish densities, distributions, and abundances, by species.

1.6 Problems and Suggestions

The aim of this work was to create a standard survey protocol for non-lethal, non-extractive surveys of the geographic and depth distributions, and abundances of rockfishes. Further work is needed to quantify the height above the seabed which is not acoustically sampled, versus acoustic pulse lengths and beamwidths, and seabed depths, types, and slopes. It is also necessary to know how far off the seabed the various species of rockfishes naturally reside during daytime, and how the various species of rockfishes react to the ROV.

1.7 Disposition of the Data

Echosounder (~60 GB), CTD (~2 MB), thermosalinograph (~30 MB), and meta data (~10 MB) – David Demer, NOAA/NMFS, 8604 La Jolla Shores Drive, La Jolla, CA 92037, david.demer@noaa.gov.

1.8 Acknowledgments

We thank the Captains and crews of *David Starr Jordan* and *Outer Limits* for competently and enthusiastically facilitating the echosounder surveys. We particularly thank Captains Ken Franke and Paul Fischer who provided vigilant attention to the repetitive tasks and were eager to assist. We are also appreciative of *Jordan*'s electronic technician for providing the project with thermosalinograph and GPS data, and both vessels for providing telephone and VHS radio communications.

1.9 References

Love MS, Yoklavich M, Thorsteinson L (2002) The Rockfishes of the Northeast Pacific University of California Press, Ltd., Berkeley and Los Angeles, CA

2. Optical surveys using a remotely operated vehicle (ROV), submitted K. L. Stierhoff and J. L. Butler.

2.1 Objectives

The research objective was to conduct visual transect surveys using a remotely operated vehicle (ROV) at offshore banks previously surveyed using multibeam and multi-frequency split-beam acoustic sampling methods described in detail above. These surveys aimed to 1) provide general information on rockfish community structure (e.g., relative abundance, size distributions, seabed associations) to aid in the apportioning of acoustic backscatter from fish targets, and 2) provide visual data on seabed composition to ground-truth acoustic survey results.

2.2 Accomplishments

A total of 97 ROV transect surveys covering a distance of ~466 km were conducted at 37 nominal sites during daylight hours between 22 October 2004 and 8 May 2006 (**Fig. 2.1, Table 2.1**). Over 240,000 rockfishes and thornyheads (~46 species) were identified and quantified between 0 and 600 m depth. Each observation included the date/time, latitude/longitude, depth, temperature, size class, seabed association, and height above the seabed.

Figure 2.1. Location of ROV (black lines) and acoustic (orange lines) transect surveys throughout the Southern California Bight survey area.

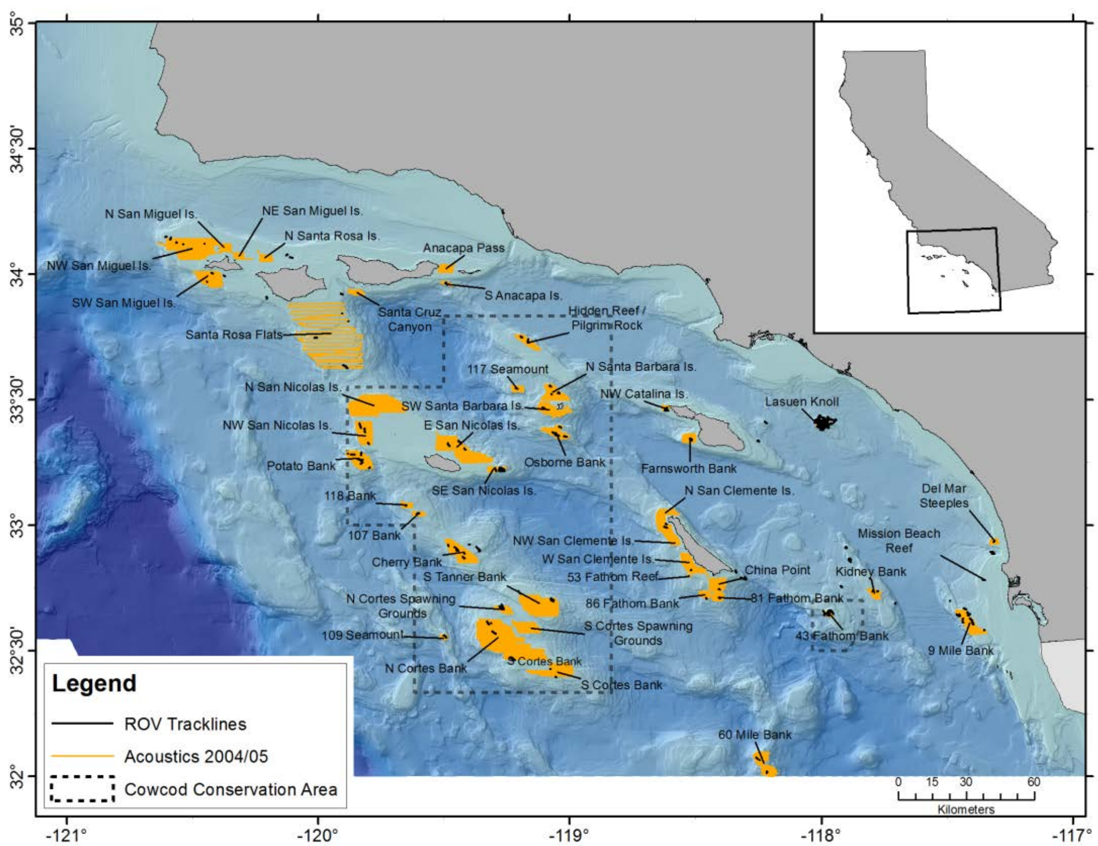


Table 2.1. Summary of visual surveys conducted within the acoustic survey areas using the SWFSC remotely operated vehicle (ROV) during the COAST 2004 surveys.

Site name	# of dives	Latitude	Longitude	Avg depth
107 Bank	2	33.050	-119.600	-210
109 Seamount	1	32.560	-119.490	-232
117 Seamount	1	33.550	-119.210	-223
118 Bank	1	33.080	-119.650	-232
43 Fathom Bank	7	32.650	-117.980	-235
57 Fathom Reef	1	32.800	-118.530	-152
60 Mile Bank	5	32.040	-118.230	-131
81 Fathom Bank	1	32.710	-118.400	-217
86 Fathom Bank	1	32.710	-118.460	-296
9 Mile Bank	6	18.190	-129.760	-219
Cherry Bank	6	32.900	-119.410	-159
China Point Reef	1	32.750	-118.410	-95
Del Mar Steeples Reef	1	32.940	-117.310	-85
E San Nicolas Island	3	33.320	-119.450	-83
Farnsworth Bank	1	33.340	-118.520	-60
Hidden Reef	2	33.740	-119.180	-118
Kidney Bank	3	32.740	-117.790	-272
Lasuen Knoll	1	33.390	-118.000	-315
Mission Beach Reef	1	32.780	-117.360	-86
N Cortes Bank	4	32.550	-119.280	-94
N Cortes Spawning Grounds	2	32.680	-119.270	-143
N Santa Barbara Island	3	33.540	-119.060	-115
NW Catalina Island	2	33.460	-118.620	-93
NW San Clemente Island	1	33.010	-118.620	-41
NW San Miguel Island	5	34.130	-120.550	-88
NW San Nicolas Island	3	33.380	-119.820	-107
Osborne Bank	4	33.370	-119.050	-101
Potato Bank	6	33.270	-119.840	-133
S Anacapa Island	3	33.960	-119.490	-131
S Cortes Bank	2	32.410	-119.060	-120
S Cortes Spawning Grounds	2	32.600	-119.170	-171
S Tanner Bank	5	32.710	-119.090	-112
Santa Rosa Flats	4	33.710	-119.930	-165
SE San Nicolas Island	2	33.220	-119.290	-82
SW San Miguel Island	2	33.990	-120.430	-94
SW Santa Barbara Island	1	33.470	-119.100	-99
W San Clemente Island	1	32.820	-118.520	-111
All sites	97			

2.3 Methods

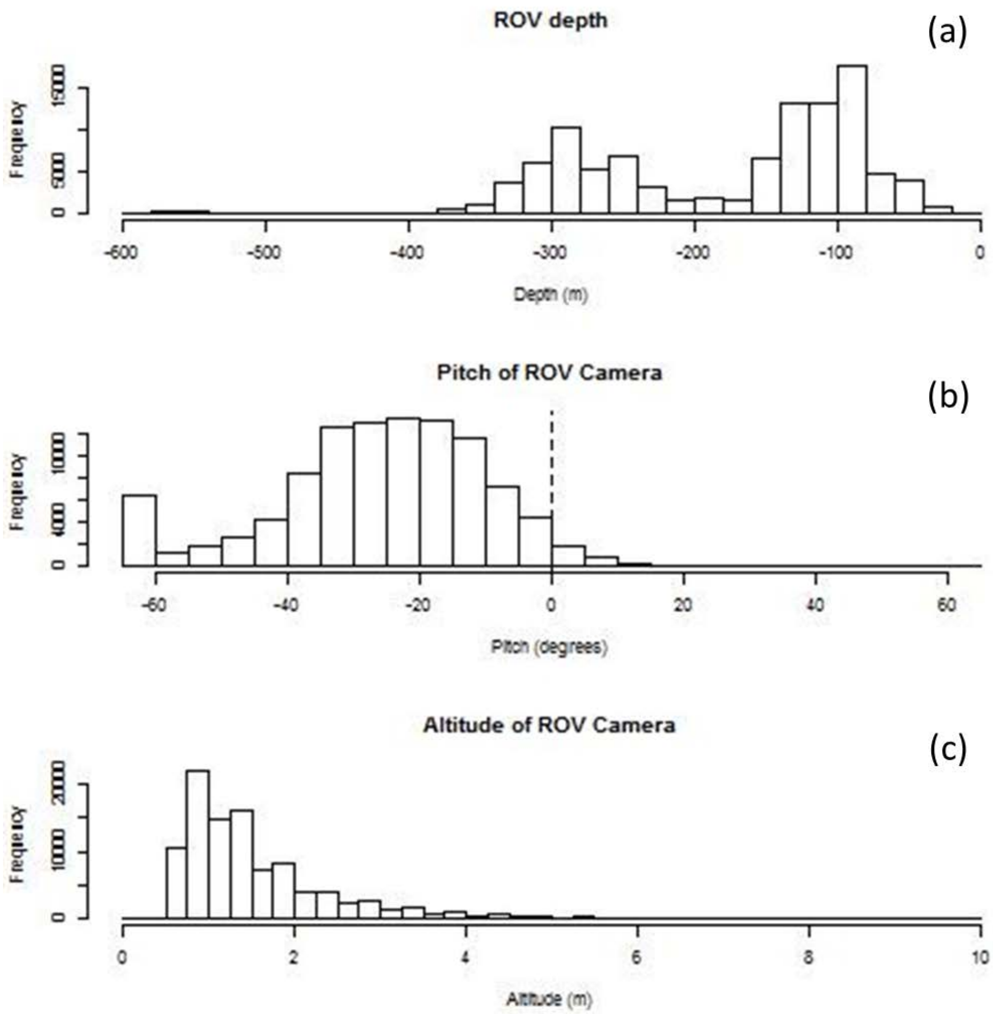
Visual transect surveys were conducted in areas of high acoustic backscatter, as identified by earlier split-beam acoustic surveys (e.g., see **Fig. 1.2**, above**),** using an ROV (Deep Ocean Engineering, Inc. Phantom DS4) fitted with a forward-looking color-video camera (Sony FCB-IX47C) with 470 lines of horizontal resolution and an 18x optical zoom. For improved species identification, the ROV was also fitted with a high-resolution-still camera (Insite Pacific, Inc. Scorpio with Nikon Coolpix 995) with 4x zoom. The location of the ROV relative to the ship was estimated using an acoustic transponder. The position of the ROV above the seabed and speed-over-ground was estimated in real-time using an ultra-short baseline (USBL) acoustic tracking system (ORE Offshore TrackPoint II-Plus) and tracking software (Fugro Pelagos, Inc. WinFrog). All other navigational data (e.g., seawater depth and temperature; ROV heading and speed; and camera pitch, roll, and altitude) were synchronously logged at one-to-two second intervals using WinFrog. The ROV's speed-over-ground was used to calculate the length of each transect. This method was calibrated over a submerged structure of known distance (~1500 m) and was deemed accurate to 1–3% (data not shown).

All adult rockfishes and thornyheads were identified to the lowest possible taxonomic level and counted (**Table 2.1**). Unidentifiable rockfishes (4,366 rosy-group rockfish, subgenus *Sebastomus*; and 24,819 other unidentified rockfishes, genus *Sebastes*), were also counted. Best efforts were made to distinguish between the newly described sunset rockfish (*S. crocotulus*, Hyde *et al.*, 2008) and vermilion rockfish (*S. miniatus*) based on color differences and depth of occurrence. Although this survey focused on rockfishes and thornyheads, all other observed fishes were also identified and quantified to the lowest level possible taxonomic level (data not shown). Fish lengths were estimated using two pairs of parallel reference lasers (20 and 61cm spacing) mounted on the camera platform, and later grouped into four broad size classes: < 10 cm, 10 – 25 cm, 25 – 60 cm, and >60 cm total length (*TL*).

2.4 Preliminary Results

A total of 97 ROV transect surveys were conducted from 30-600 m depths (**Fig. 2.2a**) covering a distance of ~162 km. Approximately 140 hours of video and 12,600 high-resolution still images were collected. The ROV surveyed from 0-10 m above the seabed, but most commonly flew within 2 m of the seabed (**Fig. 2.2b**). The camera was typically oriented at ~30 degrees below horizontal, but was rotated higher and lower to aid in the identification of species when necessary (**Fig. 2.2c**). Occasionally the ROV was flown up into the water column (as high as 10m) to survey at greater altitudes when schools of fishes were observed overhead or when data from the acoustic surveys indicated acoustic targets high above the seabed. Assuming an altitude of ~1m, camera pitch of ~25 degrees below horizontal, and the known vertical camera viewing angle (46 degrees), the ROV typically surveyed fishes within 0.9 m of the seabed and out to ~4 m in front of the ROV.

Figure 2.2. Distributions of a) ROV depth (m), b) camera pitch (degrees below horizontal), and c) camera altitude (m) during the COAST 2004/05 survey.



A total of 247,114 individual fishes representing 46 rockfish and thornyhead species were identified and quantified (**Table 2.2**). Five species (*S. ensifer*, *S. hopkinsi*, *S. jordani*, *S. semicinctus*, and *S. wilsoni*) comprised ~65% of the fish community. These most abundant species were small, schooling or aggregating species, except for *S. ensifer*, which are commonly solitary or found in small groups (<10 individuals). Two other schooling/aggregating species (*S. moseri* and *S. ovalis*) comprised an additional 8% of the overall community. Occasionally large, mixed assemblages were encountered, and were assigned to various complexes: *Sebastes* Complex 1 (*S. rufus*, *S. entomelas*, *S. ovalis*, or *S. hopkinsi*, ~12%) or *Sebastes* Complex 2 (*S. moseri*, *S. wilsoni*, *S. ensifer*, or *S. semicinctus*, ~2%). Approximately 12% of the fish community comprised unidentified rockfishes (*Sebastes* or *Sebastomus* sp.), which were likely among the five most abundant individual species that were identifiable to the species level. The greatest relative abundance of rockfishes occurred shallower than 150 m, while the greatest species richness (total number of species) occurred between 50 and 250 m (**Table 2.2**). The distribution of individuals by size class was as follows: <10 cm (3%), 10-25 cm (85%), 25-60 cm (12%), and >60 cm (>1%).

Table 2.2. Relative abundances (number of individuals km^{-1}) by depth of rockfish and thornyhead species during the COAST 2004 surveys. Species are sorted from shallow to deep using the depth stratum where each species was most abundant. The color scale indicates the depth strata where each species is least (green) to most (red) abundant. The red bars and associated percentages in the rightmost column indicate the relative abundance of that species compared to all other species.

Scientific name	Common name	Depth (m)													
		0-49	50-99	100-149	150-199	200-249	250-299	300-349	350-399	400-449	450-499	500-549	550-599	Total	% total
Sebastes mystinus	Blue rockfish	0.90	0.83											407	0.1%
Sebastes serranoides	Olive rockfish	0.47	0.24	0.17	0.00									222	0.1%
Sebastes umbrosus	Honeycomb rockfish	0.20	0.10											49	0.1%
Sebastes serriceps	Treefish	0.08	0.02											10	0.1%
Sebastes rosaceus	Rosy rockfish	1.01	1.21	0.09	0.01	0.04								649	0.1%
Sebastes hopkinsi	Squarespot rockfish	64.22	118.70	36.72	0.20	0.02								77,610	31.4%
Sebastes ovalis	Speckled rockfish		10.37	3.17	0.13	0.01								6,636	2.7%
Sebastes miniatus	Vermilion rockfish	0.08	0.45	0.36	0.02	0.04								433	0.1%
Sebastes chrysomelas	Black-and-yellow rockfish		0.04											20	0.1%
Sebastes caurinus	Copper rockfish		0.04	0.02										29	0.1%
Sebastes lentiginosus	Freckled rockfish		0.04											17	0.1%
Sebastes flavidus	Yellowtail rockfish		0.03	0.01		0.01								19	0.1%
Sebastes ruberrimus	Yelloweye rockfish		0.02	0.01	0.00	0.01								18	0.1%
Sebastes melanops	Black rockfish		0.01											6	0.1%
Sebastes pinniger	Canary rockfish		0.00	0.00										2	0.1%
Sebastes sp.	Rockfish-unidentified	7.34	23.60	22.55	2.70	0.90	0.21	0.60	0.67					24,819	10.0%
Sebastes jordani	Shortbelly rockfish		17.39	18.14	0.80	1.03	0.21	0.04						18,843	7.6%
Sebastes paucispinis	Bocaccio	0.51	1.89	1.91	0.23	0.27	0.02							2,082	0.1%
Sebastes constellatus	Starry rockfish	0.27	0.55	0.57	0.05	0.01								599	0.1%
Sebastes rubrivinctus	Flag rockfish		0.19	0.19	0.04	0.01								206	0.1%
Sebastes semicinctus	Halfbanded rockfish		16.56	35.66	0.03	0.05								28,164	11.4%
Sebastes Complex 1	Sebastes Complex 1		28.34	28.76	0.15									29,649	12.0%
Sebastes ensifer	Swordspine rockfish	0.04	3.60	27.05	17.75	5.80	1.22	0.07						22,081	8.9%
Sebastes wilsoni	Pygmy rockfish		9.17	14.12	0.17	0.02								12,386	5.0%
Sebastes moseri	Whitespeckeled rockfish		2.86	8.76	2.19	0.61								6,921	2.8%
Sebastes Complex 2	Sebastes Complex 2		1.36	5.91										4,027	1.6%
Sebastes rufinanus	Dwarf-red rockfish		0.39	4.32		0.01								2,663	1.1%
Sebastomus sp.	Rosy-group rockfish	1.21	3.35	3.85	1.44	1.39	0.12	0.07						4,366	1.8%
Sebastes chlorostictus	Greenspotted rockfish		0.56	0.90	0.25	0.02								828	0.1%
Sebastes elongatus	Greenstripe rockfish		0.05	0.34	0.31	0.28	0.12							346	0.1%
Sebastes levis	Cowcod		0.08	0.26	0.12	0.09	0.04							233	0.1%
Sebastes crocotulus	Sunset rockfish			0.00										2	0.1%
Sebastes entomelas	Widow rockfish		0.00	0.00										3	0.1%
Sebastes rufus	Bank rockfish		0.04	0.91	3.31	4.02	0.83	0.04						2,082	0.1%
Sebastes goodei	Chilipepper rockfish		0.08	0.02	0.08	0.43	0.03							147	0.1%
Sebastes eos	Pink rockfish					0.17	0.01							34	0.1%
Sebastes saxicola	Stripetail rockfish			0.02	0.01	0.09								31	0.1%
Sebastes zacentrus	Sharpchin rockfish					0.02								3	0.1%
Sebastes rosenblatti	Greenblotched rockfish		0.00	0.02	0.05	0.06	0.02	0.04						36	0.1%
Sebastes melanosema	Semaphore rockfish			0.00	0.00	0.05	0.06	0.04						19	0.1%
Sebastes macdonaldi	Mexican rockfish				0.00	0.01	0.03							5	0.1%
Sebastes gilli	Bronzespotted rockfish			0.00	0.00	0.01								5	0.1%
Sebastes helvomaculatus	Rosethorn rockfish			0.00	0.00		0.01							3	0.1%
Sebastes simulator	Pinkrose rockfish					0.08	0.51	1.16	0.51					109	0.1%
Sebastes phillipsi	Chameleon rockfish							0.25						7	0.1%
Sebastes diploproa	Splitnose rockfish					0.02	0.58	2.99	1.01					159	0.1%
Sebastes melanostomus	Blackgill rockfish					0.01	0.12	0.07	0.51					20	0.1%
Sebastes aurora	Aurora rockfish							0.04		0.78	0.35	0.13		5	0.1%
Sebastolobus alascanus	Shortspine thornyhead						0.11	0.21	0.67		2.44	2.55	4.42	71	0.1%
Sebastolobus altivelis	Longspine thornyhead											0.67	5.38	33	0.1%
All species		76.3	242.2	214.8	30.1	15.5	4.3	5.6	3.4	0.8	2.8	3.4	9.8		
Number of species		12.0	35.0	34.0	28.0	32.0	18.0	13.0	5.0	1.0	2.0	3.0	2.0		

Many of the rockfish and thornyhead species occurred over a wide range of seabed types (**Table 2.3**), from mud to high-relief reef. However, most species (~95% of individuals) were most commonly observed over low- to high-relief seabed types. The greatest species richness (total number of species) occurred in these same habitats. Since the survey targeted rockfishes, the pattern in species richness is partly due to the greater search effort over hard, rocky seabed types where abundance is also generally greater.

Table 2.3. Relative abundances (% of total observations) by seabed type of rockfish and thornyhead species during the COAST 2004 surveys. Species are sorted by seabed type, from low- (mud) to high-relief (high-relief reef) seabeds, where each species was most abundant. The color scale indicates the seabed type where each species is least (green) to most (red) abundant. The red bars and associated percentages in the rightmost column indicate the relative abundance of that species compared to all other species.

Scientific name	Common name	Mud	Sand	Pebble/gravel	Low-relief reef	Cobble	Boulder	High-relief reef	% total
Sebastes melanostomus	Blackgill rockfish	71%	12%			6%	6%	6%	0.1%
Sebastolobus alascanus	Shortspine thornyhead	63%	2%	2%	2%	26%	6%		0.1%
Sebastolobus altivelis	Longspine thornyhead	100%							0.1%
Sebastes diploproa	Splitnose rockfish	3%	54%		3%	27%	12%	2%	0.1%
Sebastes elongatus	Greenstripe rockfish	7%	45%	2%	2%	33%	11%	1%	0.1%
Sebastes jordani	Shortbelly rockfish	0%	51%		3%	16%	20%	10%	6.5%
Sebastes lentiginosus	Freckled rockfish		59%				41%		0.1%
Sebastes saxicola	Stripetail rockfish	29%	71%						0.1%
Sebastes semicinctus	Halfbanded rockfish	0%	81%		1%	15%	3%	0%	11.6%
Sebastes serranoides	Olive rockfish		35%		10%	4%	25%	26%	0.1%
Sebastes umbrosus	Honeycomb rockfish		45%		2%		43%	10%	0.1%
Sebastes chlorostictus	Greenspotted rockfish		37%	0%	6%	35%	19%	2%	0.3%
Sebastes Complex 2	Sebastes Complex 2		29%		9%	40%	13%	9%	1.6%
Sebastes ensifer	Swordspine rockfish	1%	8%	0%	2%	71%	15%	3%	8.8%
Sebastes rosenblatti	Greenblotched rockfish	4%	25%			39%	29%	4%	0.1%
Sebastes simulator	Pinkrose rockfish	3%	24%	2%	2%	60%	6%	2%	0.1%
Sebastes wilsoni	Pygmy rockfish	0%	9%		2%	43%	33%	12%	5.1%
Sebastes zacentrus	Sharpchin rockfish		33%			67%			0.1%
Sebastomus sp.	Rosy-group rockfish	0%	5%		2%	48%	12%	34%	1.8%
Sebastes goodei	Chilipepper rockfish	4%	10%			49%	6%	31%	0.1%
Sebastes caurinus	Copper rockfish		3%		3%	31%	52%	10%	0.1%
Sebastes chrysomelas	Black-and-yellow rockfish					10%	50%	40%	0.1%
Sebastes constellatus	Starry rockfish		2%		2%	23%	44%	29%	0.2%
Sebastes entomelas	Widow rockfish					33%	33%	33%	0.1%
Sebastes gilli	Bronzespotted rockfish						100%		0.1%
Sebastes levis	Cowcod	1%	4%		2%	17%	57%	20%	0.1%
Sebastes macdonaldi	Mexican rockfish						100%		0.1%
Sebastes miniatus	Vermilion rockfish		4%		4%	14%	61%	18%	0.2%
Sebastes paucispinis	Bocaccio		7%		1%	12%	47%	32%	0.8%
Sebastes phillipsi	Chameleon rockfish					29%	71%		0.1%
Sebastes rubrivinctus	Flag rockfish		21%		3%	26%	44%	7%	0.1%
Sebastes rufus	Bank rockfish	0%	2%		3%	13%	47%	34%	0.8%
Sebastes aurora	Aurora rockfish					20%	40%	40%	0.1%
Sebastes mystinus	Blue rockfish		11%		15%		40%	33%	0.2%
Sebastes pinniger	Canary rockfish						50%	50%	0.1%
Sebastes ruberrimus	Yelloweye rockfish					6%	50%	44%	0.1%
Sebastes rufinanus	Dwarf-red rockfish		4%		14%	0%	41%	41%	1.1%
Sebastes sp.	Rockfish-unidentified	0%	14%	0%	2%	20%	31%	34%	10.2%
Sebastes Complex 1	Sebastes Complex 1		4%			17%	27%	53%	12.2%
Sebastes eos	Pink rockfish	3%	3%			18%	6%	70%	0.1%
Sebastes flavidus	Yellowtail rockfish						37%	63%	0.1%
Sebastes hopkinsi	Squarespot rockfish		5%	0%	1%	13%	33%	47%	32.1%
Sebastes melanops	Black rockfish							100%	0.1%
Sebastes melanosema	Semaphore rockfish		6%			12%		82%	0.1%
Sebastes moseri	Whitespeckeled rockfish		3%		2%	12%	24%	59%	2.9%
Sebastes ovalis	Speckled rockfish		2%		0%	4%	38%	56%	2.7%
Sebastes rosaceus	Rosy rockfish		9%		4%	4%	31%	52%	0.3%
Sebastes serriceps	Treefish						10%	90%	0.1%
Number of species		18	36	7	27	37	43	40	

2.5 Tentative Conclusions

The preliminary results from the ROV surveys provided information on the species composition, depth distribution, and seabed associations of rockfishes and thornyheads in the acoustic survey areas. The images collected with cameras on the ROV also provided information about the proportions of various rockfish species present in each survey area, and their length distributions throughout the SCB. These estimates of species proportions and lengths are used to convert the acoustic backscatter from rockfishes to estimates of their abundances, by species. The geolocated observations of seabed type are being used to ground-truth model results that predict seabed type from multiple-frequency echo amplitude and interferometric-phase information.

2.6 Problems and Suggestions

The use of high-definition (HD) video could greatly improve the ability of analysts to identify more fishes without the aid of still images, thereby improving the time efficiency of video analysis, and would likely allow for the identification of many species that were only able to be identified as *Sebastes* or *Sebastomus* sp.

2.7 Disposition of Data

Video and still camera images, and ROV metadata are archived by John Butler (john.butler@noaa.gov), NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA, 92037, USA.

2.8 Acknowledgements

The analysis of video footage was done by S. Mau, D. Murfin, D. Pinkard-Meier, K. Stierhoff, and M. Wilson.

2.9 References

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