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THE WESTERN SOUTH PACIFIC REGIONAL
WORKSHOP TO FACILITATE THE DESCRIPTION
OF ECOLOGICALLY OR BIOLOGICALLY
SIGNIFICANT MARINE AREAS
Fiji, 22-25 November 2011

**COMPILATION OF SUBMISSIONS OF SCIENTIFIC INFORMATION TO DESCRIBE EBSAS
IN THE WESTERN SOUTH PACIFIC REGION**

Note by the Executive Secretary

1. The Executive Secretary is circulating herewith a compilation of submissions of scientific information to describe EBSAs in the Western South Pacific region submitted by Parties and organizations in response to CBD notification (Ref. No. 2011-198), for the information of participants in the Western South Pacific Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas, being convened in Fiji, from 22 to 25 November 2011, in collaboration with the Secretariat of the Pacific Regional Environment Programme (SPREP).
2. This compilation consists of the followings:
 - (a) A list of submissions made by Parties and organizations. The original submissions are available at <http://www.cbd.int/doc/?meeting=RWEBSA-WSPAC-01>; and
 - (b) A background document on "Data to inform the CBD Western South Pacific Regional Workshop to Facilitate the Description of Ecologically or Biologically Significant Marine Areas", which was prepared by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), with financial support from the Government of Australia, in support of the CBD Secretariat in its technical preparation for the above-mentioned regional workshop.
3. This compilation of submissions is circulated in the form and language in which they were received by the Secretariat of the Convention on Biological Diversity.

Compilation of submissions received as of 14 November 2011 (in response to CBD Notification Ref. No. 2011-198)

Authors	Background	CONTENTS OF SUBMISSION	SHORT DESCRIPTION OF SUBMISSION
<p>Aisake BATIBASAGA</p> <p>[File name: WWW-Fiji]</p>	<p>This expedition was initiated and lead by WWF-Fiji Country Programme, and partners - Vodofone Foundation, the University of the South Pacific Institute of Applied Sciences (IAS), the Packard Foundation and the MacArthur Foundation</p>	<p>FIJI'S GREAT SEA REEF (GSR): The first marine biodiversity survey of Cakaulevu and associated coastal habitats + DRAFT MAP (Ecoregions in the Pacific) + MACUATA TRADITIONAL TABU AREAS MAP</p>	<p>The report proposes for the first time a biodiversity survey method and protocol designed to map sites and measure biodiversity contents in Fiji and the neighbouring Pacific region.</p>
<p>This report (WWF document) was prepared by Veena NAIR, Etika RUPENI, Lisette WILSON, Dermot O'GORMON, Cat HOLLOWAY, Gaya SRISKANTHAN, Kesaia TABUNAKAWAI, Daniel AFZAL, Francis AREKI and Monifa FIU.</p> <p>[File name: WWW-South Pacific]</p>	<p>The workshop was organized and funded by WWF_South Pacific Program (2003), with technical support provided by Bronwen Golder-Fyfe, Ghislaine Llewelyn, Tom Allnutt, Louise Heaps, Elizabeth Erasito, Cherie Morris, David Olson and Avisake Ravuvu.</p>	<p>Identifying key areas of biodiversity importance</p>	<p>The unique natural characteristics and vibrant cultural heritage of the Fiji Islands Marine Ecoregion are today coming under increasing pressure from a variety of forces. Climate change, cyclones and tidal waves can have a devastating impact on the state of the regions biodiversity and the people who depend on it. Rapid population growth, expanding commercial interests and decision making constrained by incomplete information, are individually and collectively, also contributing to the diminished health and sustainability of the region.</p>

<p>S. ANDREFOUET a, L. WANTIEZ b</p> <p>[File name : New Caledonia-1]</p>	<p>a Institut de Recherche pour le Développement, B.P. A5 98848 Nouméa Cedex, New Caledonia</p> <p>b LIVE, Université de la Nouvelle-Calédonie, B.P. R4 98851 Nouméa Cedex, New Caledonia</p>	<p>Characterizing the diversity of coral reef habitats and fish communities found in a UNESCO World Heritage Site: The strategy developed for Lagoons of New Caledonia</p>	<p>To support the designation of areas within the 36.000 km² of New Caledonia coral reefs and lagoons as world Heritage Site, the natural value and diversity of the proposed zones needed to be demonstrated. To exhaustively identify each configuration of shallow habitats, high resolution remote sensing images were used to select the sampling sites. This optimal scheme resulted in the selection of nearly 1300 sampling sites, and was then simplified to render its application realistic. In the final sampling plan, only the most common or the most remarkable coral zones were selected.</p>
<p>Mayeul DALLEAU (1) et al</p> <p>[File name: New Caledonia-2]</p>	<p>(1) Institut de Recherche pour le Développement, Centre de Nouméa, B.P. A5, 98848, Nouméa, New-Caledonia</p>	<p>Use of Habitats as Surrogates of Biodiversity for Efficient Coral Reef Conservation Planning in Pacific Ocean Islands</p>	<p>Many criteria exist to design MPA networks, but generally, it is recommended that networks conserve a diversity of species selected for, among other attributes, their representativeness, rarity, or endemism. Because knowledge of species' spatial distribution remains scarce, efficient surrogates are urgently needed. We used five different levels of habitat maps and six spatial scales of analysis to identify under which circumstances habitat data used to design MPA networks for Wallis Island provided better representation of species than random choice alone.</p>

<p>L. WANTIEZ (1), P. THOLLOT (1), M. KULBICKI (2)</p> <p>[File name : New Caledonia-3]</p>	<p>(1) Consultant in Environment and Marine Resources, BP 9239, 98807 Nouméa Cedex, New Caledonia</p> <p>(2) ORSTOM, Centre de Nouméa, BP A5 Nouméa Cedex, New Caledonia</p>	<p>Effects of marine reserves on coral. reef fish communities from five islands in New Caledonia</p>	<p>The aim of the present study was to assess the effects of marine reserves on coral reef fish communities by comparing fish populations on five islands from the southwest lagoon of New Caledonia, before and after fishing prohibition. Species richness, density and biomass were compared and size distribution and community structure were studied. These islands supported substantial amounts of recreation fishing (spear fishing, hand line and gillnets), before the South Lagoon Marine Park was created by the South Province of New Caledonia.</p>
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<p>Camilo Mora et al., 2011</p> <p>[File name : Camilo Mora et al]</p>	<p>Department of Biology, Dalhousie University, Halifax, Nova Scotia, (Canada) and other large international network of researchers</p>	<p>Global Human Footprint on the Linkage between Biodiversity and Ecosystem Functioning in Reef Fishes</p>	<p>Using a global survey of reef fish assemblages, we show that in contrast to previous theoretical and experimental studies, ecosystem functioning (as measured by standing biomass) scales in a no saturating manner with biodiversity (as measured by species and functional richness) in this ecosystem. Our field study also shows a significant and negative interaction between human population density and biodiversity on ecosystem functioning (i.e., for the same human density there were larger reductions in standing biomass at more diverse reefs). Human effects were found to be related to fishing, coastal development, and land use stressors, and currently affect over 75% of the world's coral reefs. Our results indicate that the consequences of biodiversity loss in coral reefs have been considerably underestimated based on existing knowledge and that reef fish assemblages, particularly the most diverse, are greatly vulnerable to the expansion and intensity of anthropogenic stressors in coastal areas.</p>
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<p>Laurent WANTIEZ</p> <p>[File name : Fiji Coral Reefs]</p>	<p>Institute of Marine Resources, University of the South Pacific, Suva, Fiji</p>	<p>Coral Reef Initiative for the Pacific (CRIP) - STATUS OF CORAL REEFS IN THE FIJI ISLANDS, 2007</p>	<p>The Fiji branch of the Global Coral Reef Monitoring Network (GCRMN) was started in Fiji in 2000, when Reef Check and the GCRMN began a co-operative project to train a network of survey teams that could report on the health of the country's coral reefs.</p>
<p>Olivier CHATEAU & Laurent WANTIEZ</p> <p>[File name: New Caledonia-4]</p>	<p>University of New Caledonia, Aquarium des Lagons, BP R4, 98851 Noumea cedex, New Caledonia.</p>	<p>Movement patterns of four coral reef fish species in a fragmented habitat in New Caledonia: implications for the design of marine protected area networks</p>	<p>The information gathered in this study demonstrates the ability of the fish to carry out medium-scale movements in a fragmented habitat. Consequently, the effectiveness of the reserve to protect the entire population is probably limited for these species. Because all the identified patterns implied at least one movement across the reserve boundaries, our results support the hypothesis that the Lare'gne`re Marine Reserve, part of the South Lagoon Marine Park, could benefit the adjacent fished area through spillover.</p>

Data to inform the CBD Western South Pacific
Regional Workshop to Facilitate the Description
of Ecologically or Biologically Significant Marine
Areas

Piers Dunstan and Mike Fuller

November 15, 2011

Prepared for: the Secretariat of the Convention on
Biodiversity (SCBD) and the Secretariat of the Pacific
Regional Environment Program (SPREP)

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1 Background

CSIRO, in conjunction with international partners, has identify and mapped a large number of data sets and analyses for consideration by the Western South Pacific Regional Workshop to facilitate the description of Ecologically or Biologically Significant Marine Areas (EBSAs). The data sets obtained cover both biological and physical data sets. The data is intended to be used by the expert regional workshop convened by SCBD and SPREP to aid in identifying EBSAs through application of scientific criteria in annex I of decision IX/20 as well as other relevant compatible and complementary nationally and intergovernmentally agreed scientific criteria. Each data set may be used to meet one or more of the EBSA criteria. The layers are available as shape files and geotiffs. Printed maps will also be available for annotation at the workshop.

2 GOODS Biogeography

A new biogeographic classification of the worlds oceans has been developed which includes pelagic waters subdivided into 30 provinces as well as benthic areas subdivided into three large depth zones consisting of 38 provinces (14 bathyal, 14 abyssal and 10 hadal). In addition, 10 hydrothermal vent provinces have been delineated. This classification has been produced by a multidisciplinary scientific expert group, who started this task at the workshop in Mexico City in January 2007. It represents the first attempt at comprehensively classifying the open ocean and deep seafloor into distinct biogeographic regions. The biogeographic classification classifies specific ocean regions using environmental features and to the extent data are available their species composition. This represents a combined physiognomic and taxonomic approach. Generalised environmental characteristics of the benthic and pelagic environments (structural features of habitat, ecological function and processes as well as physical features such as water characteristics and seabed topography) are used to select relatively homogeneous regions with respect to habitat and associated biological community characteristics. These are refined with direct knowledge or inferred understanding of the patterns of species and communities, driven by processes of dispersal, isolation and evolution; ensuring that biological uniqueness found in distinct basins and water bodies is also captured in the classification. This work is hypothesis-driven and still preliminary, and will thus require further refinement and peer review in the future. However, in its present format it provides a basis for discussions that can assist policy development and implementation in the context of the Convention on Biological Diversity and other fora.

Global Open Oceans and Deep Seabed (GOODS) biogeographic classification (http://ioc-unesco.org/index.php?option=com_content&task=view&id=146&Itemid=76)

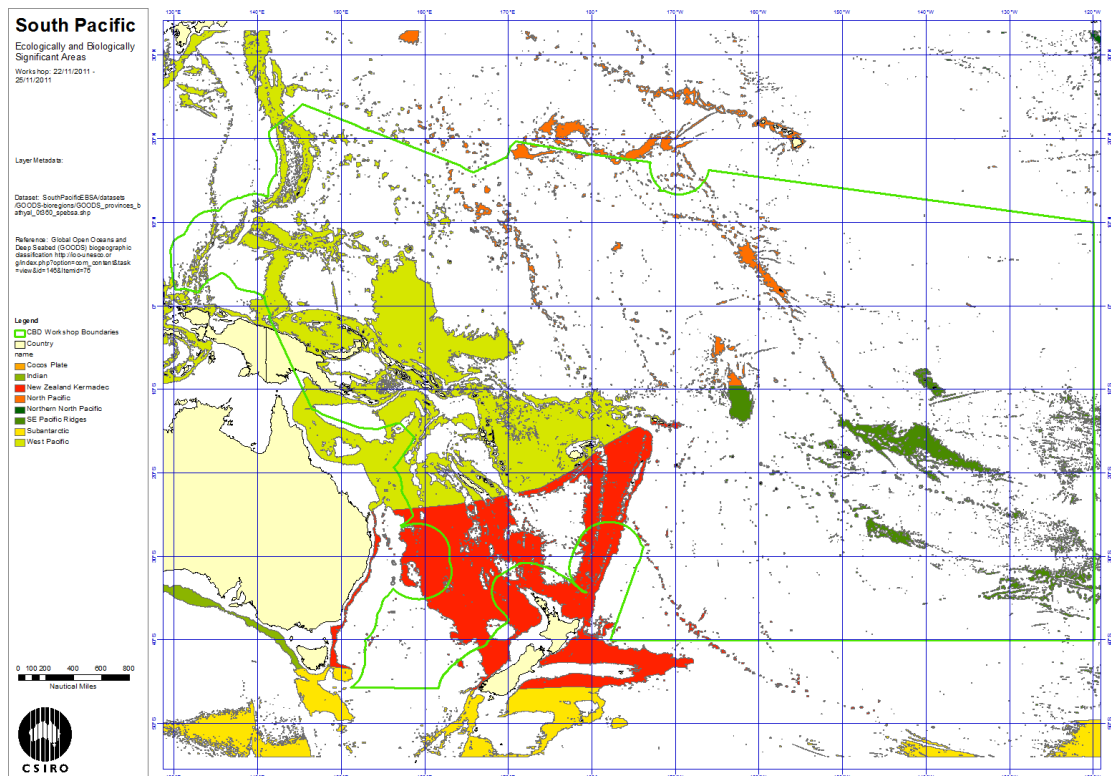


Figure 2.1: GOODS Bathyl Bioregions

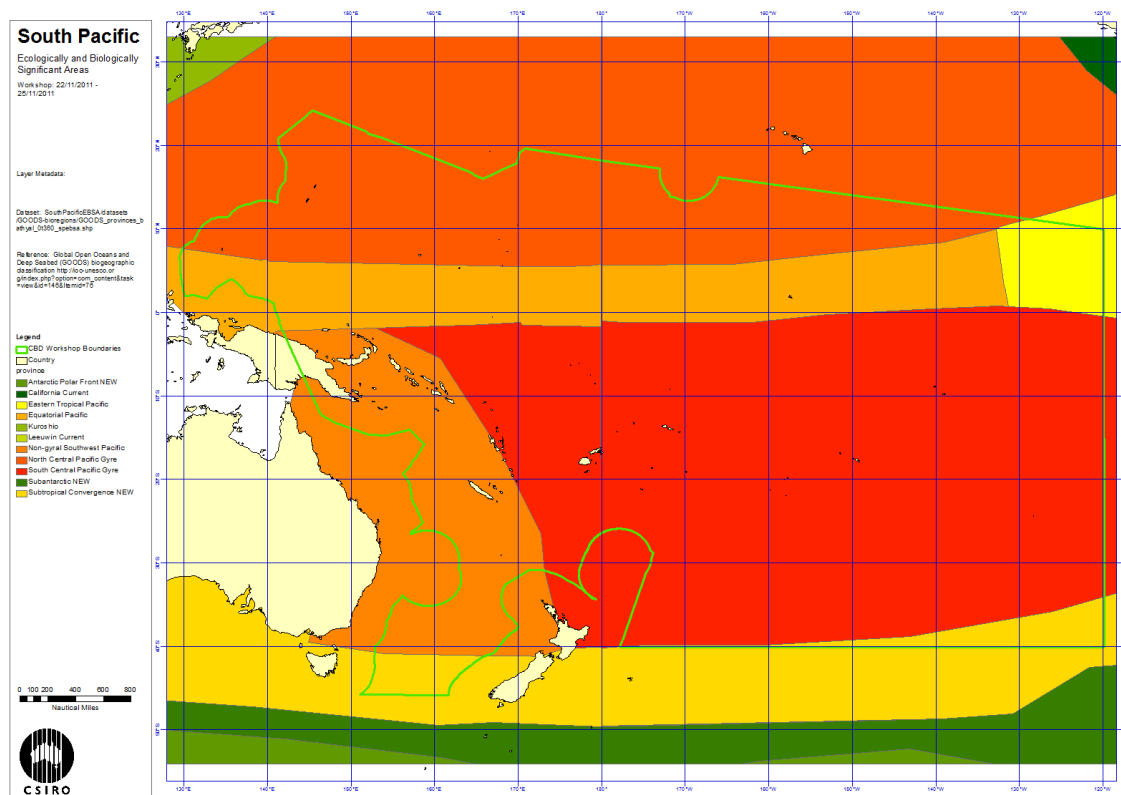


Figure 2.2: GOODS Pelagic Bioregions

3 Biological Data

3.1 Important Bird Areas

The Important Bird Areas (IBAs) programme of BirdLife International seeks to identify, document and conserve sites that are critical for the long-term viability of bird populations. The programme began in the 1980s and the process of site inventory is very well advanced in the terrestrial environment, with more than 10,000 sites already identified around the world. Conservation actions are underway at many of these sites, many now benefiting from enhanced protection status. Following the success of the IBA approach in the terrestrial and freshwater environment, BirdLife is now adapting and extending the programme to the oceans. BirdLife International (2009) found that there is considerable overlap and congruence between the criteria used to identify marine IBAs and those adopted by the CBD to identify EBSAs. This is particularly so for criteria relating to vulnerability and irreplaceability. BirdLife International manages the Global Procellariiform Tracking Database (www.seabirdtracking.org) a unique collaboration between many of the world's seabird tracking scientists. The relevant data were made available to run an IBA analysis for this region, and the resulting sites are included on the map. Three types of tracking device are available; Platform Transmitter Transponders (PTT), Global Positioning Systems (GPS) and Geolocators (GLS). Location estimates derived from each of these systems have different accuracies, GPS data being accurate to meters, PTT to within 50km and GLS data being the most erroneous, with a mean error of 186km. PTT and GPS data were combined and analysed together because erroneous fixes were within the large-scale foraging movements being investigated. However, because GLS data include much more error (and also only provides two fixes per day) they are treated separately, and only used directly for triggering sites as IBA during non-breeding migrations, when the birds' movements were much larger than (and therefore distinguishable from) the erroneous locations.

BirdLife International maintains an online database (<http://seabird.wikispaces.com/>) of seabird ecology and foraging ranges, as a basis for identifying key foraging areas around breeding sites that qualify as IBAs. The majority of congregatory seabirds are central place foragers during the breeding season returning to their breeding colony regularly to share incubation duties or feed chicks. These species, many of which forage in association with pelagic fish schools, radiate from colonies with individual and inter-trip variation in the distance travelled from the colony. Identifying foraging areas up to the maximum foraging range recorded would be a poor representation of the foraging area for the majority of birds, since these extremes apply to only a small percentage of birds. The approach adopted here was to define sites based on their importance to a greater proportion of the colony, and this was done by selecting the maximum range to which IBA threshold numbers of a trigger species travelled.

BirdLife International (2010). Marine Important Bird Areas toolkit: standardised techniques for identifying priority sites for the conservation of seabirds at sea. BirdLife International, Cambridge UK. Version 1.2: February 2011 <http://www.birdlife.org/eu/pdfs/Marinetoolkitnew.pdf>

BirdLife International (2009). Designing networks of marine protected areas: exploring the linkages between Important Bird Areas and ecologically or biologically significant marine areas. Cambridge, UK: BirdLife International. <http://www.cbd.int/doc/meetings/mar/ewbcsima-01/other/ewbcsima-01-birdlife-02-en.pdf>

O'Brien, M., and Waugh, S.M. 2010. Important Bird Areas in the Pacific 2010. Unpub-

lished report to BirdLife International. http://www.sprep.org/publication/pub_detail.asp?id=857

Ramrez I., P. Geraldes, A. Meirinho, P. Amorim & V. Paiva (2008). reas Marinhas Importantes para as Aves em Portugal. Projecto LIFE04NAT/PT/000213 - Sociedade Portuguesa Para o Estudo das Aves. Lisboa

Arcos, J.M., J. Bcares, B. Rodrguez y A. Ruiz. 2009. reas Importantes para la Conservacin de las Aves marinas en Espaa. LIFE04NAT/ES/000049-Sociedad Espaola de Ornitologa (SEO/BirdLife). Madrid.

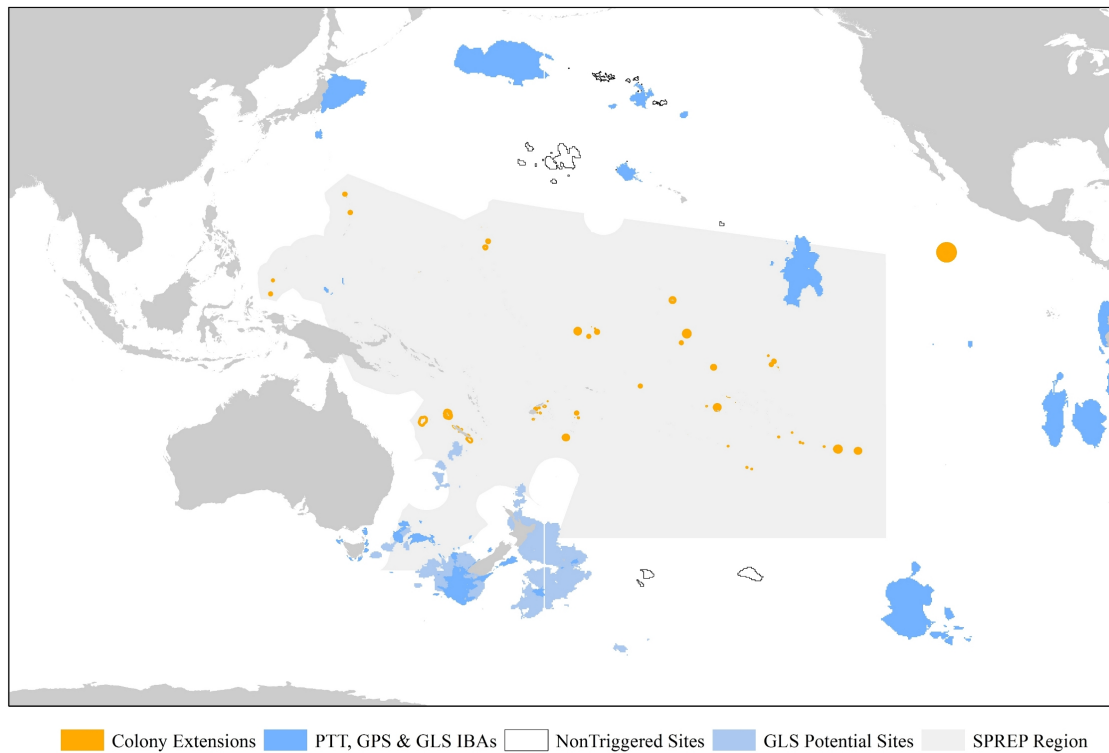


Figure 3.1: Important Bird Areas (IBA)

3.2 Seabird Densities

The map represents the seabird species density (number of species present per km²). The cells are 0.1x0.1 from Latitude 55N to 55S and Longitude 90E to 240E. The range data available were limited to average annual distributions for all species. However we established seasonal distribution map for 62 species by taking into account all the breeding colonies at a global scale and the breeding period. For each season, we compute a composite map which is the addition of the seasonal breeder layer and the seasonal non-breeder layer on a global scale (i.e. including outside the WCPFC Convention Area) assuming that 100% of the population of the species was distributed within the BirdLife Range Map (Fig. 3 for species example). We estimated the proportion of the global population that is within the WCPFC Convention Area based on the proportion of a species total range within this zone and birds. We took into account 70 species of petrels and albatross. *Bulweria bulwerii*, *Daption capense*, *Diomedea antipodensis*, *Diomedea epomophora*, *Diomedea exulans*, *Diomedea gibsoni*, *Diomedea sandfordi*, *Fulmarus glacialis*, *Halobaena caerulea*, *Lugensa brevirostris*, *Macronectes giganteus*, *Macronectes halli*, *Pachyptila belcheri*, *Pachyptila crassirostris*, *Pachyptila desolata*, *Pachyptila turtur*, *Pachyptila vittata*, *Pelecanoides urinatrix*, *Phoebastria albatrus*, *Phoebastria immutabilis*, *Phoebastria nigripes*, *Phoebastria fusca*, *Phoebastria palpebrata*, *Procellaria aequinoctialis*, *Procellaria cinerea*, *Procellaria parkinsoni*, *Procellaria westlandica*, *Pseudobulweria becki*, *Pseudobulweria macgillivrayi*, *Pseudobulweria rostrata*, *Pterodroma alba*, *Pterodroma atrata*, *Pterodroma axillaris*, *Pterodroma brevipes*, *Pterodroma cervicalis*, *Pterodroma cookii*, *Pterodroma externa*, *Pterodroma heraldica*, *Pterodroma inexpectata*, *Pterodroma lessonii*, *Pterodroma leucoptera*, *Pterodroma longirostris*, *Pterodroma macroptera*, *Pterodroma magentae*, *Pterodroma mollis*, *Pterodroma neglecta*, *Pterodroma nigripennis*, *Pterodroma pycrofti*, *Pterodroma sandwichensis*, *Pterodroma solandri*, *Pterodroma ultima*, *Puffinus assimilis*, *Puffinus bulleri*, *Puffinus carneipes*, *Puffinus griseus*, *Puffinus heinrothi*, *Puffinus huttoni*, *Puffinus lherminieri*, *Puffinus nativitatis*, *Puffinus newelli*, *Puffinus pacificus*, *Puffinus tenuirostris*, *Thalassarche bulleri*, *Thalassarche cauta*, *Thalassarche chrysostoma*, *Thalassarche eremita*, *Thalassarche impavida*, *Thalassarche melanophrys*, *Thalassarche salvini*, *Thalassarche steadi*.

D. Filippi and S. Waugh. Unpublished data.

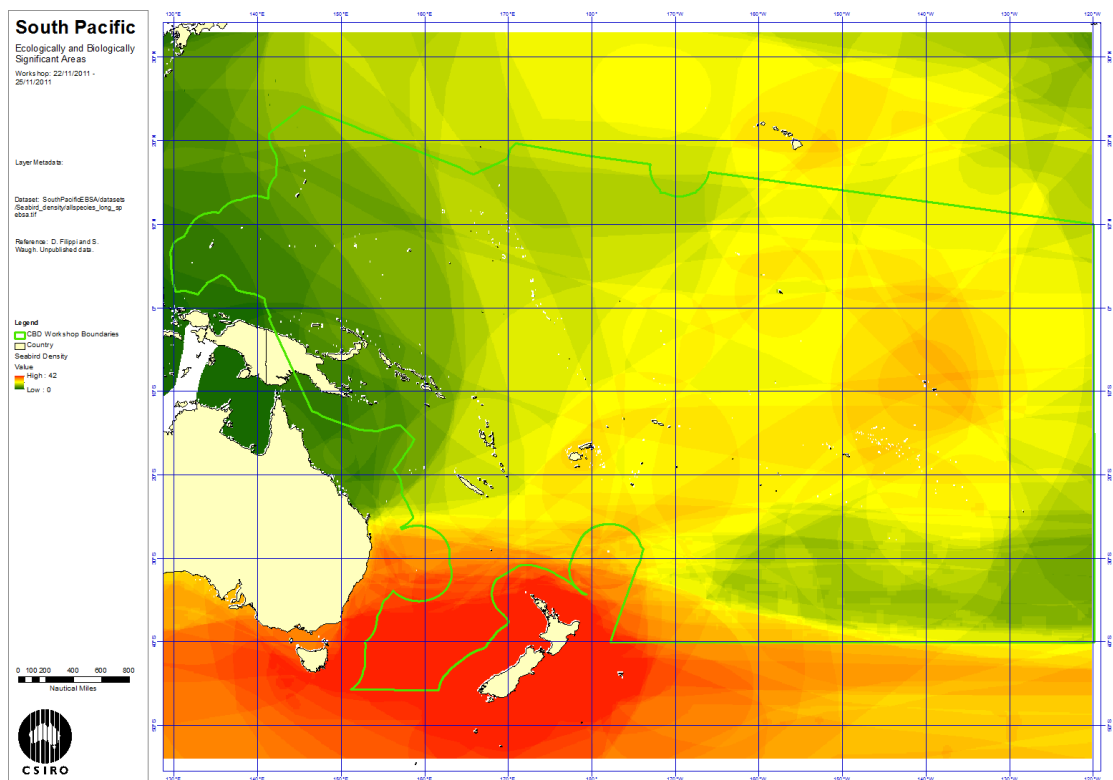


Figure 3.2:

3.3 Interactions between Tuna and Seamounts

The identification of biodiversity hotspots and their management for conservation have been hypothesized as effective ways to protect many species. There has been a significant effort to identify and map these areas at a global scale, but the coarse resolution of most datasets masks the small-scale patterns associated with coastal habitats or seamounts. Here we used tuna long-line observer data to investigate the role of seamounts in aggregating large pelagic biodiversity and to identify which pelagic species are associated with seamounts. Our analysis indicates that seamounts are hotspots of pelagic biodiversity. Higher species richness was detected in association with seamounts than with coastal or oceanic areas. Seamounts were found to have higher species diversity within 3040 km of the summit, whereas for sets close to coastal habitat the diversity was lower and fairly constant with distance. Higher probability of capture and higher number of fish caught were detected for some shark, billfish, tuna, and other by-catch species. The study supports hypotheses that seamounts may be areas of special interest for management for marine pelagic predators. Seamounts with higher catches are labeled 1 and those that do not are labelled 0.

Morato et al. 2010. Seamounts are hotspots of pelagic biodiversity in the open ocean. PNAS 107:9707-9711. (www.pnas.org/cgi/doi/10.1073/pnas.0910290107)

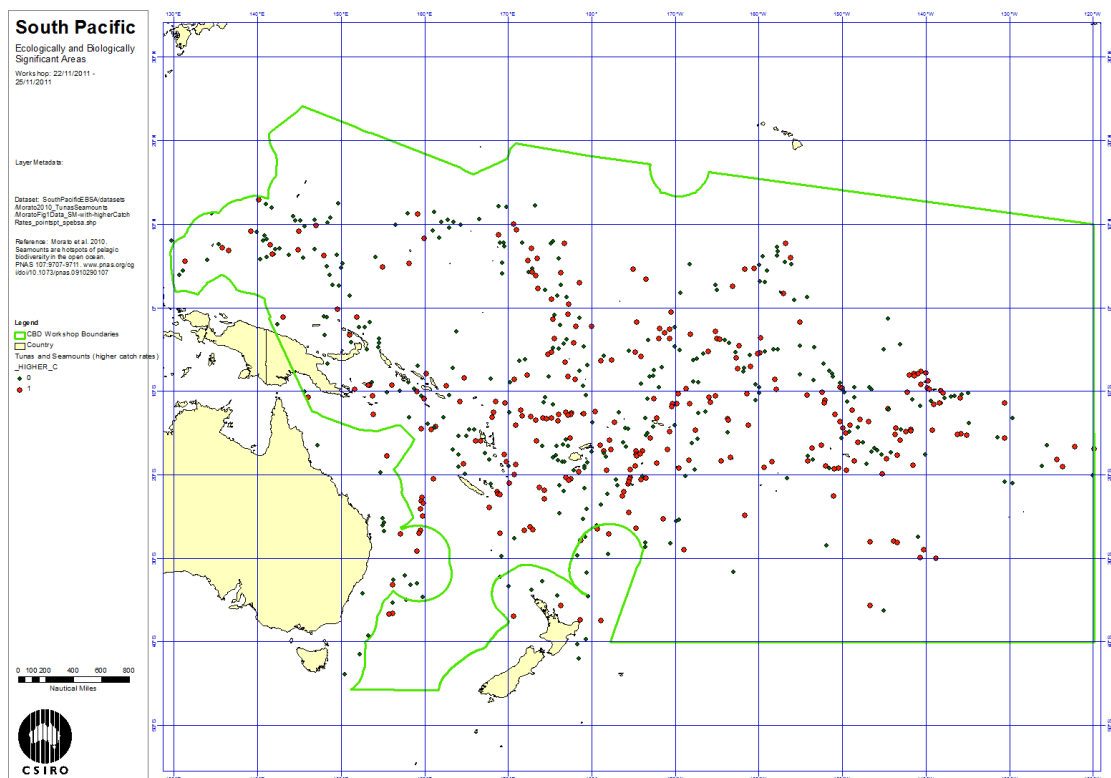


Figure 3.3:

3.4 Catches of Commercial Pelagic Species

The WCPFC have compiled a public domain version of aggregated catch and effort data using operational, aggregate and annual catch estimates data provided by Commission Members (CCMs) and Cooperating Non-members (CNMs). The data provided herein have been prepared for dissemination in accordance with the current Rules and Procedures for the Protection, Access to, and Dissemination of Data Compiled by the Commission or (RAP). Paragraph 9 of the Rules and Procedures indicates that "Catch and Effort data in the public domain shall be made up of observations from a minimum of three vessels". However, the majority of aggregate data provided to WCPFC do not indicate how many vessels were active in each cell of data which would allow data to be directly filtered according to this rule. Instead, the individual cells where "effort" is less than or equal to the maximum value estimated to represent the activities of two vessels have been removed from the public domain data. Statistics showing how much data have been removed according to this RAP requirement are provided in the documentation for the longline and purse seine public domain data. All public domain data have been aggregated by year/month and 5x5 grid. Annex 2 of the RAP indicates that public domain aggregated catch/effort data can be made available at a higher resolution (e.g. data with a breakdown by vessel nation, and aggregated by 1x1 grids for surface fisheries); however, if the public domain data were provided at these higher levels of resolution implementation of the RAP "three-vessel rule" with the current aggregate data set would result in too many cells being removed.

Records are for Albacore, Yellowfin, Bigeye, Striped Marlin, Black Marlin, Blue Marlin, Swordfish and SkipJack Tuna. The data is summarised for Tuna, Marlin, Swordfish and other species and mapped by the catch per hook for each species group, averaged annually. Seasonal catches will also be available

<http://www.wcpfc.int/science-and-scientific-data-functions/public-domain->

3.4.1 Tuna

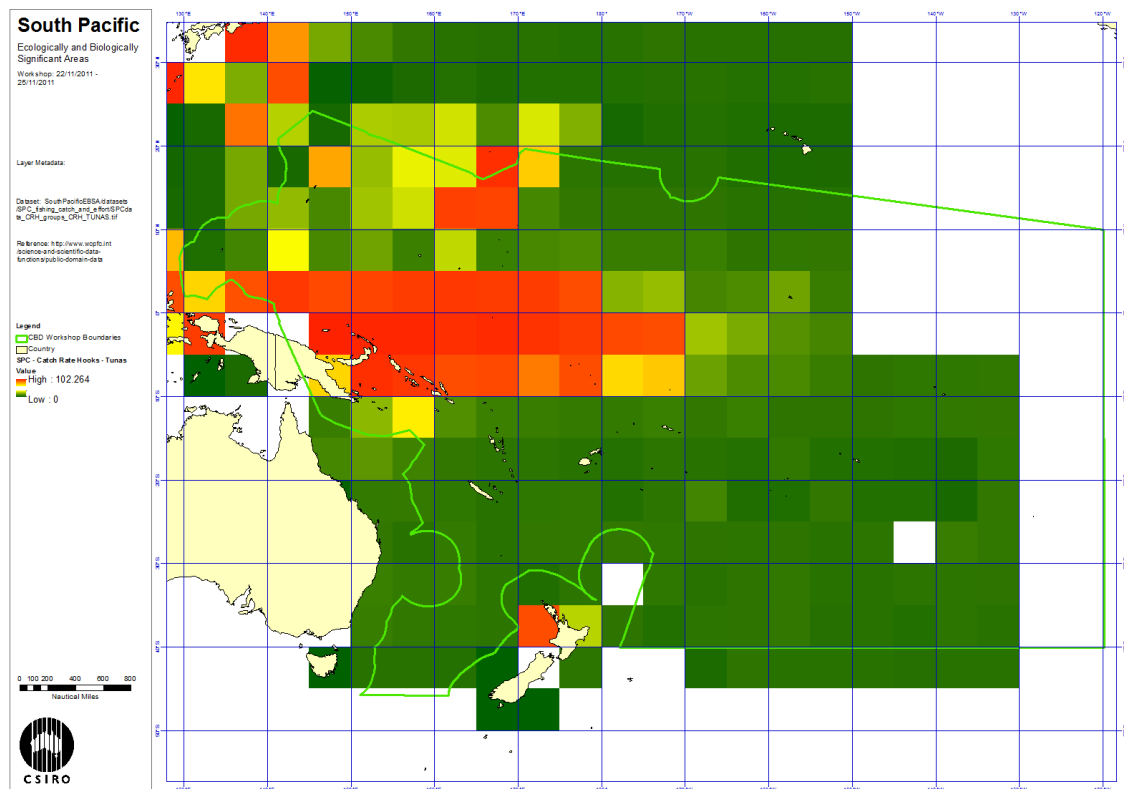


Figure 3.4: Annual Tuna Catch

3.4.2 Marlin

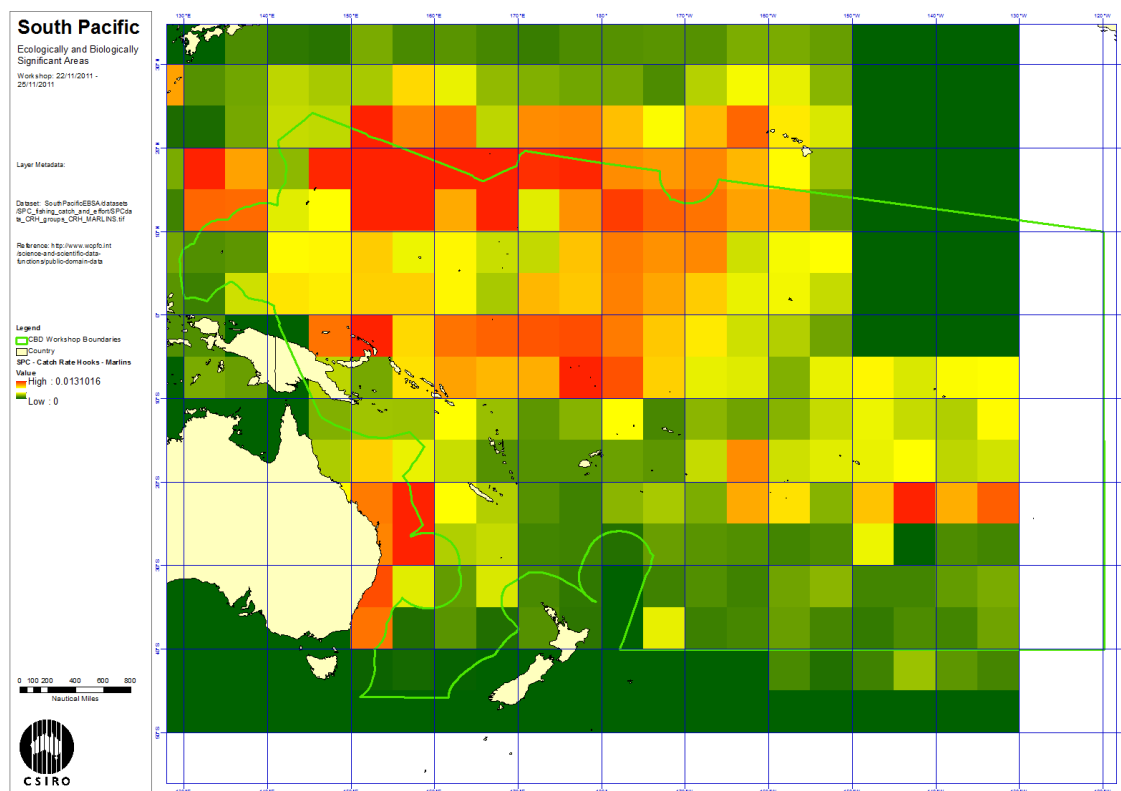


Figure 3.5: Annual Marlin Catch

3.4.3 Swordfish

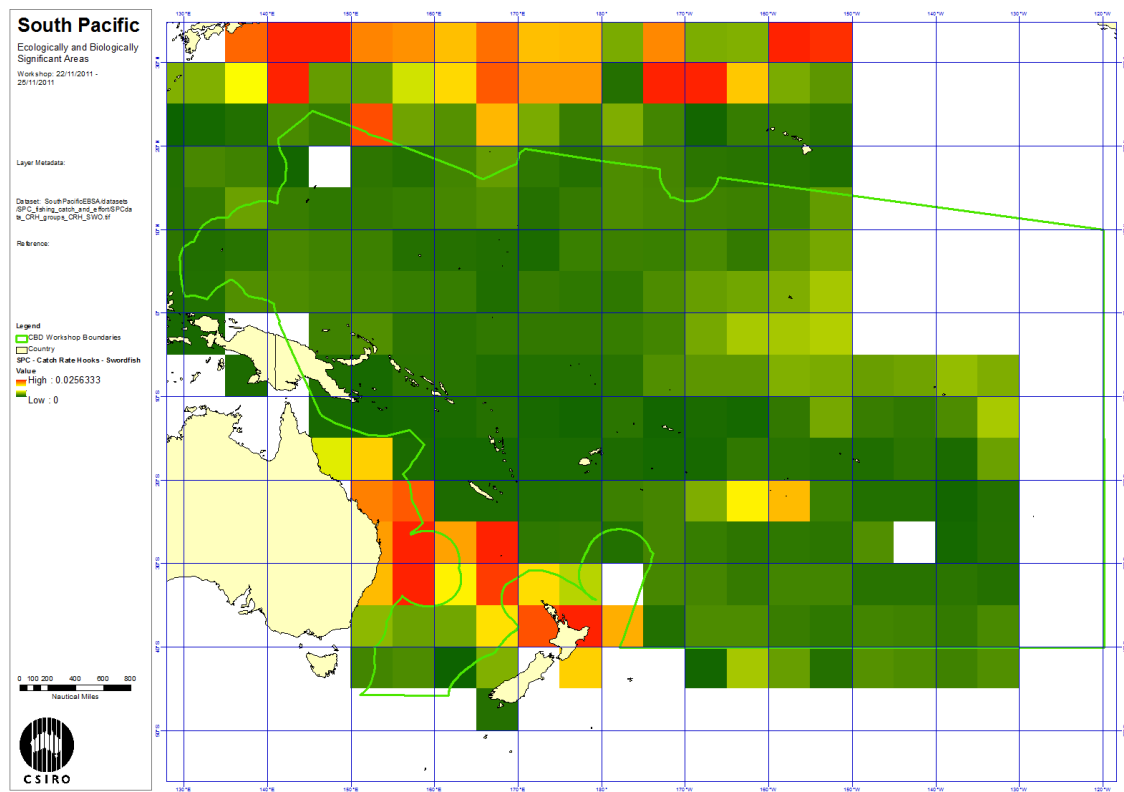


Figure 3.6: Annual Swordfish Catch

3.4.4 Other

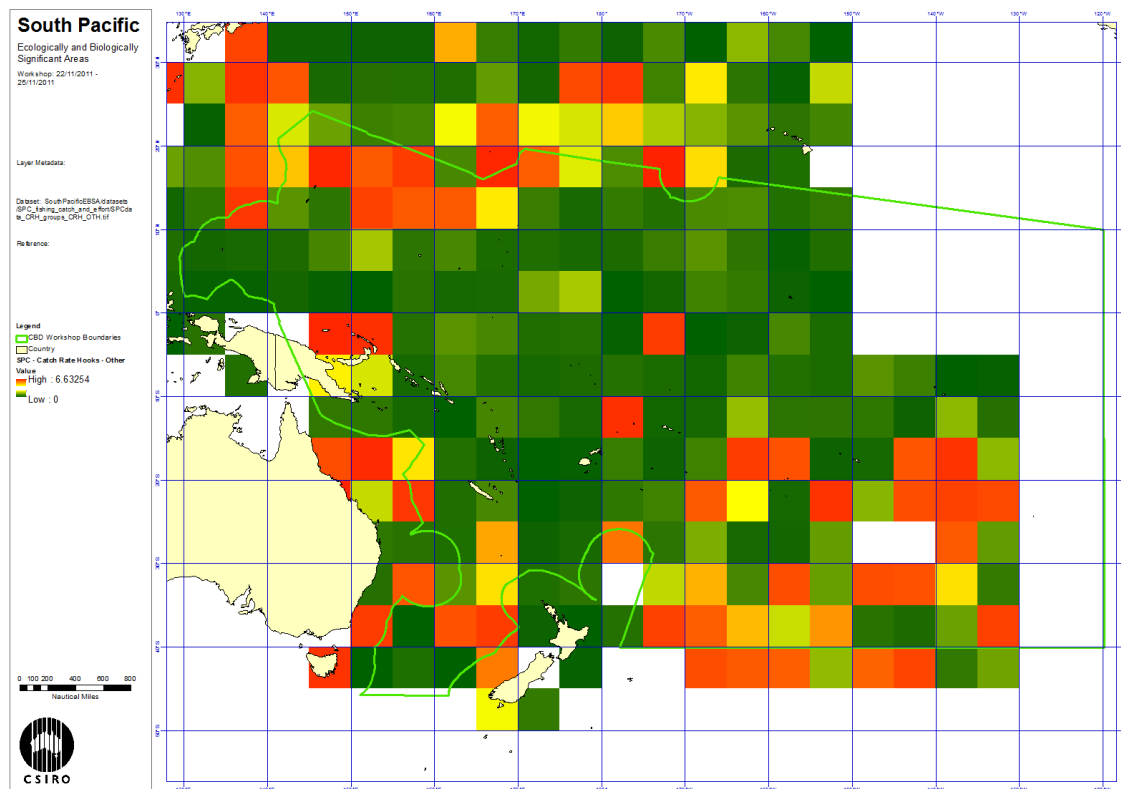


Figure 3.7: Annual Catch other species

3.5 Patterns of Turtle Movements

Data on the movement of green turtles was obtained using datasets (lon/lat) for turtles flipper-tagged and recaptured (most of the cases, different locations (countries)). These will not provide an accurate picture of the corridors in-between (where tagged and where recaptured). However, they can still be used for estimates (using a straight line) especially for turtles that were tagged after nesting, as they usually migrate straight back to their foraging areas after nesting. The actual points are sensitive - the large pixels reduce the accuracy quite a bit. The line data simply connects release and recapture tag numbers and shows some general trends. New Caledonia foraging head to Australia to nest, French Polynesia turtles head to Fiji, and FSM turtles have a fondness for the Philippines. Satellite tagging of green turtle nesters in the region indicate that most travel is a fairly straight line from nesting area to foraging area. The map is produced from data held in the SPREP regional marine turtle database.

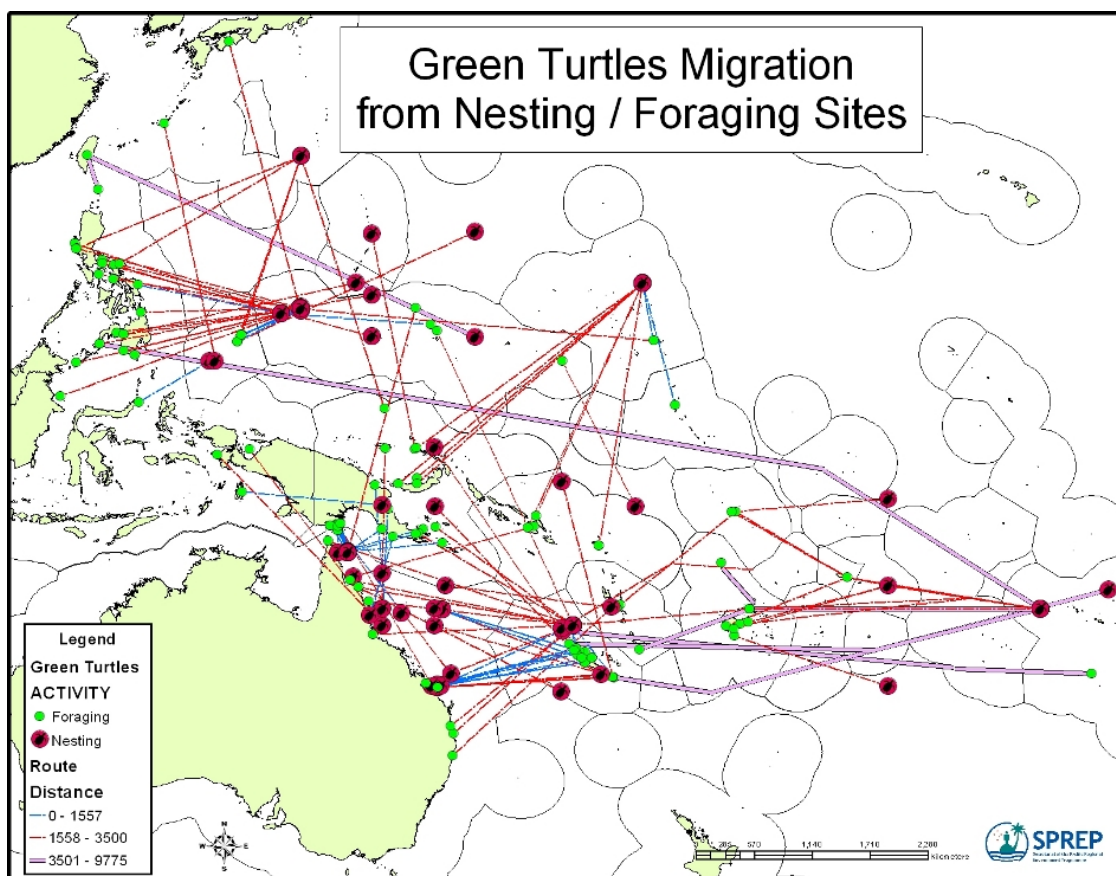


Figure 3.8: Turtle Movements

3.6 Predictions of Deep Sea Corals

Predictive habitat models are increasingly being used by conservationists, researchers and governmental bodies to identify vulnerable ecosystems and species distributions in areas that have not been sampled. However, in the deep sea, several limitations have restricted the widespread utilisation of this approach. These range from issues with the accuracy of species presences, the lack of reliable absence data and the limited spatial resolution of environmental factors known or thought to control deep-sea species distributions. To address these problems, global habitat suitability models have been generated for five species of framework-forming scleractinian corals by taking the best available data and using a novel approach to generate high resolution maps of seafloor conditions. High-resolution global bathymetry was used to resample gridded data from sources such as World Ocean Atlas to produce continuous 30-arc second (1 km²) global grids for environmental, chemical and physical data of the world's oceans. The increased area and resolution of the environmental variables resulted in a greater number of coral presence records being incorporated into habitat models and higher accuracy of model predictions. The most important factors in determining cold-water coral habitat suitability were depth, temperature, aragonite saturation state and salinity. Model outputs indicated the majority of suitable coral habitat is likely to occur on the continental shelves and slopes of the Atlantic, South Pacific and Indian Oceans. The North Pacific has very little suitable scleractinian coral habitat. Numerous small scale features (i.e., seamounts), which have not been sampled or identified as having a high probability of supporting cold-water coral habitat were identified in all ocean basins. Field validation of newly identified areas is needed to determine the accuracy of model results, assess the utility of modelling efforts to identify vulnerable marine ecosystems for inclusion in future marine protected areas and reduce coral bycatch by commercial fisheries.

Davies AJ, Guinotte JM (2011) Global Habitat Suitability for Framework-Forming Cold-Water Corals. PLoS ONE 6(4): e18483. doi:10.1371/journal.pone.0018483

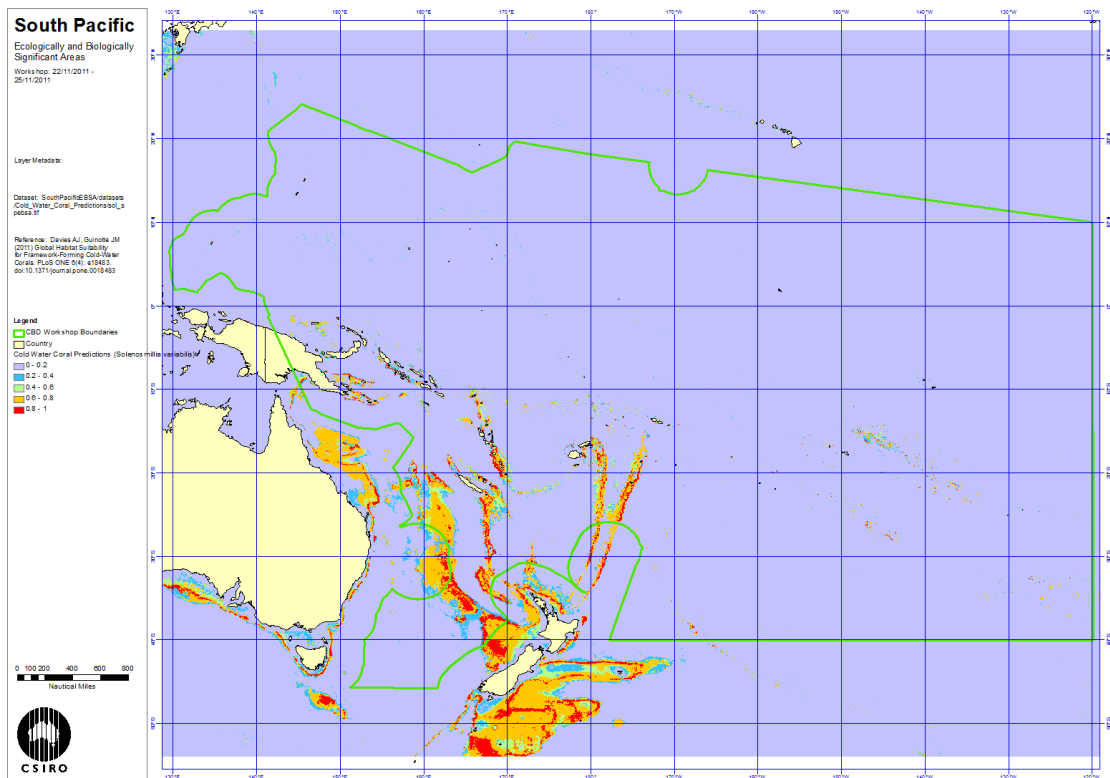


Figure 3.9: Predictions for *Solenosmilia variabilis*

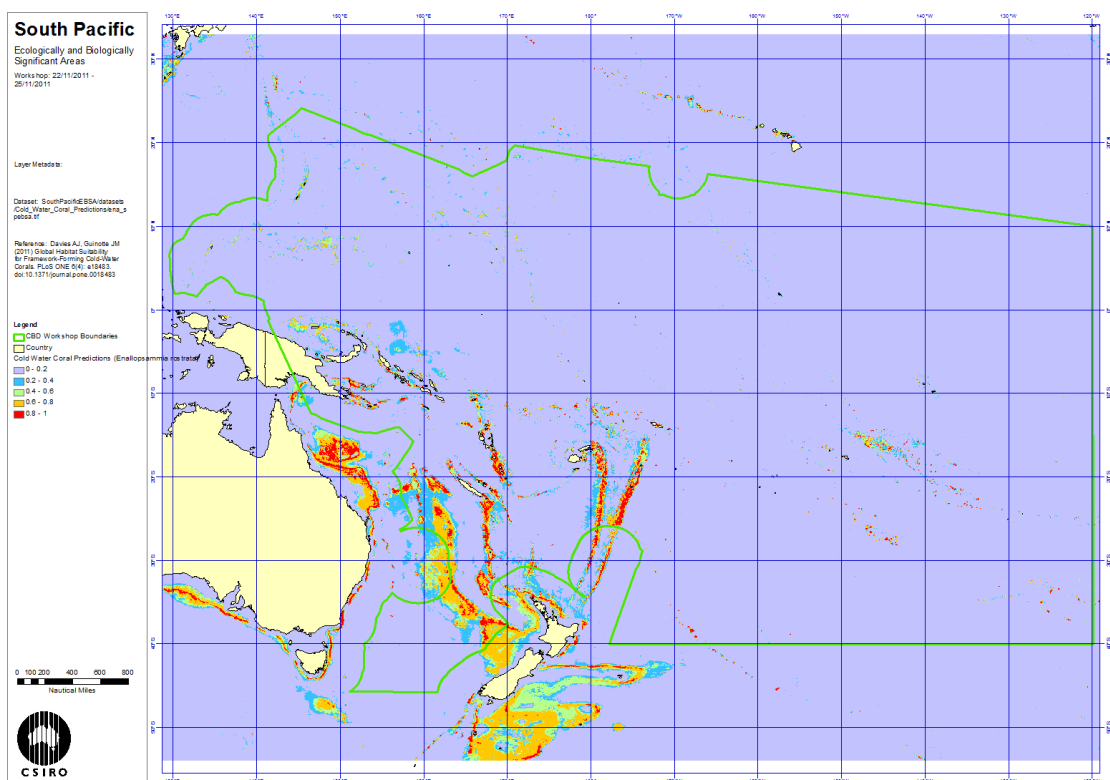


Figure 3.10: Predictions for *Enallipsammia rostrata*

3.7 OBIS Data

The concept of OBIS was first developed at a conference sponsored by the Census of Marine Life (CoML) in 1997. At the time, a comprehensive system for the retrieval of ocean biological data did not exist. The databases that did exist to distribute ocean biological data failed to "usefully summarize known distributions and abundance of marine life nor are they organized to encouraged frequent use or intercomparison of datasets" (Grassle 2000). The problems generated by this disenfranchisement of marine data from the frequent user are very serious ones: if scientists cannot efficiently collect and effectively share data about the oceans with each other, how will anyone be able to generate new, comprehensive hypotheses about our oceans? If new findings about the oceans remain localized and hidden from the rest of the marine science community, then the data fails to have an impact on research in the marine science community at large.

Not long after the initial meeting, OBIS was established as a project of the Census of Marine Life to help facilitate global enfranchisement of data within the scientific community. The goal of OBIS was simple: to create "an online, user-friendly system for absorbing, integrating, and accessing data about life in the oceans" (Grassle 2000). The system would stimulate taxonomic and systematic research and generate new hypotheses concerning: - evolutionary processes - factors related to maintainance of species distributions - roles of marine organisms in marine ecosystem function (Grassle 2000).

For the last decade, the OBIS community has worked tirelessly to make sure that all data contributed to OBIS from hundreds of providers is available to the public through its search interface. In many ways, the OBIS database has become the database that the OBIS community envisioned at its creation.

But OBIS is still evolving: OBIS hopes to become even more user friendly, appealing to both the scientific community and the common internet user. The OBIS community promotes an open access policy and believes that data collected about the oceans should be easily accessible to a diverse set of users.

The data provided here are summaries of OBIS data available. Species Richness and ES(50) data summaries for 1° grids in the Western South Pacific are provided for all species, deep species(>100m depth), shallow species (<100m depth), all mammals and turtles.

<http://www.iobis.org/>

3.7.1 All Species

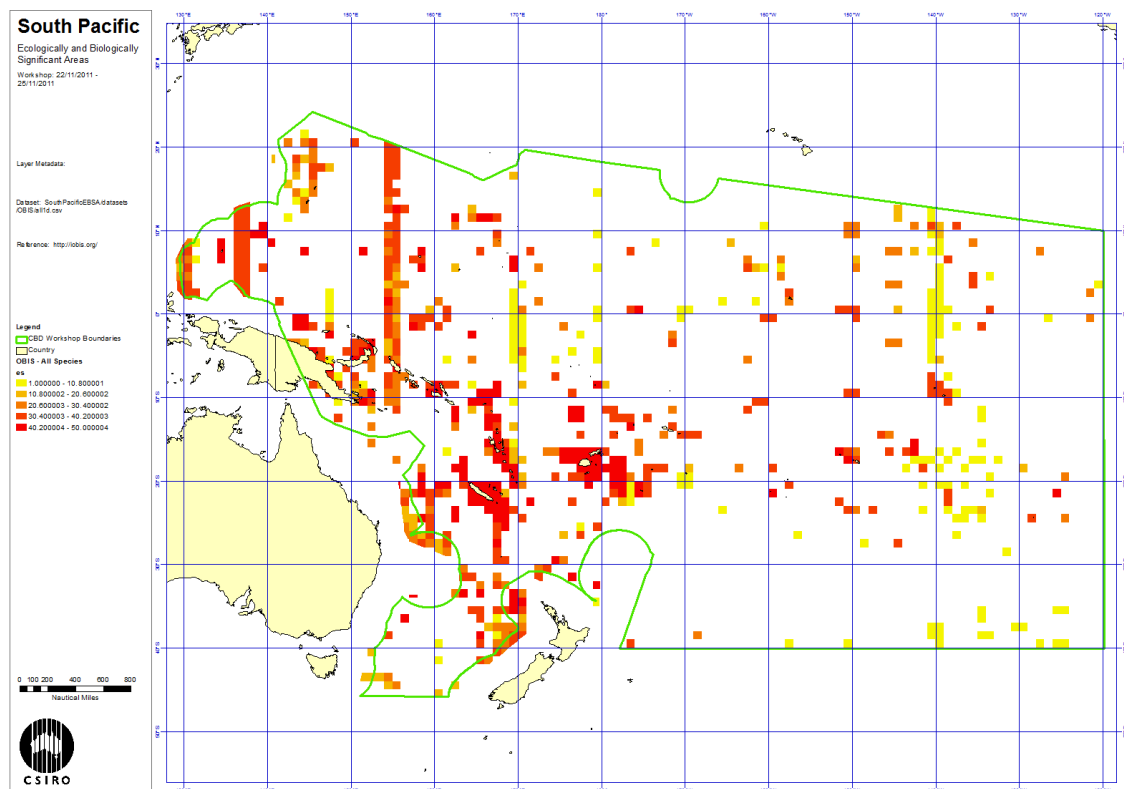


Figure 3.11: OBIS ES(50) for all species

3.7.2 Shallow Species

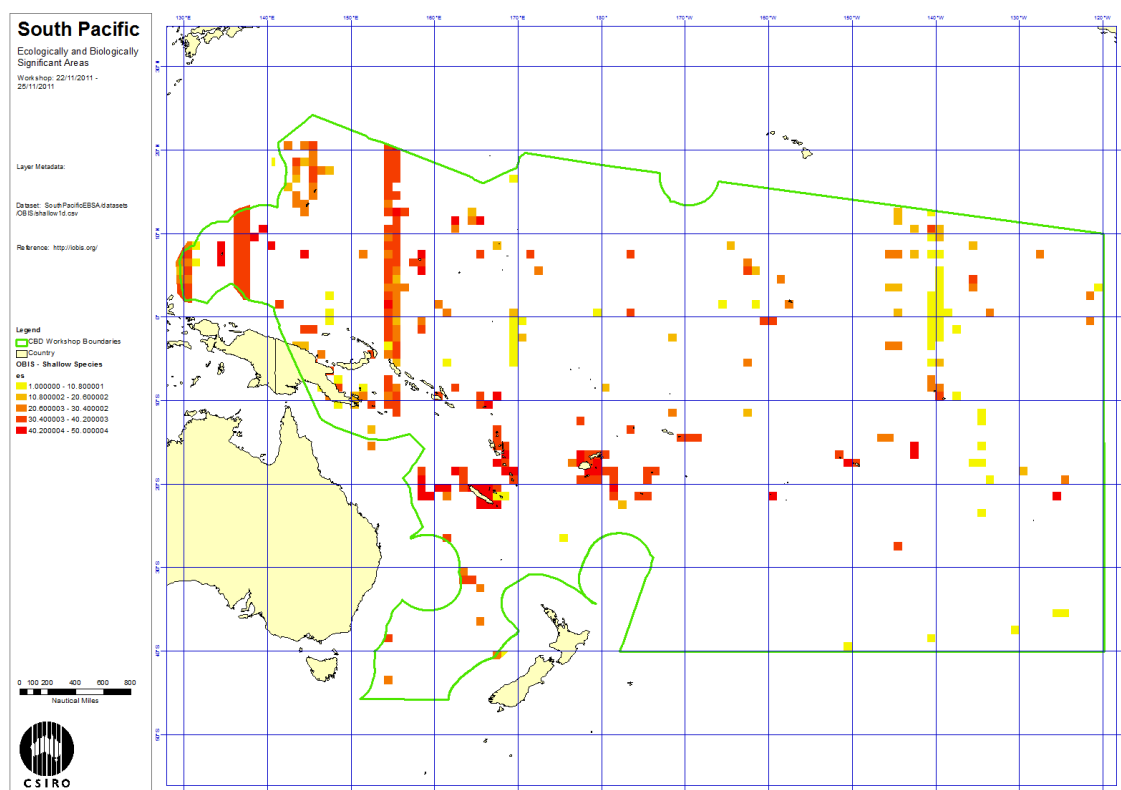


Figure 3.12: OBIS ES(50) for shallow species

3.7.3 Deep Species

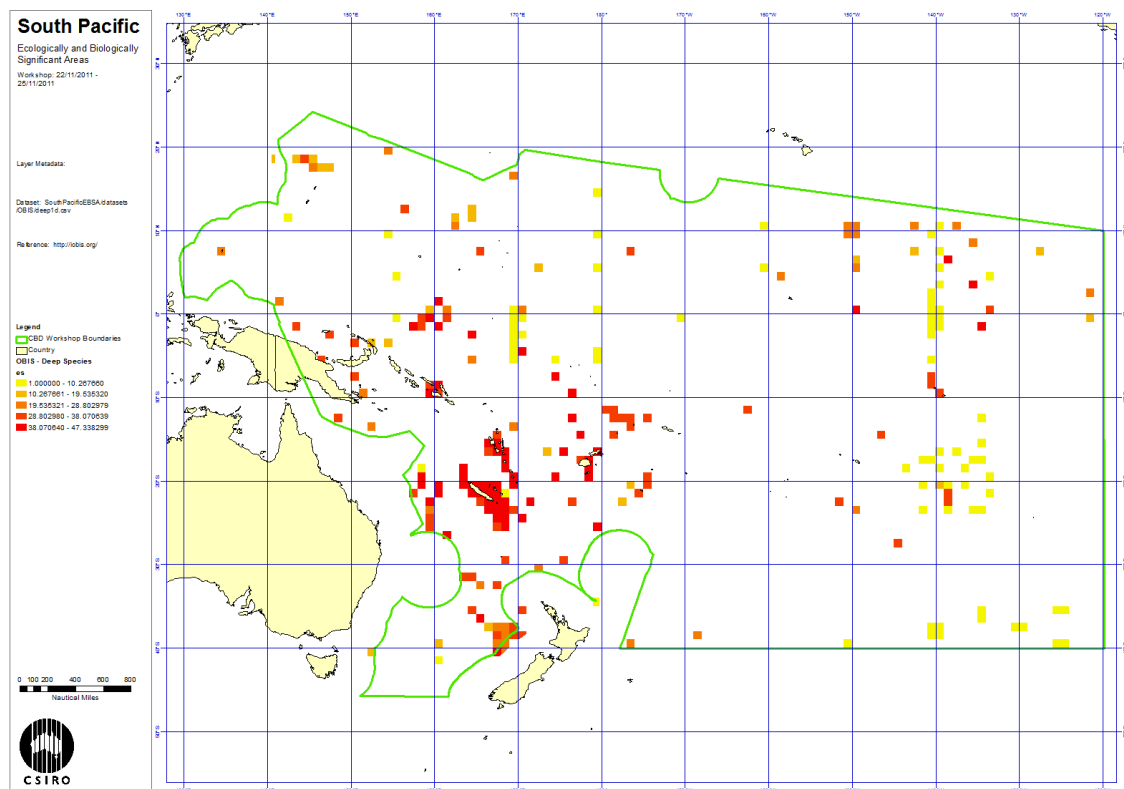


Figure 3.13: OBIS ES(50) for deep species

3.7.4 Mammals

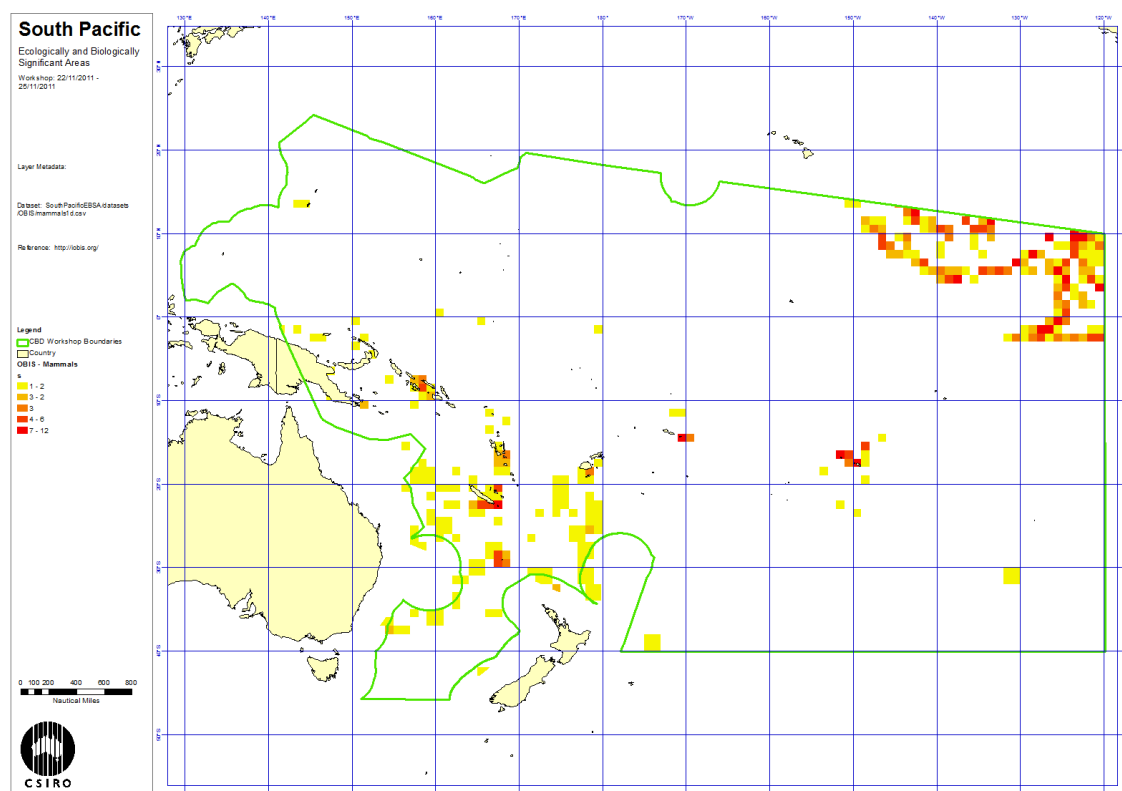


Figure 3.14: OBIS species count for mammals

3.7.5 Turtles

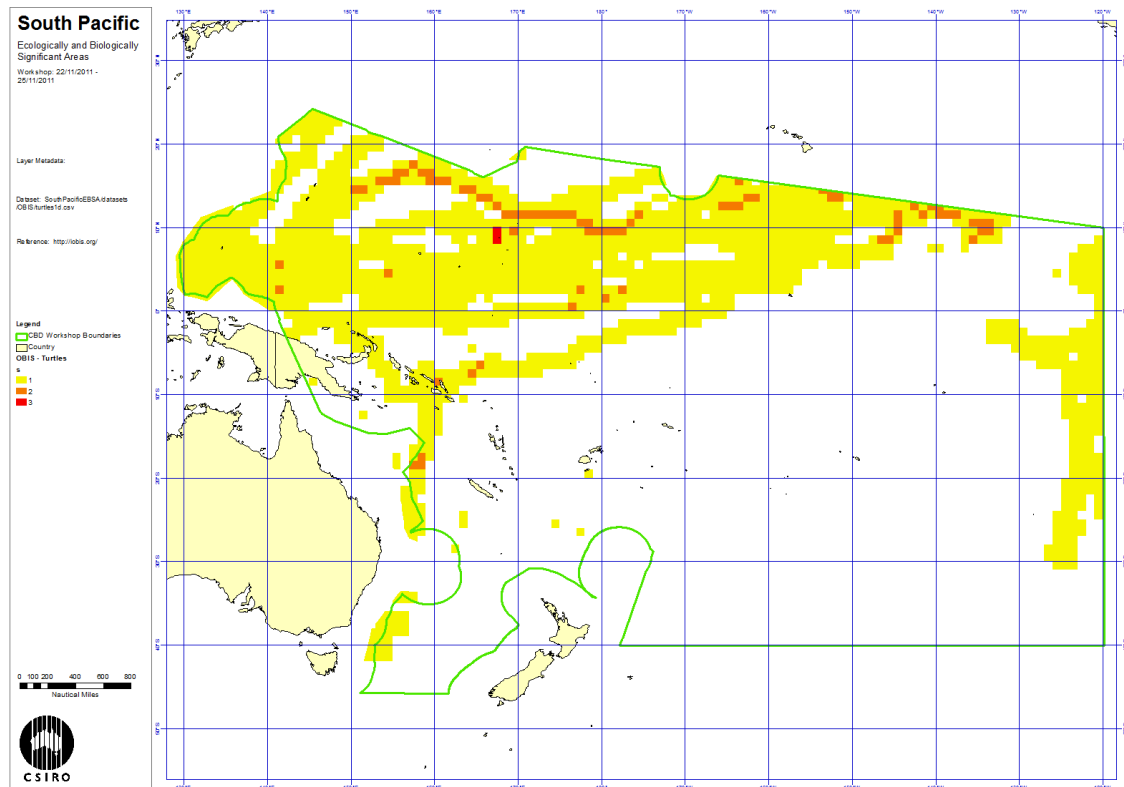


Figure 3.15: OBIS species count for turtles

3.7.6 IUCN Red List Species

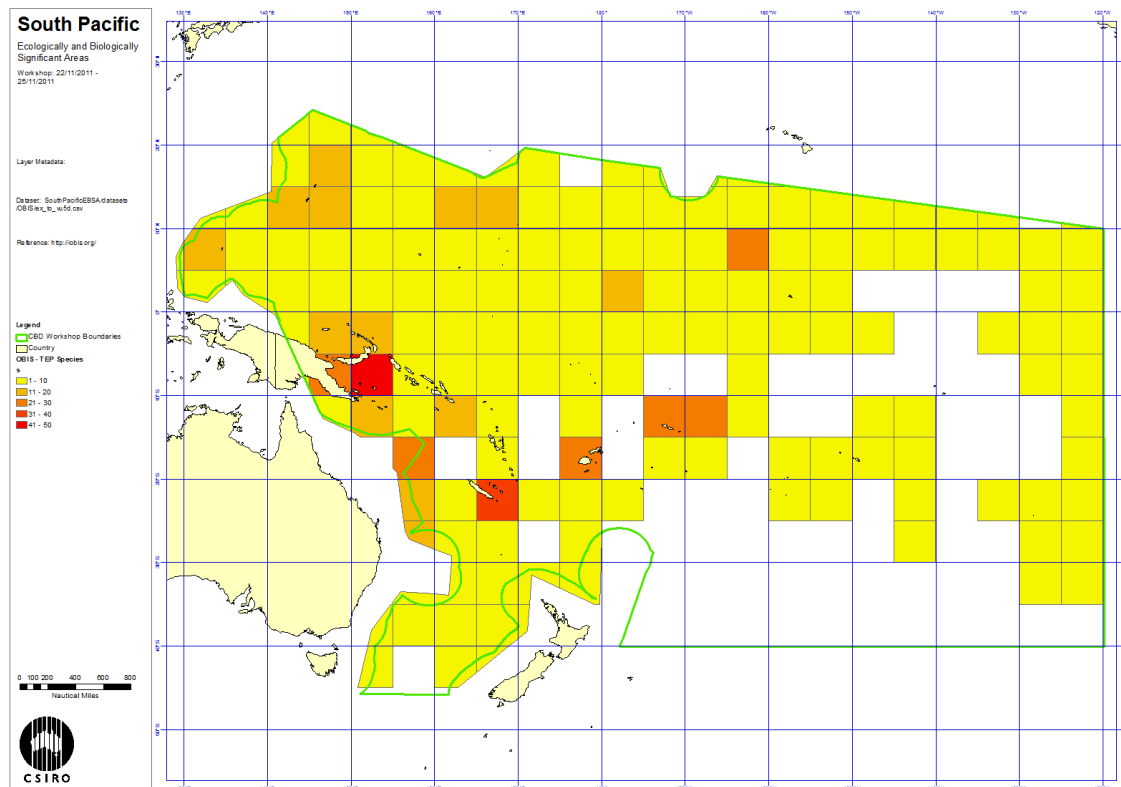


Figure 3.16: Count of IUCN redlist species in OBIS

3.8 Historical Whale Catches

The Wildlife Conservation Society has digitally captured the Townsend Whaling Charts that were published as a series of 4 charts with the article titled "The distribution of certain whales as shown by logbook records of American whale ships" by Charles Haskins Townsend in the journal *Zoologica* in 1935.

The 4 charts (of which three are used here) show the locations of over 50,000 captures of 4 whale species; sperm whales (36,908), right whales (8,415), humpback whales (2,883) and bowhead whales (5,114). Capture locations were transcribed from North American (Yankee) pelagic whale vessel log books dating from 1761 to 1920 and plotted onto nautical charts in a Mercator projection by a cartographer. Each point plotted on the charts represents the location of a whaling ship on a day when one or more whales were taken and is symbolized by month of the year using a combination of color and open and closed circles.

Townsend and his cartographer plotted vessel locations as accurately as possible according to log book records. When plotting locations on an earlier sperm whale chart published in 1931 the cartographer spaced points where locations were very dense, extending areas slightly for a number of whaling grounds. However for charts in preparation at this time Townsend states that this difficulty is avoided by omitting some of the data, rather than extend the ground beyond actual whaling limits. We assume that this statement refers to the 1935 charts but there is still some question as to whether the cartographer did in fact space locations and thus expand whaling grounds

Digitizing errors include missed points, particularly from areas of dense chart locations, and incorrect assignment of month of capture because of difficulty distinguishing between chart colors. However to limit these errors multiple checks of digitized and chart locations were made and color enhancements of chart scans were used to ensure correct month assignments. Overall we are confident that at least 95% of catch locations have been digitized and that at least 95% of month attributes are correct.

Townsend, C.H. 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologica* 19, No. 1:1-50, 4 charts.

Townsend, C.H. 1931. Where the nineteenth century whaler made his catch. *Zoologica* 34, No. 6:173-179.

Reeves, R., Smith, T.D. Josephson, E.A., Clapham, P.J. and Woolmer, G. 2004. Historical observations of humpback and blue whales in the North Atlantic Ocean: Clues to migratory routes and possibly additional feeding grounds. *Marine Mammal Science*. Vol. 20 (4), pg 774-786.

http://web.archive.org/web/20070926224128/http://wcs.org/townsend_charts

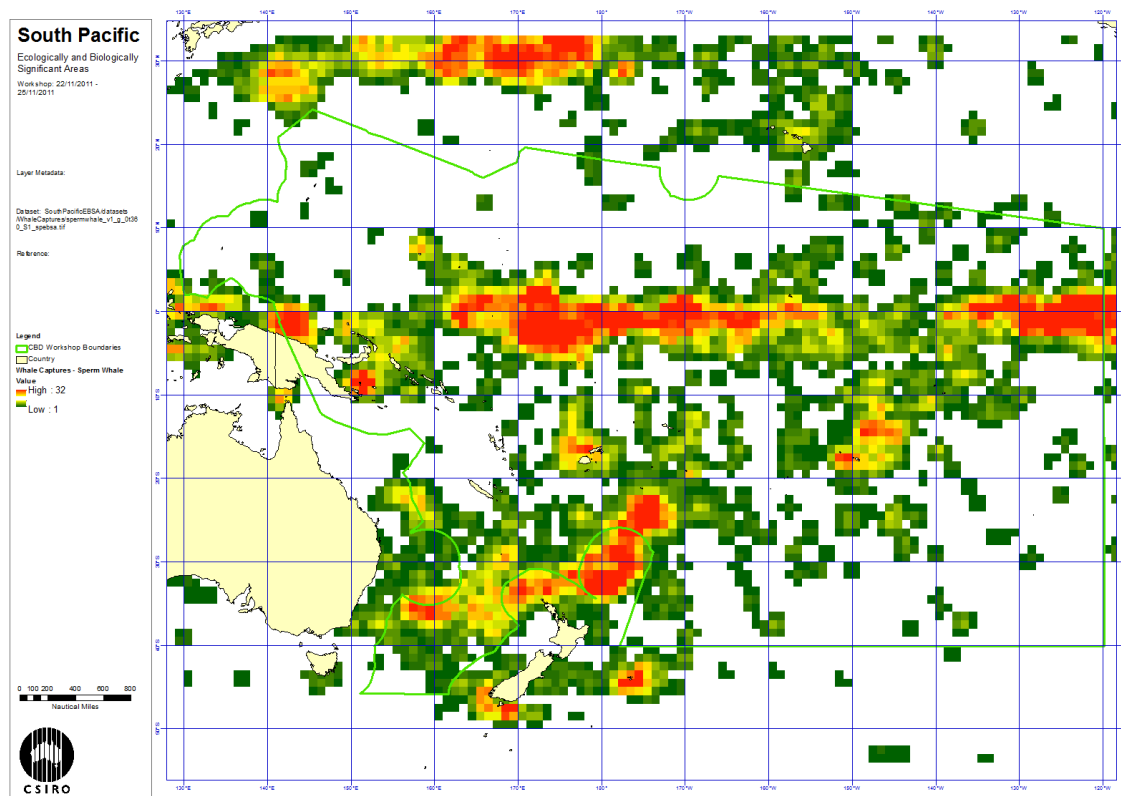


Figure 3.17: Annual Historical Captures of Sperm Whales per 1° square

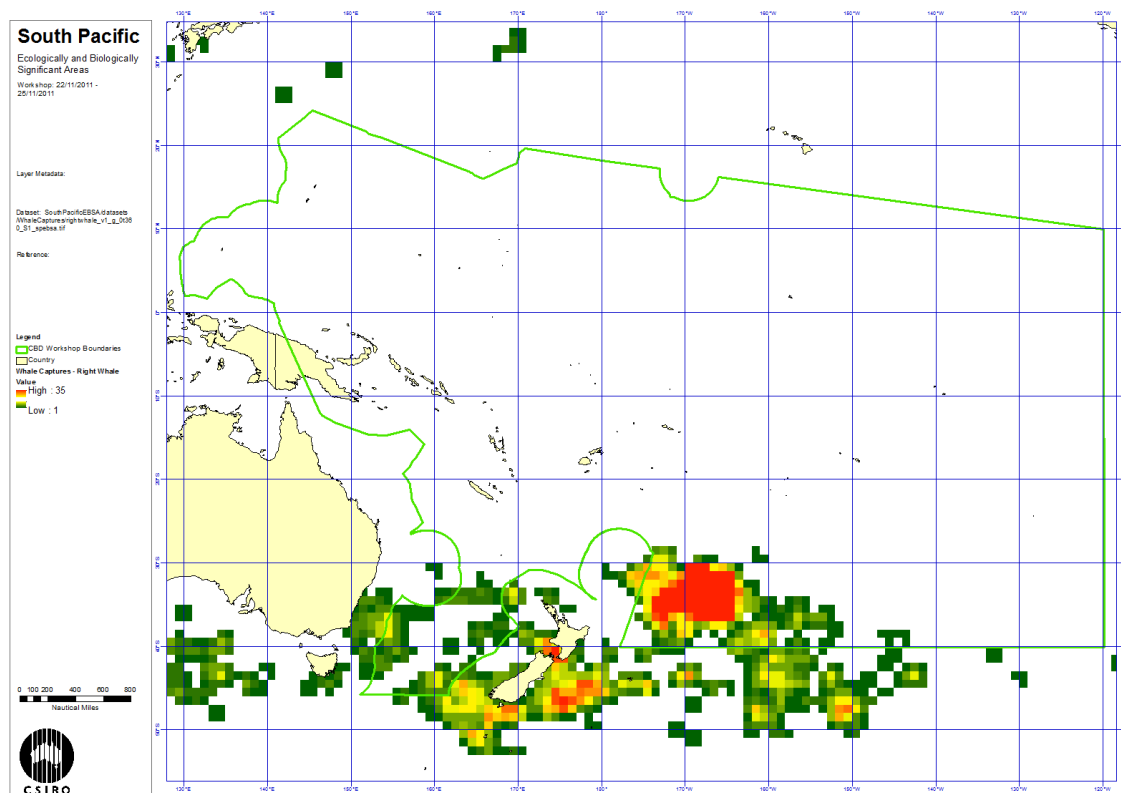


Figure 3.18: Annual Historical Captures of Right Whales per 1° square

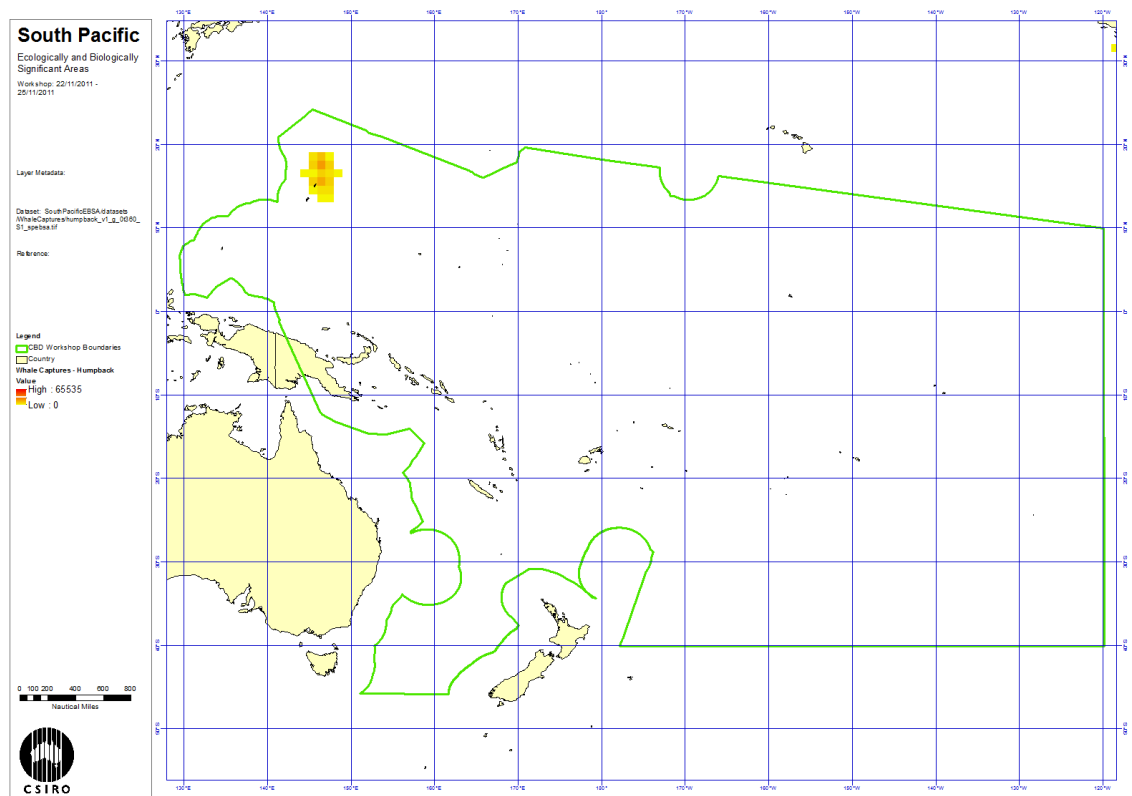


Figure 3.19: Annual Historical Captures of Humpback Whales per 1° square

4 Physical Data

4.1 Seamount Locations

Seamounts and knolls are undersea mountains, the former rising more than 1000 m from the seafloor. These features provide important habitats for aquatic predators, demersal deep-sea fish and benthic invertebrates. However most seamounts have not been surveyed and their numbers and locations are not well known. Previous efforts to locate and quantify seamounts have used relatively coarse bathymetry grids. Here we use global bathymetric data at 30 arc-sec resolution to identify seamounts and knolls. We identify 33,452 seamounts and 138,412 knolls, representing the largest global set of identified seamounts and knolls to date. We compare estimated seamount numbers, locations, and depths with validation sets of seamount data from New Zealand and Azores. This comparison indicates the method we apply finds 94% of seamounts, but may overestimate seamount numbers along ridges and in areas where faulting and seafloor spreading creates highly complex topography. The seamounts and knolls identified herein are significantly geographically biased towards areas surveyed with ship-based soundings. As only 6.5% of the ocean floor has been surveyed with soundings it is likely that new seamounts will be uncovered as surveying improves. Seamount habitats constitute approximately 4.7% of the ocean floor, whilst knolls cover 16.3%. Regional distribution of these features is examined, and we find a disproportionate number of productive knolls, with a summit depth of o 1.5 km, located in the Southern Ocean. Less than 2% of seamounts are within marine protected areas and the majority of these are located within exclusive economic zones with few on the High Seas. The database of seamounts and knolls resulting from this study will be a useful resource for researchers and conservation planners.

Yesson, C., et al., The global distribution of seamounts based on 30 arc seconds bathymetry data. *Deep-Sea Research I* (2011), doi:10.1016/j.dsr.2011.02.004

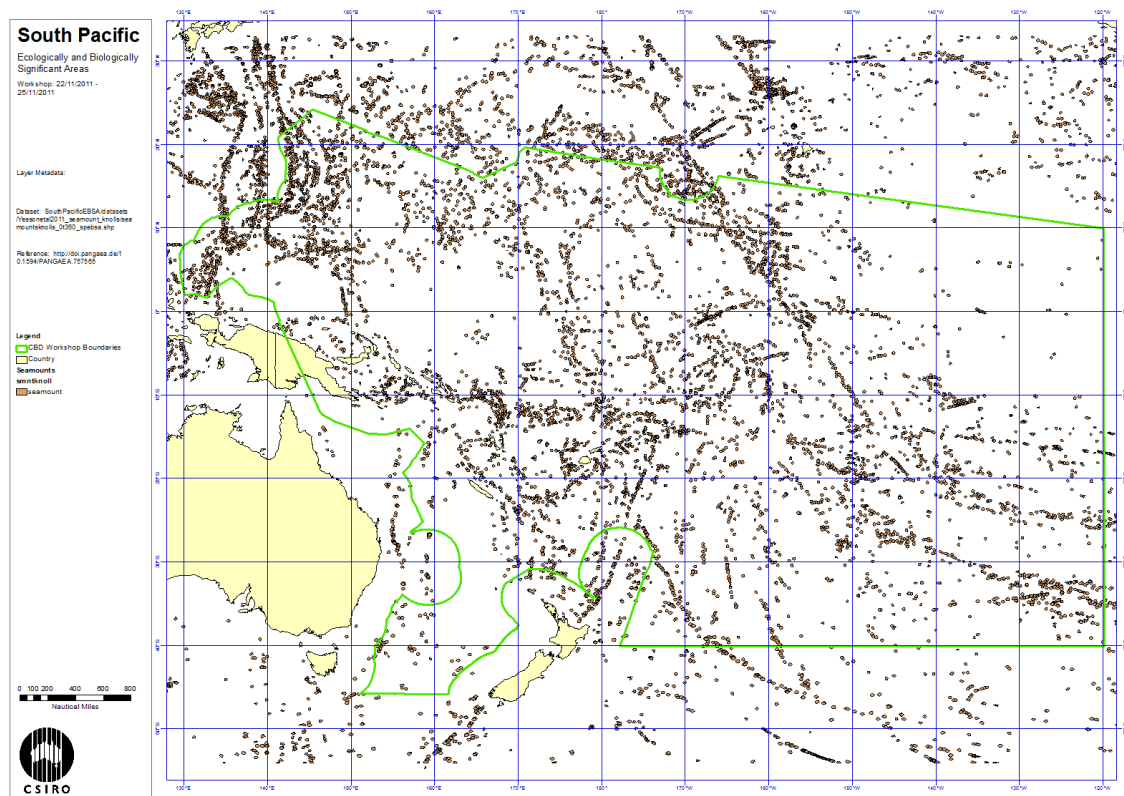


Figure 4.1: Locations of seamounts

4.2 Global Seascapes

Designing a representative network of high seas marine protected areas (MPAs) requires an acceptable scheme to classify the benthic (as well as the pelagic) bioregions of the oceans. Given the lack of sufficient biological information to accomplish this task, we used a multivariate statistical method with 6 biophysical variables (depth, seabed slope, sediment thickness, primary production, bottom water dissolved oxygen and bottom temperature) to objectively classify the ocean floor into 53,713 separate polygons comprising 11 different categories, that we have termed seascapes. A cross-check of the seascape classification was carried out by comparing the seascapes with existing maps of seafloor geomorphology and seabed sediment type and by GIS analysis of the number of separate polygons, polygon area and perimeter/area ratio. We conclude that seascapes, derived using a multivariate statistical approach, are biophysically meaningful subdivisions of the ocean floor and can be expected to contain different biological associations, in as much as different geomorphological units do the same. Less than 20% of some seascapes occur in the high seas while other seascapes are largely confined to the high seas, indicating specific types of environment whose protection and conservation will require international cooperation. Our study illustrates how the identification of potential sites for high seas marine protected areas can be accomplished by a simple GIS analysis of seafloor geomorphic and seascape classification maps. Using this approach, maps of seascape and geomorphic heterogeneity were generated in which heterogeneity hotspots identify themselves as MPA candidates. The use of computer aided mapping tools removes subjectivity in the MPA design process and provides greater confidence to stakeholders that an unbiased result has been achieved.

Harris and Whiteway 2009. High seas marine protected areas: Benthic environmental conservation priorities from a GIS analysis of global ocean biophysical data. *Ocean & Coastal Management* 52 2238. doi:10.1016/j.ocecoaman.2008.09.009

http://www.gebco.net/data_and_products/gridded_bathymetry_data/

<http://www.ngdc.noaa.gov/mgg/sedthick/sedthick.html>

http://www.nodc.noaa.gov/OC5/WOA09/pr_woa09.html

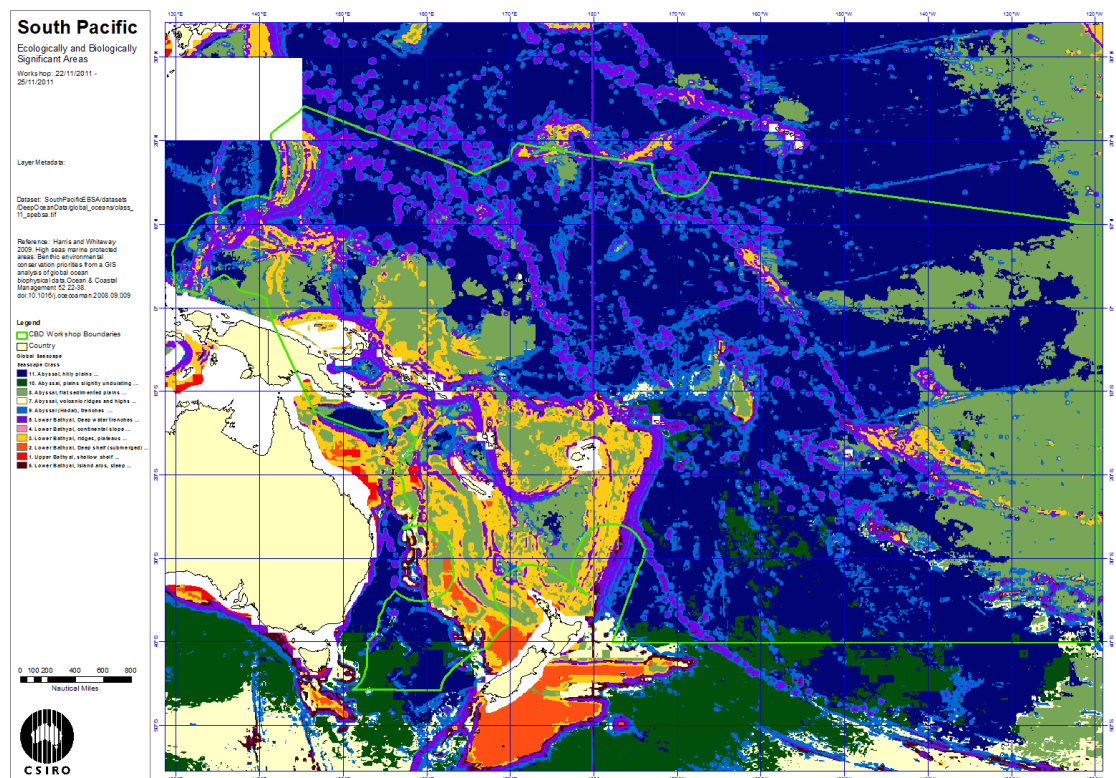


Figure 4.2: Derived Global Seascapes

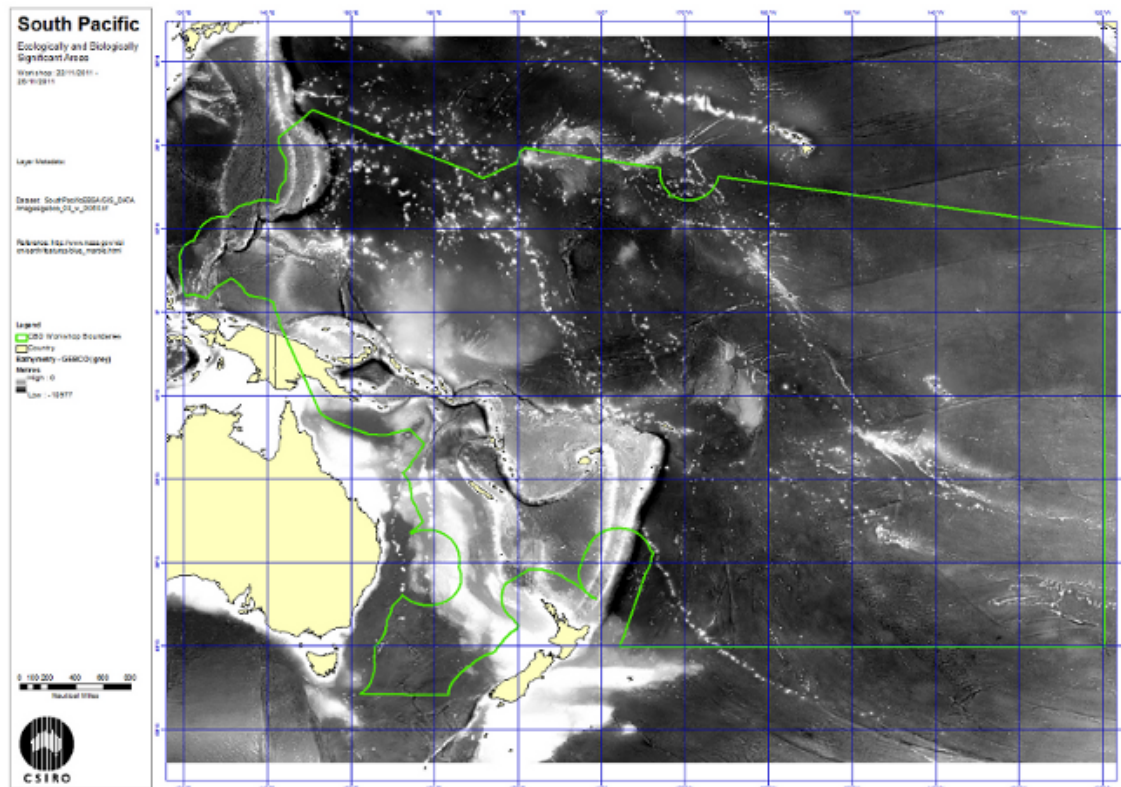


Figure 4.3: GEBCO, a global 30 arc-second grid largely generated by combining quality-controlled ship depth soundings with interpolation between sounding points guided by satellite-derived gravity data. However, in areas where they improve on the existing GEBCO 08 grid, data sets generated by other methods have been included. Land data are largely based on the Shuttle Radar Topography Mission (SRTM30) gridded digital elevation model.

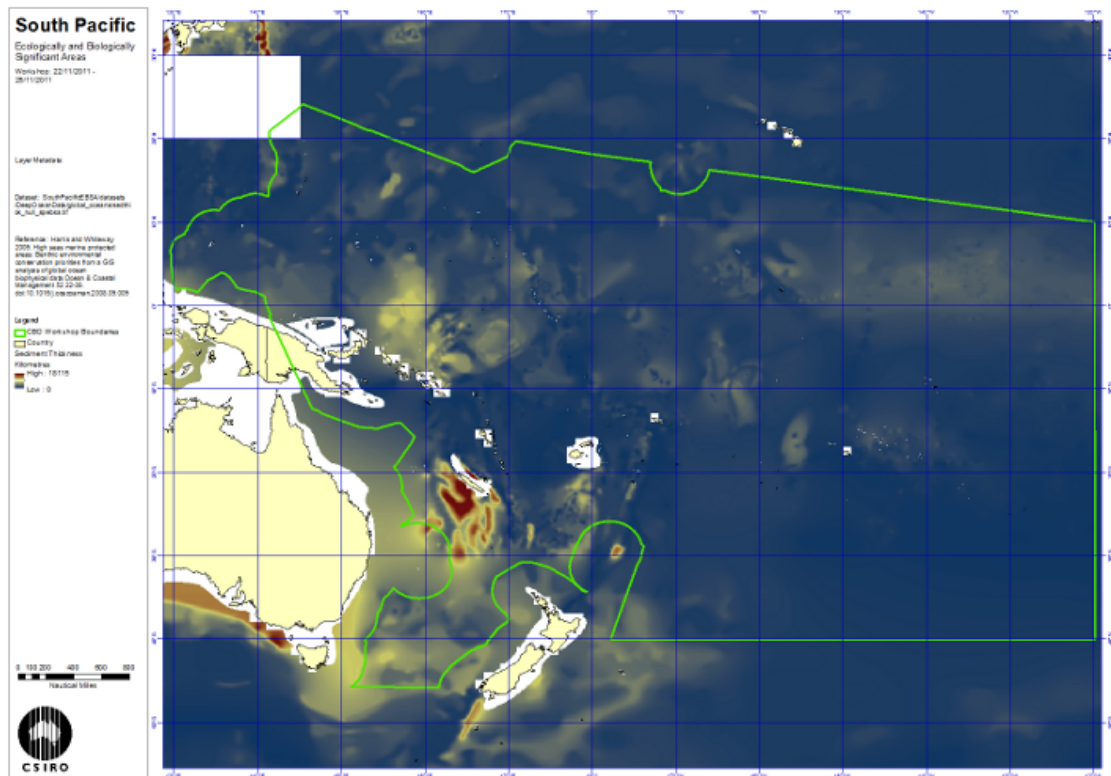


Figure 4.4: Total Sediment Thickness of the Worlds Oceans & Marginal Seas is a digital total sediment thickness database for the worlds oceans and marginal seas compiled by the National Geophysical Data Center (NGDC). The 5 min (w9 km) grid of sediment thickness data were derived from a number of sources by Divins [24]. Note data gaps occur in the area south of Japan, in the Arctic Ocean and Mediterranean Sea, which are not included in this analysis. Sediment thickness Divins DL. National geophysical data center total sediment thickness of the world's oceans and marginal seas.

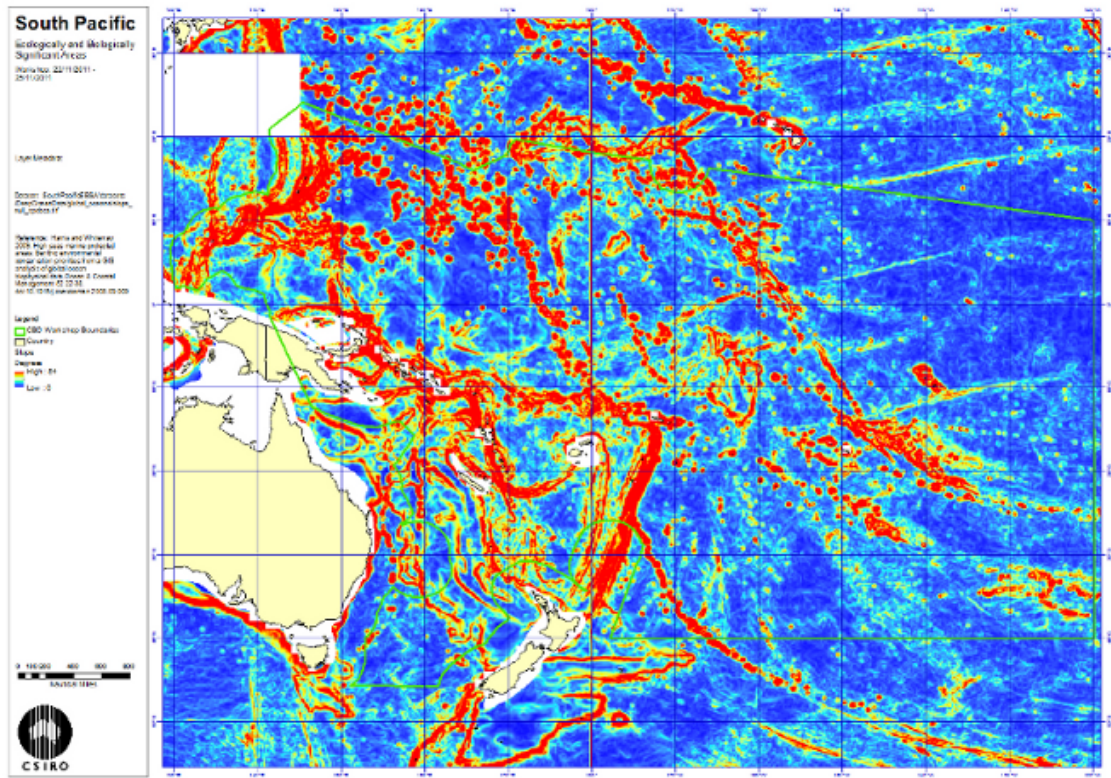


Figure 4.5: Map showing the distribution of seabed slope. Derivation of seabed slope from the ETOPO-2 bathymetry grid used an algorithm in ArcGIS that calculates the maximum slope in a grid cell from the surrounding 8 cells. We found this method gave unrealistically high slope values, presumably due to the noise inherent in the ETOPO-2 bathymetry grid which is accentuated when the maximum slope values between adjacent cells are measured. In order to produce a more realistic estimate of slope, we first smoothed the ETOPO-2 bathymetry grid using a 10-cell moving average filter which we found gave reasonable slope values. Slope derived from ETOPO-2. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Geophysical Data Center. 2-minute Gridded Global Relief Data; 2006.

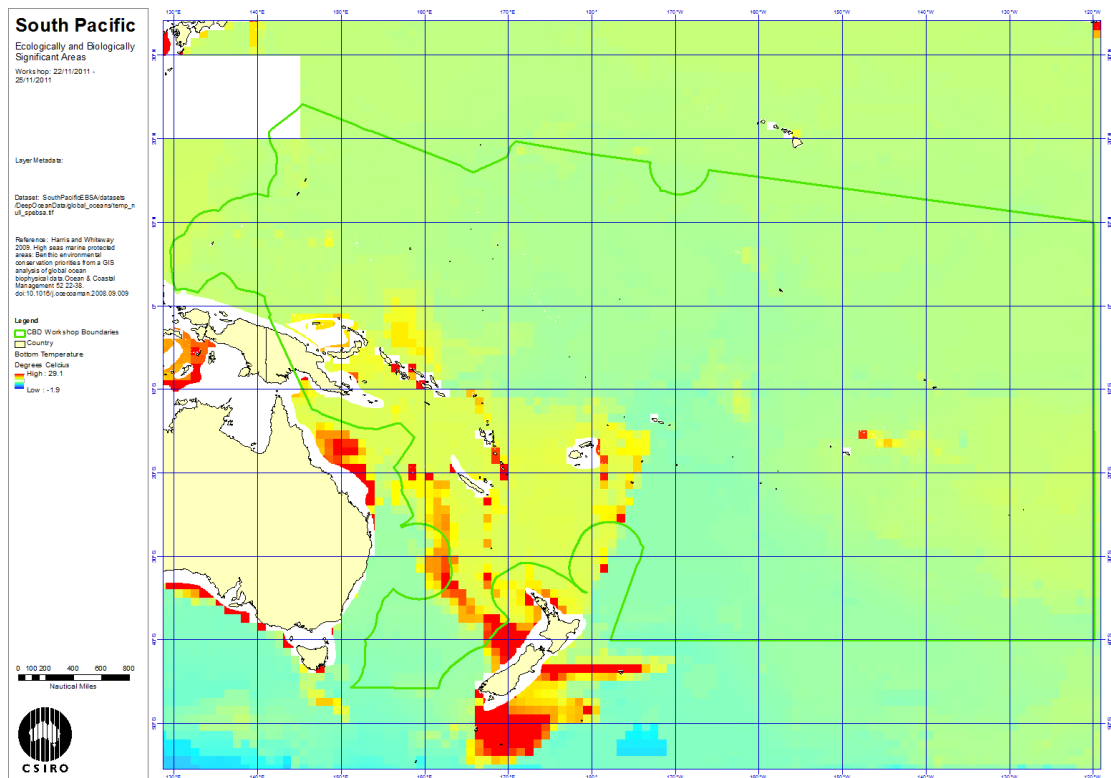


Figure 4.6: Ocean bottom water temperature from the NOAA World Ocean Atlas

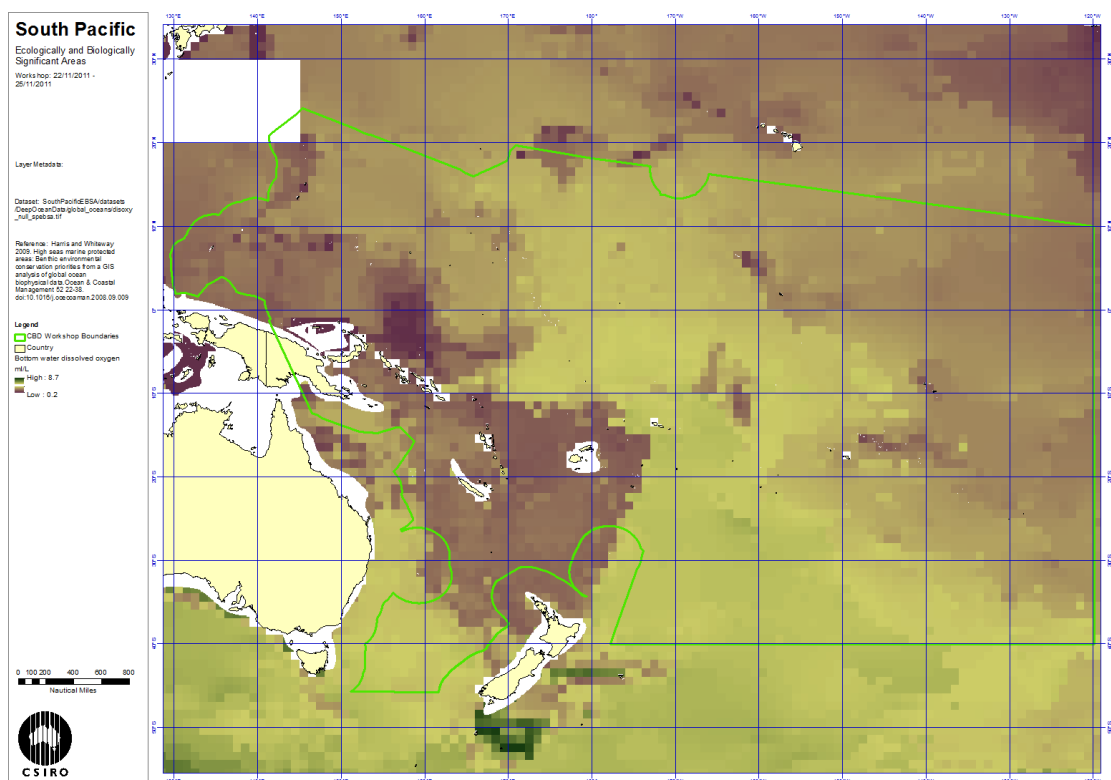


Figure 4.7: Ocean bottom water dissolved oxygen from the NOAA World Ocean Atlas

4.3 Distribution of Canyons

The aim of this study is to assess the global occurrence of large submarine canyons to provide context and guidance for discussions regarding canyon occurrence, distribution, geological and oceanographic significance and conservation. Based on an analysis of the ETOPO1 data set, this study has compiled the first inventory of 5849 separate large submarine canyons in the world ocean. Active continental margins contain 15% more canyons (2586, equal to 44.2% of all canyons) than passive margins (2244, equal to 38.4%) and the canyons are steeper, shorter, more dendritic and more closely spaced on active than on passive continental margins. This study confirms observations of earlier workers that a relationship exists between canyon slope and canyon spacing (increased canyon slope correlates with closer canyon spacing). The greatest canyon spacing occurs in the Arctic and the Antarctic whereas canyons are more closely spaced in the Mediterranean than in other areas. River-associated, shelf-incising canyons are more numerous on active continental margins ($n = 119$) than on passive margins ($n = 34$). They are most common on the western margins of South and North America where they comprise 11.7% and 8.6% of canyons respectively, but are absent from the margins of Australia and Antarctica. Geographic areas having relatively high rates of sediment export to continental margins, from either glacial or fluvial sources operating over geologic timescales, have greater numbers of shelf-incising canyons than geographic areas having relatively low rates of sediment export to continental margins. This observation is consistent with the origins of some canyons being related to erosive turbidity flows derived from fluvial and shelf sediment sources. Other workers have shown that benthic ecosystems in shelf-incising canyons contain greater diversity and biomass than non-incising canyons, and that ecosystems located above 1500 m water depth are more vulnerable to destructive fishing practices (bottom trawling) and ocean acidification caused by anthropogenic climate change. The present study provides the means to assess the relative significance of canyons located in different geographic regions. On this basis, the importance of conservation for submarine canyon ecosystems is greater for Australia, islands and northeast Asia than for other regions. Three different types were identified; (1) incise the shelf and connect to rivers, (2) incise the shelf and (3) confined to the slope.

Harris and Whiteway 2011. Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. *Marine Geology* 285 (2011) 6986. doi:10.1016/j.margeo.2011.05.008

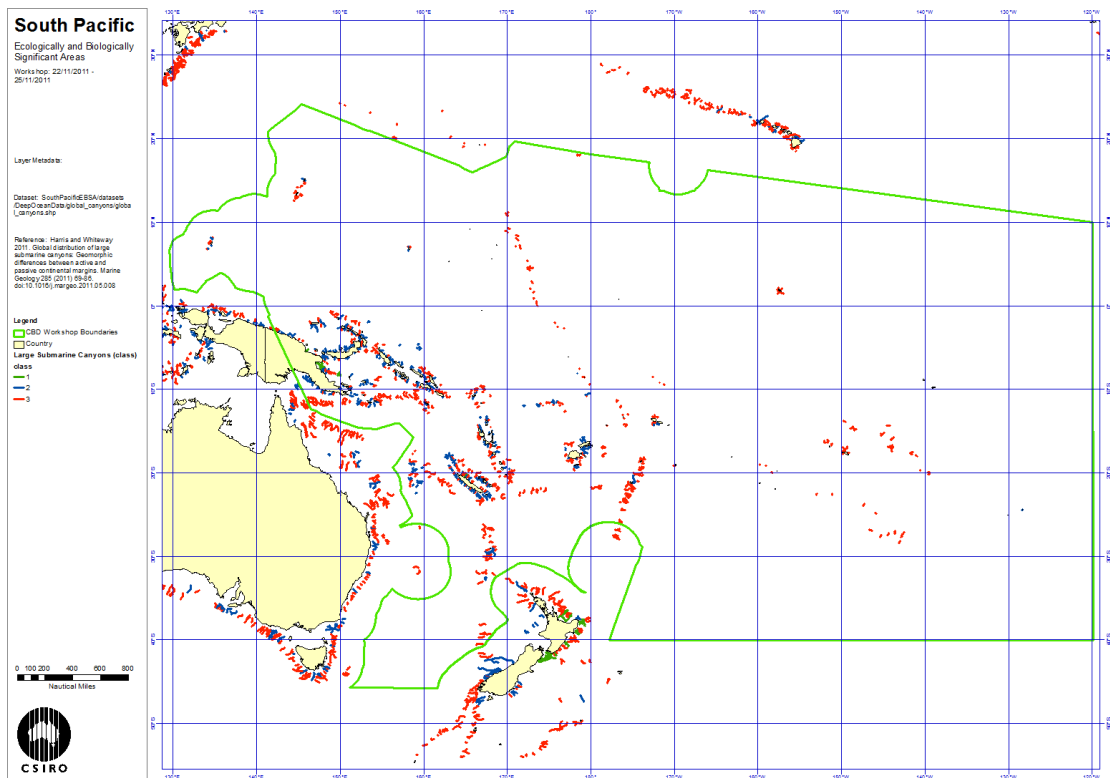


Figure 4.8: Large Submarine Canyons

4.4 Vents and Seeps

ChEss (Chemosynthetic Ecosystem Science) was a field project of the Census of Marine Life programme (CoML). The main aim of ChEss was to determine the biogeography of deep-water chemosynthetic ecosystems at a global scale and to understand the processes driving these ecosystems. ChEss addressed the main questions of CoML on diversity, abundance and distribution of marine species, focusing on deep-water reducing environments such as hydrothermal vents, cold seeps, whale falls, sunken wood and areas of low oxygen that intersect with continental margins and seamounts. Since the discovery of hydrothermal vents in 1977 and of cold seep communities in 1984, over 500 species from vents and over 200 species from seeps have been described (Van Dover et al., 2002. Science 295: 1253-1257). The discovery of chemosynthetically fuelled communities on benthic OMZs and large organic falls to the deep-sea such as whales and wood have increased the number of habitats and fauna for investigation. New species are continuously being discovered and described from sampling programmes around the globe and therefore ChEssBase is in active development and new data are being entered periodically. Currently, ChEssBase includes data on 1739 species from 193 chemosynthetic sites around the globe. These data contain information (when available) on the taxonomy, diagnosis, trophic level, reproduction, endemism and habitat types and distribution. There are now 1879 papers in our reference database.

http://www.noc.soton.ac.uk/chess/database/db_home.php

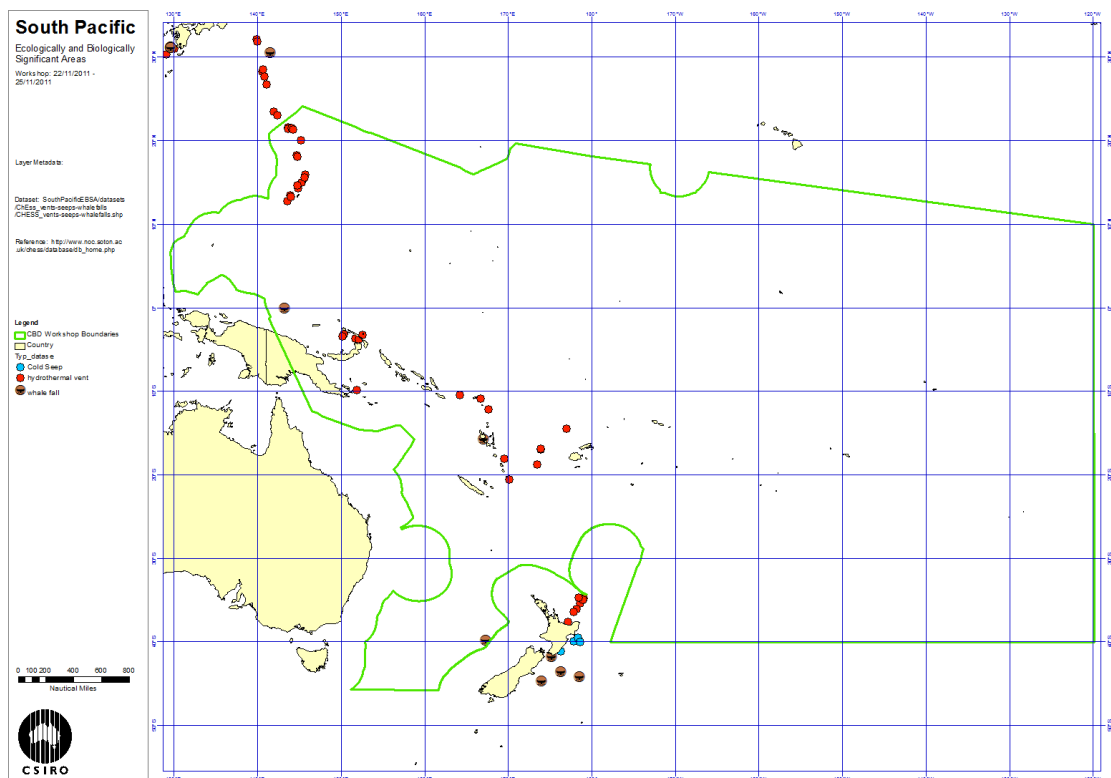


Figure 4.9: Vents and Seeps

4.5 Physical Ocean Climatologies

4.5.1 Temperature Climatology (degrees C)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

A number of global ocean climatologies are presently available, such as NODC's World Ocean Atlas. CARS is different as it employs extra stages of in-house quality control of input data, and uses an adaptive-lengthscale loess mapper to maximise resolution in data-rich regions, and the mapper's "BAR" algorithm takes account of topographic barriers. The result is excellent definition of oceanic structures and accuracy of point values.

<http://www.marine.csiro.au/~dunn/cars2009/>

CARS2009 covers the full global oceans on a 1/2 degree grid, but until June 2011 only included temperature and salinity fields. The T and S fields were created in July 2009 and were based on World Ocean Database 2005 (WOD05) [July 2008 Update], surface-pressure-corrected Argo global archives to May 2009, WOCE Global Hydrographic Program (v3.0), and many other datasets available up to 2008. See the updates section below for history of occasional sub-version releases. The nutrient fields created in June 2011 were based on WOCE and WOD09 (March 2011 download).

References - primary CARS citation:

Ridgway K.R., J.R. Dunn, and J.L. Wilkin, Ocean interpolation by four-dimensional least squares -Application to the waters around Australia, J. Atmos. Ocean. Tech., Vol 19, No 9, 1357-1375, 2002

- algorithm details:

Dunn J.R., and K.R. Ridgway, Mapping ocean properties in regions of complex topography, Deep Sea Research I : Oceanographic Research, 49 (3) (2002) pp. 591-604 - CARS seasonal fields and MLD:

Scott A. Condie and Jeff R. Dunn (2006) Seasonal characteristics of the surface mixed layer in the Australasian region: implications for primary production regimes and biogeography. Marine and Freshwater Research, 2006, 57, 1-22.

Metadata

CARS2009 metadata record: MarLIN record: 8539, Anzlic identifier: ANZCW0306008539

The webpage is itself the authoritative reference for CARS2009.

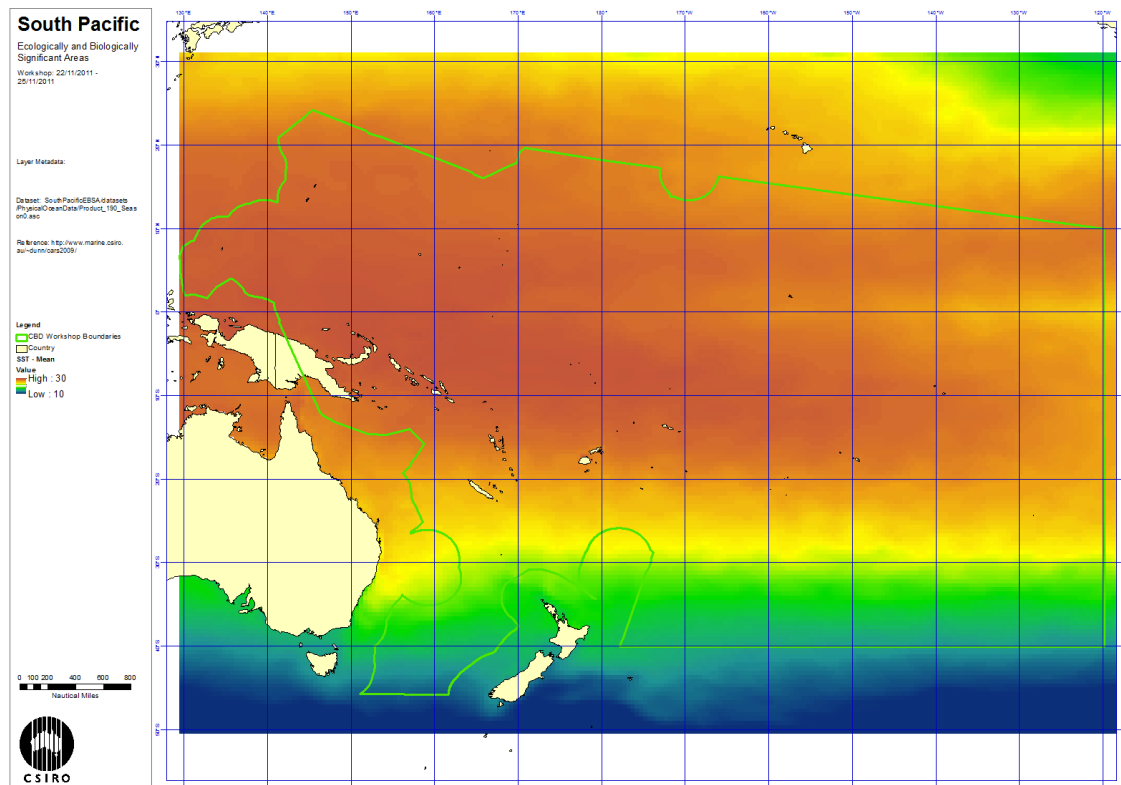


Figure 4.10: Annual SST

4.5.2 Salinity Climatology (PSU)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

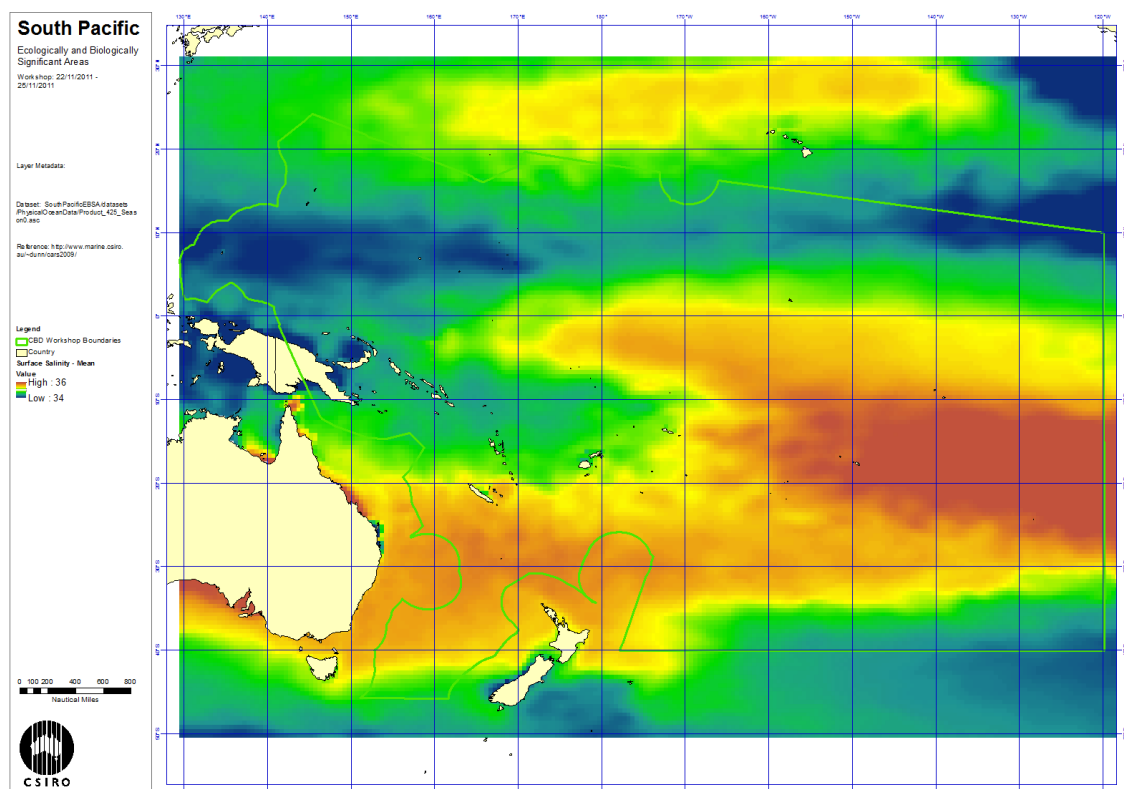


Figure 4.11: Annual Salinity

4.5.3 Oxygen Climatology (ml/l)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

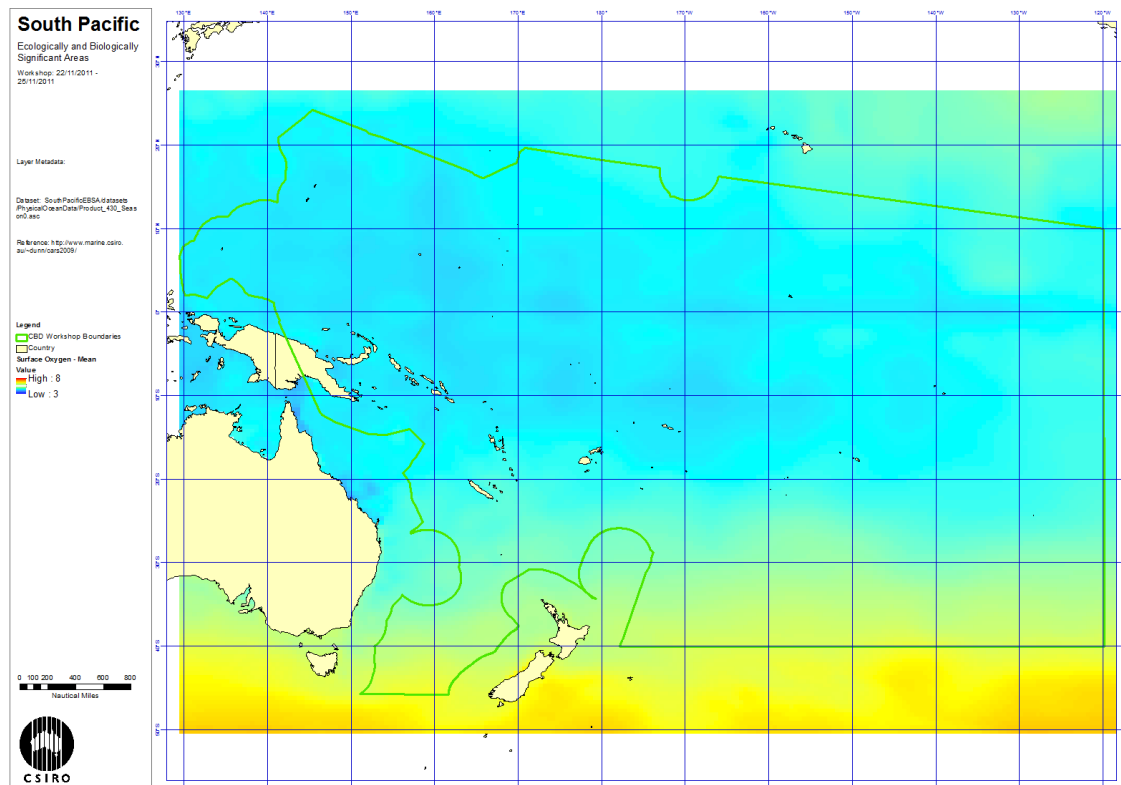


Figure 4.12: Annual Oxygen

4.5.4 Nitrate Climatology (uM)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

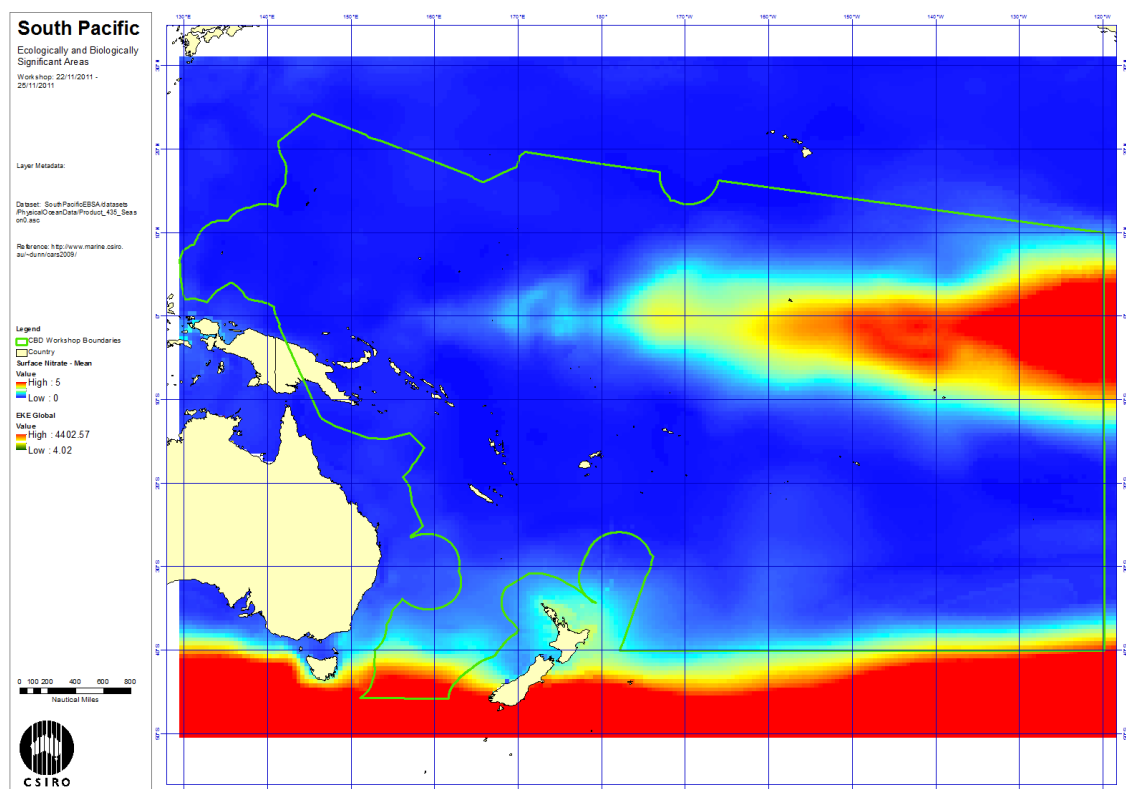


Figure 4.13: Annual Nitrate

4.5.5 Silicate Climatology (μM)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

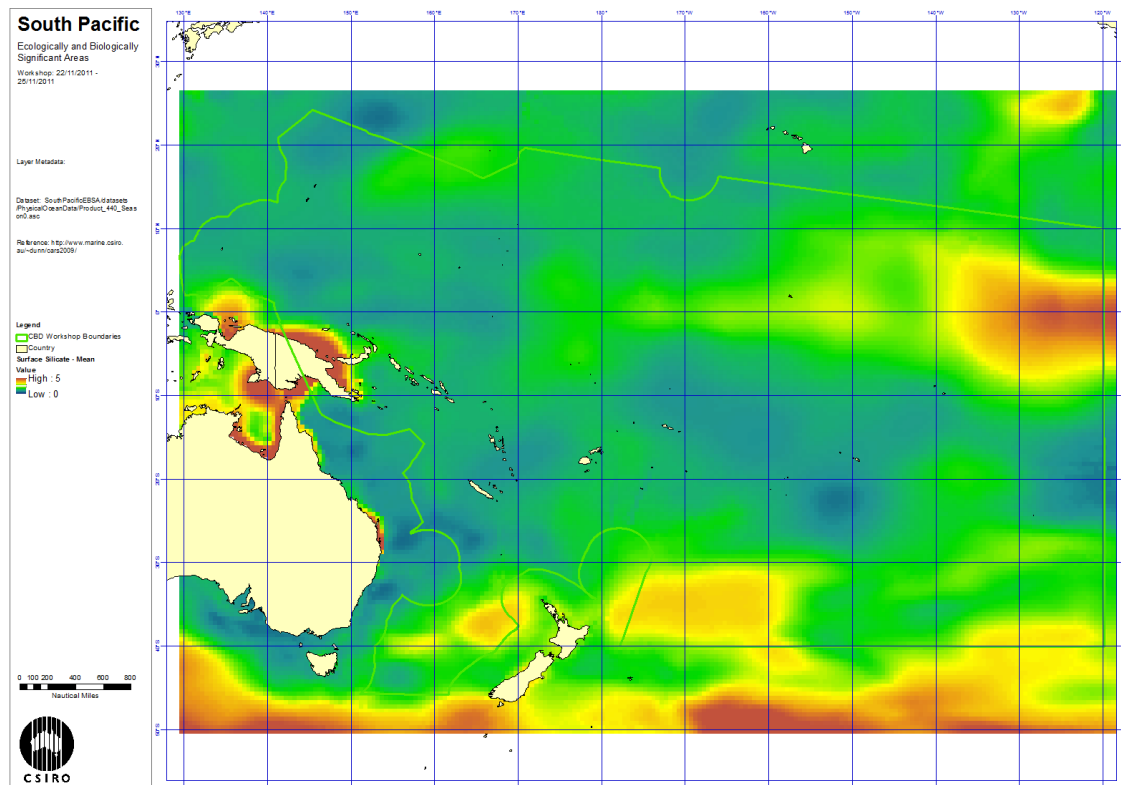


Figure 4.14: Annual Silicate

4.5.6 Phosphate Climatology (μM)

CARS is a digital climatology, or atlas of seasonal ocean water properties. It comprises gridded fields of mean ocean properties over the period of modern ocean measurement, and average seasonal cycles for that period. It is derived from a quality-controlled archive of all available historical subsurface ocean property measurements - primarily research vessel instrument profiles and autonomous profiling buoys. As data availability has enormously increased in recent years, the CARS mean values are inevitably biased towards the recent ocean state.

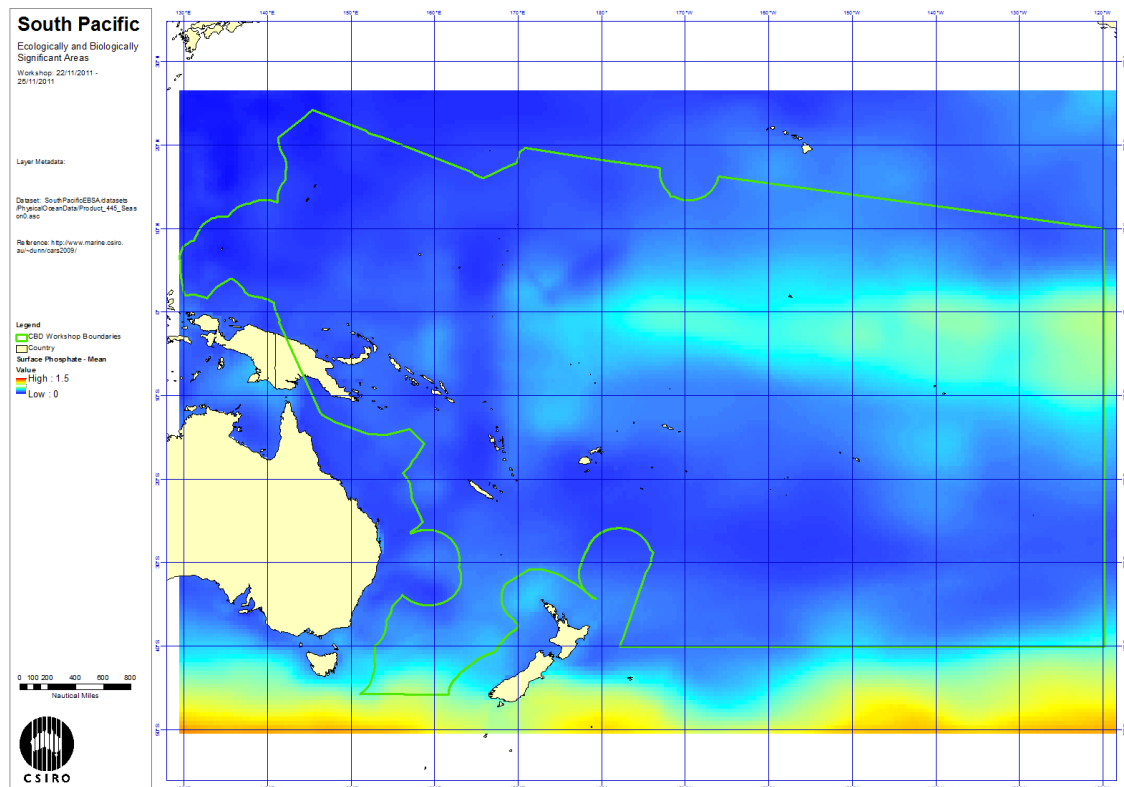


Figure 4.15: Annual Phosphate

4.5.7 Sea Surface Altimetry

Average annual sea surface height. Data derived from satellite measurement (TOPEX/POSEIDON and ERS-1) and gives the annual sea surface height.

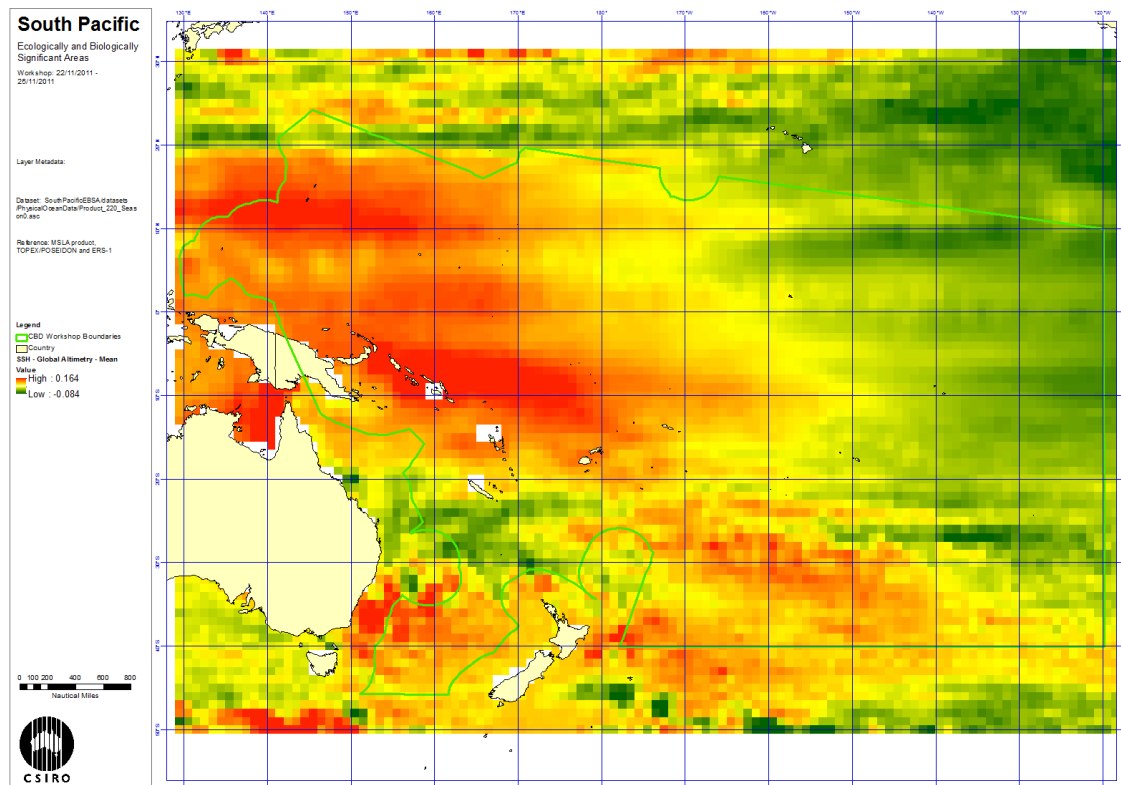


Figure 4.16: Annual sea surface height

4.5.8 SeaWiFS Chlorophyll A concentration

SeaWiFS data compiled by Thomas Moore and CMR Remote Sensing, courtesy of the NASA SeaWiFS Project and Orbimage. NASA also expects at least one author of any paper using SeaWiFS to be personally on their registered Seawifs users list. This is done by applying to NASA and can easily be done via the web at <http://seawifs.gsfc.nasa.gov/SEAWIFS/LICENSE/checklist.html>.

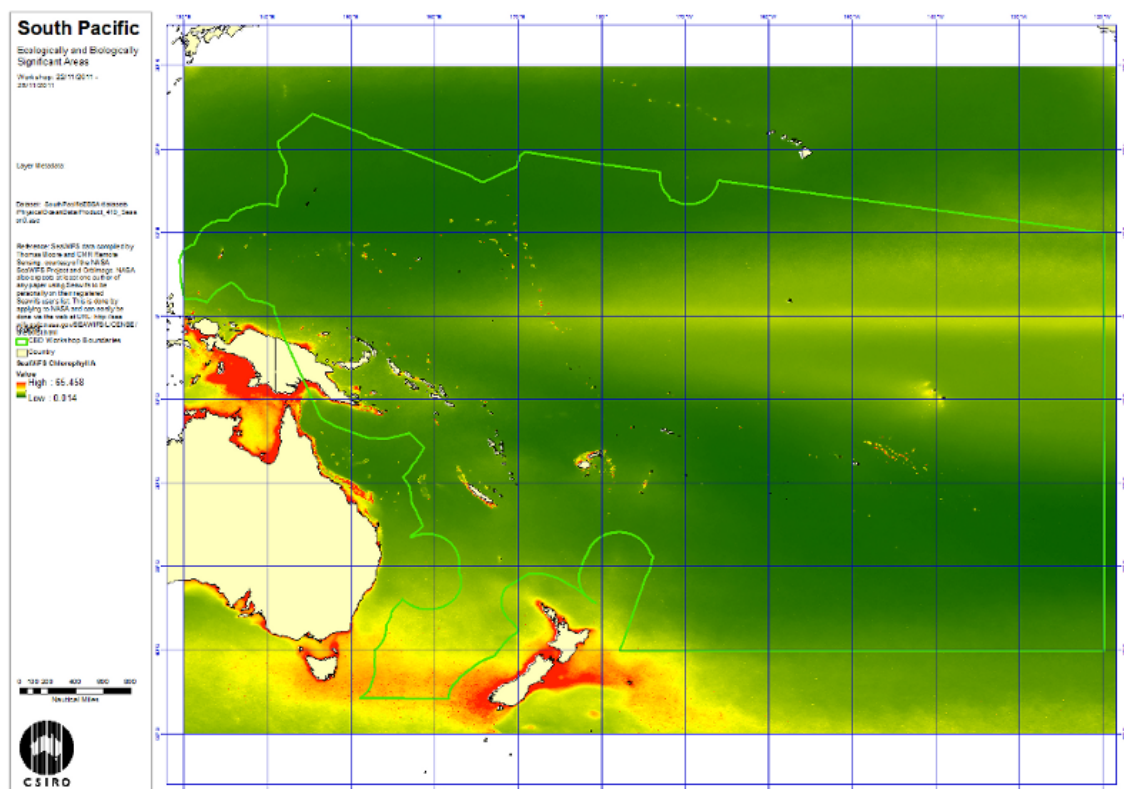


Figure 4.17:

4.5.9 VGPM Global Ocean Productivity

The VGPM is a "chlorophyll-based" model that estimate net primary production from chlorophyll.

Community guidance for developing this website was to provide a single productivity product as a Standard product. For this, we have initially chosen the Vertically Generalized Production Model (VGPM) (Behrenfeld and Falkowski, 1997a) as the standard algorithm. The VGPM is a "chlorophyll-based" model that estimate net primary production from chlorophyll using a temperature-dependent description of chlorophyll-specific photosynthetic efficiency. For the VGPM, net primary production is a function of chlorophyll, available light, and the photosynthetic efficiency.

<http://www.science.oregonstate.edu/ocean.productivity/>

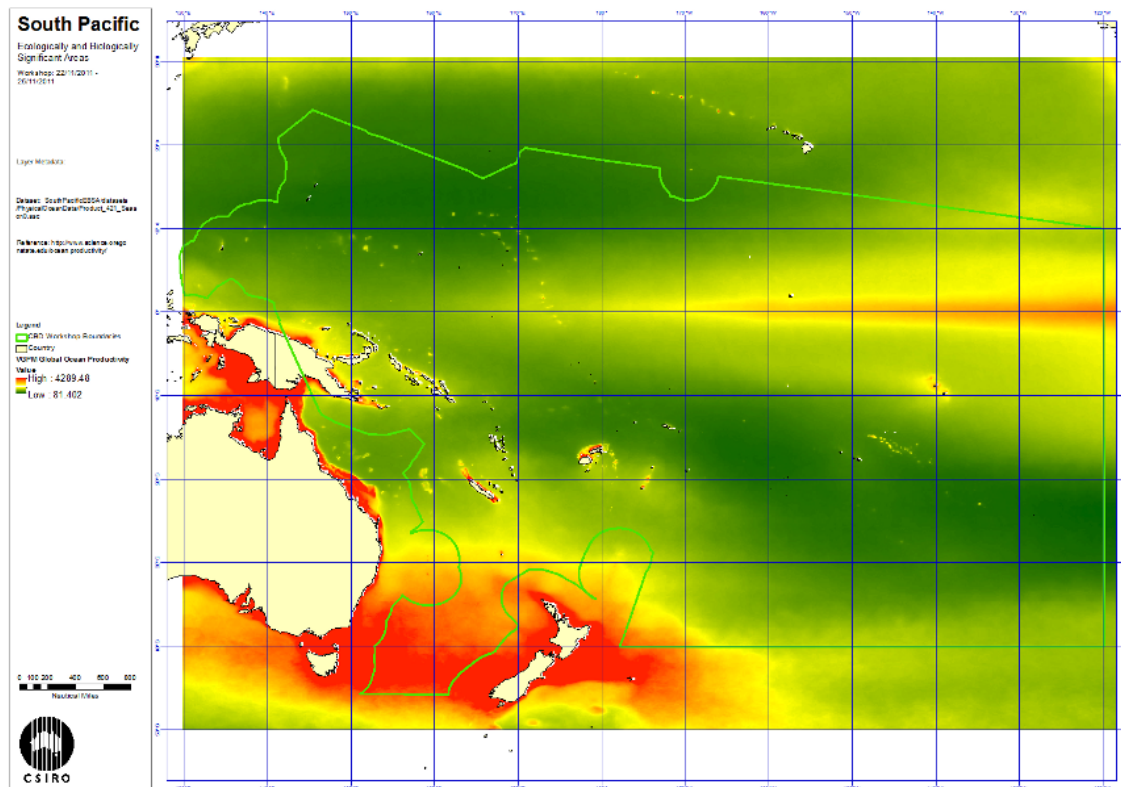


Figure 4.18: Annual VGPM Global Ocean Productivity

4.5.10 Mixed Layer Depth Climatology (m)

Production in the surface ocean is constrained by nutrient availability (at depth) and sufficient light (from the surface). The MLD can influence this productivity and has a seasonal cycle, being deeper due to wind mixing in winter, and shallow in summer due to warming and stratification.

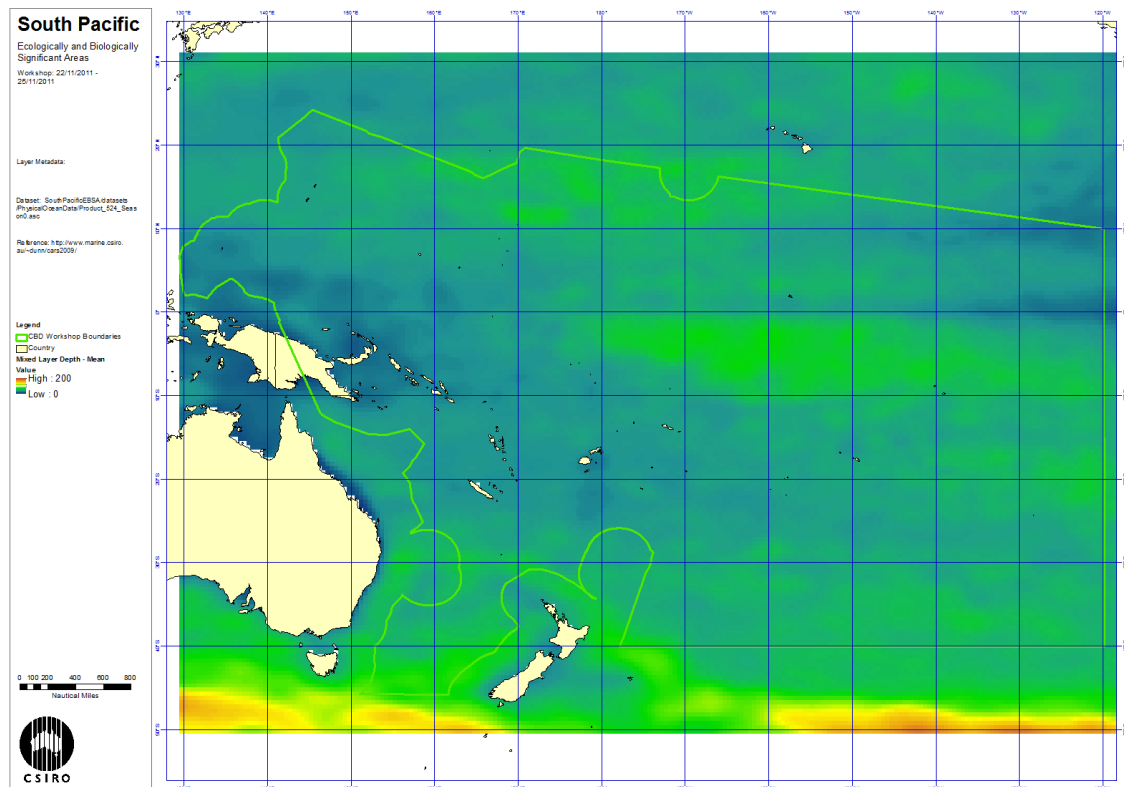


Figure 4.19: Annual Mixed Layer Depth

4.5.11 Frontal Index

Derived product Thermal fronts mark the boundary between waters of different temperature. They can be productive areas due to mixing of water masses and important for foraging animals of many species, including tunas, whales, seabirds and turtles. We applied a methodology for determining an SST front using edge detection, described in Cayula and Cornillon (1995). Hobday and Hartog (in preparation) extend this method to generate an index of frontal activity for the region of interest. Pixels in individual images are allocated to a front, and then the presence of frontal pixels summed over a period of time. The index presented here is gridded in quarter degree boxes and averaged over an 8-day week. These were averaged for the selected seasons or years as presented herein. The resulting contours are then mapped onto a 0.25 degree grid that measures the frontal density in each of these grid cells.

Cayula J-F, Cornillon P (1995) Multi-Image Edge Detection for SST Images. *Journal of Atmospheric and Oceanic Technology* 12, 821-829.

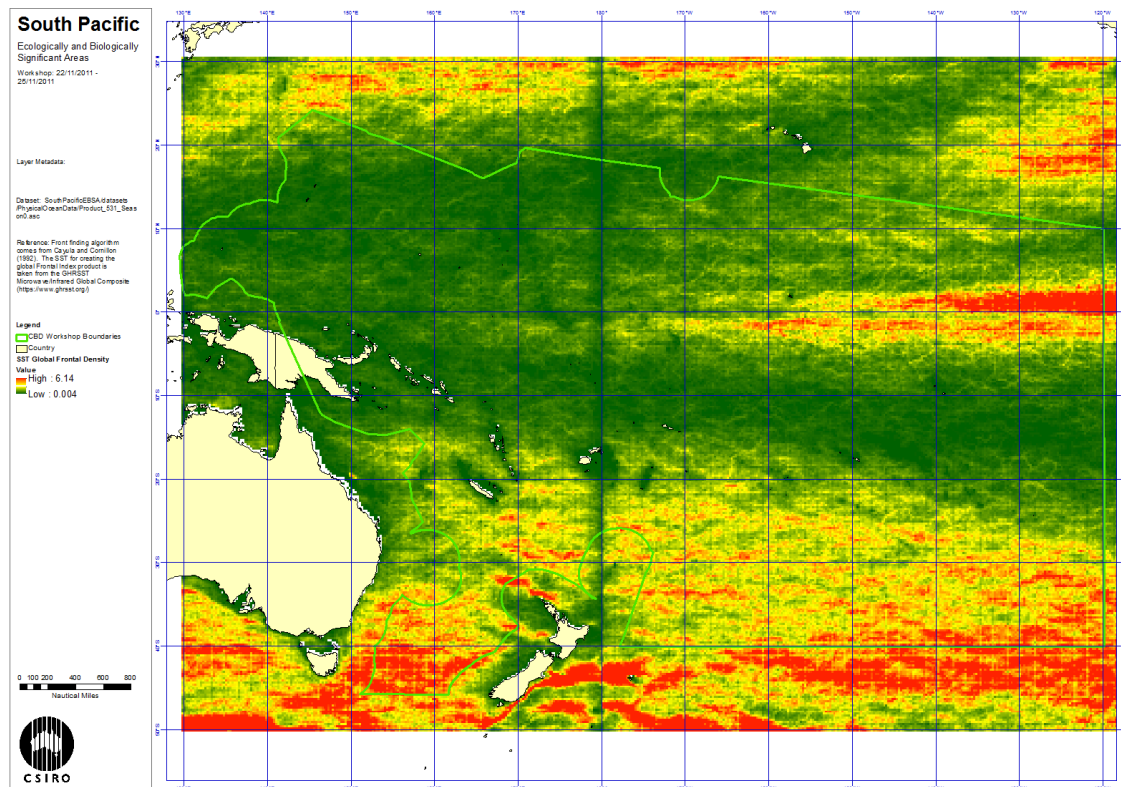


Figure 4.20:

4.5.12 Eddy Kinetic Energy

Locations where shear between water masses is high can generate productivity due to mixing. One measure of this mixing is estimated using Eddy Kinetic Energy (EKE). For example, regions of high tuna abundance occurred in relatively high EKE (Zainuddin et al 2006). EKE was calculated from the velocity maps based on sea surface height. Using the u and v values from the CARS synTS u and v products, EKE is defined as

$$0.5 * (U^2 + V^2)$$

Zainuddin M, Kiyofujia H, Saitohb K, Saitoh S-I (2006) Using multi-sensor satellite remote sensing and catch data to detect ocean hot spots for albacore (*Thunnus alalunga*) in the north-western North Pacific. *Deep-Sea Research II* 53, 419-431.

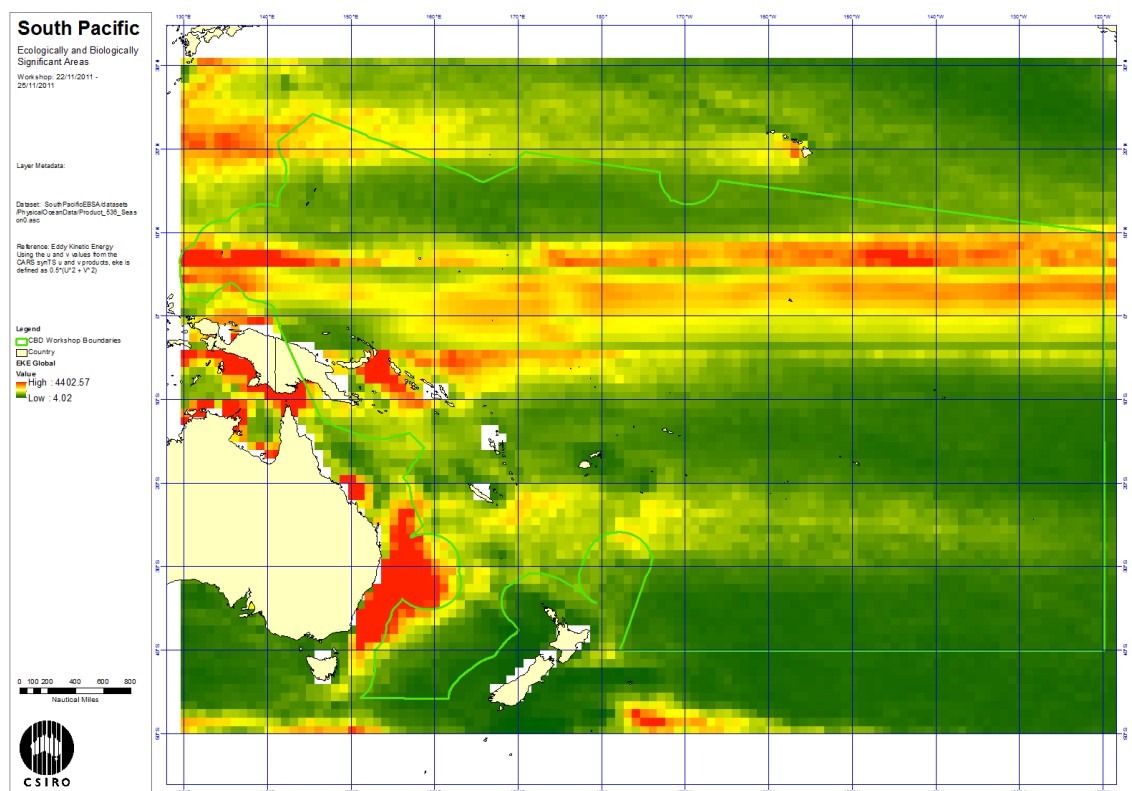


Figure 4.21: Annual Eddy Kinetic Energy

4.5.13 Summary of Currents

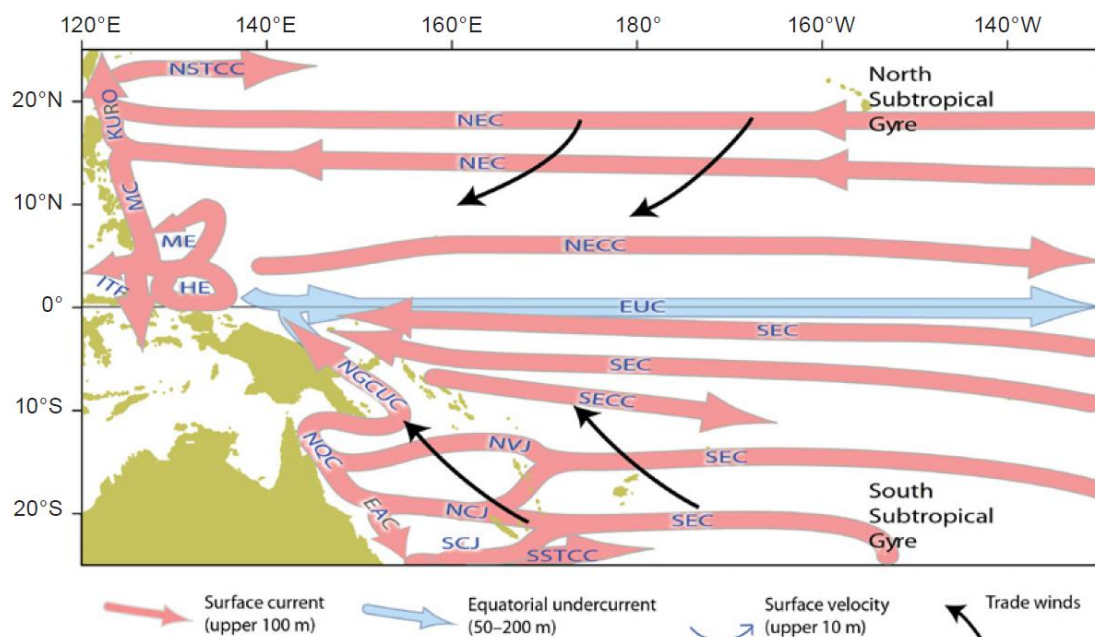


Figure 3.1 (a) Ocean surface currents in the tropical Western and Central Pacific Ocean, based on satellite data and *in situ* climatology (source: Sudre and Morrow 2008)¹⁸⁹. As indicated by the stream lines, surface flow is generally directed to the left of the wind in the Southern Hemisphere, and to the right in the Northern Hemisphere, due to Ekman transport (Box 3.1). **(b)** The main ocean currents in the upper 100 to 200 m of the water column. Currents shown are: North Subtropical Counter Current (NSTCC); Kuroshio Current (KURO); Mindanao Current (MC); Mindanao Eddy (ME); Halmahera Eddy (HE); North Equatorial Current (NEC); North Equatorial Counter Current (NECC); Equatorial Undercurrent (EUC); Indonesian Throughflow (ITF); New Guinea Coastal Undercurrent (NGCUC); North Queensland Current (NQC); East Australian Current (EAC); North Vanuatu Jet (NVJ); North Caledonian Jet (NCJ); South Caledonian Jet (SCJ); South Equatorial Counter Current (SECC); South Equatorial Current (SEC) and South Subtropical Counter Current (SSTCC).

Taken from: Bell JD, Johnson JE, Hobday AJ (Eds) (2011) 'Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change.' (Secretariat of the Pacific Community: Noumea, New Caledonia) . Chapter 3.

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