SPC factsheet

SPC
Secretariat of the Pacific Community

Aim

This fact sheet describes a model used to predict the distribution of deepwater snapper habitat across the Western Central Pacific Ocean

DEEPWATER SNAPPER

Summary

Deepwater snapper fisheries are a significant resource for many Pacific Island countries and territories. However, limited information on the extent of deepwater snapper habitat and potential sustainable yields has impeded the potential expansion of these fisheries. This report describes a modelling approach that combines available fisheries and oceanographic data to predict the distribution of deepwater snapper habitat in the Western Central Pacific Ocean.

Maps of deepwater snapper habitat were produced that showed strong regional patterns, with large areas of suitable habitat predicted in some Exclusive Economic Zones (EEZs), and more limited habitat predicted in others. The highest proportion of suitable habitat was predicted in South Pacific EEZs located between approximately 15 and 25°S. Therefore, opportunities for development of deepwater snapper fisheries are likely to be limited for many countries and territories north of approximately 15°S due to the relatively small area of predicted habitat. The maps of deepwater snapper habitat provide a useful baseline for the development of monitoring programmes and spatial management plans for deepwater snapper.

Predicting the distribution of deepwater snapper in the Western Central Pacific Ocean

Introduction

Deepwater snapper fisheries are a significant resource for many Pacific Island countries and territories (PICTs) where they have supported important domestic and export markets for decades. Rapid expansion in deepwater snapper fisheries occurred during the 1970s but was soon followed by declines only two decades later, mainly due to lower catch rates, unreliable access to export markets, and a shift towards tuna long-lining, which was more profitable at the time.

Recently, there has been interest in re-developing deepwater snapper fisheries in the Pacific in recognition of the limited potential for further commercial development of shallow reef and lagoon fisheries in the region, and the perception that there are unexploited populations in more distant locations. However, policy makers are approaching such expansion with caution because there is limited information on the extent of deepwater snapper habitat and the potential sustainable yields.

Across the Western Central Pacific Ocean (WCPO), there are over 20 countries and territories that have active deepwater snapper fisheries, have participated in deepwater snapper fisheries historically, or have expressed some interest in developing this capacity. It is plausible that many of these nations are exploiting the same stocks, given the wide distribution of most target species, and the potential for substantial connectivity among deepwater snapper populations across large spatial scales. Collaboration among PICTs, based on a consensual mapping of deepwater snapper habitats, could provide the basis for better management of deepwater snapper resources in the region.

However, at present there are no resources available to conduct the comprehensive surveys needed to create detailed maps of deepwater snapper habitat throughout the Pacific. In the absence of detailed maps, the distribution of deepwater snapper habitat can only be estimated from available data. This report describes a modelling approach that combines available fisheries and oceanographic data to predict the distribution of deepwater snapper in the WCPO.

Methods

We used state-of-the-art computer modelling techniques and existing fisheries and oceanographic data to identify which oceanographic factors are most influential in determining the distribution of deepwater snapper. We then used these factors to predict the potential distribution of deepwater snapper across the WCPO.

Fisheries data

There are at least 20 species of deepwater snapper in the Pacific Ocean. The most common species captured by deepwater fisheries are listed in **Table 1**. We collated information on the location of these species from previous Secretariat of the Pacific Community (SPC) research surveys and from New Caledonia and Tonga fisheries data. We did not consider the less common species of deepwater snapper, including Tang's snapper (*Lipocheilus carnolabrum*), saddle-back snapper (*Paracaesio kusakarii*), cocoa snapper (Paracaesio stonei), yellowtail blue snapper (*Paracaesio xanthura*), Vanuatu snapper (*Paracaesio gonzalesi*), and Randall's snapper (*Randallichthys filamentosus*), because these species are only a minor component of the catch and there was insufficient location information available. We grouped species within each genus (i.e. *Etelis*, *Pristipomoides* and *Aphareus*) for all data because often the particular species was not recorded. Although the habitat preference of species in each of these groups may vary, previous research shows a similar depth preference among species in each group.

Physical and oceanographic data

We considered that the distribution of deepwater snapper would be most influenced by depth, slope and temperature. Therefore, we used global bathymetry data, available at a spatial resolution of 0.016° (~1.85 km^2), to determine the depth (m) and slope (%) of the ocean floor. We used global temperature-at-depth data, available at a spatial resolution of 0.25° (~15 km^2), to determine the average temperate at 0–50 m and 50–100 m.

Table 1. List of deepwater snapper species commonly captured in the Pacific Ocean

Species name	Common name
Etelis carbunculus	Ruby snapper
Etelis coruscans	Flame snapper
Etelis marshi	Pygmy ruby snapper
Etelis radiosus	Scarlet snapper
Pristipomoides multidens	Goldbanded jobfish
Pristipomoides zonatus	Oblique-banded snapper
Pristipomoides filamentosus	Crimson jobfish
Pristipomoides flavipinnis	Golden eye jobfish
Pristipomoides argyrogrammicus	Ornate jobfish
Pristipomoides seiboldii	Lavender jobfish
Pristipomoides auricilla	Goldflag jobfish
Pristipomoides typus	Sharptooth jobfish
Pristipomoides squamimaxillaris	Scalemouth jobfish
Aphareus rutilans	Rusty jobfish

Distribution modelling

We used species distribution models to predict the distribution of deepwater snapper.

Firstly, a subset of the fisheries and oceanographic data was selected from New Caledonia and Tonga, where the most reliable fisheries data were available. These data were used in models to evaluate which oceanographic factors were most important in determining the distribution of deepwater snapper. The models used the depth, slope, and temperature information at each location where deepwater snapper were captured to evaluate how influential each variable was in predicting where deepwater snapper were captured.

Secondly, the full set of fisheries and oceanographic data was used in species distribution models to predict the distribution of deepwater snapper across the WCPO. Maps of predicted deepwater snapper habitat were generated for each species group: *Etelis*, *Pristipomoides* and *Aphareus*. The area and proportion of predicted habitat for each species group was then calculated for the EEZs (exclusive economic zones) surrounding 32 countries, territories or island groups.

Results

Oceanographic factors

Depth was the best predictor of presence for all deepwater snapper species groups, while slope and temperature-at-depth were much poorer predictors (**Figure 1**).

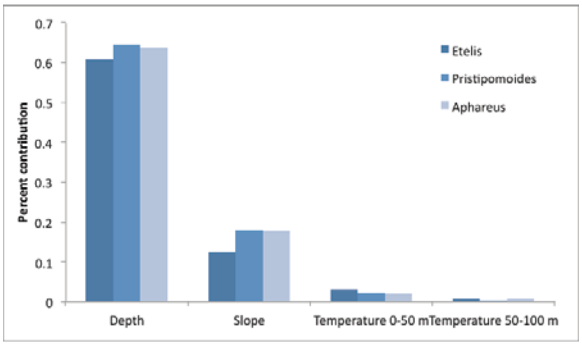

Figure 1. Relative contribution of oceanographic variables to model predictions of presence of *Etelis*, *Pristipomoides* and *Aphareus*.

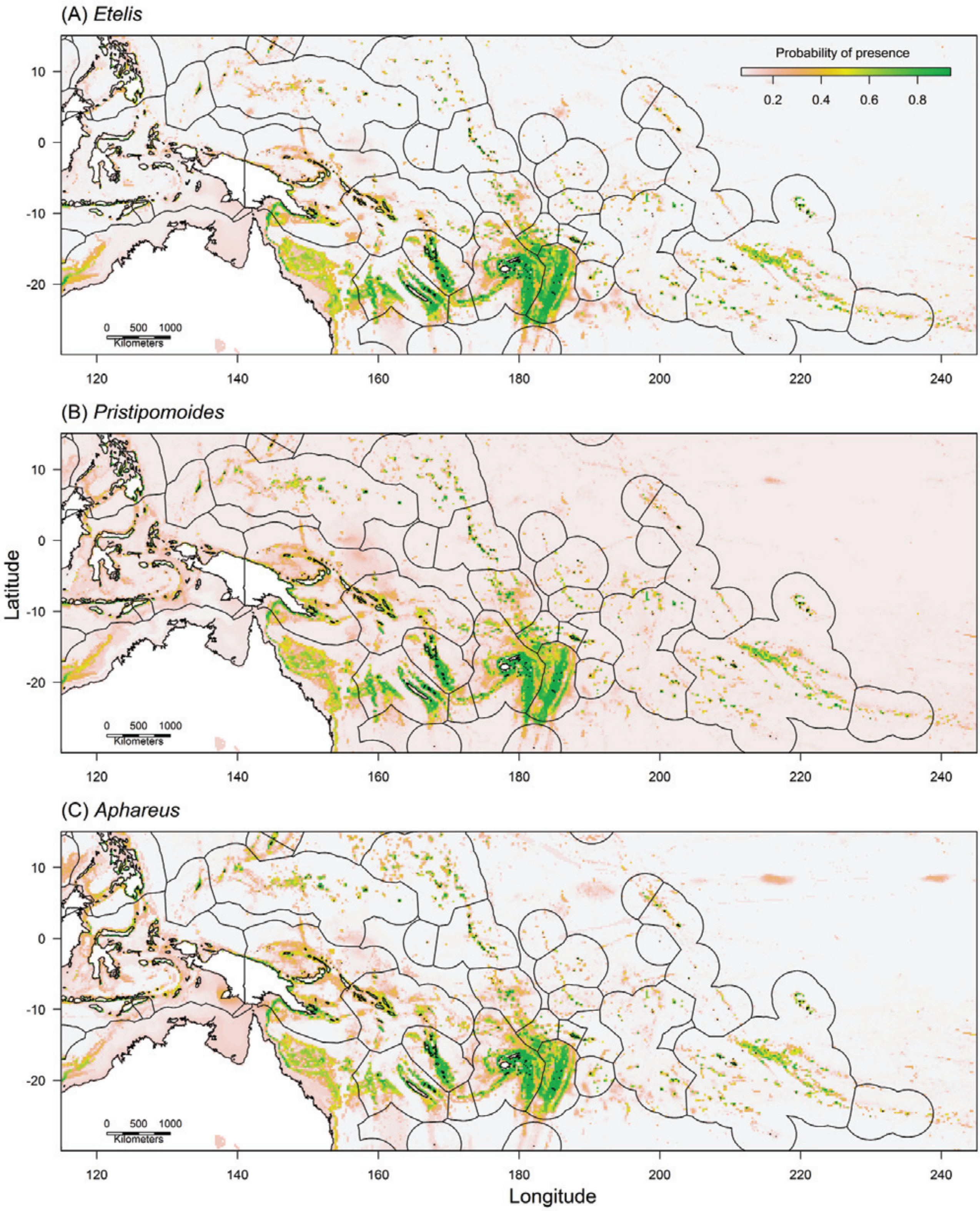

Figure 2. Predicted distribution of *Etelis* (A), *Pristipomoides* (B) and *Aphareus* (C) in the Western Central Pacific Ocean.

Habitat distribution across WCPO

Maps of predicted distribution of deepwater snapper habitat across the WCPO are shown in **Figure 2**. There were strong regional patterns in the predicted distribution of suitable habitat for deepwater snapper, with large areas of suitable habitat predicted in some EEZs, and more limited habitat predicted in others.

The highest proportion of suitable habitat was predicted in South Pacific EEZs located between approximately 15 and 25°S (**Table 2**). Over 70% of cells within Tonga's EEZ and at least 30% within the EEZs surrounding Fiji, Wallis & Futuna, Vanuatu, New Caledonia and Matthew & Hunter were predicted to contain suitable habitat for all three deepwater snapper species groups.

In contrast, less than 5% of cells within the EEZs surrounding Australia, Howland & Baker, Jarvis, and Nauru were predicted to contain suitable habitat for all three species groups (**Table 2**). It is important to note that suitable habitat area was calculated using the total area of 0.25° cells within which suitable habitat was predicted, so it potentially overestimates the area of actual suitable habitat area (i.e. the area of suitable habitat in the cell may be much smaller).

The amount of predicted habitat also varied among species groups, with the proportion of cells predicted to contain suitable habitat highest for *Aphareus* and lowest for *Etelis* in almost all EEZs (**Table 2**).

Table 2. Potential area (1000s km^2) and proportion (prop) of suitable habitat of deepwater snapper species within the EEZs surrounding 32 countries, territories and island groups based on higher-than-equal sensitivity-specificity thresholds (see text for details) from global models at 0.25° spatial resolution. Note that potential area was calculated using the total area of 0.25° cells within which suitable habitat was identified and, therefore, will overestimate actual habitat area.

Country or territory	Etelis		Pristipomoides		Aphareus	
	area	prop	area	prop	area	prop
American Samoa	18.5	0.04	23.1	0.06	30.8	0.07
Australia*	733.1	0.04	817	0.04	832.4	0.05
Cook Islands	85.5	0.04	139.4	0.07	244.9	0.12
East Timor	10.8	0.11	39.3	0.42	55.4	0.59
Federated States of Micronesia	90.1	0.03	301.9	0.10	410.4	0.14
Fiji	714.6	0.50	828.6	0.58	914.1	0.64
French Polynesia	429.7	0.08	571.4	0.11	662.3	0.12
Gilbert Islands (Kiribati)	44.7	0.04	91.6	0.09	97.8	0.09
Guam	13.9	0.06	47.7	0.21	95.5	0.42
Howland & Baker	0.8	0.00	12.3	0.29	21.6	0.05
Indonesia*	224.1	0.03	834.7	0.11	1271.4	0.16
Jarvis	0	0.00	0	0.00	9.2	0.03
Marshall Islands*	42.4	0.02	172.5	0.08	274.1	0.13
Matthew & Hunter	90.1	0.38	84.7	0.35	67	0.28
Nauru	1.5	0.50	1.5	0.50	3.1	0.01
New Caledonia	517.5	0.41	504.4	0.40	471.3	0.37
Niue	26.2	0.08	24.6	0.07	50.8	0.15
Northern Islands (Kiribati)	33.1	0.02	91.6	0.06	135.5	0.08
Northern Mariana Islands*	9.2	0.01	23.9	0.03	43.1	0.05
Palau	10	0.02	32.3	0.05	50.1	0.08
Palmyra	4.6	0.02	35.4	0.12	44.7	0.15
Papua New Guinea	363.5	0.13	736.2	0.25	944.9	0.33
Philippines	110.1	0.05	194.1	0.09	276.5	0.12
Phoenix Islands (Kiribati)	23.1	0.03	57.8	0.08	64.7	0.09
Pitcairn Islands	51.6	0.05	53.9	0.05	46.2	0.05
Samoa	22.3	0.16	37	0.27	41.6	0.30
Solomon Islands	205.6	0.12	463.6	0.28	606	0.36
Tokelau	15.4	0.04	39.3	0.11	64.7	0.18
Tonga	528.3	0.72	551.4	0.75	557.5	0.76
Tuvalu	97	0.13	177.9	0.23	249.5	0.33
Vanuatu	250.3	0.35	301.1	0.42	345	0.48
Wallis & Futuna	127.1	0.48	147.9	0.56	153.2	0.58

*partially covered by the present model.

Conclusions

» The maps of deepwater snapper habitat provide a useful baseline for the development of monitoring programmes and spatial management plans for deepwater snapper.

» Opportunities for development of deepwater snapper fisheries are likely to be limited for many countries and territories north of approximately 15°S due to the relatively small area of predicted habitat for the three main deepwater snapper species groups.

» However, the predicted habitat does not consider abundance, and so it will be necessary to obtain information on the local abundance of deepwater snapper species to estimate potential yields.

» The larger area of predicted habitat for *Aphareus* and *Pristipomoides* compared to *Etelis* might indicate greater potential for exploitation of these species. However, *Aphareus* and *Pristipomoides* are usually found in lower abundance than *Etelis* and often fetch a lower market price.

» The accuracy and precision of predicted deepwater snapper habitat from the models are only as good as the available oceanographic data. The resolution of these data is very coarse (0.25°) and much of the Pacific Ocean remains unsurveyed. Bathymetry data has been estimated from satellite data for unsurveyed areas.

» Detailed bathymetric surveys will be required if more accurate and precise habitat information is desired for deepwater snapper or other resources.

For more information

Dr Ashley Williams
Senior Fisheries Scientist
ashleyw@spc.int

Dr Simon Nicol
Principal Fisheries Scientist
simonn@spc.int

This report was funded by the Australian Government, the French Pacific Fund, and the Zone Économique de Nouvelle-Caledonie (ZoNéCo) programme. The fisheries data used in the analyses were provided by the Tongan and New Caledonian Fisheries Departments.

CONTACT DETAILS
Secretariat of the Pacific Community

SPC
Headquarters
BP D5, 98848
Noumea Cedex
New Caledonia
Tel: +687 26 20 00
Fax: +687 26 38 18

SPC
Suva Regional Office
Private Mail Bag
Suva, Fiji Islands
Tel: +679 337 0733
Fax: +679 337 0021

SPC
Regional Office
PO Box Q, Kolonia
Pohnpei, 96941 FM
Federated States of Micronesia
Tel: +691 3207 523
Fax: +691 3202 725

SPC
Solomon Islands Country Office
PO Box 1468
Honiara, Solomon Islands
Tel: +677 25543 +677 25574
Fax: +677 25547

Email: spc@spc.int
Website: www.spc.int