RAPID AQUARIUM FISH STOCK ASSESSMENT AND EVALUATION OF INDUSTRY BEST PRACTICES IN KOSRAE, FEDERATED STATES OF MICRONESIA

Prepared by the

Secretariat of the Pacific Community (SPC)



Colette Wabnitz
Fisheries Officer (Aquarium trade), SPC

Tony Nahacky
Independent consultant

September 2014

SPC Secretariat of the Pacific Community

Australian Aid

TABLE OF CONTENTS

ACKNOWLEDGMENTS

The authors are grateful to the employees of Micronesia Management & Marketing Enterprises (MMME), in particular Martin Selch, for allowing us to work with his employees, granting us open access to his facility, and patience in answering our questions. We would also like to thank staff from the Kosrae Department of Resources and Economic Affairs (DREA) and Kosrae Island Resource Management Authority (KIRMA) for logistical support and assistance in the field.

This study was made possible with the financial assistance of AusAID. The views expressed herein are those of the authors and do not reflect the official opinion of AusAID.

EXECUTIVE SUMMARY

Kosrae has a small marine aquarium fishery that started in 2005 by focusing on cultured clams, expanded to corals in 2007, and the collection of aquarium fish in 2011. This marine aquarium fishery contributes to the economy and provides income and livelihoods to a number of residents in Kosrae. The currently established business, Micronesia Management & Marketing Enterprises (MMME), is well-known and respected for the quality of its fish and other marine products in the USA, Asia, and E.U.

The main objective of this study was to conduct a rapid assessment of the sustainability of the aquarium trade fishery out of Kosrae, by:

1. Conducting underwater commercial surveys of marine aquarium fish resources around Kosrae to update and complement surveys conducted by SPC in 2007; and
2. Reviewing and evaluating the fishery's activities against recommended industry best practices.

Based on an assessment of operations, the fishery appears to be sustainable at current export levels. For a number of species found at high abundances in the field, export quantities could be increased without concerns for sustainability *if* a market could be found for them.

Recommendations to ensure the fishery remains sustainable over the long term include:

- Regular monitoring of collection and/or export data;
- Encourage the best practice of not collecting corallivore species, which constitute only a small fraction of current exports and that suffer from poor survival rates in aquaria[1];
- Given the size of the island, ability to access collection sites based on weather patterns and available stock, limited freight availability and flights out of Kosrae, capping the number of exporters at one (i.e., additional operators would increase fishing pressure on the same reefs currently utilized). Should opportunities to expand the aquarium fishery be sought in FSM, it is recommended for operators to set up on other islands, building on the quality and reputation established in Kosrae; and
- Conduct species-specific surveys for target *Cirrhilabrus* species.

It is worthy to note that during our stay on the island a mass bleaching event was underway affecting a very large number of corals of all forms (i.e., braching, massive, tubular), sometimes down to depth below 30m, and the majority of sea anemones.

[1] This recommendation (ban on import of obligate corallivores) was implemented immediately

LIST OF ACRONYMS

DOA	Dead on Arrival
DREA	Department of Resources and Economic Affairs
D-UVC	Distance based Underwater Visual Census
KIRMA	Kosrae Island Resource Management Authority
MMME	Micronesia Management & Marketing Enterprises
PIC	Pacific Island Country
SPC	Secretariat of the Pacific Community

INTRODUCTION

A marine aquarium export company, Micronesia Management and Marketing Enterprises (MMME), has been operational in Kosrae since 2005. Initially, activities focused on the production and rearing of giant clams (*Tridacna maxima* and *Tridacna derasa* mainly) for live export, expanding into the culture of corals via the establishment of 3 coral farms in Utwe, Tafunsak, & Lelu in 2007. Subsequent to initial survey work for marine aquarium fish conducted by SPC in 2007, which concluded that resources were available to support a small fishery, MMME broadened its activities to the collection and export of live marine aquarium fish in 2011. Work conducted by SPC at the time of the survey was carried out in collaboration with relevant local authorities and provided the opportunity to train government employees in underwater fish surveying techniques (Yeeting & Palik 2008). MMME currently employs a total of 19 staff.

The main objective of this study was to conduct a rapid assessment of the sustainability of the aquarium trade fishery out of Kosrae. Specifically, activities involved:

3. Conducting underwater commercial surveys of marine aquarium fish resources around Kosrae[2] to update and complement surveys conducted by SPC in 2007; and
4. Reviewing and evaluating all activities against recommended industry best practices by MMME from the point of collection to export.

MMME still exports clams and farmed corals. Discussions while on location also included an exchange of information pertaining to activities tied to the aquaculture portion of the company. However, this report shall only discuss activities relevant to the fish component of the marine aquarium fishery operating out of Kosrae.

All fieldwork was undertaken between the 28 October and 16 November 2013.

RAPID ASSESSMENT OF MARINE AQUARIUM FISH RESOURCES

2007 surveys

The original Kosrae SPC surveys (Yeeting & Palik 2008)[3] undertaken in 2007 in collaboration with the Kosrae Island Resource Management Authority (KIRMA) and the Department of Resources and Economic Affairs (DREA) were conducted to establish a baseline prior to the establishment of any commercial collection or export of aquarium fish. Surveys were done using the distance sampling underwater visual survey method (d-UVC)[4] and surveyors recorded a total of 153 species belonging to 16 families of interest to the marine aquarium trade. The report concluded that most species observed are considered low value, and are commonly found in other Pacific Island Countries (PICs). However, although low-valued, a number of species were considered relatively popular (e.g., *Centropyge loricula*, *Centropyge vrolikii*, *Pseudanthias dispar*, *Pseudanthias pascalus*) and thus were deemed to be present around Kosrae in sufficient numbers to support the establishment of a small, sustainable industry, provided an adequate management framework accompanied such development.

[2] The original workplan also included traditional transect surveys conducted by KIRMA alongside our commercial surveys. However, although staff did perform the surveys, data were not provided, thus not available for analysis, and could not be included as part of this report.

[3] Note that it is currently still in draft form.

[4] The distance-sampling underwater visual census (D-UVC) method (Kulbicki and Sarramegna 1999, Kulbicki et al. 2000) consists of a fish census technique conducted along a transect line, where a diver records fish by species name, abundance, body length and distance to transect line. Mathematical models are then used to estimate fish density (number of fish per unit area) and biomass (weight of fish per unit area) from the counts. The method is fully described in Labrosse et al. (2002).

2013 surveys

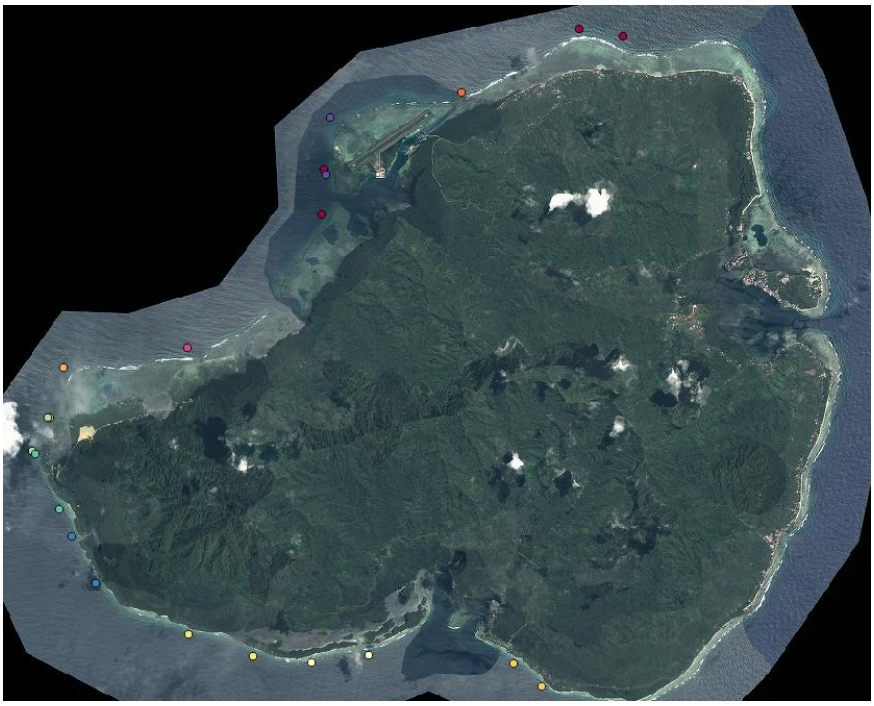

Figure 1 – Survey points around Kosrae. Areas surveyed are colour coded (i.e., surveys were conducted between two points of the same colour; with exception of the bright pink and orange points in the northwest and north respectively, where entry and exit were at the same location and the survey was conducted around that general area)

In reviewing collection and export data kindly supplied to us for assessment purposes by MMME, it was found that a number of fish species collected and shipped weekly had not been recorded as part of the original SPC surveys. Therefore our first undertaking was to determine why there appeared to be a viable export of species that were not recorded in the original surveys.

Three days were spent observing collectors for best practice. This also allowed for observation of differences in habitat, reef profile and rugosity at a number of different collections sites to ascertain possible reasons for the difference. An additional four days were spent diving independently from the collectors at a number of sites distributed over as wide an area and thus covering as much of the circumference of the island as possible (Figure 1), given time and weather constraints. Information recorded during these dives included general habitat structure; reef profile; general qualitative abundance data for the majority of targeted species for the aquarium trade; and quantitative data for some key species[5].

Commercial surveys

For the purpose of this report, commercial surveys are defined as dive assessments conducted within the depth range from which ornamental species are typically safely collected (0-40m) and during which all species of potential interest for the marine aquarium trade are recorded and placed in one of three categories:

1. Species of targetable size and high abundance – these species typically constitute the main target species;
2. Species with some market value, but not commercially viable to export on their own (as they are in sufficient abundance to collect incidentally and export or they are not viable to export due to freight expense) – such species would not be targeted per se but would be collected if encountered during a dive;
3. Species with low or virtually no market value (thus not viable to export) – individuals observed on the reef are typically observed at too large a size or at too low abundances for example.

Marine aquarium trade commercial surveys are typically undertaken to determine the viability of starting a business. In this case the business was already operating viably and had determined which species were economically worth targeting and which were not. Market demand had already been

[5] The method used consisted of timed-swims, where a diver swimming at a constant "standardised" speed records the number of fish observed either side of him over a specified estimated distance (e.g., 2m – for a total of 4m width) for a set period of time.

determined. Therefore, the commercial survey was adapted for the situation of evaluating an already operating business as follows:

1. Species of targetable size and high abundance – Was the fishery based on these fish and did these species constitute the main target species
2. Species with some market value, but not commercially viable to export on their own – What was the reliance on fish that were in sufficient abundance to collect incidentally and export.
3. Species with low or virtually no market value (thus not viable to export) – Were individuals observed on the reef that are too large a size, or too low abundance, or not demanded by the trade due to longevity issues being collected.

Note that although the categories highlighted above form the integral part of commercial surveys irrespective of location, the actual species listed under these three categories will vary from one place to another. Factors affecting classification include, but are not limited to, freight rates, local abundances, observed sizes, habitat characteristics etc…

The current work did not attempt to repeat the 2007 surveys, but instead focused on species of interest to the existing exporter on island, specifically concentrating on those target species that make the bulk of exports (30 species - see Appendix I).

MAIN FINDINGS

After seven days of diving, we conclude that the d-UVC survey may not be the best suited method for conducting stock assessments of marine aquarium fish species.

The 2007 SPC surveys focused on 50m long transects at 10m depth using d-UVC techniques. In observing the collectors we found that, for a number of species, the main habitat targeted was either in less than 10m of water or at depths greater than 10m. Although the distance-based sampling method theoretically allows for fish in less than and greater than 10m water depth to be recorded, most species targeted for the aquarium trade are small in size, cryptic or keep close to the substrate, have colour variations that can easily lead to misidentification if not observed at close enough range, and thus would easily be missed or underestimated. Rugose habitat (i.e., a reef framework with lots of relief therefore providing ample hiding spaces for fish) complicates matters even further.

There were no *Cirripectus stigmaticus* recorded in the 2007 surveys (and we did not find any *Cirripectus stigmaticus* at 10 meters when undertaking timed-swims or evaluating collectors at that depth). We did record the fish during timed-swims at depths less than 10 meters and also when evaluating the divers collecting them, which we observed was always at depths less than 10 meters (see Table 1 -).

Table 1 - Estimates of *Cirripectus stigmaticus* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Cirripectes stigmaticus				
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)
8 Nov	8	5	2	3.52
8 Nov	5	5	5	8.80
8 Nov	5	5	12	21.11
		Total	**Total**	**Average**
		15	19	**8.36**

Looking in water deeper than 10 meters we encountered the same issue. For example, the 2007 report does not mention a single observation of *Halichoeres melaspomus*. We did not see a single specimen at 10 meters nor did we observe any collected at that depth, but we observed them frequently at 30 meters or deeper (see Table 2).

Table 2 - Estimates of *Halichoeres melaspomus* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Halichoeres melaspomus				
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)
8 Nov	35	10	5	6.60
8 Nov	35	13	6	6.09
		Total	**Total**	**Average**
		23	11	**6.34**

This issue also affects species assessments for which the majority of a population's individuals reside at depths of less than, or more than, 10 meters. In other words, the fish may be rare in 10 meters but relatively common in 5 meters of water (e.g. *Macropharyngodon meleagris*, see Table 3) or relatively common at greater depths.

Table 3 - Estimates of *Macropharyngodon meleagris* densities based on numbers observed during timed-swims. Fish were counted 2m either side of the survey swimming line.

Macropharyngodon meleagris					
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)	Density (no./1000 m2) (2008)
8 Nov	7	30	19	8.36	
8 Nov	5	5	2	5.28	
8 Nov	5	5	3	7.92	
9 Nov	8	5	8	21.11	
		Total	**Total**	**Average**	
		45	32	**10.67**	**0.308**

In summary, some limitations to the d-UVC method utilised in the context of surveying marine aquarium fish include:

- Some species that are being traded are collected from waters deeper than can be adequately surveyed using d-UVC at 10 meters depth and were not surveyed in 2007 (e.g., *Centropyge multicolor*; *Halichoeres melamospomus*) – or not adequately for the purposes of an assessment of stock for trade;
- Some species that are being traded are collected from waters shallower than can be adequately surveyed using d-UVC at 10 meters depth and were not adequately surveyed, mostly because of habitat structure and composition and species behaviour, making it difficult to accurately count these species as part of a d-UVC (e.g., *Macropharyngodon meleagris*;)
- Reef habitat where flat pavement and or sand substrate is interspersed with high coral heads limits the surveyor's ability to see or adequately identify small marine aquarium fish further than a few meters away; and
- The highly cryptic and skittish nature of a number of species surveyed (e.g., *Centropyge loricula, Centropyge flavissma, Cirripectes* sp.) make traditional monitoring techniques that require laying down a transect tape inappropriate, as the fish will be scared into their refuge and not come out when conducting fish counts (although present), leading to underestimates of stock available.

Surveys for marine aquarium fish regardless of method used must be conducted with a narrow field of vision. This is because the vast majority of marine aquarium fish, as compared to most food fish, cannot be seen from a distance due to their small size, the fact that they stay close to the bottom, and that they frequently hide when disturbed from activities such as surveying. Therefore, regardless of the type survey undertaken, it should concentrate on a relatively narrow band of habitat (typically 2-4m either side).

2013 surveys

Surveys focused on a total of 30 fish species that, based on communications with the exporter, constitute the bulk of the trade (Appendix I). In the sections below we summarise our observations for (i) species that we recorded on our surveys, but as indicated above were not included in Yeeting & Palik

(2008); (ii) species for which the majority of the population would be expected to be found at depths inferior to 10 meters or superior to 30 meters; and (iii) other species that we felt warranted discussion.

Where relevant and appropriate, we present species density estimates on reefs around Kosrae as derived from our surveys and compare these to those reported by Yeeting & Palik (2008). Based on density estimates and the surface area of reef (or habitat) available, one is able to calculate total stock for a given species. In a number of instances, in the sections below, we make reference to the "*low* 10% quota estimate" and the "10% quota estimate". The former makes reference to the 10% of the lower 95% confidence limit of the stock estimate arrived at by Yeeting and Palik (2008) (see Appendix II), and which is proposed as sustainable harvestable stock size. Where this value is not provided we make reference to the "10% quota estimate" instead.

Aquarium fish species not recorded in 2007

Family Blenniidae *Cirripectes variolosus* *Ecsenius opsifrontalis* *Cirripectes stigmaticus*	These species were found to inhabit depths of less than 10 meters. These water depths were characterised by habitat tended to be highly rugose, limiting the surveyor's ability to see, or adequately identify, small marine aquarium fish further than a few meters away. These two reasons combined may explain why these species are missing in the original surveys. These species were found at the same depths (<10 meters) on all five days we looked for them, indicating that they are fairly broadly distributed around Kosrae. Individual species' abundance varied depending on location. Three sets of timed-swims undertaken for *Cirripectes stigmaticus* showed that this species is relatively common on the reef. Undertaking more detailed surveys for each species would be useful to determine stock estimates but we recommend it as a low priority based on data (Table 1) and the fact that they were at every site we looked for them.
Family Labridae *Cirrhilabrus katherinae* *Cirrhilabrus luteovittatus*	Collectors did not target the two species of *Cirrhilabrus* on dives we conducted with them to evaluate "Best Practice" and our attempt to visit one of the collecting areas had to be abandoned due to tide issues. These species were not recorded in the 2007 surveys, nor were we able to locate them. Targeted surveys should be conducted for these two species as they appear to have very specific and limited habitat – MMME's help should be enlisted in determining the sites where the fish can be found.
Halichoeres melasmopomus	This species was only seen on dives in 30+ meters of water even when not surveying for them. See Table 2 for results of two timed-swims undertaken for this species.
Family Serranidae *Pseudanthias bartlettorum*	This species was found in schools numbering in the hundreds at specific sites; always in depths exceeding 10 meters. Although when found it was recorded in great numbers, given its site specificity, overall numbers for Kosrae may be moderate. Extrapolating overall numbers from spot checks only, is likely to result in an incorrect stock assessment. To obtain accurate abundance estimates for this species, the use of an underwater scooter to find the sites at which this species is present at high density could be very useful. Should surveys be undertaken to determine standing stock for this species it is suggested that an assessment for *Pseudanthias dispar* be completed at the same time.
Family Pomacentridae	

Chromis vanderbilti	This species was found in large schools so dense with fish it was difficult to even estimate approximate abundance. It is suspected that these were inadvertently recorded in 2007 as *Chromis acares*, a species very similar in appearance and also highly abundant in large schools. Given this species' high abundance along most of Kosrae's outer reef a detailed stock assessment is not considered a priority at this time.

Aquarium fish species with the majority of their population found at depth <10m or >10m

Family Labridae *Macropharyngodon meleagris*	This species was not recorded frequently during the 2007 surveys. Our surveys seem to indicate that the main population appears to live in the shallows, in less than 10 meters of water. We observed individuals of this species on every dive day over the period of time spent in depths of less than 10 meters. While abundance varied from location to location the species was not found to be site-specific. Four timed-swims were undertaken in 5-8 meters of water, for a total of 32 specimens seen in 32 minutes of swimming (see Table 3). Based on this information, density of this species was calculated at thirty four times the number of individuals per 1000m^2 listed in Yeeting & Palik (2008) (see Table 3). Although future surveys could be conducted for *Macropharyngodon meleagris*, given that this species is collected in low quantities and our data indicate it is present on the reef at reasonable high levels, our recommendation is that surveys for this species be considered a low priority. Instead we advocate that sustainability of the trade be monitored via collection/export data. Although we did count fish over the appropriate habitat, the surveys may not be extensive enough in terms of overall surface area covered compared to total habitat area around the island to be considered comprehensive. They only serve to indicate that the population is much larger than originally thought. Therefore, if collection data are to be compared to quota recommendations based on the original 2007 stock estimates, quota numbers should be modified to account for the fact that transects were not conducted where the main population resides. A rough adjustment recommendation would be to multiply the original harvestable stock estimate by 20% of the ratio between our estimated density per 1,000m^2 and that listed in Yeeting & Palik (2008) to obtain the new recommended harvestable quota. For example, the recommended annual quota[6] for this species was set at 104 (Yeeting & Palik 2008). However, we recorded a density for this species ~35 times greater than original surveys showed. To derive the new annual harvestable quota one would multiply the density factor (34.63) by 20%, times the original recommended quota. The result, 720 individuals, would provide an exceptionally conservative figure. If annual exports in the future were to exceed this number, then more extensive surveys in 5-8 meters of water to accurately establish the stock may need to be undertaken.
Pseudocheilinus hexataenia	This species was not recorded frequently during the 2007 surveys. Our surveys showed high abundance of this species, and seven timed-swims were undertaken to get a rough estimates of stock size.

[6] Low 10% quota estimate

	Fish were observed on all dives whether surveying or evaluating "Best Practice". Therefore the species was not considered site-specific. We counted a total of 66 individuals in 60 minutes (see Table 4) during timed surveys; a density ~177 times that recorded in the original report. The significant difference is likely attributable to the fact that although found in 10 meters of water this species is highly cryptic and has a skittish nature, so traditional monitoring techniques that include laying down a transect tape and counting fish from a distance may not be appropriate. Although future surveys could be conducted for *Pseudochelinus hexataenia,* given that this species is collected in low quantities and our data indicate it is present on the reef at high levels, our recommendation is that surveys for this species be considered a low priority. Instead we advocate that sustainability of the trade be monitored via collection/export data. We suggest the same conservative approach as outlined for *Macropharynogodon meleagris* be utilized to adjust the originally proposed number of fish considered as "harvestable stock". In this case the new annual quota would be 2,234. If annual exports in the future were to exceed this number, then more extensive surveys to accurately establish stock size may need to be undertaken. Surveys would need to focus solely on this species (i.e., not be combined with joint surveys of other target species) because of its cryptic nature.

Table 4 - Estimates of *Pseudocheilinus hexataenia* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Pseudocheilinus hexataenia					
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)	Density (no./1000 m2) (2008)
8 Nov	7	30	14	4.10	
8 Nov	10	5	10	17.59	
8 Nov	8	5	10	17.59	
8 Nov	5	5	2	3.52	
8 Nov	5	5	2	3.52	
8 Nov	10	5	18	31.67	
9 Nov	8	5	10	17.59	
		Total	**Total**	**Average**	
		60	66	**13.66**	**0.077**

***Family P*omacanthidae** *Centropyge multicolor*	*Centropyge multicolor* was observed on all dives at ≥ 30 meters depth by at least one of the survey team members. A technique in spotting this species was utilized by one member of the survey team, highlighting the variability that is inherent in surveys of marine aquarium species given their often cryptic nature. A very narrow field of focus (2m either side) was required to spot this fish. An accurate stock assessment for this species could not be undertaken in 2007 given that transects were conducted at 10 meter depth and the fact that this species only occurs in deeper waters and is highly cryptic in nature. Consequently, based on this report's surveys, we conclude that the population for this species is considerably larger than reported in 2008. Conducting species-specific surveys will be difficult due to its cryptic habits, and lack of time a surveyor can spend diving safely at the species' preferred habitat depth. This species has a wide geographic range extending from the southeast Pacific through to the northern western Pacific, so there is no compelling reason

	to take the risks involved in conducting focused surveys for this species. Instead we advocate that sustainability of the trade be monitored via collection/export data. We would recommend applying the same conservative approach to derive harvestable stock from 2007 data as outlined for *Macropharyngodon meleagris* and *Pseudocheilinus hexataenia*. The 10% quota estimate for this species in the 2008 report is 63 individuals. Our densities were 64 times superior to those recorded by Yeeting & Palik (2008) (see Table 5). The new annual quota would therefore be 807 individuals. Alternatively, one could derive a quota by limiting the stock estimate to the area of reef considered as known habitat for this species (25m and deeper), rather than the entire reef area. Thus, with a reef perimeter of 47km around Kosrae and a conservative preferred habitat width extending 30m below the 25m depth contour the new harvestable quota for this species would be 695 fish. If exports exceed the higher estimate surveys focusing solely on this species - because of its cryptic nature – might be considered to obtain a more accurate stock assessment.
Pygoplites diacanthus	This species was not recorded frequently during the 2007 surveys. Our surveys showed a fair abundance of this species, and eight timed-swims were undertaken to get a rough estimates of stock size. Fish were observed on all dives whether surveying or evaluating "Best Practice"; always at depth (>20m). Therefore the species was not considered site-specific. We counted a total of 40 individuals in 61 minutes (see Table 6) during timed surveys; a density 2.4 times that recorded in the original report. This significant difference is likely attributable to the fact that although found in 10 meters of water this species prefers deeper water, particularly individuals of the right size to enter the trade. Although future surveys could be conducted for *Pygoplites diacanthus,* given that this species is collected in low quantities, is found at depth and therefore presents a risk in terms of dive safety, our recommendation is that surveys for this species be considered a low priority. Instead we advocate that sustainability of the trade be monitored via collection/export data. The original low 10% quota estimate is 1,678 individuals (Yeeting & Palik 2008). Given that similar densities were recorded during the 2007 and 2013 surveys we would recommend this quota stay the same. As only small juveniles should be targeted for the trade, leaving adults to reproduce on the reef (e.g., Palumbi et al. 2004; Beldade 2012), an additional measure may be to limit collection size to fish less than 15cm in size. If annual exports in the future were to exceed this number (for fish only up to a maximum of 15cm), then more extensive surveys to accurately establish stock size may need to be undertaken.

Table 5 – Estimates of *Centropyge multicolor* densities based on numbers observed during timed-swims. Fish were counted 2m either side of the survey swimming line.

Centropyge multicolor					
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)	Density (no./1000 m2) (2008)
8 Nov	35	13	10	10.15	
8 Nov	35	10	1	1.32	
8 Nov	30	5	1	2.64	
8 Nov	30	10	4	5.28	
9 Nov	30	10	4	5.28	
		Total	**Total**	**Average**	
		48	20	**4.93**	**0.077**

Table 6 - Estimates of *Pygoplites diacanthus* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Pygoplites diacanthus					
Date	Depth (m)	Swim time (min)	No. recorded	Density (no./1000 m^2)	Density (no./1000 m2) (2008)
8 Nov	35	13	5	3.38	
8 Nov	35	10	14	3.52	
8 Nov	40	5	17	12.31	
8 Nov	25	3	42	5.86	
9 Nov	30	5	42	3.52	
9 Nov	20	5	3	5.28	
9 Nov	30	10	9	7.92	
9 Nov	30	10	8	7.04	
		Total	**Total**	**Average**	
		61	40	**6.10**	**2.538**

Other species

Family Acanthuridae *Acanthurus nigricans*	This species is found in large numbers at varying levels of depth all around Kosrae. Juveniles tend to occur in shallow areas, while adults prefer deeper waters. Yeeting and Palik (2008) estimated 10% stock size at 20,004 (with the lower 10% estimate being 14,259 – see Appendix II). It is our understanding that this species, chiefly in its adult form, is also fished for food in Kosrae. In the case where there is overlap between subsistence take and aquarium take of a species we suggest that a more conservative quota and possibly a maximum size limit be adopted by the aquarium fishery. If the fish represents an important source of take in *subsistence fishing* then 5% of the low stock estimate should be applied as quota. To protect subsistence fishermen the same quota should be applied to other commercial activities targeting this species, for example commercial spearing. Per fish removed, the marine aquarium fishery has less impact on the resource than commercial spearing as it removes only juvenile fish and not the breeding stock. Larger females lay many more eggs than smaller individuals, and their young are more likely to survive (Green 2008). In many species, the offspring of big fish swim better, grow faster and live longer than ones from smaller mothers. Recent studies have further shown that the contribution of larger females to self-recruitment was significantly greater than expected on the basis of the relationship between body size and fecundity, underlining the importance and impact of female size on offspring traits (Beldade et al. 2012). Moreover, a study conducted in Hawaii on a species within the same family as *A. nigricans* showed that only 1% of juveniles survive until breeding age when protected from fishing (Claisse et al. 2009). Thus, the removal of a juvenile fish for export provides income to fishermen and employees in the marine aquarium trade from an individual that is unlikely to survive to adulthood. It provides a high return in value with little impact, and if combined with a more stringent quota ensures that there will

	be negligible impact on the adult breeding stock and its use as a food source. While we do not feel it is needed in Kosrae given the high standards under which the current company is operating, a size limit could be implemented to ensure only juveniles are collected for the marine aquarium trade. Our stock estimates show a 75% greater abundance than those published in Yeeting & Palik (2008) (see Table 7). Despite the increased abundance we recorded, given the noted potential conflict between the aquarium and food fisheries, we recommend that the original low 10% stock quota be reduced from 10% to 5%, resulting in an annual quota of 7,130 individuals.
Family Pomacanthidae *Centropyge loriculus*	*Centropyge loriculus* was observed on all dives at a range of depth. This species has a skittish nature and tends to dart in and out of the substrate where it seeks refuge when approached. Thus, traditional surveys where a transect tape is laid out will tend to underestimate abundance of this species. Species-specific surveys may be useful to regularly assess stock on Kosrae, as it is a desirable species. However, from a resource point of view we would advocate to chiefly monitor sustainability of the trade via collection/export data. Our average stock estimates were slightly lower than those recorded in 2008 (see Table 8) since we include surveys in shallow and deeper waters. At the preferred depth for this species our estimates corroborate previous findings and as such we would advocate the low 10% quota estimate of 7,642 be used.

Table 7 - Estimates of *Acanthurus nigricans* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Date	Depth (m)	Time Swim (min)	No. recorded	Density (no./1000 m²)	Density (no./1000 m2) (2008)
6-Nov	5	3	7	20.52	
6-Nov	5	2	10	43.98	
6-Nov	15	3	12	35.19	
7-Nov	10	3	11	32.25	
7-Nov	5	3	21	61.57	
7-Nov	5	3	27	79.17	
7-Nov	15	3	8	23.46	
7-Nov	10-15	3	12	35.19	
7-Nov	5-10	4	17	37.38	
7-Nov	5	5	34	59.81	
		Total	**Total**	**Average**	
		32	**159**	**42.85**	**24.263**

Table 8 - Estimates of *Centropyge loriculus* densities based on numbers observed during timed-swims. Fish were counted 3m either side of the survey swimming line.

Date	Depth (m)	Time Swim (min)	No. recorded	Density (no./1000 m²)	Density (no./1000 m2) (2008)
7-Nov	15	10	5	4.40	
7-Nov	5	10	20	17.59	
7-Nov	10	4	7	15.39	
7-Nov	15	10	4	3.52	
7-Nov	15	3	2	5.86	
7-Nov	10	3	1	2.93	
7-Nov	5	4	0	0.00	
7-Nov	5	3	0	0.00	
7-Nov	20	10	7	6.16	
7-Nov	10-15	20	16	7.04	
7-Nov	15	10	10	8.80	
7-Nov	10	10	9	7.92	
7-Nov	25-30	8	1	1.10	
7-Nov	5-10	4	1	2.20	

Date	Depth (m)	Time Swim (min)	No. recorded	Density (no./1000 m^2)	Density (no./1000 m2) (2008)
8-Nov	15	3	11	32.25	
8-Nov	10	3	2	5.86	
8-Nov	15	10	7	6.16	
8-Nov	10	10	8	7.04	
8-Nov	15	5	6	10.56	
8-Nov	10	3	0	0.00	
8-Nov	10	3	6	17.59	
8-Nov	5	3	0	0.00	
8-Nov	5	5	0	0.00	
8-Nov	5	4	0	0.00	
8-Nov	10	10	8	7.04	
8-Nov	10	10	7	6.16	
8-Nov	10	5	3	5.28	
8-Nov	8	5	2	3.52	
8-Nov	5	5	0	0.00	
8-Nov	20	5	5	8.80	
8-Nov	10	5	6	10.56	
8-Nov	10	10	19	16.71	
9-Nov	8	5	8	14.07	
9-Nov	10	10	23	20.23	
9-Nov	10	10	19	16.71	
		Total	**Total**	**Average**	
All		238	223	**7.76**	
Outside Range	<6 - >24	49	22	**2.09**	
Inside Range	8-24	189	201	**10.02**	**11.385**

Commercial survey findings

Surveyed species were ranked along an abundance spectrum of extremely low (1) to very high (5) depending on abundance/densities detected on the reef (see Table 9), and were informed by surveyors' experience on reefs around the region. A classification of very high abundance does not mean a numerical threshold was achieved that was consistent for all species, as species typically exhibit different habits (e.g., schooling or not schooling, territorial or not territorial). As such, density categories are relative to known densities observed at other sites in the region for a given species, not relative to other species at a known location. A low abundance rating does not necessarily mean that this species is rare; instead it means that sustainable take would be lower than in a country where this particular species is known to be encountered frequently and at high abundance on the reef. Taking *Centropyge loriculus* and *Chromis acares* as examples: densities of C*. loriculus* and *Chromis acares* were recorded as high in Nauru (Wabnitz & Nahacky 2013; 62.37/1000m^2 and 266.98/1000m^2 respectively in Yeeting & Thoma 2008). Although *C. acares* was recorded at four times the density of *C. loriculus*, species' abundances were not ranked relative to each other, with both species considered as extremely abundant in Nauru (when compared to other sites in the region).

In Kosrae, *C. loriculus* abundance was recorded as low, as numbers were inferior (11.385/1000m^2 in Yeeting & Palik 2008) to known densities for this species recorded elsewhere. Although relative densities are a useful comparison, it is important to note that the number of individuals that can be sustainably exported from any given location will naturally depend on the total area of reef that fish can be collected from. Nauru is smaller than Kosrae. Thus, despite a significant greater density recorded at the former island, standing stock was calculated at 157,180 for Nauru and 93,685 for Kosrae. There is clearly a sizeable standing stock in Kosrae that can be sustainably collected from.

The density labels assigned to target species in Table 9 should be used to determine how to allocate resources and monitoring priorities, rather than determine quotas. For example, *Chromis acares* with a standing stock estimate of 111,762 for Kosrae (Yeeting & Palik 2008), and for which export numbers

account for 3% of the standing stock (Martin Selch, pers. comm.), represents a low priority species to allocate resources for monitoring purposes.

Table 9 – Marine aquarium trade target species and abundance ranking (1-5, 1 being lowest and 5 being highest abundance)

Family/ Species surveyed	Abundance Rating (1-5)	FAMILY/ Species surveyed	Abundance Rating (1-5)
Acanthuridae		Pomacanthidae	
Acanthurus nigricans	4	*Centropyge flavissima*	2
Acanthurus pyroferus	1	*Centropyge loriculus*	2
Balistidae		*Centropyge multicolor*	2
Melichthys vidua	3	*Centropyge vrolikii*	3
Blennidae		*Pygoplites diacanthus*	2
Cirripectes variolosus	3	Pomacentridae	
Ecsenius opsifrontalis	4	*Amphiprion chrysopterus*	2
Cirripectes stigmaticus	4	*Amphiprion perideraion*	1
Chaetodontidae		*Chromis acares*	4
Chaetodon punctatofasciatus	3	*Chrysiptera traceyi*	4
Cirrhitidae		*Chromis vanderbuilti*	4
Cirrhitichthys oxycephalus	2	Serranidae	
Labridae		*Pseudanthias bartlettorum*	See text for this species
Cirrhilabrus katherinae	See text for this species	*Pseudanthias dispar*	2
Cirrhilabrus luteovittatus	See text for this species	*Pseudanthias pascalus*	4
Halichoeres melasmopomus	2	Zanclidae	
Labroides pectoralis	3	*Zanclus cornutus*	2
Macropharyngodon meleagris	2		
Pseudocheilinus hexataenia	3		
Pseudocheilinus octataenia	2		
Thalassoma lutescens	2		

Based on data presented in Table 9, *Acanthurus pyroferus* and *Amphiprion perideraion* are two species that were recorded in relative low abundance during commercial surveys and which monitoring activities may want to focus on.

No endemic species were recorded during the 2007 surveys, or the 2013 surveys. The possible, though unlikely, overexploitation of an endemic species is therefore not a concern. Given the species found in Kosrae waters and the abundances at which these were recorded, the only potential issue may be localized over-fishing. A number of natural factors contribute to minimising such a risk and ensuring the fishery is sustainable:

- Only a portion of the coastline can be targeted for collection at various times of the year due to the prevailing trade winds;
- Kosrae reefs benefits from high coral cover (Yeeting & Palik 2008), meaning that in a high proportion of available habitat it is *casi* impossible to collect fish.

In addition to weather and habitat constraints, limited freight availability and flights out of Kosrae provide natural protection from localised overfishing and a safeguard to maintain adequate stock in general terms.

REVIEW OF MMME ACTIVITIES

Two days were spent at MMME to complete an inspection of the exporter's facility itself and all fish held there. We also spent four days diving with MMME's collectors. Our assessment focused on:

- The system in which the fish were being held;
- Handling of all fish coming in to the facility and while being held at the facility itself;
- Quality and size of fish as well as type of species held;
- Dive safety practices;

- Collection techniques;
- Handling practices of fish from the point of collection (including decompression) until delivery to the facility; and
- Mortality rates at three key points: collection, holding, and arrival at the importer. In addition, all fish were observed for quality and health after arriving in Los Angeles (USA) at the importer's facility.

System

All fish were kept in a well maintained system that was adequate to keep the fish in good health. It had proper filtration, both mechanical and ultraviolet, along with protein skimming. Fish that are territorial and should not be kept together were held in individual separated cubicles. Daily waste removal and other daily and weekly procedures to maintain high quality water were in place.

Handling of fish at the facility

All handling of fish by staff at the facility followed best practice, including fish being transferred from and between holding receptacles with nets. Fish that are territorial and fight when placed together were cupped individually. Species that were held together in tanks were not crowded. Staff checked on fish often and tanks were monitored and cleaned regularly.

Fish species and quality

As the system was well maintained and tasks to maintain high quality undertaken diligently and regularly, all fish observed at the facility were considered in good health and of good quality for export.

The vast majority of fish caught and held at the facility were specifically requested by importers (i.e., caught on order). However, fives species (*Chaetodon reticulatus*, *Chaetodon ornatissimus*, *Chaetodon meyeri*, *Chaetodon lunulatus*, *Oxymonacanthus longirostris* – see Figure 2 through Figure 6) collected in low quantities fell outside of this category. These fish are strict corallivores, meaning they will feed exclusively on coral polyps and do not adapt to being fed any type of fish food in captivity. As such, these species are generally recognized to be nearly impossible to keep alive in an aquarium and are not frequently traded by reputable importers.

Figure 2 – *Oxymonacanthis longirostris*

Figure 3 – *Chaetodon meyeri*

Figure 4 – *Chaetodon ornatissimus*

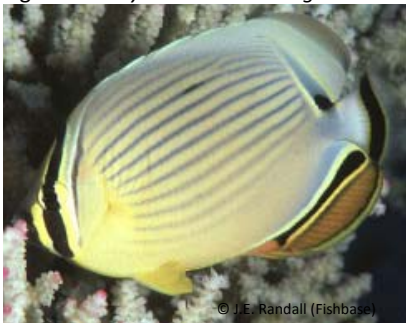

Figure 5 – *Chaetodon lunulatus*

Figure 6 - *Chaetodon reticulatus*

Recommendation: We suggested that export of these species be stopped, a measure, which was implemented over the duration of our stay. Subsequent follow-up with two of MMME's main importers and review of their records confirmed this recommendation was in place and these species were not being exported to the USA/UK.

Mortality

The mortality from collection to arrival at an exporting facility can substantially impact the sustainability of an aquarium fishery, particularly where reef area is limited. If losses are high more fish need to be collected to fill orders. During the period of assessment it was clear that mortality was low from collection through to arrival at the importer and that any impact of collection to replace mortality was negligible. Overall losses at key assessment points were as follows:

a. Collection and transport from collection point to facility: less than 1% overall, based on three days spent on board the collection boat and monitoring collection activities of all divers;
b. At the facility prior to export: Less than 1% overall; based on thorough screening and assessment of collected fish at six random different times at the exporter's facility;
c. Arrival at the importer's: average of less than 1.4% overall for the third quarter of 2013; based on an assessment of DOA[7] records obtained on site at the import end; and
d. At the importer's facility: an evaluation of fish health at the import facility in Los Angeles showed fish from Kosrae to be healthy, active, and looking very well. Importers in the EU and Hong Kong reported the same findings.

Dive safety

Overall, divers were found to follow reasonable dive profiles, with some room for improvement in terms of safety. The fact that a boat operator is at all times present at the surface is to be lauded and adds safety. Diving equipment was found to be in excellent condition and well maintained (e.g., rinsed after each dive and stored adequately).

Figure 7 – Diver monitoring fish during ascent and decompressing fish as needed. Note that the divers is stationary in the water column away from the substrate

Recommendation: We recommended that divers be trained to use dive computers that are easy to calibrate, in a manner that improves dive profile, and safety. Moreover, fish that are collected in waters deeper than 35 meters should only have a daily order for the quantity that can be collected in one tank so as to discourage multiple dives at depths greater than 35 meters. We also suggested that MMME implement a policy of not diving more than one tank per day deeper than 35 meters. These latter two recommendations were put in place right away.

Collection practices and handling skills

Once divers arrived at a collection site the boat is tied to a buoy or the boatman asked to drift following the divers. Therefore, anchor damage as a result of collection practices is not a concern. We observed virtually no damage to the reef due to fins during collection. Experienced divers exhibited a mix of care levels during collection, leaving in some instances room for improvement. Trainee divers did not exhibit the care that should be taken when collecting.

[7] Death On Arrival

Recommendations: A number of suggestions were brought to the attention of MMME's manager and all divers during a meeting, where all were given an opportunity to ask questions and discuss the issue at hand:

- When setting collecting gear on the bottom (in between dives) it should be left on top a dead coral colony or on rubble, never on a live coral head;
- All rebar should be replaced with fibreglass or graphite rods of 13mm maximum diameter. This recommendation was immediately followed-up on by arranging the export of 12.5 mm yellow fiberglass rods from Hawaii to Kosrae;
- Divers were encouraged to treat all substrate with gentle care; and
- When setting the net divers should consider if any coral damage will result from collection. If so they should look for another set or leave this fish on the reef.

The nets used for collection of all species except *Anthias* are small not exceeding three meters length and one meter height, with a small mesh size (<13mm stretched eye). Most fish that are not targeted go around the net. Due to the low strength of the monofilament line used any medium or large fish that go into the net can break through the net. To avoid their net being damaged the collectors go to considerable effort to be sure no large fish hit the net except the ones they are targeting. As a result of the small mesh size used, almost no fish were seen gilled in the nets. Observations of sets for *Anthias* using the larger net showed that a minimum of two divers constantly control and monitor the net. Thus, no disruption to non-target species was observed.

Generally, the divers were found to handle the fish carefully under water to maximise their health. Divers were found to provide regular water changes, both under water and on board the boat. Once aboard the boat, all fish are transferred to well-maintained coolers with a lid provided with good aeration. A boat cover not only shields the boat captain and divers from the sun, but also provides additional protection from water heating for the fish.

Overall, collectors were found to decompress the fish according to best practice (Figure 7), with only a few fish having had more air removed than is optimal and/or suffered subsequent infection due to a poorly sterilised needle (2-3% of *C. loriculus*, corresponding to <1% of all fish brought to the facility). While diving with the collectors we witnessed excellent handling of the net as a team during *P. bartlettorum* collection to maximise quality.

Recommendation: Needles should be kept in alcohol at all times or changed more frequently. Fish that were found to require further decompression once at the facility were being packed in a plastic bag with as much pressure as possible. It was recommended this procedure be replaced by putting the fish in a deep container (1-2 meters). This was immediately put in place by the exporter.

Summary of recommendations to MMME

- The following 5 species should not be exported[8] until we are able to keep them alive for extended periods of time in an aquarium: *Chaetodon reticulatus*, *C. ornatissimus*, *C. meyeri*, *C. lunulatus* and *Oxymonacanthus longirostris;*
- Divers should know how to and use dive computers in a manner that improves safety and that they would actually utilize;
- For fish collected from waters deeper than 35 meters the exporter should not order more fish than can be normally and safely be collected on one tank[8];
- A company policy should be introduced limiting dives to ≥35m to one tank per day[8];

[8] These recommendations were implemented right away

- Collecting gear left on the substrate in between dives should always be placed on top of a dead coral colony or rubble;
- Rebar should be replaced with a fibreglass or graphite rod of a 13mm maximum diameter[9];
- Divers should exercise utmost care with the substrate;
- Nets should always be set so as to result in no coral damage;
- Needles to decompress fish should be kept in alcohol or changed often[9]; and
- All fish that arrive at the facility in need of additional decompression should be placed at the bottom of a deep container (1-2 meters)[9].

Recommendations for Kosrae Government

- Data should be compiled by the appropriate department at species level so as to monitor collection or export trends. Emphasis should be placed on key species – e.g., *C. multicolor*, *C. loriculus*. This is the most important action to be implemented to monitor the sustainability of the trade.
- Due to the size of the reef area in Kosrae it is recommended that there only one license be issued for the island of Kosrae (i.e., one operator). Any expansion of the fishery should target other islands of FSM where there are currently not operators and collection can take place over a larger reef area.
- Re-evaluate stock of specific species (*Centropyge loriculus*, *Centropyge flavissima*, *Labroides pectoralis*, *Pygoplites diacanthus* and *Amphiprion chrysopterus*) at key sites every six months. The assessments should be done in exactly the same month each year and at multiple depths (10-15-20 meters). It is recommended that surveys focus on four sites frequently used for collection and two sites located in a protected area (being mindful that sites should have similar habitats to be comparable).

Conclusions

The export of fish for the aquarium trade from Kosrae provides jobs for 19 individuals. Currently related mariculture activities such as spawning and grow-out of Tridacna clams and coral farming would not be viable without the export of wild caught aquarium fish to meet overheads, minimum freight volumes, and customer order requirements. These activities being linked, the export of aquarium fish is an important sector to ensure and retain the economic benefits derived from mariculture activities.

Kosrae has established itself as a high quality exporter of aquarium fish and has an excellent reputation throughout the trade. Following on our monitoring of the local exporter's company we did two presentations one for the owner/managers and one which included the collectors and boat driver to outline and discuss the recommendations we had arrived at based on our observations. When we later checked-in with the exporter on location or followed-up on matters subsequent to our departure, the vast majority of our recommendations had already been implemented. Thus, little or no follow-up is required on recommendations made to the exporter.

While the aquarium fishery in Kosrae appears sustainable, government should obtain export data by species after each shipment and monitor trends in exported quantities and species over time. This would provide a cost effective way to monitor the fishery into the future to help assure it remains sustainable.

[9] These recommendations were implemented right away

REFERENCES

Beldade, R. Holbrook, S.J., Schmitt, R.J., Planes, S., Malone, D. and G. Bernardi (2012) Larger female fish contribute disproportionately more to self-replenishment Proceedings of the Royal Society B doi:10.1098/rspb.2011.24332433: 1471-2954

Claisse J.T., McTee S.A., and J.D. Parrish (2009) Effects of age, size, and density on natural survival for an important coral reef fishery species, yellow tang, *Zebrasoma flavescens*. Coral Reefs 28: 95-105

Green, B. S. 2008 Maternal effects in fish populations. Advances in Marine Biology 54, 1 –105

Kulbicki, M. and Sarramegna, S. (1999). Comparison of density estimates from strip transects and distance sampling from underwater visual censuses: a case study of Chaetodontidae and Pomacanthidae. Aquatic Living Resources 12 (5) (1999): 315 – 325.

Kulbicki, M., Labrosse, P. and Y. Letourneur (2000). Fish stock assessment of the northern New Caledonian lagoons: 2 – Stocks of lagoon bottom and reef-associated fishes. Aquatic Living Resources 13 (2) (2002): 77 – 90.

Labrosse, P., Letourneur, Y., Kulbicki, M. and J.R. Paddon (2002). Fish stock assessment of the northern New Caledonian lagoons: 3 – Fishing pressure, potential yields and impacts on management options. Aquatic Living Resources 13 (2) (2002): 91 – 98.

Palumbi, S.R. 2004. Marine reserves and ocean neighborhoods: the spatial scale of marine populations and their management. Annual Review of Environment and Resources 29: 31–68.

Yeeting, B., and S. Palik (2008) The marine aquarium fish resources of Kosrae island, Federated States of Micronesia: A survey of the resources and its potential for supporting a marine aquarium export industry. Secretariat of the Pacific Community, Noumea, New Caledonia. Draft. 52pp

Yeeting, B., and D. Thoma (2008) A first survey of the marine aquarium fish resources of Nauru. Secretariat of the Pacific Community, Noumea, New Caledonia. 43 pp

Wabnitz, C., and T. Nahacky (2013) Commercial survey for ornamental fish species in Nauru. Secretariat of the Pacific Community, Noumea, New Caledonia. 26 pp

Appendix I

Main target species that represent the bulk of MMME exports

	Scientific name	**Common name**
1	*Acanthurus nigricans*	Whitecheek tang
2	*Acanthurus pyroferus*	Mimic tang
3	*Melichthys vidua*	Pinktail triggerfish
4	*Cirripectes variolosus*	Red-speckled blenny
5	*Ecsenius opsifrontalis*	Comical blenny
6	*Cirripectes stigmaticus*	Ember blenny
7	*Chaetodon punctatofasciatus*	Spotband butterflyfish
8	*Cirrhitichthys oxycephalus*	Coral hawkfish
9	*Cirrhilabrus katherinae*	Katherine's wrasse
10	*Cirrhilabrus luteovittatus*	Yellowband wrasse
11	*Halichoeres melasmopomus*	Blackear wrasse
12	*Labroides pectoralis*	Blackspot cleaner wrasse
13	*Macropharyngodon meleagris*	Leopard wrasse
14	*Pseudocheilinus hexataenia*	Six-line wrasse
15	*Pseudocheilinus octataenia*	Eight-line wrasse
16	*Thalassoma lutescens*	Banana wrasse
17	*Centropyge flavissima*	Lemonpeel
18	*Centropyge loriculus*	Flame angel
19	*Centropyge multicolor*	Multicolor angelfish
20	*Centropyge vrolikii*	Pearlscale angel
21	*Pygoplites diacanthus*	Regal angel
22	*Amphiprion chrysopterus*	Blue stripe (orange fin) clownfish
23	*Amphiprion perideraion*	Pink skunk clownfish
24	*Chromis acares*	Midget reef chromis
25	*Chrysiptera traceyi*	Tracey's damsel
26	*Chromis vanderbilti*	Vanderbilt's chromis
27	*Pseudanthias bartlettorum*	Bartlett's anthias
28	*Pseudanthias dispar*	Dispar anthias
29	*Pseudanthias pascalus*	Purple queen anthias
30	*Zanclus cornutus*	Moorish idol

Appendix II

Species	10% Low Estimate Quota (2008)	10% of stock (2008)
Acanthurus nigricans	14,259	20,004
Acanthurus pyroferus	51	190
Amphiprion chrysopterus	2,384	3,171
Amphiprion perideraion	158	634
Centropyge flavissima	876	1,268
Centropyge loricula	7,642	9,386
Centropyge multicolor		63
Centropyge vroliki	7,796	9,894
Chaetodon punctatofasciatus		4,566
Chromis acares	84,381	111,762
Chromis vanderbilti		-
Chrysiptera traceyi	11,824	16,506
Cirrhilabrus katherinae		-
Cirrhilabrus luteovittatus		-
Cirrhitichthys oxycephalus		-
Cirripectes stigmaticus		-
Cirripectes variolosus		-
Ecsenius opsifrontalis		-
Halichoeres melasmopomus		-
Labroides pectoralis	112	317
Macropharynogodon meleagris	104	254
Melichthys vidua	999	1,395
Pseudanthias bartlettorum		-
Pseudanthias dispar	5,688	10,758
Pseudanthias pascalus		7,420
Pseudocheilinus hexataenia		63
Pseudocheilinus octotaenia		1,015
Pygoplites diacanthus	1,678	2,092
Thalassoma lutescens	4,247	5,201
Zanclus cornutus		1,332