

Final Report on Diver's Perception Survey for Palau's Kemedukl and Mami

Project: Stock Assessment for Humphead Wrasse and Bumphead Parrotfish



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EXECUTIVE SUMMARY:

We estimated market value for the fishery and dive tourism for kemedukl (bumphead parrotfish) and maml (Napoleon fish) in Palau. Market value was estimated for four ecological and management scenarios: 1) the two species do not exist; 2) the fishery is poorly managed, thus fish are few and small in size 3) the fishery is strictly managed, thus there are moderate numbers of medium-sized fishes; 4) the fishery is closed and there are numerous large-sized individuals.

- The most popular species that people come to see when diving in Palau were manta ray, turtle, shark, dolphin, napoleon fish, and bumphead parrotfish, respectively
- More than half of the divers were from Japan (25.1%), Taiwan (23.2%), and United States (17.8%).
- More than 2/3rd of the divers visited Palau for the first time, and more than half were part of a tour group.
- Ecological and management scenarios significantly affected the dive fee people were willing to pay for their diving experiences. In general, people were willing to pay \$11.8 more for healthier ecological scenario, or \$36 more for closure compared to poorly managed scenario.
- There was no significant difference between the fees people were willing to pay for poorly managed fisheries and absence of the two species.
- The average dive fee people were willing to pay ranged between \$136.7 to \$169.0 (USD) depending on the fish size and density. Therefore, total dive tourism market value was \$12,984,060 for scenario 1, \$12,642,999 for scenario 2, \$14,622,862 for scenario 3, and \$16,056,457 for scenario 4.
- Kemedukl and maml showed a gradual increase in price (annual increase of 5 cents for both species) while the fishery was open. Although landing pattern differs greatly between the two species, when comparing their market values, both showed similar price and has not shown significant differences for the last five years of the fishery.
- Based on the fishing effort provided by Friedlander and Koike 2013, the total fishery market value was \$21,919 for kemedukl and \$5,577 for maml under ecological scenario 3 (strictly regulated management). For ecological scenario 2 (poorly regulated management), the total market value was \$210,104 and \$53,471 for kemedukl and maml, respectively. The higher market value is due to greater landings caused by the lack of regulation.
- Palau's maml and kemedukl populations are still in recovery state since the closure in 2006. Therefore, we estimate current Palau to be close to scenario 3.
- The gain/loss of dive tourism is two to three orders of magnitude greater than the fishery market gain/loss when changing any ecological scenarios.

INTRODUCTION:

Marine organisms have multiple values depending on the person who perceives them (CBD 2006). A fisherman may see fish as his essential “crop”, whereas a dive operator might see them as a nice addition to their tour business but not essential. Some fish might not have any market value but have high cultural value. It is also important to think from ecological perspective and see what ecological role each marine organism is playing. Some organisms could be important for the ecosystem to function, but people may see no values in them. When considering holistic fishery management, it is important to take into account all of these values including fishery and non-fishery values of a marine organism.

Bumphead parrotfish (scientific name: *Bolbometopon muricatum*, Palauan name: kemedukl) and Napoleon wrasse (scientific name: *Cheilinus undulatus*, Palauan name: maml) have been two species of fish that are ecologically and culturally important in Palau. Both are large in size and considered as charismatic mega fauna. Kemedukl is known to be the largest of the parrotfish family and can grow up to 1.3 meters in length and live up to forty years. Maml is known to reach a maximum length of more than 2m and up to 190kg in weight and also live over 30 years. Their life history traits such as spawning aggregation and late maturation make them especially vulnerable to fishery. Due to overfishing and habitat degradation, kemedukl has been listed as vulnerable and maml has been listed as endangered under the IUCN red list. Kemedukl plays an important ecological role as the “excavator” of the reef, where they remove limestone and dead corals from the reef as they feed on algae and live corals which free up new colonizing sites.

In order to estimate the values of kemedukl and maml in tourism industry in Palau, we conducted willingness to pay surveys of visiting tourist divers in Palau. To compare the dive tourism market values with fishery market values, we also estimated fishery market values using historical market price projection and allowable catch numbers suggested by Friedlander and Koike 2013.

METHOD:

Willingness to Pay Survey Analysis

Diver willingness-to-pay (WTP) survey was developed to assess the market values of kemedukl and maml to the dive tourism in Palau. The surveys were designed to ask the following questions: 1) what are the top five preferred marine organisms they expect to see; 2) how much are divers willing to pay for certain fish sizes and densities of kemedukl and maml; 3) what are the general tourist demographics (gender, country, tour group, age, income range, previous dive experiences, number of prior visits to Palau); and 4) what are the tourist perspective on conservation (scored from 1 to 5).

Table 1. Ecological case scenarios presented to the tourist divers. Case scenario 1 was presented as a control for the rest of the scenarios.

Scenario	Fisheries management	Kemedukl/Maml present	Max fish size (m)	Density (number per school)
1	-	No	-	-
2	Poor Management	Yes	0.2-0.5	1-5
3	Effective Management	Yes	0.5-1	10-20
4	No Fishing	Yes	>2	50-100

Staffs from the Palau International Coral Research Center (PICRC) interviewed visiting tourist divers and snorkelers between 11-30 November, 2013 at either the local dive shops or at the Rock Islands in Palau's southern lagoon during lunch time between dives. Total of 13 dive operators participated in this study (Table 2).

Once the survey data were collected and entered, they were analyzed to assess the most popular species, tourist demographics, and divers' willingness to pay under different management scenarios.

Table 2. List of participating dive shops

No.	Tour Operator	Phone
1	Fish N' Fins	488-2637
2	Neco Marine	488-1755
3	Sam's Tours	488-7267
4	Aqua Magic Palau	488-1119
5	Cruise Control	488-6691
6	Day Dream	488-3551
7	Divers Palau	488-6767
8	Maml Divers	488-8029
9	Pacific Divers Oasis	488-4192
10	Carp Island Resort	488-2277
11	Peleliu Divers	345-5555
12	Blue Marlin	488-2214
13	Splash (PPR)	488-2600

Fishery Market Value Analysis for the Two Species

Previous fishery market data between 1990 and 2006 was examined for both kemedukl and maml, and included date, weight, and market price at the time. We projected the market price for 2013, and multiplied these values by the suggested total allowable landings (Friedlander and Koike 2013) in order to estimate the fishery market value of the two species under each management scenario.

ANALYSIS RESULTS:

Willingness to Pay Survey Analysis

Interviews to assess tourist diver's willingness to pay for Palau's kemedukl and maml under certain ecological condition were conducted between 11-30 November, 2013 by PICRC. A total of 324 divers were interviewed during this time period.

Marine organisms of interest:

The most popular species that people came to see in Palau were manta ray, turtle, shark, dolphin, and napoleon fish, respectively (Table 3). It is worthy to note that both maml and kemedukl ranked high among divers as preferred species (5th and 6th).

Table 3. Ranking and summed number of votes casted by tourist divers for marine organisms they want to see.

Ranking	Species	Counts	Percentage
1	Manta Ray	239	14.9%
2	Turtle	228	14.2%
3	Shark	193	12.1%
4	Dolphin	177	11.1%
5	Napoleon Fish	175	10.9%
6	Bumphead Parrotfish	124	7.7%
7	Small Fish	94	5.9%
8	Coral	81	5.1%
9	Tuna	54	3.4%
10	Barracuda	52	3.2%
11	Ship Wrecks	49	3.1%
12	Grouper	27	1.7%
13	Snapper	14	0.9%
14	Others	18	1.1%
	(blank)	76	4.7%

Tourist demographics:

More than half of the divers were from Japan, Taiwan, and United States (Table 4). More than half of the divers visited Palau for the first time (68%) and was also part of a tour group (54%).

Table 4. Number and percentage of tourist divers visiting from each country.

Country	Number	Percentage
Japan	79	25.1%
Taiwan	73	23.2%
USA	56	17.8%
China	25	7.9%
Germany	15	4.8%
Australia	12	3.8%

Palau	11	3.5%
Switzerland	6	1.9%
Czech Republic	4	1.3%
South Korea	4	1.3%
Yap	4	1.3%
Austria	3	0.9%
France	3	0.9%
Italy	3	0.9%
Netherlands	3	0.9%
Spain	3	0.9%
Canada	2	0.6%
New Zealand	2	0.6%
Slovakia	2	0.6%
Colombia	1	0.3%
Finland	1	0.3%
Guam	1	0.3%
Philippines	1	0.3%
Trinidad & Tobago	1	0.3%
Total	315	100%

Tourist diver's willingness to pay:

The main goal of this survey was to determine how much people were willing to pay under different fishery management scenarios that resulted in certain fish sizes and densities for maml and kemedukl. The interviews provided three scenarios to the divers that could be linked to differing fishery management options (no fishing, low fishing, and high fishing), and the amount that they were willing to pay for each management scenario. Since there was few number of snorkeler surveys (34 surveys), only scuba diver survey was analyzed for this report.

Management scenario was significantly correlated with the fee that tourist divers were willing to pay. People were willing to pay \$11.8 more for every healthier ecological case scenario, or \$36 more for closure compared to poorly managed scenario (Figure 1 & Table 5).

Table 5. Mean dive price tourists are willing to pay for each case scenario.

Scenario	Average Dive Fee (USD)	Annual Total Dive Fee (USD)
1 (control)	136.7	12,984,060
2 (poor management)	133.1	12,642,999
3 (effective management)	153.9	14,622,862
4 (closed fishery)	169.0	16,056,457

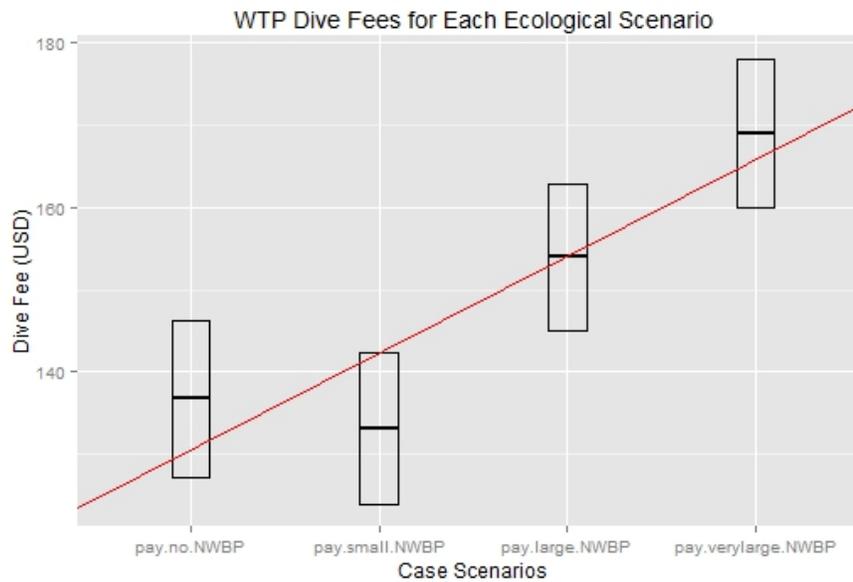


Figure 1. Diver's willingness to pay (WTP) for the four different ecological scenarios (pay.no.NWBP = scenario 1, pay.small.NWBP = scenario 2, pay.large.NWBP = scenario 3, pay.verylarge.NWBP = scenario 4). The box indicates 95% confidence interval. The red line indicates the WTP model for Palau (dive fee (USD) = $118.71 + 11.78 \times \text{case scenario number}$).

According to the Palau Visitor's Authority (PVA), 118,754 people visited Palau in 2012 and that 80% of the visitor came to Palau to go diving. Since we have no other additional information, we assume that Palau will receive the same number of tourists for the year of 2013. Therefore, we expect an annual number of 95,003 tourist divers visiting Palau. When we multiply these tourist diver numbers with mean dive fees under each ecological scenario, we get \$12,984,060 for scenario 1, \$12,642,999 for scenario 2, \$14,622,862 for scenario 3, and \$16,056,457 for scenario 4. This is more than three million dollars difference between closure scenario and poor managed scenario (24% more) and about two million dollars difference between effectively managed scenario and poor managed scenario (13% more). It is also interesting to note that there was no significant difference between the fees people were willing to pay for condition of poorly managed fishery and absence of the two species, but there are significant difference in willingness to pay between well managed scenarios (scenario 3 and 4) and poorly managed scenarios (scenario 1 and 2).

Fishery Market Value Analysis for the Two Species

Market data for kemedukl and maml were provided by the Palau Department of Marine Resources. Kemedukl had relatively high landings (40,000 lbs) in 1995 until the late 1990s, after which time catch dropped sharply. Landings for maml were at low levels until the late 1990s, when they increased sharply and then declined very rapidly within a few years (figure 2).

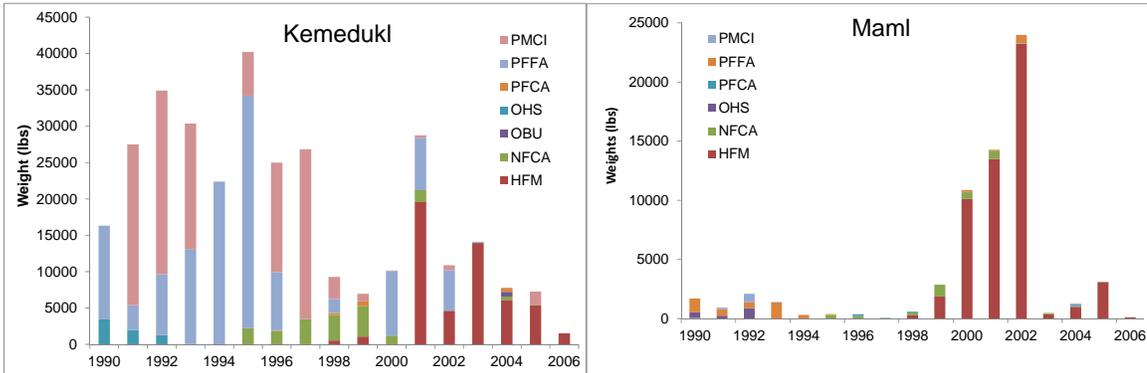


Figure 2. Market data of *kemedukl* and *maml* in Palau from 1990 to 2006.

From the early 1990s to the close of the fisheries in 2006, the two fish species showed gradual increases in price (annual increase of 5 cents for both species). When comparing their overall market value, *maml* has priced significantly higher than *kemedukl* (figure 3).

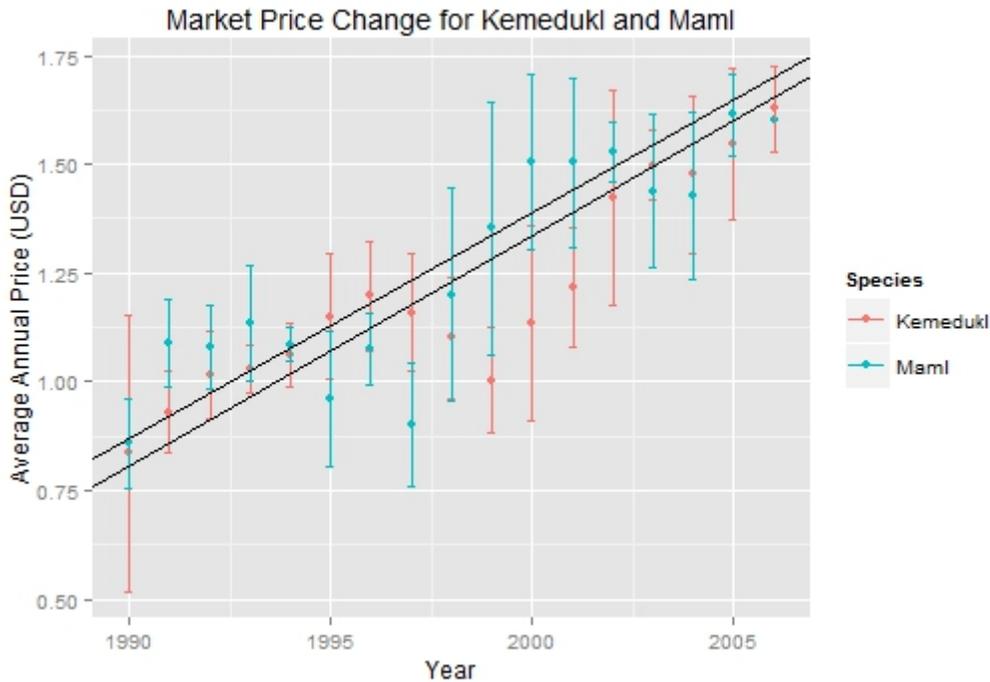


Figure 3. Historical annual mean market price of *kemedukl* and *maml* between 1990 and 2006. The error bars show standard deviation from the mean price. Black line is the price trend for the two species.

If the market value for these fishes has consistently grown, we estimate the fish’s price to be \$2.02/lbs for *kemedukl* and \$2.07/lbs for *maml* in 2013. The conservative sustainable landings proposed for *kemedukl* and *maml* are 487 (10,851 lbs) and 129 (2,694 lbs), respectively (Friedlander and Koike 2013). We expect this would be equivalent to the scenario 3 used in WTP survey. If we multiply this with each market price, the total market value will be \$21,919.02 for *kemedukl* and \$5,576.58 for *maml*. For scenario 2, we estimate the maximum allowable catch with fishing effort of 0.1 which gives about three times higher landings than Palau’s previous historical landing for *kemedukl*. In this case, the allowable landing will be 4,669 (104,011.89 lbs) for *kemedukl* and 1,234 (25,831.56 lbs) for *maml*. The low number of landing weight for *maml* is likely due to the average weight used for calculation (market landed fish are usually skewed toward

large size of the population). This will be equivalent to \$210,104.02 and \$53,471.33 total market value respectively. As for scenario 4, the fishery is closed thus the value would be \$0 for both species.

Comparison of the Two Market Values

For each case scenario, we have estimated both fishery and tourism market values (Table 6).

Table 6. Comparison of estimated market values between fishery and dive tourism for each species.

Case Scenario	Estimated Dive Tourism Market Value	Estimated Fishery Market Value (Both Spp)	Estimated Fishery Market Value (Kemedukl)	Estimated Fishery Market Value (Maml)
1 (control)	12,984,060	--	--	--
2 (poor management)	12,642,999	263,575	210,104	53,471
3 (effective management)	14,622,862	27,496	21,919	5,577
4 (closed fishery)	16,056,457	0.00	0.00	0.00

Currently, Palau's fishery for kemedukl and maml is closed to recover the two species stock size from previous overfishing. The density from the stock assessment survey showed high density of both species compared to most areas in the world (kemedukl density in Palau is 0.75 ha⁻¹ to 1.56 ha⁻¹ depending on the habitat and 0.79 ha⁻¹ to 1.05 ha⁻¹ for maml). However this is still much lower compared to pristine environment where densities of up to 20 maml per hectare have been recorded (Zgliczynski et al. 2013 and Gillet 2010). From these reference values, we can say that Palau's maml and kemedukl population is still in recovery and thus the current state for these species in Palau is close to 3. If the fishery is reopened with tight restriction allowing the population to continue recovering (scenario 3), we could expect the dive tourism to generate \$14,622,862 (USD) and fishery market creating \$27,496 (USD) annually. However, if the fishing effort cannot be well regulated and stocks become overfished, we could expect scenario 2, where dive tourism brings in \$12,642,999 and the fishery market brings in \$263.575 (USD) annually. Increase in annual market price of \$236,079, due to more landing initially, seems to be a significant increase in fishery market, but when compared with the loss of \$1,979,863 per year in dive tourism, the loss is quite considerable. Additionally, we suspect that the harvest level in scenario 2 is not sustainable, thus these gains will be short lived. In the end, the decrease in the stock size in the succeeding years will decrease the market income from the fishery in scenario 2. Furthermore, this will suffer the dive industry even greater. If the fishery remains closed, we could expect the dive tourism to bring in \$16,506,457. Here again, we see that the gain in dive tourism from scenario 3 to 4 (\$1,433,695) is much greater than the loss in fishery market closure (\$27,496). One thing to note is that this comparison is solely based on the market values of the fish and no other market costs/gains such as environmental impact costs, hotel cost/gain, restaurant cost/gain, and fishery operators' salary cost/gain is not included.

From a pure monetary stand point, scenario 4 with a closed fishery shows the most increase in market gains. However, maml and kemedukl have strong cultural and subsistence importance to Palauan. Another point to make is, the amount of allowable catch in scenario 3 is too low for a viable commercial fishery, and thus we feel allowing subsistence fishery solely would be the most practical option. This, however, could become a challenge on enforcement since there is no formal catch reporting system for subsistence fishery yet. Given the difficulty in accurately accounting the number of fish harvested, regular monitoring of maml and kemedukl populations should be mandatory.

Reference:

Convention on Biological Diversity (2006). Global Biodiversity Outlook 2 Secretariat of the Convention on Biological Diversity, Montreal, 81 + vii pages.

Friedlander, A., H. Koike (2013). *Analysis of catch quota for kemedukl and maml in Palauan water*. Stock Assessment for Humphead Wrasse and Bumphead Parrotfish Project Report. PICRC.

Gillett, R. (2010). Monitoring and management of the humphead wrasse, *Cheilinus undulatus*. FAO Fisheries and Aquaculture Circular No. 1048.

Zgliczynski, B. J., I. D. Williams, R. E. Schroeder, M. O. Nadon, B. L. Richards, S. A. Sandin (2013). The IUCN red list of threatened species: an assessment of coral reef fishes in the US Pacific Islands. *Coral Reefs* 32, Issue 3, pp 637-650.

Appendix A

Willingness to Pay Survey for Napoleon wrasse (*Maml*) and Bumphead parrotfish (*Kemedukl*)

Introduction

Napoleon wrasse (*Maml*) and Bumphead parrotfish (*Kemedukl*) are two species of fishes that are ecologically and culturally important in Palau. They are also one of the largest species of fish you will see in Palau waters. There has been a decline in the number of these fishes due to heavy fishing. In order to restore the population and to develop a sustainable management plan, the Government of Palau closed the fishery in 2006.

The Palau International Coral Reef Center (PICRC) and the University of Hawaii is currently conducting a valuation survey of Napoleon wrasse (*Maml*) and Bumphead parrotfish (*Kemedukl*) as part of ongoing research efforts. We would appreciate it if you could answer the following questions to improve our understanding for better future management of these important species.



Napoleon wrasse (*Maml*)

Bumphead Parrotfish (Kemedukl)



For more information, please visit our site: <http://www.picrc.org/>

Section 1: Diving and Snorkeling Questions

Question 1:

Please circle the top 5 animals/objects that you would like to see today.

Shark	Turtle	Manta ray
Napoleon wrasse	Bumphead parrotfish	Grouper
Snapper	Tuna	Barracuda
Small colorful reef fish	Dolphin	Ship or other wrecks
Coral	Other: _____	

Section 2: Willingness to Pay Questions

Question 2:

*In Palau have you been DIVING or SNORKELING?
(please circle one, or just diving if you've done both)*

How much did you pay for one dive or snorkel trip here in Palau (excluding the cost of renting dive gear, just diving cost if you did both)?

_____ US\$

With this in mind, please answer the following questions.

Question 3:

Would you pay the following prices to dive or snorkel in an environment where you will likely see large species such as shark, turtles, manta, and groupers but no Napoleon wrasse or bumphead parrotfish:

Please circle Yes or No for each price:

- \$30LESS than what you paid today (Yes, No)
- The same price you paid today (Yes, No)
- \$30 MORE than what you paid today (Yes, No)
- \$60 MORE than what you paid today (Yes, No)
- \$90 MORE than what you paid today (Yes, No)
- \$120 MORE than what you paid today (Yes, No)

Question4:

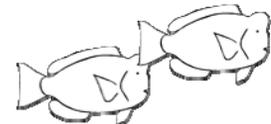
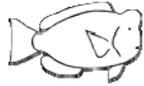
Would you pay the following prices to dive in an environment where you will likely see only few, small-sized Napoleon wrasse and bumphead parrotfish? You will also still see other large animals.

This can occur in an over fished environment, where the fishery has little or no restriction. Fish are small (20-50cm) since they are often caught before they fully grow up. Fish school size will also be small (1 -5 fish per school) since reproductive success is lower.

Please circle Yes or No for each price:

- \$30 LESS than what you paid today (Yes, No)
- The same price you paid today (Yes, No)
- \$30 MORE than what you paid today (Yes, No)
- \$60 MORE than what you paid today (Yes, No)
- \$90 MORE than what you paid today (Yes, No)
- \$120 MORE than what you paid today (Yes, No)

0.2 – 0.5 m



Question 5:

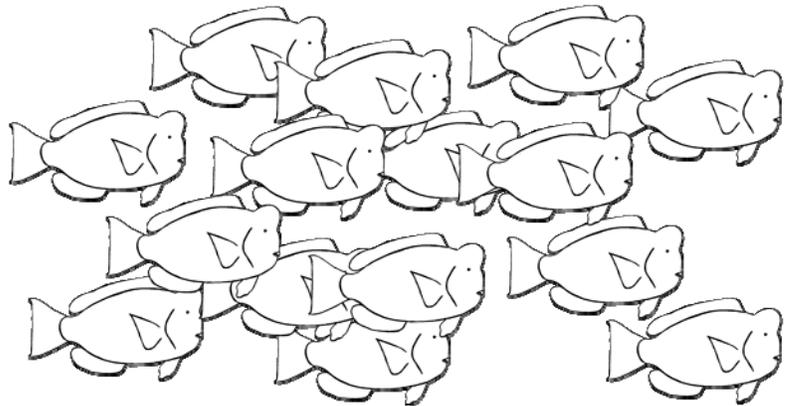
Would you pay the following prices to dive in an environment where you will likely see large Napoleon wrasse and bumphead parrotfish in schools of 10? You will also still see other large animals

You will often see this in a fished environment under effective management. Fish maintain their healthy size (50cm to 1m) with relatively large schools (number of fish in a school would range around 10-20). Fish live to have multiple chances to reproduce, although older and larger females that produce many more offspring are still rare.

Please circle Yes or No for each price:

- \$30 LESS than what you paid today (Yes, No)
- The same price you paid today (Yes, No)
- \$30 MORE than what you paid today (Yes, No)
- \$60 MORE than what you paid today (Yes, No)
- \$90 MORE than what you paid today (Yes, No)
- \$120 MORE than what you paid today (Yes, No)

0.5 – 1 m



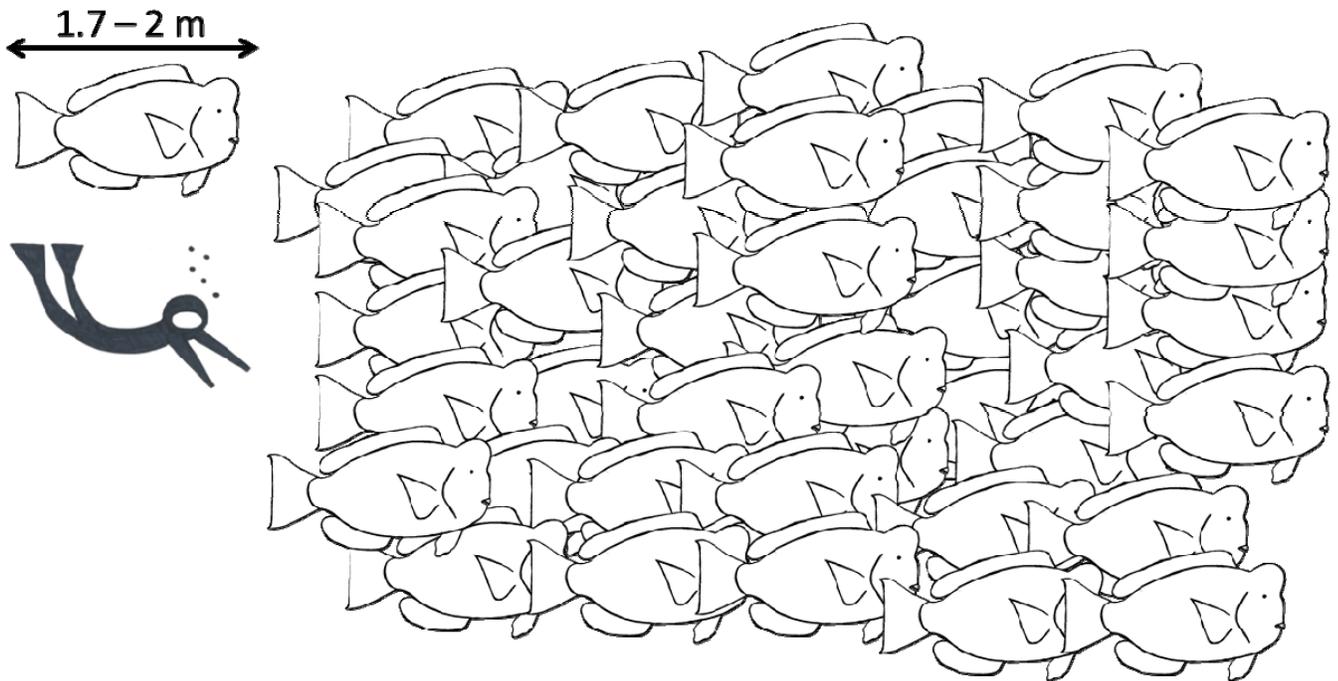
Question 6:

Would you pay the following prices to dive in an environment, where you will likely see very large Napoleon wrasse and bumphead parrotfish in a school of 50s – 100s? You will also still see other large animals.

This would be more likely to occur if fishing for these species is prohibited. These fish can live to their maximum age and can become large in size (>2.0m). Large females produce many more eggs than smaller ones, which in turn lead to a larger number of fish (number of fish per school can be up to 100s).

Please circle Yes or No for each price:

- \$30 LESS than what you paid today (Yes, No)
- The same price you paid today (Yes, No)
- \$30 MORE than what you paid today (Yes, No)
- \$60 MORE than what you paid today (Yes, No)
- \$90 MORE than what you paid today (Yes, No)
- \$120 MORE than what you paid today (Yes, No)



Section 3: Demographic Information

Question 7:

a. What is your gender? (Male, Female) *{please circle one}*

b. Where is your primary residence? ()

c. Are you on a group tour? (Yes, No) *{please circle one}*

d. What is your age range? *{please circle one}*

(18 – 25) (26 – 34) (35 – 44) (45 – 60)(61 – 75)(76+)

e. What is your annual, pre-tax household income range in US\$ *{please circle one}*

(35,000 or less) (36,000 – 70,000) (71,000 – 105,000) (106,000 - 140,000) (141,000 – 175,000) (176,000 – 210,000) (210,000 or more)

f. How many dives have you completed? (Total # of lifetime dives)

(Less than 10) (11-50) (51-100) (100 or more) *{please circle one}*

g. Is this your first time in Palau? (Yes, No) *{please circle one}*

Question 8:

To what extent do you agree with the following statements related to fishing and protection of marine species? Please select a number from One (1) to (5) (1 being strongly **disagree** and 5 being strongly **agree**) that indicates how much you identify, or agree with, each of the following statements.

Environmental Perception	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Fishing should be regulated to ensure sustainability even if that means I won't be able to eat as much of that fish.	1	2	3	4	5
I do not mind paying extra diving fees to help conservation efforts that will increase the size/number of fish.	1	2	3	4	5
Heavy fishing pressure can cause problems for the health of the coral reefs.	1	2	3	4	5

Thank you for your cooperation!