How much spiny lobster (*Panulirus argus*) can be harvested in Florida? [(*)]

by

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The Caribbean spiny lobster fishery in Florida cannot be analyzed isolated from catches within the Caribbean basin because larval connectivity, once suggested as a possibility, today is an accepted fact and also because the fishery has evolved in the same way in every fishing area.

Brazil's harvests are excluded from this discussion because its *P. argus* populations are self-sustained (Góes et al., 2007) and with insignificant impact on the Caribbean fisheries (Cruz et al., 2015) contrary to what once was thought.

All *P. argus* fisheries include an initial period, sometimes at the end of the 19th or at the start of the 20th centuries when the now so appreciated spiny lobster was used as bait for fish traps and an occasional food source for the fishers with a market value of $0.02 per pound in 1895 Florida (Crawford & De Smidt, 1923). During the 1940s and 1950s things started to change and spiny lobster commercialization and exports as a source of hard currency especially for Caribbean countries determined large fishing effort increases and even the development of "overseas" fisheries in pursue of greater profits, as happened when a large group of Florida fishers started harvesting spiny lobsters in Bahamas and some Caribbean fishing grounds (Labisky et al., 1980).

Every spiny lobster fishery grew, peaked and started to decline after some years of stable harvests of different duration. As a whole spiny lobster fisheries in the Caribbean grew from 2,457 metric tons in 1950 to a maximum of 36,272 m tons in 1999 and declined to 25,577 m tons in 2013 with a total harvest of 1.4 million tons and an annual average of about 22,000 m tons for the whole period (FAO, 2014) but not all fishing areas experienced growths and declines with similar characteristics.

Once settled in a given shelf *P. argus* specimens can migrate within it but adults in every island, fishing bank or section of continental shelf constitute an individual population isolated from other populations making them extremely vulnerable to excessive fishing effort and any adverse fishing practices as those included in the following Table that, if maintained for years, that can cause overexploitation or size reduction of irreversible levels.

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Violations and adverse consequences of some regulations (Buesa, 2012)

Country / area	Violation or adverse consequence of regulations
Antigua & Barbuda	From 1992 to 2004, 94 fishery violations recorded included possession of undersized lobsters and berried females
Belize	Unknown but suspected large numbers of juveniles are commercialized
Costa Rica	Harvested juveniles amounted to 44% of landings in 2004 (about 30 mt)
Cuba	After 12 consecutive years (1978 to 1989) of landings above a MSY of 10,300 mt , the situation worsened when the 1999 and 2000 closed seasons were cancelled and the fishery remained open for 33 consecutive months (June 1998 to February 2001)
Dominican Rep.	In 1997, around 70% of lobsters caught in "Parque Jaragua" were below legal size
Florida	Existing regulations allow using juvenile lobsters as attractants in lobster traps causing the death of 28.32 million from 1978/79 to 2008/09 or close to 1 million juveniles annually. These juveniles amount to 9,629 mt or 16% of the total local harvest during the period. The number of undersize lobsters taken or sold illegally was still a problem in 2002.
Honduras	From 1996-2002, 24.29 million juveniles weighing 2,643 mt (12% of the local total harvest in the period) were commercialized. In some areas about 60% of landings are juveniles.
Jamaica	In 2005, 0.2 million juveniles caught amounted to 30% of 221 mt landed. In 2007, immature females were 76% of landings (228mt or 0.67million lobsters). About 0.87 million juveniles are caught annually.
Nicaragua	Between 1990 and 2007 around 30% of landings (18,720 mt) were juveniles (55.06 million). During the early 2000s, juveniles exceeded 40% of annual landings (about 1700 mt). The illegal catch amounts to about 3.06 million juveniles annually.
Puerto Rico	Juveniles were 40% of 174 mt landed from 1985 to 1989 (0.2 million). From 1989 to 1991 juveniles increased to 59% of 107 mt landed (0.19 million), but in 1998 the harvest of juveniles was reduced to 24% of 48 mt (0.03 million). About 0.14 million juveniles are harvested annually.
St. Lucia	Undersized lobsters represented from 20 to 62% of catches (2 to 12 mt annually) from 1990 to 2005, variable by areas. Local restaurants prefer juveniles contributing to their harvest.
US Virgin Islands	1.3% of landings from 1987 to 1989 in St. Croix, and 2.9% of landings from 1985 to 1989 in St. Thomas and St. John, were juveniles.

At the FAO-WECAF meeting in Panama (FAO, 2015) no single country acknowledged their spiny lobster resources as being overfished or under fished. Six countries, including Bahamas, Cuba and Nicaragua declared their stocks as being “fully fished or stable” which is disingenuous and just trying to avoid repercussions “at home”. Seven delegations, including the US (Florida), opted for declaring their stocks in “unknown condition” which is essentially true.

It is worth noting that Nicaragua reported a series of actions taken to manage the fishery in spite of which the landing declared at the meeting (3,629 m tons) was less than the 4,278 m tons in the previous year and 59% of the maximum harvest of 6,180 m tons obtained 14 years earlier (in 2000).

Cuba also described implementing controls in the form of fishing permits and quotas, an extension of the closed season to 145 days, a minimum 76 mm legal cape length and protection to older females (140 mm CL and larger) known to produce larger broods. With state owned means of production and effective means of enforcement it seems that Cuba has finally decided to protect better their spiny lobster stocks whose harvests declined from a maximum of 13,578 m tons in 1985 to 4,621 m tons in 2013 but still represent 75% of the hard currency obtained from the whole fishing industry. The catch of 4,700 m tons reported for 2014, which is 1,800 m tons less than the 1957 catch, was qualified as stable and a possible indicator that the new measures are starting to produce their desired effects.

For Cuba there are several estimates of post larva imports, ranging from 35% (Buesa, 1970); 25% (Gutiérrez, 2012) and 43% (Gutiérrez et al., 2012), to self-recruitment in the SW shelf (Cruz et al., 2015) although all other modelling point to sizable post larval imports (Kough et al., 2013) to that area including those from Honduras and Belize (Cowen et al., 2002) and from Mexico and Haiti (Chávez & Chávez, 2012).

More stable or even growing Cuban spiny lobster populations is welcome news for those in Florida given the fact that larvae produced locally are essentially “expatriated out” (Yeung & Les, 2002) while 23% of larvae produced in Cuba are recruited in (Gutiérrez et al., 2012) along with larvae from Dominican Republic and Mexico (Chávez & Chávez, 2012) and from Honduras and Belize (Cowen et al., 2002).

In the most comprehensive summary of regional larval transmigration to date (Kough et al., 2013) all the Caribbean spiny lobster fishing areas are characterized as either producing larvae that will reach other areas, or those depending on imports to sustain their populations. Of those “sink” or larvae import areas one of great interest is Bahamas because in 2013 harvested 24% of all Caribbean spiny lobster catches while retaining less than 20% of their native larvae (Callwood, 2010) which means that this large fishery, with an average annual landing of 8,239 m tons for the period 1985-2013 is sustained essentially by imported post larvae, as the Florida fishery also is.

All the available information for 26 major Caribbean spiny lobster harvesting areas are presented in the next Table. The data include the harvest obtained the year when the fishery peaked along with the catch during 2013 (FAO, 2014) or 2014 (FAO, 2015) and what percentage of the maximum the most recent catch is. It is now necessary to realize that once a fishery has peaked the usual trend is to increase the effort even more to obtain ever growing economic benefits which always lead to catches reductions, as reflection of fishery damage sometimes either irreversible or difficult to overcome. Usually the effort is increased until the profit no longer cover expenses and the fishery collapses.

The information gathered was adjusted with a power function to calculate a theoretical percentage and the ratio to the actual ("real") percentage. The results show areas where the "real %" is higher than the predicted by the power function, and vice versa.

Landings in 2013 or 2014 as a percenage of Maximum landings years earlier (real and calculated values and their ratio)

COUNTRY OR AREA	Maximum catch in		Metric tons in	After maxinun catch		Calculated	Ratio
	YEAR	metric tons	2013 or 2014	years	% of catch	% of MaxC	real/calc
Anguila	2008	232	113	5	58	63	0.9
Antigua & Barbuda	1998	357	156	16	44	31	1.4
Bahamas	2003	10378	6088	10	59	41	1.4
Belize	2011	833	597	3	72	86	0.8
Bermuda	1968	250	31	45	12	16	0.8
Bonaire/S.Eustatius/Saba	2011	45	43	3	96	86	1.1
British Virgin Islands	2002	168	40	11	24	39	0.6
Colombia	1992	524	97	21	19	26	0.7
Costa Rica	1962	700	13	51	2	15	0.1
Cuba	1985	13578	4700	29	34	21	1.6
Dominican Republic	2011	2568	2542	2	99	>100	
Florida	1999/2000	4633	3114	15	67	32	2.1
Granada	1999	72	23	14	32	33	1
Haití	1996	950	450	18	47	29	1.6
Honduras	1986	5320	1657	27	31	22	1.4
Jamaica	2005	738	300	8	41	47	0.9
Martinique	1965	300	40	49	13	15	0.9
México (Yucatán)	2002	1070	1000	12	94	37	2.5
Nicaragua	2000	6180	3629	14	59	33	1.8
Panamá	2005	1053	723	8	69	47	1.5
Puerto Rico	2000	212	98	13	46	35	1.3
Saint Kitts & Nevis	2011	48	15	2	31	>100	
San Vicente/Grenadinas	2004	11	29	9	76	44	1.7
Turks & Caicos Islands	1972	600	211	41	35	17	2.1
US Virgin Islands	2004	150	72	8	48	47	1
Venezuela	1990	1126	90	23	8	25	0.3

Ratio % real / % calc > 1 = larval	import
Ratio % real / % calc < 1 = larval	deficit

Why the "real %" is higher than the calculated? It essentially means that the catches decreasing rate is smaller than the population growth rate especially considering that all spiny lobster fisheries mostly exploit the first three ages groups after recruitment so this scenario can only take place in areas where post larvae are imported from other areas. All "import" areas in the table, except for San Vincent/Grenadines, are identified as "sink" or post larva "importers" by Kough et al. (2013) and some (Belize, Cuba, Nicaragua and Turks & Caicos) are also post larva "exporters".

Conversely, why the "real %" is lower than the calculated? It essentially means that the population growth cannot fully compensate the extraction and this happens with excessive effort which can lead to overfishing. It is also worth noting that the 9 areas with "post larval deficit" peaked, as an average, 24 years before 2013 or 2014, while the 13 areas with "post larval import" peaked 7 years later, so it may be that excess effort during longer time could also influences these results.

Regardless of these unknowns all areas with large historical landings, the main Caribbean spiny lobster producers, have been characterized as “post larva importers” and some with “real %” lower than average (Belize, Costa Rica and Jamaica) are known for harvesting juveniles in large quantities.

The case of Bermuda, at the outermost limit of the species geographical distribution and not included in Kough et al.’s 2013 review, has an stagnant but very well regulated fishery that peaked 45 years ago whose survival most likely solely depends on Caribbean imported larvae although it cannot be identified as such.

Could this be the final stage of every Caribbean spiny lobster fishery if the populations keep dwindling by excessive fishing effort driven by hard currency pursue causing that the total number of larvae produced is not enough on a regional basis?

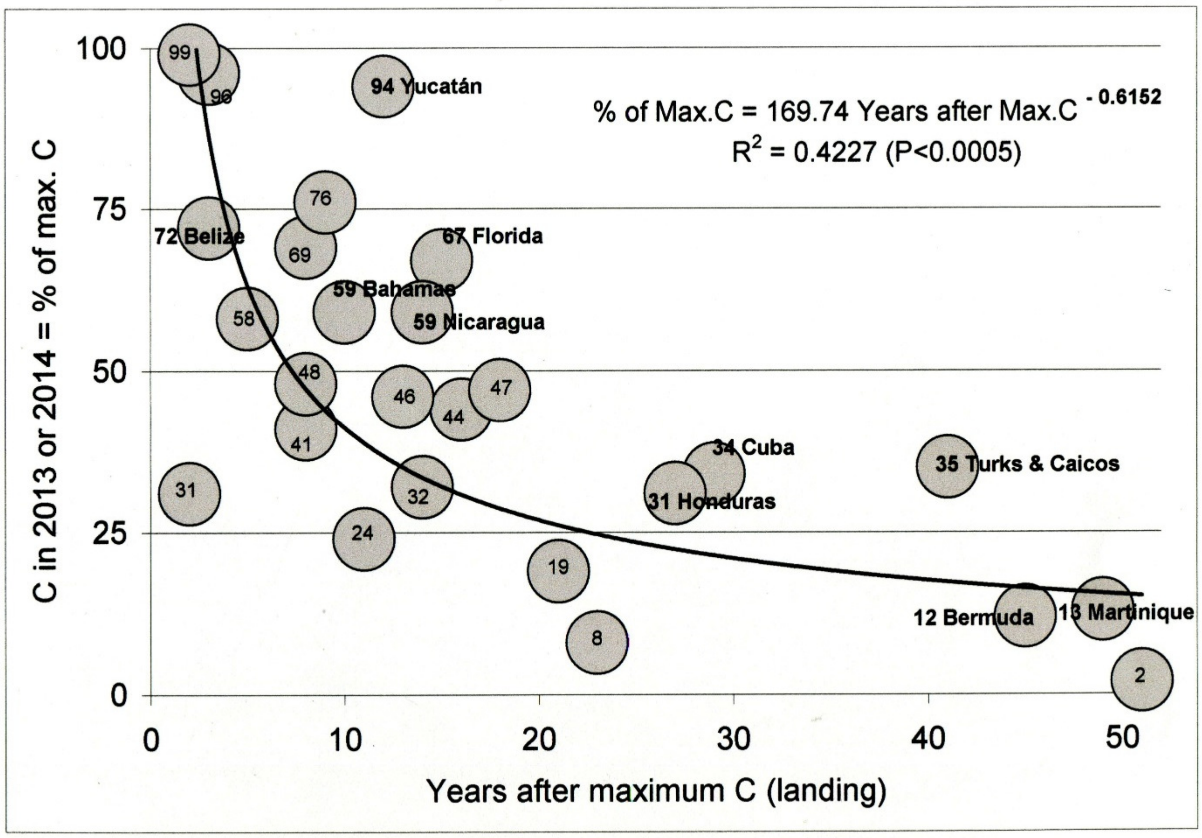
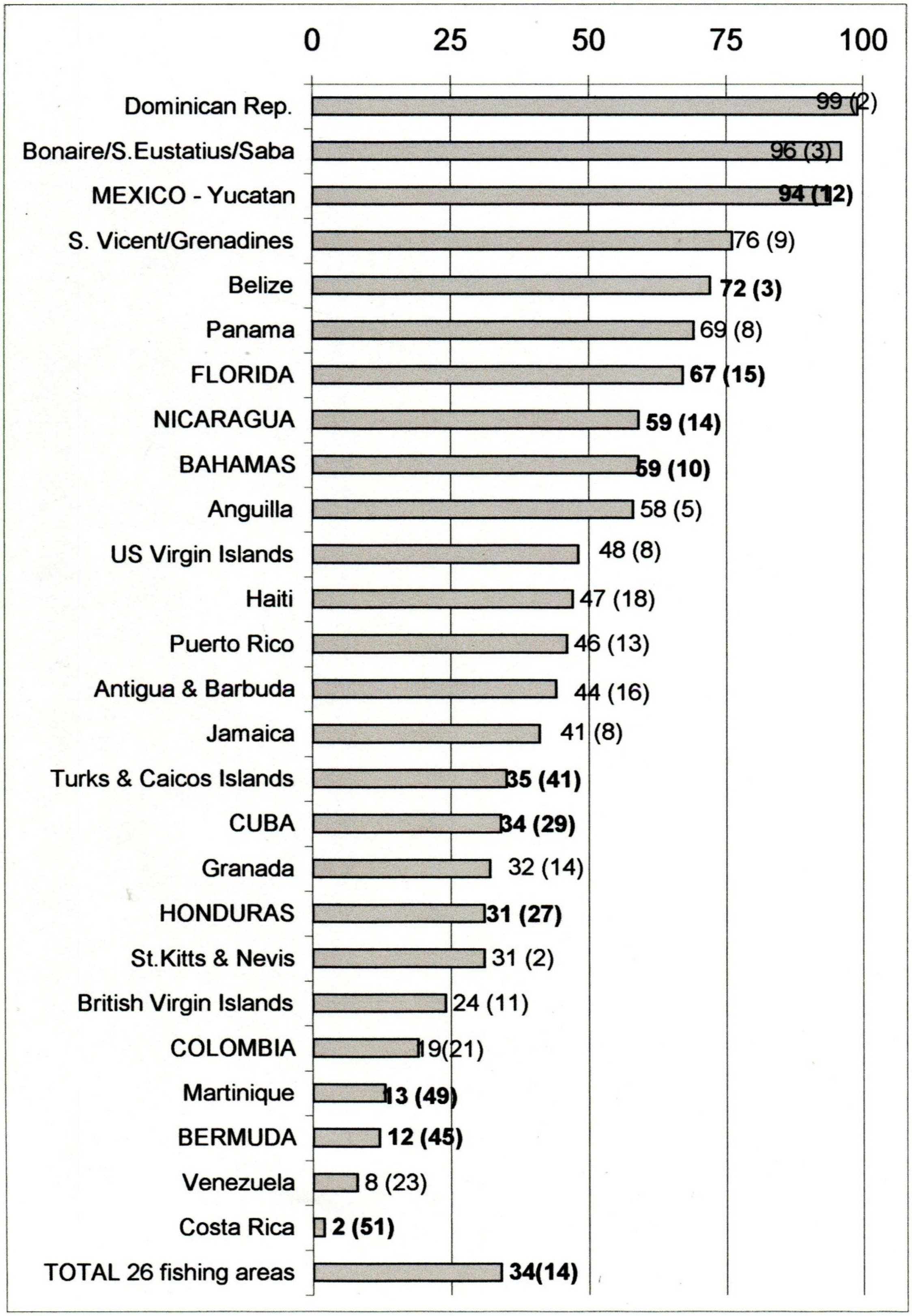


Figure 1 - Power correlation between the percentage value of each area landing in 2013 or 2014 and the landing when each fishery peaked 2 to 51 years earlier.

The information in this Figure is also presented in the next, this time arranged by percentages order with years from when each fishery peaked. As an average the whole area picked 14 years ago and now the total landing represents 34% of what it then was. As a whole, Caribbean spiny lobster landings have been reduced by 66% representing similar reductions in the populations’ sizes and their postlarval production as well.


0
25
50
75
100
Dominican Rep.
99 (2)
Bonaire/S.Eustatius/Saba
96 (3)
MEXICO - Yucatan
94 (12)
S. Vicent/Grenadines
76 (9)
Belize
72 (3)
Panama
69 (8)
FLORIDA
67 (15)
NICARAGUA
59 (14)
BAHAMAS
59 (10)
Anguilla
58 (5)
US Virgin Islands
48 (8)
Haiti
47 (18)
Puerto Rico
46 (13)
Antigua & Barbuda
44 (16)
Jamaica
41 (8)
Turks & Caicos Islands
35 (41)
CUBA
34 (29)
Granada
32 (14)
HONDURAS
31 (27)
St.Kitts & Nevis
31 (2)
British Virgin Islands
24 (11)
COLOMBIA
19(21)
Martinique
13 (49)
BERMUDA
12 (45)
Venezuela
8 (23)
Costa Rica
2 (51)
TOTAL 26 fishing areas
34(14)

This regional panorama is necessary to understand the Florida spiny lobster fishery and how to address the question of "How much spiny lobster can be harvested in Florida?"

Firstly it is necessary to enumerate some issues regarding the Florida spiny lobster fishery:

1- Official statistical data on "commercial" landings are essentially accurate but they do not include "recreational" catches nor the weight of undersized animals or "shorts" placed or left in the traps as attractants. Under these conditions, from 1985 to 2014 "commercial" landings represent about 76% of the whole harvest and it is very likely that this percentage is even lower because the total weight of "recreational" catches and "shorts" are the result of surveys answered on a voluntary basis and most likely reflect below real totals meaning that the actual harvest is unknown with precision and probably is close to 1.45 times the reported "commercial" value.

2- This statistical uncertainty questions the validity of Annual Catch Limit (ACL) or "fishing quota", as well as the Annual Biological Catch (ABC) for they are essentially based on landing data that represent underestimates of actual harvests. Similarly, with recruits to the populations essentially of Caribbean origin calculating a Maximum Sustainable Yield (MSY) using any recruit number or parental population approaches could be of little value.

3- An alternative approach to understanding the situation of the spiny lobsters populations is a comprehensive review of all the information gathered since the early 1970s about post larval arrivals to Florida coasts and try to determine if there is a significant correlation between these data and the catches two to four years later. Similarly there should be a biological sampling program on the nursery areas to calculate the number of recruits to the commercial populations.

3- Additionally, it has been pointed out the spread of the PaV1 virus as a dangerous to the Florida spiny lobster populations but as of today there is no concrete landing data of the present percentage the population is affected by this pathogen. Such base-line study is of special importance because the mean water temperature is expected to increase in future years with a likely increase in this virus spread.

Can we now determine how much spiny lobster can be harvested in Florida with the existing information? The short answer is "no, we cannot" at least in a meaningful way.

We can go around with some "guestimates" and "decide" which is better than other but the degree of uncertainty will not be reduced.

We just do not really know how much spiny lobster can be harvested but we can always propose that instead of just "analyzing" the significance of landing above the ACT it is better to determine some important fishing effort information such as:

1- Was the increase in landing due to an increase of the fishing effort defined as total number of traps*soaking days?

2- How the catch per unit effort (CPUE) defined as spiny lobster weight / trap*soaking day in 2014/15 compares with the previous 2013/14?

3- Is the trap reduction program "on track" to reach its goal of 400,000 traps licenses?

4- How many traps are really used every fishing year?

5- What can be done about the fishing effort from recreational fishers?

6- How many "shorts" are really used and how many of those actually die and are lost to the population growth and how can we reduce the number of "shorts" used or how can they be substituted?

7- How the recreational catch information can be improved?

At this moment the path to follow is assuring effort reduction to reach the proposed levels and a better understanding of the evolution of the CPUE as a measure of abundance in a single species fishery as the spiny lobster is (Steven & David, 2006).

The Caribbean spiny lobster fishery in Florida should be exempted of any quota for its status is essentially poorly understood as the US delegation to the FAO-WECAF Panama meeting stated.

But the issue is not acknowledging a poorly understood status, but what can be done to improve this understanding in order to properly manage the fishery always taking into account that managing this fishery has to be an international effort due to the resources interdependence via larval transmigration.

The GMFMC should try to promote contacts with the WECAF (Western Central Atlantic Fishery Commission) to coordinate research efforts to better understanding this fishery with a USD500 million value for the area fishers and fishing corporations.

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