TUNA CATCHES AND FISHERIES MANAGEMENT IN COSTA RICA'S PACIFIC EXCLUSIVE ECONOMIC ZONE

# TUNA CATCHES AND FISHERIES MANAGEMENT IN COSTA RICA'S EXCLUSIVE ECONOMIC ZONE

## A PROPOSAL FOR ALTERNATIVE DEVELOPMENT

*PRESENTED TO THE GOVERNMENT OF THE REPUBLIC*
*BY THE NATIONAL FISHERIES SECTOR COMMISSION*
*AND THE COSTA RICAN FISHERIES FEDERATION (FECOP)*
*IN CONSULTATION WITH INCOPESCA*

*AUGUST, 2013*

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| BRP | biological reference points |
| CITES | Convention on International Trade in Endangered Species of Wild Flora and Fauna |
| CONAMAR | National Marine Commission |
| EEZ | exclusive economic zone |
| EPO | eastern Pacific ocean |
| FAD | fish aggregating device |
| FAO | Food and Agriculture Organization (of the United Nations) |
| FECOP | Costa Rican Fisheries Federation |
| FENAPES | National Federation of the Fisheries Sector |
| GDP | gross domestic product |
| GPS | global positioning system |
| IATTC | Inter-American Tropical Tuna Commission |
| ICT | Costa Rican Tourism Board |
| IICE | Instituto de Investigaciones en Ciencias Económicas (research institute on economic sciences of the University of Costa Rica) |
| IMO | International Maritime Organization |
| INCOPESCA | Costa Rican Institute of Fisheries and Aquaculture |
| IUU | illegal, unreported and unregulated (fisheries) |
| MARF | Marine Areas for Responsible Fisheries |
| MPA | Marine Protected Areas |
| MSY | maximum sustainable yield |
| NGO | non-governmental organization |
| nm | nautical miles |
| OSPESCA | Central American Fisheries and Aquaculture Organization |
| PNDPA | National Fisheries and Aquaculture Development Plan |
| SICA | Central American Integration System |
| t | tonnes (1,000 kg) |
| UCR | University of Costa Rica |

TUNA CATCHES AND FISHERIES MANAGEMENT IN COSTA RICA'S PACIFIC EXCLUSIVE ECONOMIC ZONE

# EXECUTIVE SUMMARY

The lack of policies on sustainable fisheries in Costa Rica has resulted in the deterioration of social, economic and environmental conditions in coastal communities. Over the last 10 years the abundance of fish stocks available to the national fisheries sector has declined by at least 50%, affecting the socio-economic situation of fishing communities, as reflected in the poverty index of around twenty-two percent. Approximately 50,000 Costa Rican families live in coastal zones and on islands and where the majority of people from nuclear fishing families benefit directly or indirectly from artisanal fishing.

We understand that some of the causes of this vicious cycle creating increased poverty among these communities include an historical lack of fisheries management plans and an extractive policy involving the lowest possible cost which has predominated over a management system based on scientifically-established sustainable use. However, the international tuna sector – with licenses purchased, donated or non-existent – has extracted the national resource for over 50 years, blatantly competing against the national fisheries sector, which is unable to compete technologically and thus unable to access this valuable resource.

## Tuna fisheries

Between 2002 and 2011, 146 international tuna vessels carried out 1,512 fishing trips within Costa Rica's Pacific exclusive economic zone (EEZ), with a total of 16,626 sets, of which 1,877 (11.3%) were over fish aggregating devices (FADs), a non-selective type of fishing gear with considerable environmental impact. Their use was banned in Costa Rica as a result of an agreement of the Executive Board of the Costa Rican Institute of Fisheries and Aquaculture (INCOPESCA). Over that decade a total of 252,899 tonnes (t)[1] of the five different species of tuna were caught and stored.

In spite of the decline in national fisheries over the cited period, 48 industrial tuna vessels flying international flags caught 15 times more tuna (22,376 t on average) in territorial waters than Costa Rican fisheries (1,428 t). Purse-seine fishing took place outside the 12-mile stretch along the coast, while national fishers had to sail as far as 1,200 miles to fish outside the EEZ with higher operating costs, more uncertainty, greater fishing effort, and less economic reward. Over the same period the average State revenue from the sale of tuna fishing licenses to the purse-seine fleet was a mere US$37/t of tuna stored, while this product would have a value of US$2,800-US$6,000/t if managed selectively by national fisheries.

Regarding the sale of licenses for tuna fishing, the Inter-American Tropical Tuna Commission (IATTC) reported that 193 vessels operated within Costa Rica's EEZ over the 2008-2011 period, while INCOPESCA reported only 81 licensed vessels, from which it can be deduced that 114 vessels (58%) were apparently operating illegally. In addition, of those vessels operating with licenses, 39 of these, or 24% of those duly 'paid' for, were granted free of charge.

[1] Throughout the document referencies to tonnes (t) are metric, i.e. 1000 kg (as opposed to short tons = 2000 lb/907.18 kg).

## Tourist fishing

Tourist fishing in Costa Rica is an industry that generates millions of dollars for the country, and represents 2.13% of gross domestic product (GDP) according to the University of Costa Rica's (UCR) research institute on economic sciences (Instituto de Investigaciones en Ciencias Económicas 2010). The Costa Rican Tourism Board (ICT) estimates visits from around 175,000 sport fishers a year (ICT 2012 survey) each spending at least US$3,000 per visit. This provides the country with an annual revenue of approximately US$525 million. These visits are the result of the EEZ's particular oceanographic conditions, rendering Costa Rica an ideal place for catching large pelagic fish, and especially billfish such as the sail fish and Marlin (Ehrhardt & Fitchett 2006 ). However, studies based on abundancy indices have showed a reduction ranging from 85.5% to 91.3% (Ehrhardt, N.2012. RSMAS, UM.), with the average trophy size also falling by forty percent.

Sport fishing, based on the catch and release of fish, provides an opportunity for sustainable economic and social development that creates high quality employment. However, the resources on which sport fishing is based are being seriously affected by non-selective, indiscriminate fishing. At the level of the taxonomic group, the billfish (sailfish, marlins) and dolphins showed the highest density of bycatch in tuna fisheries using purse-seine gear within the first 40 nautical miles (nm); mahi-mahi and peto, also of interest to sport fishers, showed higher densities of bycatch in the EEZ beyond 350 nm limit in the extreme south. Extrapolation (ICr 97.5%)[2] of data on the bycatch of billfish by the purse-seine fleet (2002-2011) indicate that 1,196 t of billfish, and 903 t of mahi-mahi and peto were extracted as bycatch, having a direct impact on the sport fishing sector that, according to the study of the University of Costa Rica's research institute on economic sciences (IICE), provides direct and indirect employment to some 63,000 people. Such data demonstrate that the conservation of billfish species, declared to be of interest to tourism through Costa Rica's Law on Fisheries and Aquaculture, is unsustainable under current tuna purse seine commercial use patterns.

## The opportunity cost

Data from INCOPESCA for the 2005-2009 period establishes gross revenue from the national, longline fisheries sector at US$29 million. This sum comprises three main groups: tuna (US$14 million), mahi-mahi (US$12,000), and billfish (US$3 million). Average landings of tuna by longliners in Costa Rica over this period amounted to 1,427 tonnes.[3]

The Costa Rican Fisheries Federation (FECOP) established the volumes reported by the purse-seine tuna vessels in Costa Rica's EEZ based on IATTC data. Under a scenario of exclusion of purse-seine vessels between the 12 nm and 350 nm limits, an estimated potential catch value of US$224 million[4] was established, if tuna are caught by local longline fishers instead of international purse-seine vessels, and sold fresh.

National fisheries could thus receive a gross income 16 times higher than they currently receive (only for tuna), and could also benefit from a further US$12 million from the sale of mahi-mahi, with the huge advantage of not having to make such long fishing trips, thus reducing operating costs and the risks involved.

[2] Correlation index.
[3] Weight of fish without entrails and head. Total weight would be approximately 1,678 tonnes.
[4] 22,160 t @ US$10.11 kg.

Tourist fishing would also benefit as longline fishers could minimize the catch of billfish, with little market value, by choosing tuna instead, and ensuring the opportunity cost of not catching the billfish, that would represent approximately US$104 million for the tourism industry. A reduction in the bycatch of billfish by the purse-seine fleet, of the order of 1,196 t (ICr 95%), would also add to this value.

**Conclusion**

In view of the panorama presented and detailed in this proposal and in response to the mandate of the Office of the President of the Republic given to the National Commission of the Fisheries Sector, the latter, represented by the National Federation of the Fisheries Sector (FENAPES) and FECOP, representing the Costa Rican tourism and sport fishing sector, have decided to join forces, share knowledge and work together in presenting this fisheries management proposal within the framework of the National Fisheries and Aquaculture Development Plan (PNDPA) and National Marine Commission (CONAMAR) policies.

It is a proposal to undertake work and research purse-seine fisheries over the period of a six-year moratorium that would allow the parallel development of a fisheries management plan and an on-board observer program on the national fleet, and the research and development of alternative fishing gear to reduce bycatch. This would focus specifically on billfish and maximize tuna catches by the national fisheries sector that would have access to tuna, free from competition from the international purse-seine fleet, while also reducing its bycatch of billfish.

On the Pacific island archipelagos, south of Australia, a new type of tuna fishing is already underway. This is driving the development of small- and medium-sized fishing entities, and particularly those of an artisanal nature, creating new market opportunities for socially responsible and environmentally sustainable fisheries, and offering a new path towards tuna fishing in the Pacific. (http://www.fishnewseu.com/latest-news/world/10929-greenpeace-launches-tuna-blueprint.html)

A limit on the use of purse-seine nets is being sought within the first 370 nm from the coast and reaching latitude 5° North, located at this distance within Costa Rica's exclusive economic zone. It is proposed that fishing alternatives aimed at reducing or eliminating bycatch, while optimizing the selective capture of tuna, be jointly sought with commercial fisheries.

**Justification of the moratorium**

Some reasons to justify a moratorium of at least six years include:

1. To allow the recovery of yellowfin tuna. According to some studies, the yellowfin and skipjack tuna have displacement ranges that are much smaller than has been thought for many years. These are within a 400 nm range, a large part of which falls within Costa Rica's exclusive economic zone. Therefore, if tuna spend a large part of their lifecycles within territorial waters, an increase in the size and abundance of individuals is to be expected.

2. To ensure sufficient time to observe and evaluate an upturn in the economy of Costa Rican fishers. Should this take place in a timely manner, an increase in the efficiency and profitability of fishing would be expected (more and larger individuals closer to shore), thus considerably improving income from fisheries.

3. It is known from growth charts that yellowfin tuna can reach a weight of 80 kg over three years. By the end of the moratorium it is to be expected that Costa Ricans would thus be catching large, high-quality tuna with improved economic returns.

4. In recent times, many countries (western and central Pacific) have re-established low-impact fishing techniques that result in a much higher cost-benefit ratio, and have a greater impact on local economies. The use of these techniques is spatially incompatible with purse-seine fishing that is non-selective, uses helicopters and fast boats that frighten and stress fish. Stressed and frightened tuna will thus avoid passive fishing gear such as free-floating lines.

5. In many instances the success of selective fishing gear rests on the appropriate use of FADs or fishing stations. The fishing station is an ancient art, the regulated use of which, together with selective fishing gear, can result in the more efficient fishing of tuna that is larger and of better quality. The use of fishing stations has to be mutually exclusive of the use of purse-seine nets. Purse-seine tuna vessels take advantage of the concentration of fish round fishing stations in making their sets, catching all the fish clustered around them involving high bycatch rates. The cost of installing fishing stations requires a period of time to recoup the investment and evaluate results.

6. It is known that yellowfin tuna, which can be most effectively caught with selective fishing gear, is to be found between the coast and a distance of 350 nautical miles. This is where the adult, largest tuna, that brings greater benefits to national fleets, is concentrated (Cubero and Martínez 2013). A series of undersea features, such as ocean ridges and seamounts, are also to be found within this area and present oceanic conditions such as thermal domes that merit research due to their importance for the aggregation of commercial species and those of interest to tourists. It is thus

important for the moratorium on purse-seine fishing to consider the whole area between the coastline and the 350 nm limit.

7. The highest bycatch of sailfish and marlin is recorded within the first 80 miles from the coast, and between the 150–200 nm limit, so the use of purse-seine nets should be prohibited in these latitudes to avoid a negative impact on the tourism fishing sector.

*In summary:* the need for a period in which tuna populations can recover, the time required for fishers' economies to stabilize, the need for research to improve the efficiency of national fisheries within a framework of responsible fisheries (that in itself requires research), combined with the appropriate use of FADs and the spatial distribution of tuna according to age group, would justify a moratorium for a minimum six-year period between the coast and 350 nm out to sea. The effectiveness of the measure to exclude industrial purse-seine fishing for the benefit of fisheries by national fleets will be evaluated over this period.

## THE MANAGEMENT PROPOSAL AS PART OF THE NATIONAL POLITICAL CONTEXT

This is a proposal for the management of tuna fisheries within Costa Rica's Pacific EEZ that seeks to maximize their use by national fleets, medium-sized and advanced artisanal longliners, and reduce competition from purse-seine tuna fleets.

The proposed management consists of a spatial delimitation that defines an area for the exclusive use of national fleets in which purse-seine tuna fishing is excluded as well as an area for mixed fishing in which both national fleets and purse-seine tuna fleets can operate. It is accompanied by a proposal for terms of reference for a tuna fisheries management plan.

This system for the use of national tuna fisheries has been prepared in such a manner that it forms part of the recently approved (Executive Decree 37587-MAG) PNDPA, and contributes to compliance with the country's sustainability and conservation goals, in the context of the CONAMAR Executive Decree (37212-MINAET-MAG-SP-MOPT) and INCOPESCA, entities that hold responsibility for monitoring PNDPA implementation.

The management proposal and the terms of reference for the management plan include important elements for fisheries management as defined in PNDPA strategies and goals. It specifically includes goals to be met within the first four years of the plan. These correspond to structural areas involving research, institutional strengthening, management and the management of oceanic fisheries.

In the field of research, this proposal contributes to objective C that proposes the country has the scientific basis and the ecosystem focus for the management of fisheries and aquaculture resources. The following goals are included:

1. The design of databases to produce national statistics based on scientific and technical parameters (PNDPA goal 1.9 for year 3).
2. The implementation of official fishing logbooks (PNDPA goal 1.10 for year 3).
3. Implementation of the National On-board Observer Program (PNDPA goal 1.11 for year 2).
4. Implementation of the National Program for the Control of Landings in Ports (PNDPA goal 1.12 for year 2).
5. Implementation of the National Plan for Satellite Tracking of vessels over 18 meters in length (PNDPA goal 1.13 for year 2).
6. Evaluation of pelagic resources to establish the need to reserve quotas or percentages for sport fishing and carry out a cost-benefit analysis including other sectors (PNDPA goal 1.15 for year 3).
7. Socio-economic monitoring of fisheries, taking into consideration the levels of employment and direct employment and related activities, and the potential for diversification (PNDPA goal 1.17 for year 3).
8. Operation or implementation of a program to collect and process information generated by the National On-board Observer Program, the satellite tracking system, fishing logs, controls of fisheries landings, and socio-economic monitoring (PNDPA goal 1.19 for year 2).

9. Implementation of a research program into fishing methods and gear in favor of sustainability and resource use, and the reduction of bycatch and the negative ecological impact of fisheries (PNDPA goal 1.27 for year 4).

In the area of institutional strengthening, this proposal contributes to the development of strategy 5 that proposes the establishment of monitoring and control mechanisms to allow an adequate level of accountability. It also contributes to compliance with the goals:

1. Follow-up and implementation of the PNDPA regarding tuna fisheries, being the responsibility of INCOPESCA's Chief Executive Officer and the CONAMAR Technical Secretariat (PNDPA goal 5.1 for year 1).
2. Formalization of inter-institutional coordination in PNDPA implementation (PNDPA goal 5.2 for year 2).

As far as management is concerned, a contribution is made to the development of strategy 10 that seeks to implement the Uniform System of Traceability, the goal of which is to formalize this system through an executive decree (PNDPA goal 10.1 for year 3).

Regarding oceanic fisheries, the proposal makes an important contribution to strategy 3 that seeks to implement agreements or resolutions adopted by IATTC and other sub-regional fisheries organizations, such as the Central American Fisheries and Aquaculture Organization (OSPESCA), that are applicable to national fleets that catch tuna and similar species. It specifically contributes to meeting the goal of having legislation that requires compliance of tuna vessels with the country's commitments in different areas, including illegal, unreported and unregulated (IUU) fishing, the respective satellite tracking, data on catches and landings, as well as the Observer Program (PNDPA goal 3.3 for year 3).

Within the area of oceanic fisheries, it also contributes to strategy 4 that encourages rational use among different countries that share tuna fisheries in the eastern Pacific ocean (EPO). In this sense, this proposal contributes directly to the goal of approving a mechanism to establish quotas and their respective distribution among the different fisheries sectors, including semi-industrial fisheries, longline fisheries, rod fishing, trolling, sport, tourist, and artisanal fishing (PNDPA goal 4.3 for year 5).

Finally, the proposal establishes an important starting point in the development of strategy 5 applying to oceanic fisheries. This strategy proposes a zoning of the EEZ for the responsible use of fisheries based on Marine Areas for Responsible Fisheries (MARF). The proposal directly contributes to the three goals of this strategy by:

1. Defining target fisheries in concrete EEZ areas according to ecosystem-based and management criteria (PNDPA goal 5.1 for year 2).

2. Identifying areas or zones to be managed and defining fisheries management plans in each of these within the EEZ (PNDPA GOAL 5.2 for year 4).

3. Implementing Marine Areas for Responsible Fisheries and the permanent monitoring of management plans (PNDPA goal 5.3 for year 1).

TUNA CATCHES AND FISHERIES MANAGEMENT IN COSTA RICA'S PACIFIC EXCLUSIVE ECONOMIC ZONE

## VOLUNTARY DECLARATION BY THE NATIONAL FISHERIES SECTOR ON THE PRINCIPLES OF RESPONSIBLE FISHING

1. Recalling that the 1982 United Nations Convention on the Law of the Sea establishes the rights and obligations of States regarding the use and conservation of oceans and their resources, including the conservation and management of live marine resources.
2. Reaffirming FAO's Code of Conduct for Responsible Fisheries, and considering that the use and protection of our fisheries and our oceanic environment are not mutually exclusive goals, but rather complementary ones.
3. Recognizing that the responsible management of fisheries calls for the repercussions of fishing on the marine ecosystem and the effects of the marine ecosystem on fisheries, especially those resulting from climate change, to be taken into consideration.
4. Recalling that guaranteeing healthy marine ecosystems with responsible and selective, low-impact fisheries, favors higher oceanic and fisheries productivity contributing to the food security of coastal communities.
5. Recognizing that concerns regarding the status of turtle, shark and billfish populations are legitimate and seek measures to prevent or reduce the impacts on these species and on the affected tourist and sport sectors.
6. Aware that the Government of Costa Rica has not avoided the use of fish aggregating devices (FADs), that attract young, sexually immature juvenile tuna and large quantities of mahi-mahi, peto, and a variety of small fish, with the resulting risks to populations of fish of commercial and tourism interest.
7. Recognizing that INCOPESCA's programs to gather data are inadequate to ensure the appropriate management of populations of commercially interesting fish, by both pelagic and tuna fisheries.
8. Aware that it is imperative for pelagic fisheries to avoid illegal fishing and that un-reported or un-regulated catches result in the over-exploitation of fisheries to the detriment of other fishers.
9. Recognizing that fishers, by virtue of their practical experience, can contribute to the analysis of problems relating to bycatch and provide expert input to scientists on possible solutions to reduce bycatch and increase the capture of target species.
10. Recognizing the existence of possible types of equipment (circular hooks, deep-sea devices, alternative baits, selective fishing gear) and fishing techniques that could have positive results in reducing bycatch, turtle and billfish mortality in longline fisheries, without affecting catches of target species.

## WE THUS DECLARE:

We, the national fisheries sector for artisanal, medium-sized and advanced pelagic fisheries, do voluntarily declare our willingness to carry out and support the following actions:

a. Participate as protagonists and decision-makers in the management of fisheries aimed at the responsible

use of resources[5] for different fisheries sectors, while protecting the interests of coastal communities of artisanal, tourist and sport fishers who depend on these resources in Costa Rica's Pacific ocean.

b. To this end, actively participate and share our experience in the development of workshops, projects, programs and other measures.

c. Seek and implement mechanisms to reduce the impact of pelagic fisheries on turtles and sailfish, promoting an integrated focus with other fisheries and users of these resources, without compromising the productivity of the target species.

d. Contribute to a fisheries zoning based on scientific studies, as well as to management measures, such as targeted fishing gear, ways to identify illegal fishing, and temporal and spatial closures.

e. Work with the Government, research institutes, international cooperation and universities, to generate a data and statistics gathering system to enable the sound management of fisheries, an increased yield of fisheries, and a reduction in bycatch of non-target species, including on-board observation programs.

f. Find, implement and use fishing gear in pilot projects, aimed at different fishing fleets, such as the Green Stick, and other gear to be identified, in order to evaluate their economic, ecological, and environmental validity for fisheries.

g. Support educational programs to ensure that fishers develop and strengthen their knowledge of the impacts of their fisheries on marine biomass and associated resources, and are able to make recommendations in establishing measures to improve their fisheries, increasing the business capacity of the sector, while ensuring the sustainability of fisheries.

h. Support organizations and universities in recognized and consistent research programs, aimed at gaining greater knowledge of fisheries so as to generate the necessary tools for their responsible management.

i. Support actions that ensure fair and reasonable conservation and management measures adopted at local, national and regional levels, so as to ensure the sustainability of fisheries; denounce illegal fishing and protect sensitive species for other economic sectors.

j. Research and support the use of fishing gear aimed at tuna and other species of high commercial value for the artisanal, medium-sized and advanced fleets, to increase catches of target species and maximize profitability of fishing within the framework of responsible fisheries.

k. Strengthen international cooperation to incorporate different types of resources that support fisheries management geared to responsible fisheries.

l. Comply, both jointly and individually, with national fisheries regulations in accordance with the national fisheries development plan, encouraging the dissemination and awareness of its scope within the country's population of fishers.

m. Ensure that authorities adhere to the criteria and technical contributions (biological, social and economic) of recent studies in which we have participated, as the basis for decision-making regarding spatial management, fisheries use, and the development of fishing gear.

[5] According to FAO's Code of Conduct for Responsible Fisheries.

## PROFILE OF FECOP

The Costa Rican Fisheries Federation (FECOP) is an organization of fishers that seeks to halt the tendency toward depletion of Costa Rica's fisheries, including those of interest to tourist and sport fishers. In accordance with our mission and to guide us in our actions, we adhere to FAO's Code of Conduct for Responsible Fisheries, to which Costa Rica is signatory since 1995, and given that fisheries are inter-dependent with the marine ecosystem, we support team work among the coastal artisanal fishers and medium-sized and advanced commercial pelagic fishing sectors.

We have an interdisciplinary focus, in which people, and in this case fishers, are also part of the environment. We seek solutions to problems and address proposed fisheries policies from environmental, social, legal, political and economic perspectives. We support projects in the Golfo Dulce, Coyote and San Juanillo MARFs, encourage alternative sources of production such as oyster farming, the artisanal and selective fishing of shrimp, the use of selective fish traps, and support community and organizational efforts to strengthen the establishment and defense of the rights of coastal communities.

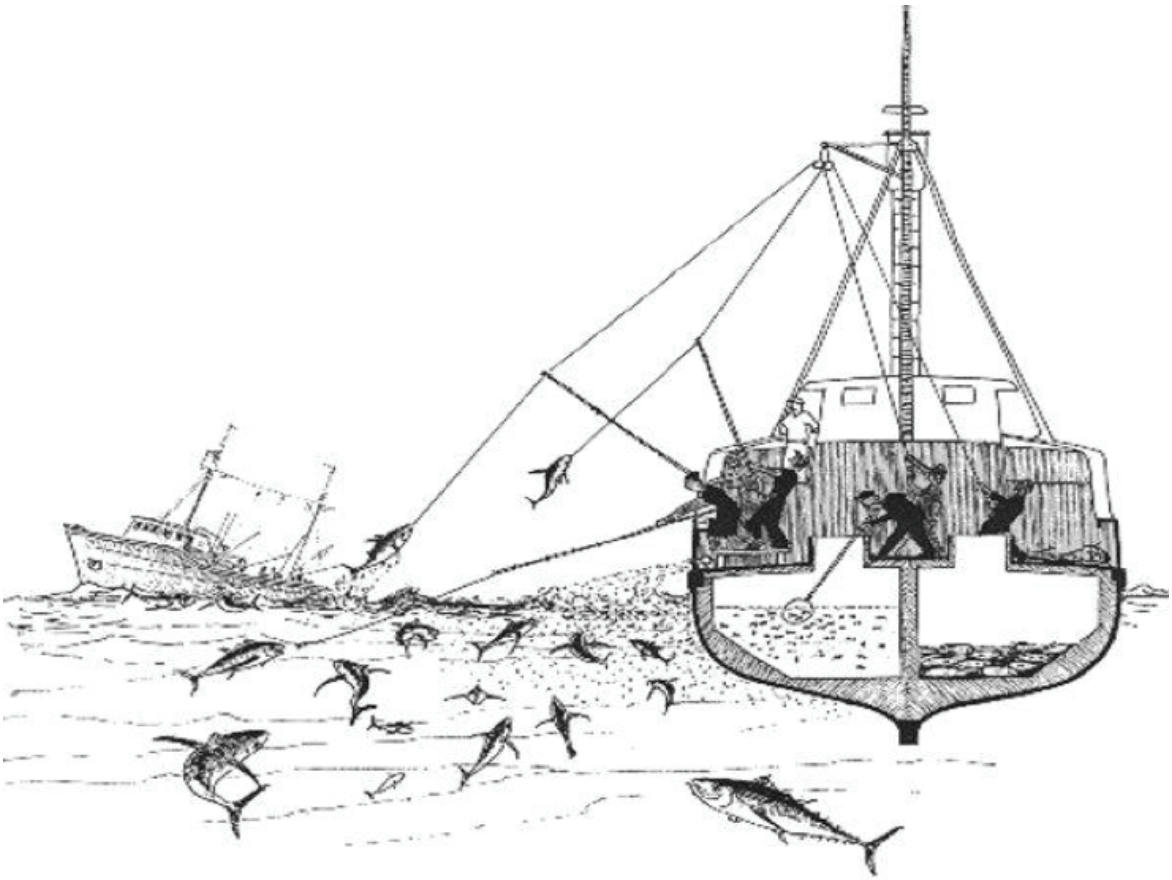
### Brief recent history

Between 1944 and 1964, tuna was caught selectively with fishing pole and line in what is now our exclusive economic zone. Some fishers from that time tell us that nine people with poles could catch 112 t (112,000 kg) over a 10-hour period from a 125 ft boat with a 300-350 t hold capacity.

Fishing was carried out at a distance of no further than 25-30 nm, or some 15 nm from Cabo Blanco in Cabuya and Papagayo, where yellowfin tuna used to come to within 500 m–1,000 m from the shore. Schools of dolphin could be divided into hectares of water, where 20,000 dolphins in a single group could easily be spotted. At that time we are told by Ortiz (2013) that one of these boats caught so much tuna that it almost overturned while it continued to fish over a school estimated at 20,000 tonnes.

On May 31st, 1949, the agreement to create IATTC was signed by Costa Rica and the United States of America. Around 1964 a Yugoslavian invented the power block, a type of hydraulic winch that enabled a five-hour net raising task to be reduced to 20 minutes. Nets can now attain a height (depth) of 200 m with a circumference of 1,500 m, and easily catch 200 t (200,000 kg) per set in two hours of labor. Likewise, with vessel the advent of the steam that replaced sail power, the fishing effort was multiplied, as well as the catch volume/time. Hold capacity increased 3-5 times, and today average capacity is around 1,000 t, and the impact on other non-target species also multiplied with the transition from fishing poles to purse-seine nets. Fifty-three non-target species are currently affected by the use of this industrial, non-selective fishing gear in our territorial waters.

In 1975 the Ferreto Law was passed imposing taxes on international tuna vessels that fish in Costa Rican territorial waters through the granting of licenses. However, a review of IATTC catch data and INCOPESCA records on income from licenses over the 2008-2011, indicate that 59% of operating vessels did not pay for licenses.



## CURRENT STATUS OF COMMERCIAL AND TOURIST FISH STOCKS

### Commercial fishing

INCOPESCA's statistics over the last 10-year period (2000 to 2009) indicate a drastic fall in the size of landings by Costa Rica's artisanal fishing fleet.

Over that decade, annual landings dropped by half, from 23,000 t/year to less than 13,000 t/year, representing a fall in excess of 40 percent.

If we carry out an analysis by species, those that are more seriously affected are the following:

- **Mahi-mahi (also known as dolphinfish)**: its reduction is enormous. At the beginning of the decade between 8,000 t and 11,000 t were caught annually, while catches had fallen to 3,000 t–4,000 t/year by the end of the decade, representing a reduction in excess of 60 percent.
- **Billfish**: catches have also dropped significantly and reached half of what they were at the beginning of the decade, falling from 2,500 t–3,000 t to 1,300 t–1,400 tonnes.
- **Sharks**: the reduction in these species is similar, dropping from 4,000 t–5,000 t/year to a mere 1,500 t–2,000 tonnes.

The following table and the figures warn us of the extremely serious situation faced by Costa Rican artisanal fishers (advanced, medium-sized and small vessels).

For comparative purposes, the last line of table 1 provides figures of annual catches by purse-seine tuna vessels. The completely distorted situation can be clearly appreciated. National fisheries suffer while others, comprising foreign purse-seine vessels, catch far more that all artisanal national fleets combined.

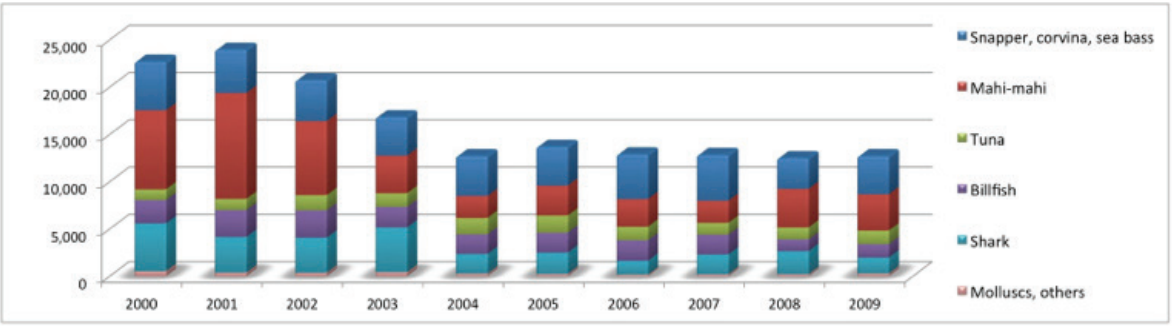



Figure 1: Annual catches by national fleet.

**Landings Costa Rican Artisanal Fleet (tonnes) Source: INCOPESCA**

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 |
|---|---|---|---|---|---|---|---|---|---|---|
| Snapper, corvina, sea bass | 5,153 | 4,573 | 4,342 | 4,082 | 4,234 | 4,120 | 4,739 | 4,849 | 3,265 | 4,046 |
| Mahi-mahi | 8,373 | 11,221 | 7,832 | 3,970 | 2,322 | 3,161 | 2,917 | 2,341 | 4,084 | 3,843 |
| Tuna | 1,134 | 1,163 | 1,585 | 1,436 | 1,725 | 1,816 | 1,429 | 1,248 | 1,254 | 1,430 |
| Billfish | 2,461 | 2,858 | 2,911 | 2,190 | 2,079 | 2,110 | 2,172 | 2,098 | 1,248 | 1,419 |
| Shark | 5,060 | 3,759 | 3,704 | 4,725 | 2,074 | 2,240 | 1,455 | 2,084 | 2,422 | 1,685 |
| Molluscs, others | 521 | 379 | 362 | 423 | 271 | 241 | 175 | 203 | 217 | 283 |
| **Total** | **22,702** | **23,954** | **20,736** | **16,827** | **12,705** | **13,689** | **12,887** | **12,823** | **12,489** | **12,706** |

* Excluding data on shrimp and sardines.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Purse-seine tuna vessels | | **34,430** | **34,706** | **18,716** | **26,711** | **26,811** | **22,023** | **21,866** | **24,038** |

* Comparison. Tuna catches in the Costa Rican Pacific (IATTC)

Table 1: Comparison of annual catches by national fleet and purse-seine tuna vessels.

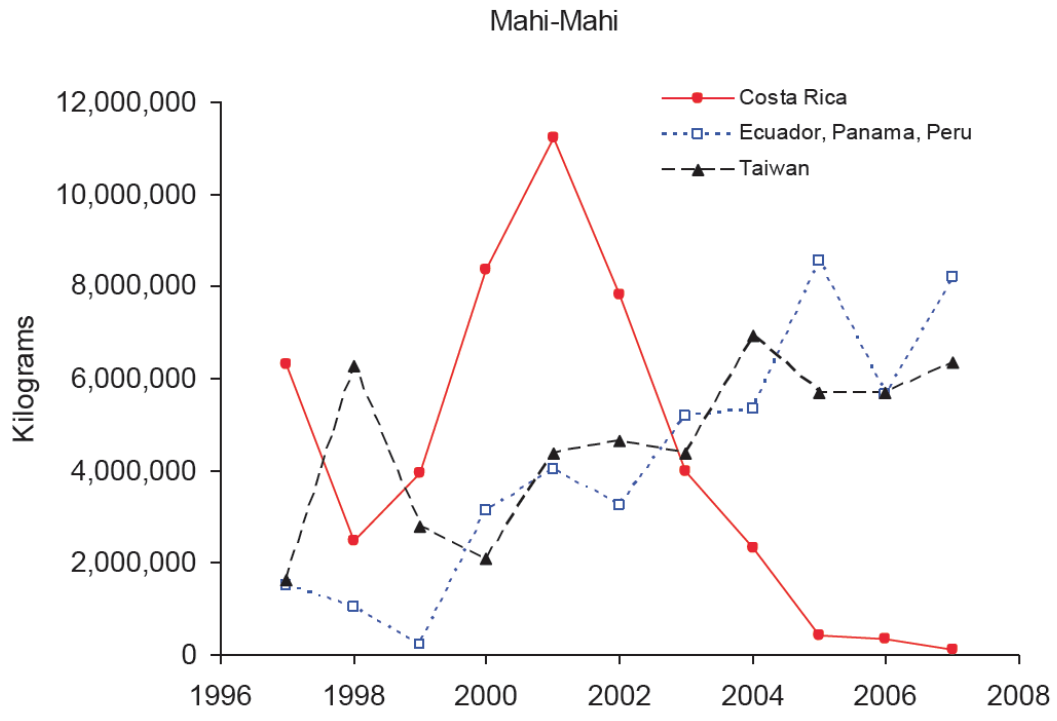



Figure 2: Fall in mahi-mahi *(Coryiphaena hippurus)* catches by the Costa Rican fleet and regional landings of mahi-mahi in Costa Rica affected by fishing competition in the region.
12 million kilograms = 2.4 million mahi-mahi (Ehrhardt 2011).

## Sport fishing

Sport fishing in Costa Rica is an industry that generates millions of dollars for the country. For example, in 2008, an economic study of the contribution of sport fishing indicated that this type of fishing represented 2.13% of gross domestic product (GDP) (Instituto de Investigaciones en Ciencias Económicas 2010). Ocean currents and other oceanographic conditions make Costa Rica an ideal site for the catching of large pelagic fish, particularly billfish, of which the sailfish is the most common (Ehrhardt and Fitchett 2006).

The reason for this concentration of animals is that regions with ideal conditions for billfish to hunt and move around are to be found off Costa Rica's Pacific coast. They contain sufficient dissolved oxygen and an appropriate temperature, and are found at a depth of between 0 m and 100 m, resulting in billfish concentrating near the surface (Hoolihan et al. 2001) where they are more vulnerable to being caught by both sport fishing boats and commercial fleets.

Despite Costa Rica having ideal oceanographic conditions for the catching of billfish, their populations have declined drastically. Some studies based on abundance indices, such as catches per unit of effort, have shown a drop of between 85.5% and 91.3% (Nelson Ehrhardt, Rosentiel School of Marine and Atmospheric Science, UM. 2012). The average sport fishing trophy size has also fallen by 40%, indicating that average lifespan has also been reduced, most probably due to mortality as a result of fishing.

Given their highly migratory nature, billfish suffer the combined effect of multiple fisheries throughout the ocean. On the open sea, far from the continental platform, marlin are caught by the hooks of international longline fleets, among which the Japanese fleet stands out with its rapid expansion throughout the EPO at the end of the nineteen forties. Along the coast between Ecuador and Costa Rica, the sailfish is severely affected by the fleets of American countries that are mainly seeking mahi-mahi and tuna. Another aspect that impacts sailfish populations is bycatch by industrial tuna purse-seine vessels (Cubero and Martínez 2013).

Sport fishing based on the catch and release principle, provides an excellent opportunity for the economic and social development of fisheries. It is an industry that supports the development of tourism, generating high-quality jobs, according to an economic study carried out by the University of Costa Rica's research institute on economic sciences (Instituto de Investigaciones en Ciencias Económicas 2010).

The characteristics of billfish migrations require their conservation to have a national and regional framework of reference. Political will is required to optimize their rational use. Costa Rica, Panama, and Guatemala have developed large tourist infrastructures based on sport fishing, the survival of which is not ensured due to the inexistence of billfish conservation programs, as can be appreciated from the four following figures.[6]

[6] Nelson M. Ehrhardt and Mark Fitchett, Division of Marine Biology and Fisheries, Rosenstiel School of Marine and Atmospheric Science, University of Miami (2011)

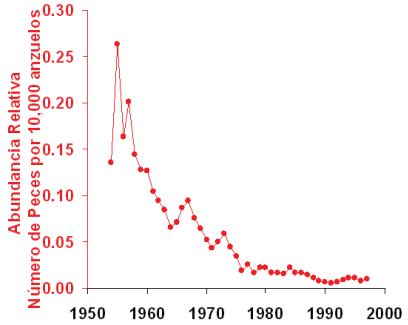



Figure 3: 91.3% drop in the relative abundance of the black marlin in the eastern Pacific ocean.

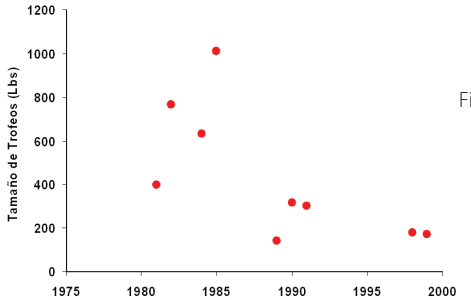



Figure 4: Historical loss of trophy quality sizes of blue marlin in the eastern Pacific ocean.

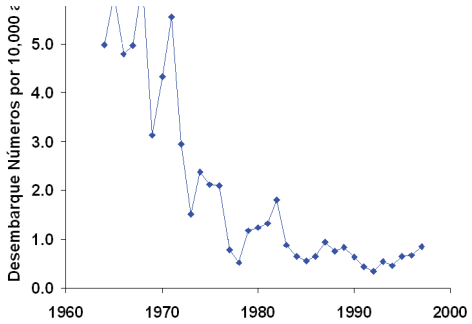



Figure 5: 85.5% drop in the relative abundance of striped marlin in the eastern Pacific ocean.

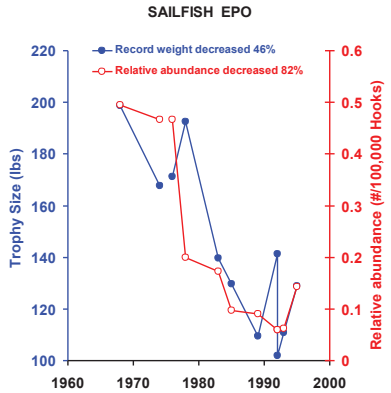



Figure 6: 85% drop in the relative abundance of sailfish in the eastern Pacific ocean.

## CHARACTERIZATION OF THE LANDINGS BY THE NATIONAL COMMERCIAL FLEET

By volume, the main income of longline fishers is from the sale of mahi-mahi. This species was particularly abundant in EEZ waters between 1996 and 2002, and their catches were responsible for the highest income for national longline fishers. However, this income has fallen over recent years.

This fall can be explained by comparing the 49% drop in catches between the periods 1996–2002 and 2003–2009. Although the reduction in landings was 17% in monetary terms, operating costs increased because fishers were obliged to sail greater distances from our coasts. As a result, gross profit, the difference between income and expenditure, for longline fishers has dropped. This situation could have been worse had it not been for a 47% increase in the price of mahi-mahi between these periods.

For national longliners, a dependency on mahi-mahi landings means compromising their income and lifestyles in an increasingly volatile fishing environment. This species is caught commercially and intensively from Peru up to the United States of America. An unusual feature of mahi-mahi is that often when fishing is good in Costa Rica, it is also good, for example, in Panama and Ecuador, so overall export prices fall and fishers receive a lower price for their product.

Mahi-mahi is a highly migratory species, and other species have to be sought now their populations are clearly diminishing (figure 7). An alternative species for national longline fishers is the tuna, mainly of the yellowfin species. For the same periods (1996–2002 and 2003–2009), landings have been fairly stable and fell by only 8 percent. However, in economic terms the increase is 3%, so unlike mahi-mahi, income has improved slightly, or at least remained stable over these two periods.

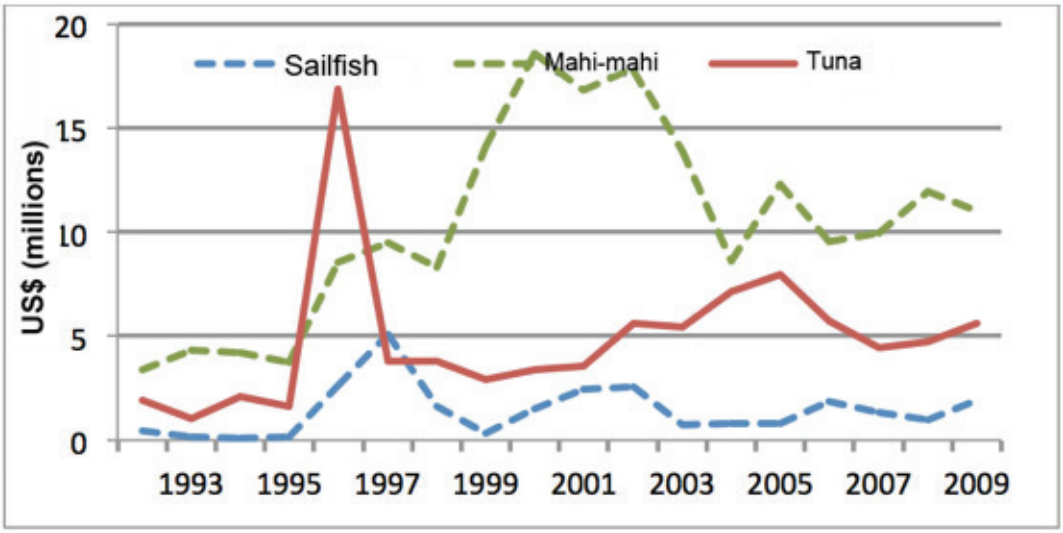



Figure 7: Income/year according to fish type (1993-2009).

According to INCOPESCA data, extraordinary catches of tuna, totaling 4,082 t, were recorded in 1996. If the value is corrected[7] for that year and the average of the remaining years over this same period is used, we note an increase in its economic value to fishers of almost 52%, and of 24% in terms of landings.

Synthesizing the previous figures, mahi-mahi, that was originally the target species of Costa Rican longline fishers, is becoming increasingly scarce. It would be difficult for the price of mahi-mahi to compensate falls in landings. While mahi-mahi landings fell by 49% in volume, those for tuna increased by 24%; and in economic terms, while gross income for mahi-mahi fishers fell by 17%, in the case of tuna this increased by 52 percent.

Although no official figures are available from INCOPESCA on longliner landings between 2010 and today, longline fishers and exporters have suffered a serious drop in catches, indicating that the situation is far from improving, and in fact, is probably worsening.

For this reason longline fishers are interested in conserving tuna stocks for national fishers, rather than allowing their capture by international fleets. We might even venture to say that tuna fishing with longlines and other targeted fishing gear is more environmentally, socially and economically viable for the country than the industrial fishing of tuna.

The demand for fresh tuna in the United States of America is increasing and prices paid to Costa Rican longline fishers have improved. Currently, a large fresh, grade $1^+$ tuna trunks of 60 lb (27.2 kg) and over for export can reach a price of US$12.80/kg[8] compared with US$2.8/kg for frozen tuna that is used for canning.

[7] Using an average value of 1,186 tonnes and US$3.8 million (1997-2002).
[8] A value of $10.10/kg is used, allowing for viscera and the head in the volume of the purse-seine net. Compared with purse-seiners, the trunks are larger and of better quality because the trips are of shorter duration.

## CHARACTERIZATION OF TUNA FISHING IN COSTA RICA, 2002-2011

For further details see Cubero and Martínez, 2013.

Costa Rica's EEZ covers a total area of 543,842 km$^2$ in the Pacific ocean. International purse-seiners operate throughout this area, except within the first 12 nm from the coast, and fishing five species of tuna that include yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), black skipjack (*Euthynnus lineaus*) the frigate (*Auxis thazard/A. rochei*) tuna.

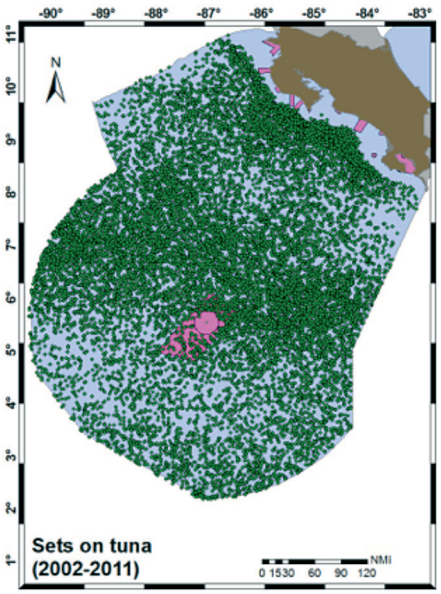



Figure 8: Georeferenced sets by purse-seine tuna vessels in Costa Rica's EEZ (Cubero and Martínez 2013).

Between 2002 and 2011, international tuna vessels carried out 1,512 fishing trips within Costa Rica's EEZ with a total of 16,626 sets (figure 8). The majority of these sets (14,005 or 84%) were carried out over dolphins, the remainder were carried out over some natural floating object (tree trunks) or an artificial one (FAD) (1,877 or 11.3%) or shoals of tuna unassociated with any floating object (744 or 4.47%).

Over the decade a total of 252,899 t of five species of tuna were caught and held. Fishing over floating objects resulted in the largest quantity of tuna being caught per set (23 t/set), followed by fishing over free-swimming shoals (18.6 t/set). Fishing over dolphins was the least effective (13.9 t/set), but the ease with which these cetaceans can be located rendered this option the most frequent.

The majority of the catch (84.97%) comprised yellowfin tuna, mainly resulting from the use of sets over dolphins. The majority of the other four species were caught as the result of sets associated with floating objects.

Over the 10 years a total of 146 different vessels operated within the EEZ, with hold capacities ranging between 76 t and 2,833 tonnes. Over this period there was a 52.56% drop in the number of operating vessels, in other words an average of 3.12 vessels a year (-5.35 to -0.84 t/year, ICr 95%). Vessels' average carrying capacity remained close to 1,000 t throughout the decade.

The quantity of tuna extracted, each time the net was set, fell by 24.75%, with an average annual fall of 0.6 t/set (-1.12 t to -0.07 t/set/year, ICr 95%). This trend suggests a possible reduction in populations, in that it would be expected that with a decrease in the number of vessels and no changes to their average carrying capacity, the quantity of tuna caught would increase or have stabilized each time the net was set, if populations had not fallen. The total annual catch retained fell by 1,202 t (-2,293 t to -186 t/year, ICr 95%).

There was a differentiation between the type of set used, the distance from the coast, and the size of tuna caught. Fishing with FADs was most effective in catching small tuna, and had an average efficiency in catching medium-sized tuna. Sets on schools of dolphins were more effective in catching medium-sized tuna, and very effective in catching large-sized individuals. Smaller specimens were found within the 350-450 nm limit; medium-sized ones were mainly found within the first 60 nm, but also between 130 nm and 250 nm; and large specimens were also found concentrated within the first 60 nm, although they predominated within the 200 nm–300 nm limit.

Twenty-seven percent (4,516 cases) of the 16,626 sets made over the 10 years were reported to have been associated with bycatch involving a total catch of 1,373 t and 53 species. The majority of sets involving bycatch were made over dolphins (49%) and FADs (35%). Sailfish, marlin, peto, common mahi-mahi, and the silky shark were the most affected. Extrapolating the bycatch of the 16,626 sets made over the decade and correcting for the catch probability of each group analyzed estimated a total, non-targeted catch of 4,394 tonnes.

The highest densities of bycatch were located within the first 40 nm throughout the EEZ's central and northern Pacific areas, as well as in its extreme south-east between the 350 nm and 450 nm limits. Mainly billfish and dolphins were caught within the first 40 nm, as well as within the 180 nm–200 nm limit, while mahi-mahi and peto (*Acanthocybium solandri*) were caught mainly beyond the 350 nm limit. A high density of a variety of small fish species were noted in both extremes of the EEZ; the capture of rays peaked around the 150 nm limit, and sharks were caught mostly within the first 40 nm, around the 150 nm limit and then past the 350 nm limit.

The type of set made defined the main taxonomic group caught. More billfish were caught on sets over dolphins and natural objects; a variety of different species of small fish was mainly caught over undefined floating objects, FADs and over unassociated shoals of fish. Fishing over shoals of unassociated tuna resulted in catches particularly of billfish, sharks and rays.

Of the 1,512 fishing trips made over the 10 years, only 14.5% involved Costa Rica as their first landing country. The remainder of the trips made their first landings in seven countries other than Costa Rica, the majority being in Ecuador. Between 2008 and 2011, landings were made by vessels flying Panamanian or Venezuelan flags, except on two occasions in 2008 when Ecuadorian ships made landings. Over these four years between 40.88% and 73.78% of tuna caught and retained in Costa Rica's EEZ was landed, in other words only a fraction of all catches. Over these four years tuna catches generated an average of US$37/tonne for the Costa Rican state.

In addition, a greater presence of smaller vessels was noted beyond the 250 nm limit, the majority of which made their landings in Ecuador. Likewise, the majority of vessels that used FADs within Costa Rica's Pacific waters between 2002 and 2011 appeared to have come from Ecuador and made their landings in that country. The use of FADs was most notable beyond the 250 nm limit, and as far as the 350 nm–450 nm range. It is possible that the majority of purse-seiners that operated within the last 250 nm were unauthorized. INCOPESCA data between 2008 and 2011 reported a number of licensed vessels below the number of registered vessels operating in the Cost Rican Pacific over these four years. None of the licensed vessels over these four years was flying the Ecuadorian flag.

The wide range of tuna fishing by international purse-seiners in Costa Rica's Pacific EEZ results in an inevitable spatial overlap with national longline and sport fisheries, resulting in considerable pressure on resources and a negative economic impact on the country's fisheries.

While the international tuna industry caught an annual average of 26,163 t of tuna between 2002 and 2009 (IATTC 2012), the national longline industry caught an annual average of 1,484 t of tuna (INCOPESCA 2012). The tonnes caught by the international purse-seine fleet represented an opportunity loss for national fisheries of at least US$200 million.

For its part, the international purse-seine industry had a bycatch of 17,256 individual billfish between 2002 and 2011, while the national longline industry caught 13,615 billfish between 2009 and 2012. This billfish mortality carried a heavy loss in opportunity cost of at least US$92.6 million for the country, due to the negative effect on the Costa Rican tourist/sport fishing sector, according to the estimated value of live billfish within the sector by the UCR research institute on economic sciences (Instituto de Investigaciones en Ciencias Económicas 2010).

## BYCATCH BY PURSE-SEINE VESSELS

Over the 2002-2011 period, the industrial purse-seine tuna fleet caught 53 non-target species. The main groups of fish caught were the billfish (six species), shark (six species), mantas and rays (five species), mahi-mahi (two species), and peto or wahoo (one species), as well as a variety of 27 other species ("Others" in figure 9).

The bycatch by purse-seine nets can vary according to the type of set used and the geographic area where it is made. The sets made over groups of dolphins, billfish and rays were the most affected, this is the only type of set that reports dolphin mortality, although it represents a low percentage of deaths. The species composition on floating objects, these being natural, FADs or unidentified, is very similar and affects different species to a greater degree. Finally, unassociated (Not associated) sets mainly caught billfish, rays and shark.

The highest density of bycatch, in tonnes per square kilometer (t/km$^2$), was found in a strip close to the coast up to a distance of approximately 60 nm; a spike in catches was noted at the 150 nm limit; and finally, bycatch tended to increase near the 350 nm limit and extended as far as the edge of Costa Rica's EEZ in the Pacific. This high catch rate beyond the 350 nm limit is closely related to the use of FADs, a type of fishing gear that is banned in Costa Rica.[9] According to medium-sized and advanced fishers, the main areas for mahi-mahi catches are near the coast and up to 200 mn out to sea. However, mahi-mahi catches associated with FADs also take place beyond the 350 nm limit, these being caught prior to arrival at these fishing grounds, and are thus not taken advantage of by the national fleet.

It is probable that tuna itself is the species most affected by bycatch with purse-seine nets. The yellowfin tuna weighs approximately 20 kg at time of sexual maturity. However, small tuna weighing less than 15 kg are frequently caught with purse-seine nets, and the situation worsens if tuna catches associated with FADs are analyzed, as the capture of individuals weighing less than 2.5 kg is very common. This last point is extremely worrying if considered in a regional context where the use of FADs near Costa Rica's EEZ has increased in recent years. This could indicate very high catches of juvenile yellowfin tuna that would mean a depleted spawning biomass for the future.

The use of FADs and their repercussions on tuna populations is currently a highly discussed topic (Castro et al. 2002, Dagorn et al. 2012). The use of FADs in other latitudes, and aimed at the skipjack tuna, is an effective and relatively selective method. However, FADs in tropical zones, where biological diversity is very high, mainly catch yellowfin tuna juveniles and a wide variety of other non-target species, as shown by the Cubero and Martínez (2013) study.

[9] Decisions of the INCOPESCA Board of Directors, A.J.D.I./032-99, A.J.D.I.P./241-99, 15/07/99. Ban on fishing on FADs. Puntarenas. 1999.

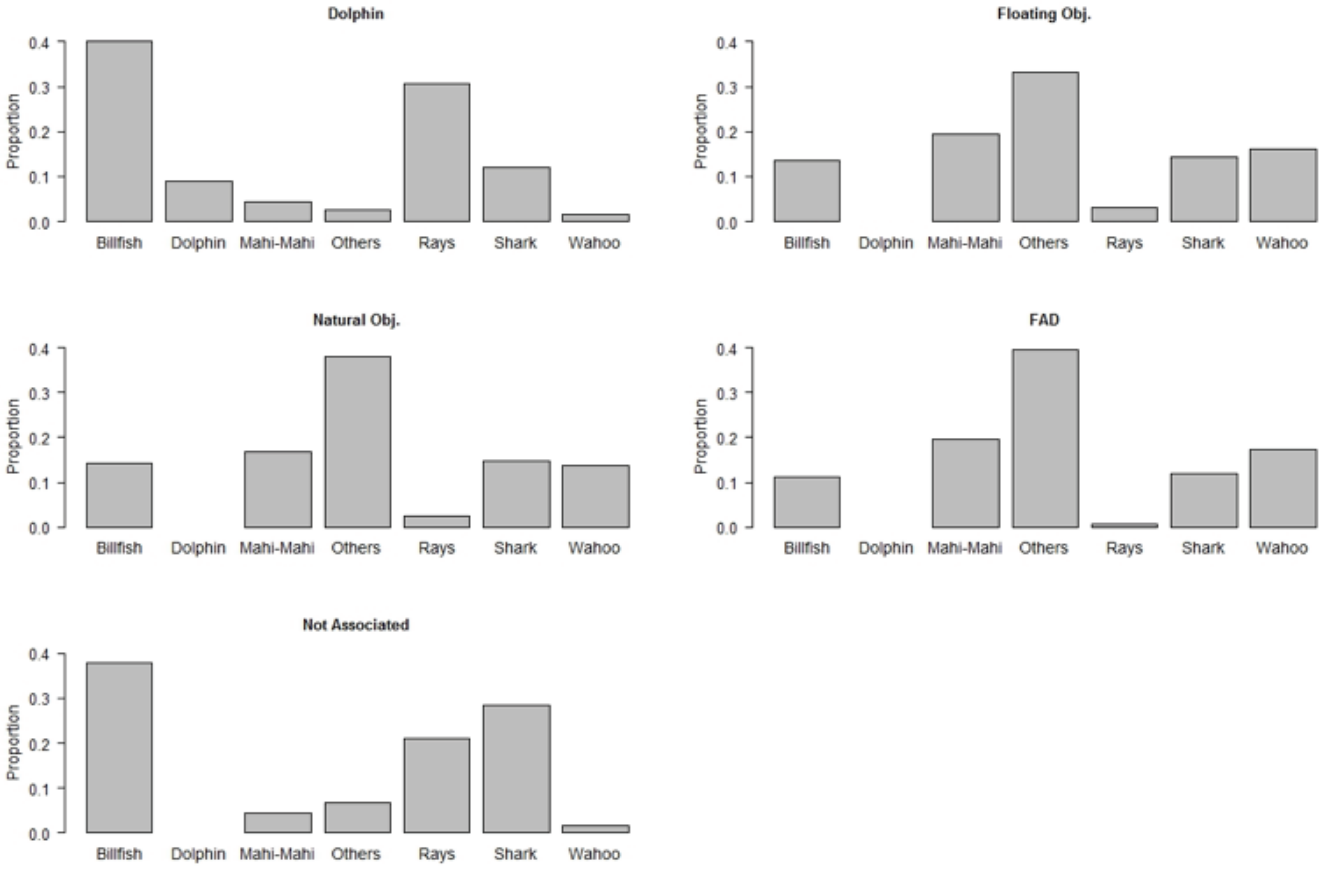



Figure 9: Distribution of bycatches based on the appearance frequency of each group, according to type of set.

### Influence of bycatch by purse-seine nets on tourist fishing

According to Cubero and Martínez (2013) the billfish were the group involved in the highest number of sets (figure 10), followed by "Other", and then by rays. These three groups, in the same order, were also associated with the highest levels of bycatch.

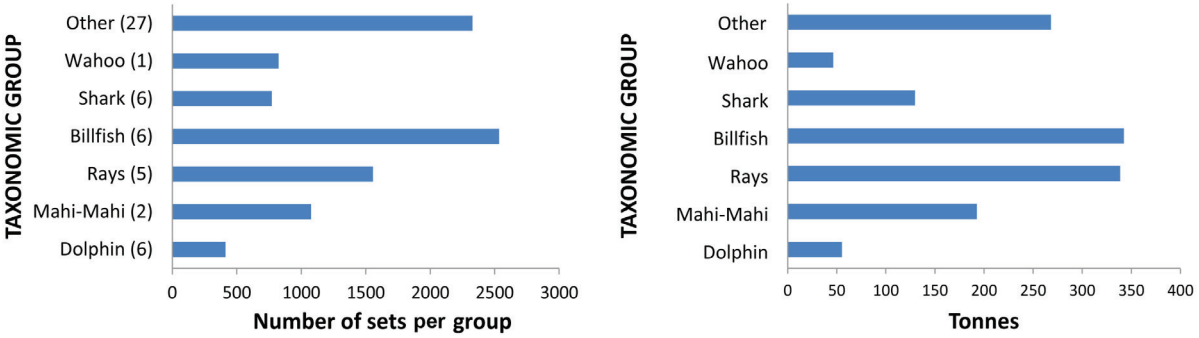



Figure 10: Taxonomic groups associated with bycatch according to number of sets.

### Number of sets and tonnes associated with the bycatch of non-target species by tuna fisheries in the EEZ, 2002-2011

The highest levels of bycatch take place within the first 40 nm along the central and northern Pacific coastline, as well as in the extreme southeast of the EEZ, between the 350 nm and the 450 nm limits. According to taxonomic group, the billfish and dolphins showed the highest levels of bycatch within the first 40 nm; mahi-mahi and peto had the highest levels of bycatch in the far south of the EEZ, beyond the 350 nm limit; small fish of a variety of species (others) showed high catch densities in both extremes of the EEZ; rays showed the highest catch levels around the 150 nm limit; and sharks showed the highest catch densities within the first 40 nm, around the 150 nm limit, and then beyond the 350 nm limit.

Over the decade under scrutiny, some species stood out within each group due to the greater number of sets in which they were caught. The sailfish, marlin and peto, the common mahi-mahi and the silky shark were the most affected. The first four species are of considerable importance in sport fishing activities. The mahi-mahi is also very important for consumption, and the silky shark is of high value in recreational scuba diving on the oceanic islands and archipelagos of the tropical eastern Pacific ocean.

## Non-target groups most involved in bycatch by tuna fisheries in the EEZ, 2002-2011

| | | Tonnes extrapolated to 16,626 sets (2002-2011) | | |
|---|---|---|---|---|
| **Group** | **Tonnes in 4,516 sets** | **Average** | **ICr 2.5%** | **ICr 97.5%** |
| Dolphins | 28.78 | 90.32 | 86.97 | 112.13 |
| Mahi-mahi | 192.71 | 671.21 | 620.12 | 727.70 |
| Billfish | 342.51 | 1,154.65 | 1,114.01 | 1,196.13 |
| Rays | 338.60 | 1,133.90 | 1,051.09 | 1,229.72 |
| Sharks | 196.64 | 659.27 | 613.77 | 709.93 |
| Peto | 46.30 | 160.96 | 148.82 | 176.58 |
| Others | 227.87 | 514.96 | 485.13 | 544.89 |

Table 2: Non-target groups involved in bycatch, in tonnes.

Data shown in table 2 is indicative of the fact that the conservation of billfish, declared to be of interest to tourism by Costa Rica's Law on Fisheries and Aquaculture, is unsustainable under current systems of commercial exploitation. Billfish suffer from high levels of bycatch. According to Ehrhardt and Fitchet (2011), populations have fallen by over 85% and trophy size by 40 percent.

# ILLEGAL TUNA FISHING

## Pirate fishing

Modern-day piracy in the EEZs of a variety of countries is responsible for annual fish catches that are valued at between US$10 and US$20 billion. It is estimated that up to 30% of world fish catches is illegal (Hilborn and Hilborn 2012). These facts support the interpretation that crime should be understood as an economic activity rather than a social aberration in which the potential income is weighted against the risk of being caught.

Over the years 2008–2011, between 40.88% and 73.78% of tuna caught and retained in Costa Rica's EEZ was landed in Costa Rica. As reported by IATTC, over this period the country received on average US$37/t of tuna extracted (with licenses paid for, granted free of charge or without licenses) from its Pacific EEZ, as gross income from the sale of fishing licenses.

According to the same IATTC report, 59% of tuna vessels operating in Costa Rica's EEZ over this same period did so without a license. In other words, they operated without a permit and extracted Costa Rican tuna without paying anything, otherwise known as illegal, unreported and unregulated (IUU) fishing.

## Use of fish aggregating devices

Fish aggregating devices or FADs are artificial substrates that provide a meeting point on the high seas or a concentrated habitat for different fish species seeking refuge and food. The proliferation of these devices has a negative impact on the biodiversity of tropical oceans as it is estimated that between 47,000 and 105,000 devices are released to float freely, with radio-buoys, echo sounders, and solar panels, that indicate to tuna vessels via satellite the amount of biomass associated with them.

In the nineteen fifties the first tuna purse-seiners in the EPO found it useful to catch schools of tuna associated with natural floating objects such as tree trunks (Hall 1998). From that time industrial purse-seine tuna vessels concentrated on the use of free-floating objects to improve their catches, starting to use FADs in the nineteen eighties, and rapidly increasing their use in the following decade.

The use of these devices raised the possibility of at least four negative impacts:

a) A reduction in the recruitment of small-sized yellowfin tuna to fish stocks;

b) An increase in the bycatch of non-target species and a disturbance in the balance of the pelagic ecosystem;

c) Alterations to normal migrations of species associated with FADs; and

d) A reduction of the biomass with spawning capability and the size of the fish stock normally associated with bigeye (*Thunnus obesus*) and yellowfin (*Thunnus albacares*) tuna.

The use of FADs was banned in July 1999 as a result of the agreement of INCOPESCA's Board of Directors (INCOPESCA-AJDIP/241-99), recognizing their predatory effect as an ecological trap. However, between 2002 and 2011, 795 (4.98%) of a total of 16,626 sets were made on these devices. The distribution of sets on floating objects (making no distinction between natural and artificial ones in the form of FADs) significantly

coincides with that of FADs in the extreme southeastern EEZ, which suggests that a high percentage of these floating objects are indeed fish aggregating devices.

The use of FADs occurred particularly beyond the 350 nm limit, established from the 12 nm limit of territorial waters, and was associated with high catch levels of juvenile yellowfin tuna (weighing less than 2.5 kg), mahi-mahi, peto (*Acanthocybium solandri*) and a variety of other species. Throughout the decade almost 1.7 million yellowfin and bigeye tuna were caught, even when they weighed less than 2.5 kg. The size at first maturity of bigeye tuna is around 12.4 kg, while that of the yellowfin is at least 20 kilograms. This means that such catches involved animals that had not yet reproduced on extraction.

The majority of the vessels that used FADs made their landings in Ecuador (66%), and most of the catches associated with sets on FADs made in the extreme south-southeast of the EEZ were taken to Ecuador.

The distribution of the hold capacity of the fleets registered by IATTC, and corresponding to the five countries with tuna licenses to fish in Costa Rica between 2008 and 2011 (Panama, Nicaragua, Guatemala, El Salvador and Venezuela), as well as Ecuador, was compared with the distribution of the hold capacity of vessels that used FADs during the decade under analysis.

The vessels that used FADs covered the whole range of the capacity of the Ecuadorian fleet. As far as Nicaragua, Guatemala and El Salvador are concerned, there was very little coincidence, while in the case of Panama and Venezuela there was a medium-level of coincidence. This would suggest that the majority of vessels that used FADs came from Ecuador.

Databases of tuna fishing licenses made available by INCOPESCA for the period 2008-2011 showed that the Ecuadorian purse-seine fleet did not have licenses to fish in Costa Rican waters over these four years.

## SOCIO-ECONOMIC CONTEXT OF THE NATIONAL FISHERIES SECTOR

### Current general context

The lack of sustainable fishing policies in Costa Rica has led to the overexploitation of fisheries and the subsequent deterioration of socio-economic conditions within the Costa Rican fisheries sector. This has happened because fisheries have never been considered part the national development strategy. It has been assumed that commercial fishing does not contribute in any considerable way to the national economy, in that not long ago it was just an incipient sector much smaller than it is today. Data from 1983 reveal that the participation of commercial fisheries in GDP was a mere 0.25% (Universidad de Costa Rica 1985). However, twenty-five years later, 2008 data provide a different picture, showing that national commercial fisheries were contributing 1.88% to gross domestic product. Conditions have changed. Although, the incipient fisheries sector has grown and is now contributing to the country's economy, having increased its catch capacity, employment created and technologically, the conditions that characterize this sector have not kept pace and are unfavorable to its development.

In 2011, the presence of 37 industrial tuna vessels were reported fishing in Costa Rica's exclusive economic zone, while the artisanal fisheries sector, with a total of 6,100 registered vessels representing national fisheries, is the largest productive and social sector most at risk when compared with the industrial sector (OSPESCA and SICA 2009). This small- and medium-scale, and high seas fisheries sector needs urgent

attention as it provides a livelihood to a large segment of the population. While the international tuna fishing sector extracted average reported tuna catches of slightly over 25,000 t, Costa Rican fishers caught 18 times less, only 1,400 tonnes. This phenomenon is due to unequal conditions and limited access to this resource by national fishers in the face of international fleets equipped with more efficient fishing gear and under unequal conditions.

### Constitution of the national fisheries sector and its socio-economic context

Approximately 14,800 fishers live on our coasts and islands. Costa Rican fishers include 86% men and 14% women (OSPESCA and SICA 2009). There is a masculinization of the trade, but the contribution of women within the sector is indispensible in those processes involving added value as well as in fishing per se. In our country, family ties prevail among fishers and nuclear fishing families still exist, although they frequently live in conditions of poverty due to fisheries deterioration, poor remuneration, low levels of schooling, poor labor conditions, little infrastructure, and a generalized poor development of the sector, as well as a market with an industrial bias. It is important to provide the men, women and youth who work in this sector, together with their families, with the tools required to strengthen their contributions.

According to FAO (2004) the fishing of large pelagic species by the longline fleet (medium-sized artisanal and high seas) comprised 588 vessels. The current number of operating vessels has dropped to below 450 due to the economic and resource availability crisis affecting the sector. The longline fishing sector alone is responsible for over 1,500 direct jobs, including captains, sailors and dock workers.

> *"According to the multi-purpose household survey of the National Institute of Statistics and Census for 2003, the fisheries sector created 8,567 direct jobs and it is estimated that for each of these two indirect jobs were created, indicating that the total number of jobs resulting from this activity would be in excess of 25,000."*[10]

According to the cited survey and the 2006 State of the Nation report, the deteriorating conditions suffered by this population of fishers has resulted in their working below the minimum wage, thus jeopardizing their livelihoods. The economic gains of this sector are not good and conditions need to change to ensure improvements to their socio-economic situation.

According to IICE, commercial fishing in 2008 contributed to approximately 57,000 jobs throughout the country.

[10] ftp://ftp.fao.org/FI/DOCUMENT/fcp/es/FI_CP_CR.pdf (in Spanish).

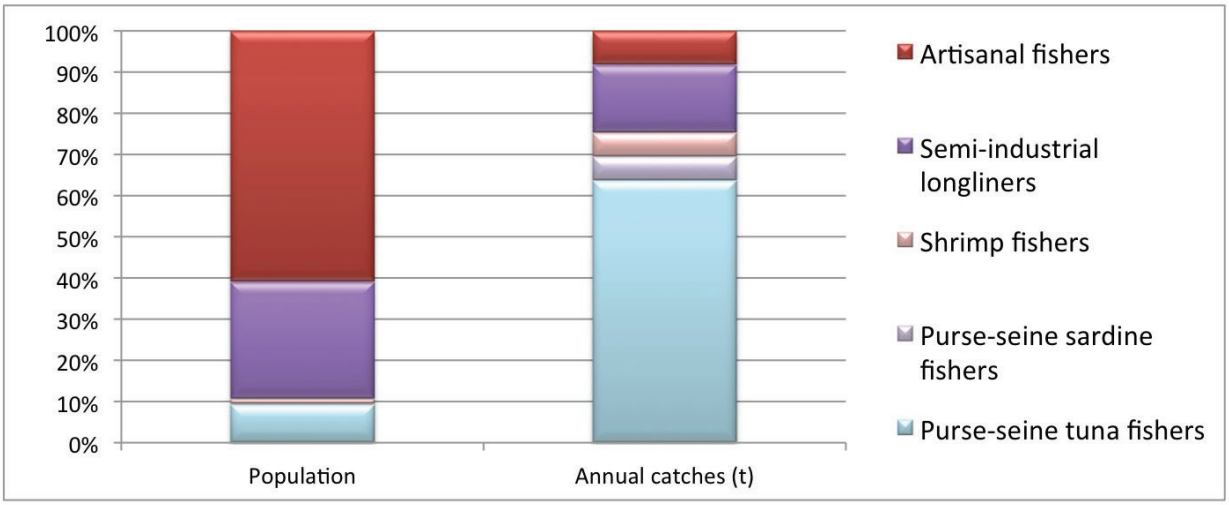



Figure 11: Ratio between populations of the corresponding fisheries sectors and annual catches (Shigeru 2013).

It is important to provide the sector with the necessary tools and opportunities, not only because of the previously mentioned conditions, but also because of its high level of dependency in that 79.1% of all fishers have no other activities, while 19.6% are involved in subsistence agriculture, 0.4% in domestic work, and 0.9% in livestock farming (OSPESCA and SICA 2009). This situation does not allow for alternative activities, but indicates the need for improved management and the need to consider the creation of opportunities within the sector to ensure the sustainability of economic activities.

The situation does not change when education within the sector is examined. If the educational level of fishers in Costa Rica is analyzed, it is found that 29.1% of this population has not terminated primary education, 43.7% has completed it, 15.6% has not completed secondary education, 3.8% has no education whatsoever, and higher-level education has benefited only 1.8% of the population (OSPESCA and SICA 2009). The United Nations Food and Agriculture Organization recognizes that in general terms the population in question is in a poor condition and comments on the subject:

> *"In recent years the pressure from fishing on these fisheries has increased considerably, as a result of external and internal migrations of people who are unemployed due to the poor economic situation of neighbouring countries and due to structural changes within the country that have resulted in a crisis in the agricultural sector." (FAO 2004 )*

This population of fishers is distributed throughout approximately 90 fishing and aquaculture communities. Among these communities, and according to OSPESCA and SICA (2009), there are seven main ports for the landing of fish. Data on sustainable human development in the cantons where these landing points are located indicate poor levels of development compared with other cantons. According to the United Nations Development Programme's human poverty index, access of these populations to a variety of basic services is poor; the canton with the highest index level is Golfito in position 78, followed by Puntarenas in position 75 of a total of 81 cantons. This is alarming in that Puntarenas has a large population of fishers who are living in such conditions. These are the most critical examples on this index, but other cantons located between the main landing ports are also facing high poverty levels. These poverty levels reflect the lack of economic opportunities in the cantons.

| | # Landings | # people/ landing | Population | | Annual catches (t) | |
|---|---|---|---|---|---|---|
| Artisanal fishers | 3,000 | 3 | 9,000 | 61% | 4,300 | 8% |
| Semi-industrial (longliners) | 600 | 7 | 4,200 | 28% | 8,500 | 16% |
| Shrimp fishers | 30 | 6 | 180 | 1% | 3,000 | 6% |
| Purse-seine sardine fishers | 2 | 7 | 14 | 0% | 3,000 | 6% |
| Purse-seine tuna fishers | 55 | 25 | 1,375 | 9% | 33,000 | 64% |
| Total: | 3,687 | 48 | 14,769 | 100% | 51,800 | 100% |

Table 3: Employment estimates by type of commercial fishing in the exclusive economic zone.
* 2,421 landings plus illegal ones / * 588 landings
Source: FAO 2004

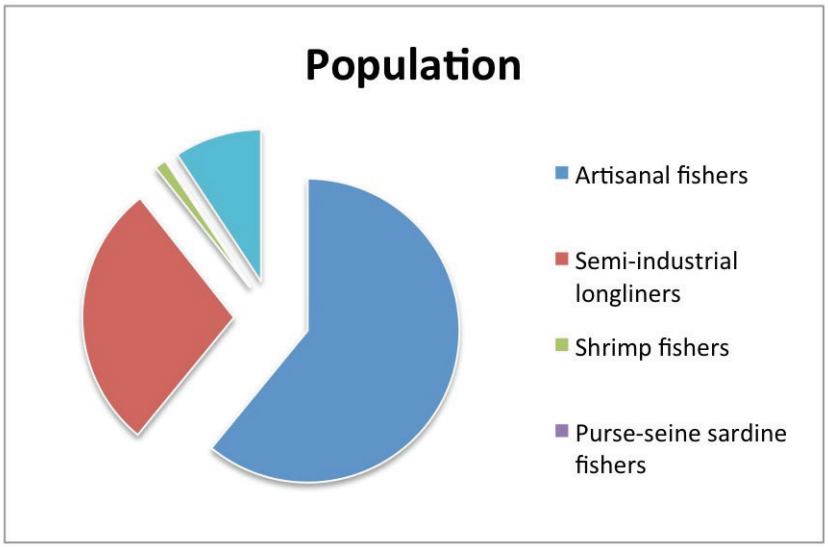



Figure 12: Estimate of employment distribution in fisheries according to type of fishing.

Regarding the conditions for productive fishing in these 90 fisher communities, 25.5% have no working infrastructure whatsoever, reflecting the lack of support and attention to the sector that requires certain inputs for it to perform (OSPESCA and SICA 2009); only 14% of them have a fishing dock, 8.3% have a fuelling station, 55% have some form of collection center, and a mere 3.3% of the communities have processing plants, indicating the poor industrialization of the sector and highlighting the lack of development opportunities.

## ECONOMIC SCENARIOS FOR LONGLINE FISHING

Purse-seine tuna vessels use a net that is set around the schools of tuna and then hauled in with the fish inside. These vessels belong solely to international tuna fishing fleets as Costa Rica has none. Longline vessels, on the other hand, release a line with hooks and bait that is subsequently drawn in to remove captured fish. According to INCOPESCA, there are 239 Costa Rican vessels that fish for tuna in our exclusive economic zone.

Data from INCOPESCA over the 2005-2009 period showed that longliner vessels' gross revenue in 2009 was US$29 million. This revenue was from three main groups of fish: tuna with a value of US$14 million, mahi-mahi with US$12 million, and billfish which generated US$3 million. The average landings of tuna from longliners in Costa Rica for this period was 1,427 metric tonnes.[11]

Volumes caught by tuna purse-seine vessels in Costa Rica's EEZ were established by FECOP on the basis of data provided by the Inter-American Tropical Tuna Commission. In a scenario involving the exclusion of purse-seiners between the 12 nm and 235 nm limits, the value of potential catch was estimated at US$224 million[12] if the tuna were caught by local longline fishers and sold fresh, instead of by international longliners (table 4).

In other words, if these local fishers had caught all the tuna reported by IATTC, they would possibly increase their revenue from US$14 million to US$224 million (only from tuna), representing a gross income 16 times higher than their current income from tuna. In addition, they could still benefit from the sale of mahi-mahi to the tune of a further US$12 million, with the advantage that they would not have to undertake such long fishing trips.

Not only longliners would benefit from the exclusion of international purse-seine vessels from our exclusive economic zone. Sport fishing would also benefit as longline fishers would be able to minimize catches of billfish, that have little value on the market and the commercialization of which is illegal. This would result in an annual opportunity cost for the tourist industry of not killing them estimated at approximately US$104 million.

[11] Weight of fish gutted and without heads. Adjusted weight for whole fish would be 1,678 tonnes.
[12] 22,160 t @ US$10.11/kg

In summary, if Costa Rican longliners could fish the 22,160 t currently caught by purse-seiners and minimize billfish deaths, the opportunity cost of limiting access of these fishing vessels to the 350 nm area would be approximately US$328 million.[13] If we add the US$14 million they currently earn from fished tuna, plus the US$12 million from mahi-mahi, the total opportunity cost of excluding the international purse-seine fleet would be US$354 million.

An important point to take into consideration is that in economic terms frozen tuna from tuna purse-seiners has a value of US$62 million. At the national level and in economic terms this means that the exclusion of the international tuna fleet would generate 5.7 times more in gross revenue. This figure is obviously important from an economic perspective, but of more relevance is the fact that the US$62 million currently goes to foreign companies and is channelled through their own countries of origin.

On the other hand, if national longliners could catch this tuna, the US$250 million[14] would be channelled through our landing docks and the port towns in which they are located. In this manner an economic value would be created in hitherto deprived areas, thus contributing to Costa Rica's development; and an additional US$104 million would be channelled through recreational fishing areas and hotel services in our tourist regions.

Finally, tuna is a resource used by different groups throughout the country. It is important to have a clear understanding of the different economic scenarios based on exclusion limits of the international fleet so as to generate the greatest common good within tuna fisheries.

Data expressed in previous paragraphs correspond to the 350 nm exclusion scenario. Table 4 shows the results of different exclusion scenarios of the purse-seine fleet and a graphic representation of the 350 nm exclusion zone scenario is presented in figure 13. A reduction of the exclusion zone of purse-seine vessels reduces the opportunity cost for national longline fishers and the ability of the country to benefit from tuna fisheries.

| Estimated value | Units | 350-mile limit |
|---|---|---|
| TUNA: Real average of tuna catches by tuna purse-seiners (2002-2011) | Tonnes | 22,160 |
| TUNA: 100% value of tuna at longline price with the exclusion of purse seiners at today's price | US$ in millions | US$224 |

Table 4: Potential value of tuna with exclusion of purse-seine fleets.

[13] US$104 + US$224 = US$328 million
[14] US$14 million + US$12 million worth of currently fished tuna and mahi-mahi + US$224 million worth of potential catch = US$250 million.

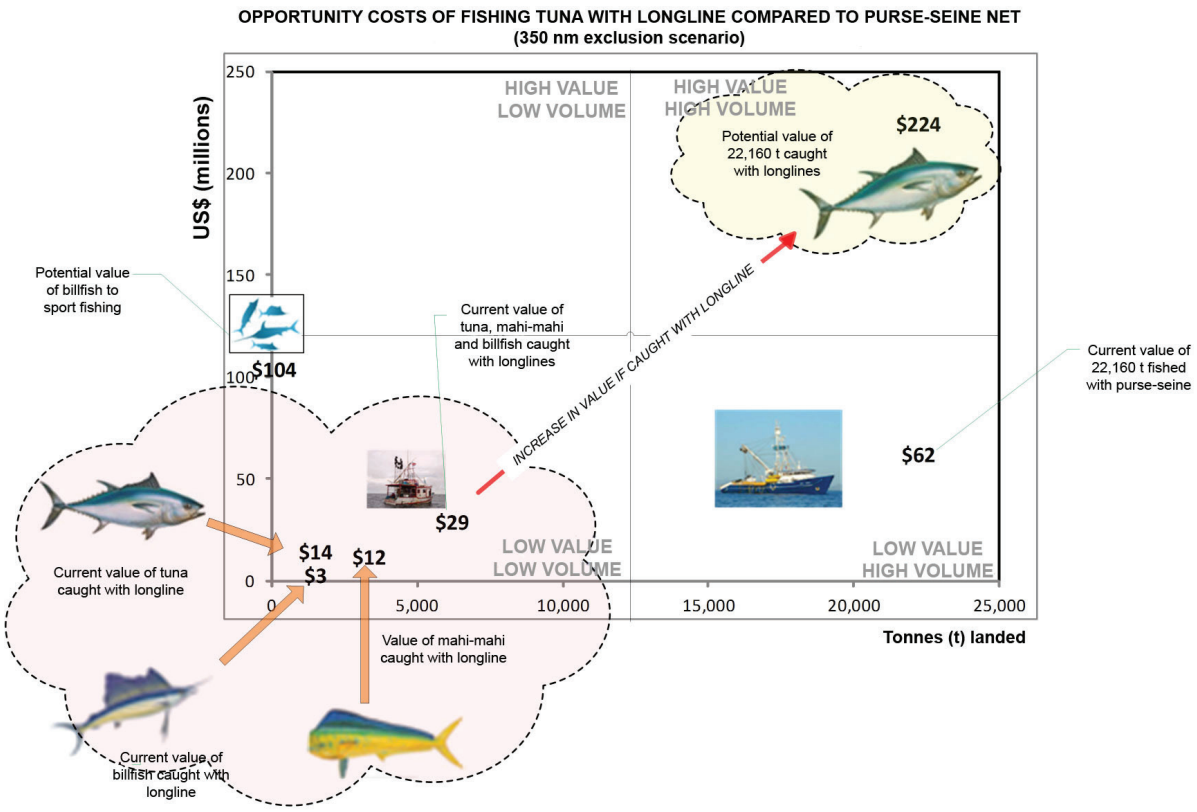



Figure 13: Comparative opportunity costs of fishing with longlines and purse-seine gear.

| | TONNES | | | US$ (thousands) | | |
|---|---|---|---|---|---|---|
| **YEAR** | **TUNA** | **SAILFISH** | **MAHI-MAHI** | **TUNA** | **SAILFISH** | **MAHI-MAHI** |
| **1992** | 639 | 0 | 1,201 | 1.9 | 0.5 | 3.4 |
| **1993** | 292 | 0 | 1,534 | 1.0 | 0.2 | 4.3 |
| **1994** | 613 | 776 | 1,400 | 2.1 | 0.1 | 4.2 |
| **1995** | 555 | 1,114 | 1,511 | 1.6 | 0.2 | 3.7 |
| **1996** | 4,082 | 1,191 | 3,922 | 16.9 | 2.6 | 8.5 |
| **1997** | 990 | 1,092 | 6,302 | 3.8 | 5.1 | 9.5 |
| **1998** | 1,213 | 988 | 2,489 | 3.8 | 1.6 | 8.3 |
| **1999** | 1,057 | 1,118 | 3,951 | 2.9 | 0.3 | 14.1 |
| **2000** | 1,110 | 1,239 | 8,370 | 3.4 | 1.5 | 18.6 |
| **2001** | 1,160 | 1,289 | 11,221 | 3.6 | 2.5 | 16.9 |
| **2002** | 1,583 | 1,399 | 7,832 | 5.6 | 2.5 | 17.9 |
| **2003** | 1,432 | 1,002 | 3,969 | 5.4 | 0.7 | 13.9 |
| **2004** | 1,723 | 1,244 | 2,320 | 7.1 | 0.8 | 8.6 |
| **2005** | 1,814 | 767 | 3,161 | 7.9 | 0.8 | 12.3 |
| **2006** | 1,422 | 972 | 2,915 | 5.8 | 1.9 | 9.6 |
| **2007** | 1,238 | 923 | 2,339 | 4.4 | 1.4 | 10.0 |
| **2008** | 1,242 | 372 | 4,082 | 4.8 | 1.0 | 11.9 |
| **2009** | 1,418 | 201 | 3,839 | 5.6 | 1.9 | 11.0 |

Table 5: Reported landings of national fleet and estimated product value.

## ECONOMIC ANALYSIS AND OPPORTUNITY COST

If tuna were to be fished only with longlines in our EEZ, a potential income of US$224 million could be envisaged. Unfortunately, Costa Rican fishers do not benefit from the enormous potential of tuna as most is caught by industrial fishing vessels from other countries.

If this situation is analyzed from a micro-economic perspective, we can see why Costa Rican fishers have recently started to abandon their trade. They are no longer able to comply with the commercial and financial obligations related to their operations and eventually face bankruptcy.

A vessel with an operating cost or "alistos"[15] of almost ¢9 million colons (US$18,000–US$20,000) per trip, that catches around 19 tuna trunks per trip, and makes nine trips a year and being obliged to sail beyond Cocos Island, and even close to Ecuadorian waters, has a negative income. In order to offset losses, such a vessel has to catch species of lesser value, although this is not always possible. Making a profit on such difficult trips is not easy because high-value species such as mahi-mahi, shark, and marlin, are increasingly scarce and have market prices that are lower than those for fresh tuna. It is thus necessary to catch more of these species with a lower value on the export market in order to compensate for the lack of available tuna. This is the reality of our fishers who sail our exclusive economic zone. If low catch rates persist fishers lose interest as they rapidly incurr an annual deficit of at least ¢35 million[16] (table 6).

| TABLE OF VARIABLES FOR LONGLINERS | | | | YEAR | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variables in production price data | kg/trunk | Price (US$/kg) | Trips/year => | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| | | | | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| Trunks without head/trip grade 1+ tuna | 43 | $8.0 | | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Grade 2+ tuna | 43 | $4.4 | Number of | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Grade 3 tuna | 43 | $2.0 | trunks/trip => | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Dorado 1era | 15 | $4.0 | | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| **PROFIT AND LOSS STATEMENT (*millions CRC*)** | | | ***YEAR=>*** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| **SALES** | | | | **31** | **32** | **32** | **33** | **34** | **35** | **35** | **36** | **37** | **38** |
| **FIXED COSTS ("Alisto")** | ¢ million per trip | | | **80.6** | **84.2** | **88.0** | **81.7** | **85.3** | **89.2** | **93.2** | **97.4** | **101.8** | **106.3** |
| ***Fuel*** | ₡6.00 | | | 54.0 | 56.4 | 59.0 | 61.6 | 64.4 | 67.3 | 70.3 | 73.5 | 76.8 | 80.2 |
| ***Food supplies*** | ₡0.70 | | | 6.3 | 6.6 | 6.9 | 7.2 | 7.5 | 7.9 | 8.2 | 8.6 | 9.0 | 9.4 |
| ***Ice*** | ₡0.45 | | | 4.1 | 4.2 | 4.4 | 4.6 | 4.8 | 5.0 | 5.3 | 5.5 | 5.8 | 6.0 |
| ***Bait*** | ₡0.50 | | | 4.5 | 4.7 | 4.9 | 5.1 | 5.4 | 5.6 | 5.9 | 6.1 | 6.4 | 6.7 |
| ***Other fixed costs*** | ₡0.30 | | | 2.7 | 2.8 | 2.9 | 3.1 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 4.0 |
| ***Contingency*** | ₡1.00 | | | 9.0 | 9.4 | 9.8 | - | - | - | - | - | - | - |
| **VARIABLE COSTS** | | | | **(24.9)** | **(26.4)** | **(28.0)** | **(24.5)** | **(26.0)** | **(27.6)** | **(29.2)** | **(31.0)** | **(32.8)** | **(34.7)** |
| ***Piecework payroll*** | | | | (19.8) | (20.9) | (22.2) | (19.4) | (20.6) | (21.8) | (23.2) | (24.5) | (26.0) | (27.5) |
| ***Social security charges (CCSS)*** | 25.0% | | | (4.9) | (5.2) | (5.5) | (4.8) | (5.1) | (5.5) | (5.8) | (6.1) | (6.5) | (6.9) |
| ***Occupational risk insurance (INS)*** | 1.2% | | | (0.2) | (0.3) | (0.3) | (0.2) | (0.2) | (0.3) | (0.3) | (0.3) | (0.3) | (0.3) |
| ***Variable quota/extraction*** | | | | 0.0 | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **GROSS INCOME** | | | | **(24.5)** | **(25.9)** | **(27.5)** | **(24.0)** | **(25.5)** | **(27.0)** | **(28.7)** | **(30.4)** | **(32.2)** | **(34.0)** |
| **OPERATING COSTS** | ¢ millones x Año | | | **9.7** | **9.9** | **10.0** | **10.2** | **10.4** | **10.6** | **10.8** | **11.0** | **11.3** | **11.5** |
| ***Vessel maintenance*** | ₡2.50 | | | 2.5 | 2.6 | 2.7 | 2.9 | 3.0 | 3.1 | 3.3 | 3.4 | 3.6 | 3.7 |
| ***Rental/services*** | ₡0.00 | | | - | - | - | - | - | - | - | - | - | - |
| ***Fishing licenses*** | ₡0.20 | | | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| ***Insurance and other*** | ₡0.00 | | | - | - | - | - | - | - | - | - | - | - |
| ***Professional services*** | ₡0.00 | | | - | - | - | - | - | - | - | - | - | - |
| ***Other costs*** | ₡1.00 | | | 1.0 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 |
| ***Depreciation*** | ₡6.00 | | | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 | 6.0 |
| **Payment of interest on loans** | | | | - | - | - | - | - | - | - | - | - | - |
| **INCOME BEFORE TAX** | | | | **(34.2)** | **(35.8)** | **(37.5)** | **(34.2)** | **(35.9)** | **(37.6)** | **(39.5)** | **(41.4)** | **(43.4)** | **(45.5)** |
| **Income tax payments** | | | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **NET PROFIT** | | | | **(34.2)** | **(35.8)** | **(37.5)** | **(34.2)** | **(35.9)** | **(37.6)** | **(39.5)** | **(41.4)** | **(43.4)** | **(45.5)** |

Table 6: Estimate of current losses for a medium-sized longline boat (includes inflation).

[15] The investment required prior to a fishing trip includes fuel, food, insurance, bait and equipment.

[16] Average deficit between years 1 and 2 of operations according to the profit and loss statement in table 6.

The main objective behind the request to exclude the international purse-seine fleet from Costa Rica's EEZ is to create conditions in which tuna can return to a higher abundance level so fishing can once again become profitable for our fishers.

In Costa Rica there are three types of longline fishers who could benefit from increased tuna availability in our EEZ: large, and medium-sized artisanal longliners who are already fishing tuna, and small artisanal fishers who operate close to the coast. These small artisanal fishers could also fish for tuna if its abundancy increased again along our coasts.

According to INCOPESCA[17], there are some 239 large- and medium-sized Costa Rican longline vessels that are actively seeking tuna as their main target species, and some 241 small longline vessels that would also actively fish for tuna near the coast. According to González[18] there are some 480 vessels that would become involved in tuna fishing should international purse-seine fleets not fish for tuna in our exclusive economic zone.

In economic terms, it should be understood that fishers calculate their profitability on the basis of cash in hand rather than the internal rate of return (IRR) on investment. The majority of fishing licenses are also registered in the name of physical persons rather than legal entities. We thus refer to their profitability in terms of how much they receive from fishing on a monthly basis, as this is more in line with the family context than the business one.

It is important to stress that these calculations depend on whether the vessel is small, medium or large in size. The operational break-even point for these vessels would be with a catch of around 20, 63 and 233 tuna trunks respectively per trip, corresponding to an average monthly income of 1 million, 2.5 million and 5.5 million colons respectively (table 7).

| Type of fleet | SMALL | MEDIUM | LARGE | TOTAL |
|---|---|---|---|---|
| **# of vessels** | **250** | **150** | **80** | **480** |
| # of trips per year | 20 | 15 | 8 | |
| 42kg grade 1+ tuna trunks | **16** | **53** | **190** | |
| 42kg grade 2 tuna trunks | **2** | **5** | **19** | |
| 42 kg grade 3 tuna trunks | **2** | **7** | **24** | |
| 15 kg grade 1 mahi-mahi trunks | **15** | **15** | **15** | |
| kg extracted/vessel/trip | 688 | 2,279 | 8,170 | |
| Projected inflation rate Costa Rica | 4.5% | 4.5% | 4.5% | |
| US$ inflation rate | 2.1% | 2.1% | 2.1% | |
| Investor capital cost | 50% | 50% | 50% | |
| **Sales (Million/Year)** | **₡66** | **₡148** | **₡273** | |
| **Net profit (million/Year)** | **₡10** | **₡26** | **₡57** | |
| **IRR** | **49%** | **50%** | **50%** | |
| **Withdrawal owners (million/month)** | **₡1.0** | **₡2.5** | **₡5.5** | |
| | Total estimated tuna in Costa Rica's EEZ | | | 25,000 |
| Tonnes extracted /fleet/year | 3,340 | 5,128 | 5,229 | 13,797 |
| **Tuna surplus/shortfall** | | | | **11,203** |
| Tuna prices/kg | US$ | | | |
| Tuna grade 1+ | $8.0 | | | |
| Tuna grade 2+ | $4.4 | | | |
| Tuna grade 3 | $2.0 | | | |
| Mahi-mahi grade 1 | $4.0 | | | |

Table 7: Summary of profitability or break-even point of national longliners according to vessel size.

[17] INCOPESCA, Department of Protection and Registrations.
[18] Mauricio González, member of the Presidential Commission on the National Fisheries Sector. Personal communication, August 2013.

These previous estimates are based on the assumption that 20, 15, and 8 trips are made annually by the small, medium, and large vessels respectively, with an annual inflation rate of 4.5%[19] for the national currency, the colon, and a 2.1% dollar inflation rate[20] for the price of tuna, as the majority is sold on the export market. Estimates were based on tuna catches, and it is to be noted in table 7 that those of mahi-mahi remained constant, because once fishing focuses on abundant shoals of tuna mahi-mahi catches will be minimized. As a cut-off point, the capital cost for fishers was established at 50% and inflation is factored in from the second year rather than the first year, as operations are already underway.

A characteristic of the microanalysis of Costa Rica's longline fishers is that the operational cost is considered a fixed cost while the payroll is treated as a variable. Operating costs and taxes can be deducted from gross income. This is because on each trip the operational cost will always be spent, while there is no certainty as to how large the catch (income) will be. As far as payroll[21] is concerned, it is a tradition that pay depends on volume (income), so this is a variable cost linked to income. Under these conditions, the salary of vessel owners is not included in the payroll and their returns or income are deducted from cash flow.

There are exceptions regarding catches as some trips are currently barely meeting break-even point. As we have previously seen, a vessel can return home with only 19 trunks when it should return with slightly over 200 in order to reach break-even point. And even though attempts are made to earn something by catching other species, populations of these are also falling and are of lower value.

This reality demonstrates the seriousness of the situation, and as trips such as those described are made, fishers will eventually be obliged to stop their fishing activities so as not to fall into bankruptcy and lose everything.

From a mathematical perspective, longliners should catch approximately 11,203 t of tuna in order to remain close to break-even point, and beyond this figure they could ensure healthy finances. In spite of the fact that additional income can be made from mahi-mahi catches, caution needs to be exercised as fishing intensity for this species is high outside our EEZ, and there could be little or nothing left to build on, and it is more than likely that these populations deteriorate in the near future.

From a commercial perspective, if more tuna were to be found in Costa Rican waters national longline fishers would use more selective fishing gear, such as Green Stick, in catching tuna because prices are higher and trunks are larger. As the lines would be shorter and sets more rapid, other bycatch species such as sailfish[22] will be of no interest to longliners because they would cause them to lose time and money.

It is estimated that current tuna catches could be around a mere 1,000 t, resulting in the economic distress being faced by fishers. As an example, and based on 2007-2009 INCOPESCA dock landing data (2009), average tuna landings from longline catches are approximately only 1,300 tonnes.

In order to escape current realities and improve the situation of fishers, synergies need to be created between the operational elements of tuna fisheries. We could hope for increased numbers of trunks caught per trip, more trips per year if these were not so long, and lower operating costs per trip, as tuna would be closer to shore and, being fresh with lower on-board storage costs, would be of higher quality.

[19] According to World Bank data for Costa Rica, 2012. http://datos.bancomundial.org/indicador/FP.CPI.TOTL.ZG
[20] According to World Bank data, the United States of America is the main buyer of fresh tuna from Costa Rica. 2012. http://datos.bancomundial.org/indicador/FP.CPI.TOTL.ZG
[21] In Costa Rica there is often an agreement that after deduction of the "alisto", 40% goes to the captain and crew, and 60% goes to the vessel owner.
[22] It is calculated that each live sailfish is worth US$3,000 to tourism.

Based on information provided by fishers, and in a situation of species abundance, it is estimated that monthly profitability for fishers, according to vessel size (small, medium, and large respectively), could reach 3.3 million, 8 million and 7.6 million colons respectively if they were able to catch the necessary 49, 150, and 299 individuals on each trip. This information is presented in table 8.

| Type of fleet | SMALL | MEDIUM | LARGE | TOTAL |
|---|---|---|---|---|
| **# of vessels** | **250** | **150** | **80** | **480** |
| # of trips per year | 20 | 15 | 8 | |
| 42kg grade 1+ tuna trunks | **40** | **130** | **250** | |
| 42kg grade 2 tuna trunks | **4** | **13** | **25** | |
| 42 kg grade 3 tuna trunks | **5** | **7** | **24** | |
| 15 kg grade 1 mahi-mahi trunks | **15** | **15** | **15** | |
| kg extracted/vessel/trip | 1,720 | 5,590 | 10,750 | |
| Projected inflation rate Costa Rica | 4.5% | 4.5% | 4.5% | |
| US$ inflation rate | 2.1% | 2.1% | 2.1% | |
| Investor capital cost | 50% | 50% | 50% | |
| **Sales (Million/Year)** | ₡151 | ₡352 | ₡358 | |
| **Net profit (million/Year)** | ₡39 | ₡95 | ₡83 | |
| **IRR** | 158% | 154% | 68% | |
| **Withdrawal owners (million/month)** | ₡3.3 | ₡8.0 | ₡7.6 | |
| Total estimated tuna in Costa Rica's EEZ | | | | 25,000 |
| Tonnes extracted /fleet/year | 8,600 | 12,578 | 6,880 | 28,058 |
| **Tuna surplus/shortfall** | | | | **-3,058** |

| Tuna prices/kg | US$ |
|---|---|
| Tuna grade 1+ | 8.0 |
| Tuna grade 2+ | 4.4 |
| Tuna grade 3 | 2.0 |
| Mahi-mahi grade 1 | 4.0 |

Table 8: Summary of estimated profitability of national longliners according to vessel type in the absence of purse-seiners in the exclusive economic zone.

In absolute terms, landings involving the cited numbers of individuals are equivalent to 28,000 t of tuna, and it could be considered that these levels exceed our EEZ's productivity. However, this figure might not be so far from reality in that over 30,000 t have already been caught annually in our exclusive economic zone. Between 2009 and 2011 the purse-seine fleet extracted almost 23,000 t/year, in addition to the 1,300 t caught by national longliners, giving us an annual figure of about 24,400 t of tuna.

Taking into consideration operating costs and the number of longliners in the country, Costa Rica's longline fleet should operate under conditions that provide access to the highest possible number of tuna within our exclusive economic zone. This is not happening at the moment because purse-seine fleets from other countries are extracting more than 22,000 t of Costa Rican tuna, most of which is processed overseas.

Although national longliners are unable to capitalize on 28,000 t of catches for a variety of reasons, whether environmental, technical, regulatory or otherwise, there are many opportunities for the national longline

fleet to become profitable if licenses for the international fishing fleet in our EEZ are eliminated or restricted.

Considering the previous information, this restriction placed on international tuna vessels would guarantee an annual catch approaching 11,203 t that tuna fishers need in order to reach their break-even point and cope with the fluctuations usually associated with fishing, and have the positive margin needed to enable them to extend fishing activities and increase incomes.

As an example, and in the case of annual catches of 19,000 t, by maintaining the same number of vessels and calculation parameters, the quantity of tuna that would be caught by small, medium and large longliners correspond to 29, 101 and 257 trunks respectively. This is equivalent to ¢1.8 million, ¢4.6 million and ¢6.2 million monthly per vessel for fishers. These are the conditions that fishers would consider fair and necessary to compensate for their effort and risks taken.

A more thorough sensitivity analysis is shown in table 9, which includes data for the three types of vessel. The shaded areas represent numbers of trunks and prices of fresh tuna for export that would enable fishers to reach break-even point within the context of this analysis. This data is related to break-even points for each vessel type.

| SMALL LONGLINE BOAT (1 million/month) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | US$/kg=> | **$6** | **$7** | **$8** | **$9** | **$10** | **$11** |
| **Trunks per trip** | **10** | 0.0 | 0.2 | 0.4 | 0.5 | 0.7 | 0.8 |
| | **12** | 0.3 | 0.4 | 0.6 | 0.8 | 0.9 | 1.0 |
| | **14** | 0.4 | 0.6 | 0.8 | 1.0 | 1.2 | 1.3 |
| | **16** | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 | 1.6 |
| | **24** | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 | 2.6 |
| | **32** | 1.8 | 2.2 | 2.6 | 2.9 | 3.3 | 3.7 |
| | **40** | 2.4 | 2.8 | 3.3 | 3.8 | 4.3 | 4.7 |

| MEDIUM LONGLINE BOAT (2.5 million/month) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | US$/kg=> | **$6** | **$7** | **$8** | **$9** | **$10** | **$11** |
| **Trunks per trip** | **23** | 0.0 | 0.0 | 0.0 | 0.0 | 0.7 | 1.0 |
| | **33** | 0.0 | 0.7 | 1.1 | 1.4 | 1.7 | 2.0 |
| | **43** | 1.0 | 1.4 | 1.8 | 2.2 | 2.6 | 2.9 |
| | **53** | 1.6 | 2.0 | 2.5 | 3.0 | 3.4 | 3.9 |
| | **83** | 3.2 | 3.9 | 4.6 | 5.4 | 6.1 | 6.8 |
| | **113** | 4.8 | 5.8 | 6.8 | 7.8 | 8.8 | 9.8 |
| | **143** | 6.4 | 7.6 | 8.9 | 10.2 | 11.4 | 12.7 |

| LARGE LONGLINE BOAT (5.5 million/month) | | | | | | | |
|---|---|---|---|---|---|---|---|
| | US$/kg=> | **$6** | **$7** | **$8** | **$9** | **$10** | **$11** |
| **Trunks per trip** | **55** | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.5 |
| | **100** | 1.4 | 1.9 | 2.3 | 2.8 | 3.2 | 3.6 |
| | **145** | 2.6 | 3.3 | 3.9 | 4.5 | 5.2 | 5.8 |
| | **190** | 3.8 | 4.6 | 5.5 | 6.3 | 7.1 | 8.0 |
| | **210** | 4.3 | 5.3 | 6.2 | 7.1 | 8.0 | 8.9 |
| | **230** | 4.9 | 5.9 | 6.9 | 7.9 | 8.9 | 9.9 |
| | **250** | 5.4 | 6.5 | 7.6 | 8.7 | 9.8 | 10.9 |

Table 9: Sensitivity analysis based on the price of fresh tuna and the number of trunks landed (in millions of colons).

Finally, the reality which is demanded by longliners in order to survive and involving greater numbers of tuna, can be verified through a relative variation analysis of the most relevant parameters of their operations as related to their incomes.

In order to present the scenarios of an average longliner, and by expressing the variation in cash withdrawals as a variation of the internal rate of return (IRR), we can plot the graph shown in figure 14. Lines two and four of this figure demonstrate income sensitivity to the number of trunks caught per trip, and to payroll costs. Actions taken to displace the international purse-seine fleet from our EEZ would thus constitute a congruent and rational step towards ensuring increased tuna catches, allowing Costa Rican artisanal fishers to increase their production and improve their socio-economic situation.

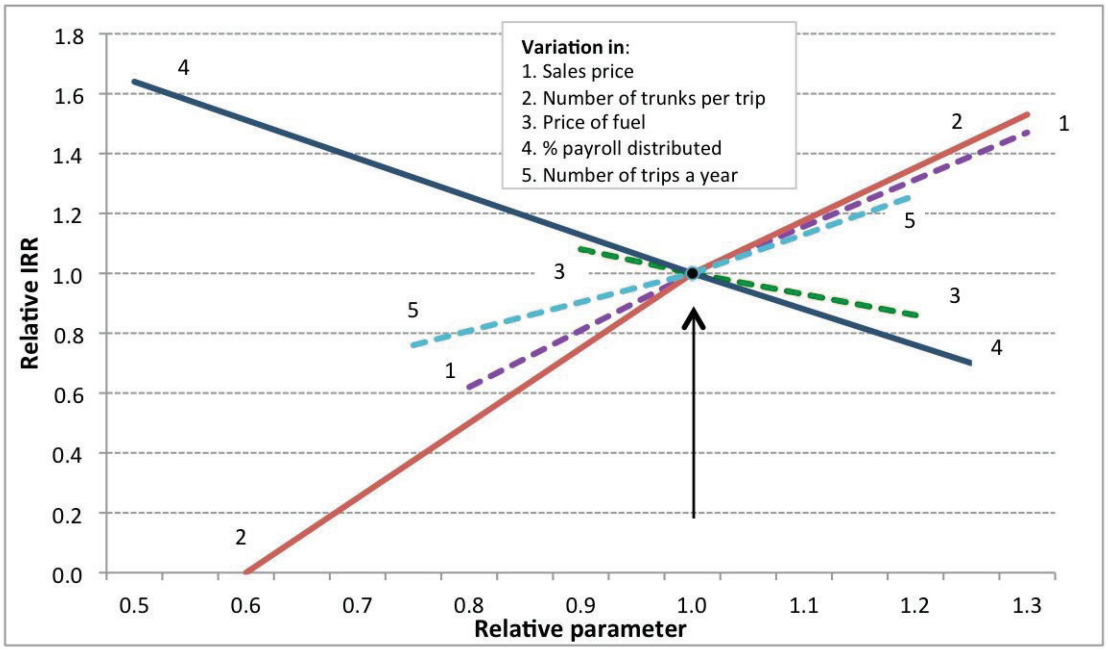



Figure 14: Relative variation analysis of most relevant parameters of an average longline fisher and changes to IRR or fisher's income.

# FISHERIES AND MARINE SPATIAL MANAGEMENT – A PROPOSAL

## Objective

This is a proposal for tuna management within Costa Rica's Pacific EEZ to optimize tuna exploitation by national, medium-sized and advanced artisanal longline fleets and reduce competition for the resource from tuna purse-seine fleets. In this manner, it aims to improve income of Costa Rican longline vessel owners, of the fishers who are crew members and of the families who depend on them, and the communities in which they live. The sustainable development of fisheries, with an ecosystem approach promoting a reduction of negative impacts on the marine environment, including the reduction of bycatch, is also sought.

The proposed management involves a spatial delimitation that defines a zone for the exclusive use of national fleets and from which tuna purse-seiners are excluded, and a zone for mixed fishing in which both national fleets and tuna purse-seine fleets can operate. It is accompanied by a proposal for terms of reference for a tuna fisheries management plan.

This type of use of national tuna fisheries has been prepared to align with the recently approved National Fisheries and Aquaculture Development Plan (PNDPA) (Executive Decree 37587-MAG) and contribute to the country's sustainability and conservation goals in the context of responsibilities held by the National Marine Commission (CONAMAR, Executive Decree 37212-MINAET-MAG-SP-MOPT) and INCOPESCA, to monitor implementation of the development plan.

## Scope

### Main and secondary target species

The main target species in this management plan is the yellowfin tuna (*Thunnus albacares*; Bonnaterre, 1788. Scombridae), a species widely distributed in tropical and subtropical seas throughout the world. Highest catch levels of this species are recorded in the Pacific ocean, particularly in the western and eastern Pacific ocean (CIAT 2013).

Most catches of yellowfin tuna in the EPO are made by the purse-seine fleets that make sets on tuna associated with dolphins. It is considered that this species comprises a single, continuous population, with possible genetic isolations, throughout the Pacific, and displacements of hundreds and rather than thousands of kilometers (CIAT 2013).

The fleets of 22 different nations fish for tuna and similar species (large pelagic fish) in the EPO, mainly using purse-seine vessels, and longliners to a lesser degree, but also pole-and-line vessels, troll vessels, and those using surface gill nets. These fleets fly the flags of Belize, Bolivia, Canada, China, Cook Islands, Colombia, Costa Rica, Ecuador, Guatemala, Japan, Kiribati, Republic of Korea, Mexico, Nicaragua, Panama, Peru, El Salvador, Chinese Taipei, United States of America, Venezuala and Vanuatu.

**Secondary target species**

The secondary target species covered in this management plan are:

1. Bigeye tuna (*Thunnus obesus;* Lowe, 1839. Scombridae).
2. Mahi-mahi (*Coryphaena hyppurus*; Linnaeus, 1758 and *Coryphaena equiselis*; Linnaeus, 1758. Coryphaenidae).
3. Swordfish (*Xiphias gladius*; Linnaeus, 1758. Xiphiidae).

**Non-target species or bycatch**

This management plan will take into consideration the following non-target species, referred to as incidental take or bycatch:

*Fish*

1. White or blue marlin (*Makaira nigricans; Lacepede*, 1802. *Istiophoridae*),
2. Pink or striped marlin (*Tetrapturus audax* o *Kajakia audax;* Philippi, 1887. Istiophoridae).
3. Indo-Pacific sailfish (*Isthiophorus platypterus;* Shaw, 1792. Istiophoridae)
4. Peto (*Acanthocybium solandri;* Cuvier, 1832. Scombridae)
5. Yellowtail amberjack (*Seriola lalandi;* Valenciennes, 1833. Carangidae)
6. Almaco jack (*Seriola rivoliana*; Valenciennes, 1833. Carangidae)
7. Rainbow runner (*Elagatis bipinnulata;* Quoi & Gaimard, 1825. Carangidae).
8. Silky shark (*Carcharhinus falciformis;* Müller & Henle, 1839. Carcharhinidae).
9. Blue shark (*Prionace glauca;* Linnaeus, 1758. Carcharhinidae).
10. Oceanic whitetip shark (*Carcharhinus longimanus;* Poey, 1861. Carcharhinidae)
11. Scalloped hammerhead shark (*Sphyrna lewini*, Griffith & Smith, 1834. Sphyrnidae)
12. Great hammerhead shark (*Sphyrna mokarran;* Rüppel, 1837. Sphyrnidae)
13. Scalloped bonnethead shark (*Sphyrna corona;* Springer 1940. Sphyrnidae)
14. Shovelhead shark (*Sphyrna tiburo;* Linnaeus, 1758. Sphyrnidae)
15. Scoophead shark (*Sphyrna media;* Springer, 1940. Sphyrnidae).
16. Ocean sunfish (*Mola mola;* Linnaeus, 1758. Molidae)

*Turtles*

1. Leatherback sea turtle (*Dermochelys coriacea*; Vandelli, 1761. Dermochelydae).
2. Pacific green turtle (*Chelonia mydas agassizii;* Linnaeus, 1758. Cheloniidae).
3. Loggerhead sea turtle (*Caretta caretta*; Linnaeus, 1758. Cheloniidae).
4. Olive ridley sea turtle (*Lepidochelys olivacea*, Eschscholtz; 1829. Cheloniidae).
5. Hawksbill turtle (*Eretmochelys imbricata;* Linneo, 1766. Cheloniidae).

**Management area, fleets and authorized fishing gear**

The plan's management area covers the whole range of Costa Rica's Pacific EEZ, and includes the following zones where its measures apply:

*Zone 1. Tuna fishing zone exclusively for national fleets.*

This zone covers the whole extension of the EEZ from the coastline as far as latitude 5° North. In this zone, medium-sized and advanced artisanal fleets can fish for tuna with surface longlines and other fishing gear such as rods, Green Stick, trolls, line and hooks, harpoon, or carry out fishing experiments with other gear. The use of tuna purse-seine nets, gill and drift nets is prohibited. Measures and regulations adopted by the country regarding tuna fishing are to be complied with, including resolutions approved by IATTC and applicable to these fleets' operations.

*Zone 2. Tuna fishing zone shared with purse-seine tuna vessels.*

It covers EEZ waters between latitude 5° North and from there southwards in a straight line and parallel to the Costa Rica's Pacific coastline. Tuna purse-seine vessels can fish in this zone protected by existing provisions in this area, and having requested or having been granted a fishing license by INCOPESCA. In accordance with corresponding national legislation, tuna purse-seine fleets will be prohibited from fishing for tuna using sets on artificial floating objects known as FADs (fish aggregating devices).

National tuna vessels will also be able to fish in this zone using surface or deep longlines, rods, Green Stick, trolls, line and hook, or carry out fishing experiments with other gear. The use of gill and drift nets is prohibited.

Tuna purse-seine vessels and national fleets using other types of fishing gear are to comply with measures and regulations adopted by the country regarding tuna fishing, including resolutions approved by IATTC and applicable to the operation of these fleets.

**Timespan of plan**

Upon approval, this plan will be valid for a period of six years. It is to be reviewed at the end of each year, and adjustments made according to adaptive management criteria. The plan can be extended for an additional four-year period, following the amendments and adjustments considered necessary and in line with consultation protocols established in the plan.

**Fleets and fisheries covered by the plan**

The fleets covered and subject to the regulations of this management plan are:

1. National fleets currently fishing with surface longlines.
    a. Medium artisanal fleet with an authorized autonomy of 40 nautical miles;
    b. Advanced artisanal fleet with an authorized autonomy of over 40 nautical miles.

    This fleet currently comprises approximately 480 longline vessels, and it is estimated that this management plan will initially cover around 60 vessels.

2. Tuna purse-seine fleets flying international flags, fishing in accordance with the country's tuna fishing regulations and adopted IATTC resolutions and measures.

**Plan administration, operation, review and evaluation**

Responsibility for the administration and operation of this management plan lies with the INCOPESCA, and to this end the institution will establish the following management entities:

1. *Director*

This person will be a scientist holding at least a master's degree in Fishery Sciences. He or she will be the person responsible for all the technical and administrative aspects of the management plan, and will coordinate with all the appropriate departments within INCOPESCA and externally with the fleets covered by the plan, as well as with other partners or participants, including coordination of the plan's governance commission. This person will answer to INCOPESCA's chief executive officer or the designated person in INCOPESCA's upper management.

2. *Scientific team*

A team of scientists will hold responsibility for implementing the scientific research program, to evaluate the effectiveness of the plan's management measures, propose adjustments, changes or recommend new management or conservation measures to ensure the plan's objectives are fulfilled. It will include, at least, the following professionals:

a. **Fisheries Biologist** holding at least a master's degree in Fisheries Sciences or Fisheries Evaluation. This person will hold the position of scientific director and be responsible for designing and directing the plan's scientific program. He or she will be supported by the rest of the scientific team and other INCOPESCA departments, and report to the management plan director.

b. **Marine or Fisheries Biologist** holding at least a master's degree and with knowledge and experience in managing on-board observer programs.

c. **Geographer or professional** with experience and knowledge of geographic information systems (GIS), holding at least a secondary degree (licenciatura).

d. **Fisheries Statistician,** holding at least a secondary degree (licenciatura).

e. **Economist,** holding at least a secondary degree (licenciatura), with experience in and knowledge of the economic evaluation of fisheries.

f. **Sociologist or Anthropologist,** holding at least a secondary degree (licenciatura), and with experience and knowledge of fisheries and work in coastal communities.

3. *Governance commission*

This is the body in which different fisheries stakeholders will participate in receiving feedback on the plan's progress, including technical, scientific and administrative details, and in facilitating links by coordinating and communicating with the fleets covered by the plan and other partners. The governance commission is to make recommendations to the plan's director who will be responsible for their review and provide a reply, communicating the results of queries to INCOPESCA's chief executive officer.

It will comprise:

1. The management plan director who will preside over the body as technical secretary and coordinator.
2. The scientific director of the management plan.
3. A representative of longline fisheries organizations that include medium and advanced longline fleets within their membership.
4. A representative of FENAPES.
5. A representative of non-governmental organizations (NGOs) with experience and legitimate and proven interests in the issue of national tuna fisheries management and conservation.

4. *Communications and outreach system*

The director of the management plan, in coordination with the scientific team and the governance commission, will keep files of all measures and agreements relating to the plan, as well as of technical and scientific reports, including general reports for the public.

All this information will be placed on a website that will serve as the main channel of communication with users of the plan and the general public. The information uploaded onto the website will have the prior approval of the scientific director and the governance commission, and should have the final approval of INCOPESCA's chief executive officer.

## Plan policies

This management plan will be aligned with the policies, objectives, strategies, goals or regulations of the following instruments or bodies:

1. Fisheries law (Law n.º 8436, Gaceta n.º 78, 25 April 2005).
2. National Fisheries and Aquaculture Development Plan (Executive Decree 37587-MAG, Gaceta n.º 119, Friday, 21 June 2013).
3. National Marine Commission (CONAMAR) (Executive Decree 37212-MINAET-MAG-SP-MOPT, Gaceta n.º 149, 3 August 2012).
4. IATTC resolutions.
5. Other norms and regulations issued through INCOPESCA laws, decrees or agreements that could be directly related to the implementation of this management plan.

## Description of the fisheries

### *Historical development and evolution*

In this area, the scientific team will keep a documented record of the historical development of tuna fishing by both national fleets and those flying international flags that use tuna purse-seine vessels, through requests for and the granting of tuna fishing licenses, and that are covered by this plan's norms and regulations.

The first historical description will be prepared during the plan's first year of implementation and will serve as the baseline for subsequent comparisons.

### *Fleet characteristics and their production*

The scientific team will keep a register of vessels that are covered by the plan and its regulations and norms, and keep a record of their fish production and other related information.

This vessel register will include both the national advanced and medium artisanal fleet, as well as tuna purse-seine vessels flying international flags fishing in Costa Rica's EEZ, according to the conditions defined in this plan. An up-to-date register will be kept for each vessels including at least:

1. Vessel name
2. Vessel characteristics such as length, hold capacity in cubic meters, authorized fishing equipment and gear, product conservation technology, authorized autonomy, engine characteristics and fuel storage capacity, communications equipment, probes, sonar, radar, global positioning system (GPS) equipment
3. International Maritime Organization (IMO) ship identification number
4. Satellite monitoring system

5. Number of fishing logbook
6. Vessel registration
7. Data of the vessel owner or vessel company
8. Name of captain
9. Number of crew members
10. Home port and landing ports
11. License type and period of validity

**Current regulations relating to tuna**

The management plan director and the governance commission will keep an updated list of existing regulations relating to the fishing of tuna and the environmental or conservation norms or regulations that could be directly related to the implementation of the plan, and that should be complied with by fleets that operate under the plan. These regulations will also be published on the website to be used as part of the plan's communications and outreach system.

These will include at least:

1. Resolutions and agreements adopted by IATTC to be observed by fleets that fish under the plan.
2. Fisheries Law (Law n.º 8436, Gaceta No. 78 of 25 April 2005).
3. National Fisheries and Aquaculture Development Plan (Executive Decree 37587-MAG, Gaceta n.º 119, Friday, 21 June 2013).
4. Policies and agreements of the National Marine Commission (CONAMAR) (Executive Decree 37212-MINAET-MAG-SP-MOPT, Gaceta n.º 149, 3 August 2012).
5. Other norms and regulations issued through INCOPESCA laws, decrees or agreements that could have direct applicability to the implementation of this management plan.

**Objectives**

Four groups of objectives are defined in this management plan covering fisheries, economic, ecological and social objectives to be met through the adoption of management measures and regulations.

**Fisheries objectives**

1. After three years from approval and the start of the management plan, tuna fisheries will be equitably distributed for sustainable use between national advanced and medium-sized artisanal fleets, competition for their use from tuna purse-seine fleets will have been reduced, and an increase achieved in catch per unit effort in fisheries operations of the national fleets, promoting the specialization of fleets in tuna fishing.

2. After two years of the plan's implementation, a positive balance will have been achieved between the tuna catches in Costa Rica's Pacific EEZ between national fleets and international tuna purse-seiners that fish with tuna fishing licenses under this plan, and thus ensure improved supply of national tuna for the fresh and frozen tuna markets from national fleet catches, while the country improves its control and management of bycatch mortalities due to tuna fishing by tuna purse-seine fleets.
3. After one year of the plan's implementation, the tuna fishery in Costa Rica's Pacific EEZ is developed according to control and monitoring standards and regulations within a framework of sustainability and responsibility in such a manner as to actively avoid activities that are typified as, or involve fleets or the country in illegal, unreported and unregulated fishing.
4. After three years of the plan's implementation, INCOPESCA has sufficient criteria to design and promote a national policy on the distribution and management of tuna fisheries that optimizes their sustainable use by national fleets and enables contribution to the development of a coherent management scheme for the promotion and defense of national interests in EPO tuna fisheries through Costa Rica's participation in the Inter-American Tropical Tuna Commission.

**Economic objectives**

1. After two years of the plan's implementation, advanced and medium artisanal fishing fleets register an improvement in the economic viability of their fishing activities.
2. After two years of the plan's implementation, improvements are registered in fishers' incomes and in the redistribution of fisheries' earnings within coastal communities.

**Ecological objectives**

1. After two years of the plan's implementation, national fleets are operating and making use of fishing methods and strategies that reduce catches of the non-target species described in this plan.
2. After three years of the plan's implementation, fishing gear that improves selectivity in tuna catches and reduces bycatch of non-target species has been tested through fishing experiments, and management recommendations have been made for their adoption and regulation in fisheries regulated by the plan.
3. After three years of the plan's implementation, information has been collected on the interactions of the fisheries with non-target species, so as to consider the design and implementation of spatial/temporal management measures of these species in sites or periods when the interactions are considered critical or highly problematic for resolution through other methods.

**Social objectives**

1. After three years of the plan's implementation, direct jobs in fisheries have been consolidated making them permanent and involving better salaries and improved livelihoods within the fisheries sector.

2. After three years of the plan's implementation, an improvement in the quality of life of fishers' families and the self-esteem of fishers and their families is documented.
3. After three years of the plan's implementation, improvements in the perception of the Costa Rican society regarding tuna fisheries are documented, and an improved coordination and collaboration of the fishery with the environmental sector, within the framework of CONAMAR, is achieved.

## Goals

*Interim or transitory (work plan) goals*

The plan's implementation requires the establishment of a series of interim or transitory goals that will help create the necessary conditions for the implementation and operation of the plan. A list of goals to help achieve these conditions follows:

1. Within the first month of the plan's approval, INCOPESCA's chief executive officer will have selected and nominated the management plan director.
2. Within the first month of the plan's approval, the scientific team has been selected and nominated, and the plan's governance commission has started operating.
3. Within the second month of the plan's approval, a strategic planning workshop has taken place, and the objectives, strategies, goals and activities have been incorporated in operational plans for each year of the plan's duration, including the respective budgets.
4. Within the third month of the plan's approval, the on-board observer program has been established and started functioning to provide a service to the plan.
5. Within the second month of the plan's approval, the list of vessels from the national fleet that will participate in and be subject to the measures and regulations of the plan will have been drawn up, and these vessels will form the basis of the plan's register of tuna vessels.
6. Within the third month of the plan's approval, the scientific team will have prepared the research plans as well as the protocols for the collection of fisheries information by on-board observers and through controls at landing ports, fishing logbooks will have been produced, and protocols for the quality control of data designed, and databases for their storage and analysis developed.
7. Within the fourth month of the plan's approval, the management plan's information and outreach system will have been designed and started operating, and all documents produced to date and those to be produced in the future, will be made available to the public.
8. Within six months of the plan's approval, a mechanism to carry out annual internal and external audits of the plan together with a mechanism to incorporate recommendations emanating from these, will have been agreed upon.
9. Within the third month of the plan's approval, a financing mechanism that includes contributions from the State, through INCOPESCA's ordinary budgets, as well as contributions from the private sector both in kind as well as through economic resources, will have been identified. This financing mechanism will become operational in the fourth month of the plan's approval.

*Strategic planning goals of the National Fisheries and Aquaculture Development Plan*

This management plan must incorporate important fisheries management elements that are among the PNDPA's strategies and goals, and specifically those to be implemented within the plan's first five years, involving the structural areas of research, institutional strengthening, management and ocean fisheries management, as defined in that document.

In the area of research, this management plan contributes to PNDPA objective C (Management) that proposes the country be able to count on the scientific basis for the management of fisheries and aquaculture resources with an ecosystem focus. The following goals will be incorporated:

1. Design of databases to produce national statistics based on scientific and technical parameters (PNDPA research goal 1.9 for year 3).
2. Implementation of fishing logbooks (PNDPA research goal 1.10 for year 3).
3. Implementation of the National On-board Observer Program (PNDPA research goal 1.11 for year 2).
4. Implementation of the National Port Landings Control Program (PNDPA research goal 1.12 for year 2).
5. Implementation of the National Satellite Tracking Program of vessels of 18 m and over (PNDPA research goal 1.13 for year 3).
6. Evaluation of pelagic resources to ascertain the need to establish fishing quotas or percentages for sport fishing and carry out a cost-benefit analysis including other sectors (PNDPA research goal 1.15 for year 3).
7. Socio-economic monitoring of fisheries, considering levels of occupation and direct employment and associated activities and potential for diversification (PNDPA research goal 1.17 for year 3).
8. Operation and functioning of a program to collect and process information produced by the On-board Observer Program, the satellite tracking program, fishing logbooks, controls of fish landings, and socio-economic monitoring (PNDPA research goal 1.19 for year 2).
9. Implementation of a research program into fishing methods and gear aimed at sustainable resource use and reducing bycatch and the ecological impact of fisheries (PNDPA research goal 1.27 for year 4).

Regarding PNDPA objective B (Institutional Strengthening) this management plan contributes to development of strategy 5 involving the establishment of monitoring and control mechanisms to ensure appropriate accountability. It also contributes to achievement of the following goals:

1. Follow-up and implementation of the PNDPA regarding tuna fishing, as responsibilities of INCOPESCA's chief executive officer and CONAMAR's Technical Secretariat (PNDPA institutional strengthening goal 5.1 for year 1).
2. Formalization of the inter-institutional coordination processes in the implementation of the PNDPA (PNDPA institutional strengthening goal 5.2 for year 2).

Regarding PNDPA objective C (Management), this management plan contributes to development of strategy 10 by seeking the implementation of a Uniform System of Traceability, the goal of which is to formalize this system via executive decree (PNDPA management goal 10.1 for year 3).

In oceanic fishing, this management plan makes an important contribution to strategy 3 of PNDPA objective D (International Management), that seeks to implement agreements or resolutions adopted by IATTC, and other sub-regional fisheries organizations such as OSPESCA at the national level, and that these be applicable to national fleets fishing for tuna and other similar species. It specifically contributes to meeting the goal of drawing up legislation that requires tuna fishing vessels to comply with the country's commitments in different areas, including IUU fishing, the corresponding satellite tracking, catch and landing data, as well as the On-board Observer Program (PNDPA operational area, oceanic fishing [objective A] goal 3.3 for year 3).

Again within the PNDPA oceanic fishing areas, this management plan contributes to strategy 4 that promotes rational use among different countries that share tuna resources in the EPO through harmonious mechanisms for use on which agreement has been reached, access and control in this region. In this sense, this proposal directly contributes to the goal of approving a mechanism for the establishment of quotas and their respective distribution among different fisheries sectors, including semi-industrial fisheries, longline fisheries, trolling, sport, tourist and artisanal fishing (PNDPA operational area, oceanic fishing [objective A] goal 4.3 for year 5).

Finally, the proposal establishes an important starting point to ensure development of the PNDPA oceanic fishing strategy 5 that proposes a zoning of the EEZ to ensure the responsible use of fisheries based on Marine Areas for Responsible Fisheries. This proposal directly contributes to meeting three of the goals of this strategy:

1. The definition of target fish in concrete EEZ areas, in line with an ecosystem focus and management criteria (PNDPA operational area, oceanic fishing [objective A] goal 5.1 for year 2).
2. The identification of areas or zones apt for management and the definition of fisheries management plans for each one within the EEZ (PNDPA operational area, oceanic fishing [objective A] goal 5.2 for year 4).
3. Marine Areas for Responsible Fisheries are implemented and the permanent monitoring of the management plans are being carried out (PNDPA operational area, oceanic fishing [objective A] goal 5.3 for year 1).

## Management strategies

The management plan's scientific team will prepare an integral, ecosystem-focused management strategy. This strategy will included, at least, the following elements:

### *Total allowable catch*

Given that tuna fisheries management of Costa Rica's Pacific EEZ is part of the EPO tuna fishery, management should take place within the framework of IATTC, of which Costa Rica is a founder member, to ensure that tuna populations and the fishing effort remain within maximum sustainable yield (MSY) limits.

However, an alternative management of tuna within EEZ waters can be based on a reduction of the ecological impacts of the fishery, seeking a practical and viable means to reduce the bycatch of non-target species, particularly those under special conservation régimes, such as marine turtles, shark species covered by IATTC resolutions, or the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), or species of interest to the sport, tourism, or recreational fishing industries.

To this end, the plan's the scientific team will prepare management recommendations that are to be made available to, discussed, and adopted by the tuna fleets that participate in the plan, and that will establish maximum catch limits of non-target species, and recommend actions to be taken once these limits are reached. In addition, at least the following measures are to be adopted:

1. Measures to reduce the bycatch and death of turtles associated with the fisheries. These measure will include at least:
    a. Training and certification of captains and crews in the correct rescue, handling and releasing of turtles, and their respective registry in the fishing logbooks.
    b. The use of equipment to free turtles, such as de-hookers, muzzles, cable cutters, leaders or nets with rings to hoist turtles and bring them on board.
    c. The use of circular, non-swivel hooks size 16/0 and over and the banning of J hooks.
    d. Reduce the use of squid as bait to a minimum and promote the use of fish instead.
    e. The exclusive use monofilament line for the mother line and for the leaders or branch lines, with the use of polypropylene or rope to construct the longline being prohibited.

2. Measures to reduce the bycatch of sharks. These measure are to be included:
    a. Training and certification of captains and crews in the correct rescue, handling and releasing of sharks, and their respective registry in the fishing logbooks.
    b. The obligatory use of equipment to free sharks such as line or cable cutters, and long pole de-hookers.
    c. Prohibit the use of steel or metallic cable leaders.
    d. Prohibit night fishing.

3. Measures to reduce the bycatch of sailfish:
    a. Exclusive use of circular 16/0 hooks and above, without swivel.
    b. Training and certification of captains and crews in the correct handling and releasing of sailfish, and their respective registry in the fishing logbooks.
    c. Prohibit the use of steel or metallic cable leaders.
    d. Prohibit the use of live bait on longlines.

*Biological reference points*

The biological reference points (BRP) for yellowfin tuna fishing will be the same as those used by IATTC, and tuna fishing in Costa Rica's Pacific EEZ will contribute by providing information on fishing effort and catches in the annual reports on fisheries that the country has to present to this commission.

Likewise, those BRPs used by IATTC for secondary target species, non-target species or bycatch will also be used. The information on fishing effort and catches will also be sent to IATTC as part of the annual reports of fishing in Costa Rica's Pacific exclusive economic zone.

Nonetheless, the plan's scientific team will carry out evaluations of fisheries to determine the existence of patterns in fishery dynamics that should be taken into account in estimating BRPs, and should develop limit reference points or local target reference points.

*Spatial-temporal management*

The scientific team can establish management measures of a spatial or temporal nature, or both, in complying with the plan's objectives and goals. It will specifically seek to establish the convenience of taking these measures to reduce the interaction with fisheries' non-target species.

Likewise, for this plan, regulations defined for the management of Marine Protected Areas (MPA) in Costa Rica's Pacific EEZ will be respected.

*Requirements for participation*

Medium and advanced national artisanal fleets are to comply with a series of requirements in order to gain access to tuna fishing under this plan. These requirements include the holding of all necessary operational permits, as defined in the corresponding legislation.

Additionally:

1. All vessels should comply with the dispositions, and management and conservation measures established in and as part of this management plan, and be subject to compliance with general norms relating to fleets.
2. All vessels should keep a fishing logbook at all times and record in it all information on fishing operations therein stipulated, including, among other things: the fishing goal of the trip, the equipment and operational cost of the vessel at time of setting sail, the positions of the sets, including the beginning and end of each one, catches by species, the purpose of the catch, quantities landed by species in the port of arrival, and the name of the captain and the crew, as well as other important information regarding the trip. At the time of arrival, the captain will hand over a copy of the fishing logbook to the official responsible for controlling landings in port, and will clarify any queries, detail or inconsistency that is necessary prior to processing information from the log.

3. If the vessel is over 18 meters in length, it should carry a tracking device compatible with the satellite tracking equipment currently used by INCOPESCA. Vessels that do not yet have this equipment will have until June 2016 to have it installed and functioning.
4. Every vessel must be willing to receive an observer on board on one or more fishing trips, as stipulated by the management plan's scientific team. The vessel owner, the captain and the crew will collaborate with the observer in all tasks that he or she has to undertake, and will facilitate information requested in the forms and protocols to be completed by the observer. This includes information on the position of the set and other important information on the fishing trip. If the trip has been selected for a fishing experiment, the vessel owner, the captain and the crew will collaborate with the observer to ensure the conditions required for the carrying out of the experiment. However, the work of the observer and the experiments must not cause delays or unnecessarily hamper fishing operations. The vessel owner, the captain and the crew must, at all times, respect the personal, moral, and physical integrity of the observer. The on-board observer program will start functioning as soon as it has been established and personnel recruited.

*Adaptive management – the response of fisheries management*

The plan's scientific team will prepare an annual report on the management plan's implementation, as well as results of the fishing year and progress in meeting the plan's objectives, goals and activities. This report will be reviewed by the director and the governance committee, that will make the necessary changes, adjustments or modifications to the plan as they consider appropriate.

Each change will be documented, and feedback from the fishery on management measures will also be documented, studied and reported in the next report so that INCOPESCA and the fishery users have the best information available for decision-making and directing the fishery towards their goals.

*Sanctions*

The plan's compliance with national fisheries norms and regulations is obligatory, as is compliance with management and conservation measures and other dispositions stipulated in this plan.

Offences and violations of the plan's norms, measures and dispositions of this plan will be sanctioned according to national regulations in this area. Likewise, violations of related laws concerning the environment, biodiversity, national security, or others important in the plan's implementation, shall be considered as violations of the plan and sanctioned as established by law.

*Monitoring I*

A core task of the plan involves monitoring its implementation and results in the fishery and will be jointly assumed by the plan's director and the scientific team. The performance report will be prepared on an annual basis.

*Plan performance indicators*

A series of performance indicators with their respective definitions will be designed, and details drawn up

on how to measure and collect information relating to the indicator, the analysis method and interpretation. Annual values that are obtained from these indicators will be included in the plan's annual report.

*Fishery monitoring and follow-up methods*

The fishery monitoring and follow-up methods will be based on five sources of information on the fishery.

i. On-board observers

The on-board observer program will collect important information on the fishery, particularly on details of fishing effort, fishing gear and technology used, catches made and the purpose of the catch. Information on fishing experiments and important data for research projects underway will also be collected.

ii. Satellite tracking system

Information from the satellite tracking system will provide invaluable information on fishing zones, the position and duration of sets, and zone productivity. It will also enable the crosschecking of information with other environmental or oceanographic variables for the carrying out of research projects.

Tracking of fishing operations of vessels and avoiding fishing in prohibited areas, such as marine protected areas or spatially or temporarily closed areas, will also be possible; and captains can be warned if they are in restricted zones or in other territorial waters.

iii. Fishing logs

Fishing logbooks will constitute official documents supplied by INCOPESCA and will be made of water-resistant paper and have numbered pages with two copies. The fisheries institute, together with the plan director and the scientific team will establish the information required and the variables to be completed by the captain before, during and on termination of each fishing trip. This information will be considered as the main source of data directly from the vessel and its captain. The information on each trip will be reviewed by a port official in charge of landings, and will be modified if necessary in consultation with the captain. Information on the cost of the fishing trip and the value of product sales in port will also be recorded.

iv. Controls in port

Controls of catch landings will be carried out in port. A team of inspectors will carry out an inventory and controls of the landings of the fishing trip and that remaining in the hold. The information collected in port controls should coincide with information in the fishing logbook, as well as with information from the on-board observers, should the vessel have had an observer.

v. Research and evaluation of fisheries

Evaluations of fisheries will be made, and a performance review carried out of the management measures, as well as the results of catches and the respective economic analyses, on the basis of information collected, so as to measure fulfillment of the plan's objectives and goals.

Specific research will also be carried out of fisheries, such as on reproductive biology, the food resource of target and non-target species, effectiveness and selectivity analyses of fishing gear, as well as of bycatch analyses.

*Information collected by on-board IATTC observers*

Information collected by the IATTC's on-board observer program on tuna purse-seine vessels with tuna licenses in Costa Rica's Pacific EEZ will be requested. This information will enable a quantification of tuna catches by purse-seine vessels and a comparison with catches of national longliner vessels, as well as the establishment of comparative patterns in the production of tuna fisheries with the rest of the eastern Pacific ocean.

**Research**

*Research areas*

The plan's scientific team will prepare a research program that includes the following areas:

1. Fisheries evaluation
2. Bycatch
3. Fishing technologies and gear
4. Zoning and distribution of the resource between fisheries sectors: advanced and medium artisanal fishing, purse-seine tuna fishing, sport, tourist and recreational fishing, and spatial/temporal management
5. Economic performance of fisheries
6. Social impact of fisheries.

*Databases*

All the information resulting from research projects as well as fisheries data, including that emanating from fishing logbooks, on-board observers, fishing experiments, the satellite tracking system and controls in port, will be subjected to strict quality controls. Once the information from each fishing trip or research project has been reviewed, data will be uploaded into the specifically designed database.

*Research reports*

Research reports will be drawn up for each research area. Research reports will be prepared according to scientific editorial norms of the University of Costa Rica's *Revista de Biología Tropical*. As a research document, each report will be given a unique number. These reports will be included in the management plan's annual report.

*Collaboration with academic research bodies*

The plan's research team will be able to establish joint research projects with research centers and institutes of state and private, national or international universities. It will also be able to establish joint research programs with non-governmental organizations with legitimate interests in the plan fulfilling its objectives and goals and that contribute to sustainable tuna fisheries.

Joint research programs will be sought on issues of interest to the plan or related issues that are complementary and necessary for the fulfillment of the plan's objectives.

**Financing**

A coordinated effort between the plan's director, its scientific team and the governance commission will involve the preparation of a detailed budget of the plan's operational costs.

Likewise, a financing mechanism will be identified that includes contributions to the plan from the State, via INCOPESCA ordinary budgets, and from the private sector, both in kind and in direct economic resources. An effort will be made to identify budgetary shortfalls and prepare a fund-raising strategy.

The plan's director will hold responsibility for the fund-raising process. The financing mechanism will be set in motion within four months of the plan's approval.

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