and Conservation

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ABSTRACT

Divers in the San Andres Archipelago have been fishing in the last 20 years, but their operations have significantly expanded during last five years. This fishing technique has changing through time mostly in number of divers, fishing trips and fishing gears, accounting for a net increase in fishing effort. Diving techniques promote the use of scuba gears (including hookahs) and the spear guns which are of common use, even artesanal fishers are presently using these autonomous techniques which in the past were associated only to illegal industrial operations. However, there are many other aspects that divers are influencing the fishery in the Archipelago. Aspects related to use of new and shallower fishing areas, which contain higher percentage of corals contributing to greater impacts to benthic habitats. Similarly, new target species including spiny lobsters, groupers and snappers (potentially during reproductive season) or juvenile queen conch are of divers interest including sea turtles. Divers not following safety operations are suffering health problems, as had been reported for the region in the past. Perhaps, one of the most important effects of divers in the archipelago is related to the socio-cultural influences on island's customs, since majority of them came from Colombia's continent or are foreign. Conflicts between divers and line or trap fishermen are increasing, because there are believed to be responsible for the significantly reduction of demersal fish production. This paper discuss all the aspects described above and provide important considerations for the fisheries management and the definition of the MPA's management plan which is being elaborated in this moment.

KEY WORDS: Diver fishery, San Andres archipelago, effects of diving

Efectos de la Pesqueria con Buzos en el Archipielago de San Andres: Consideraciones hacia el Manejo Pesquero y la Conservacion

Los buzos en el Archipiélago de San Andrés han estado pescando durante los últimos 20 años, pero sus operaciones se han expandido significativamente

en los últimos cinco. Esta técnica de pesca ha cambiado a través del tiempo principalmente el número de buzos y características de los botes, generando un incremento neto del esfuerzo pesquero. En las operaciones industriales, las embarcaciones han cambiado el sistema de propulsión y en las artesanales el nivel de autonomía. El buceo promueve el uso de equipos autónomos (incluyendo compresores) y del arpón los cuales son usados comúnmente, incluso pescadores artesanales están usando estas técnicas autónomas ilegales las cuales en el pasado estaban asociadas sólo a operaciones industriales. Sin embargo, hay otros aspectos en los que buzos están influyendo en las pesquerías del Archipiélago, tales como el uso de nuevas áreas de pesca que por lo general son más someras y tienen mayores porcentajes de coral, lo que aumenta los impactos en los hábitats bénticos. Igualmente, hay nuevas especies objetivo incluyendo langostas espinosas, chernas y pargos (potencialmente durante temporada reproductiva) o juveniles de caracol reina son de interés de los buzos. La captura acompañante de esta pesquería industrial que no ha sido todavía documentada afecta especies protegidas (tortugas) y peces arrecífales no comerciales, pero de importante valor ecológico. Los buzos no siguen normas de seguridad y sufren problemas de salud, como ha sido reportado para la región en el pasado. Talvez, uno de los efectos más importantes de buzos en el Archipiélago esta relacionado con influencias socio – culturales sobre las costumbres nativas, dado que la mayoría de estos vienen del continente colombiano o del extranjero. Conflictos entre buzos y pescadores de línea o nasas se están incrementando, ya que los creen responsables de la reducción significativa de la producción de peces demersales. Este artículo discute todos los aspectos descritos anteriormente y provee consideraciones importantes para el manejo de las pesquerías y la definición del plan de manejo de las AMP's que se esta elaborando actualmente.

PALABRAS CLAVES: Pesquería de buzos, Archipiélago San Andrés, efectos del buceo

INTRODUCTION

Divers in the San Andres Archipelago have been fishing in the last 20 years, but their operations have significantly expanded during the last five years. This fishing technique has changed through time mostly in number of divers, fishing trips and fishing gears, accounting for a net increase in fishing effort. Diving techniques promote the use of scuba gears (including hookahs) and spear guns which are commonly used; even artesanal fishers are presently using these autonomous techniques which in the past were associated only with illegal industrial operations.

The objective of this paper is to discuss all aspects related to operations of the diving fishery, base on three main issues — fishery aspects, socio-cultural conflicts and environmental concerns. It will focus more on industrial level fishing, which has the greatest impact, but also includes qualitative information of artesanal operations. Their presence on the islands and their effects will be of critical concern now that extensive areas of the archipelago have been

declared as a system of multiple use marine protected areas, which are also within the Seaflower Biosphere reserve.

STUDY AREA

This study refers to the participation of divers in the San Andres archipelago, which is composed by al least eight isolated shelves (atolls), which are fished at industrial as well as artesanal levels. San Andes (SAI), East-south-east (ESE), South-south-west (SSW) and Providence (PVA) are traditionally fishing grounds for artesanal fishermen located in the south or mid-archipelago's areas. In addition, larger areas located at north and including a section of the Nicaraguan rise, Quitasueño, Serrana, Roncador, Serranilla, and Alice and New banks are fished at industrial levels. These reef complexes are characterized by a well developed coral reef, which are being recognized as important fishing grounds in the context of the western Caribbean.

METHODS

Three different aspects were considered when analyzing the effects of divers in the archipelago's lobster and conch fisheries. The first one reviewed the growing participation of divers in the lobster fishery following restrictions imposed on the conch fishery due to reduction of its global quota. The effects were characterized in terms of catch and effort data. Catch data on lobster and conch resulting from the diving fishery was obtained from a recent diagnostic elaborated with the participation of all stakeholders involved directly or indirectly with fisheries management (Prada 2004). Effort data included information on number of divers, duration of the trips, description of the boat and the fishing gear used; additional information resulted from interviews and existing reports on inspections done immediately after boat arrival by the Fisheries and Agriculture Department.

The second aspect analyzed the socio-economic context of the divers living/working the archipelago. Information to this regard evaluated peoples' origin, conflicts among fishers and with the local community, as well as the occurrence of decompression sickness.

The third aspect considered the ecological and biological impacts of divers, and examined the use of fishing habitats, changes in size and weight of lobsters, trends in CPUE during reproductive season, and finally reviewed the potential of divers capturing protected species. Using Arc View Vs.3.2, spatial analysis were conducted to determining habitats fished by divers using existing maps (Diaz et al. 2000) and positions of a single canoe participating in an industrial conch trip (a fishing boat regularly takes 10 - 12 canoes) during 12 effective days of fishing. On a broad scale, fishers identified conch sites by abundance within a social cartography process, and habitat information was also obtained from existing maps (Diaz et al. 2000). By the other hand, changes in size (weight) were obtained from the fishery diagnostic (Prada 2004). Undersize extractions of lobsters and conchs were included for the last four months in 2004. Finally, catches of protected species are referred to only qualitatively from observers.

RESULTS

Fishery Aspects

Traps utilized at industrial levels are the main fishing method in San Andres archipelago, although divers in the lobster fishery became important in the last five years. Divers working in industrial operations utilize a main boat for transportation and small canoes once they reach the fishing area. Each canoe fishes approximately five to six miles from the main boat, and carries onboard two to three divers. Each boat takes a total of 9-12 canoes. Landings from divers accounted for only 9.9% of total catches in 1998 but increased to 46.3% in 2003 (Figure 1). This increase is the result of divers shifting from the conch to the lobster fishery as a consequence of the significant reduction in conch quota (53%). Therefore, fishing effort presented a net increase mostly because more fishing trips were being conducted. Duration of the trips, the number of divers and number of boats have remained similar (Table 1). However, because an undetermined proportion of the divers are using hookahs, calculation of fishing effort is subject to error, resulting in a positive trend seen in the mean values of CPUE of lobsters for divers, due to underestimation of the fishing effort (Figure 2).

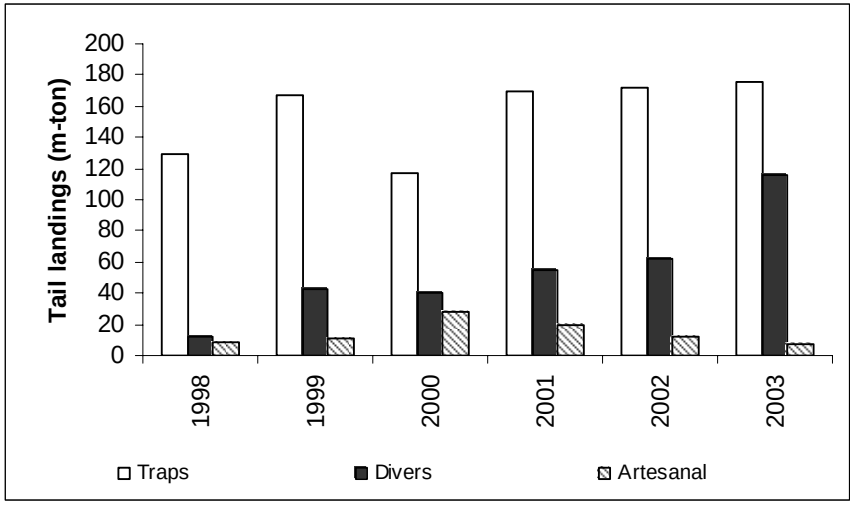

Figure 1. Industrial landings of spiny lobster in the San Andres Archipelago by fishing technique, showing a net increase in landings from divers.

Table 1. Characteristics of the industrial fishing effort of spiny lobster fishery in the San Andres Archipelago by fishing technique.

Year	No. fishing trips		Mean No. days		Mean No. divers
	divers	traps	divers	traps	
1998	26	66	20	54	19
1999	47	99	28	52	19
2000	57	83	25	32	19
2001	82	134	25	44	17
2002	80	116	28	54	18
2003	50	160	23	43	25

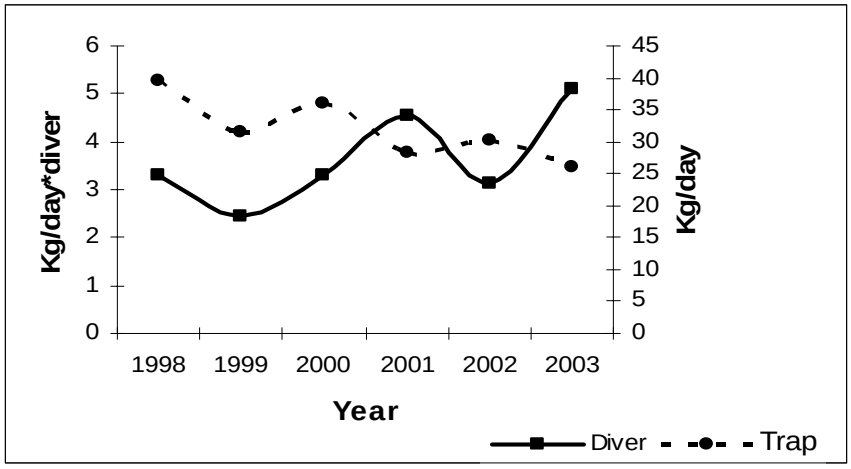

Figure 2. Catch per unit effort in the industrial spiny lobster fishery in the San Andres by fishing technique. Increase CPUE for divers respond to new fishing areas and increase in number of trips.

It is not possible to conduct a similar analysis for the participation of divers at artesanal levels, because there are not trips exclusively for them, but a combination of fishing techniques and gears. Medina (2003) in PVA reported that at least 40% of the time of the artesanal trips is dedicated to diving. On average, there are 25 artesanal boats in SAI and probably a similar number in PVA that spend more time in diving. It is known, that around 30 fishermen in PVA are regularly utilizing scuba tanks fishing for lobster, even though this is an illegal practice. The use of scuba tanks for SAI divers is rare, however there have been complaints about the use of hookahs by artesanal fishermen on both reefs.

On the other hand, significantly reductions in landings of the queen conch fishery have resulted from more than 20 years of divers operations, fishing

with or without autonomous equipment. Present trends respond mainly to global quota established in 1997 at 200 metric tons but reduced to 96 tons in 2001 (Figure 3). In general, landings have exceeded the quota due to illegal fishing, lack of enforcement, and capture of sub-adults individuals, which in conjunction also put this fishery at serious risk. Additionally, the new trade for conch pearls is targeting mostly juvenile conchs, thereby increasing the illegal harvest of these already reduced stocks.

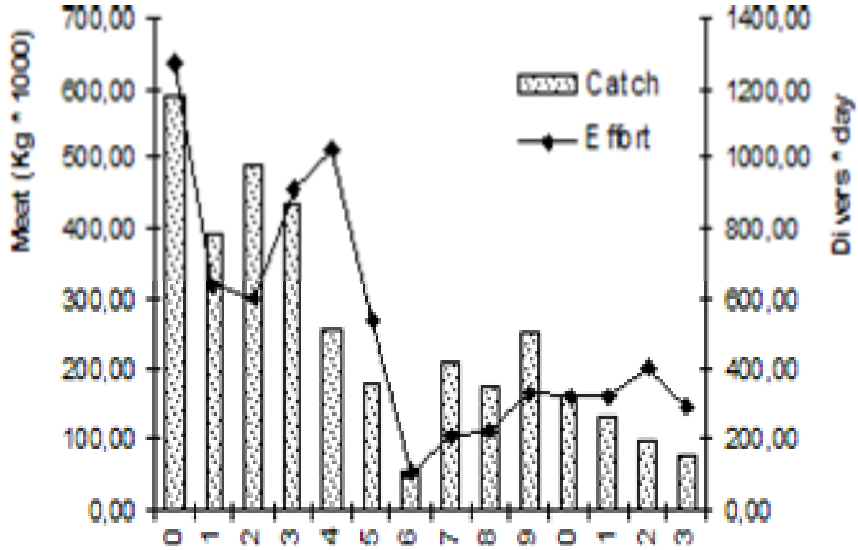

Figure 3. Catch per unit effort in the industrial spiny lobster fishery in the San Andres by fishing technique. Increase CPUE for divers respond to new fishing areas and increase in number of trips.

Socio-Economical Conflicts

Socio-economical issues related to the presence of divers in the archipelago's fisheries began considering their origin. Most divers fishing at industrial levels are not islanders (Figure 4). Indeed, during the 2004 season, the majority of them were Colombians (69%) from Cartagena and Rincón, who in general, are not legal residents to the islands. In addition, divers from the Dominican Republic and Honduras are participating in this fishery (22%).

The low enrollment of native people in this activity is unexpected considering the high unemployment rates (around 40%), and perhaps explained by several factors. On one hand, local fishermen are not willing to stay long and frequent periods of time at sea (artesanal fishing trips last not more than eight days). On the other hand, most local fishermen and seamen explain their low participation based on low salaries and lack of social security. Another factor is the minimal accommodation conditions; fishing boats do not have sufficient space to hold comfortably that many divers, hygienic conditions are minimal, and there is a need for space to store canoes (and illegal air compressors).

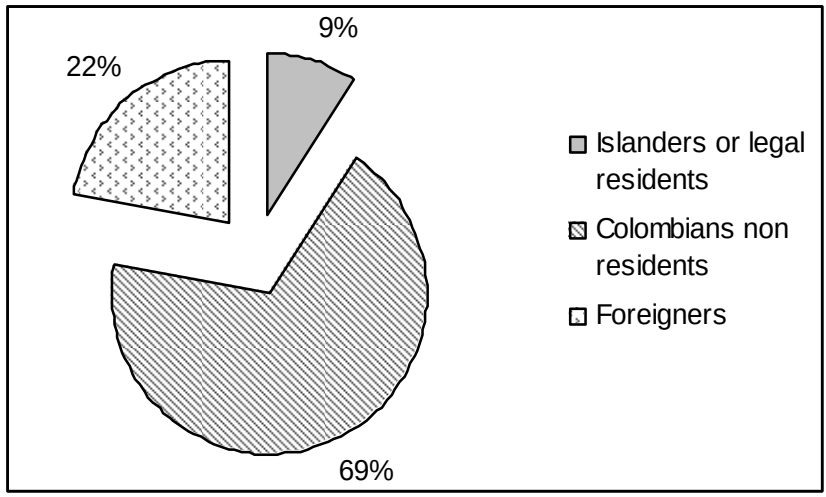

Figure 4. Origin of the legal divers fishing at industrial levels spiny lobsters and queen conch in the San Andres Archipelago.

Colombian divers are being asked to have a legal residence in the islands to work as fishermen since 2001. However, the office that controls the residence does not have efficient mechanisms to guarantee that people leave the islands once their temporary permit has expired, thus they become illegal residents. Usually, they bring their families with them, making the present overpopulation problem in SAI even worse.

Conflicts between non-resident divers and San Andres fishermen are increasing because if the boat stays in port for several weeks, they go out and fish in the traditional fishing areas using scuba gears. Trap fishermen have complained that divers working on industrial boats empty their traps. Other conflicts have emerged because non-resident divers spend most of their time in port around a traditional zone to the artesanal fishers, which is also a residential area. Therefore, the residential community is being degraded through increasing alcohol consumption, declining security, excess noise, and even prostitution.

The introduction of autonomous scuba gear by non-resident divers, including hookahs, is becoming more commonly used in artesanal operations. The Fishery and Agriculture Department confiscated two air compressors and one set of scuba gear from two industrial fishing boats between 2000 and 2004. In addition, two illegal conch vessels from the Dominican Republic and Honduras were captured with scuba gear onboard. Nevertheless, it is suspected that hookahs are widely used because there are insufficient enforcement resources in distant and isolated fishing areas. It is estimationed that around 25 to 50% of the licensed boats use hookahs frequently or at least have used them sometime during last two years.

However, given the vicinity of the Archipielago's fishing areas to Nicaragua and Honduras, the probability of illegal fishing by miskitos divers is

high. It is possible that around 5,000 miskito divers fish in the region, and approximately 10% of them fish frequently and illegally within Colombian waters (around Quitasueño, Serranilla, and the Nicaraguan rise). This number doubles the number of legal divers in the area (maximum 250 people). Thus, an international legal framework and enforcement is in need.

Finally, the presence of divers using autonomous equipment is affecting their health. In the islands, not much information is available concerning deaths or injuries caused by decompression sickness. Fishermen mentioned that at least four people were severely injured from decompression sickness, and probably three persons have died because of that in the period of five year. Nevertheless, the majority of non-resident fishers suffering from decompression sickness are not recorded because they are transported to the mainland Just recently, one artesanal fishermen from PVA was at risk of being paralyzed due to unsafe diving.

Safety does not refer only to frequency of diving and bottom times, but also to the lack of equipment maintenance, which may result in interruption of air supply with dramatic consequences. Frequently, divers utilize homemade gear which are not designed be in compliance with safety procedures. Decompression sickness in the Islands is a critical concern for divers since fishing areas are distant from hyperbaric chambers, and the one located in SAI is not working properly.

ENVIRONMENTAL CONCERNS

Habitat Aspects

Despite the absence of habitat maps for most fished areas located deep and far northern in the archipelago, habitat considerations regarding the impact of divers were estimated for both lobster and conch fisheries. Based on data from an observer on one conch trip, it was found that in addition to traditional unconsolidated habitats where this mollusk is most captured, coral habitats are also fished. For instance in Serrana, one of the most productive area in the Caribbean (Appeldoorn et al 2003), 10% of the fished sites happened on corals, and this percentage increased to a 66% in Roncador, a coral dominated atoll. It was not possible to get precise positioning in the case of lobster, but there are indications that divers utilized more the islands atolls than the section of the Nicaraguan rise belonging to the archipelago, which is the preferred area for the trap fishery (Medina et al 1996, Gallo et al 2002, Prada 2004).

In agreement to information from observers, the social cartography process identified a total of 13% of conch areas to be present in coral habitats in Serrana, and a total of 54.9% in Roncador. Fishermen also acknowledge that around 50% of the conchs found in coral habitats are juveniles (Figure 5). Unfortunately, there is no similar information for lobster divers.

To date, there is no information as to what extent this large number of divers may cause fragmentation and other mechanical alterations to corals.

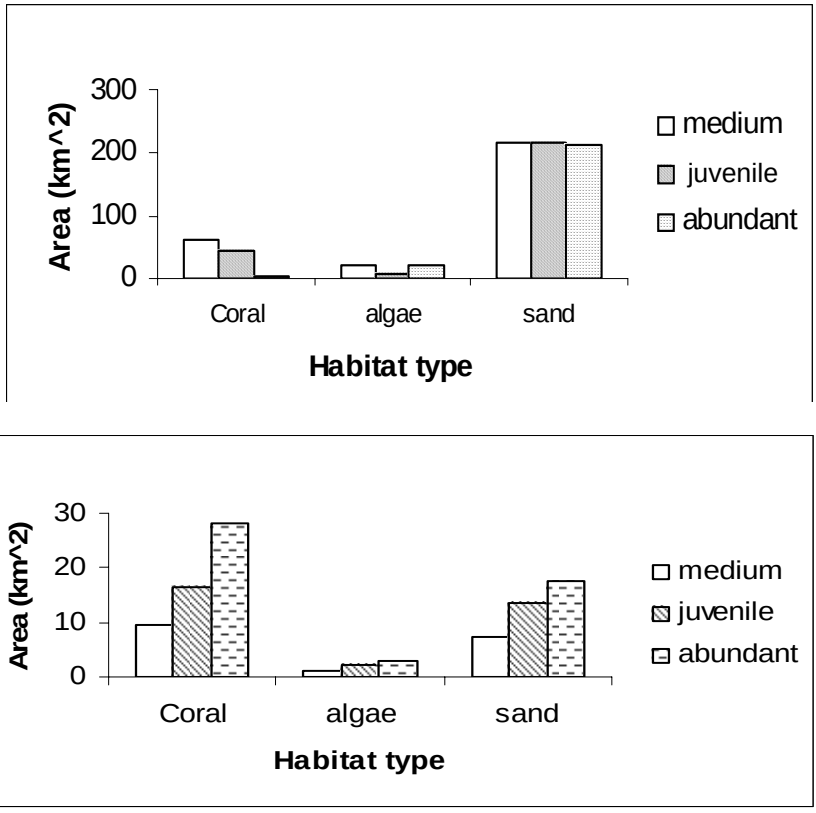

Figure 5. Identification of conch abundance according to fishermen perspective. Upper graph for Serrana, lower graph for Roncador.

Biological Aspects

Divers are affecting more the lobster population dynamics than is the trap fishery. On average, divers are capturing 14.7% (SD 15.6) undersized individuals, 7.73% (SD 10.8) of gravid females and 12% (SD 21.5) individuals with egg remnants, in comparison with 1.5 (SD 3.5), 2.51% (SD 3.4) and 4.7% (SD 6.9) respectively of the trap fishery. Changes of mean lobster size and weight through time did not proved to be statistically different by fishing method, despite a negative tendency in tail length for trap fishery was observed (Figure 6). Divers, apparently are getting larger lobsters since 2002, thus indicating that probably they are fishing deeper, where larger individuals are expected; therefore, most probably they are using autonomous (illegal) diving gear. Indeed, divers are being enticed to empty the traps (Prada et al In press).

When comparing changes in lobster CPUE from the diving fishery through time, it was clear that a major abundance of lobsters were fished during May – July during 1990 - 1996. However, this pattern shifted to a more uniform variations since 1997, similarly to the observed for trap fishery.

Therefore, this data suggests that divers are not exclusively fishing the presumed shallow water stock, but also the deeper one (Prada et al. In press).

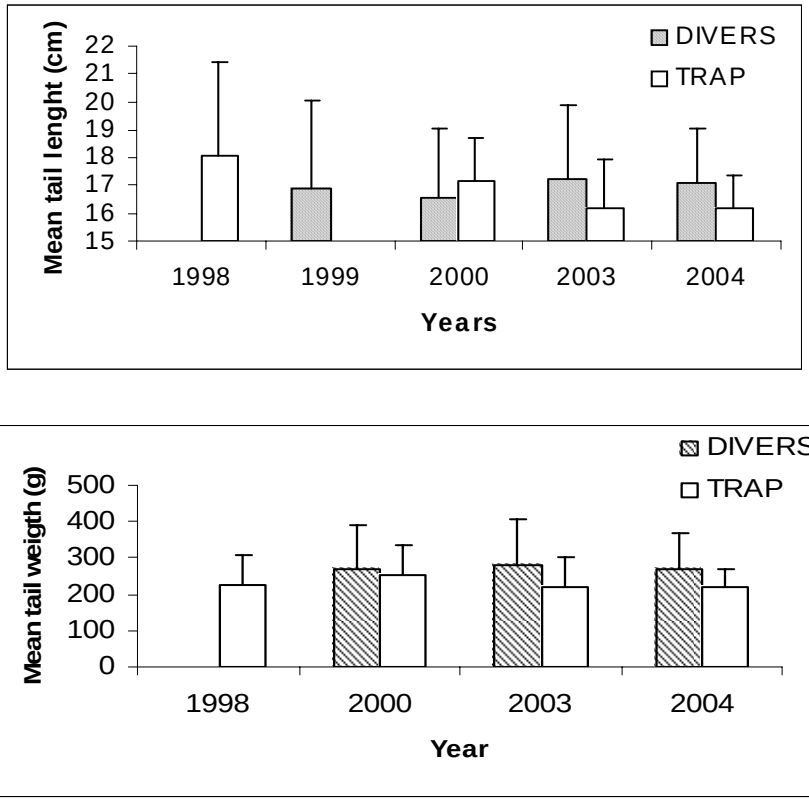

Figure 6. Changes in mean tail length (cm) and mean tail weight (g) in lobster fished at industrial level in the San Andres archipelago. Error bars illustrate one standard deviation.

Captures of Protected Species

Reports made by observers indicate that divers capture and consume onboard several species subjected to different levels of protections. Usually they are not the target species, but they play a significant historical role in the local culture, such as all species of sea turtles, a delicacy in the Antillean culture. In addition, unidentified species of sharks, particularly juvenile individuals, are extracted. Reef fishes fished in spawning aggregations are also captured mostly from divers (Prada et al. 2004). It is important to remember that the use of spear gun for industrial divers was prohibited by CORALINA since 1998.

CONCLUSIONS

Highly exploited spiny lobster populations in the San Andres archipelago began to show signs of over-fishing, and the participation of divers have significantly contributed to this situation. Their operations increased mostly as a consequence of reduction in the queen conch global quota, resulting in a shift of effort to a more valuable, less controlled trade. Apparent increments in lobster CPUE from divers may not be accurate since estimations of fishing effort are fraught with errors, due to no inclusion of the use of illegal autonomous diving gears, particularly hookahs. The queen conch stocks fished exclusively by divers already accounted for critical reductions in their populations, and at present are targeting juveniles looking for conch pearls.

The presence of divers have created additional socio-cultural conflicts, because they are a group of people (Colombian non-residents or foreigners) with different customs, and in most cases are not legally allowed to work in the islands. They brought their families with them, thus increasing the already existing over-population problems on San Andres. Conflicts with these people have extended to the local community, because they congregate within a residential sector, and transformed completely the style of life there. Divers using illegal gears generate conflicts with native divers because they compete for fishing areas with most traditional fishermen both at industrial and artesanal levels. Indeed, they have introduced the use of hookahs to artesanal fishermen, not previously reported. Using autonomous diving equipment and not following safety regulations, divers suffer decompression sickness which have caused serious injury or even death to an unknown number of people. The vicinity of the archipelago's fishing areas to Nicaragua and Honduras, where traditionally thousands of Miskitos kill themselves for the named "red gold" increases potential risks to the stability of our fishery resources.

Not only the fishery and socio-cultural aspects involved the situation of divers, but also environmental concerns. In fact, fishing out of small canoes they can reach shallow coral reef habitats affecting essential fish habitat as well as deep reproductive zones. Diver operations in the last two years were responsible for the capture of 14% of undersized lobster, 7% of gravid females, and 12% females with eggs remnants; these values represent ten times the proportion of undersized individuals, three times the proportion of gravid females and four times the proportion with eggs remnants of the trap fishery. Several species under protection are also being captured by divers, including all sea turtles, juvenile sharks, and groupers and snappers at spawning aggregation, thus contributing with the reduction of the islands biodiversity and productivity.

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