ARIEL DiD HANDBOOK

Project Training Kit
DT2.3.3

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The Ariel Project

ARIEL is a project co-financed by the INTERREG V B ADRION 2014-2020 Programme – Axis 1 Smart and innovative region (https://www.adrioninterreg.eu/).

ARIEL aims to promote technological and non-technological solutions for innovation speed-up and up take in small-scale fisheries and aquaculture among scientists-policy-makers-entrepreneurs, acting as a knowledge network and considering in a single frame the complex ecological, economic and societal challenges.

The ARIEL partnership is composed by 8 scientific and institutional organizations from 4 Countries:

- CNR-IRBIM (Italy)
- Marche Region (Italy)
- Institute of Oceanography and Fisheries (Croatia)
- Public Institution RERA SD for Coordination and Development of Split Dalmatia County (Croatia)
- Hellenic Centre for Marine Re-

search HCMR, (Greece)

- University of Montenegro, Institute of Marine Biology (Montenegro)
- Sicily Region - Mediterranean Fisheries Department - Sicilian Region (Italy)
- Ministry of Agriculture and Rural Development (Montenegro)
- Region of Western Greece (Greece)

Introduction

Dolphin-fishery interactions have been known for more than a century (Backhouse, 1843), but in the context of a drastic decline in fish stocks, this topic is attracting worldwide attention because it also affects the survival of wild dolphin populations

Figure 1. Example of dolphin teeth damage to the sole (*Solea* sp.)

and the life of fishermen through the economic consequences (reduced landing catch of landing), especially in coastal fisheries (Jackson et al., 2001; Myers and Worm, 2003). While direct interactions involve the damage done by dolphins to fishing gear, indirect interactions (biological and/or environmental) relate to their negative impact on fisheries catch and yield. Damage to the ecosystem caused by overfishing and habitat degradation probably enhanced the very perception of dolphins as major pests in fisheries (Reeves et al. 2001). In Mediterranean coastal waters, dolphins are often seen as competition with fisheries and are held responsible for reducing overall catches.

Conflicts with dolphins have been mainly reported by fishers working with trammel nets, but interactions with dolphins have also been reported in gillnet, bottom trawl and surrounding purse seine net fisheries all along the Eastern Adriatic coast. The greatest damage is caused by fixed nets due to the long time they are left in the sea (usually overnight), which gives dolphins plenty of time to locate them and try to consume the fish. Dolphins use opportunistic strategy to increase feeding rates, while at the same time reducing energy consumption for feeding. Such a prey capture strategy can lead to the tearing of the net, and if they fail to eat/tear out the whole fish, it will be damaged and not suitable for the market. The negative impacts of dolphins when fishing with trawls can be divided into direct damage (i.e. damage inflicted on the fishing gear in terms of holes of different sizes, reducing the value of the catch, but also the amount of catch itself) and indirect damage (reducing the

amount of catch as dolphins scatter prey, waste of money and time for the fishermen for procuring new and repairing old nets).

When fishing, dolphins scatter their prey, and when trying to get to the fish in the net, they try to grab the fish from the outside of the net and pull it out, which can tear the mesh. In addition to the creating holes in the mesh, there is an added risk that most of the catch will escape from the net through the holes. In addition, further efforts are needed to either repair the nets or invest additionally in buying new ones.

In trawl fisheries, the damage to the net itself is not as pronounced as in the fixed nets, due to the construction of the net itself, which is much thicker and stronger compared to other nets, but it is still pre-

Figure 2. Dolphin behaviour in vicinity of small-scale fisheries

sent. The dolphins feed at the mouth of the bottom trawl, or remove fish directly from the mesh, which scares the fish and makes the catches significantly smaller. Additionally, a portion of the catch is usually partially damaged and impossible to place on the market.

According to available literature, the presence, recent nature and texture of bite marks on fish can indicate whether the damage wa sinflicted by dolphins. Dolphins usually tear the body of the fish, leaving characteristic oval bite marks. Often, only the fish head will remain in the mesh. Sharks, for example, usually bite the fish through, leaving a clear cut. The presence of small bites on the body of a fish indicates predation by fish or crustaceans. Dolphins make medium- to large-sized holes in the mesh as they pull the fish. Other animals (fish, cephalopods and crustaceans) will do more damage to the catch, while dolphins will cause significantly more damage to the tool. Dolphins also concentrate near fish farms and can attack fish in breeding cages.

Dolphins in the Adriatic have almost no natural enemies, but they face many threats to their survival. In the Adriatic in the 1950s, dolphin was considered a great pest. During this time, an extensive program for their destruction was carried out, resulting in hundreds of dolphins killed, mainly in the northern and central Adriatic, significantly reducing the population of bottlenose dolphin (*Tursiops truncates*) and causing regional extinction of the short-beaked common dolphin (*Delphinus delphis*). Dolphins were later put under strict protection, and the population of bottlenose dolphin has recovered, as many fishermen testify

every day. As highly intelligent animals, part of the population has developed the technique of catching fish already caught in fishing nets, which they consider to be a new resource (Reeves et al., 2001).

Figure 3. The DiD (Dolphin interactive Deterrent) (STM Products, 2016)

The use of traditional noise-producing dissuasors has been proven to be, in general, quite ineffective. Either they increase the anthropogenic noise without a specific effect on dolphins, or they act as "dinner bell" attracting skilled (and smart) dolphins towards the fishing locations. Similar effects are produced by the noise of specific fishing activities, being the dolphins able to recognize a fishing boat from a navigating one. More recently, a new generation of dissuasors is becoming more and more in use. They detect the echolocation sounds produced by dolphins and react by generating random noise. An accurate and quantitative description of the hunting strategies actuated by dolphins and by a proof-of-concept description of the efficacy of new-generation dissuasors will be interesting.

General Information

The DiD (Dolphin interactive Deterrent) is an electronic equipment able to keep the dolphins away from fishing nets, thanks to an efficient technique of interaction with their echo-localization system (sonar) (Fig. 3). Tested devices were STM Products S.r.l. (http://www.stm-products.com/prodotti/fishing-technology/dissuasori-per-delfini-green/did-01~54.html). The use of the DiD 01 avoids most of the incidental captures of dolphins and protects the capture and fishing nets from predation by mammals, therefore it protects also the profit of the fishing industry. The device has a broadband transducer able to detect the presence of marine mammals in the surrounding area and to react by emitting variable ultrasounds in order to disturb their echo-localisation system and therefore to induct them to move somewhere else.

Table 1. Fishing gear or locations according to their suitability for DiD use

FISHING GEAR	SUITABLE YES/NO
Set nets, gillnets, trammel nets, drift-nets	YES
Trawl net, seine net	NO
Purse seine, Seine tournant	NO
Longline	YES
Single line	YES
Harbours, eolic plants, marinas	YES

The DiD is the interactive evolution of the standard DDD 03 models. It produces the ultrasounds only when it detects the

presence of the dolphins in the area, by means of its "hearing" circuitry, that is activated by the "clicks" emitted by the mammals. It is powered by internal (sealed) rechargeable batteries and generates an acoustic signal in case of insufficient charge. The advantages of this model in comparison with the DDDs are the reduction of the possibility that dolphins become accustomed to the signals, the increased duration of the battery charge and the reduction of the acoustic pollution (Table 1). The level of the DiD emissions doesn't produce any harm to mammals or fish; these last are insensitive to the frequencies emitted.

Instructions for Use

(From the Producer)

- Before the first use of the device, perform a complete battery charge for 24 hours.
- Producer suggest to use only the STM BATTERY CHARGER (code 3301004) or the STM MULTIBATTERY CHARGER – MBC4 (code 3320002/3).
- Attach the DiD 01 to the net (or line); it will be activated automatically upon contact with water.
- After a first sound emission (indicating the battery is charged), it remains in reception mode until it detects dolphin presence (by receiving their "clicks"). It then produces special, variable ultrasound signals for about 50-60 seconds.
- The emission of randomly modulated (in frequency, inten-

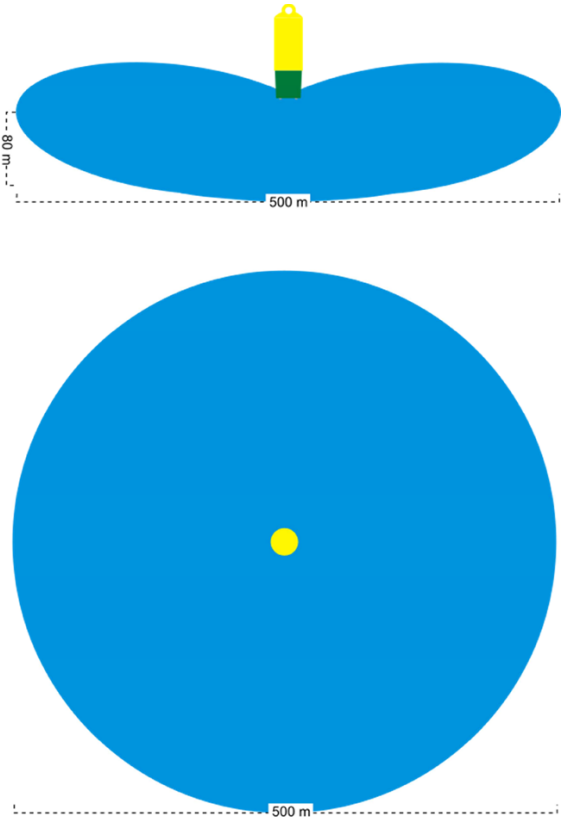

Figure 4. Emission area of Dolphin Interactive Dissuader (STM Products, 2016)

sity and length) signals, makes it difficult for dolphins to adapt to the signal.

- After each activation, it restores the maximum sensitivity progressively in about 2 hours. This avoids the chain reaction between several devices and entering into an infinite loop.
- The devices should be placed on the fishing equipment

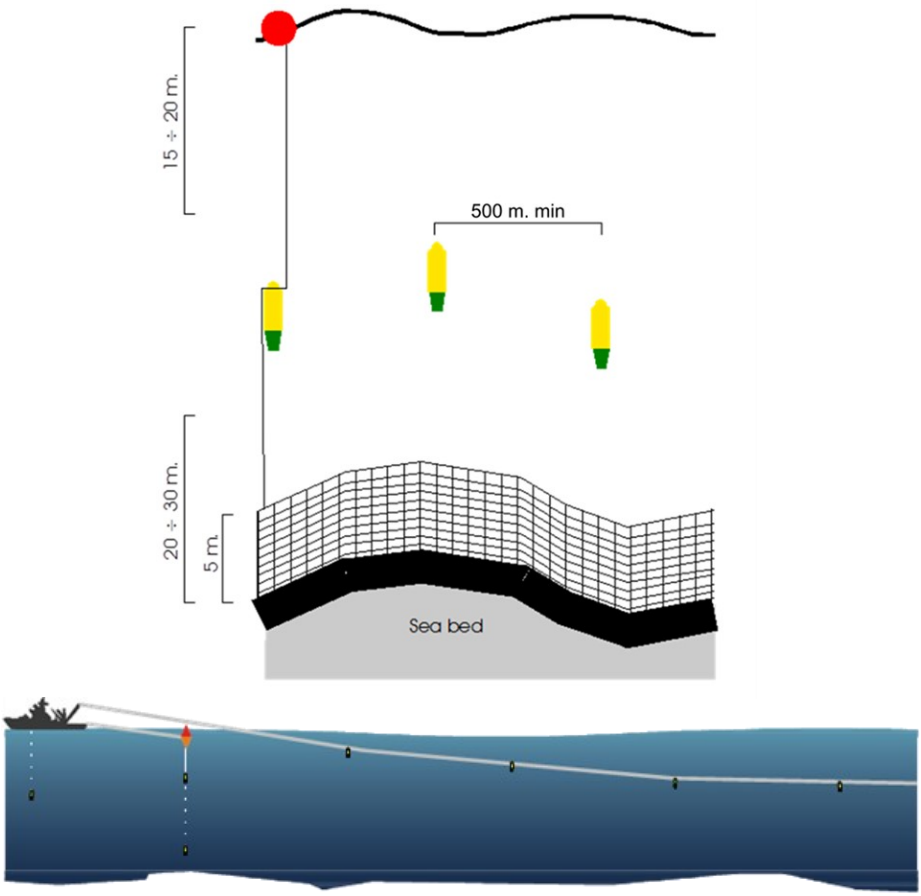

Figure 5. Instructions for attaching devices to fishing gear (STM Products, 2016)

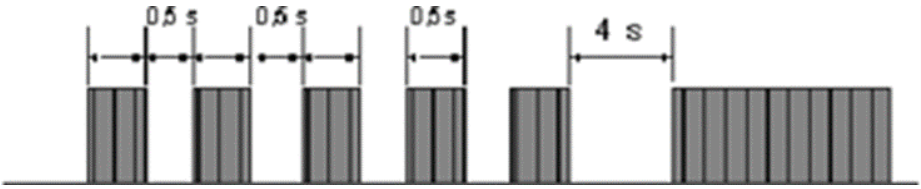

Figure 6. Start sequence from the minimum level up to the maximum sensitivity level (STM Products, 2016)

(nets or lines) according to the best strategy considering the emission area (Fig. 4) and the type of fishing (Fig. 5).

- When the sensors touch the water, the device performs a series of easily recognizable sounds. These may indicate: (1) that the batteries are low (short sounds at regular intervals, each lasting 2 seconds), (2) low-battery signal, (3) that the DiD 01 has started its normal activity under the current sentivity range, from the minimum level S1 (200-300 meters) up to the maximum sensitivity level S7 (800 -1200 meters) (Fig. 6)
- ***Warning**: Do not place a DiD less than 600 – 800 m from another DiD.* If this happens regularly during fishing operations (e.g. in purse seine nets), it is recommended to use model DDD 03X (Dolphin Dissuasive Device) instead.
- Interaction with DDD (Dolphin Dissuasive Device): the DiD's behaviour may be influenced by the presence of DDD 03X units in the area. The DiD doesn't distinguish between the emissions of a DDD and dolphin echolocation signals (the frequencies are the same), so it may continuously produce signals, reducing drastically the battery duration and the desired effect on the dolphins. Therefore *do not place a DiD at less than 1 km from a DDD*.

Suggestions for Use

(From practice)

- For a single fisherman working with 400 m length of fishing gear, at least two pingers are required.
- Before using the device, perform a complete battery charge for at least 20 hours. Although the producer claims that batteries last more than 12 hours in continous emission mode, and more than 300 hours in reception mode, our experience suggests daily reacharges.
- The use is very simple, just attach it to the fishing gear (at the beginning and at the end). The DiD must be placed at least 20—30 m above the fishing gear.
- The devices have to be placed on the fishing equipment according to the best strategy considering the emission area and type of fishery.
- Do not place a DiD less than 400 m from another DiD. The DiD behavior may be influenced by the presence of another DiD units in the area, which may cause it to produce signals continuously, drastically reducing both the battery duration, and the desired effect on the dolphins.
- The emission of random modulated signals makes it difficult for the dolphins to adapt to the signal. The sound seappears to interfere with the dolphins' long-term retention of the net, so the damage to the catch is visible, while the damage to the gear is much smaller.

Maintenance Instructions

(Producer)

- After every use, carefully dry head and electrodes (screws) of the pinger, in order to avoid rusting (which may happen despite the use of AISI 316 stainless steel), which interferes with establishing of the electrical contact and successful recharging of the batteries.
- Remove any traces of visible rust using a brass brush.

Used Device Disposal

(Producer)

The used device may be disposed through regular disposal treatment centres. It is made only with non-polluting materials, recyclable as secondary prime materials. The device, accessories and batteries included, does not belong to the domestic disposals category, due it's made of valued materials which could be recycled and reused. The European Directory 2002/96/CE about electric and electronic devices disposal (RAEE) prescribes the separate collection of the electric and electronic devices respect to the mixed urban disposals for their further recovery, reuse and recycle. Don't dispose the electric and electronic devices together with domestic disposals or through the regular disposals collection services. The EU countries require the use of se-

parate collection services. Be informed about your local separate collection services for electric and electronic devices disposal showing this symbol:

Conclusion

Pilot actions on the use of DiD (Dolphin interactive Deterrent) in small-scale fisheries were conducted in Italy (Ancona), Croatia (Istra) and Montenegro (Kotor). Preliminary work on the pilot-action included agreeing on a protocol for the pilot action itself. The pilot-action was originally desgined around the activities of three separate groups of fishing activities:

1. Nets with DiDs attached;
2. Nets without the DiDs set up close to the nts with DiDs attached (in order to determine the possible interaction); and
3. Control group of nets without DiDs, set up out of DiD range.

All fishers engaged in activities were required to fill a logbook provided to them by the partners.

The results of the pilot studies are promishing, indicating that the use of DiDs does reduce the amount of predation by dolphins and damage inflicted both to the catch iand to the fishing nets used in fishing operations.

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