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Observers and Factory-deck Crew are not Shark Taxonomists

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Abstract

Observers (and vessel crews) inevitably do not have the experience and easy-to-use guides to ensure accurate identification of the species comprising deep-sea shark bycatch in the bentho-pelagic trawl fishery of the SWIO. Further , it is our view that it is unrealistic expected these workers to possess these skills. Given the possible time required to ensure an accurate identification in many sampling situations we believe that a rethink of this problem is necessary and assessment of options, several of which are presented would be of benefit.

This paper to be considered in conjunction with the Workshop on deepwater sharks in the SIOFA Area (WS2023-DWS).

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Southern Indian Ocean Deepsea Fishers Association
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Observers and Factory-deck Crew are not Shark Taxonomists

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1. INTRODUCTION

Conservation and management of deepwater shark resources, as for any taxonomic group, requires accurate identification of the shark species that are caught. If a specimen cannot be identified, this taxonomic uncertainty needs to be indicated in the catch record. Conventional practice is to provide observers and others recording details of shark catches with taxonomic keys which they can reference to identify the species that is being recorded. For the Southern Indian Ocean the standard guide is that of Ebert and Mostada.[3]

Our personal experience from field studies that require fish species identification using species keys, is that no matter how good an identification guide may be, using them successfully can be difficult in some situations. This may lead to false confidence in the accuracy of species identification and thus confounding of fisheries data. There are many reasons why this task can be so difficult:

- Personnel's lack of previous experience identifying the species of concern
- Difficulty involved with using keys to deal with the complexity of separating species which are similar in appearance and the variation in seemingly intuitive obvious characters such as body types and colouring
- Other responsibilities of the observers that compete for their availability.
- The inherent difficulty of resolving the shark species in question.

- *Observers new to the area*

In the Southern Indian Ocean, shark species identification is nominally the responsibility of observers that are embarked on all factory trawlers in the Southern Indian Ocean Fisheries Agreement (SIOFA) area. These fishing trips can last in excess of 60 days and the long duration results in considerable turnover of observer personnel from trip to trip. As a result, during successive trips, observers often encounter shark species for their first time. Gaining familiarity with a detailed and comprehensive species identification guide takes considerable time, especially when the guide has been prepared to cover a relatively wide geographical area and so covers a

[3] Ebert, D.A. & E. Mostarda 2013. Identification Guide to the Deep-Sea Cartilaginous Fishes of the Indian Ocean. FishFinder Programme, FAO, Rome. 76pp.

relatively large number of species, many of which will never be encountered due to their rarity in the area of fishing operations. The identification problem experienced by observers working in an ocean area for the first time can be mitigated by help from the crew who are available to help sort the shark catch and often have considerable experience with the sharks that are encountered. Commonly the factory deck crew will have been employed on the vessel for over a decade and are familiar with some/many of the species. However, fieldwork shows that this is not a fail-safe process and crew, while invariably helpful, can misidentify shark species too.

- *Difficulty of keys to successfully deal with the complexity of identifying deep-sea shark species*

It is our common experience that it is almost impossible to prevent observers (and crew) from focusing on searching the guide for a photograph or artist's impression that is closest to the shark they wish to identify that is in front of them. The identification is then made, without recourse to checking the body features that have been used to create the key. Too often we have found observers misidentify a specimen based on body shape and colour while overlooking less obvious but key factors such as presence or absence of fin spines and tooth morphology. Artist's impressions, by their very nature, attempt to encompass all of the features of the species in a single image. The reality is that body colour, relative size of fins, and general body shape can be deceptively variable within a species. Often, identification keys are prepared from preserved specimens. Body parts readily identifiable on a preserved specimen may be nearly invisible to the novice eye on a fresh specimen and vice versa. Freezing and/or fixing specimens in formalin, then alcohol can dehydrate and shrink tissue, so that body spines become more apparent while being well hidden on fresh material. Further, preservation can deform the body and fade skin pigments. It is extremely difficult to prepare species keys that will work in all circumstances.

To add to this, rare species will occur that are poorly described or even new to science. Clerkin (2023)[4] is testament to this. He described at least 31 species and 14 genera from two trips on one factory trawler. Several species may look the same; in other species, individuals may look distinctly different but be the same species! We have found multiple instances where a group of genetically distinct species fit the description of a single species and were not distinguishable based on the available literature. Further, we have encountered a species of *Chimaera* (the first time the genus was documented in the Southwestern Indian Ocean) with three district colour-morphs and thus a unique appearance in different geographic areas. These examples of multiple species looking alike, and a single species looking different highlights the challenge to, and importance of, effective species identification resources for observers.

- *Workload of observers*

Observers are fully occupied when the factory trawler is 'in the fish'. Samples (100 fish) of the targeted species may have to be measured for length, weight and their sex and gonad condition and weight determined. In some cases, otoliths must also be extracted. Then the bycatch of benthic invertebrates must be recorded, with parallel demands for more detailed species identification. Possible bird and mammal interactions may need to be observed deck-side as well as monitoring of other vessel activities.

[4] Clerkin, P. 2023. Deepwater Sharks of the Southwestern Indian Ocean. 102 pp. preparation.

Working through a key with a single unfamiliar shark individual for the first few incidences takes time and the factory deck of a trawler late at night with the vessel pitching and rolling is a far cry from the calm environment of the well-lit shore-side laboratory where the key would have been developed. It is completely understandable that the pressure will be on the observer to rapidly identify, alas, often guess, the species identity. Failure to recognize this when specifying operational guidelines will result in identification of shark species (to the extent that taxonomists agree among themselves) continuing as a hit and miss activity.

Correctly identifying shark species can be extremely difficult even for trained taxonomists. There are some species that are genetically distinct, but researchers have failed to identify physical characters that can distinguish the different species. We believe that taxonomy must be combined with genetic methods to develop new tools which will allow observers to accurately identify species at sea.

2. WAY FORWARD

2.1 Define the Problem

The issue of characterising the shark bycatch (few if any batoids are caught) in the bentho-pelagic aimed-trawl fishery bycatch in the SWIO would benefit from specifically determining the purpose of monitoring and recording the nature of the shark bycatch. Doing so would then provide a context for how to handle the complex nature of the species composition of the catch, i.e., one dominant bycatch species (*Etmopterus granulosus)* and a handful of 'common', rare and extremely rare species (Clerkin and Shotton – this workshop) that are encountered. Should each of the species groups have their own conservation objectives or should there be a more aggregate species characterization objective? While we can identify the problem, we believe that articulating an operational desideratum will be challenging.

2.2 Train Crews

As noted above, vessel crew, as a matter of course, assist the observers with their duties and when needed provide the observers with necessary training and continuity of experience. Because crew members may work on the vessel for more than, e.g, 10 years, they usually are familiar with the common shark species. However, they too would benefit from formal training in identification of the shark species they are likely to encounter during the fishing operations. We believe means of doing this can be identified with the help of outside agencies. But the issue of providing incentive for them to undertake this work should be recognized.

2.3 Develop a Photographic Protocol and use an Appropriate Shark Taxonomy Expert

Checks comparing photographic images of shark species identified by a shark taxonomy expert have shown as little as only three correct identification by an observer among ten images; it was once in seven attempts in another trial. We propose that the emphasis on at-sea species identification should be on obtaining high-quality appropriately posed photographs of sharks. The identify of these sharks would be undertaken or confirmed by an expert in this field.

Ideally, a video would be prepared to demonstrate how to take images necessary to identify shark species. These may include images showing the dental arrangement and teeth structure (needed to distinguish some genera!), fin arrangement and spines. Observers should be given copies of the

video prior to their embarkation. Designated crew members would also be provided with these aides.

SIOFA may undertake building and maintaining a database of the images along with information on when, where, and at what depth the sharks are caught.

2.4 Develop a More User-Friendly Shark-Species Identification Aide

Ebert & Mostarda (2013) have produced a valuable, and the best available, guide that should be on all vessels. However, we believe that something more user friendly and directed towards detailed discrimination is required to reduce misidentifications. It is recognized that there will be no perfect solution and this issue will require constant attention.

We have experimented with the preparation of identification guides starting with the species that are the most commonly encountered. Alas, these are not always the easiest species to identify. An example is provided in the annex below. We consider this an 'Open Project'. If users believe they can offer improvements to the identification material, they are invited to make the information available.

These guides would be most efficient if developed into a digital dichotomous key. This would make the guide faster to use, while discouraging an observer from neglecting due process by flipping through a key and ignoring the proper steps and identifying characteristics. The key would guide species-specific data collection resulting in higher resolution data and less time demanded on observers. Further, digitally collected data recorded on tablets can organize and link data, specimen images, and samples via barcodes, and upload and transmit this data automatically making it quickly and widely useable to those involved in species management. Using such a smart-key would improve the data collected by at sea observers and help further establish a working catalog documenting shark species of the region.

2.5 Develop of Shark Species Identification Artificial Intelligence

Increased documentation and proper taxonomic study will help compile a catalog of SWIO sharks. Because of the difficulty of identifying species and the fact that some species' morphology changes over their lifetime, genetic verification is a necessity for this work. The combination of detailed taxonomic research and genetic verification will result in a highly curated set of data. Photographs from this data set could then be used to train artificial intelligence (AI) to identify species. Object recognition is becoming increasingly commonplace, and fish species identification models are readily available for common coastal species. The only missing element is an extensive photo data-set, which will be a byproduct of increased research and at-sea documentation. Once a large set of annotated photographs representing each species is organized, they can be fed into an open-source model and the model will learn how to identify new images of sharks based on the training images.

At first this AI would simply augment the digital key to expedite the process, but eventually it would identify sharks to species automatically. In the future, AI would also be able to record not only species but other externally identifiable information such as sex and length, again already developed for coastal species. This powerful tool for observers will increase data available to scientists and aid vessels in species-related compliance. Object recognition models have been developed for many groups of organisms including coastal fish, and through transfer-learning an

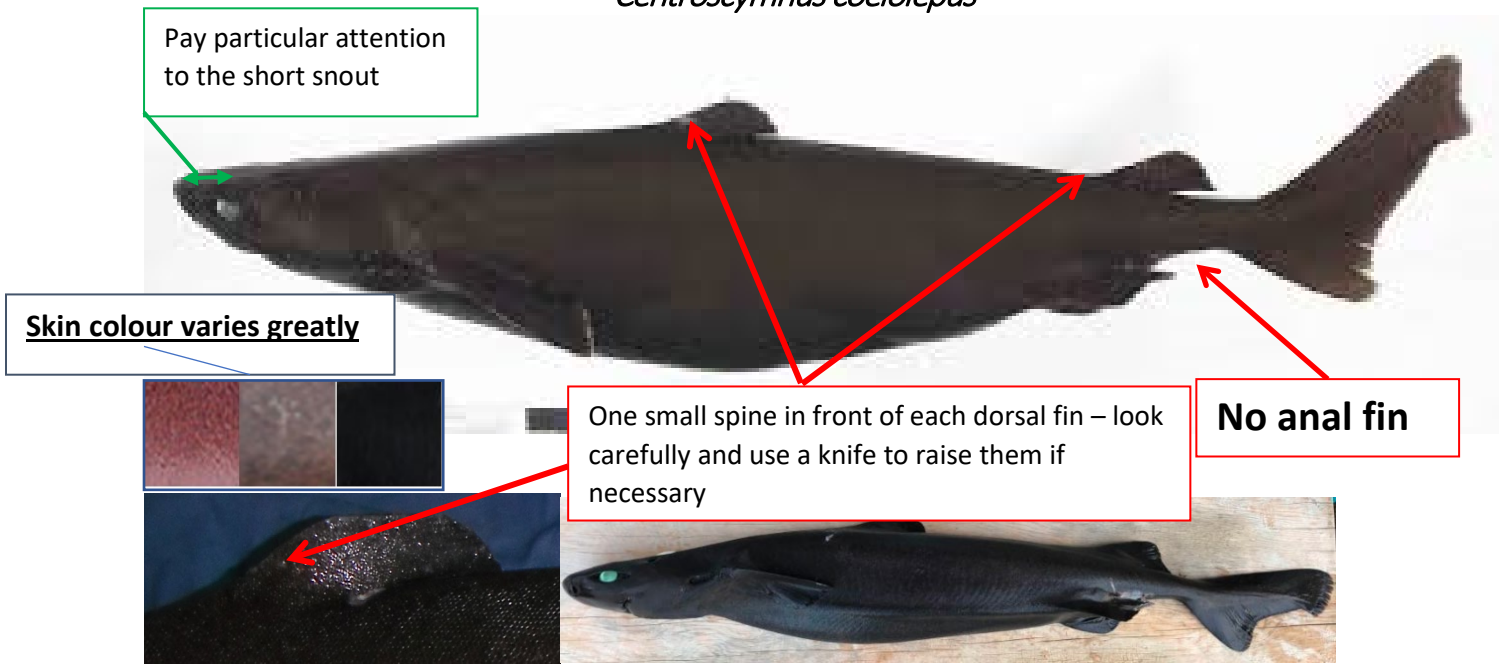
already trained model can be adapt for deep-sea shark species using a collection of verified photographic data.

We also note the excellent identification guides prepared by *Fishwell Consulting* in 2009 for the Fisheries Research and Development Corporation and the Australian Fisheries Management Authority, both of the Australian Government (Annexe II). This work suggests ways in which developments may proceed.

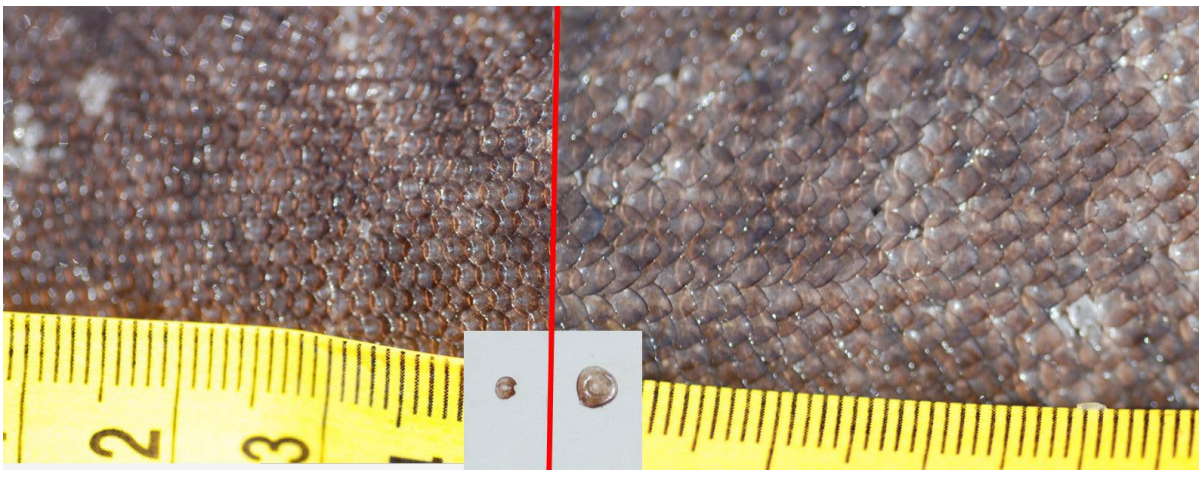
Annex I

Pilot of a Possible Style of Species Identification Guide

Centroscymnus coelolepus



Most common examples are 'fatties', but not all specimens will have bodies that are so deep (see above). The **lack of anal fin** is a key indicator for the dogfish, then the small dorsal fins, large tail, and flabby body. The small spines are important but sometimes you have to really look for them.

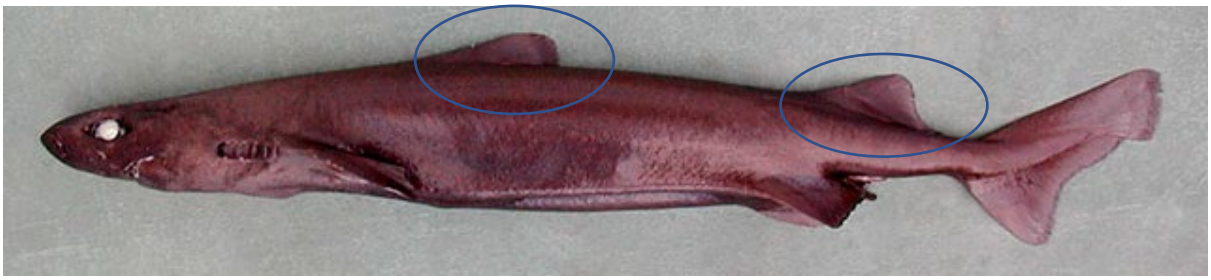


Another good ID character for this genus is they have **fish-scale-like denticles** - most sharks have thorn, prong, cone, etc., shaped denticles. *Centroscymnus coelolepis* have flat, overlapping denticles that resemble those of a fish (above), which flake off easily. Other shark genuses do not have with denticles like this, which makes this genus easy to ID. You should use your magnifying glass (that should be standard equipment in your kit) to confirm this.

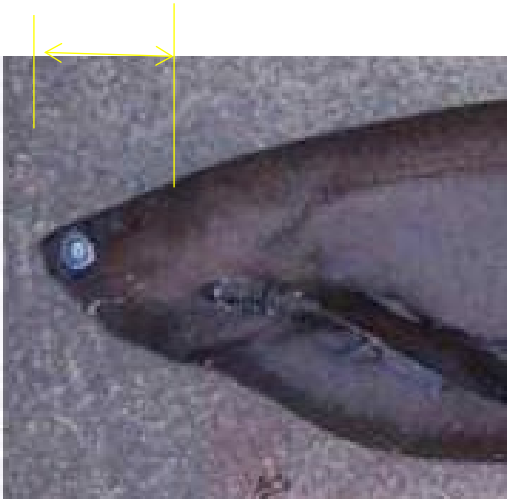
See also **page 35** in the FAO guide.

Where it all may go wrong!

Centroscymnus owstonii is the only other species of the genus and may easily be confused with *C. coelolepis.* Make a careful check of the sizes of the dorsal fins. The two dorsal fins of *C. owstonii* differ in size, with the posterior fin, i.e., the one closer to the tail being somewhat larger that the anterior, i.e., first fin.

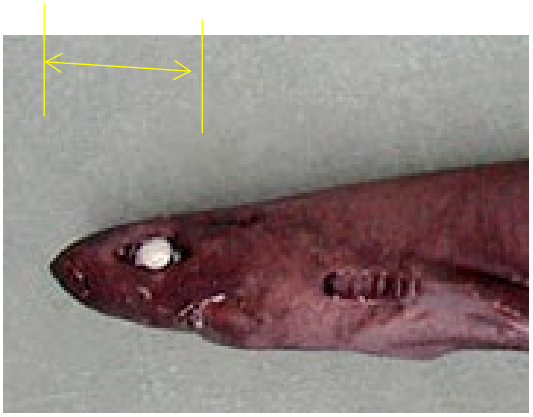


If it were that easy! These fish will also have small spines in front of the dorsal fins, but note there is no sign of them in this image. Even worse, frequently the size difference of the fins will not be obviously different and it will be hard to decide one way or the other. So, you must go to step 2! Turn the dogfish on its back and compare the distances from the tip of the snout to the mouth and then from the mouth to a line connecting the first gill slips.



C. coelolepis

(Roughskin Dogfish)

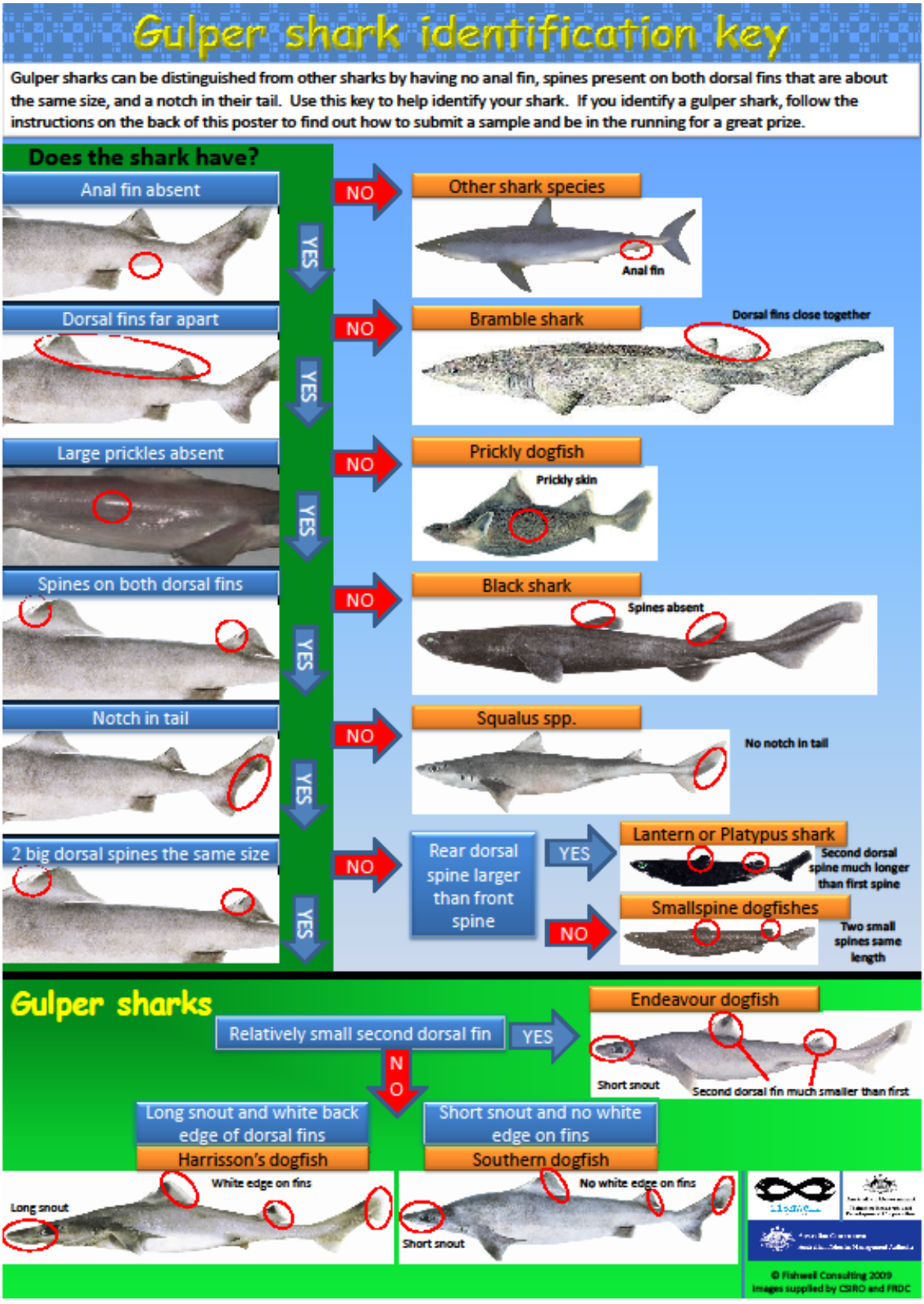


(Portuguese Dogfish) ***C. owstonii***

But, the Plunket shark, (*Proscymnodon plunketi),* is similar to the Portuguese dog fish in that it has a short snout (short pre-oral distance), the spines in front of the dorsal fins, though much more evident, but it has prong-like denticles. The fish scale denticles of *Centroscymnus* should help sort this out.

Plunket Shark
Proscymnodon plunketi

Annexe II
Identification Sheets Prepared by Fishwell Consulting, released in2009

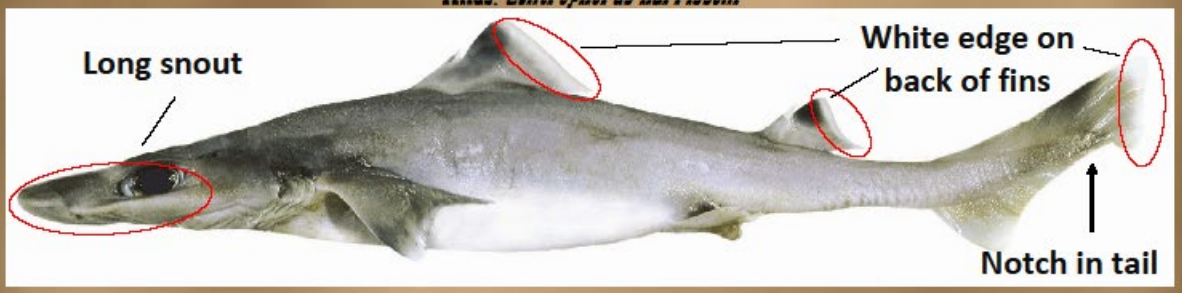


WANTED

INFORMATION REGARDING THE APPREHENSION AND IDENTIFICATION OF THESE SUSPECTS IN YOUR CATCH

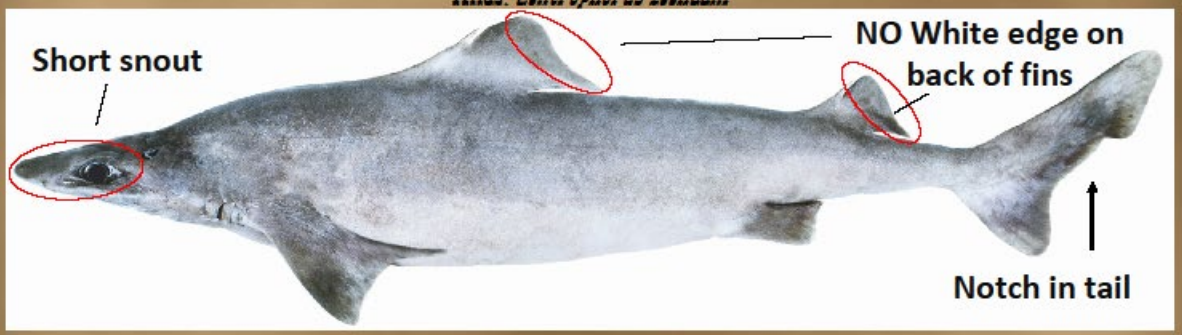
HARRISSON'S DOGFISH

Alias: *Centrophorus harrissoni*



SOUTHERN DOGFISH

Alias: *Centrophorus zeehaani*



ENDEAVOUR DOGFISH

Alias: *Centrophorus moluccensis*

REWARD { Either a Playstation 3 or an Apple iPhone }

FOR CORRECT IDENTIFICATION OF THESE SPECIES

TO FIND OUT HOW, SEE YOUR GULPER SHARK ID KIT OR PHONE MATT KOOPMAN ON 0408 582422

Australian Government
Australian Fisheries Management Authority

fishwell