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TECHNICAL REPORT

LARGE SHARK TAGGING PROGRAM IN NEW CALEDONIA

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Community





Le CRISP est un programme mis en œuvre dans le cadre de la politique développée par le Programme Régional Océanien pour l'Environnement afin de contribuer à la protection et la gestion durable des récifs coralliens des pays du Pacifique.

La cellule de coordination du CRISP est un projet du Secrétariat de la Communauté du Pacifique depuis avril 2008 afin d'assurer une coordination et une synergie maximales avec les actions de la CPS touchant à la gestion des écosystèmes coralliens.

L'initiative pour la protection et la gestion des récifs coralliens dans le Pacifique (CRISP), portée par la France et préparée par l'AFD dans un cadre interministériel depuis 2002, a pour but de développer une vision pour l'avenir de ces milieux uniques et des peuples qui en dépendent. Elle vise à mettre en place des stratégies et des projets visant à préserver leur biodiversité et à développer dans le futur les services économiques et environnementaux qu'ils apportent tant au niveau local que global. Elle est conçue, en outre, comme un vecteur d'intégration entre états développés (Australie, Nouvelle-Zélande, Japon et USA), collectivités françaises de l'outre-mer et pays en développement du Pacifique.

Pour ce faire, l'initiative développe une approche spécifique qui vise à :

- associer activités de réseau et projets de terrain ;
- articuler recherche, aménagement et développement ;
- combiner les apports de disciplines scientifiques diverses, incluant la biologie, l'écologie, l'économie, la sociologie, le droit et les sciences humaines ;
- intervenir sur l'ensemble des thèmes - terrestres et marins - intéressant les récifs (y compris l'assainissement et la gestion des bassins versants) ;
- ne pas créer de structure nouvelle mais apporter des ressources financières à des partenaires déjà opérationnels et souhaitant développer leurs activités dans un esprit de coopération régionale. C'est la raison pour laquelle l'initiative a été préparée sur la base d'un appel à propositions auprès de l'ensemble des institutions et réseaux.

Le dispositif d'intervention du CRISP se structure en trois composantes majeures :

Composante 1 : AMP et Bassins Versants

- 1A1 : Planification de la conservation de la biodiversité marine
- 1A2 : Aires Marines Protégées (AMP)
- 1A3 : Renforcement institutionnel et mise en réseau
- 1A4 : Gestion intégrée des zones côtières récifales et des bassins versants

Comp. 2 : Développement des Écosystèmes Coralliens

- 2A : Connaissance, valorisation et gestion des écosystèmes coralliens
- 2B : Restauration récifale
- 2C : Valorisation des Substances Actives Marines (SAM)
- 2D : Mise en place d'une base de données régionale (ReefBase Pacifique)

Comp. 3 : Coordination et Valorisation du Programme

- 3A : Capitalisation, valorisation et vulgarisation des acquis du programme CRISP
- 3B : Coordination, promotion et développement du Programme CRISP
- 3C : Appui aux filières économiques alternatives et durables (Capture et Culture de Postlarves)
- 3D : Conservation des espèces et écosystèmes vulnérables
- 3E : Cellule économique

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Ce projet est financé par les organisations suivantes :



Cover photo: 3.8 m tiger shark restrained in harness with Clua and Werry present in photo (28/01/2009).

Abstract

In order to obtain an understanding on the movement patterns, habitat use and fishery-independent catch statistics of large sharks in Prony Bay, in the Southern Province of New Caledonia, two pilot surveys were undertaken in January and July 2009. Modified baited drumlines were set in different areas of Prony Bay and Woodin Channel and checked every 2-5 hr. Seven tiger sharks (*Galeocerdo cuvier*, 1.65 to 3.9 m total length (TL)) captured were internally acoustic tagged and three large tigers, 3 to 3.9 m TL were also tagged with archival pop-off satellite tags. An acoustic array (VR2W) was deployed and sharks were externally tagged to identify recaptures. The status of all sharks was monitored during tagging procedures and sharks were restrained in a non abrasive harness and water flow over the gills was maintained. Initial results indicate one satellite tagged 3 m TL female *G. cuvier* moved into tropical waters of Australia and one 3.8 m male *G. cuvier* tagged in January was periodically detected on the Prony Bay acoustic array in March, May and June 2009. Three bull sharks, *Carcharhinus leucas*, (2.5 to 3 m TL) and one sandbar whaler, *Carcharhinus plumbeus*, were also caught during surveys. These initial results indicate the diversity in potential movement of large *G. cuvier*, including medium range migration and site fidelity (i.e. returning to/remaining within Prony Bay). A comprehensive understanding of these patterns is needed for the effective management and conservation of large sharks. These pilot results will form the basis of a longer term study on the movements and habitat use of *G. cuvier* and other large sharks in New Caledonian waters and the connectivity of these habitats with the rest of the South Pacific in supporting the endangered sharks.

Keywords: *Galeocerdo cuvier*, tiger shark, *Carcharhinus leucas*, bull shark, *Carcharodon carcharias*, great white shark, habitat use, movement, acoustic tags, acoustic receiver, satellite tags, catch statistics

Citation of the report:

Werry^{1,3}, J. M., Clua², E., Planes³ (2009) Preliminary results for the study on movement of tiger, *Galeocerdo cuvier*, and other large shark species in Prony Bay, New Caledonia. Technical Report (field work conducted in January and July 2009). 10 pp.

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1.0 Introduction

Globally there is increasing concern over decline in shark populations, largely due to fishing pressures (Figure a), and the ecological effects of the decline for important marine habitats such as coral reefs (Baum *et al.* 2003; Bascompte *et al.* 2005, del Monte-Luna *et al.* 2007, Myers *et al.* 2007; O'Connell *et al.* 2007, Stevens *et al.* 2000). In New Caledonia, Prony Bay, in the Southern Province was listed as World Heritage site in 2008 and is

locally known for its coral reef habitats and shark populations. However, scientific data for the management of sharks in this region is lacking. The first steps to managing shark populations include (a) the determination of centres of shark activity, (b) the proportion of time sharks spend in management zones and reef habitats and (c) identification of hot spots or species specific site fidelity. Understanding potential migration pathways to and from Prony Bay (i.e. connectivity with other reef habitats in the South Pacific) is also a major management issue as the size of shark home ranges beyond the waters of Southern Province, and hence their exposure to fishing pressure, are unknown.



Figure a. Sharks harvested from the Indo-Pacific Ocean



Figure b. The tiger shark, *Galeocerdo cuvier*

The tiger shark, *Galeocerdo cuvier* (Figure b), is generally considered the top-level predator in coral reef ecosystems (Friedlander and DeMartini 2002). It occurs across both tropical and subtropical regions of the world and specifically in New Caledonia (Last and Stevens 1994). The bull shark, *Carcharhinus leucas*, and the Great White shark, *Carcharodon carcharias*, have also been recorded in tropical waters of New Caledonia (Last and Stevens, 1994).

The aim of this study is to determine the long-term habitat use and range of movement of large sharks (primarily *G. cuvier*) in Prony Bay, Southern Province. This technical report presents initial findings from two pilot survey trips in January and July 2009.

2.0 Materials and Methods

2.1 Study site

Prony Bay is situated in the Southern Province of New Caledonia. The area is geographically separated from the main region of human activity, i.e. Noumea, and a large nickel mine has been established in the northeast boundary of the bay. In order to quantify the fine scale catch per unit effort in our study site, we divided fishing effort into areas or ‘zones’ (Figure 1).

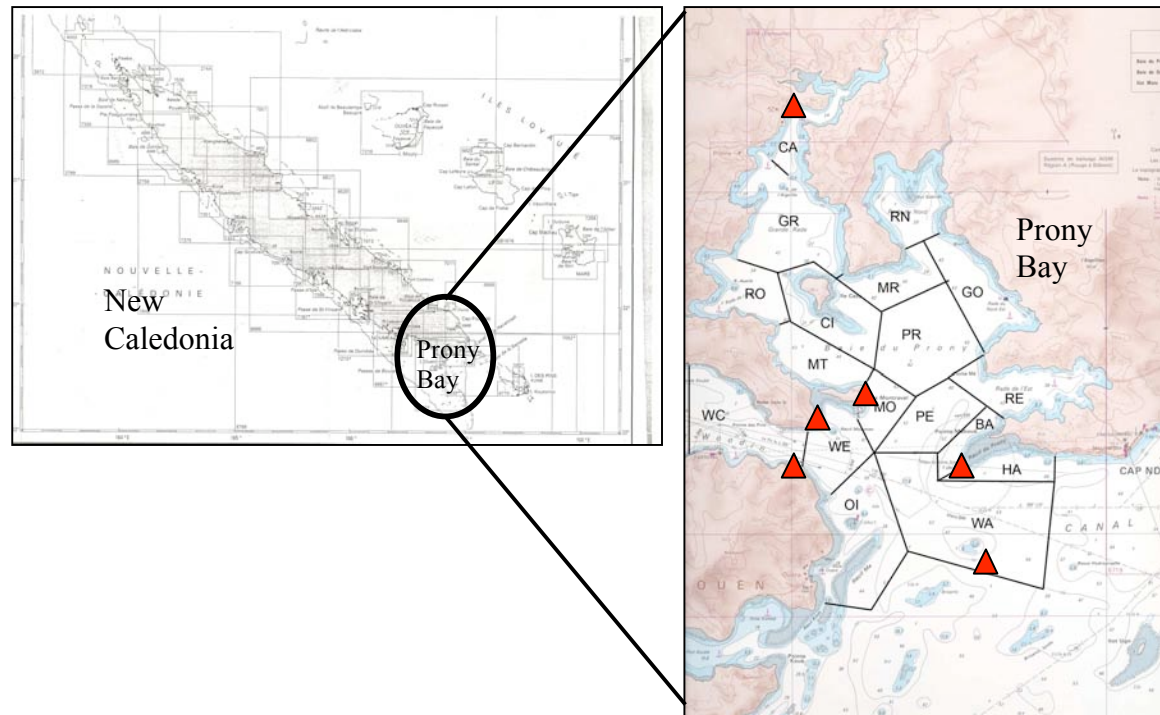


Figure 1. Prony Bay, New Caledonia with fishing zones for the purposes of the current study. Indicate the site of  VR2W Vemco acoustic receivers mentioned in section 2.4.

2.2 Catch statistics

Drumlines consisting of two or three 20L floats were attached using 8 to 12mm rope to a large weight lowered onto the sea floor (Figure 2). A large trace and tuna hook were attached to rope close to the float that was furthest from the main rope to the weight. Hooks were baited with tuna or meat and checked every 2 to 5 hr. Drumlines were deployed in different regions or zones of Prony Bay and Woodin Channel (WC) (Figure 1).

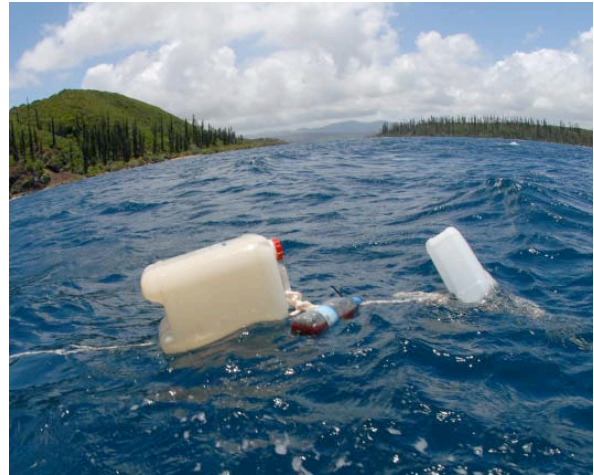


Figure 2. Clua and Werry showing modified baited drumlines with a tuna head (left) and example of deployment in Prony Bay (right).

2.3 Shark capture

Morphometrics, i.e. total length and gender of sharks caught were recorded (Figure 3). Sharks were restrained in a harness tied to the research vessel and their condition during capture continually monitored (Figure 4).



Figure 3. Measurement of total length taken as a straight line from the tip of the sharks snout to end of the caudal fin.



Figure 4. Werry and Planes with a male 3.9 m *G. cuvier* restrained in the shark harness, with a piece of black PVC pipe in the mouth, used for safely removing the hook.

2.4 Acoustic array

Acoustic VR2W Vemco receivers were deployed to determine the long-term movement patterns and site fidelity of large *G. cuvier* in Prony Bay. Receivers were either attached to existing navigational markers or to metal poles embedded in large tyres filled with concrete deployed on the sea floor at depths of 5 to 20 metres (Figure 5). Receivers have been deployed as per Figure 1. in fishing zones of higher *G. cuvier* catch. Detection range of receivers was found to be between 200 to 300 m. As such one receiver was deployed in zone CA at a junction in the bay where opposite shores are within 300 m.

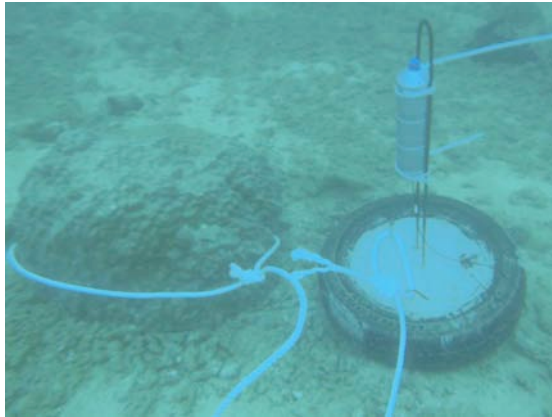


Figure 5. VR2W acoustic receiver attached to a concrete anchor deployed on the sea floor in the vicinity of Prony Bay.

2.5 Acoustic, satellite and stream tagging

Vemco acoustic tags (V16) were internally inserted into the body cavity of tiger sharks ($n = 7$) and the incision was then sutured (Figure 6 a and b). The acoustic tags last for 2 to 10 years depending on configuration. Wildlife computers archival pop-off satellite tags were applied to three large tiger sharks and a stitch was used to secure the tag in the dorsal musculature (Figure 6 c). These tags were set for release for between 3 to 11 months from capture. Captured sharks were also externally tagged with plastic dart tags in order to identify recaptured individuals. A tissue sample was taken from the dorsal fin of sharks for future DNA analysis.



Figure 6. Clua preparing a *G. cuvier* for internal acoustic tagging (left) and attachment of an external archival satellite tag with a stitch (right).

3.0 Results

3.1 Catch statistics

Throughout the surveys undertaken in January (18 to 30/01/2009) and July (6 to 17/07/2009) a total of eleven *G. cuvier* (1.64 to 3.9 m total length (TL)), three *C. leucas* (2.5 to 3 m TL) and one female *Carcharhinus plumbeus* (1.8 m TL) were captured. Animals tagged with external, acoustic and satellite tags included eight tiger sharks and two bull sharks (Table 1). The majority of the catch occurred in zone WE, with one bull shark captured in CA and a 2.1 m tiger at CI. No sharks were captured in zones RN, RE, BA or HA despite baits being deployed simultaneously in WE (Figure 1). Majority of the tiger shark catch was within the 3.1 to 3.5 m TL range (Figure 7).

Common Name	Species Name	Date of Capture	Gender	Total Length (m)	Stream Tag No. and dorsal fin notches	Acoustic Tag ID. No.
Tiger	<i>G. cuvier</i>	26/01/2009	M	2.1	196	
Tiger *	<i>G. cuvier</i>	26/01/2009	F	3	155	54338
Tiger	<i>G. cuvier</i>	28/01/2009	M	3.8	183	54345
Tiger	<i>G. cuvier</i>	7/07/2009	F	1.64	174	54339
Bull	<i>C. leucas</i>	8/07/2009	F	2.95	na	54343
Tiger	<i>G. cuvier</i>	9/07/2009	F	2.7	200	54344
Bull	<i>C. leucas</i>	9/07/2009	F	3	195	54342
Tiger	<i>G. cuvier</i>	13/07/2009	M	3.12	1 Notch at top	54341
Tiger *	<i>G. cuvier</i>	13/07/2009	M	3.4	1 Notch midway	54340
Tiger *	<i>G. cuvier</i>	15/07/2009	M	3.9	1 Notch at bottom	55428

Table 1: Catch statistics for all sharks externally tagged and internally acoustic tagged. Satellite tagged *G. cuvier* are highlighted by *.

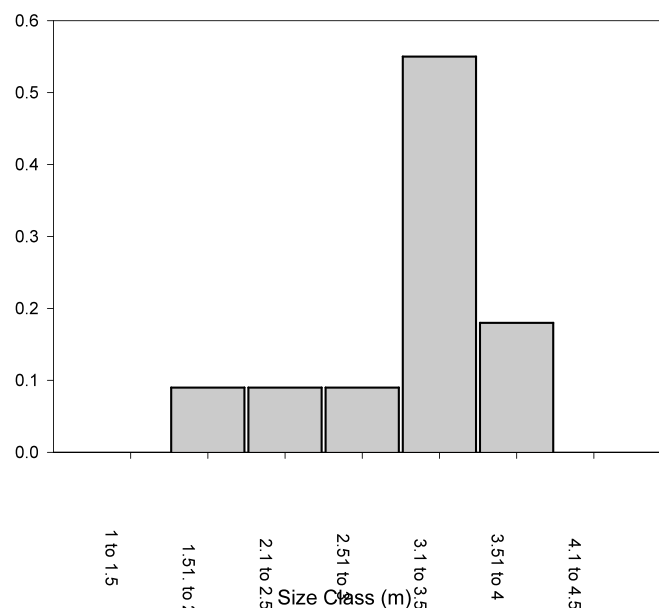


Figure 7. Size distribution (50 cm size classes) of *G. cuvier* catch for both pilot surveys.

3.2 Satellite data

Recent data from a female *G. cuvier* tagged with an archival pop-off satellite tag (july 2009) -that had an early release- suggests direct short-term connectivity between Prony Bay and the Loyalty islands.

3.3 Acoustic data

Acoustic receivers were downloaded in July 2009 and the 3.8m tiger shark internally acoustic tagged (28/01/2009) was recorded on the receivers in Prony Bay up to 5 months later. Detections occurred in the Woodin channel (WE zone) and on a station deployed at BA (Figure 8).

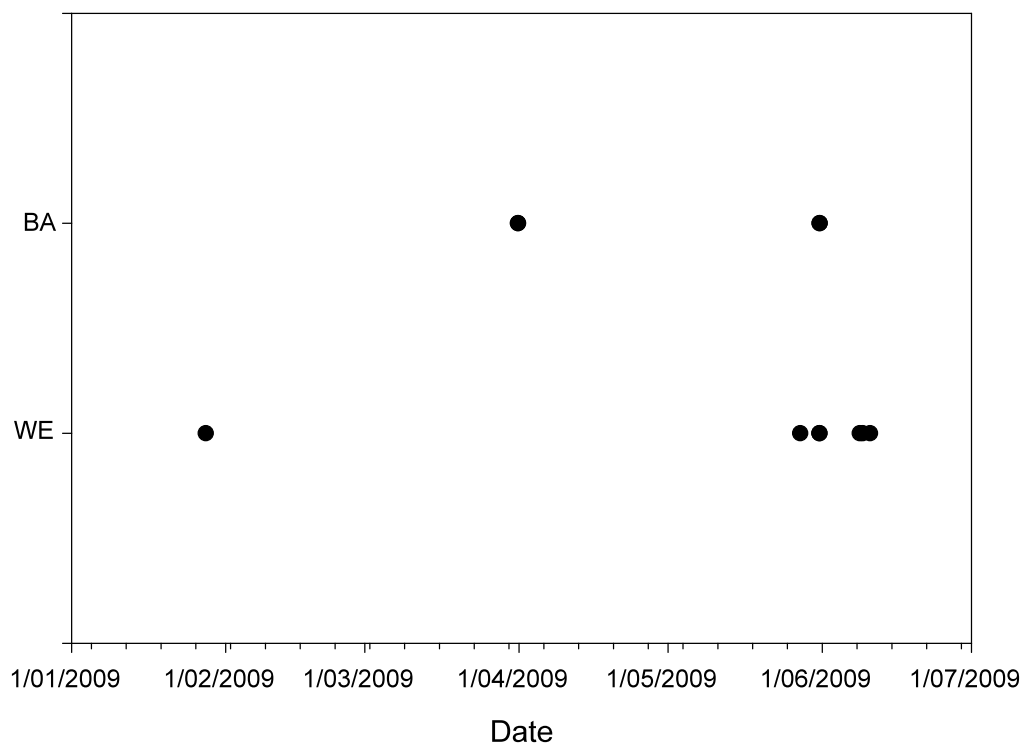


Figure 8. Acoustic detections (i.e. presence) of large tiger (3.8m) tagged on 28/01/2009 in Woodin Channel (zone WE) indicated by black dots.

4.0 Discussion

4.1 Catch statistics

Fishery-independent catch analysis of large shark in Prony Bay and Southern Province provides an important base-line dataset for large shark management in this area, particularly for the identification of hotspots or sites of frequent shark catch. Over 50 % of the *G. cuvier* catch was greater than 2.9 m TL, indicating that the areas sampled are of potential importance to large adult *G. cuvier*.

4.2 Habitat use in Prony Bay and Southern Province

Understanding how key shark species use habitat (and thus habitat connectivity) in Prony Bay is essential for the management and conservation of shark populations and the coral reef habitats they regulate. Our initial results indicate that large *G. cuvier* (one of two *G. cuvier* acoustic tagged in Jan. 2009) return periodically to this site.

4.3 Long-distance movements

Rapid long-distance migration of *G. cuvier* from Prony into international waters raises the concern for exposure of large sharks to international fishing pressures. The movement of the 3 m female *G. cuvier* between New Caledonia and Australia, that could not be confirmed 100% so far, reflects however the potential conservation implications for managing these widely separated habitats lying on a migration 'highway' for marine megafauna (Table 1). The movement of this individual illustrates the need for a better understanding of the movement patterns, habitat requirements and extent of connectivity between coral reef habitats for large sharks in the South Pacific. These data are essential to ensure their effective conservation and provide protection at the spatial level of their home range. Movements of other large sharks such as the Great White, *Carcharodon carcharias*, have been found between New Zealand, New Caledonia, Australia and other regions of the South Pacific along similar latitudes of the Tropic of Capricorn (C. Duffy, pers. comm.).

4.4 Further Research

Further tagging efforts and the deployment of additional listening stations will enable a more comprehensive evaluation of the habitat use and movement of large sharks, primarily *G. cuvier*, in Prony Bay and New Caledonia. Understanding these patterns will also enable management recommendations for the potential reduction in shark-human interactions, whilst ensuring the conservation of large sharks particularly in the light of their essential ecological role.

5.0 Conclusion

This report presents preliminary data from two pilot field trips in Prony Bay. The majority of large shark catch consisted of *G. cuvier* and, of this species, most animals were larger than 2.9 m TL. Pilot data suggest Prony Bay and surrounding waters are an important region for large sharks and understanding the habitat use and movement of large sharks, particularly *G. cuvier*, in this area is essential for their management and conservation, particularly in the light of declining shark populations in most other areas of the globe.

This work was conducted under permit No. 6024-4916/DENV/SMer (New Caledonia) and ethics ENV/16/08/AEC (Griffith University).

6.0 Acknowledgments

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Large shark tagging program in New Caledonia

ABSTRACT

In order to obtain an understanding on the movement patterns, habitat use and fishery-independent catch statistics of large sharks in Prony Bay, in the Southern Province of New Caledonia, two pilot surveys were undertaken in January and July 2009. Modified baited drumlines were set in different areas of Prony Bay and Woodin Channel and checked every 2-5 hr. Seven tiger sharks (*Galeocerdo cuvier*, 1.65 to 3.9 m total length (TL)) captured were internally acoustic tagged and three large tigers, 3 to 3.9 m TL were also tagged with archival pop-off satellite tags. An acoustic array (VR2W) was deployed and sharks were externally tagged to identify recaptures. The status of all sharks was monitored during tagging procedures and sharks were restrained in a non abrasive harness and water flow over the gills was maintained. Initial results indicate one satellite tagged 3 m TL female *G. cuvier* moved into tropical waters of Australia and one 3.8 m male *G. cuvier* tagged in January was periodically detected on the Prony Bay acoustic array in March, May and June 2009. Three bull sharks, *Carcharhinus leucas*, (2.5 to 3 m TL) and one sandbar whaler, *Carcharhinus plumbeus*, were also caught during surveys. These initial results indicate the diversity in potential movement of large *G. cuvier*, including medium range migration and site fidelity (i.e. returning to/remaining within Prony Bay). A comprehensive understanding of these patterns is needed for the effective management and conservation of large sharks. These pilot results will form the basis of a longer term study on the movements and habitat use of *G. cuvier* and other large sharks in New Caledonian waters and the connectivity of these habitats with the rest of the South Pacific in supporting the endangered sharks.

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