CRISP
Coral Reef InitiativeS for the Pacific
Initiatives Corail pour le Pacifique

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Shark conservation

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LICENCE TRAINING

Literature review on catching methods of tiger sharks *(Galeocerdo cuvier)* & white sharks *(Carcharodon carcharias)* around the world

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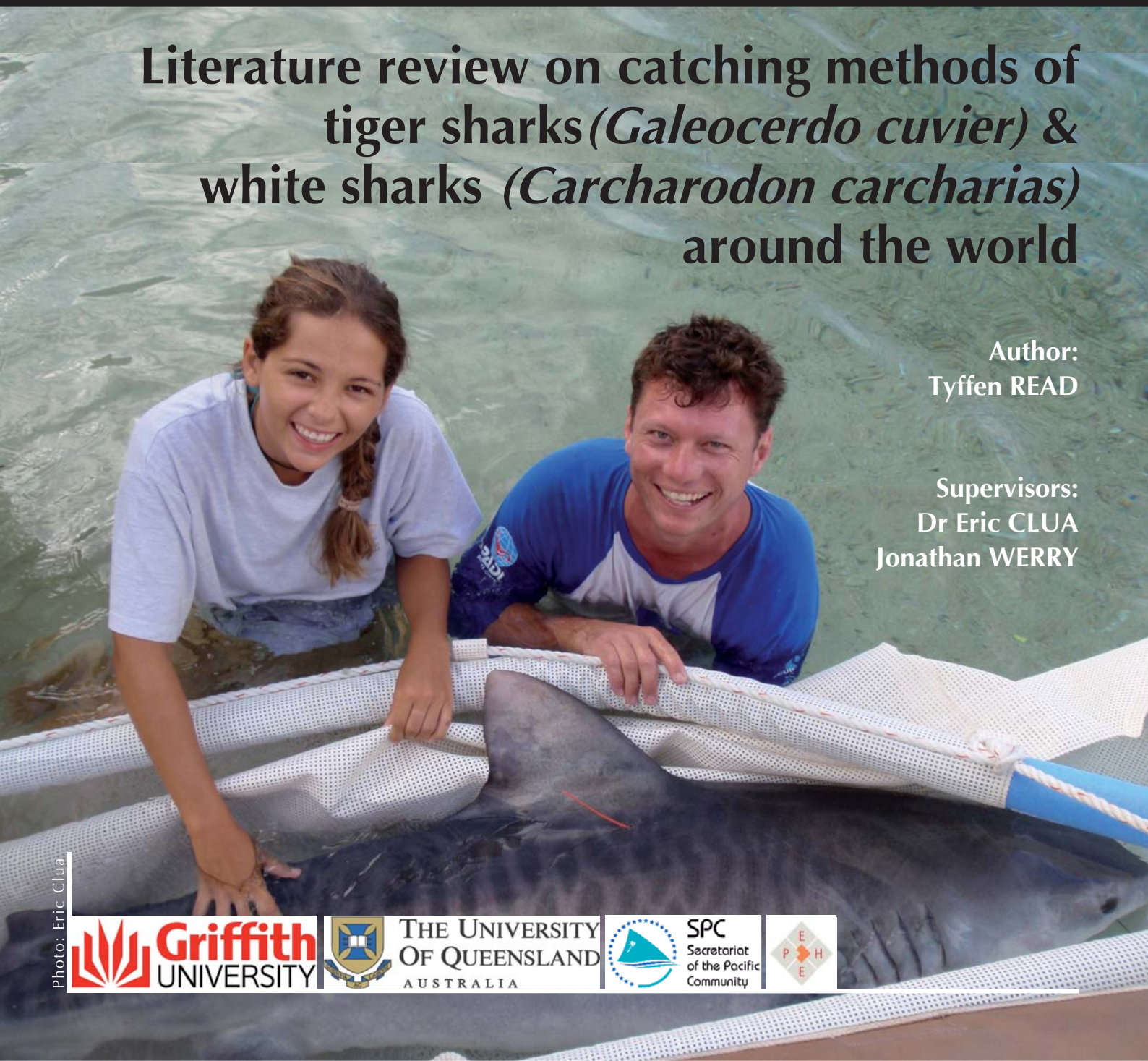

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CRISP

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SPREP/PROE

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 alternatiques et durables (Capture et Culture de Postlarves)
- 3D : Conservation des espèces et écosystèmes vulnérables
- 3E : Cellule économique

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PROVINCE SUD

A.C.R.E.M.

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Literature review on catching methods of tiger sharks (*Galeocerdo cuvier)* and white sharks (*Carcharodon carcharias)* around the world

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Abstract:

Fishing sharks has been a sport for decades but in order to study them, scientists had to come up with fishing methods where the sharks would survive the study. This is a literature review of the different methods used around the world to catch large sharks, tiger sharks (*Galeocerdo cuvier)* and white sharks (*Carcharodon carcharias*). The biggest numbers of sharks caught was usually in shark control programs as the fishing effort to catch a large shark is quite important and is not an exact science. A method can be effective in one area but not as much in another area. Most of studies done of those large sharks did not include the catch rate at which the individuals were caught.

Keywords: *Galeocerdo cuvier; Carcharodon carcharias;* fishing methods; bait; sex ratio

Introduction:

Sharks have been feared by Men for centuries for different reasons. Media plays a big part in continuing to feed this fear but some scientists realised that those animals play a very important part in the marine ecosystem (Figure 1) as they are apex predators (Bonfil, 2005; Heithaus, 2001; Heithaus, 2002; Kitchell, 2002; Wirsing, 2006). In order to understand them and their movements, some studies involved catching the sharks. Different methods are used to catch large sharks like tiger sharks (*Galeocerdo cuvier)* and white sharks (*Carcharodon carcharias)* around the world .We will compare the fishing effort and the catch rates of the different studies and compare them in order to determine the best method.

Biology of tiger shark

Systematics

Tiger sharks are recognisable by faded strips on the side of their body. They have heterocercle tail. They are one of the largest and most abundant large sharks in tropical waters (Simpfendorfer, 1992).
In Shark Bay, Western Australia, the sex ratio of juveniles is 1.8:1, bias towards females. For mature adults, the ratio is 1:1 (Heithaus, 2001).

Movements

Tiger sharks are diurnal and not nocturnal like previously thought. They are caught in higher numbers during daylight (Heithaus, 2001). In Western Australia, their movements are correlated with water temperature. Catch rates were higher when the water temperature was above 19°C (Heithaus, 2001).

Food habits

They feed on a broad range of species(sea turtles, dugongs, sea snakes, sea birds, jellyfishes, rays, marine mammals, crabs, teleosts and much more) (Heithaus, 2001; Randall, 1992) Teleosts and sea snakes were predominantly found in stomach content in Queensland, Australia and New-Caledonia(Heithaus, 2001; Simpfendorfer,1992) as in Hawaii, it was sea birds (Heithaus, 2001). It seems that the size of prey increases with size of the shark (Simfendorfer, 2001).

Age and Growth

In the same paper from Randall, it is stated that tiger sharks with precaudal length over 200 cm were 5 years old as tiger sharks with a precaudal length of 300cm would be about 15 years old.
They can reach a maximum size between 4.9 metres FL and 7.2 metres TL (Natanson, 1999; Sinpfendorfer, 1992) but usually large tiger sharks reported are about 5.5metres TL (Simfendorfer, 2001).
Size at birth is between 61 cm and 120 cm (Fork Length) (Natason, 1999).

Reproduction

Size for reproduction is approximately 287cm TL for females and 290cm TL for males (Simpfendorfer, 1992).

Biology of white shark

Systematics

Carcharodon carcharias is a pelagic apex predator (Weng, 2007).
White sharks have “counter current heat exchangers in the circulatory system” (Klimley, 1996, chapter 10).

Movements

Their movement range is temperate, tropical and polar oceans (Weng, 2007).
White sharks have an anti-tropical distribution in temperate seas but make oceanic migrations (Bruce, 2006).

Food habits

Adults feed on fishes and marine mammals (Weng, 2007).

Age and Growth

Can grow up to 6 metres TL (Bruce, 2006).

Reproduction

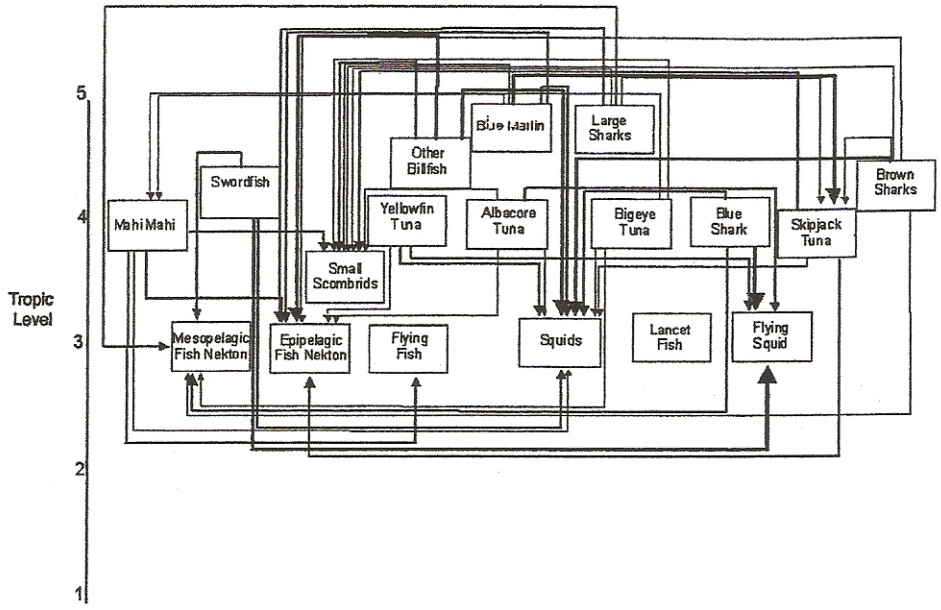

Figure 1: Food web of higher trophic levels (Kitchell, 2002).

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Methods:

In 1981, Timothy C. Tricas *et al* looked at diel behaviour of Tiger sharks in Hawaii. To catch the animals, they sat longlines baited with shark flesh at dusk and checked the lines in the morning. When an individual was caught, it was brought on the side of the boat and tagged with a transmitter on the first dorsal fin. A pole and an applicator were used to apply the device on the animal (Tricas, 1981).

Colin Simpfendorfer did a study on tiger sharks caught on the shark control program off Townsville. The data was collected from 1964 to 1986. The control program was made of gill nets and drumlines. Each gill net was 62 m long and was made of 50 cm mesh. They were anchored off rocky headlands of 6 beaches. There was no detail on the drumlines and what they were made off (Simpfendorfer, 1992).

In the same year, a study was done on White sharks in South Australia. To attract the large sharks “measured amounts of tuna and horse-meat by-product were mixed” (Strong, 1992). They standardized the hours at which the attractants were put into the water by using a robotized pump. When sharks came near the boat, about 1 kg of tuna or horse-meat was baited on 6-10 metres tethers. The sharks were lured at a very close distance of the boat to enable the crew to tag, sample and photograph the animal. When possible, the baits were removed from the water without the sharks being able to ingest it.

A study on space utilization and swimming depth of white sharks was run in 1999 by Kenneth Goldman and Scot Anderson in central California. They decided that it would be easier to make the sharks eat the transmitters than to attach it to them.

Pieces of elephant seal blubber (3-4 kg each) were attached around Vemco transmitters and attached to an unbaited decoy which also had a video camera attached to it to sex each individual. No attractants were used, to avoid a change in behaviour after the tag was ingested and get more accurate data (Goldman, 1999).

One of the papers that gives the most detail on how to catch a tiger shark was written in 1999 by Holland *et al*. They were looking at the movements of *Galeocerdo cuvier* in Hawaii. They used longlines with 12/0 hooks and the baits were tuna heads or some other fish parts. Lines were set at dusk and checked in the morning, like Tricas study in 1981. The area sampled was 11 km long. The lines were set approximately 3.5 km away from the shore and lines would go from 17 to 75m deep. 40 m would separate each line from the other. When a shark was caught, it was attached to the side of the boat (same technique as Tricas in 1981). Two types of acoustic tags were used: external and internal. First type of tags was attached to the dorsal of the sharks as the second type was inserted chirurgically in the abdominal wall through a 12cm incision. The internal tags were only put into sharks that had a TL of 2m or more. Before inserting the internal tags, these were coated with bee and paraffin wax (7:3) to avoid any immunological response or infection. Incisions were closed with a nylon thread (Holland, 1999).

A single great white shark was caught with a halibut gill set net in California (Benz, 2000).

Heithaus in 2001, did a study on the biology of *Galeocerdo cuvier* in Western Australia. They put drumlines in the water, each separated by 300m to 700 m. Each drumline was equipped with a single hook (Mustad Shark Hook) that could be 12/0, 13/0 or 14/0. The hooks were at a depth ranging from 0.7m to 2m. As baits, they used Australian salmon (*Arripis truttaceus*). Each hook had 2 kilos of baits on it.
Lines were checked every 2-4 hours and when a shark was caught, it would be put on the side of the boat to be measured, sexed and tagged(Heithaus, 2001).

In 2002, a group of scientists wanted to look at the habitat use and foraging behaviour of tiger sharks in a seagrass ecosystem (Shark Bay, Australia). They used the same technique and the same bait as in Heithaus (2001). The largest sharks caught got an internal transmitter put into they peritoneal cavity (10 cm incision). As in the study done by Holland in 1999, the transmitters were also coated with a mix of bee and paraffin wax (7:3). To close the incision, nylon thread was also used and 6 stiches were done (Heithaus, 2002).

In order to look for copepods on white sharks, Benz *et al* in 2003, used a halibut gill set net in 60m deep waters and 4.8 km away from the shore (Benz, 2003).

Young *Carcharodon carcharias* were the object of a study by Dewar in 2004. To catch them, they used bottom set nets. The only tag inserted was an external tag at the base of the fin using a large plastic dart (Dewar, 2004)

A study on abundance and growth of tiger sharks in Shark Bay (Australia) used the same method of capture as Heithaus (Heithaus, 2002). They used 10 drumlines with mostly 13/0 mustard shark hook but also used 12/0 and 14/0.

They kept the same bait (Australian salmon) when possible but when it was not available they used Baldchin gropper (*Choerodon rubescens*), Pink snapper (*Pagrus auratus*), Sea mullet (*Mugil cephalus*) and Tailor (*Pomatomus saltatrix*).
This study was over a 7 year period (Wirsing, 2006).

In a study on white sharks of Australia, Bruce was attracting the sharks with mince fish and tuna oil around the boat near a pinniped colony. The sharks got tagged while free swimming, the tags attached were archival tags. For satellite and acoustic tracking, the sharks had to be caught. They used baited setlines. They also used other methods for conventional tagging: Game-fishing, commercial bycatch… (Bruce, 2006).

Kevin Weng published a study, in 2007, on migration and habitat of great white sharks. In order to tag the animals, they did not catch them, they used a 2m long pole to insert the tags in the dorsal musculature. The tags used were pop-up tags. This is one of the less invasive methods. No attractants were used. In order to make this method work, they had to put themselves in predatory events. To determine the sex of the individuals and have an approximate size, they used underwater cameras (Weng, Boustany *et al*, 2007).

Weng published another paper in 2007, on juveniles *Carcharodon carcharias.* His method changed as he is, in this study, getting the sharks from the bycatch of bottom set gillnets. Pop-up tags were also used in this investigation (Weng, O'sullivan *et al*, 2007).

Accidental bycatch of tiger sharks in Hawaii was used to study their reproductive biology (Whitney, 2007).

Heithaus did another study in 2007 on long terms movements of *Galeocerdo cuvier* in Australia using the same method as in 2002 (Heithaus, 2002).He tagged the animals with position-only tags (SPOT4). The tag was attached on the first dorsal fins. Position of the animal would be recorded as soon as the dorsal fin would surface. This tag also allows getting travel speeds (Heithaus, 2007).

Results:

In the study done by T. Tricas, only one female tiger shark(4m) was caught (Tricas, 1981).

In a study down in Townsville between 1964 and 1986, 835 tiger sharks were caught (512F and 313M) The nets had an annual catch rate that varied between 0.0025 to 0.0075 shark net-day $^{-1}$, as the drumlines had an annual catch rate between 0.002 and 0.006 shark line-day $^{-1}$. There was no significant differences in the catch rates of the nets between the years (P=0.7418) as there was with the drumlines (P=0.0005) (Simpfendorfer, 1992).

During the 4 expeditions (total of 152 days), 58 White sharks were caught but only 49 were sexed (24 M and 25 F). The daily catch rate is 0.3816 shark day^{-1} (Strong, 1992).

4 white sharks were caught in the study done by Goldman: 3 males (4.9, 4.6 and 3.7 m) and one female (3.9 m) (Goldman, 1999).

Between September 1993 and May 1997, Holland caught 8 tiger sharks (6 males and 2 females, ranging from 2m and 4,17m) (Holland, 1999).

A single female white shark of 4.333m was caught in Benz's study (Benz, 2000).

In his study on the biology of tiger sharks in Shark Bay, Heithaus caught 252 sharks but 29 were recaptures. So they caught 144 females and 83 males (n=227). They found that hook size and bait type had an effect on the catch rates. 13/0 hooks caught more sharks then 12/0 (x^2=7.5, df=2, p<0.05) and lines with salmon heads (0.39 sharks hook $^{-1}$) got a lot more sharks than lines with other parts of the salmon (0.22 sharks hook $^{-1}$) (x^2=18.2, df=2, p<0.001). This study also showed that more sharks were caught during the day (0.06 sharks hour $^{-1}$) rather than at night (0.02 sharks hour $^{-1}$) (x^2=12.1, df=2, p<0.001) (Heithaus, 2001).

Heithaus, for his study on foraging, caught 49 tiger sharks (27 females and 22 males). They noticed that sharks that had a telemetry device attached to them spent a lot of time at the surface (Heithaus, 2002).

Only one shark was caught in Benz's study with a halibut gill set net (4.33 m, female) (Benz, 2003).

In the study on young white sharks, only one juvenile female was caught (1.4 m, FL)(Dewar, 2004).

Since 1991, 492 sharks were caught in the study done by Wirsing in Australia, 449 of which were *Galeocerdo cuvier*. They found that they caught more tiger sharks during the hot months of the year and a lot less during cold months. Another finding was that bait type did affect the catching of these large sharks. Their catch rates ranged from 0 to 0.28 sharks h^{-1} for the 7 years this study lasted. In total, they caught 305 females and 117 males (only 422 sharks could be sexed) (Wirsing, 2006).

Bruce, during his study, tagged 485 white sharks, all methods included. The most important tagging occurred with the free-swimming method (n=399) but only 6 individuals got satellite tracking which means that only 6 sharks (4 females and 2 males) were caught on the baited lines (Bruce, 2006).

With his non-invasive method, Weng tagged 20 sharks in a 5 year period. 11 were males, 5 were females and the 4 others could not be sexed (Weng, Boustany *et al*, 2007).

In his other study, Weng tagged 6 juveniles *Carcharodon carcharias* in a 2 year period. It was 4 females and 2 males (Weng, O'sullivan *et al*, 2007).

During Whitney's study, 359 tiger sharks were caught as bycatch (185 females and 174 males) (Whitney, 2007).

In 2007, Heithaus tagged 5 sharks with satellite tags (4 females and 1 male) (Heithaus, 2007)

	females	males
study 1	1	0
study 2	1	3
study 3	2	6
study 4	27	22
study 5	1	0
study 6	1	0
study 7	305	117
study 8	4	2
study 9	11	5
study 10	4	2
study 11	185	174
study 12	4	1
study13	1	0
study14	512	323
study15	144	83
Total	**1203**	**738**

Table1: Sex ratio on sharks tagged in the different studies

We did an ANOVA to look at the difference in the catch between males and females (Table1) on the different studies and we got a P value of 0.500895.

Discussion:

We can see from the different studies that most sharks tagged were caught in order to be tagged. Baits were usually used, either to get the sharks caught on a hook or to come close to the boat. Different scientific have different approaches to the tagging of large sharks either by fear or by not wanting to disturb too much the animals. There are pro's and con's about not catching the animals: it is true that catching the individuals on a hook or in a net looks much more traumatising than just getting them to eat something(Goldman, 1999) or tagged while free-swimming(Bruce, 2006 and Weng, Boustany *et al*, 2007) but it has consequences on the data collected. In order to sex the animals (which is significant in most study) a video camera was put under water, but an important number of sharks could not be sexed in some studies (Bruce, 2006 and Weng, Boustany *et al*, 2007).
Tagging large sharks while free-swimming implies an important number of sharks in the area (usually feeding grounds) but it also rely on the factor that you can get the shark close enough to your embarkation to allow the tagging.
Even within the free-swimming technique there are some variations: some use attractants (Bruce, 2006 and Wirsing, 2006) and some do not (Weng, Boustany *et al*, 2007).
Catching the shark means that you can get more data out of it, skin and blood samples can be collected, sexing the animal becomes a lot easier and a lot more accurate and you can also measure the animal. So in one study, you can actually get more data.

There are also a lot of variations within that method: some actually used lines and baits to specifically catch sharks (Tricas, 1981; Holland, 1999; Heithaus, 2002 and Heithaus, 2007) and some used the bycatch from fisheries or shark control programs (Benz, 2003; Dewar, 2004; Simpfendorfer, 1992; Weng, O'sullivan *et al*, 2007 and Whitney, 2007).

Usually when the sharks are caught within a shark control program, the animals die. The lines or nets within a program are not allowing them to swim to ventilate their gills and sharks die of asphyxiation.

The ANOVA we did on the sex ratio gave us a P value of 0.500895 which means that there is no statistical significance in the sex ratio which is in agreement with the findings of Heithaus in 2001.

Not all studies calculated their catch rates and did not provide enough information for us to do it.

References:

Benz W. Georges, Mollet F. Henry, Ebert A. David, Davis R. Corinne, and Van Sommeran R. Sean, 2003, 'Five Species of Parasitic Copepods (Siphonostomatoida: Pandaridae) from the Body Surface of a White Shark Captured in Morro Bay, California' , *Pacific Science*, N1, Vol57, pp39-43

Bonfil Ramon, Meyer Michael, Scholl M. Michael *et al*, 2005, 'Transoceanic migration, spatial dynamics and population linkages of White Sharks', *Science*, Vol310, pp100-103

Bruce B. D, Stevens J. D, and Malcolm H, 2006, 'Movements and swimming behaviour of white sharks (*Carcharodon carcharias*) in Australian waters', *Mar Biol*, N150, pp161-172

Dewar Heidi, Domeier Michael and Nasby-Lucas Nicole, 2004, 'Insights into young of the year white shark, *Carcharodon carcharias*, behavior in the Southern California Bight', *Environmental Biology of Fishes*, N70, pp 133-143

Goldman J. Kenneth and Anderson D. Scot, 1999, 'Space utilization and swimming depth of white sharks, *Carcharodon carcharias*, at the South Farallon Islands, central California', *Environmental Biology of Fishes*, N56, pp351-364

Heithaus R. Michael, 2001, 'The biology of tiger sharks, *Galeocerdo cuvier*, in Shark Bay, Western Australia: sex ratio, size distribution, diet, and seasonal changes in catch rates', *Environmental Biology of Fishes*, N61, pp25-36

Heithaus R. Michael, Dill M. Lawrence, Marshall G.J and Buhleier B, 2002, 'Habitat use and foraging behaviour of tiger sharks (*Galeocerdo cuvier*) in a seagrass ecosystem', *Marine Biology*, N140, pp237-248

Heithaus R. Michael, Wirsing J. Aaron, Dill M. Lawrence, Heithaus I. Linda, 2007, 'Long-term movements of tiger sharks satellite-tagged in Shark Bay, Western Australia', *Mar Biol*, N151, pp 1455-1461

Holland K.N, Wetherbee C.G, Lowe and Meyer C. G, 1999, 'Movements of tiger sharks (*Galeocerdo cuvier*) in coastal Hawaiian waters', *Mar Biol*, N134, pp665-673

Kitchell F. James, Essington E. Timothy, Boggs H. Cristofer, Schindler E. Daniel and Walters J. Carl, 2002, 'The role of sharks and longline fisheries in a pelagic ecosystem of the central Pacific', *Ecosystems*, Vol.5, N2, pp202-216

Klimley A. Peter and Ainley G. David, 1996, Great white sharks: The Biology of *Carcharodon carcharias* , Academic Press, San Diego

Natanson J. Lisa, Casey G. John and Kohler E. Nancy, 1999, 'Growth of the tiger shark, *Galeocerdo cuvier*, in the western North Atlantic based on tag returns and length frequencies; and a note on the effects of tagging', Fishery Bulletin, Vol97, N4, pp944-953

Randall E. John, 1992, 'Review of the Biology of the Tiger Shark (*Galeocerdo cuvier*)', *Australian Journal of Marine and Freshwater Research*, N43, pp21-31

Simpfendorfer Colin, 1992, 'Biology of Tiger Sharks (*Galeocerdo cuvier*) Caught by the Queensland Shark Meshing Program off Townsville, Australia', *Australian Journal of Marine and Freshwater Research*, N43, pp33-43

Strong R. Wesley Jr, Murphy C. Richard, Bruce D. Barry and Nelson R. Donald, 1992, 'Movements and Associated Observations of Bait-attracted White Sharks, *Carcharodon carcharias*: A Preliminary Report', *Australian Journal of Marine and Freshwater Research*, N43, pp13-20

Tricas C. Timothy; Taylor R. Leighton and Naftel Gary, 1981, 'Diel Behavior of the Tiger Shark, Galeocerdo cuvier, at French Frigate Shoals,Hawaiian Islands', *Copeia*, Vol.1981, N4, pp904-908

Weng C. Kevin, Boustany M. Andre, Pyle Peter, Anderson D. Scot, Brown Adam, Block A. Barbara, 2007, 'Migration and habitat of white sharks (*Carcharodon carcharias*) in the eastern Pacific Ocean', *Mar biol*, N152, pp877-894

Weng C. Kevin, O'Sullivan B. John, Lowe G. Christopher, Winkler E. Chuck, Dewar Heidi, Block A. Barbara, 2007, 'Movements, behavior and habitat preferences of juvenile white sharks *Carcharodon carcharias* in the eastern Pacific', *Mar Ecol Prog Ser*, vol.338, pp211-224

Whitney M. Nicholas and Crow L. Gerald, 2007, 'Reproductive biology of the tiger shark (*Galeocerdo cuvier)* in Hawaii', *Mar Biol*, N151, pp63-70

Wirsing J. Aaron, Heithaus R. Michael and Dill M. Lawrence, 2006, 'Tiger shark (*Galeocerdo cuvier*) abundance and growth in a subtropical embayment: evidence from 7 years of standardized fishing effort', *Mar Biol*, N149, pp961-968

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Abstract

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