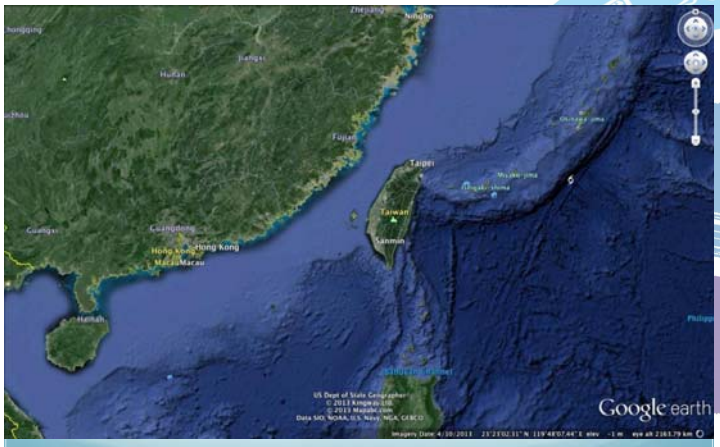
計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

東沙精靈-尖齒檸檬鯊

東沙島周邊海域檸檬鯊族群與分布研究

Study of Distribution and Population of Sharptooth Lemmon Shark (*Negaprion acutidens*) Around the Nearshore Water of Dongsha Island

Chen, Yu-Yun
2016, 05, 20



Environment

Plenty of Seagrass beds around the Dongsha island and inner side of atoll 。

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

一. Introduction

The diversified environment surrounding Dongsha island and inner side of atoll

More like a nursery ground, so that the young predators are easily to search for food at shallow seagrass beds.

The seagrass beds around Dongsha island provide food and shelter to various creatures, which include the young sharks and rays.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

Cartilagnious fishes of Dongsha

The one

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

What kinds of sharks and rays here?

Where to find shark and ray?

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 結果 | 工作配置

板鰓亞綱（Elasmobranchii）
正鮫首目（Galeomorphii）
鬚鮫目（Orectolobiformes）
異齒鮫目（Heterodontiformes）
白眼鮫目（Carcharhiniformes）
真鮫科
真鮫（白眼鮫屬）*Carcharhinus*
汙鰭真鮫 *Carcharhinus melanopterus* (NT)
黑邊鰭真鮫 *Carcharhinus limbatus* (NT)
柳葉鮫屬 *Negaprion*
尖齒柳葉鮫 *Negaprion acutidens* (VU)
琵鷺鮫首目（Squatinomorphii）
鮫首目（Squalomorphii）
鱝目（Rajomorphii）
燕魟目（Myliobatiformes）
燕魟科 Myliobatidae
燕魟屬 *Aetobatus*
納氏燕魟 *Aetobatus narinari* (NT)
土魟科（魟科）Dasyatidae
條尾魟屬 *Taeniura*
邁氏條尾魟 *Taeniura meyeni* (VU)
土魟屬（魟屬）*Dasyatis*
鬼魟 *Dasyatis lata* (NT)
帶尾魟屬 *Himantura*
費氏帶尾魟 *Himantura fai* (LC)
鱝首目（Rajomorphii）

6 or 7 Elasmobranches (*Carcharhinus melanopterus* 、*Carcharhinus limbatus* 、*Negaprion acutidens*、*Aetobatus narinari* 、*Dasyatis lata* 、*Taeniura meyeni* and *Himantura fai*) in Dongsha's waters

(Shen et al., 1983; Chen et al., 2011)

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

Lemmon shark

How many? Dangerous?

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

So, this study would like to know

1. How many lemon sharks here?

2. Where do they live?

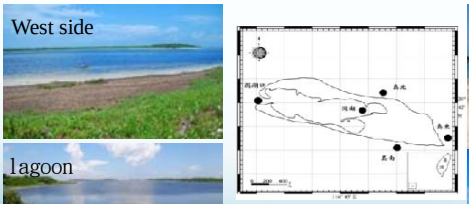
Previous study show low visual record here.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

三、Method

1.Diversity and abundance

Fig. 3-1 5 investigating area
(west, north, east, , so



計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

Visual method

Fig.3-2 Snorkeling and scuba diving

50m x 10m area，2 to 3 person for Visual survey

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

Set net and fixed net 網罟

centipede net

Fig. 3-3 Tagging and capture samples from set net and centipede netprocess

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

Measure and record

1. Examine the sex ratio, tagged record and photo
2. Plastic, Tagging on the first dorsal fin
3. Measure Total Length, Fork Length, Precaudal Length；
4. Catch the DNA and Isotope sample from the caudal fin and anal fin (2cm*2cm each)for diversity study
5. Find the scar or any signs on the body
6. Measure weight
7. Finally, gently release

Fig. 3-4 Measuring and recording captured sample.

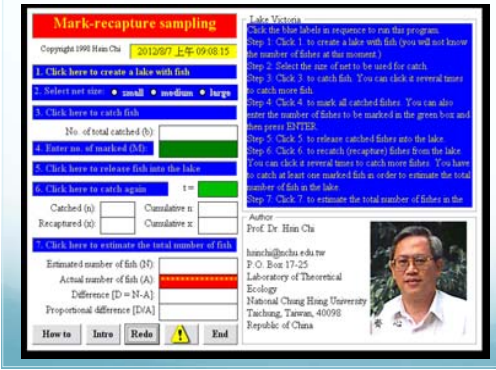
計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

Fig. 3-5 Tagging juvenile lemon shark with plastic tag and microchip.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

Population size

Lincoln-Peterson method



N=(t*n)/R
N: No. of total sharks
t : No. of tagged
n: No. of captured
R: No. of recaptured

Fig. 3-7 Estimation of population size with Lincoln-Peterson method.

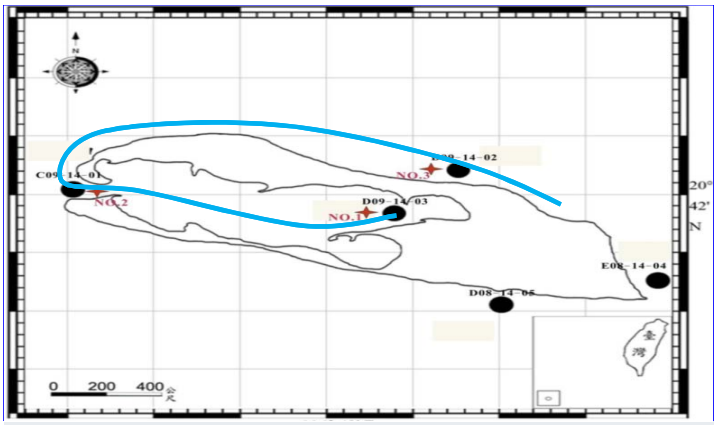


Fig. 3-8 Locations of receivers. Receivers 1, inner side of small lagoon 20°42'19"N, 116°43'30"E; Receivers 2, Gape of lagoon 20°42'25"N, 116°42'38"E; Receivers 3, northern side of Donsha island 20°42'25"N, 116°43'30"E。

Fig. 3-6 Tagging with acoustic tag on the back of shark.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

四. Results

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 結果 | 工作配置

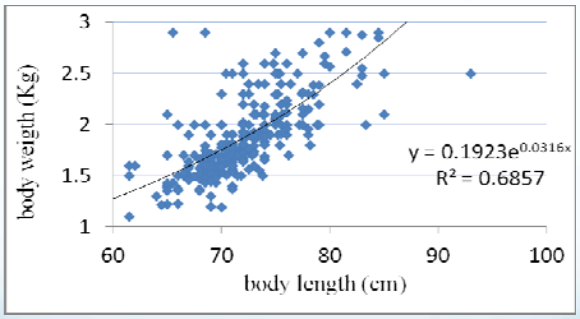


Fig. 4-1 Length-Weight relation of sharp-tooth lemon shark.

Table 4-1、2014' s marked-recapture analysis of lemon shark' s population size.

				Total marked	Total capture	Recaptured	Esitmated population size	SE
Estimation				t	n	R	N=t*n/R	
	New tagged	Dead No.	recaptured	live				
	26	0	0	26	26	26	0	
	15	0	5	41	41	15	0	
1st	14	1	1	54	54	16	1	918	8827
2nd	33	1	4	86	86	38	4	513	388
3rd	31	0	10	117	117	41	10	352	105
4th	7	0	5	124	124	12	5	280	110

Table 4-2、2015’s estimated population size of lemon shark around the waters of Dongsha Island.

月份	Recaptured	New tagged	Total	Mp	Male	Female	Sex ratio
一	2	2	4		4	0	
四	3	7	10		3	7	
五	8	41	49	55	27	22	
七	23	13	36	78	24	12	
十	13	19	32	155	19	13	
十一	22	23	45	167	26	19	
Total	71	105	176	260	103	73	1.41

Table 4-3、Informations about tagged sharks from Oct/2014 to Jan/2016

Shark ID code	Tagging date	Days deployed	TL (cm)	FL (cm)	Sex	Detections
10022	2013/10/24-2016/01/12	446	73.0	61.5	M	199442
10023	2013/10/24-2016/01/12	446	69.5	58.5	F	131029
40000	2013/10/24-2016/01/12	446	72.5	61.0	M	35422
10020	2014/10/27-2016/01/12	443	77.5	65.5	M	184165
10024	2014/10/28-2016/01/12	442	68.5	58.0	F	3110
10021	2014/11/07-2016/01/12	432	74.0	64.0	F	92000
40100	2014/11/12-2016/01/12	427	211.0	174.0	F	733
29500	2015/10/13-2016/01/12	92	101.0	86.0	F	3642
29600	2015/10/13-2016/01/12	92	64.0	59.0	F	7182
29700	2015/10/13-2016/01/12	92	75.5	64.5	M	0
T14823	2015/11/09-2016/01/12	65	182.0	154.0	F	0
T418160	2015/11/09-2016/01/12	65	70.0	60.5	M	0

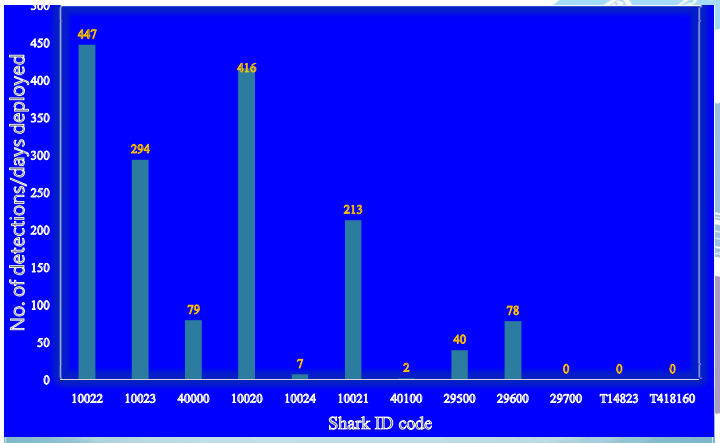


Fig. 4-2 Recording frequency of acoustic tagged lemon shark from 10/2014 to 1/2016 .

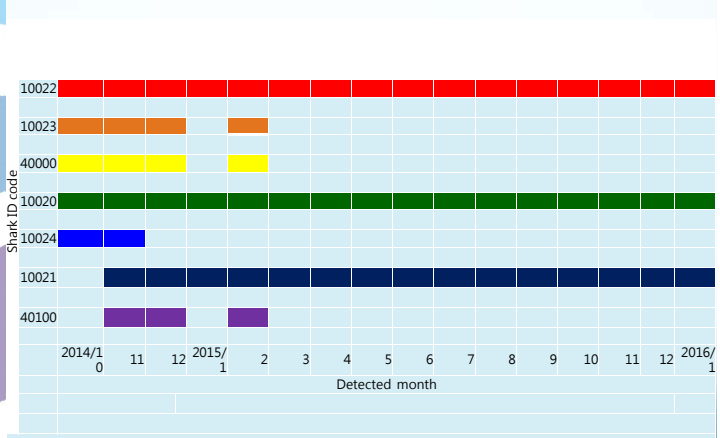


Fig. 4-3 Detected months of acoustic tagged shark from 2014/10 to 2016/1.

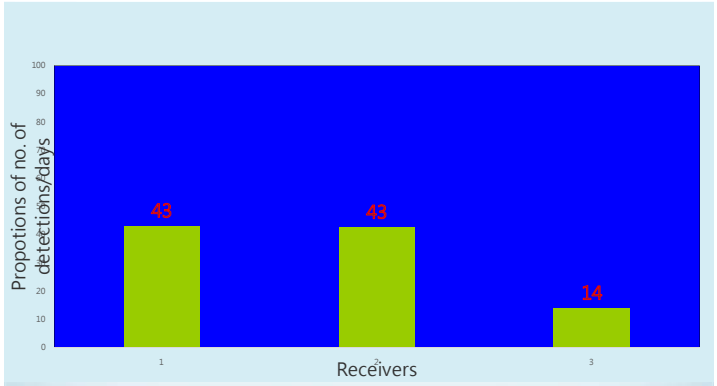


Fig. 4-4 Recording proportions of detections among three receivers from acoustic tagged lemon shark from 10/2014 to 1/2016. “1” receiver located at inner lagoon, “2” receiver located at the gape of the lagoon, “3” receiver located at the northern side of Dongsha island.

Fig. 4-4 Detected density of acoustic tagged lemon shark 10022 from 10/2014 to 1/2016 .

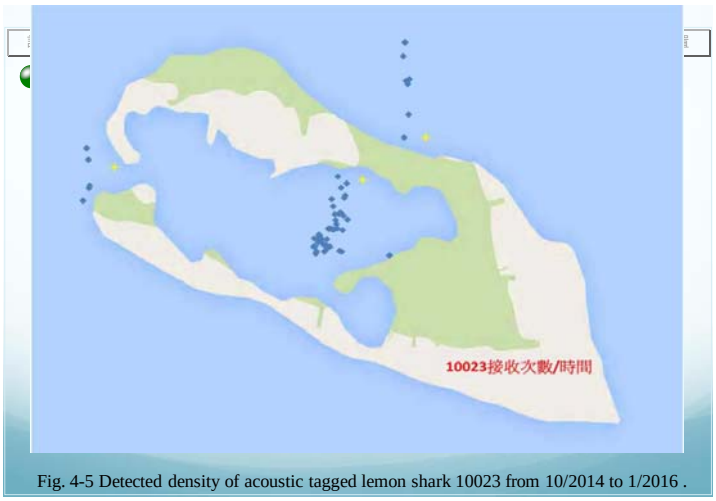


Fig. 4-5 Detected density of acoustic tagged lemon shark 10023 from 10/2014 to 1/2016 .

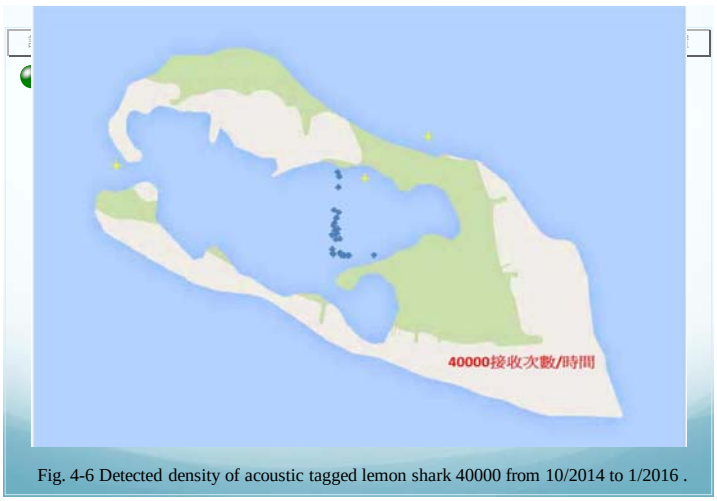


Fig. 4-6 Detected density of acoustic tagged lemon shark 40000 from 10/2014 to 1/2016 .

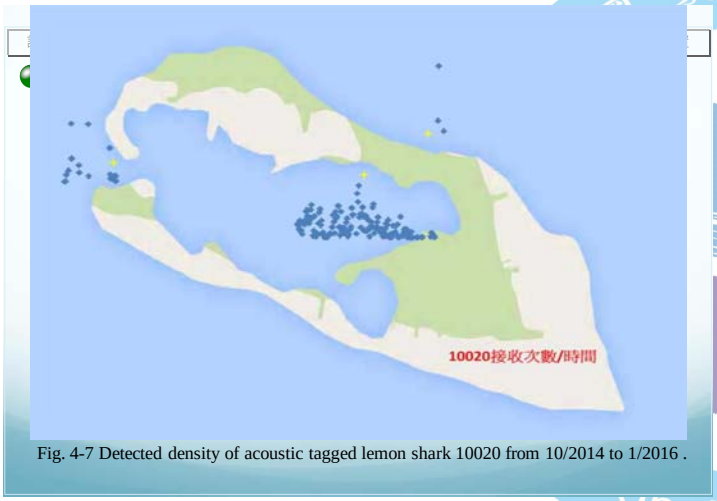


Fig. 4-7 Detected density of acoustic tagged lemon shark 10020 from 10/2014 to 1/2016 .

Fig. 4-8 Detected density of acoustic tagged lemon shark 10024 from 10/2014 to 1/2016 .

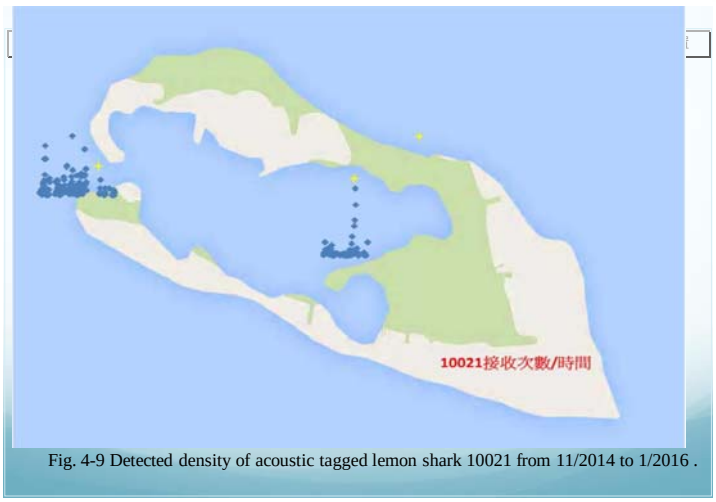


Fig. 4-9 Detected density of acoustic tagged lemon shark 10021 from 11/2014 to 1/2016 .

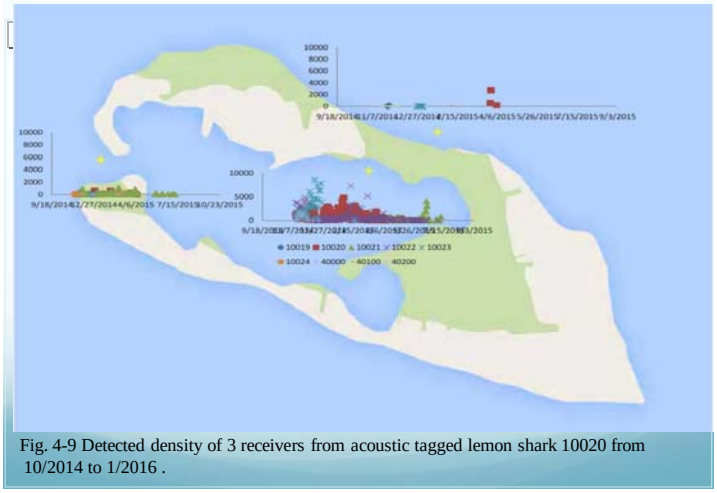


Fig. 4-9 Detected density of 3 receivers from acoustic tagged lemon shark 10020 from 10/2014 to 1/2016 .

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

五. Conclusion

1. According to the 2013-2014's calculations, lemon shark's population size is around 260-280. And most caught samples are juvenile. 檸檬鯊族群大小介於260-280隻。
2. Average TL of sharks caught from southern side > northern side>gape of lagoon> inner side of lagoon.捕捉大小：南邊大於北邊大於潟湖口大於小潟湖內。
3. Most of young lemon sharks distributed around the inner lagoon of Dongsha island, and the gape of lagoon, which congruent to the results of Murchie et al. 2010 and Filmalter et al. 2013. 個體密度以小潟湖與潟湖口最高，與之前國外印度洋及大西洋的研究成果一致。

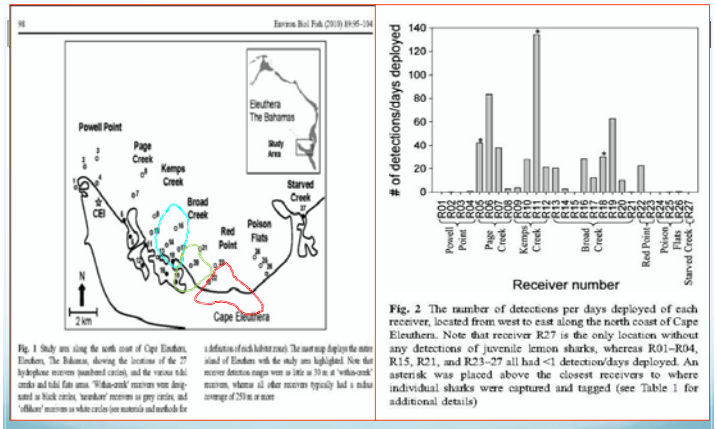


Fig. 4-10 Distribution of lemon shark from Cape Eleuthera, Bahama, Atlantic Ocean (Murchie et al. 2010) 。

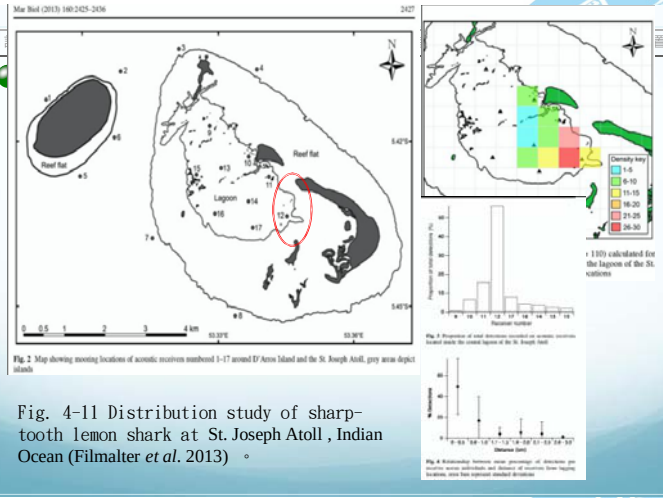


Fig. 4-11 Distribution study of sharp-tooth lemon shark at St. Joseph Atoll , Indian Ocean (Filmalter *et al*. 2013) 。

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

4. Dongsha's *Negaprion acutidens*'s haplotype and nucleotide diversity is 0.44 and 0.00074 (more than the world average 0.28 & 0.00056), which shows Dongsha lemon shark population genetic diversity is higher.

5. In view of the neutality and expansion test, they reveals an isolated group or population here, which shows though Dongsha's lemon shark a higher diversified group, but less or no gene flows with the other population. This results indicate lemon shark do not migrate far away or off the atolls to the other island or coasts of Southeast Asia (congruent to the previous sttudies).

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

6. The result of historical demographic analysis (mismatch distribution, neutrality test, Bayesian skyline plots) showing a multi-model distribution, reveals that lemon shark is gradually run into a steady state population without going through population expansion mode. Surmising the lemon sharks migrating along the water of Dongsha atoll has evolved as a separate ethnic group.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方式 | 預期成果 | 工作配置

Fig. 4-12 Adult lemon shark move around the mouth side of lagoon at 16/4/2013.

Fig. 4-13 Photograph of whip ray and eagle ray from aircraft DJI Phantom 3.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 工作配置

This time we just get a little information about the sharp-tooth lemon shark.

Next time we hope could provide more data including juvenile shark's feeding behavior, spatiotemporal distribution, philopatric site, and population expanding.

Fig. 4-15 (1).receiver 1: 20°42'19"N, 116°43'30"E ; (2).receiver 2: 20°42'25"N, 116°42'38"E ; (3).receiver 2: 20°42'25"N, 116°43'30"E · 水深1-5公尺 ; (4).receiver 4: 20°42'196"N, 116°44'237"E ; (5).receiver 5: 20°41'52"N, 116°43'44"E ; (6).receiver 6: 20°42'383"N, 116°42'124"E ; (7).receiver 7: uncalibrated. ; (8).receiver 8: 20°43'100"N, 116°43'825"E ; (9).receiver 9: uncalibrated. ; (10).receiver 10: uncalibrated. ; (11).receiver 11: uncalibrated. ; (12).receiver 12: uncalibrated.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 建議

Suggestions

1. Over 300 sharp-tooth lemon sharks' tagging and adding more observation during March to June for the verification of possible parturition period
2. Real-time monitoring to find out the sharp-tooth lemon shark or ray's way of life with live recording
3. More satellite transmitter or acoustic tag trailing the sharp-tooth lemon shark's migratory route and habitat
4. Long-term recommendations: Dongsha island waters with lots of cartilaginous fish resources may be used as another achievement of conservation action. Conservation of biological breeding ground help preserve its resources, while it can also achieved to enhance ecological balance and sustainable value.

計畫目標 | 團隊實績 | 背景分析 | 規劃構想 | 進行方法 | 預期成果 | 感謝

Acknowledgements

We would like to thank

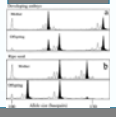
- Research funds from Marine National Park Headquarters and many helps from staffs of Dongsha research station.
- Adult lemon shark's picture from 邱百合.
- Especially, thanks to 莊政賢、陳慧如 for the help on the research process.
- Also thanks to our colleague and graduate students, e.g., 蘇焉、齊心、簡毓群、方培文、張清煌、黃天欣、黃櫛玉

Thanks for your patient and considerartions

計畫目標 | Microsatellite DNA | 背景分析 | 規劃構想 | 進行方法 | Mitochondrial DNA | 預期成果 | 工作配置

DNA 萃取

PCR
多組loci



數據分析：
族群結構
族群聯通性
親子關係
有效族群估算

Marker 特性：
核遺傳
變異性非常高
通常反應近期數個世代的基因交流

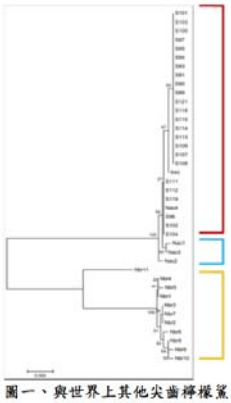
DNA 萃取

PCR
單一locus

數據分析：
族群結構
族群聯通性
有效族群估算

Marker 特性：
母系遺傳
變異性較低
通常反應歷史上的基因交流

計 | 粒線體DNA: | 作配置



成果：

Negaprion acutidens

Taiwan

Other regions in the world

Negaprion brevirostris

因突變速率較低，
所以反映的是經過
數千或萬年變異累積的
結果，如有分化，
將會觀測到有不同的
系群產生。

圖一、與世界上其他尖齒樽複鯊比較所得之親緣關係樹。