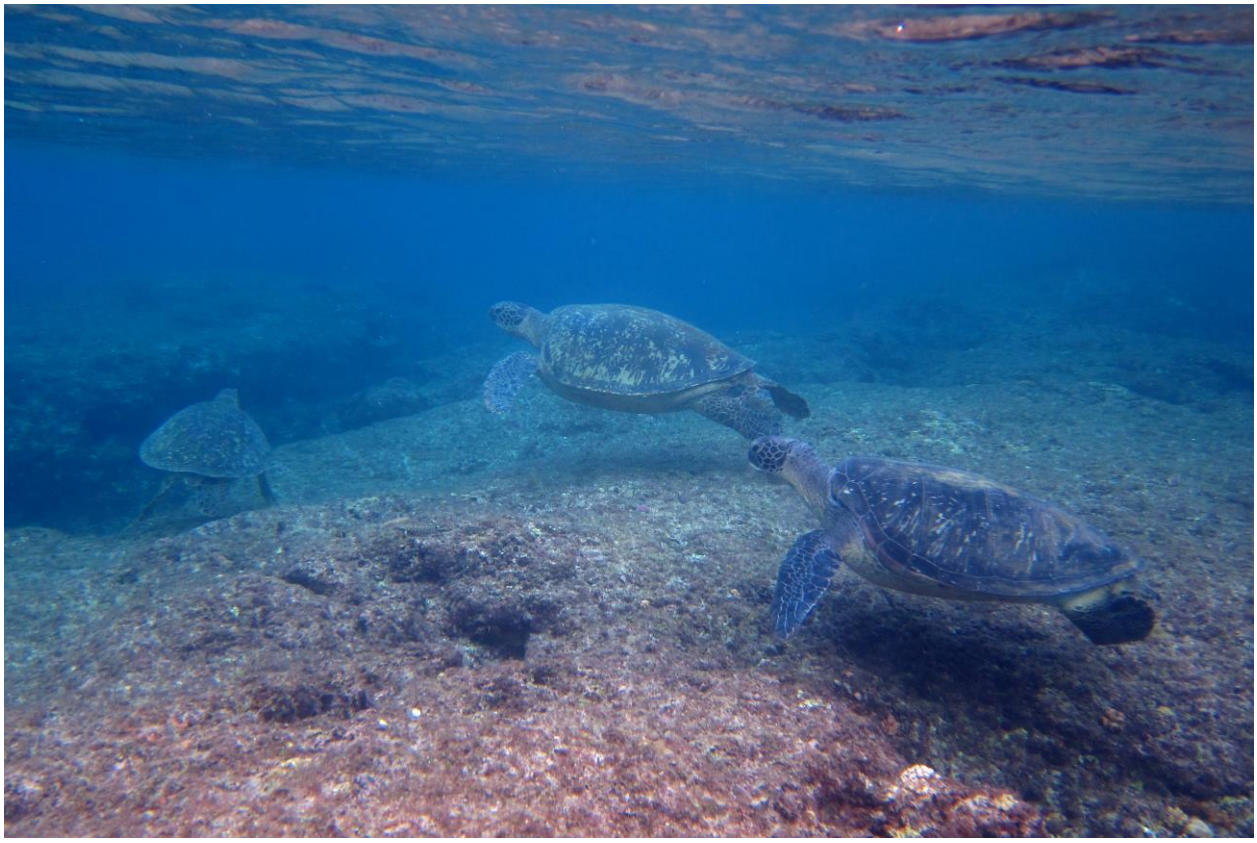
Sea Turtles in the East Asia Region

MTSG Annual Regional Report 2020



Green turtles foraging in the coastal waters of Luichiu Island, Taiwan
© Connie Ka Yan NG

Editors:

Connie Ka Yan NG[1,3] and Yoshimasa MATSUZAWA[2,3]

[1]Department of Chemistry and State Key Laboratory in Marine Pollution, City University of Hong Kong, Hong Kong Special Administrative Region, People's Republic of China
[2]Sea Turtle Association of Japan, Japan
[3]Regional Co-Vice Chairs for the East Asia Region, MTSG

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REGIONAL OVERVIEW

Editors: Connie Ka Yan NG[1,3] and Yoshimasa MATSUZAWA[2,3]

[1]Department of Chemistry and State Key Laboratory in Marine Pollution,
City University of Hong Kong, Hong Kong Special Administrative Region,
People's Republic of China
[2]Sea Turtle Association of Japan, Japan
[3]Regional Co-Vice Chairs for the East Asia Region, MTSG

Four chapters (Japan, Republic of Korea, Hong Kong and Taiwan) in the East Asia Region contribute to this MTSG regional report, representing 5 Sea Turtle Regional Management Units (RMUs, Wallace et al. 2010). We hope chapter on sea turtles in mainland China would be available in the coming updates. The below sections summarize each RMU contributed by the countries in East Asia Region and present each individual country chapter. Each country chapter, serving as auxiliary information, should be read in conjunction with the data compiled in each corresponding spreadsheet for completeness.

1. RMU: Green Turtle *Chelonia mydas*, Pacific Northwest (CM-PNW)

Countries/ places contributing to this RMU: Japan, Republic of Korea, Hong Kong, Taiwan

1.1. Distribution, abundance, trends

Green turtle is a common species encountered in the East Asia Region.

1.1.1. Nesting sites

Nestings of green turtles were recorded in Ogasawara Islands and Nansei Islands of

Japan, some remote beaches of Hong Kong and several islands in Taiwan (see *Japan, Hong Kong, Taiwan*).

1.1.2. Marine areas

Important in-water habitats such as migratory corridors of post-nesting green turtles and foraging grounds were found in Japan, Republic of Korea, Taiwan and South China Region, where Hong Kong is located (see *Japan, Republic of Korea, Hong Kong, Taiwan*).

1.2. Other biological data

Genetic study was carried out to identify the similarity of green turtle rookeries in Japan and the Pacific (see *Japan*). Genetic analysis revealed several primary source rookeries in the Pacific contributing to foraging green turtle aggregations in the South China Region, including Taiwan and Hong Kong. Green turtles in Hong Kong were found to consume 6 red algae species, 1 brown alga species and 1 seagrass species (see *Hong Kong and Taiwan*).

1.3. Threats

1.3.1. Nesting sites

Historical harvest of green turtle eggs (see *Japan, Hong Kong*) and light pollution in nesting beaches near residential areas (see *Japan*) pose threats to nesting green turtles and their nesting sites. Illegal poaching on the high seas along the migratory corridor is believed to cause reduction in nesting population on Wan-an Island in Taiwan (see *Taiwan*).

1.3.2. Marine areas

By-catch (see *Japan, Republic of Korea, Hong Kong, Taiwan*) and marine pollution such as plastic debris (see *Republic of Korea, Hong Kong, Taiwan*) are documented

threats to green turtles in water. Fibropapillomatosis (FP), a debilitating tumor-forming disease, has been reported in green turtles in Taiwan (see *Taiwan*).

1.4. Conservation

Green turtles and their habitats are legally protected under national laws and local ordinances. Habitat protection and management, monitoring of nesting beaches and public education have been in place (see *Japan*, *Republic of Korea*, *Hong Kong*, *Taiwan*).

2. RMU: Loggerhead Turtle *Caretta caretta*, Pacific North (CC-PN)

Countries/ places contributing to this RMU: Japan, Republic of Korea, Hong Kong and Taiwan

2.1. Distribution, abundance, trends

Loggerhead turtle is a common species encountered in northern part of the East Asia Region, namely Japan and Republic of Korea.

2.1.1. Nesting sites

Nestings of loggerhead turtles were mainly recorded along the coast of the Pacific and East China Sea from Fukushima Prefecture to Okinawa Prefecture in Japan. Occasional nestings were recorded along southern coasts – Pohang, Busan and Jeju Island- in South Korea (see *Japan, Republic of Korea*).

2.1.2. Marine areas

Important in-water habitats such as migratory routes of post-nesting loggerhead turtles were found in Japan and the Pacific Ocean (see *Japan*). Loggerhead turtles were encountered as stranded or by-catch individuals in South Korea. Some of these

individuals were satellite tracked (see *Republic of Korea*). Sporadic stranded loggerhead turtles were also observed in Hong Kong.

2.2. Other biological data

Life history parameters in oceanic and neritic foraging female loggerhead turtles and maturation age of the species were investigated in Japan (see *Japan*).

2.3. Threats

2.3.1. Nesting sites

Eggs predation (see *Japan*), coastal development, human activities and light pollution in nesting beaches (see *Japan, Republic of Korea*) pose threats to loggerhead green turtles and their nesting sites.

2.3.2. Marine areas

By-catch (see *Japan, Republic of Korea*) and marine pollution such as plastic debris (see *Republic of Korea*) are documented threats to loggerhead turtles in water.

2.4. Conservation

Loggerhead turtles and their habitats are legally protected under national laws and local ordinances (see *Japan, Republic of Korea, Hong Kong, Taiwan*). Habitat protection and management, monitoring of nesting beaches and public education have been in place (see *Japan*).

3. RMU: Hawksbill Turtle *Eretmochelys imbricata*, Pacific West (EI-PW)

Countries/ places contributing to this RMU: Japan, Republic of Korea, Hong Kong and Taiwan

3.1. Distribution, abundance, trends

Hawksbill turtle is mostly encountered in southern part of the East Asia Region, such as the southern outlying islands in Japan.

3.1.1. Nesting sites

Approximately 10 hawksbill turtle nests were annually observed in Nansei islands of Japan (see *Japan*).

3.1.2. Marine areas

Foraging ground for hawksbill turtles in Japan was speculated to be in Niigata Prefecture at the side of Japan Sea and the Kanto region at the side of the Pacific Ocean. These areas are considered as the northern limit foraging ground for hawksbill turtle (see *Japan*). Stranded hawksbill turtles were scarcely encountered in South Korea and Hong Kong (see *Republic of Korea, Hong Kong*).

3.2. Other biological data

Not available.

3.3. Threats

3.3.1. Nesting sites

Predation of turtle eggs by natural predators and light pollution in nesting beaches pose potential threats to the nesting sites of hawksbill turtles in Japan (see *Japan*).

3.3.2. Marine areas

By-catch and direct take under a licensed system may cause impact to hawksbill turtles in water (see *Japan*). Marine waste also might have caused mortality of hawksbill turtles (see *Republic of Korea*).

3.4. Conservation

Loggerhead turtles and their habitats are legally protected under national laws and local ordinances (see *Japan, Republic of Korea, Hong Kong, Taiwan*). Habitat protection and management, monitoring of nesting beaches and public education have been in place (see *Japan*).

4. RMU: Olive Ridley Turtle *Lepidochelys olivacea,* Pacific West (LO-PW)

Countries/ places contributing to this RMU: Japan, Republic of Korea, Hong Kong and Taiwan

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

No nesting of Olive Ridley turtles were recorded in Japan, Republic of Korea, Hong Kong and Taiwan.

4.1.2. Marine areas

Olive Ridley turtles were sometimes encountered as by-catch in Japan.

4.2. Other biological data

Not available.

4.3. Threats

4.3.1. Nesting sites

Nil.

4.3.2. Marine areas

This species was occasionally by-caught in Japan.

4.4. Conservation

Olive Ridley turtles are legally protected under national laws and local ordinances in Japan, Republic of Korea, Hong Kong and Taiwan.

5. RMU: Leatherback Turtle *Dermochelys coriacea*, Pacific West (DC-PW)

Countries/ places contributing to this RMU: Japan, Republic of Korea, Hong Kong and Taiwan

5.1. Distribution, abundance, trends

5.1.1. Nesting sites

Only two nests of leatherback turtles were recorded in Japan in the year 2002.

5.1.2. Marine areas

Leatherback turtles were sometimes encountered as by-catch in Japan and Republic of Korea.

5.2. Other biological data

Not available.

5.3. Threats

5.3.1. Nesting sites

Nil.

5.3.2. Marine areas

This species was occasionally by-caught in Japan and Republic of Korea.

5.4. Conservation

Leatherback turtles are legally protected under national laws and local ordinances in Japan, Republic of Korea, Hong Kong and Taiwan.

JAPAN

Authors for green turtles: Emi Inoguchi[1], Takashi Ishihara[2]
Author for loggerhead turtles: Takashi Ishihara[2]
Author for hawksbill turtles: Emi Inoguchi[1]

[1]Ever Lasting Nature of Asia, Japan
[2]Suma Aqualife Park, Japan

1. RMU: Green Turtle *Chelonia mydas*, Pacific Northwest (CM-PNW)

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Nestings of green turtle (*Chelonia mydas*) were mainly recorded on Ogasawara Islands and Nansei Islands (Tables 1 and 2). The location of each nesting site in Japan is indicated in Figure 1.

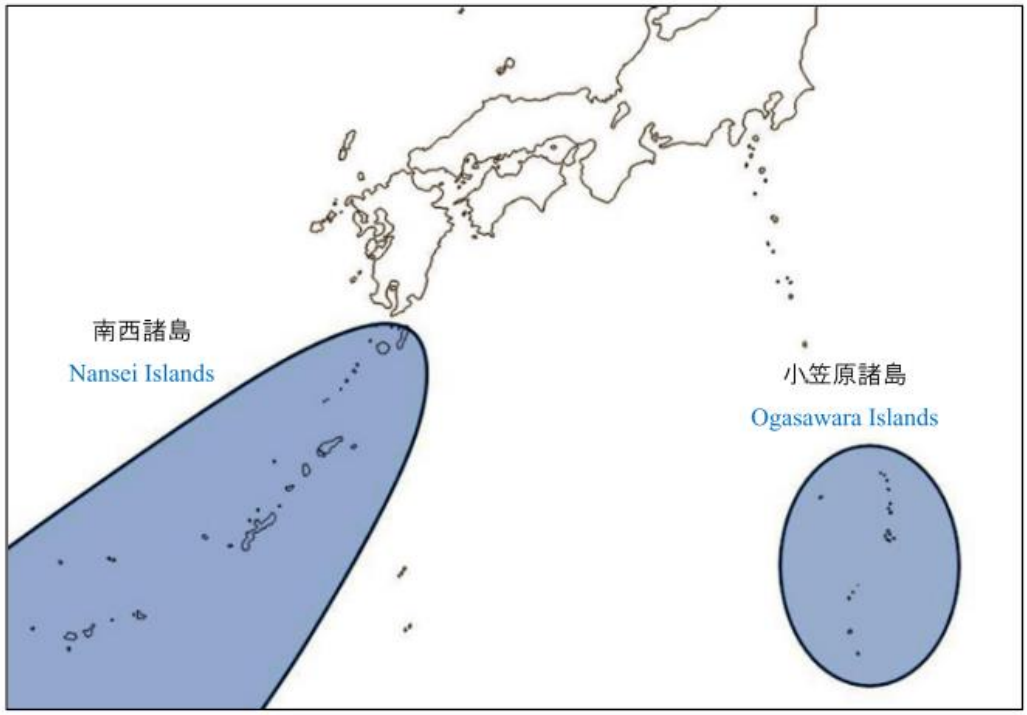

Figure 1. Nesting Biogeography of Green Turtle in Japan (Quoted from Kameda [ed.], 2013)

Ogasawara Islands is the biggest rookery for green sea turtle in Japan. The nesting occurs mainly in Chichi-jima islands and Haha-jima islands.

Number of Nesting Females (Table 1) — There has been an increasing trend in the annual number of nesting since nesting surveys began in 1975 (Fig. 2). Chaloupka et al. (2007) estimated that the abundance of nesting turtles in Ogasawara increased at an annual growth rate of 6.8% from 1978 to 2003. A further increase in annual nesting females occurred from 2005 and 2015, with a maximum of 582 nesting females in 2008 (Kondo et al., 2017) (Fig. 3).

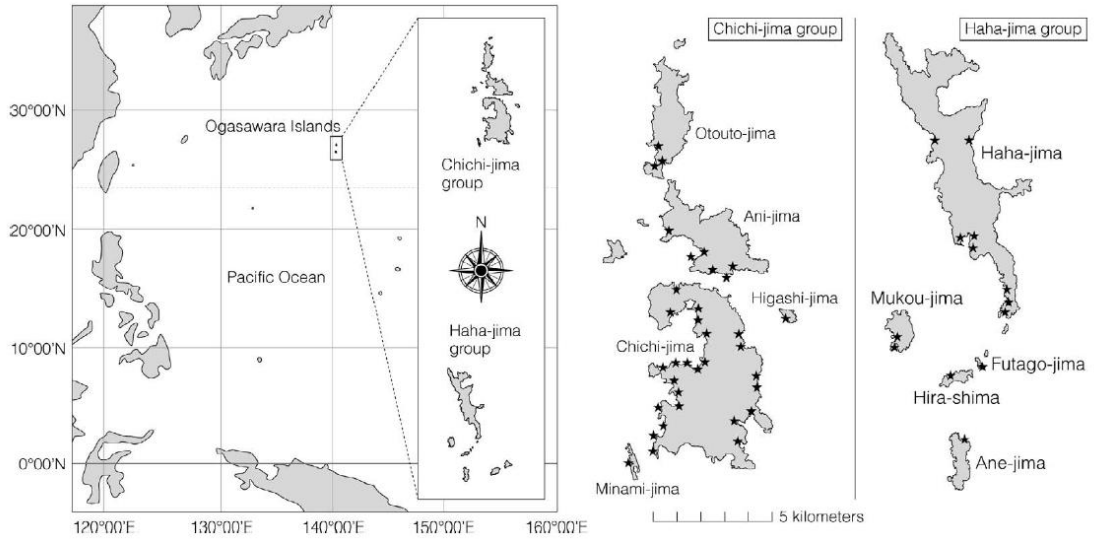

Figure 2. Location of Chichi-jima Group and Haha-jima Group in the Ogasawara Islands where nest surveys, turtle harvest, and the hatch and release project were conducted (Kondo et al., 2017). Star-shaped characters indicate nesting beaches.

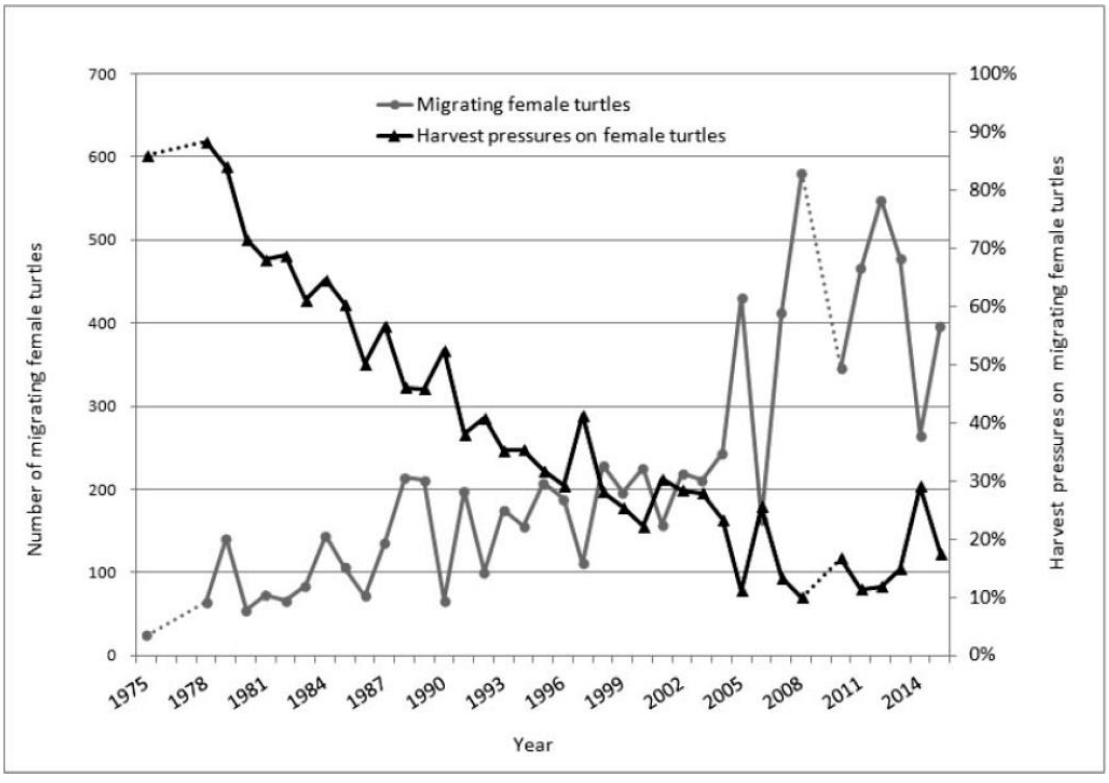

Figure 3. Sum of estimated nesting and harvested female turtles from 1975 to 2015 in Chichi-jima and Haha-jima groups combined, and harvest pressures on the female turtles from 1975 to 2015 (Referred from Kondo et al., 2017). Dashed line represents years when nesting surveys were not conducted in either Chichi-jima or Haha-jima.

As for Nansei Islands, Kameda (2013) summarized about green turtle in Japan. Please see p27-34 of Kameda (2013).

1.1.2. Marine areas

Nesting females in Ogasawara Islands mainly use near main land of Japan as their post-nesting foraging ground. According to Hatase et al. (2006), 69% of the females nesting on Ogasawara Islands mainly used neritic habitats and 31% mainly used oceanic habitats by using isotope analysis (Fig. 4).

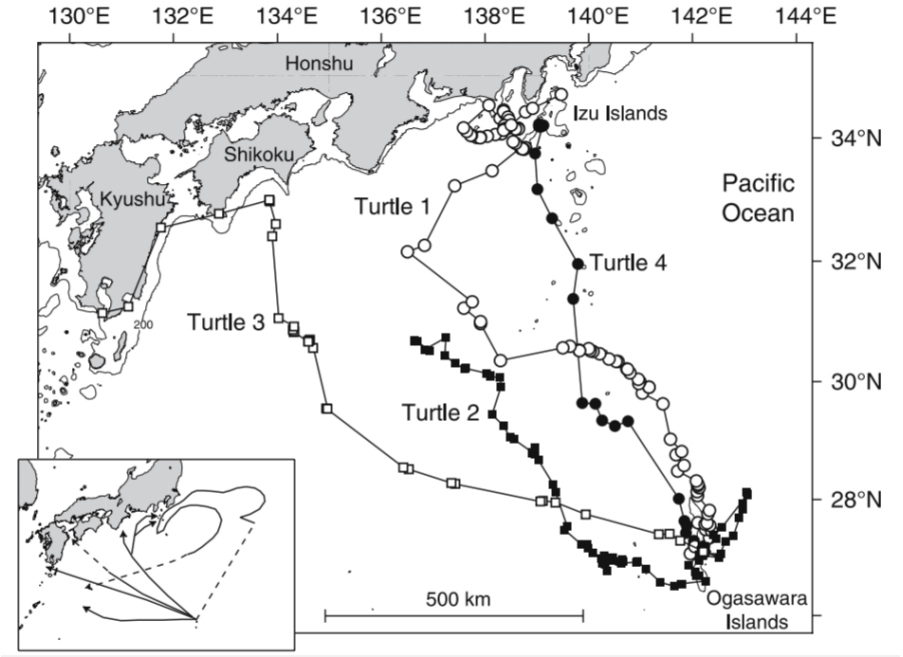

Fig.4 Post-nesting migratory routes of four green turtles (*Chelonia mydas*) tracked by satellite from the Ogasawara Islands, Japan (Referred from Hatase et al. 2006). Contour line 200 m depth. Inset a schematic map of post-nesting migratory routes of seven green turtles tracked by satellite from the Ogasawara Islands during 1994–1998 (Japan Fisheries Resource Conservation Association, 1999). Broken lines indicate the periods during which transmissions were not received

As for Nansei Islands, Kameda (2013) summarized about green turtle in Japan. Please see p33-38, 68-98 of Kameda (2013).

1.2. Other biological data

Accompanying text to data summarized in Table 1 of the excel, if needed.

Hamabata et al. (2014) summarized genetic population structure using mtDNA control region. See below figure.

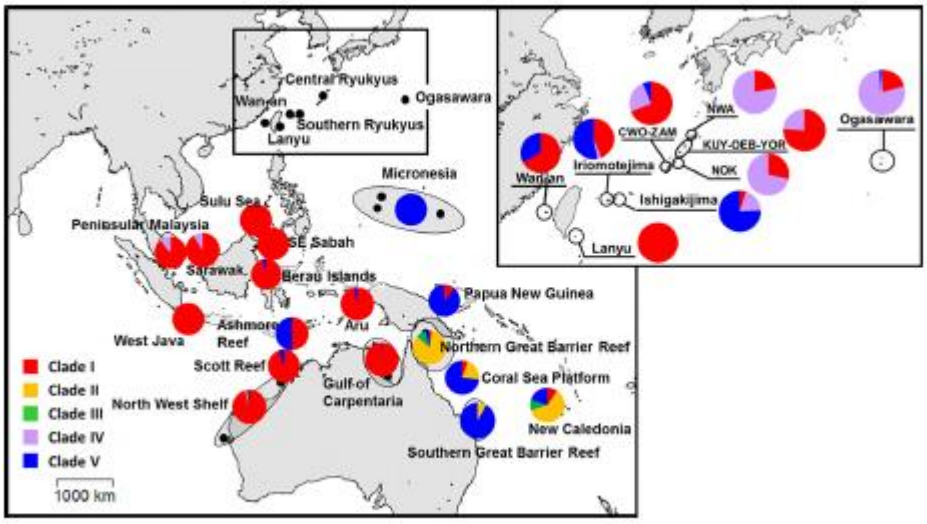

Fig. 3 Frequencies of observed clades in reported populations (absolute values). Clade frequency data other than for the central Ryukyu population were from Dethmers et al. (2006), Cheng et al. (2008), Nishizawa et al. (2011), and Nishizawa et al. (2013)

1.3. Threats

1.3.1. Nesting sites

Expanding from what listed in Table 1 of the excel.

Harvest: Historical harvest of green turtle meats have occurred within Chichi-jima and Haha-jima islands for more than 188 years. Because of the high harvest pressure in 1800s, the number of nests decreased around 1975. To recover the number of turtles, harvesting turtles has been strictly regulated since 1994 and, the number of nest have been gradually increasing and it reached over 2,600 nests. For more details, see Kondo et al. (2017)

Light pollution: Artificial light pollution occurs some beaches near residential areas in

the Chichi-jima island of Ogasawara Islands and Okinawajima island of Nansei Islands.

1.3.2. Marine areas

Expanding from what listed in Table 1 of the excel.

Bycatch: Ishihara et al. (2014) reported that accidental bycatch of sea turtles occasionally occurs around Japan. More than 5-10 sea turtles was annually bycatch per operation in large and small pound net, gill net, bottom trawl, boat seine, surround net, rod and line, and trawl fisheries. The highest bycatch frequency was reported in large pound net fisheries, but it varied widely by operation. Bycatch mortality rate in large pound nets also varied, from 0 to 100%. Bycatches of green sea turtles were reported in large and small pound net and gill net.

1.4. Conservation

Protection status: expanding from what listed in Table 1 and 3 of the excel
All sea turtle species are protected by national laws referred in table 1. In addition, some local government established local conservation laws for sea turtles and/or nesting beaches.

Governmental or NGO programs, especially long-term ones. (Table 4 of the excel)
Nesting site: In Ogasawara Islands, “Hatch and release project” was experimentally conducted in 1877, and the Japanese Ministry of Agriculture and Commerce officially commenced the project in 1910 (Kondo et al. 2017). The project was discontinued in 2008 owing to difficulties in maintenance of the facilities and increased numbers of nests on natural beaches, which were considered to produce more hatchlings than those from the project.

Currently, Everlasting Nature of Asia (ELNA), a NPO, work on the conservation. Under the NPO’s policy, all of nests are basically natural hatched and emerged in situ. Eggs laid in Omura Beach have been translocated to the hatchery after sex determination anticipated, because of avoiding the accidents by light pollution to hatchlings. The hatchlings from these eggs are immediately released at some dark beaches after emergence. Moreover, some of them are raised in captivity as

head-starting program for researching their migration. The night patrol in Omura Beach are conducted to avoid obstruction by tourists to nesting females and enlightenment to the tourists and the residents. The call system is also active when nesting females lost her way by light pollution or are stuck something. These projects are conducted by NPO support by Ogasawara Village.

In Nansei Islands, monitoring of green turtle nests had been counted in Nishinohama, Kuroshima island, Okinawa prefecture since 1989.

Marine area: Fishery Agency attempts to establish the bycatch avoidance practice. Although this is not practically operated under the fishing area yet.

Conservation priorities and specific recommendations to decision makers or other subjects.
Conservation priorities in Japan are on beach erosion, bycatch, and light pollution.

1.5. Research

Key knowledge gaps/ Existing but unpublished data that should be urgently published

Nesting surveys are mainly conducted by local non-profit organizations and individuals. In addition, research of sea turtles also conducted by them or collaboration with university. Stranding or bycatch surveys are conducted around coast of Japan as foraging ground.

1.6. References

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Kameda, K. (ed.) (2013). *Green Turtle of Japan*. (English translation: Mai Takase). Sea Turtle Association of Japan, Hirakata. Pp138.

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Long-Term Population Dynamics of Green Turtles (*Chelonia mydas*) in Ogasawara, Japan: Influence of Natural and Artificial Production of Hatchlings and Harvest Pressure. *Chelonian Conservation and Biology*, *16*(1), 83-92.

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Hatase, H., Sato, K., Yamaguchi, M., Takahashi, K., & Tsukamoto, K. (2006). Individual variation in feeding habitat use by adult female green sea turtles (*Chelonia mydas*): are they obligately neritic herbivores?. *Oecologia*, 149(1), 52-64.

Japan Fisheries Resource Conservation Association (1999). *Research on migratory routes and diving ecology of sea turtles. General report on commissioned project for conservation research of aquatic animals in 1994–1998*. Vol 1. Japan Fisheries Resource Conservation Association, Tokyo, pp 1–90 (in Japanese)

2. RMU: Loggerhead Turtle *Caretta caretta*, Pacific North (CC-PN)

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Nestings of loggerhead turtles (*Caretta caretta*) were recorded along the coast of the Pacific and East China Sea from Fukushima Prefecture to Okinawa Prefecture. In addition, small number of nestings were also recorded at the coast of Sea of Japan, Seto Inland Sea, and Ise Bay (Tables 1 and 2). The location of each nesting site in Japan is indicated in Figure 1.

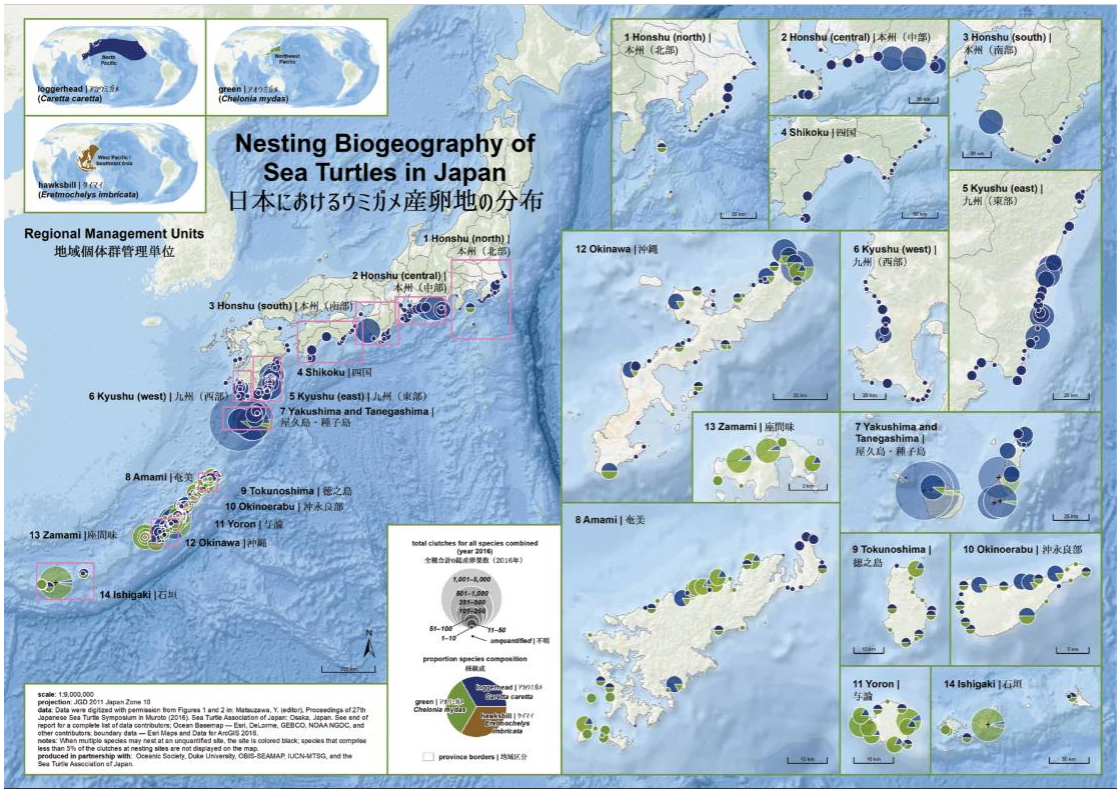

Figure 1. Nesting Biogeography of Sea Turtles in Japan (Quoted from Matsuzawa, 2018)

Because the data of each nesting sites including nesting number is belonged to researchers, we must respect their priority. However, you can see the result in Matsuzawa et al. (2017).

Number of nests and crawls were collected by beach monitoring by dozens of research groups, researchers, and local authorities. Most of beach monitoring are operated in morning or daytime to count the crawls and detect species, presence of egg laying. Daily night patrol are conducted only in 3 sites, Minabe-senrihama, Hiwasaohama, and Nagata region in Yakushima Island, to identify individual nesting females.

The oldest monitoring involves recorded number of crawls in Hiwasaohama beach, Tokushima Prefecture since 1950 except 1955-1964 and 1966 (Kamezaki et al., 2003; Tanaka, 2017). The trend in Hiwasaohama beach shows an increase from 1950 to the maximum record as 308 crawls in 1968, then decrease while fluctuating to 1990 with 220 crawls. After 1990, the number of crawls and nests (# of nests were counted since 1989) show decrease trends. These trend from 1950 contains not only population trend but also regional and the beach factors.

Matsuzawa et al. (2017) mentioned the trends of number of nests in main nesting sites. According to Matsuzawa et al. (2017), although nationwide trend shows rapid decrease in 1990's and then gradual recovering trend in the new century with a big surge in 2007-2008, there are differences in detail among beaches: For example, in Minabe, numbers of nests in 2012 and 2013 are as many as those at the top of 1990's, whereas in Miyazaki, numbers in 2012 and 2013 are larger than those at the top of 1990's. Also, contrasting to decreasing trends in Miyazaki and Minabe in 1990's, there is an increasing trend in Hyuga until 2012.

2.1.2. Marine areas

Identified foraging grounds, mating areas, migratory corridors.

See Figures 1 and 3 of Hatase et al. (2007) for post-nesting migratory routes of loggerhead turtles. Copied down.

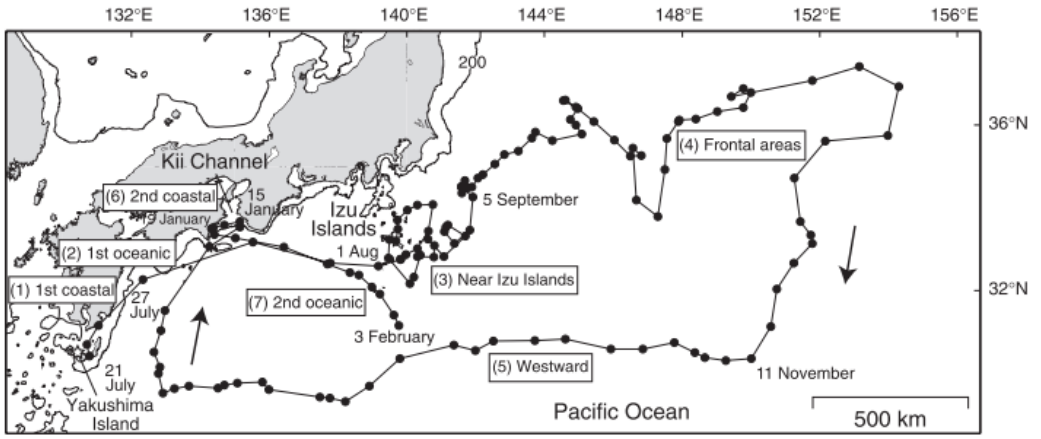

Figure 1 Post-nesting migratory route of the small female loggerhead turtle *Caretta caretta* released from Yakushima Island (☆), Japan, which is divided into seven periods. The arrows indicate the direction of movement. Contour line: 200 m depth.

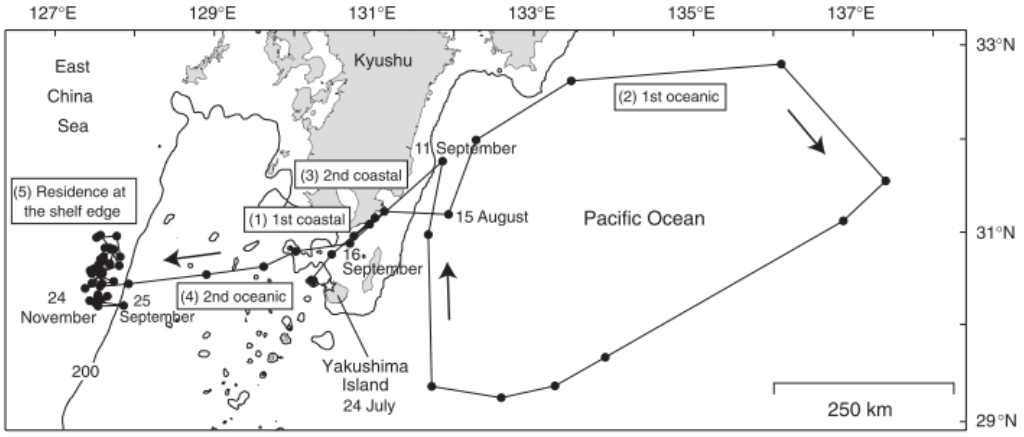

Figure 3 Post-nesting migratory route of the large female loggerhead turtle *Caretta caretta* released from Yakushima Island (☆), Japan, which is divided into five periods. The arrows indicate the direction of movement. Contour line: 200 m depth.

Here shows coastal bycatch survey data from Table 2 and 3 of Ishihara et al. (2014) (translated from Japanese to English). Important Note: We should be careful in making generalizations regarding bycatch patterns across each fishing method, because responses varied within fisheries, areas, and slight geographic and bathymetric differences.

Table 2 extracted from Ishihara et al. (2014). Comparison of fishing methods described in MAFF Fishery Census and in the current study, expressed as a percentage of total answers acquired. Interview sites were selected based on former information (“chosen sites”), or randomly selected from fishing ports in MAFF reports (2010) (“random sites”).

the Census of Fishery (MAFF, 2010)		this study				
fishing method	rate (%)	fishing method	rate (%) total	rate (%) chosen site	rate (%) random site	number of responses
large pound net	0.3	large pound net	4.3	0.0	0.0	89
small pound net	2.6	small pound net	7.8	0.0	0.0	163
gill net	13.6	gill net	19.2	0.0	0.0	400
		drift net	1.3	0.0	0.0	27
bottom trawl	5.4	bottom trawl	8.4	0.0	0.0	175
boat seine	1.9	boat seine	3.7	0.0	0.0	77
		jibiki-ami	0.3	0.0	0.0	6
long line	3.5	long line	6.3	0.0	0.0	132
Tuna long line on distant water	0.1	Tuna long line on distant water	0.1	0.0	0.0	2
surrounding net	0.6	surrounding net	2.8	0.0	0.0	59
rod/line fishing	32.0	rod/line fishing	11.7	0.0	0.0	244
		trolling	8.7	0.0	0.0	182
		tate-nawa	1.2	0.0	0.0	26
lift net	0.2	lift net	0.0	0.0	0.0	1
		stick-held dip net	0.3	0.0	0.0	7
other net fisheries	2.0	*gochi-ami*	0.5	0.0	0.0	10
		sweeping net	0.2	0.0	0.0	4
		kome-ami	0.2	0.0	0.0	4
		hari-ami spp.	0.1	0.0	0.0	2
		utase-ami	0.1	0.0	0.0	2
		sasa-ami	0.1	0.0	0.0	2
		sukui-chirimen	0.1	0.0	0.0	2
		hikimawashi-ami	0.0	0.0	0.0	1
		hassoubari-ami	0.0	0.0	0.0	1
		mawashi-ami	0.0	0.0	0.0	1
small-scale whaling		small-scale whaling	0.1	0.0	0.0	2
diving	1.0	diving	5.4	0.0	0.0	112
Shellfish/seaweed collecting	16.4	Shellfish/seaweed collecting	3.6	2.5	4.9	76
		isomi-ryo	0.6	0.0	0.0	13
		kanagi-ryo	0.6	0.0	0.0	12
		mizuki	0.2	0.0	0.0	4
		ganzume	0.1	0.0	0.0	3
other fisheries	9.7	*cage*	3.3	0.0	0.0	69
		tubo	1.1	0.0	0.0	23
		tsutsu	0.2	0.0	0.0	5
		spear fishing	0.2	0.0	0.0	5
		tobiuo-oikomi	0.1	0.0	0.0	3
		tsukinbo	0.1	0.0	0.0	3
		coral trawl	0.1	0.0	0.0	3
		takiya-ryo	0.1	0.0	0.0	3
		suishi-ryo	0.0	0.0	0.0	1
		takkomi	0.0	0.0	0.0	1
		squid gathering	0.0	0.0	0.0	1
		shirasuunagi gathering	0.0	0.0	0.0	1
		yoteji	0.0	0.0	0.0	1
aqua culture	10.7	aqua culture	4.6	0.0	0.0	96
out of category		leisure fishing by fleet	0.6	0.0	0.0	13
		sightseeing	0.3	0.0	0.0	7
		unspecified	0.5	0.6	0.4	11
						2,087

Table 3 extracted from Ishihara et al. (2014). Bycatch frequency by fishing method, expressed in number of responses for each frequency category. Class 1: none or close to none (0 to less than 1 turtle/year); class 2: a few per year (1-5 turtles/year); class 3: less than 10 (6-10 turtles/year); class 4: approximately 20 (20±10 turtles/year); class 5: approximately 50 (50±20 turtles/year); class 6: approximately 100 (100±30 turtles/year); and class 7: extend well beyond 100 (>130 turtles/year). Fishing methods are the same as Table 2, except methods without responses of class 3 or greater were collapsed together as “all others”.

	Class								number of
fishing method	1	2	3	4	5	6	7	uncertain	responses
large pound net	9	25	18	9	8	4	3	13	89
small pound nt	49	44	10	8	3	0	1	48	163
gill net	198	33	9	2	1	1	0	156	400
bottom trawl	83	9	0	2	0	0	0	81	175
boat seine	20	11	0	2	0	0	0	44	77
long line	54	5	6	0	0	0	0	67	132
Tuna long line on distant water	0	1	0	0	1	0	0	0	2
surrounding net	22	4	0	1	0	0	0	32	59
rod/line fishing	89	0	0	2	0	0	0	153	244
trolling	133	1	0	0	1	0	2	45	182
all others	202	8	0	0	0	0	0	354	564
									2,087

2.2. Other biological data

Accompanying text to data summarized in Table 1 of the excel, if needed.

Hatase et al. (2013) revealed important parameters. See Table 2 extracted from Hatase et al. (2013).

TABLE 2. Overall means of life history parameters among years (1999, 2008, and 2011) in oceanic and neritic foraging female loggerhead turtles (*Caretta caretta*) nesting at Yakushima Island, Japan.

Parameter	Oceanic			Neritic			
	Mean ± SD	Range	*n*	Mean ± SD	Range	*n*	*P*
Straight carapace length (mm)	791 ± 36	715–902	58	859 ± 41	729–968	282	<0.0001
Clutch size (no. eggs)	103.2 ± 15.6	78.0–134.5	22	115.5 ± 19.8	64.0–164.0	98	<0.005
Emergence success (%)	64.8 ± 13.3	43.0–80.0	7	62.8 ± 17.6	23.3–86.8	32	
No. emergent hatchlings per nest	66.3 ± 15.4	34.0–80.0	7	68.9 ± 23.3	24.0–114.0	32	0.94
Clutch frequency (no. clutches)	3.6 ± 1.0	1–5	31	4.3 ± 1.2	1–6	229	0.0005
Breeding frequency (seasons)	1.8 ± 1.2	1–5	16	3.3 ± 2.3	1–10	82	<0.005
Breeding life span (yr)	4.0 ± 3.9	1–12	16	4.8 ± 3.5	1–15	82	0.17
Cumulative reproductive output (hatchlings)†	433 ± 16			1029 ± 27			
Remigration interval prior to sampling eggs (yr)	4.9 ± 1.5	3–7	7	1.6 ± 0.6	1–3	125	<0.0001
Mean remigration interval within an individual (yr)	3.8 ± 0.9	2.8–5.0	8	1.8 ± 0.5	1.0–3.0	69	<0.0001

Notes: Division of turtles into the two groups is based on $\delta^{13}C$ and $\delta^{15}N$ in egg yolks; *n* indicates sample size. *P* values were calculated using Mann-Whitney *U* tests.

† Cumulative reproductive output = clutch size × emergence success × clutch frequency × breeding frequency.

Maturation age was estimated by Ishihara (2011) using skeletochronology. Age at maturity was estimated at 37 years old by regression growth protocol, and individual age was estimated by correction factor protocol as 38, 46 and 47 years old in adult male and 43 ± 11 years old (n = 15, range: 22–61) in adult female. Considerable individual variability was observed in estimated age and indicates timing of maturation varies quite a bit even in same population (Ishihara, 2011).

2.3. Threats

2.3.1. Nesting sites

See table 1 of the excel table.

2.3.2. Marine areas

See table 1 of the excel table.

2.4. Conservation

Protection status: expanding from what listed in Table 1 and 3
All sea turtle species are protected by national laws referred in table 1 of the excel. In addition, some local government established local conservation laws for sea turtles and/or nesting beaches.

Governmental or NGO programs, especially long-term ones. (Table 4)
Monitoring of loggerhead crawls had been started in Hiwasaohama, Tokushima prefecture in 1950, although there are monitoring breaks in 1950's and 1960's. This program was started by science club of Hiwasa junior high school students and their teacher. Currently, Hiwasa Chelonian Museum takes over and continue the monitoring project. In 1954, the other monitoring program for loggerhead crawls has started and it is still continuing now, i.e. it is the longest monitoring project in the world (Matsuzawa and Kamezaki, 2012). In addition, dozens monitoring program for loggerhead crawls and nests had begun in 1970's and 80's at most of major nesting beaches in Japan. Currently, almost 100% beaches that have >10/year loggerhead nests in Japan may be monitored by someone. Most of all monitoring groups, individuals, and local administrations share their data via network organization Sea Turtle Association of Japan.

Conservation priorities and specific recommendations to decision makers or other subjects.

Conservation priorities in Japan are on beach erosion, bycatch, and light pollution.

2.5. Research

Key knowledge gaps/ Existing but unpublished data that should be urgently published

Most of key information has been published. Bycatch intensity in high seas, survival rate, and unpublished satellite telemetry maps should be published soon.

2.6. References

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3. RMU: Hawksbill Turtle *Eretmochelys imbricata*, Pacific West (EI-PW)

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

Approximately 10 hawksbill turtle nests were annually observed in Nansei islands (chain of islands extending from southwestern Kyushu to northern Taiwan). The nests have been recorded on 12 islands: Ishigaki-jima, Kuroshima, Aragusuku-jima, Iriomote-jima, Irabu-jima, Minna-jima, Okinawa-jima, Zamami, Akajima, Kumejima, Kakeroma-jima, Amamioshima (Hirate 1995, Mizuno 2013) (Tables 1 and 2, Fig. 1). Local organizations have conducted nesting survey at each nesting site. Regarding the long-term nesting data, that of Kuroshima island is only available (Table 4).

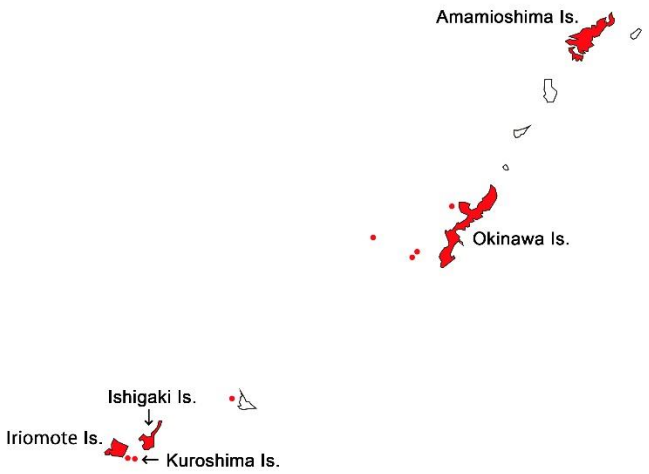

Fig. 1. Location of hawksbill turtle nesting site in Japan

3.1.2. Marine areas

The foraging grounds and migration route of female nesting in Japan are unknown. The straight carapace length (SCL) of turtles range from 289 to 820 mm were observed around the nesting ground, Yaeyama islands. Their maturities were predominantly immature (Kamezaki and Hirate 1992). Stranding, bycatch and diver's eyewitness information of hawksbill turtle are sporadically observed in Niigata Prefecture at the side of Japan Sea (Honma et. 2010) and the Kanto region at the side

of the Pacific Ocean (Fig. 2 and Table 5). These areas are considered as the northern limit foraging ground for hawksbill turtle.

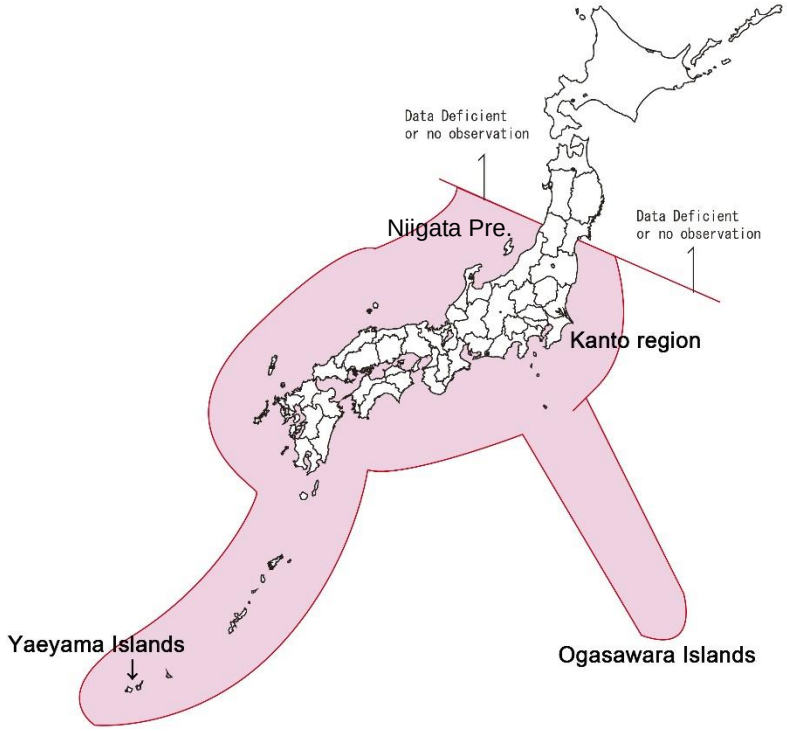

Fig.2 foraging ground for hawksbill turtles in Japan

3.2. Other biological data

Not available

3.3. Threats

3.3.1 Nesting sites

Predation

Ryukyu wild boar (*Sus scrofa riukiuanus*) and ghost crab sp. were reported as predator for sea turtle eggs around nesting ground, but no data is available whether hawksbill turtle eggs are preyed.

Artificial impacts/ Nesting environments

Artificial light pollution by building new hotel was reported in Iriomotejima island. Despite this, since most of nesting grounds, especially Yeyama islands, are hard to

access by humans, non-disturbed beaches still remain. Diminution of the sand is concerned in some beaches, but no significant data is available.

3.3.2 Marine areas

Fishery

Fishing hawksbill turtle is only allowed for person who gets the permission by the Okinawa Ocean District Fisheries Adjustment Commission. Annual limit is 28 turtles in 2017, and allowed size is SCL 30-60 cm. The fishing is not allowed during the nesting season, from June and July. Collecting eggs is not allowed.

Bycatch

Bycatch of hawksbill turtles occasionally occur by set nets or gill nets. In case that turtle is alive, some of them reared and released by aquariums.

3.4. Conservation

See Table 1 of the excel table.

3.5. Research

Nesting surveys are conducted by Local research units, non-profit organization, aquarium, and students. Stranding or/and bycatch surveys are conducted in some areas.

3.6. References

Kameda, K. and Wakatsuki M. (2011) Reproductive biology of the Hawksbill Turtle (*Eretmochelys imbricata*) on Kuroshima Island, of Yaeyama Group, Ryukyu Archipelago (in Japanese). Umigame Newsletter 89, 11-14

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Table 1. Main biology and conservation aspects of sea turtle Regional Management Units (RMU) occurring in Japan

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**CC-PN-Japan**	Ref #	**Cm-PNW-Japan**	Ref #
Occurrence				
Nesting sites	Y	1,2,3,54	Y	14,55
Pelagic foraging grounds	JA	8,22	n/a	
Benthic foraging grounds	JA	8,22	Y	55
Key biological data				
Nests/yr: recent average (range of years)	6860 (2014-2016)	1,2,3	1048(2014-2016) in Nansei Islands 2055(2010-2016)in Ogasawara Islands	1,2,3,14
Nests/yr: recent order of magnitude				
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	47	1,2,3,54	25 in Nansei Islands 41 in Ogasawara Islands	14
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	698	1,2,3,54	388 in Nansei Islands	1,2,3,14

			7 in Ogasawara Islands	
Nests/yr at "major" sites: recent average (range of years)				
Nests/yr at "minor" sites: recent average (range of years)				
Total length of nesting sites (km)	n/a		n/a	
Nesting females / yr	2000-3500	1,2,3,4,5	n/a in Nansei Islands 200-600 in Ogasawara Islands	14
Nests / female season (N)	2.5, 3.6(31), 4.3(229)	4,5	n/a	
Female remigration interval (yrs) (N)	3.8 (8), 1.8 (69), 2.7 (108)	5,6	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	0.176, 0.812	7	n/a	
Sex ratio: Immatures (F / Tot) (N)	0.653 (121)	8	n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a	
Min adult size, CCL or SCL (cm)	69.2 SCL	9	n/a	
Age at maturity (yrs)	22-61 (Ave. 37-43)	10,11	ca. 30 in Ogasawara Islands	14
Clutch size (n eggs) (N)	103.2(22),	5,12	n/a	

	115.5(98), 109.4			
Emergence success (hatchlings/egg) (N)	n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	0.52-0.56	1,2,3	0.60-0.64 in Nansei Islands	1,2,3
Trends				
Recent trends (last 20 yrs) at nesting sites (range of years)	Up (2008-2013) Down (2014-2016)	1	Up(2000-2016) in Nansei Islands Up(1978-2016) in Ogasawara Islands	1,13,14
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a			n/a
Oldest documented abundance: nests/yr (range of years)	74.2 crawls/yr (1950-1954)	4,41,53	24 (1975) in Ogasawara Islands	14
Published studies				
Growth rates	Y	6,8	N	
Genetics	Y	25,26,30,31	Y	18,23,24,27,29
Stocks defined by genetic markers	Y	25,30,31	Y	18,23,29

Remote tracking (satellite or other)	Y	32,33,34,35,36,37	Y	56
Survival rates	Y	38	N	
Population dynamics	n/a		Y	14
Foraging ecology (diet or isotopes)	Y	5,31,32,37,39	Y	57,58
Capture-Mark-Recapture	Y	6	N	N
Threats				
Bycatch: presence of small scale / artisanal fisheries?	Y (PLL, SN, PN)	21,40	Y (PLL, SN, PN)	21,50
Bycatch: presence of industrial fisheries?	Y	21	n/a	
Bycatch: quantified?	Y	21,40	Y	21
Take. Intentional killing or exploitation of turtles	N		Y	14
Take. Egg poaching	N		N	
Coastal Development. Nesting habitat degradation	Y	41,44	Y	55
Coastal Development. Photopollution	Y	41,44	Y	55 refer to text
Coastal Development. Boat strikes	n/a		n/a	

Egg predation	Y	41,44	Y	refer to text
Pollution (debris, chemical)	n/a		n/a	
Pathogens	n/a		Y(fiblopapillomatosis)	n/a
Climate change	n/a		n/a	
Foraging habitat degradation	n/a		n/a	
Other	n/a		n/a	
Long-term projects (>5yrs)				
Monitoring at nesting sites (period: range of years)	Y (1954-ongoing and many other)	54	Y (1975-ongoing)	14
Number of index nesting sites	hundreds	1,2,3	hundreds in Nansei Islands >50 in Ogasawara Islands	14
Monitoring at foraging sites (period: range of years)	N		N	
Conservation				
Protection under national law	Y	42,	Y	42
Number of protected nesting sites (habitat preservation)	n/a		n/a	n/a

(% nests)				
Number of Marine Areas with mitigation of threats	n/a		n/a	n/a
N of long-term conservation projects (period: range of years)	n/a		n/a	n/a
In-situ nest protection (eg cages)	Y	41,44,54	n/a	
Hatcheries	Y	41,44,54	Y	refer to text
Head-starting	Y	41,44,54	Y	refer to text
By-catch: fishing gear modifications (eg, TED, circle hooks)	Y	45,,46,47,48,49,50, 51	Y	45,,46,47,48,49,50, 51
By-catch: onboard best practices	Y	48	N	
By-catch: spatio-temporal closures/reduction	N		N	
Other				

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**Ei-PW-Japan**	Ref #	**Lo-PW-Japan**	Ref #	**Dc-PW-Japan**	Ref #
Occurrence						
Nesting sites	Y	15	N		Y	59

Pelagic foraging grounds	n/a		JA	n/a	JA	60,61
Benthic foraging grounds	Y	refer to text	n/a		n/a	
Key biological data						
Nests/yr: recent average (range of years)	<10	1,2,3	n/a	1,2,3	n/a	1,2,3,5 9
Nests/yr: recent order of magnitude						
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	0	refer to text	n/a		n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	13	refer to text	n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)						
Nests/yr at "minor" sites: recent average (range of years)						
Total length of nesting sites (km)	n/a		n/a		n/a	
Nesting females / yr	n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		n/a	
Female remigration interval (yrs) (N)	3 (1)	16	n/a		n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a	

Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a	
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a	
Age at maturity (yrs)	n/a		n/a		n/a	
Clutch size (n eggs) (N)	n/a		n/a		n/a	
Emergence success (hatchlings/egg) (N)	n/a		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	0.48-0.67	1,2,3	n/a		n/a	
Trends						
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a (2005-2016)	17	0		0.1 (only 2 nests in 2002)	59
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a		n/a	
Oldest documented abundance: nests/yr (range of years)			n/a		2 (2002)	59
Published studies						
Growth rates	N		N		N	
Genetics	Y	19, 20	N		Y	61
Stocks defined by genetic markers	N		N		N	

Remote tracking (satellite or other)	N		N		N	
Survival rates	N		N		N	
Population dynamics	N		N		N	
Foraging ecology (diet or isotopes)	N		N		Y	62
Capture-Mark-Recapture	Y	16	N		N	
Threats						
Bycatch: presence of small scale / artisanal fisheries?	Y (SN, Gill net)	21	Y (PLL, PN)	21	Y (PLL, PN)	21
Bycatch: presence of industrial fisheries?	Y (SN, Gill net)	21	Y	21	Y	21
Bycatch: quantified?	N		N		N	
Take. Intentional killing or exploitation of turtles	rare	refer to text	N		N	
Take. Egg poaching	N		N		N	
Coastal Development. Nesting habitat degradation	n/a		N		N	
Coastal Development. Photopollution	n/a		N		N	
Coastal Development. Boat strikes	n/a		n/a		n/a	

Egg predation	Y	refer to text	N		N	
Pollution (debris, chemical)	n/a		n/a		n/a	
Pathogens	n/a		n/a		n/a	
Climate change	n/a		n/a		n/a	
Foraging habitat degradation	n/a		n/a		n/a	
Other	n/a		n/a		n/a	
Long-term projects (>5yrs)						
Monitoring at nesting sites (period: range of years)	Y (1978-ongoing)	refer to text	N		N	
Number of index nesting sites	1	refer to text	0		0	
Monitoring at foraging sites (period: range of years)	N		N		N	
Conservation						
Protection under national law	n/a		Y	42,43	Y	42,43
Number of protected nesting sites (habitat preservation) (% nests)	n/a		0		0	
Number of Marine Areas with mitigation of threats	n/a		n/a	n/a	n/a	n/a

N of long-term conservation projects (period: range of years)	n/a		N		N	
In-situ nest protection (eg cages)	n/a		N		N	
Hatcheries	n/a		N		N	
Head-starting	n/a		N		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	n/a		Y	45,,46,47,48,49,50,51	Y	45,,46,47,48,49,50,51
By-catch: onboard best practices	N		Y	48	Y	48
By-catch: spatio-temporal closures/reduction	N		N		N	
Other						

Table 2. The nesting beaches of Japan

RMU / Nesting beach name	**Index site**	**Nests/yr: recent average (range of years)**	**Crawls/yr: recent average (range of years)**	**Western limit**		**Eastern limit**		**Central point**		**Length (km)**	**% Monitored**	**Ref #**	**Monitoring Level (1-2)**	**Monitoring Protocol (A-F)**
CC-PN-Japan	Yakushima Island (Total), Kagoshima, Pref.	5588(2005-2009)	2646(2005-2009)							5	99	63	1	

CC-PN-Japan	Miyazaki, Miyazaki Pref.	1114(2008-2016)	1768(2008-2016)							28	99	64	1	
CC-PN-Japan	Hiwasa-Ohama, Tokushima Pref.	31(2008-2016)	47(2008-2016)							0.5	100	65	1	
CC-PN-Japan	Minabe, Wakayama Pref.	80-300(2008-2016)	200-700(2010-2016)							1.3	100	66	1	
Cm-PNW-Japan	Ogasawara Islands	2055(2010-2016)	n/a							<1km x 50 beaches	90	14	1	

Table 3. The conventions signed by Japan

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles	
CITES	1980			loggerhead turtle green turtle hawksbill turtle olive ridley turtle leatherback turtle			CITES is the only international conventions for sea turtles related to Japan. Japan signed to CITES in November 1980 without 9 species (reservation) including hawksbill turtle. The reservation of hawksbill turtle was withdrawed in July 1994.

Table 4. Annual number of landing and nesting of hawksbill turtle on Kuroshima Island. (revised the date from Kameda 2007)

year	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
landing		9	12	0		2	2	0	0	0
nesting	2	4	5	0		2	1	0	0	0
year	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
landing	5	4	0	2	0	0	1	0	6	3
nesting	3	4	0	1	0	0	1	0	4	3
year	1998	1999	2000	2001	2002	2003	2004	2005	2006	
landing	0	2	12	2	4	4	0	0	3	
nesting	0	1	2	0	3	4	0	0	2	

Table 5. Stranding and bycatch of hawksbill sea turtles in Kanto region

Year	#	SCL (cm)	stranding/ bycatch	Condition	source
1990	3	-	Bycatch (set net)	live	Maruyama and Nakamura 2000
1992	2	-	Bycatch (set net)	Live/ dead	As above
1998	1	-	Bycatch (set net)	live	As above
2004	1	56.5	stranding	dead	ELNA unpublished
2005	2	ca.45, 31.9	stranding	dead	As above
2006	2	ca.59, ca.66	stranding	dead	As above
2007	2	58.1, 33.2	stranding	dead	As above
2008	2	ca.69, 63.0	stranding	dead	As above
2011	1	35.4	stranding	dead	As above
2015	1	57.0	stranding	dead	As above
2016	1	39.3	bycatch (gill net)	dead	As above
2017	1	36.6	stranding	dead	As above

REPUBLIC OF KOREA

Authors: Dae Yeon Moon[1] and IL Hun Kim[1]
[1]National Marine Biodiversity Institute of Korea, Republic of Korea

1. RMU: Green Turtle *Chelonia mydas*, Pacific Northwest (CM-PNW)

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

No nesting of green sea turtles has been reported (Tables 1 and 2).

1.1.2. Marine areas

Recent research revealed that green sea turtle is the most dominant sea turtle species found in Korean waters and Jeju Island is the most important area for distribution of greens. Based on the size range of stranded and bycaught greens, it is envisaged that Jeju Island provide greens feeding ground as it has wide area of seagrass and algae beds. This hypothesis was supported by satellite tracking with a juvenile green released into Jeju coastal waters, which showed the released green remained Jeju coastal waters throughout the year even during winter months when sea temperature decreased to around 14ºC. Jang et al. (2018) also revealed that green turtles from different regions, including China and Japan, may use the areas around Jeju Island for foraging, for overwintering, and/or as a migratory corridor in a satellite tracking study of 8 green turtles by-caught in pound nets near Jeju island.

Data of the stranding and bycatch of loggerhead sea turtles has been compiled through the efforts of research institutes (National Institute of Fisheries Science and National Marine Biodiversity Institute of Korea) for the past 20 years from 1990s to recent years (Table 4). Among the bycaught greens released into the sea, nine juvenile-adult

greens were monitored by satellite tagging to understand their distribution pattern and migration route (Table 5).

1.2. Other biological data

Not available

1.3. Threats

1.3.1 Nesting sites

Not available.

1.3.2 Marine areas

All commercial fisheries conducted in coastal and offshore areas can be serious threats to green turtles. During the past 20 years, of the reported 93 greens, the majority were bycaught in local set nets and about 40% were stranded on beaches. To understand cause of death, recent research includes autopsy of dead sea turtles and found significant amount of marine waste including discarded nets and plastic materials, indicating marine pollution also is one of major threat to greens inhabiting in coastal areas. However, since many dead stranded sea turtles are in a state of decay, it is difficult for researchers to determine the cause of death.

1.4. Conservation

Expanding from what listed in Tables 1 and 3 of the excel

For conservation of sea turtle species occur in Korean waters, the Korean government has listed four sea turtle species into the list of Marine Protected Species of Korea in 2012, which is an implementation of conservation programs in compliance with the Conservation and Management of Marine Ecosystems Act entered into force in 2006. The key components of the Act include protection of marine habitats, spawning areas

and migratory routes, conservation of sea turtles outside of habitats through Ex-situ Conservation Institutions, and rescue and treatment of sea turtles stranded through Marine Animal Rescue Centers appointed by the government. Korea is also protecting and managing marine biodiversity by designating Marine Ecosystem Protected Areas and Marine Environment Conservation Zone.

1.5. Research

As for sea turtle research in Korea, national research institutes took initiatives in conducting government-funded research in collaboration with local aquariums, coast guard and universities. However, due to lack of resources, it was 2008 when the first research on sea turtles initiated to obtain basic information on sea turtles occurred in Korean waters. The research includes monitoring of sea turtle stranding, bycatch, nesting and migrating behavior. Research outcomes have been published and provided guidelines managers and policy makers to put all sea turtles species found in Korean waters in the Marine Protected Species of Korea in 2012. To monitor distribution and migration route, so far nine greens have been released with satellite tagging.

1.6. References

Jang, S., Balazs, G.H., Parker, D.M., Kim, B., Kim, M.Y., Ng, C.K.Y. & Kim, T.W. (2018) Movements of Green Turtles (*Chelonia mydas*) rescued from pound nets near Jeju Island, Republic of Korea. Chelonian Conservation and Biology 17(2), 236-244.

Jung, M.M., Moon, D.Y., Kim, S.H., Kim, H.S. & Kim, J.W. (2012a). Environmental conditions as accidental nesting place of Sea turtle located in Jeju island of Korea. Journal of Fisheries and Marine Sciences Education 24, 507-515.

Jung, M.M., Moon, D.Y., Kim, S.H., Kim, H.S. & Kim, J.W. (2012b). Observation and Record of Sea Turtles in Bycatch and Stranding from Jeju Island of Korea. Journal of Fisheries and Marine Sciences Education 24, 662-669.

Kim, I.H., Moon, D.Y., Cho, I.Y., Kim, M.S., An, Y.R., Han, D.U., Han, W.M,. Han, D.J. & Park, D.S. (2017). Occurrence of Sea Turtles in the Korean Waters and the Morphological Characteristics of Two Major Species. Korean journal of fisheries and aquatic sciences 50 (3), 311-318.

Koo, K.S., Han, S.H. & Oh, H.S. (2014). First report of a hybridization between *Caretta caretta* and *Chelonia mydas* from Jeju Island, South Korea. Korean Journal

of Environmental Biology 32, 377-381.
Moon, D.Y., Jung, M.M., An, Y.R., Choi, S.G., Oh, B.S., Kim, Z.G., Lee, C., Kim, M.J. & Kim, S.Y. (2009). Distribution and strandings of endangered sea turtles in Korean waters. Korean journal of fisheries and aquatic sciences 42, 657-663.
Moon, D.Y., An, Y.R., Jung, M.M., Kim, S.Y., Choi, S.K., Lee, H.Y., Yoo, J.T. & Kim, M.J. (2011). Satellite tracking of Green sea turtles *Chelonia mydas* in Korean waters. Korean journal of fisheries and aquatic sciences 44, 709-716.

2. RMU: Loggerhead Turtle *Caretta caretta*, Pacific North (CC-PN)

2.1. Distribution, abundance, trends

2.1.1. Nesting sites

Out of seven sea turtle species of the world, there are four species - green, loggerhead, leatherback and hawksbill sea turtles - found almost year around in Korean waters, except some areas with cold sea temperature during winter months. However, it is only loggerhead that has made nests on Korean beaches, although it is considered to be intermittent or opportunistic nesting by a few females. Main sea turtle nesting sites in Korea are located along southern coasts – Pohang, Busan and Jeju Island (Tables 1 and 2, Fig. 1), with other places as nesting sites witnessed by fishermen but not documented. Due to lack of research on sea turtles before 1990s, this report presents data and information available from mid-1990s to recent years.

Fig. 1. Number and location of nesting sites.

Most of loggerhead nesting episodes were observed on the beaches of Jeju Island, the southernmost and largest island which lies in the path of warm current originating from south tropical areas and close to Japanese islands where mass nesting of loggerhead sea turtles occur every year. The most important beach for loggerhead's nesting on Jeju Island is the Jungmun beach that is characterized as sandy beach with a length of approximately 600 meters. While Busan and Pohang have not served a nesting beach any more since the mid-1960s and early 2000s, respectively, Jungmun has been reported until 2007 as loggerhead has nested (Table 6).

2.1.2. Marine areas

As sea turtle nesting takes place occasionally on Korean shores once every few years with only a few females, it did not bring national attention so no research has been conducted before 2008 when a government-funded research project began to implement conservation programs in compliance with the Conservation and Management of Marine Ecosystems Act entered into force in 2006. Initial research activities focused on monitoring of sea turtle stranding and bycatch, nesting behavior on a nesting beach of Jeju Island, and monitoring of migration behavior using satellite tagging.

Data of the stranding and bycatch of loggerhead sea turtles has been compiled through the efforts of research institutes (National Institute of Fisheries Science and National Marine Biodiversity Institute of Korea) for the past 20 years from 1990s to recent

years (Table 7). Among all bycaught loggerhead sea turtles released into the sea, two sub-adults were monitored by satellite tracking to understand their distribution pattern and migration route (Table 8).

2.2. Other biological data

Not available.

2.3. Threats

2.3.1 Nesting sites

Since the three nesting sites are well-known swimming beaches for visitors and local residents, increased number of visitors up to hundreds of thousands within a day during swimming season from June to August causes the most serious threat to nesting females. Night-time human activity together with artificial lighting is an additional threat to nesting females and hatchlings emerging from their nests. Due to these potential threats, there were no records of nesting after 2007, with possible witnesses of landing, nesting females or hatchlings by local fishermen on Jeju Island. Beachfront construction and coastal development might have been serious threats to nesting beaches of Busan and Pohang.

2.3.2 Marine areas

As is well known, all sea turtle species are affected by commercial fisheries conduced in the ocean and there are several types of fisheries active in coastal and offshore areas of Korea, which incidentally can capture migrating or feeding sea turtles. A research revealed that in the case of loggerheads recorded in Korean waters during the past 20 years, the majority was stranded on beaches and about 33% were accidentally caught by local set nets and released alive into the sea. To understand the cause of death, recent research includes autopsy of dead loggerheads and found a significant amount of marine waste, including discarded nets, plastic bags and others from their gut, indicating marine pollution also is one of the major threats to sea turtles inhabiting coastal waters. However, since many dead stranded sea turtles are in a state

of decay, it is difficult for researchers to determine the cause of death.

2.4 Conservation

Expanding from what listed in Tables 1 and 3 of the excel

For conservation of sea turtle species occur in Korean waters, the Korean government has listed four sea turtle species into the list of Marine Protected Species of Korea in 2012, which is an implementation of conservation programs in compliance with the Conservation and Management of Marine Ecosystems Act entered into force in 2006. The key components of the Act include protection of marine habitats, spawning areas and migratory routes, conservation of sea turtles outside of habitats through Ex-situ Conservation Institutions, and rescue and treatment of sea turtles stranded through Marine Animal Rescue Centers appointed by the government. Korea is also protecting and managing marine biodiversity by designating Marine Ecosystem Protected Areas and Marine Environment Conservation Zone.

2.5 Research

As for sea turtle research in Korea, national research institutes took initiatives in conducting government-funded research in collaboration with local aquariums, coast guard and university professors. However, due to lack of resources, it was 2008 when the first research on sea turtles initiated to obtain basic information on sea turtles inhabit Korean waters. The research includes monitoring of sea turtle stranding, bycatch, nesting and migrating behavior. Research outcomes have been published and provided guidelines to put all sea turtles species found in Korean waters into the list of Marine Protected Species of Korea.

2.6. References

Jung, M.M., Moon, D.Y., Kim, S.H., Kim, H.S. & Kim, J.W. (2012a). Environmental conditions as accidental nesting place of Sea turtle located in Jeju island of Korea. Journal of Fisheries and Marine Sciences Education 24, 507-515.

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Lee, H.J., Kim, I.H., Kim, J.K., Jeong, S. & Park, D. (2014). First detailed morphological description of the loggerhead sea turtle (*Caretta caretta*) caught from the Yellow Sea of Korea. Journal of Ecology and Environment 37, 201-208.

Moon, D.Y., Jung, M.M., An, Y.R., Choi, S.G., Oh, B.S., Kim, Z.G., Lee, C., Kim, M.J. & Kim, S.Y. (2009). Distribution and strandings of endangered sea turtles in Korean waters. Korean journal of fisheries and aquatic sciences 42, 657-663.

3. RMU: Leatherback Turtle *Dermochelys coriacea*, Pacific West (DC-PW)

3.1. Distribution, abundance, trends

3.1.1. Nesting sites

No nesting of leatherback sea turtles has been reported.

3.1.2. Marine areas

Only a few instances of leatherback bycatch and stranding were reported during the past 20 years (Table 9).

3.2. Other biological data

Not available

3.3. Threats

3.3.1 Nesting sites

Not available.

3.3.2 Marine areas

There are many types of fisheries under operation in Korean coastal areas, which can cause main threat to migrating or feeding sea turtles. In case of leatherback, frequency

of appearance is comparatively low and only four instances of the stranding and bycatch of leatherback have been reported during the past 20 years. As observed in dead stranded loggerhead and green sea turtles, marine waste also might have caused mortality of this species.

3.4. Conservation

Same as loggerheads and greens

3.5. Research

Same as loggerheads and greens

3.6. References

Jung, M.M., Moon, D.Y., Kim, S.H., Kim, H.S. & Kim, J.W. (2012b). Observation and Record of Sea Turtles in Bycatch and Stranding from Jeju Island of Korea. Journal of Fisheries and Marine Sciences Education 24, 662-669.

Kim, I.H., Moon, D.Y., Cho, I.Y., Kim, M.S., An, Y.R., Han, D.U., Han, W.M,. Han, D.J. & Park, D.S. (2017). Occurrence of Sea Turtles in the Korean Waters and the Morphological Characteristics of Two Major Species. Korean journal of fisheries and aquatic sciences 50 (3), 311-318.

4. RMU: Hawksbill Turtle *Eretmochelys imbricata*, Pacific West (EI-PW)

4.1. Distribution, abundance, trends

4.1.1. Nesting sites

No nesting of hawksbill sea turtles has been reported.

4.1.2. Marine areas

Only a few instances of hawksbill bycatch and stranding were reported during the past 20 years (Tables 10 and 11).

4.2. Other biological data

Not available.

4.3. Threats

4.3.1 Nesting sites

Not available.

4.3.2 Marine areas

Like other species, hawksbill also is exposed to threats of various anthropogenic factors, including coastal fisheries and marine wastes. In case of hawksbill, frequency of appearance is comparatively low and only seven instances of the stranding and bycatch of hawksbill have been reported during the past 20 years. As observed in dead stranded loggerhead and green sea turtles, marine waste also might have caused mortality of this species.

4.4 Conservation

Same as other species

4.5 Research

Same as other species

4.6. References

Jung, M.M., Moon, D.Y., Kim, S.H., Kim, H.S. & Kim, J.W. (2012b). Observation and Record of Sea Turtles in Bycatch and Stranding from Jeju Island of Korea. Journal of Fisheries and Marine Sciences Education 24, 662-669.

Kim, I.H., Moon, D.Y., Cho, I.Y., Kim, M.S., An, Y.R., Han, D.U., Han, W.M,. Han, D.J. & Park, D.S. (2017). Occurrence of Sea Turtles in the Korean Waters and the Morphological Characteristics of Two Major Species. Korean journal of fisheries and aquatic sciences 50 (3), 311-318.

Table 1. Main biology and conservation aspects of sea turtle Regional Management Units (RMU) occurring in the Republic of Korea

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**CC-PN-Korea**	Ref #	**CM-PNW-Korea**	Ref #	**DC-PW-Korea**	Ref #
Occurrence						
Nesting sites	Y	1	N		N	
Pelagic foraging grounds	n/a		n/a		n/a	
Benthic foraging grounds	n/a		Y	2	n/a	
Key biological data						
Nests/yr: recent average (range of years)	6 (in the past 20 years)	1	n/a		n/a	
Nests/yr: recent order of magnitude	n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		n/a		n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	3	1	n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	6 (in the past 20 years)	1	n/a		n/a	

Total length of nesting sites (km)	0.6 (Jeju)	1	n/a		n/a	
Nesting females / yr	n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		n/a	
Female remigration interval (yrs) (N)	n/a		n/a		n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a	
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a	
Age at maturity (yrs)	n/a		n/a		n/a	
Clutch size (n eggs) (N)	n/a		n/a		n/a	
Emergence success (hatchlings/egg) (N)	n/a		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a	
Trends						
Recent trends (last 20 yrs) at nesting sites (range of years)	6 (in the past 20 years)	1	n/a		n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	n/a		n/a		n/a	
Published studies						
Growth rates	n/a		n/a		n/a	

Genetics	n/a		n/a		n/a	
Stocks defined by genetic markers	n/a		n/a		n/a	
Remote tracking (satellite or other)	Y	7	Y	7	N	
Survival rates	n/a		n/a		n/a	
Population dynamics	n/a		n/a		n/a	
Foraging ecology (diet or isotopes)	n/a		n/a		n/a	
Capture-Mark-Recapture	n/a		n/a		n/a	
Threats						
Bycatch: presence of small scale / artisanal fisheries?	Y (SN)	2,3,6	Y(SN)	2,3,6	Y (SN)	2,3,6
Bycatch: presence of industrial fisheries?	n/a		n/a		n/a	
Bycatch: quantified?	Y	2,6	Y	2,6	Y	2,6
Take. Intentional killing or exploitation of turtles	N		N		N	
Take. Egg poaching	N		n/a		n/a	
Coastal Development. Nesting habitat degradation	Y	6	n/a		n/a	
Coastal Development. Photopollution	Y		n/a		n/a	
Coastal Development. Boat strikes	n/a		n/a		n/a	
Egg predation	n/a		n/a		n/a	
Pollution (debris, chemical)	Y	2,6	Y	2,6	n/a	
Pathogens	n/a		n/a		n/a	
Climate change	n/a		n/a		n/a	

Foraging habitat degradation	n/a		n/a		n/a	
Other	n/a		n/a		n/a	
Long-term projects (>5yrs)						
Monitoring at nesting sites (period: range of years)	Y (2008-2011)	6	n/a		n/a	
Number of index nesting sites	n/a		n/a		n/a	
Monitoring at foraging sites (period: range of years)	n/a		n/a		n/a	
Conservation						
Protection under national law	Y	6	Y	6	Y	6
Number of protected nesting sites (habitat preservation) (% nests)	0		n/a		n/a	
Number of Marine Areas with mitigation of threats	0		n/a		n/a	
N of long-term conservation projects (period: range of years)	1(2008-2011)	6	1(2008-2011)	6	1(2008-2011)	6
In-situ nest protection (eg cages)	N		n/a		n/a	
Hatcheries	N		n/a		n/a	
Head-starting	N		n/a		n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)	N		n/a		n/a	
By-catch: onboard best practices	N		n/a		n/a	
By-catch: spatio-temporal closures/reduction	N		n/a		n/a	

Other	N		N		N	

Table 2. The nesting beaches of the Republic of Korea

RMU / Nesting beach name	Index site	Nests/yr: recent average (range of years)	Crawls/yr: recent average (range of years)	Western limit		Eastern limit		Central point	
CC-PN-Korea				Long	Lat	Long	Lat	Long	Lat
Jeju-Jungmun		6 nests in the past 20 years		33.2543N	126.4068 E	33.2446N	126.4137 E	33.2450N	126.4104 E
Pohang-Odo		1 nest in the past 20 years		36.3548N	129.3876 E	36.3577N	129.3897 E	36.3570N	129.3886 E
Busan-Haeundae		1 nest in the past 50 years		35.1564N	129.1547 E	35.1593N	129.1697 E	35.1587N	129.1604 E

RMU / Nesting beach name	Length (km)	% Monitored	Reference #	Monitoring Level (1-2)	Monitoring Protocol (A-F)
CC-PN-Korea					
Jeju-Jungmun	0.6		42		
Pohang-Odo	0.4		43		

Busan-Haeundae	1.5		news report		

Table 3. The conventions signed by the Republic of Korea

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
CITES	09-Jul-93	10-Oct-93				protect all species

Table 4. Stranding and bycatch of greens

Year/month	Number/size (CCL)	Stranding/bycatch
2004/ Jul-Sep	4 / 76-82.6cm	stranding 3, bycatch 1
2007/ Apr-Sep	3 /	stranding 1, bycatch 2
2008/Jan-Nov	11 / 39.2-87.6 cm	stranding 3, bycatch 8
2009/ Jan-Dec	13 / 40.0-81.6 cm	stranding 4, bycatch 6
2010/ Feb-Nov	17 / 48.0-80.0 cm	stranding 4, bycatch 13
2011/ May-Nov	13 / 42.8-80.0 cm	stranding 5, bycatch 6
2012/ May-Sep	7 / 46.0-90.0 cm	stranding 2, bycatch 5
2013/ Jul-Oct	8 / 45.0-97.0 cm	stranding 4, bycatch 4
2014/ Aug-Nov	6 / 55.0-88.0 cm	bycatch 6
2015/ Jun-Aug	3 / 46.0-72.0 cm	stranding 1, bycatch 2
2016/ Jun-Oct	3 / 82.0 cm	stranding 1, bycatch 2
2017 / Aug-Oct	5/ 78.1-86.2	stranding 4, bycatch 1

Table 5. Release of greens with satellite tags

Date released	Species	Size(CCL)	Days monitored
Oct 2009	2 greens	63cm, 93cm	247 days, 270 days
May 2011	2 greens	30-40cm	66 days, 361 days
Oct 2015	2 greens	-	47 days, 694 days
Jul 2016 Sep	1 green 1 green	91.8cm 70.4cm	447 days 349 days
Sep 2017	1 green	76.5cm	Under monitoring

Table 6. Abundance Index of loggerhead turtles (nests, females)

Year/month	Nests/females	Place
1964/ May	1 nest/1 loggerhead	Busan (105 eggs)
1998/ August	1 nest/1 loggerhead	Jeju Island (100 eggs)
1999/ October	loggerhead hatchlings	Jeju Island (100 hatchlings)
2002/ July	1 nest /1 loggerhead	Jeju Island
2003/ August	1 nest / 1 loggerhead	Pohang
2004/ -	1 nest / 1 loggerhead	Jeju Island

2007/ -	1 nest / 1 loggerhead	Jeju Island

Table 7. Stranding and bycatch of loggerhead sea turtles

Year/month	Number/size (CCL)	Stranding/bycatch
1997/Sep	1 / 110cm	bycatch
1998/ Jul	1 / 122cm	bycatch
2004/ Jul-Sep	3 / 87.7cm	stranding 3
2005/ Aug	1 / 80.5cm	bycatch
2006/ May-Sep	6 / 75-85cm	stranding 3, bycatch 3
2007/ Apr-Sep	2 /	stranding 2
2008/Jan-Nov	7 / 76.5-85.0cm	stranding 6, bycatch 1
2009/ Jan-Dec	3 / 70.0-81.8cm	stranding 3
2010/ Feb-Nov	4 /	stranding 2, bycatch 2
2011/ May-Nov	3 / 80.0-100.0cm	no data
2012/ May-Sep	3 / 81.2cm	stranding 2, bycatch 1
2013/ Jul-Oct	2 / 76.8-87.5cmc	stranding 1, bycatch 1
2014/ Nov	1 / 110.0cm TL	stranding 1
2015/ Jun-Aug	5 / 74.0-100.0cm	stranding 2, bycatch 3
2016/ Jun-Oct	4 / 86.1-89.0	stranding 3, bycatch 1
2017 / Aug-Oct	11/ 68.8-92.0	stranding 10, bycatch 1

Table 8. Release of loggerhead sea turtles with satellite tags

Date released	Species	Size (CCL)	Days monitored
Jun 2016	1 loggerhead	74cm	48 days
Sep 2017	1 loggerhead	76cm	Under monitoring

Table 9. Stranding and bycatch of leatherbacks

Year/month	Number/size (CCL)	Stranding/bycatch
2001/ Jun	1 /	stranding
2010/ Sep	1 / 107.0cm	stranding
2011/ Sep	1 /	bycatch
2012/ May	1 / 132.0cm	stranding

Table 10. Stranding and bycatch of hawksbill

Year/Month	Number/Size (CCL)	Stranding/bycatch
2009/ Jan-Feb	2 / 41.9-41.9cm	bycatch 2

2013/ Aug	2 / 33.2cm	bycatch 2
2014/ Aug	1 / 35cm	bycatch 1
2016/ Aug	2 / 43.4-45.3cm	stranding / bycatch 1

Table 11. Release of hawksbill sea turtle with satellite tag

Date released	Species	Size (CCL)	Days monitored
Sep 2017	1 Hawksbill	45.3cm	Under monitoring

HONG KONG

Special Administrative Region (SAR), People's Republic of China

Authors: Connie Ka Yan NG[1] and Simon Kin Fung CHAN[2]
[1]Department of Biology and Chemistry and State Key Laboratory in Marine Pollution, City University of Hong Kong, Kowloon Tong, Hong Kong Special Administrative Region, People's Republic of China
[2]Agriculture, Fisheries and Conservation Department, Hong Kong Special Administrative Region, People's Republic of China

1. RMU: Green Turtle *Chelonia mydas*, Pacific Northwest (CM-PNW)

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Nestings of green turtles (*Chelonia mydas*) were recorded at 5 sites: (1) Tai Long Wan at Sai Kung, (2) Tai Long Wan of Hong Kong Island, (3) Tung O and (4) Sham Wan of Lamma Island and (5) Tai Long Wan of Lantau Island (Tables 1 and 2). The location of each nesting site in Hong Kong is indicated in Figure 1.

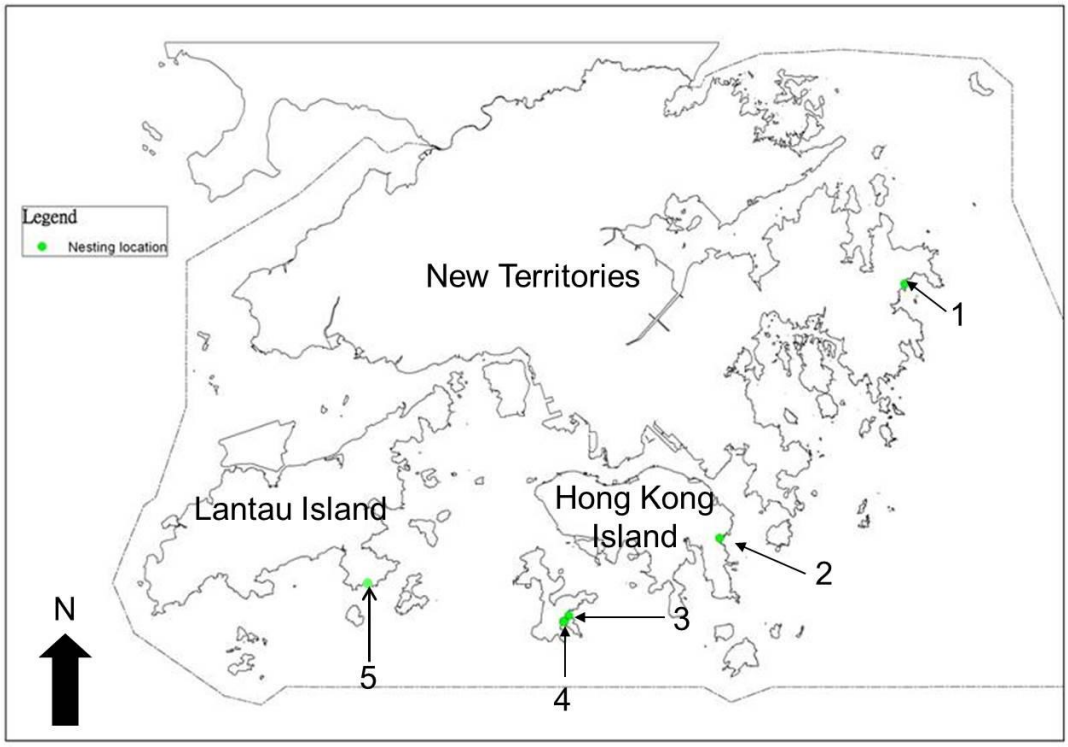

Figure 1. Location of green turtle nesting site in Hong Kong

Sham Wan of Lamma Island is the nesting site where green turtles nesting was observed and recorded regularly among the other nesting sites. Please refer to Table 2 of the Excel for details.

According to Chan *et al*. (2007) and Ng *et al*. (2014), particulars of nesting of green turtles observed at Sham Wan are tabulated below (extracted from Table 1 of the excel):

Nests/yr: recent average (range of years)	7 (1998, 2000-2003, 2008, 2012)
Nests/yr: recent order of magnitude	10
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	5
Nests/yr at "minor" sites: recent average (range of years)	7 (1998, 2000-2003, 2008, 2012)
Total length of nesting sites (km)	0.2
Nesting females / yr	1 to 5 (1998, 2000-2003, 2008, 2012)
Nests / female season (N)	7 (1)
Female remigration interval (yrs) (N)	4 to 5

Min adult size, CCL or SCL (cm)	86, CCL
Clutch size (n eggs) (N)	117.7 (23)
Emergence success (hatchlings/egg) (N)	0.4-0.9 (18)

Based on the data from 1998 to 2012 at Sham Wan (Chan *et al*. 2007, Ng *et al*. 2014), the number of nesting green turtles observed each season ranged from 1 to 5 in the years 1998, 2000 to 2003, 2008 and 2012. No nesting occurred between 2013 and 2017. The number of nesters observed in Hong Kong was relatively low compared with other rookeries in southern China. These nesters are likely a remnant of a small population previously depleted as a result of historical egg harvest (Ng *et al.* 2014).

The oldest documented record dated back to 1970, where 30 to 40 green turtle nests were observed each season at Sham Wan by local villagers, implying that 4 to 13 green turtles nested there if each turtle deposited three to seven clutches in a season (Ng *et al.* 2014).

1.1.2. Marine areas

The nesting green turtle tagged in 2002 was tracked from Hong Kong for about 20 days to its foraging ground in coastal waters off Wanning City of Hainan Island, which is about 500 km from Hong Kong (Chan *et al.* 2003) (Figure 2a). Another female green turtle migrated to its foraging ground in Dao Bach Long Vi, a marine protected area in Vietnam, approximately 700 km from Hong Kong, within a month after nesting at Sham Wan in both 2003 and 2008. The same green turtle that nested in both 2003 and 2008 was tracked again after nesting in Hong Kong in 2012. The turtle, on its migratory pathway back to the foraging ground in Dao Bach Long Vi in Vietnam, was reported entangled in a fishing net and found dead when fishermen recovered the net in early October 2012. The turtle was subsequently buried with Buddhist prayers in a sandy beach at Xuwen of Guangdong Province, China (Figure 2b) (Ng *et al.* 2014).

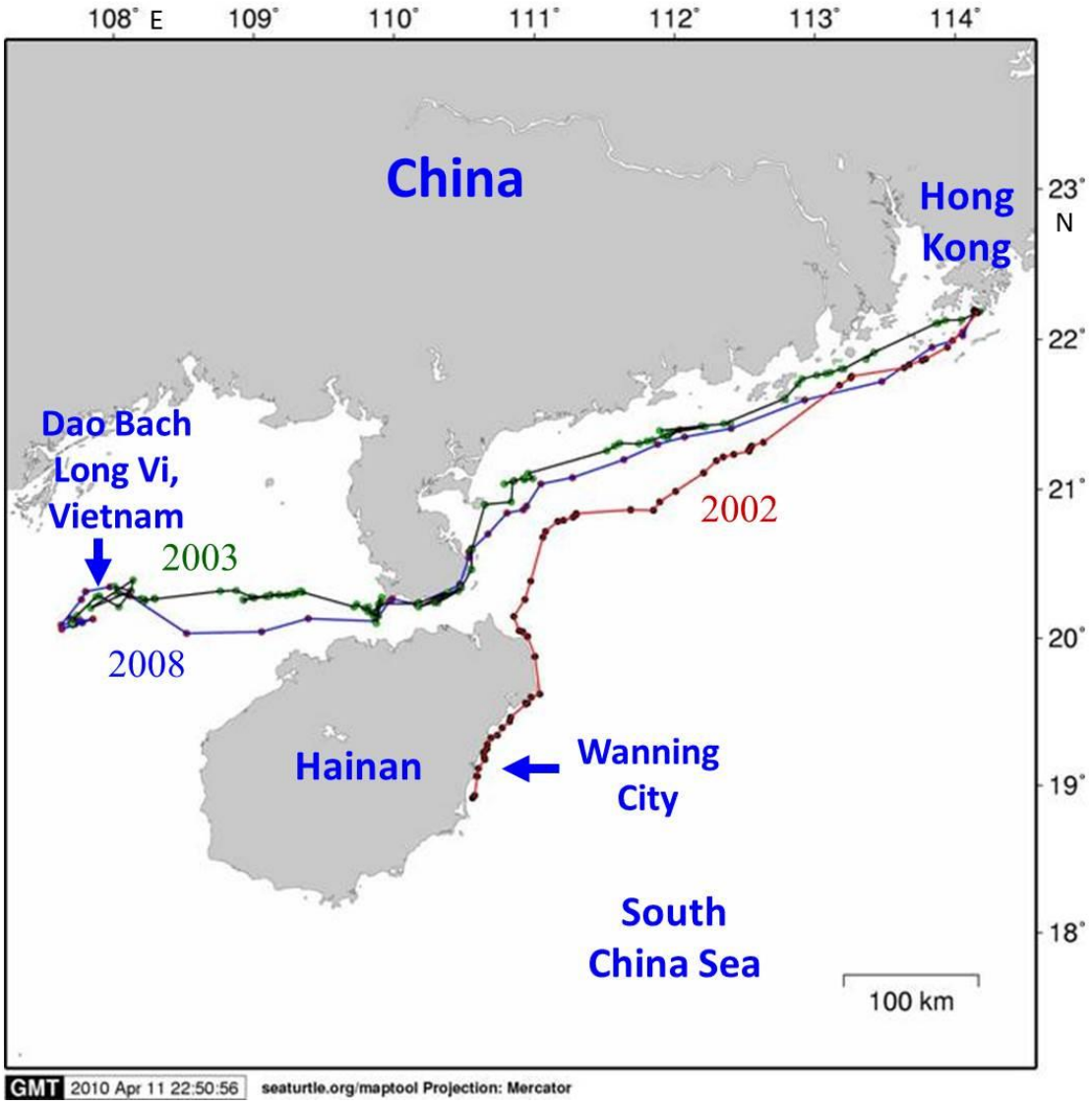

Figure 2a. Three post-nesting tracks of two green turtles from Sham Wan in the years 2002 (red), 2003 (green) and 2008 (blue).

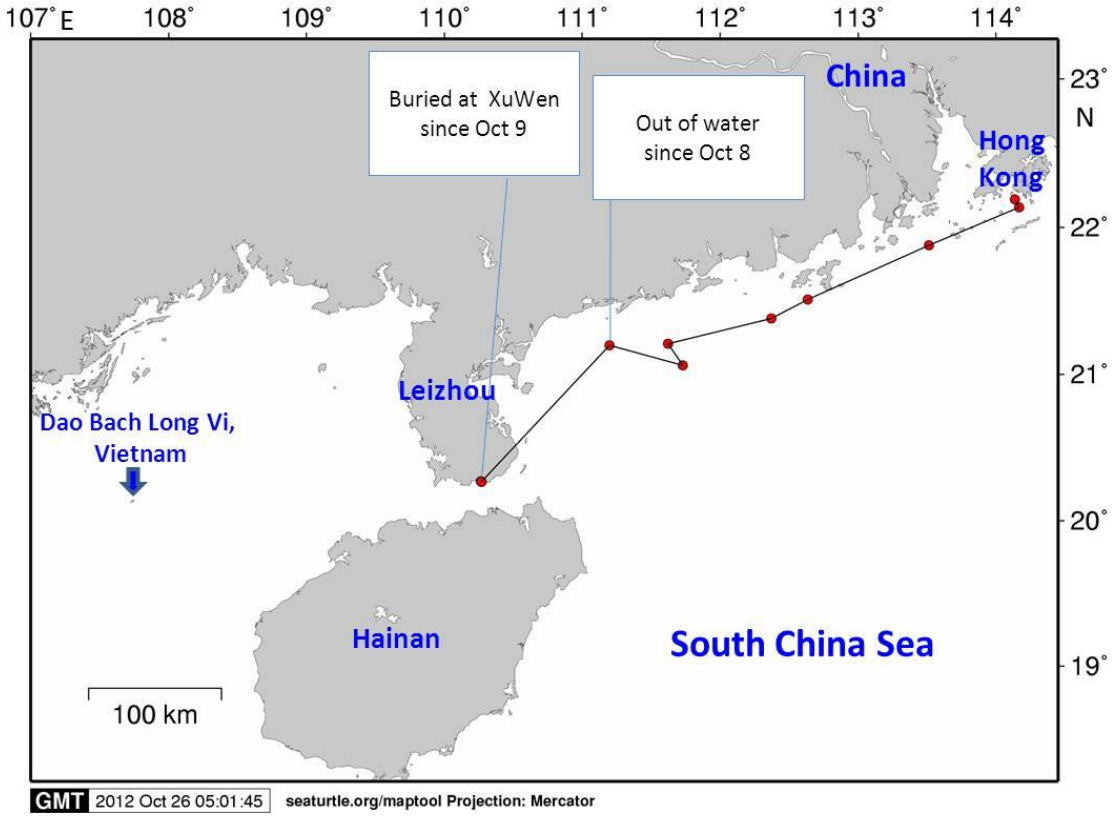

Figure 2b. Post-nesting track of the green turtle, which also nested in 2003 and 2008, in 2012.

Satellite tracking study by Ng *et al.* (2018) revealed that green turtles foraged in the eastern Hong Kong waters, where Yan Chau Tong Marine Park and Tung Ping Chau Marine Park are located. According to the same study, Hong Kong waters form part of the migratory corridor along the coastal waters of Guangdong Province, China, where nesting green turtles from Hong Kong, Gangkou Sea Turtle National Nature Reserve, Penghu Islands and Luichiu Island travelled to their respective foraging grounds after nesting.

A database of sea turtle sightings and strandings from 1951 to 2013 was compiled by historical documentation, public reports, interviews with local people (e.g. fishermen) and on-site monitoring (Ng 2015). From 1951 to 2013, a total of 147 occurrences of sea turtles were documented: 28 records were unknown species according to public reports; the relative abundance of the five sea turtle species in the remaining 119 records in descending order was green turtle (76%), hawksbill turtle (8%), olive ridley turtle (7%), loggerhead turtle (6%) and leatherback turtle (4%). According to Ng (2015), the majority of sea turtle sightings and strandings (over 80% of total records) occurred in the eastern and southern areas of Hong Kong. Occurrence reports were

clustered in bays and inlets. A rare stranding of a heavily-decomposed sub-adult leatherback turtle was recorded in May 2020.

1.2. Other biological data

Accompanying text to data summarized in Table 1, if needed.

Mixed stock analysis based on the 760 bp mitochondrial DNA (mtDNA) control region of green turtles (Ng *et al.* 2017) revealed that the primary source rookeries in the Pacific contributing to foraging green turtle aggregations in the South China Region, including Hong Kong, were Peninsular Malaysia, Yap in the Federated States of Micronesia, Aru of Indonesia, Sulu Sea, northeastern Borneo, Republic of Marshall Islands, Wan-an of Taiwan, and the central Ryukyu and Yaeyama of Japan.

Green turtles in Hong Kong consumed 6 red algae species (*Pterocladiella tenuis, Gelidium pusillum, Chondrus ocellatus, Gracilaria chorda, Grateloupia filicina, and Amansia glomerata*), 1 brown alga species (*Lobophora variegata*), and 1 sea grass (*Halophila ovalis*) (Ng *et al.* 2016).

1.3. Threats

1.3.1. Nesting sites

Expanding from what listed in Table 1.

Historical harvest of green turtle eggs occurred at Sham Wan according to Chan *et al.* (2007) and Ng *et al.* (2014).

1.3.2. Marine areas

Expanding from what listed in Table 1.

By-catch: According to Ng (2015), accidental by-catch of sea turtles occasionally occurred in the eastern waters of Hong Kong, such as near Yan Chau Tong, in Tolo

Channel, or near Tai Long Wan of Sai Kung, by trawler fishing boats. As trawl ban came into effect in Hong Kong waters since 2012, it is believed that the chance of sea turtle by-catch is tremendously reduced. There was also a report in 2007 that a fisherman rescued a juvenile green turtle from entanglement in a fishing line in Miao Wan Dao, Wanshan Archipelago (Ng 2015). As discussed above, the nesting green turtle from Hong Kong in 2012, on its migratory pathway back to the foraging ground in Dao Bach Long Vi in Vietnam, was reported entangled in a fishing net and found dead when fishermen recovered the net.

Pollution: Lam *et al.* (2006) reported that the concentrations of selenium (Se), lead (Pb) and nickel (Ni) in the green turtle eggs collected from Hong Kong were generally higher than those reported in other studies. Se and Ni may pose some risks to the green turtles based on estimation of hazard quotients. In a dietary study of green turtles in Hong Kong by Ng *et al.* (2016), plastic fragments and a small plastic bag of tissue packaging and other foreign materials, such as rope strands, were found in the stomach contents of 2 of the 8 individuals sampled. According to Ng *et al.* (2018), ten-fold higher levels of Pb, barium (Ba), vanadium (V) and 40-fold greater cadmium (Cd) levels were measured in green turtle livers in South China, including Hong Kong, relative to other studies conducted over 10 years ago. Measured polybrominated diphenyl ethers (PBDE) levels were also 27-fold and 50-fold greater than those reported in Australia and Japan.

1.4. Conservation

Protection status: expanding from what listed in Table 1 and 3

All sea turtle species are protected by local laws. Under the Protection of Endangered Species of Animals and Plants Ordinance, any person who imports, exports or possesses a sea turtle or its egg, shall be liable to a maximum fine of $10,000,000 and imprisonment for 10 years. Under the Wild Animals Protection Ordinance, it is an offence to hunt, wilfully disturb, possess, control, buy, sell or export any part of a local sea turtle and its nest or eggs. Offenders are liable to a maximum fine of $100,000 and 1-year imprisonment. Besides, Sham Wan of Lamma Island has been designated as a Restricted Area. Any person who enters into or stays within this area without a permit within the period from 1 June to 31 October (i.e. the nesting season) shall be liable to a maximum fine of $50,000.

Governmental or NGO programs, especially long-term ones. (Table 4)

In Hong Kong, an array of management measures has been implemented since 1998 by the Agriculture, Fisheries and Conservation Department (AFCD) of the Hong Kong SAR Government for the conservation of sea turtles, including protection and management of the nesting beach, enforcement, and scientific research.

Before the onset of nesting season (i.e. from June to October) each year, management work is carried out in the nesting site at Sham Wan. These include removal of weeds which hinder turtles coming ashore to nest, regular monitoring of the site's conditions and collection of refuse on the beach, etc. Both daytime and overnight beach patrols are conducted at Sham Wan to monitor and count any nesting green turtles and their nests during the nesting season. To avoid entanglement of green turtles at Sham Wan, AFCD also conducts underwater surveys for abandoned fishing nets at the bay and arrange removal of the nets and other marine debris if necessary. On occasions that turtle eggs are threatened by external environmental factors in the natural nesting beach, e.g. inundation due to heavy rainfall, artificial incubation of the eggs would be undertaken to enhance the hatching success. Some of the hatchlings from artificial incubation have been raised to certain sizes before release in suitable weather to enhance their survivorship in the wild. Since 1998, over 1,000 hatchlings from both natural and artificial incubation have been released to Sham Wan. AFCD has also implemented a sea turtle rescue programme to monitor and rehabilitate any stranded/ by-catch sea turtles. Besides, AFCD has been conducting satellite tracking of sea turtles since 2002 to understand the movements and habitat use of nesting green turtles and rehabilitated sea turtles. Public engagement in sea turtle conservation has also been promoted through educational seminars, talks, posters and publications.

Conservation priorities and specific recommendations to decision makers or other subjects.

Habitat and species protection by means of local laws should be continued. As sea turtles are migratory species, international and regional efforts should be allied and devoted to sea turtle conservation in a more effective fashion. Considering the broad geographic coverage and connectivity of habitats used by green turtles, it is necessary to first establish and reinforce networks among stakeholders including managers, scientists, conservationists and fisheries industries in South China and with other areas of ecological connectivity of green turtles, such as Malaysia, Japan and Vietnam based on genetic connectivity and migratory pathways. Diverse means of modern media and communication tools (e.g. social media applications and apps on mobile devices) among stakeholders and educators should be explored and facilitated. In the

effect of the concerted international and regional efforts, the following measures are proposed below for sea turtle conservation in South China as a whole:

1. At times of the declining population of nesting sea turtles in South China, exhaustive and bold research efforts should be deployed to recover the nesting populations, such as captive breeding and headstarting in collaboration with universities, aquariums or aquaculture farms to optimize effective use of expertise and resources.
2. Anthropogenic threats, namely direct take and bycatch of sea turtles, at both nesting and foraging habitats in particular activity hotspots should be thoroughly assessed and properly mitigated by regional collaboration to sustain populations. Observer programmes in close liaison with local fishermen in South China should be first established to identify areas of high by-catch risk in the activity hotspots and quantify interactions between fisheries and sea turtles. Further quantitative studies on interactions of by-catch with oceanography features and fisheries could be pursued in these by-catch hotspots for developing mitigation measures, such as an adaptive management tool similar to TurtleWatch developed by Howell *et al*. (2008 and 2015).
3. In view of increasingly polluted marine environment (e.g. high level of pollutants detected in green turtles in South China reported by Ng *et al.* (2018)) and the general lack of knowledge of ecotoxicology in relation to reptiles, future research related to marine pollution should focus on monitoring the pollutant levels in sea turtles within the West Pacific/ Southeast Asia regional management unit which spans from East Asia to Southeast Asia, such as Vietnam, Malaysia, the Philippines and Thailand. Threshold concentrations of trace elements and persistent organic pollutants that can cause undesirable chronic biological effects should also be determined to assess possible ecological risks to green turtles in South China and nearby areas.
4. The deeply-rooted traditional linkage of sea turtles with Chinese people as one of the core drives to sea turtle conservation should be wisely used. Conservation action compatible with local cultural practices, such as incorporating proper and scientific-based religious release, supporting rehabilitation of sea turtles as “life release” by religious bodies (e.g. fund raising) or discouraging the collection/purchase of sea turtle taxidermy for fung shui, should be explored and implemented.
5. Local knowledge, in particular that of fishermen, should be integrated into management assessments to enrich the baseline data for sea turtles, such as for identifying by-catch hotspots and high-use areas. Local direct involvement should also be incorporated into monitoring programmes that include proper

training, such as nesting beach protection and sea turtle monitoring using standardized methods.

1.5. Research

Please refer to the recommendations discussed in the above session on “Conservation Priorities”.

1.6. References

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Table 1. Main biology and conservation aspects of sea turtle Regional Management Units (RMU) occurring in Hong Kong

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**CM-PNW-HK**	Ref #	**CC-PN-HK**	Ref #
Occurrence				
Nesting sites	Y	1,2	N	
Pelagic foraging grounds	n/a		n/a	
Benthic foraging grounds	Y	3,4	n/a	
Key biological data				
Nests/yr: recent average (range of years)	7 (1998, 2000-2003, 2008, 2012)	1,2	n/a	
Nests/yr: recent order of magnitude	10	1,2	n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	5	1,2	n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	7 (1998, 2000-2003, 2008, 2012)	1,2	n/a	

Total length of nesting sites (km)	0.2	1,2	n/a	
Nesting females / yr	1 to 5 (1998, 2000-2003, 2008, 2012)	1,2	n/a	
Nests / female season (N)	7 (1)	1,2	n/a	
Female remigration interval (yrs) (N)	4 to 5	1,2	n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a	
Min adult size, CCL or SCL (cm)	86, CCL	1,2	n/a	
Age at maturity (yrs)	n/a		n/a	
Clutch size (n eggs) (N)	117.7 (23)	1,2	n/a	
Emergence success (hatchlings/egg) (N)	0.4-0.9 (18)	1,2	n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a	
Trends				
Recent trends (last 20 yrs) at nesting sites (range of years)	Down (1998, 2000-2003, 2008, 2012)	1,2	n/a	
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	30 to 40 (1970)	1,2	n/a	

Published studies				
Growth rates	N		N	
Genetics	Y	5	N	
Stocks defined by genetic markers	Y	5	N	
Remote tracking (satellite or other)	Y	1,2,3,4,6	N	
Survival rates	N		N	
Population dynamics	N		N	
Foraging ecology (diet or isotopes)	Y	6	N	
Capture-Mark-Recapture	N		N	
Threats				
Bycatch: presence of small scale / artisanal fisheries?	Y (MT)	1,2,3,4	N	
Bycatch: presence of industrial fisheries?	N		N	
Bycatch: quantified?	N		N	
Take. Intentional killing or exploitation of turtles	N		N	
Take. Egg poaching	Y	1,2	N	
Coastal Development. Nesting habitat degradation	N		N	
Coastal Development. Photopollution	N		N	
Coastal Development. Boat strikes	N		N	
Egg predation	N		N	

Pollution (debris, chemical)	Y	1,3,7,8,9	N	
Pathogens	N		N	
Climate change	N		N	
Foraging habitat degradation	N		N	
Other	n/a		n/a	
Long-term projects (>5yrs)				
Monitoring at nesting sites (period: range of years)	Y(1998-ongoing)	2	n/a	
Number of index nesting sites	n/a		n/a	
Monitoring at foraging sites (period: range of years)	N		n/a	
Conservation				
Protection under national law	Y	refer to text	Y	refer to text
Number of protected nesting sites (habitat preservation) (% nests)	1(100%)	refer to text	n/a	
Number of Marine Areas with mitigation of threats	n/a		n/a	
N of long-term conservation projects (period: range of years)	Y(1998-ongoing)	refer to text	Y(1998-ongoing)	refer to text
In-situ nest protection (eg cages)	N		n/a	
Hatcheries	N		n/a	
Head-starting	Y	refer to	n/a	

		text		
By-catch: fishing gear modifications (eg, TED, circle hooks)	N		n/a	
By-catch: onboard best practices	N		n/a	
By-catch: spatio-temporal closures/reduction	N		n/a	
Other	n/a		n/a	

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**EI-PW-HK**	Ref #	**LO-PW-HK**	Ref #	**DC-PW-HK**	Ref #
Occurrence						
Nesting sites	N		N		N	
Pelagic foraging grounds	n/a		n/a		n/a	
Benthic foraging grounds	n/a		n/a		n/a	
Key biological data						
Nests/yr: recent average (range of years)	n/a		n/a		n/a	
Nests/yr: recent order of magnitude	n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		n/a		n/a	

Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	n/a		n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a		n/a		n/a	
Total length of nesting sites (km)	n/a		n/a		n/a	
Nesting females / yr	n/a		n/a		n/a	
Nests / female season (N)	n/a		n/a		n/a	
Female remigration interval (yrs) (N)	n/a		n/a		n/a	
Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a	
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a	
Age at maturity (yrs)	n/a		n/a		n/a	
Clutch size (n eggs) (N)	n/a		n/a		n/a	
Emergence success (hatchlings/egg) (N)	n/a		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a	
Trends						
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a		n/a		n/a	

Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	n/a		n/a		n/a	
Published studies						
Growth rates	N		N		N	
Genetics	N		N		N	
Stocks defined by genetic markers	N		N		N	
Remote tracking (satellite or other)	Y	3	N		N	
Survival rates	N		N		N	
Population dynamics	N		N		N	
Foraging ecology (diet or isotopes)	N		N		N	
Capture-Mark-Recapture	N		N		N	
Threats						
Bycatch: presence of small scale / artisanal fisheries?	N		N		N	
Bycatch: presence of industrial fisheries?	N		N		N	
Bycatch: quantified?	N		N		N	
Take. Intentional killing or exploitation of turtles	N		N		N	
Take. Egg poaching	N		N		N	
Coastal Development. Nesting habitat degradation	N		N		N	

Coastal Development. Photopollution	N		N		N	
Coastal Development. Boat strikes	N		N		N	
Egg predation	N		N		N	
Pollution (debris, chemical)	N		N		N	
Pathogens	N		N		N	
Climate change	N		N		N	
Foraging habitat degradation	N		N		N	
Other	n/a		n/a		n/a	
Long-term projects (>5yrs)						
Monitoring at nesting sites (period: range of years)	n/a		n/a		n/a	
Number of index nesting sites	n/a		n/a		n/a	
Monitoring at foraging sites (period: range of years)	n/a		n/a		n/a	
Conservation						
Protection under national law	Y	refer to text	Y	refer to text	Y	refer to text
Number of protected nesting sites (habitat preservation) (% nests)	n/a		n/a		n/a	
Number of Marine Areas with mitigation of threats	n/a		n/a		n/a	
N of long-term conservation projects (period: range of years)	Y(1998-ongoin	refer	Y(1998-ongoin	refer	Y(1998-ongoin	refer

	g)	to text	g)	to text	g)	to text
In-situ nest protection (eg cages)	n/a		n/a		n/a	
Hatcheries	n/a		n/a		n/a	
Head-starting	n/a		n/a		n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)	n/a		n/a		n/a	
By-catch: onboard best practices	n/a		n/a		n/a	
By-catch: spatio-temporal closures/reduction	n/a		n/a		n/a	
Other	n/a		n/a		n/a	

Table 2. The nesting beaches of Hong Kong

RMU / Nesting beach name	**Index site**	**Nests/yr: recent average (range of years)**	**Crawls/yr: recent average (range of years)**	**Western limit**		**Eastern limit**		**Central point**	
CM-PNW-HK				Long	Lat	Long	Lat	Long	Lat
Sham Wan, Lamma Island	N	7 (1998, 2000-2003, 2008, 2012)	n/a	n/a	n/a	n/a	n/a	114.139E	22.191N
Tai Wan, Sai Kung	N	n/a							

Tai Long Wan, Hong Kong Island	N	n/a							
Tung O, Lamma Island	N	n/a							
Tai Long Wan of Chi Ma Wan Peninsula, Lantau Island	N	n/a							

RMU / Nesting beach name	**Length (km)**	**% Monitored**	**Reference #**	**Monitoring Level (1-2)**	**Monitoring Protocol (A-F)**
CM-PNW-HK					
Sham Wan, Lamma Island	0.2	100	1,2	1	D
Tai Wan, Sai Kung					
Tai Long Wan, Hong Kong Island					
Tung O, Lamma Island					
Tai Long Wan of Chi Ma Wan Peninsula, Lantau Island					

Table 3. The conventions signed by Hong Kong

International Conventions	Signed	Binding	Compliance measured and reported	Species	Conservation actions	Relevance to sea turtles
Convention on International Trade in Endangered Species of Wild Fauna and Flora	Y	Y	n/a	ALL	CITES has been implemented through the Protection of Endangered Species of Animals and Plants Ordinance, Cap. 586, in Hong Kong	All sea turtle species are scheduled species under the CITES, which are protected under the local ordinance Cap. 586.

TAIWAN

Authors: Tsung Hsien LI[1] and I Jiunn CHENG[2]
[1] National Museum of Marine Biology and Aquarium, Checheng, Pingtung, 94450, Taiwan
[2] National Taiwan Ocean University, Institute of Marine Biology, National Taiwan Ocean University, Keelung, Taiwan 202-24, Taiwan

1. RMU: Green Turtle *Chelonia mydas*, Pacific Northwest (CM-PNW)

1.1. Distribution, abundance, trends

1.1.1. Nesting sites

Nestings of green turtles (*Chelonia mydas*) were recorded at 3 sites: (1) Wan-an Island, (2) Lanyu Island, (3) Luichiu Island. The location of each nesting site in Taiwan is indicated in Figure 1.

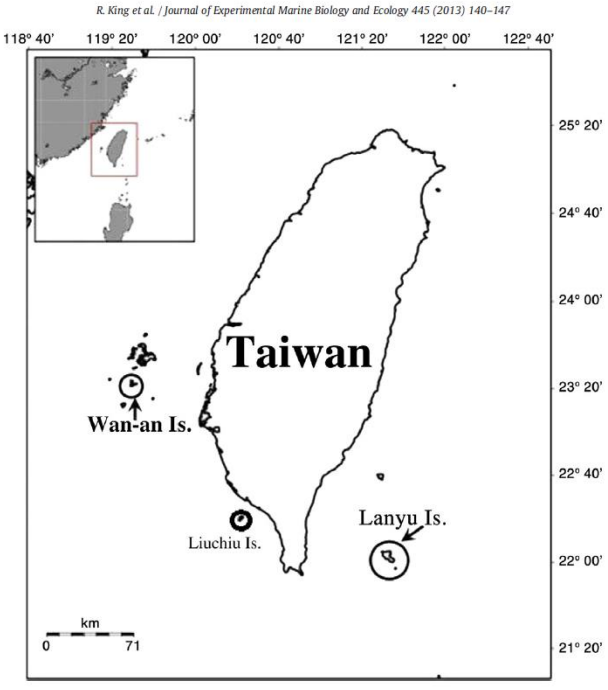


Fig. 1. Map of Taiwan with sampling sites marked in circles: Wan-an Island, Lanyu Island and LiuChiu Island.

Figure 1. Location of green turtle nesting site in Taiwan

Wan-an Island is the index nesting site where the highest numbers of green turtle nests were observed and recorded regularly among the other nesting sites. Please refer to Table 2 of the Excel for details.

According to Chen *et al*. (1995) and Cheng *et al*. (2009), particulars of nesting of green turtles observed at Wan-an Island and Lanyu Island are tabulated below (extracted from Table 1 of the excel). Occasional green turtle nestings were also recorded in eastern part of Taiwan (unpublished data).

Nests/yr: recent average (range of years)	4-55 (1992-2015),average: 25 nests, Wan-an Island; 4-67(average 25) (1997-2018) Lanyu Island
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	2
Nests/yr at "minor" sites: recent average (range of years)	One site 5-15 (2011-2018), one site has 4
Total length of nesting sites (km)	2.5 Lanyu Island 4 Wan-an Island
Nesting females / yr	2-19 (7 ± 5) Wan-an Island 4-24 (9 ± 5) Lanyu Island
Nests / female season (N)	4-55 (1992-2015) Wan-An Island; 4-67(1997-2018) Lanyu Island
Female remigration interval (yrs) (N)	4.5±1.54 (44) Wan-an Island 4.5±1.6 (54) Lanyu Island
Min adult size, CCL or SCL (cm)	82.5 cm SCL (Wan-an Island) 86 cm SCL (Lanyu Island)
Clutch size (n eggs) (N)	104.6±23.9 Wan-an Island 107±26 Wan-an Island 106.7±12.3(23)Wan-an Island 105.5±28.3 Lanyu Island 107±27 Lanyu Island 103±11 (22); Lanyu Island
Emergence success (hatchlings/egg) (N)	47±39.1 Wan-an Island 72±21(23) Wan-an Island 64.1±39.7 Lanyu Island 67±20(22); Lanyu Island

Based on the data from 1997 to 2006 at Lanyu Island (Cheng *et al*. 2009), the number of nesting green turtles observed each season ranged from 3 to 11 in the years 1997 to 2006. Results showed that the main nesting season occurs in the warm and dry summer. Cheng *et al.* (2009) showed that nesting green turtles on Lanyu Island were forced to nest on the smallest beach, where anthropogenic disturbances were relatively low.

A study of the green turtle genetics and nesting ecology in Taiwan by Cheng et al. (2008) showed that nests hatching success, hatchling emergence success and clutch survival rate in Lanyu Island was higher than that on Wan-an Island. Cheng et al. (2018) further documented that the green turtle population on Wan-an Island declined to only 2 nesting females, whereas the Lanyu Island population showed peaks in abundance (up to 24 nesters) every 3±5 years with no long-term decline.

1.1.2. Marine areas

Five sea turtle species can be found in Taiwanese waters, including green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricate*), loggerhead turtles (*Caretta caretta*), olive ridley turtles (*Lepidochelys olivacea*), and leatherback turtles (*Dermochelys coriacea*) (Cheng and Chen, 1997; Li *et al.* 2015).

In previous research on post-nesting migration of green turtles from Wan-an Island and Lanyu Island, the results showed that the end points of postnesting migrations were different, where most Lanyu nesters end in the west Pacific while most Wan-an nesters in the East China Sea (Figure 2) (Cheng *et al.* 2018).

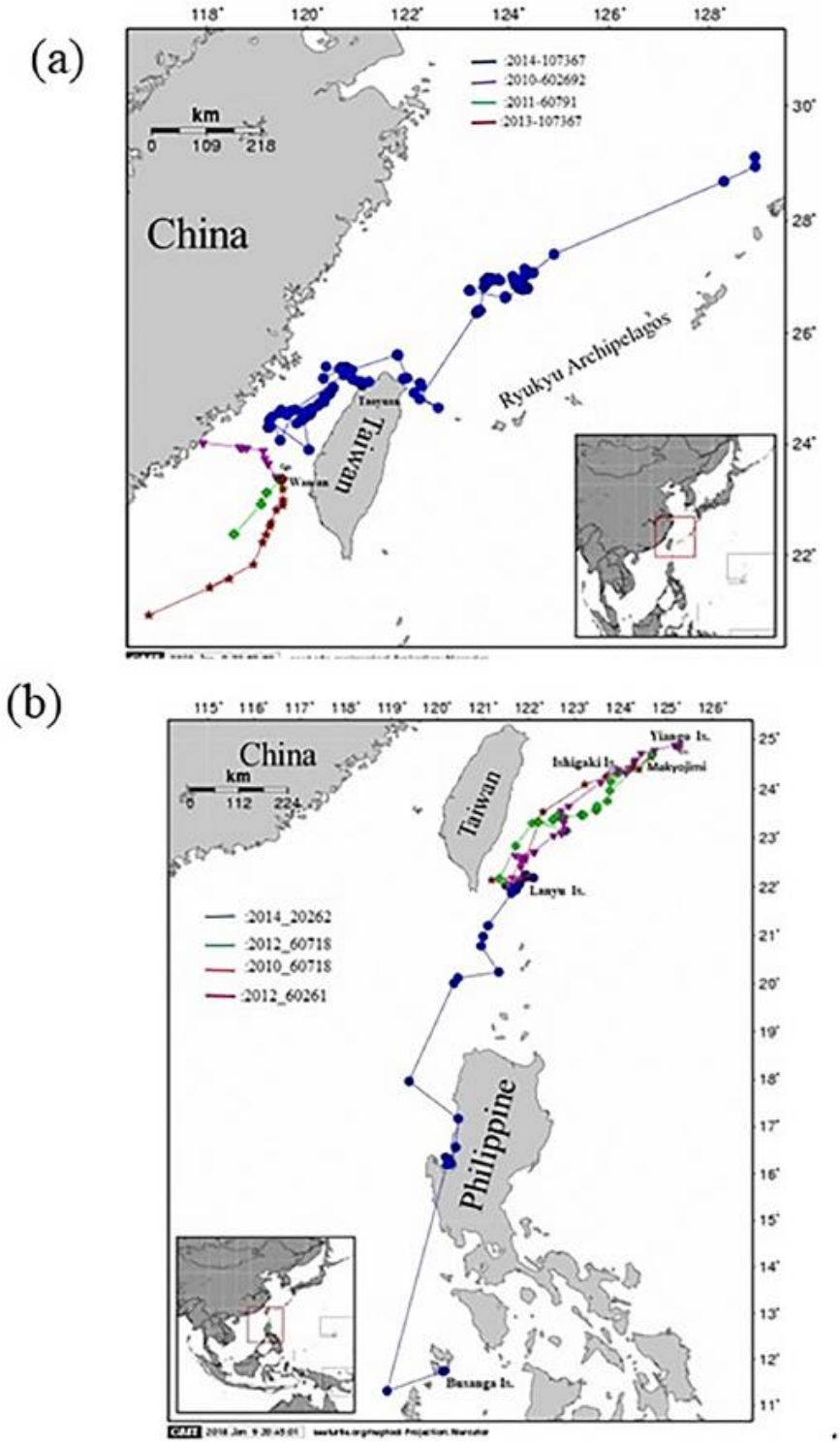
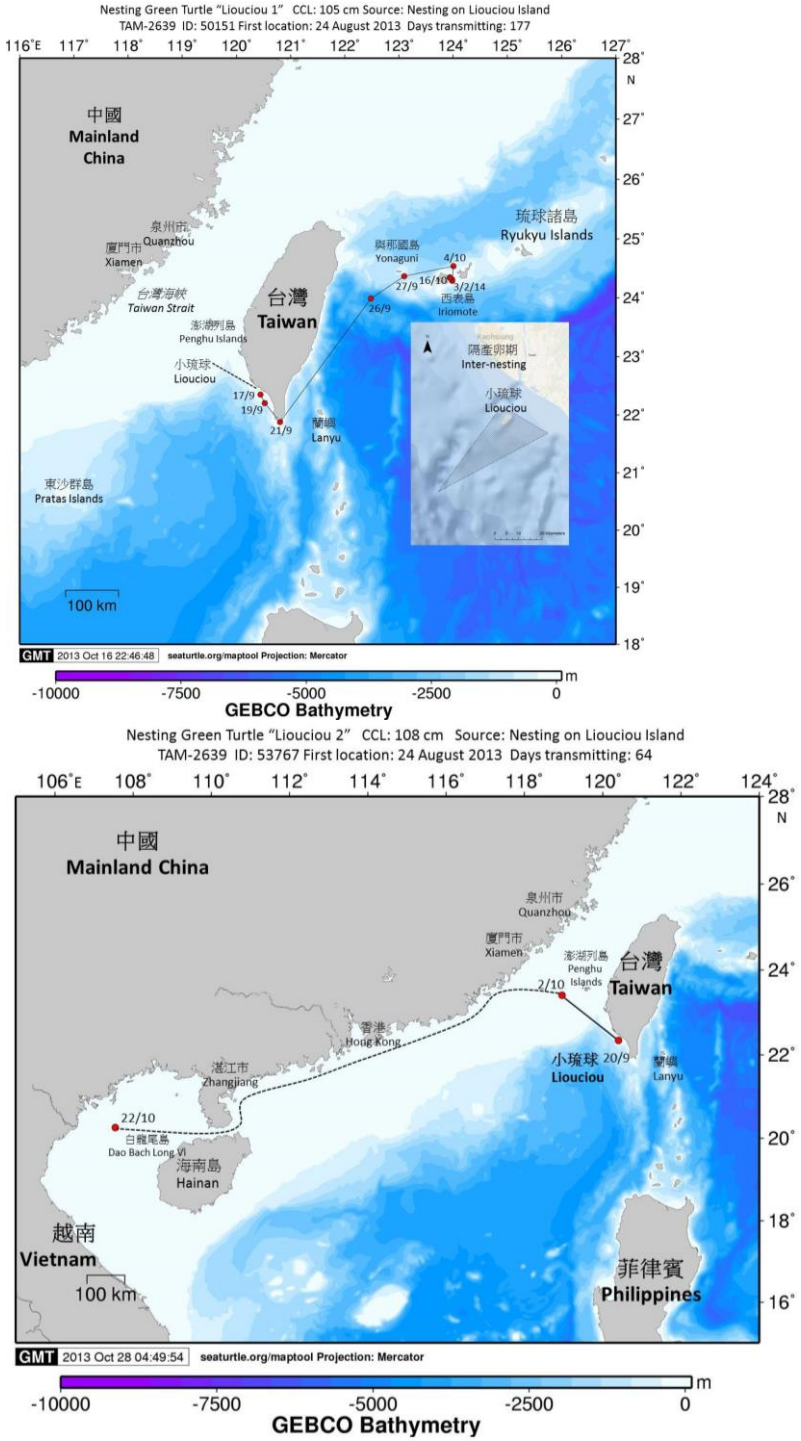


Fig 3. Post-nesting migration of green turtles from (a) Wan-an Island, which included turtle ID 107361 in 2013, turtle ID 602692 in 2010, turtle ID 60791 in 2011, and a rehabilitated turtle with ID 107367 in 2014. (b) from Lanyu island, which included turtle ID 20262 in 2014, turtle ID 60718 in 2012, turtle ID 60718 in 2010, and turtle ID 60261 in 2012.

https://doi.org/10.1371/journal.pone.0200063.g003

Figure 2. Post-nesting migration of green turtles from Wan-an Island and Lanyu Island

According to Ng *et al.* (2018a), two nesting green turtles migrated from the nesting site in Luichiu Island to their respective foraging grounds at Iriomote-jima in the Ryukyu Islands of Japan, and Dao Bach Long Vi Island of Vietnam (Figures 3a and b). Taiwan coastal waters served as foraging grounds for green turtles. Penghu Island contained both nesting site (Wan-an Island) and foraging grounds for green turtles (Ng *et al.* 2018a).



Figures 3a and b. Post-nesting migration of green turtles from Luichiu Island

By using photo-ID (see examples of facial ID in Figure 4), Su et al. (2015) determine the foraging population in the nearshore waters of Luichiu Island ranged from 106 to 142 turtles, and turtles were most concentrated from Beauty Cave to Vase Stone, and least numerous from Shan-fu Fishing Port to Clam Bay.

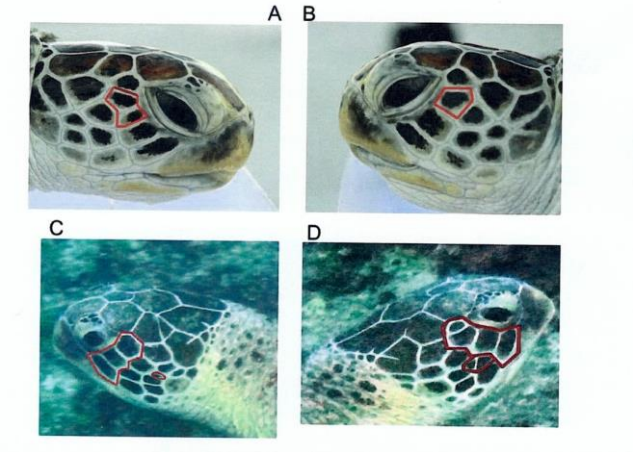


Figure 4. Facial ID of green turtles in Luichiu Island

One green turtle was released and equipped with a satellite transmitter at Haikou Beach with the help of local school children on November 20, 2015. The first tracking signal was received on November 30, 2015. During the 105 d of tracking, the turtle did not undertake any long-distance migration, but rather resided in the coastal waters of Haikou Bay (Figure 5). The tracking data suggested that the rehabilitated turtle continued to live well in the wild and stayed in the area where it was initially found stranded (Kuo *et al.* 2017).

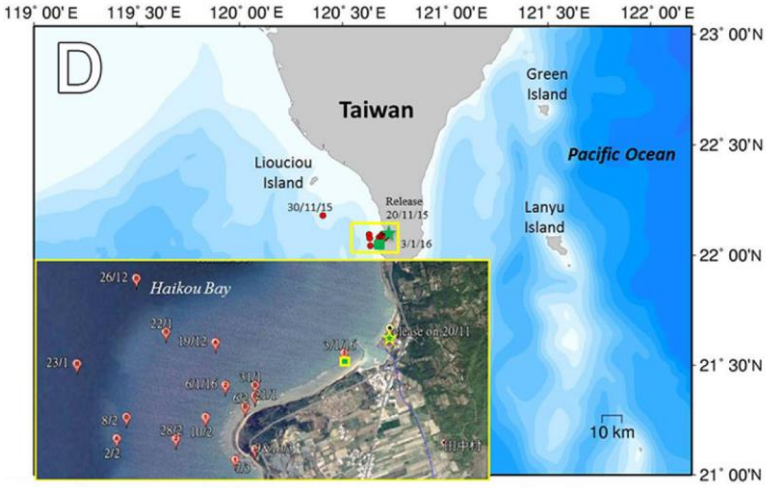


Figure 5. Satellite tracking of a rehabilitated green turtle at Haikou Bay

1.2. Other biological data

Accompanying text to data summarized in Table 1, if needed.

A previous study (King *et al.*2013) estimated the sex ratio of green sea turtles (*Chelonia mydas*) in Wan-an Island of Taiwan. The drier and hotter weather during the nesting season produced more female hatchlings than the other main nesting island-Lanyu Island.

Mixed stock analysis based on the 760 bp mitochondrial DNA (mtDNA) control region of green turtles (Ng *et al.* 2017) revealed that the primary source rookeries in the Pacific contributing to foraging green turtle aggregations in the South China Region, including Taiwan, were Peninsular Malaysia, Yap in the Federated States of Micronesia, Aru of Indonesia, Sulu Sea, northeastern Borneo, Republic of Marshall Islands, Wan-an of Taiwan, and the central Ryukyu and Yaeyama of Japan.

Kowalski (2015) analyzed 6 polymorphic microsatellite loci from three nesting females from Wan-an Island, Lanyu Island, Luichiu Island of Taiwan and two nesting females from southern Ryukyu Archipelagos, Iriomote and Ishkiiga Islands in Japan (Figure 6). The study found that, in spite mtDNA evidenced that there existed strong genetic differentiation between Wan-an, Lanyu Islands, and the nearby Japanese islands of Iriomote and Ishigaki in Japan's Ryuku Island Chain, all of which are less than 600km apart. Microsatellite analysis indicating one panmictic genetic population among these 5 rookeries. This suggests the potential for male-mediated gene flow.

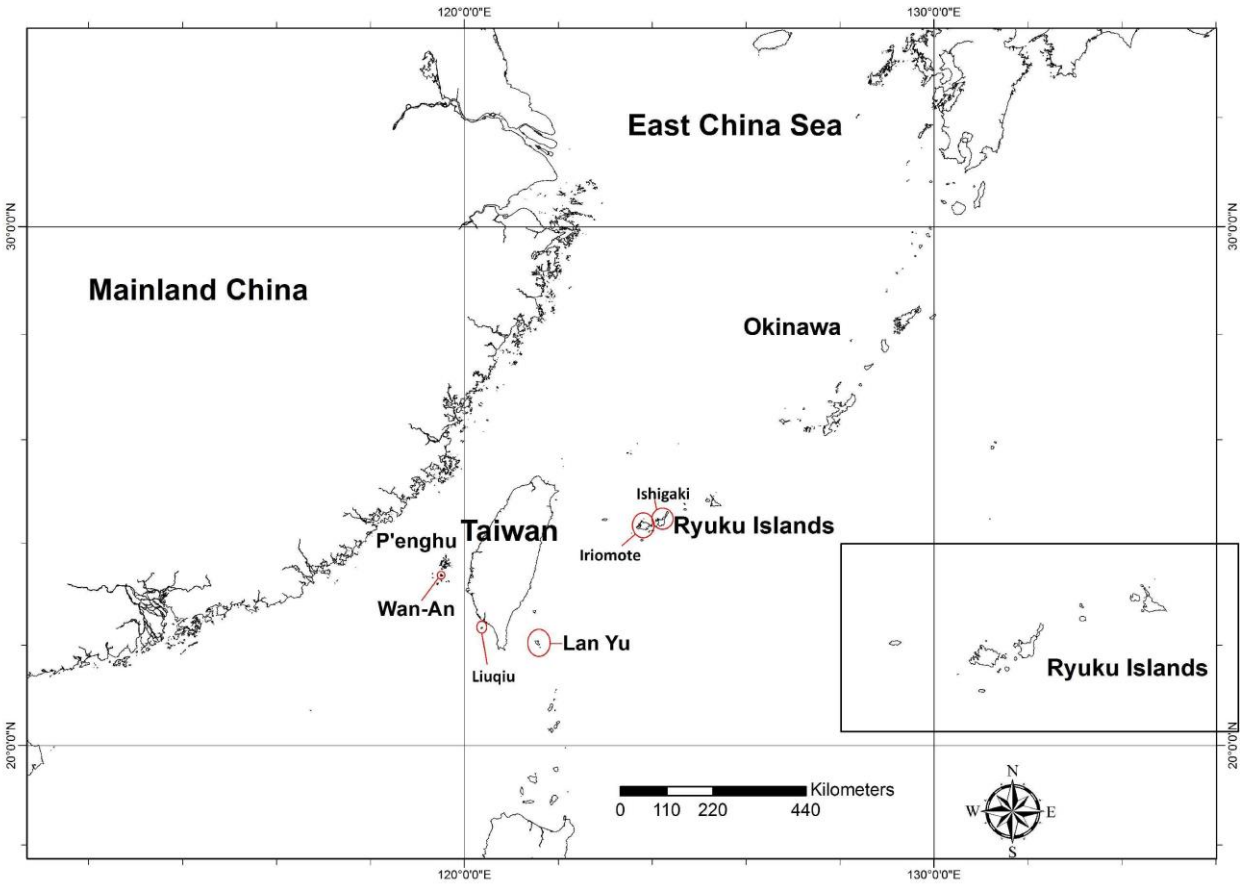


Figure 6. The six rookeries where polymorphic microsatellite loci were sampled and compared

1.3. Threats

1.3.1. Nesting sites

Expanding from what listed in Table 1.

A study on sea turtle nesting populations reported that the decrease of the nesting population on Wan-an Island might be due to illegal poaching on the high seas along the migratory corridor of the turtles (Cheng et al. 2018).

1.3.2. Marine areas

Expanding from what listed in Table 1.

By-catch: According to Fong (2010), accidental by-catch of sea turtles occasionally occurred in the I-Lan County of Taiwan by set-net fishing ground. There was also a report in 2015 that sea turtles accidentally caught by fishermen during fishing work (Li *et al.*2015). In another previous study, most of the incidental captures of sea turtles were in Eastern Taiwan (Cheng and Chen 1997). Chen *et al.* (2012) further reported that fishery by-catch is probably responsible for the mortality of stranded turtles.

Pollution: According to Ng *et al.* (2018b), ten-fold higher levels of Pb, barium (Ba), vanadium (V) and 40-fold greater cadmium (Cd) levels were measured in green turtle livers in South China, including Taiwan, relative to other studies conducted over 10 years ago. Measured polybrominated diphenyl ethers (PBDE) levels were also 27-fold and 50-fold greater than those reported in Australia and Japan. In a case report study of green turtle in Taiwan by Kuo et al. (2017), analysis of the turtle's fecal matter revealed evidence of consumed plastic bags.

Pathogens: In recent decades, Fibropapillomatosis (FP) a debilitating tumor-forming disease has been observed globally and is an emerging panzootic disease in sea turtles. However, few reports of FP in Asia exist. The first evidence of Chelonid herpesvirus 5 (ChHV5) DNA associated with FP in endangered green turtles from Taiwan have been reported. The phylogenetic tree revealed that Chelonid herpesvirus 5 (ChHV5) from the green turtles in Taiwan were closest to the ChHV5 from Hawaii, Puerto Rico, and Sao Tome (Li *et al.* 2017).

The previous study of sea turtles stranded on Taiwan also found that four species of flukes were identified, namely, *Leardius learedi, Hapalotrema postorchis, H. mehrai*, and *Carettacola hawaiiensis*. The main infection sites were the major arteries and heart (Chen *et al.* 2012).

Two new records of marine Ozobranchid Leeches (Oligochaete: Ozobranchidae) in Taiwan was found, namely *Ozobranchus branchiatus* and *O. margoi* (Tseng and Cheng 2013). Further genetic diversity studies of these two species from the Atlantic and Pacific oceans showed that *Ozobranchus branchiatus* had a greater pairwise distance within Taiwan than *O. margoi*. The better environmental adaptability and

lower host specificity of *O. margoi* might result in lower genetic divergence among populations (Tseng *et al.* 2017).

1.4. Conservation

Protection status: expanding from what listed in Table 1 and 3

All sea turtle species in Taiwan are protected by Wildlife Conservation Act. These turtle species are listed as endangered species under the Schedule of Protected Species by the Ocean Conservation Administration, the Ocean Affairs Council, Executive Yuan, Taiwan. Under the Wildlife Conservation Act, the following offenses shall be punished with imprisonment for not less than six months and not more than five years, and/or a fine of not less than NT$300,000 and not more than NT$1,500,000:

1. Violation of Article 24, Paragraph 1, unapproved import or export of live Protected Wildlife Species or products.
2. Violation of Article 35, Paragraph 1, trading, display or exhibiting with the intent to sell Protected Wildlife and its products.

Governmental or NGO programs, especially long-term ones. (Table 4)

In Taiwan, an array of management measures has been implemented since 1989 by the Council of Agriculture for the conservation of sea turtles, including protection and management of the nesting beach sea turtle rehabilitation, and scientific research.

To strengthen marine wildlife conservation, the Ocean Conservation Administration (OCA) has been established in 2018. The OCA may also invite academic institutions or private organizations to conduct wildlife surveys, studies, conservation, utilization, education or promotion, etc.

For example, to reduce the anthropogenic threats and increase sea turtle conservation efficiency, the Ocean Conservation Administration has established a Marine Animal Rescue Network (MARN) that oversees the report and rescue of stranded sea turtles and cetaceans around the nation. Members of the MARN include the Coast Guard Administration (CGA), the county government, research institutes, and local organizations and volunteers. Initial reports of stranding events are typically made to the CGA. Following examination, visibly healthy sea turtles are directly released into their natural environment. However, those suffering from injuries, emaciation, or other abnormalities are normally transported to a nearby rehabilitation facility for further medical care or rehabilitation. A total of 3 confirmed sea turtle rehabilitation facilities have been established in Taiwan.

Regarding the conservation plans of the nesting site, before the onset of nesting season each year, management work is carried out in the nesting site at Wan-an Island, Luichiu Island and Lanyu Island. These include regular monitoring of the nesting site's conditions. Overnight beach patrols are conducted at Wan-an Island, Luichiu Island and Lanyu Island to monitor and count any nesting green turtles and their nests during the nesting season. Local authorities may establish Wildlife Refuges for Major Wildlife Habitats with special conservation needs, as well as formulate and carry out conservation plans in those areas. If necessary, they may commission other agencies or organizations to carry out the plans.

1.5. Research

Please refer to the recommendations discussed in the above session on "Conservation Priorities".

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Table 1. Main biology and conservation aspects of sea turtle Regional Management Units (RMU) occurring in Taiwan

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**CC-PN-TAI**	Ref #	**CM-PNW-TAI**	Ref #
Occurrence				
Nesting sites	N		Y	7,11,12,13,18,20, 22
Pelagic foraging grounds	Y	14	N	
Benthic foraging grounds	n/a		Y	5
Key biological data				
Nests/yr: recent average (range of years)	n/a		4-55 (average: 25)(1992-2015) Wan-An Island 4-67(average 25)(1997-2018) Lanyu Island	8, 22
Nests/yr: recent order of magnitude	n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		1	7

Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	n/a		2	8
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a		One site 5-15 (2011-2018), one site has 4	
Total length of nesting sites (km)	n/a		2.5 Lanyu Island 4 Wan-an Island	8, 20, 22
Nesting females / yr	n/a		2-19 (7 ± 5) Wan-an Island 4-24 (9 ± 5) Lanyu Island	8, 20, 24
Nests / female season (N)	n/a		4-55 (1992-2015) Wan-An Island 4-67(1997-2018) Lanyu Island 10-100 (N=unknown) Taiping Tao	8, 18
Female remigration interval (yrs) (N)	n/a		4.5±1.54 (44) Wan-an Island 4.5±1.6 (54) Lanyu Island	8, 20
Sex ratio: Hatchlings (F / Tot) (N)	n/a		0.68±0.33 (9) Lanyu Island 0.93±14 (13) Wan-an Island 1±0 (2) Liouciou Island	7
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a	

Min adult size, CCL or SCL (cm)	n/a		82.5 cm SCL (Wan-an Island) 86 cm SCL (Lanyu Island)	
Age at maturity (yrs)	n/a		n/a	
Clutch size (n eggs) (N)	n/a		104.6±23.9 Wan-an Island 107±26 Wan-an Island 106.7±12.3(23)Wan-an Island 105.5±28.3 Lanyu Island 107±27 Lanyu Island 103±11 (22); Lanyu Island	20, 24
Emergence success (hatchlings/egg) (N)	n/a		47±39.1 Wan-an Island 72±21(23) Wan-an Island 64.1±39.7 Lanyu Island 67±20(22); Lanyu Island	20
Nesting success (Nests/ Tot emergence tracks) (N)	n/a			
Trends				
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a		Wan-an Islandwith a declining trend (1993-2015) Lanyu Island population increased (1997-2015)	20, 24

Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a		n/a	
Oldest documented abundance: nests/yr (range of years)	n/a		n/a	
Published studies				
Growth rates	N		N	
Genetics	N		Y	10,20
Stocks defined by genetic markers	N		N	
Remote tracking (satellite or other)	N		Y	14,15,19,21
Survival rates	N		N	
Population dynamics	N		N	
Foraging ecology (diet or isotopes)	N		N	
Capture-Mark-Recapture	N		N	
Threats				
Bycatch: presence of small scale / artisanal fisheries?	N		Y (SN)	16
Bycatch: presence of industrial fisheries?	N		N	

Bycatch: quantified?	N		N	
Take. Intentional killing or exploitation of turtles	N		Y	5
Take. Egg poaching	N		N	
Coastal Development. Nesting habitat degradation	N		N	
Coastal Development. Photopollution	N		N	
Coastal Development. Boat strikes	N		N	
Egg predation	N		N	
Pollution (debris, chemical)	N		Y	23
Pathogens	**Y**	**2**	Y	1,2
Climate change	N		N	
Foraging habitat degradation	N		N	
Other	**Y**	**3**	Y	3,6
Long-term projects (>5yrs)				
Monitoring at nesting sites (period: range of years)	n/a		Y (1996-2007)	8
Number of index nesting sites	n/a		3	8
Monitoring at foraging sites (period: range of years)	n/a		N	
Conservation				
Protection under national law	**Y**	**4**	Y	4

Number of protected nesting sites (habitat preservation) (% nests)	n/a		2 (50%)	refer to text
Number of Marine Areas with mitigation of threats	n/a		n/a	
N of long-term conservation projects (period: range of years)	n/a		N	
In-situ nest protection (eg cages)	n/a		N	
Hatcheries	n/a		N	
Head-starting	n/a		N	
By-catch: fishing gear modifications (eg, TED, circle hooks)	n/a		N	
By-catch: onboard best practices	n/a		N	
By-catch: spatio-temporal closures/reduction	n/a		N	
Other	n/a		N	

RMU **(all RMUs of all species occurring in a Country or Region)** **add or remove columns on the right according to the RMUs**	**EI-PW-TAI**	Ref #	**LO-PW-TAI**	Ref #	**DC-PW-TAI**	Ref #
Occurrence						
Nesting sites	Y	17	N		N	
Pelagic foraging grounds	n/a		n/a		n/a	

Benthic foraging grounds	n/a		n/a		n/a	
Key biological data						
Nests/yr: recent average (range of years)	n/a		n/a		n/a	
Nests/yr: recent order of magnitude	n/a		n/a		n/a	
Number of "major" sites (>20 nests/yr AND >10 nests/km yr)	n/a		n/a		n/a	
Number of "minor" sites (<20 nests/yr OR <10 nests/km yr)	n/a		n/a		n/a	
Nests/yr at "major" sites: recent average (range of years)	n/a		n/a		n/a	
Nests/yr at "minor" sites: recent average (range of years)	n/a		n/a		n/a	
Total length of nesting sites (km)	n/a		n/a		n/a	
Nesting females / yr	n/a		n/a		n/a	
Nests / female season (N)	10-100 (6-11)	18	n/a		n/a	
Female remigration interval (yrs) (N)	n/a		n/a		n/a	

Sex ratio: Hatchlings (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Immatures (F / Tot) (N)	n/a		n/a		n/a	
Sex ratio: Adults (F / Tot) (N)	n/a		n/a		n/a	
Min adult size, CCL or SCL (cm)	n/a		n/a		n/a	
Age at maturity (yrs)	n/a		n/a		n/a	
Clutch size (n eggs) (N)	n/a		n/a		n/a	
Emergence success (hatchlings/egg) (N)	n/a		n/a		n/a	
Nesting success (Nests/ Tot emergence tracks) (N)	n/a		n/a		n/a	
Trends	n/a					
Recent trends (last 20 yrs) at nesting sites (range of years)	n/a					
Recent trends (last 20 yrs) at foraging grounds (range of years)	n/a					
Oldest documented abundance: nests/yr (range of years)	n/a					
Published studies						
Growth rates	N		N		N	
Genetics	N		N		N	

Stocks defined by genetic markers	N		N		N	
Remote tracking (satellite or other)	N		N		N	
Survival rates	N		N		N	
Population dynamics	N		N		N	
Foraging ecology (diet or isotopes)	N		N		N	
Capture-Mark-Recapture	N		N		N	
Threats						
Bycatch: presence of small scale / artisanal fisheries?	N		N		N	
Bycatch: presence of industrial fisheries?	N		N		N	
Bycatch: quantified?	N		N		N	
Take. Intentional killing or exploitation of turtles	N		N		N	
Take. Egg poaching	N		N		N	
Coastal Development. Nesting habitat degradation	N		N		N	
Coastal Development. Photopollution	N		N		N	
Coastal Development. Boat strikes	N		N		N	
Egg predation	N		N		N	
Pollution (debris, chemical)	N		N		N	
Pathogens	N		N		N	
Climate change	N		N		N	
Foraging habitat degradation	N		N		N	

Other	Y	3	Y	4	Y	**4**
Long-term projects (>5yrs)						
Monitoring at nesting sites (period: range of years)	n/a		n/a		n/a	
Number of index nesting sites	n/a		n/a		n/a	
Monitoring at foraging sites (period: range of years)	n/a		n/a		n/a	
Conservation						
Protection under national law	Y	4	Y	4	Y	**4**
Number of protected nesting sites (habitat preservation) (% nests)	n/a		n/a		n/a	
Number of Marine Areas with mitigation of threats	n/a		n/a		n/a	
N of long-term conservation projects (period: range of years)	n/a		n/a		n/a	
In-situ nest protection (eg cages)	n/a		n/a		n/a	
Hatcheries	n/a		n/a		n/a	
Head-starting	n/a		n/a		n/a	
By-catch: fishing gear modifications (eg, TED, circle hooks)	n/a		n/a		n/a	
By-catch: onboard best practices	n/a		n/a		n/a	
By-catch: spatio-temporal closures/reduction	n/a		n/a		n/a	
Other	n/a		n/a		n/a	

Table 2. The nesting beaches of Taiwan

RMU / Nesting beach name	**Index site**	**Nests/yr: recent average (range of years)**	**Crawls/yr: recent average (range of years)**	**Western limit**		**Eastern limit**		**Central point**	
CM-PNW-TAI				Long	Lat	Long	Lat	Long	Lat
Badai Beach, Lanyu		Badai+Big Badai+ Donchin:5-13(average 8.6) (1997-2006)							
Big Badai Beach, Lanyu		Badai+Big Badai+ Donchin:5-13(average 8.6) (1997-2006)							
Donchin Beach, Lanyu		Badai+Big Badai+ Donchin:5-13(average 8.6) (1997-2006)							
Wan-an Island	**Y**	**41-55 (1992-1993)**							
Luichiu Island		2 (2011), 4 (2012), 1(2015)							

RMU / Nesting beach name	**Length (km)**	**% Monitored**	**Reference #**	**Monitoring Level (1-2)**	**Monitoring Protocol (A-F)**
CM-PNW-TAI					
Badai Beach, Lanyu	0.2		8		
Big Badai Beach, Lanyu	1.5		8		
Donchin Beach, Lanyu	0.8		8		
Wan-an Island			22		
Luichiu Island			11, 12, 13		

(END)