The Asian-Japan Workshop on Cooperative Sea Turtle Researches and Conservation

11-13 December 2001

Hosted by…
Phuket Marine Biological Center
Department of Fisheries
THAILAND

Sponsored by…
Graduate School of Agriculture, Kyoto University
Graduate School of Informatics, Kyoto University
Ocean Research Institute, University of Tokyo
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JAPAN

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by CHAIRMAN OF ORGANIZING COMMITTEE

On behalf of the organizing committee, I would like to extend a warm welcome to all participants, observers and guests and thanks for your kind acceptance to participate the Asian-Japan Workshop on Cooperative Sea Turtle Research and Conservation to day.

It is well know that sea turtles are described as migratory species of the region and therefore it is a common resource of the regional countries. However, so much information of sea turtles were not known, particularly on population, breeding ground and migratory pattern. Therefore the cooperative research on sea turtles in the regional countries is needed. In response to such issue a programme was established called the South East Asian Sea Turtle Associated Research Programme in short SEASTAR. This workshop is carried out in order to provide a substantial data on sea turtle research under SEASTAR programme.

During the coming period from 11-13 December 2001, we congregate here to learn from about 27 oral presentations. The workshop is concluded with a discussion session where the participants would choose to discuss the cooperative research plan in the future. After the workshop there will be a study tour to sea turtle sites in Phuket. On 13 December we will visit the sea turtle site on Racha Island one of the sea turtle feeding ground by our research vessel Chakratong Tongyai.

I hope you will enjoy the present programme of the SEASTAR workshop. I would also like to thank funding from Japan and all your participation that make the workshop possible to day.

Thank you very much

MR. SUPOT CHANTRAPORNSYL

FORWARD

by SEASTAR PROJECT DIRECTOR

SEASTAR 2000 Status Report

The director of the Phuket Marine Biological Center, Mr. Praween Lympsaichol, distinguishes participants, ladies and gentlemen. I am deeply grateful to the staff of Phuket Marine Biological Center for arrangement of this meeting.

This project began in 1999 by the fund of Kyoto University and Tokyo University. From 2001 , fortunately this project is supported by A Grant −in-Aid of Ministry of Education, Culture, Sport, Science and Technology in Japan (JSPS).

In 1999 the Thai-Japanese cooperative research started on the sea turtle research and conservation with the objectives that are listed as follows:

1. Migratory paths of adult female green turtles in the Gulf of Thailand and the Andaman sea, using satellite tracking system. This co-research is mainly carried out with Kyoto University, Sea Turtle Conservation Center (Mannai Island) and Phuket Marine Biological Center (PMBC).
2. Monitoring of sand temperature using temperature recording data loggers in the nesting ground to estimate sex ratio of new-hatched individuals. This is supported by Tokyo University, PMBC, and Mannai-Island.
3. Genetic analyses of the local population structures of the sea turtle. This research is carried out by researchers of PMBC and Mannai-Island.
4. Correlation between fishing effort of trawling and the number of sea turtle by-catch, proposed by Department of Fisheries, Thailand and Kyoto University.
5. Development of a scientific strategy for the conservation. This work will be carried out by all participants.

In the first year, the co-project was emphasized on studies migratory paths and monitoring of sand temperature in the nesting ground of green turtle both in the Gulf of Thailand and the Andaman Sea, Thailand. The sea turtle migratory paths were demonstrated in the internet at website http://bse.soc.i.kyoto-u.ac.jp. In 2000, we found the two different populations of green turtle, between the Gulf of Thailand and the Andaman Sea by the satellite tracking.

Since sea turtle extensively migrates within and outside of the region and the results of our cooperation showed the traveling was longer distance than has ever expected. Therefore, in the year 2000, the co-project was extended to regional cooperation so call SEASTAR 2000 (South East Asian Sea Turtle Associative Research). The extending cooperation periods will be extended into the year 2003 by the fund of JSPS. Malaysia was included in 2000. And to this extent we would like to welcome Cambodia and Vietnam to joint as well.

Considering that the sex ratios of the hatchling sea turtles are dependent on the temperature, thus monitoring of sand temperature in nest clutches was measured through the nesting season both in the Gulf of Thailand, the Andaman Sea and South China Sea. The sand temperature data will be available to estimate sex ratio, hatching ratio and escape ratio from nesting beach. They are the fundamental data for management of the hatcheries.
Surveying of sea turtle nesting numbers in various nesting grounds will be continuously monitored. The genetic analysis is the one of the most effective for study the population structure. A hundred of sea turtle tissues have been collected from various nesting ground for DNA analysis. DNA analysis of the tissue was examined at Kyoto University in 2001. Two different populations between the Gulf of Thailand and the Andaman Sea may be separated.

Data of shrimp trawling activities were also collected. The data of fishing location found its tendency to superimpose on the migratory paths and may used to determine the possibility of by-catch turtles. In addition, feeding ground such as sea grass areas will be estimated as it harmonizes to the migratory movement of the tracking data.

This workshop will certainly encourage our co-research activities in various aspects and the conclusion enriches our future cooperation. I hope that this would also be the good time to update our selves with new knowledge and review our effort for more effective cooperation.

DR. WATARU SAKAMOTO

FORWARD

by DIRECTOR OF PHUKET MARINE BIOLOGICAL BENTER

Professor Sakamoto, Dr. Tatsukawa, Dr Arai, distinguish participants, ladies and gentlemen, I wish to extend a warm welcome to all of you on behalf of the Phuket Marine Biological Center.

Thank you for all the reports and progress in various aspects of sea turtle research and conservation. It is learnt that, as you may know Southeast Asia accommodates various species of sea turtles. However the populations of sea turtles have severely declined in most part of the world. In Thailand there are even considered to be endangered species with possible extinction in a few years. The declination is caused by various factors, the greatest threats today are related to human and their activities. Similar threats are also happening worldwide. Therefore conservation strategies have been initiated. I believe that conservation programme already existed in most countries, but satisfactory result has not been achieved. The Department of Fisheries of Thailand has seriously concerned in sea turtle research and conservation. In this regard, Phuket Marine Biological Center as a government agency takes responsibility to cover the Andaman Sea, while the Mannai Sea Turtle Conservation Station covers the Gulf of Thailand. Such implementation has been kindly assisted by the Sea Turtle Conservation Project of Royal Thai Navy both in the Gulf of Thailand and in the Andaman Sea. The Royal Forestry Department and some NGO are also fully acknowledged to assist in the project. Considering the fact that sea turtles are common resource of the region thus, cooperation within the region and international basis should also be stressed and prioritize. It is with this understanding that led to establishment of the SEASTAR project. The project needs greater joint regional coordination of research activities in order to provide overall prospects of the population, breeding habitats and migratory pattern of these particular sea animals. I really hope that the workshop presentation and discussion would facilitate exchanging experience and knowledge. It is also hoped to clearly identify the cooperative work in the region and a networking could be more closely achieved.

Finally, with my congratulation to the work you have been achieving on sea turtle research and conservation. And please accept my grateful thanks to all financial organizations from Japan who make the workshop possible today and may I take this opportunity to declare the workshop open.

MR. PRAWEEN LIMPSAICHOL

AGENDA

11 DECEMBER 2001

08:30-09:00	REGISTRATION
09:00-09:30	OPENING REMARKS
09:30-10:00	COFFEE BREAK

Session 1
Chairman **Mr. Mickmin Charuchinda**

10:00-10:20	INTRODUCTION TO THE PHUKET MARINE BIOLOGICAL CENTER PROJECTS *Mr. Supot Chantrapornsyl*
10:20-10:40	THE ROYAL THAI NAVY AND SEA TURTLES CONSERVATION IN THE ANDAMAN SEA *Capt. Winai Klom-in*
10:40-11:00	THE ROYAL THAI NAVY'S SEA TURTLE CONSERVATION CENTER *Cdr. Surasak Chaiyaphan*
11:00-11:20	SEA TURTLE RESEARCH AND CONSERVATION PROJECT AT PHRATHONG ISLAND, PHANG-NGA PROVINCE, THAILAND *Dr. Monica Aureggi*
11:20-11:40	PRESENT STATUS OF SEA TURTLES IN CAMBODIA *Mr. Pich Sereywath*
11:40-12:00	THE STATUS, CONSERVATION, AND MANAGEMENT OF SEA TURTLE RESOURCE IN KHANH HOA PROVINCE, VIETNAM *Mr. Dinh Hong Thanh*
12:00-13:00	LUNCH

Session 2
Chairman **Mr. Wannakiat Tubtimsang**

13:00-13:20	LONGRANGE MIGRATION OF LOGGERHEAD TURTLE IN THE NORTH PACIFIC OCEAN *Dr . Wataru Sakamoto*
13:20-13:40	DEVELOPMENT OF A GPS-ARGOS PTT DEVELOPMENT OF A GPS-ARGOS PTT *Dr . Nobuaki Arai*
13:40-14:10	EXPERIMENT ON DUMMY ATTACHMENT WITH SEA TURTLES IN CAPTIVITY MIGRATION PATTERN OF POST-NESTING GREEN TURTLE, IN THE GULF OF THAILAND, TRACKED BY SATELLITE SYSTEM *Mr. Mickmin Charuchinda*
14:10-14:40	FEEDING AND INTER-NESTING GROUNDS OF THE GREEN TURTLE NESTING POPULATION AT SIMILAN ISLANDS, THAILAND DNA ANALYSIS OF GREEN TURTLES IN THAILAND: A PROGRESS REPORT *Mr. Kongkiat Kittiwattanawong*
14:40-15:00	MOVEMENT ABILITY OF CULTIVATED HAWKSBILL TURTLES, IN THE OPEN SEA, DETERMINED BY SATELLITE *Mr. Somchai Mananunsap*

15:00-15:20 COFFEE BREAK

Session 3
Chairman Dr. Nobuaki Arai

15:20-15:40 THE TRACKING OF MARY, A JUVENILE GREEN TURTLE RAISED IN CAPTIVITY
Dr. Liew Hock chark

15:40-16:00 THE RELATIONSHIP BETWEEN SHRIMP TRAWL GROUNDS AND MIGRATION COURSES OF ADULT FEMALE GREEN TURTLES IN THE GULF OF THAILAND
Mr. Naoya Shiba

16:00-16:40 SEX RATIO OF HATCHLING GREEN TURTLES RELATED WITH NEST TEMPERATURE
Dr. Kenichi Tatsukawa

16:40-17:00 ANALYSIS OF THE BEHAVIOR OF SEA TURTLES BY USING MR DATA-LOGGERS
Ms. Mizuki Yoshida

18:30-21:00 Banquet (Thai-Nan restaurant)

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Session 4
Chairman Dr. Kenichi Tatsukawa

09:00-09:20 EFFECTS OF DETERMINATE GROWTH ON POPULATION DYNAMICS OF HAWKSBILL TURTLE
Dr. Shin-ichi Ebina

09:20-09:40 DIVING BEHAVIOR OF LEATHERBACK TURTLE IN FRENCH GUIANA
Dr .Hideji Tanaka

09:40-10:00 (TITLE UNKNOWN)
Dr. Chan Eng Heng

10:00-10:20 AN INTER-NESTING MOVEMENT OF THE FEMALE GREEN TURTLE, *CHELONIA MYDAS* STUDIED BY SATELLITE TELEMETRY AT MA' DAERAH SANCTUARY, MALAYSIA
Dr. Kamarruddin Bin Ibrahim

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10:40-11:00 AN ADAPTIVE MANAGEMENT STRATEGY FOR HAWKSBILL TURTLE
Mr. Hiroyuki Matsuda

11:00-11:20 FISHERY RESOURCE MANAGEMENT AND ENVIRONMENTAL PRESERVATION: INSTITUTIONAL COMPARISON BETWEEN UNITED STATES AND JAPAN
Dr .Mitsutaku Makino

11:20-11:40 BIOTELEMETRY STUDY ON MARINE LIVES USING CODED ULTRASONIC TRANSMITTERS
Mr. Hiromichi Mitamura

11:40-12:00 ESTIMATES OF SWIMMING BEHAVIOR OF FISH USING ACCELERATION DATA-LOGGER
Dr . Yasushi Mitsunaga

12:00-13:00 LUNCH

Session 5

Chairman **Dr. Wataru Sakamoto**

13:00-13:20	CONSERVATION OF DUGONG IN THAILAND *Ms. Kanjana Adulyanukosol*
13:20-13:40	MAPPING OF SEAGRASS BEDS USING ACOUSTIC METHODS *Dr. TERUHISA Komatsu*
13:40-14:00	INFLUENCE OF ENVIRONMENTAL FACTORS ON ABALONE *Haliotis discus* *Ms . Yukako Saikyo*
14:00-14:20	COFFEE BREAK
14:20-16:30	DISCUSSION AND FUTURE PLANS
18:30-21:00	FAREWEL DINNER (BAN-THAI RESTAURANT)

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09:00-10:45	CRUISE TO RACHA ISLAND BY CHAKRATONG TONGYAI RESEARCH VESSEL
09:00-10:45	CHOICES OF ACTIVITIES, LUNCH ON BROAD
16:00-17:30	CRUISE BACK TO PMBC BY CHAKRATONG TONGYAI RESEARCH VESSEL

ABSTRACTS

INTRODUCTION TO THE PHUKET MARINE BIOLOGICAL RESEARCH PROJECTS

Supot Chantrapornsyl

Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand. E-mail: supotc@fisheries.go.th

THE ROYAL THAI NAVY AND SEA TURTLES CONSERVATION IN THE ANDAMAN SEA

Winai Klom-in

Naval Special Warfare Group, Royal Thai Navy, P.O. Box 21 Sattahip, Cholburi 20180. Thailand.

In order to celebrate the Royal Golden Jubilee of His Majestic King Bhumiphol in 1996, Royal Thai Navy had set projects to conserve marine natural resources. One of the target resources was sea turtles. The conservation of sea turtles was initiated in both of the Gulf of Thailand and the Andaman Sea. In the gulf of Thailand, sea turtles' eggs were collected from Khram, E-Raa, and Jan Islands, Chonburi province. The eggs then were hatched and released. Total number of 50,939 hatchlings was released during 1st January 1995 to 31st December 1996. In the Andaman Sea, the eggs were collected from Huyong Island (one of Similan Islands), Phang-Nga province. Total number of 34,616 hatchlings was released during 1995 to November 2001. The average hatching rate was about 80%. Besides, the project in cooperated with Phuket Marine Biological Center, has tagged the nesting females with internal microchips and external stainless tags since 1997. The tagging result revealed that each nesting female laid eggs every 3-5 years. In each nesting season, the turtles spawn 2-8 clutches. The interval between each clutch was 10-16 days. Further more, platform transmitter terminals (PTTs) were employed to investigate migration, feeding and resident grounds.

THE ROYAL THAI NAVY'S SEA TURTLE CONSERVATION CENTER

Surasak Chaiyaphan

Royal Thai Navy

The Royal Thai Navy (RTN) began sea turtle conservation since 1950 in many areas, especially in the bay of Sattahip where its success was little known to the public. In 1992 the RTN stepped up its effort with the appointment of the RTN's maritime and coastal environmental conservation committee with Deputy Commander-in-Chief, Royal Thai Navy as chairman to oversee the matter. The committee established a sea turtle conservation center and later put it under supervision of the marine live conservation committee with the Hydrographic Department and the Air and Coastal Defense Command being designated to act as the center's operating forces. Over the years, both private sector and government sector have provided a continual good support to this project. The center plays a vital role in hatching eggs and looking after hatchlings until they are grown up enough to go to sea. The center has been quite successful with its operation. It can set hatchlings free to sea in great numbers each year. In addition to this, its activities have drawn a large number of people across the country to visit the center all the year round. However, at present the Air and Coastal Defense Command has now assumed the role of the RTN's maritime and coastal environmental conservation committee after it was dissolved recently.

Mission of the Sea Turtle Conservation Center

1. To protect hatchling nests for sea turtles along the coastal areas on islets in the bay of Sattahip and vicinity areas
2. To serve as a nursing place for sea turtles of all kinds collected from various conserved places after emerging from their eggs
3. To serve as a source to release young turtles to the safety sea with maximum survival
4. To serve as source of knowledge and information on the life cycle of sea turtles for the public and interested students and serve as a source of inspiration for the public to protect Thailand 's natural resources at sea

Difficulties and Obstacles

1. Capabilities and facilities of the center at present do not sufficiently meet the rising demand of its operation for the increasing number of eggs, hatchlings and visitors.
2. Budget is needed to undergo large scale improvement to meet the demand.

SEA TURTLE RESEARCH AND CONCERVATION PROJECT AT PHRATHONG ISLAND, PHANG-NGA PROVINCE, THAILAND

Monica Aureggi

Naucrates, Onlus, Via Corbetta, 11, 22063 Cantu 8217 (CO) 211, Italy. E-mail: naucrates12@hotmail.com

Phra Thong Island is located on the south west coast of Thailand in the Andaman Sea. The island is among the main sea turtle nesting sites of the coast. In 1996 a Sea Turtle Project was started aiming to collect scientific data on the nesting population, to carry on an educational programme in the local schools and to conduct conservation awareness activities among tourists. Three nesting species were identified: olive ridley (*Lepidochelys olivacea*), leatherback turtle (*Dermochelys coriacea*) and green turtle (*Chelonia mydas*).The number of nests laid each season range from 7 to 13 showing a drastic decline of about 83% confirming the trend reported from 1979 to 1990. Even if the number of nests laid was low, egg poaching was found to be one of the main threats. The project activities lead to the elimination of this problem in five years. In the last three years a study on sex ratio of olive ridley turtle was started likewise an evaluation of beach erosion along the beaches. The educational programme in the schools was successful in providing conservation knowledge to the local community. A display area was set up in the GBB resort of the island in order to carry on conservation awareness activities among visitors.

PRESENT STATUS OF SEA TURTLES IN CAMBODIA

Pich Sereywath

Department of Fisheries, Cambodia. E-mail: sereywath@hotmail.com

Sea turtles study in Cambodia has just begun to identify species, habitats, and to conserve. However, sea turtle has been regulated and conserved since 1975 when Cambodia signed as a member of the CITES convention (7 December 1975) and acceded to the convention on 2 October 1997 (Try, 2000). Recently, Cambodia still lack of study, research as well as information related to the sea turtle population statistic, nesting ground and their habitats. The protected area for sea turtle conservation is not yet defined. This due to the Department of Fisheries has no budget and fund for studying and researching.

So far, there were studies by Mr. Touch Seang Tana (1997) and Mr. Ing Try (1999). Their studies focused at Kompong Som Bay and Koh kong province by interviewing fishermen who were living along the coastline of Cambodia. The studies reported five existing species of sea turtles *i.e.* olive ridley turtle (*Lepidochelys olivacea*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), green turtle (*Chelonia mydas*), and leatherback turtle (*Dermochelys coriacea*). Among these turtles, only hawksbill and green turtle had often been found along the coastline, especially Kompong Som Bay and some islands *e.g.* Koh Rong, Koh Rong Salem, Koh Tang, and Koh Pring Islands. Sea turtles are always disturbed by fishermen because the islands mentioned above are not only the houses for sea turtles, but also resting places for the fishermen. Most sea turtles were caught by co-incident (gill net, hooks line trawling net and bomb). Fortunately sea turtle consumption in Cambodia is not popular. No fishermen intend to catch the sea turtles. They believe that it is bad luck to catch them. Sometime the meat of sea turtles even harm to their health as well as their life. Besides, during Buddhism ceremonies, Cambodian always releases turtles for their happiness and luck.

Regarding sea turtle conservation, the Department of Fisheries has received tagging equipment from SEAFDEC and the officers have been trained for marine turtles tagging and hatchery management in Malaysia. In managing, monitoring, preserving and conservation sea turtle as well as other marine living resources, Cambodia, especially Department of Fisheries need co-management with other countries in the region. Funds for conservation studies are requested from NGOs or international organizations. Sea turtle conservation is not only important for Cambodia, but for other countries in the region as well.

THE STATUS, CONSERVATION, AND MANAGEMENT OF SEA TURTLE RESOURCE IN KHANH HOA PROVINCE, VIETNAM

Dinh Honh Thanh

Department of Vertebrate Resources, Institute of Oceanography, 01 Cauda-Nhatrang, Vietnam. E-mail: haiduong@dng.vnn.vn

Based on previous studies and the data in 1998 - 2001 in Khanh Hoa sea.

This report indicated that sea turtle in this area has been decreased in numbers of individuals. The increasing caught numbers of sea turtle yearly were mainly belong to the genus Chelonidae (Into 2 species Hawksbill & Green turtle). Due to over exploitation for food, medicines and handcrafts and environmental pollution, many species of sea turtle have been in a nearly exhaustion.

Making a plan and strategy in order to manage, and conservation sea turtle resource in the most effective way have been suggested.

LONGRANGE MIGRATION OF LOGGERHEAD TURTLE IN THE NORTH PACIFIC OCEAN

Wataru SAKAMOTO

Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan, E-mail: sakamoto@kais.kyoto-u.ac.jp

Introduction: The nesting beaches of loggerhead turtle are distributed along temperate area in Japan archipelago in the North Pacific Ocean. New hatched turtles are transported toward open sea by the Kuroshio current. Some of them arrive at the coastal area in California. After 14 to 17 years later, they return to Asia side to nest and arrive at the beach where they themselves hatched. Adult female turtles land to nesting beach every 2 to 4 years intervals. We tracked post nesting turtles use by satellite tracking devices so called PTT. Besides post-nesting tracking, inter-nesting behavior were recorded by Time Depth Temperature recorder (TDTR).
METHOD: Postnesting migration: Adult female turtles were attached PTT at Minabe coast in Wakayama prefecture on July after nesting in 1995 (1 PTT, Toyocom, T-2038), 1996 (1, Toyocom, T-2038), and 1999 (5,Telonics, ST-10). Besides these females, one PTT (T-2038) was attached to adult male on January 10, 1996. This turtle sent signals until August 1,1996. The other females sent signals from July to October.

Internesting behavior: Inter-nesting behavior was measured at Minabe coast. Female turtles land to nesting beach in every 3 to 4 times throughout a nesting season. If we attach data loggers on the carapace at the first or second nesting period, we can recover those devices in the next landing and obtained data successfully. These data were analyzed to understand the correlation between body temperature and ambient temperature, difference of body temperature between loggerhead turtle and green turtle.

Result: Two different migration paths were found in the postnesting turtles. One was migration path toward the East China Sea, another was migration path toward the northern Pacific Ocean. The course toward the East China Sea was separated into two, one was south western course passing through the Kuroshio, another was the course along Japan Islands. The main feeding ground of loggerhead turtle is the East China Sea. However remain turtles migrate for several years in the open sea, the northern Pacific Ocean. It is said that the different migration courses were found in adult sea turtles such as green turtle and loggerhead turtle. Body temperature of loggerhead turtles maintained several degrees higher than ambient water temperature. When turtle encountered the frontal zone where highly water temperature different horizontally, the diving record indicated rapid descending and ascending pattern. Those vertical movements were repeated 3 to 4 times until body temperature became higher than the ambient water temperature.

DEVELOPMENT OF A GPS-ARGOS PTT

Nobuaki Arai[1)] & Kazuhiko Ono[2)]

[1)] Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan,
arai@i.kyoto-u.ac.jp
[2)] Toyo communication equipment Co., Ltd.

In the Argos system, the location of platform terminal transmitters (PTTs) is determined by calculating the Doppler effect on receive frequencies on the satellite. The regular Argos processing system calculates platform locations using at least four messages from a PTT. Calculations comprise three stages including geometric initialization, location calculation proper and quality control on chosen position. The quality level is stated in terms of location class (LC). The LCs such as LC 3, 2, 1, 0, A, B and Z are based on satellite-transmitter geometry during satellite pass, number of messages received during the pass, and transmitter frequency stability. Of these LC 3, 2, 1 and 0 may be provided only when at least four uplinks are received on the satellite; LC A occurs when a location is determined from three uplinks; LC B when a location is determined from only two uplinks; and LC Z without location data occurs when only one uplink is received. LC 3 offers one-standard-deviation accuracy of 150m; LC 2, 350m; LC 1, 1000m; LC 0, A, and B cannot be guaranteed. In these two years, we employed 22 PTTs both in Thailand (9 PTTs in 2000 and 11 PTTs in 2001) and in Malaysia (2 PTTs in 2001). The total Argos satellite transmission from PTTs amounted to 7463 in 2000 and 5071 in 2001 (as of 21 November). The LC obtained from the PTTs is summarized here. In 2000, LC 3 was 0.64%, LC 2 was 1.29%, LC 1 was 3.38%, LC 0 was 3.30%, LC A was 9.41%, LC B was 23.0% and LC Z was 59.0%. In 2001, LC 3 was 5.01%, LC 2 was 3.87%, LC 1 was 6.19%, LC 0 was 5.03%, LC A was 11.9%, LC B was 25.8% and LC Z was 42.2%. These results show that almost half of the transmission were only one uplink and determined no location. In other words, we wasted almost a half of a charge for Argos system as well as location data. In this background, we decided to develop a combined GPS-Argos PTT. The GPS is also a satellite-based navigation system made up of a network of 24 satellites placed into orbit. Since principal of the GPS is based on time not on the Doppler effect as Argos system, it doesn't need multi uplinks to the satellite. Once location data are obtained by the GPS, the PTT stores the location data onto inside memories. Then the PTT can send some information including location and sensor data via the Argos satellite. Even when only one message from the PTT is received, the accurate location can be determined. We are now manufacturing two prototypes of the GPS-Argos PTT to perform field tests. One is a potting type filled with epoxy resin with ca. 190 x 40 x 38 mm^3 and the other is a reusable type built in a metal cylinder with ca. 210 mm x 54 mm in diameter to test several times. We plan to perform the first trial in the near future in Thailand. In the trial, we expect at least every 6 hour to obtain accurate location less than 10 m.

EXPERIMENT ON DUMMY ATTACHMENT WITH SEA TURTLES IN CAPTIVITY

Mickmin Charuchinda, Narong Mudsuk & Somchai Monanansup

Sea Turtle Conservation Station, Mannai Island, Tumbol Krum, Klang District, Rayong 21190. E-mail: mannai@loxinfo.co.th

Since loss of Platform Transmitter Terminal (PTT) from carapace of sea turtle could presumably cause the missing of tracking signals, four dummy PTTs were attached to the turtles in captivity to investigate their persistence at Mannai Island, Rayong Province, Thailand during 2001. Techniques and materials used for PTT attachment with the experimental stocks were exactly identical to those for field observations. The results showed that the dummy PTTs could stay in act on the carapace, even the shortest in this experiment longer than the last signals received from PTT model KiwiSat101 in the field. Thus, it could be confidently presumed that materials and techniques of attachment were suitable and good enough for field practices.

Keywords: sea turtle, Platform Transmitter Terminal, dummy PTTs

MIGRATION PATTERN OF POST-NESTING GREEN TURTLE, IN THE GULF OF THAILAND, TRACKED BY SATELLITE SYSTEM

Mickmin Charuchinda[1)], Somchai Monanansup [1)], Wataru Sakamoto [2)] & Nobuaki Arai [3)]

1) Sea Turtle Conservation Station, Department of Fisheries, Mannai Island, Rayong 21190 Thailand. E-mail: mannai@loxinfo.co.th
2) Graduate school of Agriculture, Kyoto University, Kyoto, Japan. E-mail: sakamoto@kais.kyoto-u.ca.jp
3) Graduate school of Informatics, Kyoto University, Kyoto, Japan. E-mail: arai@bre.soc.i.kyoto-u.ac.jp

Study on migration pattern of post nesting green turtles in the Gulf of Thailand was conducted by using satellite telemetry during the year of 2000-2001. Ten turtles from the eastern coast of the Gulf of Thailand were attached by Platform Transmitter Terminal (PTT) during the nesting season. Results showed that many females moved from their nesting area steadily to the neighbour water after finished nesting. There are two different directions of movement: the first direction passed the east coast of Thailand and straight to Vietnam peninsular, some crossed South China Sea and entered to Zulu Sea of Philippines water. The second way went down to the south cross the Gulf of Thailand to Malaysia peninsular. This trial indicated that female green turtles could migrate long distances from nesting ground to their habitats within the region. There is no doubt that the collaborative work among neighbour countries is needed for conservation on our sea turtle.

Keywords: green turtle, satellite tracking, migration pattern

FEEDING AND INTER-NESTING GROUNDS OF THE GREEN TURTLE NESTING POPULATION AT SIMILAN ISLANDS, THAILAND

Kongkiat Kittiwattanawong[1)], *Supot Chantrapornsyl*[1)], *Wataru Sakamoto*[2)] & *Nobuaki Arai*[3)]

1) Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand. E-mail: Kongkiat_k@hotmail.com; Supotc@fisheries.go.th
2) Graduate School of Agriculture, Kyoto University, Japan. E-mail: sakamoto@kais.kyoto-u.ac.jp
3) Graduate School of Social Informatics, Kyoto University, Japan. E-mail: aria@bre.soc.i.kyoto-u.ac.jp

Platform transmitter terminals (PTTs) developed by Telonics and Kiwisat companies were employed to monitor feeding and inter-nesting grounds of the green turtles (*Chelonia mydas*) nesting at Huyong Islands, Thailand. The PTTs were attached to 8 nesting green turtles during 2001-2002. The results showed that during inter-nesting period which lasts up to 100 days, the turtles aggregated mainly within 27 km from the nesting island. After the last spawn, the turtles headed to Andaman Islands situated to the north-west of Huyong Island. They spent more than 11 days traveled over 600 km to reach feeding grounds around Andaman Islands. The implementations of this study to green turtle conservation are 1) restriction of some fishing gears around 30 km from Huyong Island during April-Aug (which is the peak nesting season), 2) Co-operation with India to protect green turtle and its habitats at Andaman Islands.

DNA ANALYSIS OF GREEN TURTLES IN THAILAND: A PROGRESS REPORT

Kongkiat Kittiwattanawong[1)], Somchai Mananasup[2)], Masato Kinoshita[3)] & Kouji Nakayama[4)]

1) Phuket Marine Biological Center, Phuket 83000, Thailand. E-mail: kongkiat_k@hotmail.com
2) Sea Turtle Conservation Station, Department of Fisheries, Mannai Island, Rayong 21190 Thailand. E-mail: mannai@loxinfo.co.th
3) Department of Fisheries, Faculty of agriculture, Kyoto University, Sakyo-ku, Kyoto 606-8520, Japan. E-mail: kinoshit@kais.kyoto-u.ac.jp
4) Laboratory of Marine Stock-enhancement Biology, Division of Applied Biosciences, Graduate School of Agriculture, Kyoto 606-8502, Japan. E-mail: nakayama@kais.kais.kyoto-u.ac.jp

Genetic structure of nesting green turtles populations from the East (the Gulf of Thailand) and West (the Andaman Sea) Thai waters has been analyzed. Mitochondrial DNA has been extracted from the collected turtle tissues using phenol/chloroform. Sequencing technique has been performed using outer primers (Green 15552F "GTGTC CACAC AAACT AACTA CCT" and Green 16300R "GTCTC GGATT TAGGG GTTTG GCG") and inner primers (Green 15579F "CTGCC GTGCC CAACA GAACA" and Green 16087R "CCAGT TTCAC TGAAT CGGCA").

The preliminary result (5 individuals from the Gulf of Thailand and 4 individuals from the Andaman Sea) revealed that there was a tendency of separated populations. The result was in agreement with the satellite tracking data (SEASTAR, unpublished data). More samples from both populations are planned to be sequenced. The conclusion is expected to be available at the end of year 2002.

THE TRACKING OF MARY, A JUVENILE GREEN TURTLE RAISED IN CAPTIVITY

Liew Hock Chark[1)], Chan Eng Heng[1)], Wataru Sakamoto[2)] & Nobuaki Arai[3)]

1) Sea Turtle Research Unit (SEATRU), University College of Science and Technology Malaysia, 21030 Kuala Terengganu, Malaysia.
2) Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan.
3) Graduate School of Informatics, Kyoto University, Kyoto 606-8502, Japan.

Head-starting sea turtles is a controversial concept largely due to the pelagic nature of the early life stages and lack of evidence that head-started turtles can survive in the wild upon release. However, if the pelagic phase can be circumvented, perhaps they would stand a better chance. To test this, a few green turtle hatchlings were raised in captivity to an age of three to five years and have attained sizes similar to juvenile turtles that are regularly seen in coastal habitats. These juvenile turtles were tagged and released from their natal beach in Redang Island, Terengganu, Malaysia. One of the turtles, a 5 year-old named Mary, was fitted with a PTT (Kiwisat 101) to track her movements after release. She was initially seen exploring the benthic coastal habitat with occasional feeding attempts. The tracks revealed that she stayed close to Redang Island during the first 3 days following which she headed offshore in a northerly direction towards Vietnam. After 10 days, she reached the islands of Hon Tho Chau, Vietnam, and remained there for 3 days before continuing east towards Ko Samui, Thailand. About 90km before reaching Ko Samui, she changed course and remained offshore moving northwest and subsequently southeast until trasmission ended. The transmission lasted from 13th Sept to 3rd Nov., 2001 i.e. a period of 51 days. Over this period she travelled a straightline distance over 1,200 km. The viability of head-starting turtles for a more extended period of up to three to five years and the continuation and extension of the project presented in this paper is discussed.

MOVEMENT ABILITY OF CULTIVATED HAWKSBILL TURTLES, IN THE OPEN SEA, DETERMINED BY SATELLITE

Somchai Monanansup[1)], Mickmin Charuchinda[1)], Kenichi Tatsukawa[2)] & Hiroyuki Matsuda[2)]

1) Sea Turtle Conservation Station, Department of Fisheries, Mannai Island, Rayong 21190 Thailand. E-mail: mannai@loxinfo.co.th
2) Ocean Research Institute, University of Tokyo, Tokyo, Japan.
E-mail: tatukawa@ori.u-tokyo.ac.jp; matsuda@ori.u-tokyo.ac.jp

Sea turtle tagging and releasing program in the Gulf of Thailand is one of activities for conservation and management conducted by Mannai Sea Turtle Conservation Station, Department of Fisheries. Many cultivated sea turtles are always preserved in captivity for reproduction and releasing for increased a number of sea turtles to the wild. In 2001, satellite telemetry was served in the study on movement ability of hawksbill turtles after released to the open sea. Four juvenile and adult hawksbills aged 4-12 years old were deployed with Platform Transmitter Terminal (PTT) on their carapace.

Signal obtained showed that all hawksbills moved randomly for searching on feeding areas only along the coastline in the upper of the Gulf of Thailand within the water depth less than 20 m. They traveled to many areas without any directions throughout 2-3 months. It seemed that all hawksbills could not decide to stay in any habitats. Swimming speed is approximately all time 0.5-2 km/hr determined on high class of location accuracy signal (LC 1-3). Since the movement of the hawksbills looked in order and complexity, this data received for a few months might not enough time for clearly explanation to their behaviour in the open sea.

Keywords: hawksbill turtle, satellite telemetry, releasing

THE RELATIONSHIP BETWEEN SHRIMP TRAWL GROUNDS AND MIGRATION COURSES OF ADULT FEMALE GREEN TURTLES IN THE GULF OF THAILAND

Naoya SHIBA[1)], Nobuaki Arai[1)], Wataru Sakamoto[2)] & Wannakiat Tubtimsang[3)]

1) Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan, shoba@bre.soc.i.kyoto-u.ac.jp
2) Graduate School of Agriculture, Kyoto University
3) Department of Fisheries, Thailand

Study on migration courses of thirteen adult female green turtles was conducted by using satellite tracking in the Gulf of Thailand during the year 2000 and 2001. Eleven turtles were released from Khram Island, Chonburi Province and the rest two turtles were released from Mannai Island, Rayong Province. The migration courses of adult female green turtles were divided into three groups. Three turtles migrated to the South China Sea along the western coast of the Gulf of Thailand. Two turtles migrated to Singapore along the western coast of the Gulf of Thailand. In these two groups, migrating along the eastern and western coastal area, the turtles migrated in the coastal areas less than 40 km from main land. In the rest group, three turtles stayed near the released point, which may be nesting sites. All the turtles swam very slowly ranging from 1.7 to 2.5 km/day when they seemed to be staying in sea grass beds for more than one month. The sea grass beds were located in the very shallow and very near coastal areas. On the other hand the migrated further in the deeper and further from the land. Especially the turtles migrated fast ranging from 42 to 53 km/day across the South China Sea with more than 100 m in depth for more than one month since they seemed to reach their feeding grounds as soon as possible.

Department of Thailand reported in 1996 that fishing grounds of the trawl spread out 100 km in front of the shorelines. Thai government prohibited all pushing net and pulling nets within 3,000 m from the shorelines in order to preserve the coastal fisheries resources. The fishing grounds were ranging from 12 to 45m depths, mainly from 15 to 25 m depth. On the other hand, the depth of the vegetation of sea grass beds as the turtle feeding grounds within a depth of 10 m was too shallow to operate shrimp trawl. The migration courses of adult green turtles overlapped with shrimp trawl fishing grounds, but the sea grass beds where the turtles seemed to stay were overlapped with the areas where trawl fishing was prohibited.

SEX RATIO OF HATCHLING GREEN TURTLES RELATED WITH NEST TEMPERATURE

Kenichi Tatsukawa[1)], Mickmin Charuchinda[2)], Somchai Monanasup[2)] & Hiroyuki Matsuda[1)]

1) Ocean Research Institute, University of Tokyo, Tokyo 164-8639, Japan.
E-mail: tatukawa@ori.u-tokyo.ac.jp; matsuda@ori.u-tokyo.ac.jp
2) Sea Turtle Conservation Station, Department of Fisheries, Mannai Island, Rayong 21190 Thailand. E-mail: mannai@loxinfo.co.th

Introduction: Sex ratio of hatchling green turtles, *Chelonia mydas*, changed seasonally according to air temperatures in Thailand and the ratio in the nest under the shade condition became lower than that under sunlight, because of high nest temperatures (Tatsukawa et al; 2000). Effects of nest temperatures on sex ratio of hatchling green turtles were examined furthermore by field experiments in 2001.

Materials and methods: Nine clutches (85 to 128 eggs / nest) were used to test hatching processes and sex ratios of green turtle under five experimental conditions on nest temperatures on the Khram Island, Thailand, during May to September 2001. A styrofoam box (SB) in a room was one of these conditions. Three experimental shade pens with different plastic net roof (5m x 4m in wide) were built severally on a sandy beach. The light intensity on the area with 100% shade net (LI) was 3-11% of the sunlight intensity (about 100,000 luxes at noon, May), 70% shade net (MI) 8-23%, and 50% shade net (HI) 23-33%, respectively. Last one was under the sunlight (SL). Both sand temperatures beside the nest and nest temperatures in the nest were measured by temperature data loggers (StowAway TidbiT).
Note: Two clutches of August and September birth are under examinations of sex.

Results and discussions:

1) Sand temperatures: The average temperatures of SB, LI, MI, HI and SL were 28.2 ℃, 29.5℃, 29.5℃, 30.1℃ and 32.1℃, respectively. The temperature increased as the degree of shade decreased.

2) The middle third of nest temperatures (MTNT): The average MTNT of SB, LI, MI, HI and SL were 28.0℃, 30.3℃, 30.8℃, 30.9℃ and 32.7℃, respectively. The temperature increased as the degree of shade decreased. It was nearly same results even if the first third of nest temperature was used instead of MTNT.

3) Hatching rate: The average rates of SB, HI, MI, HI and SL were 45.3%, 83.4%, 91.2%, 91.8% and 83.3%, respectively. The rate had a tendency of increase as a nest temperature had increased. The rate may have the highest value under 32℃.

4) Sex ratio as % female: The average % female of SB, HI, MI, HI and SL were 0, 36.5, 68.3, 68.3 and 100, respectively. The ratio increased as a nest temperature had increased. The ratio became more than 50% when a nest temperature has gone up hotter than 30.5 ℃. Sex ratio of hatchling green turtles may be estimated by a nest temperature measured using a temperature data logger.

Keywords: green turtle, hatching rate, sex ratio, nest temperature, data logger

DIVING BEHAVIOR OF LEATHERBACK TURTLE IN FRENCH GUIANA

Hideji Tanaka[1)], Sandra Ferraroli[2)], Nobuaki Arai[1)], Yasuhiko Naito[3)] & Y. Le Maho[2)]

1) Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan, htanaka@bre.soc.i.kyoto-u.ac.jp
2) CNRS/CEPE, 23 rue Becquerel, 67087 Strasbourg cedex 02, France
3) National Institute of Polar Research, Tokyo 173-8515, Japan

French Guiana is the most important Leatherback turtle (*Dermochelys coriacea*) nesting zone of the world where 40% of the world's leatherback are nesting. Within French Guiana, 90% of all Leatherback nests are laid on Yalimapo beach. For more than 20 years, scientists and volunteers from more than 25 countries have worked within the Kawana marine turtle project, of which main activity has been the numbering and tagging of leatherbacks. However, the detail information about the diving behavior during the internesting interval has been poorly described, principally as a result of the difficulties encountered in monitoring turtle behavior in the sea. The present study describes the use of a recently developed electronic data logger and ARGOS system, to obtain simultaneous records of swimming speed, depth, forelimb beating activity and migration range of leatherback turtles. Most of time-depth profile of leatherbacks assumed a V shape with a short bottom phase during internesting intervals which lasted 9-11 days. Generally, dive depths of turtles were less than 30 m and the maximum dive depth was 83.7 m. The depth of neutral buoyancy of turtles was estimated between 15-20 m. The dive depth of turtles tended to be deeper while they showed horizontal zigzag movements. The forelimb beatings during the dive cycle were approximately 0.2 HZ and did not decrease even during the bottom phase. The results of the study are discussed in relation to the foraging behavior of leatherback turtles during the internesting interval in French Guiana.

Keywords: *Dermochelys coriacea*; internesting interval; data logger; ARGOS; foraging

ANALYSIS OF THE BEHAVIOR OF SEA TURTLES BY USING MR DATA-LOGGERS

Mizuki Yoshida[1)], Wataru Sakamoto[2)], Nobuaki Arai[3)] & Haruhiko Masuda[4)]

1) Faculty of Agriculture, Kyoto University, Kyoto 606-8502, Japan, yoshida@bre.soc.i.kyoto-u.ac.jp
2) Graduate School of Agriculture, Kyoto University, Graduate School of Agriculture, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan. E-mail: sakamoto@kais.kyoto-u.ac.jp
3) Graduate School of Informatics, Kyoto University
4) Alec Electronics Co., Ltd.

It is difficult to study the behavior of marine animals including sea turtles, since they spend most of their life underwater. However, to study the behavior of marine animals is very important to conserve their resources especially endangered species like sea turtles. Recently, remarkable technological advances in animal-carried devices including micro data loggers, ultrasonic biotelemetry, and platform terminal transmitters have led to new knowledge about the behavior of aquatic animals. We are now developing new devices to measure the behavior of marine animals. The device is a MR logger. The logger has magneto-resistive effect (MR) sensors and accelerometers. The MR sensor detects 3-D magnetic field to transform into 3-D direction data. Combing 3-D direction data and 3-D acceleration data, we can estimate 3-D position of animals. In this study we conducted the field tests of MR loggers using adult sea turtles. The field tests were executed in breeding pond at the Sea Turtle Conservation Station situated at Mannai Island. We attached a MR logger on two captive adult hawksbill turtles (*Eretmochelys imbricata*) in 12:00 on September 25, and we recovered loggers in 9:00 on September 27. Three-directional magnetic field and two-directional acceleration were obtained for over 43 hours. In addition, we measured depth and temperature simultaneously using micro data loggers (MDS, Alec Electronics Co., Ltd.). In this experiment, turtles exhibited diurnal and nocturnal behaviors. Turtles were active in daytime, while they showed little movement in nighttime.

EFFECTS OF DETERMINATE GROWTH ON POPULATION DYNAMICS OF HAWKSBILL TURTLE

Shin-ichi Ebina & Hiroyuki Matsuda

Ocean Research Institute, University of Tokyo, E-mail: ebina@ori.u-tokyo.ac.jp

Population dynamic model of wildlife animals depends on growth, survival and reproduction. In general, it is known to be two ways of growing. One is "determinate growth", which they stop growing after maturation, and the other is "indeterminate growth", which they continue to grow after maturation. In this study, we made two population dynamic models for Hawksbill turtles (*Eretmochelys imbricata*) living in Cuban waters in view of determinate growth (model A) and indeterminate growth (model B). We took some biological data (growth rate, mortality rate, the rate of maturity, etc.) from some literatures, and made matrix models. We compare the difference in impacts of harvest on population dynamics between the two models. Setting the values of parameters to fulfill the initial conditions, and calculating the estimated population size, the results show that model B is liable to underestimate it. This indicates that it is necessary to consider the growth pattern when you estimate population size and implement wildlife management.

Keywords: determinate growth, population dynamic model, Hawksbill turtles, wildlife management

(UNKNOW TITLE)

Dr. Chan Eng Heng

AN INTER-NESTING MOVEMENT OF THE FEMALE GREEN TURTLE, *CHELONIA MYDAS* STUDIED BY SATELLITE TELEMETRY AT MA' DAERAH SANCTUARY, MALAYSIA

Ibrahim, K.[1)], Saleh, I.[1)], Sakamoto, W.[2)], Arai, N.[3)] & Ismail, M.[1)]

1) Marine Fishery Resources Development and Management Department, Southeast Asian Fisheries Development Center (SEAFDEC) Chendering 21080 Kuala Terengganu, Terengganu, Malaysia
2) Graduate School of Agriculture, Kyoto Unviversity, Kyoto 606-8501, Japan
3) Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan

A female green turtle, *Chelonia mydas* was tracked with satellite telemetry at Ma' Daerah Sanctuary, Malaysia with the aims to study her inter-nesting movement and to use the information for management purposes. A Platform Transmitter Terminal, PTT (KiwiSat 101, # 09727) was fitted on a female turtle, Melur after she finished laying her eggs on July 19, 2001 for the fifth time. The location, surface temperature and surface time data were received from NOAA satellites via theFrench-based ARGOS Company. Data collection to date indicates that the signals have been last transmitted on August 31, 2001 giving the total tracking duration of 43 days. The transmissions ended after 43 days was probably due to the PTT was not functioning or some other reasons. Analysis of the satellite data suggests that Melur occupied the offshore area close to her nesting beach while completing her last three clutches of eggs. The observed inter-nesting area was within the range of 7.7 nm (14.3 km) offshore, and 6.4 nm (11.9 km) and 2.2 nm (4.1 km) to the north and south of the beach, respectively. The speed of turtle during inter-nesting movement was relatively slow and varied between 0.05 km/h to 11.70 km/h with an average 1.17 km/h. This study has management implications as it reinforces other studies which show that green turtles utilise coastal shallow area in the vicinity of nesting beach during a breeding season. The results also highlight potential offshore area of Ma' Daerah sanctuary for protection. It is recommended that more PTTs to be employed in order to gain a comprehensive information before it is finalized for management decision.

Keywords: Satellite telemetry, Green turtle, *Chelonia mydas*, inter-nesting movement, Ma' Daerah sanctuary.

AN ADAPTIVE MANAGEMENT STRATEGY FOR HAWKSBILL TURTLE.

Hiroyuki Matsuda & Shin-ichi Ebina

Ocean Research Institute, University of Tokyo, E-mail: matsuda@ori.u-tokyo.ac.jp

There are many types of uncertainties in population management; absolute and relative stock size, genetic structure, life history parameters, exploitation rate and environmental factors. Under a constant harvest rate policy, the risk of stock collapse is not negligible from precautionary point of view, even under very small catch quota. If we monitor trends of relative stock size and change catch quota with the population trends, the risk of stock collapse is kept to be sufficiently small. This is called adaptive management. Although the magnitude of risk depends on population dynamic models we adopt, we show difference in the risk and expected yield among constant harvest ratio, adaptive management and zero catch under the wide range of scenarios in absolute stock size and life history parameters. The key factor that diminishes the risk and increase yield is the accuracy of relative trends in stock size estimation. The monitoring procedure or method of estimation should be consistent throughout years.

Keywords: population management, monitoring, risk, stock collapse.

FISHERY RESOURCE MANAGEMENT AND ENVIRONMENTAL PRESERVATION: INSTITUTIONAL COMPARISON BETWEEN UNITED STATES AND JAPAN

Mitsutaku Makino[1)], Wataru Sakamoto [2)] & Nobuaki Arai[3)]

1) Graduate School of Human and Environmental Studies, Kyoto University, Kyoto 606-8501, Japan, makino@borg.jinkan.kyoto-u.ac.jp
2) Graduate School of Agriculture, Kyoto University
3) Graduate School of Informatics, Kyoto University

Institutional Comparison of Fishery Resource Managements: Firstly, fishery institutions in U.S. and Japan are roughly introduced. In U.S., basically every citizen has common rights of fishing on the sea (*commune piscarium*). Since mid 90s, however, Individual Transferable Quota (ITQ) system was introduced to some of ocean fisheries. On the other hand, most of inland fishery activities (at rivers and lakes) are restrained by exclusive fishery rights.

In Japan, almost no commercial fishery can be operated without fishery rights or licenses. Fishery rights are entitled by governors of the waters under their jurisdiction (including inland waters), but the governors have to hear the opinions of the Fishery Adjustment Commissions beforehand. In addition, the Fishery Adjustment Commissions, which are mainly composed of local fishermen, play the main role in fishery resource management in Japan.

In U.S., fishery resource managements (and environmental preservations) are fundamental obligations of local or/and federal governments. This juridical relationship between citizens' rights and governments' obligation is called "Public Trust".

Public Trust Doctrine and Environmental Preservation in U.S. (Ideas and Logics): Here, the history of Public Trust Doctrine is summarized, and then, two important precedents and a characteristic feature of American lawsuit system (the Class Action System) are presented.

The first precedent is Mono Lake Case, which is a dispute between natural resource use and environmental preservation in U.S. The Second example of Public Trust Doctrine in use is relating to United States' "Endangered Species Act (ESA)". In order to protect small fish (Snail Darter) habitats, construction of a dam, which was nearly finished, was suspended according to ESA Section 7(a)(2), (Tellico Dam Case).

Finally, American ESA and corresponding law in Japan are compared, where the role of the Class Action System in environmental preservation will be analyzed.

Future Research Plans: Finally, our research interests and future plans are presented.

BIOTELEMETRY STUDY ON MARINE LIVES USING CODED ULTRASONIC TRANSMITTERS

Hiromichi Mitamura[1)], Nobuaki Arai [1)], Yasushi Mitsunaga[2)] & Wataru Sakamoto[3)]

1) Graduate School of Informatics, Kyoto University, Kyoto 606-8501, Japan, mitamura@bre.soc.i.kyoto-u.ac.jp
2) Faculty of Agriculture, Kinki University
3) Graduate School of Agriculture, Kyoto University

Radio and ultrasonic biotelemetry were employed to measure the marine life behavior since 1960's. The performance of them was improved since micro-electronics technologies were developed rapidly in these several years. We employed coded ultrasonic transmitters (V8SC-6L,Vemco Ltd., Canada) in order to track many fish simultaneously. An ultrasonic coded transmitter was 8.5mm diameter with 25mm long and weighed 2.2g in water. The transmitter was used to transmit complex codes of up to six pulses. We can chase after up to 256 different fish using the transmitters on the same frequency. Two receiver systems were used for tracking sample fishes with coded ultrasonic transmitters. One was a VR28 system (Vemco Ltd., Canada) to detect the direction of the sample fish using 4 hydrophones. The VR28 was on board. The position of the ship was measured by GPS (Germin Co., USA). The other was a VR1 system (Vemco Ltd., Canada) to detect signals from the transmitters and to record time of fish attendance and its ID onto inside memories. The dimension of the VR1 was 60mm in diameter with 205mm length. The lithium battery inside lasted for 180 days. The VR1 was installed in the place where the sample fish pass through in advance. The range of the signal detection was within 300-500m. In this paper, we introduce preliminary results using the coded ultrasonic transmitters and the receiver systems. Twenty five black rockfishes *Sebastes inermis* were fished at the 3 points of the eastern seawall of the Kansai International Airport (KIX) Island. The transmitters were implanted surgically into the abdomen of the fish under anesthesia using 0.1% 2-Phenoxyethanol. They were released in two different release points. One was near the KIX Island and the other was the other side. Two VR1 systems were installed in this study at the no.4 girder of the liaison bridge that was in the northeastern direction from the release point near the KIX Island. We found that seventeen of them migrated to their habitat within 11 days. Throughout the experiments, the VR1 systems at the liaison bridge recorded few attendances of the most sample fish. In other words, most of the sample fish released near the KIX moved along the eastern seawall of the KIX to the southwestern direction and the sample fish released at the other side didn't approach to the liaison bridge but might move straight to their home. The fish that migrated to their habitat didn't move out from each habitat during our investigation. We applied the V test modified Rayleigh's test to verify migration patterns of them. The behavior of the black rockfish was unintentional after the release within four hours (the V test, $p > 0.05$) and significantly different from random after 4 hours from release (the V test, $p < 0.0025$).

ESTIMATES OF SWIMMING BEHAVIOR OF FISH USING ACCELERATION DATA-LOGGER

Yasushi Mitsunaga[1)], Nobuaki Arai[2)] & Wataru Sakamoto[3)]

1) Faculty of Agriculture, Kinki University, Nara 631-8505, Japan,
mittsu@nara.kindai.ac.jp
2) Graduate School of Informatics, Kyoto University
3) Graduate School of Agriculture, Kyoto University

Data-logger is a powerful tool that provides continuous and simultaneous monitoring of fish in their natural environment, in both space and time. Recently, due to development of acceleration data-logger, we can record the information of movement of fish. The acceleration data-loggers were attached to red sea bream, salmon, and largemouth bass to reveal their swimming behavior. The logger recorded multi channel data including surging and swaying acceleration, depth, temperature, and swimming speed. Acceleration data were recorded at a frequency of 16-128 Hz, temperature, depth, and swimming speed data were recorded at a frequency of 1 Hz. An adult red sea bream was tagged with an acceleration data-logger and released into a fish pond that was a rectangle 125-m by 42-m with 3-m depth. As swimming thrust of fish was powered by its tail beat, fluctuation of the acceleration was expected to represent the tail beat frequency. By spectrum analysis, the tail beat frequency was estimated 4 Hz at burst swimming and 2 Hz at moderate swimming. Six adult salmon (three males and three females) that came back to their home river to spawn were tagged with acceleration data-loggers and released into the river. As the acceleration data-logger also can record gravity acceleration, the angle of fish body was estimated. From the change of the base line of acceleration data, digging a nest behavior was distinguished from normal swimming. To make sure of the estimates, the acceleration data-logger was used with digital video tape recorder. Largemouth bass was tagged with an acceleration data-logger and inserted into a water tunnel. The bass was force-swum in different water velocity and movement of its tail was recorded by a digital video tape recorder. By digital graphic analysis, positions of the tip of the tail were determined at a frequency 30 Hz. Using these positions, frequency and amplitude of tail beat were found. Now the data derived from two digital devices, an acceleration data-logger and digital video tape recorder ware under comparison. It seems that acceleration data-logger can be used for other marine lives such as sea turtle. We can estimate nesting behavior of sea turtle e.g. landing, moving on the beach, and pitting behavior by analyzing the records of acceleration.

CONSERVATION OF DUGONG IN THAILAND

Kanjana Adulyanukosol

Phuket Marine Biological Center, P.O. Box 60, Phuket 83000, Thailand. E-mail: k_adulyanukosol@hotmail.com

The dugong in Thailand is close to extinction, and has been declared a reserved and protected aquatic species under the Thai Fishery Act since 1947. Although the overall population consists of small groups scattered along the coasts (the Gulf of Thailand and Andaman Sea), sizable numbers of dugongs have been observed by aerial surveys at Talibong and Muk Islands, Trang province, in the Andaman Sea. Dugongs are occasionally entangled or drowned in fishing gears. Among various types of gears, gill nets are considered to be the main cause of death of dugongs.

Marine Protected Areas in Trang province have been adopted in May 1992 under the Provincial Notification "The Provincial Notification for not using some kinds of fishing operations in certain areas of seagrass beds". The aim of this notification is to conserve seagrass resources for dugongs and other marine organisms. Enforcement occurs via The Fisheries Act 1947 and executed by the Department of Fisheries. Penalties have occurred for non-compliance and push nets and beach seines are reported to have decreased following the introduction of the Marine Protected Area. The dugong is considered a "flagship" species for this Marine Protected Areas and it is envisaged that a "Dugong National Sanctuary" should be announced in the near future.

MAPPING OF SEAGRASS BEDS USING ACOUSTIC METHODS

TERUHISA Komatsu & KEN-ICHI Tatsukawa

Ocean Research Institute, the University of Tokyo, 1-15-1, Minamidai,
Nakanoku, Tokyo, 164-8639, Japan. E-mail: komatsu@ori.u-tokyo.ac.jp

Mapping of seagrass beds is very important for management and conservation of sound littoral ecosystems and sustainable fisheries in the coastal waters. The methods to map seagrass beds are reviewed. The methods are classified into two categories. One is direct methods by visual observation and the other is indirect methods using a remote sensing apparatus. Indirect methods are divided into optical or hydro-acoustic methods. Indirect methods require sea truth by direct methods. Optical methods are image analysis of aerial photography or satellite imagery. They are effective for mapping broad areas but limited to shallow waters due to attenuation limit of light in waters. When target shallow waters are influenced with a great tidal range, it is better to shot images during low tides. Hydro-acoustic methods such as an echosounder and a side scan sonar have no limitation of turbidity. The echosounder is practical to map density and height distributions of seagrass beds. The side scan sonar is appropriate for mapping broad geographic distributions in relatively deeper waters. Coupling of several indirect mapping methods is more useful than using only one method.

Keywords: seagrass, seaweed, mapping, remote sensing, hydro-acoustic

INFLUENCE OF ENVIRONMENTAL FACTORS ON ABALONE *Haliotis discus*

Yukako Saikyo[1)], *Wataru Sakamoto*[1)] & *Nobuaki Arai*[2)]

1) Graduate School of Agriculture, Kyoto University, Kyoto 606-8502, Japan, saikyo@kais.kyoto-u.ac.jp;
2) Graduate School of Informatics, Kyoto University

Abalone aquaculture is an important fishery in Japan since annual catch has gradually decreased. In Thailand, shrimp aquaculture is popular now, but recently many problems arise, such shrimp disease and environmental pollution. So now more attention should be paid to abalone aquaculture as 'post shrimp farm'. Abalone is an expensive marine food item than shrimp, so abalone has been expected to become important resource. However we need to understand ecology of abalone, especially the influence of environmental factors on abalone to maintain stable supply. The main objective of this report is to understand the influence of water temperature on locomotion of abalone. We investigated its locomotion under difference temperature using a CCD camera (KEYENCE, CV-500) monitoring system. We used 5 mature abalones, *Haliotis discus*. They were maintained in a reserved tank in the laboratory under L12:D12 conditions before the experiment. Each abalone was attached a light-emitting diode (LED) float and released into the 500L tank calmly. It was left alone in the tank for 24h for acclimation. The water temperature in the tank was controlled in 4 cases in each experimental series, 10, 15, 20 and 25ºC, respectively. The water was circulated through a pump from inflow-tank to outflow thermoregulator. We started to monitor locomotion of abalone for 24h with a CCD camera (KEYENCE, CV-500). The laboratory was in darkness, and the position of the abalone was measured using a luminous float. This datum was continuously recoded on a personal computer connected with RS-232C. We could estimate their locomotion. Under 10, 15, 20 and 25 ºC, abalones didn't move during day(8:00-20:00) and some moved for a piece of kelp during night(20:00-8:00).This was implied that L12:D12 conditions before the experiment had an effect on their locomotion however the laboratory was in darkness during the experiment.

PARTICIPANTS

CAMBODIA

Mr. Pich Sereywath — sereywath@hotmail.com
Department of Fisheries
Phnom Penh, Cambodia

ITALY

Ms. Monica Aureggi — naucrates12@hotmail.com
Naucrates, Onlus,
Via Corbetta, 11, 22063
Cantu 8217 (CO) 211, Italy

JAPAN

Dr. Wataru Sakamoto — sakamoto@kais.kyoto-u.ac.jp
Ms .Yukako Saikyo — saikyo@kais.kyoto-u.ac.jp
Graduate School of Agriculture
Kyoto University
Sakyo-ku, Kyoto 606-8502, Japan

Ms .Mizuki Yoshida — yoshida@bre.soc.i.kyoto-u.ac.jp
Faculty of Agriculture
Kyoto University
Sakyo-ku, Kyoto 606-8502, Japan

Mr .Mitsutaku Makino — makino@borg.jinkan.kyoto-u.ac.jp
Graduate School of Human and Environmental Studies
Kyoto University, Sakyo-ku,
Kyoto 606-8501, Japan

Dr .Nobuaki Arai — aria@bre.soc.i.kyoto-u.ac.jp
Dr. Hideji Tanaka — htanaka@bre.soc.i.kyoto-u.ac.jp
Mr. Naoya Shiba — shiba@bre.soc.i.kyoto-u.ac.jp
Mr. Hiromichi Mitamura — mitamura@bre.soc.i.kyoto-u.ac.jp
Graduate School of Information
Kyoto University
Kyoto 606-8501, Japan

Dr .Yasushi Mitsunaga — mittsu@nara.kindai.ac.jp
Facuty of Agriculture
Kinki University
Nara 631-8505, Japan

Dr. Kenichi Tatsukawa — tatukawa@ori.u-tokyo.ac.jp
Dr. Hiroyuki Matsuda — matsuda@ori.u-tokyo.ac.jp
Dr. Shin-ichi Ebina — ebina@ori.u-tokyo.ac.jp
Ocean Research Institute
University of Tokyo
Tokyo164-8639, Japan

MALAYSIA

Dr. Liew Hock Chark hcliew@kustem.edu.my
Dr. Chan Eng Heng chaneh@kustem.edu.my
Sea Turtle Research Unit (SEATRU)
Faculty of Science & Technology,
Kolej Universiti Sains & Teknologi Malaysia 21030
Kuala Terengganu, Terengganu, Malaysia

Dr. Kamarruddin Bin Ibrahim kamarruddini@yahoo.com
Mr. Mazlan Ismail
Marine Fisheries Resources Development and Management
Department/ Southeast Asian Fisheries Development Center
Fisheries Garden, Chendering, 21080 Kuala Terengganu
Malaysia

Dr. Yoshikazu Nakamura seafdec@tm.net.my
Deputy Chief of MFRDMD/SEAFDEC
Taman Perikanan Chendering, 21080
Kuala Terengganu, Malaysia

THAILAND

Mr. Supot Chantrapornsyl supotc@fisheries.go.th
Ms. Kanjana Adulyanukosol adulyanukosol@hotmail.com
Mr. Kongkiat Kittiwattanawong kongkiat_k@hotmail.com
Phuket Marine Biological Center
P.O. Box 60 Phuket 83000, Thailand

Mr. Mickmin Charuchinda mannai@loxinfo.co.th
Mr. Somchai Mananunsap mannai@loxinfo.co.th
Sea Turtle Conservation Station
Man-nai Isdland, Tumbol Krum, Klang District
Rayong 21190

Capt. Winai Klom-in
Naval Special Warfare Group
Royal Thai Navy
P.O. Box 21 Sattahip
Cholburi 20180

Cdr. Surasak Chaiyaphan
Royal Thai Navy

VIETNAM

Mr. Dinh Hong Thanh haiduong@dng.vnn.vn
Department of Vertebrate Resources
Institute of Oceanography
01 Cauda-Nhatrang, Vietnam