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Assessment and Initial Treatment of Cold-Stunned Sea Turtles

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Although primarily tropical and subtropical animals, numerous instances of cold-stunning of sea turtles have been reported (Witherington and Ehrhart, 1985, 1989; Meylan and Sadove, 1986; Meylan, 1986), with recovery rates for animals varying widely. Historical incidences of sea turtle cold-stunning in relatively southern areas such as Florida, USA (Ehrhart, 1983), were often reliant on immediately impending warming trends to mitigate overall impact upon the local populations. However, cold-stunning events reported in more northern latitudes such as New York, USA (De Sola, 1931; Meylan and Sadove, 1986), cannot rely upon the recovery of animals based upon improving temperature conditions. Historical records indicate that cold-stunning or hypothermic events have always occurred in northern latitudes and have consistently represented a portion of the overall mortality for the species (Murphy, 1916; Latham, 1969; Morreale et al., 1989). With dramatically reduced populations of many species, particularly the Kemp's ridley, *Lepidochelys kempi*, mortalities from cold-stunning should be avoided if possible by treating the affected animals.

We have developed the following protocol for assessment and initial treatment of cold-stunned sea turtles based on our experiences in New York, utilizing primarily *L. kempi* and *Caretta caretta*. Our methods do not utilize sophisticated equipment such as heart monitors and are therefore useful for field conditions. The initial protocols were developed and described in unpublished annual New York State Stranding reports to the New York State Department of Environmental Conservation between 1986 and 1989. These protocols have subsequently been modified into the format presented here based upon a more comprehensive review of the stranding data.

Assessment Protocol. — These guidelines involve only initial assessment and determination of initial treatment of cold-stunned hypothermic sea turtles and do not include complete veterinary procedures.

The protocol described here is based upon the classification of all hypothermic sea turtles into one of four severity classes (I, II, III, or IV). Class definitions are based upon certain reflex responses of animals to specific touch stimuli or observed movement or behavior.

1. Head lift observation. When sea turtles breathe they lift their heads well above the horizontal axis of the body. In most healthy animals lying on a flat surface, the maximal head elevation corresponds to an angle of 45° or more.

2. Cloacal or tail touch reflex. This involves stimulating the tail, including the cloacal section, by a light touch of a finger around the opening of the cloaca and moving it posteriorly along the ventral surface quickly. In healthy or minimally impaired animals the reflex response involves the movement of the cloaca or a side movement of the tail.

3. Eye touch reflex. A healthy sea turtle will exhibit a flinch response to having its eye or the upper eyelid lightly touched. In a cold-stunned animal the flinch response may be very slight, and a hard touch may mask a response. Animals may demonstrate a bilateral response, although in many instances only the stimulated eye will react.

4. Nose touch reflex. The distal portion of the nose surrounding the nares of sea turtles includes soft innervated tissue. In healthy sea turtles touching this region also produces a flinch response. This reflex response involves inward pulling of the eyes and/or retraction of the head and neck region. In cold-stunned animals the response to this stimulus may only involve one or the other reflex response. It is very important that an animal be watched closely when this test is performed. The touching should be firm but not forceful enough to move the animal or the head in any manner. It should also be done quickly and repetition should be very limited. The reflex response for this appears to disappear rapidly, and a lack of response to repetitive touching may not be indicative of the animal's condition.

The definition of what class of cold-stunning an animal merits depends upon the response it exhibits to the various stimuli presented. In addition, the definition of its class status also involves the overall responsiveness of the animal. Once a class definition is assigned, appropriate treatment can be initiated. The class definitions are as follows:

Class I:

A. Strong swimming attempts or actual swimming behavior are maintained by the turtle.

B. Strong response to all reflex tests including nose, eye, and cloaca, as well as strong withdrawal responses also elicited by manual contact with extremities. In addition, the nose or eye touch often elicits a flipper movement that may be quite strong and rapid.

C. The body of the turtle is not limp when lifted off the floor. Muscular tone allows the animal to hold its limbs even with or above the plane of the ventral surface of the body.

D. When a flipper or the neck is held and attempted to be moved there is a strong withdrawal reaction.

E. The animal may attempt to make moderate to weak crawl movements when placed on a solid surface such as a floor.

F. The turtle will exhibit strong head lift when breathing.

Class II:

A. Moderate, weak, or even strong swimming movements may be observed, but these will be slow.

B. Nose or eye reflex tests produce only a weak localized flinch response.

C. The nose or eye reflex tests will also produce a slight generalized extremity response, but this will be weak and decrease distally.

D. Cloacal reflex will produce a weak response. Often this will only involve lateral movement of the tail, but cloacal reaction is often present initially.

E. Limited withdrawal from forced movement of the head or flippers may occur but not be sustained.

F. Crawl attempts may occur, but result in no overall movement of the turtle in any direction when placed on a solid substrate.

G. When the animal is held by the sides in a level manner with the ventral surface down, its flippers will gradually fall below the carapace plane. The appearance is of the animal gradually becoming limp.

H. The head lift for breathing is present but may appear weak and incomplete.

Class III:

A. The animal does not move, or its movements are clearly not under complete control. The movements are very erratic or spastic and non-directional, appearing uncontrolled. Swimming movements are absent.

B. Nose or eye reflex is absent or has an almost undetectable response.

C. The body is completely limp when lifted from a solid substrate. The head and neck may support themselves slightly for short periods of time and/or fall immediately below the plane of the plastron.

D. There is no withdrawal from forced movements, but when flippers are held and then released there may be erratic pulse-like movements of the distal portions of the front flippers.

E. The cloacal reflex may produce only a very slight lateral movement of the tail or no response will be observed.

F. No attempts will be made by the animal to move on a solid substrate.

G. The head lift for breathing will be either absent or very slight and incomplete. The throat may move during the lift attempt, but the head is usually not lifted above the carapace.

H. There may be partial freezing of the tips of the extremities.

Class IV:

A. The animal does not move.

B. Nose or eye reflex is absent.

C. The body appears completely limp when lifted, with all limbs, head, and neck falling below the plane of the plastron.

D. There is no response to forced movements of the flippers, head, or neck.

E. No attempts to move will be made by the animal when placed on a solid substrate. Limbs and neck will lie flat on the substrate with no apparent muscle tone.

F. The cloacal reflex elicits either no response or only a slight movement of the tail tip.

G. There is no head lift or any indication of attempts at breathing.

H. Extremities, eyes, or neck may be partially frozen and limbs may be stiff.

Treatment Protocol. — Initial treatment is based upon determining the severity class of the cold-stunned animal. The following treatment protocol is intended as broad guidelines to assist veterinary and animal care staff in initial treatment of this condition. More detailed invasive treatments may also be determined by attending veterinary staff.

Class I. These animals may only require supportive care and are usually treatable without invasive procedures. We have found the prognosis for these animals to be very good. Animals in this class can often be placed into filtered tanks containing sea water immediately. The water temperature should initially be only 2-4°C warmer than the ambient water temperature to which the animals had been exposed. The water should then be slowly warmed passively by indirect heating lamps or by gradually increasing the ambient room temperature. In most instances it is best to place these animals in small, round tanks 2.5 times the diameter of the carapace length. The water depth should be moderately shallow at 16–30 cm in depth. The animal should be monitored for approximately 30 minutes after being placed into water. If the swimming movements of the turtle are observed to be strong, the water level should gradually be increased.

If strong swimming motions continue, further water heating should be initiated for approximately 4–6 hours. This can be accomplished by in-line heaters or by the placement of a glass aquarium heater directly in the water. All water heaters placed in the tank with a turtle should be shielded with PVC or some similar obstructing device as the turtle may bite the glass tube. If strong swimming continues once the water reaches 20°C then the animal may be placed into a large, long term rehabilitation tank, observing it closely for floating behavior. If intermittent or no floating is observed then a favorable prognosis is likely. At any point in the process of treatment if there is either no improvement or a decrease in one of the class-defining variables then rehabilitation should be retraced to the previous point and continued more slowly.

Class II. These animals are at a greater risk and require more attention to the rate of warming and responses to reflex tests. We have found that recovery from this severity class is also very high when close attention is paid to the animal's progress and condition.

Animals in this class can sometimes be placed in water immediately. However, the depth is important and largely determined by the degree of strength of the head lift for breathing. The initial water depths should be only 3–4 cm for those animals with a weak head lift, and 6–7 cm for those with stronger head lifts. The water mixture should be 50% freshwater if the animal appears dehydrated. Broad indication of this condition can be determined by standard hematology procedures. Weaker animals may be placed in a tank onto small pieces of foam to elevate the mid-body region of the animal. The resulting downward movement of the flipper will facilitate easier movement for weaker animals. In addition, a small foam pad can be placed under the head for those animals with weaker head lifts. It is also possible, based upon submergence recovery techniques used by National Marine Fisheries Service for sea turtles entrapped in fishing gear, that movement of flippers may greatly assist in the treatment of shock by increasing blood flow and, therefore, oxygen absorption. Therefore, manual pumping movements of the foreflippers imitating a swimming motion should act to increase vascular flow.

Initial temperatures should be no greater than 2–3°C above the ambient water temperature the animal came from, or the animal's measured cloacal temperature, provided it is not above 12.7°C. The water temperature should not be increased for the next 2–4 hours except passively through sunlight or slow increase in the ambient room temperature, but not exceeding a maximum of 10–13°C. If an increase in activity or stronger responses to reflex stimuli are noted within this period then a gradual increase in water temperature may be initiated. However, an increase in the water level is not recommended. If the water temperature reaches 13–15°C and the animal's swimming movements are more characteristic of Class I animals, an increase in the water level should be initiated. This increase should be no more than 10 cm every 30–60 minutes. Observe the turtle for stronger swimming activities. These animals are likely to be observed floating. If attempts at diving are made, this should be of no real concern. Once the water depth reaches 60 cm the animal may be transferred to a large, deep, permanent rehabilitation tank. As in the previous class any lack of progress or reversal requires a return to the previous steps and a slower resuscitation.

Class III. These animals have a very poor initial prognosis and require much closer attention and possibly more invasive veterinary or experimental treatment techniques. It is the authors' experience that the majority of these animals do not survive following standard techniques. However, some more recent experimental techniques may produce better results. Treatment of animals in this class requires rigid adherence to the treatment plan, and they must be watched almost continuously. If these animals are placed in water, it should never be at a depth beyond simply making cloacal contact. The water level should remain at or below the mouth line. Turtles in this class should be periodically moistened with particular attention paid to the eyes, head, neck, and cloaca.

Warming of turtles in this class must be done passively with indirect heat lamps, while regular moistening will prevent drying. The temperature increase should not exceed 0.5°C per hour. At no time should the water or air temperature exceed 18°C until the animal becomes more responsive and is judged to be Class II or I status. Manual pumping of foreflippers every 30 minutes for 2–4 hours followed by every two hours thereafter may be helpful for vascular flow. Signs of positive responses to reflex stimuli should be looked for frequently. If a head lift becomes more defined or controlled and/or flipper movement is also more controlled the water level can be raised to a point even with or just below the nares. Animals in this class often benefit from placement on a foam pad. This will enable flipper movements to be more natural and swim-like in nature.

If the animal makes no progress or the medical condition declines the best procedure we have observed is to increase flipper movement and to consider more aggressive therapies such as intubation and respiratory support to accomplish breathing.

Class IV. These animals are those with the poorest recovery rate, with only rare successful recoveries. Further research is needed on treatment of animals in this class. These animals are usually partially frozen and suffering acute or chronic hypoxia. All warming must be extremely indirect and gradual with rates of no greater than 0.25°C per hour. In addition, placement in water is not recommended. The animal's eyes, neck, head, and cloaca should be regularly moistened. These animals are also in critical need of respiratory assistance and should be intubated and placed on respiratory support. Full scale veterinary support should be considered if feasible.

Summary. — The protocol we describe here has been used in the recovery of cold-stunned sea turtles in New York since 1985. The intention of this protocol is to assist in the initial triage and determination of treatment for hypothermic sea turtles. It should be used in conjunction with the advice and assistance of a veterinarian and sea turtle animal care specialists. Our intention is not to provide a complete treatment protocol, but to provide the initial means under which severity and treatment of the condition can be determined. We strongly suggest that the occurrence of hypothermia in sea turtles be taken as a serious life-threatening event and hope that this protocol will help resuscitate those animals that can be recovered.

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Ecological Notes on Feral Populations of *Trachemys scripta elegans* in Northern Taiwan

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The natural distribution of the red-eared slider, *Trachemys scripta elegans*, is confined to the southeastern United States and northeastern Mexico (Ernst, 1990; Iverson, 1992). However, this turtle has been exported to various countries and areas, including Taiwan, by pet dealers. The introduction of this sub-species has occurred in many countries in Asia, Europe, and Africa (Newbery, 1984; Uchida, 1989; Iverson, 1992; Platt and Fontenot, 1992; da Silva and Blasco, 1995; Ota, 1995; Luiselli et al., 1997), as well as in North America outside its natural range (Hutchison, 1992; Iverson, 1992). Until recently, the introduction of foreign commercial and pet animal species has been a common practice in Taiwan (Shao and Tzeng, 1993). Although the status of *T. s. elegans* in Taiwan has never been documented, it is believed to be widely distributed on this island. Individuals who have bought juveniles of this species as pets may occasionally release the turtles into ponds and rivers when they become inconveniently large. Some individuals are also released through Buddhist "mercy" ceremonies.

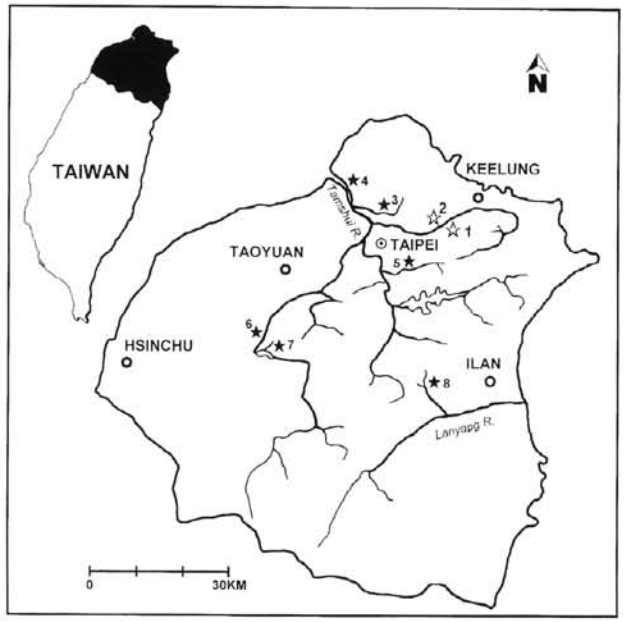

Figure 1. Localities of collecting sites of *Trachemys scripta elegans* from northern Taiwan. Stars represent the collecting sites, open stars (1 and 2) are the major study sites. 1 = Wutu, 2 = Hsichih, 3 = Waishuanhsi, 4 = Chouwei, 5 = Mucha, 6 = Yuansulin, 7 = Dashi, 8 = Shuanlanpi.

Shao and Tzeng (1993) noted that many red-eared sliders had been observed in various water bodies, including rivers, ponds, lakes, and artificial reservoirs in Taiwan. However, whether this exotic turtle has established a breeding colony remains uncertain. Considering its broad ecological tolerances, omnivorous diet, and dispersal ability (Gibbons, 1990), *T. s. elegans* is likely to be capable of reproducing in natural environments of Taiwan. If feral populations of *T. s. elegans* become established, it is possible that they may impact the indigenous fauna on this island.

The purpose of this study is to investigate the status of feral *T. s. elegans* in northern Taiwan. We have also obtained some ecological data on this turtle to assess its potential impact on other native organisms.

Materials and Methods. — Fieldwork was conducted from February 1995 to May 1996 at seven sites in the Tamshui River basin and one in the Lanyang River (Fig. 1). Five sites were located in the urban area near Taipei, whereas three sites were in the montane area. Most studies on the population structure, food habits, and reproductive characteristics were carried out at the urban sites of Wutu and Hsichih on the Keelung River. Turtles were collected either with funnel traps baited with canned cat food, long-handled dipnet, or by hand. Traps were set in shallow water near the bank. Location, time, and date of each capture was recorded.

The maximum straight carapace length (CL) was measured to the nearest 0.1 mm with vernier calipers. Animals were sexed as males based on secondary sexual characteristics by examining the position of the cloacal opening beyond the rear carapacial margins and elongation of the foreclaws;