Glossary

ACP: Area Contingency Plan

albedo: ratio of solar energy reflected from an object to solar energy received by it.

arribada: mass nesting aggregation; Spanish, meaning literally, "arrived."

ATSDR: Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services.

bbl: petroleum barrel, equal to 42 U.S. gal.

beach renourishment: replenishment of beach sand by mechanically dumping or pumping sand onto an eroded beach; also referred to as beach nourishment.

brevetoxicosis: a deadly condition caused by ingestion of dinoflagellate organisms often responsible for red tides; recently linked to deaths of manatees in Florida and common murres in California.

Calipee: cartilage

carapace: dorsal (top) shell of a turtle.

cheloniid: hard-shelled sea turtles composed of the genera *Chelonia*, *Caretta*, *Lepidochelys*, *Eretmochelys*, and *Natator*; contrast to dermochelyid.

CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora.

dermochelyid: leathery-shelled sea turtles (i.e., leatherback).

diverticulum: an abnormal saclike pouch projecting from a defect in the wall of a tube or cavity.

endangered: Any species of animal or plant that is in danger of extinction throughout all or a significant part of its range (from the Endangered Species Act of 1973).

ESI: Environmental Sensitivity Index map.

fibropapilloma: a tumor-forming, debilitating, and often fatal disease of sea turtles, manifested by formation of multiple fibrous masses of tissue 1 mm to 30 cm in diameter growing from the eyes, flippers, neck, tail, scutes, and in the mouth.

FP: see fibropapilloma.

hematocrit: red blood cell volume.

hemorrhagic enteritis: bleeding inflammation of the intestine.

***in-situ* burning: response technique in which spilled oil is burned in place.**

lachrymal gland: tear glands highly modified to excrete excess salt.

Langmuir cell: individual counter-rotating vortices (i.e., one rotates clockwise, the next counter clockwise, the next clockwise, etc.), resulting in the commonly observed "windrows" in which flotsam is arranged in rows paralleling the wind direction. At boundaries between the cells, water is moving either up or down. Where it is moving down, the surface water is converging (being pulled together), and any surface objects will be pulled into the boundary line between the cells; where the water is moving up between the cells, the water diverges, and no material collects.

MDF: Mexican Department of Fisheries.

MMS: U.S. Minerals Management Service (U.S. Department of the Interior).

nares: external nostrils.

neonate: post-hatchling.

NMFS: National Marine Fisheries Service (NOAA).

NOAA: National Oceanic and Atmospheric Administration. (U.S. Department of Commerce).

NRDA: Natural Resource Damage Assessment.

oleophilic: oil-attracting.

osmolarity: the concentration of an osmotic solution, especially when measured in osmols or millios-mols per liter of solution.

phalanges: long "finger" bones of a turtle flipper.

plastron: ventral (bottom) shell of a turtle.

PM10: particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers.

ppm: parts per million.

pyrosoma: pelagic colonial tunicate; most species inhabit tropical waters, with some up to 4 m in length.

RAR: resources at risk.

sargassum: genus of brown algae, also known as gulfweed. There are 15 species in the genus, and each has air bladders. Some species are free floating. Off the U.S. coast, south of Bermuda, is the Sargasso Sea, a large (two-thirds the size of the United States), loosely-defined portion of the Atlantic Ocean where an estimated 7 million tons of live sargassum may be found.

SCL: straight carapace length.

scute: plates of the sea turtle shell.

Section 7 consultation: requirement under the Endangered Species Act for federal agencies to address potential impacts of their actions on threatened species.

surf-washing: a technique for removing oil from deposited beach material in which oil or oiled sediments are moved to a tidal elevation where they may be exposed to higher levels of wave energy (i.e., "washed"). The reworking of surface or subsurface sediments accelerates natural degradation processes.

STSSN: Sea Turtle Stranding and Salvage Network.

TED: turtle excluder device, an adaptation to commercial shrimp nets to permit sea turtles to escape.

threatened: any species likely to become endangered in the foreseeable future (from the Endangered Species Act of 1973).

USFWS: U.S. Fish and Wildlife Service (U.S. Department of Interior).

weathering: the alteration of the physical and chemical properties of spilled oil through a series of natural biological, physical, and chemical processes beginning when a spill occurs and continuing as long as the oil remains in the environment. Contributing processes include spreading, evaporation, dissolution, dispersion, photochemical oxidation, emulsification, microbial degradation, adsorption to suspended particulate material, stranding, or sedimentation.

Appendix A: Protocol for Recovery of Oiled Marine Turtles at Sea

Produced as guidance during the 1993 *Bouchard B155* oil spill in Tampa Bay, Florida, by the Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute

Protocol for Recovery of Oiled Marine Turtles at Sea

1. Bring turtle on board (dipnets are useful for small turtles).
2. Determine health status (live, dead, injured) and degree of fouling by oil.
3. Determine position at sea (latitude/longitude, Loran reading, GPS coordinates, landmarks, etc.).
4. Contact the Florida Marine Patrol to report the recovery of the turtle, and inform them whether you can transport the turtle to the Pinellas Oiled Wildlife Response Center at Fort Desoto. Alert the Response center that a turtle is being brought in and estimate your time of arrival. Turtles should be brought in as soon as possible.
5. If the turtle is alive, keep it out of the sun and keep it moist with towels or wet it frequently. Do not put it in water in which it can submerge.
6. If a camera is available, take a few photographs of the animal to document its condition at the time of recovery.
7. Record the place and time of discovery of the animal and any relevant information about oil conditions at the site to pass on to the Wildlife Response Center. Provide your full name and contact numbers.
8. Deliver the animal to the Pinellas Oiled Wildlife Response Center at Fort Desoto.
9. Turtles found dead or that die in transit should be kept cool (with ice, refrigerator, freezer, shade) until transferred to the Response Center.

Protocol communicated by:

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APPENDIX B: Excerpted Sections from Marine Turtle Guidelines, State of Florida Fish and Wildlife Conservation Commission

Note: Included as an informational reference only. Spill responders are not authorized to perform these activities unless specifically permitted by state and federal agencies.

Full citation:

Florida Fish and Wildlife Conservation Commission. 2002. Sea Turtle Conservation Guidelines, April, 2002 Revision. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 61 pp. + appendices.

SECTION 2 - NESTING BEACH SURVEY ACTIVITIES

Summary

If your permit authorizes you to conduct nesting surveys you are also authorized to conduct the following activities:

- mark nests
- conduct hatching success evaluations
- rescue and release hatchlings

Unless specifically stated on the permit, personnel are NOT authorized to conduct the following activities:

- relocate nests
- screen nests with self-releasing screens/cages
- screen nests with restraining cages
- use a self-releasing hatchery
- use a restraining hatchery
- use probes (other than fingers) to locate clutches
- conduct nighttime surveys
- conduct public hatchling releases

Activity Description

This activity involves the daily survey of a specific beach area (as specified on the permit) to identify, enumerate, and evaluate nesting activities. In nesting surveys, surveyors count and identify "crawls," which are the marks left in the sand by sea turtles that have attempted to nest. The official sea turtle nesting season varies across the state due to geographic differences in the seasonality among the various sea turtle species. For most of the state, nesting season is between May 1, when loggerheads begin nesting, and October 31, after which period most nests of each species have hatched. In Brevard through Broward Counties, where the majority of leatherback nesting occurs, nesting season is between March 1 and October 31.

For best viewing of crawls, nesting surveys should begin shortly after sunrise but never earlier than ½ hour before sunrise. Because of potential disturbances to nesting females and the difficulty of locating and interpreting crawls in the dark, nesting surveys may not be conducted at night.

Surveyors should traverse the beach along (and seaward of, if possible) the most recent high tide line. This is important not only for ensuring that turtle crawls are not obscured before they can be evaluated, but also for avoiding impact to nesting Wilson's plovers and other nesting shorebirds. Surveyors should become familiar with and keep alert for shorebird chicks in the intertidal zone as well, since they use this habitat once they leave their nests. For additional information on how to identify and protect shorebirds, contact FWC's Division of Wildlife at (850) 488-3831. You can also contact the USFWS (USFWS, Migratory Birds and State Programs, 1875 Century Boulevard, Suite 240, Atlanta, GA 30345-3301).

Figure 2-1. Crawl crossed out using foot.

Upon discovery of a crawl, surveyors should make a visual determination as to whether the crawl was a nesting emergence (i.e., a nest) or non-nesting emergence (often called a "false crawl"); they should also determine what species of turtle made the crawl. All crawls should be recorded on a data sheet. If a crawl is clearly identifiable as a nest and the nest does not have to be screened, caged, precisely marked, or relocated, the surveyor should not dig into the nest simply to verify the presence of eggs. After each crawl is evaluated and documented, the tracks should be marked to avoid duplicate reporting. To accomplish this, a surveyor may obliterate a section of the upper track (not the nest site) by sweeping his/her feet across the track (Figure 2-1) or by crossing over the track (well above the high tide mark but not over the clutch) with a survey vehicle (Figure 2-2).

Figure 2-2. Crawl crossed out using ATV.

Nesting surveys may only be conducted within the boundaries specified on the permit. Ideally, boundaries should not change, either within a season or from year to year. Requests for expansion of authorized nesting survey areas must be submitted in advance and in writing to FWC, Bureau of Protected Species Management. It is imperative that

survey areas do not overlap. Please inform FWC immediately of any reduction in survey efforts so that steps can be taken to ensure continuity in nesting beach coverage. It is extremely important that FWC be informed of any changes in monitoring effort in order to maintain accurate and consistent nesting survey records.

Survey boundaries should be permanent and specific. GPS coordinates are highly desirable, in addition to physical landmarks such as state roads, county lines, etc. Street addresses are preferable to condominium names, which may change at any time. FWC has latitude and longitude coordinates, most collected with differentially corrected GPS, for every INBS beach and for all zones within these beaches. If INBS zone markers are lost, contact FWC for the coordinates that would allow correct repositioning of missing zone markers.

SPECIES IDENTIFICATION AND DETERMINATION OF NESTING SUCCESS

The tracks and other evidence left on the beach after a sea turtle has emerged (crawls) can be used to identify what species of turtle came up and whether or not it nested. The following outline describes how to use crawl evidence to make these identifications.

Figure 2-3. Incoming vs. outgoing track (this turtle had a right rear flipper injury).

I. Identify which is the incoming (emerging) track and which is the outgoing (returning) track.

- As a turtle crawls it pushes sand backward with each flipper stroke.
- If one track is shorter, it will be the incoming track (Figure 2-3).
- If tracks overlap, the outgoing track will be on top.

II. What species made the crawl (loggerhead, green turtle or leatherback)? Note: Although hawksbills and Kemp's ridleys occasionally nest on Florida beaches, nesting is rare and their crawl and nest-site characteristics are similar to the loggerhead. Minimal discussion will be provided below for hawksbills and Kemp's ridleys. (Track widths listed below for loggerhead, green turtle, and leatherback were provided by Erik Martin, EAI. All artwork was provided by Dawn Witherington).

Figure 2-4: tracks from a sea turtle with an alternating gait, no tail drag mark, and track width typically ranging from 70 to 124 cm (27.6 to 48.8 inches) with a mean of 94 cm (37.0 inches): loggerhead turtle (*Caretta caretta*). Species with similar tracks: hawksbills (*Eretmochelys imbricata*) typically leave a wavy tail-drag mark near the track center (Figure 2-5) and hawksbill track widths typically range from 70 to 85 cm (27.5 to 33.5 inches). Kemp's ridley (*Lepidochelys kempii*) seldom leave a conspicuous tail-drag mark and a ridley track width ranges from 70 to 80 cm (27.6 to 31.5 inches). Both hawksbills and Kemp's ridleys crawl with an alternating gait, like loggerheads. Kemp's ridleys are

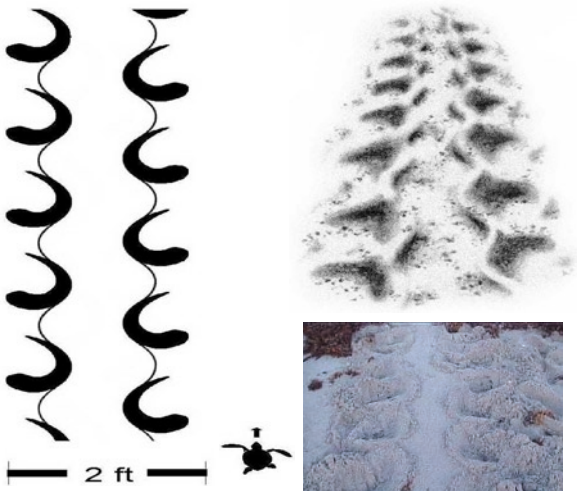
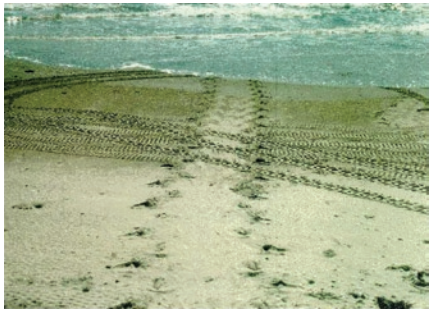


Figure 2-4. Loggerhead track

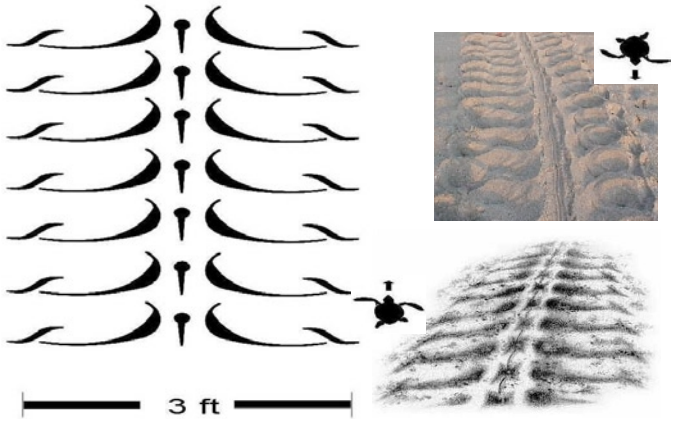


Kemp's ridley tracks.

Hawksbill tracks.

Figure 2-5. Hawksbill and Kemp's ridley tracks.

Figure 2-6. Green turtle track



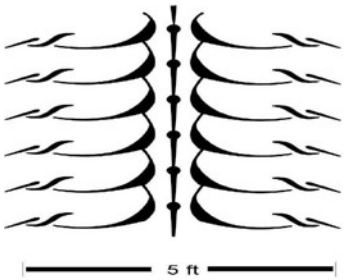
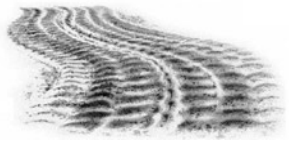


Figure 2-7. Leatherback track



predominantly daytime nesters. If you find a turtle nesting during the daytime, be sure to look at it closely (and take pictures if possible) to determine its species. Kemp's ridleys also pack the sand down by rocking their bodies from side to side during nest covering (unlike the other species that use their rear flippers to "knead" sand to compact it).

Figure 2-6: tracks from a sea turtle with simultaneous limb movement, a center drag mark from the tail (the center drag mark may be a solid or broken line), and track width typically ranging from 95 to 144 cm (37.4 to 56.7 inches) with a mean of 119 cm (46.8 inches): green turtle (*Chelonia mydas*).

Figure 2-7: tracks from a sea turtle with simultaneous limb movement, a center drag mark from the tail, and track width typically ranging from 175 to 214 cm (68.9 to

84.3 inches) with a mean of 196 cm (77.2 inches); track path sometimes circling or sinusoidal (S-shaped): leatherback turtle (*Dermochelys coriacea*).

Note: Flipper injuries to turtles may alter track appearance (Figure 2-8). Characteristics of the nest (given below) should be used in conjunction with track characteristics to identify species.

If the crawl is from a loggerhead, is it a nest or a non-nesting emergence? It is important to record both types of emergences. One should NOT dig into the nest to confirm the presence of eggs unless the nest is to be screened, caged, or marked for later determination of hatching success.

A. Identify emerging and returning tracks by their direction (see I.).

B. Follow the path taken by the turtle and look for the following attributes.

1. Evidence of covering the nest with the front flippers (Figure 2-9). If present, the crawl can be considered a NEST.

a. Presence of a secondary body pit and/or escarpment.

b. Sand "misted" or "thrown" over the emerging track.

2. Evidence of an abandoned nesting attempt. If present, the crawl can be considered a NON-NESTING EMERGENCE (i.e., false crawl).

a. Very little or no sand disturbed other than tracks (Figure 2-10).

b. Back stop with sand pushed back (not thrown) over emerging crawl, typically between two mounds of sand piled by the front flippers during construction of the primary body pit (Figure 2-11).

c. Considerable amount of sand disturbed from a digging effort, but with the crawl exiting the disturbed area and continuing toward the dune before turning toward the ocean (Figure 2-12).

d. Considerable amount of sand disturbed from a digging effort, but with a smooth-walled or abandoned/open egg chamber (15–25 cm diameter) in the center of a pit within the disturbed area (Figure 2-13).

IV. If the crawl is from a green turtle, is it a nest or a non-nesting emergence?

A. Identify emerging and returning tracks by their direction (see I. above).

B. Follow the path taken by the turtle and look for the following attributes.

1. Evidence of front flipper covering. If present, the crawl can be considered a NEST.

Figure 2-8. Loggerhead turtle track with right rear flipper injury.

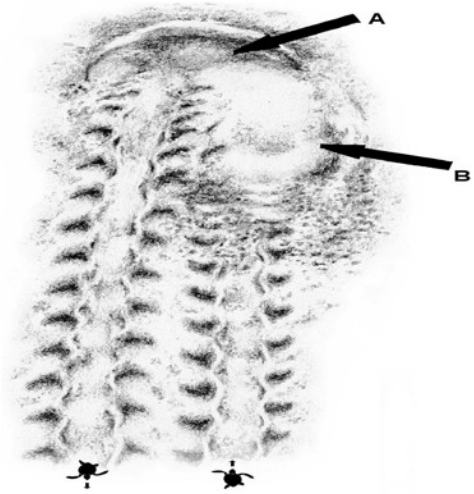


Figure 2-9. A loggerhead nest site showing a secondary body pit (A) and a mound of thrown sand that is wider than the track.

Figure 2-10. A loggerhead false crawl showing no evidence of disturbed sand other than the track.

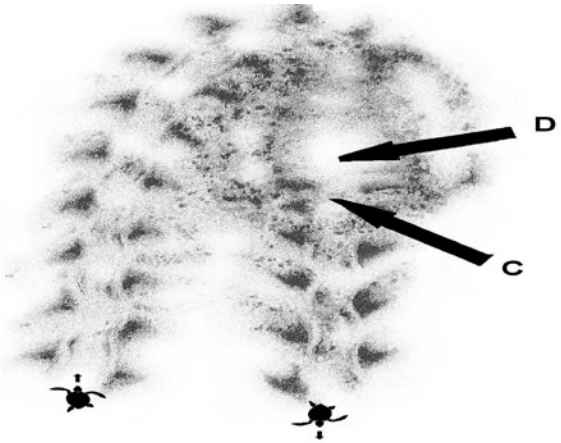


Figure 2-11. A loggerhead false crawl showing a small abandoned primary body pit (C) and a mound of pushed sand (D) no wider than the track and lying between two conspicuous ridges.

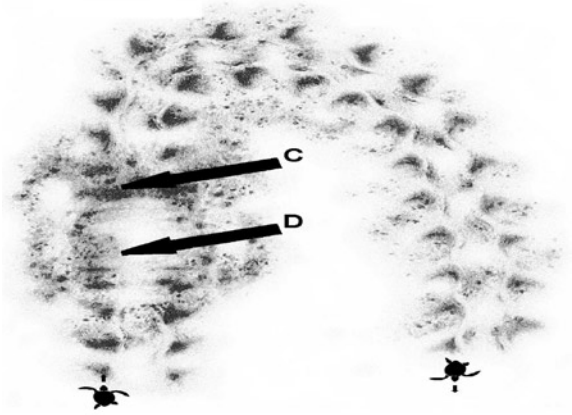


Figure 2-12. A loggerhead false crawl showing an abandoned primary body pit (C) and a mound of pushed sand (D) no wider than the track and lying between two conspicuous ridges. As is rarely found in nests, a track continues up the beach from the site where the turtle's last digging occurred.

a. Sand thrown into a mound covering more than 2 m of the emerging track and a deep (20–50 cm) secondary body pit with an escarpment (Figure 2-14).

2. Evidence of an abandoned nesting attempt. If present, the crawl can be considered a NON-NESTING EMERGENCE.

a. Very little or no sand disturbed other than tracks (Figure 2-15).

Less sand thrown over the emerging track and a smaller body pit than described in 1a above.

V. If the crawl is from a leatherback turtle, is it a nest or a non-nesting emergence?

A. If the disturbed sand in the crawl covers a large expanse of beach (>4 square meters) with sand thrown in multiple directions, the crawl can be considered a NEST.

B. If the crawl is less extensive than in A, the crawl can be considered a NON-NESTING EMERGENCE.

Note: The extent of the excavations described for all species above will be influenced by vegetation, sand compaction, and objects encountered by turtles while digging. There is some variation in the behavior of turtles, and the above guidelines will not lead to a correct determination in every case. They are offered solely to help you with the task of determining whether a nest has been made.

NEST MARKING

Not every sea turtle nest needs to be marked. Marking is necessary for protection from hazardous activities being conducted on the beach or to obtain information on reproductive (hatching) success. Nest-marking methods for each of these two objectives are slightly different. Please keep in mind when driving stakes that at least some undiscovered and/or unmarked clutches are probably present on every beach. Drive stakes with caution.

I. Marking nest sites to protect buried eggs from hazardous activities

The goal of this marking method is to clearly identify the nest area and protect it from human activities such as beach cleaning, vehicular traffic, or construction. Any such construction activity that occurs on the nesting beach during nesting season, including beach cleaning, must have a valid permit from the DEP (see Section 1 for additional information on construction permitting). Activities such as the placement of beach furniture may, at the discretion of DEP, be exempted from permitting.

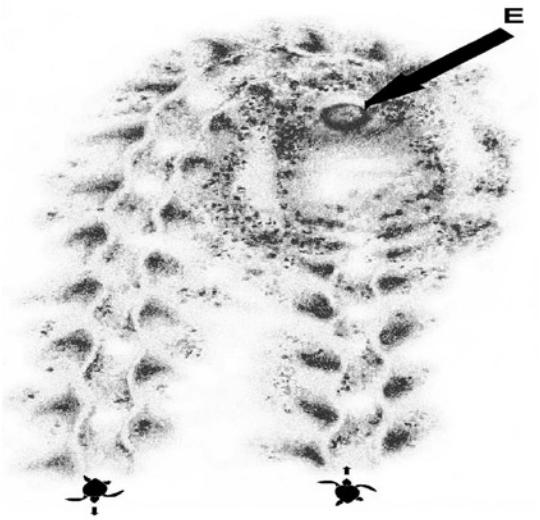


Figure 2-13. A loggerhead false crawl showing a primary body pit with an abandoned egg cavity (E).

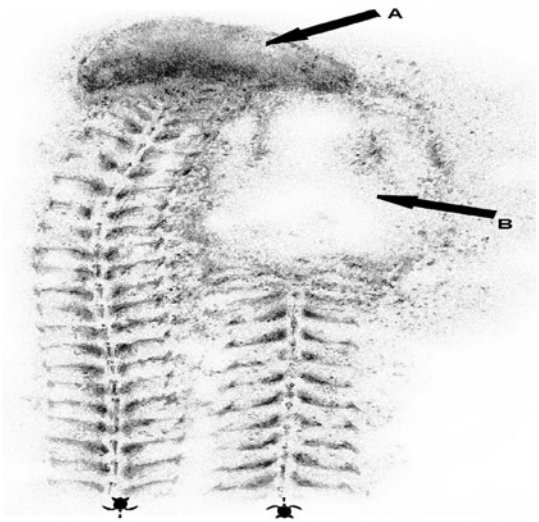


Figure 2-14. A green turtle nest site on an open beach showing a secondary body pit (A) and a mound of thrown sand (B) that is greater than twice as long as the visible secondary body pit. Note that smaller nest mounds are expected when obstacles or vegetation impede digging.

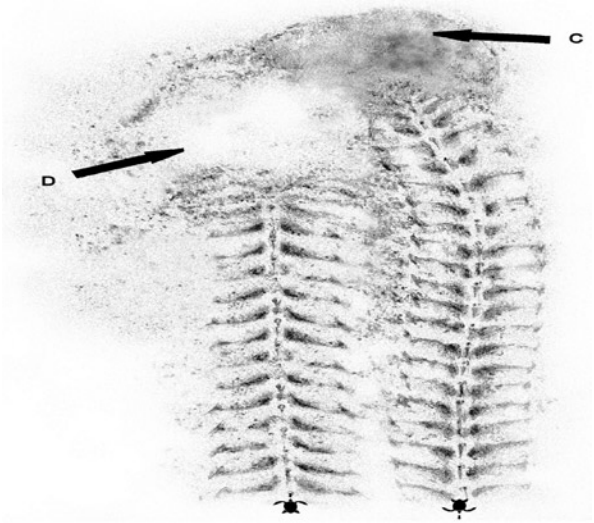


Figure 2-15. A green turtle false crawl on an open beach showing an abandoned primary body pit (C) and a mound of thrown sand (D) that is smaller than twice as long as the visible primary body pit. Note that many green turtle nests may have body pits and nest mounds that look similar to this.

If at all possible, visually inspect the site to determine whether a nest exists. We do not recommend that nests be dug into simply to verify the presence of eggs. If you are not sure whether eggs were deposited, be conservative and mark the area as a nest. The entire disturbed area (where digging has occurred) should be delineated with stakes (Figure 2-16). Construction permits generally require that the nest site be marked with a radius of at least three feet, centered at the approximated location of the clutch. The stakes should extend about 36" above the sand. To further identify the nest site, surveyor's ribbon can be tied from the top of one stake to another to create a perimeter around the nest site. Additionally, a nest sign can be attached to one of the stakes used to create the perimeter (signs are available from FWC—see Appendix C). A nest-identifying number and the date the eggs were laid should be placed on at least one of the nest perimeter stakes. At least one additional stake should be placed a measured distance from the clutch location at the base of the dune or seawall to ensure that a future location of the nest is possible should the nest perimeter stakes be lost.

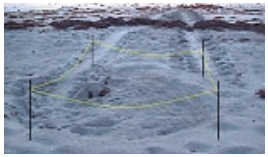


Figure 2-16. Entire disturbed area of nest site marked.

II. Marking nest sites to determine hatching success

The goal of this marking method is to allow an investigator to locate the clutch in order to evaluate the hatching success of a nest. Nests should be marked by locating the precise location of the clutch at a fresh nest site by carefully digging shallow, finger probing holes into the nest, by finger-probing for softer sand over the clutch, and by verifying the location of the eggs. Digging into a nest may alter the incubation environment if not done carefully and with lengthy training. It is preferable to avoid digging into a nest site unless the nest will be screened, caged, relocated, or marked for hatching success.

Figure 2-17. Approximate location of egg chamber in a typical loggerhead nest.

To locate the clutch in a fresh nest, note the characteristics of the nest site to predict the location of the clutch. To approximate the location of a loggerhead clutch, follow the tracks emerging from the water and leading towards the nest site. Commonly, the clutch is located about two feet into the broad disturbed area (the nest mound) from this approach; it is generally centered between the edges of this area. To estimate the location of a green turtle clutch, measure about three feet back from the escarpment created by the final covering activities. On leatherback nests, measure about 4.5 feet from the escarpment created by the final covering activities.

To precisely locate the clutch within the approximated area, dig gently and systematically by hand into the nest site. Focus the digging effort at the center of the mound of sand that was piled by the nesting turtle. Probe with fingers only, feeling for the softer (less compact) sand that will be on top of the clutch. Do not use shovels or any other tools. Once the soft sand is found, and the eggs beneath are verified, fill the hole with moist sand and gently pat the sand surface above the eggs with your hand. Replace the dry sand over this area to the depth present before you began, and place a temporary

marker over the clutch site. Rebury any other holes dug in the nest site so that the nest site is restored to its original condition.

To mark the nest site, measure the exact distance from the precise or approximate clutch location to two separate marking stakes on the dune that are aligned so that a straight line between them orients directly toward the location of the clutch (Figure 2-18). If the clutch location is approximate, note the distance between the approximate clutch location and the edges of the disturbed area in each of four opposite directions. Both stakes should be labeled with an identifying nest number and the date the eggs were laid. On beaches where removal of marking stakes by the public is a potential problem, an additional stake, driven deeply and hidden from view, should be placed a measured distance landward of the first two. As added insurance, an aluminum marker can be buried hand-deep and 24" from the approximate clutch location in a standardized direction. This metal marker can be found later with a metal detector.

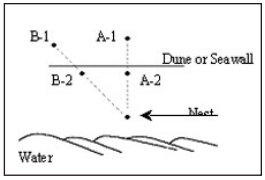


Figure 2-18. Site A stakes are directly landward of the nest in dune vegetation or at the base of a seawall. Site B stakes are in a similar position as Site A but located at an angle from the nest. Stakes A-1 and B-1 should be sunk deeply so that they are not conspicuous to someone not looking for them. Precisely measure the distance from stakes to the clutch location. Then, sink additional stakes (A-2 and B-2) directly between the clutch and the dune stake(s).

Use the marking stakes to find the egg chamber. Many times, a clutch may not produce hatchlings and the location of the clutch will not be indicated by the conspicuous signs of hatchling emergence. Moreover, some hatchling emergence evidence near the nest site may be from a nest other than the one that was marked for hatching success. To accurately determine overall hatching success, it is very important that the clutches from all marked nests be found and evaluated. A nest from which hatchlings did not emerge will be more difficult to locate again, but an inability to find these nests, and their exclusion from the sample representing one's beach, will result in overestimating hatching success for the beach. Please make the greatest effort possible to locate all nest cavities after waiting the appropriate length of time.

HATCHING SUCCESS EVALUATIONS (NEST INVENTORIES)

Hatching success must be determined for all caged, screened, and relocated nests. Hatching success may also be conducted on all other nests or on a sample of nests on the beach. A hatching success evaluation involves the excavation and inventory of a post-emergent nest to determine the fate of each egg. Because sea turtle eggs are subjected to a variety of incubation environments, including many that are affected by human activities, we encourage you to conduct nest inventories for hatching success on a representative sample of the nests in your survey area each year.

Selecting Nests To Be Marked for Inventory

A proper, representative sample of nests will allow assessments of hatching success that can be compared to other beaches and to other nesting seasons. To properly represent the beach, nests in a marked sample must be chosen by a system that removes seasonal, spatial, and observer bias. A sample of nests that is not properly representative can over- or under-represent certain zones on the beach or certain portions of the

season. For example, a sampling strategy whereby a set number of nests are marked each day will always under-represent the middle of the nesting season. A sample of nests that is poorly representative, no matter how numerous, will yield potentially misleading information about hatching success.

Like selecting a representative sample of nests, it is also important to use (monitor and inventory) nearly every nest in the sample. Because the most difficult-to-find nests often have the poorest hatching success, the more these nests are excluded from a sample, the more the sample paints a rosier picture of hatching success than actually exists. Before giving up on finding a sample nest, one should feel confident that they know the fate of the nest and that failure to find it is due to its destruction (e.g., from erosion) and not due to imperfections in nest-marking techniques (e.g., stakes washing away from a surviving nest).

The best way to select a representative sample of nests is to decide in advance which nests of the season will be in the sample. If all nests on the beach can be marked and inventoried, then this selection is simple; mark and inventory all nests (but be sure not to overestimate how many nests can be sampled; marking nests is easy, inventorying them is difficult). However, if only part of the nests on a beach can be sampled, then every nth nest should be marked as a sample nest. With this technique, "n" is a number that sets a pace for nest marking that results in a sample size that is adequate, but not too large to handle. Here are some examples of how to use this technique:

On beach A, surveyors feel they can mark, monitor, and inventory about 100 nests. In an average season, this beach gets about 2000 nests. Here, marking every 20th nest will reach the goal if the season is average. Note that the 20th nest is independent of the date of the season. For example, if on the first day of the season there are 19 nests, the first marked sample nest will be the first nest encountered (nest number 20) on the second day of the season. The second sample nest will be the 40th nest, the third will be the 60th … etc.

Using a subtle modification to the above technique, some surveyors may wish to mark sample nests only one day per week. This is fine. To adjust the sampling protocol, divide your "n" by 7 to determine what nests to mark on the one day per week when nest-marking is done. For example, if your calculations are that every 35th nest at your beach needs to be marked in order to keep a pace that would result in 100 nests marked, then every 5th nest marked one day-per-week would keep the same pace and give an adequate sampling of nests. This math gets only slightly more difficult if the "n" for the beach is not divisible by 7. For instance, if 2500 nests are expected, and 100 sample nests are needed, (which gives a daily pace of marking every 25th nest) then the pace for marking nests one day-per-week would be 25 divided by 7, or every 3.6th nest. Of course, there are no fractional nests. In this case one can approximate a pace to achieve 100 nests by choosing two alternating n's that bracket the number calculated. In this case, 3 and 4 bracket 3.6, and a proper pace would be to mark the 3rd, then 7th, then 10th, then

14th nests … etc. FWC staff can help with any questions on proper sampling of nests for hatching success.

Marked nests should be monitored on a regular basis, preferably each morning during the incubation period. Predation to the nest and other significant events should be noted. It is important to give marked sample nests the same treatment as other nests. Do not relocate, screen, or cage a nest just because it is a sample nest. During sample-nest monitoring, treat sample nests like other nests, that is, "clean up" depredated sample nests only if this practice is carried out for all other nests.

Nest Inventory

To conduct a nest inventory, begin by excavating the nest. Carefully dig down into the nest chamber with your hands until you reach eggs or eggshells. D o not use shovels or other tools. If you encounter live hatchlings before reaching any eggs or eggshells, the hatchlings have probably not finished emerging. Quickly cover the egg chamber with moist sand and return the site to its original condition. Wait at least 24 hours before excavating again.

Carefully remove the contents of the nest and place them in a pile on the sand or in a tray for easier sorting (Figure 2-19). Separate the contents into the following categories: hatched eggs (empty eggshells), live hatchlings, dead hatchlings, pipped eggs with live hatchlings, pipped eggs with dead hatchlings, and unhatched eggs (Figure 2-20). In pipped eggs, the turtle has broken through the egg but the hatchling is not completely free of its eggshell. Pipped eggs range from those with just a small hole to those with large tears.

Determine and record the number of eggs that hatched by carefully counting the eggshells (Table 2-1). Count each eggshell that is more than 50% complete as one hatched egg and disregard the smaller pieces. Be sure that all the eggshells are completely separated from each other. Record the number of live and dead hatchlings. These will account for some of the hatched eggs. The rest of the hatched eggs represent hatchlings that emerged from the nest. To determine the number of hatchlings that emerged from the nest, subtract the sum of live and dead hatchlings from the total number of hatched eggs. The sum of the live, dead, and emerged hatchlings should equal the number of hatched eggs.

Figure 2-19. Removal of nest contents.

Hatched eggs

Unhatched eggs

Pipped egg with dead hatchling

Partially developed embryo

Egg with no discernible embryo

Figure 2-20. Categories of the contents of a nest.

Table 2-1. Contents of a Post-Emergent Nest

Hatched eggs	=	98
Live in nest	=	3
Dead in nest	=	1
Live pipped	=	0
Dead pipped	=	1
Unhatched eggs	=	5
No discernable embryo	=	3
Partially developed embryo	=	1
Fully developed embryo	=	1
TOTAL # EGGS	=	104

Next, determine and separately record the number of pipped eggs with live hatchlings, the number of pipped eggs with dead hatchlings, and the number of unhatched eggs. Finally, determine the number of eggs originally present in the nest by adding together the hatched eggs, the pipped eggs, and the unhatched eggs. After completing the nest inventory, the nest contents can be reburied within the original egg chamber.

A nest inventory may only be conducted either 72 hours after the first sign of emergence or 70 days after the eggs were deposited (80 days for leatherbacks), whichever occurs first. Digging into a nest before some hatchlings have emerged may adversely affect these hatchlings. Because cooler temperatures sometimes delay hatching and emergence, a nest that has been subjected to inundation, excessive rainfall, shading, or cool fronts, should not be excavated until 80 days after egg deposition or 96 hours after the first emergence. It is important to allow all hatchlings to emerge naturally before excavating the nest.

Note: If the first emergence of a nest has occurred (more than 3 hatchling tracks) and the hatchling tracks indicate a clear sign of disorientation you should contact the property owner responsible for the offending light(s), explain the situation, and ask them to turn the light(s) off. If the property owner cannot be reached or is not receptive to turning off the light(s) you may place a temporary restraining cage over the nest to contain the next emergence of hatchlings…

For the subsampling technique to succeed, a sampling plan based on the total number of nests expected has to be devised before the nesting season so that the sample of nests marked for evaluation will represent hatching success over the entire nesting season and nesting beach. The easiest way to do this is to mark for evaluation all nests made every other day, or every three days, or every five days, etc. (for a statistically valid sample, you should try to mark and evaluate at least 100 nests). Once a sampling plan is initiated, it should be followed throughout the nesting season. FWC sea turtle program staff are available to assist you in developing the best approach for your particular survey area.

When a nest marked for evaluation is completely depredated (all the eggs are destroyed), record this (no further evaluation is necessary). This nest is a very important part of your sample to accurately determine overall hatching success. Do not select another nest as a replacement. When a nest marked for evaluation is partially depredated, remove and count the depredated eggs. Cover the egg chamber with moist sand, and return the site to its original condition. Record the nest as partially depredated and record the number of eggs that were depredated. Then, at the appropriate time, inventory the remainder of the nest.

During nest inventories, some live hatchlings or pipped eggs with live hatchlings may be encountered. If this happens often, try waiting a day or two longer before conducting the inventory. Pipped eggs with live hatchlings or live hatchlings that have prominent yolk sacs may be carefully re-buried at the top of the egg chamber or held on moist sand (not in water) until ready for release. If pipped eggs or hatchlings are held on moist sand, they are to be kept in a darkened, quiet, temperature-controlled area. When ready, these hatchlings are to be released on the beach at night and allowed to crawl to the water. See the following section for more information on the rescue and release of live hatchlings.

HATCHLING RESCUE AND RELEASE

This activity includes salvaging live hatchlings (primarily disoriented hatchlings or those found at the bottom of excavated nests) and ensuring that they reach the water safely. Hatchling rescue and release does not authorize permit holders to conduct public hatchling releases. See Section 7-4 for information on conducting public hatchling releases.

Due to the short duration of the hatchling frenzy period, hatchlings should be released as soon as possible following rescue. All hatchlings found during darkness are to be released immediately. Small numbers of hatchlings (<5) that are found disoriented or at the bottom of nests during daylight excavation may also be released on the beach immediately (but no later than 9 am). Otherwise, rescued hatchlings must be released the following night. Hatchlings collected from excavated nests should never be held in

water. Small Styrofoam or plastic coolers lined with damp sand work well as temporary holding containers. The lid of the cooler should be placed loosely over the top to provide a near-dark environment. Once placed in a holding container, hatchlings should not be handled or disturbed until they are ready for release. Activity causes increased expenditure of limited energy stores.

Hatchlings should be placed on the beach and allowed to crawl to the water on their own. Artificial lights should not be utilized during hatchling releases. This applies to any members of the public observing such releases, as well as all permitted personnel involved in the release. A quick check of the release area with a small flashlight a short time after release will insure that all hatchlings have reached the water. Occasionally, individual hatchlings may need assistance in reaching the water. In such cases, they may be moved closer to the water's edge or placed in the shallows and allowed to swim off on their own.

In some cases, weak hatchlings may need to be held for slightly longer periods (1-2 days) to allow them to recover. However, holding hatchlings overnight should not be a routine event. If hatchlings require further holding, contact FWC to arrange for their transfer to an authorized rehabilitation facility.

HATCHLING AND ADULT DISORIENTATION

Although sea turtles do nest on beaches with artificial lights, there is much evidence suggesting that they prefer darker beaches. When sea turtles choose to nest on lighted beaches, their hatchlings are at great risk. In Florida, artificial lighting is probably the single greatest human threat to emergent hatchlings trying to reach the ocean.

Both hatchlings and nesting adults exposed to artificial lighting can be led in the wrong direction (become misoriented) or meander and circle (become disoriented). It is extremely important that sea turtle permit holders who conduct nesting surveys look for and document signs of disorientation. These events should be reported on the standard reporting forms. Because we may be able to immediately resolve a lighting problem and thus avoid subsequent problems, it is very important that you inform the FWC Tequesta office of all disorientation events as soon as possible. You can fax the forms to Tequesta at: (561) 743-6228.

Some indirect tracks from adult turtles may not be due to artificial lighting. Adult females in search of a nesting site may wander on the beach for a period of time looking for a suitable nesting site. Leatherback turtles are known to make orientation circles on their way back to the ocean after nesting. A diagram of the crawl should be included with adult disorientation reports to help assess the actions of the turtle.

Wind and rain may obscure tracks, making it difficult to document hatchling disorientation. Still, every effort should be made to count the number of hatchlings

disoriented. Counting the tracks farther from the nest, in the area where the tracks spread out, is generally a little easier than trying to count the tracks right next to the egg cavity.

Identifying the light source is also important. If the disorientation was documented during a morning survey, and if time and personnel permit, a subsequent nighttime lighting survey would be useful in identifying the light source. The address of the property, and the number, type, and location of lights are important to the local code enforcement persons and/or FWC. Several counties and municipalities have lighting ordinances. A list of local ordinances and contact numbers can be found in Appendix C. In cases where a local ordinance is in place, the local code enforcement person is generally responsible for ensuring compliance with the ordinance. In areas where there is no local ordinance, FWC tries to work with the property owner to correct the problem light(s). Please notify the local code enforcement office and/or FWC as soon as possible after a disorientation event.

NEST RELOCATION

Summary

This section is specifically intended for those persons whose permit authorizes them to relocate nests. These personnel are also authorized to:

- mark nests

Personnel are not authorized to conduct the following activities unless specifically stated on their permit:

- conduct nesting surveys
- protect nests with self-releasing screens/cages
- protect nests with restraining cages
- use a self-releasing hatchery
- use a restraining hatchery
- relocate a clutch at anytime after 9:00 a.m. the morning following deposition
- use probes (other than fingers) to locate clutches.

ACTIVITY DESCRIPTION

Moving sea turtle eggs creates many opportunities for adverse impacts. Movement alone is known to kill developing embryos by disrupting delicate membranes that attach to the inside of the egg. Because the incubation environment greatly influences the developing embryo, nest relocation can involve the transfer of eggs from an

appropriate environment to an inappropriate one. For this reason, nest relocation is considered a management technique of last resort.

Natural events, like storms, that accelerate beach erosion and accretion can sometimes reduce hatching success in existing nests. While damage from storm events can be severe, it is difficult to predict the precise areas where the storm is most likely to inflict damage. Because of the negative effects of relocating eggs and the unpredictability of storm events, FWC does not generally authorize permit holders to move nests out of areas threatened by storms. As a general rule, nests should only be relocated if they are low enough on the beach to be washed daily by tides or if they are situated in well documented high-risk areas that routinely experience serious erosion and egg loss (e.g., nests laid near river mouths or beneath eroding sea walls).

FWC does not generally authorize nest relocation for heavy foot traffic, lighting problems or beach cleaning. Foot traffic is not known to cause problems for nests, but if traffic is heavy, a nest can be marked so that it will be avoided by pedestrians. If a nest is made near a light that may misorient the hatchlings, efforts should focus on getting the light turned off or shielded (if protection is necessary, the nest should be caged). If nests are deposited on beaches that are periodically raked with mechanical equipment, beach raking should be discontinued or the nests should be marked clearly so that they can be avoided by the beach cleaners.

When a nest does require relocation, the eggs must be moved no later than 9:00 a.m. the morning following its deposition. About 12 hours after deposition, the potential for movement-induced mortality in sea turtle eggs increases rapidly. Eggs should be moved no later than 12 hours after deposition (turtles may nest as early as 9:00 p.m. the preceding night). To relocate a nest, find the location of the egg chamber by gently and systematically digging by hand, and probing with fingers only. Never use shovels or any other tools for either digging or probing. Once the eggs are located, carefully remove the sand from around the top eggs. Individual eggs should be gently lifted from the egg chamber and placed into a rigid container with a 2″–3″ layer of moist sand on the bottom. When moving eggs, be sure to maintain each egg's original orientation; do not rotate eggs in any direction and avoid abrupt movements. As eggs are placed in the container, be sure that they do not roll. Eggs are to be shaded if relocated after sunrise. The easiest way to do this is to lay an open umbrella on its side (because there may be eggs incubating nearby, do not stick the umbrella into the ground) or place a towel over the top of the container holding the eggs. When all eggs are in the container, cover them with a layer of moist sand.

Find a suitable nearby location on the beach that is successfully used by nesting turtles. Be sure that the new nest site is above the high tide level but not in dense vegetation. With your hands, dig a new nest chamber to the same depth, size, and shape of the original nest. The shape of the nest chamber should be such that there is a spherical bottom and a slightly narrower neck. The depth of a loggerhead nest chamber should be

18–22 inches and the diameter of the spherical bottom should be volleyball to basketball size. The neck should only be 2–4 inches more narrow than the bottom. Clutches that are greater than or less than average may require respective nest-chamber dimensions that are larger or smaller. Place the eggs in the new egg chamber by transferring them one at a time while continuing to maintain each egg's original orientation. After all the eggs have been transferred into the new egg chamber, cover them with the moist sand excavated from the egg chamber. Dry sand should not be allowed to fall into the egg chamber. Once the eggs are reburied to the upper level of the surrounding moist sand, gently pat the sand surface above the eggs with your hand. Replace the dry sand over this area to the depth present before you began. The relocated nest can then be marked and later evaluated for hatching success.

SPECIAL PERMIT CONDITIONS FOR USING HATCHERIES

Because the use of hatcheries requires that eggs be relocated, it is not considered a preferred management technique (see FWC's Sea Turtle Conservation Guidelines, Section 2, Nest Relocation). However, the use of hatcheries is authorized by FWC in a limited number of areas where artificial lighting problems are extreme. These areas typically have little or no sections of beach where nests can be left *in-situ* without emerging hatchlings becoming disoriented by artificial lights. Persons authorized to relocate nests to a hatchery must follow the guidelines for Nest Relocation in Section 2 of the Sea Turtle Conservation Guidelines. Nest success evaluations are required for ALL nests relocated to self-releasing or restraining hatcheries.

Self-releasing hatcheries are typically located on dark areas of beach. Nests placed in a self-releasing hatchery should be spaced uniformly at least one meter apart and marked using a stake(s). The purpose of marking nests in a self-releasing hatchery is to ensure that previously relocated nests are not inadvertently dug up or placed too close to each other. Stakes are also needed later to evaluate nest success. Nests in self-releasing hatcheries must be checked daily by permitted personnel [to monitor threats to the nests].

Restraining hatcheries are utilized in areas where there are no sections of the beach dark enough to allow hatchlings to emerge and find the water on their own. Restraining hatcheries must be checked for emerging hatchlings at least three times a night (once between 9 p.m. and 11:00 p.m., once between 12:00 a.m. and 2:00 a.m. and once between 3 a.m. and 5:00 a.m.) beginning 45 days after the first clutch is deposited in the hatchery and ending when all nests in the hatchery have emerged. Release locations should be varied to avoid creating a feeding station for in-water predators. During the day, the hatchery must be checked at least once every half hour unless the seaward side of the hatchery can be opened in such a way that hatchlings emerging during the daytime can escape the hatchery and crawl to the ocean on their own.

Hatcheries must be situated in areas that mimic good-quality sea turtle nesting habitat. If located on the seaward side of a primary dune the hatchery should be at least one-meter vertical distance above the level of the highest spring tides to prevent excessive inundation of the eggs. Hatcheries should be located in areas exposed to the sun most of the day and where vandalism is not a concern. Hatcheries should not be situated near drainage or outfall pipes. Hatcheries must be in good physical repair and maintained in such a way that vegetation does not encroach into the hatchery. To prevent infestation from fungus and bacteria, the sand in the hatchery must be replaced every year prior to the beginning of the nesting season to a minimum depth of three feet.

Hatcheries may not be used to store any type of equipment other than nest marking materials (i.e., stakes, bottomless buckets, etc.). Under no circumstances may hatcheries be used to store vehicles (e.g., ATV's), gasoline, or other equipment that may be potentially harmful to incubating nests or that pose an entanglement risk to emerging hatchlings.

Appendix C: Sea Turtle Stranding and Salvage Network (STSSN) Coordinators

Barbara Schroeder, National Sea Turtle Coordinator, NOAA/National Marine Fisheries Service 6/6/03

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