TABLE OF CONTENTS

FIGURES

SEA TURTLES OF THE VIRGIN ISLANDS

The Virgin Islands provide critical nesting, foraging, and developmental habitat for three species of sea turtle, the leatherback (*Dermochelys coriacea*) and hawksbill turtle (*Eretmochelys imbricata*) both endangered species, and the green turtle (*Chelonia mydas*), a threatened species. Loggerhead turtles (*Caretta caretta*) are transitory and only occasionally seen in the fishery.

The Virgin Islands comprise a vast complex of islands and small cays surrounded by coral reefs and sea grass beds adjacent to deep-water drop off. These islands provide a range of nesting and foraging habitats that support all three species of sea turtle. The leatherback turtle, found in the Virgin Islands only during nesting season, requires open sand beaches with no near shore reef; such beaches are found on St. Croix's Sandy Point National Wildlife Refuge and Buck Island Reef NM's West Beach. The green turtle and hawksbill turtle will nest in vegetated dunes, low scrub and beach forested areas often fringed by shoreline reefs. The hawksbill often nests in low vegetation or the beach forest (Hillis, et al, 1989). Adult green and hawksbill turtles forage throughout the Virgin Islands. Juvenile sea turtles take up residency in coral reef/sea grass habitats during their adolescent years and remain there for up to 20 years before they reach sexual maturity (Frazer, 1994; Limpus, 1990), and then, if female, make their first reproductive migration to a nesting beach.

The amount of time that data has been collected on sea turtles is extremely short when compared with the long life of an individual sea turtle. Sea turtles require between 20 - 30 years to reach sexual maturity and may be reproductive for 30 more (Frazer, et al, 1994). They are highly migratory and through their life will exhibit fidelity to particular nesting beaches (Hillis, 1991; Melucci, et al, 1992). Genetic studies of female nesting populations indicate that female sea turtles may be returning to their natal beaches to nest (Bass, et al, 1995). It is quite obvious now, that once a nesting population is extirpated (removal of all eggs and adults) from a particular beach, it is unlikely the nesting population will recover, at least not in the near future.

SPECIES DESCRIPTIONS

The Leatherback Sea Turtle (*Dermochelys coriacea)*

Sandy Point National Wildlife Refuge, St. Croix, is the principal nesting beach for leatherback turtles in the Northern Caribbean. Tagging studies have shown movement by females between regional nesting beaches in Puerto Rico, Anguilla, and St. Croix (McDonald, et al, 1995; Eckert, et al, 1989; Boulon, et al, in press). This long-term saturation-tagging program provides essential information on leatherback turtle population trends available nowhere else in U.S. properties. Since 1981, 342 leatherback turtles have been tagged with a range of 18 - 55 females nesting per year (Boulon, et al, 1996; MacDonald, 1995). Historically, it is possible that 100 percent of the nests laid at Sandy Point were either poached or lost to beach erosion (seasonally

50 to 60 percent). With the advent of the research program (1981) the beach is protected and nests threatened by erosion are relocated; nest loss is now less than five percent annually. It is possible to speculate that the increase in numbers of females nesting per season, given an average age to maturity for leatherbacks of 10 to 15 years, is a direct result of beach protection and nest relocation (Boulon, et al, 1996).

LB GENERAL CHARACTERISTICS (Figure 1):

Adult female leatherback turtles, primarily a pelagic species, migrate every 2 to 3 years to the tropics to nest (Boulon, et al, 1996).

- Shell is smooth, scaleless, uniformly black with white spots, raised into seven narrow ridges that extend the length of the carapace.
- APink spot≅ on dorsal surface of the skull. Its shape is considered similar to human fingerprint and maybe used to identify individuals.
- Adult females are 140 to 160 cm long, and weigh 365 to 725 kg (800 to 1600 pounds).
- Nesting season March to June.
- Females nest on open sand beaches, free of shoreline reefs, with deep-water access.
- Crawl pattern is parallel flipper tracks approximately 2 meters across.
- Nest site is a large area of disturbance with several craters over 2 meters wide.
- Internesting Interval is 10 to 11 days.
- Each female can lay between 8 to 11 clutches per season.
- Clutch size ranges from 50 to 80 yolked eggs, the size of cue balls, plus 10 to 30 yolkless eggs varying from pea size up to cue ball.
- Nests incubation is between 55 to 75 days depending on time of season.
- Hatchling is black with small white dots. Plastron is lighter in color than adults aiding in counter shading and pelagic predator avoidance.
- Hatchling is largest of all sea turtles measuring 5 - 6 cm (2 2 inches long)

The Green Turtle *(Chelonia mydas)*

Observations of green turtle nesting populations have been collected incidentally by both leatherback and hawksbill turtle research programs in the Virgin Islands since 1980s. In 1993 and 1994 daytime beach surveys were conducted for green and hawksbill turtles on St. Croix (Mackay, et al, 1994; Mackay, et al, 1995). The Virgin Islands have never been a significant green turtle nesting area, but rather a juvenile foraging ground. The number of green turtle nesting activities remains low for all the islands, but there appears to be a gradual increase in numbers of juveniles observed in the foraging grounds since mid-1970s (Boulon, pers comm.). The only island that still supports any amount of green turtle nesting is St. Croix with an average of 100 nests per year between 1980 - 1990 (Eckert, 1992). The largest concentration of green turtle nesting activities occurs on St. Croix's east end beaches averaging 15 nests per year (Mackay, et al, 1995). Buck Island Reef supports 1 to 3 nesting green turtles per season resulting in 8 to 10 nests per year.

GR GENERAL CHARACTERISTICS (Figure 2):

< A bony-shelled sea turtle, dark gray/green domed shell and smooth white underbelly or plastron.
< Adults grow to over 1.5 meters long (4 feet) and weigh up to 180 kg (400 lbs.)
< Nesting season is between May and August.
< Nest along open sand beaches placing their nests up to the dune grass or beach vines.
< Crawl pattern is parallel tracks up to 2 meters wide
< Nest site includes several very deep craters, up to 1.5 m across and 1 m deep.
< Internesting interval is 11 to 14 days.
< Each female can lay between 5 to 7 clutches per season.
< Clutch size ranges from 100 to 120 yolked eggs, the size of golf balls.
< Nests incubation is between 55 to 75 days depending on time of season.
< Hatchlings are counter shaded; dark on top and bright white below.
< Hatchling is second largest of Virgin Island's sea turtles - 2 inches long (4 - 5 cm)

THE HAWKSBILL SEA TURTLE *(Eretmochelys imbricata)*

There are very few places in the Caribbean where any large numbers of hawksbill turtles remain today (NMFS/USFWS, 1993). In the Virgin Islands hawksbill nesting occurs on St. Croix (Buck Island Reef NM and east end beaches), a few isolated beaches on St. John, St. Thomas (primarily on the offshore cays). In 1993 only 32 hawksbill nesting activities were observed on all of St. John's beaches, where over 50 percent of the island remains undeveloped national park (Mendelson, 1993). In 1994, 100 hawksbill nesting activities were recorded on St. Thomas' offshore cays. Sixty-one percent of these hawksbill activities occurred on Greater Hans Lollick, which is threatened by a major hotel development (Boulon, 1994). Throughout their range, hawksbill turtles nest in low density; nesting aggregations consist of a few dozen to at most a few hundred individuals (NMFS/USFWS, 1993).

The most important concentrations of hawksbill turtle nesting activities remaining in the Virgin Islands occurs at Buck Island Reef National Monument and St. Croix's east end beaches (Jack's/Isaac's/East End Bays). Buck Island and St. Croix's east end beaches are supporting two remnant populations of between 20 - 30 nesting hawksbill turtles per season (Hillis, 1994; Mackay, et al, 1994). Since 1988, 138 individual hawksbill turtles have been tagged nesting on Buck Island Reef National Monument. Hawksbill turtles return to nest every 2 to 4 years indicating high degree of nesting beach fidelity (Hillis, 1991). Of these remigrants, between 50 to 80 percent have returned to nest in subsequent years representative of the high survivorship of adult sea turtles (Hillis, 1994; Frazer, et al, 1995, in press). Prior to 1996 annual recruitment of first time nesters at BUIS was less than 15%; in 1996 and 1997, the number of recruits increased to almost 50% of the nesting population (Hillis and Phillips, 1997). In 1994 a

saturation tagging program was initiated on St. Croix's east end beaches; 14 hawksbill turtle were tagged that season (Mackay, et al, 1994). In 1996 & 1997, the first intra seasonal movements of two hawksbill females were recorded. A Buck Island nesting female nested in Jack's Bay and an East End tagged hawksbill female nested on BUIS twice.

The smallest of the three species of sea turtle nesting in the Virgin Islands, hawksbill turtles are the most seriously endangered throughout their range. They are omnivorous, living and feeding in coral reefs and mangroves. They are best known for their beautiful shell, Atortoise-shell≅, which has been prized for jewelry throughout the world -- also the cause of their present endangered status.

HB GENERAL CHARACTERISTICS (Figure 3):

< A bony shelled sea turtle, golden skinned with a mottled brown shell.
< The scales of the carapace or scutes overlap like shingles on a roof (imbricated).
< Adults grow to over 1 meter long (3 feet) and weigh up to 95 kg (200 lbs.).
< Nesting season is between April to December, but hawksbill nesting has been recorded for every month of the year.
< They migrate to their nesting beaches every 2 to 4 years.
< Nest beaches fringed by coral reef frequently selecting a nest site deep into the beach forest vegetation.
< Crawl pattern is alternating gait, less than 1 meter wide.
< Nest site typically in vegetation or at the back of the beach at the base of a rock cliff.
< Nesting activity is typically a small area of disturbance with several aborted nest holes or one small shallow body pit.
< Internesting interval is 14 to 16 days.
< Each female can lay between 3 to 5 clutches per season.
< Clutch size ranges from 140 to 200 eggs, the size of ping-pong balls, plus 1 to 10 yolkless eggs varying from pea size to bird egg size.
< Nests incubation is between 55 to 75 days depending on time of season.
< Hatchlings are uniformly brown all over and are miniatures of the adults.
< Hatchling is smallest of Virgin Island's sea turtles measuring 3 to 6 cm (1.5 to 2.5 inches long).

VIRGIN ISLANDS SEA TURTLE SPECIES SUMMARY SHEET

This summary is not meant to be definitive, but rather meant to give you some very basic information to enable you to distinguish one species of sea turtle from another. If you have further questions about the species of sea turtle found in the Virgin Islands the following persons have been involved with sea turtle research for many years and would be good contacts: Ralf Boulon, VIDPNR, Division of Fish & Wildlife, 775-6762; Mike Evans, USFWS, Sandy Point NWR, 773-4554; Zandy Hillis-Starr, NPS, Buck Island Reef NM, NRM Specialist, 773-1460; Amy Mackay, Country Day School, Biology Teacher / St. Croix Sea Turtle Research Program, 778-4852.

Species	Identifying Characteristics	Adult Size[o]	Adult Weight[5]	Hatchling Size[o]	Hatchling Weight	Color
Leatherback *Dermochely coriacea*	No boney shell, tapered body form, 7 ridges, flippers as long as shell	130-165 cm	280-430kg	62mm	45g	Black w/ white carapace stripes
Green Turtle *Chelonia mydas*	Round beak, often no barnacles, shell smooth/ domed, scutes don't overlap	95-120 cm	up to 230kg	53m	----	Gray/ green carapace, white plastron
Hawksbill *Eretmochelys imbricata*	Narrow pointed beak, barnacles/ algae on carapace, overlapping scutes	70-85 cm	up to 90+kg	42mm	14g	Uniform gray/brown

Species	Nesting Season	Internesting Interval;	Clutch Size[4]	Egg Size	Nest Depth	Incubation Period
Leatherback	March-July[5]	9-11 days	40-120 eggs	54mm	70cm	57-72 days mean=64
Green Turtle	Peak = July - Sept.[6]	12-14 days	120-150 eggs	49mm	50cm	54-62 days mean=56
Hawksbill	Peak =	14-16 days	80-220	42mm	35cm	50-75 days

July - Sept.[7]	eggs[8]	mean=60

SEA TURTLE BIOLOGY AND REPRODUCTION

Excerpt from Fauna of Australia, Volume 2A, Amphibia & Reptilia -- Limpus, C. And Jeffery Miller, Chapter 19, page 135 - 137.

REPRODUCTION

Age at sexual maturity for cheloniids is probably about 30 to 50 years. The adult female has massive, paired ovaries, which mature ovarian follicles > 2.5 cm in diameter. The oviducts are up to 6 m long. Copulation usually occurs before the first ovulation for the season. A female may mate with a series of males and stores sperm in the oviducts for use later in the breeding season. Cheloniids produce white, spherical eggs that average 35 to 55 mm in diameter (depending on the genus), with flexible calcareous shells. Individual females normally do not breed in successive years. The egg laying period may be distinctly seasonal (summer in Caribbean), or all year round with a dry season peak in activity, as occurs with hawksbill turtles in the Virgin Islands (Hillis and MacKay, 1989). Within a breeding season females lay one to 11 clutches, containing on average 50 to 200 eggs. Clutches are laid at about two week intervals, depending upon the genera. Nests are 43 to 70 cm deep, depending on the species, and are dug in the supratidal, frontal sand dunes or beach forest areas (Hillis, 1993). Hatchlings emerge from nests approximately two months after the eggs are laid. Hatchlings of a single clutch may have different fathers as a result of fertilization by sperm from several males having been stored in the oviducts. Male *Ca. caretta* appear to be annual breeders, but this may not apply for other genera. Testes are abdominal and a single grooved penis is erectile from within the cloaca.

EMBRYOLOGY AND DEVELOPMENT

The cleidoic eggs of cheloniids follow typical turtle embryological development. At oviposition the embryos are at middle gastrulation. For successful incubation, they must be laid in well ventilated, low salinity, high humidity nest substrate, which is not subjected to flooding. Embryos can be killed by rotation of the eggs during incubation. Nest temperature, which may range from 25° to 33° C, determines the length of the incubation period, of approximately 6 to 13 weeks. The sex of hatchlings is a function of nest temperature during middle incubation. The theoretical temperature that produces a 1:1 sex ratio with constant temperature incubation (pivotal temperature) varies between species and breeding units. For hawksbill turtles nesting on Jumby Bay Antigua West Indies the pivotal temperature was >29°C, although this maybe an atypical measure based on a limited sample size for one season alone (Mrosovsky, et al, 1992). Two heterogeneous nuclear ribonucleoprotein particles that are differentially expressed in male and female embryonic urinogenital systems at different incubation temperatures are implicated in sexual differentiation of loggerheads (*Caretta caretta).*

NATURAL HISTORY

Life History

After they emerge from the nest, hatchlings swim out to sea where they are dispersed by currents into the open ocean. During this post-hatchling, planktonic phase, the juveniles are believed to feed on macrozooplankton at the surface convergence lines. After several years and one or more circuits of the ocean gyre, the young of most species select a feeding area within continental shelf waters and change to benthic feeding when they are approximately 300 to 400 mm in carapace length or greater, depending on the species. An immature turtle remains associated with the same continental shelf or inshore feeding area for years. However, it may make one or more shifts in feeding site before selecting the feeding area it occupies as an adult. In the tropics, at least, an adult associates with the one feeding area, possibly for life, which it leaves only during its breeding migrations. Turtles migrate from widely scattered feeding areas to breeding areas (Figure 4).

The slow growth to maturity is reflected in the large proportion of the total population that is immature. Sex ratios are variable and often significantly biased towards females. Reliable predictive population models are scarce because of difficulties in estimating the age of individuals and the survivorship of cohorts over the vast feeding areas of a single population. It appears that large immature and adult cheloniids require a high annual survivorship and a long breeding life to maintain population stability.

ECOLOGY

Most ecological studies of marine turtles have been conducted on the nesting beaches. Conversely, there have been few ecological studies of marine turtles in their aquatic habitats. *Chelonia mydas* principally inhabits areas with abundant seagrass and algae, especially coral reefs, rocky reefs and seagrass flats, and it appears to have a positive feedback effect on the seagrass community. As a result of the hind gut digestion of fiber and the incomplete removal of nutrients, especially nitrogen, during the passage of seagrass through the gut, the turtle returns to the environment a coarsely cut and partly digested fecal product with a C: N nutritional quality that is superior to the original seagrass. Thus the turtle increases the rate of movement of nitrogen and other elements through the food web of sea grass beds. On the other hand, the migrating female transports substantial quantities of nutrients from the feeding areas in the form of mature follicles, which she deposits as eggs at the rookeries. Some of these nutrients then enter the food web at the rookeries as decaying eggs on the beach, and as eggs and hatchlings eaten by predators. While slow growth, delayed sexual maturity and long intervals between breeding seasons of wild *Chelonia mydas* are probably under nutritional control rather than genetic control, they may also be characteristic of the family. Limpus & Nicholls (1988) have demonstrated that regional climatic events, such

as the El Nino southern oscillation (ENSO), determine the proportion of adult female *Chelonia mydas* available to breed in any one year, and hence presumably the timing between breeding seasons. A similar ENSO effect has not been detected in the other genera. Within the Caribbean the hawksbill turtles are associated with various hard-bottomed foraging habitats, primarily coral reefs and mangrove systems.

Nesting marine turtles can have some negative impacts on strand vegetation communities. However, while nesting they bury nutrients (eggs, humus, vegetation) and seeds back into the soil. In loose coralline sand, the grass and tree roots enhance the ease with which a nesting turtle can construct an egg chamber and hence deposit her eggs. Regularly nesting under trees, however, could be a disadvantage to the turtle population in providing relatively cooler sand and thus affecting the sex ratio. The dark sand/soil substrate found under the beach forest habitats at BUIS produce predominantly female hatchlings of *Eretmochelys imbricata* in 1995 and 1996, and the cooler, white coral sand beaches produce more males (Wibbels, et al, in press).

BEHAVIOR

The hatchling is imprinted by the earth's magnetic field at the nesting beach as it leaves the nest. Imprinting to the smell of the nest substrate or to the water that the hatchling first contacts may also occur. Genetic studies provide convincing evidence that the breeding adult does return to the region of birth. It remains to be demonstrated however, whether this fidelity is the result of imprinting to the natal beach during the egg or hatchling phase, or whether the hatchling is imprinted to the general region of her birth and subsequently imprinted to the specific rookery as an adult during the first breeding season.

The hatchling does not feed or sleep between leaving the nest and moving into deep, offshore water. Hatchlings orient to low elevation light horizons when moving from the nest to the sea. Bright lights can disorient them, although not by the yellow wavelengths of low-pressure sodium vapor lights. By swimming perpendicular to wave fronts, the hatchlings are directed to swim out to the open ocean.

Each adult female migrates faithfully between its particular feeding area and rookery, although different paths are followed on their breeding migrations. While some migrate in excess of 2600 km, most migrate less than 1000 km to their rookeries. Recaptures of females tagged at Buck Island Reef NM have been recorded from Nicaragua, C.A. and Cuba (Hillis and Phillips, 1998). Adult females display a high degree of fidelity to their chosen nesting beach, with most females returning to the same small beach for their successive clutches within a breeding season and in successive breeding seasons (Hillis 1994).

The Cheloniidae and the Dermochelyidae display remarkably similar nesting behaviors. The female selects a nest site above the tide level and clears the loose sand by excavating a body pit with the front and rear flippers; below the body pit she digs a vertical sided, flask-shaped egg chamber with the hind flippers; she lays the eggs in the

egg chamber and then conceals them with sand using first her rear flippers, then all four flippers. Prior to departing the nesting beach the female continues to camouflage the nest using all four flippers while she slowly moves off the nest location. This camouflaging behavior can continue for up to twenty minutes after the nest has been covered. At some point during camouflaging the female is Asatisfied≅ and turns toward the sea and begins her departure crawl.

SEA TURTLE CONSERVATION

HUMAN HISTORY & THREATS:

Modern sea turtles are little changed from their ancient reptilian ancestors that appeared on earth millions of years before humans. For thousands of years humans have been exploiting sea turtles as a source of food, trade tokens, decorative ornaments, and leather. In the last 200 years the uncontrolled harvest of adult and juvenile turtles, and eggs have caused sea turtle populations worldwide to decline to frighteningly low levels. The remaining populations are either endangered or threatened with extinction.

It wasn't until 1972 when Virgin Island law made it illegal to harvest sea turtles on the nesting beaches and allowed harvest in the water only between October - April. Finally in 1973, leatherback and hawksbill turtles were protected under the Endangered Species Act, and in 1988 the green turtle, a threatened species, was included. At present, populations do not seem to be declining and juvenile green turtle populations seem to be increasing in the sea grass beds around the Virgin Islands (Boulon, pers. comm.), but there are no significant signs of recovery despite more than twenty years of protection (Eckert, 1991). Today, the greatest threats to the remaining sea turtle populations in the Virgin Islands include coastal and upland development, introduction of domestic and exotic animals, boating (commercial and recreational), incidental take in the fishery, illegal harvest of adults and eggs, marine debris, inadequate local protection and enforcement, and insufficient regional cooperation.

Coastal and upland development, without proper concern for the down stream effect, is causing degradation of nesting beaches, sea grass, coral reef, and mangrove areas, each critical components of sea turtle habitat. Upland developments increase lighting above a nesting beach; any high intensity lighting will disorient hatchlings and adults (Philibosiam, 1975; Witherington, 1991, and 1992). Nesting turtles forced away from protected public beaches to adjacent areas are more vulnerable to poaching. Beach landscaping for recreational use causes loss of sand and native vegetation, which changes the nesting beach temperature regime altering the sex ratio of hatchlings produced on those beaches. All kinds of recreational activities will impact a sea turtle nesting beach. For example, off-road vehicles (illegal on Virgin Island's beaches) can crush nests and leave deep tire tracks that can trap hatchlings on their way to the sea. Domestic and introduced exotic animals (dogs, pigs, goats, horses, and mongoose) harass nesting females, and prey upon nests and hatchlings. Prior to removal of exotic mongoose (1985) from Buck Island Reef National Monument, more than 50 percent of all hawksbill nests were destroyed annually (Hillis-Starr and Phillips, 1998, Small, 1982).

Local fishing practices, trap fishing, gill nets, and long lining are hazards to sea turtles in the near shore waters around the Virgin Islands. Abandoned fishing gear is especially deadly, causing entanglement and subsequent drowning, and is a particular threat to

nesting females while they remain near the shore between nesting. Stranding of young sea turtles is typically the result of either entanglement, ingestion of marine debris, or collision with watercraft. In recent years the number of sea turtles killed by boat collisions, especially along ferryboat routes where turtles are foraging, has increased (Boulon, pers. comm., 1995).

Many of the important nesting areas have been protected, but all three species are still threatened by illegal take for meat and eggs, habitat loss and degradation, boat collisions, entanglement, and ingestion of marine debris. The lack of sufficient enforcement greatly limits the protection of nesting sea turtles. In all, the islands public education programs have become the greatest weapon against the continued killing of sea turtles.

Inconsistent regional protection for sea turtles offers little protection for this highly migratory species, either in the foraging grounds or on the nesting beaches. Despite protective legislation in the U. S. Virgin Islands, the subsistence use of meat and eggs, and harvest of hawksbill turtles for shell continues in adjacent island nations, posing a significant threat to the survival of sea turtles in the region. Just 2 mile east of St. Thomas/St. John, the British Virgin Islands (BVI) has a four-month open season (December to March), allowing legal take of sea turtles, and tortoiseshell items are for sale year round. BVI historically supported a large turtle fishery. In the 1920s, six leatherback turtles nested per night throughout the season (Eckert, et al, 1992). In 1991 only four females were observed nesting, and two of these were slaughtered (Eckert, 1992). On many beaches, leatherbacks have been completely extirpated. Records from harvests during open season show a similar decline for the green turtle and hawksbill populations. With the decline in BVI sea turtle populations, stricter regulations have been recommended to the BVI Ministry of Natural Resources for adoption by the UNEP/Widecast Sea Turtle Recovery Action Plan, 1992. However, until such regulations are adopted and enforcement improved, there is still no protection for eggs, no size restriction for turtles harvested during open season, and there is still the continued threat to turtles passing between the political jurisdictions.

Confusion exists among Virgin Island residents with regard to sea turtle products purchased outside U.S. jurisdiction. Today, illegal trade in tortoiseshell trinkets persists and there is incidental take for personal consumption of meat. Turtle products legally purchased in the BVI are frequently brought back to the Virgin Islands, the owner having no knowledge of the prohibitions on importation of sea turtles. The items are seized and possible fines levied (NMFS/USFWS, 1993). This conflict between our two neighboring countries is the single greatest threat to sea turtle protection in the Virgin Islands.

SEA TURTLE CONSERVATION TODAY

Two federal mandates guide the conservation of sea turtles in the United States and the Virgin Islands. The Endangered Species Act (1973) in part states that federal agencies will seek to conserve endangered species and utilize their authorities in furtherance of the purposes of this Act. The Government of the Virgin Islands passed the Indigenous and Endangered Species Act of 1990, which also protects sea turtles. These laws prohibit the take, capture, transport, and export of any whole or parts of specimens. They also prohibit harassment, injury, disruption, or damage to any sea turtle or nest of a sea turtle. Therefore, obtaining special permits to conduct research on these animals is necessary. In 1993 the Recovery Plan for the Hawksbill Turtle *(Eretmochelys imbricata)* in the U. S. Caribbean, Atlantic, and Gulf of Mexico outlined recovery goals for the species. It stated the need for long-term protection of important nesting beaches, such as, Buck Island Reef National Monument, which was identified as an index beach to be monitored for the recovery status of hawksbill sea turtles. It also states the need to minimize threats from illegal exploitation and to increase hatch and emergence success of nests. To abide by the laws and regulations covering endangered species BUIS Sea Turtle Research Program applies for an Endangered Species Permit each year to conduct research on hawksbill sea turtles at the Monument.

BUCK ISLAND SEA TURTLE RESEARCH & MONITORING PROGRAM

INTRODUCTION

Buck Island Reef National Monument (BUIS) was designated in 1961. It was established as a National Monument for the magnificent example of an elkhorn coral barrier reef surrounding the islands= east end. This 176-acre uninhabited island lies 1.5 miles northeast of the island of St. Croix in the U.S. Virgin Islands (17°47= N, 64°37= W). The Monument is administered by the National Park Service and includes 176 acres of land and 704 of water and coral reef system. The majority of the Monument's waters have been designated as a AMarine Garden≅ that is closed to fishing and all collecting activities.

The Monument is St. Croix's most popular tourist destination. Daily, visitors come to the island by boat to enjoy the white coral sand beaches, quiet shoreline picnic areas, and views from the overland hiking trail. The novice can learn to swim in the beautiful turquoise waters and snorkel through the underwater trail protected by the coral barrier. The more experienced snorkeler can venture outside the underwater trail leads to the Ahaystacks", large elkhorn coral patch reefs which rise to the surface from a depth of 40 feet.

BUIS is home of many unique, rare and endangered animals and plants including three federally listed sea turtles. The green turtle, a threatened species, forages year round in the offshore sea grass beds and nests between June and September. Only a few endangered leatherback turtles nest on BUIS each year. BUIS is identified as an index beach for hawksbill turtle recovery in the Eastern Caribbean. Annually 20 - 30 adult hawksbill turtles nest on BUIS, while year round BUIS= coral reef habitat provides a protected developmental habitat for juvenile hawksbill sea turtles. Seasonally BUIS is also a nesting area for the endangered brown pelican and threatened least tern.

BUCK ISLAND SEA TURTLE RESEARCH PROGRAM

HISTORY

Buck Island Reef NM is one of the most significant areas under U.S. jurisdiction where hawksbill sea turtles *(Eretmochelys imbricata)* are still nesting in any numbers. The nesting population of hawksbill turtles at Buck Island Reef NM provides relatively easy access to this highly endangered species. This study, as addressed in the 1993 U. S. Fish & Wildlife Service/National Marine Fisheries Service Hawksbill Recovery Plan, is working toward answering some of the critical questions that would provide better information for protection and management of hawksbill sea turtles, not only at Buck Island Reef NM, but also throughout the Caribbean. BUIS was identified in that document as an index beach for hawksbill turtle recovery in the Eastern Caribbean.

The Buck Island Sea Turtle Research Program (BISTRP) was initiated in 1988. The BUIS Resource Management Specialist, under the supervision of Christiansted National

Historic Site/ Buck Island Reef National Monument's Superintendent, directs this program, which primarily studies the biology of the endangered hawksbill sea turtle. The BISTRP operates the research program with seasonal biological aides, hired by the National Park Service each summer, to conduct nightly beach patrols with the assistance of research volunteers. The annual monitoring and research project is funded by BUIS= resource management budget, which provides for permanent and seasonal hires= salaries, boat operation, equipment and supplies. Volunteer assistance is essential to maintaining the sea turtle research program. A local partnership with the Buccaneer Hotel on St. Croix supported two summer interns for three months during the 1993 to 1996, 1998, 1999 study years. These interns provided technical field support for the BISTRP and environmental education for hotel guests and public. In 1994 and 1995, BISTRP was awarded an interagency grant from the U.S. Fish & Wildlife Service to support sea turtle research volunteers for BISTRP and St. Croix East End Beaches Sea Turtle Pilot Program. These volunteers assisted with sea turtle monitoring and research at BUIS, Sandy Point National Wildlife Refuge and at several beaches on St. Croix's east end. This work identified other significant nesting populations of hawksbill turtles on St. Croix, in addition to Buck Island.

BUIS sea turtle nesting activities are monitored year round, with intensified monitoring during peak nesting season, July to October. In order to maintain the delicate balance between visitor use of the beaches and seasonal sea turtle nesting, BUIS instituted regulations to safe guard sea turtle nesting in 1988. These sea turtle nesting season regulations include, beach closure from sunset to sunrise, minimize light and noise on vessels overnighting in the anchorage, no anchoring on-shore above the high water mark, no beach umbrellas, pole, stakes, or digging allowed above high water mark, and no dogs are allowed on the beach at anytime. From July to October, research staff and volunteers patrol the nesting beaches each night recording the nesting activities of hawksbill, green, and leatherback sea turtles. The saturation tagging program, which was instituted in 1990, has focused on hawksbill sea turtles. Nightly patrols are conducted to record every nesting hawksbill turtle and tag her as appropriate; describe nesting behavior, site selection and fidelity; remigration intervals; fecundity (clutch counts and egg measures); size, weight, and growth, and nesting and hatch success. All clutches are followed through their 60 day incubation periods to hatching. Threats to hatch success are recorded, such as predation, poaching, inundation by seawater, and desiccation; every effort is made to prevent adverse impacts. Only nests so threatened are relocated after egg deposition.

BISTRP has cooperated with both the National Marine Fisheries Service and the University of Florida at Gainesville by providing blood samples for genetic analysis of nesting females to help determine the genetic composition of the hawksbill rookeries in the Caribbean. Genetic samples have been collected from more than 50 % of the hawksbill turtles nesting at Buck Island. To date, analysis indicate that Buck Island nesting hawksbill turtles are not part of a larger population, but genetically distinct and isolated from hawksbill turtles nesting in Puerto Rico, Antigua, and Barbados, and that they show strong genetic identity with hawksbill turtles sampled in Belize. To further

support the Central American Aconnection≅, BUIS= first long distance tag recovery was for a BUIS hawksbill female, tagged QQD 033, captured in the Miskito Cays, off the coast of Nicaragua in 1991. On March 31, 1998, BUIS received its second tag recovery report - QQD 506, tagged on BUIS July 28, 1997, was reported captured on February 9,1998, seven months later, in the Aannual harvest≅ area in Nuevitas, Cuba (northwest of Cayo Guajaba). QQD 506 was a neophyte (first time nester) to the BUIS nesting population. Genetic analysis of the blood sample collected during her nesting at BUIS is pending. Both of these cases have added important information into the migratory behaviors of these endangered sea turtles.

RESEARCH & MONITORING RESULTS SUMMARY

In the course of conducting basic research on hawksbill sea turtle nesting behavior and conservation, several other projects have been initiated in conjunction with the BISTRP, including:

- In 1991, BISTRP and USC/ Moss Marine Landing conducted a radio- and sonar-telemetry project to determine the movements of nesting hawksbill turtles during their internesting period. It was determined that nesting hawksbill turtles remain close to the island during their nesting period, and depart immediately after laying their final nest of the season. This study resulted in a master's thesis.
- In 1991 and 1992, BISTRP and USFWS/VA Polytechnical Institute cooperated on a satellite telemetry study to determine the movements of nesting hawksbill turtles after completion of nesting for the season. Satellite tracking showed post-nesting hawksbill turtles traveling hundreds to thousands of miles away from Buck Island in order to return to their foraging grounds. This study also resulted in a master's thesis.
- In 1994, BISTRP began a collaborative study with Dr. Thane Wibbels, University of Alabama, to determine a non-lethal method of determining the sex of sea turtle hatchlings. Incubation temperature, not X or Y chromosomes, determine the sex of sea turtles, and this study in conjunction with recording nesting beach temperatures, enables management to determine the sex ratio of hatchlings produced on Buck Island without sacrificing them. This information is critical to meeting species recovery goals.
- Also in 1994, BUIS Resource Management began surveys for hawksbill turtles in the coral reef around BUIS. This study was conducted on found time and would not have been possible without an enormous volunteer contribution. The project expanded each summer with the assistance of the BISTRP research team. As of December 1997, 67 hawksbill turtles have been hand-captured, tagged, measured, and had blood samples collected for genetic and testosterone analysis. BISTRP and University of Florida, Gainesville, collaborate on the genetic analysis of the juvenile hawksbill turtle population at BUIS as well.
- In 1997, BISTRP was awarded a science base grant from the NPS Southeast Regional office to expand the juvenile hawksbill turtle study. This was used to establish a radio and sonic telemetry tracking system for individual juveniles in BUIS developmental habitat, and through a cooperative agreement support a

graduate student's master's thesis project to study juvenile hawksbill sea turtle foraging behavior at BUIS. The graduate student, Roy A. Pemberton Jr., is a St. Croix native and master's candidate from Virginia Institute of Marine Science. In December 1997, the radio tracking station was set up at the Monument and two juvenile hawksbill turtles were radio/sonic tagged. To date, QQD 613, a young female, and QQD 622, a young male, are being tracked daily. These two animals have been part of the Buck Island studies since 1994. A third juvenile hawksbill, QQD 672, was radio/sonic tagged in April 1998.

< Also in 1997, BISTRP assisted Dr. Pamela Plotkin, University of Delaware, with a satellite telemetry study. Five nesting hawksbill turtles were fitted with transmitters on their last or next to last nesting activity to track their migration route back to their respective foraging grounds. Their signals are currently being monitored by Dr. Plotkin through the Argos Wildlife Satellite Tracking Service to map their migration route and final destinations.

< 1998, the Buccaneer Hotel supported the work of a PhD student from University of Kiel, Germany, who conducted field trials of unique data logging devices to record the behavior of nesting hawksbill turtles during their internesting interval (time off the beach between nesting). Fieldwork on this project will continue in 1999.

< The 1998 nesting season is over and the 1999 season beginning. After 80 nights of patrol 27 female hawksbill sea turtles and 9 female green turtles were encountered at the Monument. Sixteen of these hawksbill turtles and four of the green turtles had nesting on Buck Island Reef NM in previous years. The other 11hawksbill turtles and four of the green turtles were new to the program and received metal flipper tags to help identify them when they return. Nests continue to be monitored for hatching and evaluated for hatch success. Also this season, in cooperation with the National Marine Fisheries Service 2 nesting hawksbill turtles were fitted with satellite transmitters on their last or next to last nesting activity to track their migration route back to their respective foraging grounds. Both of these females departed from Buck Island Reef and traveled hundreds of miles away to their foraging grounds. For the last nine months we have been tracking their locations through their transmitter signals. One female is located off the southeast coast of Puerto Rico and the other is north of Virgin Gorda in the British Virgin Islands. We continue to monitor these turtles on a daily basis through their satellite transmissions.

< At BUIS, hawksbill sea turtles nest every 2-4 years. During the first four years of the study, 1988 - 1991, the majority of turtles encountered were not tagged. The nightly saturation tagging program covering the peak nesting months, enabling us to determine whether the nesting turtles were remigrants or new recruits. By the 5th year of the study more remigrants and less untagged turtles were encountered indicating saturation tagging of the population had been achieved. From that point on, any untagged turtles would represent new recruits to the BUIS nesting population (Figure 5).

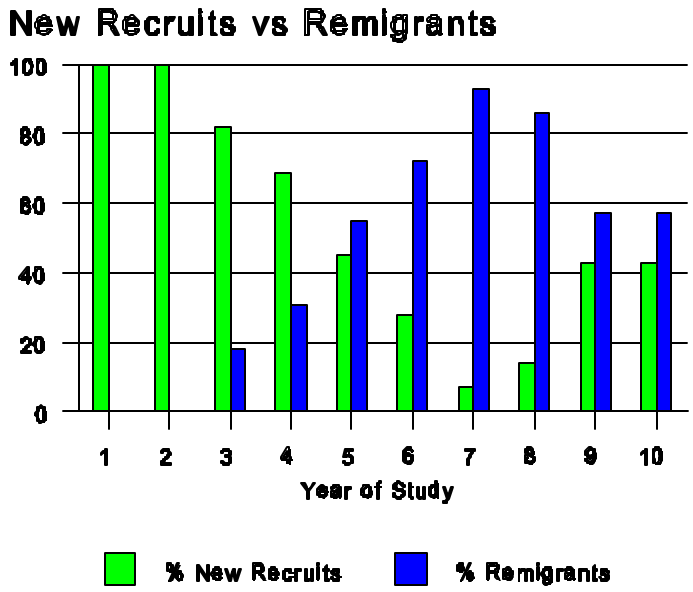

Figure 5. BUIS Nesting Hawksbill Turtles - Neophytes vs. Remigrants

Each of these projects has lead to considerable insights into the biology and/or behavior of hawksbill sea turtles. It is believed that bony-shelled sea turtles, like the hawksbill, may take upwards of 30 years to reach sexual maturity. In light of the increasing number of new recruits encountered during 1996 and 1997, BUIS may be starting to see the results of 23 years of nesting beach protection and conservation. The results of BUIS= nesting hawksbill turtles genetic analyses indicate that this population may be distinct in the Caribbean and therefore should be afforded as much protection as possible. Hawksbill sea turtle populations in some parts of the Caribbean, and worldwide, are still under pressures of legal and illegal take. The BUIS population must continue to be protected as a valuable member of a species who's genetic diversity is already reduced throughout the world. The nesting beach monitoring efforts at Buck Island Reef NM will continue to maintain a close scrutiny on this critical hawksbill sea turtle nesting population and collect the necessary information for the conservation and recovery of the species in the Virgin Islands.

ANNUAL OPERATIONAL OVERVIEW:

Typically, by the end of January the prior season's nesting data analysis and summary are completed, and preparation for attending the Annual Symposium on Sea Turtle Biology and Conservation have begun. The following is a monthly outline of the needs of the program:

January - prior year data summary and analysis, NPS Investigators Annual Report for nesting beach study

February - prep for annual ST symposium presentation, update letters, job announcements, and history statement, prep seasonal bio aide job announcement and submit to VIIS personnel specialist

March - attend annual ST symposium, interview interested field technicians, seasonal bio aide job announcement

April - update training manual, select research team (bio aide, research assistants, volunteers), request VIDPNR T&E permit renewal

May - Beach prep, equipment inventory and maintenance, new purchases, housing prep, boat maintenance, first public service announcements about sea turtle research program

June - finalize training manual, research team arrival, last two weeks of month begin orientation to BUIS (swim test/boat operation training), team and local volunteer training, Public Service Announcement about sea turtle nesting

July - start nightly nesting beach monitoring and research, Public Service Announcement about sea turtle nesting

August - continue nightly nesting beach monitoring, mid-season program review last week of month, Public Service Announcement about sea turtle nesting

September - continue nightly nesting beach monitoring, Public Service Announcement about sea turtle nesting

October - continue nightly nesting beach monitoring until Oct 7th, switch to daytime for last week of program to review all nesting beach activities and conduct nest excavation, inventory of project equipment, and close down Sion Farm Housing, research team departure.

November - continue daytime beach surveys (2 to 4 times per week depending upon

staff availability), conduct nest excavations, update BUIS ST tag list, submit seasonal tag data to NMFS

December - continue daytime beach surveys (1 to 2 times per week depending upon staff availability), conduct nest excavations, begin data analysis for seasonal summary.

At the end of the nocturnal Sea Turtle Research Program, transition back to daytime patrol schedule.

1. October 7 to 12, Last week of sea turtle research program team switches to daytime patrol schedule.
2. Review data sheets. Make corrections based on field review of all nesting activities.
3. Conduct nest excavations as needed.
3. Clean up beach markers. Do end of season photo-point documentation. Measure perpendicular beach measurements at each marker.
5. Final review database entries with bio aide.
6. Inventory and nighttime equipment return.

United States Department of the Interior

NATIONAL PARK SERVICE

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Buck Island Reef National Monument
Danish Customs House, Kings Wharf
Christiansted, Virgin Islands 00820-4611
809-773-1460 ph/ 809-773-5005 fax

February 20, 1999

Ralf Boulon
VI Department of Planning and Natural Resources
Division of Fish & Wildlife
101 Estate Nazareth
St. Thomas, VI 00802

Dear Ralf,

I would like to request the re-authorization of our permit to conduct research and monitoring on threatened and endangered sea turtles nesting and foraging within the boundaries of Buck Island Reef National Monument and on the main island of St. Croix, Virgin Islands. This year will be the twelfth season of research on the hawksbill turtle population nesting at Buck Island Reef NM and we look forward to another productive year. We re-established our partnership with the Buccaneer Hotel this summer and monitored their three beaches for nesting activities. Enclosed is my report summarizing nesting data and our data collection protocols for those beaches.

As in past years the National Park Service will be hiring one or two seasonal biological aides and several research volunteers to assist with the nocturnal research program from July to October. Ms. Brendalee Phillips, USGS, Biological Resource Division, biologist will be assisting with all aspects of the research as part of the NPS/BRD Inventory and Monitoring Program. I will be the field supervisor for everyone who participates in the sea turtle research program at Buck Island, and will train all of the technicians and volunteers.

Our NPS/VIMS cooperative research study on juvenile hawksbill sea turtles is continuing. Roy Pemberton Jr., master's student, will be furthering his study of juvenile hawksbill turtles this spring and summer. Pending the re-establishment of the USCG tower on Buck Island several more juvenile hawksbill turtles will be outfitted with radio and acoustic transmitters which will enable us to track their movements 24 hours a day and locate them in the reef system for detailed visual observations of their activities. To date four juveniles have been transmitted and all are doing well. We have had several conversations with NMFS concerning getting a permit for our juvenile sea turtle study;

we are working on the application and will apprise you of the outcome.

Our cooperative research effort with Sandra Storch, a doctoral student from the University of Kiel, Germany, was mostly a success. Several internesting hawksbill turtles were tagged with automated data storage tags to record their activities throughout the internesting period. Several fell off, but some were successfully recovered and the data is very interesting, especially from the female who collected data on her whereabouts during Hurricane Georges. We are not sure if Sandra will be returning to continue her studies at Buck Island as yet. We will keep you informed as plans develop.

The following is an outline of what I would like to accomplish at Buck Island under our endangered sea turtle research permit for 1999:

Nesting Beach Research -

1. Continue saturation tagging from July to October 15, 1998. Tagging with NMFS inconel tags, series PPW and QQD. All four flippers will be tagged to maximize tag retention and recapture identification.
2. Measurements will include: ccl, ccw, plastron length and width, weight of each female at lease once after egg deposition. Clutch counts for long-term remigrant females only, and nest measurements, and a sample of 10 eggs from each clutch will be weighed and measured on only new nesting females.
3. Blood samples will be taken for population genetics and glucose testing. A 1 to 2 ml sample will be taken from the cervical sinus and put in lysis buffer. Samples will be taken during egg deposition.
4. Nests will only be relocated when there is a threat to nest success from erosion, rats, clutch destruction from other turtles, or human impacts from foot traffic.
5. The nesting beach temperature study will continue. Ten Omega temperature data loggers will be placed in all habitats to monitor temperature throughout the nesting season. We will also put temperature loggers into nests and immediately adjacent to these same nests to measure temperature differences. We will also be continuing the nest/shade experiment measuring the loss of vegetation cover on hatch success.
6. Hatchling sex ratio study is continuing in cooperation with Dr. Thane Wibbels, University of Alabama. We will be collecting blood samples (0.2 to 0.3 ml) from hawksbill hatchlings, approximately 25 individuals from 15 to 20 nests, throughout the season. These blood samples will be sent to U of Alabama for analysis. Hatchlings are released the same night from the nesting beach. No adverse effect has been observed.

Juvenile Hawksbill Sea Turtle Study -

1. Continue snorkel surveys along Buck Island's barrier reef and lagoon to observe and hand capture juvenile hawksbill turtles, tagged and untagged. We will attempt to make observations on tagged individual's daily routines and foraging strategies.
2. When a turtle is captured, data collected will include: ccl, scl, ccw, scw, plastron length and width, head measurements, weight in kg, carapace diagnostics, and photographs.

3. All turtles will be tagged with NMFS inconel tags, one front flipper/one hind flipper, and PIT right front flipper muscle tissue.

4. Blood sample will be taken for genetic, testosterone (sex determination), and glucose level, and CBC (complete blood count). Samples of 3-4 ml will be taken from the cervical sinus.

5. Radio and acoustic telemetry devices, designed by Lotek Engineering, will be applied to four different size class individuals for 24 hour tracking for over 6 months. Four individuals have been transmitted, including two in the 40 - 50 ccl size class and two 50 - 60 ccl. We are in the process of relocating these individuals to remove the transmitters. We anticipate capturing and attaching 4 new study animals for transmitters this spring/summer to track 20 - 30 and 60 - 70 ccl size classes. After radio tagged individuals are located by radio/acoustic tracking, snorkelers will make visual observations of their behavior throughout the day.

We still have VIDPNR straight-line calipers and would like to continue to do measures on nesting and juvenile turtles. We appreciate the equipment loan.

For now, please put myself, Brendalee Phillips, Roy A. Pemberton, Jr. on our permit. As soon as I have made the seasonal biological aide, research assistants, and volunteer selections, I will send you the list of names.

Thank you again for your guidance and assistance with the Buck Island Sea Turtle Research Program. As always we look forward to seeing you at the Sea Turtle Symposium and anytime you find yourself on St. Croix.

Sincerely,

Zandy Hillis-Starr
Resource Management Specialist
Buck Island Sea Turtle Research Program

Enclosures:

1) 1998 Buck Island Sea Turtle Research Program Summary - Nesting Study

2) 1998 Buck Island Sea Turtle Research Program Summary - Juvenile Study

3) Sea Turtle Nesting Activities Summary Report - The Buccaneer Hotel, St. Croix, VI

STUDY SITE DESCRIPTION:

Buck Island Reef National Monument is an uninhabited island 1⁄2 miles off the north coast of St. Croix, Virgin Islands. The island is a little over a mile long and 2 miles wide, rising to 330 feet above sea level. The island is not volcanic, but formed by continental up lift and is primarily sedimentary rock. Buck Island and St. Croix are separated from the other Virgin Islands by the southern end of the Puerto Rican trench; the second deepest point in the ocean (15,000 feet deep). The oldest exposed sedimentary formations (black and white rocks) are from the Caledonia Period, 18,000 years ago.

The Monument consists of 880 acres, including 176 (71.4 hectares) land and 704 water and surrounding coral reef system. It is a tropical dry forest island, 2/3 of which is surrounded by elkhorn coral barrier reef which includes the AMarine Garden≅ area closed to all fishing and collecting activities (BUIS Brochure and Figure 6). The AMarine Garden≅ begins mid-island on the south side including the entire barrier reef as it wraps around the eastern tip of the island and continues down to the northwestern most corner of the island. To the northeast and outside the barrier reef are the unusual elkhorn coral formations called Ahaystacks≅. These elkhorn coral patch reefs, resembling giant haystacks, are scattered along the outside of the forereef rising up from the bottom at 40 feet to just beneath the surface. The haystacks make passage outside the barrier reef almost as treacherous as passage through the shallows inside the north lagoon.

Although the majority of the Monument is underwater, the remaining 176-acre island is one of the most beautiful natural areas in the Virgin Islands. It supports a rich and representative land flora of the dry forest, tropical zone, totaling 228 species of seed plants (Woodbury and Little, 1976). The island has rocky cliffs at the beach, gravelly slopes rising to a low east-west ridge along the summit. At the northwest end there is a sandy coastal plain and beach. Near the western end of the southern shore there is a salt pond, located at sea level, it contains brackish water with no outlet. There are no springs, streams, pools, or marshes of fresh water. The coastal plain forest, or beach forest, occupies the area behind the beaches reaching from the southeastern bay to the north shore. The characteristic beach forest plants are manchineel (*Hippomane mancinella)*, sea grape *(Coccoloba uvifera*), water mampoo (*Pisonia subcordata*), pink cedar (*Tabebuia heterophylla),* tamarind *(Tamarindius indica*), sweet briar (*Acacia tortuosa)*, purple sage *(Lantana involucrata)*, various Croton sp., and associated ground cover including sea purslane *(Sesuvium portulacastrum)*, sand bur *(Cenchrus incertus)* and marsh cordgrass *(Spartina patens)* (Woodbury and Little, 1976; Nellis, 1994).

Buck Island Reef NM has three shoreline types, wide-open coral sand beach with ground cover, exposed rock and cliffs, and beach forests with sand/coral cobble shorelines. The beaches change seasonally. During the winter and spring the south/western beaches are building and widening, and except for an occasional November storm when swells erode the north beach area. As quickly as it disappears, it

rebuilds. During the summer the beaches are eroding and by the end of summer the beach will be half the spring width. The coral cobbles/reef along the south side will be exposed and steep berms cut into the beach face. In the event of a tropical storm or hurricane, storm waves can wash away and replace up to 15 meters of beach in less than 24 hours.

NESTING BEACHES

The island provides protected habitat for several threatened and endangered plants and animals, and one of the few protected areas in the Caribbean where the endangered hawksbill sea turtle still nests. The nesting habitat, 1500 meters of shoreline, has been divided into four areas: North Shore, West Beach, South Shore, and Turtle Bay (Figure 7). Semi-permanent wooden markers numbered 1 to 100 have been placed every 15 meters parallel to the shoreline in the nesting habitat in order to mark the exact location of each nesting activity.

The North Shore (NS) is 367.5 meters long beginning at the rock cliffs (marker 1) at the northern most end, it continues to the west ending at the West Beach Picnic area (marker 24). It is a narrow sand beach with associated beach forest bordered by a shoreline reef. The beach forest gradually slopes down to the water's edge. There are frequent physical obstructions along the shoreline-nesting habitat created by fallen trees and eroded root masses.

West Beach (WB), 510 meters long, is an open, wide sand beach with associated vegetated dunes (markers 25 - 58). Unlike both NS and SS, WB is an exposed beach with no offshore reefs for protection. This beach is affected by wind, waves and currents causing seasonal shifts in the beach area (Gladfelter, 1980).

South Shore (SS) beach is 360 meters long starting at marker 59 (Pier) and ending at the ≅Marine Garden≅ sign (marker 82). SS is relatively sheltered from the prevailing winds and waves. The beach forest extends out to the vegetated shoreline and often to the edge of steep berms that change seasonally. A mixture of coral cobble and sand with fringing shoreline reef borders the beach.

Turtle Bay (markers 83 - 100) is the eastern most nesting area. It is a crescent shaped sand beach, 262.5 meters long, with low sea grape vegetation sheltered behind a shallow coral lagoon. The beach forests on the northwest, south, and southeast sides of the island are the principle hawksbill nesting areas.

NESTING HABITAT DESCRIPTION

BUIS nesting beaches can be characterized by three different habitat zones, beach forest (BF), shoreline vegetation (SV), and open beach (OB). These zones can be found in each of the nesting areas and have defined borders or edges. Beach forest area is the densely vegetated area, consisting primarily of woody plants and trees,

above the beach berm. Shoreline Vegetation is the transitional area between the beach forest/berm edge and the open beach, comprised primarily of small shrubs, salt tolerant ground cover, and beach vines. Open beach is characterized by open sand area with no vegetative cover or perhaps some sparse beach grasses.

PRE-NESTING SEASON MONITORING PROTOCOLS

NESTING BEACH MARKER PROTOCOL

The Buck Island Reef Sea Turtle Research Program established a standardized distance of 15 meters between nesting beach markers. Wooden stakes 4'x2"x2" were painted white and numbered sequentially from 1 to 100 with black paint before being installed on the beach. In the areas along West Beach and Turtle Bay, where the sand beach abuts a rock wall, numbered metal tags with the corresponding marker numbers were put into the rock wall with cut nails instead of the wooden markers. This method is used to reduce visual intrusion on the tropical beach scenery. Each marker has a small band of reflective tape placed around the top of it to make it easier to find with a flashlight at night. The markers remain out year round to provide a reference point for all sea turtle activities. Markers are checked and maintained at least monthly to prevent them from eroding out of the berm and washing away, especially during the winter months. BUIS= nesting beach markers begin at the North Shore benchmark location zero, and are spaced 15 meters apart going across West Beach, past the pier, along South Shore, and down to the end of Turtle Bay (Figure 8). The beach and beach forest area accessible to the turtles for nesting measures 1500 meters.

MONTHLY MAINTENANCE:

1. Confirm the presence of each nesting beach marker along all four nesting beaches.
2. Move markers out of erosion zones as needed. If lost, replace markers with an appropriately numbered stake.

START OF NESTING SEASON (MAY/JUNE):

1. Measure the distance between markers and adjust marker location as necessary. Begin measuring at North Shore benchmark location zero, located at the base of the rock cliff at the north end of North Shore. The reference point is marked with a steel rebar and aluminum tag.

2. Standing at the high water mark, one person holds the tape measure while the second person measures out 15 meters parallel to the shoreline.

3. At the 15-meter point, make a line in the sand perpendicular to the shoreline, indicating the line on which the marker should be installed.

4. Install markers even with this line, but well above the erosion zone. They must be visible from the high water mark and not obstructed by vegetation (remove vegetation if necessary). Hammer the stake into stable beach forest substrate with a mallet, leaving at least 1 meter of stake visible above the ground. If markers become threatened by erosion, they should be moved out of erosion zones, but still along the same line (15 meters from markers on either side of it).

5. Continue measuring 15-meter distances between markers and installing or repositioning markers as needed, all the way to Turtle Bay, marker #100 (Markers 44-60, 99, and 100 are metal tags nailed into rock face).

PERSONNEL:
At least 2 people

EQUIPMENT:
- Properly numbered markers as needed for replacements (wooden 4'x2"x2" painted stakes or round numbered metal tags)
- White paint
- Black paint
- Paint brushes
- Reflective tape
- 25 meter fiberglass tape measure
- 3" cut nails
- Mallet or 3 Lb. Sledge hammer
- Pruning shears to clear vegetation
- Personal gear: backpack, sunscreen, water, etc.

TIME REQUIRED:
Eight hours. Typically the North Shore/ West beach markers can be installed in the morning. Take a lunch break when you reach the Pier/Dietrich's Picnic area, and continue positioning South Shore/ Turtle Bay markers after lunch, finishing by 1600.

BUIS NESTING BEACH PHOTO DOCUMENTATION PROTOCOL

HISTORY:

Prior to 1988 no Astandardized≅ photographs were taken at BUIS. Some photographs exist from the 1980's in the NPS photo archive, which are of some historic value, but nothing repeatable. Beginning in 1987, with the hiring of a biological technician responsible for BUIS= natural resource program, photographs were taken seasonally, winter, spring, summer, and fall, to document natural changes along the shoreline. Beginning in 1988, during the nocturnal sea turtle research program, photographs were taken of nesting events and vegetative cover in nesting beach habitats. Just before Hurricane Hugo, September 17-18, 1989, a series of photographs was taken along BUIS sea turtle nesting beaches, NS, WB, SS, and TB. These were repeated after Hugo documenting the drastic changes in the shoreline. Since then, standardized beach photo points have been established and photographs are taken at least summer and winter.

OBJECTIVES:

Beach photos are taken seasonally (winter, spring, summer, and fall) to document the condition of the beach, vegetative cover/regrowth from hurricanes, berm height in the sea turtle nesting areas before and after nesting season, and erosion events (both heavy winter swells and hurricanes). Since 1988 slides have been used for beach photo documentation, beginning in 1998 a video of each standardized photo point will be taken as well.

STANDARDIZED BEACH PHOTO POINT PROTOCOLS:

1. Photographs and video are usually taken during daytime hours, 1000 to 1500 when sun is above the horizon and not interfering with horizon level shots. If the photos must be taken when the sun is low in the sky, take North Shore photos in the morning while the sun is to the west, and South Shore/Turtle Bay photos in the afternoon when the sun is to the east.

2. Standardized photo points are at the following nesting beach markers:

North Shore	West Beach	South Shore	Turtle Bay
North Shore 002	West Beach 025	South Shore 066	Turtle Bay 085
North Shore 004	West Beach 032	South Shore 071	Turtle Bay 087
North Shore 008	West Beach 038	South Shore 073	Turtle Bay 094
North Shore 017	West Beach 045	South Shore 077	Turtle Bay 100
	West Beach 052	South Shore 079	

	West Beach/Pier 059	South Shore 082	

3. At each photo point, the photographer stands at the high water mark with clear visibility down the beach in either direction.

4. Three photos are taken at each photo point standing directly in front of the marker from a height approximately five feet above the sand. The camera should be held level with the horizon.
    - Facing the marker with your back to the sea - turn 90° to the left. The first photo is taken looking down the beach along the high water mark.
    - Then turn 90° to the right back toward land. The second photo is taken facing the beach marker.
    - Turn 90° to the right again, and take the third photo looking in the opposite direction down the beach along the high water mark.

5. Each photo/frame number is recorded in a field notebook at location of the photo.

6. The video camera is then used to record the same area. As the video is being shot, verbally state the date, photo point beach marker, directions of shots, and any other comments. These will be picked up by the microphone and document the video.

    - Starting in the position used for photograph #1 above, turn on the camera and record the view looking down the beach along the high water mark. Remain on this shot for 5 to 10 seconds.
    - Keep the video running and <u>slowly</u> pan inland (to the right) until facing the beach as in photograph #2 above. Zoom in onto beach marker number, if visible, to record video location. Then slowly zoom out and hold this shot for 5-10 seconds.
    - <u>Slowly</u> pan to the right again until facing down the beach as in photograph #3 above. Hold this shot for 5-10 seconds.
    - Turn the camera off to conserve the battery.

7. Continue down the beach, repeating steps 3-6 at each photo point.

8. Label the videotape “Beach Condition Video Points”, date, and videographer.

9. The beach photo point slide film should be developed as soon as possible and slides labeled in order of being taken which will correspond with field notes.

10. Label slides with the following: BUIS, Date, Photographer, Location, and Direction (E.g., NS = north/left, beach, south/right: WB = west/left, beach, east/right: SS = west/left, beach, east/right: TB = south/left, beach, north right)

<u>PERSONNEL:</u>

One person is okay but, two people are faster, one to take photos and the other to

record data (Frame Number/Marker Number, etc.)

EQUIPMENT:

- 35 mm camera
- 2 rolls of slide film, 100 or 200 ASA, 36 exposures (20 photo points x 3 photos per point = 60 photos)
- DCR-VX700 Sony video camera with fully charged battery
- Extra fully charged video camera battery
- 2-60 minute Mini digital videocassettes. One should be plenty, but one is for backup.
- Backpack, personal gear, sunscreen, hat, water, etc.
- Field notebook to record date, slide frame #, marker #, personnel, notes, etc.
- Optional photo data information slate (BUIS, date, marker #)

BEACH PROFILE MONITORING PROTOCOLS

HISTORY:

Beach profile long-term monitoring points were established IN 1977 by West Indies Laboratory (WIL) researchers while conducting base line inventory of natural resources at BUIS for NPS. These beach profiles were established to monitor the rate of erosion at the northwest tip of the island through the year and provide a baseline set of profiles showing maximum changes in the beach over a one-year cycle. Ten stations were established beginning at the Southside Pier and continuing around the beach to the northern most end of the beach. Transect points were marked with steel rebar stakes to serve as the zero point for each transect. The process of sand transport and deposit occasionally reshapes the beaches on the island. Tide changes are small (0.5 feet) and occur twice daily (NPS, 1983). Beach profiles are conducted in February and October (minimum) to replicate historic profile dates, but for optimal sea turtle nesting beach monitoring, profiles should be conducted in Feb/Mar, June, Aug/Sept, and Nov/Dec, if possible.

BUIS BEACH PROFILE MONITORING PROTOCOLS:

The following beach profile methods and protocols are excerpts from Dr. Hubbard's final report to NPS, BUIS, December 1997.

Locations of Current Beach Profiles:

Beach Profile #	Location/NPS stake #	Compass Heading*	Date Monitored
BI - 01	North shore/ 003	358E	Aug/Nov 1997
BI - 02	North shore/ 008	338E	Aug/Nov 1997
BI - 03	North shore/ 021	325E	Aug/Nov 1997
BI - 04	West Beach/ 025	282E	Aug/Nov 1997
BI - 05	West Beach/ 029	266E	Aug/Nov 1997
BI - 06	West Beach/ 033	264E	Aug/Nov 1997
BI - 07	West Beach/ 039	242E	Aug/Nov 1997
BI - 08	West Beach/ 042	226E	Aug/Nov 1997
BI - 08A	West Beach/ 047	190E	Aug/Nov 1997
BI - 09	West Beach/ 051	210E	Aug/Nov 1997
BI - 10	NPS Pier/ 059	209E	Aug/Nov 1997

* = conduct beach profile transect along this compass heading off shore from transect point

METHODS:

The horizon is used to measure the change in elevation between two points. If the beach is dropping toward the shore, a line between the horizon and the top of the seaward pole will intersect the landward pole at some point. This point is equal to the drop between the two poles. When the horizon and the top of the seaward pole are

lined up, they intersect the landward pole at a point X cm from the top; this is the elevation change. If the ground rises toward the water, then the observer will line up the horizon and the landward pole and take the reading off the seaward pole. The profiles will be run using two similar methods. Both methods use two identical poles separated by a standard distance, usually 3 meters. By leapfrogging down the beach, the profile can be measured accurately.

Method 1:
Where the horizon is clearly visible seaward of the profile, the person behind the landward pole lines up the top of the seaward pole with the horizon (Fig. 9). When the horizon and the top of the seaward pole are lined up, they intersect the landward pole at a point equal to the elevation change between the two poles (Fig. 9, inset).
When the horizon is blocked, a hand level is used to determine elevation change. The hand-level is placed on the seaward pole (Fig. 10). The eyepiece is moved up and down until the bubble is centered in the field of view. At that point, the elevation change is read off the landward pole. This example assumes that the beach is sloping seaward. If the ground rises, then the measurement will be taken off the seaward pole, with the hand level moved to the landward pole.

Method 2:
When the horizon is blocked by land, the elevation measurement is taken with the aid of a hand level. The person with the seaward pole places the hand level near the top of the pole such that the center of the hand level is level with the top of the pole (Fig. 10). Sighting through the hand level, the observer changes the orientation of the barrel until the bubble inside the hand level is centered on the reference line (Fig 10, inset). At this point, the instrument is level and will intersect the landward pole at a point equal to the difference in elevation.

Measuring the Profile:
Before starting the profile, the height of the reference stake must be measured. This references the ground near the stake to a common reference - the top of the stake. This value should be measured to the nearest centimeter and entered at the top of the form provided.

One pole is placed on the ground near the reference stake. Care should be taken to not change the height of the sand in the process. Using a tape measure, the seaward pole is placed either at a standard distance away from the first pole or at some important feature you want to locate. Using whichever method is appropriate, the change in elevation is measured as shown in Figures 9 and 10.

Notes:
Record the horizontal (in meters) and vertical changes (in centimeters) on the form provided for data collection. As a standard, use a minus sign on the vertical values to designate a drop in elevation, and a plus value to note a rise in elevation. After the first reading, move the landward pole to the exact spot where the seaward pole previously sat and move the seaward pole seaward. By stepping down the beach in this fashion,

the change in elevation over the profile is measured.
It is important to be careful with set-up and measurement. The tape should be pulled tight and held level between the two poles. Otherwise, the measurement will be inaccurate. Both poles should be perfectly vertical. Otherwise, both horizontal and vertical measurements will be erroneous. It is also important to get the poles in the same point as they are moved down the beach for each measurement.

As you move down the beach, take notes on what is in the interval between poles. Think of the sides of the box as representing the two profile poles. Any measurements (e.g., to the waterline or a change from grass to sand) are referenced to the landward pole and the left side of the data box.

Both researchers need to watch the other to make sure the poles are straight. The person on the seaward pole will generally be responsible for keeping the profile on line by lining up with the landward pole and the reference stake at the start of the profile. You may have to place a temporary stake on the beach to help with this if you cannot see the reference stake clearly all the time.

Table 2. Computing the profile change from the data on the field sheet.

Relative (from data sheet)		**Absolute**	
Hor	**Vert**	**Hor**	**Vert**
		0.0	-65 (stake ht)
3.0	-4	3.0	-69
3.0	-12	6.0	-81
3.0	*+5*	9.0	-76
3.0	-2	12.0	-78
2.5	-25	14.5	-103
3.5	-6	18.0	-109
3.0	-13	24.0	-122
3.0	-13	27.0	-135
1.8	-6	28.8	-141
4.2	-25	33.0	-166

Plotting the Data:
Whether you use graph paper or a spreadsheet, the method for plotting is basically the same. First, the data from the field sheets must be converted to absolute change referenced to the top of the starting stake. The first plotted point will have a horizontal value of "O" (i.e., it is at the stake) and a vertical value equal to the stake height multiplied by minus 1 (i.e., the elevation below the stake's top - -65 in Table 2). Subsequent values are calculated by adding the value of each paired data set to the absolute value computed above. For example, 3.0 is added to 0.0 and -4 is added to -65 to get -69; then 3.0 is added to 3.0 and - 12 is added to -69 to get -8 1; and so on.
The data should be plotted with the vertical dimension exaggerated by three to five times. If one inch equals one meter vertically, then one inch horizontally will represent from three to five meters. This is the way the eye sees things, if you plot the profile at

one-to-one, it will look flatter than you remember it.

PERSONNEL:

2 people minimum, preferably 3 so the third can record data.

EQUIPMENT:

- two poles that are exactly the same length and identical marked
- a tape measure
- a hand level
- sufficient profile data sheets

Try both methods once before taking actual data. Go to some spot where you can see the horizon and the ground slopes toward it. The person who is located landward should determine the elevation change using method 1. The seaward person should use the hand level, and should get the same reading. Keep practicing until both people are comfortable with both methods and you can get the same readings by either method.

BEACH TEMPERATURE MONITORING PROTOCOL

At Buck Island Reef NM hawksbill sea turtle nesting activities occur predominantly within shoreline vegetation and beach forest. The vegetative cover shading hawksbill turtle nests may have an important influence on the temperature regimes that are critical for the nest development, hatchling sex determination, and hatch success. Hurricanes in 1989 and 1995 altered the vegetative cover along the shoreline and in the beach forest nesting areas. In 1995 and 1996 hawksbill hatch success was significantly reduced in nests laid in the beach forest habitat, in dark soil with no vegetative cover. To determine the beach temperature regime through the nesting season BUIS initiated a beach temperature monitoring study. This study collects ambient beach temperature at 30 cm (the mean depth of a hawksbill turtle's clutch) in the four nesting areas (NS, WB, SS, TB) with various vegetative covers. Temperatures are collected from April through December. The objective is to collect seasonal beach temperatures and record the effect vegetative recovery has on nesting beach temperature in the four primary nesting areas.

LOCATION OF UNITS:

North Shore:	Marker 4, Beach forest/Berm top
	Marker 14, Shoreline Vegetation/Beach forest
West Beach:	Marker 38, Open Beach/dune grass
South Shore:	Marker 71, Beach forest/Shoreline Vegetation
	Marker 82, Beach forest
Turtle Bay:	Marker 93, Shoreline Vegetation

SEASONAL DEPLOYMENT PROTOCOLS:

Length of deployment has been set at 120 days (four months). This deployment regime was selected because it best covers the daily temperature changes throughout the sea turtle nesting season. Dataloggers are deployed by the following schedule: April to July, July to October, and October to January. In January the units are pulled, downloaded, and shipped for calibration.

1. Prior to the start of the sea turtle nesting season, usually in January, all datalogger units are sent to the University of Alabama for battery replacement and calibration in incubators.

2. Units are typically returned to BUIS by March for redeployment on the nesting beaches.

3. Omega datalogger units use a host software called BOXCAR. Each unit is launched from the NRM computer. BOXCAR is located in the Omega directory but also has a shortcut icon. Hook the unit up to the computer with the data plug. Select launch. Set to data collection for 120 days. Unit will be programmed to collect temperature readings in Celsius every 1.6 hours. The unit has been successfully launched when

the red light on the unit begins to blink.

4. Write out an identification card for each unit, including - Unit #, Date launched, beach site where it will be deployed, and the name of the technician who did the launch.

5. Each unit and the corresponding identification card is placed in a plastic vacuum bag and sealed with vacuum sealer.

6. After sealing, over lay one edge of vacuum bag with duct tape to attach a monofilament tether (fishing line). The tether should be at least 3 feet long. A small hole is placed through the duct tape and one end of the tether is passed through and tied in a knot. The free end will be tied to a permanent steel stake at each beach temperature monitoring site.

7. Units are installed at respective beach sites on either the day launched or the following day and ANesting Beach Temperature Study Datasheets≅ are filled out with all appropriate information.

8. The holes for the beach temperature units are usually left open after each removal. However, rain or animal activity can fill them in. Each hole should be dug out and the 30 cm bottom depth checked with tape measure. Place the unit in the hole and tie the free end of the tether to the steel stake behind the hole.

9. Fill the hole with soil and cover with ground litter, replicating the natural ground cover in the general area.

10. The unit is removed 120 days later. Record the time the unit is removed from the hole on the temperature data sheet.

11. Bring units back to NRM office and remove from a plastic bag. Note if the red light is still flashing or not. If the light is off, it indicates that the unit has shut itself off. The deployment may have gone longer than 120 days, but data are still retrievable.

12. Hook the unit up to NRM computer data cord and initiate data download through Omega Boxcar software.

13. Name each data file as follows: Unit #, Month and Year of Launching (example: 008Jun97). Print out a copy of the temperature graph for each unit. The printout should be attached to the field data sheet and stored in the Nesting Beach Temperature Study notebook.

14. Raw data are stored on NRM computer hard drive and on a backup disc.

15. After download, the unit is launched again for the next beach deployment. Each battery will last for 1 - 2 years.

16. Launch/download information is recorded on a Quattro Pro spreadsheet entitled ADatalogger Information Sheet≅ (NRM computer Quattro Pro file datalogg.wb2)

PERSONNEL:
One or two people

EQUIPMENT:
- Omega Temperature Logger, RD-Temp, 8 - 10 Units
- BOXCAR software & NRM PC w/ data cord
- food storage vacuum sealer and plastic bags
- permanent marker and white note cards
- duct tape & fishing line
- trowel for digging holes (optional)
- meter stick or fiberglass tape measure
- disposable gloves

BUIS NESTING BEACH TEMPERATURE STUDY

Data Logger Unit No. _____

Unit Calibration Information:

Calibrated by _____ Calibration Date:_____

Unit Deployment and Retrieval Information:

Date Unit Launched:_____ Time:_____

Date Unit Installed:_____ Time:_____

Date Unit Retrieved:_____ Time:_____

Date Unit Downloaded to PC:_____ Time:_____

Filename:_____

Unit Installation Information:

In a nest? Y N If yes, nest ID #_____ &=s Primary tag #_____

Depth of unit from surface _____(cm) Loc.. within nest: Top Middle Bottom

Ambient Marker # to Left= # _____ Distance_____ Marker # to Right= # _____

Distance_____

Distance from HWM_____(meters) Photographs:_____

Open Beach ~ Shoreline Vegetation ~ Beach Forest ~

Habitat Description:_____

Vegetation/ Type cover:_____% Soil _____%

Percent cover (% shade over site unit)_____%

Comments:_____

_____

_____

_____

_____

_____

PEAK SEASON NESTING SEA TURTLE MONITORING PROTOCOL

INTRODUCTION:

Each year sea turtle nesting activities are recorded on Buck Island Reef NM from January to December. All three species that nest in the Virgin Islands, leatherback *(Dermochelys coriacea)*, green *(Chelonia mydas),* and hawksbill turtles (*Eretmochelys imbricata*) nest on BUIS. Turtle nesting activities have been recorded as early as March, which is typically a leatherback nesting activity, however it can be either a leatherback turtle or an early hawksbill turtle. No more than three leatherback turtles have been recorded nesting on BUIS in any year. Their activities are concentrated on West Beach. Leatherback nesting continues until May, and all nests are hatched by July. Green turtle nesting begins in May/June and peaks in August. BUIS typically sees no more than three green turtles per season. They concentrate their nesting activities on either West Beach or in Turtle Bay. The last clutches of eggs will have hatched by October.

Hawksbill turtles have been recorded nesting in every month of the year on BUIS. Their nesting season can begin as early as March and continue through December. On average, no more than five hawksbill turtles will be nesting pre-peak season (April to June), and many of these females will still be nesting when the nocturnal nesting beach research program begins in July. In June, numbers of hawksbill turtle activities will increase from one per week (preseason) to five per week, signaling the start of the nesting season. During peak season there will be between 8 and 14 nesting activities per week continuing through mid-October (NPS annual reports, 1995-1997). Seasonal hawksbill nesting activities will continue through December and often carry over into the next calendar year. These carry-over activities (usually less than 5) are recorded as belonging to the next nesting season although biologically they probably belong to the end of the last season. Defining the nesting season according to the calendar year was necessary for use with the BUIS Sea Turtle Research Program database.

From January to April, BUIS Resource Management and volunteers conduct daytime nesting beach patrols. The number of late season nesting activities determines whether the beach needs to be patrolled once or twice per week to keep up with nesting activities. Nests are checked and post-hatch nest excavations are conducted during the daytime patrols.

Pre-season nesting beach preparation begins in May. Daytime patrols are increased to twice per week in order to service nesting beach markers, conduct beach profiles and photo-point documentation, and install nesting beach temperature dataloggers. From May to June, daytime patrols are maintained by RM staff documenting nesting activities, recording predation and any conflicts between sea turtle nesting and visitors. NPS begins a public education campaign through newspapers and radio stations, to inform the public of changes in Monument regulations pertaining to sea turtle nesting.

The last week of June is the first week of the BUIS Sea Turtle Research Program. Seasonal research staff arrives and the daytime training and orientation week begins. BUIS RM staff provides both classroom and field orientation to NPS, BUIS, the natural resources, boat operation, safety, and the sea turtle research program. Nightly nesting beach monitoring and research begin the first week of July. During the first four nights of the program, every member of the research team is on BUIS. They are learning to see Buck Island in the dark, practicing the patrol schedule, learning about hawksbill turtles, how to collect data on nesting adults, eggs, and hatchlings, nest relocation, hatch success determination, radio communication, boat handling, safety and emergency procedures, experiencing a 12-hour work night, and most important, learning how to be a team doing hawksbill sea turtle research on Buck Island Reef National Monument.

During the first two weeks of the nighttime nesting beach research, everyone works in pairs or groups, always with one experienced team member overseeing the data collection. Everyone has to learn to flipper tag, measure and weigh the turtle, nest, and eggs, collect blood for genetics, record all data, take standardized photographs, and maintain the patrol schedule. Because the BUIS Sea Turtle Research Program is often shorthanded, there are times when a team member will have to work up a turtle completely alone, at least until it comes time to weigh her. After the three training weeks are completed, there will typically be three people on patrol each night. Two individuals patrol, trading off with the third person, which roves between the two beaches to assist with nesting turtles as needed.

Barring tropical storms and hurricanes, each season the BISTRP spends about 90 nights on the beach. By the end of September, the NPS seasonal biological aide is no longer on the payroll, and the team has paired down to only those team members that can stay voluntarily through to the middle of October. Nighttime nesting beach patrols end about October 7 and daytime patrols resume. During the daytime patrols, prior to the teams= departure from St. Croix, all nesting activities will be reviewed and hatched nests excavated. A final review of data sheets and the database entries will be done, and corrections made as necessary. It is critical that the BUIS permanent staff visits, and reviews, each nest site with the field technician that recorded the activity to ensure that it can be found later for nest excavation. This guarantees quality control and that all confirmed nests are accounted for at the end of the season. During this week, the end of season photo-points and perpendicular beach measures will be done as well. Prior to the departure of the research team, all equipment will be turned in and an inventory conducted. Most of the project equipment has been in service for more than five years, and we hope will continue to serve the project for many more years. After the departure of the seasonal research team, the responsibility for daytime nesting beach monitoring patrols returns to the BUIS RM staff and volunteers. Daytime patrols are conducted at least three times per week, especially when there are lots of nest excavations to perform. By the middle of December most of the hawksbill nests have hatched and activities are less than one per week. Frequently the final hawksbill nest

isn’t excavated until February the next year.
Few other sea turtle research programs have to travel to the nesting beach by boat each night and leave again each morning, nor do they have as long a work night, or as long a nesting season as this one. Because of these demands on the research personnel, extensive protocols have been developed for everything from boat maintenance to data recording. This program has worked, and is ongoing, because of the adherence to standardized nesting beach methods and protocols, with emphasis on personal safety at all times.

2000 BUCK ISLAND SEA TURTLE RESEARCH PROGRAM
NESTING STUDY OBJECTIVES

1. **Saturation Tagging** - Every sea turtle encountered will be identified by tagging.

2. **Genetic Identification** - Each nesting turtle will have a tissue sample taken for genetic analysis.

3. **Diagnostics** - Every time a sea turtle nests the following data is collected: carapace measurement, carapace drawings, and descriptions, sketches, and samples of ectobiota from the carapace, photos of anterior, posterior, and overall carapace, and head profile.

4. **Nest Measurements** -For any nests that need to be relocated, measure nest top (height), then remove all eggs, then take nest bottom (depth) measurement. Also measure neck and bowl widths. Eggs should be counted when deposited in new nest hole.

5. **Nest Site Characteristics** - Record description of each nest site, including; percent soil, type of vegetation, distance from nest to seaward vegetation, and high water mark. This information is critical for determining effects of erosion events on beaches.

6. **Egg Measurements** - For remigrant hawksbill turtles for which this is the third season or more in which they have been seen, weigh and measure a random 10 eggs from each of her nests throughout the season.

7. **Temperature Studies -** Ambient beach temperatures will be recorded on all 4 nesting beaches by Omega temperature data loggers buried at a depth of 30cm.

SEA TURTLE NESTING ACTIVITY TYPES & DEFINITIONS

Description of the types of sea turtle activities observed on BUIS beaches.

There are several types of sea turtle nesting activities. A **nesting activity** is defined as anytime a gravid female sea turtle leaves the water to attempt nesting. Every time a nesting female is on the beach, it is considered one nesting activity. At BUIS, there will frequently be several sets of half-moon crawls in a row, especially if the turtle hits a steep berm and is turned back to the sea. All of these tracks could be from the same turtle or possibly made by two turtles on the beach at the same time. Each set of tracks; one coming out of the sea and one back to the sea, is considered one activity and recorded on a single data sheet. The direction of the turtles= crawl can be determined with training, even the often light crawl tracks of a hawksbill turtle.

If egg deposition occurs during that Aevent,≅ or Aactivity≅ as we chose to call it at BUIS, it is a **Confirmed Lay**. If egg deposition is not actually observed, determining if a sea turtle has actually laid eggs from the disturbance left behind on the beach, requires years of practice Areading≅ turtle nesting activities, and the result of the outcome is an educated guess at best. A Aconfirmed lay≅ nesting activity typically has one set of tracks leading out of the sea and up the beach. These tracks terminate in a body pit. The nest hole is dug at one end of the body pit or other depending on her orientation. (Turtles do not always face into the beach while nesting!) During the excavation of the nest hole the turtle will create two piles of sand, between her front and hind flippers, one on each side. Even after laying and covering the nest, evidence of these two piles should still be visible. During camouflaging, when the turtle uses all four flippers to cover/camouflage the nest site, sand is thrown backward with her front flippers. This will give the sand immediately around the nest area a very fluffy appearance. While she is camouflaging the turtle is ever so slowly moving forward off the nest. The final body pit, usually has deep sharply defined edges and is often well forward of the actual nest site, for hawksbill turtles this could be one meter or more. When the hawksbill is done camouflaging, she immediately heads back to the sea, her departure tracks leaving directly from that final body pit (Figure 11).

If the nesting activity was interrupted or the turtle did not find a suitable nest site and left the beach, it is called an **Emerge No Lay**. Unsuccessful nesting activities have been called by many names including, dry run and false crawl. All three terms have been used at BUIS. In 1995, the Buck Island Sea Turtle Research Program settled on the term Emerge No Lay, which best describes the activity according to the turtle's biology and actions. Determining what caused a turtle to abort her nesting attempt is not always easy. At BUIS a whole host of reasons has been determined, some natural some not.

Prior to Hurricane Hugo, September 1989, on average, the emergence to lay ratio was 1 to 1 on all nesting beaches. After the hurricane, which eroded berms and blocked access to beach forest nesting areas, the emergence to lay ratio jumped to 3.5 to 1. In many instances hawksbill turtles were leaving the sea and trying to climb up one-meter high berms. Crawl tracks were found scalloping up and down the beach for more than 20 meters. Fallen logs and debris prevented access to the nesting areas as well. Turtles began nesting in whatever Abeach≅ they found leaving many nests threatened by erosion. Between 1989 and 1992 Resource Management cleared away some of the fallen debris and reopened access to the principle nesting areas. In some severely eroded areas Asand ramps≅ were constructed to improve turtle access to the beach forest.

Hawksbill turtles will abort a nesting attempt for a variety of reasons. They are tenacious in their nesting attempts, and have to be to successfully nest in the beach forest area at BUIS. Frequently hawksbill turtles dig 3 to 4 nest holes prior to making a successful one. Investigation of the aborted nest holes will find rocks or coral cobbles, collapsing sand, and thick roots they could not break with their flippers. They will tolerate roots in the nest chamber and often dig their nests around a root that bisects the neck of the nest. Hawksbill turtles can climb steep berms to reach the beach forest, but slopes greater than 45E presents a problem.

Human disturbances will turn any species of sea turtle off the nesting beach. Bright lights, loud noises, moving shadows and rough contact, especially during the initial stages of nesting, will cause a hawksbill to leave the beach. At BUIS, with the explosion of the tree rat population, it is suspected that rats drawn to a nesting turtle's activities may get so curious and numerous that their presence has Ascared≅ turtles off the beach. During the full moon, patrolling research personnel have wondered if their movement along the beach has caused turtles to abort emergences. There have only been a few encounters along West Beach where this might have been the case. No matter what the reason, aborted nesting attempts are not energetically Agood≅ for the nesting female and each season BISTRP tries to mitigate the stresses a nesting turtle may encounter on the beach.

BUIS DAYTIME SEA TURTLE PATROL PROTOCOLS

BISTRP daytime patrols are conducted January through June and resume again from mid-October through the end of December, after the end of the nocturnal research program. Daytime foot patrols are conducted one to two times per week January through May, and depending upon the number of early turtles, one to three times per week from May through to the start of the nocturnal program (July to mid-October). From mid-October to the end of December, patrols are conducted two to three times per week to monitor the end of season hawksbill activities and keep up with nest excavations. All patrols are conducted on foot along the four principle nesting beaches. A full patrol of all four beaches may take up to 3 hours depending on numbers of activities to record and nest excavations. A patroller walks along the shoreline looking for sea turtle tracks indicating nesting activity and hatchling tracks signifying a nest emergence.

SEA TURTLE BEACH PATROL AND DATA RECORDING:

1. Travel to Buck Island via NPS patrol boat. Anchor or dock the boat at the pier.

2. Leave the pier and walk to marker 1 at the far end of North Shore (NS). En route, make a mental note of any sea turtle activities to record on the return walk. Once at NS 1, patrol back to the pier and continue on south to Turtle Bay marker 100, recording activities as they are encountered.

3. Walk along the beach looking for signs of sea turtle nesting activities. In areas with high visitor use, it may be difficult to distinguish sea turtle activities from human activities. Look carefully for crawl tracks, crushed vegetation, and depressions resembling turtle body pits. If an activity looks suspicious, record it. It will be checked in 60-70 days for signs of emergence and it will be determined at that time if there was a nest or not.

4. When a sea turtle activity is found, record all requested information on a Daytime Activity Log.

5. After all data have been recorded, “clear” the area. This means to remove all signs of a sea turtle nesting activity or a human activity. This will help prevent either yourself or someone else from accidentally recording the activity again by mistake at a later date. Fill in any abandoned nest holes and cover the body pit with sand and/or leaf litter to make it blend with the surrounding area.

6. Either draw a line in the sand/soil across the area, or place small sticks (referred to as “Crumbley” sticks after the technician that developed the method) standing across the front of the body pit. The next time this area is patrolled, if the line is obliterated or the sticks are knocked down, the researcher will know to check to see if a turtle has crossed the area and another activity has occurred.

7. Once the activity is □cleared□, continue foot patrol and record all activities as they are encountered, until the beach has been completely patrolled.

8. At the office, assign an activity number to each data sheet in chronological order, using the next available number for that season.

9. Enter all data into the BUIS Sea Turtle Database.

10. Make a copy of the data sheet and place the original in the activity book for that years activities, and place the copy in the duplicate book as an archive copy.

PERSONNEL:

One person can do the entire patrol. If two people are available, they can go opposite directions from the pier and one will cover NS/WB while the other patrols SS/TB.

EQUIPMENT:

- Clipboard and pencil
- Daytime Activity Logs
- Backpack, personal gear, sunglasses, sunscreen, lots of water, etc.
- NPS Handheld Radio

SEA TURTLE DAYTIME ACTIVITY LOG
BUCK ISLAND REEF NATIONAL MONUMENT, USVI **Activity No._____**

Date of Activity : _____ /_____/ 2000

Species: HB GR LB **(Date Recorded: _____ /_____/ 2000)**

Sector: NS WB SS TB Mkr #: _____ Dist from Nest (m): _____ Dir to Mkr:_____

DISTANCE FROM NEST (meters): to HWM _____ to SEAWARD VEG _____

Habitat: OB SV BF % Soil: 100 / 75 / 50 / 25 / 0 Cover Type:_____

RESULTS: LAY / NO LAY / SUSP REASON:_____

ACTIVITY/ NEST DIAGRAM

Perpendicular Measures

COMMENTS:

PRIMARY TECHNICIAN:_____OTHERS:_____

BUIS "SEA TURTLE DAYTIME ACTIVITY LOG" TERMINOLOGY KEY

Act. No.: Activity Number: This is the sequential number of the activity within a given year (January 1 to December 31). This number is not filled out in the field, but assigned back in the office. Before assigning activity numbers, all data sheets are put in order of occurrence by date, then the next activity number is assigned in chronological order. The first two digits represent the year of the activity; the last three numbers represent the sequential order of the activity for that year. For example, Activity Number 98-058, would be the fifty-eighth activity observed in 1998.

Date of Activity: Record the date on which the sea turtle activity occurred as determined by examination of the site.

Species: Circle the appropriate code for the species of sea turtle that created this activity: HB=hawksbill, GR=green, and LB=leatherback.

Date Recorded: Record the date on which the sea turtle activity was encountered and recorded on the data sheet.

Sector: Circle the appropriate code corresponding to the location of this activity. NS=North Shore, WB= West Beach, SS= South Shore, and TB= Turtle Bay

Mkr#: Marker Number. Write in the number of the marker closest to the activity. All directional measurements are made to this marker.

Dist. From Nest (m): Distance from Nest. Pace off the distance to the left or right of the marker and parallel with the waterline, from the nest to the nearest marker. Do not measure diagonally. All measurements are recorded to the nearest 2 meter. (See example data sheets.)

Dir. to Mkr: Direction to Marker. With your back to the sea, determine whether the nearest marker is to the left or the right of the nest, or if it is seaward or landward of the nest if the marker is directly in line with the nest.

Distance from Nest to HWM: Distance from the Nest to the High Water Mark. Stand over the nest, then pace off and record the straight-line distance from the nest to the high water mark at the time the activity is recorded.

to SEAWARD-VEG: distance from the nest to Seaward Vegetation. Pace from the nest to the seaward edge of the beach vegetation and record the measurement. If the nest is in front of the vegetation line, pace off the distance from the nest back to the vegetation line, enter the measurement, and write Ain front≅ next to the number, indicating that the nest is in front of the seaward vegetation.

Habitat: Circle the appropriate letters. This identifies the habitat in which the activity occurred. OB= Open Beach, open sand beach with no vegetative cover or perhaps sparse beach grasses. SV= Shoreline Vegetation, low ground cover consisting of purslane, sporadic shrubs, or beach vines. BF= Beach Forest, vegetative cover consisting of hard wood trees or saplings, usually located above the berm.

% Soil: Percent Soil content. Circle the closest number that represents the percent soil content present at the activity site. (Ex: 0% would indicate sand with no soil, and 100% would be all soil, no sand.)

Cover Type: Record the type of vegetative cover over the nest. (i.e., none or open, sage, purslane, manchineel, casha, etc.)

Results: Circle the result as determined by examination of the activity. LAID= egg deposition did occur. NO LAY= egg deposition did not occur. If unsure, circle the best guess and write Asuspected≅ above it. All activities are checked in 60-70 days for signs of hatch emergence and a final determination will be made at that time.

Reason: If this activity is determined to be a No Lay, record any reasons that may have contributed to egg deposition not occurring (i.e., roots or rocks in the nest hole, human or other animal disturbance, high water, steep berm, etc.).

Activity/Nest Diagram: This area is used to draw a sketch of the activity site. **All** drawings are made with the technicians back to the sea. The sketch is used, in conjunction with the measurements, to locate the nest for hatch determination 60-70 days after the activity occurred.

Perpendicular Measures: Pace off the perpendicular distances from the nest or activity, to the nearest marker. Draw the perpendicular lines representative of the path from the nest to the marker, indicate the distance in meters. Indicate the marker number in the drawing. (See data sheet examples.)

Comments: Make any additional notes about the activity in this section.

Primary Technician: Record the first and last name of the technician that worked the activity most. This is not always the most senior technician, but who physically did most of the work for this activity.

Others: List all other technicians, visiting researchers, and guests that were present during the recording of the activity.

BUCK ISLAND SEA TURTLE RESEARCH PROGRAM
Buck Island Reef National Monument

NIGHTLY SEQUENCE OF EVENTS FROM HOUSE TO BUCK ISLAND & BACK

DEPART NPS HOUSING & TRAVEL TO BOAT:

1. Bio Aid or Program Director is the primary technician for the night. They are responsible for making the final weather check with Superintendent or Resource Management Specialist (if not on duty) by 1700. If bad weather is predicted, patrols may be canceled. Once nightly patrol approval is given, the research team departs.

REMEMBER- DRIVE ON THE LEFT

2. Bio Aid and Nightly Research Team depart Sion Farm by 1745 - 1800. Primary technician is responsible for checking volunteer schedule to ensure adequate beach patrol coverage for the night, preparing and bringing necessary field gear, NPS radios, and all other necessary research materials.

3. Local volunteers will rendezvous with team at Green Cay Marina by 1830. Boat should be ready to depart by 1845 at the latest.

BOAT PREPARATION & DEPARTURE from GREEN CAY MARINA:

1. Boat Preparation:
   A. Captain/ Primary technician designates crew to assist with boat preparation and handling. Open cabin and stow all gear securely.
   B. Organize guests. Review boat safety (volunteers and guests should have arrived by 1830). Handout life jackets to all passengers, crew, and captain and everyone must put them on anytime the boat is underway.
   C. Turn battery switches to “ON” position.
   D. Place the keys in ignition attach the safety clip (dead man’s switch).
   E. Both NPS and VHF Marine radios should be turned on.
   F. Lower the port and starboard engines using trim\ tilt switches.
   G. Check the fuel level. If fuel is at 2 full, boat should be refueled the next day.
   H. VRO oil reserves should be checked every Sunday night.
   I. Take the throttles out of gear. Pump each throttle twice and pull them back to neutral position.
   J. Depress the ignition key, “choke”, while turning it to start the engine. This engages the choke mechanism.
   K. Start the engines and let them idle at 1000 rpm for 3-5 minutes warm up.
   L. Make sure coolant water is running out of the side of each engine (should be a strong jet stream).

M. All gear and equipment should be stowed and secured.
N. Review safety procedures with all passengers and be sure that they are safely positioned before leaving the dock.
O. Complete final boat check and prepare for departure. Immediately notify Superintendent or Resource Management Specialist by phone or radio of any boat problems.

2. Departure from Dock:

A. Captain is at the helm.
B. Crew releases port side dock lines and then moves forward and stands by on bowlines for Captains order to release lines.
C. Second crew stands by starboard stern line and third crew stands by starboard "brake" line.
D. When in place Captain tells crew to release all lines and Captain slowly backs out of slip. Crew stands by to fend off as needed.
E. Using both engines, slowly back the boat out of the slip at idle speed.
F. About two boat lengths out of the slip put port engine in forward and leave starboard in reverse. Bow will turn to starboard.
G. Once bow is pointed toward breakwater put both engines in forward.
H. Proceed out of marina at slow speed. No wake. Crew brings in both fenders and stows them.
I. Once a month check the water level in the batteries.
J. Make NPS and VHF Marine Radio checks outside the marina breakwater.
K. Captain makes last safety check, making sure that all passengers are seated and gear is secure before beginning travel to BUIS at a safe speed.

ARRIVING AT BUCK ISLAND:

1. Travel time from Green Cay Marina to Buck Island (BUIS) is between 15-20 minutes depending upon sea conditions. Rate of speed is determined by sea conditions.

2. Reduce speed outside the West Beach anchorage. Remember this is a No wake zone. Make safe arrival radio check.

3. Motor up to each boat anchored off West Beach:
A. Hail the boats occupants.
B. Identify yourself and NPS Sea Turtle Research Program.
C. Ask if they are spending the night at BUIS. If they are...
Explain that the island is closed to visitors at night, and that lights and noise in the anchorage must be kept to a minimum.
D. If this is their first visit to BUIS, offer them a BUIS brochure (they are stowed below in cabin). Thank them for their time and wish them a good night.

4. Proceed to pier for docking.
   A. Designated crew prepares stern anchor and bowlines for docking.
   B. Crew advises guests to stay seated until the boat is docked.
   C. Approach perpendicular to the pier, slowly. No wake.
   D. Designated crew drops and sets anchor on Captain's order. Second Crew is already on the bow.
   E. When boat is close enough to pier Second Crew steps off and secures bowline.
   F. Crew works together to secure bowline and anchor line setting boat at safe distance from the pier.
   G. Once lines are secure engines are turned off.
   H. Captain shuts off the VHF marine radio.

5. Crew and guests remove and stow life jackets and then move provisions, coolers, and equipment to pier and everyone disembarks onto pier for the night.

6. Captain secures cabin. Close door, shut off all lights and fans. Keys remain in the ignition throughout the night.

Upon arrival at BUIS Primary Technician is responsible for -

1. Giving orientation to any new volunteers and guests.
2. Providing staff with "Female Priority List" updates.
3. Reviewing expected hawksbill arrivals, who needs blood taken, photos needed, weights needed and nest emergences expected.
4. Assigning patrol teams (maximum of 4 people per team with at least one being a research staff member), patrol schedule, and radio check-in schedule.
5. Reviewing beach protocol and etiquette (e.g. lights, voices, encountering a turtle, encountering people on the beach, safety, vegetation and hazards, terrain, and what to do when, etc.
6. Patrols should begin by 1700 or 1715 at the latest.
7. Final patrol in 0500 or until last turtle is off the beach.

PREPARING TO DEPART BUCK ISLAND in the MORNING:

1. Prior to boarding the boat, rinse the sand off your feet and/or dive booties.

2. Primary technician:
   A. makes sure everyone has returned to the boat.
   B. checks to see that the shed has been locked, all equipment is aboard the boat (ie. Scale, turtle kit, etc.) and collects all equipment from visiting volunteers.
   C. collects data sheets from all field technicians and checks to make sure they are complete.

3. Primary technician/ Captain and crew prepare boat for departure from Buck Island.
    A. Start and warm up engines
    B. Stow equipment and get passengers seated.
    C. Life jackets are handed out to everyone and put on.

4. When Captain gives OK, crew removes bowline from pier cleat and boards boat.

5. Second Crew begins pulling up anchor. Tells Captain when anchor is aboard.

6. Crew stows anchor and bowline and advises Captain so they can begin traveling back to STX.

7. Captain/Crew ensures all passengers are secure. Begin departure from BUIS. Safe speed to St. Croix.

8. Arrival at Green Cay Marina (0515-0530):
    A. Reduce speed well outside breakwater to eliminate wake.
    B. Passengers are advised to stay seated until the boat is secure.
    C. First Crew prepares boat hook to catch starboard side line that is tied from forward side of cleat to secure line. Tie off starboard stern line then move to dock to hand off lines for bow and port.
    D. Second Crew stands by at starboard mid-ship cleat and waits to pick up "brake"
    E. Third crewmember puts out the two starboard fenders when inside marina and
    F. Once in slip with three starboard lines attached. Crew works on securing bowlines
    G. Captain shuts off engines and collects life jackets for other passengers.
    H. Once all lines are attached and all crew are back aboard, gear is stowed and equipment handed off the boat.
    I. Once all gear is off the boat Captain centers and raises engines. Remove keys and
    J. Crew/Captain rinses the boat and engines off with fresh water. Remove all sand.
    K. Fill out the Boat Use log (yellow spiral), Nightly log, and Patrol log.
    L. Close all cabin windows and door. Lock cabin.
    M. **TURN OFF THE BATTERY SWITCH!**
    N. Load all equipment into NPS vehicle and drive safely back to housing.

DO A FINAL VISUAL CHECK TO MAKE SURE EVERYTHING IS DONE.

** If wind and sea conditions are rough the boat may be docked at the end of the fuel dock. The primary technician **must** notify Superintendent or Resource Management Specialist so they can move the boat into the NPS slip first thing in the morning.

RETURN TO NPS HOUSING:

1. All equipment is unloaded from the vehicle and brought into the house.

2. All radios are turned off and placed in chargers.

3. All specimens (ex. Blood, serum, ectobiota etc.) are removed from cooler. Serum samples are placed in freezer. Blood, tissue, and ectobiota samples are placed in refrigerator.

Make sure all samples are **completely and properly labeled before putting them away.

4. All booties and rain gear (if it was used) are **hung** out to dry. Do not leave any equipment on the ground outside, neighborhood dogs may come and take it and/or chew on it.

5. Turtle Weigh bag is unpacked and the bag and ropes are hung out to dry if they are wet. All sand is cleaned from the equipment (ie. Calipers, scales etc.). ***Please, wash the weigh ropes when dirty. They can be put in the washing machine with other field items.***

6. In the afternoon, the blood kits and egg rinse water are restocked.

7. After all gear is cleaned and restocked, it should be packed by 1600 in preparation for that nights patrol team.

NIGHTLY NESTING BEACH PATROL PROTOCOLS

The research team and guests depart St. Croix's Green Cay Marina at approximately 1830 for the 20-minute boat ride to Buck Island Reef NM. Once the captain and crew have secured the boat at the pier, all passengers remove and stow life jackets. Then coolers, provisions, and equipment are moved to the pier and everyone disembarks for the night. All equipment and radios are turned on, checked, and packed in backpacks in preparation for the night's patrols.

The primary technician distributes flashlights and ponchos to all guests and VIPs (Volunteers in the Park). While on the pier, he/she will gives an orientation to the Buck Island Sea Turtle Research Program (BISTRP), discussing what can be expected during the night, what will happen when a turtle is encountered, patrol protocols, and beach safety and etiquette (e.g., lights, voices, encountering a turtle, encountering people on the beach, vegetation and hazards, terrain, eye protection from sand and awareness of movements that could get sand in someone else's eyes etc.).

The primary technician reviews which turtles may be encountered that night with all team members and guests. Each night at least one person that worked the previous night is scheduled to be back on the beach. It is their job to tell the team and guests about the previous nights= activities and the turtles that emerged but did not lay and may be back. Each member of the research team carries a small field book called the AFemale Book≅ in which they list each turtle seen during the current nesting season and her activities. Each entry includes the turtle's primary tag number and all tags present on the turtle when it was last observed, which of the data collection requirements have been completed for the season and what data still needs to be collected, date and marker where the turtle was last encountered, and if she nested or not during that emergence. All technicians must be sure their book is updated with the most current information. Usually this is done on the pier prior to starting the first patrol.

There are usually a few unique experiments carried out on certain turtles each season. These turtles are identified as APriority Females.≅ Some past APriority Female≅ experiments include; sequential egg measurements on all eggs laid by an individual turtle for each of her clutches that season; weighing the female after each clutch is laid to determine weight loss per clutch and over the nesting season; measurement of ten random eggs and nest measurements from each of an individual's clutches; and radio and satellite telemetry candidates and recipients. The team will review if any APriority Females≅ are expected and what will be done when they are encountered.

ESTABLISHING PATROL TEAMS FOR THE NIGHT:

Typically, at least three people are scheduled each night, but the number may vary depending on guests and volunteers. The primary technician assigns the patrol teams and patrol routine, governed by the number of staff that night. Each patrol team will have at least one BISTRP technician. Any changes in the patrol teams or schedule will

be cleared with the primary technician and communicated to the other team.

POSSIBLE PATROL SCENARIOS:

< 3 Person Staff - each team consists of one person and the third person will be the "Rover≅. The Rover can work with either team during regular patrols, but when a turtle is nesting, the Rover helps the person with the turtle.

< 4 Person Staff - each team consists of two persons conducting regular patrols. When one team gets a turtle, one member of other team becomes the Rover and goes to help the team with the turtle.

< 5 Person Staff - each team consists of two persons, the fifth is the Rover and they move between the patrols teams as needed to help with turtles.

< 6 or more Staff - teams are divided equally between the beaches. A Rover is designated from among the patrol team when a turtle is encountered. The Rover will go get any equipment needed during data work up and help with work up, maintaining patrols, etc.

Teams usually take a 20 to 30 minute "lunch" break sometime between 2330 and 0030. The NS/WB Patrol team can choose to eat at the Pier or on West Beach and the SS/TB Patrol team can eat at the pier or at Dietrichs' picnic shelter. Afterward, teams can swap patrol beaches for a change of scenery if they like.

Patrols continue until 0500 or until the last turtle has left the beach, whichever comes last.

NIGHTLY PATROL ROUTINE:

At BUIS the various segments of hawksbill nesting behavior (e.g., Emergence, body pitting, nest hole digging, etc.) were timed and recorded in the early years of the research program. Analysis showed that hawksbill sea turtles nesting at BUIS, unlike some other species, can complete their nesting in as little as 45 minutes from time of emergence to time of departure.

1. The first patrol can take 30 to 40 minutes one way to Aclear≅ the beach of all daytime activities. Human activities such as sand castles and holes where anchors were placed on the beach, etc., can look similar to a fresh sea turtle body pitting activity, especially in the middle of the night. It is much less confusing and makes new turtle activities much easier to see if the beach is Aclear≅ to start with each night.

ACLEARING≅ THE BEACH:

A. Walk along the shoreline; use a flashlight to identify **all** daytime activities (people

body pits, sand castles, anchor marks, etc.).

B. Use feet and hands to smooth out any depressions in the sand.

C. Use your foot or "walking stick" to draw a line through the area. If the area still looks confusing, stand small sticks/ "Crumbly sticks" (named after the BUIS technician that started the technique) across the area so that if the sticks are found fallen down during the night it could mean that a turtle has moved over the area and may still be on the beach.

D. Check that the Aknockdowns≅ are all in place and adjust them as needed. AKnockdowns≅ are thin wire surveyor stakes with the flags removed and a 1" strip of reflective tape placed on the end. They are placed along the top of the beach forest berm about fifteen inches apart in sections of the beach where there is little or no sand in front of the vegetation. They are typically used from NS1 to NS24 and SS68 to TB83, once aged by weather; they are difficult to see during the day. Occasionally, however, guests to the Monument see the Aknockdowns≅ and feel they are doing a good deed by removing them from the beach. They usually place them neatly in a pile either at the end of the beach or near a trashcan. This just means that the team puts them back in place during the first patrol. As you patrol, shine a small beam of light along the row of stakes. If there is a gap in the reflectors, it may mean that a turtle has emerged, gone over the Aknockdowns≅, and may be on the beach. By looking at the direction in which the Aknockdowns≅ are lying, you can also tell if this is where she went into or out of the beach forest.

2. The first radio check is done when the two teams reach the far ends of the beach. At this time, one team is on NS and the other is on TB. Radio checks continue at least every two hours throughout the night to maintain contact between beach patrol teams and check radio function.

3. All subsequent patrols take about 10-15 minutes one way, with a rest period, usually 15 min. at either end of patrol. The beach should be patrolled every 45 minutes.

   For example:
   If you leave NS 1 at 2000, and arrive WB 59 (the pier) by 2015, rest there until 2030 then patrol back to NS 1 arriving by 2045. This way, if a turtle came up at NS1 right after you left, chances are good that she will still be there when you return 45 minutes later, even though she may be camouflaging or just getting ready to leave the beach.

If a turtle is encountered, inform the other patrol team by radio that a turtle is on the beach. Then refer to Turtle Encounter Flowchart (pg 65) and Data Collection Protocols (pg 58). Once the turtle and her activity have been identified, depending on the circumstances, either continue the patrol to clear the beach, making sure no other

turtles are on the beach, and immediately return to the turtle, or wait for assistance so someone can stay with the turtle while someone else clears the beach and returns.

If the patrol is completed without a turtle encounter, continue patrols to cover the beach every 45 minutes. During patrols use minimal light (only a portion of the full beam) to help identify activities on the beach. If more than one person is walking the patrol, try to walk in a single file and minimize talking. Conversations can be carried on during the rest breaks.

PERSONNEL:

3 to 6 researchers. At least one must be either the Resource Management Specialist or the Biological Aide.

PATROL EQUIPMENT:

4 NPS radios with batteries (one radio for each person or team)
2 radio batteries (fully charged and kept on the boat as a backup)
First aid kit (kept on boat until needed)
Box of AAA≅ batteries (as back up supply for head lamps and mini maglites)

PERSONAL EQUIPMENT:

- Backpack
- 1 Headlamp
- 2 mini maglites with batteries (one for backup)
- Spare bulbs for headlamp and mini maglite
- Extra AAA≅ batteries for lights
- Rain Gear or poncho
- Towel (Optional, but recommended for kneeling or sitting on and for wiping off sand)
- Drinking water
- Small cooler for food and drinks

BUIS SEA TURTLE RESEARCH PROGRAM SAFETY PROCEDURES

ROUTINE RADIO CONTACT:

< Check in with other team by radio or flashlight at least every two hours. Communication is clearest from the beaches closest to the pier (West Beach and South Shore). Radio transmissions can be on line of sight channel and light signals can be observed.

< If the timing of patrol schedules does not allow contact from West Beach to South Shore, radio contact can almost always be made from locations on North Shore and Turtle Bay (NS 3-6, or 8-10 and Turtle Bay 90-93).

< If one patrol team encounters a turtle, notify the other patrol and advise them that you may be out of radio contact for a while. During turtle work up, you may not have the radio close at hand and may not be able to hear radio calls. Notification of a turtle encounter will reduce communication frustrations between patrol teams.

< If patrols go without radio contact for more than two hours, communication attempts should be made until the other patrol has been reached. If initial check-in time exceeds two and one half hours, one member of the patrol should go to the other patrol area and make contact to be sure everyone is ok. As they are walking, they can continue radio and flashlight attempts to contact the other team, but if necessary, they continue until face-to-face contact is made and communication problems are resolved.

Flashlight Codes:

1= Hi
2= O.K.
3= I have turtle
4= Have turtle/problem, need help

IN CASE OF INJURY WHILE ON PATROL:

Single Person Patrols:

1. Notify other patrol by radio of any situation even minor injuries (small cut, nausea, dizzy, pain etc.). Small first aid kit is stored in the Dietrich's Picnic shed as well as a large first aid kit and eye wash stored on the boat. Notification will give the other patrol knowledge of the situation and relieve questions when they see lights either on the boat or on the beach where they otherwise wouldn't expect it.

2. If major injury occurs (broken limb, inability to move, severe bleeding etc.) Make radio contact immediately so the other patrol can bring medical assistance and supplies to your aid as quickly as possible.

< If radio contact cannot be made with the other patrol, try to reach either the superintendent or resource management specialist by radio or cellular phone, if they don't respond try calling KID722, St. John Ranger base station. This call will go out to all NPS units and anyone listening may respond. Even though they are on St. John, tell them the problem and they can telephone the superintendent or resource management specialist for you. If necessary you can ignite a flare in the direction above you and away from the island out over the water. Be aware of the wind and look away when igniting the flare to avoid getting debris in your eyes or flash burn.

Multi-Person Patrols:

1. Minor Injury: Injured party should get in touch with the other patrol and notify their partner about their injury and first-aid requirements.

2. Major Injury: Injured party should get in touch with the other patrol for assistance if needed. Some situations may warrant that the partner not leave the injured person for medical attention (severe bleeding, seizure, fear of further injury). If the injury warrants leaving the island to seek further medical attention, all patrols will cease and provide assistance to the injured party.

SITUATIONS FOR WHICH THE SUPERINTENDENT AND/OR RESOURCE MANAGEMENT SPECIALIST SHOULD BE CONTACTED:

- Medical assistance is needed, make contact by NPS radio, cellular phone, or VI Radio land-line call. Emergency help may have to be summoned to the island.
- Visitor will not leave the beach, uncooperative behavior.
- Irregular of suspicious boating activities.
- Low flying aircraft during the night.
- Flares observed offshore

NO ONE SHOULD BE LEFT ON THE ISLAND TO CONTINUE PATROLS!

IF THE BOAT LEAVES, EVERYONE *MUST BE ABOARD*!

HAWKSBILL SEA TURTLE (*Eretmochelys imbricata*) NESTING BEHAVIOR

Emergence: (1-2 min.)
When the turtle is emerging from the water, she is wary. If disturbed by bright lights, movement, or loud noises she may return to the water. She can cover the distance from the beach forest to the sea (between 3 to 100 feet) rapidly.

Approach Crawl: (2-4 min.)
Hawksbill turtles crawl using an alternating gait (diagonal limbs working together). The crawl track is not typically straight and may involve considerable zigzags. They may crawl under and over dense vegetation, up steep berms, over logs, across shoreline reef, cobbles or rocks frequently leaving no crawl track.

Body Pitting: (10-20 min.)
When the turtle has selected a potential nest site it makes several sweeps with it's fore flippers simultaneously to clear the site of debris. The hind flippers, working together, sweep over he same site. During body pitting you can smell disturbed soil and hear her flippers hitting her carapace. If the site is not suitable, she may move to another site and repeat the process or leave the beach to return and try again later. When she does find a suitable nesting site, the fore flippers stop and the hind flippers begin nest hole digging.

Nest Hole Digging: (15-25 min.)
The hind flippers work alternately to dig the flask shaped hole. The leading edge of the hind flipper is pressed to the ground, curled to scoop out the sand, then lifted and swung laterally to deposit the sand several inches in front of the hind margin of the shell. As the sand is dropped and the flipper is set down, the other hind flipper repeats the process. This cycle continues until the hind flippers can no longer reach loose dirt or sand in the hole. If roots or rocks are encountered, the hole will be abandoned.

Egg Deposition: (20-30 min.)
When the nest hole is finished the hind flippers are placed on either side of the hole. The tail is positioned over the cavity, the cloaca is slightly prolapsed and egg deposition begins. The eggs are generally dropped in twos and threes. As the eggs are dropped, the hind flippers curl, and the head and neck are retracted, returning to the extended position

between depositions. Mucus is secreted between eggs.

Covering Eggs: (10-15 min.) The turtle begins filling the egg chamber immediately after the last egg has been laid. The hind flippers alternately scoop sand from beside the nest and move it over and into the hole. The tail is repeatedly placed into the filling egg chamber. When her tail contacts the soil/sand over the eggs she begins tamping with her knees. This is repeated until the chamber is completely covered.

Camouflaging: (5-15 min.) After the egg chamber is covered, she uses her front flippers to throw sand backwards over the nest site. After throwing sand with her front flippers, she will move her hind flippers in a swooshing motion over the nest. She continues camouflaging, alternating front and hind flippers. This motion slowly moves her forward, obliterating the nest site leaving a 3-6 foot area of disturbed sand/soil. When she is finished, the surface over the nest will be relatively flat, and she will be several feet away from the nest site.

Departure: (30 sec. - 5 min.) When camouflaging is complete, the turtle will orient toward the brightest point on the horizon. Typically this is in the direction of the sea. She then rapidly crawls towards it, usually taking less than 60 seconds to reach the water.

NESTING SEA TURTLE DATA COLLECTION PROTOCOL

The primary objective of the Buck Island Sea Turtle Research Program is to identify and tag every turtle that comes ashore to nest. The beaches are patrolled nightly during the peak nesting season, July through September, and every turtle encountered is identified by existing tags or has tags applied upon first encounter. When patrolling the beach, the researcher must use all of their senses to determine if a turtle is on the beach.

How to know a turtle is on the beach:

LOOK, LISTEN, AND SMELL -

1. See her emerging from the water.
2. See crawl track on the beach. *
3. See knockdowns disturbed. *
4. Hear noise in woods.
5. Smell fresh dirt from her digging.

**Be sure to look further down the beach for exit signs before searching in the woods for the turtle. She may have left the beach, and while you're looking for her, she has returned further down the beach where she is quietly nesting.*

APPROACH ANY TURTLE AS IF SHE IS UNTAGGED!

A turtle may be encountered during any phase of nesting. She could be quietly laying eggs or making her way to the water, in any case, it is essential that every turtle be identified before she leaves the beach. If she is tagged, any one of her tags numbers can be recorded for identification, but, if she is not tagged, she must receive at least one tag before she is allowed to return to the water. Therefore, approaching every turtle with a tagging tool loaded with a tag is important. Keep spare tags and needle nose pliers nearby incase the first tag malfunctions.

ENCOUNTER WITH A NESTING HAWKSBILL:

1. The turtle lays her eggs during this emergence.

   A. Record time first observed and the turtle's activity.
   B. Approach the turtle from the rear without disturbing her and carefully look for tags using minimal light, avoid casting a shadow across turtles= eyes.
   C. Record a hind flipper tag number.
   D. Refer to your AFemale Book≅ to see what data is needed from this turtle. If this is her first time seen this season, notify primary technician of tag number so they can cross-reference for the primary tag number.

E. Make radio call to notify other team members of turtle's activity and when the turtle begins egg deposition, have the Rover bring the equipment to your location. The scale and weigh pole are only needed if this turtle's weight has not been taken yet this season. The Rover will help with data collection, maintaining patrols, and weighing the turtle.

2. Once the turtle has finished the egg chamber and has laid about 50 eggs, place flagging tape in egg chamber and tie the free end to a nearby tree or bush to mark the nest. Flagging tape will help to locate the nest in the event she begins to cover before being moved off the nest for clutch workup (nest and egg measurements).

3. Now begin contact for data collection:

A. Approach the turtle from behind, using low light level. Disturb the turtle as little as possible.
B. Record all diagnostic markings and ectobiota on the carapace. (Ex. Algae, barnacles, etc.)
C. Take carapace measurements (remove barnacles as necessary for best measurement). Note all barnacles removed on data sheet. (see example data sheet and Figure 12)
D. If head is in good position (accessible and able to lower the neck), take blood from the cervical sinus (4ml) during egg deposition. If the turtle is in a bad position (head up or too far under bushes), wait until she is camouflaging and move her to a better location.
E. Check all four flippers for tags and/or tag scars. Record all numbers and position of tag(s) in flipper(s). Remove any loose tags. Apply tags as needed, so there is a minimum of one tag per flipper. Tag application should be done close to the end of egg deposition or during covering.

4. Turtle finishes egg deposition. At the start of rear flipper covering, pull the turtle off the nest site. Move her about 2 meters away to an open area clear of rocks and debris.

A. Everyone should have headlamps on so that your hands free. There should be at least two technicians present at this time.
B. Clear an area before moving the turtle (no rocks, logs, coral cobbles, etc.). The turtle is moved off the nest if she needs to be flipped for weighing or plastron measurements, if data needs to be collected on the eggs or nest dimensions, or if the nest needs to be relocated. In the latter two examples, moving her will save you from having to uncover the nest.
C. Move the turtle to the cleared area by either letting her to crawl or by crouching in front of her, holding both shoulders, and pulling her slowly over to the site. She will continue with her rear flipper covering as if she is still over the nest.

5. If blood collection was unsuccessful during laying, prepare to take blood after moving the turtle. It may be necessary to have someone hold the turtle.

6. Take carapace and face photographs. Take additional photographs to document unusual scars or deformities. Record first and last frame number on data sheet.

7. Weighing and Plastron Measurements (Done only once each season, usually after first egg deposition of the season)(Figure 13):

   A. When the turtle is flipped, sand will fly everywhere so it is recommended that eye protection and a jacket with the hood up be worn. Hold the flipper you plan to flip toward, making sure it is tucked under the turtle when you flip her. Carefully roll the turtle diagonally over her tucked shoulder, preferably down a slight incline.
   B. Once the turtle is on her back, the person recording data can calm her by stroking the ventral side of the neck or the skin/plastron junction.
   C. Record plastron measurements - width, length, tail measurements, and draw all diagnostics.
   D. Take plastron photographs.
   E. Prepare the Ohaus electronic scale. Hook the load cell of the scale up to the weigh pole and have it accessible with weigh ropes ready. Keep Aload cell unit≅ free of sand.
   F. A minimum of two technicians are needed to weigh a turtle. Ropes are attached to all four flippers with slipknots and hooked up to the scale. The turtle is lifted between the two technicians on the weigh pole, suspending the turtle completely off the ground. One of the technicians will read the weight.
   G. After weighing, the turtle is **carefully** lowered to the ground.

DO NOT DROP THE TURTLE!!!

   H. All ropes are detached from the scale and then promptly removed from all four flippers. Count and make sure all ropes are removed and returned to the weigh bag. Record the weight on the data sheet.
   I. Check the data sheet to verify that all information has been recorded. If anything was missed, do it before the turtle leaves the beach.
   J. **Carefully** flip the turtle back to her upright position. The entire time of the work-up while the turtle is flipped should take no longer than 5-10 minutes.

8. Releasing the turtle after data collection is complete:

   A. **Shut off all lights!!!**
   B. Allow the turtle to orient to the sea. Let her rest, but if she has not started to depart after 3 minutes, use your light to guide her toward the sea. Point the beam of the flashlight in front of her face and walk toward the sea--she should follow.
   C. Record the time she returns to the sea, if observed.

9. Clutch Count & Egg Measurements:

Determine if the clutch needs to be relocated. If it is in an erosion zone, high visitor use area, or an area of high rat activity, it should be relocated to a better area (refer to Nest Relocation Protocol).

If the nest is in a good location just pick 10 random eggs (this can even be done as they are being laid) and weigh and measure them as outlined in D below then skip to F and continue as outlined, the eggs will be counted at time of excavation.

WEAR DISPOSABLE LATEX GLOVES ANY TIME YOU HANDLE EGGS.

A. Nest Top = Measure from the surface of the ground to the top of the clutch.
B. Clutch count = Remove all eggs from the nest hole and place in a large, clean plastic trash bag.
C. Nest Bottom = Measure depth of egg chamber from surface of ground to bottom of nest cavity. If nest needs to be relocated, take two measurements of the neck width and two of the bowl width (measurements should be perpendicular to one another in each set)

D. Egg Measurements = As eggs are being removed from the nest, one team member picks 10 random eggs to weigh and measure. Each egg is rinsed in rainwater to remove excess soil/sand. Using calipers, measure two diameters 90 degrees apart. Make sure to zero the calipers before each measurement. Weigh the egg on the electronic scale (grams). Keep the scale level and "TARE" between each egg weight. Keep the scale in a small plastic ziplock bag during the weighing process to keep it as clean and dry as possible.

E. Count the eggs as they are returned to the nest chamber and record the totals of yolked, yolkless, deformed, and broken eggs on the data sheet.
F. Prepare a 12 inch piece of flagging tape with clutch information, including; female's tag number, date, location/marker number, clutch count, and technician's initials. After about 2/3's of the eggs are back in the egg chamber insert the flagging tape and put in the remainder of the eggs.
G. Cover the eggs with any mucus covered sand first, then cover with substrate that was excavated up by the female (moist soil first).
H. Occasionally tamp sand/soil over eggs, **gently** packing the sand over the eggs.
I. Fill the nest hole to the surface and then cover with an additional 2" - 4" of substrate. Smooth over the body pit and scatter leaf litter to camouflage the nest site.

10. Nest location and identification:

A. On an aluminum rectangular nest tag write the date, one of the turtles= flipper tag numbers, location/marker number, and technicians initials.
B. Attach the rectangular nest tag and a round pre-numbered aluminum nest id tag to the nearest permanent vegetation or, as a last resort tie them to a ACrumbley≅ stick placed in the ground 0.5 m behind the nest site when no suitable vegetation is available. Record the nest id number on the data sheet.
C. Draw the activity and nest site, including the location of the nest id tag. Record distance from nest to markers, high water mark and seaward vegetation (see example data sheets for perpendicular and parallel measurements)*. Make sure **all** data are recorded properly and legibly.

* Since hawksbill turtles usually nest in the beach forest, tape measures would get entangled in the vegetation when measuring distances from the nest. To alleviate this problem, measurements are paced off to the nearest 2 meter by the technician. During the first weeks of training, each technician measures their pace/stride along a 25-meter tape laid out along the pier to get the feel of pacing off meter increments. For some people it takes two natural strides to equal one meter, for someone taller, it may take only one long stride. The Resource Management Specialist checks technicians' measurements until the technician becomes accurate in their measurements.

11. "Clearing" the activity site:

A. Reposition "knockdowns"
B. Obliterate crawl tracks and draw a distinct line in the sand through the area.
C. Fill in any aborted egg chambers and draw a line through the activity or put ACrumbley≅ sticks through the body pit to avoid confusion later.

EMERGE NO LAY ENCOUNTER WITH A HAWKSBILL:

A turtle is on the beach but begins to leave the beach after an unsuccessful nesting attempt;

1. Intercept using minimal light.

2. Look for tags,
   A. If she is tagged, record at least one tag number. Skip to step 3.
   B. If she is **not** tagged.

   THE TURTLE CANNOT LEAVE THE BEACH UNIDENTIFIED! ! !

   a. Restrain the turtle and tag at least one flipper.
   b. To restrain - Hold and tag the front flipper or lead the turtle back up the beach with your light. Try to position the turtle so she cannot move away while the tag is being applied.
   c. If unsuccessful in tagging, at the very least, record a carapace mark, barnacle pattern, or anything that will ensure positive identification of the turtle when she returns to nest.

3. Let her leave the beach. She will return.

PERSONNEL:

One person can do a complete work-up on a turtle if it does not need to be weighed, but two or even three technicians make data collection and recording go much more quickly.

PERSONAL EQUIPMENT:

- Backpack
- 1 Handheld NPS Radio
- 1 Headlamp
- 2 mini maglites with batteries (one for backup)
- Spare headlamp and mini maglite bulbs
- Extra AAA≅ batteries for lights
- Tagging tool
- Inconel tags
- Needle nose pliers
- Tape measure
- Clipboard with rubber bands to hold papers, and a tethered pencil
- Sea Turtle Nesting Activity Log Data Sheets
- 2 pencils and 1 pen
- Flagging tape
- Aluminum write on forestry tags
- Pre-numbered round aluminum tags

- 4" pieces of thin wire to secure tags to vegetation
- Rain Gear or poncho
- Towel (Optional, but recommended for kneeling on and for wiping off sand)
- Drinking water
- Plastic bags, small and large ziplock bags, and large white Atrash≅ bags
- Latex disposable gloves
- Small cooler for food and drinks

TURTLE WORK UP EQUIPMENT:

- NPS Olympus 35 mm camera and 2 rolls of 36 exposures 200 ASA slide film
- Blood collection kit with needles, 5 red top Vacutainers tubes, 10 ml red top Vacutainer tubes filled with 9 ml of lysis solution, Vacutainer holders, pipettes, and cryotubes
- ExacTech Glucose Card with ExacTech glucose strips calibrated to the machine
- AWeigh ropes≅ used to suspend the turtle during weighing
- Acculab scale in small plastic bag, stored in small yellow APelican A box
- Bottle of water used to rinse eggs for weighing and measuring
- Plastic bags, small and large ziplock bags, and large white Atrash≅ bags
- Vanier calipers
- Extra latex disposable gloves
- Heavy-duty poncho, to cover gear if it starts to rain

ADDITIONAL TURTLE WORK-UP EQUIPMENT:

Turtle AWeigh pole≅ (stored in Dietrich's Shed)
Centrifuge (either hand operated or electric)
Generator with fuel and oil (stored in Dietrich's Shed for running centrifuge)
Cooler with ice packs and Styrofoam blood tube holder inside
Ohaus electronic scale in small gray pelican box

TIME REQUIRED:

With 2-3 technicians, a complete work-up takes between 40 and 50 minutes. The amount of time may vary depending on the number of technicians, the data required on the turtle and clutch, and if the nest needs to be relocated.

BUCK ISLAND REEF NATIONAL MONUMENT, USVI
SEA TURTLE NESTING ACTIVITY LOG

Date: _____ / _____ / 2000
Act. No. _____ Nest Id. _____

Species: HB GR LB Primary Tag #: _____ - _____ Nest Relocated? Y N

Sector: NS WB SS TB Mkr #: _____ Habitat: OB SV BF Time: _____ / _____
OBSV / GONE

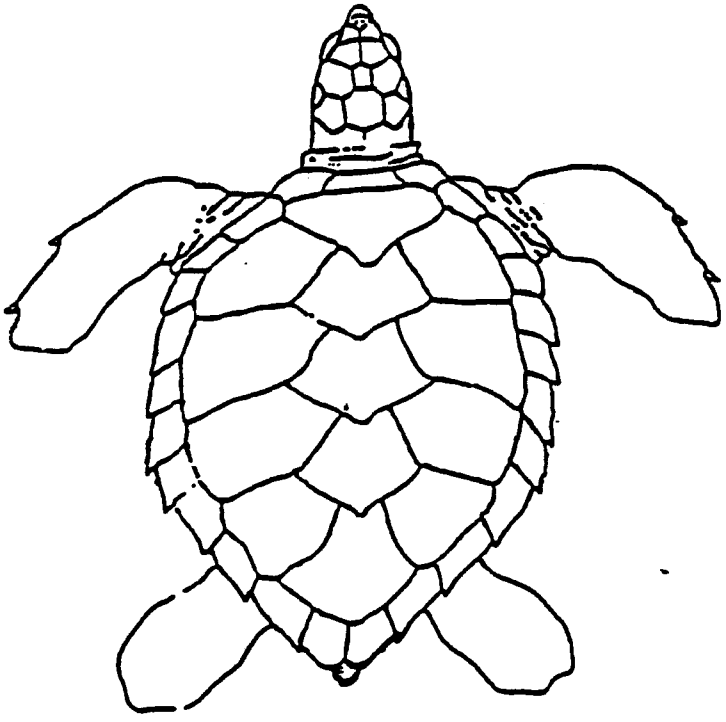
Action (upon initial sighting): _____

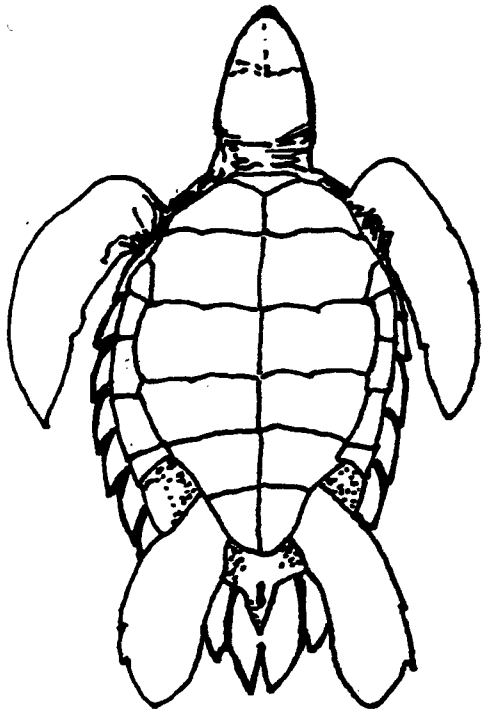
Existing Tag(s): LF_____(___) RF_____(___) LH_____(___) RH_____(___)

New Tag(s): LF_____(___) RF_____(___) LH_____(___) RH_____(___)

Tag Observations: _____

Activity Results: LAY / NO LAY / SUSP Reason: _____
(Ex - roots, rocks, human, animals, water, berm, trees, lights, noise)





CARAPACE (cm): CCL Nuc-Not _____ Nuc -T _____ L R Not - T _____ CCW _____

PLASTRON (cm): L _____ W _____ TAIL: P-V_____ P-T _____ N-T _____

Measured by :_____ Over Barnacles? Y N Marginals? Fused / Serrated Weight (kg) _____

Blood Taken? Y N by:_____ When: _____ Amount: ____ (mls) Tissue Taken? Y N by:___

Photo's Taken: RP AC OC PC PL Other None Frame #'s: _____ Camera:_____

NEST MEASURES (cm): Top of Clutch _____ Bottom of Nest _____ OVER FLOW? Y N

Neck Width: _____ _____ Bowl Width: _____ _____

Total Eggs Laid: _____Yolkless: _____ No. Eggs Incubated: _____ Other: _____ (Deformed/ Broken)

Eggs Counted by: _____Eggs Measured by: _____Eggs weighed by: _____

EGG MEASUREMENTS, this nest:

EGG	1	2	3	4	5	6	7	8	9	10
DIAMETER 1										
DIAMETER 2										
WEIGHT (gm)										

ACTIVITY / NEST DIAGRAM

Perpendicular Measures

Data Loggers Location
Unit #: _____ T, M, B, A
Unit #: _____ T, M, B, A
Unit #: _____ T, M, B, A
Unit #: _____ T, M, B, A

NEST ID #_____ LOCATION:_____

ORIGINAL NEST: SECTOR: NS WB SS TB MKR #: _____

Dist. From Nest (m): to MKR _____ DIR: _____ Dist. to HWM _____ to SW-VEG_____

Habitat Description: OB SV BF % Soil: 100 / 75 / 50 / 25 / 0 Cover Type:_____

RELOCATED NEST: SECTOR: NS WB SS TB MKR #: _____
Dist. From Nest (m): to MKR _____ DIR: _____ Dist. to HWM _____ to SW-VEG_____

Habitat Description: OB SV BF % Soil: 100 / 75 / 50 / 25 / 0 Cover Type:_____

Primary Technician:_____ Others:_____

BUIS "SEA TURTLE NESTING ACTIVITY LOG" TERMINOLOGY KEY

Date: Record the date the nightly patrol was started. For example, if the nights patrol team arrived on BUIS on July 5 to patrol July 5 from 19:30 until July 6 at 05:00, all activities recorded that night would receive the date of July 5. In terms of the turtles' biological clock/behavior, it is all the same night.

Act. No.: Activity Number: This is the sequential number of the activity within a given year (January 1 to December 31). This number is not filled out in the field, but assigned in the office while data sheets are being reviewed. Before assigning activity numbers, all data sheets for the night are put in order of occurrence by time observed, then the first activity observed that night receive the next sequential number. For example, Activity Number 98-058, would be the fifty eighth activity observed in 1998. The first two digits represent the year of the activity, the last three numbers represent the sequential order of the activity for that year.

Nest Id.: Nest Identification Number: Record the number from the nest identification tag. Each nest receives a nest identification number. Technicians receive a set of pre-numbered aluminum discs to use as nest id tags. One of these numbered discs is placed within a half meter of the nest attached to permanent vegetation in an inconspicuous place, out of sight of visitors. The location of this tag is recorded on the data sheet. Sometimes there are numerous nests within meters of one another. This helps to insure that when nests are excavated, the proper excavation data is assigned to the right nest.

Species: Circle the letters for the species of sea turtle this data sheet refers to, HB=hawksbill, GR=green, and LB=leatherback.

Primary Tag #: Primary Tag Number: Record the Primary tag number of the turtle. The first flipper tag ever applied to a turtle becomes the primary tag number. It becomes that turtles "name" even if that tag is ever lost or removed. All subsequent tags applied to that turtle are cross-referenced to the primary tag in the BUIS sea turtle database, and on the BUIS tag list. If that tag is not present, any of the current tags can be cross-referenced to obtain the Primary Tag #.

Nest Relocated: Circle either "Y" for yes, the nest was relocated from its' original location, or "N" for no, the nest was left insitu (where the turtle laid it).

Sector: Circle the appropriate letters. They represent the BUIS beach on which the activity occurred. NS=North Shore, WB= West Beach, SS= South Shore, and TB= Turtle Bay

Mkr#: Marker Number. Write the number that appears on the marker closest to the original activity. This marker is the one referenced for all activity measurements.

Habitat: Circle the appropriate letters. This identifies the habitat in which the activity occurred. OB= Open Beach, open sand beach with no vegetative cover or perhaps sparse beach grasses. SV= Shoreline Vegetation, low ground cover consisting of purslane, sporadic shrubs, or beach vines. BF= Beach Forest, vegetative cover consisting of hard wood trees or saplings.

Time: Record the time of initial sighting of the turtle or activity, also record the time the turtle departs the beach and returns to the water, if observed. Time is expressed in 24 hour military time.

Action (upon initial sighting): Record what the turtle was doing when it was first observed (i.e., emerging form the water, body pitting, nest hole digging, egg deposition, rear flipper covering, camouflaging, departing, gone).

Existing Tag(s): Record the number of all tags found on the turtle at the time of the activity. The National Marine Fisheries Service inconel tags consist of three letters and three numbers separated by a hyphen (example: ABC-123). Record the number and the location of the tag in the space designating the corresponding flipper. The number is written on the line and the position code is written inside the parentheses (example: ABC-123 (L3)). Flipper and position codes are as follows: L=left, R= right, F=front, H=hind, 1= third scale out from the body on a front flipper, 2= second scale out from the body on a front flipper, 3= first scale out from the body on a front flipper, S=scale tab on a hind flipper, T= tissue on a hind flipper (Refer to BUIS Sea Turtle Tagging Protocol diagram).

New Tag(s): Record the tag number and location of any new tags applied during this activity. All codes are the same as mentioned above.

Tag Observations: Record the condition of the tags (IE, any tags removed, algal growth, tag scars, overgrown tissue, tags cleaned, etc.).

Activity Results: Circle the result of the activity. If the activity was observed, this will be a definitive result. However, if the activity was not observed, circle the result determined by examination of the activity. If unsure, circle the best guess and write “suspected” above it. All activities are checked in 60-70 days for signs of hatchling emergence and a final determination will be made at that time. LAID= egg deposition did occur. NO LAY= egg deposition did not occur.

Reason: Record any reasons that may have contributed to egg deposition not occurring, if it can be determined (roots or rocks in the nest hole, human or other animal disturbance, high water, steep berm, etc.). If the activity was observed, write “observed”.

Carapace: The hard dorsal shell of a sea turtle. The individual plates that make up the carapace are called scutes.

(cm): All measurements are recorded in centimeters to the nearest tenth. All measurements are taken with a fiberglass tape measure. The zero end metal tab is held at the starting point, while the tape is stretched to the end measuring point. Once the tape is straight and taught, check the starting point position to be sure it hasn't been pulled out of place, then place the thumb of the hand at the end point at the location on the tape that marks the measurement. Hold this point until you lift the tape measure, read the number, and verify that it has been recorded properly. (Refer to the Measurement Diagrams for start and end points of the various measurements.)

CCL: Curved Carapace Length. Various measurements of the carapace taken with a fiberglass tape measure following the curve of the carapace.

Nuc-Not: Nuchal curve to Notch. Measure from the skin/carapace junction at the curve of the nuchal scute, straight down the midline of the carapace, to the anterior edge of the notch between the post marginal scutes.

Nuc-T: Nuchal curve to post-marginal Tip. Measure from the skin/carapace junction at the curve of the nuchal scute, in a straight line, to the posterior point of the longest of the two tips of the post-marginal scutes. Since the post-marginal tips are off center, the tape will run a little off the midline of the carapace. Circle the letter that identifies which post-marginal scute was used in the measurement, L=left, R= right.

Not-T: Notch of the post-marginal tips to the Tip of the longest post-marginal scute. Measure from the anterior junction of the notch between the two post-marginal scutes to the tip used for the Nuc-T measurement.

CCW: Curved Carapace Width. Measure from left to right across the widest portion of the carapace, this is usually across the third vertebral scute, from the point at which the marginal scute curves under on the left, straight across the third vertebral scute, to the equivalent point on the right side of the turtle.

Plastron: The ventral or abdominal plate/shell of a sea turtle. The individual plates that make up the plastron are also called scutes. L= Length, W= width.

Tail: Measurements taken of the tail. All tail measurements are taken with the turtle upside down, lying on its' carapace with the plastron up.

P-V: Plastron posterior tab to Vent/cloaca. Measure from the posterior tip of the plastron tab to the middle of the vent/cloaca.

P-T: Plastron posterior tab to Tip of the tail. Measure from the posterior tip of the plastron tab to the tip of the tail. If the turtle has her tail tucked, it may be necessary to put the tape measure in place, and wait a few minutes with minimal contact until the turtle relaxes.

N-T: Notch of the post-marginal scutes to the Tip of the tail. Measure from the anterior junction of the post-marginal notch to the tip of the tail. This may be expressed as a negative number if the tail does not extend to the junction of the post-marginal scutes.

Measured by: Record the initials of the technician that measured the turtle.

Over Barnacles?: Circle the appropriate letter. Answer the question, " Are there barnacles under the line of the tape measure during carapace measurements. "Y" = yes, "N" = no.

Marginals? Fused/ Serrated: Circle the appropriate description for the outer edges of the marginal scutes. Fused= the tips of the scutes are not pointed, they are rounded to the body and mostly smooth. Serrated= the tips of the marginal scutes are pointed, if you were to rub your hand posterior to anterior along the side of the body, it would get caught on the tips of the scutes.

Weight (kg): Enter the weight of the turtle as displayed on the Ohaus electronic scale in kilograms.

Blood Taken?: Circle the appropriate letter. Was a blood sample collected? "Y"= yes, "N"= no. If tried but unsuccessful, write "unsuccessful".

by: Enter the initials of the technician that took the blood sample.

When: Enter the nesting behavior the turtle was engaged in when the blood sample was collected. (i.e., nesting, rear flipper covering, after flipped, departing, etc.)

Amount: Enter the number of milliliters of blood collected to the nearest whole number.

Tissue: Circle the appropriate letter. Was a tissue sample collected? "Y"= yes, "N"= no. If tried but unsuccessful, write "unsuccessful".

by: Enter the initials of the technician that took the blood sample.

Photos Taken: Standard photos are taken of every turtle at least once during the season. Circle the codes for the photographs that were taken during this encounter. Photo Codes: RP= right profile of the head, AC= anterior carapace, OC= overall carapace, PC= posterior carapace, PL= overall plastron, Other= any other photos taken with a brief description written below, None= no photos were taken.

Frame #'s: Frame numbers. Record the first and last photograph frame numbers used during this activity.

Camera: Note which camera was used to take the photographs. The NPS Olympus 35-70 mm camera should always be used unless it is not functioning. If someone also uses their personal camera, this should be noted incase one set of photos does not turn out the others can be duplicated.

Nest Measure: Enter the number for the corresponding measurement in centimeters.

Top of Clutch: The measurement from the surface of the ground to the top of the eggs in the nest. To determine the surface level, lay a clipboard across ½ the nest opening and measure down form the bottom of the clipboard.

Bottom of Nest: With all of the eggs removed, measure from the surface of the ground to the deepest part of the nest hole.

Overflow?: Circle the appropriate response. Did the eggs overflow the top of the nest hole? "Y"=yes, "N"=no.

Neck Width: If a nest is relocated, it is necessary to replicate the original nest as closely as possible. The nest is usually flask shaped. Measure the width of the neck about halfway down the neck.

Bowl Width: Measure the width of the nests' "bowl" at its widest point. Take two measurements of the bowl width, each perpendicular to the other.

Total Eggs Laid: Count and record the total number of eggs laid, including yolkless, deformed, etc.

Yolkless: Record the number of yolkless eggs laid in the clutch. These are usually extremely small eggs, about pea sized, that have no yolk, just clear fluid inside.

No. Eggs Incubated: Number of Eggs Incubated. Record the total number of eggs actually placed in the nest for incubation. This is equal to the number of eggs laid minus any eggs that were broken or predated by rats during the work-up.

Other: Enter the number of eggs that were deformed or broken. Circle the appropriate notation, Deformed or Broken. Deformed would include eggs connected by calcium strings or dumbbell shaped, etc.

Eggs Counted by: Enter the initials of the technician that counted the eggs.

Eggs Measured by: Enter the initials of the technician that measured the eggs.

Eggs Weighed by: Enter the initials of the technician that weighed the eggs.

Egg Measurements: Ten random eggs are weighed and measured from each nest as determined by the research protocol for each season. Two diameters are taken of each egg, 90 from one another using Vernier calipers. These measurements are recorded in centimeters. Each egg is also weighed on an Acculab scale and the results are recorded in grams.

Activity/Nest Diagram: This area is used to draw a sketch of the activity site. **All** drawings are made with the technicians back to the sea. The sketch is used, in conjunction with the measurements, to locate the nest for hatch determination 60-70 days after the activity.

Perpendicular Measures: Pace off the perpendicular distances from the nest or activity, to the nearest marker. Draw the perpendicular lines representative of the path from the nest to the marker and indicate the distance in meters. Indicate the marker number in the drawing (Refer to example data sheets)

Nest Tag Location: Record the distance (measured in centimeters with cloth tape measure), and direction of the nest id tag from the nest. Give a brief description of the location of attachment of the tag (IE. Base of sage bush 10cm directly above nest, "Crumbley" stick 27cm to the left of the nest.

Original Nest: All information in this section pertains to the location of the activity created by the turtle. Sector, Mkr #, and habitat description are as previously defined.

Dist. From Nest (m): Distance from the Nest. Record the following measurements in the appropriate space. All measurements are recorded to the nearest ½ meter.

to MKR: distance from the nest to the nearest Marker. Pace off the straight line distance, parallel with the waterline, from the nest to the nearest marker. Do not measure diagonally.

Direction: Direction to Marker. With your back to the sea, determine whether the nearest marker is to the left or the right of the nest, or if it is seaward or landward of the nest if the marker is directly in line with the nest.

Dist. To HWM: Distance from the nest To High Water Mark. Measure the straight line distance from the nest to the high water mark at the time the activity is recorded.

to SW-VEG: distance from nest to Seaward Vegetation. Pace off the distance from the nest to the leading or Seaward edge of the beach vegetation and record the distance. If the nest is in front of the Seaward vegetation, enter the measurement, and write "in front" next to the number, signifying that the nest is in front of the vegetation line.

% Soil: Percent Soil content. While working with the nest, notice the percent of soil versus sand present at the site. Circle the closest number that represents the percent soil present. Range =0, 25, 50, 75, or 100 (Ex: 0% would indicate all sand, no soil, and 100% would be all soil, no sand.)

Cover Type: Record the type of vegetative cover over the nest. (IE, none or open, sage, purslane, manchineel, casha, etc.)

Relocated Nest: All information in this section pertains to the location of the relocated nest. See above for definitions of terms repeated from Original Nest information section.

Relocation Reason: State the reason the nest was relocated (IE. erosion zone, roots in nest hole, rats in area of original nest site, high visitor use area, high numbers of ants in the area, etc.).

Primary Technician: Record the first and last name of the technician that did most of the work on this turtle activity. This is not always the most senior technician, but the technician that physically did most of the work for this activity.

Others: List all other technicians, visiting researchers, and guests that were present during the recording of the activity.

SEA TURTLE TAGGING PROTOCOL

PROCEDURE:

1. Before leaving the pier for first patrol, check that your tagging tool is loaded with a tag.
2. Prior to approaching any turtle, check that the tag is properly loaded in the tagging tool.
3. Spread tag wide so it fits snug in the tagger.
4. Gently close the tagger to see if tag point aligns with hole, but **do not** crimp tag.
5. Remove tag and spread it again. Use needle nose pliers to adjust point of tag as needed to get alignment with hole.
6. Make sure tag is placed in tagger so the hole of the tag matches up with the depression located on the bottom jaw of the tagger.
7. Make sure tag is seated all the way into the notch at the back of the tagger.

APPROACH ANY TURTLE AS IF SHE IS UNTAGGED !
(Refer to Turtle Encounter Flowchart

8. Determine direction the turtle is facing and always approach from behind.
9. If turtle is departing the beach -
    A. Approach using minimal light, avoid casting shadow over turtle.
    B. Check all four flippers for existing tags.
    C. If turtle is tagged, record at least one tag number before she departs
    D. If turtle is not tagged, you must apply a minimum of one tag before she leaves the beach.
10. If turtle is nesting -
    A. Approach using minimal light, avoid casting shadow over turtle.
    B. Examine all four flippers for tags. Rub hand along the trailing edge of front flippers to feel for tags and tag scars. Also check for hind flipper tags, they will be on the interior edge of the hind flipper above the 5th flange.
    C. Look carefully at numbers and record them. BUIS tags are NMFS inconel series PPW-800's, QQD-001 thru QQD-900, or yellow Dalton Roto Riese series BI-001 to BI-020.

Double check your numbers! Have someone else read the tag numbers, or double check all flipper tags yourself for accuracy.

    D. Each nesting hawksbill should have one tag in each flipper. Note the tag position of all tags; L1, L2, L3, R1, R2, R3, LH, RH, and on hind flipper tags note if the tag is located in the scale (S) or tissue (T).
    E. If any existing tags are loose they should be removed.

RETURN ALL REMOVED TAGS TO THE RESOURCE MANAGEMENT SPECIALIST FOR ARCHIVING AND CONFIRMATION OF TAG NUMBERS.

F. Apply the replacement tag in an adjacent scale.
G. Draw the position of the tag scar on the turtle diagram on the data sheet.
H. If turtle is not tagged, tag all four flippers while she is laying or hind flipper covering.

HAWKSBILL TURTLE TAG APPLICATION PROCEDURE with NMFS INCONEL TAGS

1. Hold the turtle's flipper in opposite hand from tagger and brush excess sand off flipper.
2. Place tagging tool in position and apply tag (Figure 14):
   A. Tagging front flipper -
      i. Place tip of tag 2/3 up the L3 or R3 scale (the first large scale out from the body) so that only 1/8" of the tag is hanging beyond the edge of the flipper.
      ii. Crimp tagging tool firmly. People with smaller hands may have to use both hands to crimp tag completely closed.

   B. Tagging hind flipper -
      i. Tag is placed on the interior edge of the tissue above the fifth flange and scales. Scales are no longer tagged because that portion of the flipper is used in digging egg chambers and the tag can get caught on the carapace during digging and tear the flipper.
      ii. After positioning the tagging tool, crimp it firmly. Turtle may flinch depending upon her nesting activity at the time.

3. Check that the point of the tag has crimped through the hole and is securely folded over. It should be tight against the tag -- you should barely be able to get your fingernail under the point.

4. If tag fails to crimp fully you may be able to crimp it with needle nose pliers. If this does not work, and tag has still not crimped properly, remove it and set up a new tag in tagger and try again. Try to position new tag into the hole created on first attempt.

IF YOUR TAG MALFUNCTIONS DURING TAGGING DO NOT DISCARD IT: KEEP IT FOR OUR RECORDS.

DOUBLE CHECK ALL TAG NUMBERS AND TAG LOCATIONS AND MAKE SURE THEY ARE RECORDED PROPERLY BEFORE LEAVING THE TURTLE !!!!!

EQUIPMENT:
- Tagging tool - "Tagger"
- Needle nose pliers
- National Marine Fisheries Service (NMFS) Inconel tags - series PPW or QQD

EQUIPMENT CARE AND MAINTENANCE

1. Each person is assigned a tagging tool. NMFS inconel numbered tags, pliers, flashlight, headlamp, tape measure, clipboard, dive booties, and miscellaneous other consumable supplies.

2. Each person is responsible for maintaining this equipment in good working order and if any item is lost, please report it to the bio aide or program director as soon as possible. Many tape measures, flashlights, and pliers that have been lost on the beach have been recovered because everyone knew to look for them!!

3. Clipboards, tagging tools, pliers, and flashlights should all be flagged with bright colored flagging tape and/or reflective tape to help locate it if placed on the ground while working on a turtle.

4. All tools, clipboards, headlamps, and flashlights should be cleaned of sand after **each** night on the beach. Please do not let it accumulate, it will wear the gear out quickly.

5. When any piece of equipment breaks, please let either the bio aide or program director know as soon as possible so it can be replaced. No one should go into the field without all the necessary equipment properly functioning.

WE WILL APPRECIATE EVERYONE'S COOPERATION ON THIS AND CARE OF THE PROGRAM'S LIMITED TOOLS AND EQUIPMENT. *Thank you!*

ADULT HAWKSBILL SEA TURTLE BLOOD COLLECTION PROTOCOL

HISTORY:

The Buck Island Sea Turtle Research Project is conducting genetic analysis through the collection of blood samples from nesting hawksbill turtles. Genetic analysis determines the genetic relationship of the hawksbill turtle nesting on Buck Island to other genetically identified populations in the Caribbean. Blood required in total is 1 to 5ml. Blood collection is most easily done while the turtle is depositing her eggs or rear flipper covering, however, occasionally drawing the blood when the turtle is camouflaging or trying to depart the beach is necessary.

BLOOD COLLECTION DURING NESTING OR REAR FLIPPER COVERING:

Note: These instructions are for a right-handed person.

1. Have the pipette and 10 ml tube w/ lysis at easy access. These should be set up in an area where they will be protected if the turtle should throw sand.

2. Position yourself directly in front of the turtle.

3. Attach the needle to the Vacutainer holder. The 5 ml Vacutainer tube is positioned inside the holder but **DO NOT** pierce the stopper with the needle yet. (Figure 15)

4. The turtles' head should be in a downward position allowing blood to fill the cervical sinus. If necessary, scoop the sand/soil under the turtles' head so that her head neck can be extended in a downward direction.

5. With your left hand, hold her head just behind her skull and pull it outward and down. This will expose the cervical sinus. Hold this position.

6. Find the pair of tendons running down the center of the neck.

7. Blood can be collected from two areas or the dorsal cervical sinus. One is midline between the tendons, and the other is lateral to the tendons (Figure 16). With practice, each person will develop a feel for what works best for them.

    - The midline site is about two inches below the carapace/skin junction and is located midway between the two tendons.
    - The lateral site is located about 1/4 inch outside the right-hand (or left-hand) tendon, and 1 to 1.5 inches from the carapace/skin junction.

8. Wiping the area with a disinfectant is not necessary, but do so if desired.

9. Remove the protective cap from the needle. With the bore of the needle upwards, insert the needle into the skin at the desired point. Insert the needle to at least half the length of the needle shaft, then push the Vacutainer tube onto the collection

needle inside the holder. This inner and smaller needle should pierce the rubber stopper. This allows the vacuum within the tube to draw the blood automatically once the sinus is found. If the needle is pulled from the turtle's neck before the Vacutainer tube is removed from the collection needle, the vacuum will be lost and the tube must be replaced with a new one.

10. While holding the assembly as one unit, slowly move it outward. **DO NOT PULL THE NEEDLE OUT OF THE SKIN**. Continue to reposition the needle until the sinus is found. The needle may need to be rotated, moved in or out, or the angle changed. However, all of this can be done without removing the needle from the skin. When the sinus is found, a strong stream of blood will begin to fill the Vacutainer. If the sinus is not hit after a few seconds, it may be necessary to move the needle higher or lower on the neck. First remove the tube from the collection needle so that it no longer pierces the stopper, then the needle can be extracted from the tissue and moved to a new location to try again.

11. It may take several attempts to find the sinus. If blood collection is unsuccessful during egg deposition, wait until after the turtle begins rear flipper covering. This may increase her blood pressure and make the sinus easier to find.

12. If the needle is reinserted several times, it will get dull and need to be replaced.

13. When the sinus is found, a strong stream of blood will fill the Vacutainer tube. Collect a full 5 ml of blood if possible.

14. When the Vacutainer is full, pull it off the collection needle and then remove the needle from the turtles' neck. Usually no bleeding occurs at the point of insertion, but if bleeding does occur, have another team member pinch the puncture site between two fingers to apply pressure for a few seconds until the bleeding stops.

15. Remove the stopper from the top of the 10 ml Vacutainer tube. Draw 1 ml of blood into the pipette from the 5 ml tube and dispense it into the 10 ml tube with the lysis solution. Insert the stopper back into the 10 ml tube and gently mix back and forth until well mixed.

16. Label all tubes with the date, turtles primary tag number, technicians' initials that collected the blood, and "BUIS HB Adult."

17. Place the 5 ml tube into the ice cooler standing upright and place the 10 ml tube in the pocket on the outside of the cooler.

18. Detach the needle from the Vacutainer holder and put the protective caps on the needles. Dispose of the needle, pipette, and any malfunctioned tubes in the Hazardous waste container on the boat.

BLOOD COLLECTION DURING CAMOUFLAGING OR DEPARTURE:

The following method is used for a hawksbill that has not successfully had blood collected during egg deposition, rear flipper covering, or is encountered when she has already finished nesting and is leaving the beach. The only difference to the above method is that the turtle will probably need to be restrained during the procedure. If blood collection was not successful in any of the previous attempts, another attempt can be made after she has been flipped back to her plastron after being on her carapace for weighing or measurements. This will allow the sinus to fill and increase blood pressure. At least two people are required, one to restrain the turtle and the other to collect the blood sample.

1-3. Follow instructions as stated above.

4. The assistant will sit on the anterior portion of the turtle's carapace and place their feet in front of the turtles' shoulders on either side of the neck. This should prevent the turtle from continuing to crawl forward and keep the flippers out of the way.

5. Once the turtle is held still, the assistant can grasp the turtle's head and extend the neck out and downward, presenting the neck and cervical sinus for the person collecting the sample.

6-18. Follow all the previously mentioned procedures from this point. The only thing that has changed is that the turtle may be moving around because she is ready to leave the beach. Nevertheless, with patience and determination, this method works well.

After successfully collecting blood from a few turtles, it will get easier. The total time for blood collection, once practiced, is less than two minutes and is not traumatic to the turtle or the technician!

PERSONNEL:

One person can collect blood if the turtle is depositing eggs or rear flipper covering. More people may be needed if the turtle is camouflaging or departing the beach. The additional people will hold the turtle and extend the neck for the person collecting blood.

EQUIPMENT:

- One Vacutainer holder
- One 22Ga 1 ½" Vacutainer needle, with extra available if needed.
- One 5ml Vacutainer tube (untreated red top tube), with extra available if needed.
- One 1 ml plastic pipette
- One 10ml Vacutainer tube (untreated red top tube) containing 9 ml Lysis buffer

TISSUE SAMPLE COLLECTION FOR GENETIC ANALYSIS PROTOCOL

HISTORY:

The Buck Island Sea Turtle Research Project is conducting genetic analysis through the collection of tissue samples from nesting hawksbill turtles. Genetic analysis determines the genetic relationship of the hawksbill turtle nesting on Buck Island to other genetically identified populations in the Caribbean. The tissue sample needs to be about 1cm^2. Tissue collection is most easily done while the turtle is depositing her eggs or after she has been removed from or left the nest site.

1. Have a team member extend one of the hind flippers and place it on top of a clipboard for support as a cutting surface. Refer to Figure 6 for possible sample sites.

2. Open a sterile Uni-Punch 8.0 mm biopsy punch packet and firmly grasp the yellow handle.

3. Place the outside edge of the biopsy punch at the edge of the flipper at the chosen site and firmly press down on the punch and twist. This motion will make a clean cut and the sample should come cleanly away from the flipper. If the turtle flinches while making the cut be prepared to pull the punch away from the turtle to minimize the chance of unwanted injury to the turtle or technicians. When the turtle settles down reposition the punch over the same site and try again.

4. If bleeding occurs, hold the site with a cotton ball and apply pressure until the bleeding stops.

5. Place the tissue sample in a container with either tissue buffer or 90% Ethanol. If the sample will not come out by tapping the punch on the inside of the container, use tissue forceps to remove it from the punch and place it in the container.

6. Label the container with the turtles' primary tag number, the date, the initials of the technician that cut the sample, and "BUIS HB JUV.".

7. Store the container in the "Blood Collection kit" until reaching the office.

8. At the office place the labeled container in the NRM cabinet that is labeled "Juv. HB Genetics Samples". These will later be shipped for analysis.

Alternate Method using scissors and forceps if no biopsy punch is available:

1. Rinse the ends of a sharp pair of tissue scissors and tissue forceps with alcohol.

2. Hold the instruments in the flame of a lighter to burn off the alcohol and sterilize the instruments then allow a few seconds for the instruments to cool.

3. Have a team member extend one of the hind flippers. Refer to Figure 6 for possible sample sites.

4. If the turtle flinches while making the cut be prepared to pull the punch away from the turtle to minimize the chance of unwanted injury to the turtle or technicians. When the turtle settles down reposition the punch over the same site and try again.
5. Use the tissue forceps to grab hold of the tissue you plan to cut. Cut an approximately $1cm^2$ tissue sample as cleanly and quickly as possible. This will reduce the chance of the turtle pulling and creating ragged edges or possibly deeper cut than desired.

6. If bleeding occurs, hold the site with a cotton ball and apply pressure until the bleeding stops.

7. Place the tissue sample in a container with either tissue buffer or 90% Ethanol

8. Label the container with the turtles' primary tag number, the date, the initials of the technician that cut the sample, and "BUIS HB JUV.".

9. Store the container in the "Blood Collection kit" until reaching the office.

10. At the office place the labeled container in the NRM cabinet that is labeled "Juv. HB Genetics Samples". These will later be shipped for analysis.

PERSONNEL:

Two people are needed for this procedure. One person will restrain the turtle while the other person collects the sample.

EQUIPMENT:

- One sterile Uni-Punch 8.0mm biopsy punch
- Container with tissue buffer or 90% Ethanol (ETOH)
- One pair of tissue forceps
- Cotton balls
- Fine tip permanent marker to label the container

Additional equipment if no biopsy punch is available:

- One sharp pair of tissue scissors
- Rubbing alcohol
- One lighter

NEST RELOCATION PROTOCOL

HISTORY:

Since Hurricane Hugo, September 17-18, 1989, and Hurricanes Luis and Marilyn, September 1995, the number of sea turtle nests requiring relocation at Buck Island Reef NM has increased. Presently, less than 5 percent of all nests laid on BUIS annually are relocated for any of the following reasons:

- Eroded berm was too steep and turtle nested in erosion zone.
- Access to beach/beach forest was obstructed by fallen trees and root tangles and turtle nested in erosion zone.
- Turtle nested in known erosion zone; no obvious reason.
- Turtle nested in a high visitor use area. Hatch success is threatened by high density foot traffic, high concentrations of biting ants, and/or high levels of bacteria in the soil adjacent to trash containers.
- The nest is laid in areas of high rat activity or rat predation on nests has been recorded.

RELOCATION PROTOCOL:

Nests may be relocated for any of the reasons described above. The nest is best relocated directly landward of the turtle's nest site, above the berm and into a stable beach/beach forest area. If no acceptable relocation sites are found in the adjacent beach forest, the nest is moved to West Beach between markers 32 and 42. West Beach is used for nest relocations because annually it has the highest hatch success, 75-100%. Nests are relocated to the dune grass/beach vine area parallel to, or behind, a beach marker. Relocation should be completed within 2 hours of egg deposition to prevent compromising the viability of the eggs.

RELOCATION EGG HANDLING PROCEDURES:

During egg deposition, the technician will decide if the clutch needs to be relocated. If so, the following protocols are followed:

1. During egg deposition place one end of a long section of flagging tape in the nest hole and tie the other end to a strong root or bush. This marks the nest in the event the technician must leave the turtle before it finishes laying and covers the nest while technician is away.

2. After the turtle has completed egg deposition, gently move her off the clutch.

3. Cover the nest opening with a plastic bag. Secure the corners with rocks to prevent rats from getting to the eggs.

4. Complete data collection on the female, she will finish covering her "false" nest, and depart.

5. Take nest top and neck width measurements. (Refer to Sea Turtle Data Collection Protocol)

*****ALWAYS PUT ON LATEX GLOVES BEFORE HANDLING ANY EGGS*****

6. Count eggs as they are removed and placed in a clean plastic garbage bag. Keep the mucus on the eggs and avoid getting excess sand/soil on the eggs. (Egg measurements and weights can be done at this time, if needed.)

7. Once all the eggs are removed take the nest bottom and the two bowl width measurements. It is important to duplicate the original nest dimensions as closely as possible when digging the relocation nest hole.

8. Draw the nest site diagram and measurements for the original nest.

9. Fill in the original nest chamber and "clear" the nest site.

10. Carefully carry the eggs, now in a large white trash bag, to the relocation site.

11. Clear vegetation, beach grass and break root hairs, two meters around the relocation site and 6-10 cm below the surface. This will reduce the number of root hairs that might grow into the nest during the 60-day incubation. Simulating the body pitting action of a nesting turtle.

12. Dig the nest chamber to the same dimensions as the original nest.

13. Gently drop the eggs, one or two at a time, into the nest chamber from the approximate height of the turtle's cloaca during egg deposition.

14. Count the eggs as they are dropped into the nest hole to verify the first clutch count. Record the number of eggs on the data sheet identifying number yolked, yolkless, or broken.

15. Before the top layer of eggs is put in the nest, write all the required information on a one foot piece of flagging tape and place it in the nest (Females tag #, Date, Loc/marker, clutch count, and tech initials).

16. Put in the remaining eggs. Dump any soil and mucous in the bottom of the plastic bag over the eggs. Continue to cover the nest with the sand dug from the bottom of the chamber first because it will be moister.

17. Continue covering eggs, gently tamping/pressing the soil intermittently with your fist.

18. Cover the nest until the sand/soil level is 2-4" above the surface of the beach. Scatter surrounding leaf litter over the nest, simulating the turtles camouflaging phase.

19. Tie the nest id/number tag on a strong plant base, root, branch, or on a “Crumbley” stick ½ meter behind the nest site.

20. Draw the relocated nest site diagram and record measurements.

21. Camouflage the nest area by scattering sand and leaf litter, so the area looks undisturbed.

22. Clear all footprints and tracks prior to leaving the area.

NESTING SEASON THREAT MITIGATION PROTOCOL

EXOTIC PREDATOR CONTROL PROTOCOLS

HISTORY:

Over the last 20 years BUIS' sea turtle hatch success has been reduced by exotic predators, primarily mongoose and tree rat, preying on eggs and hatchlings. Between 1970 and 1980 nearly 100 percent of all sea turtle nests were lost to the combination of predation and/or poaching. In 1975, in response to the Endangered Species Act, BUIS established law enforcement patrols to provide both visitor and natural resource protection. Early morning ranger patrols were significant deterrents to many illegal activities and drastically reduced poaching on adult female sea turtles and their nests. Once poaching was under control, the park turned its' efforts toward the unwanted predators. Beginning in the early 1980's, NPS began trapping the mongoose. In 1982 and '83, NPS and Virgin Islands' Department of Planning and Natural Resources, Division of Fish and Wildlife, jointly undertook an island-wide mongoose trapping program. By 1985, the final report states that 90 percent of the mongoose were eliminated. Between 1988 and 1994, one live and one dead mongoose have been sighted on BUIS. In the years prior to the mongoose trapping program, 1980 to 1986, hawksbill sea turtle nest emergence success was less than 31 percent (Zullo, 1986). After trapping, 1987 to 1997, hawksbill nest emergence success rose to 67.4 percent, a one hundred percent increase, even taking into consideration the numbers of nests lost in two major hurricanes (Hillis-Starr and Phillips, 1998).

Unfortunately, removing the mongoose has enabled the exotic tree rat to take its place as a predator on hawksbill turtle nests. Beginning in 1995, following Hurricane Marilyn and drought conditions, tree rats became a significant threat to hawksbill eggs and hatchlings. During nocturnal research patrols, rats were observed around nesting turtles, even sitting on the backs of nesting turtles. It was suspected that rat activities around nesting turtles caused several aborted nesting attempts. Nests were robbed of eggs both during laying and during nest relocation procedures. In order to protect hawksbill turtle nests, eggs and resulting hatchlings, several "new" relocation protocols and nest protection measures were devised. Rats were trapped along the nesting beaches at night and constant vigilance was keep over nesting turtles and their eggs during nest data collection and relocations.

Since then, Buck Island Reef NM Division of Natural Resources has been successful in securing NPS funding to undertake an island-wide rat eradication project. The project began in October 1999 baiting along the sea turtle and least tern nest beaches and went island-wide in April 2000. To date the rat populations have been severely reduced all over the island, but baiting and follow-up monitoring will continue into the fall. We may be fortunate that this turtle season on BUIS may be the first one that is rat-free in thirteen years. We are looking forward to the full success of this project to provide essential protection to BUIS flora, fauna, and visitors.

PREDATOR CONTROL CRITERIA AND ACTIONS:

Hawksbill sea turtles are a federally listed endangered species, and as such require the NPS' best effort to preserve, protect, and mitigate manageable threats like the exotic tree rat. The loss of any eggs or hatchlings to an exotic predator is unacceptable. BUIS has established a threshold of predation at zero. After one predation event is documented on either a nest or hatching, BUIS' sea turtle research staff will begin trapping in the effected area.

Predation events are documented in the nightly activity log, and reported to the Resource Management Specialist. If rats are observed during a turtle nesting/egg deposition, and the rats have located the nest, it must be relocated to another area following the BUIS Nest Relocation Protocols. If rats are sighted in an area consistently, or a nest is predated, traps will be set to remove the rats from the area.

NESTING BEACH RAT TRAPPING METHODS:

1. The location of the rat predation event is recorded.
2. Trapping will be conducted two marker stakes either side of the predation event for a total of 60 meters along the nesting beach (For example: If predation occurs at NS 5, traps will be set from NS 3 to NS 7).
3. Set out ten traps, one at each marker, one between each marker, and on at the predation site. Have at least one spare trap on hand in case the bait treadle is lost or malfunctions.
4. Rat-size snap traps are mounted securely to trees or logs using cable ties or rubber bands. Snap bar set in up-tree position.
5. Traps are baited with peanut butter and rolled oat mix and carefully set.
6. Leave traps set for one hour then check each one. Monitor traps in the same order each time.
7. Record trap data in field book by code -
    A. trap with rat (Rat)
    B. trap sprung, no rat, re-bait (RB)
    C. trap okay (OK)
    D. trap with ants (OK/ants)

Fieldbook Notations:

Date - Time	Location	Trap #	Status of Trap
06/25/98 - 2100	NS 1	#1	Rat, male
		#2	OK
	NS 2	#3	Rat, female
		#4	Tripped, RB
	NS 3	#5	OK

8. Each rat captured is collected for diagnostic information.
   BEFORE HANDLING RATS PUT ON DISPOSABLE GLOVES !!!
9. Make a label on masking tape with permanent marker. Write - time, location, trap #, tech initials. Wrap tape on rat's tail.
10. Carefully remove rat from snap trap and put rat in garbage bag for collection.
11. Re-bait and re-set trap as necessary.
12. All rat traps are sprung on last patrol and left sprung for the day.
13. Re-bait and set traps on first patrol following night.
14. Rat trapping will continue for a minimum of three nights or after first night of no rat captures, which ever comes first.
15. Rat diagnostics can be done between patrols if it does not interfere with turtle work. The data is recorded using the following codes:
    A. Trap ID= Marker number near trap. If the trap is between markers put a "/ " between numbers. If it is the predation site enter "ps". See tail label.
    B. Time= time rat was found in trap as noted on tail label.
    C. Body and tail length= measurement (mm) from tip of nose to tip of tail, with body fully extended.
    D. Tail length= measurement (mm) from base of tail to tip of tail.
    E. Weight= weight in ounces.
    F. Sex= "M" for male or "F" for female as determined by looking at genitals.
    G. Right testis length= length of right testis of male rats measured in millimeters with small calipers.
    H. Vaginal condition= "UP" for unperforated, "SP" for slightly perforated, and "P" for perforated vaginal opening.
    I. Right ear length= measured (mm) from bottom of "v" in bottom of ear to the top of the ear flap.
    J. Right hind foot length= length (mm) of foot from heal to longest toe.

Rat Diagnostics: Date (month, day, year)

Trap ID	Time	Body & tail length (mm)	Tail length (mm)	Weigh t (oz)	Sex	Right Testis length (mm)	Vaginal conditio n	Right ear length (mm)	Right hind foot length (mm)
NS3	2100	406	210	4.8	M	20.7	---	22.5	36.0
NS5/6	2100	410	217	6.2	F	---	P	22.3	34.9
NS3	2200	320	180	2.5	F	---	UP	19.4	32.7
NS5ps	2200	309	176	2.3	M	13.9	---	22.2	32.6
NS6/7	0200	422	221	5.3	M	19.0	---	23.5	36.7

16. After rat measures are recorded, rats are disposed of in a dumpster on St. Croix the next morning or that day. If rats have to be held until diagnostics are completed they can be put in a freezer and thawed for measurements.

Personnel:
one or two people

Equipment:
- 11 Rat-sized snap traps marked with reflective tape
- disposable gloves
- trash bags
- peanut butter and rolled oats
- cable ties, 12 “
- rubber bands, large
- field notebook
- masking tape and permanent marker pen
- calipers
- spring scale

HURRICANE PREPARATION AND POST-STORM PROTOCOLS

HISTORY:

The peak-nesting season for hawksbill turtles at Buck Island Reef NM happens to coincide with the Caribbean hurricane season. BUIS's sea turtle nesting habitats have been severely affected by hurricanes over the past number of years. In September 1989, Hurricane Hugo hit St. Croix and Buck Island Reef National Monument lasting more than 12 hours with sustained winds in excess of 175 mph and gusts of up to 204 mph. The storm stripped all vegetative cover from the trees of the beach forest nesting habitat, left tons of downed trees and debris blocking the nesting beaches, and created one meter high berms preventing access to major nesting areas. In September 1995, Hurricanes Luis and Marilyn hit just 10 days apart, once again, although to a lesser extent, altering BUIS's beaches and beach forest (Hillis-Starr and Phillips, 1998). The beaches came and went too quickly to document until both storms had passed. On West Beach more than 12 meters of beach and beach vegetation was lost. In Turtle Bay, while trying to locate a known nest site, technicians began digging to locate the nest id tag known to be tied to the base of a small tree. The top of the tree branches were found sticking just above the "new" beach sand. The area was excavated down to the base of the little tree (6 feet); the nest tag was located but not the nest. Freshly killed soft corals and sponges were found at the bottom of the excavation. We would never have known the extent of the beach removal and replacement without doing this crazy excavation.

Thanks to the technology of weather monitoring, the tracks and severity of storms are closely monitored and forecast to the public. Early warning permits time to carry out hurricane preparation tasks at BUIS which minimize loss of equipment, document pre-storm beach conditions, and shorten the length of time it takes to get back to nightly patrols after the storm passes. Post-storm protocols assess the natural resource damage, reestablish access for sea turtles to nesting areas, and eventually allow researchers to continue nightly monitoring of nesting activities.

The most important phase of hurricane preparation is to know that a storm is approaching. Once a storm has been identified as a possible threat, the direction of travel and the current warning stage is monitored daily. The stages to the warning system denote the force of the storm and the amount of time expected before it reaches the area. The following terms are used when describing the strength and timing of a storm:

- **Tropical Depression**: One or more closed isobars and some rotary circulation on the surface. Highest wind speeds of 39 miles per hour (mph)

- **Tropical Storm**: Closed isobars, distinct rotary circulation, wind speeds 39-73 mph.

- **Hurricane**: Closed isobars. Strong and very pronounced circulation with wind speeds of 74 mph or more.

The following storm alerts will indicate the area to be affected, the time during which the warning will apply, and the expected intensity of the storm. The warnings are listed in order of severity from least to most severe.

- **Storm Warning**: Winds of 55-74 miles per hour are expected. Due to the unpredictable track of storms, this warning may last for a number of days, especially if the storm stalls in one location for a period of time.

- **Hurricane Watch**: If the hurricane continues its advance and threatens the area, a watch is issued for that area 48 hours prior to the predicted strike.

- **Hurricane Warning**: Hurricane conditions are expected within 24 hours with wind speeds of at least 74 miles per hour.

PRE -STORM PREPARATION PROTOCOLS:

When a hurricane watch has been issued, usually about 48 hours before the storm, the park begins hurricane preparation procedures. The BUIS Resource Management Specialist notifies the sea turtle research team and sets a schedule for instituting hurricane preparation protocols. Personnel will be assigned tasks and time lines in which those tasks need to be completed.

1. The team travels to BUIS by boat to secure equipment and document the pre-storm beach condition.
2. Video documentation of the beach is made from the boat from the West Beach (WB) anchorage area past the pier, and into Turtle Bay (TB).
3. Once on the island, team members will depart the pier toward West Beach.
4. As they walk around West Beach, the distance from each marker to the berm and the high water mark is measured and recorded. A piece of flagging tape with the marker number written on it in permanent marker is attached about two meters behind the stake to the most sturdy piece of vegetation possible, then the marker stake is removed. The wooden marker stakes between the pier and the picnic area are collected. All of these stakes are stored in the shed behind the bathroom facilities at the West Beach picnic area.
5. The team walks to North Shore 1.
6. One person will conduct video documentation of the beach. Starting at marker 1, a slow pan is done looking down the beach, turning landward, and continuing until looking down the beach in the opposite direction. This process is repeated at every fifth marker (1,5,10,15, etc. to 100)
7. As the team makes its way back toward the pier, the measurements and marker stakes between NS1 and the WB picnic area are collected as above. These markers are also stored in the WB shed.
8. All wooden marker stakes are collected in the same manner as previously described from TB and South Shore (SS), as the team makes their way back to Dietrich's picnic shelter.

9. All excess field gear stored in the shed at Dietrich's, is removed for safe keeping at NPS housing on St. Croix. This includes, the centrifuge, generator with fuel, the turtle weigh pole, and any other vital research equipment.
10. The SS and TB marker stakes are stored in Dietrich's shed.
11. The rain gauge located on the back of the NPS sign is removed and the bottom two thirds of the collection container is set into the ground near the picnic shelter. This will allow it to record rainfall without being lost, should the sign be destroyed.
12. When all beach preparation is complete, the team returns to Gallows Bay Marina. The boat is docked at the fuel dock and as the boat is being filled with, the gear is unloaded from the boat and loaded in the vehicles.
13. Once the boat is unloaded and fueled, a crew coordinates with the BUIS Ranger Division to pull the boat out of the water and trailer it to NPS Housing for safe storage during the storm.
14. Afterwards, the team meets at the NRM office to secure the office, equipment, and the NRM storage room.
15. All equipment is picked up off the floor, all electrical equipment is unplugged except the refrigerator, and everything gets draped with plastic sheeting which is taped or tied in place.
16. All cold storage specimens in the NRM refrigerator are removed, and packed on ice to be moved to NPS housing where it will be stored in the designated refrigerator and freezer. Generators are available at the housing to run electrical equipment in case of a power outage.
17. Each residence of the research team, including, the Resource Management Specialist, The USGS/BRD Biologist, and the team at NPS housing, is given an NPS radio and a cellular phone to ensure lines of communication should the phone system go out.
18. Once everything at the office is secure, team members depart for their respective homes to make personal storm preparations and to wait out the storm.

GOOD LUCK TO ALL AND HOLD ON TIGHT !!!!!

PERSONNEL:

ALL personnel are required.

EQUIPMENT:

- NRM Sony video camera with 2 fully charged batteries and two video tapes
- Flagging tape
- Personal gear; backpack, water, sunscreen, etc.
- Cooler with ice packs
- plastic sheeting
- rolls of duct tape
- string or twine to secure plastic sheeting
- NPS Handheld Radios with fully charged batteries
- NPS Cellular phones

POST-STORM PROTOCOLS:

1. The Superintendent contacts each residence by radio, cell phone, or in person, to determine the safety of the personnel.
2. The Superintendent will determine when the boat can be put back in the water and the first trip can be made to BUIS to assess damage. This is determined by equipment condition, available road passage, and boat launch ramp condition.
3. When permission is given, the boat is trailered to the launch ramp and launched.
4. The Resource Management Specialist and team travel to BUIS to make initial damage assessment.
   A. Video documentation of the beach is made from the boat from the West Beach (WB) anchorage area past the pier, and around Turtle Bay (TB).
   B. Dock or anchor, depending on condition of the pier.
   C. Two teams are established, one covers NS/WB, the other covers SS/TB.
   D. Each team records the following as they walk their assigned beaches:
      i. structural damage- what is damaged and to what degree
      ii. dead wildlife - species, size, and cause of death if apparent are noted. The remains are either collected as a specimen or buried.
      iii. equipment lose- note what equipment is missing
      iv. flooded sections of beach- area affected and depth of standing water
      v. vegetative damage- species damaged, extent of damage (i.e., salt burn, eroded roots, fallen trees, etc.), size of the specimen
      vi. beach damage-(i.e., steep berms, eroded root tangles, etc.). Perpendicular measurements are taken from the beach forest to the berm edge.
      vii. sea turtle activities- washed out sea turtle nests, exposed sea turtle nests (any remaining eggs are relocated at this time to try to save surviving eggs.), and any new turtle activities are recorded.
   E. The rain gauge is recovered and the amount of rainfall recorded.
   F. The teams regroup at the pier to discuss equipment needs for the follow-up visit

EQUIPMENT:

- NRM Sony video camera with 2 fully charged batteries and two video tapes
- Clip board with pencil
- Daytime Sea Turtle Nesting Activity Logs
- Field notebook
- Personal gear; backpack, water, sunscreen, etc.

5. Follow-up visit prior to returning to nightly monitoring patrols:
   A. Gather all necessary equipment for beach restoration.
   B. Clear a pathway along the shoreline for patrols
   C. Restore beach forest access by sea turtles by grading berms and clearing fallen trees and debris in high density nesting areas.
   D. Reinstall nesting beach markers

PERSONNEL:
ALL personnel are required.

EQUIPMENT:
- Any special equipment deemed necessary from initial visit (i.e., shovels, chain saws, protective gear, ropes, machetes, etc.).
- 25 meter tape measure
- Sledge hammer to install beach markers
- Personal gear; backpack, water, sunscreen, etc.

Return to nocturnal patrols when the Superintendent gives approval.

SEA TURTLE NEST EXCAVATION PROTOCOL:

Sea turtle nests may hatch in any month of the year at BUIS, depending on when they were laid. Every effort is made to excavate every observed nest, as well as, unobserved suspected lays. These nests are more difficult to locate and are often laid in inaccessible areas, but nest excavation is attempted, and hatch success is determined to provide a complete summary of overall hatch success at BUIS for the season for all species of sea turtle.

The average length of incubation for hawksbill sea turtle nests is 60 days. This may range from 50 to 75 days depending on the time of season, habitat, soil type, air temperature, beach temperature, and the amount of rainfall during incubation. During the nocturnal research program, when the beaches are patrolled nightly, nests are checked beginning at about 55 days from date laid for signs of hatching. During off-season day patrols, nests are checked on or about 60 days for hatching. There are two obvious signs that indicate the nest has hatched, hatchling tracks leaving the nest site and running down the beach face, and/or a very definite emergence sink hole at the nest site. The sinkhole is created as the hatchlings dig their way to the surface and move the soil from above them to below them (Figure 17).

During off-season day patrols if the nest has fully emerged and all hatchlings have left the nest, it can be excavated. During the nocturnal research program, if hatchlings are observed emerging, unless hatchlings are being collected for special measurements or blood samples, the nest is left alone until the following night before excavation.

Solo nest excavation -

1. Prepare “Sea Turtle Hatch Data Log” sheet. Record the date of excavation, person excavating nest, location of nest, species, habitat, % soil, dates laid and emerged, time of emergence if observed, if nest was identified by nest tag, record nest tag number, and turtle’s tag number, if known. (Obviously, turtle tag numbers are not known for unobserved nests).

2. **Put on latex gloves** to protect from bacteria that may be present in the nest.

3. Push away all loose top soil/sand and debris away from the nest, so it doesn’t fall back into the nest hole as you excavate. Clear an area to place excavated soil, and an area for nest contents.

4. Excavate the loose soil in the nest. Use a scooping motion around the sides of the nest to get all loose soil. This motion, rather than digging straight down, prevents the excavator from accidentally breaking undeveloped eggs.

5. Check each handful of soil for hatchlings, egg shells, and eggs. If these are not present, place the soil in a pile out of your way but accessible for later filling in the hole. If live hatchlings are found, place them in a large plastic bag, leave the top of the bag open and place the bag in the shade nearby for easy access if needed again. Place all other nest contents in a pile for later analysis.

6. Continue excavating the nest until all contents have been recovered. The walls and bottom of the nest cavity are usually well defined, but check behind roots and in crevices for stray hatchlings. This is even more important if there are a lot of roots in the nest hole.

7. Count the number of stranded live hatchlings, and record on data sheet.

8. Sort remaining nest contents - hatched shells, dead hatchlings, pipped embryos/shell, and unhatched shells (midterm and undeveloped).

9. Count the number of dead hatchlings. Place remains back in the nest hole, and record number on data sheet.

10. Count number of hatched shells. This may require putting a number of smaller shell fragments together to equal one eggshell. Don't count the number of individual fragments; the goal is to get the number of eggs that hatched. Place counted shells into the nest hole and record the number on the data sheet.

11. Count and record the number of pipped embryo/shells. These are shells where the hatchling pierced the shell to emerge, but for some reason, never made it completely out of the shell.

12. All remaining contents are unhatched eggs. Open them one at a time and determine the stage of development, and record on data sheet:

    Unpipped/Fullterm - the ratio of hatchling to yolk is greater than 50%
    Midterm - the ratio of embryo or hatchling to yolk is less than 50%
    Undeveloped - there is no sign of development, yellow yolk only
    Yolkless - there is only clear amniotic fluid in the shell, no yolk,

    Record findings on the data sheet and place all remains in the nest hole. Note and photograph any abnormalities found in eggs, hatchlings, or embryos (i.e. twins, albinos, shells connected by calcium strings, etc.)

Note: Egg counts can be recorded as whole numbers or hash marks on data sheet, but when all counts have been completed, total each category and write the total on the right of the category and circle it. This is to prevent confusion between hash marks and numbers (i.e. Two hash marks could be mistaken for the number eleven).

13. If a nest tag or flagging tape were found which listed the number of eggs incubated, record this number on the data sheet.

14. Record predation impacts, number of eggs predated, number of hatchlings predated, and type of predation (i.e. rats, mongoose, dog, human, etc.)

15. Measure and collect blood samples from the live hatchlings if needed, and record the data on data sheet (Wibbels, et al, in press).

16. Release the live stranded hatchlings -
    - At night, release the hatchlings from the beach.
    - During the day, either release hatchlings from the boat (after reaching mid-channel en route to St. Croix), or hold them until night and release from a St. Croix beach. Releasing hatchlings from the beach during the day is disorienting and puts them at risk of predation by reef fish, frigate birds and pelicans.

Data analysis back in the office:

17. Check the total number of eggs incubated against the total number of pipped, unpipped, midterm, hatched shells, undeveloped, and yolkless eggs. If these two totals are not the same, the only place where counting error might have occurred is in the number of hatched shells. Subtract the total pipped, unpipped, midterm, undeveloped, and yolkless eggs from the number of eggs incubated, the result is the adjusted shell count. Write what the hatched shell count <u>should</u> be with the phrase "adjusted count" next to it and circle both. This corrected number will be used in the calculations.

18. Enter clutch outcome information into BUIS Sea Turtle database for that nesting activity. It will automatically calculate the hatch success and emergence success.

19. On the hatch data sheet, enter the percent hatch success. Hatch Success is the number of hatchlings that successfully got out of their eggshell. Hatch Success = (# of hatched shells/ total # of eggs incubated) x 100. Record on data sheet.

20. Enter the percent emergence success on the hatch data sheet. Emergence Success is the number of hatchlings that actually emerged from the nest. Emergence Success = [(# hatched shells {or adjusted if adjustment made} - live trapped - dead) / # of eggs incubated] x 100. Record on data sheet.

21. On top right hand corner of Hatch Data Sheet, in pink highlighter, place a mark and above it write the letters "DB" (for data base), and below it write your initials. This signifies that this data has been entered into the database and by whom.

22. Make a copy of the data sheet. Place the original datasheet just behind the corresponding nesting activity. Place the copy in the duplicate nesting activity with it original nesting activity sheet.

PERSONNEL:

Nest excavations can be done by one person who does both the excavation and the data recording. However, two people are more efficient. While one person excavates the nest contents, counts shells and makes the determination on unhatched eggs, the second person records data. This allows the person excavating (wearing gloves and generally getting messy) to do the counts without having to stop and record data.

EQUIPMENT:

- Disposable Latex Gloves
- Clipboard and pencil
- Sea Turtle Hatch Data Log sheets
- Large plastic bags
- Disinfectant hand-wipes
- Backpack, personal gear, towel to kneel on, sunscreen, water, etc.

SEA TURTLE HATCHING DATA LOG
BUCK ISLAND REEF NATIONAL MONUMENT, USVI

Date : _____/ _____/ 2000

Species: HB GR LB Primary Tag #:_____-____ Act. No. _____ Nest Id. _____

Sec/Mkr: _____ Dist. _____ Dir. _____ Habitat: BF SV OB %SOIL:_____

Temperature Data logger Unit #: _____ Comments:_____
Data logger Unit #: _____ Comments:_____
Data logger Unit #: _____ Comments:_____
Data logger Unit #: _____ Comments:_____

HATCHING RESULTS:
Date Laid - _____ Date Emerged - _____ No. Days Incubation - _____
Time Emerged - _____ (if observed) Date Excavated - _____ By _____

NEST CONTENTS: (Contents found below surface only) # Eggs Incubated:_____

HATCHLINGS -
Live/Trapped: _____
Dead Hatchlings: _____
Pipped: _____
_____
_____
Unpipped/Fullterm: _____
_____
_____
Midterm - _____
_____

EGGS -
Hatched Shell: _____
_____
_____
_____
Undeveloped: _____
_____
_____
_____
_____
Yolkless: _____

PREDATION:
No. Eggs Predated = _____ No. Hatchlings Predated = _____
Describe type predation suspected: _____

NEST SUCCESS CALCULATIONS:
Hatch Success = (_____ / _____) x 100 = _____%
(# Hatched Shells / Total # Eggs Incubated) x 100 = % Hatch succ

Emergence Success = (_____ - _____ - ____) / _____ x 100 = _____%
(Shells - Live/Trapped - Dead) / Eggs Incubated) x 100 = % Emerg succ

HATCHLING MEASUREMENTS, this nest:

TURTLE	1	2	3	4	5	6	7	8	9	10
LENGTH (cm)										
WIDTH (cm)										
WEIGHT (gm)										

Comments & Notes:_____
_____
_____

"SEA TURTLE HATCHING DATA LOG" TERMINOLOGY KEY

Date: Enter the date upon which the nest excavation is taking place.

Species: Circle the appropriate letters for the species of sea turtle, HB=hawksbill, GR=green, and LB=leatherback.

Primary Tag #: Primary Tag Number: The first tag ever applied to a turtle becomes the primary tag number, in other words, becomes that turtles "name" for that moment forward, even if that tag is ever lost or removed. All subsequent tags applied to that turtle are cross-referenced to the primary tag in the BUIS sea turtle database, and on the hard copy of the BUIS tag list. The primary tag number for the turtle that completed this activity should be noted in a variety of places, on the write on aluminum tag placed near the nest or on the flagging tape place in the nest at time of deposition. The number should be verified against the original data sheet for this activity.

Act. No.: Activity Number: Enter the activity number that was assigned to the original activity at time of occurrence.

Nest Id.: Nest Identification Number: Each observed nest received a random nest identification number that was attached near the nest at time of deposition. Find this tag and record the number. Verify the number against the number noted on the original data sheet to be sure the nest results are being assigned to the proper nest.

Sec/Mkr: Sector/Marker: Write the appropriate code to correspond to the beach the nest excavation is taking place on (NS=North Shore, WB= West Beach, SS= South Shore, and TB= Turtle Bay), and the marker number closest to the activity.

Dist: Distance: Pace off the distance from the nest to the nearest marker, do not measure diagonally.

Dir.: Direction: Note whether the nearest marker is to the left or the right of the nest.

Habitat: Circle the appropriate letters. This identifies the habitat in which the activity occurred. OB= Open Beach, open sand beach with no vegetative cover or perhaps sparse beach grasses. SV= Shoreline Vegetation, low ground cover consisting of purslane, sporadic shrubs, or beach vines. BF= Beach Forest, vegetative cover consisting of hard wood trees or saplings.

% Soil: Percent Soil content: While working with the nest, notice the percent of soil versus sand present at the site. Circle the closest number that represents the percent soil present.

Number of Eggs Incubated: Enter the number of eggs incubated in the nest. The number should have been recorded on the data sheet and/or on the flagging tape placed in the nest at time of deposition.

Hatch Results: Enter the data pertaining to the nest and the subsequent hatch in the appropriate space.

Date Laid: Enter the date of the original activity upon which egg deposition occurred. This can be found on either the original data sheet, the write on aluminum tag near the nest, or the flagging tape inside the nest.

Date Emerged: If observed, or if an estimation can be made, record the date the nest hatched.

No. Days Incubated: Number of Days Incubated: If the date laid and date of emergence are known, when the hatch data is entered into the BUIS Sea Turtle Database, the number of days for incubation will automatically be calculated. Enter that calculated number here.

Time Emerged: If the emergence is observed, note the time at which it occurred in military (24 hour) format.

Excavated by: Enter the name of the technician that excavated the nest.

Others: List the initials of any other persons present at time of excavation.

Nest Contents: All results entered in this section refer to only contents found below the surface. If the nest was predated and eggshells are scattered, or dead hatchlings are found on the surface, these numbers are recorded in the predation section below. Data can be recorded as whole numbers or hash marks that can be totaled upon completion of the excavation.

Live/Trapped: Enter the number of live hatchlings found trapped inside the nest.

Dead Hatchlings: Enter the number of dead hatchlings found inside the nest.

Pipped: Enter the number of shells found in the nest in which the hatchling pierced the shell to emerge, but for some reason, never made it out completely.

Unpipped/Fullterm: Enter the number of eggs opened in which the ratio of hatchling to yolk is greater than 50%.

Midterm: Enter the number of eggs opened in which the ratio of hatchling to yolk is less than 50%.

Hatched Shell: Enter the number of empty shells found inside the nest.

Undeveloped: Enter the number of eggs checked in which there is no sign of development.

Yolkless: Enter the number of eggs found inside the nest that contain only clear embryonic fluid in the shell, no yolk, indicating that fertilization did not occur.

No. Eggs Predated: Enter the number of eggs predated from the nest.

No. Hatchlings Predated: Enter the number of dead and live hatchling found predated from the nest.

Describe type of predation suspected: Write a brief description of the signs of predation (IE., eggs scattered on surface, hatchling found with bite marks, etc.), and the suspected type of predator (IE., rats, mongoose, dog, human, etc.).

Hatchling Measurements: All live hatchlings are weighed, measured, and have scutes counted. Length= straight-line carapace length (in centimeters) taken with Venier calipers from the curve of the nuchal scute to the tip of the longest post-marginal scute. Width= straight-line carapace width (in centimeters) across the part of the carapace. Weight= weight (in grams) as determined by placing the hatchling on the Acculab scale. It may be necessary to tuck the front flippers on the carapace and place a small rubber band snugly around the hatchling, from side to side, to restrict movement for an accurate weight. Scute count for hawksbill turtles should be as follows: 1 nuchal, 5 vertebral, 4 costal on each side, 11 marginals on each side, and 1 post-marginal on each side.

****Note:** Hatchlings should be kept warm and out of the wind either in somebody's backpack or pockets when they are not being directly worked on. They may become lethargic if kept out in the open too long and they get cool (remember, they are reptiles). Before releasing them, stimulate them to move around by rubbing their carapace and plastron with your fingers and allowing them to crawl around on top of each other. After 1-2 minutes of this they should be ready to go!

Comments & Notes: Record any additional information about the nest site, contents, predation, or hatchlings, etc. in this section.

Nest Success Calculations: Enter the numbers as signified under the space provided. These numbers should all be attainable from the data sheet. Once the data is entered into the BUIS Sea Turtle Database, these calculations will be done automatically. Verify the manual calculations against the computer calculations for quality assurance.

DATA MANAGEMENT PROTOCOLS

The Buck Island Sea Turtle Research Program (BISTRP) collects a tremendous amount of data on nesting sea turtles. All of the data must be accurate and managed properly if it is to be of any use to managers in conserving and protecting the endangered sea turtle species at BUIS. The following is a list of the quality assurance and quality control measures in place at this time to ensure accurate data collection, recording, and archiving.

FIELD DATA COLLECTION

1. Data sheets. Data sheets have been designed to fit the different types of sea turtle data collection and research at BUIS. Each data field should be filled with the appropriate information. Before releasing the turtle, the data sheet must be checked to insure that all information has been collected and recorded. Datasheets are updated by the program manager as needed to meet the changing requirements of the research program.

2. Field Data Accuracy. When one person is collecting data, they must double-check each measurement and number. This is to insure accuracy in reading of the measurements and recording of the numbers.

3. Quality Control. When two or more people are collecting data, one person takes the measurements and clearly states the numbers to the person recording data. The person recording data must repeat the number to insure that is was heard and recorded properly. If time permits, the two data collectors should exchange places and repeat the measures to confirm the data collected.

4. Field Data Management. When the night of patrols is complete, all completed data sheets are turned into the biological aide or Resource Management Specialist. The data sheets are reviewed for any missing data, and any omissions are brought to the attention of the data collector for completion before departing BUIS. This reduces the amount of time that passes and the confusion of multiple activities that one person has handled before they are asked to recall a specific detail concerning a particular activity.

5. Office Data Management. The information from the "Nesting Activity Logs", "Daytime Activity Log", and the "Hatching Data Log" are entered into the BISTRP computer database. Each data entry should be confirmed prior to saving the computer file.

6. Archiving Data. Data sheets are photocopied and the original is placed in the three-ring binder designated for that years' nesting beach activities in order of activity number. This book is kept in the Natural Resource Management office.

7. The photocopy is placed in a separate binder as a backup copy of all field data sheets for that year. The backup copy is not kept in the same area as the original book. This practice increases the chances of one copy surviving an unforeseen disaster, such as fire or hurricane.

NESTING ACTIVITY LOG BOOK

Every sea turtle program studying nesting female turtles' finds a way to track the seasonal nesting activities of the turtles. Originally, BUIS had poster board size charts that showed on what date a tagged turtle had nested. From this chart, we were able to predict, with relative accuracy, what the next date might be that she'd return to BUIS to lay again. In the beginning, pre-Hurricane Hugo, hawksbill turtles' internesting interval was 14 to 15 days. Since the hurricanes and the changes in the nesting beaches, the internesting interval is typically 14 to 16 days. The increase is due to a higher number of emerge no lays than is "normal" for the species because of the difficulties they encounter in the hurricane damaged nesting areas.

At present BISTRP is using several methods to track hawksbill nesting activities at BUIS. The most important is, of course, our version of the **Nesting Turtle Activity Log** or "Nalgene Book". The Nalgene book is simply that, a blue, waterproof Nalgene Field book, catalogue number 6303-1000, 8.5"X11", with numbered pages graph paper-lined. The book is used to track tagged hawksbill females observed nesting on the beach each research season. Each season is a discrete section in the book that begins on the first night of nocturnal patrol and ends the last night of patrol for the season (July - mid-October).

BISTRP's book begins with the first year of nocturnal nesting beach patrol (1988), and contains every year's activities to present. The pages of the book are laid out by month and day of the week. **Unobserved nesting activities** are marked across the top of the page indicating either a **suspected lay (X)** or an **emerge no lay (/).** Turtle's primary tag number is listed down the left side of the page in the order the turtles are encountered on the nesting beach. Listed below each turtle's **primary tag number** are the years the turtle has been seen nesting on BUIS. Many of the females return to BUIS like clockwork, every two years. The nesting activity is recorded on the day it was observed. It is either marked a lay (X) or (/) emerge no lay. The location of the nesting activity is also written in the day block, including **sector and marker number.** The turtle's next nesting can be predicted from this chart by counting the internesting days, 14 to 16, from the last lay.

No patrol nights and **no turtle nights** are also recorded in the Nalgene Book. This helps keep track of how well we maintained full coverage of the nesting beach, seven nights per week. In a normal season, barring hurricanes and major engine or boat failures, we average 80 nights on the nesting beach out of 102 possible patrol nights.

Example page from Nesting Activity Log Book (Nalgene Book):

Month	**July, 1997**									
**Day----------> **	1	2	3	4	5	6	7	8	9	10
Unobserved Activities ------>				/ SS 80						
Primary Tag # / years nested										
1. PPW 804/ '88, '90, '92, '95, '97	X NS 07									
2. PPW 838/ '89, '91,'93,'95, '97					/, SS 78	X, SS 8 3				
3. QQD 100/ '91, '93, '95, '97			X, WB 43							
4. PPW 822/ '88, '90, '92, '94, '97							/ SS 65	/ SS 66	X, SS 66	

PHOTOGRAPHS

Several standard 35mm slide photographs are taken of each turtle at least once each season. Photographs are taken of any unusual findings (i.e., injuries, deformities, egg or hatchling deformities, etc.). When a roll of film is completed, it is removed from the camera, labeled with the date and the last photos taken (turtles' primary tag number if possible). The roll of film is then turned into the biological aide or Resource Management Specialist. They are responsible for mailing the film, including getting a film mailing envelope (each has a unique number) from the NRM office and filling out the shipping label. On the receipt tab the information on the date and last photos taken (turtles' primary tag number if possible) is copied. The film is mailed for developing and the receipt tab is filed until the film returns. When the developed film returns, the receipt tab, with the matching number from the film is pulled. Both are then given to the technician labeling the photos along with the data book for the season. Turning to the date matching the last photo taken in the pack, the technician starts with the last photo and matches it to those frame numbers recorded as taken on the data sheet. Each photo is labeled with the following information: BUIS, month/day/year, turtles' primary tag number, activity number, and a brief description of what the photo is of (IE. Overall carapace photo, deformity in right front flipper, etc.). Proceeding backwards in the data book, the technician continues to match and label the photos with those recorded for the various activities. The slides are then stored in archival 2x2-20B 35mm slide preserver sheets. The sheets are then put in a three ring binder: general slides in the BISTRP book, and turtle slides are placed with the corresponding activity sheet.

SEA TURTLE RESEARCH PROGRAM COMPUTER DATABASE:

IN BRIEF...

The Buck Island Sea Turtle Research Program developed a relational database in conjunction with computer programmer John Crow, Computer Support Services, St. Croix. This database allows data to be entered into a Windows driven database in a user friendly environment. All data is inter-connected, allowing for reports to be created and generated by the user. These reports are a vital management tool in the protection of these turtles and the habitats they utilize. Accurate data entry is, of course, vital to accurate reports. To decrease the number of data entry errors, many quality control measures have been implemented within the program (Hillis-Starr, et al, 1997).

The following is a list of those measures:

- Each activity is given a unique "activity number" which the program will not allow to be duplicated.
- Each tag number is unique and cannot be duplicated in the program.
- Specific marker numbers are associated with each of the four nesting beaches on BUIS (IE. North Shore= markers 1-24, West Beach = markers 25-59, South Shore = markers 60-82, and Turtle Bay = markers 83-100). Since the beach and marker numbers are entered in separate fields, the program will not allow entry of a marker number that is not associated with that beach.
- To avoid possible entry error, wherever possible, once data has been entered, it is carried over to other areas where it needs to be viewed so it does not need to be typed in again.
- Numerical fields have been limited to the number of spaces appropriate to that measurement.
- Calculations are done by the computer to avoid mathematical errors.

LITERATURE CITED

A matter of time, Sea turtles of Queensland,1994. Queensland Department of Environment and Heritage, Queensland, Australia.

Bass, A.L., D.A. Good, K.A. Bjorndal, J.I. Richardson, Z-M.Hillis, J.A. Horrocks, and B.W. Bowen. 1996. Testing Models of Female Reproductive Migratory Behavior and Population Structure in the Caribbean Hawksbill Turtle, *Eretmochelys imbricata*, with mtDNA Sequences. Molecular Ecology: 5, 321-328.

Boulon, R.H., Jr., 1994. Turtle Nesting Activity on St. Thomas and Offshore Cays: 1993. Final Report to V.I. Division of Fish & Wildlife, Department of Planning and Natural Resources, 4 pp.

Boulon, R.H., Jr., Dutton, P.H., and McDonald, D.L. 1996. Leatherback turtles (Dermochelys coriacea) on St. Croix, U.S. Virgin Islands: fifteen years of conservation. Chelonian Conservation and Biology 2(2): 141-147.

Eckert, K.L., S.A. Eckert, T.W. Adams and A.D.Tucker. 1989. Inter-nesting migrations by leatherback sea turtles (Dermochelys coriacea) in the West Indies. Herpetologica, 45(2):190 -194.

Eckert, K.L., 1991(Draft) Five-year status review of sea turtles listed under the Endangered Species Act: Hawksbill sea turtle (Eretmochelys imbricata). U.S. Fish & Wildlife Service/U.S. National Marine Fisheries Service, 24 pp.

Eckert, K.L.,1992 (Revised) Draft WIDECAST Sea Turtle Recovery Action Plan for the United States Virgin Islands. CEP Technical Report No. # UNEP Caribbean Environmental Programme.

Eckert, K.L., J.A. Overing, and B.B. Lettsome. 1992. WIDECAST Sea Turtle Recovery Action Plan for the British Virgin Islands. CEP Technical Report No.15. UNEP Caribbean Environmental Programme, Kingston, Jamaica. 116 pp.

Florida's Sea Turtles, Copyright 1990. Florida Power & Light Company. CC9008-06/20M.

Frazer, N.B., J. I. Richardson and J.D. Congdon. In press. High Survivorship Rates Recorded for Adult Female Hawksbill: Implications for Conservation and Life History Evolution. In: Proc. Fifteenth Annual Symposium on Sea Turtle Biology and Conservation (J. Spotila, compilers). NOAA Tech. Memo. NMFS-SESFC-#.

Frazer, N.B., C.J. Limpus, and J.L. Greene. 1994. Growth and estimated age at maturity of Queensland Loggerheads. 42 - 43 pp. In: Proc. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation (K. Bjorndal, A. Bolten, D. Johnson, P. Eliazar, compiliers), NOAA Tech. Memo. NMFS-SEFC-351.

Frick, Michael G., A Guide for the Identification of Stranded Sea Turtles: The Eastern United States and the Gulf of Mexico. Savannah Science Museum Special Publication No. 4, iii 22p.

Gladfelter W.B., E.H. Gladfelter, R.K. Monahan, J.C. Ogden, R.F.Dill. 1977. ___ Environmental Studies of Buck Island Reef National Monument St. Croix U.S.V.I. Ecological Studies of Buck Island Reef National Monument, St. Croix, U.S.Virgin Islands. A Report prepared for the U.S. Department of the Interior, National Park Service.

Gladfelter, W.B., E.H. Gladfelter, D.K. Hubbard, R.C. Carpenter, and G.S. Simpson Environmental Studies of Buck Island Reef National Monument II St. Croix U.S.V.I. A Report prepared for the U.S. Department of the Interior, National Park Service, 1979.

Hillis, Z.M. and A. L. Mackay. 1989. Research report on nesting and tagging of hawksbill sea turtles (Eretmochelys imbricata) at Buck Island Reef National Monument, U. S. Virgin Islands, 1987-1988. Final Report for National Park Service Purchase order contract PX5380-8-0090, 50 pp. Unpublished.

Hillis, Z.M.1993. The First Five Years at Buck Island Reef National Monument: the Hawksbill Story. In: Schroeder, B.A., and B.E. Witherington (Compilers). 1994. Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, 281 pp.

Hillis, Z.M., 1994. The Hawksbill Turtles of Buck Island Reef National Monument: A Shared Caribbean Resource. 59 - 61 pp. In: Proc. Fourteenth Annual Symposium on Sea Turtle Biology and Conservation (K. Bjorndal, A. Bolten, D. Johnson, P. Eliazar, compiliers), NOAA Tech. Memo. NMFS-SEFC-351.

Hillis, Z.M. 1995. BISTRP Annual Sea Turtle Nesting Beach Summary Report. NPS/ Natural Resource Management Report to file. unpublished. 8pp.

Hillis, Z.M. 1996. BISTRP Annual Sea Turtle Nesting Beach Summary Report. NPS/ Natural Resource Management Report to file. unpublished. 6pp.

Hillis, Z.M. 1997. BISTRP Annual Sea Turtle Nesting Beach Summary Report. NPS/ Natural Resource Management Report to file. unpublished. 3pp.

Hillis-Starr, Z.M. and B. Phillips. In press. National Park Service Inventory & Monitoring Program 1997 Annual Summary Report.

Hillis-Starr, Zandy-Marie, Phillips, B., Crow, J.T. (1998). A Windows Operated Database for Sea Turtle Research. Epperly, S.P. and J. Braun, compilers. Proceedings of the Seventeenth Annual Sea Turtle Symposium. U.S. Dep. Commer. NOAA Technical Memo. NMFS-SEFSC-415, 294pp.

Hubbard, D.K., 1991. Geologic Development of Buck Island Reef National Monument. National Park Service report, March, 1991.

Hubbard, D.K., 1997. Buck Island Reef National Monument Beach Profiles. Final report: USGS/Biological Resource Division, Virgin Islands National Park. PX 83020-7-0296. August 23, 1997. Unpublished.

Limpus, C.J. 1990. Puberty and first breeding in Caretta caretta, p. 81-83. In: Proc. Tenth Annual Workshop on Sea Turtle Biology and Conservation (T.H. Richardson, J.I. Richardson, and M.Donnelly, Compilers). NOAA Tech. Memo. NMFS-SEFC-278. U.S. Dept. Commerce.

Limpus, C.J., and Jeffery D. Miller. 1993. Family Cheloniidae. Pp. 133-138. In: Galsby, C.J., Ross, G.J.B., and Beesley, P.L. (eds) (1993). Fauna of Australia. Vol. 2A Amphibia and Reptilia. Australian Government Publishing Service: Canberra.

Mackay, A.L. 1994. Sea turtle activity survey St. Croix, U.S. Virgin Islands. Annual report to V.I. Division of Fish & Wildlife, Department of Planning and Natural Resources, 5 pp.

Mackay, A.L., and J. Rebholz. 1995. 1994 Sea turtle activity survey St. Croix, U.S. Virgin Islands. Annual report to V.I. Division of Fish & Wildlife, Department of Planning and Natural Resources, 6 pp.

McDonald, D. L., and P.H. Dutton. 1996. Use of PIT tags and photo identification to revise remigration estimates of leatherback turtles (Dermochelys coriacea) nesting in St. Croix, U.S. Virgin Islands, 1979-1995. Chelonian Conservation and Biology 2(2):148-152.

Melucci, C., J.I. Richardson, R. Bell, and L.A. Corliss. 1992. Nest site preference and site fixity of hawksbills on Long Island, Antigua. 171-174 pp. In: Proc. Eleventh Annual Workshop on Sea Turtle Biology and Conservation. (M. Salmon and J. Wyneken, Compiliers) NOAA Tech. Memo. NMFS-SEFC-302.

Mendelson, T. 1993. Hawksbill sea turtle nesting activity, Virgin Islands National Park; 1992. Unpublished Report, National Park Service, 3 pp.

Mrosovsky, N., Bass, A., Corliss, L.A., Richardson, J.I., and Richardson, T.H.. 1992. Pivotal and beach temperatures for hawksbill turtles nesting in Antigua. Can. J. Zool. 70: 1920-1925.

National Marine Fisheries Service and U.S. Fish & Wildlife Service. 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries, St. Petersburg, Florida, 52 pp.

National Park Service, Department of Interior. General Management Plan, Buck Island Reef NM. September 1983. Internal document.

Nellis, D.W., 1994. Seashore Plants of South Florida and the Caribbean, 1st ed.

Philibosiam, R.1975. Disorientation of hawksbill turtle hatchling, Eretmochelys imbricata, by stadium lights. Copeia 1975(4):824.

Pritchard, et al., 1983. WATS II Manual of Sea Turtle Research and Conservation Techniques.

Small, V. 1982. Sea Turtle Nesting at Virgin Islands National Park and Buck Island Reef National Monument, 1980 and 1981. Department of the Interior, National Park Service, Research Resource Management Report, SER-61. 54 pp.

Starbird, C.H., and Z.M. Hillis, 1992. Telemetry studies on the internesting behavior of hawksbill sea turtles, Buck Island Reef National Monument, U.S.V.I., In: Richardson, J.I. and T.H. Richardson (Compilers). 1995. Proceedings of the Twelfth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum. NMFS- SEFSC-361. PP134-137.

Wibbels, T., Hanson, J., Balazs, G., Hillis-Starr, Z-M., Phillips, B.. In press, ...*Get name of publication from Thane*

Wibbels, T., and Hillis, Z-M.. In press. Preliminary examination of hatchling sex ratios of hawksbill sea turtles from Buck Island Reef National Monument. American Society of Zoologists. National meeting, Dec. 1995, Washington, D.C..

Witherington, B. E. and K.A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (Caretta caretta). Biol. Cons. 55(2):139-150.

Witherington, B. E, 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:3-39.

Woodbury, R.O., and Little, E.L., 1976. Flora of Buck Island Reef National Monument (U.S. Virgin Islands). U.S. Department of Agriculture, U.S. Forest Service Research Paper ITF-19, 27pp.

Zullo, E. 1986. Sea Turtle Nesting at Virgin Islands National Park and Buck Island Reef National Monument 1980-1985. Virgin Islands National Park Report Unpublished.