HAWKSBILL TURTLE RESEARCH COORDINATION MEETING
2/27/98

(Federal Building, Honolulu)

MEETING NOTES

(From Hawaii Wildlife Fund notes)

Meeting Agenda: See Appendix 1

Attendees: See Appendix 2

Introductions

Karen Rosa (FWS) did not attend the meeting, but was present at the beginning to introduce Kitti Jensen as the new turtle project coordinator. Jensen will identify activities the FWS would like to pursue that dovetail with the turtle recovery plan. Permits and Section 7 consultations will be referred to her.

The Honu Project (THP) was invited, but no representatives attended. Rosa said no draft of THP's hawksbill video was available and more funds were needed to complete the hawksbill video. Rosa later distributed the Honu Project's current proposal for additional funding.

Gene Nitta (NMFS) and Karen Gardner (State of Hawaii) were invited, but they did not attend.

All attendees introduced themselves. Hannah Bernard took notes for later distribution to all participants.

Pacific Turtle Recovery Plan Status

George Balazs reported that the U.S. Pacific Turtle Recovery Team 1991-1995 had drafted the plan (which actually began with the Hawaii Turtle Recovery Team in 1985) and it has now been approved and signed off; it's currently at the printers. This plan includes only U.S. turtles in U.S. controlled waters (heads of states of island territories were notified and asked if they wanted to be included, they all agreed and are partners).

Puleloa: Were they active in the plan's development?
Balazs: Yes
Puleloa: Are their needs addressed?
Balazs: The information is applicable to their areas.

Research/Recovery Projects Updates

1. Mike Nishimoto (talking about Ma'alaea Beach at Kealia Pond): Construction of 1.3 mi. of fence along roadway in 4/97 resulted from the highway death of a female hawksbill in '96. Hatchlings were also killed. Not much opposition to the fencing. FWS Ecological Services provided $18,000 and Maui CC inmates provided the labor. Sea Grant (Rob Mullane) got involved in direction of fence construction, but the fence was set up wrong at the t-posts so FWS maintenance had to do repairs. Wind damage more of a problem than vandalism. Some campers using fence for firewood and the fence catches trash. Sand accumulating fairly well in one area. Fence worked for preventing turtles from getting on the road. One turtle did go through a gate, but she came right back through and this site has since been blocked. No vehicles have been on the beach since the fence has been completed all the way to Canoes (west end). Fishermen are glad the fence is there because it keeps vehicles off the beach and them safe.

Jensen: Re: future..fence may last 2 seasons, need to evaluate a more permanent structure. Plastic guardrail or some other more durable material is needed.
Nishimoto: FWS cannot keep up the maintenance of the fence. Re-vegetation effort not effective because of summer dryness.
Rowland: Need to get aggressive and plant naupaka.
Williams: Naupaka not the best choice of plant.
All: Need to realign the N. Kihei road!
Nishimoto: Long-term plan is needed, this season the fence may need more maintenance support.
Balazs: Credit to Rowland for obtaining $ for fence.

2. Skippy Hau: He's been working with Balazs to determine if eggs recovered from nests had shown signs of development. Eggs/dead hatchlings also provide material for genetic work (no genetics results yet). The FWS volunteer Dawn Patrol monitors Kealia beach in a.m., notifies Skippy when tracks are found. Many false nests - can easily be fooled. Documented the effort of nesting females. What kind of measurements of tracks do we want to take? Have taken width measurements. Noticed one unusual track, indicative of a "limp"!

Kihei nesting: Beach reserve at Kihei VFW - one nest under ironwood tree; two others reported but not found! Public saw hatchlings high on beach slope and picked them up and released them in the water.

General excavation methods: Eggs were not numbered as they were collected in '97, but will do so in future. Width and depth measurements of nests taken.

M. Stahl (mtg. observer): Noticed the roots in one nest photo and questioned the organic content effects.
Balazs: Not really a problem.

Hau's Excavation summary (See also Appendix 3):
Makena 9/6: 33 hatchlings/141 eggs = 23%
Kihei 10/14: >27 hatchlings/unknown # of eggs
11/1: 65 hatchlings/152 eggs = 43%

Kealia 11/20: false nest
11/21: old nest, no hatchlings found, mixed old and new (numbers not reliable)
12/9: 225 undeveloped eggs
12/29: false nest

Season totals:
177 average, 141-225 range (from nests with developed eggs)
125 (min.) hatchlings

Incidental sighting: 2/10/98 public call re: 2 foot length hawksbill seen off N. Beach...will we tag them: there are 2 or 3 there. Photo needed to confirm species.

3. Steve Williams: Most of the project already described by others. Honu'ea Watch before fence to keep turtles off the highway, not needed after fence, therefore volunteers only really needed at dawn and to clear weeds from around nests, and put up light barrier near emergence times. Observations of nesting at Kealia had been documented in early 90's, now we have confirmed it's not just sporadic usage.

Volunteers good at finding adult female tracks. Can volunteers really recognize hatchling tracks? -- could not test this season due to lack of success of nests. Concurred that fence was a success in deterring turtles based on tracks along the fence. Low hatching success rate confirmed at Kealia. Should consider future actions to enhance survival. Wants to add Kihei and Makena into Dawn Patrol.

Hau: Public consciousness high on hawksbills, therefore increased support for species.
Gilmartin: Fence needs some repair for upcoming season or turtles will likely break through, wood has deteriorated and wire is rusted.

4. Larry Katahira: Surveyed for nesting from Hilo to around S. Point. In 1989, Balazs and Katahira started helo recon for potential hawksbill habitat and confirmed nesting at 10-12 nests/yr thru 1993. FWS provided funds for technician and volunteer support. 52 nests identified in 93...possibly because of increased search effort.

Limiting factors/threats: humans, pigs, cats, mongoose based on 4 years observations. Trends -- Every year tagging more turtles. Tagged 37 total, 6 new last year.

Williams: Are the new turtles tagged young ones?
Balazs: Size and sexual maturity don't correlate well, some may reach at later ages. Turtles renesting cycle may also vary, some could be foraging far away and their recycle time may be longer. Turtles cycles could be up to 5 yr, not 2 yr cycle.
Katahira: Most Big Isl. Turtles on 2-3 yr cycle.

Katahira has 22 volunteers per year. They can cover more area and all of the season. Two turtles nested 6 times each in '97 season. Nesting interval: 14 - 24 days.

Re: Site fidelity..one turtle nested at Kamehame then nested at Punaluu, several miles away. False nesting very common. Examine the substrate to help determine if is false nest or not. Translocated one nest and achieved 100% success.

Balazs: Egg max. turgidity between 24 - 48 hrs, success less as time progresses for translocation.

Katahira: Kamehame about 75% emergence success. Substrate much different, cinder sand (black sand).

Balazs: Substrate analysis done by Mortimer...turtles have wide range. Drainage appears to be critical. Turtles seem driven by internal "altimeter", they go for highest ground (esp. greens in Leeward chain).

Katahira again on predation -- 60-90 mongoose/season trapped. Nest loss from predation where trapping occurs = zero. Ghost crabs and seabirds not a problem. Nests are into naupaka plants. Coconut roots are a bad problem, koa haole replacing naupaka. He suggests removing kiawe at Kealia.

Kahuku Ranch and Green Sand Beach: private land, confirmed nests; would like to expand surveys toward Kona.

Balazs: The protection afforded greens has benefitted hawksbills, so we may be seeing this increased nesting due to this factor more than anything else.

5. Bill Puleloa: Moloka'i - Halawa beach habitual nesting...old timers collected turtles and took some home for pets. Has confirmed 6 hawksbill nestings. People more casual on Moloka'i, no nesting patrols, hard for him to investigate in a timely fashion. Has had a dozen unconfirmed nestings. Halawa split in two portions by the river and greens also seen on beaches. No excavations done. Success rates unknown, but people do retrieve hatchlings or find them in their tents. Nesting occurs in pahuihui beach vines, on left side as you look from the sea. Some camping done there. Greens also seen on left side coming up with hawksbills. Nesting also seen on right side but most on the left. People saw young turtles washed up on rocks during big swells last season.
Kawaaloa (Mo'omomi) may have hawksbills, none seen yet. Turtles (greens) keep going to vegetation line to nest.

Stahl: This is a surprise to me...
Balazs: A few individuals are nesting several times, probably, and it also occurs on O'ahu too.

Puleloa again, nice beach on south shore of Moloka'i where throw netting done, therefore he may not get reports of turtles there. Heard they are bringing back eggs. Nesting occurs there. Seems that south shore is the foraging pasture and then going to FFS to nest (greens). Aug - Nov...all confirmed sightings occurred in these months.

6. George Balazs: Hawksbill work is largely a spin-off of green turtle work, including the stranding network. Juveniles brought in, necropsied, stomach contents examined. 99% strandings are greens. Two hawksbills tagged on Moloka'i in 15 years. Kiholo on BI - hawksbills consistently encountered. 12 green and one hawksbill turtles tagged at the Waikoloa Hilton internal lagoons.

NMFS La Jolla lab has Peter Dutton on post doc for turtle genetics. Hawksbill samples have been submitted to him, but unfertilized eggs are very hard to get genetic material from. Genetics will eventually tell us:

1)Relationship between Hawai'i hawksbills and juveniles sampled around islands.

2) How does Hawai'i population fit in with other samples from all over Pacific. Damien Broderick is doing PhD on this project.

Dutton is developing an archive of turtle material.

Katahira: Is our population endemic, unique?
Balazs: Our isolation is profound, and our greens do not migrate away from Hawaiian Archipelago (they are as different from other Pacific greens as they are different from Atlantic greens), therefore, it's likely our hawksbills are going to be fairly discrete too.
Katahira: International issues ... other hawksbills have heavy takes, Hawai'i probably the best rookery.
Balazs: Program on incidental fisheries take, primarily long-line. No hawksbills observed taken in 5% coverage of the fishery. Turtle mortality in this fishery is very low even with deeply-seated hooks, but satellite telemetry will shed more light on this. Our hawksbills may not be very pelagic at all.

Balazs again on Kiholo Bay, BI (See Appendix 4) Since 1987, 3-400 greens tagged. A few hawksbills are caught and re-caught at the location. Hawksbills are highly residential (hand-captures). One animal caught 7 times in 7.7 years, measured each time, therefore got growth rate of approx. an inch in length per year, similar to greens. Other data elsewhere are similar. Kiholo has shown that the animals are residents, good rate of survival, net fishery in area excluded thanks to DLNR. No stomach contents for these guys.

Telemetry, Balazs (See Appendix 5)

1995: 5 turtles tracked. Couldn't have done it without Katahira's project and HWF this last year. No one knew where adult hawksbills lived when they weren't nesting until 1995. Received transmissions for 236 days post-instrumenting and positions from Aug - Feb. Second turtle: 86 positions Aug-April. Good positions (LC1 and LC2) showed turtle stayed in same area for several months.

1996: One turtle went c-clockwise around BI, her transmissions were high quality in the calm water on Kona coast. One turtle went to Maui. HWF provided radio tags on these two. Satellite data not as good in Kahului, but radio tracking filled in for 5 months:114 positions, 348 transmission days. 196 miles traveled. It took 20 days from tagging to arrival at Kahului.

1997: Kealia Pond (Maui) turtle went to Hamakua Coast, BI. Internesting habitat located. Departure from Kanaloa Pt. on 10/14, traveled along Haumakua Coast to Kuku Point. 3 weeks ago got last position. Probably antennae were damaged. But dive pattern data still coming in.

Future telemetry suggestions of Balazs: Moloka'i, Kealia, Kamehame in that order so we can id foraging areas and manage better. Asked group to make a recommendation to NMFS for future tracking projects and he can justify a few sat. transmitters for this.

7. Bill Gilmartin: (See Appendix 6) Hawaii Wildlife Fund worked with Balazs in 1996 and 1997 to put tracking instruments on 3 turtles. Balazs previously summarized migration routes and general site of foraging for these three turtles. HWF radio data can give precise fixes on these foraging sites and on the internesting site used by the Maui turtle in 1997. Fairly uniform surface and dive interval data (from the radio signals) suggest that the Maui turtle was not foraging during her internesting time (See Appendix 7). Her position during this time remained near the center of Ma'alaea Bay where the chart indicates greater vertical relief than in other parts on the bay.

Stahl: Would transmitter work if turtle were eaten?
Gilmartin: No, antenna must be above the water.
Puleloa: What is range of radio transmitter?
Gilmartin: 1-2 miles.

Balazs: Our info does not dupe his. Satellite down time and surface time is only an average over 12 hr. - radio data gives detail of how time spent.

Stahl, Puleloa: Can you relocate hatchlings across the street (N.Kihei Rd)?
Balazs: Don't dabble unless there's a dire need.

Williams: In Florida, all of the nests are routinely moved to avoid predation.
Balazs: ...or can remove predators.
Williams: Nests relocated to caged area...

Stahl: Ants are a problem on the mainland, what about here.
Balazs: A paper was published on this that was wrong. We need to find out if the ants can eat these turtles.

<u>Future Research and Recovery Actions</u>

Gilmartin (see Appendix 8):
- HWF will begin to survey internesting and foraging habitats in 1998.
- HWF will seek a permit to relocate hawksbill nests that are laid in marginal habitat. Good habitat that will lead to better hatching success will be identified along the Kealia beach.

- Instrumentation of animals will continue to identify internesting and foraging habitats.
- Flipper tagging nesting females will continue.
- HWF will attempt to summarize lighting guidelines for distribution to Kihei/Ma'alaea shoreline residents.

Katahira:
- Exclusion fence at Kamehame will cost about $5,000. Cattle are eating the naupaka - Property owned by state, zoned agriculture.
- Would like to expand survey work toward Kona to find nests and instrument these animals.
- Genetics, would be willing to take a flipper nip from every animal. (Balazs supported having a larger sample size, emphasized that sampling tools must be sterilized.)

Is this material valuable from hatchlings? Balazs: target the nesting females for genetics work, hatchlings are complicated. Balazs will train staff for genetics collections.

- Need more public information -- traditional activities can conflict with nesting, his volunteers are usually from the mainland and cultures collide. Green turtles hauling out still being harassed Punaluu. Balazs: they are habituated to people and MOP program is working to educate the bus drivers. People think the turtles are 'stranded' and need help.
- At Punaluu, the road behind beach a problem - Katahira suggested re-creating a more natural beach to increase nesting likelihood. The county wants to enhance this beach, too. Balazs: Nesting so minuscule here he would rather focus efforts on Kamehame. Hawksbills should not be the driving force for this beach restoration. Hau: Kealia has similar issues, we didn't want to focus everything on the turtle, but the bigger picture.

- Katahira priorities: Continue what we're doing and fence off Kamehame.

Puleloa:
- Wants to instrument animals, but will get back with us. Balazs: some things done on other islands may not be appropriate on Moloka'i. Balazs will contribute sat. transmitter for Moloka'i, can FWS contribute too, as have done in past on other islands? Puleloa: Let me instrument the animal, you are busy. Balazs: Need to come out and do hands-on training. Katahira: I would like to be allowed to do same thing, in case you are not available and the area is remote. Balazs: Needs to be done by one of the NMFS representatives, but will consider.

Gilmartin: Do we want to tag more young hawksbills nearshore? Balazs: Where are they, besides the possible Maui N. Beach animal? It is in the recovery plan, under studying developmental habitat. Maybe on Maui if we have the dive industry photo document potential animals, go from there.

Hau:

- Need more overall management plan for Kealia. Some important areas are not in the reserve.
- Training for Dawn Patrol begins in May, so let's standardize the data collection, etc.
- Brooks Tamaye moved to enforcement, and have no assistant, but should be replaced. Positive - Brooks is beefing up marine patrol. Loss in the education program, though. He will continue some of his commitments with education and will visit schools thru enforcement's education program.
- Kihei and Makena: lighting issue on shoreline...we have better justification to bring this issue forth in development discussions. South Maui Heritage Corridor includes this beach reserve, this will make beach more accessible, and they may be persuaded to remove alien vegetation. Jensen: Resort development in Makena...can DLNR comment on this issue (plans). (Reference here to Witherington's lighting manual for Florida). Hau: We may or may not get to comment. Williams: No lighting problem at Makena now.

- Will continue our work, responses to dawn patrol sightings, nest excavation, and will watch our numbering of eggs.
- Supportive of moving nests to increase production.

Nishimoto:

- FWS role in fence management will diminish. Need to pass it on, don't know what new refuge manager's emphasis will be. Need funds for fence, not just human support. Better plan now to replace it next year. Need agency or well-established conservation group who will stay on it. Do an adopt-a-fence! Williams: A&B may be approachable for support. Nishimoto: Need more systematic dune restoration program, we currently have interest at opposite ends of the fence. Need planning, need spurs to collect more sand. What happened to Rob Mullane? All: A meeting on fence future should be conducted soon.
- FWS will still support the Dawn Patrol.

Williams:

- Where nesting habitat is not a problem, let's leave the turtles alone. Road lights may be a problem...assess Kihei for possible education of nearby residents for lighting reduction.

- Continue habitat restoration near pond outlet. Agree with Skippy that we're losing sand into mud flat area because of roadways left by off-roaders. When boardwalk is built, could use machinery to move sand.
- Re-align N. Kihei Road.
- Bully still waiting for funding from OHA, hoping they will step in.

Puleloa: What happened to Emily Gardner? (Probably at whale stranding.)
Does she support this work?

Gilmartin: Re: Lighting problem, observed one turtle deterred from beach due to lights at construction lighting at road next to MOC, over 1 mi away! Future construction could greatly affect nesting. Work with current condos to change lighting must be attempted.

Nishimoto: A brochure is needed.

Jensen: FWS had a form to send to developers during the commenting process politely informing them of species that would be adversely affected by lights.

Can FWS get materials to distribute to condos. Yes.
Need to connect with Jensen or Rowland about this.

Action Items

1. Gilmartin will do mock-up brochure on lighting using the Florida lighting guide, get with the authors at Mazatlan Turtle Conference.

2. Certificate of Appreciation for Kathy Smith that we all sign to acknowledge her contribution.

3. Next meeting...Gilmartin will work with Katahira to set one up for July-August at Big Island.

Appendix 1

HAWAII HAWKSBILL TURTLE RESEARCH COORDINATION MEETING

2/27/98

0930 Introductory Comments
- FWS (Rosa), NMFS (Nitta)
- Recovery Plan status (Rosa, Nitta)

1000 Current Research/Activity Presentations
- Monitoring: nesting and hatching
  - Nishimoto
  - Hau
  - Williams
  - Katahira
  - Puleloa
- Tracking
  - Balazs
  - Gilmartin
- Video production
  - Lindelow

LUNCH

1230 Future Plans
- All above
- Gardner

1330 Discussion
- Funding
- Coordination
- Methodologies
- Other

1430 Summary Comments (all)

APPENDIX 2

HAWKSBILL TURTLE RESEARCH COORDINATION MEETING
2/27/98
(Federal Building, Honolulu)

Attendees

George Balazs
National Marine Fisheries Service
2570 Dole St.
Honolulu, HI 96822-2396
943-1240
gbalazs@honlab.nmfs.hawaii.edu

Bill Gilmartin
Hawaii Wildlife Fund
55-472A Palekana St.
Laie, HI 96762
293-9558
jarman@aloha.net

Skippy Hau
Division of Aquatic Resources
State of Hawaii
130 Mahalani St.
Wailuku, HI 96793
243-5834
skippy@dar.ccmail.compuserve.com

Mike Nishimoto
Fish and Wildlife Service
P.O. Box 1042
Kihei, HI 96753
875-1582
(fax) 875-2945

Craig Rowland
Fish and Wildlife Service
Pacific Islands Ecoregion
300 Ala Moana Blvd., Room 3-122
Honolulu, HI 96850
541-3441
craig_rowland@mail.fws.gov

Hannah Bernard
Hawaii Wildlife Fund
P.O. Box 5361
Lahaina, HI 96761
667-0437
wild@aloha.net

Kitti Jensen
Fish and Wildlife Service
300 Ala Moana Blvd., Room 3-122
Box 50088
Honolulu, HI 96850
541-3441
kitti_jensen@mail.fws.gov

Larry Katahira
Hawai'i Volcanoes National Park
P.O. Box 52
Hawai'i National Park, HI 96718
985-6088
larry_katakhira@nps.gov

Bill Puleloa
Division of Aquatic Resources
State of Hawaii
P.O. Box 1857
Kaunakakai, HI 96748
553-3778
puleloa@aloha.net

Steve Williams
537 Kumulani Dr.
Kihei, HI 96753
874-6194
williams@mauigateway.com

Analysis of six Maui hawksbill nest contents excavated by Skippy Hau,
State of Hawaii Division of Aquatic Resources
The counts presented in this table represent the contents shipped to NMFS for analysis
Eggs or hatchlings removed prior to shipment are not included

CLUTCH ID	HATCHED EGGSHELLS	EEM*	PARTIALLY DEVELOPED	FULLY DEVELOPED	DEAD HATCHLINGS	NO APPARENT DEVELOPMENT	TOTAL EGG UNITS	HATCHLINGS EMERGED	PERCENT EMERGED
12/9/97 Kealia	0	0	0	0	0	223	223	0	0
10/28/97 Kealia	0	0	0	0	0	188	188	0	0
11/1/97 Kihei	120	1	28	0	55**	3	152	65	43
09/9/97 Makena	55	0	26	37	22**	23	141	33	23
10/21/96 Maui	13	0	151	0	0	19	183	13	7
9/19/96 Maui	0	0	0	0	0	121	121	0	0
Totals	**188**	**1**	**205**	**37**	**77****	**577**	**1008**	**111**	**11**

**Eggshells for dead hatchlings are included in the hatched eggshell count
*Early embryonic mortality

This hawksbill nest contains egg units from both the 11/21/97 Kihei nest and a previous season's clutch

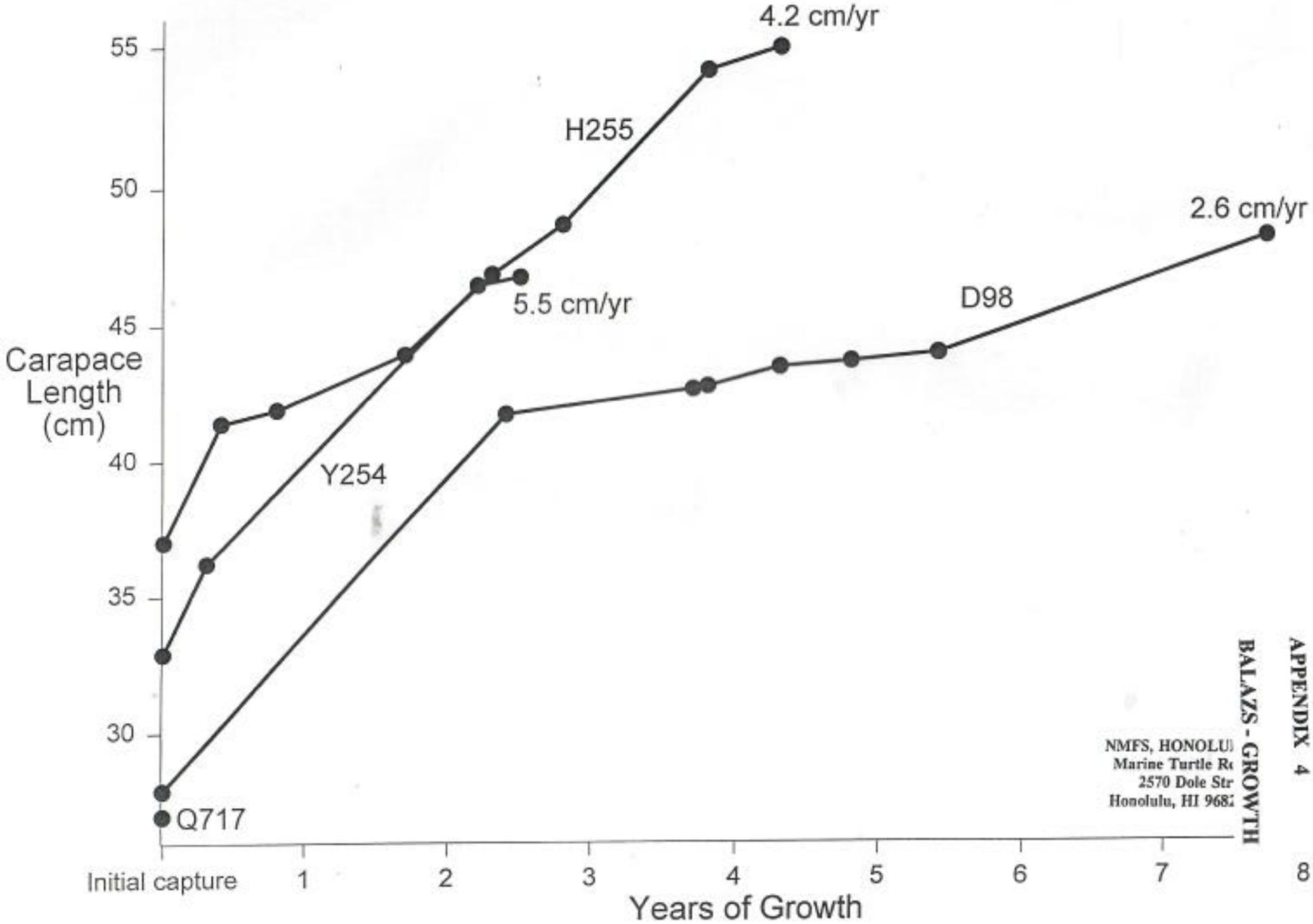
CLUTCH ID	HATCHED EGGSHELLS	EEM*	PARTIALLY DEVELOPED	FULLY DEVELOPED	DEAD HATCHLINGS	NO APPARENT DEVELOPMENT	TOTAL EGG UNITS	HATCHLINGS EMERGED	PERCENT EMERGED
11/21/97 Kihei	74	0	103	6	0	12	195	74	—

*Early embryonic mortality

Analysis conducted
by G.Balazs and
A. Veit. Table revision
prepared 1/30/98

NMFS, HONOLULU LAB
Marine Turtle Research
2570 Dole Street
Honolulu, HI 96822-2396

Growth Rates of Three Juvenile Hawksbill Turtles Residing at Kiholo Bay, North Kona, Hawaii



BALAZS - GROWTH

APPENDIX 4

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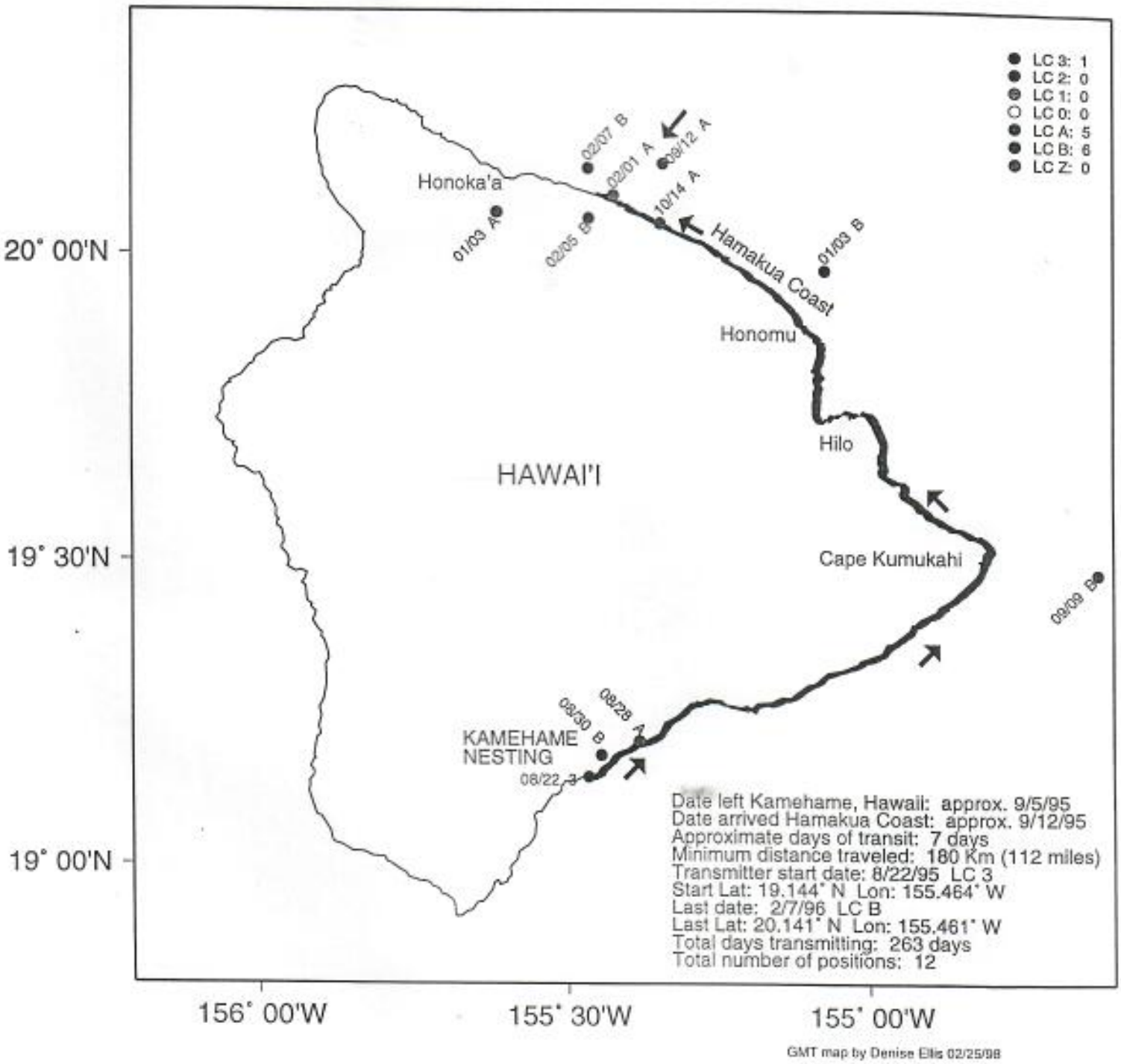
2570 Dole Street
Honolulu, HI 96822-2396

APPENDIX 5

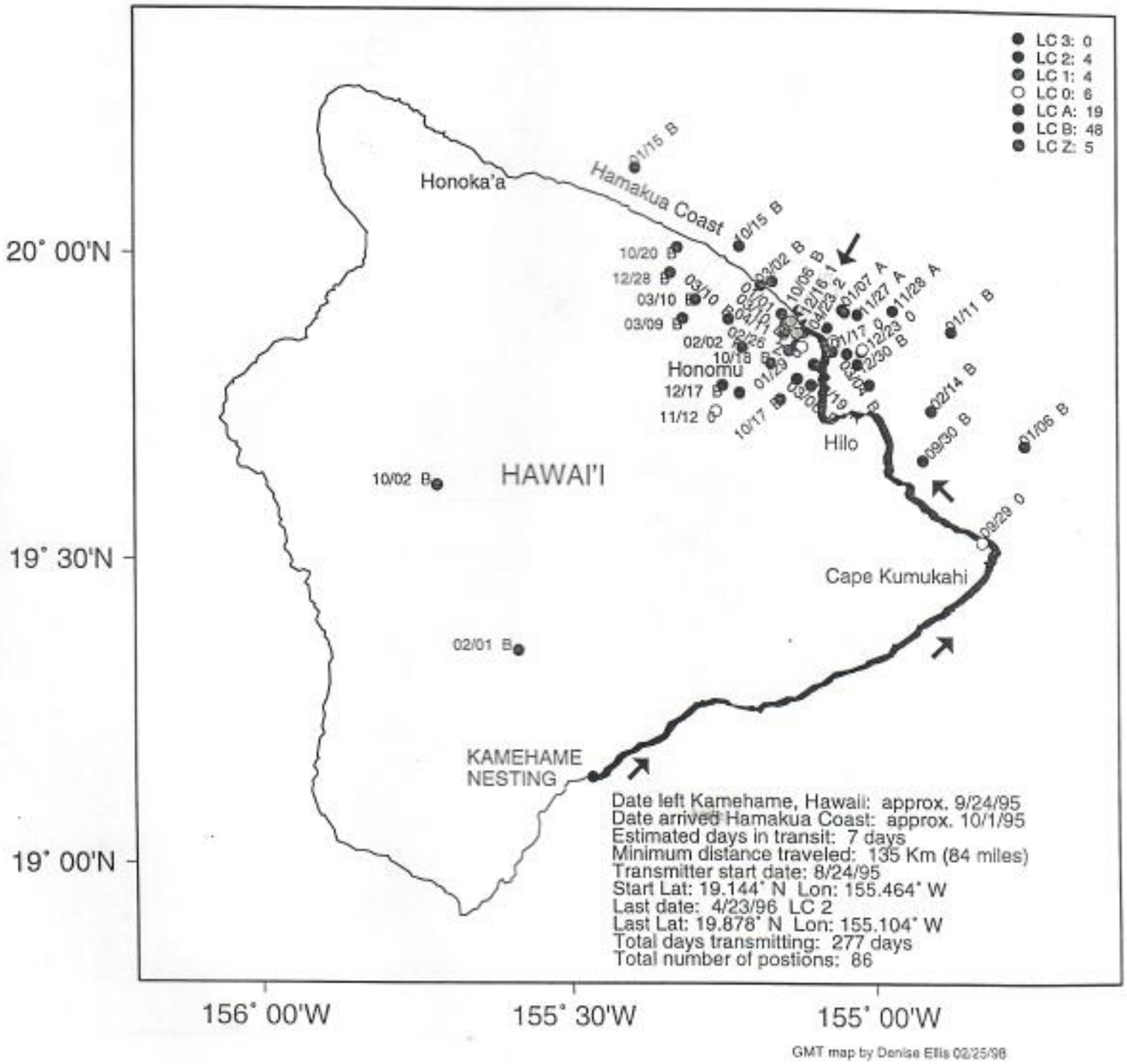
BALAZS - TRACKING

1995 Post-nesting migration of Hawksbill 2212 Kamehame to the Hamakua Coast, Hawai'i



NMFS, HONOLULU LAB
Marine Turtle Research
2570 Dole Street
Honolulu, HI 96822-2396

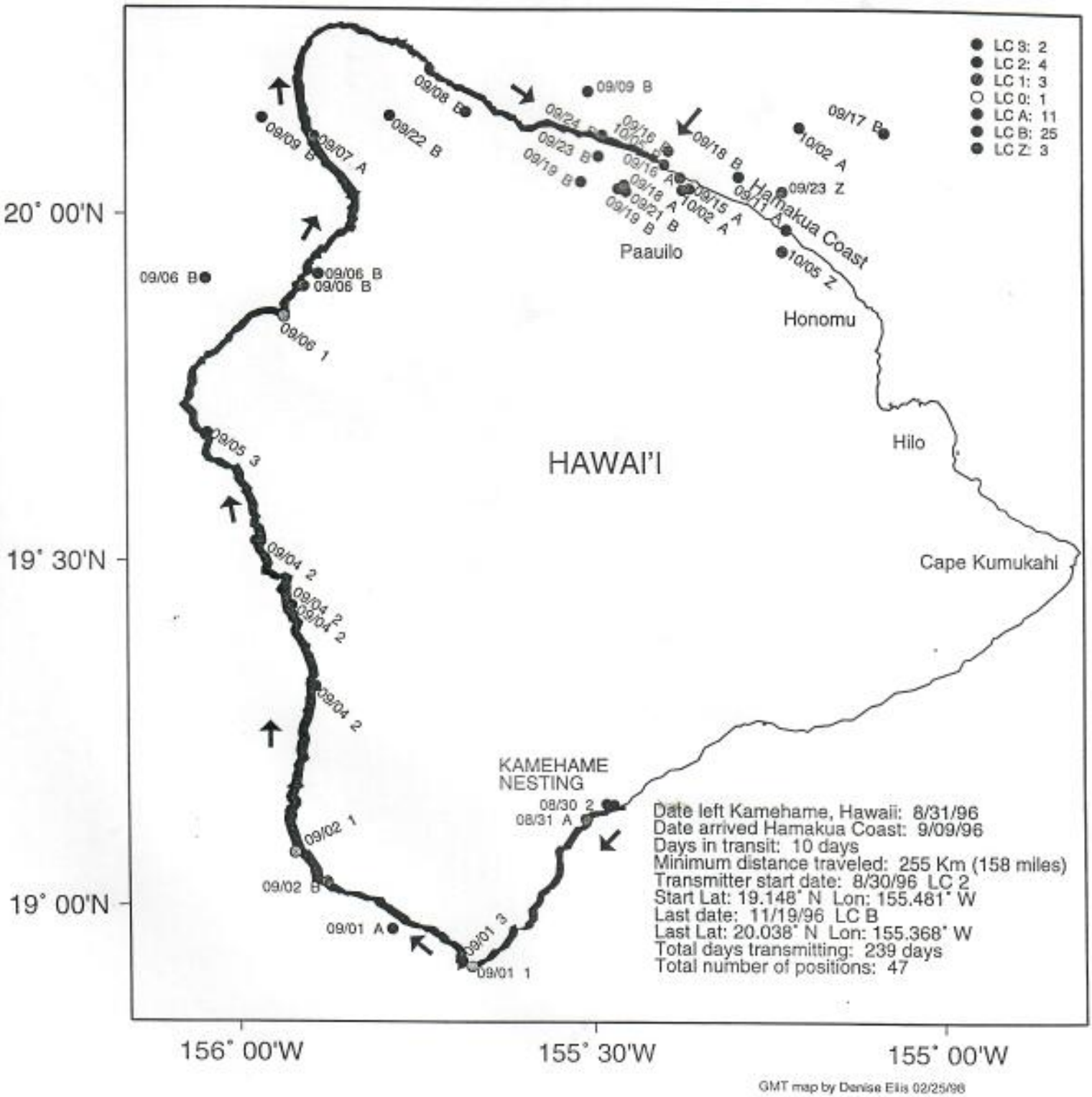
1995-96 Post-nesting migration of Hawksbill 22134 from Kamehame to Honomu, Hamakua Coast, Hawai'i



5-2

NMFS, HONOLULU LAB
Marine Turtle Research
2570 Dole Street
Honolulu, HI 96822-2396

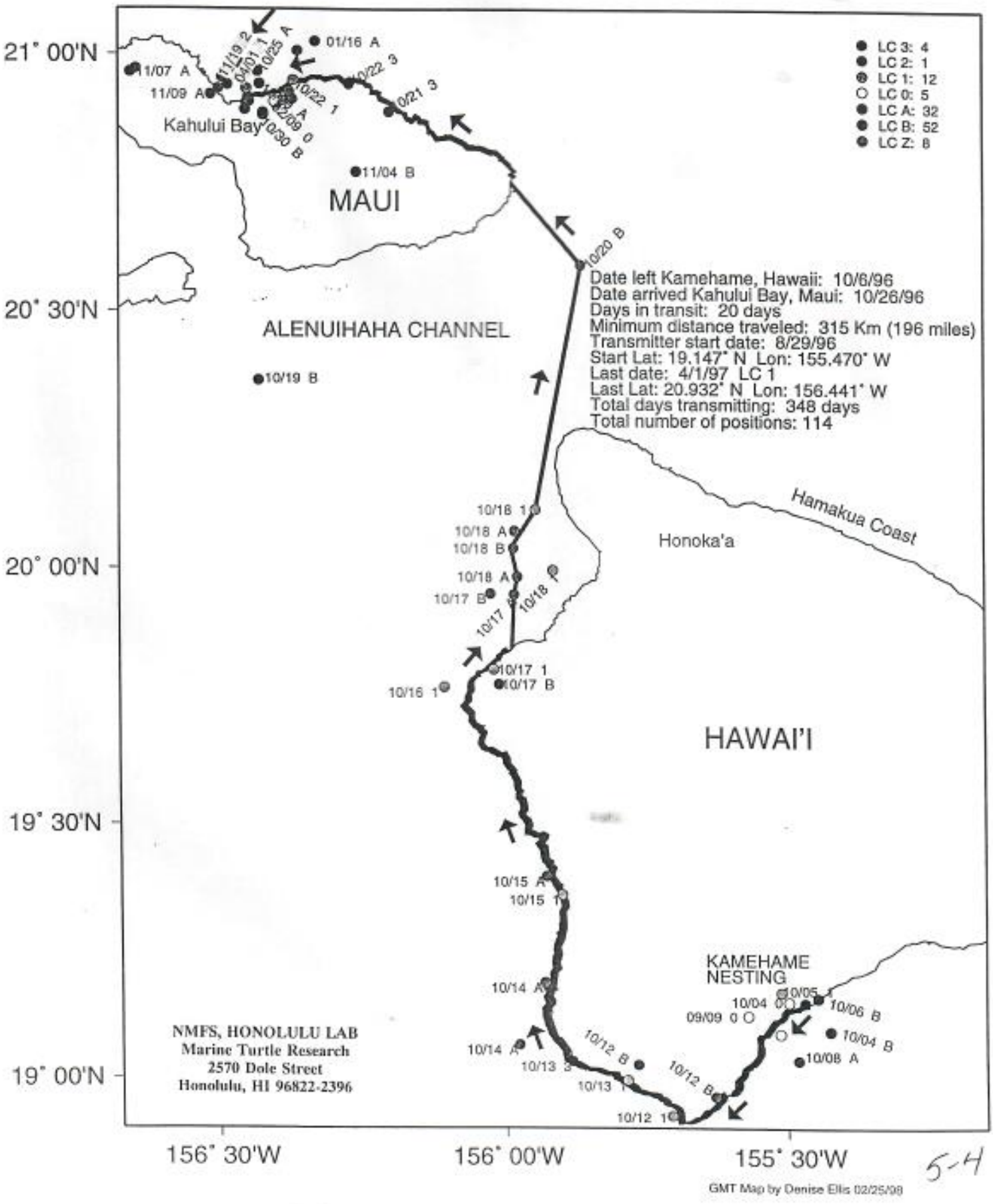
1996 Post-nesting migration of Hawksbill 24191 from Kamehame to Paauilo, Hamakua Coast, Hawai'i



GMT map by Denise Ellis 02/25/98

5-3

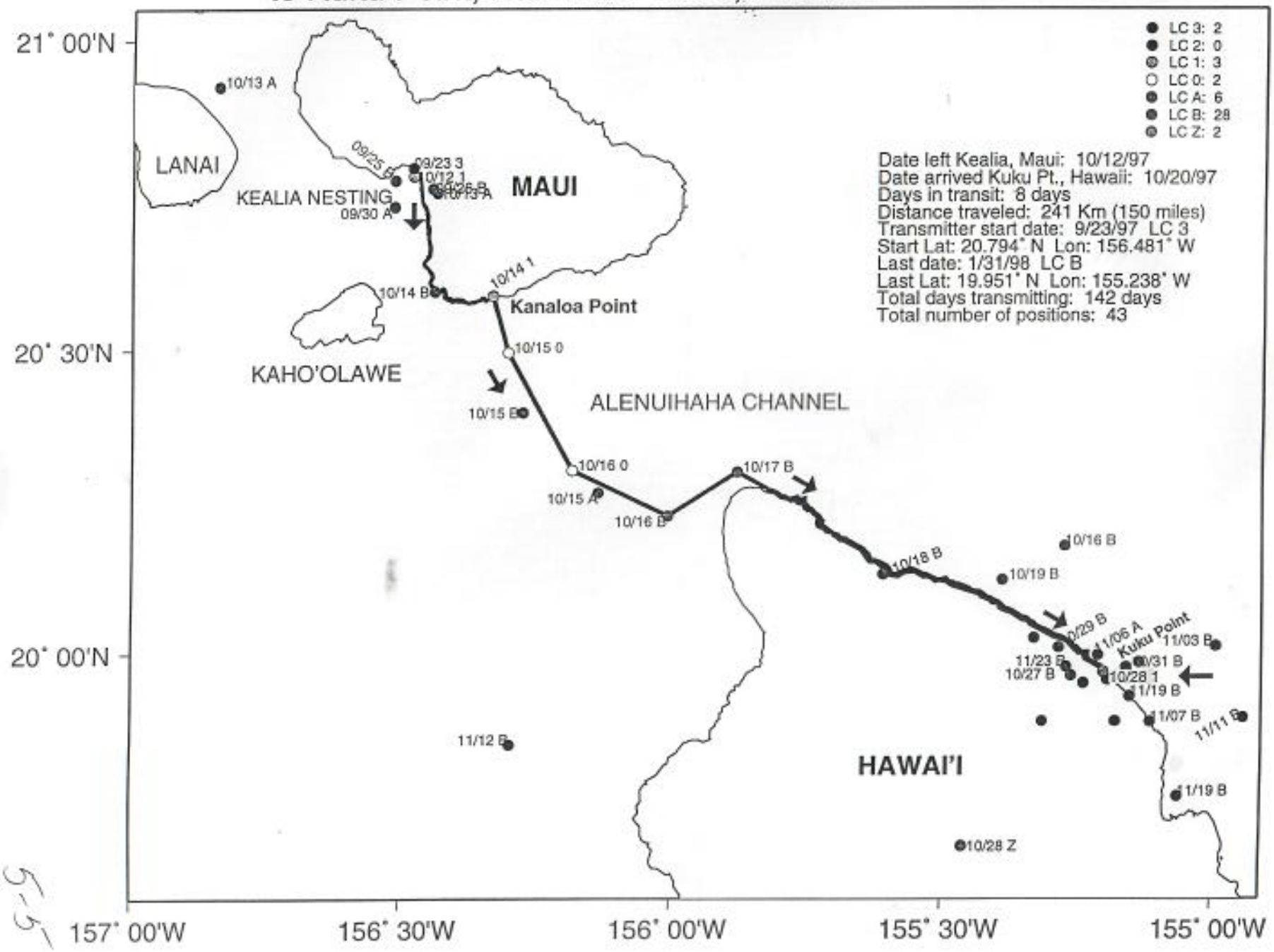
1996 Post-nesting migration of Hawksbill 25695 from Kamehame, Hawai'i to Kahului Bay, Maui



5-H

NMFS, HONOLULU LAB
Marine Turtle Research
2570 Dole Street
Honolulu, HI 96822-2396

1997 Post-nesting migration of hawksbill 4802 from Kealia, Maui to Kuku Point, Hamakua Coast, Hawai'i



GMT Map by Denise Ellis 02/25/98

HAWAI'I WILDLIFE FUND
HAWKSBILL TURTLE TRACKING PROJECT

1996

1. ATTACHED RADIO TAGS TO 2 TURTLES AT KAMEHAME, BIG ISLAND

2. CONFIRMED FORAGING LOCATIONS BY TRIANGULATION
   - KAHULUI BAY (MAUI)
   - PAAUILO (HAMAKUA COAST)

3. MONITORED POSITIONS AND ACTIVITY PATTERNS
   - REMAINED IN SAME LOCATIONS
     AT LEAST 3 MONTHS (PAAUILO)
     AT LEAST 5 MONTHS (KAHULUI)

HAWAI'I WILDLIFE FUND
HAWKSBILL TURTLE TRACKING PROJECT
1997

1. ATTACHED RADIO AND SATELLITE TAGS TO 1 TURTLE AT MA'ALAEA BAY, MAUI

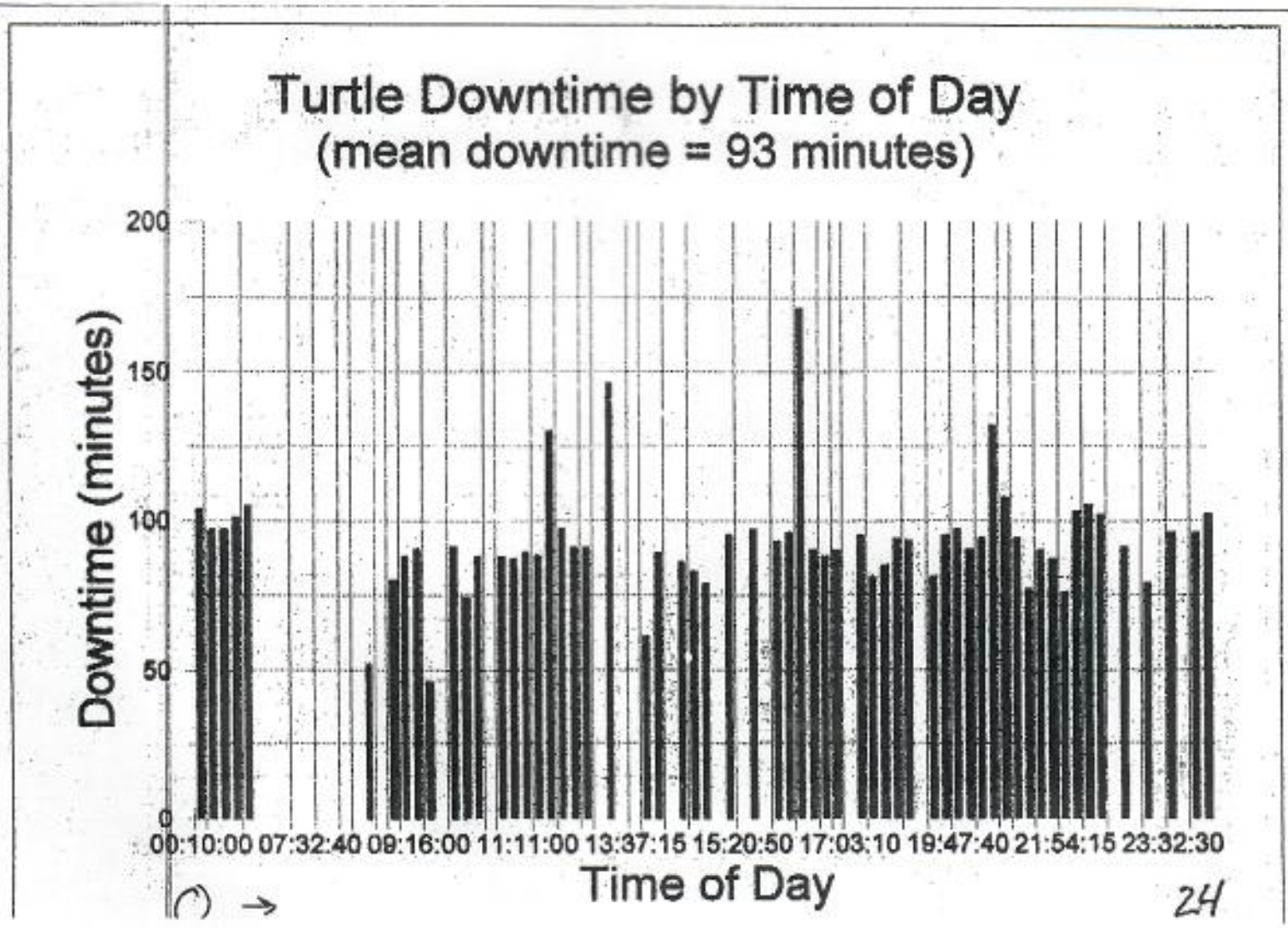
2. CONFIRMED LOCATION BY TRIANGULATION

3. MONITORED POSITIONS AND ACTIVITY PATTERNS
   - INTERNESTING LOCATION IN MA'ALAEA
   - NESTING LOCATIONS

4. FORAGING LOCATION BY SATELLITE
   - REMAINED IN SAME LOCATION FOR AT LEAST 4 MONTHS (KUKU PT.,HAWAII)

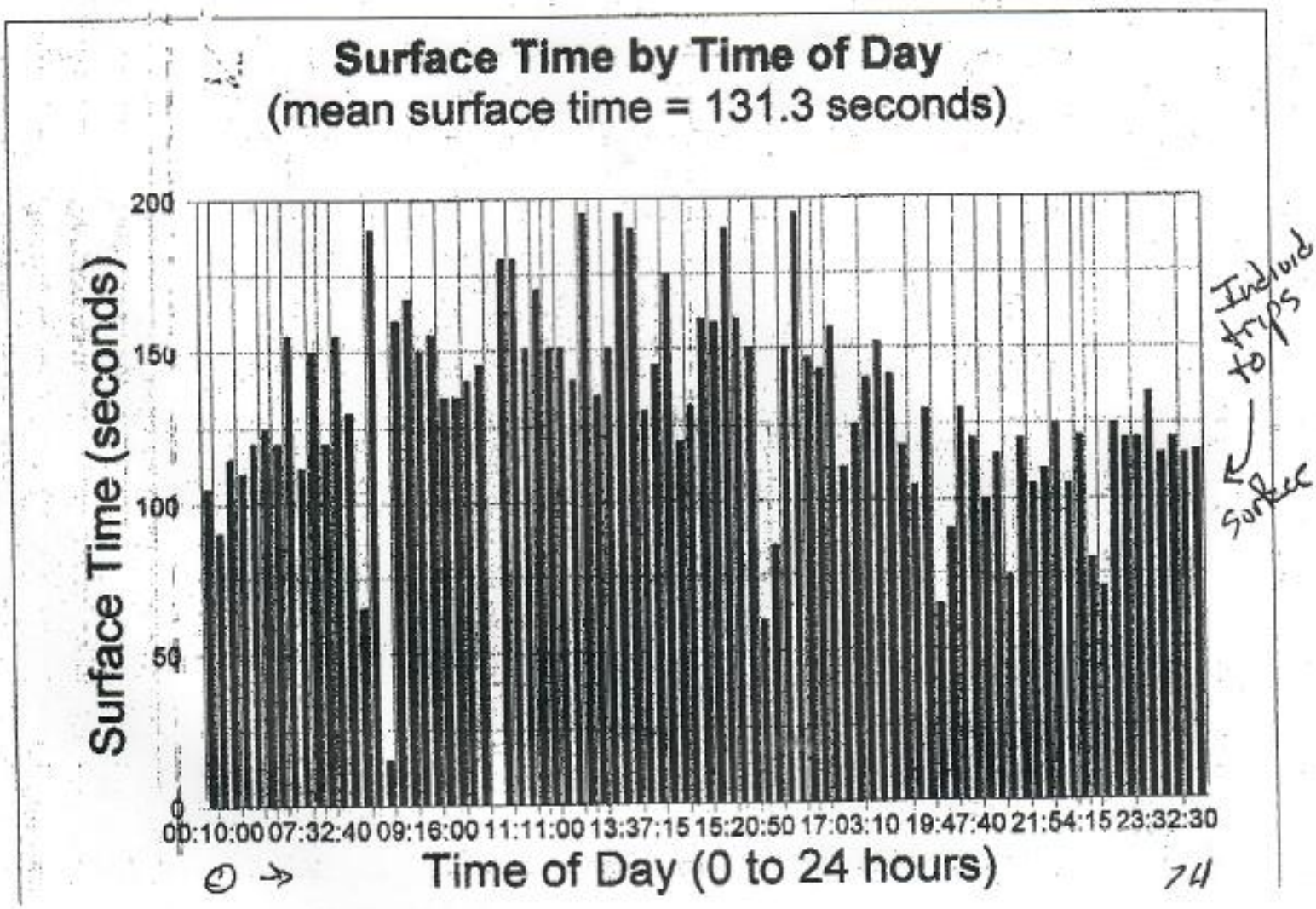
HAWAI'I WILDLIFE FUND

SURFACE AND DOWN TIMES FOR HAWKSBILL TURTLE # 4802 IN MA'ALAEA BAY, 1997



HAWAI'I WILDLIFE FUND

SURFACE AND DOWN TIMES FOR HAWKSBILL TURTLE # 4802 IN MA'ALAEA BAY, 1997



HAWAI'I WILDLIFE FUND
HAWKSBILL TURTLE PROJECT

1998

1. Place radio transmitters on Maui and Hawaii turtles to identify internesting habitat.

2. Working with Balazs, place radio and satellite tags on turtles to identify internesting sites and foraging habitat.

3. Collect more 24h dive-surface interval data to establish activity patterns.

4. Dive survey and characterize habitat sites identified in 1996 and 1997.

5. Relocate hawksbill nests at Ma'alaea that are laid in poor habitat.

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1998

Hawksbill Nest Relocation

1. Relocate Ma'alaea nests that have a high probability of flooding or are in high dirt content sand.

2. Place foster nest site near original - same beach.

3. Identify, evaluate, and groom alternate nest sites prior to nesting season.

4. Relocate nests within 12-24 hr of egg deposition.

5. Monitor hatching success.

6. Compare hatching data to similar original nest site data of 1997 and other non-relocated nest data of 1998.