24 August 82

George -

Here's a table of the updated results, with data from 1981 & 1982.

Elapsed Time	Estimated Probability of Tag Shedding $1-\hat{k}$	95% Confidence Limits on $(1-k)$ Lower Limit	Upper Limit
2 yrs.	.17	.02	.32
3 yrs	.23	.09	.37
4 yrs	.30	.07	.53
5 yrs	.33	.0	.95

The confidence limits are based on the formulas:

$$\text{Lower Limit} = (1-\hat{k}) - 2\,\hat{\sigma}_{1-\hat{k}}$$

or zero if this expression is negative.

$$\text{Upper Limit} = (1-\hat{k}) + 2\,\hat{\sigma}_{1-\hat{k}}$$

Here the standard errors are computed from

$$\hat{\sigma}_{1-\hat{k}} = (2-\hat{k}) \sqrt{\frac{\hat{k}(1-\hat{k})}{2(r_s+r_d)}} \quad .$$

Notice that the standard error is inversely proportional to the square root of the total sample size, r_s+r_d. Thus in order to double precision (i.e. cut the standard errors in half) you have to quadruple the sample size. Right now your most precise estimate is the one for 3-yr stabilizing probability, and in this case you can be 95% sure your estimate (0.23) is within about 60% of the true value.

JHW

22 July 82

George -

Here's the solution to your tag shedding problem. Let k_i be the probability of tag retention from the time tags are placed on the turtles until the midpoint of the i^{th} recapture period. Then the number of double tagged recoveries in the i^{th} period will be proportional to k_i^2, and the number recovered with only a single tag remaining is proportional by the same factor to $2k_i(1-k_i)$. Of the total number of recoveries in the i^{th} period the proportion bearing two tags

is Therefore

$$\rho d_i = \frac{k_i^2}{k_i^2 + 2k_i(1-k_i)} = \frac{k_i}{2-k_i}$$

If we solve this equation for k_i we get

$$k_i = \frac{2\rho d_i}{1+\rho d_i}.$$

Now if there are rd_i double tagged fish and rs_i single tagged fish recovered in the i^{th} period our estimate of ρd_i is

$$\hat{\rho} d_i = \frac{rd_i}{rs_i + rd_i}$$

So plugging this into the equation for k_i we get

$$\hat{k}_i = \frac{2rd_i}{rs_i + 2rd_i}.$$

In your case it all boils down to the following table:

Elapsed Time	r_d	r_s	$\hat{k}$	$(1-\hat{k})$	$(1-\hat{k})^2$
2 yrs	6 (12)	3 (5)	$\frac{12}{15} = .80$ $\frac{24}{29} = .83$	.20	.17
3 yrs	6 (17)	7 (10)	$\frac{12}{19} = .63$ $\frac{34}{44} = .77$	.37	.23
4 yrs	4 (7)	4 (6)	$\frac{8}{12} = .67$ $\frac{14}{20} = .70$	.33	.30
5 yrs	(1)	(1)	$\frac{2}{3} = .67$		

So based on this relatively small number of recoveries it looks like about 20% of the tags are shed in the first 2 yrs after tagging and about 35% or so after 3 yrs. Then shedding seems to stop. However, I would have very little confidence in these statements because

of the small sample sizes.

Based on large-sample theory, the standard errors and approximate 95% confidence intervals for the shedding rates would be as follows:

Elapsed Time	Shedding Rate Estimates $\hat{1-k}$	Standard Errors $\hat{\sigma}_{\hat{1-k}}$	95% Confidence Intervals (k_{lower}, k_{upper})
2 yrs	.20	.1131	(0, .43)
3 yrs	.37	.1294	(.11, .63)
4 yrs	.33	.1562	(.02, .64)

For these small samples the level of confidence associated with these intervals would be less than 95%.

JAW

114
33 RECOVERIES OF TAGGED GREEN TURTLES

TAG LOSS DATA
- 1981 NESTING SEASON -
FEMALES - INCONEL TAGS ONLY

2 TAGS ORIGINALLY ATTACHED

ELAPSED TIME	NO TAGS LOST	1 TAG LOST	TOTAL	% LOSS
2 YEARS-	6	3	9	33.3%
3 YEARS-	6	7	13	53.8%
4 YEARS-	4	4	8	50%
TOTAL	16	14	30	46.7%

3 TAGS ORIGINALLY ATTACHED

	NO TAGS LOST	1 TAG LOST	2 TAGS LOST	TOTAL
2 YEARS	1	-	-	1
3 YEARS	1	-	-	1
4 YEARS	-	1	-	1

68 RECOVERIES OF TAGGED TURTLES

Check D. Green article in MTN

1981 & 1982 TAG LOSS DATA

NESTING FEMALES - INCONEL

2 TAGS ORIGINALLY ATTACHED

ELAPSED TIME	No. turtles with NO TAGS LOST	No. turtles with 1 TAG LOST	TOTAL
2 years -	12	5	17
3 years -	17	10	27
4 years -	7	6	13
5 years -	1	1	2
			59

3 TAGS ORIGINALLY ATTACHED

	NO TAG LOSS	1 TAG LOST	2 TAGS LOST	
2 years -	1	5	0	6
3 years -	1	0	0	1
4 years -	1	1	0	2
				9

Table 4.--Shedding rates of Inconel tags: 59 recoveries of double-tagged green turtles at French Frigate Shoals during the 1981 and 1982 breeding seasons (analysis by J. A. Wetherall).

Recovery interval in years (i)	No. of turtles with no tags shed	No. of turtles with one tag shed	Estimated probability of tag shedding ($1-\hat{K}_i$)	95% confidence limits on ($1-K_i$)	
				Lower limit	Upper limit
2	12	5	0.17	0.02	0.32
3	17	10	0.23	0.09	0.37
4	7	6	0.30	0.07	0.53
5	1	1	0.33	0.00	0.95

$$\hat{K}_i = \frac{2r_{di}}{r_{si} + 2r_{di}}$$

where: K_i = Probability of tag retention from the time of tagging until the midpoint of the recapture period i years later.

r_{di} = Number of turtles recovered with two tags, i years after tagging

r_{si} = Number of turtles recovered with one tag, i years after tagging

Table 4.--Shedding rates of Inconel tags: 59 recoveries of double-tagged green turtles at French Frigate Shoals during the 1981 and 1982 breeding seasons (analysis by J. A. Wetherall).

Recovery interval in years (i)	No. of turtles with no tags shed	No. of turtles with one tag shed	Estimated probability of tag shedding (1-K)	95% confidence limits on (1-K)	
				Lower limit	Upper limit
2	12	5	0.17	0.02	0.32
3	17	10	0.23	0.09	0.37
4	7	6	0.30	0.07	0.53
5	1	1	0.33	0.00	0.95

$$K_i = \frac{2rd}{rs_i + 2rd}$$

where: K_i = Probability of tag retention from the time of tagging until the midpoint of the recapture period i years later.

rd_i = Number of turtles recovered with two tags.

rs_i = Number of turtles recovered with one tag.

WGG/GHB
255

Milestone III-4-23-021

Complete Annual Assessment of East Island Green Turtle Nesting Population

Reported by: Richard S. Shomura, Milestone Leader

Report date: 23 December 1986

Results:

The nesting population of green sea turtles at East Island, French Frigate Shoals was observed for 29 nights during June and July, 1986. As in past years, comprehensive records were kept on the history of each nester, both neophytes and remigrants. All neophyte nesters were tagged and remigrants were retagged if necessary.

During the survey period, observers encountered 105 individual turtles hauling out to nest. Using a model of nesting behavior derived from detailed observations in 1974 and 1975, the probability of encountering a member of the 1986 nesting population (neophytes and remigrants) during the specified survey period was estimated to be 0.57.

By dividing the sample count of nesters by the encounter rate, the total 1986 nesting population was estimated to be 184 females. This is less than the estimates of 252 nesters in 1985 and 248 nesters in 1984. However, this decrease in the East Island nesting population in 1986 is consistent with the pattern of the previous 13 years, which indicates short-term cyclic variation superimposed on a long-term increasing trend.

Dissemination:

The results will be reported to the Sea Turtle Recovery Team and incorporated into the population assessment section of the Green Turtle Recovery Plan under development by the team. They will also be made available to other interested parties through normal channels.

Edit as you wish. Document is on
L: mstur87.JAN

Jerry

9-85

National Marine Fisheries Service
Milestone Back-Up Information

Fishery or Program: Protected Species

Milestone Code: III-4-7

Text: Complete development of a method to monitor the status of the Hawaiian green turtle population which will be based on the level of nesting activity observed.

Purpose: In order to determine if the threatened Hawaiian green turtle population is still declining, stable or increasing a valid technique to monitor trends in the population must be developed. Information on the status and trends of the population in addition to indicating certain research needs will be used in management decisions where activities with potential impacts on the turtle are evaluated.

Background: No technique is available for estimating the size of any marine turtle population.

Total nesting activity of the Hawaiian green turtle has been monitored for 12 years.

Nesting frequency of many tagged individuals is known.

Results:

Each summer since 1973, the nesting population of green sea turtles has been surveyed during the peak of the nesting season at East Island, French Frigate Shoals, the key nesting ground for this species in Hawaii.

Neophyte females nesting for the first time and veteran females remigrating to nest after a lapse of 1 to 6 years have been identified and tagged with numbered flipper tags. An extensive file of tag recovery data has permitted the estimation of tag shedding rates and the estimation of a probability distribution for the remigration interval. In addition, detailed observations of nesting activity during 1974 and 1975 have provided data for a stochastic model of residence time on East Island. The residence time model permits estimation of the coverage rates associated with each of the annual nesting surveys and the calculation of raising factors to convert the observed numbers of nesting females to estimates of the total population of nesting females.

Estimates for 1973 through the recent 1985 survey suggest that there is a trend toward increase in the population of nesting females occupying East Island, although there is considerable cyclic variation. Although the basic estimation method for East Island has been developed by Dr. Jerry A. Wetherall of the Honolulu Laboratory, additional survey work needs to be done to strengthen estimates of the residence time distribution and to validate other assumptions of the procedure. In addition, further work needs to be carried out to determine the significance of the East Island nesting ground to the reproductive success of the entire Hawaiian green turtle stock.

Dissemination of Results

A report, when completed, will be made available to the Turtle Recovery Team.

Due Date: September 1985

Responsibility: