Bayesian semiparametric modelling of factors affecting post-release mortality of loggerheads in the North Pacific: Preliminary results

(PFRP PI Meeting November, 2006)

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NOAA need for robust estimates ...

Report of the Workshop on Marine Turtle Longline Post-Interaction Mortality

Bethesda, Maryland, USA
15-16 January 2004

Cheryl E. Ryder
Therese A. Conant
Barbara A. Schroeder

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

NOAA Technical Memorandum NMFS-OPR-29
January 2006
<table>
<thead>
<tr>
<th>Condition of turtle upon capture:</th>
<th>Old rate:</th>
<th>New: &gt; 0.5 carapace length line</th>
<th>New: &lt; 0.5 carapace length line</th>
<th>New: all line &amp; hook removed</th>
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</thead>
<tbody>
<tr>
<td>HOOKED W or W/out ENTANGLEMENT</td>
<td></td>
<td>Hard shell turtles (Leatherback in parentheses)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Externally hooked</td>
<td>27%</td>
<td>20% (30%)</td>
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<tr>
<td>Beak (not penetrating soft tissue)</td>
<td>27%</td>
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</tr>
<tr>
<td>Mouth, upper throat hooked</td>
<td>42%</td>
<td>45% (55%)</td>
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<tr>
<td>Deep (esophagus) hooked</td>
<td>42%</td>
<td>60% (70%)</td>
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<td>Leave in</td>
</tr>
<tr>
<td>ENTANGLED ONLY: Disentangled</td>
<td>0%</td>
<td></td>
<td></td>
<td>1% (2%)</td>
</tr>
<tr>
<td>Released entangled</td>
<td>27%</td>
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<tr>
<td>COMATOSE AND RESUCITATED</td>
<td>N/A</td>
<td>Should not happen</td>
<td>70% (80%)</td>
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Revised predicted mortality - Hard Shell Turtles (100% line removed)

27% to 5%

Leave in line: 42% to 60%

27% to 10%

42% to 25%

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Modelling post-release mortality of loggerhead sea turtles exposed to the Hawaii-based pelagic longline fishery

Milani Chaloupka\textsuperscript{1,}\textsuperscript{*}, Denise Parker\textsuperscript{2}, George Balazs\textsuperscript{3}

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\textsuperscript{2}Joint Institute for Marine and Atmospheric Research, 8604 La Jolla Shores Drive, La Jolla, California 92037-0271, USA
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ABSTRACT: Loggerhead sea turtles \textit{Caretta caretta} are an endangered species exposed to anthropogenic hazards such as pelagic longline fisheries. Many loggerheads caught in these fisheries are alive when released from the gear, but many probably die soon after because of hook injuries or line entanglement. Robust estimates of post-release mortality are essential for stock assessment and evaluating the benefit of releasing turtles caught alive in the gear, yet none are available for any sea turtle species. Here, the post-release mortality of 40 loggerheads caught in the Hawaii-based pelagic longline fishery was investigated using satellite telemetry deployed by a National Marine Fisheries Service (NMFS) observer program. We modelled time-to-failure of all transmitters using nonpara-

"But satellite transmitters fail for many reasons which results in a hazard function that confounds competing risks"

founds these competing risks. Hence we propose that it might not be possible to infer true post-release mortality based on satellite telemetry unless the cause of each transmitter failure is known, which is rarely the case. We discuss other survey design and statistical modelling challenges involved in the evaluation of post-release mortality based on satellite telemetry.

KEY WORDS: Loggerhead sea turtles · Pelagic longline fisheries · Satellite telemetry · Post-release mortality · Failure time modelling · Competing risks
PSATs set to release/report:

At pre-set pop-up date
  or
If tag at constant depth for 4 days*
  or
If tag > 1,200 m depth*
  or
If tag and/or baseplate are shed, will float to surface

*these parameters exceed what is expected to occur in a live turtle (we assume mortality)
2002-2006 PSATs in N. Pacific
29 loggerheads
25/29 reported at least start and end ARGOS location
4 never reported
Nesting beaches in Japan?

Forage area off Baja, Mex.

Avg size = 63 cm

Avg track = 68 d

Olive ridley (Lepidochelys olivacea)

Loggerhead (Caretta caretta)
20/29 Tags - decent depth data, 2/20 (10%) suggest mortality
Model

- 29 PSATs on loggerheads in North Pacific
- Cox-type hazard model using empirical Bayes approach and fitted using REML (a geoadditive model without PH restriction)
- censoring mechanism comprising both right and left (interval) censoring as well as left truncation to accommodate the staggered entry design
- accounts for nonlinear baseline hazard, nonlinear covariate functional form, individual turtle/tag heterogeneity (frailty), time-varying effects and geo-referenced spatial effects
Model (cont’d) …

- spatial effect derived using 2D smoothing spline surface then AKIMA bicubic spline interpolation for irregular spaced data for imaging plotting
- then kaplan-meier-turnbull survival curve estimate to summarise psat duration data (excl. staggered entry effect)
Hazard rate as function of (long, lat) at tag-and-release location. White = highest risk (ca 146W, 37N), red = lowest risk

Hazard rate as function of (long, lat) at pop-up report location. Westward decreasing hazard as that is direction of movement of the surviving turtles
psat survival curve
kaplan-meier-turnbull estimate
Acknowledgements

- PFRP
- NOAA Fisheries Observers
Sources of Tag/Transmission Failure:
To be evaluated with modelling data

If tag sheds, should float to surface and transmit after 4 days constant depth....

If corrosible link does or RD 1,500 does not release, we would lose information
Tools for tracking

Platform Terminal Transmitters (PTT)

Pop-up Satellite Archival Tag (PSAT)