Initial results from PSAT attachments to swordfish, blue shark & yellowfin tuna in Hawaii

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Also Linked to the following 4 PFRP projects:

Developing biochemical and physiological predictors of long term survival in released blue shark and turtles

*Chris Moyes, Rich Brill and Mike Musyl*

Post-hooking survivorship, migrations, and foraging patterns of sea turtles released from commercial longline fishing gear, determined with pop-up archival satellite transmitters

*Rich Brill, George Antonelis, George Balazs, and Jeff Polovina*
Investigation of Pacific Broadbill Swordfish Migration and Habitat Characteristics using Electronic Archival Tag Technology

Chris Boggs

Population biology of oceanic sharks

Chris Boggs
Objectives:

1). Chronicle vertical and horizontal movement patterns and local distribution - including residency time

2). Evaluate survivability of released fish (blue sharks)

3). Identify spawning seasons and locations

4). Provide data that will allow further refinement of catch models based on vertical behavior and environmental conditions
Also important in the context of bycatch reduction, e.g., can swordfish be taken on deeper daytime sets whilst reducing turtle interactions?
PSATs

Fishery independent

Record pressure (depth) and temperature every hour

Geolocations estimated onboard the tag based on light levels

(Ongoing double tagging studies to provide error estimates, i.e. PTT and PSAT affixed on turtles)
PSATs

Tag will release and transmit if it:

1) experiences no significant pressure change in four consecutive days

2) reaches a depth of about 1200 m (tag rated to about 2000m)

3) reaches the pre-programmed pop-off date

Allow conclusions as to whether tag was free-floating or if tagged animal died and sank (can tell “dead” from “shed”)

The range of archival & PSAT, and conventional tags
Tagged 8 blue sharks
8 swordfish
1 yellowfin tuna

PSAT Summary:
14 blue sharks
8 swordfish
2 yellowfin tuna
1 oceanic white tip shark

Longline Operations in March/April 2001 aboard RV Townsend Cromwell
Taking blood sample for biochemical study
Caught by longliner
Stomach everted when tagged

This female moved 8 nmi in 1 day

5 days 11.5 nmi/day

35 days 10 nmi/day

41 days 10.5 nmi/day

51 days 16 nmi/day

26 days 12 nmi/day
Blue Shark Male #2

Starts transmitting At surface to ARGOS

Tag initiates Release at about 1200m

5 day trace

Shark Mortality

Depth (m)

Temp (°C)
The tag on this female shark came to the surface
And reported within about 1 day of deployment

Perhaps other sharks, attracted to blood and
Electrical field of transmitter (see Kienath & Musick, Copeia 1993,
Haine et al. Mar. FW. Res, 2001) severed the tether releasing tag???
Tag didn’t go deep enough to trigger depth-release mechanisms
Some tags came off early, why?

1). one confirmed mortality, one possible mortality

2). two suspected due to nuptial bites

3). One unexplained tag shedding (probably more of a problem in swordfish and yellowfin tuna)
Harness consists of:
270# fluorocarbon line
Stainless steel thimbles
Braided stainless steel wire encased in heavy gauge tubing

Breaking strength of eyelet on tag is 120#
(greater than breaking strength of tag’s fusible link)

Tag shedding can be probably ruled out in the short term

This tag/tether was cut out of a shark by Japanese longliners
After it was out for 41 days—

No obvious abrasions or cuts caused by dermal denticles

Of special note is that upon tagging, the female shark had it’s stomach everted
RD 1500s extensively tested by 2 labs in pressure chambers--
Simulating the tag going up and down about 300 times
from about 0 m to 1000m (what a typical bigeye tuna does in one month)

General consensus is that they do work from about 1500-1800m
All Blue shark samples (5)
118 days-at-liberty
2 males – 31 days
3 females – 87 days
All Blue Shark Samples
Yellow=female (3), 87 days
Red=males (2), 31 days

Temp(C) Bins

% frequency

Yellow=female (3), 87 days
Red=males (2), 31 days

Depth(m) Bins

% frequency
Results of 2-sample Kolmogorov-Smirnov tests used as input for a Dissimilarity Matrix Among Shark PSAT samples using depth distribution information
Blue Shark Catch on 313 longline sets, 96-97

CPUE (per unit effort) against TDR Depth (m).

- Red = males
- Yellow = females

% frequency across different depth bins (0-1100 m).
Blue Shark Catch on 313 longline sets, 96-97

- CPUE vs TDR Temp. (C)
- Red = males
- Yellow = females

Red=males
Yellow=females

% frequency vs Temp(C) Bins
Sedberry and Loefer, Marine Biology, 2001
Reported a 40% shedding rate of PSATs in swordfish—
To date, we still have 2 long term samples swimming
But 6 of 8 tagged fish reported in “early”—
still waiting on data for 3 samples
Swordfish #2

4 day trace (hrs)

Depth (m)

Temp (°C)

Swordfish #1—time at surface—in peril?
All Swordfish Samples (3)
52 days-at-liberty

Swordfish catch on 180 longline sets, 96-97
All Swordfish Samples (3)
52 days-at-liberty

Swordfish catch on 180 longline sets, 96-97

Temp(C) Bins

% frequency

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

TDR Temp. (C)

CPUE

0 5 10 15 20 25

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27

TDR Temp. (C)
2 Yellowfin tuna tracks

- 40 days
- 235 nmi
- 6 nmi/day

- 24 days
- 191 nmi
- 8 nmi/day
All yellowfin samples (2)
64 days-at-liberty

Yellowfin catch on 153 longline sets, 96-97
All yellowfin samples (2)  
64 days-at-liberty

Yellowfin catch on 153 longline sets, 96-97
Interpretation of Hawaiian-based longline fish captures 96-97, 319 sets

Variables:
- TDR Depth: 0.37, -0.45
- Lat: -0.46, -0.05
- Lon: 0.30, -0.23
- CPUE Shallow v. Deep: -0.40, 0.17
- Set time: -0.46, -0.16
- SST: 0.43, 0.30
- TDR temp: 0.11, 0.77

% variation:
- PC1: 65%
- PC2: 22%

PC1 = North-South, Day-Night Axis
PC2 = Vertical axis

Epipelagic tropical
- O. White-tip
- Blue marlin
- Striped marlin
- Yellowfin

Epipelagic
- Blue shark
- Stingray
- Dolphinfish
- Snake Mackerel
- Albacore
- Lancetfish
- Albacore
- Bigeye

Deepwater
- Spearfish
- Skipjack
- Bigeye

Temperate pelagic
- Swordfish

Nighttime Sets
Daytime Sets