

# Sea Turtles and Longline Fisheries: Impacts and Mitigation Experiments

Yonat Swimmer, Mike Musyl, Lianne M<sup>c</sup>Naughton,  
Anders Nielson, Richard Brill, Randall Arauz

PFRP P.I. Meeting  
Dec. 9, 2003



# Sea Turtles in the Pacific

<b>Species</b>	<b>Population Trend</b>	<b>Major Nesting Beaches</b>
Leatherback Turtle	Declining	Mexico Costa Rica Malaysia
Loggerhead Turtle	Declining	Australia Japan
Green Turtle	Declining (except in Hawaii & Australia)	Hawaii
Black Turtle	Declining	Mexico Galapagos
Hawksbill Turtle	Unknown	Hawaii
Olive Ridley Turtle	Declining (except in Oaxaca)	Mexico Costa Rica Malaysia Thailand Irian Jaya India

- Destruction of nesting beaches
- Long generation times
  - 15-20 years until adulthood
- High mortality of eggs
  - Egg harvesting (poaching)
  - Egg predation (mammals)



- High natural predation of hatchlings and juveniles at Sea



- Adult harvest by humans



- Disease

- Pollution



- Entanglement and ingestion of marine debris



- Incidental capture in fisheries





# Longline Fishing and Sea Turtle Interactions:

## Leatherback turtle (*Dermochelys coriacea*)

- Generally entangled or foul-hooked (snagged)
- Status: Endangered\*



# Longline Fishing and Sea Turtle Interactions:

## Hard-shelled turtles



- e.g. loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*)
- Generally hooked - opportunistic feeders bite baited hooks.
- Status: Threatened

What is fate of turtles after their release from longline-fishing gear?



Our chosen tool...



# Pop-up satellite archival tags (PSATs)



To determine

- survivorship
- geolocation  
(& migratory corridors)
- dive depths
- temperature

Deployed by at-sea observers

# How can PSATs determine survivorship??

## PSATs set to release/report:

At pre-set pop-up date

or

After tag has been at constant depth for 4 days\*

or

After tag has exceeded 1,500 m depth\*

or

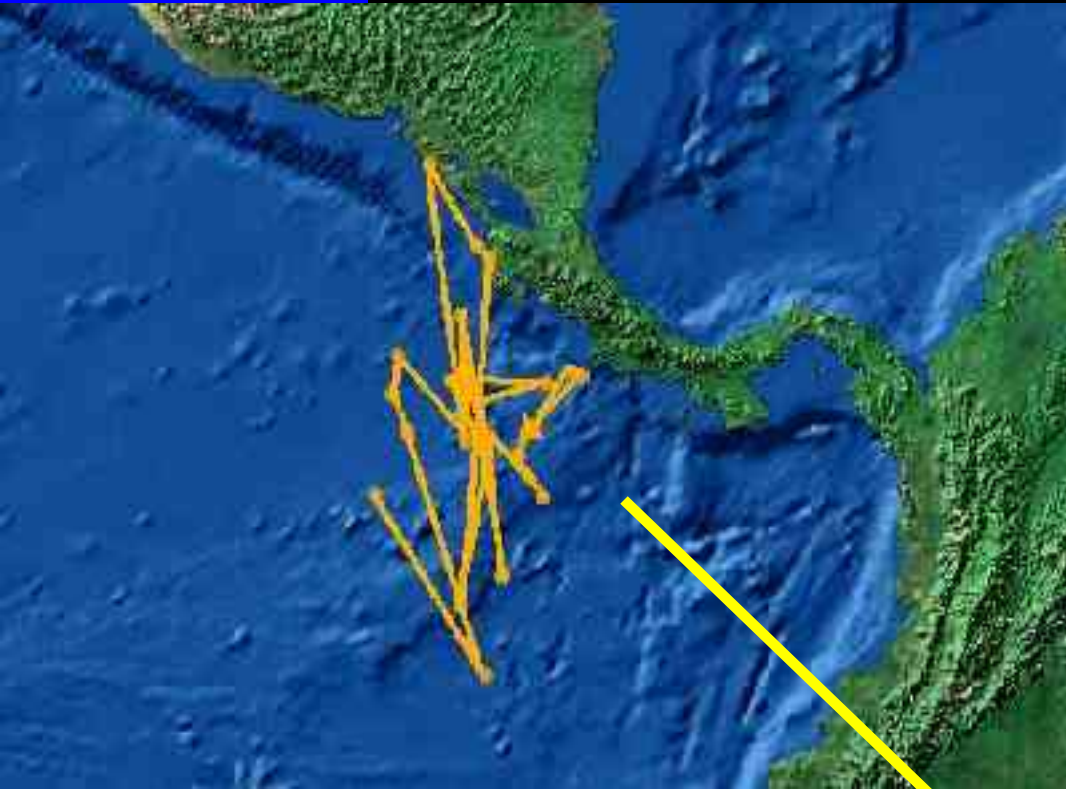
If tag and/or baseplate are shed, will float to surface

**\*these parameters exceed what is expected to occur in a live turtle (we assume mortality)**

# PSAT concerns

- Early tag shedding observed in fish and turtles
- Data quantity relatively low
- Light-based geolocations require additional filtering to data (e.g. Kalman filter)

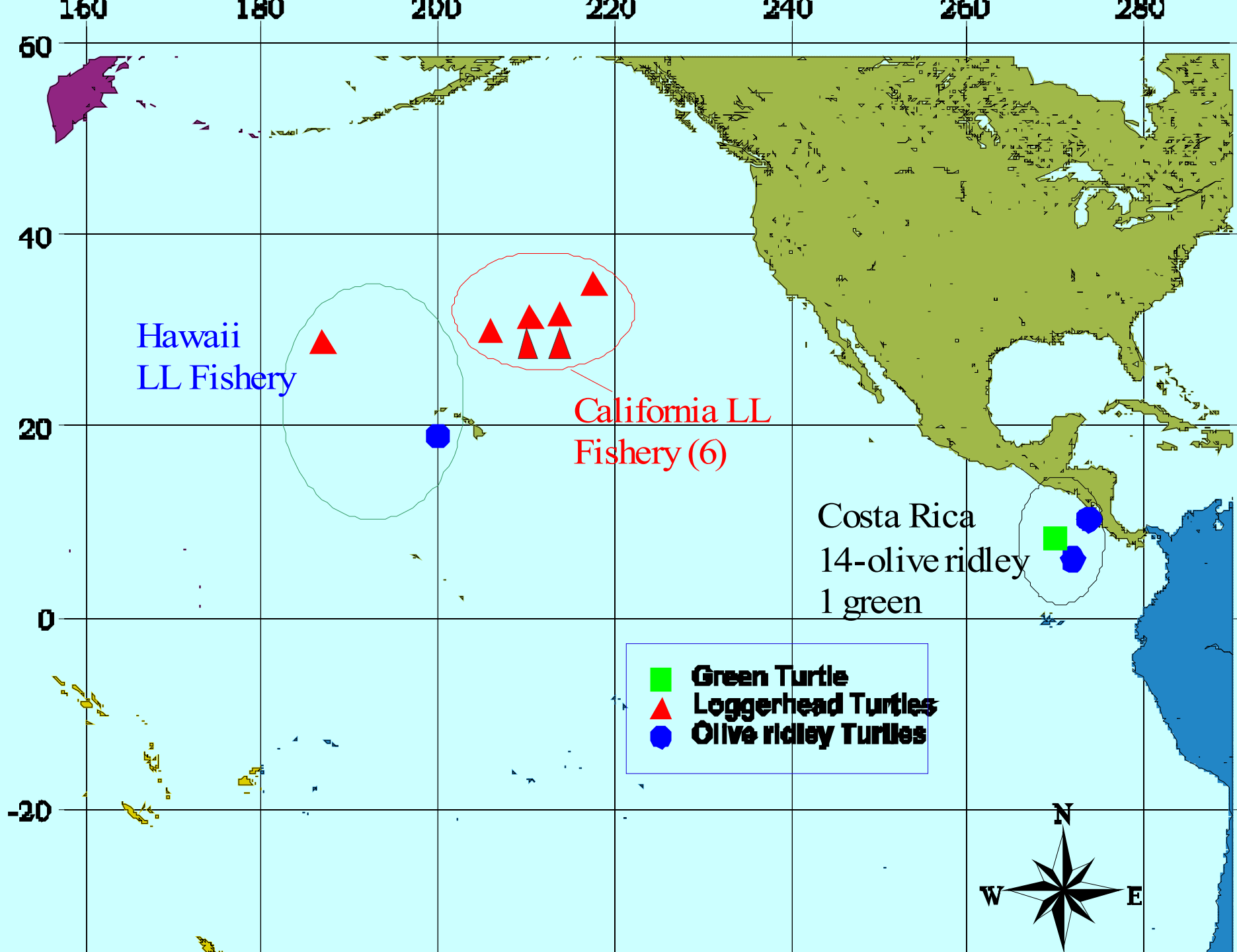
# Geolocations determined by PSATs



Most probable track predicted from state-space model via the Kalman filter (Sibert and Nielson).

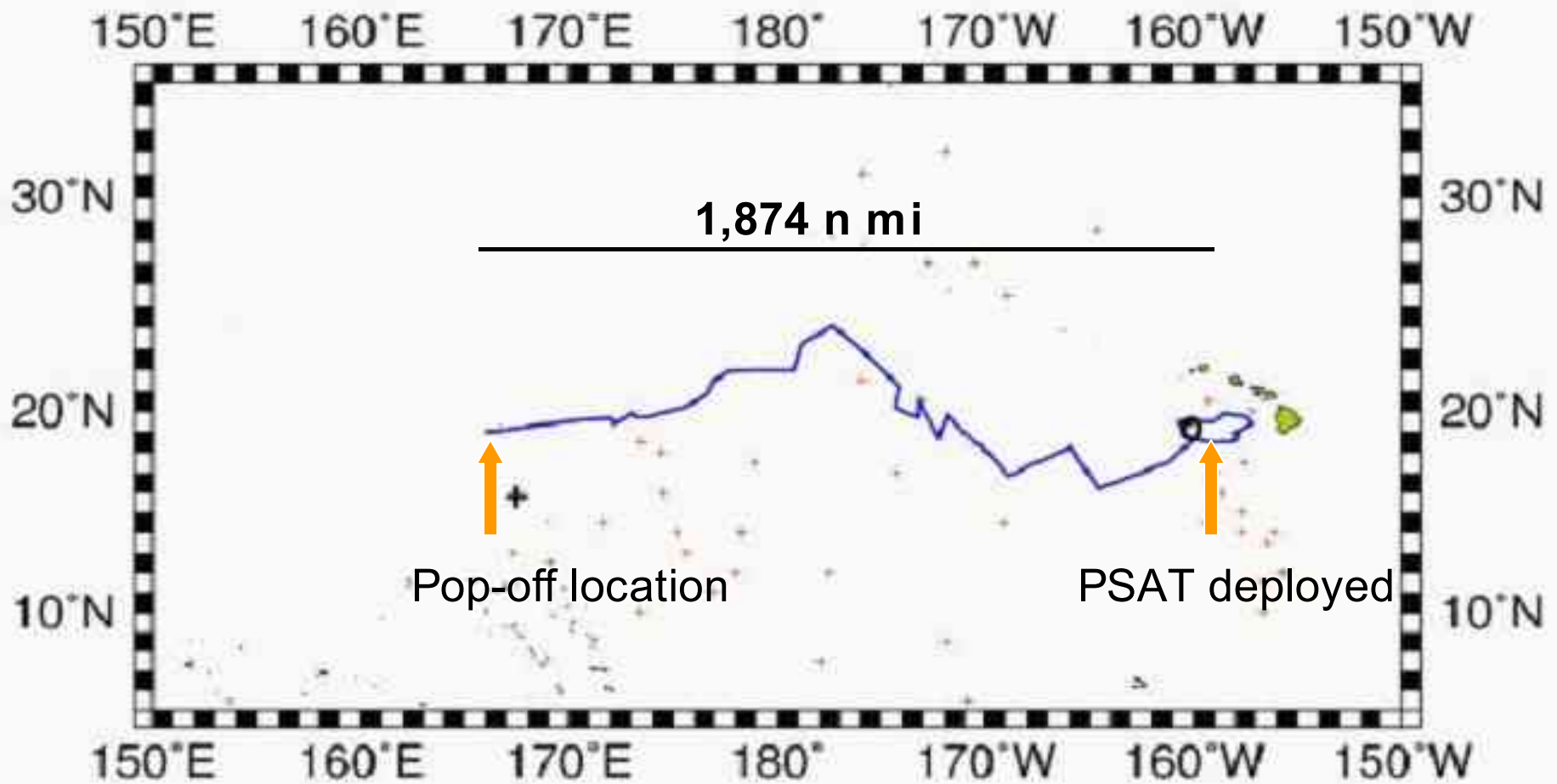


Incorporation of SST data is in progress.



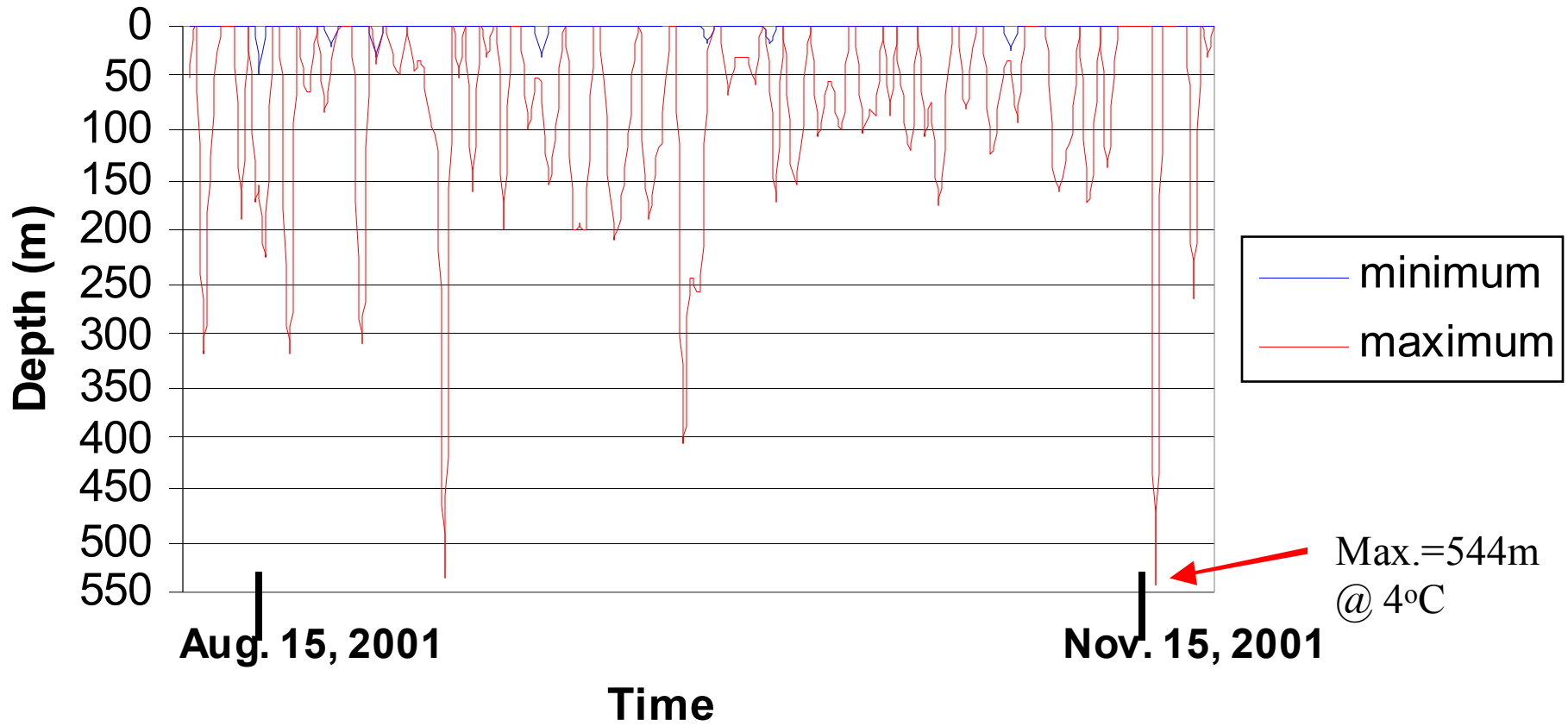
## PSATs in Hawaii:

### Olive Ridley (13202): Hooked in mouth

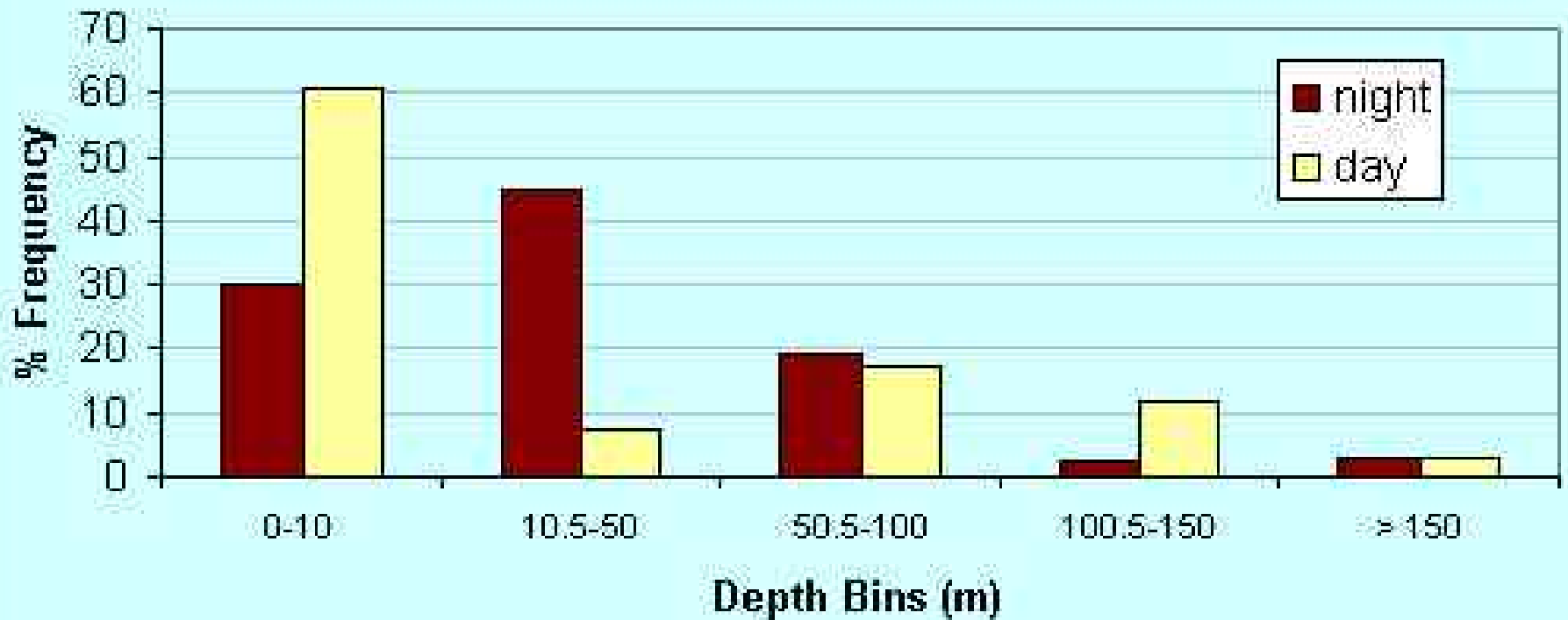


~ 4 months at liberty post-release

# Min-Max Depth for Olive ridley (13202)

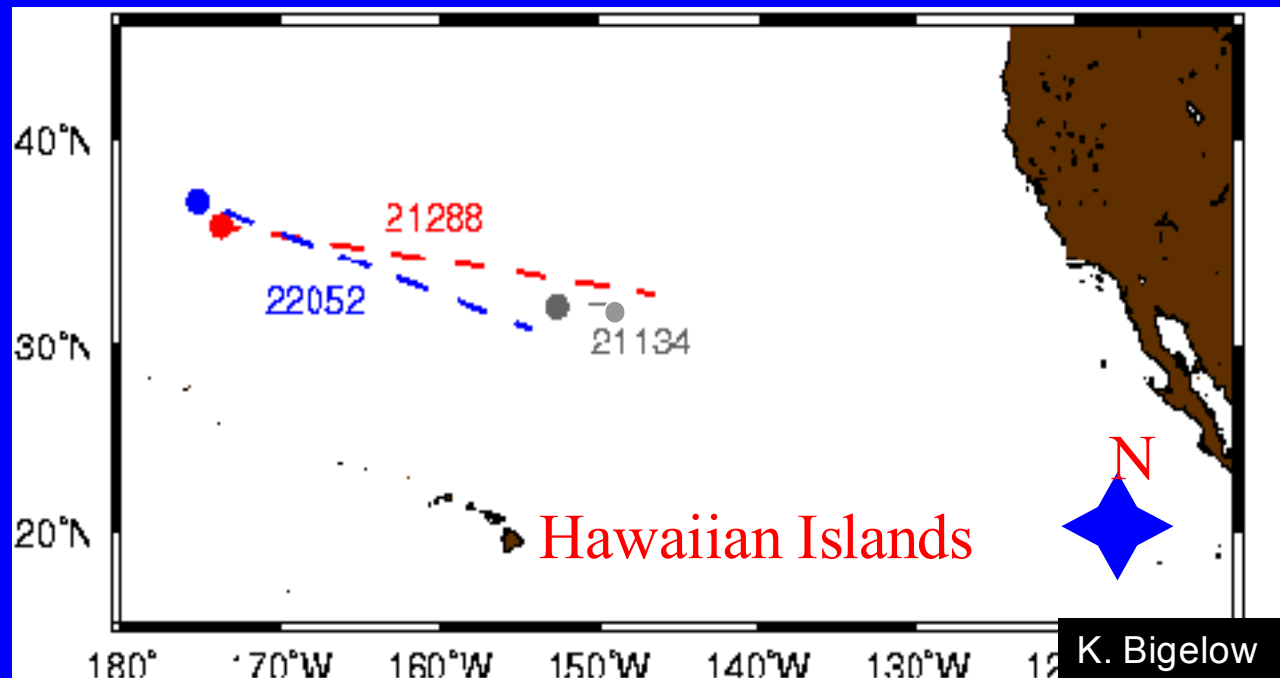


# Depths for Longline-caught and released olive ridley (13202) in North Pacific Ocean

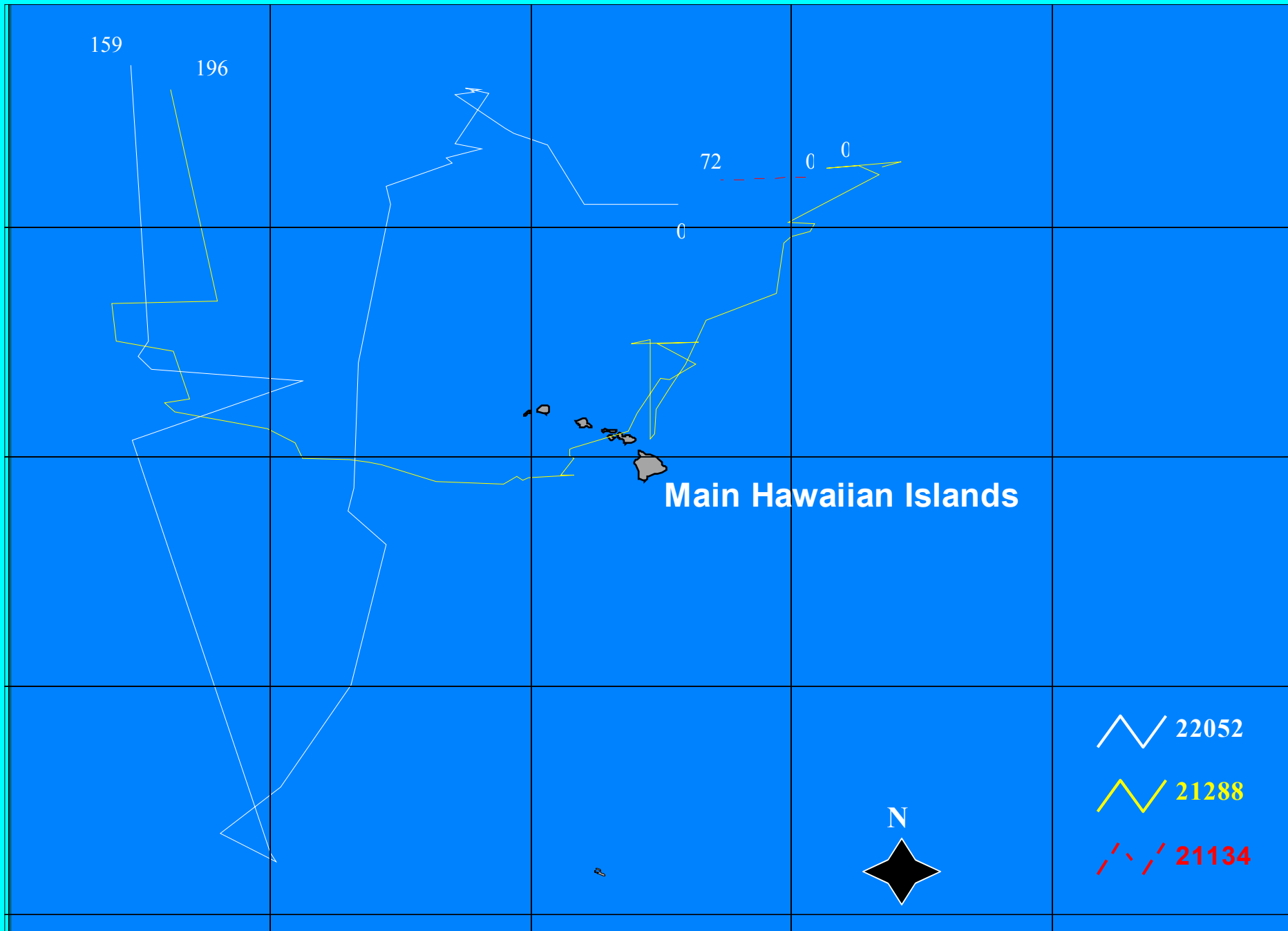


# PSATs released from California Fishery 2002-2003

- 15 trips, 6 PSATs deployed



- One dud, 2 still out
- One possible mortality 6 mos. later---data inconclusive.



159

196

72

0

0

Main Hawaiian Islands

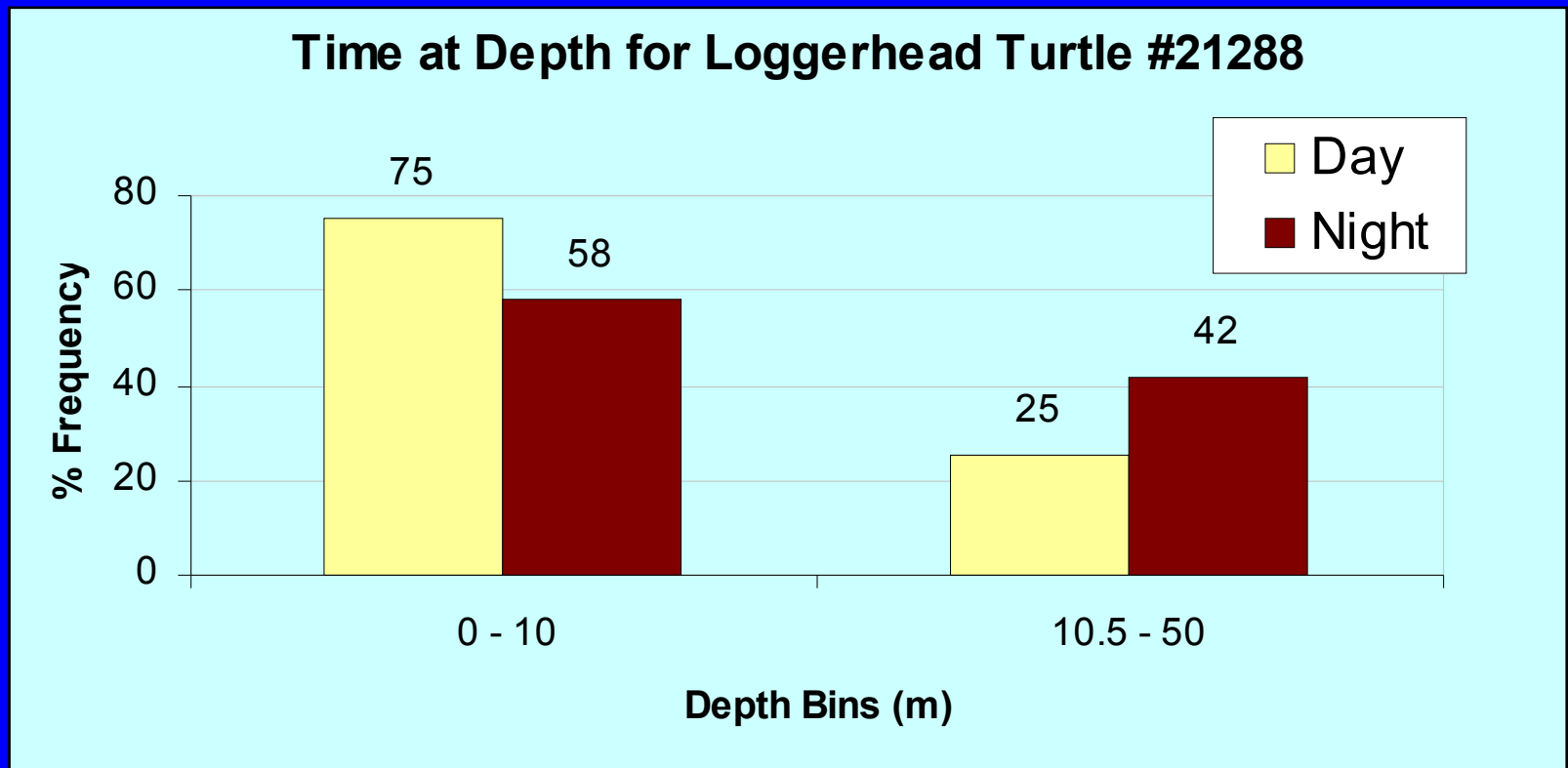
P

 22052

 21288

 21134





- Turtle 21288: Depth data for first three months. Only geolocation data btwn. 3-6 mos., then 1,108 m dive.

**Mortality??**

- Turtles 21134 & 22052: no depth data, geolocation only.

# Is there a "turtle layer" in the North Pacific??



**YES!!**

**Loggerhead spent 100% total time < 50 m**  
**Olive ridley spent 90% total time < 100 m**

# Costa Rica

Sea turtles= 8% total catch longline fishery

Cooperative fishers!!



Collaboration:  
Univ. of Hawaii, PRETOMA,  
NMFS, Sea Turtle Restoration  
Program

10 Caught and released from longline gear

5 Controls (free swimming)



Tags on CR olive ridley turtles stayed on for only ~ 60 days

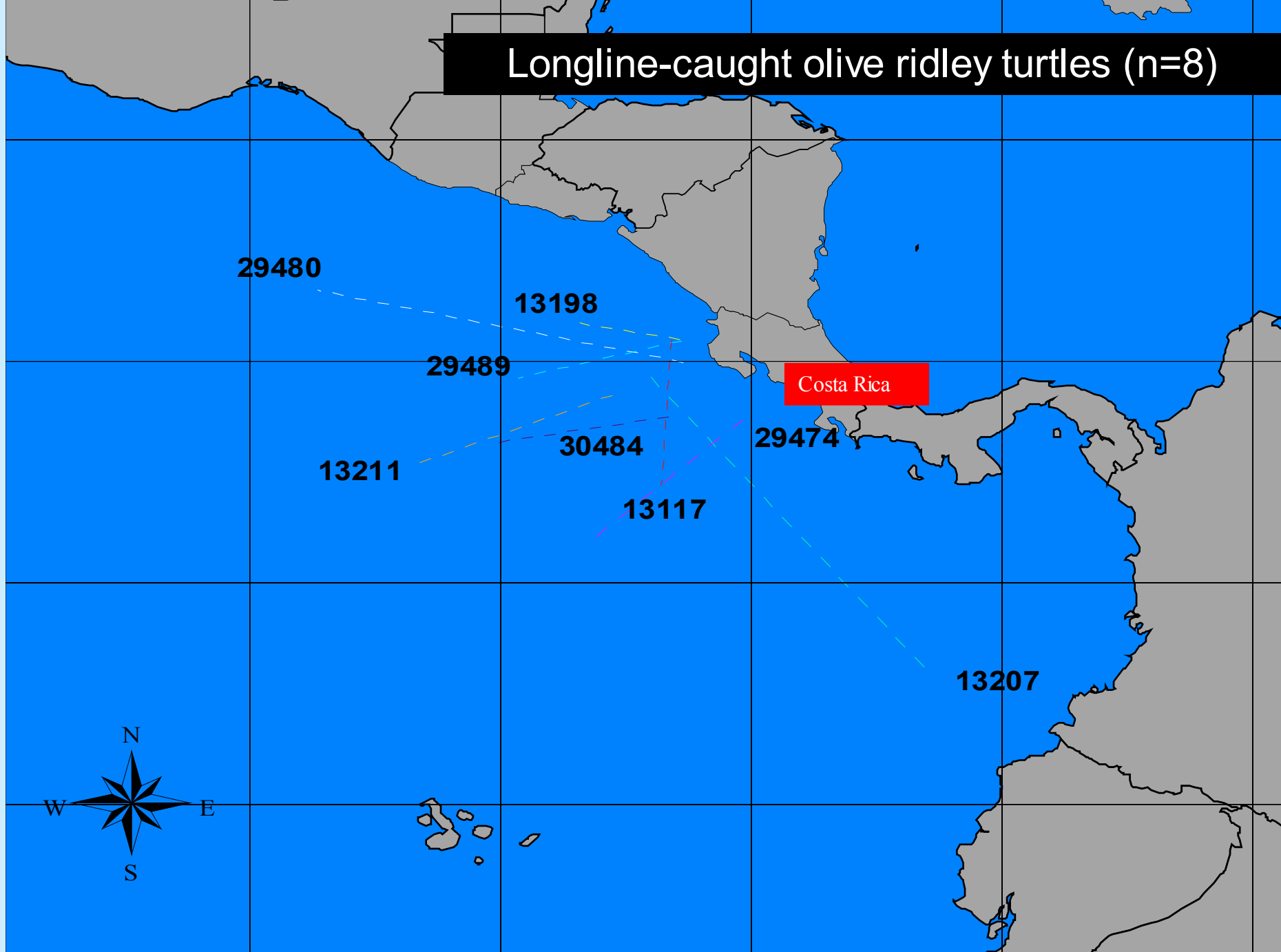


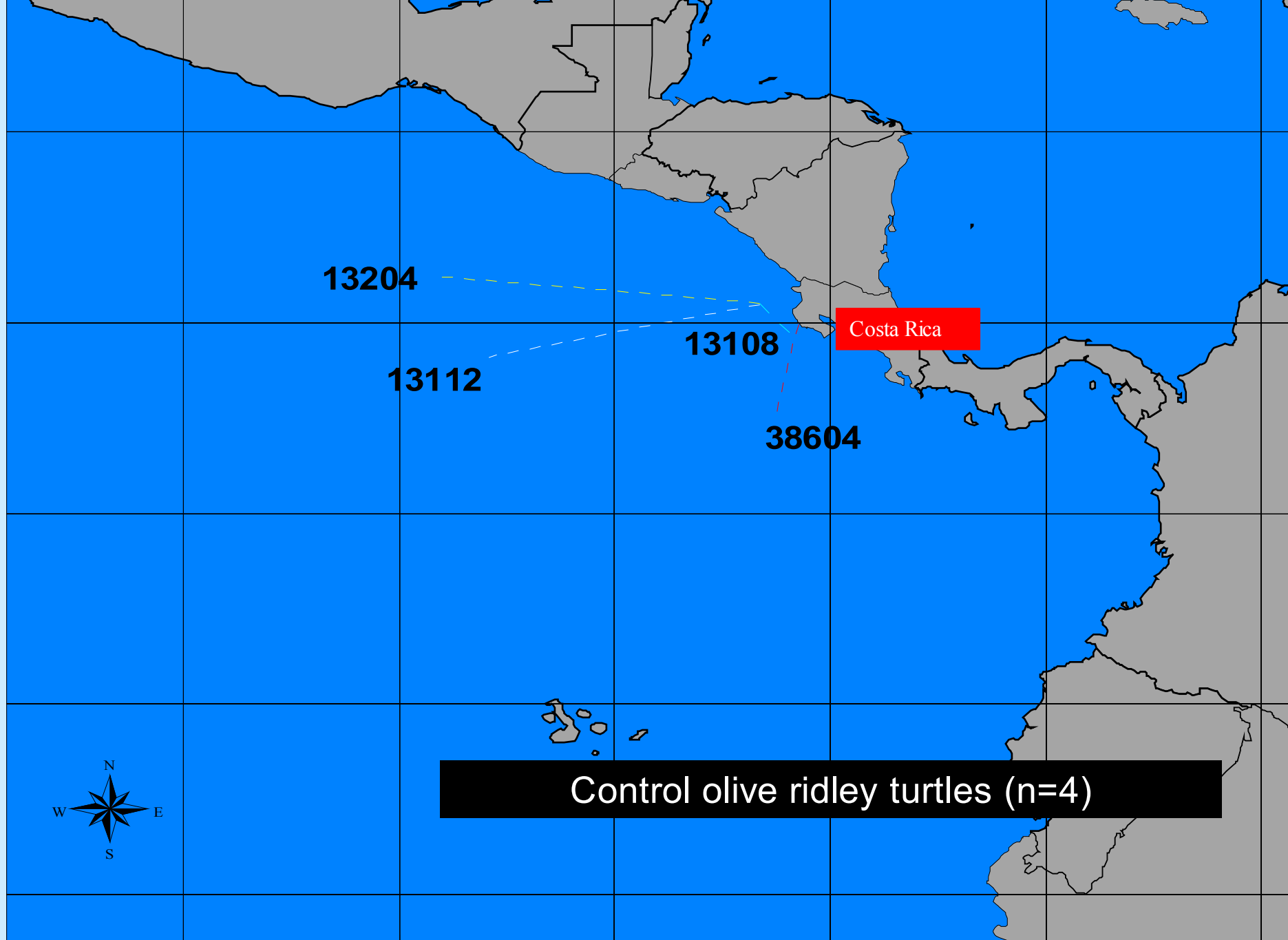
Are tags removed by fishers?

Are turtles mating and knocking tags off?

Does an olive ridley carapace form a weaker epoxy bond as compared to loggerheads??

# Longline-caught olive ridley turtles (n=8)





13204

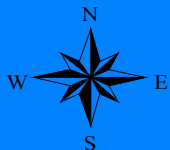
13112

13108

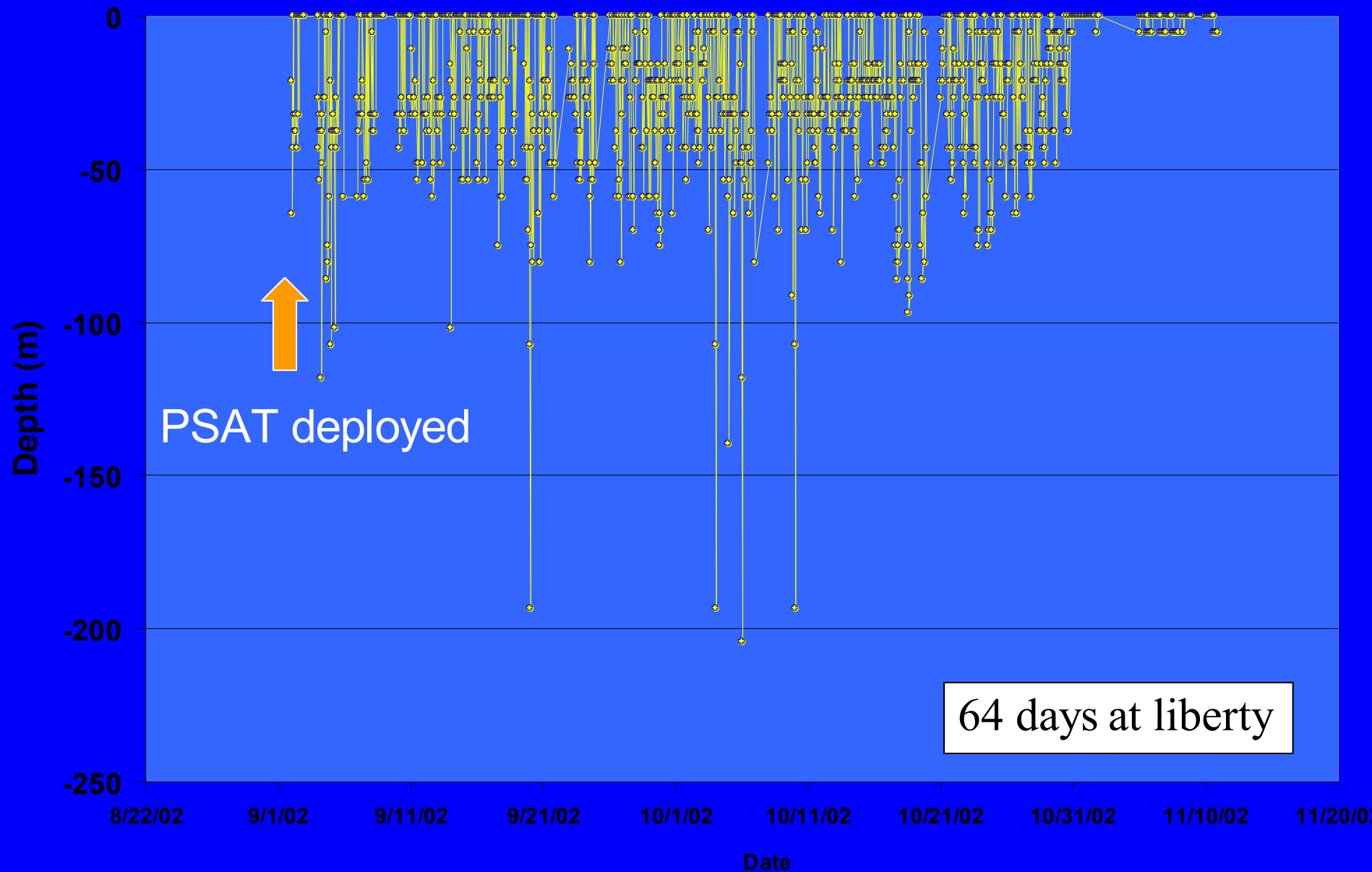
38604

Costa Rica

Control olive ridley turtles (n=4)



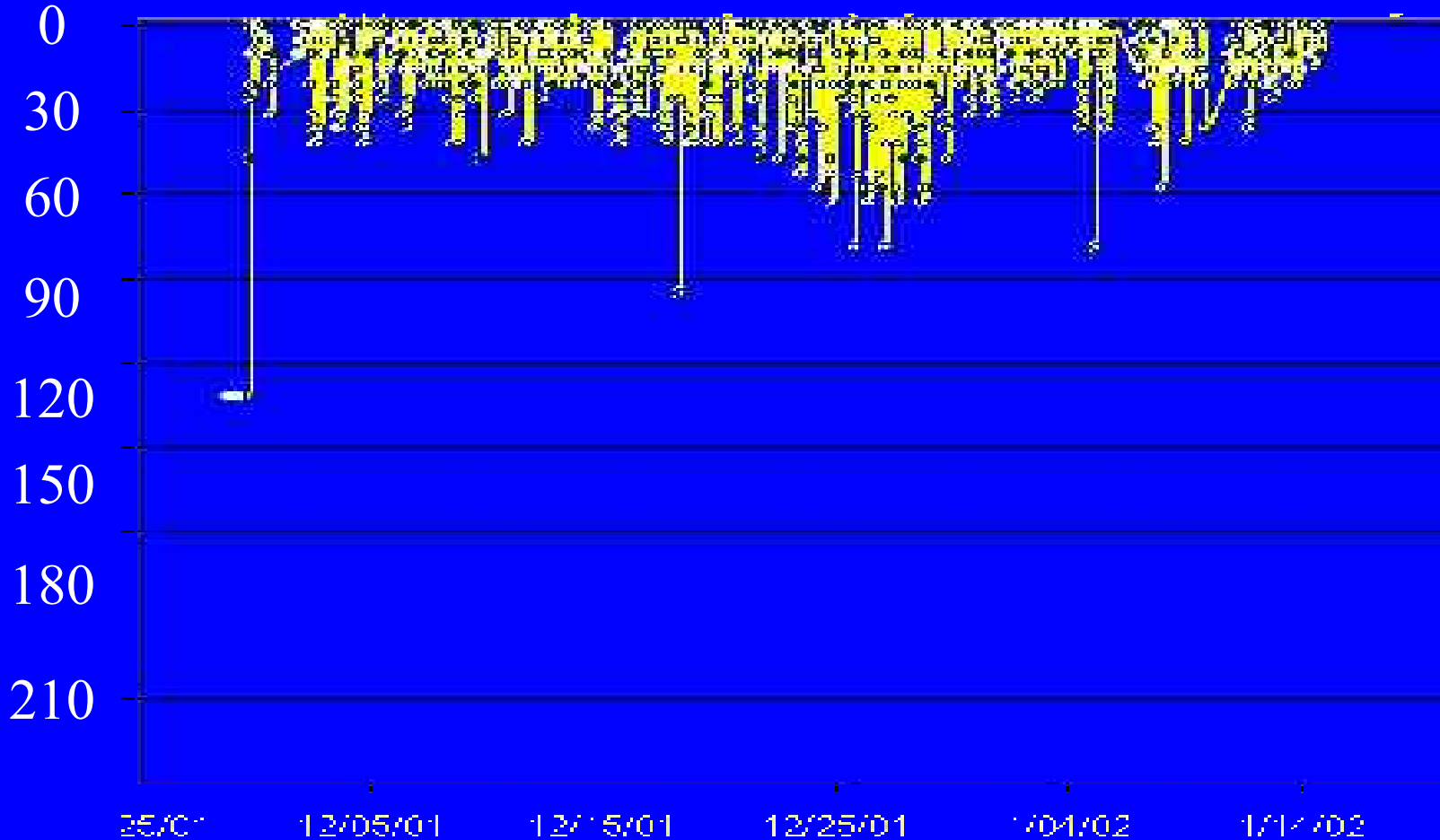
# Depth(m) for Tag 29474 -- Hooked in mouth



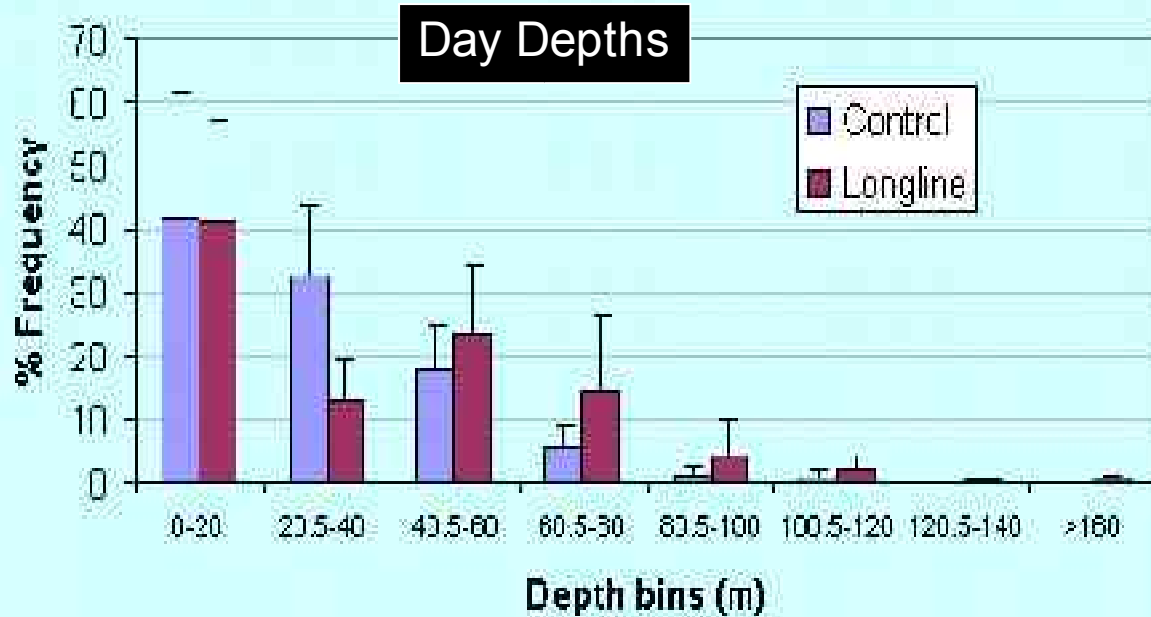
# Free-swimming control

Dive Depth for CR 13112

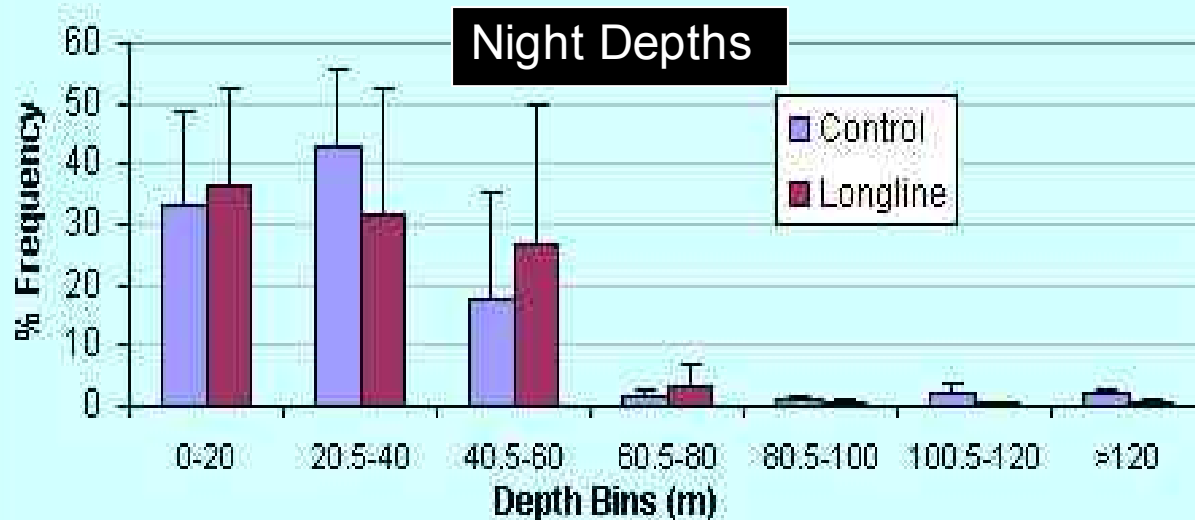
Depth (m)



(Two months at liberty)

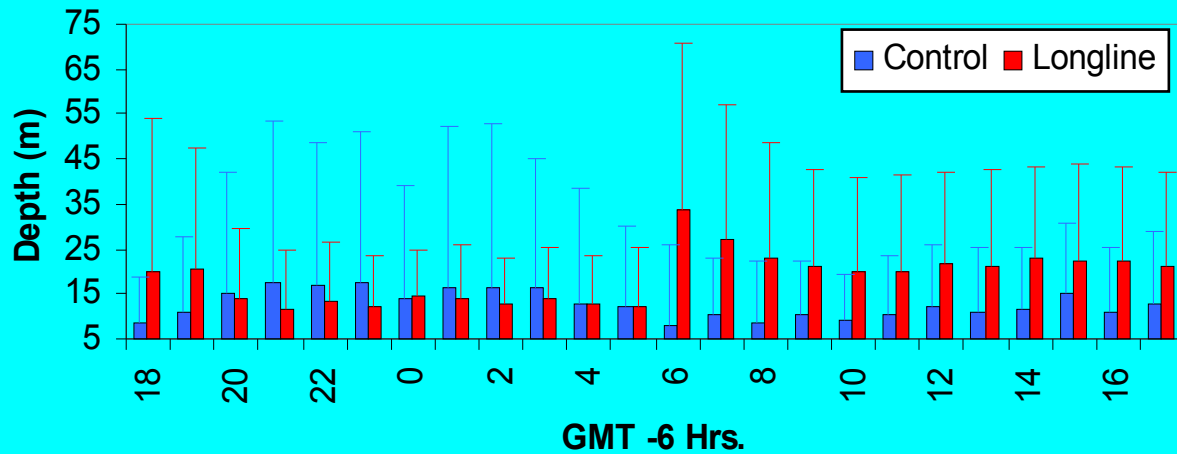


- 90% time turtles' within top 80m
- Turtles more shallow at night.

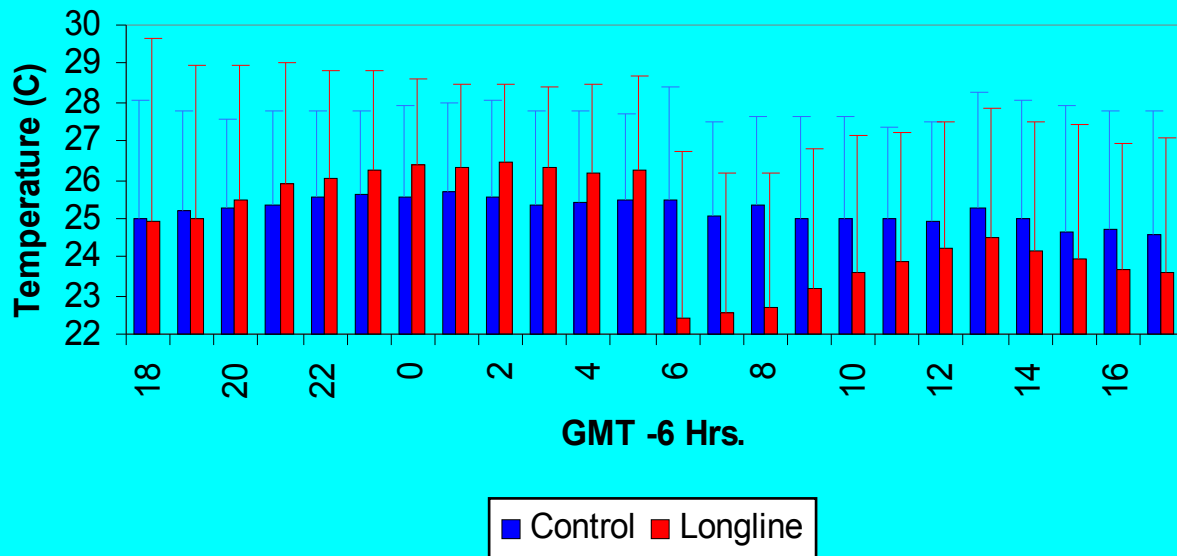


- Longline-caught turtles remain deeper

## Average Hourly Depth



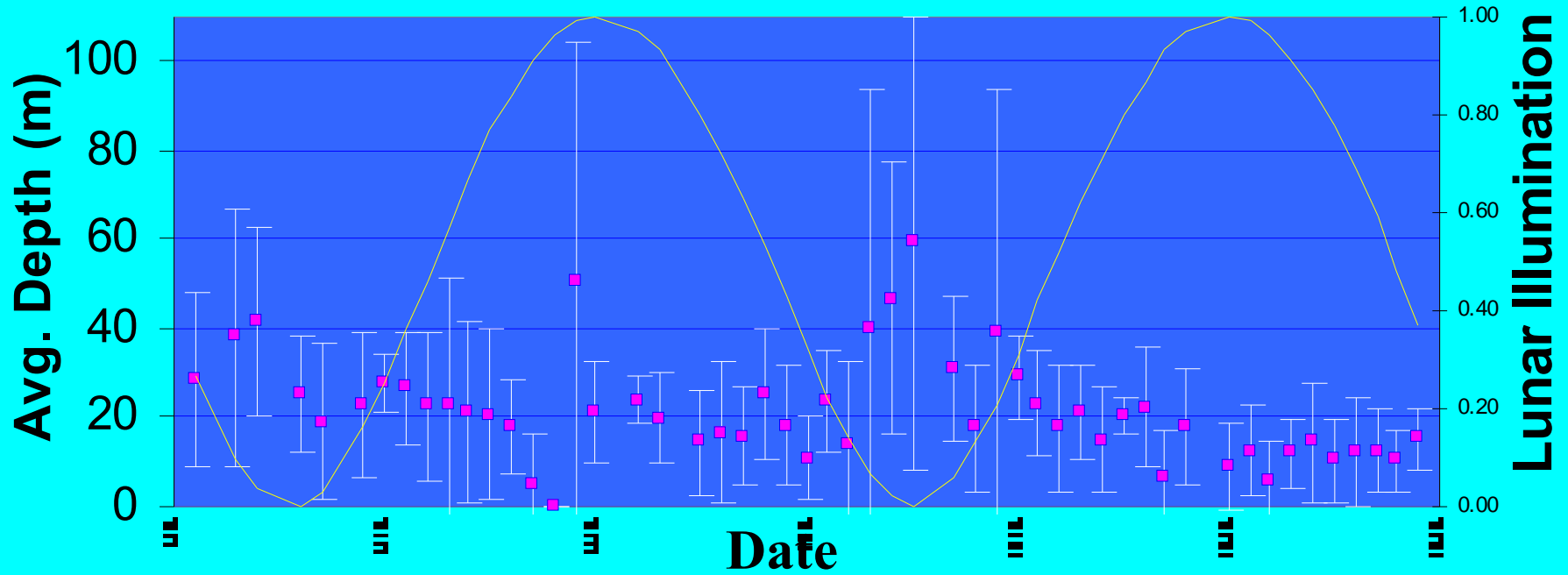
## Average Hourly Temperature



Longline-caught turtles remain deeper and in colder water during the day.

# Night Depths & Lunar Illumination (#29474)

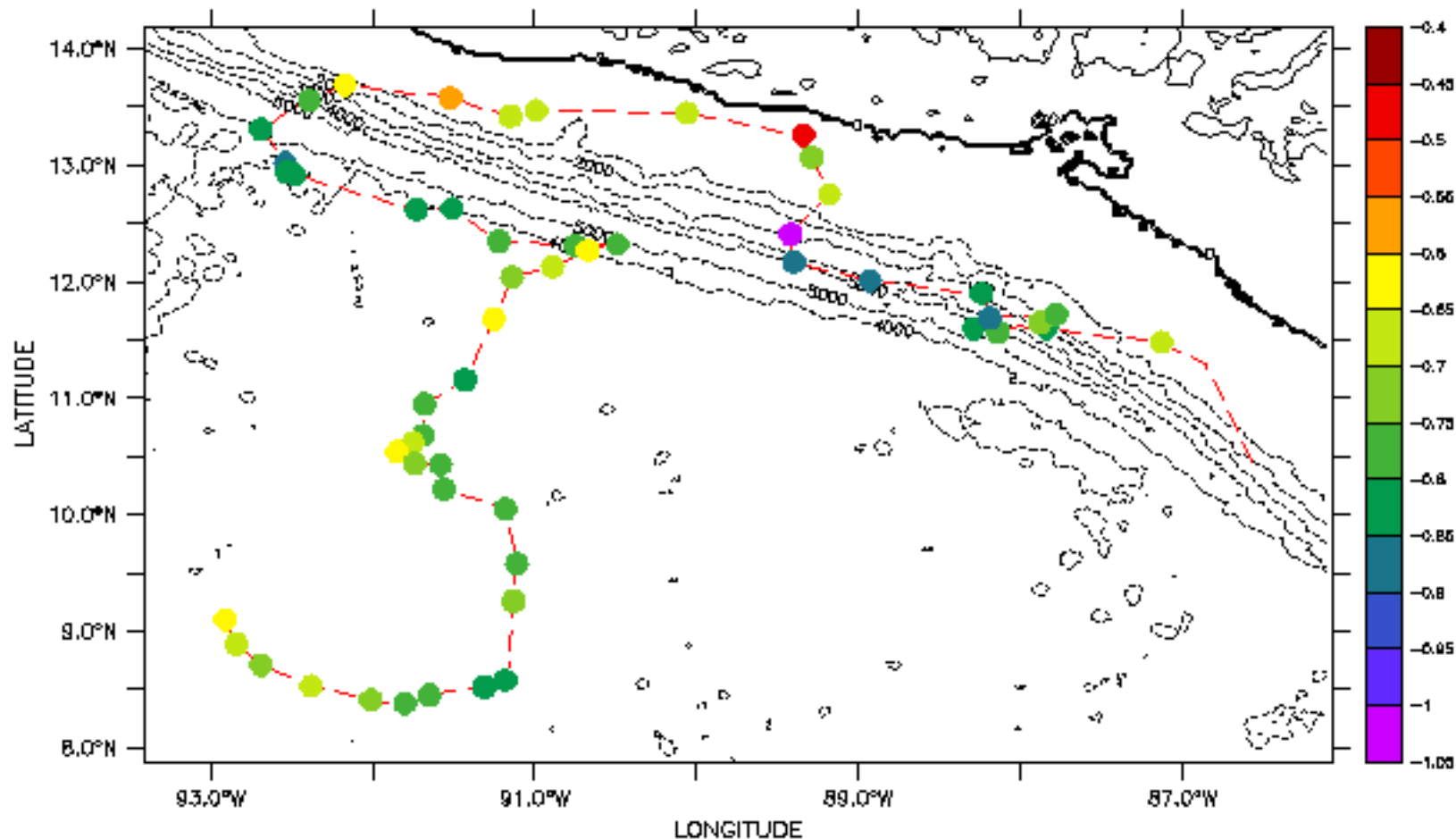
(0=New moon, 1=Full moon;  $r=0.55$ )



# CR-Olive Ridley 13112: Chlorophyll

NOAA/PFEL  FERRET Ver 5.50

29-NOV-2001 00:00 to 27-JAN-2002 00:00



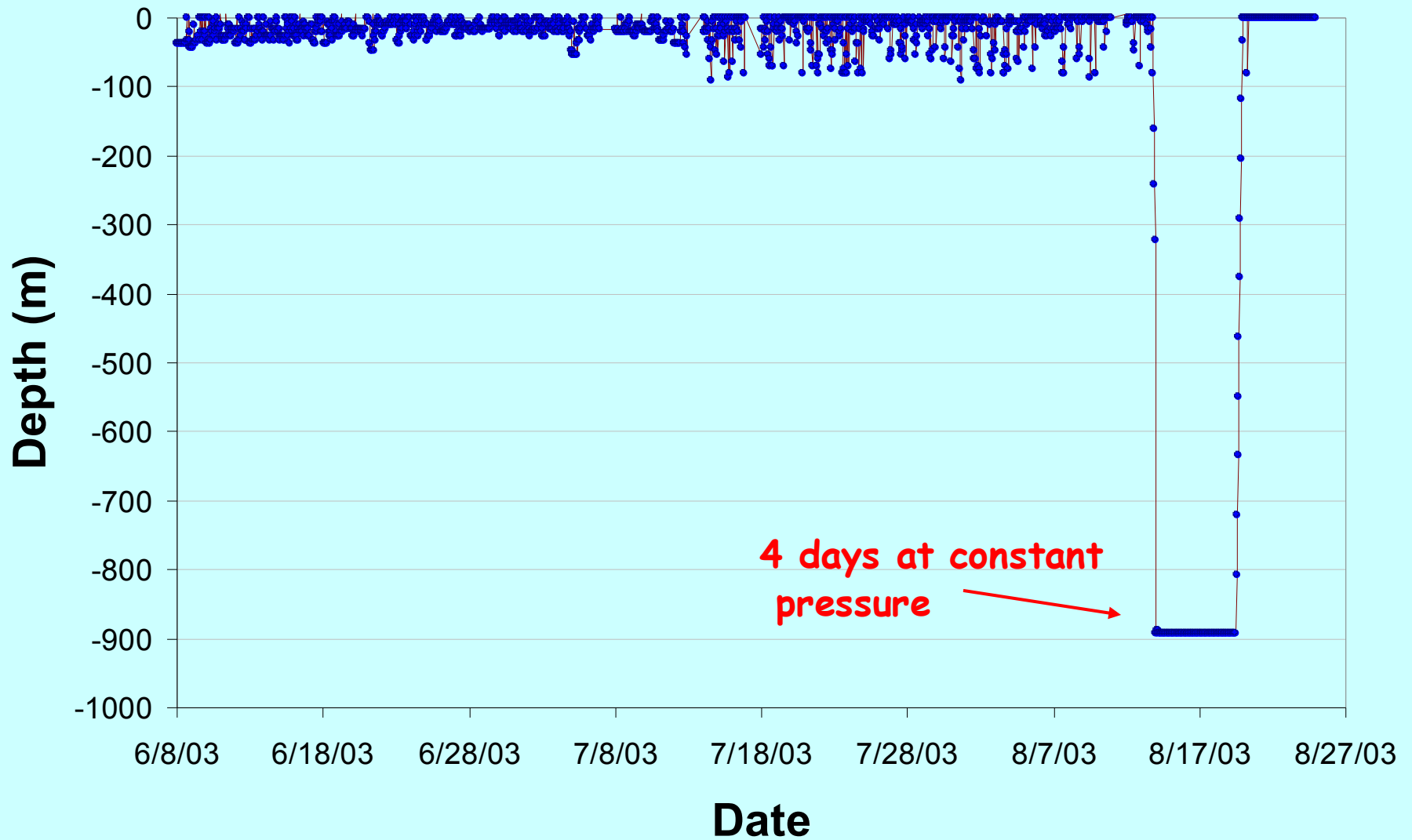
2001\_TNxxxxx2, Chlorophyll a (log, mg m<sup>-3</sup>)

# Survivorship

- Longline-caught olive ridley (8) and loggerhead turtles (4) were tracked from 35-196 days, & no mortalities were confirmed.
- One turtle that was deeply-hooked had the longest track (72 days) for all CR olive ridleys.
- 4 control turtles were successfully tracked from 40-68 days.
- One “control” turtle died.

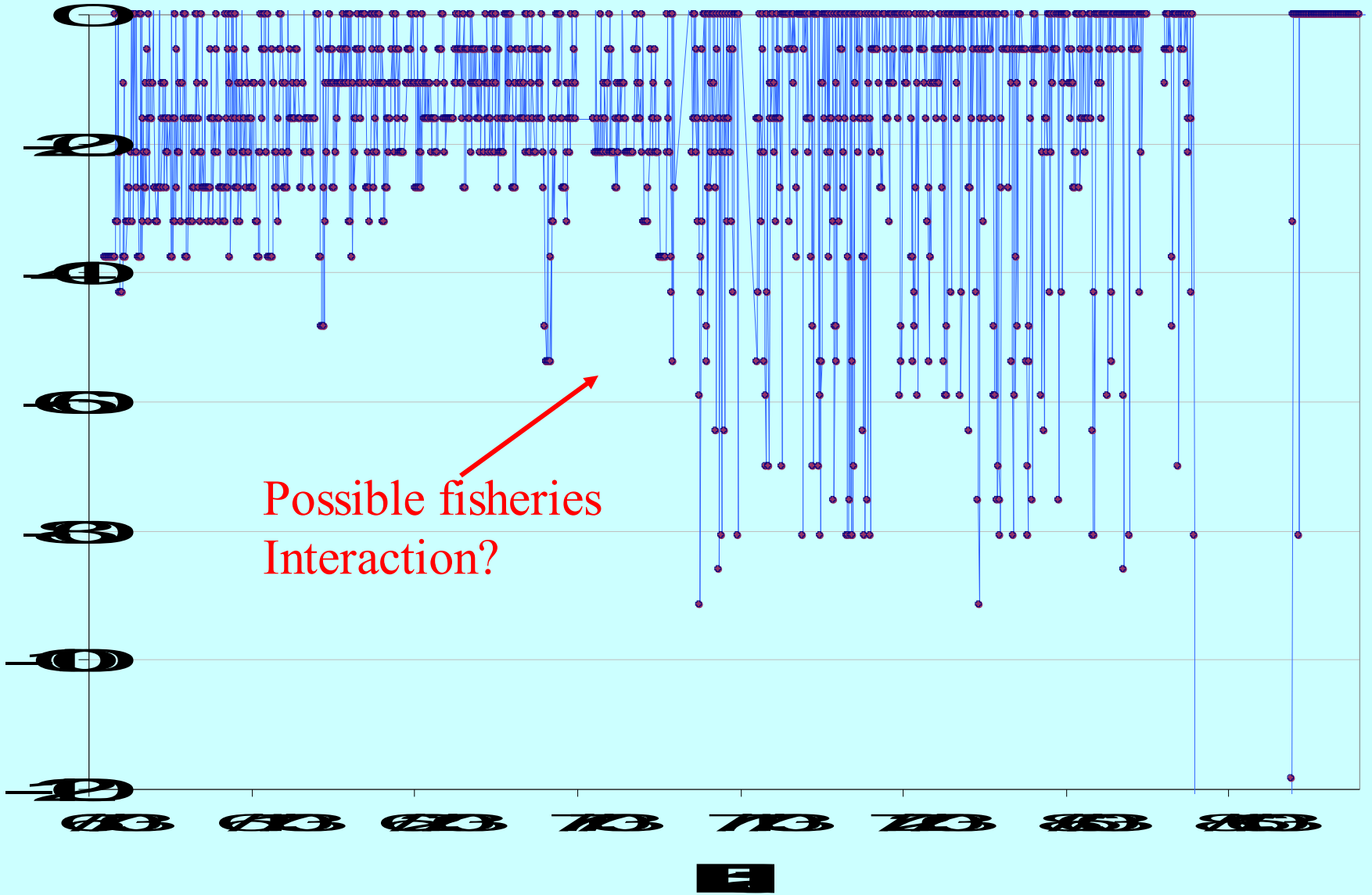


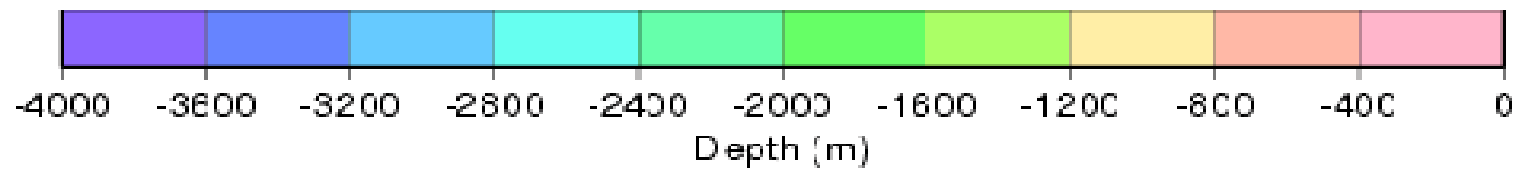
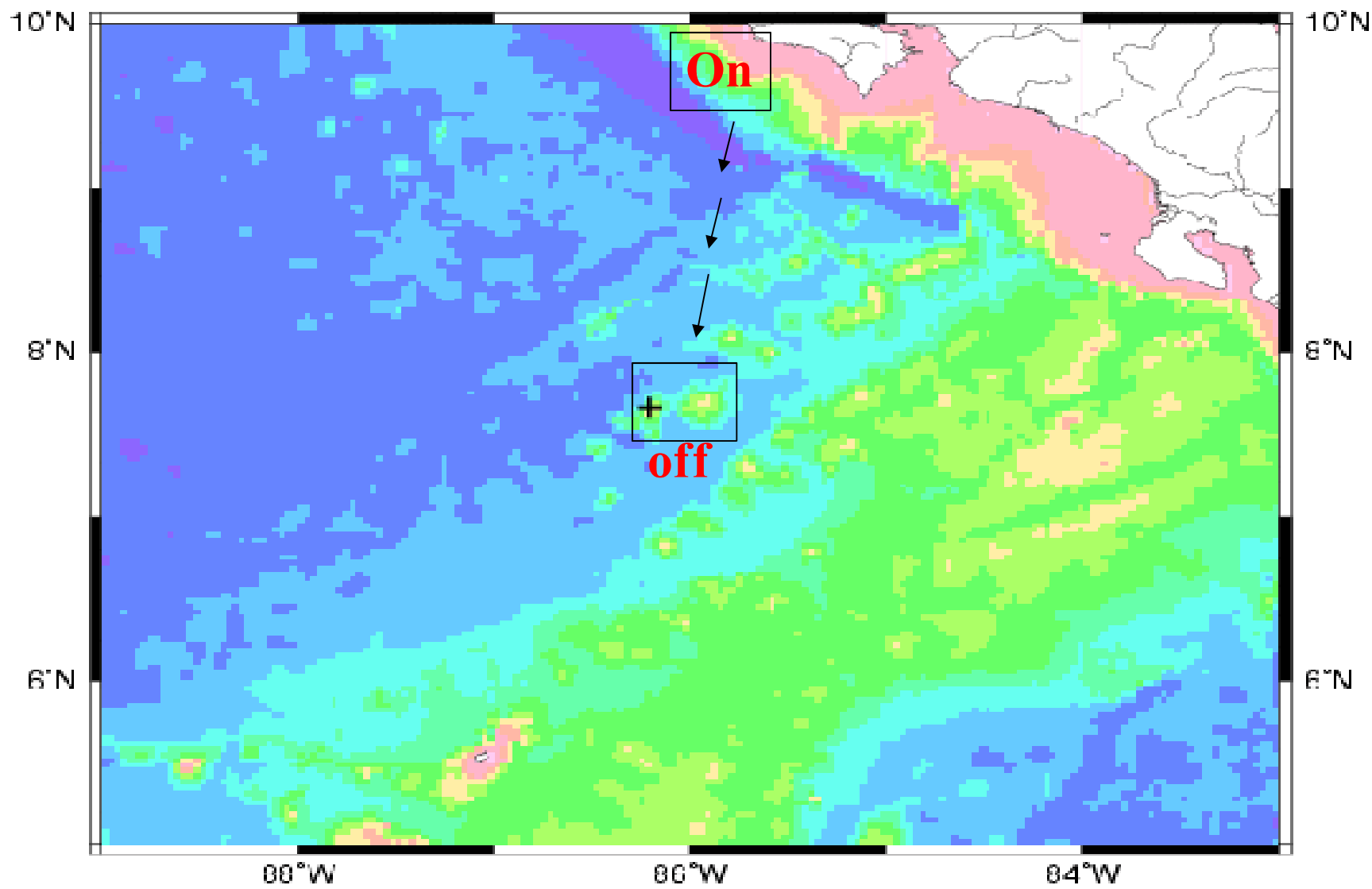
# Depth (m) for Olive Ridley (#38604)





# FORTRAN







#38604



## Drilling method

(based on Epperly et al. 2003)

- Most sea turtles survive longline hooking.
- Multiple interactions could contribute to mortality.
- Turtles released after capture in longline gear have markedly different dive patterns...
- ...that could affect turtles' foraging or reproductive ecology.

# Fishing Experiments on Sea Turtle Bycatch Reduction



- PRETOMA (CR), NMFS, Papagayo Seafoods (CR), Sea Turtle Restoration Program (USA), University of Hawaii.
- Happening Now!
  - Test of blue dyed bait in shallow mahi mahi fishery within the EEZ of Costa Rica

## Why blue bait???



Kemp's ridley,  
loggerhead and green  
turtles avoided blue-  
foods in laboratory  
studies

# Why Costa Rica??

Daytime, shallow fishery



Cooperative Fishers



Olive ridley turtle CPUE  
approx. 7 (per 1,000 hooks)



# Experimental Design

- Two boats fishing within same general area
- 12-16 sets/ boat (1 trip/boat)
- Treated or untreated squid randomly determined
- Ideally, treated and untreated # days equal
- Statistical tests will be done to determine mahi mahi CPUE and turtle BPUE by treatment.

# Acknowledgements

- Funding and facilities provided by the National Marine Fisheries Service and the Pelagic Fisheries Research Program at the University of Hawaii.
- Collaborators include: NMFS observers and observer program, Don Peterson, R. Arauz, STRP, Dave Foley, Keith Bigelow, Lucas Moxey, Mike Laurs (PFEL/NOAA), Marti McCracken.