

New findings on Washington marine mammals and behavioral response of whales to Navy sonar



- New findings with gray whales: Genetics and Western population
- Shifts in species: Harbor porpoise, Bryde's whale, bottlenose dolphin
- Ship strike studies
- Impacts and behavioral response to Navy sonar
- Future work and planned surveys

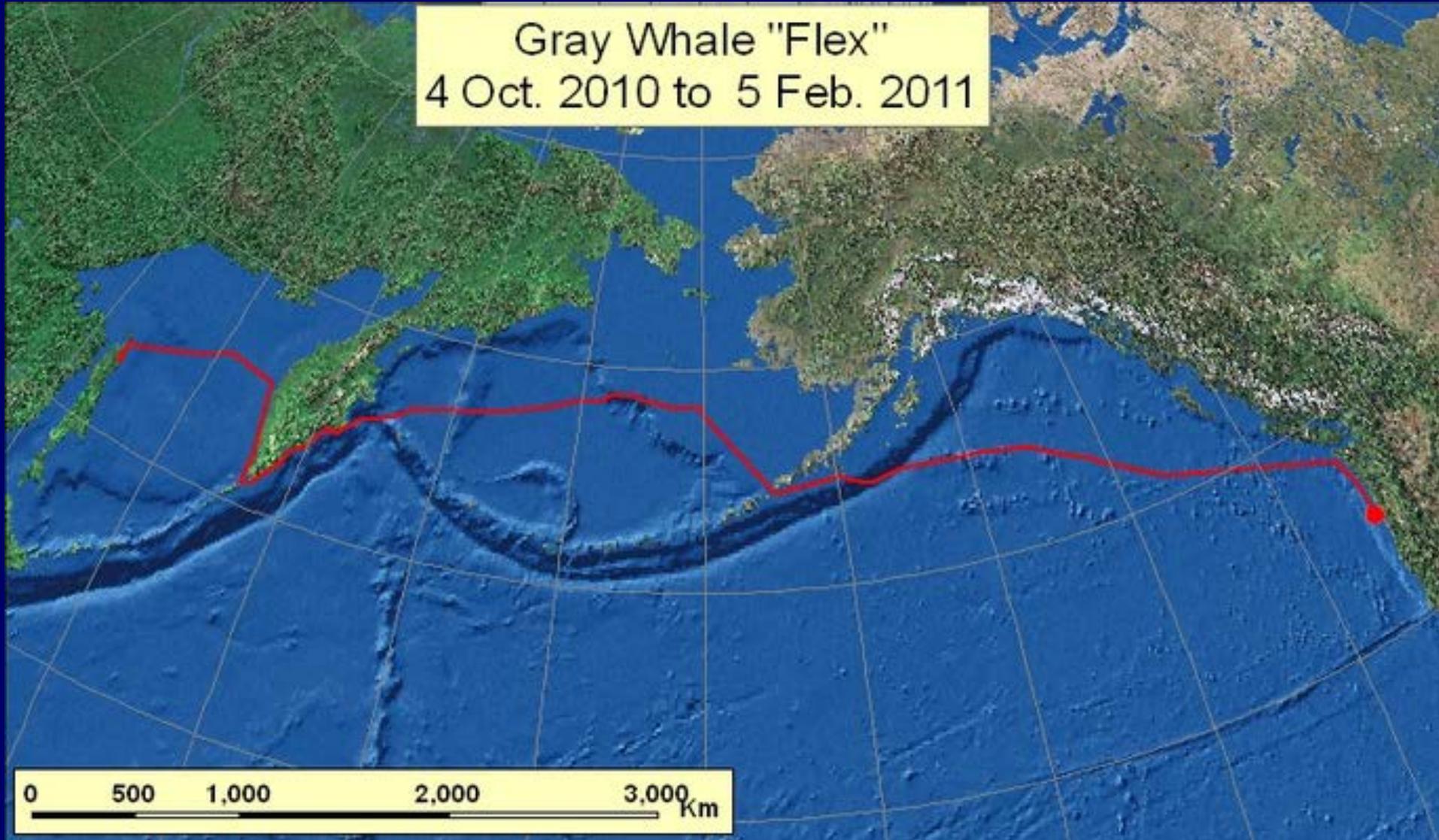
New findings with gray whales



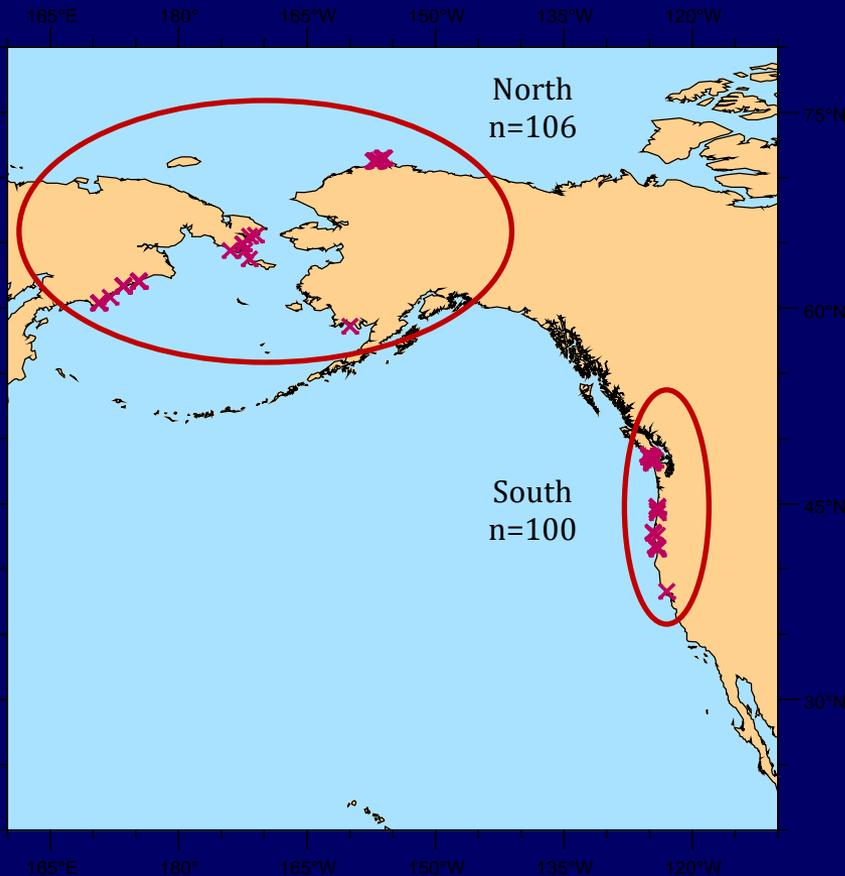
- Status review underway of gray whales by IWC
- New findings on genetic studies of Seasonal Resident whales in the Pacific NW
- Status of Western Gray Whales and relationship to our area
- Updated abundance estimates
- Recent strandings

W Gray Whale movement from OSU satellite tagging

Gray Whale "Flex"
4 Oct. 2010 to 5 Feb. 2011

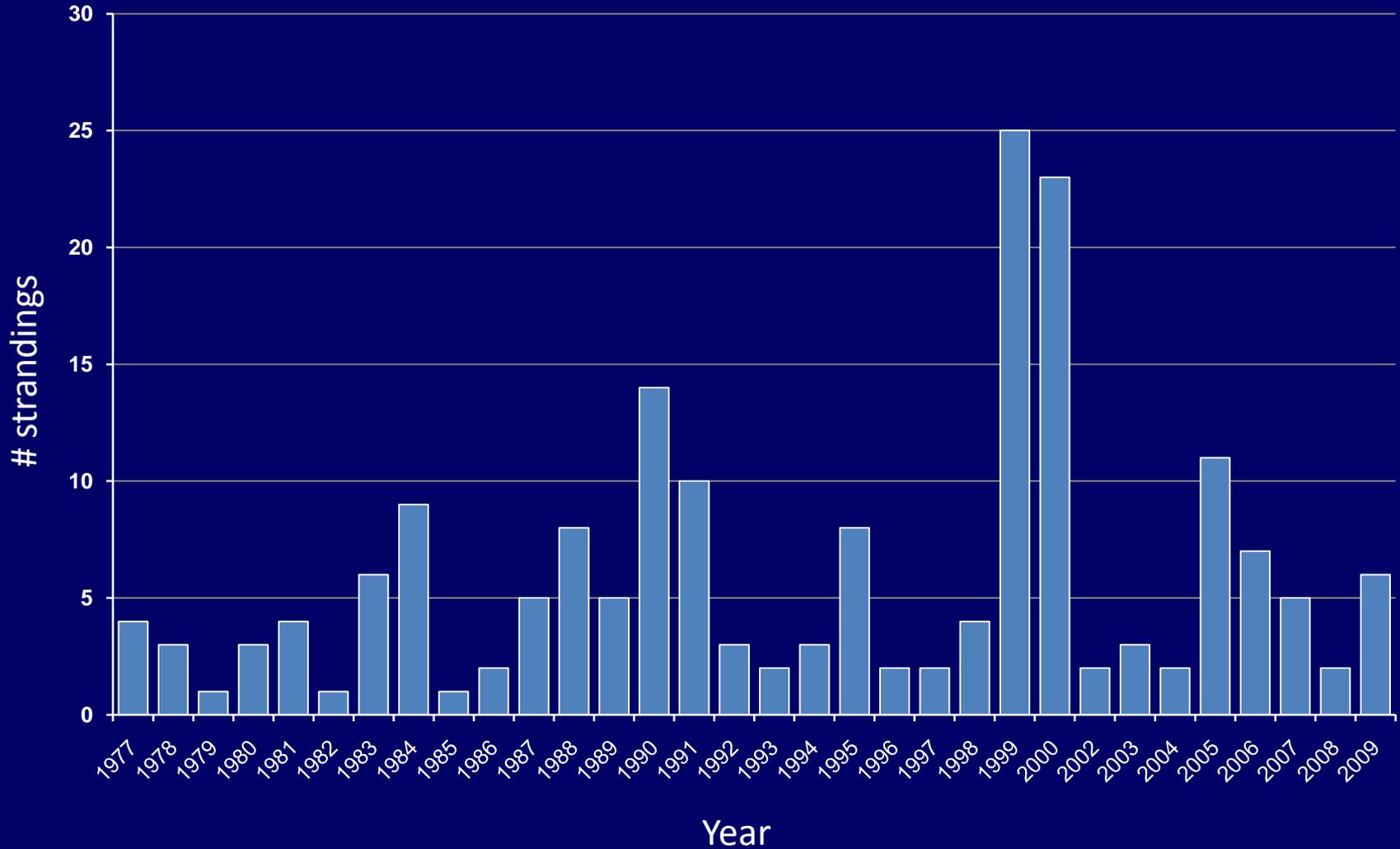


Genetic studies on summer gray whales

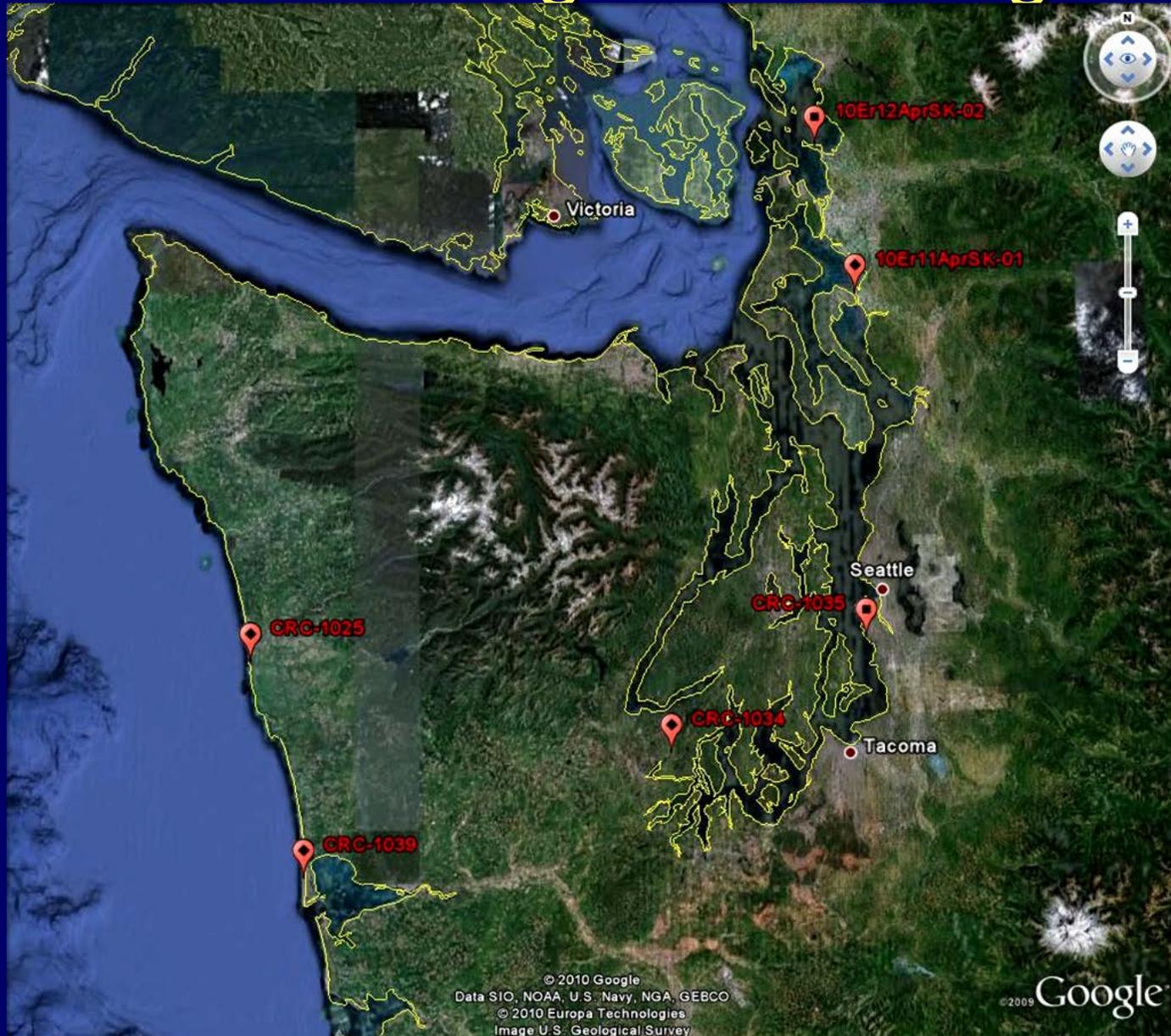


- Study that gray whales in BC feeding in summer were genetically distinct from the larger migratory population
- Follow up study with whales sampled in summer off WA, OR, N CA
- Implications for management including Makah hunt

Gray whale strandings: 1977-2009



Gray whale strandings in Washington, 2010



CRC-1035

Gray Whale, April 14, 2010

- 37 foot male (young adult or juvenile), live stranded and died the same day near Fauntleroy, West Seattle.
- Animal thin, but not terribly emaciated.
- Evidence of possible propeller strike near head, but not fatal.

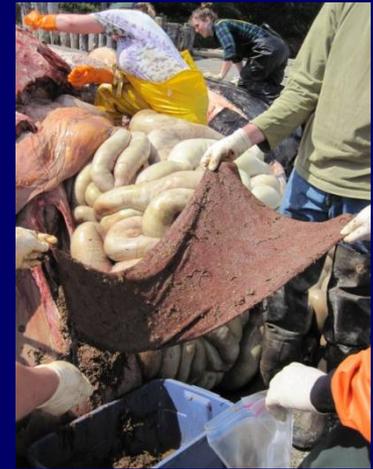


- The only really unusual finding was a substantial amount of trash in the stomach.....

CRC-1035

Gray Whale, Stomach Contents

- 1-2% of stomach contents (3.2lbs) were human debris, including plastic bag material, fabrics (including a leg of sweatpants), fishing line, golf ball, duct tape and a juice pouch.
- 15 oz of the total debris were plastic bag pieces alone.
- Did not cause the death of this animal but may have played a role





Two Bottlenose dolphins in S Puget Sound

1st animal sighted in 4-13 June 2010, dead 18 July 2010

2nd animal seen 15 Dec 2010 – 18 Jan 2011

Only two other known occurrences N of California



CRC-1022

Bryde's Whale, January 16, 2010



- Sightings that did not match any species known to area in early January 2010
- 39 foot juvenile male, found in South Puget Sound on Jan 16th, examination on the 18th
- No evidence of having been brought in by ship
- Thin, dry blubber, no food remains

- Tropical species, usually not seen north of Southern California
- First sighting or stranding ever recorded of this species in the Pacific Northwest



2nd Bryde's
whale 1st
sighted 13
Nov. 2010,
found
dead on 4
Dec 2010



Changes in harbor porpoise

- Concerns about disappearance in some areas and incidental takes in fisheries
- Lack of abundance surveys for 10 years
- Dramatic increase in mortality starting in 2006 in Washington and Oregon
- Return of harbor porpoise to Puget Sound



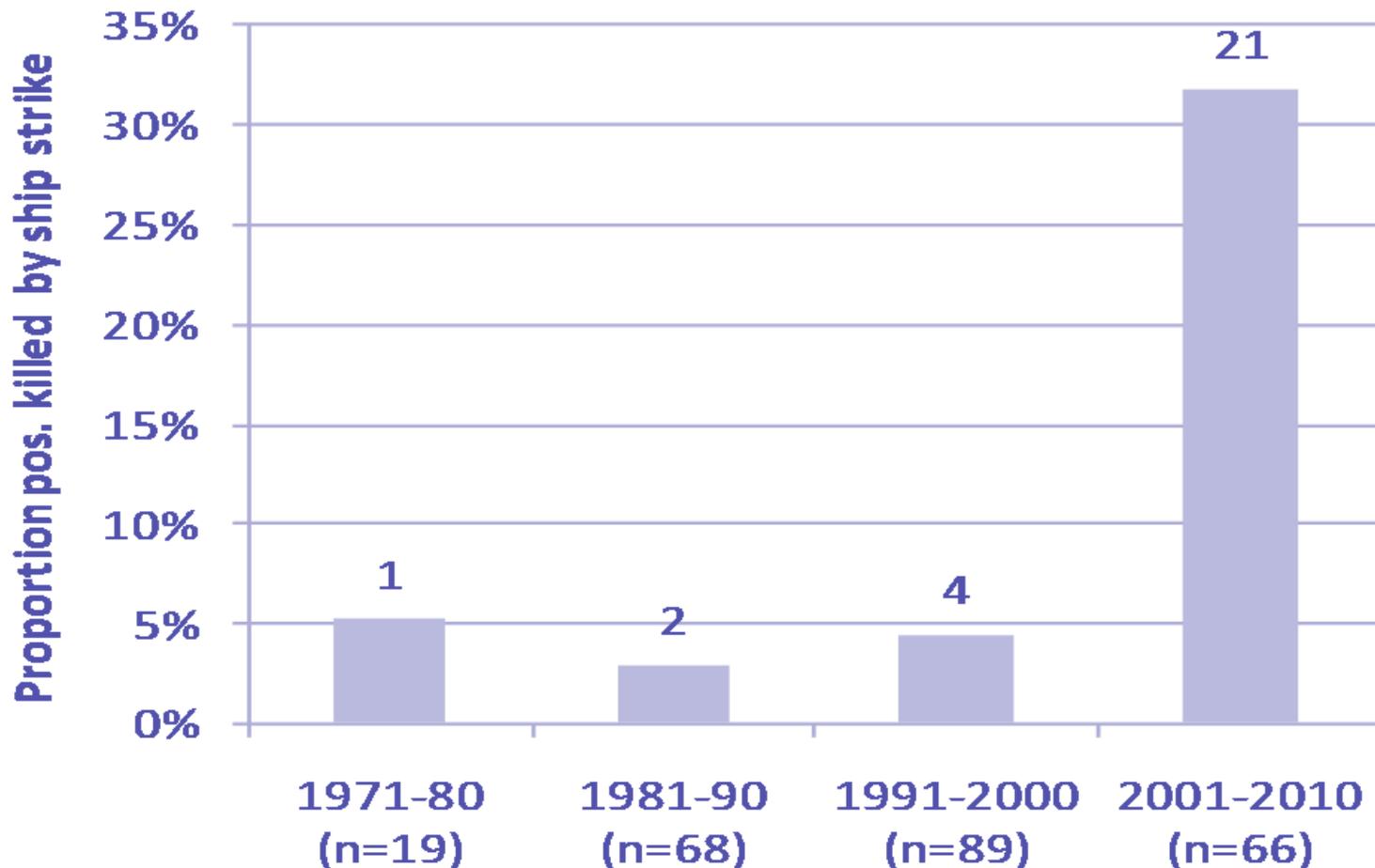
Sperm whale depredation of longline fisheries



Tagging sperm whales to examine how they remove fish from line

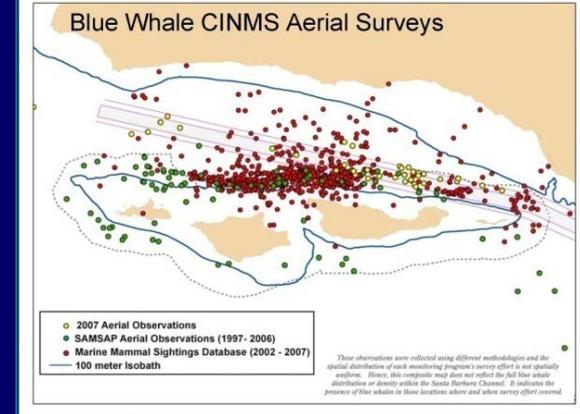
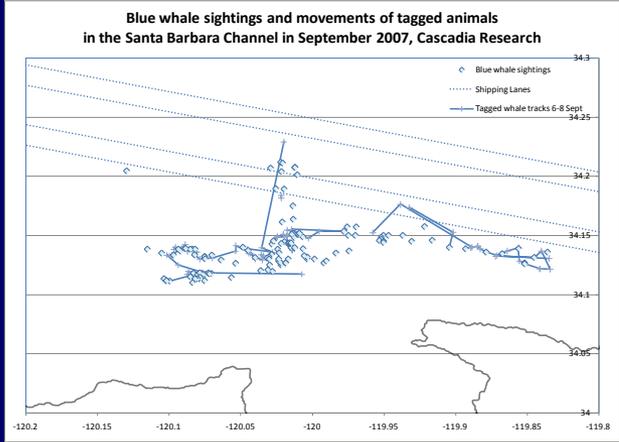


Proportion of whale strandings involving ship strikes in Washington



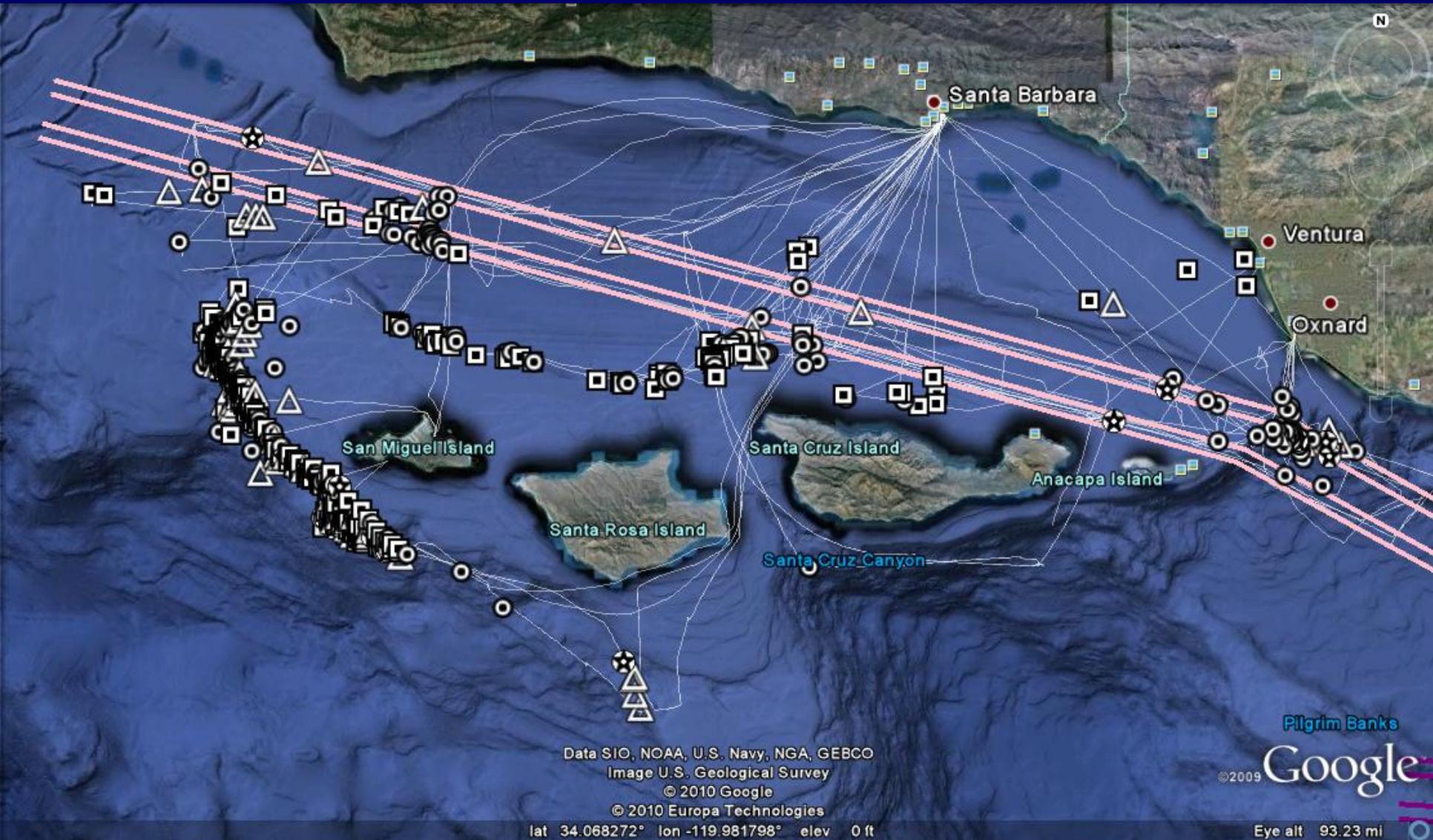
From: Calambokidis, J., J.L. Huggins, A.B. Douglas, D.M. Lambourn, S.J. Jeffries, S.A. Norman, S. Raverty, G. Ylitalo, and B. Norberg. 2010. Temporal changes in whale strandings and human interactions in Washington State. Presentation/Proceedings of the 2010 National Marine Animal Health and Stranding Network Conference, 6-9 April 2010, Shepherdstown, WV.

Blue whale ship strikes Sept-Oct 2007

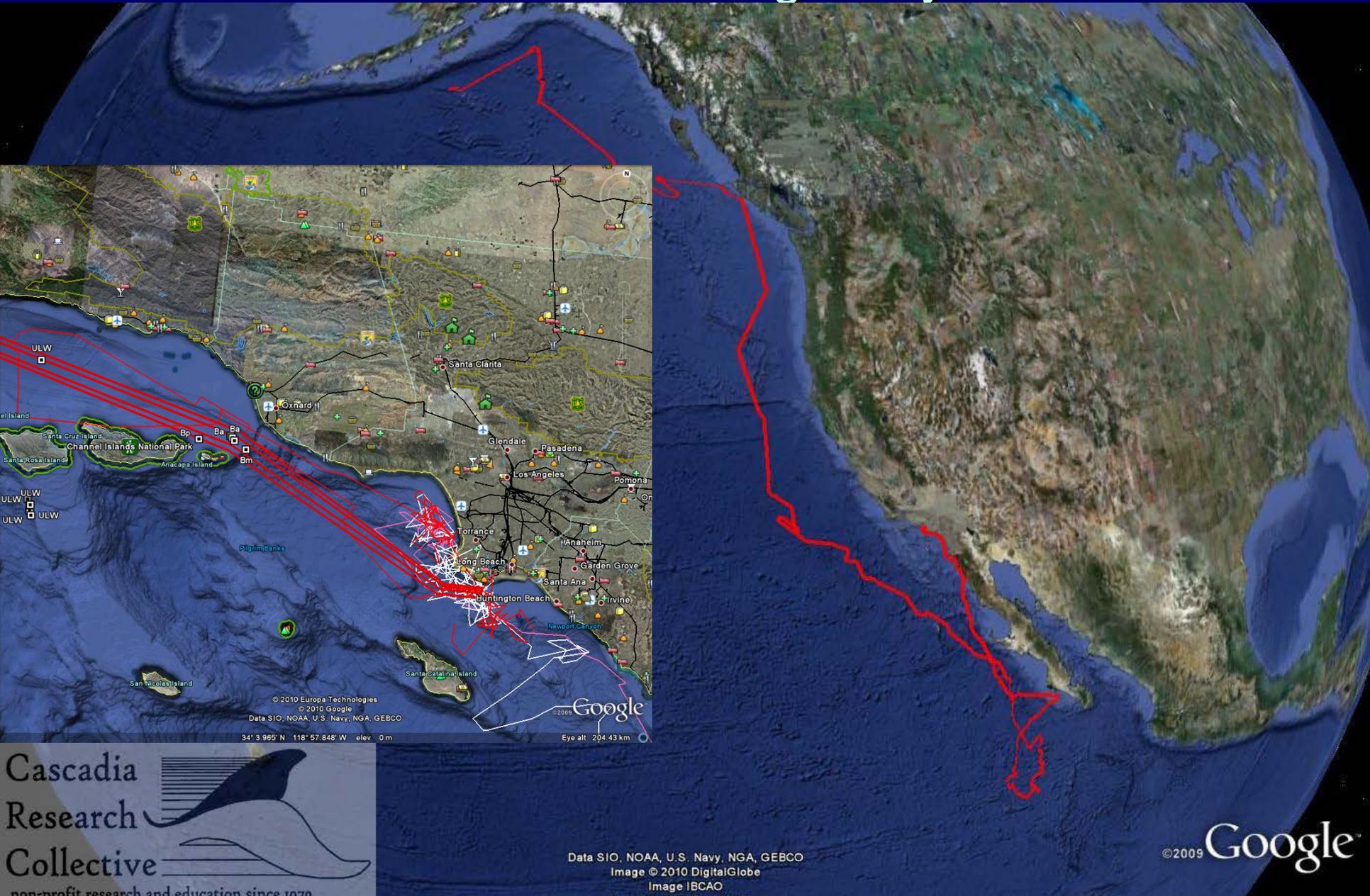


Map courtesy of CINMS (B. Waltenberger)

2009 Sightings by Shearwater and Cascadia RHBs



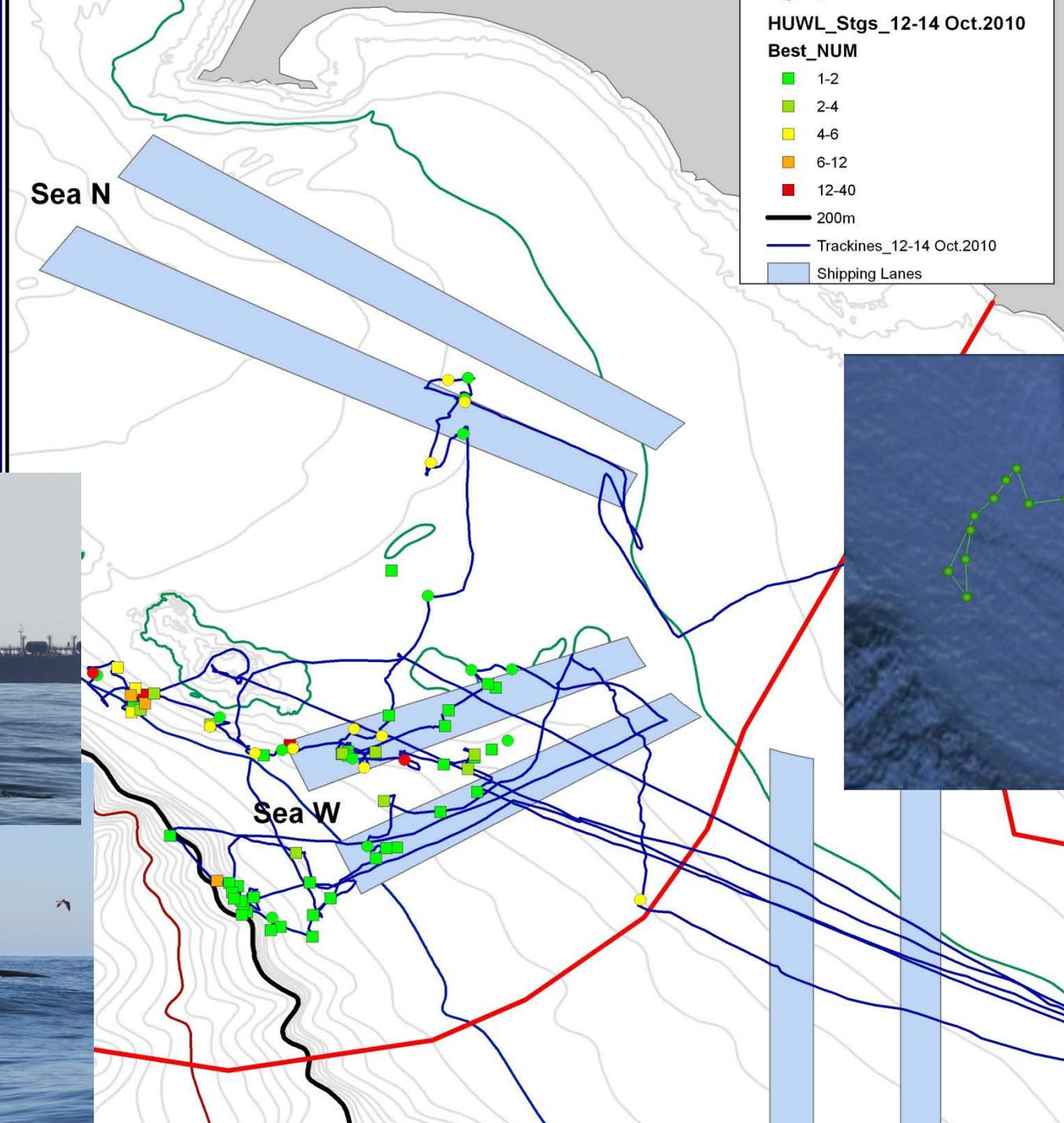
Movement of satellite tagged blue whale November 2009 through May 2010



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image © 2010 DigitalGlobe
Image IBCAO



Humpback and blue whales off SF Bay 12-14 Oct 2010



Methods

- Surveys of shipping lanes and documentation of whales in lanes
- Tracking of ships
- Tag deployments late-2008-2009 near shipping lanes
 - **Bioacoustic Probe:**
 - digital sound, depth, temperature, pitch and roll angle, VHF, & satellite
 - 13 deployments >1 hr, total of 50 hours
 - **Wildlife Computer Mk10:**
 - Fastloc GPS, depth, temperature
 - 10 Mk 10 deployments > 1 hr, 91 hours

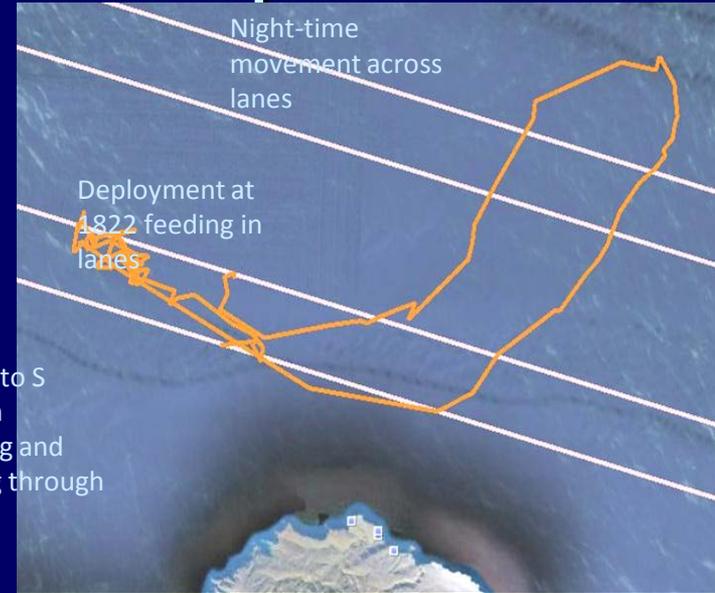


Pair of blue whales in Santa Barbara Channel shipping lanes – 16 August 2008



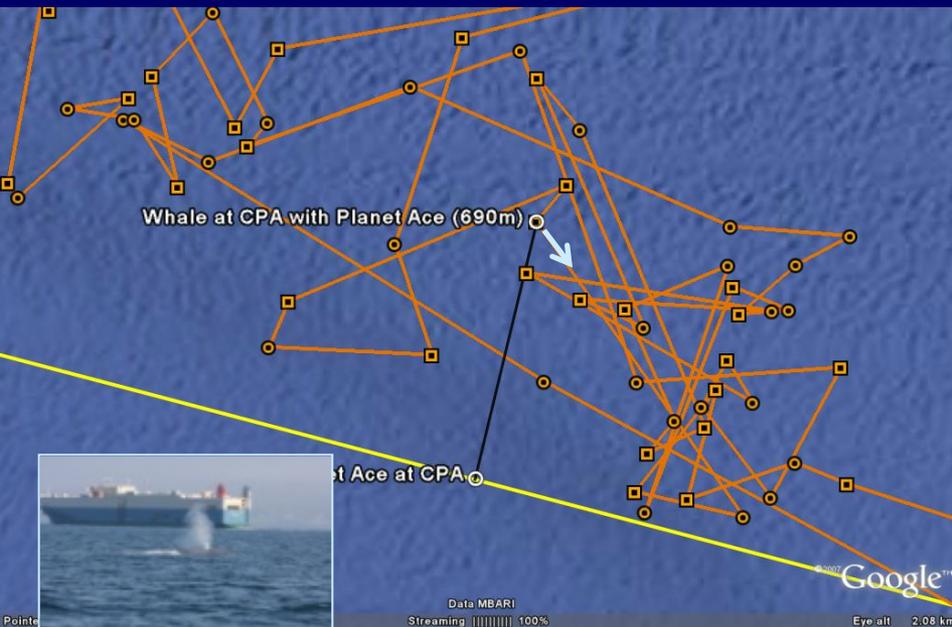
Blue whale reactions to ships

Pair of blue whales in SB Channel shipping lanes – 16 August 2008



Return to S lanes in morning and feeding through day

Planet Ace pass, whales at surface, CPA 690 m



NYK Athena pass, whales at surface w/ variable orient, next surface series across ship track, CPA 197m



Data SIC, NOAA, U.S. Navy, NGA, GEBCO

©2007 Google™

Data MBARI Streaming 100%

Eye alt 2.08 km

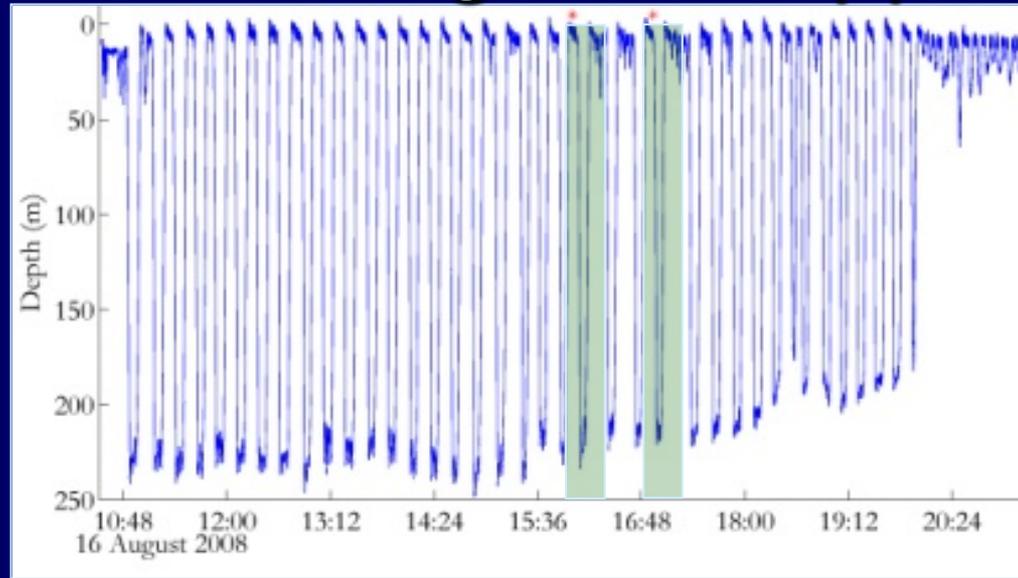
Data MBARI Streaming 100%

Eye alt 1.05 km

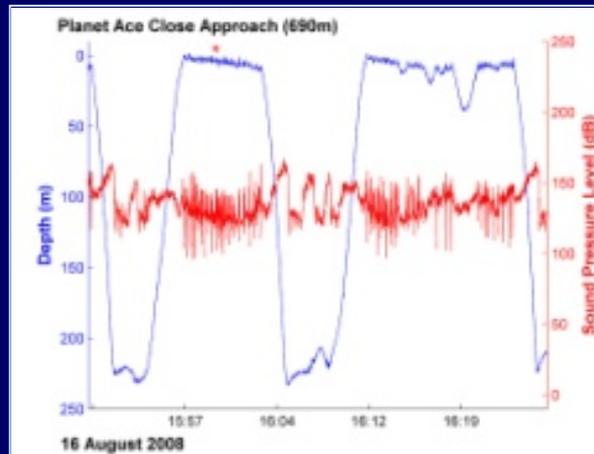
Diving behavior during close approaches



Planet Ace (Vehicle Carrier)
38,394GT
Traveling 17kts



NYK Athena (Container Ship)
75,484GT Traveling
23.1kts

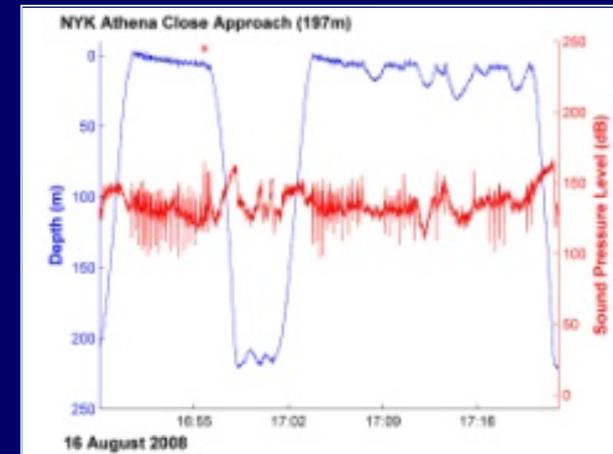


Calculated Received Sound Level

Source level (HARP) = 181 dB re $1\mu\text{Pa}^2$ at 1m

Received Level = $181 - 20 \cdot \log(690\text{m}) = 124 \text{ dB re } 1\mu\text{Pa}^2$

Cannot measure ship noise on tag (flow noise and distance)



Calculated Received Sound Level

Source level (HARP) = 189 dB re $1\mu\text{Pa}^2$ at 1m

Received Level = $189 - 20 \cdot \log(262\text{m}) = 141 \text{ dB re } 1\mu\text{Pa}^2$

**138 dB measure on Tag at 877m

Conclusions – Ship strikes

■ Observation of whales

- Spikes in ship strikes often result of prey/feeding near lanes
- Most close approaches at locations where shipping lanes intersect w/ shelf edge/contour

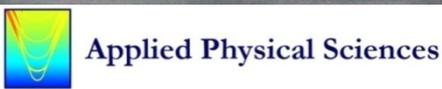
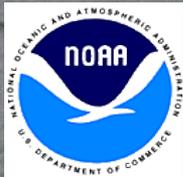
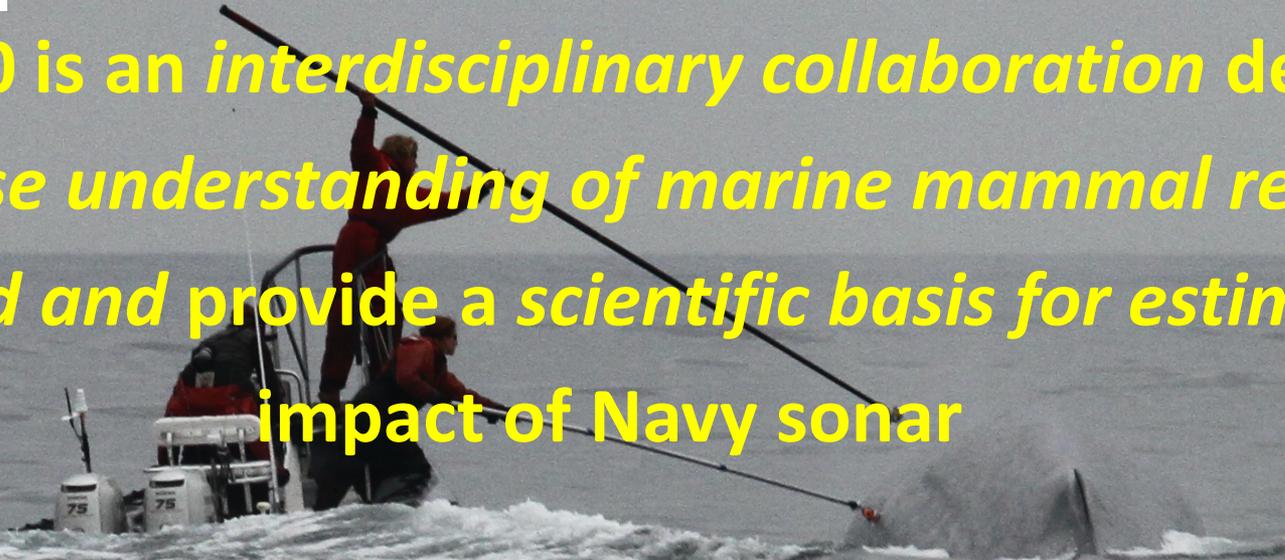
■ Tagging data

- No avoidance of ships on close approach: 3 of 4 closest approached moved toward vessel.
- Increase in surface time immediately after close approach (2 of 4 close approaches).
- Surface time and vulnerability highest at night

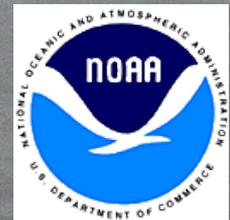


Biological and Behavioral Studies of Marine Mammals in Southern California

SOCAL-10 is an interdisciplinary collaboration designed to increase understanding of marine mammal reactions to sound and provide a scientific basis for estimating impact of Navy sonar



Institute of Marine Sciences
an Organized Research Unit
at UC Santa Cruz



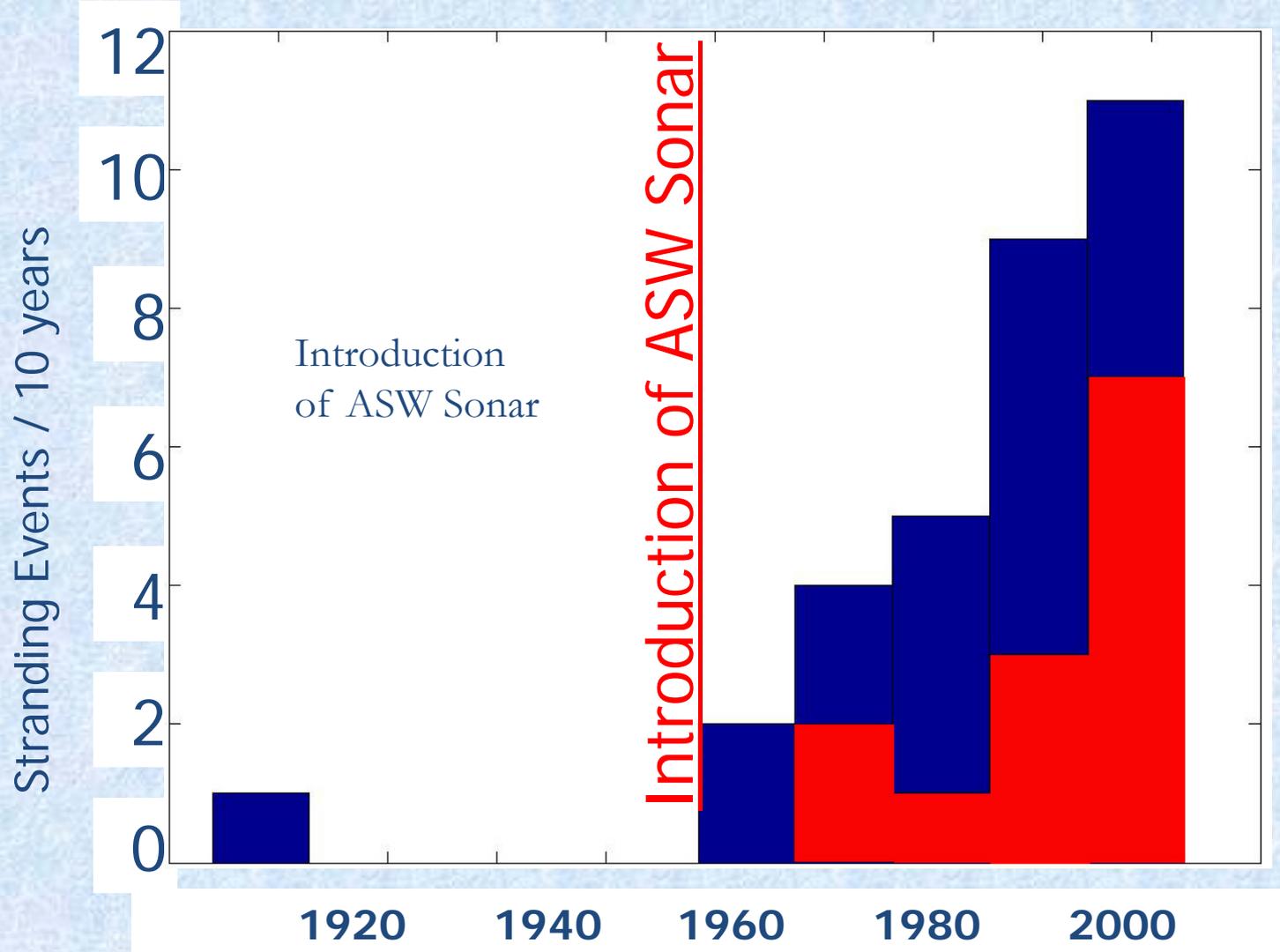
Overview - Marine Mammals and Sonar: *Need for Directed Behavioral Response Studies*



- Strandings coincident with some sonar training exercises in certain circumstances
- Vast scientific uncertainty = divergent speculation on possible adverse impacts
- Numerous scientific and government panels/task forces have called for *behavioral response studies (BRS)*



Multi-Animal Beaked Whale Strandings





SOCAL-10: Objectives

- 1) Tag a variety of species and obtain baseline behavioral data***
 - 2) Conduct controlled exposure experiments (CEEs) using similar methods to previous pioneering studies***
 - 3) Test optimal configuration for subsequent studies, which may include realistic/actual military sources.***
 - 4) Obtain data to support range monitoring/habitat models***
- Provide a scientific basis for estimating risk and minimizing impact of sound to navies and regulators***





SOCAL-10: Overall Approach and Focal Species

Approach: *Extend* previous BRS methods to and *integrate* with ongoing range monitoring and mammal studies in southern CA



Focal Species: Blue, Fin, Beaked, Sperm whales; Various dolphins (Risso's, Common, Bottlenose, White-sided, northern right whale)



SOCAL-10: Timing, Vessels, & Operational Area

TIMING and VESSELS

Scouting Leg: 6 to 18 Aug (*R/V Truth*)

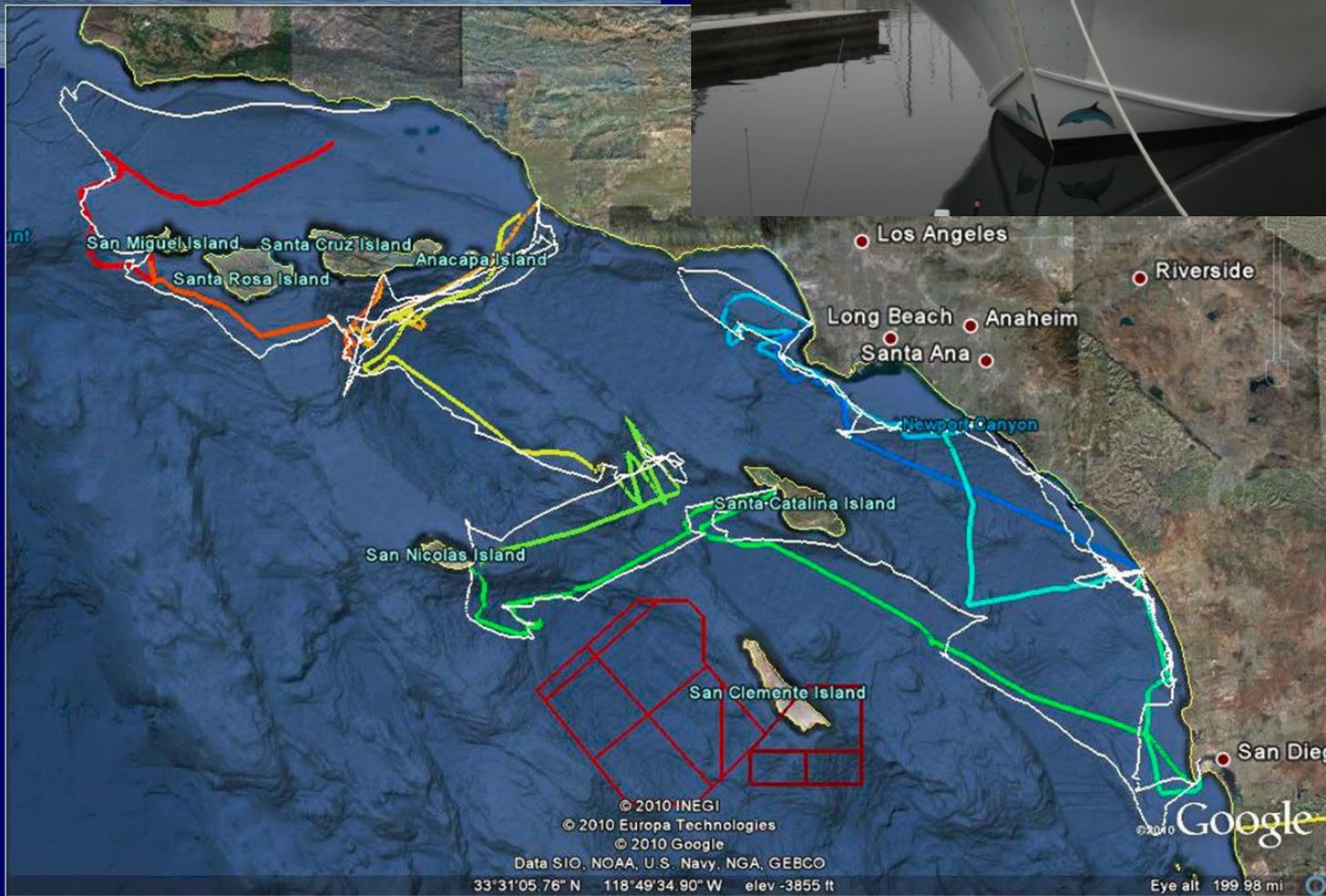
Leg I : 22 Aug to 10 Sept (*R/V Truth*)

Leg II: 21 Sept to 1 Oct (*R/V Sproul*)



Operational Area: Inshore
and Offshore waters from
Morro Bay to San Diego





120°00'W

119°00'W

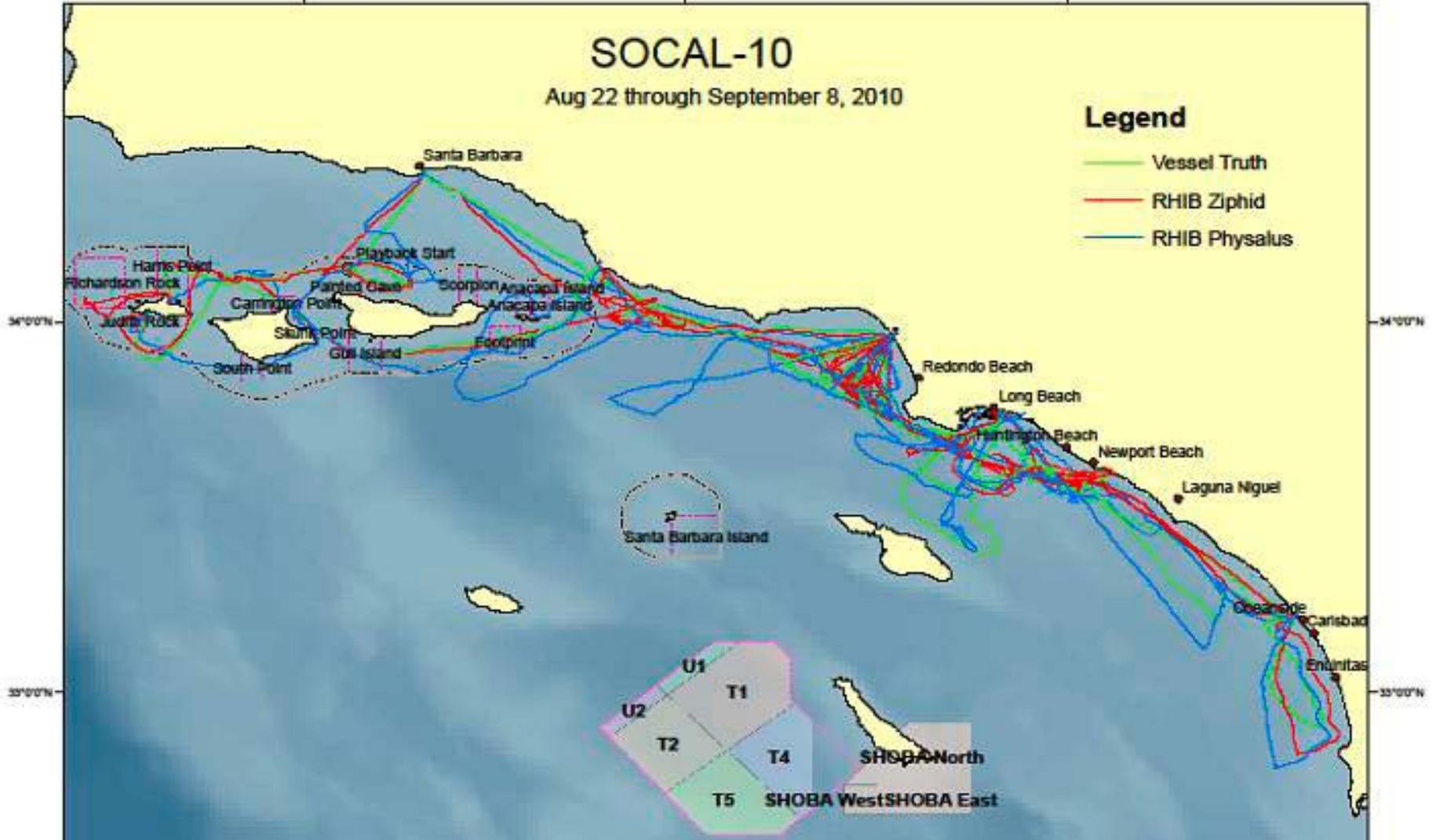
118°00'W

SOCAL-10

Aug 22 through September 8, 2010

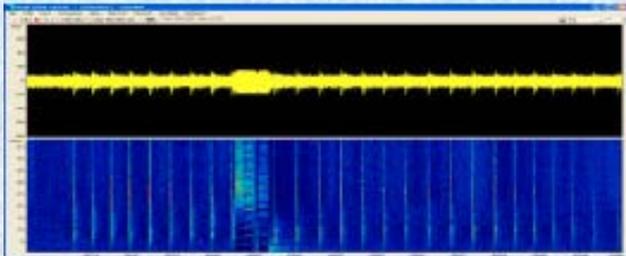
Legend

- Vessel Truth
- RHB Ziphid
- RHB Physalus





SOCAL-10: Multidisciplinary Approach



Passive acoustic observers used listening sensors to detect animals and monitor exposures and responses

SOCAL-10 sound source was custom-built, relatively light, vertical array (up to 210 dB)



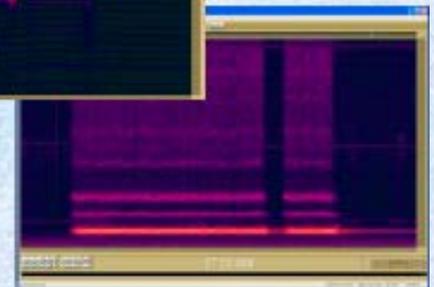
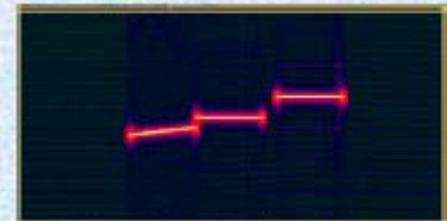
CEE signal types:



Simulated mid-freq (MFA) sonar



Pseudo-random noise (PRN)

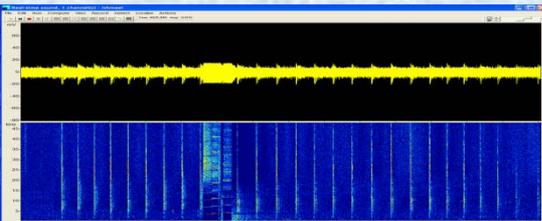


SOCAL-10: Multidisciplinary Approach



Visual observers, experienced in sighting marine mammals miles away with powerful binoculars, search for subjects and monitor during tagging, controlled exposure experiments (CEEs).

Photo identification will be used to catalog and keep track of individuals (incl. long-term) and groups sighted and involved in CEEs.



Passive acoustic observers will use different listening systems, in certain conditions, from the U.S. Navy SCORE range as well as those deployed from SOCAL-10 vessels to detect vocalizing whales and monitor exposures and responses during CEEs



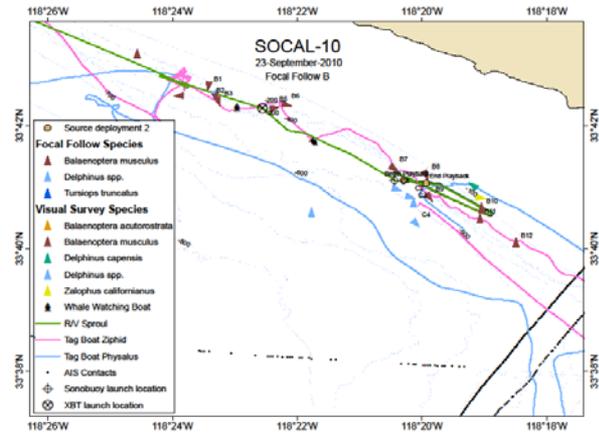
SOCAL-10: Multidisciplinary Approach



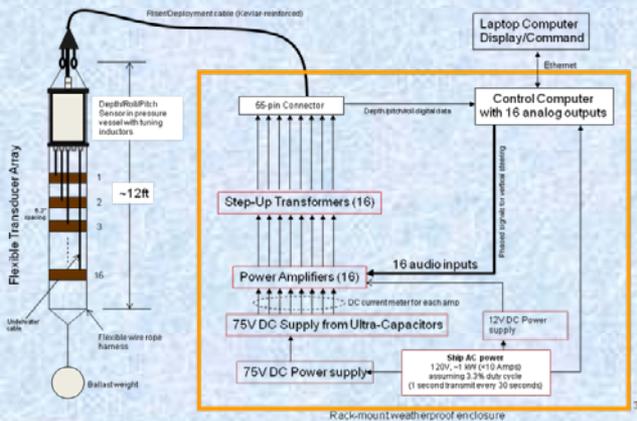
Photo taken under U.S. NMFS permit # 14534

Tagging teams carefully approached animals and deployed acoustic monitoring tags (Dtag, Bprobe/AcouSonde) with suction cups; provided visual monitoring during CEEs

Geographical Information Systems (GIS) engineers integrated vessel position, visual sightings, and environmental data, for operational awareness/archive of SOCAL-10



SOCAL10 BRS Acoustic Source Layout



SOCAL-10 sound source was custom-built light package to produce up to 210 dB re: 1uPa (Actual 53C sonar closer to 235 dB) in controlled sound exposures:

- Simulated mid-frequency active (MFA) sonar
- Pseudo-random noise (PRN)

Suction cup attached tags deployed

■ WHOI Dtag

- Acoustics, accelerometer, magnetometer, and depth

■ Bill Burgess Bioacoustic Probe and new Acousonde

- digital sound, depth, temperature, pitch and roll angle

■ Wildlife Computer Mk10

- GPS, depth, temperature

 **TECHNICAL APPROACH** 
Equipment

DTAG – Sound and Orientation Recording Tag

- 192 kHz audio sampling rate, stereo hydrophones, 16 bit
- pitch, roll, heading and depth sampled at 50 Hz
- 6.6 GByte of memory
- loss-less audio compression



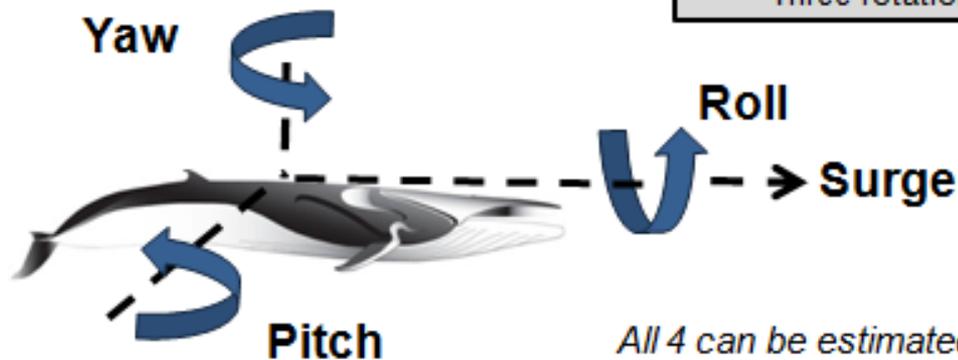


Photo: ULL



Four kinematic degrees of freedom

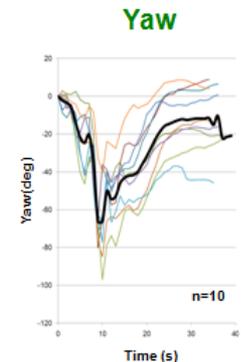
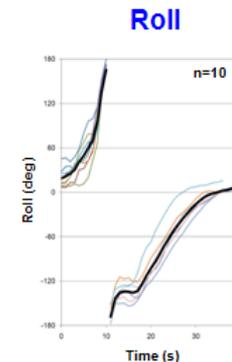
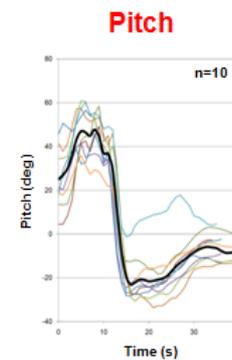
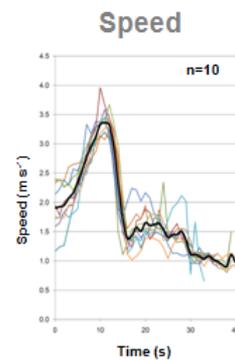
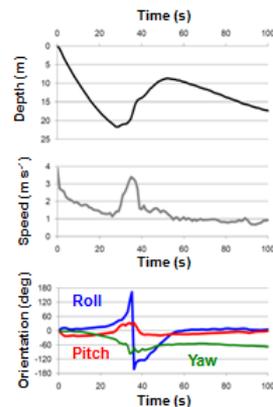
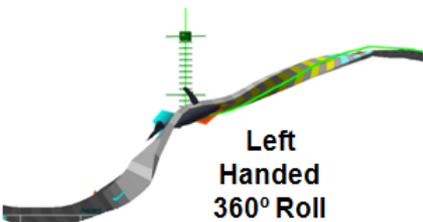
One translational components: surge
Three rotational components: roll, pitch, yaw



All 4 can be estimated from current tag technology:
roll, pitch, yaw, surge (speed)

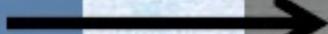
Quantifying complex maneuvers:

Tag: DTAG
Maneuver: 360° roll during lunges
Data: pitch, roll, yaw, speed
Stimulus: None





SOCAL-10: CEE Procedure



Photos taken under U.S. NMFS permit # 14534



SOCAL-10 ACCOMPLISHMENTS: TAG DEPLOYMENTS

Scouting/LEG I Summary: 55 tags of five different types on 37 individuals of seven marine mammal species

30 Days	Blue Whales:	25 total individuals (21 Dtags; 9 Bprobes; 7 MK-10s)
	Fin whales:	7 total individuals (7 Dtags; 1 Bprobes)
	Sperm whale:	One individual (2 Dtags; 2 MK-10)
	Baird's Beaked whale:	One individual (satellite tag)
	Sei whale:	One individual (satellite tag)
	Bottlenose dolphin:	One individual (Dummy Dtag with TDR - 3 minutes)
	Killer whale:	One individual (satellite tag)

LEG II Tag Summary: 7 tags of two different types on 7 individuals of four marine mammal species

10 Days	Blue Whales:	3 total individuals (2 Dtags; 1 ACOUSONDE)
	Rissos dolphins:	2 total individuals (2 Dtags)
	Bottlenose dolphin:	One individual (Dtag - 0.5 min)
	Cuvier's Beaked Whale	One individual (Dtag)

SOCAL-10 TOTAL Tag Summary:

62 tags (6 types) on 44 individuals of 9 marine mammal species



SOCAL-10 ACCOMPLISHMENTS: Controlled Exposure Experiments

**Blue
Whales:
19**

**Fin
Whales:
5**

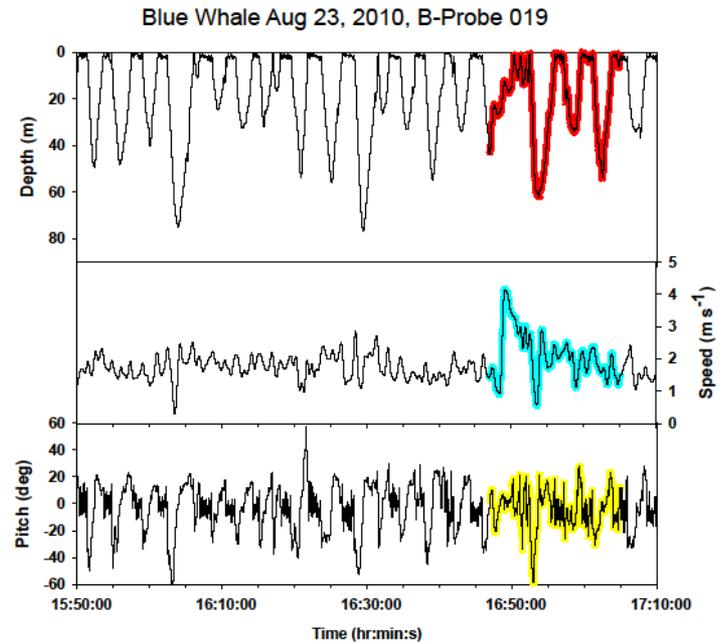
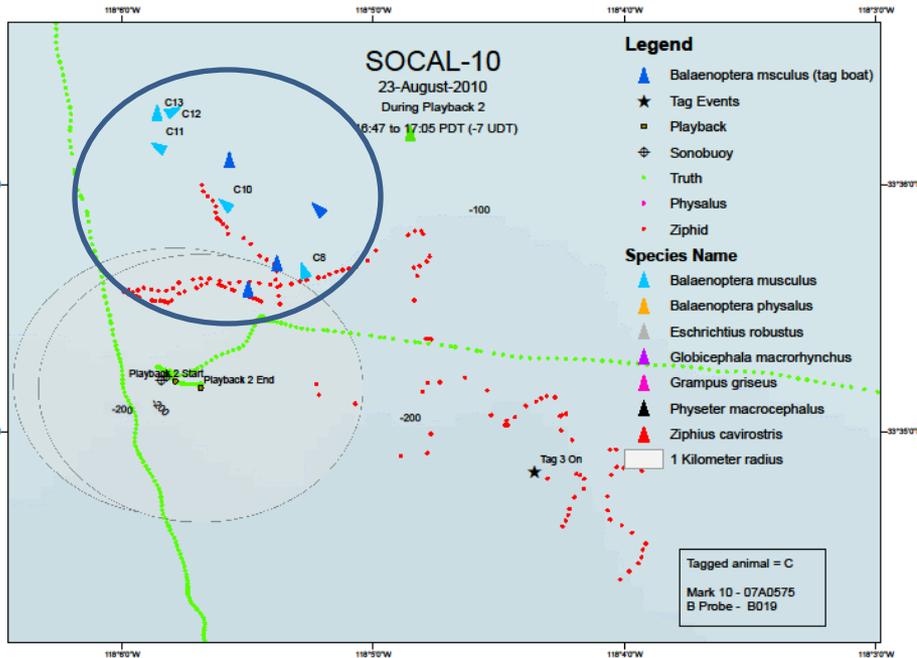
**Sperm
Whale:
2**

**Risso's
Dolphin:
1**

**Cuvier's
beaked
whale:
1**

**28 Complete CEEs
3 Mock Exposure (Control)
31 TOTAL SEQUENCES**

Blue whale CEE (PRN) – Deep Feeding

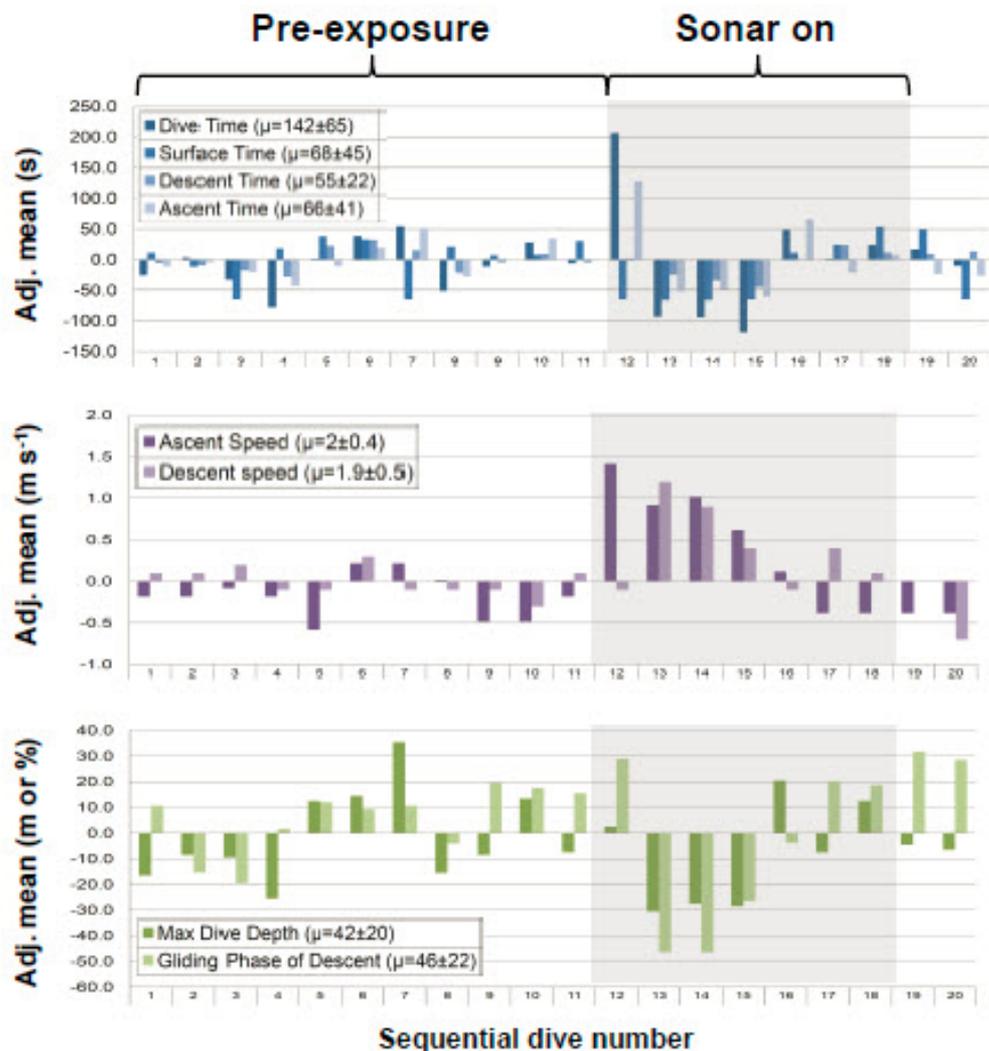
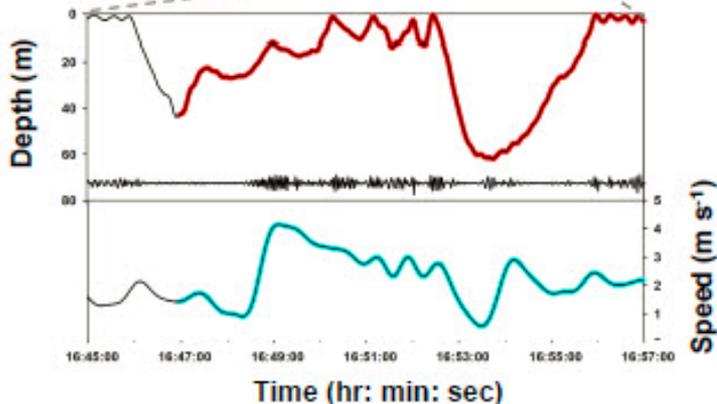
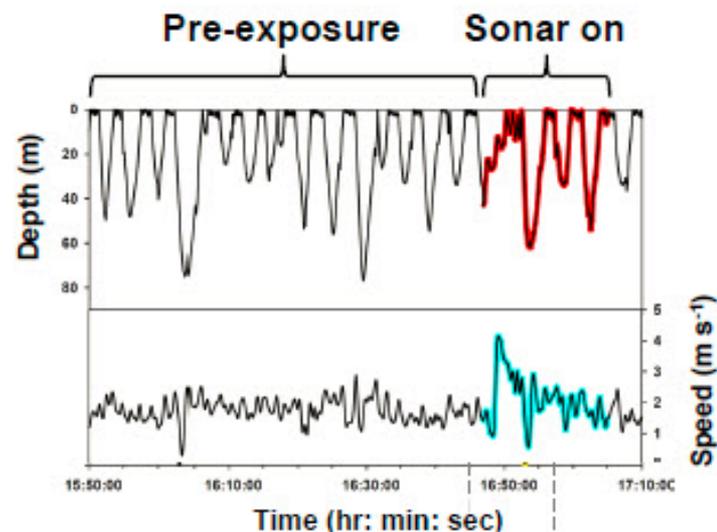


Behavioral response to simulated sonar

Tag: Bioacoustic Probe

Data: basic dive parameters and speed

Stimulus: MFA sonar



Sperm whale

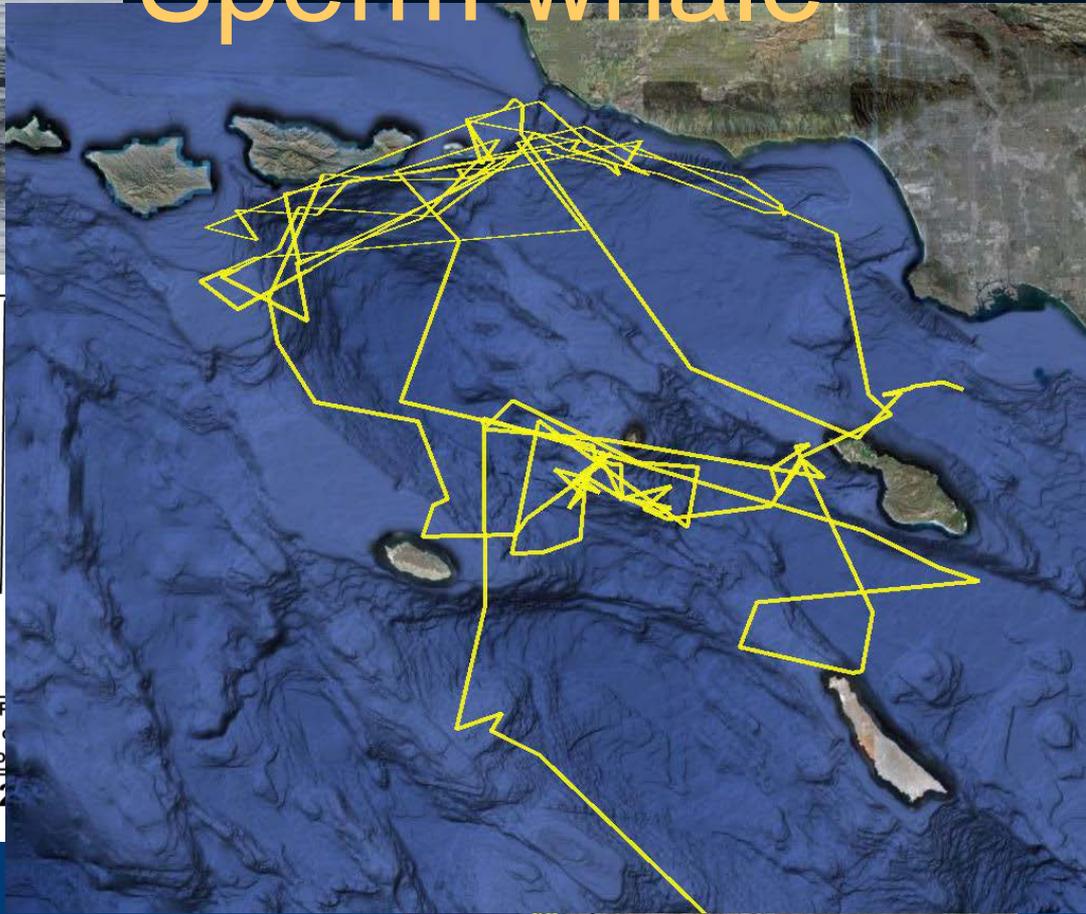
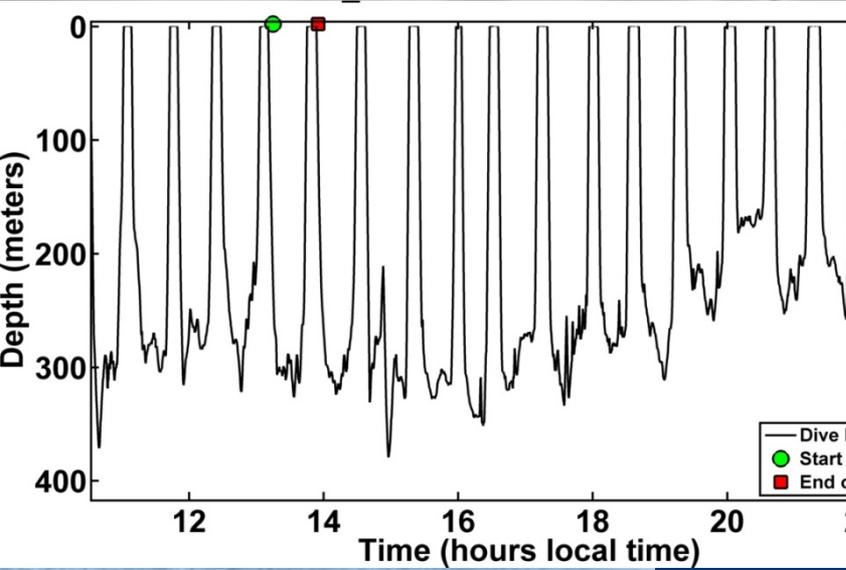


Photo from 2010 BRS

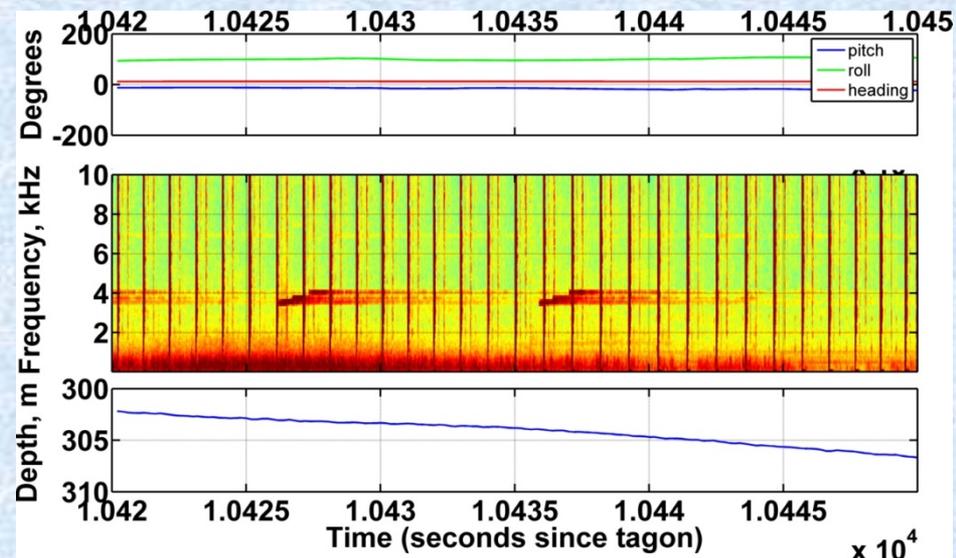
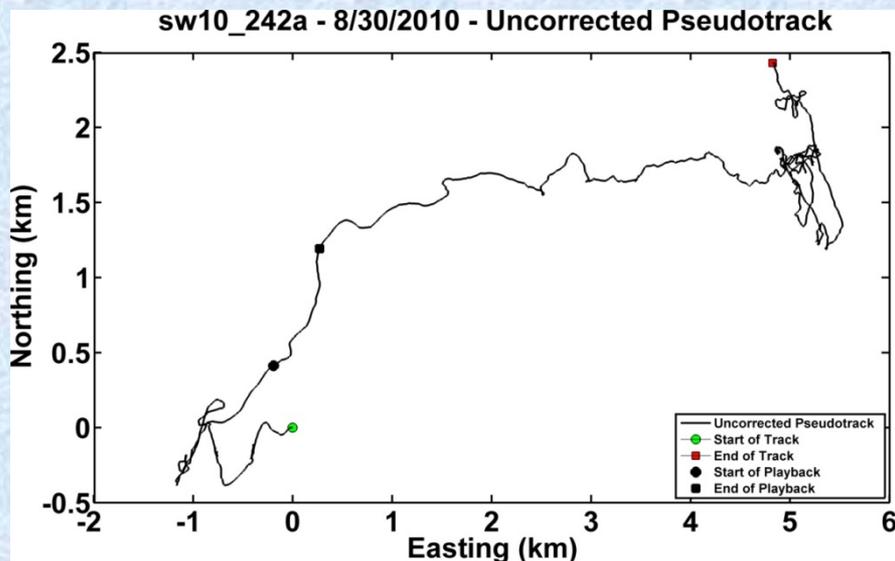
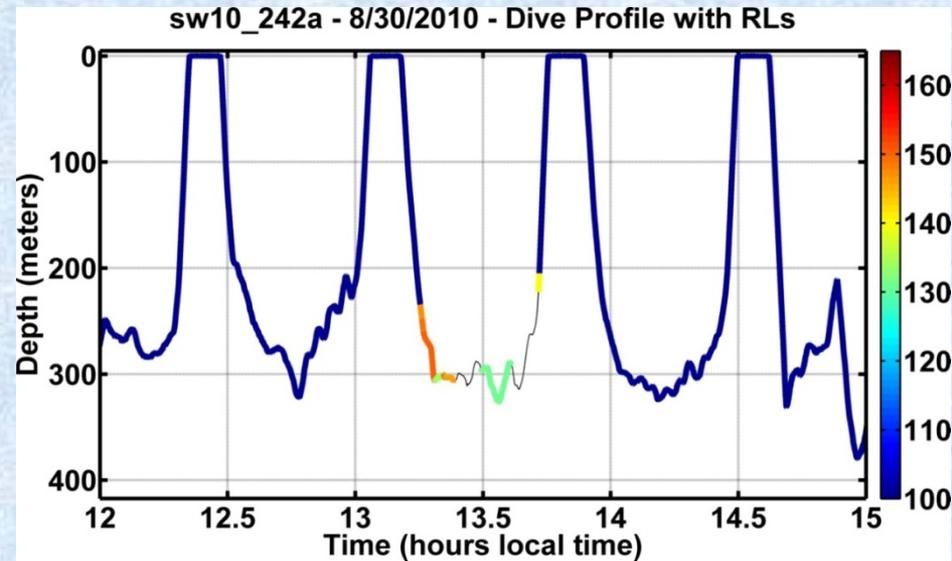


Photo from 13 Jan 1996

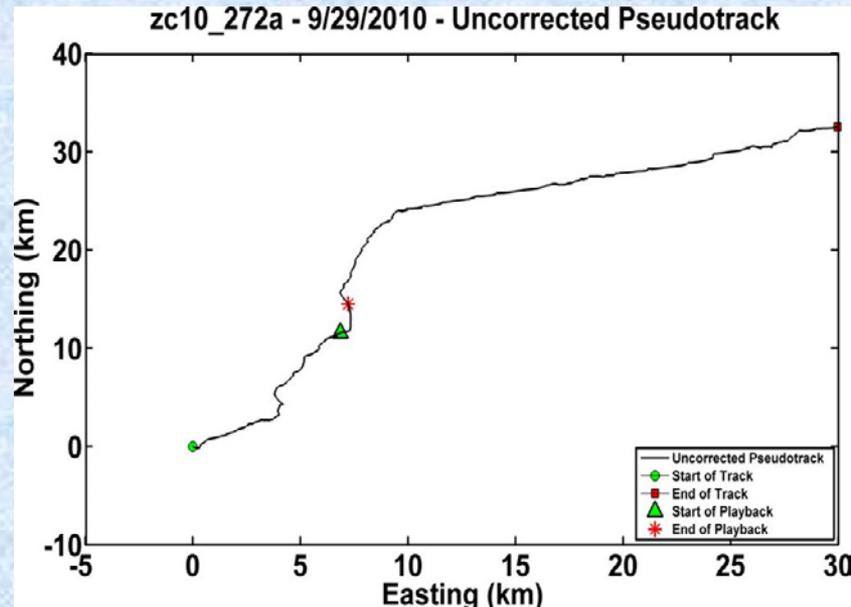
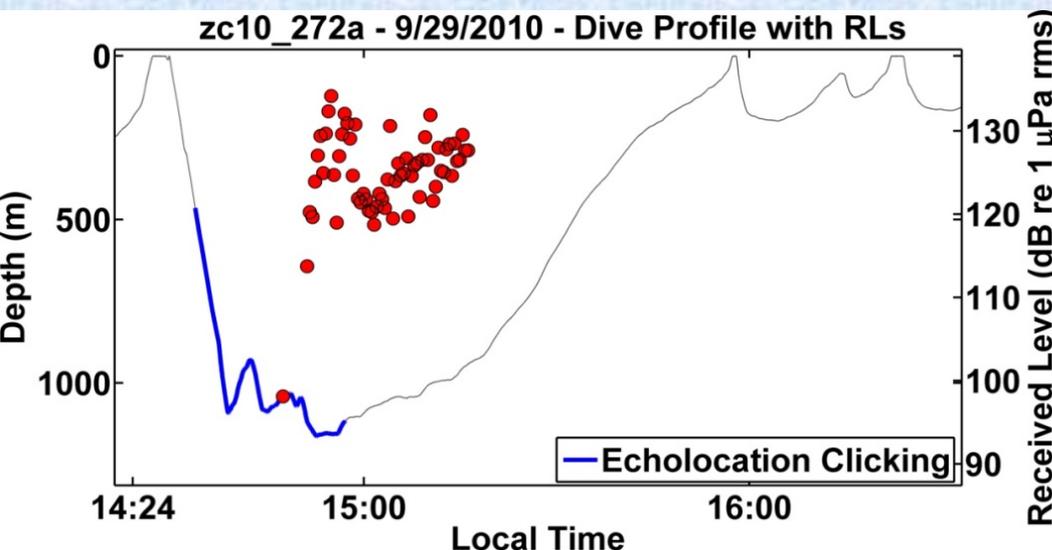
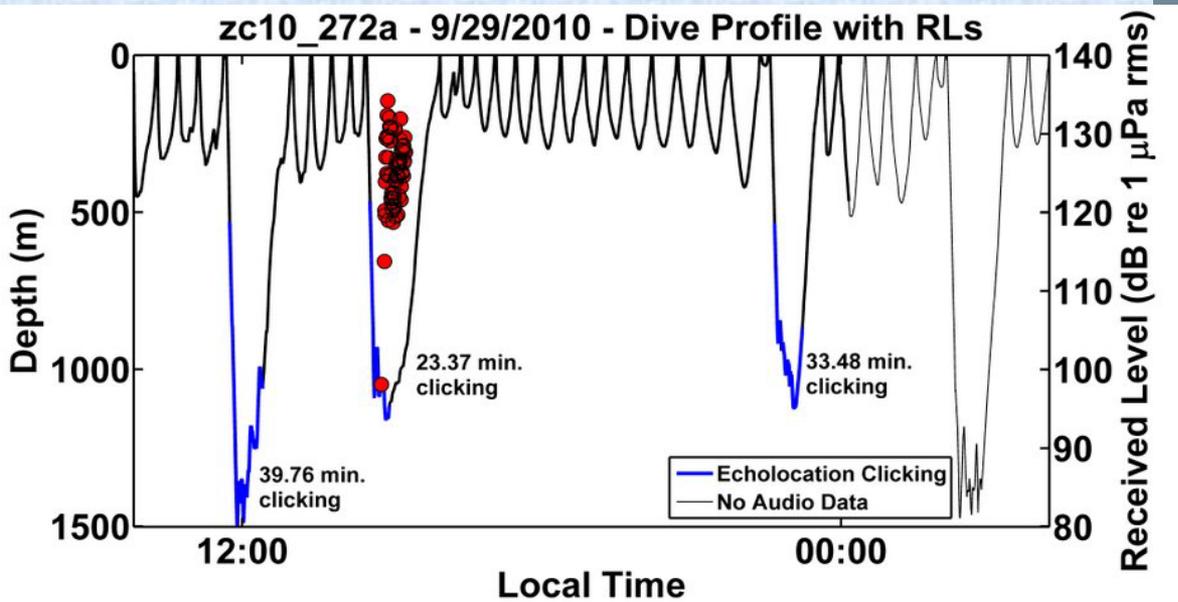
Sperm whale: Tagged 6 August 2010, locations through 10 October 2010 (86 days)



Sperm whale CEE (MFA)



Cuvier's Beaked whale CEE (MFA)





SOCAL-10 – Quicklook summary

- 1. Modification of previous BRS approaches and application in southern California on new species was successful**
 - *SOCAL-10 overwhelmingly productive (28 CEEs in 2010 vs. 7 in 07-09), but different species and favorable weather, animal distribution, range access*
 - *62 tags of 6 types on 44 individuals of 9 species (~400h)*
- 2. Results (very preliminary) indicate observable responses to sonar/noise sounds in some conditions and species,**
 - *Points to a more complex, context-specific type of response than a simple dose-response function based solely on loudness*
- 3. SOCAL-10 will enable Navy & NOAA to better fulfill requirements to understand and assess impacts on marine mammals**
 - *First direct measurements on large whales (major issues within litigation)*
 - *Relatively large sample sizes with ability to contrast behavioral states*
 - *First ever controlled measurement on beaked whale sp. most often stranded*

Future work and research on marine mammals off Washington

- Continuation of BRS and shift to real sources
- Navy monitoring off Washington: Acoustic monitoring, small boat surveys, and Sat tagging
- Collaborative surveys with WDFW and ODFW supported by NOAA and Navy
- Gray whale status review and continuation of genetic and population studies

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