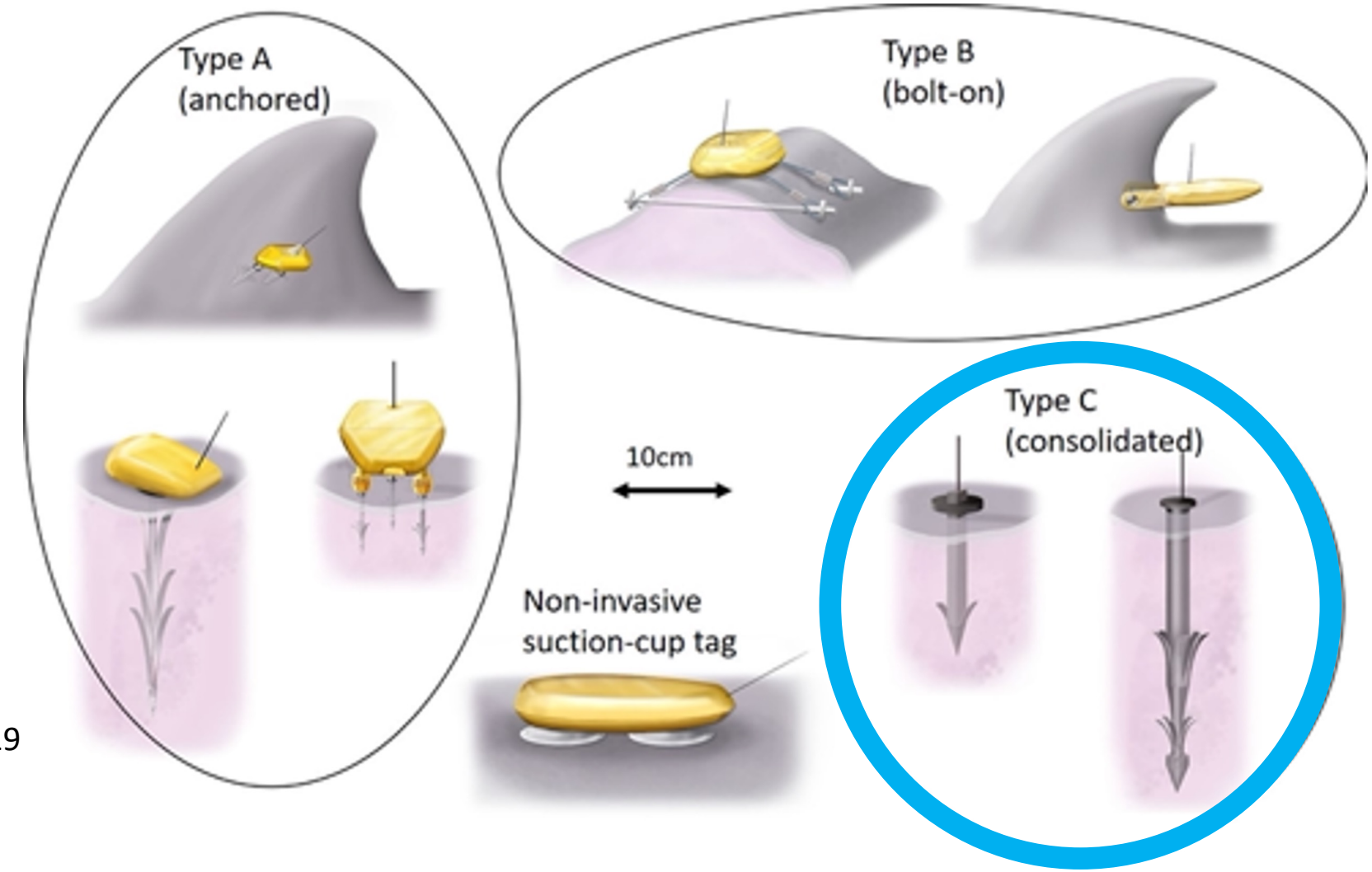
Type C or Consolidated Tags

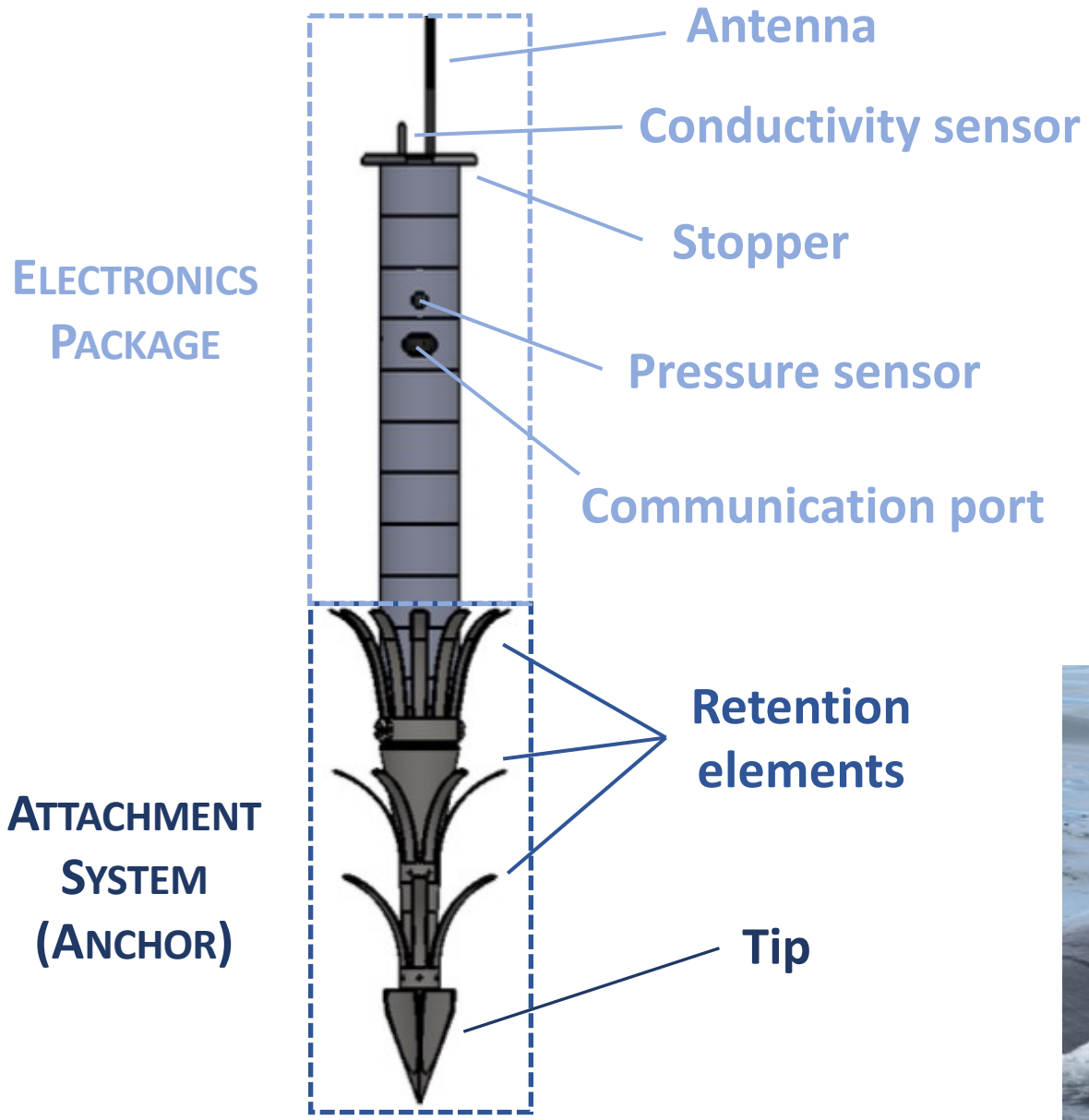
Alex Zerbini (CICOES/UW, AFSC-NOAA, MarEcoTel)
Daniel Palacios (WHET/OSU)
Ladd Irvine (WHET/OSU)
Amy Kennedy (CICOES/UW)
Federico Sucunza (Instituto Aqualie)

What is a Type C Tag?



Andrews *et al.* 2019

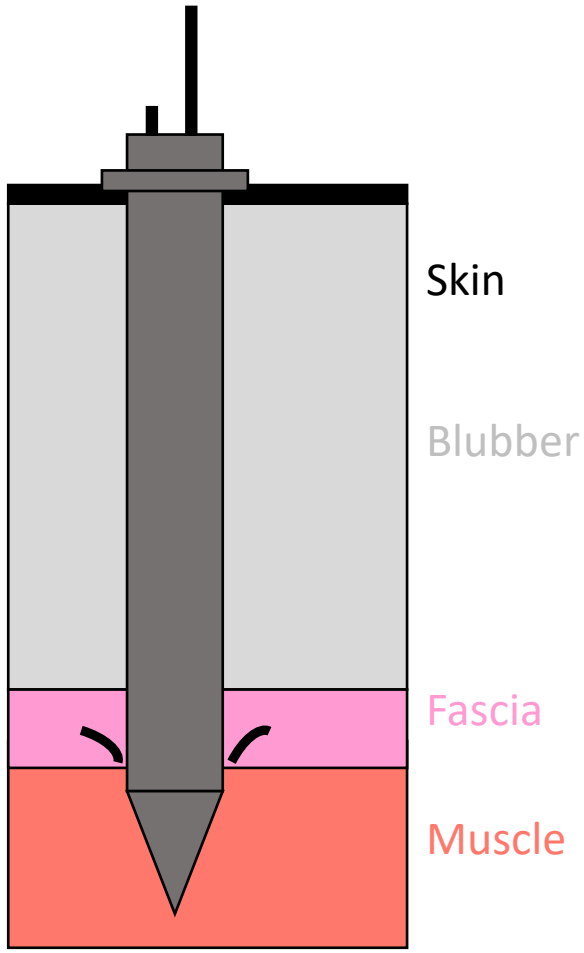
Consolidated tags



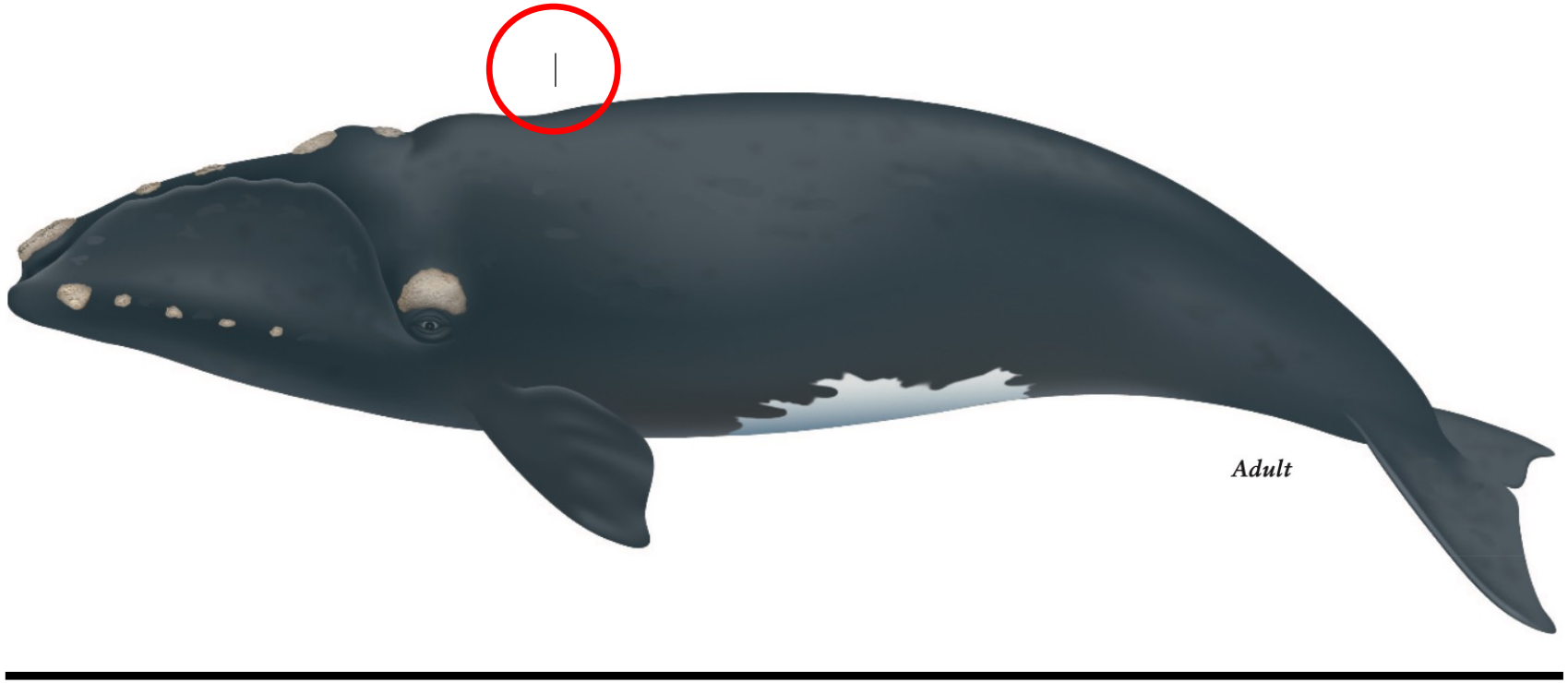
- Terminology: Implantable, deep-implant, Type C.
- Surgical quality stainless steel.
- Length: up to 11.8 in. (30 cm).
- Diameter: 0.78-0.95 in (2.0-2.4cm).
- W: up to 390 g.
- Gas sterilization or coated with antibiotics.
- Attachment to the blubber or below the fascia
- Tags will remain attached for weeks or months.
- The tag wound will heal and leave a small scar

Tag dimensions in perspective

L: 11.8 in
D: 0.95 in
W: 390 g

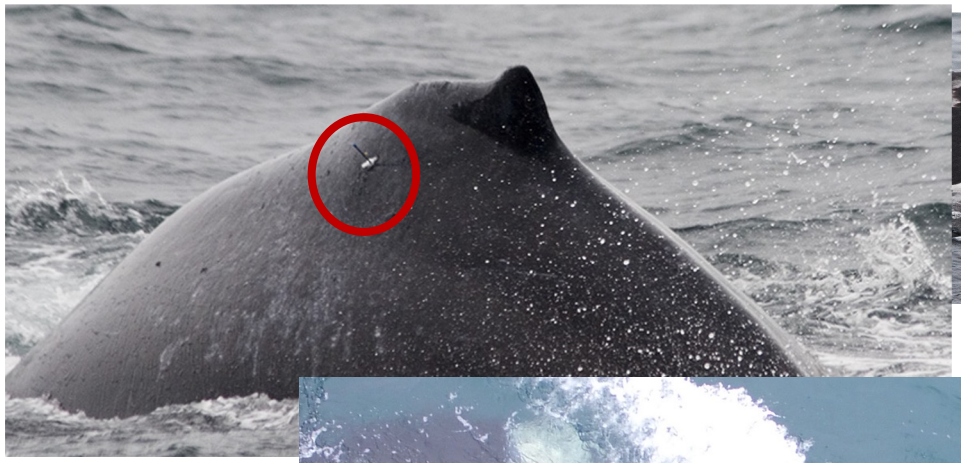


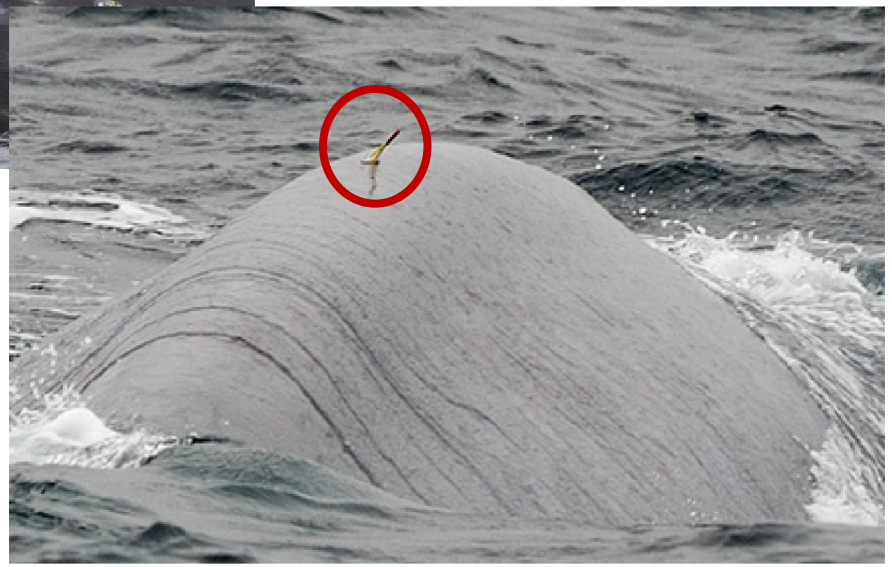
Weight = $^{1}/_{1000}$ of a % of the body weight of a 40 ton whale

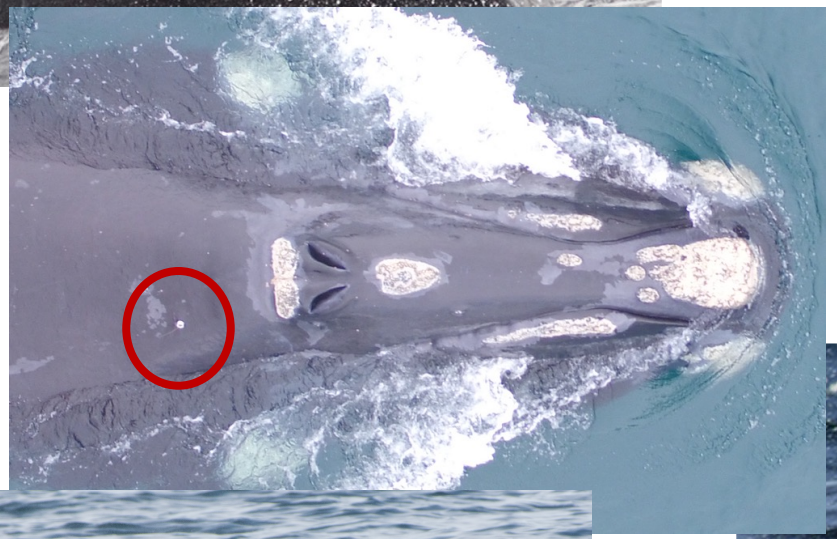


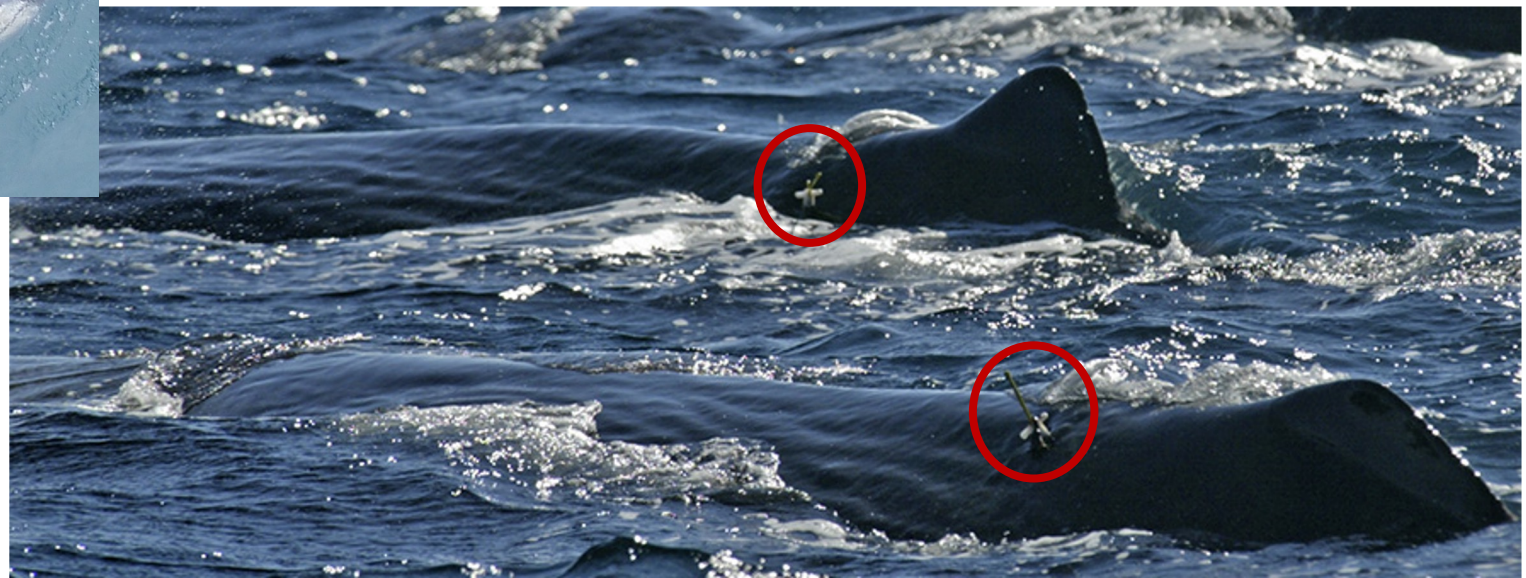
How and where tags are deployed?

Where are the tags deployed?









A brief history of consolidated tags: Early radio tags (VHF)

Montgomery (Ed.). 1987. Workshop to assess possible systems for tracking large cetaceans, 24-26 February 1987. OCS Study MMS 87-0029.

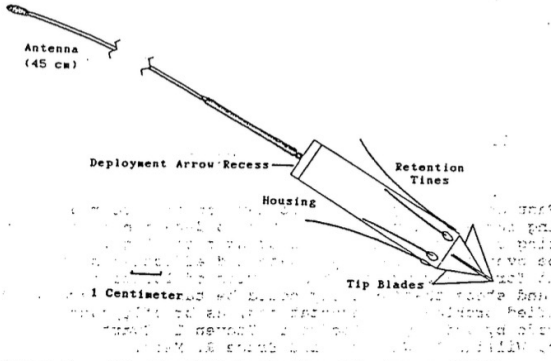


Figure 1. Capsule VHF Radio Tag (Goodyear, 1985)

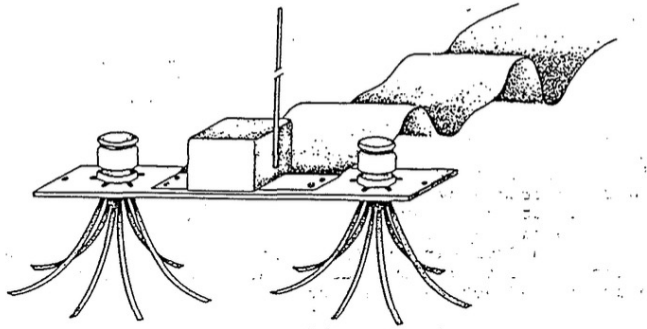


Figure 3. Radio tag showing transmitter (square box) with its antenna, visual identification streamer, and two "umbrella" attachments mounted on a base plate (from Mate and Harvey, 1984).

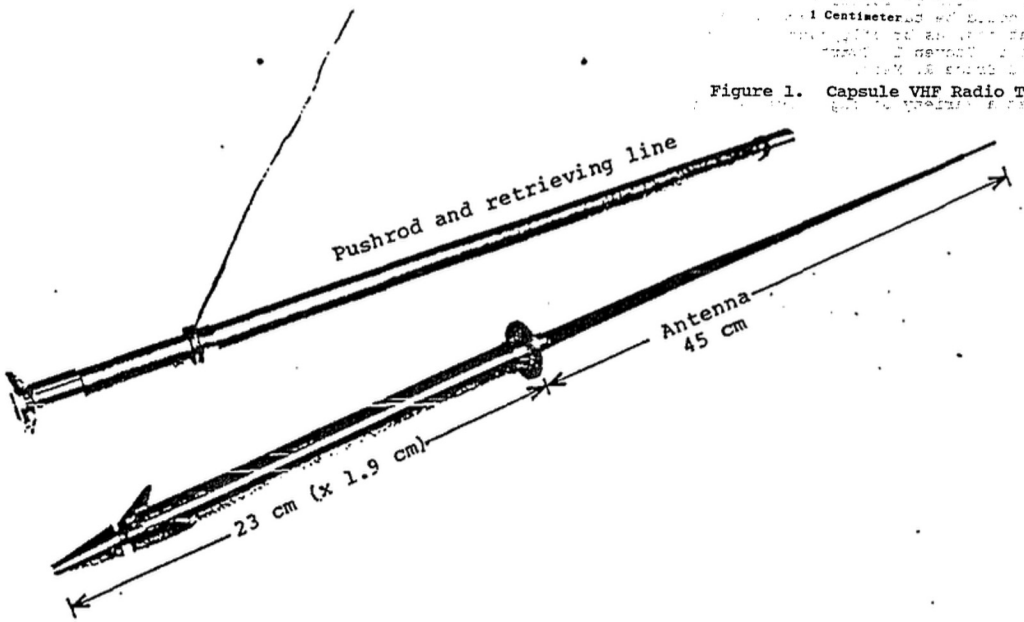
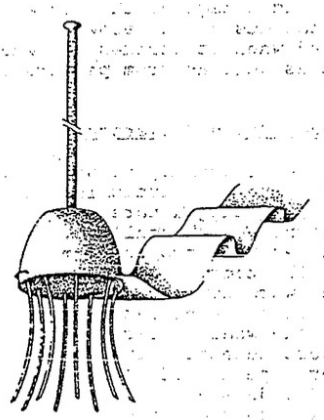


Figure 2. WHOI Projectile Tag (from Watkins, 1977)



re 4. Barnacle tag with eight attachment tines, nna, and visual streamer (from Mate and Harvey,)

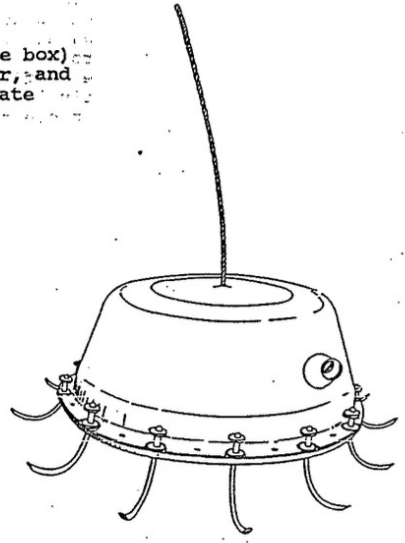


Figure 5. Platform transmitter terminal (PTT) with teflon-coated, spun-case housing, with 12 hollow (deployed) attachment tines.

A brief history of consolidated tags: Early radio tags (VHF)

Montgomery (Ed.). 1987. Workshop to assess possible systems for tracking large cetaceans, 24-26 February 1987. OCS Study MMS 87-0029.

Although it may be impossible to develop a penetrating tag (i.e., a tag that penetrates the surface of the animal) that will remain in place for a year or more, it should be possible to develop a penetrating tag that will remain in place for at least 1-1/2 to 3 months.

Thus, tag retention time of a penetration tag can probably be increased by: increasing the depth of penetration (e.g., implanting the tag deeper into the blubber or at the muscle/blubber interface); increasing the surface area of the tag attachment; making the tag attachment as immobile as possible; and using certain materials.

A brief history of consolidated tags: Bruce Mate, Oregon State University

ELSEVIER

Deep Sea Research Part II: Topical Studies in Oceanography

Volume 54, Issues 3–4, February 2007, Pages 224-247

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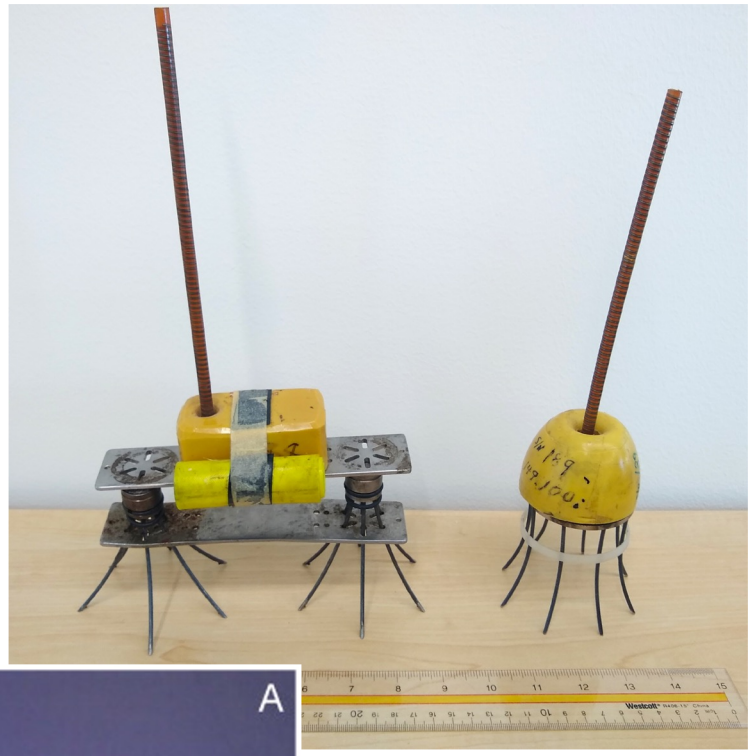
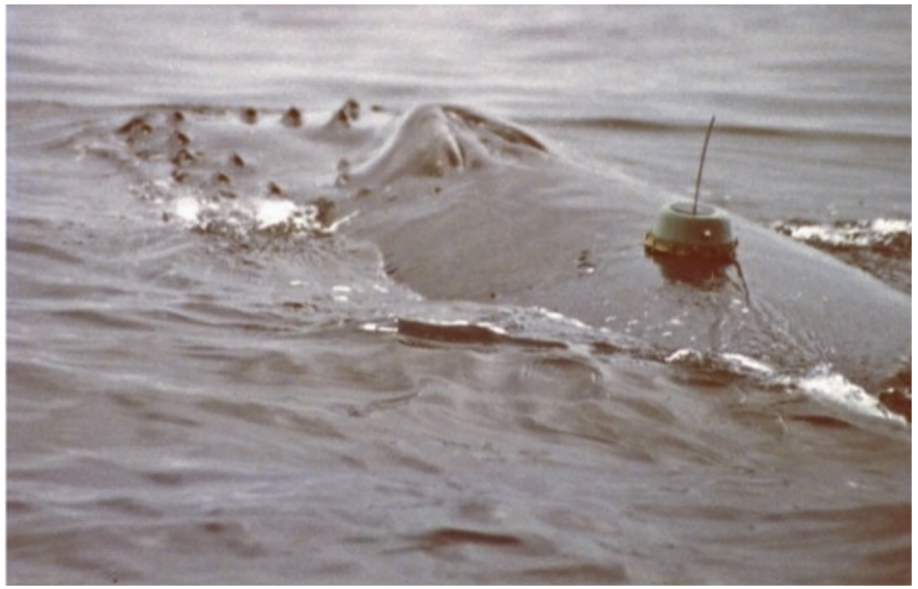
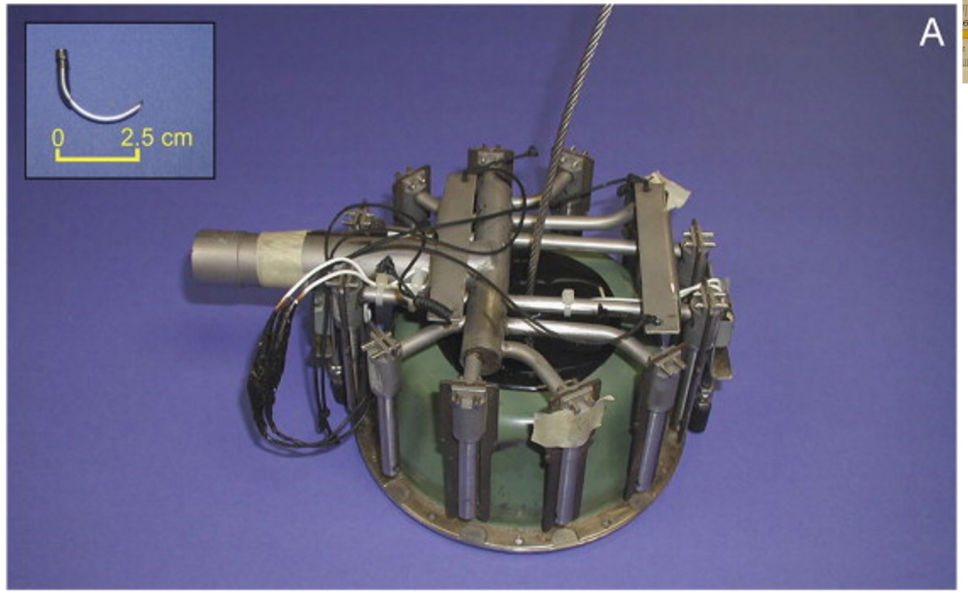
Bruce Mate [a], Roderick Mesecar [b], Barbara Lagerquist [a]







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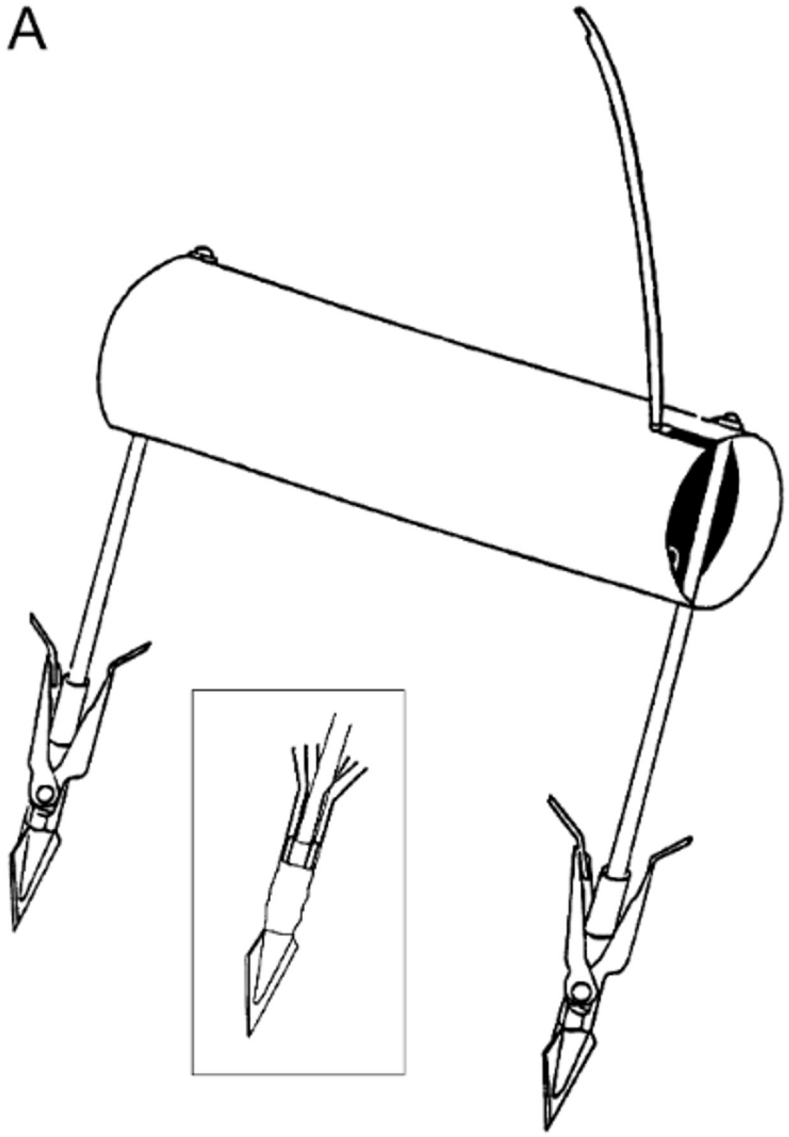

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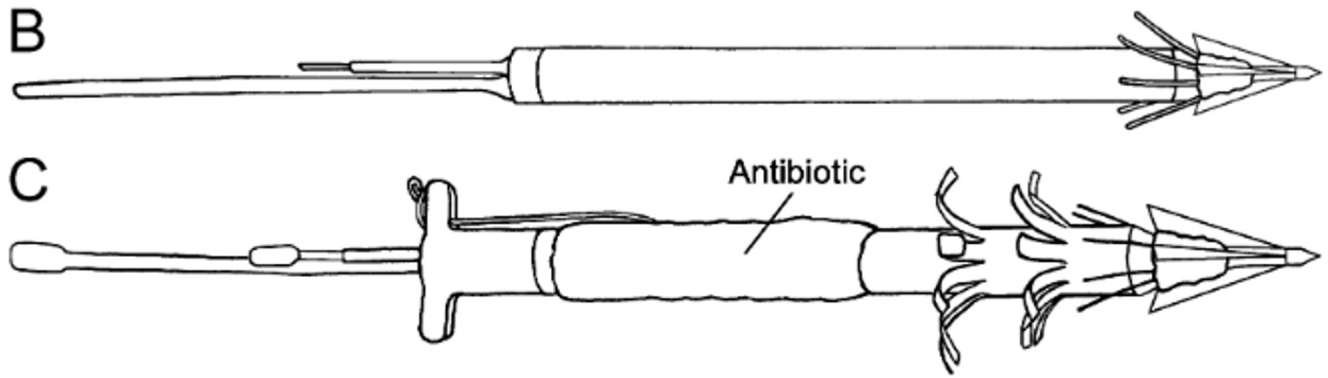

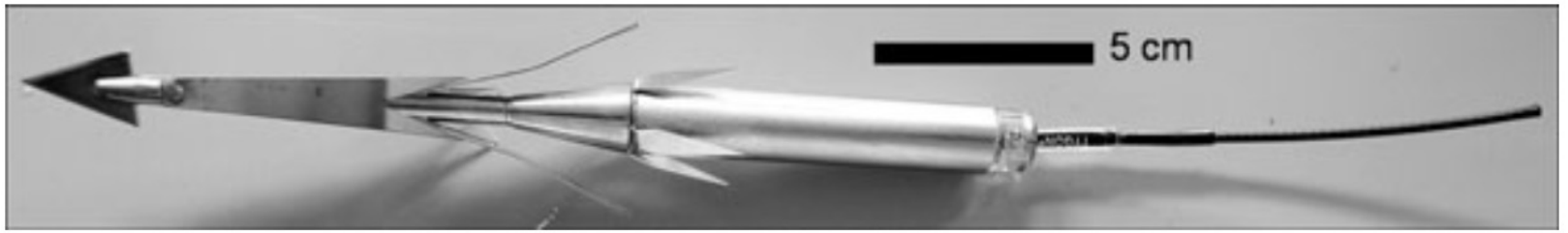
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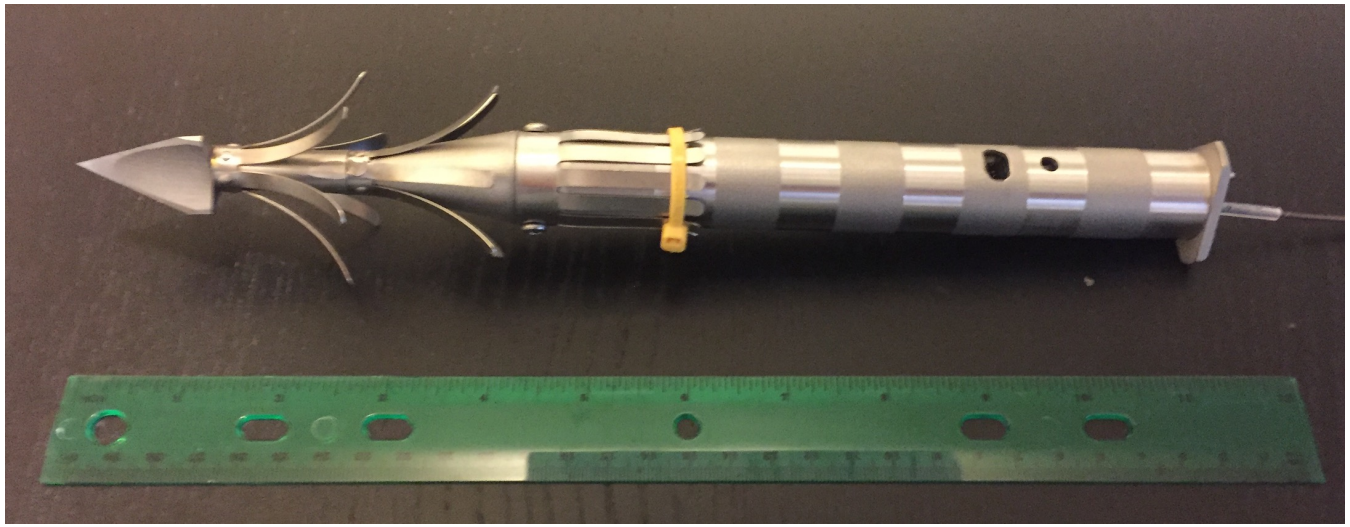
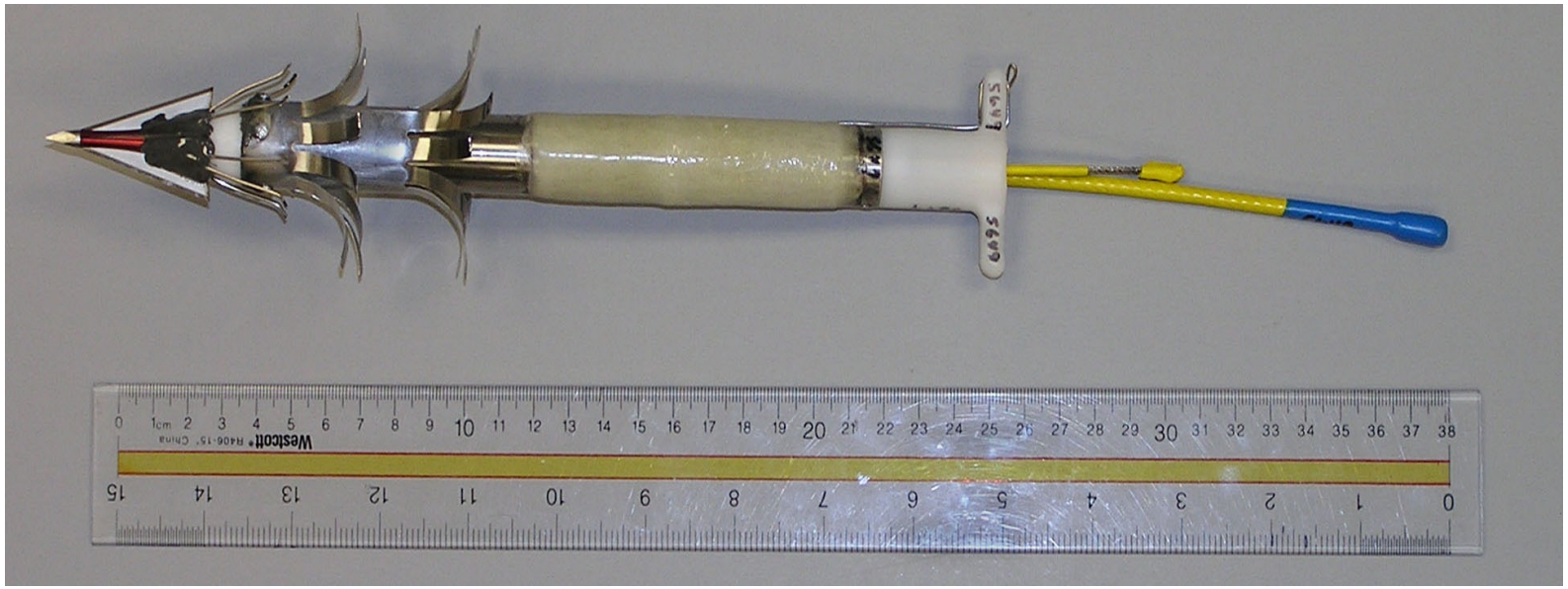
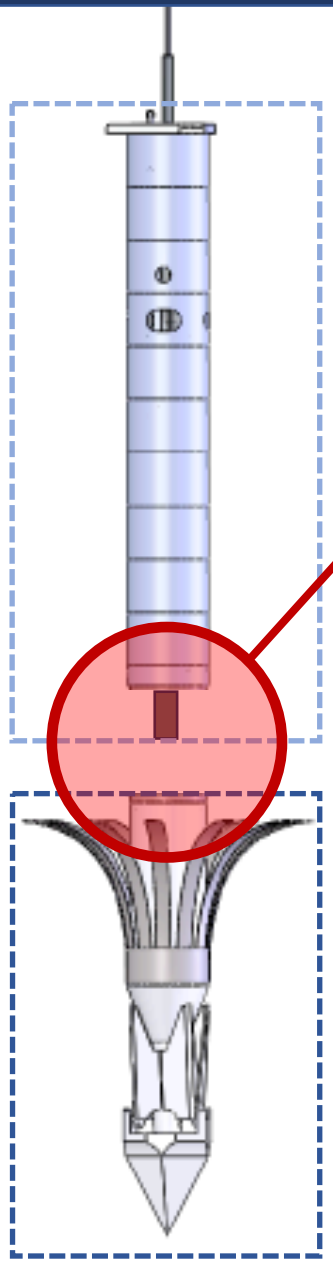




Evolution of consolidated tags: fixing design flaws

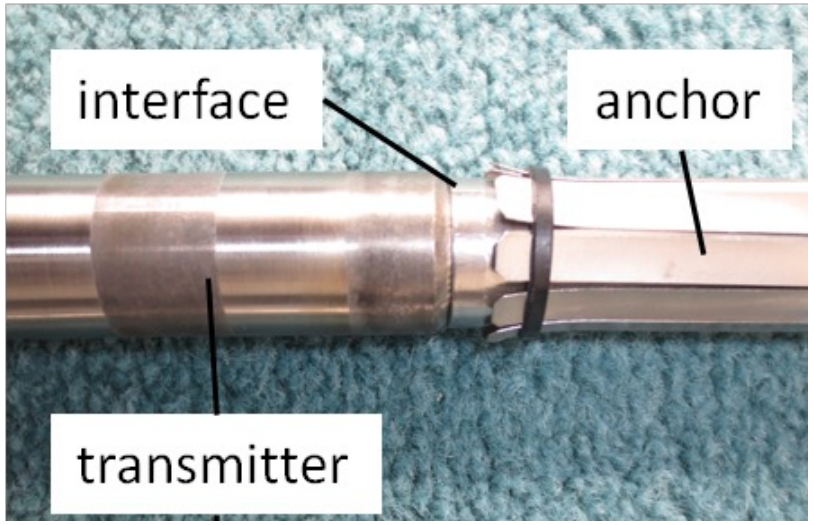


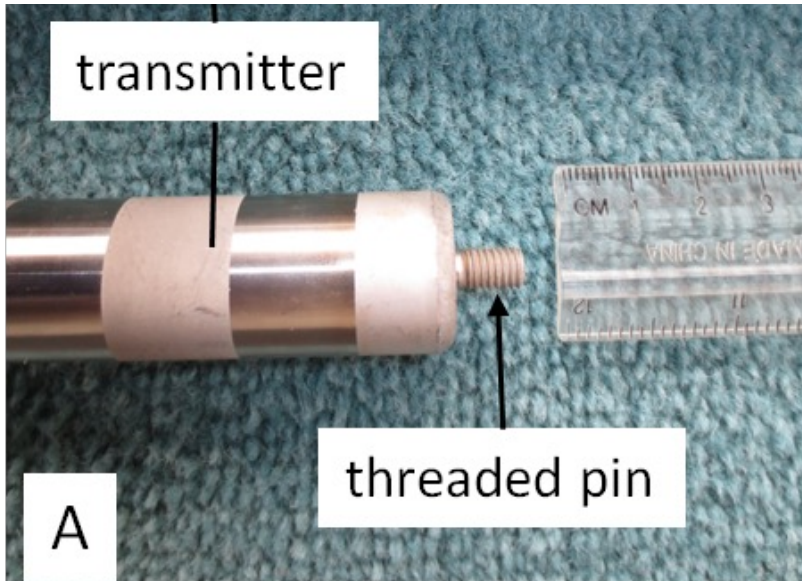
ELECTRONICS PACKAGE

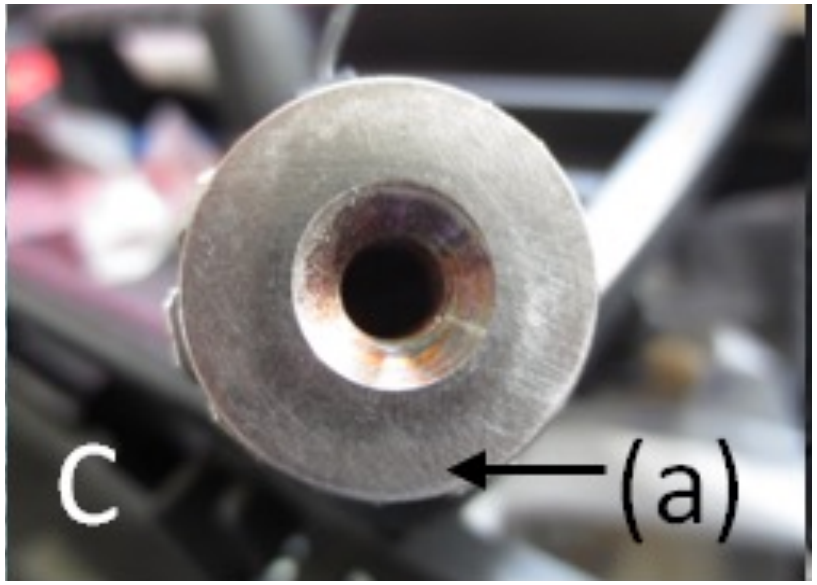
ATTACHMENT SYSTEM (ANCHOR)

TRANSMITTER/ANCHOR INTERFACE

NON-INTEGRATED







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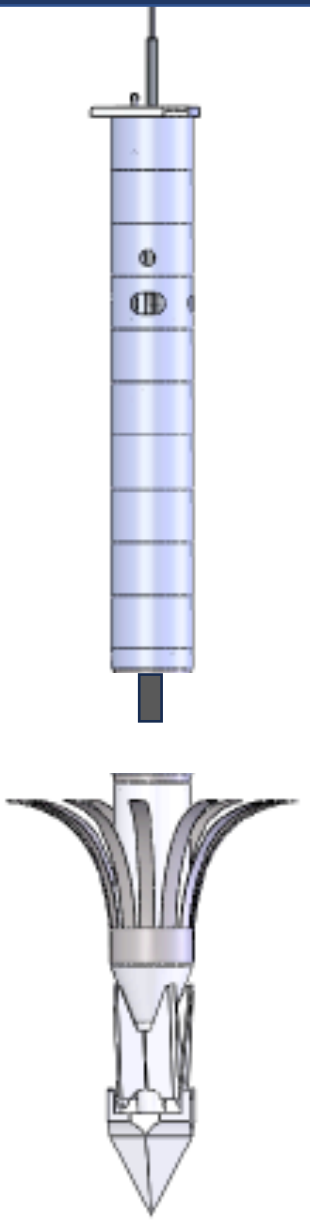
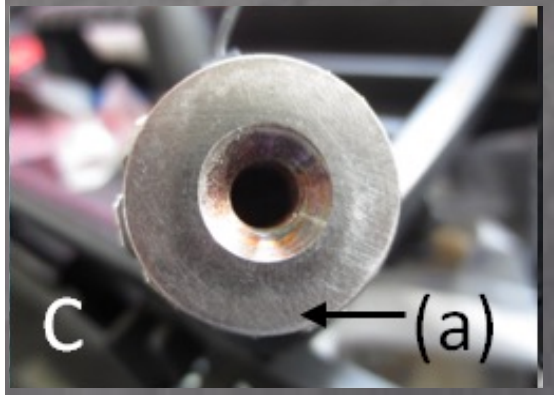


NON-INTEGRATED

FOLLOW-UP STUDIES



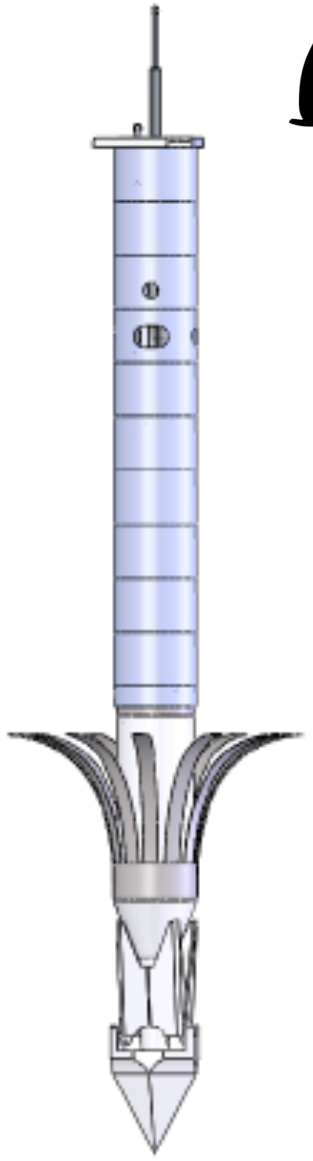

322 days post-tagging

Evolution of consolidated tags: fixing design flaws

NON-INTEGRATED

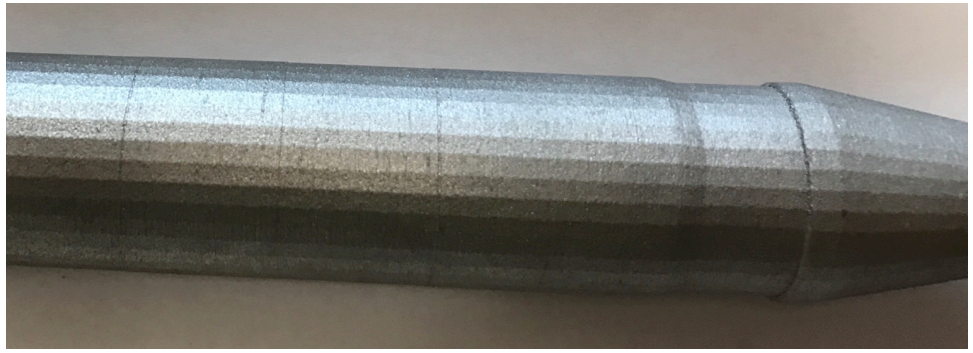
WILDLIFE COMPUTERS

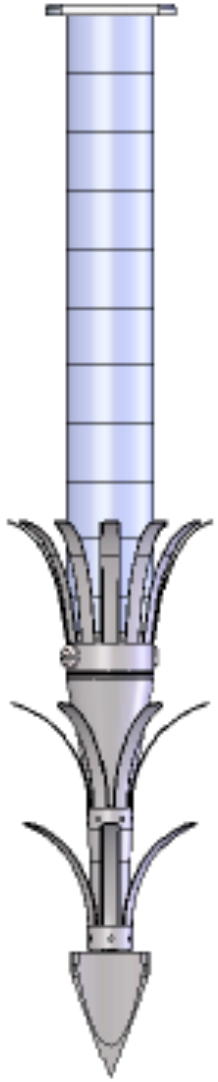
INTEGRATED



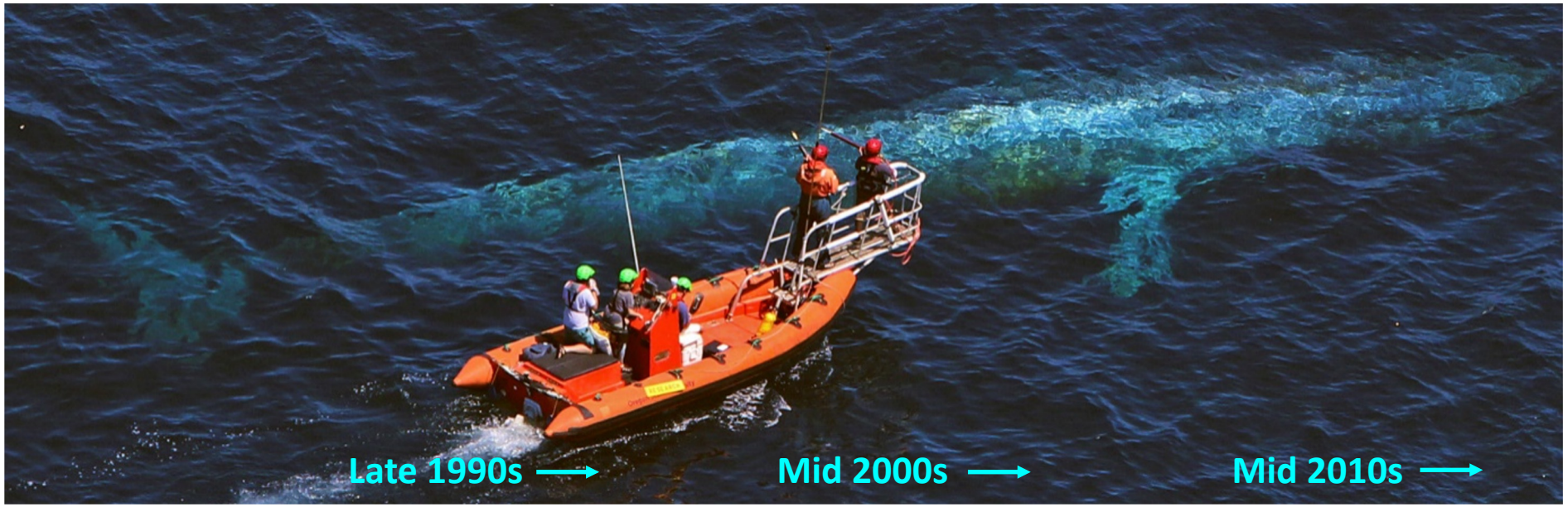
Welded

3-D Printed





Data streams



Tag Type	**Location Only Tag** (Telonics, Wildlife Computers)	Archival/Additional sensors (Wildlife Computers)	RDW Tag (Telonics)
Sensors	Wet/dry, temperature	Wet/dry, temperature, depth	Wet/dry, temperature, depth, accelerometer, on-board processing (foraging)
Messaging capabilities/ Data transmission and recovery	Latitude and Longitude	Location data and customizable summaries of selected sensors (max depth, % time at depth)	Location data, customizable summaries of selected sensors, detection of behavior events
Life Expectancy	> 1 year battery life	~90-120 days	< 150 days

Pros

- Long term data (weeks to months).
- Embedded: minimize drag and less vulnerable to body contact or contact with the substrate.
- Proven robustness of the design.

Cons

- Fewer data streams/sensors
- Higher risk of negative effects

Tag performance: transmission duration

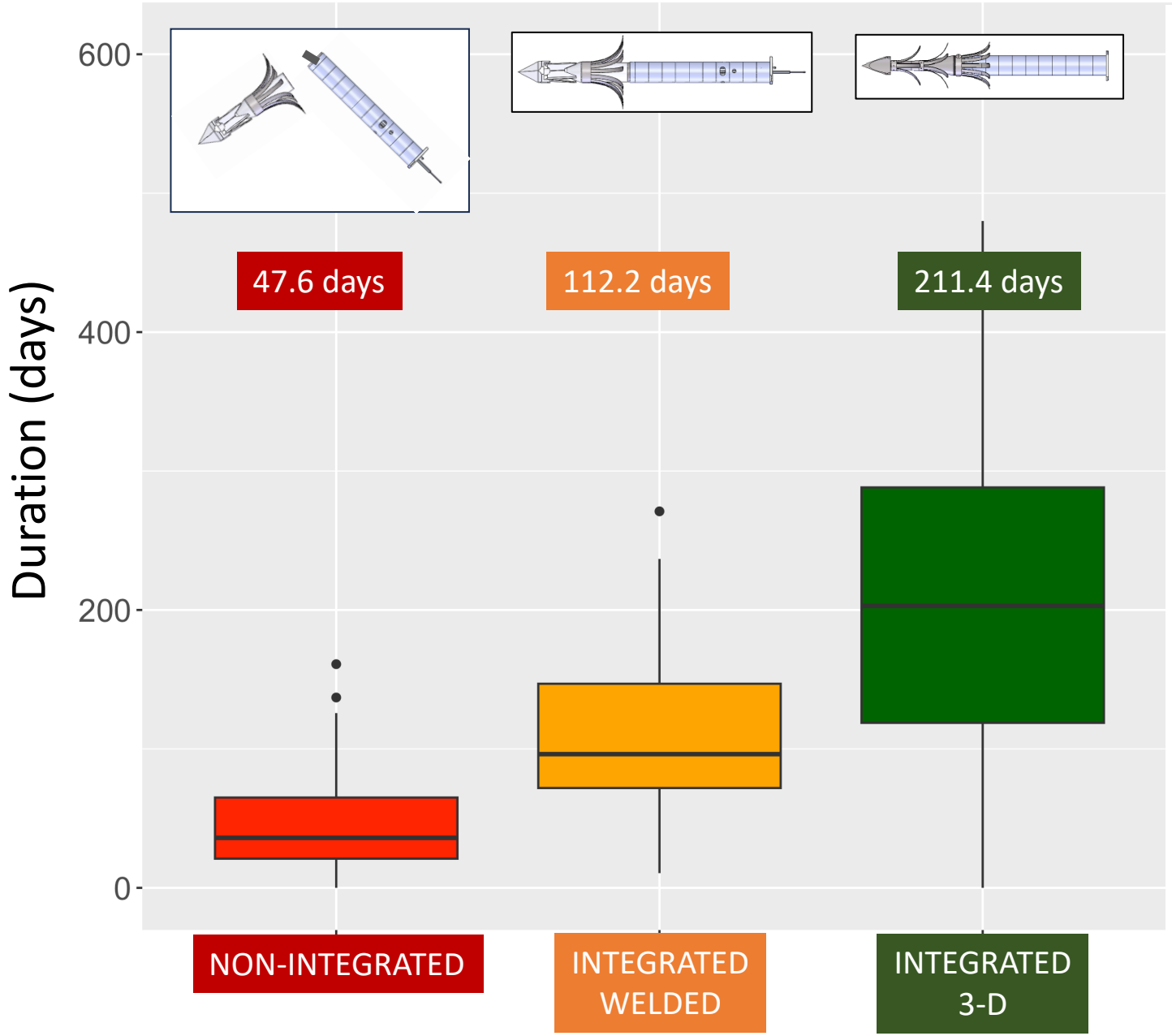
- Why broad overview?
- Average durations for type C tags are not simple to calculate:
  - Different designs were used by different research groups.
  - Some species have not been tagged with newer generation consolidated tags (e.g., NARWs).
  - Sample sizes for some species is very small.

Species	Mean	Max
Southern right whales	211	607
North Atlantic right whales	43	126
North Pacific right whales	40	58
Bowhead whales*	133	365
Gray whales	107	408
Blue whales	92	513
Fin whales	86	394
Bryde's whales	90	90
Sei whales	51	120
Minke whales	52	113
Humpback whales	35-74	323
Sperm whales	165	607

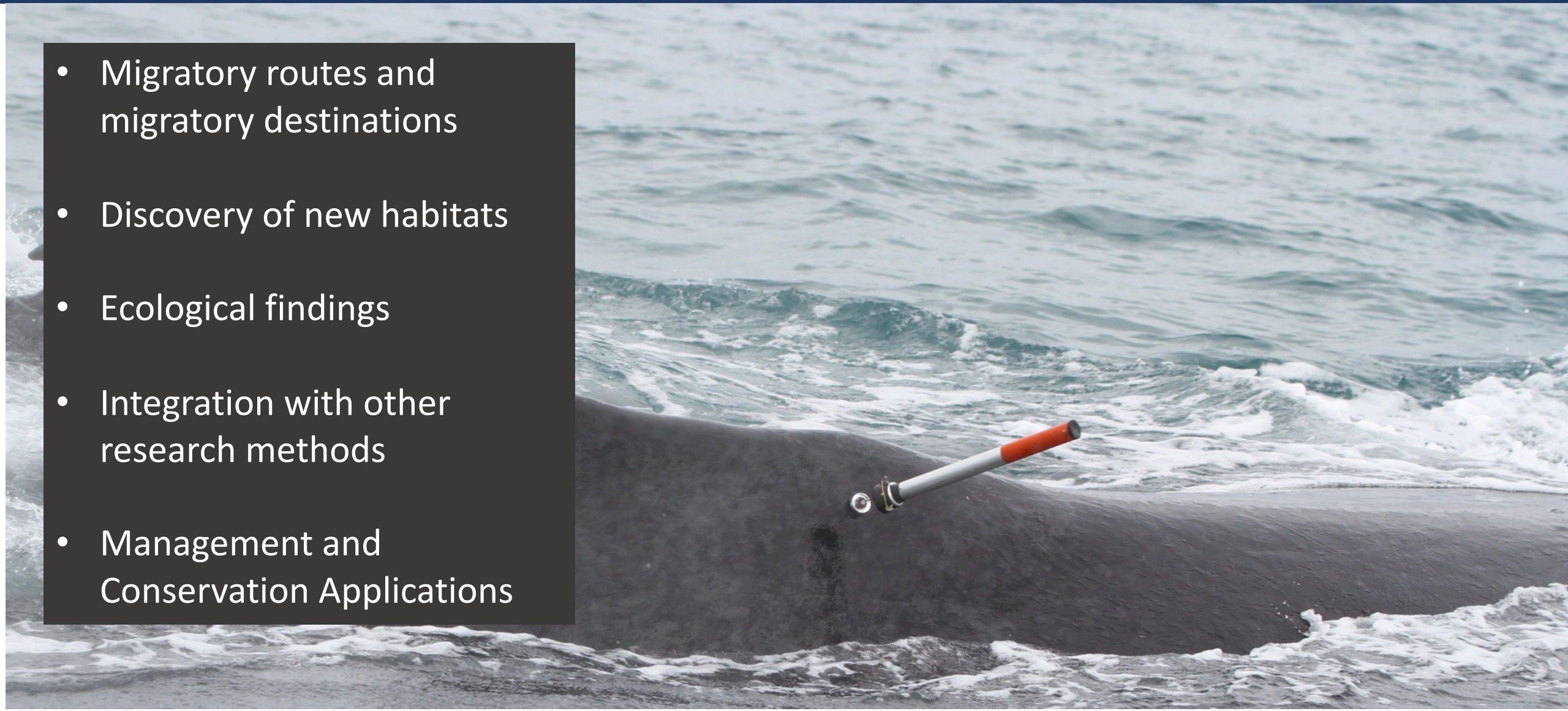
*may include multiple tag types

Data sources: Work by Citta, Friedlaender, Gales, Guzman, Heide-Jørgensen, Irvine, Kennedy, Mate, Palacios, Prieto, Quakenbush, Zerbini

Consolidated tag performance on right whales



Main Findings and Applications



- Migratory routes and migratory destinations
- Discovery of new habitats
- Ecological findings
- Integration with other research methods
- Management and Conservation Applications

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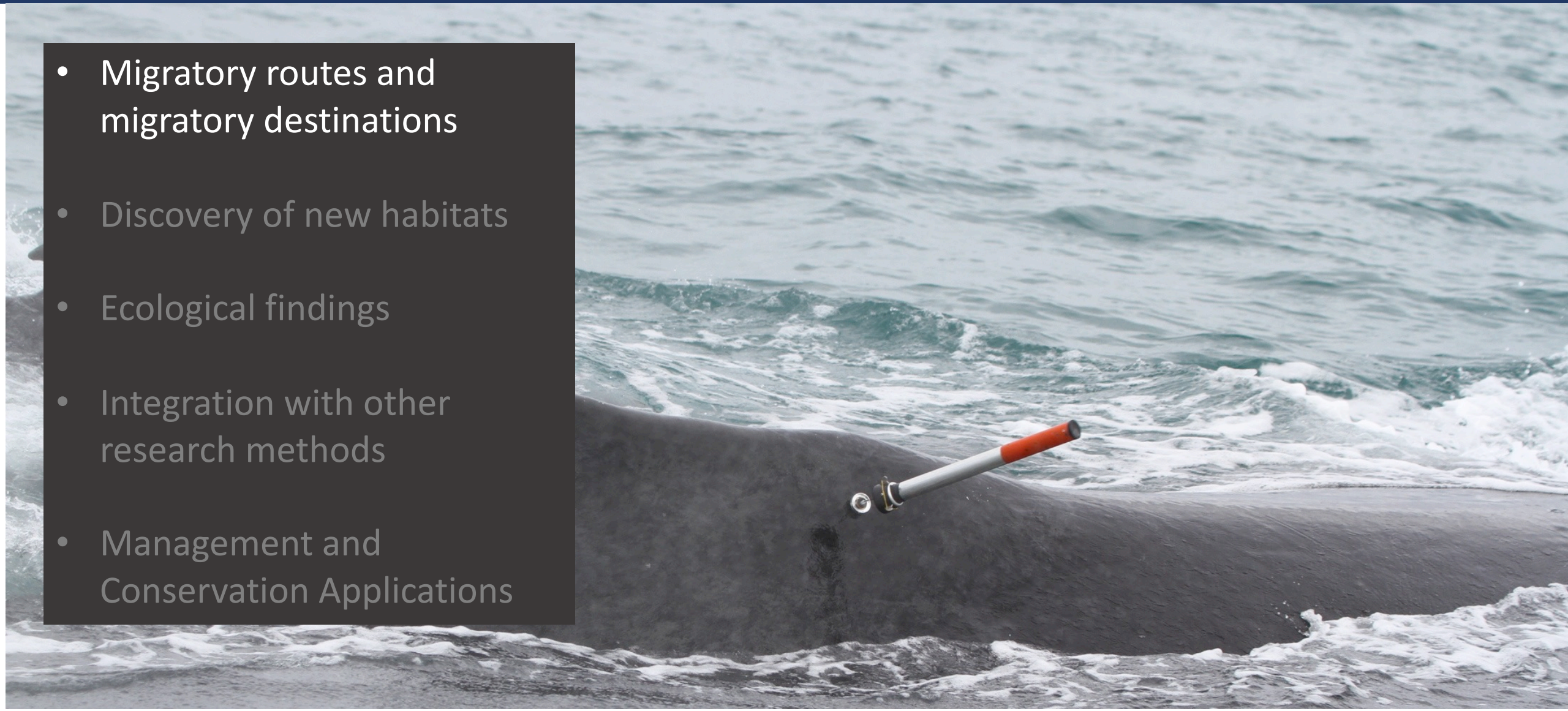
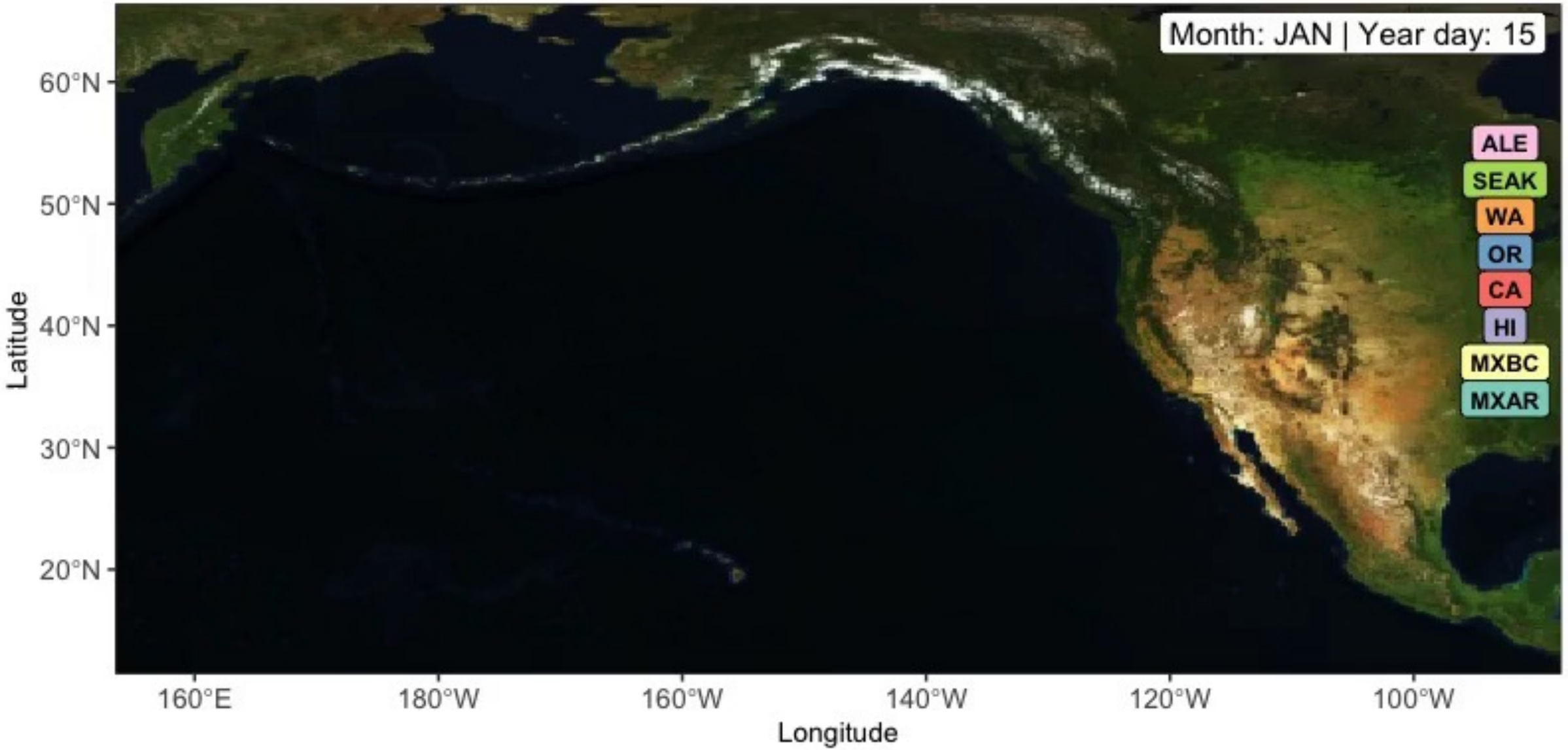


OSU Humpback whale tracking, 1995-2019



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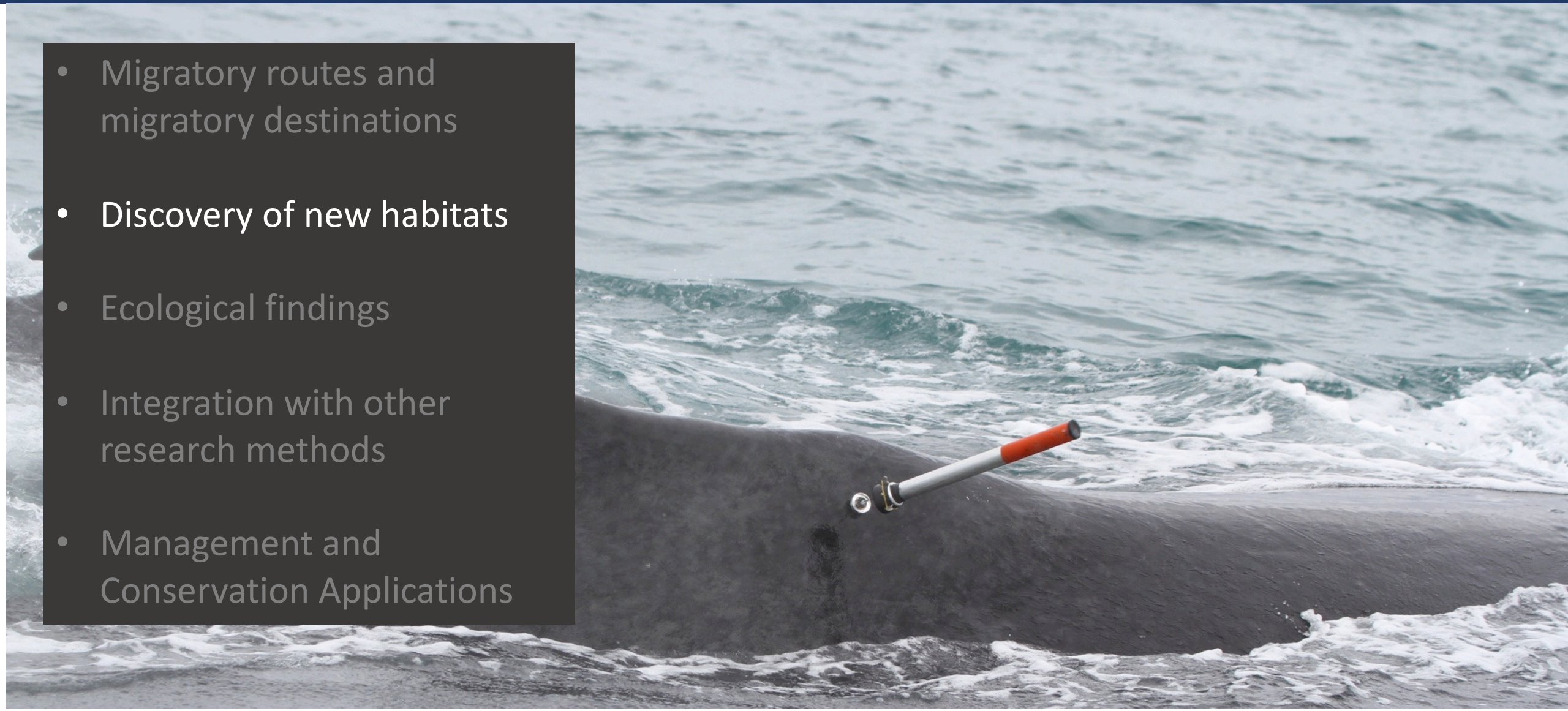

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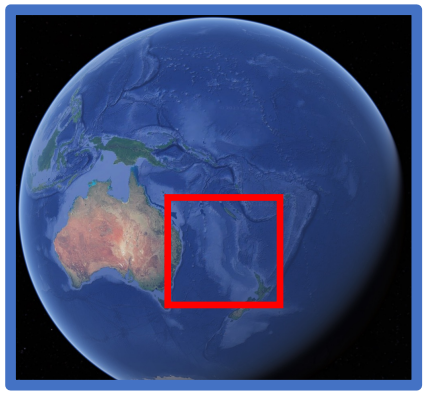

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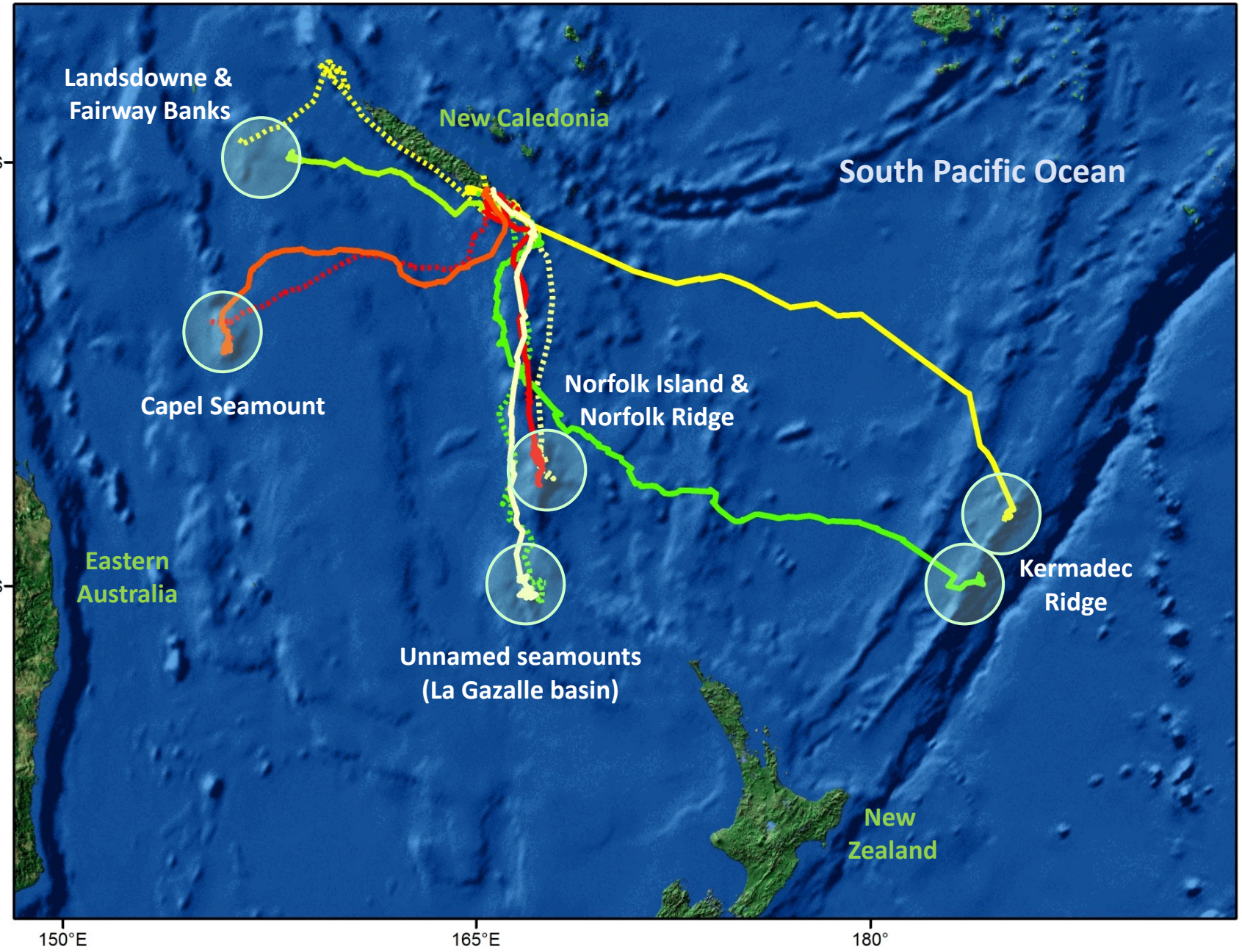
Research

Cite this article: Garrigue C, Clapham PJ, Geyer Y, Kennedy AS, Zerbini AN. 2015 Satellite tracking reveals novel migratory patterns and the importance of seamounts for endangered South Pacific humpback whales. *R. Soc. open sci.* **2**: 150489.
http://dx.doi.org/10.1098/rsos.150489

Satellite tracking reveals novel migratory patterns and the importance of seamounts for endangered South Pacific humpback whales

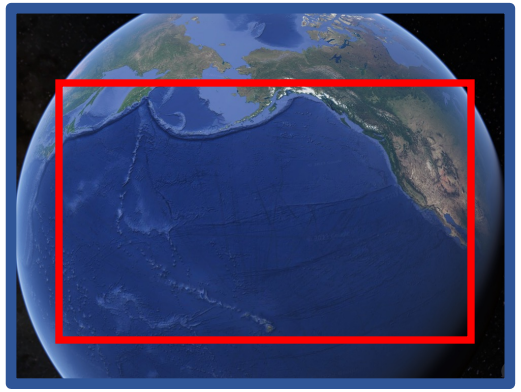
Claire Garrigue[1,2], Phillip J. Clapham[3], Ygor Geyer[4], Amy S. Kennedy[3] and Alexandre N. Zerbini[3,4,5]

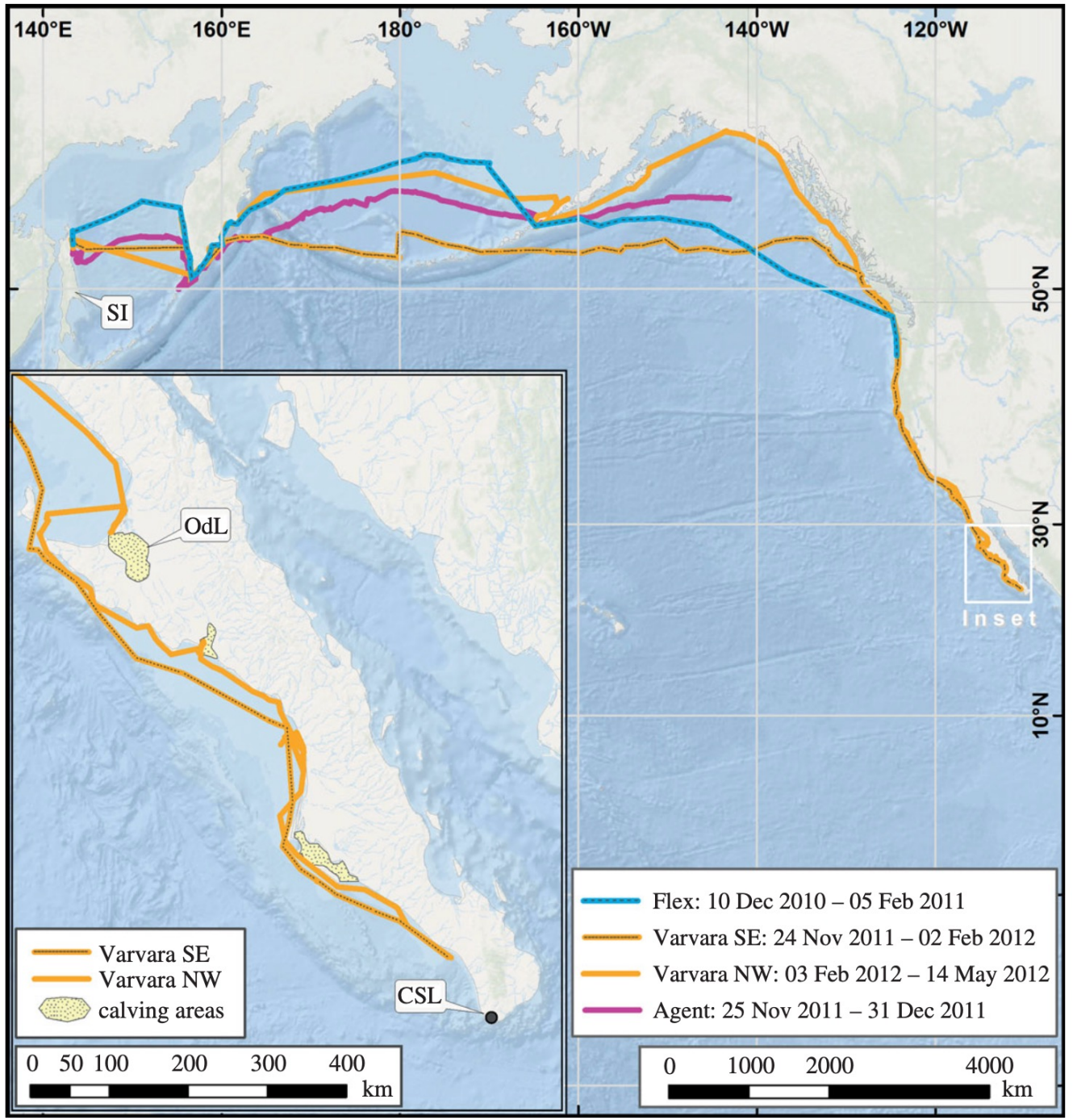


Marine biology

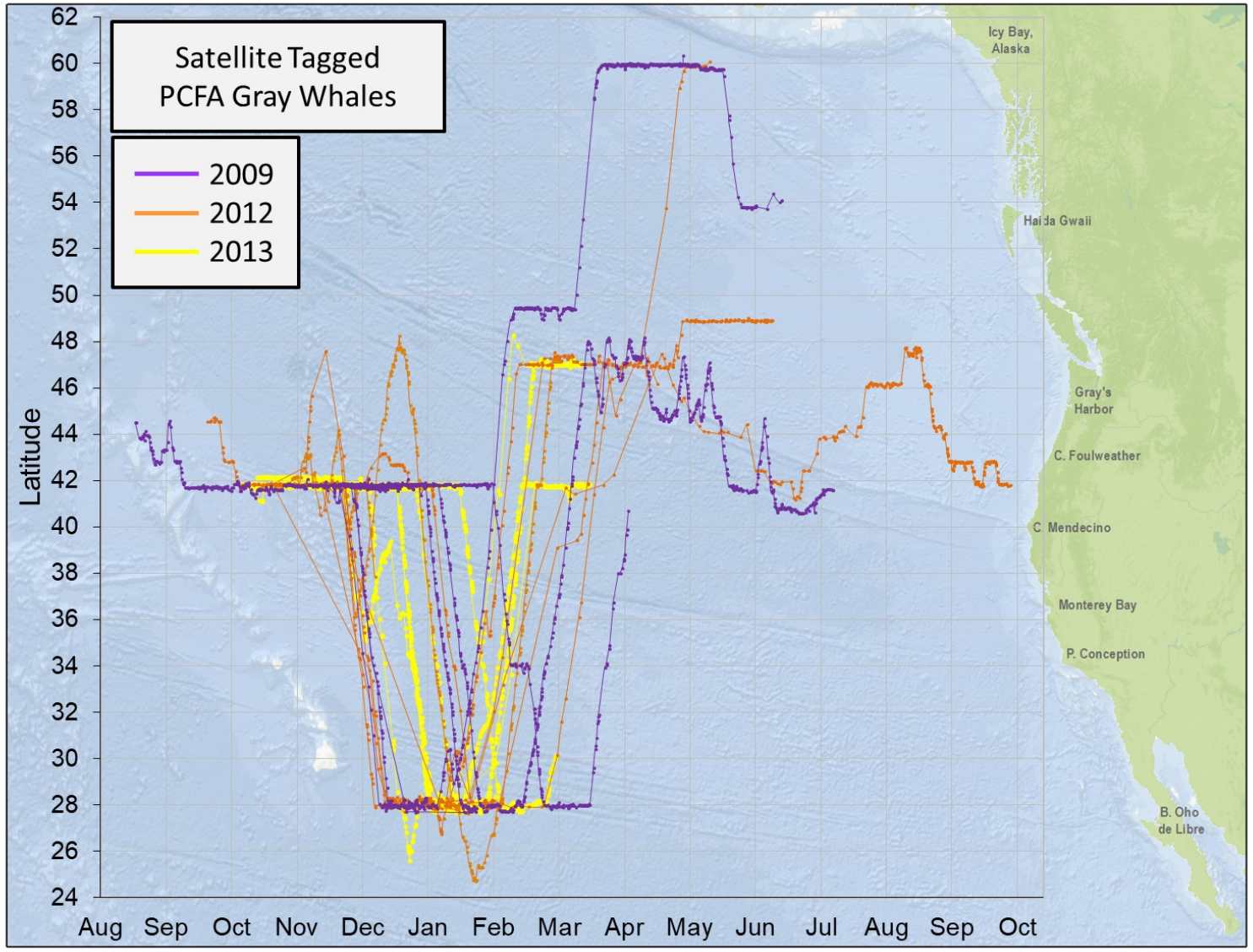
Critically endangered western gray whales migrate to the eastern North Pacific

Bruce R. Mate[1], Valentin Yu. Ilyashenko[2], Amanda L. Bradford[3,†], Vladimir V. Vertyankin[4], Grigory A. Tsidulko[2], Vyacheslav V. Rozhnov[2] and Ladd M. Irvine[1]

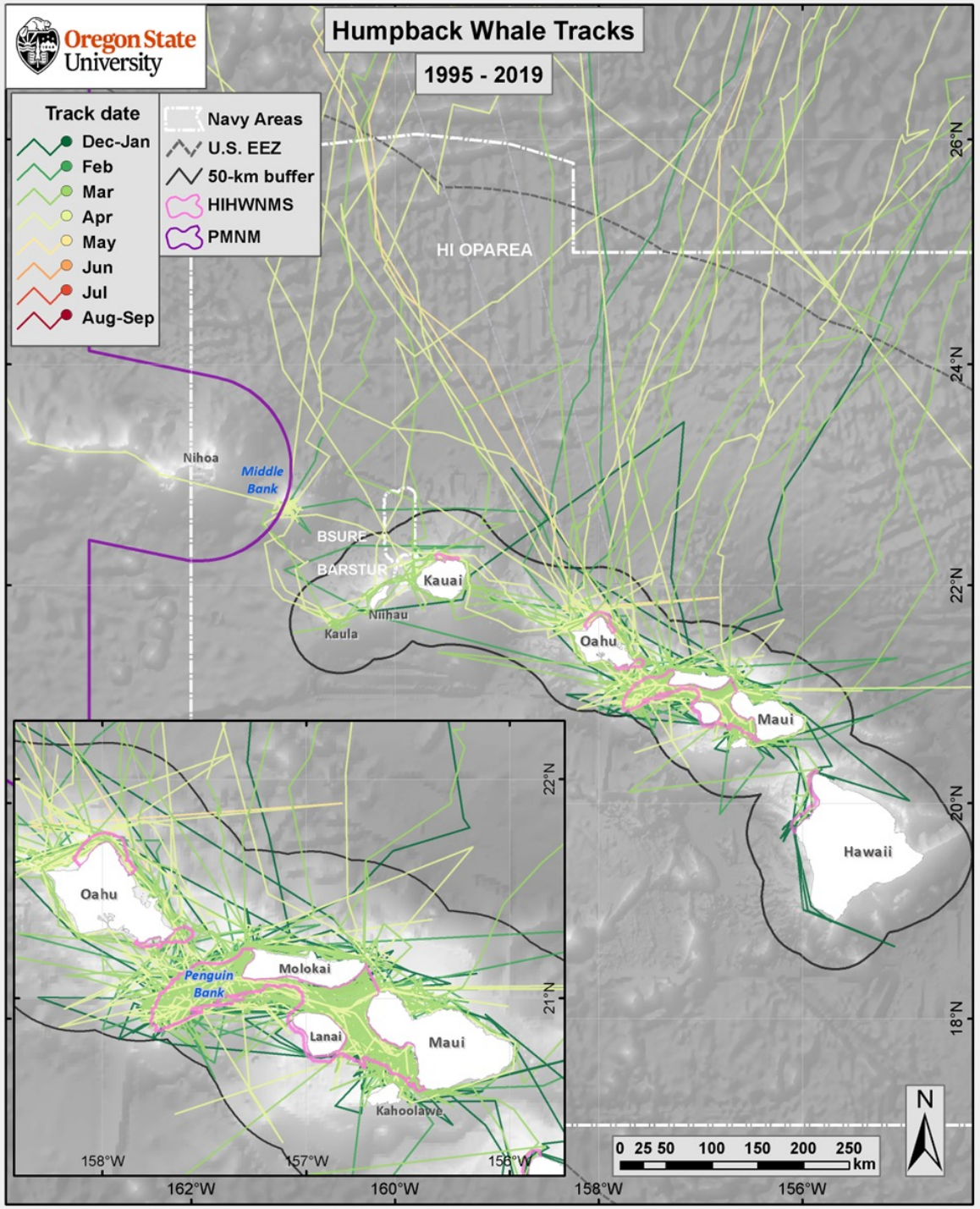




Turn over time of whales in feeding & breeding areas



Mate, B.R. et al. 2014. Offshore Gray Whale Satellite Tagging in the Northwest Training Range Complex (NWTRC). Prepared for Commander, U.S. Pacific Fleet, under Contract # N62470-10-D-3011, issued to HDR Inc., San Diego, California 92123.



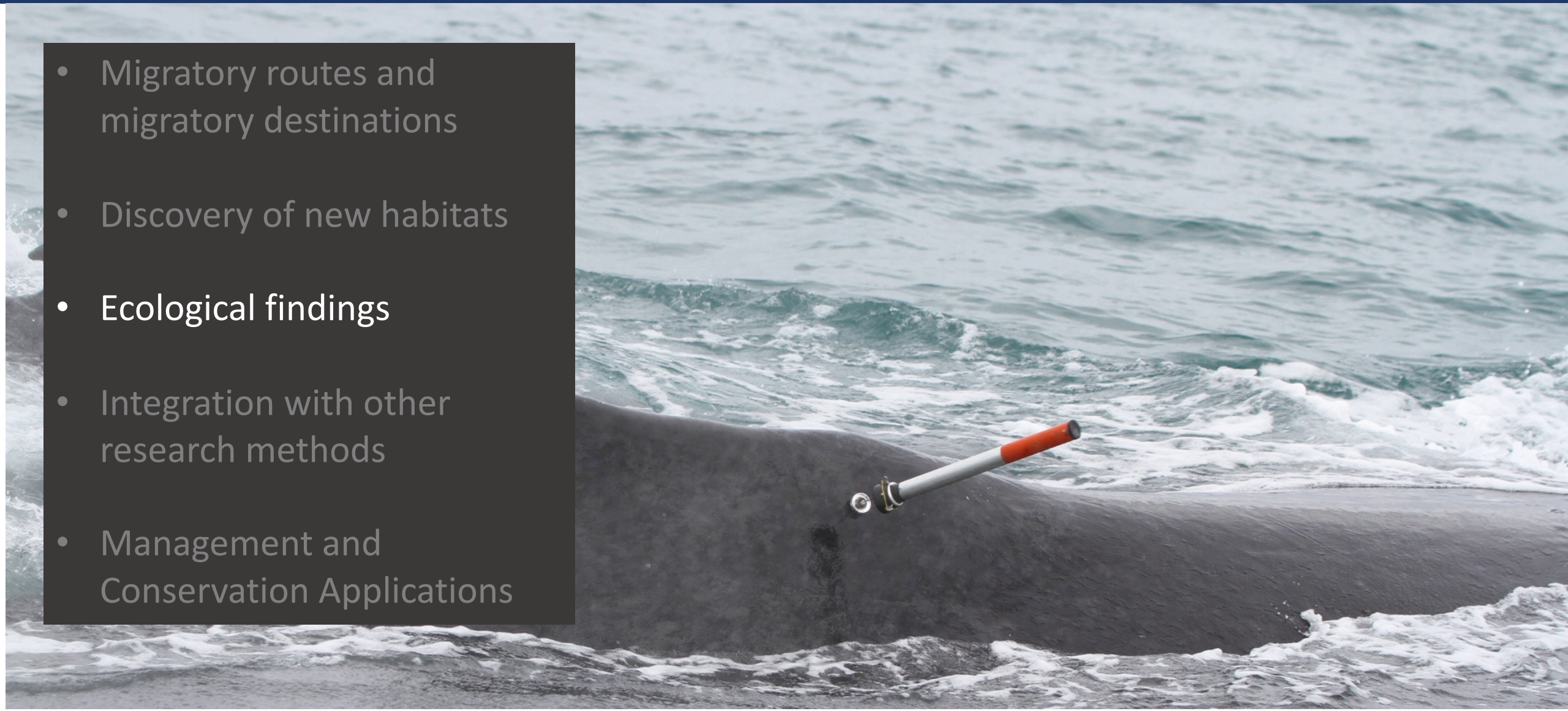
Residence time in Hawai‘i

Days from tagging to departure				
Overall				
n	Mean	SD	Min	Max
39	13.1	9.4	1.1	42.8
Females with a calf				
3	10.4	10.7	2.7	22.6
Females without a calf				
2	11.3	10.9	3.6	19.0
Males				
17	15.9	10.4	3.3	42.8

- Time from tagging to departure from a 50-km buffer around the islands
- Departure dates ranged from 20 December to 3 May

Main Findings and Applications

- Migratory routes and migratory destinations
- Discovery of new habitats
- Ecological findings
- Integration with other research methods
- Management and Conservation Applications



Vol. 532: 269–281, 2015
doi: 10.3354/meps11366

MARINE ECOLOGY PROGRESS SERIES
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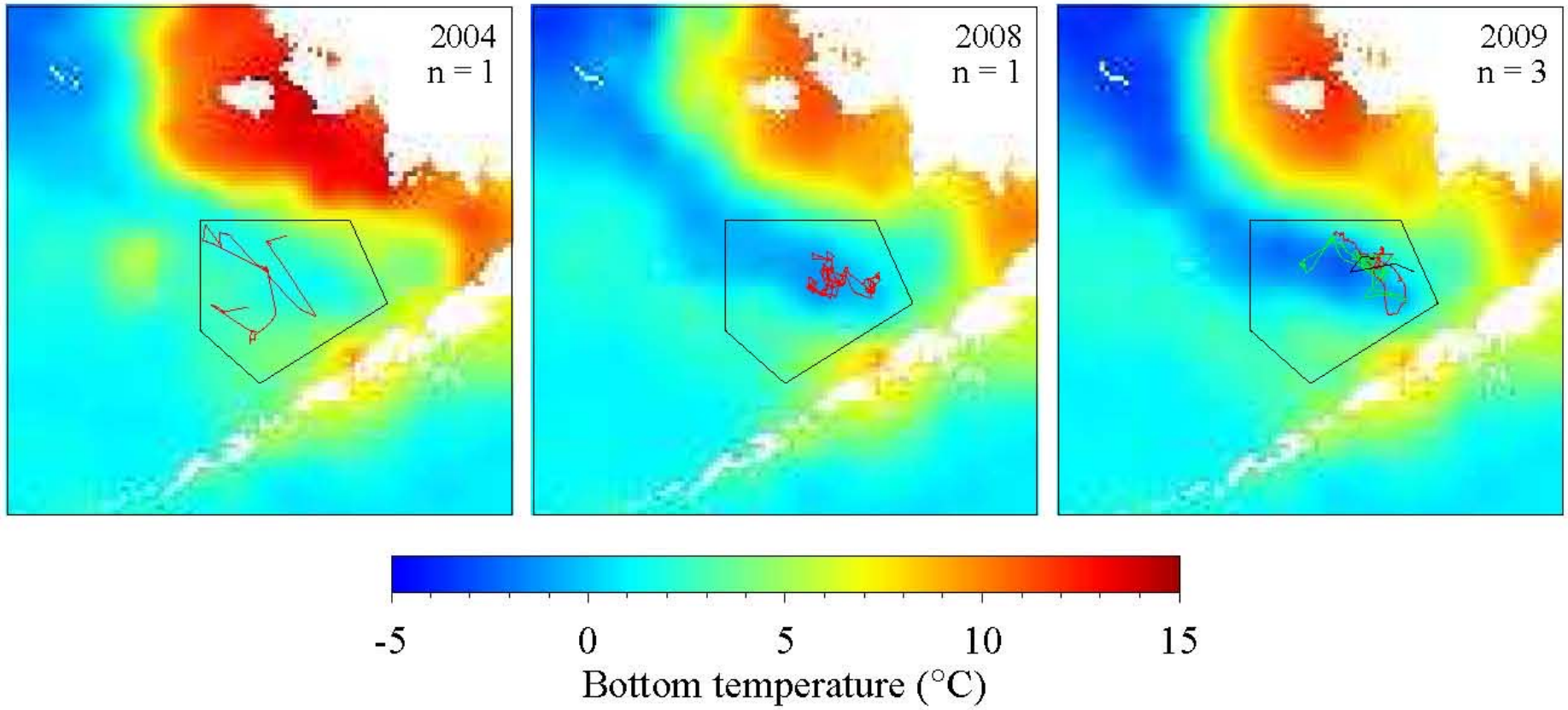
Published July 21

Space use patterns of the endangered North Pacific right whale *Eubalaena japonica* in the Bering Sea

Alexandre N. Zerbini[1,2,*], Mark F. Baumgartner[3], Amy S. Kennedy[1], Brenda K. Rone[1], Paul R. Wade[1], Phillip J. Clapham[1]



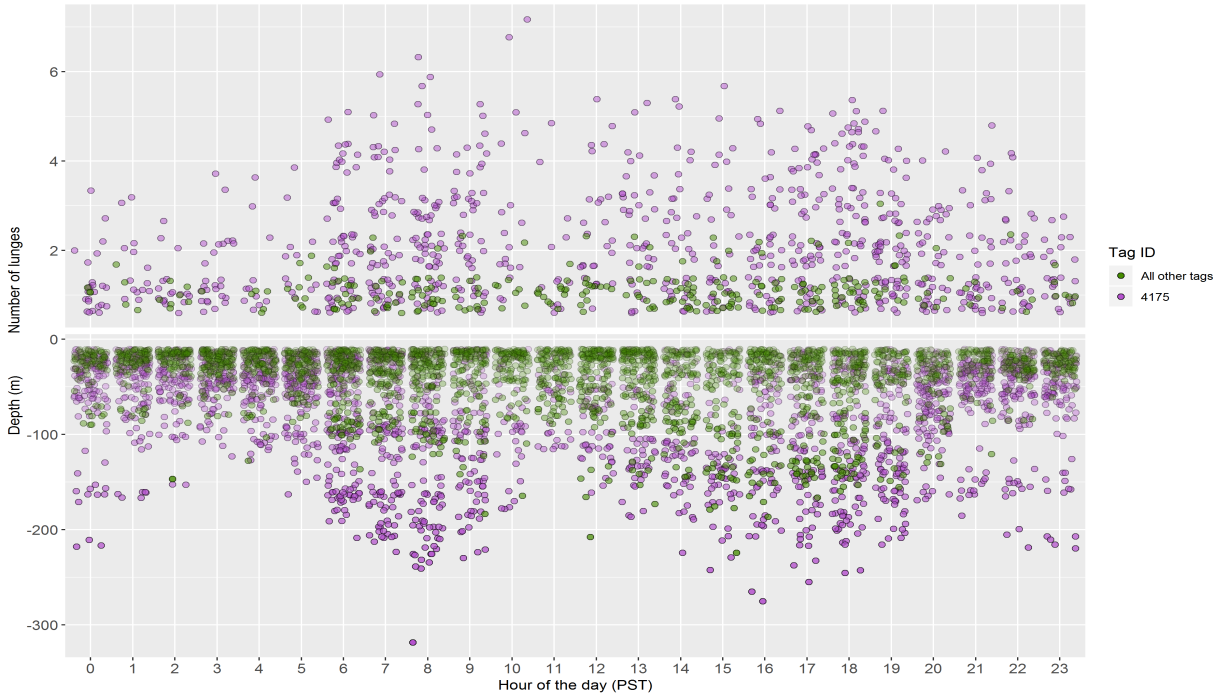
Palacios *et al. Animal Biotelemetry* (2022) 10:26
https://doi.org/10.1186/s40317-022-00297-9

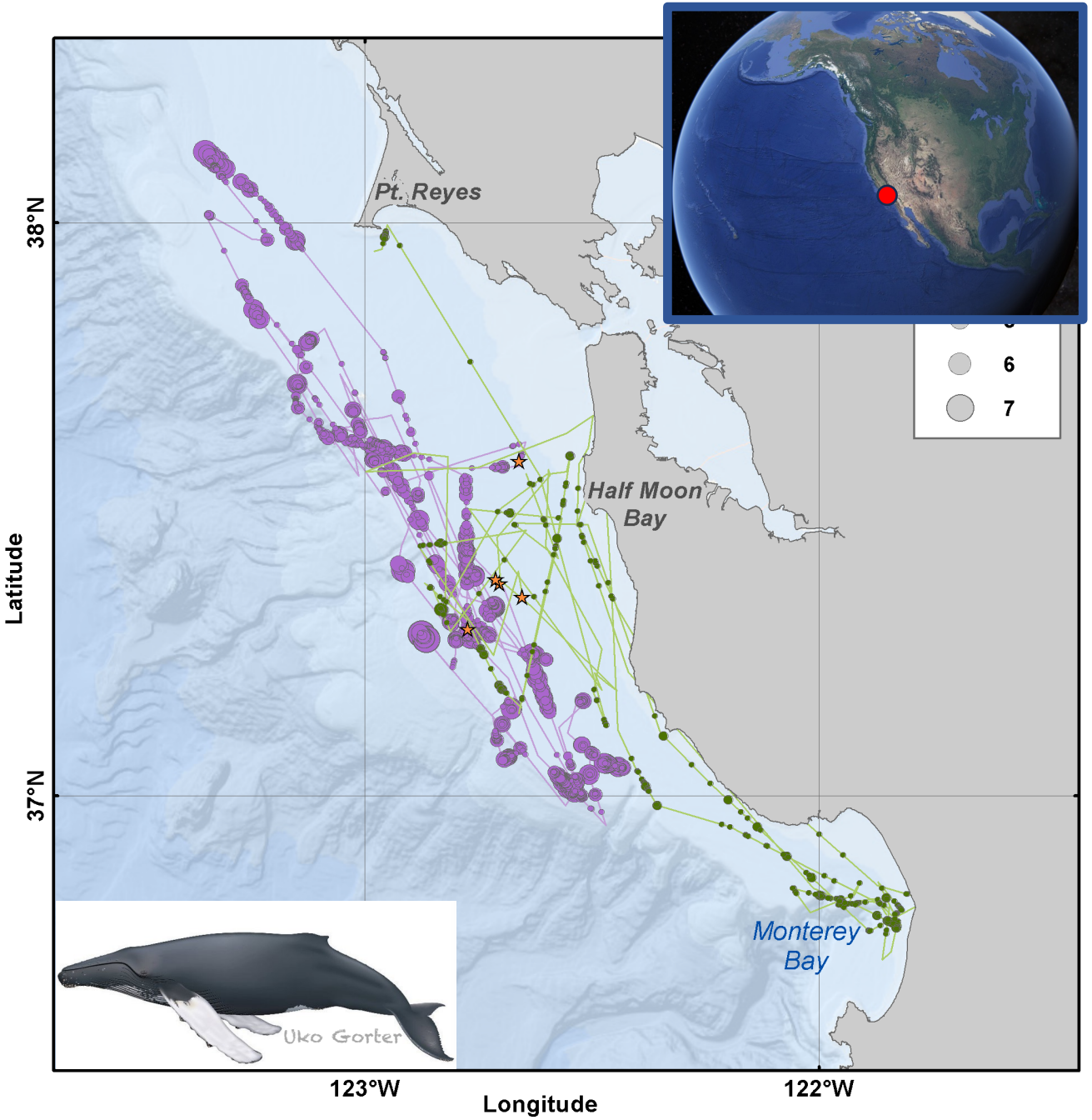
Animal Biotelemetry

METHODOLOGY Open Access

A satellite-linked tag for the long-term monitoring of diving behavior in large whales

Daniel M. Palacios[1,2*†], Ladd M. Irvine[1,2†], Barbara A. Lagerquist[1,2], James A. Fahlbusch[3,4], John Calambokidis[4], Stanley M. Tomkiewicz[5] and Bruce R. Mate[1,2]





nature communications

Article

https://doi.org/10.1038/s41467-023-40849-y

Impacts of marine heatwaves on top predator distributions are variable but predictable

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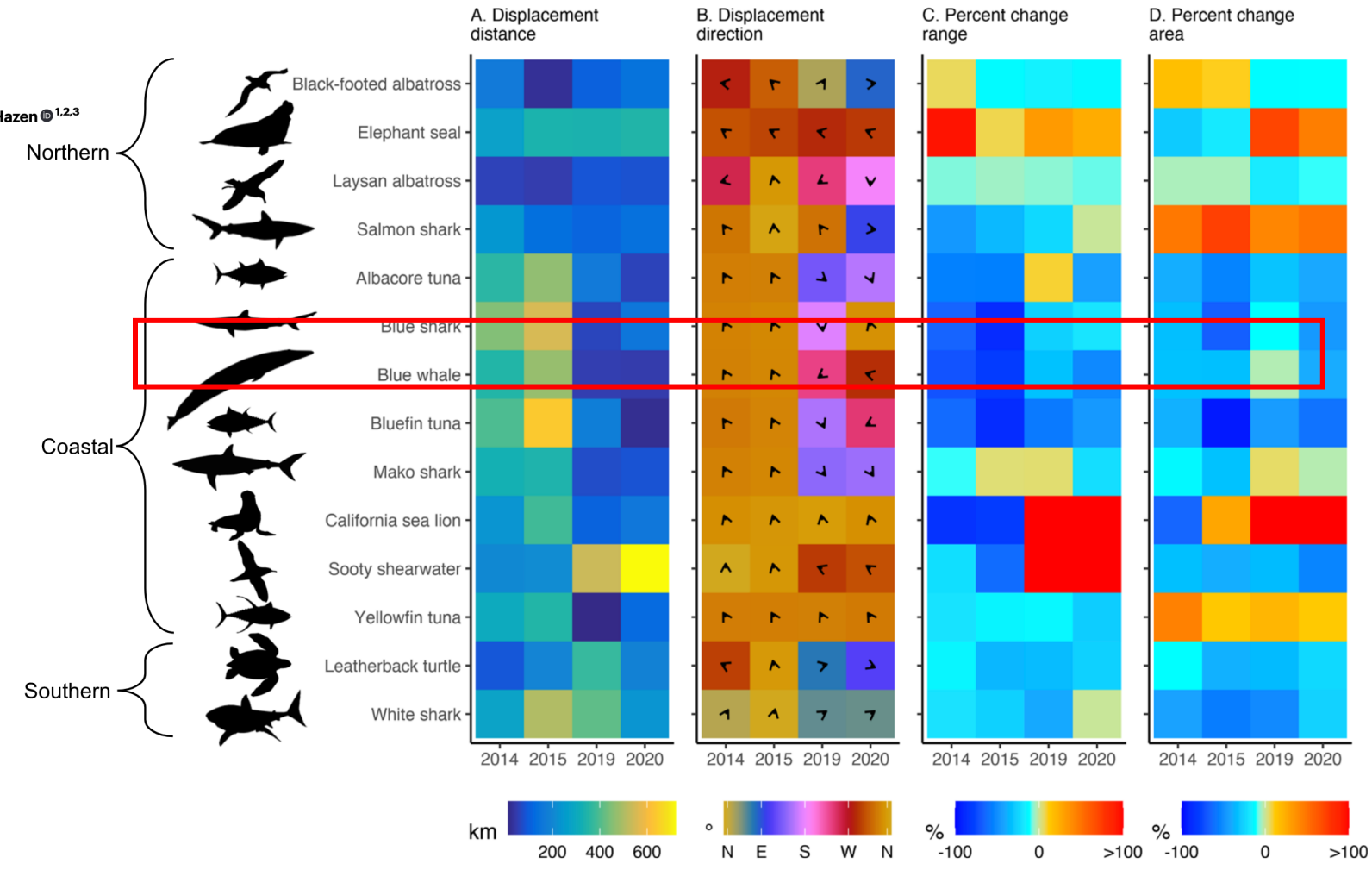
Accepted: 11 August 2023

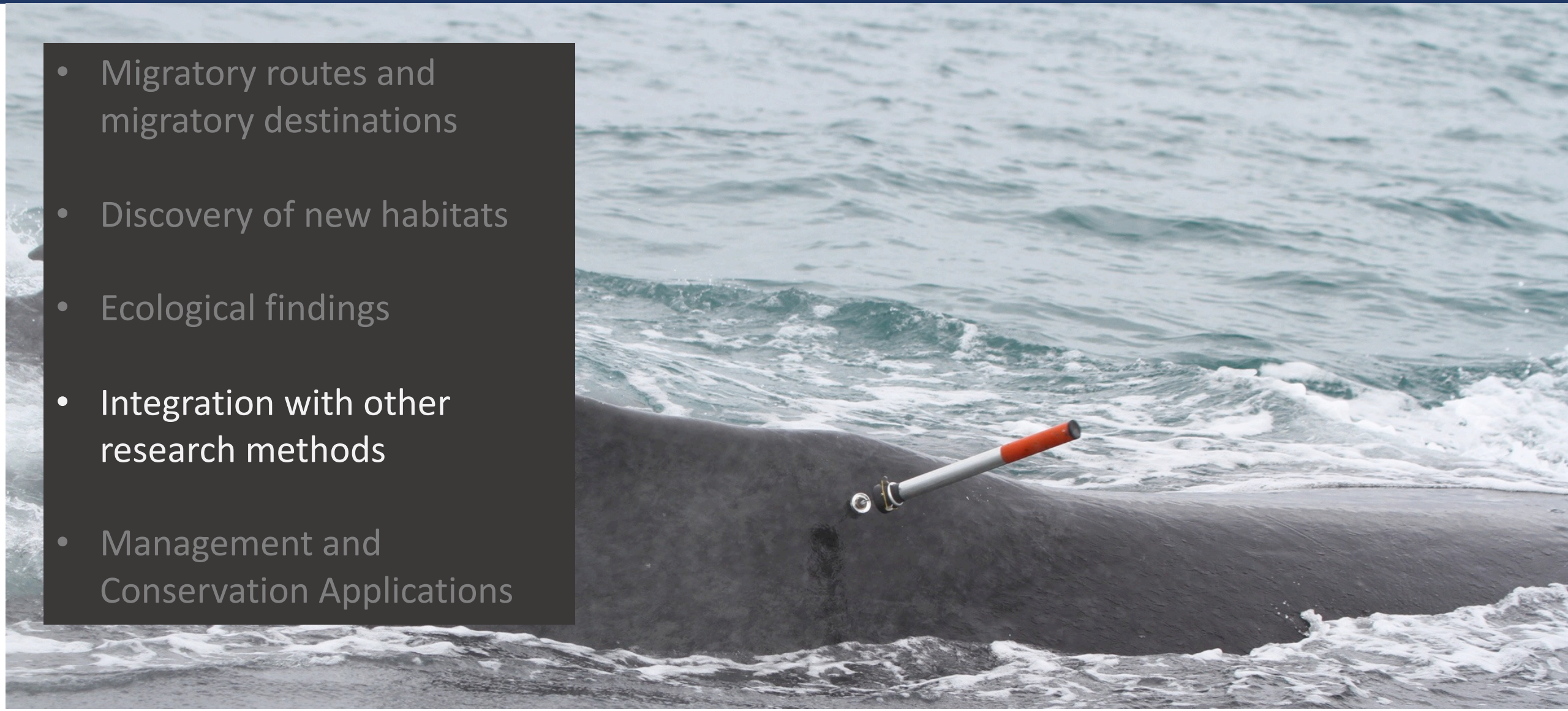
Published online: 05 September 2023

Check for updates

Heather Welch[1,2] ✉, Matthew S. Savoca[3], Stephanie Brodie[1,2], Michael G. Jacox[1,2,4], Barbara A. Muhling[2,5], Thomas A. Clay[1,2,6], Megan A. Cimino[1,2], Scott R. Benson[7,8], Barbara A. Block[3], Melinda G. Conners[9], Daniel P. Costa[2,10], Fredrick D. Jordan[9], Andrew W. Leising[1], Chloe S. Mikles[3], Daniel M. Palacios[11,12], Scott A. Shaffer[13], Lesley H. Thorne[9], Jordan T. Watson[14,15], Rachel R. Holser[2], Lynn Dewitt[1], Steven J. Bograd[1,2] & Elliott L. Hazen[1,2,3]



Main Findings and Applications



- Migratory routes and migratory destinations
- Discovery of new habitats
- Ecological findings
- Integration with other research methods
- Management and Conservation Applications

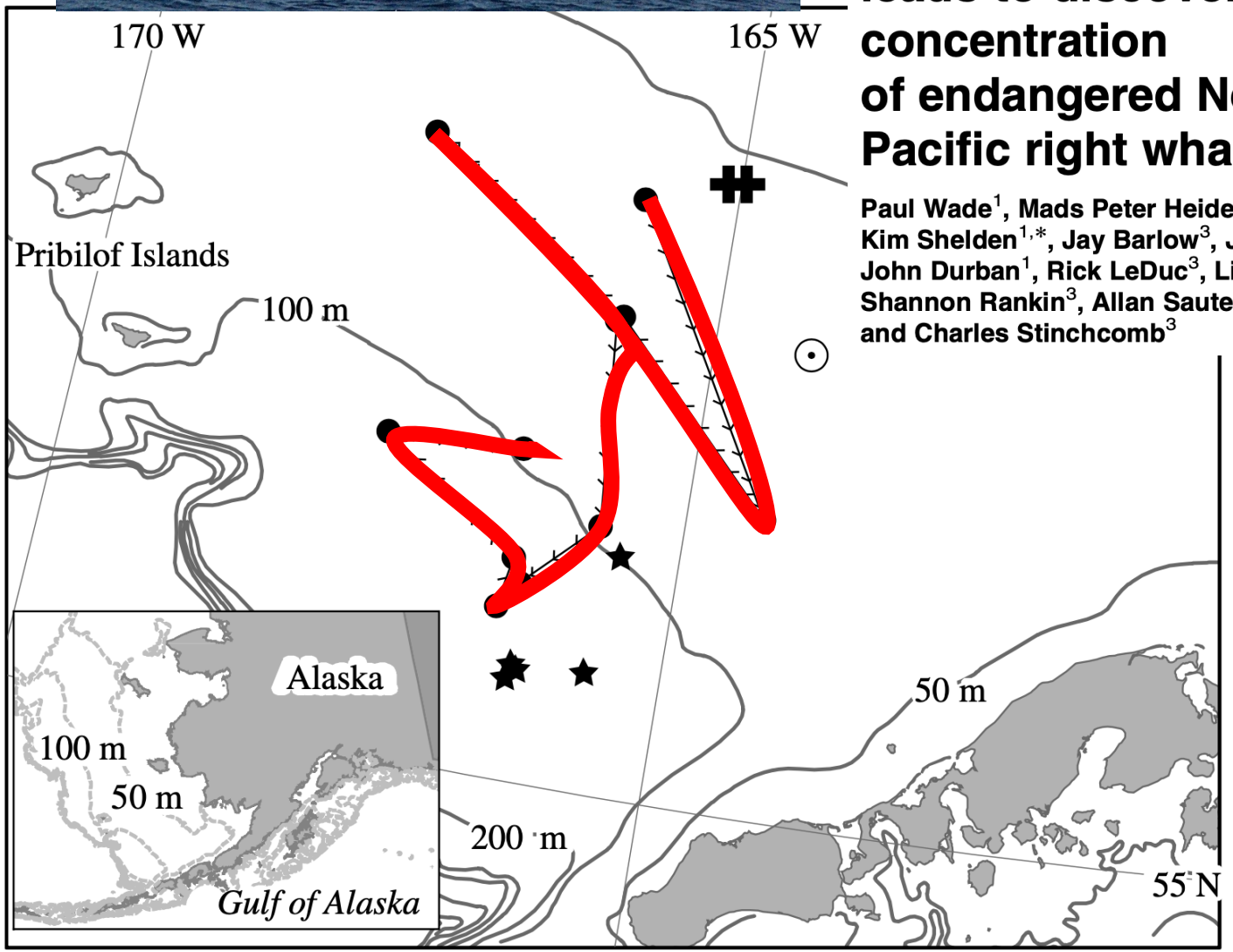
- Discovery of the larger aggregation of NPRWs since the 1960s.
- Photo-identification and biopsy samples from at least 17 individuals.
- Data contributed significantly to the only estimate of abundance of this critically endangered population (~30 whales).

biology letters

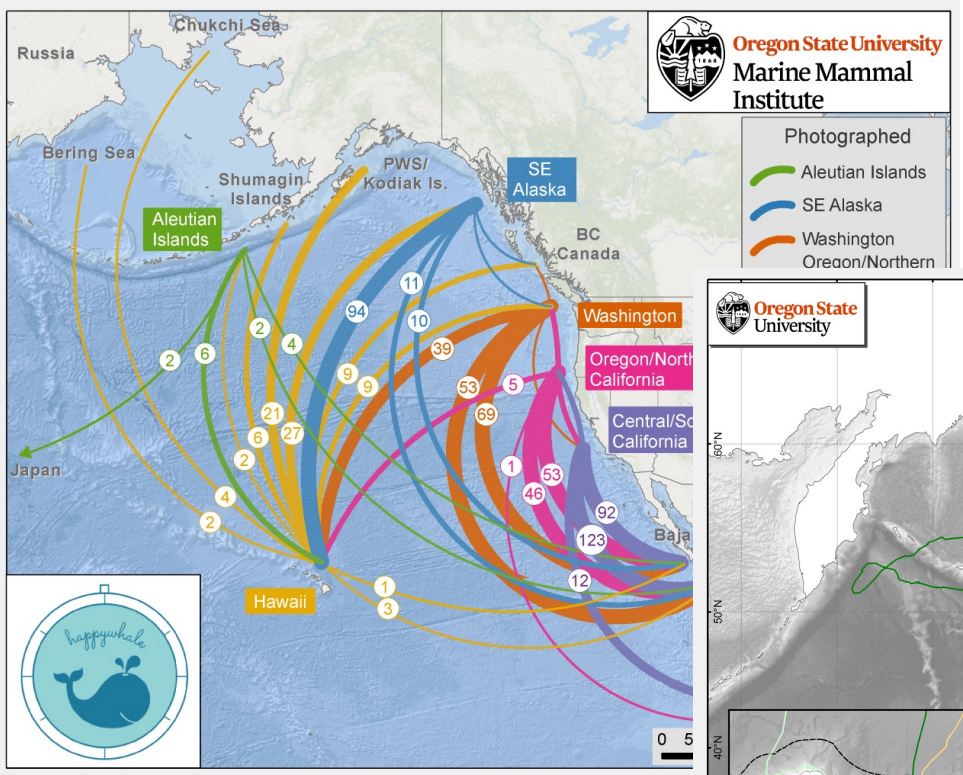
Biol. Lett.
doi:10.1098/rsbl.2006.0460
Published online

Acoustic detection and satellite-tracking leads to discovery of rare concentration of endangered North Pacific right whales

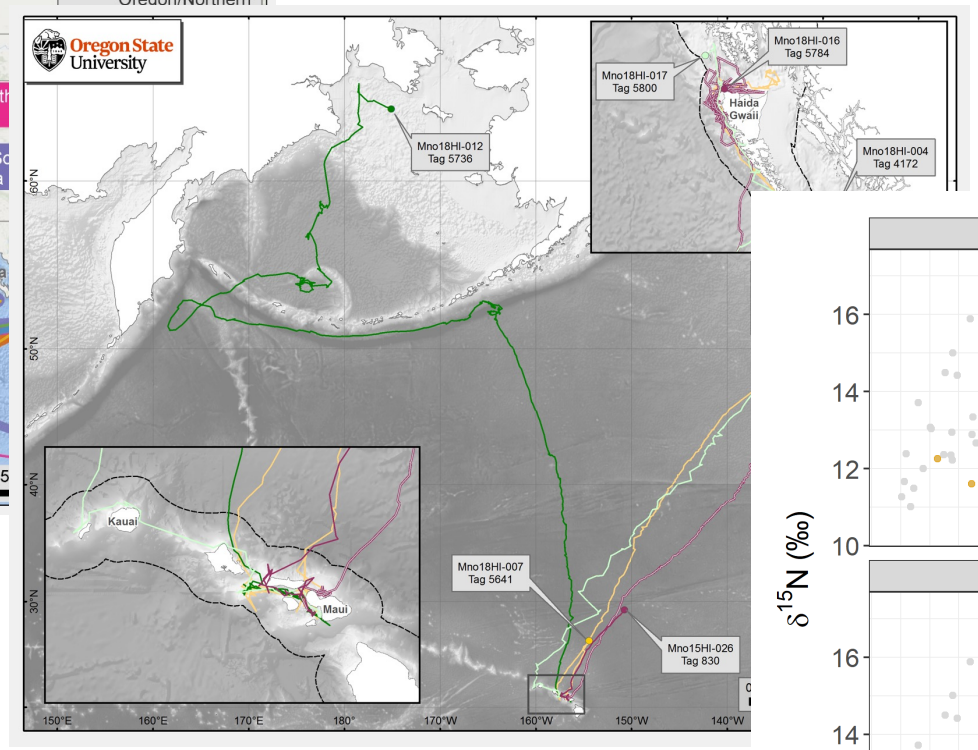
Paul Wade[1], Mads Peter Heide-Jørgensen[2], Kim Shelden[1,*], Jay Barlow[3], James Carretta[3], John Durban[1], Rick LeDuc[3], Lisa Munger[4], Shannon Rankin[3], Allan Sauter[4] and Charles Stinchcomb[3]

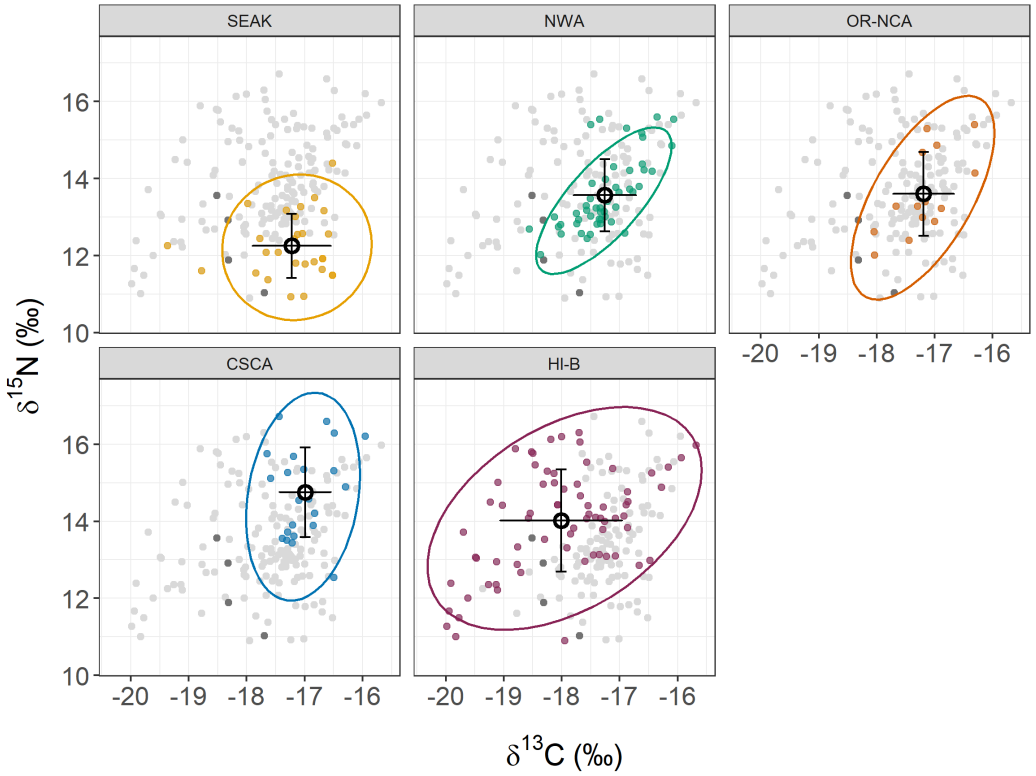


Augmenting tagging data…



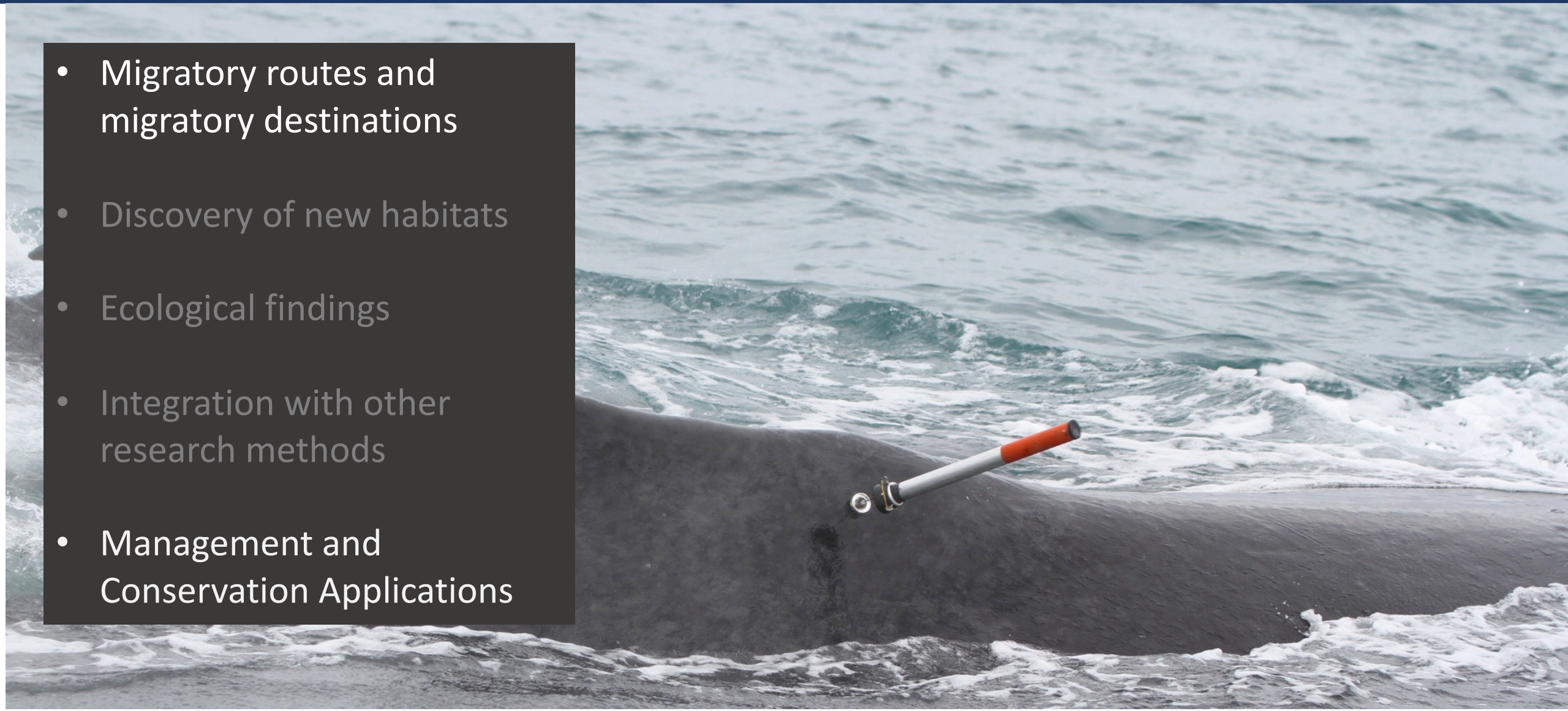
- Photo-ID (sighting history, tag effects)
- Genetics (population structure)
- Stable isotopes (feeding ecology)





Main Findings and Applications

- Migratory routes and migratory destinations
- Discovery of new habitats
- Ecological findings
- Integration with other research methods
- Management and Conservation Applications



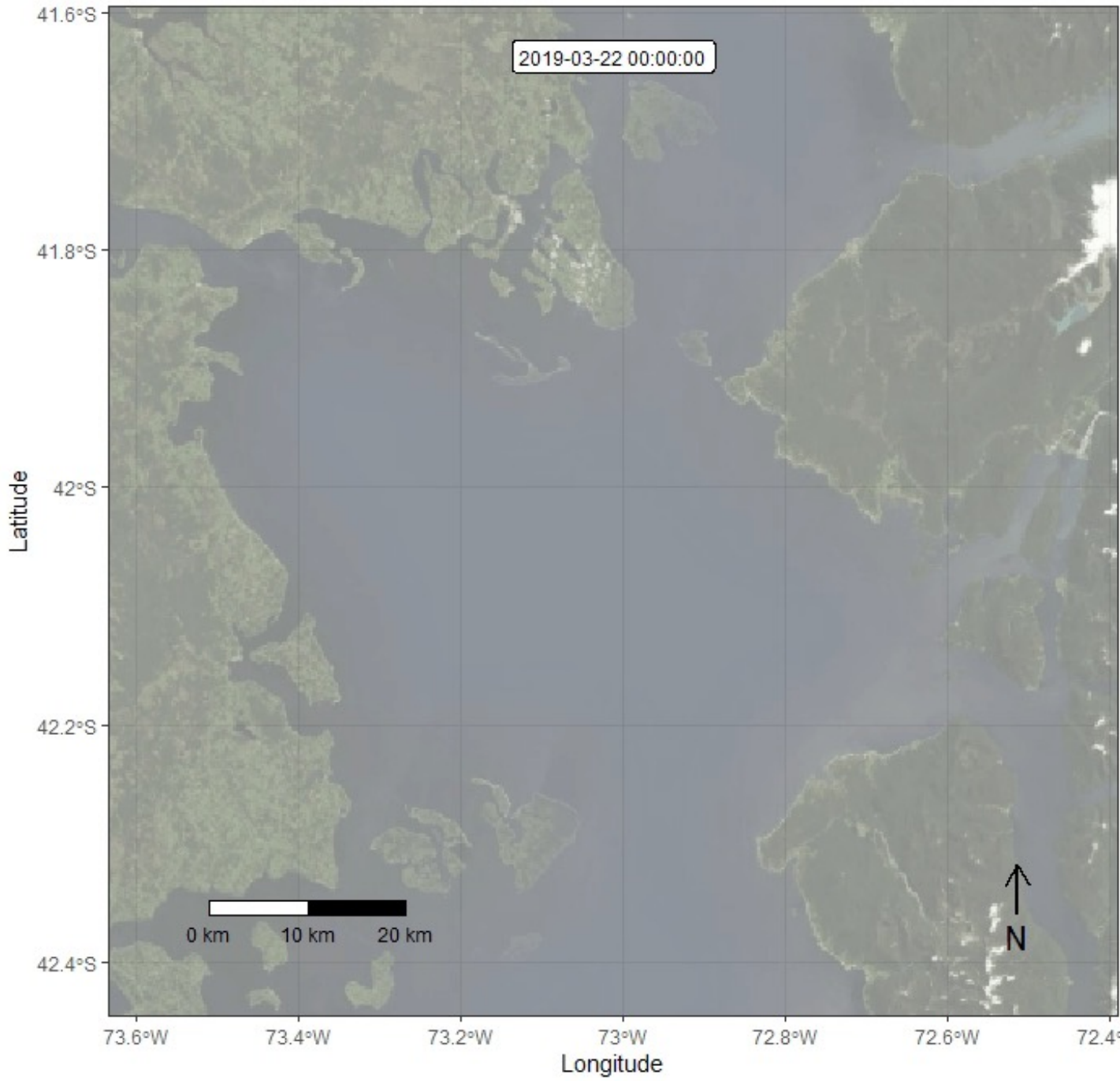
Ship strike risk assessm

scientific reports

OPEN

Defining priority areas for blue whale conservation and investigating overlap with vessel traffic in Chilean Patagonia, using a fast-fitting movement model

Luis Bedriñana-Romano[1,2]✉, Rodrigo Hucke-Gaete[1,2]✉, Francisco A. Viddi[1,2], Devin Johnson[3], Alexandre N. Zerbini[3,4,5,6], Juan Morales[7], Bruce Mate[8] & Daniel M. Palacios[8]



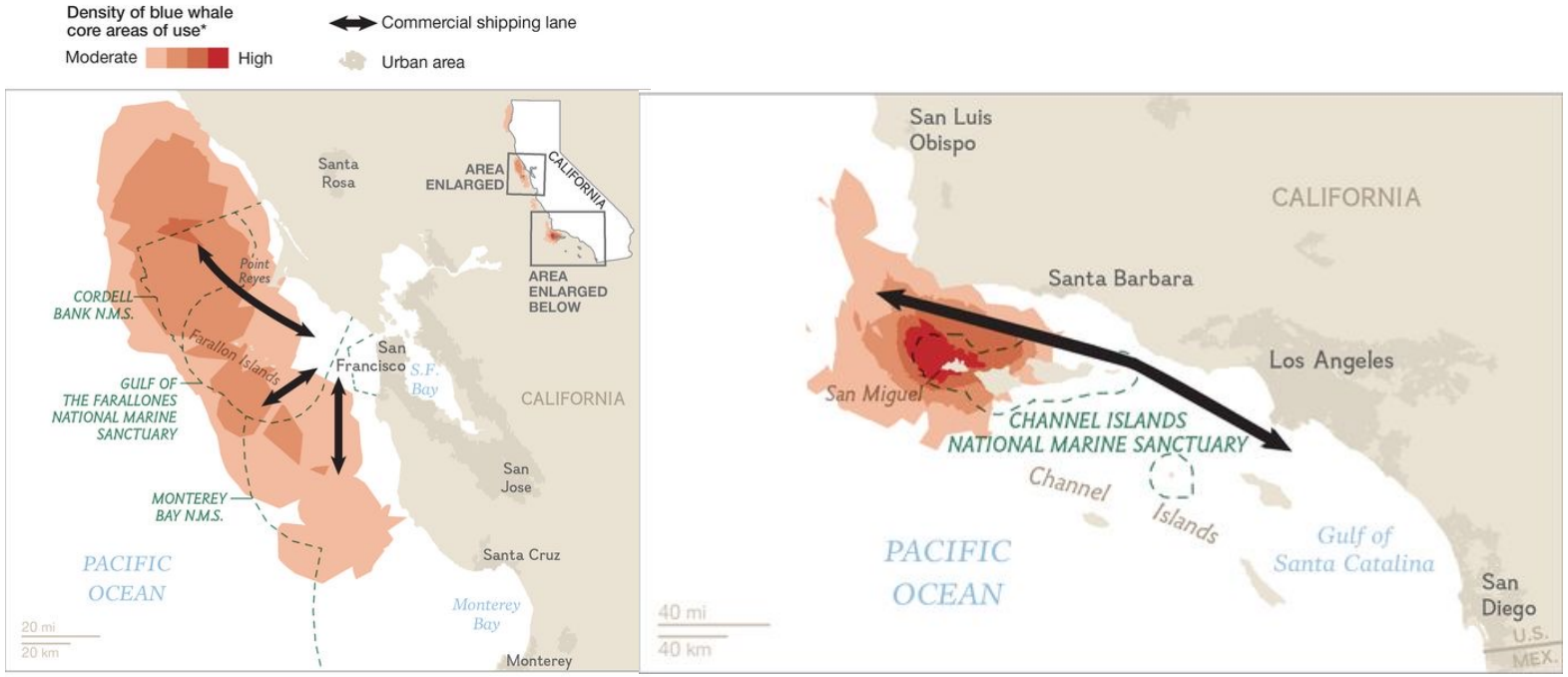
Ship strike risk assessment

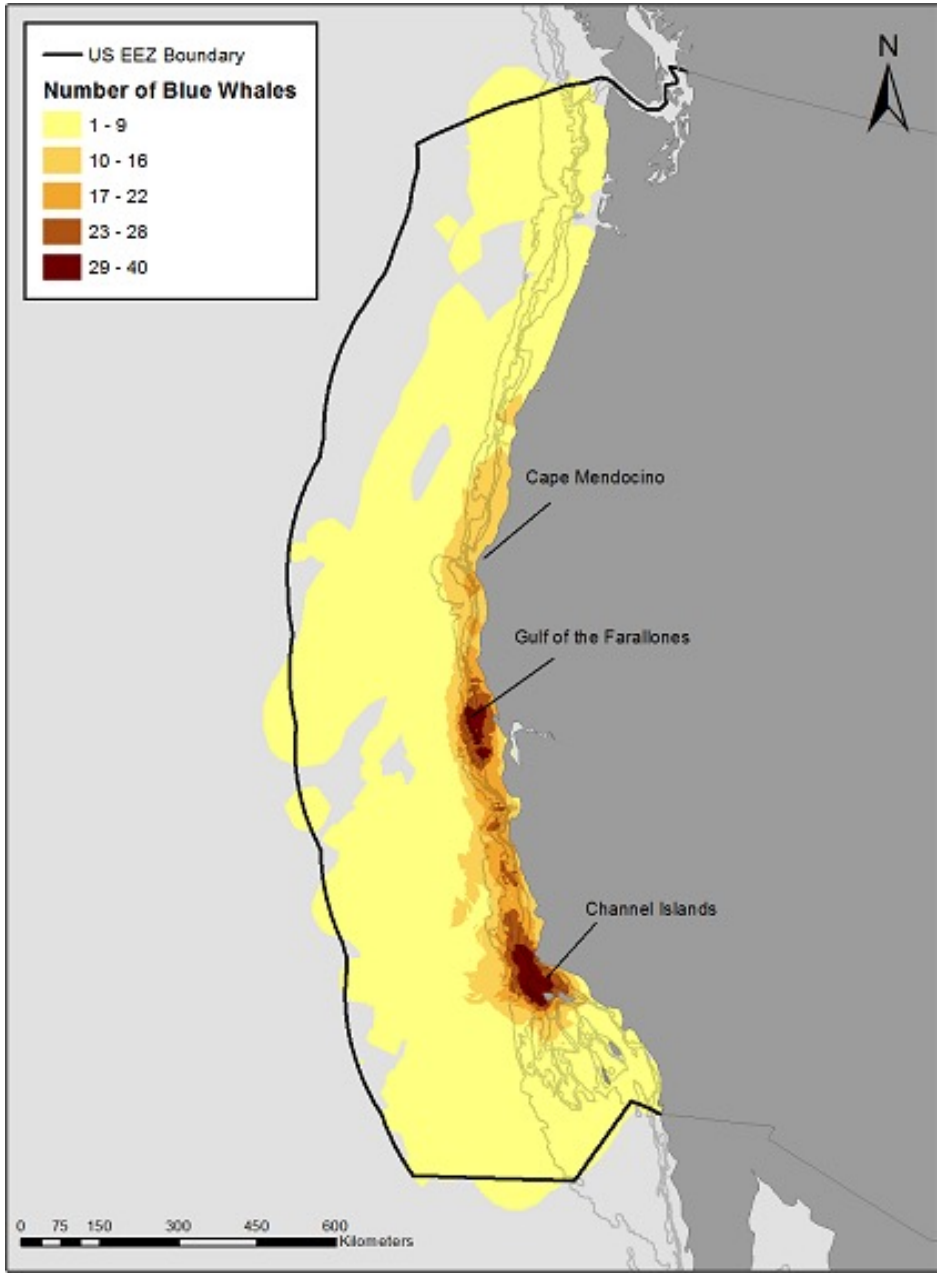
OPEN ACCESS Freely available online

PLOS ONE

Spatial and Temporal Occurrence of Blue Whales off the U.S. West Coast, with Implications for Management

Ladd M. Irvine[1]*, Bruce R. Mate[1], Martha H. Winsor[1], Daniel M. Palacios[2,3¤], Steven J. Bograd[3], Daniel P. Costa[4], Helen Bailey[5]





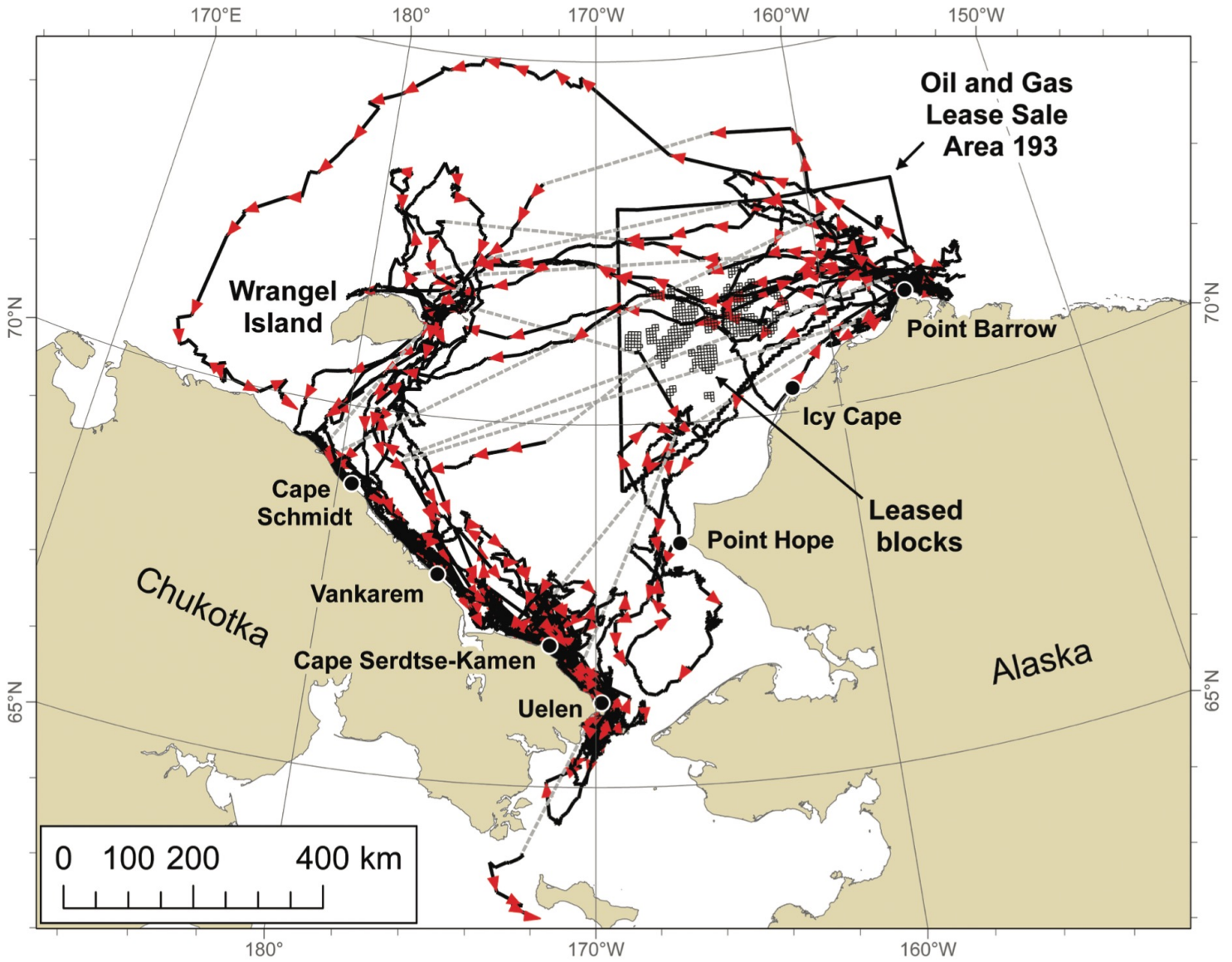
Evaluate habitat use in the energy industry areas

ARCTIC
VOL. 63, NO. 3 (SEPTEMBER 2010) P. 289–307

Fall and Winter Movements of Bowhead Whales (*Balaena mysticetus*) in the Chukchi Sea and Within a Potential Petroleum Development Area

LORI T. QUAKENBUSH,[1,2] JOHN J. CITTA,[1] JOHN C. GEORGE,[3] ROBERT J. SMALL[4] and MADS PETER HEIDE-JØRGENSEN[5]

- Assessment of spatial/temporal habitat use of bowhead whales during their seasonal migration in an Oil and Gas lease area in the Arctic.



Revising humpback whale BIAs: Hawai‘i

frontiers | Frontiers in Marine Science

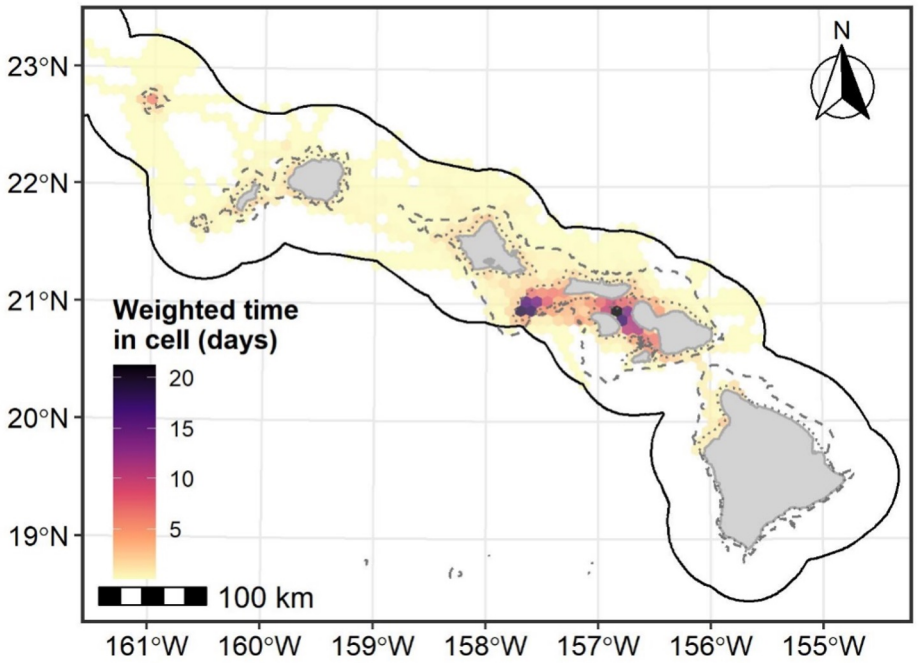
TYPE Original Research
PUBLISHED 26 January 2023
DOI 10.3389/fmars.2023.1053581

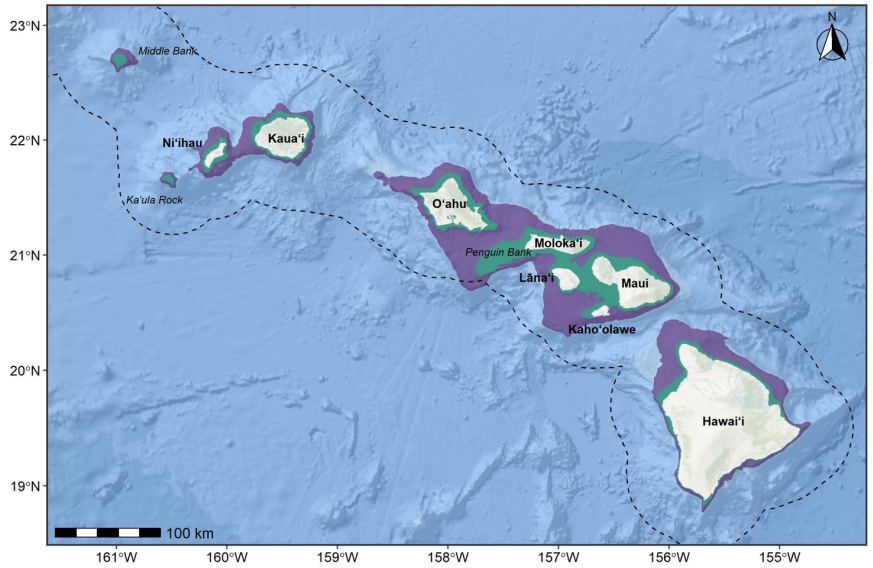
Biologically Important Areas II for cetaceans within U.S. and adjacent waters – Hawai‘i Region

Michaela A. Kratofil[1], Annette E. Harnish[1], Sabre D. Mahaffy[1], E. Elizabeth Henderson[2], Amanda L. Bradford[3], Stephen W. Martin[4], Barbara A. Lagerquist[5,6], Daniel M. Palacios[5,6], Erin M. Oleson[3] and Robin W. Baird[1]*

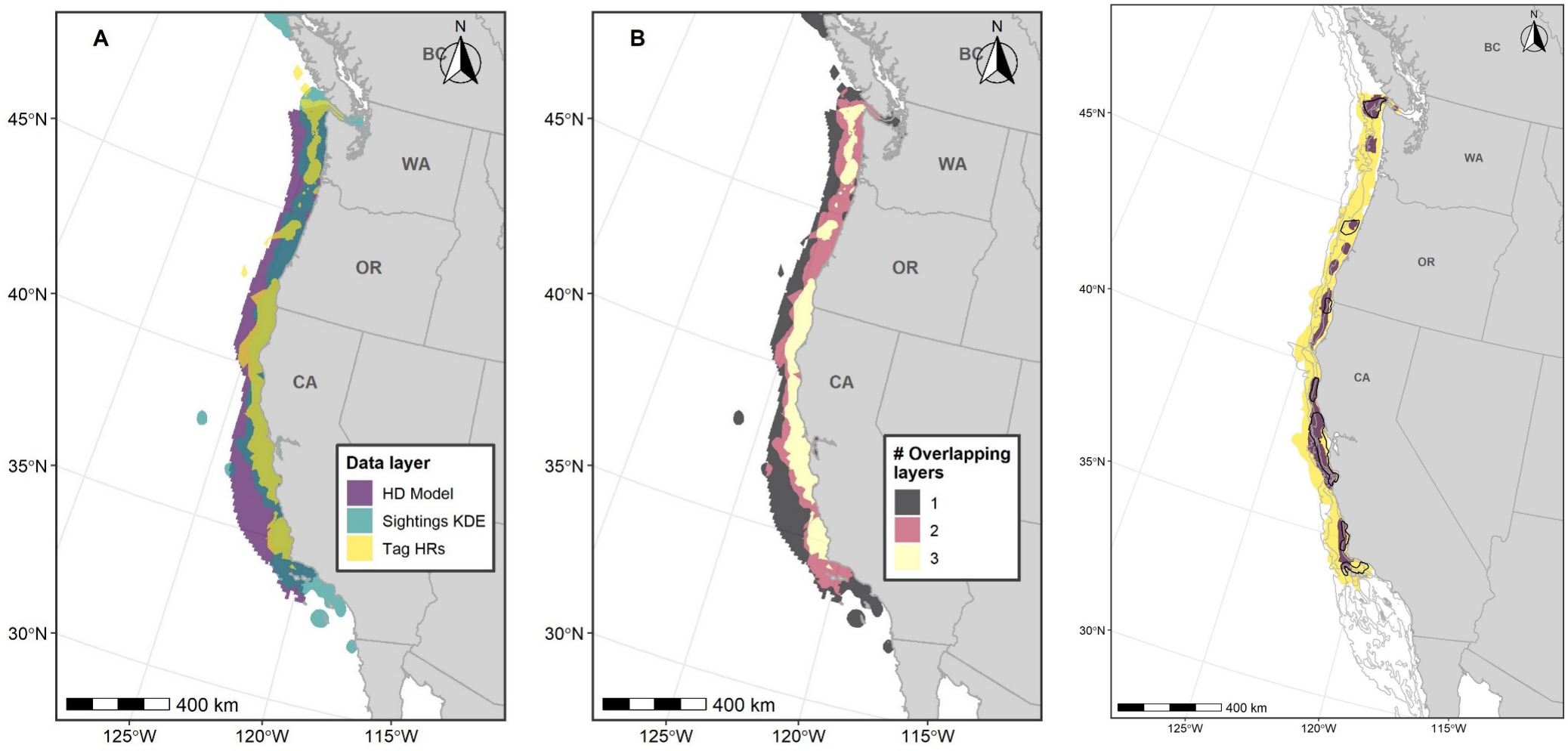
[1]Cascadia Research Collective, Olympia, WA, United States, [2]Naval Information Warfare Center Pacific, San Diego, CA, United States, [3]Pacific Islands Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Honolulu, HI, United States, [4]National Marine Mammal Foundation, San Diego, CA, United States, [5]Marine Mammal Institute, Oregon State University, Newport, OR, United States, [6]Department of Fisheries, Wildlife, and Conservation Sciences, Oregon State University, Corvallis, OR, United States

Tagged whale spatial occupancy pattern





Revising humpback whale BIAs: West Coast

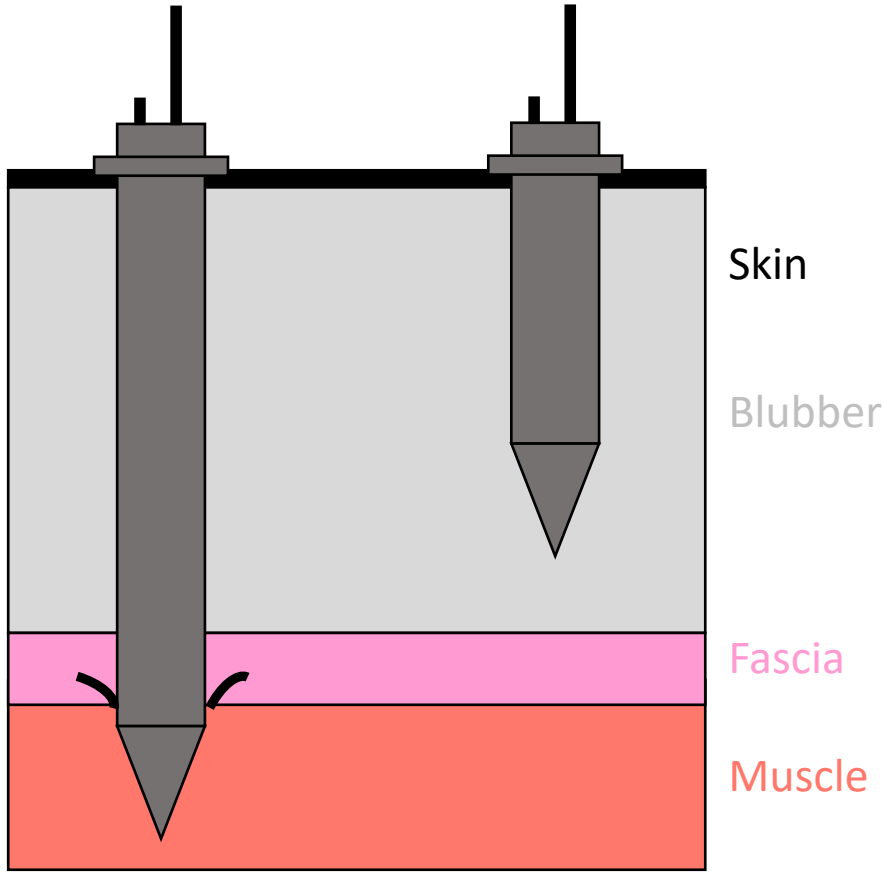


Calambokidis et al. Submitted. Biologically Important Areas II for cetaceans within U.S. and adjacent waters – West Coast Region. *Frontiers in Marine Science*.

Development of a “blubber” tag for right whales

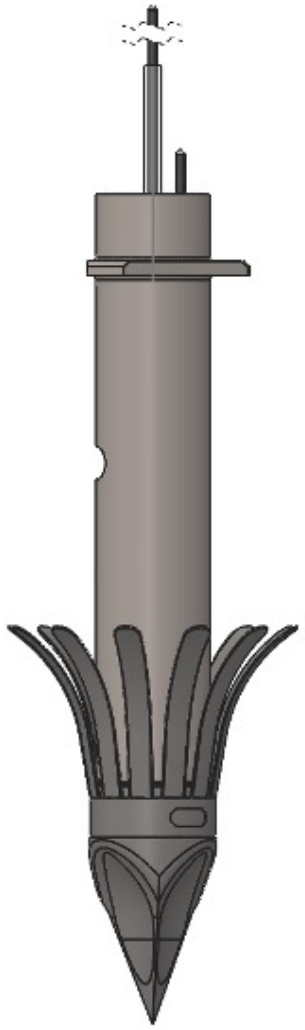
L: 11.8 in
D: 0.95 in
W: 390 g

L: 5.1 in
D: 0.95 in
W: 180 g

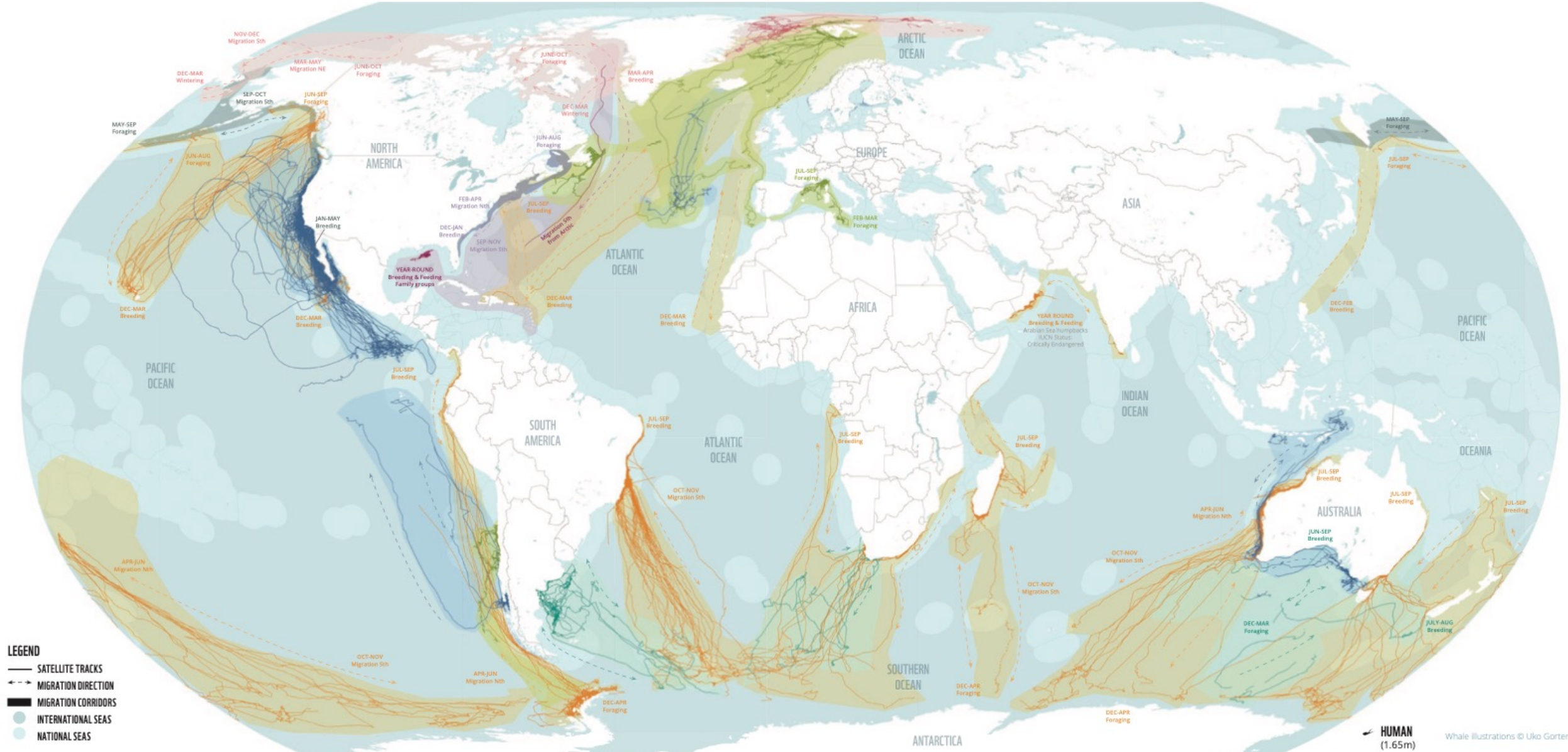


- Develop a tag for right whales that could fill a gap between Type A (e.g., LIMPET) and longer Type-C tags:

- Planned tag features:
  - Embedded electronics
  - Deployment in the blubber (minimize invasiveness)
  - Medium term-duration (~30 days on average)
  - Added benefit: possible application in other smaller whale species (e.g., Rice’s, Bryde’s, sei and minke whales).



23.2 days



FIN WHALES
(Balaenoptera physalus)

IUCN Status: Vulnerable
Length: 17-20m
Population: ~100,000

BOWHEAD WHALES
(Balaena mysticetus)

IUCN Status: Least concern
Length: 13-15m
Population: ~10,000

GRAY WHALES
(Eschrichtius robustus)

IUCN Status: Least concern
Length: 12-14m
Population: ~27,000

NORTH ATLANTIC RIGHT WHALES
(Eubalaena glacialis)

IUCN Status: Critically Endangered
Length: 13-16m
Population: ~350

HUMPBACK WHALES
(Megaptera novaeangliae)

IUCN Status: Least concern
Length: 13-16m
Population: ~84,000

SOUTHERN RIGHT WHALES
(Eubalaena australis)

IUCN Status: Least concern
Length: 15-18m
Population: ~13,600

SPERM WHALES
(Macrocephalus physeter)

IUCN Status: Vulnerable
Length: 11-20m
Population: ~350,000

BLUE WHALES
(Balaenoptera musculus)

IUCN Status: Endangered
Length: 24-26m
Population: ~5,000–15,000