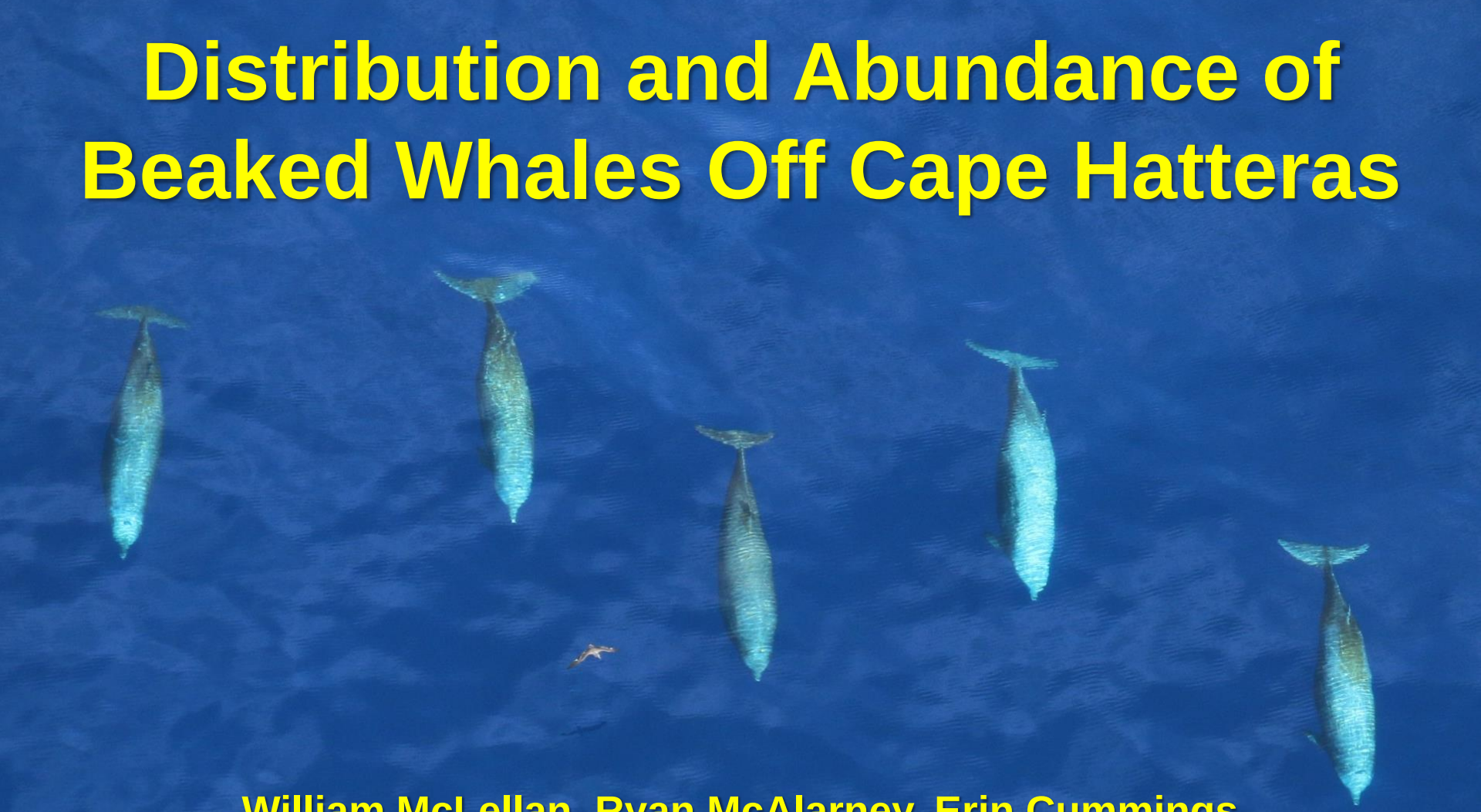
Distribution and Abundance of Beaked Whales Off Cape Hatteras



William McLellan, Ryan McAlarney, Erin Cummings,
Andy Read, Charles Paxton, Joel Bell and Ann Pabst

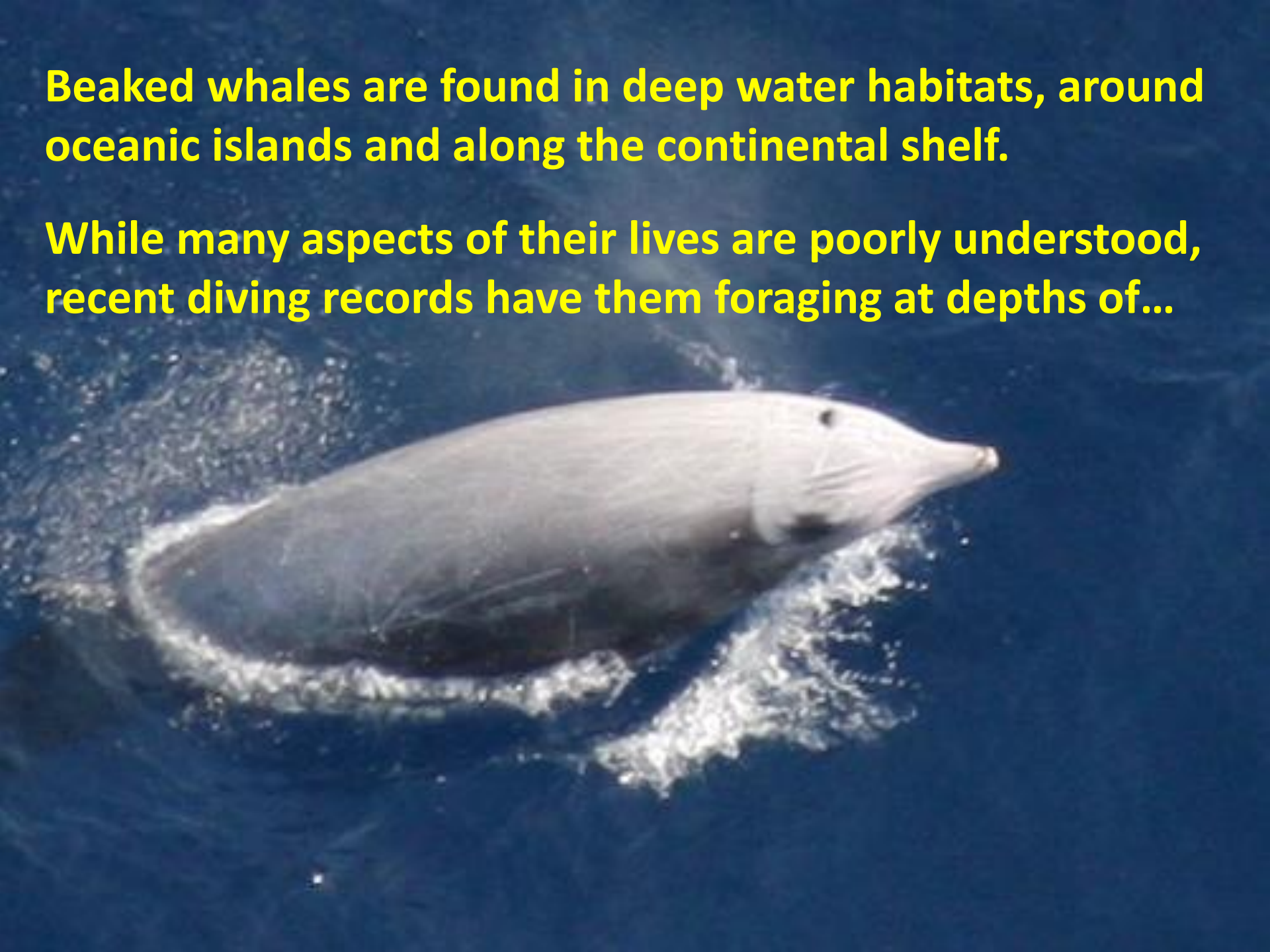
UNCW

Duke
NICHOLAS SCHOOL OF THE ENVIRONMENT

St. Andrews
UNIVERSITY
A Branch of Webber International University

NAVFAC
Naval Facilities Engineering Command

UNCW Aerial Survey, under NOAA permit

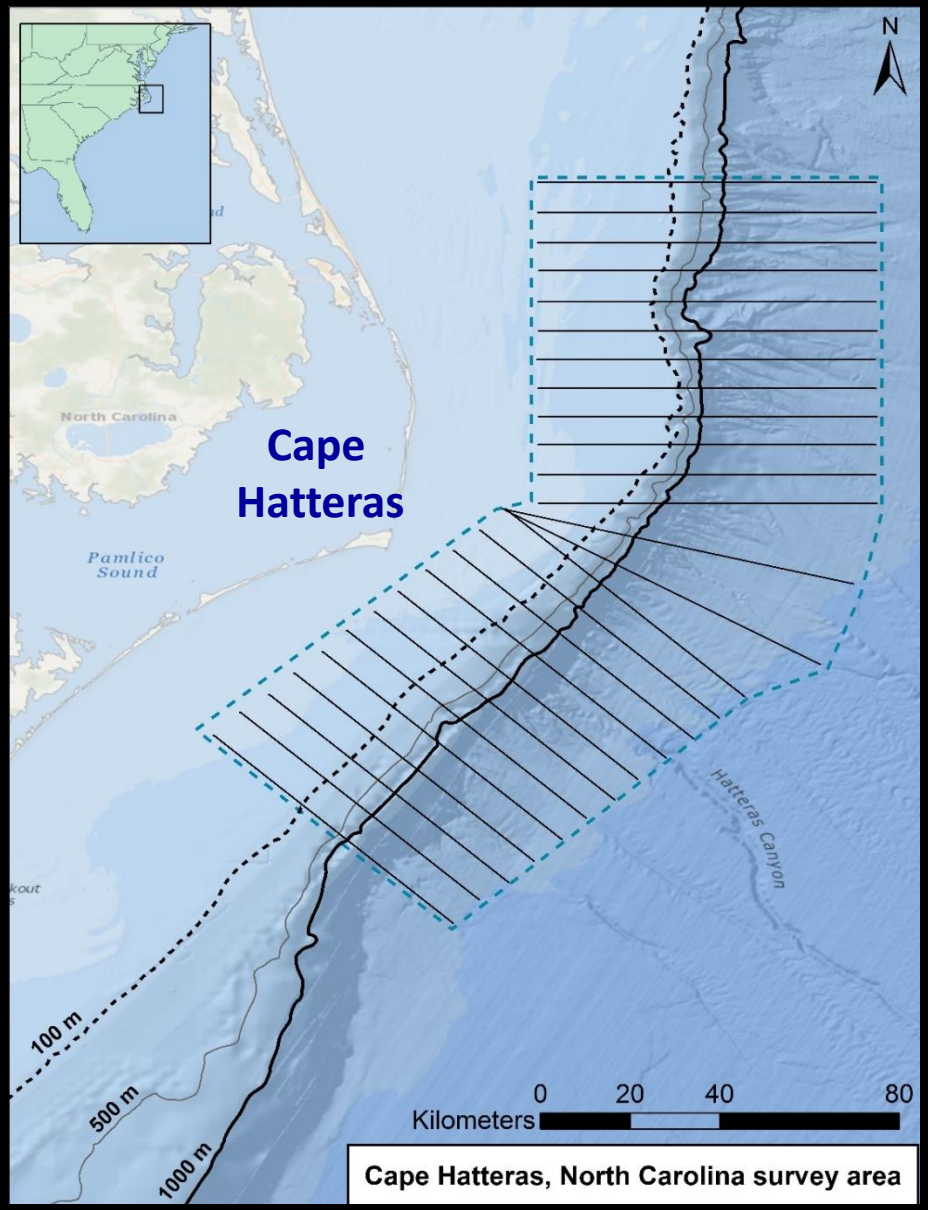


Beaked whales are found in deep water habitats, around oceanic islands and along the continental shelf.

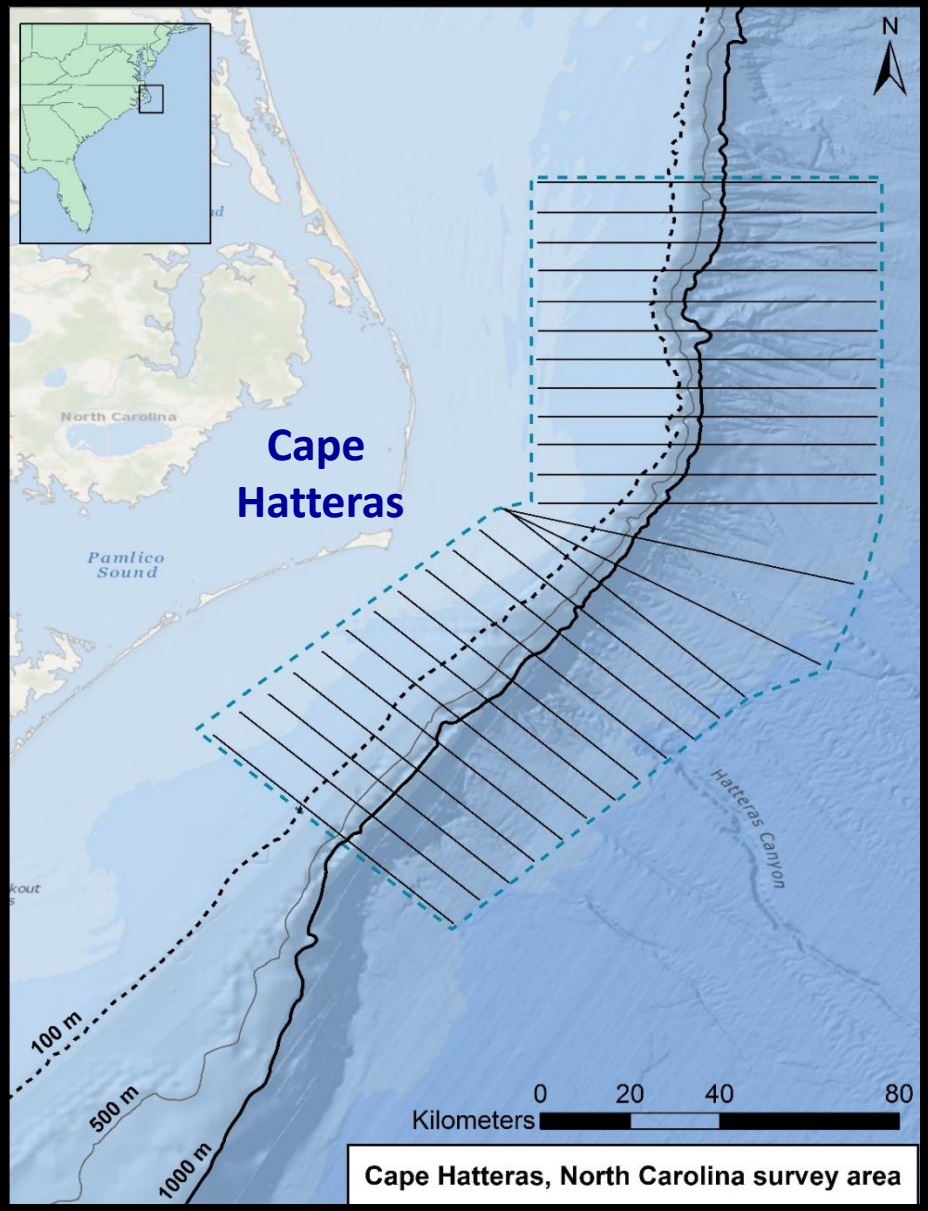
While many aspects of their lives are poorly understood, recent diving records have them foraging at depths of…


Beaked whales are found in deep water habitats, around oceanic islands and along the continental shelf.
While many aspects of their lives are poorly understood, recent diving records have them foraging at depths of…
2600m for over 2hrs!
Schorr *et al*. 2017

Distribution & Abundance of Beaked Whales

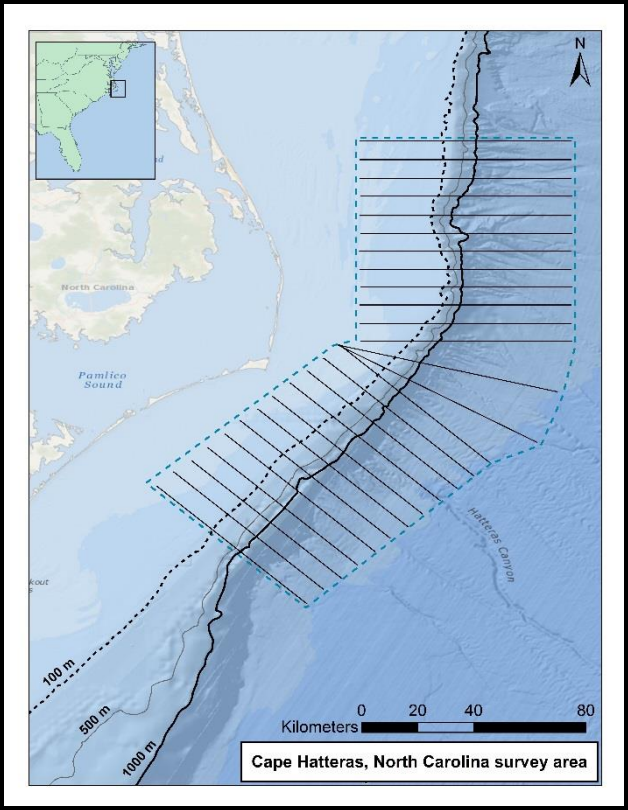


Distribution & Abundance of Beaked Whales



AFTT Navy Monitoring

Seismic Surveys



AERIAL SURVEYS

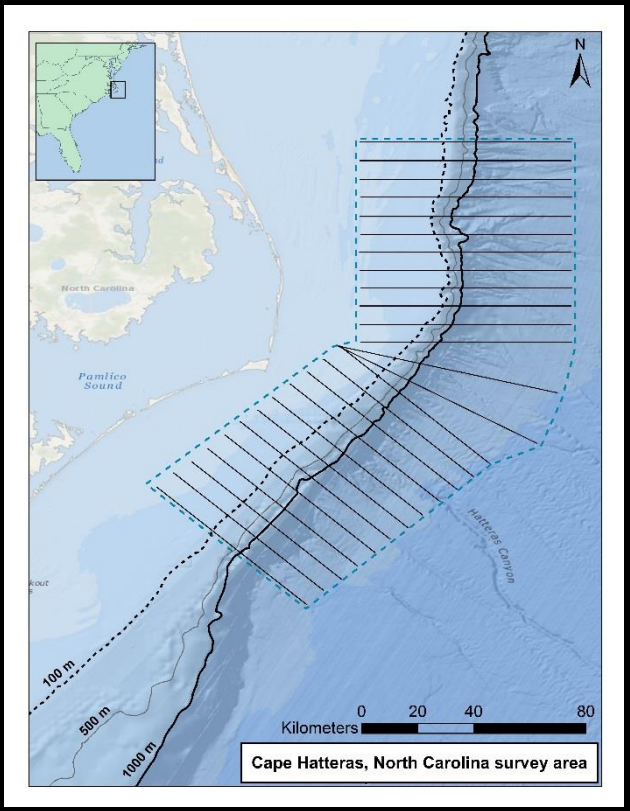
May 2011 – November 2015

Year-round monthly surveys

Targeted low BSS

Highly Skilled Observers

Protocols suggested in Barlow *et al.* 2006



AERIAL SURVEYS

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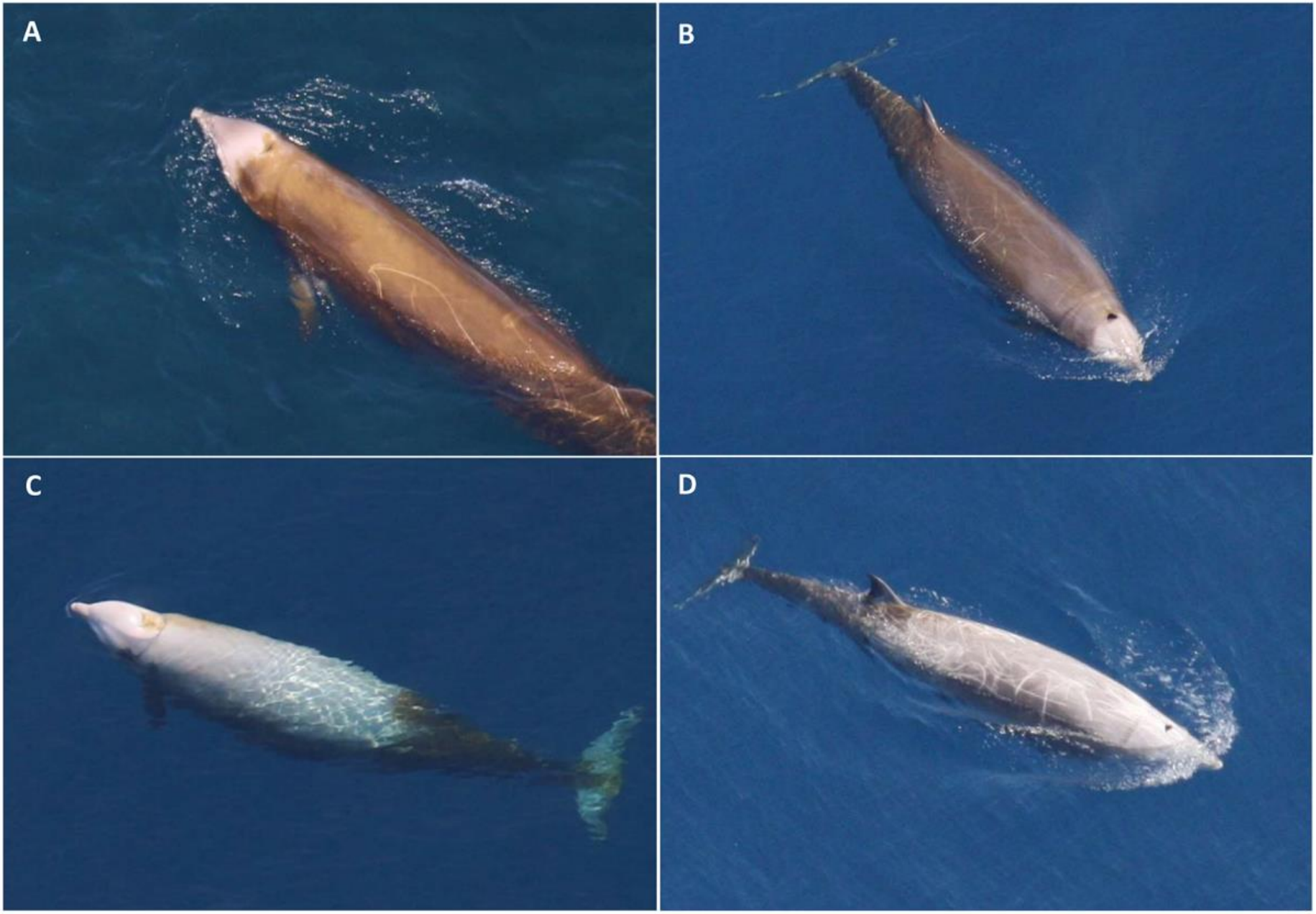
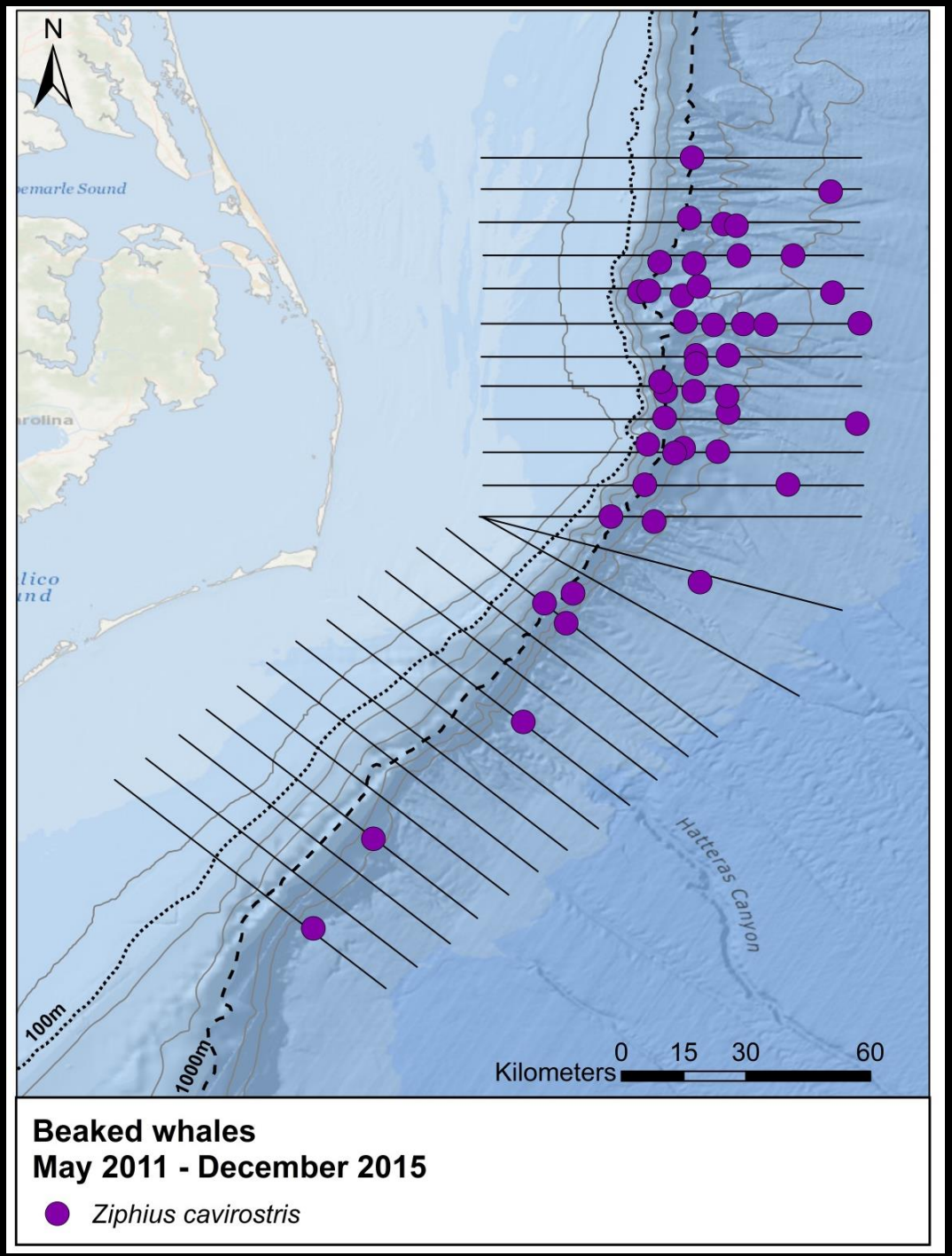
Month	Effort (km) 2011	Effort (km) 2012	Effort (km) 2013	Effort (km) 2014	Effort (km) 2015	Total Effort (km) 2011 - 2015	Total Sightings
January	0	1325	0	0	0	1325	**3**
February	0	582	0	583	0	1165	**2**
March	0	1456	149	0	0	1605	**2**
April	0	0	0	1010	0	1010	**2**
May	766	1160	709	407	492	3534	**19**
June	964	1901	0	1068	549	4482	**9**
July	1031	0	1755	1192	142	4120	**9**
August	0	701	1744	1164	648	4257	**12**
September	0	735	0	0	635	1370	**3**
October	1184	0	556	990	0	2730	**2**
November	1030	314	0	0	551	1895	**6**
December	0	981	0	573	0	1554	**5**
Totals	**4975**	**9155**	**4913**	**6987**	**3017**	**29047**	**74**



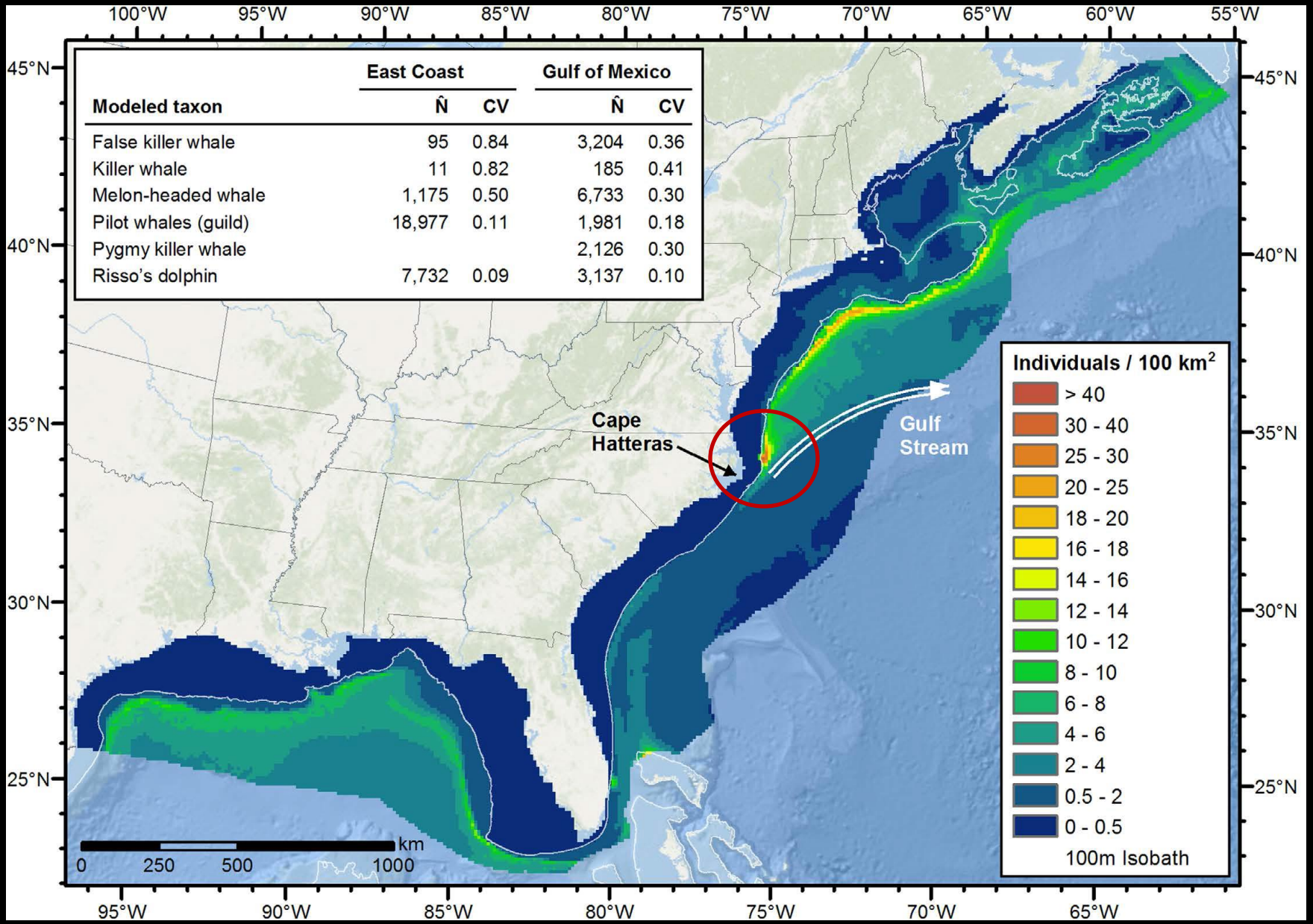
Cuvier's Beaked Whale (*Ziphius cavirostris*)

Cuvier's Beaked Whale
Ziphius cavirostris

Year-round presence – sighted in all months



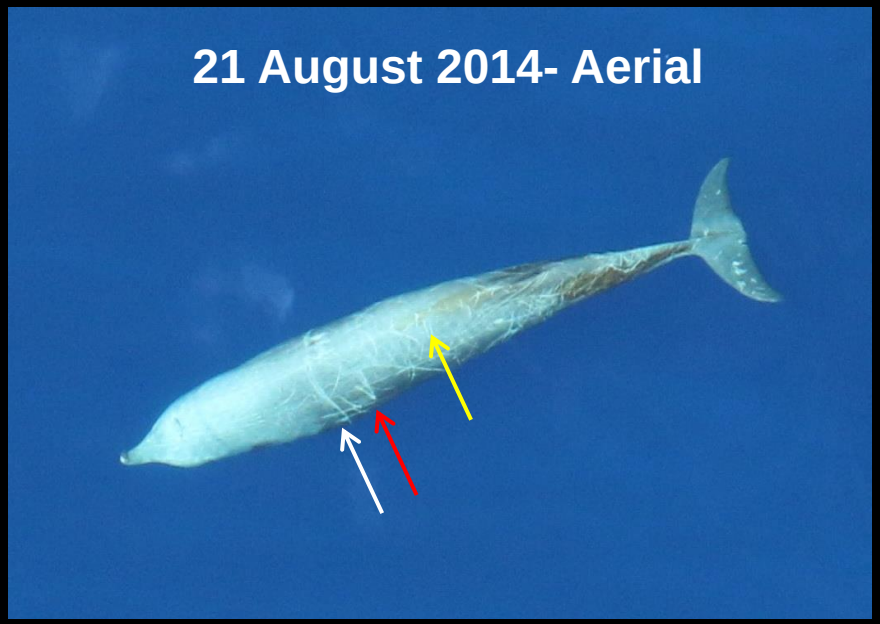
Roberts *et al*. 2016 "Habitat-based cetacean density models…"

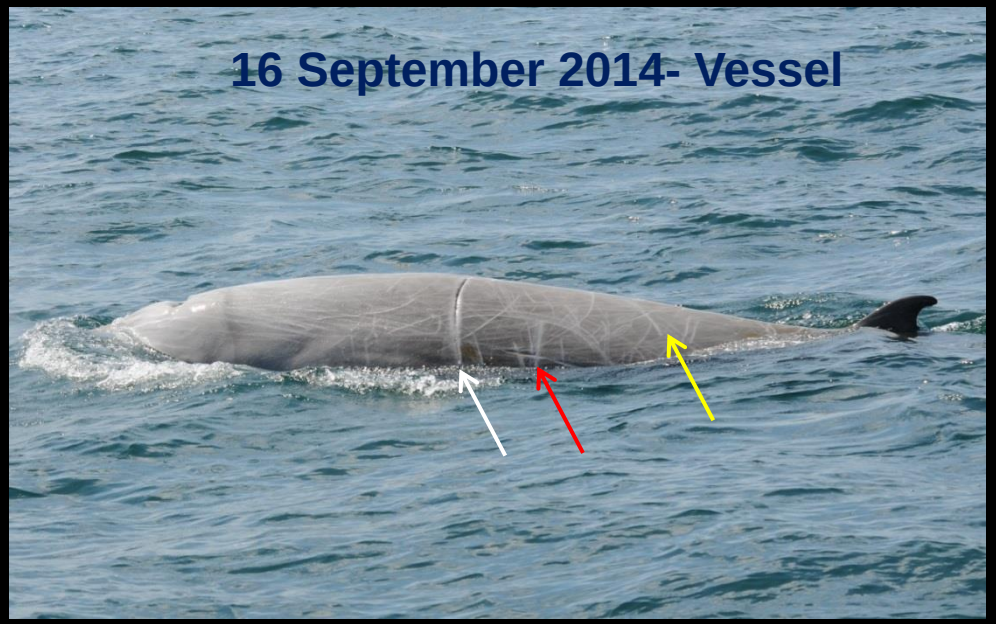


Modeled taxon	East Coast N̂	East Coast CV	Gulf of Mexico N̂	Gulf of Mexico CV
False killer whale	95	0.84	3,204	0.36
Killer whale	11	0.82	185	0.41
Melon-headed whale	1,175	0.50	6,733	0.30
Pilot whales (guild)	18,977	0.11	1,981	0.18
Pygmy killer whale			2,126	0.30
Risso's dolphin	7,732	0.09	3,137	0.10

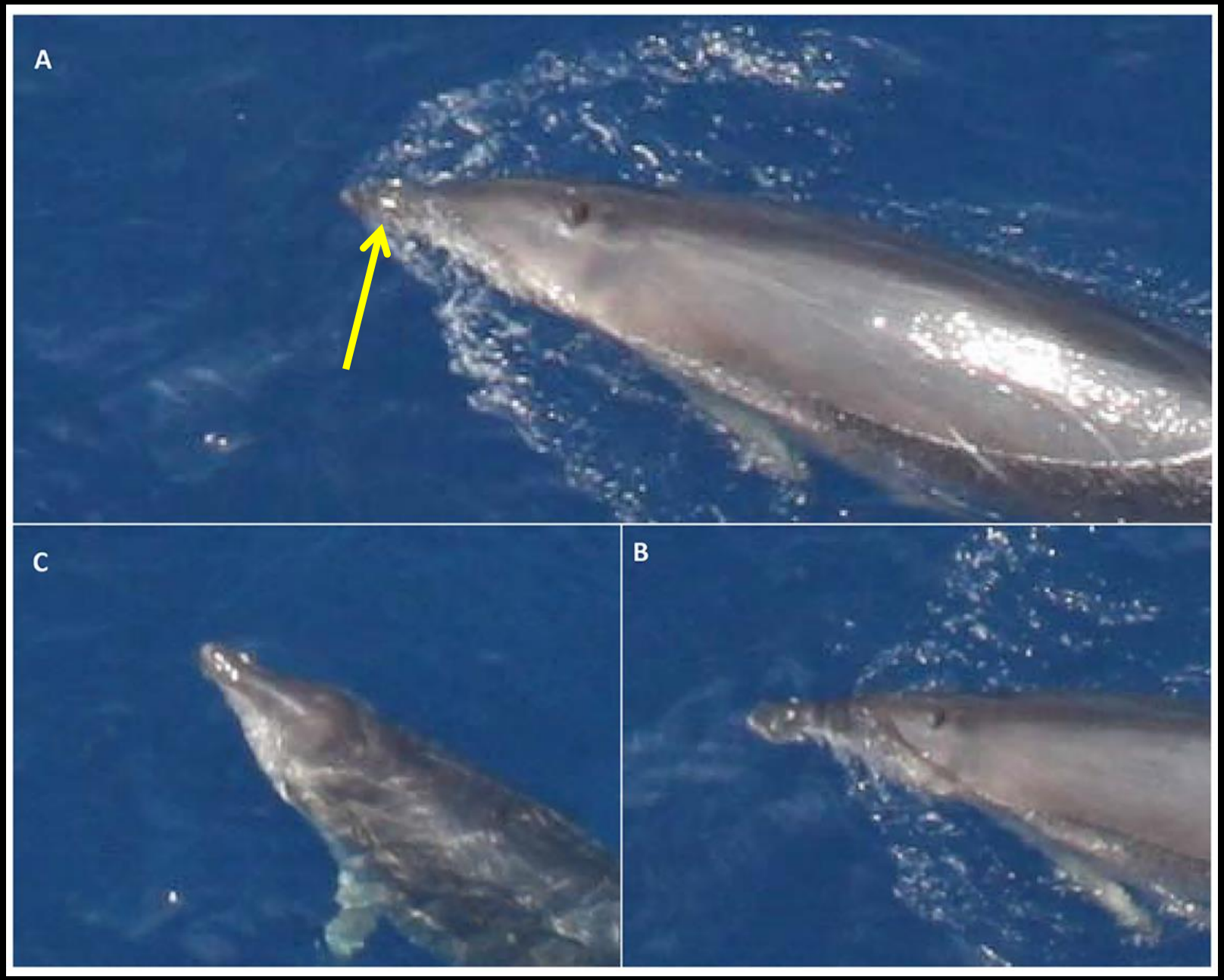
Friday: 13:30-15:00 Habitat and Distribution/Population Biology and Abundance

The view from above: Combining images from vessel and aerial surveys to identify individual Cuvier's beaked whales (*Ziphius cavirostris*)

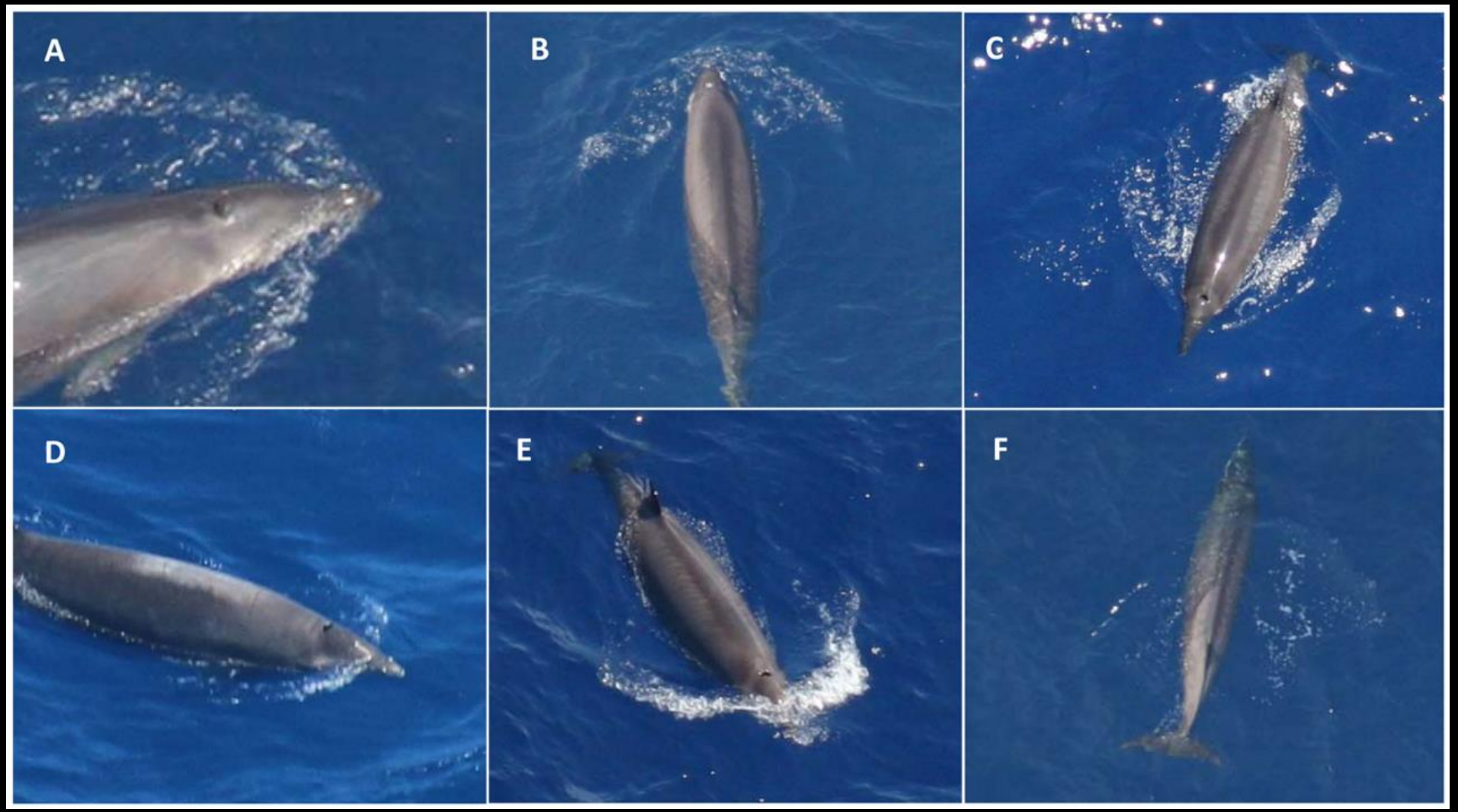




D.M. Waples[1], E.W. Cummings[2], H.J. Foley[1], R.J. McAlarney[2], W.A. McLellan[2], D. Ann Pabst[2], Z.T. Swaim[1], J.T. Bell[3] and A.J. Read[1]



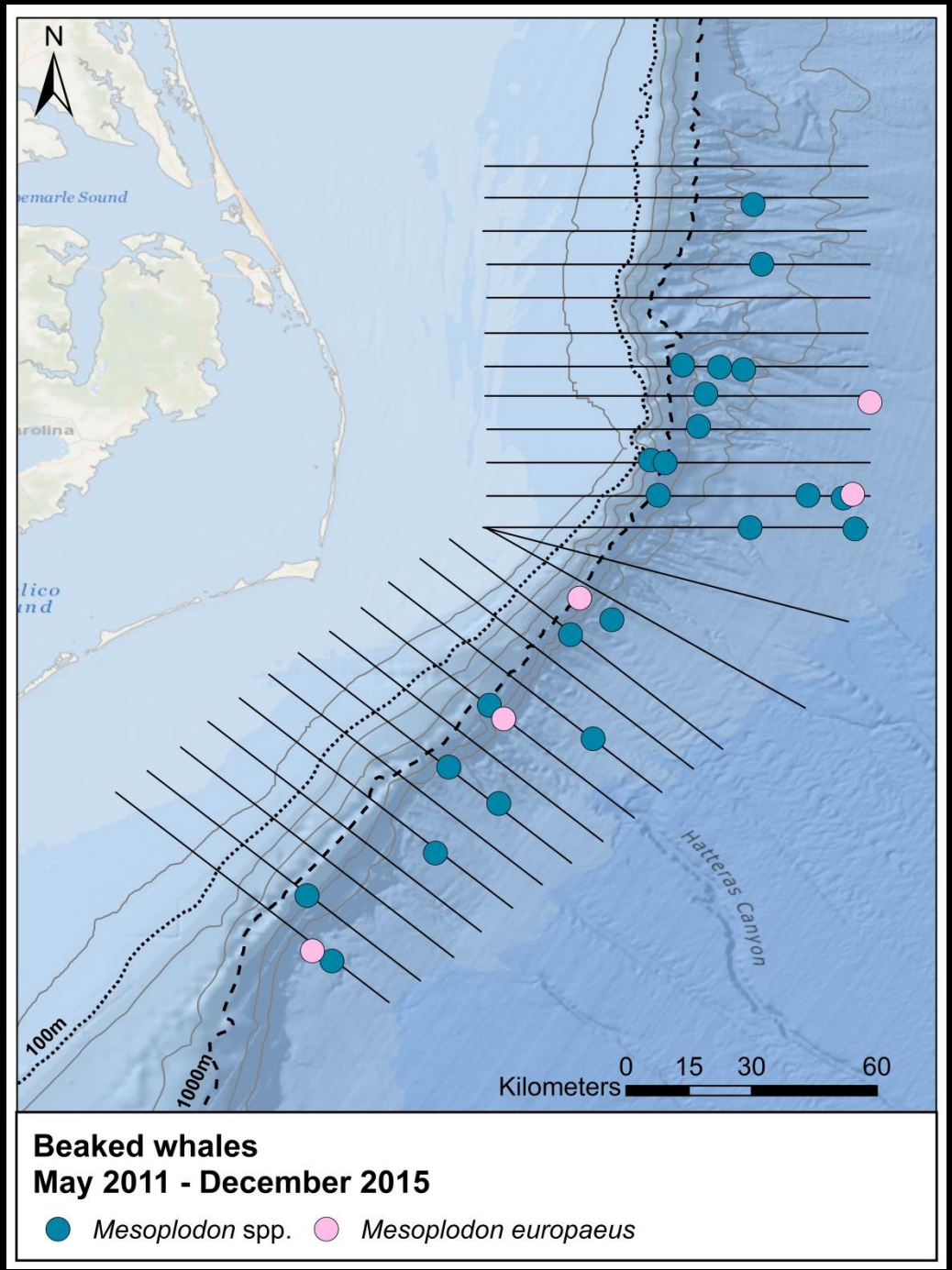
Gervais' Beaked Whale (*Mesoplodon europaeus*)

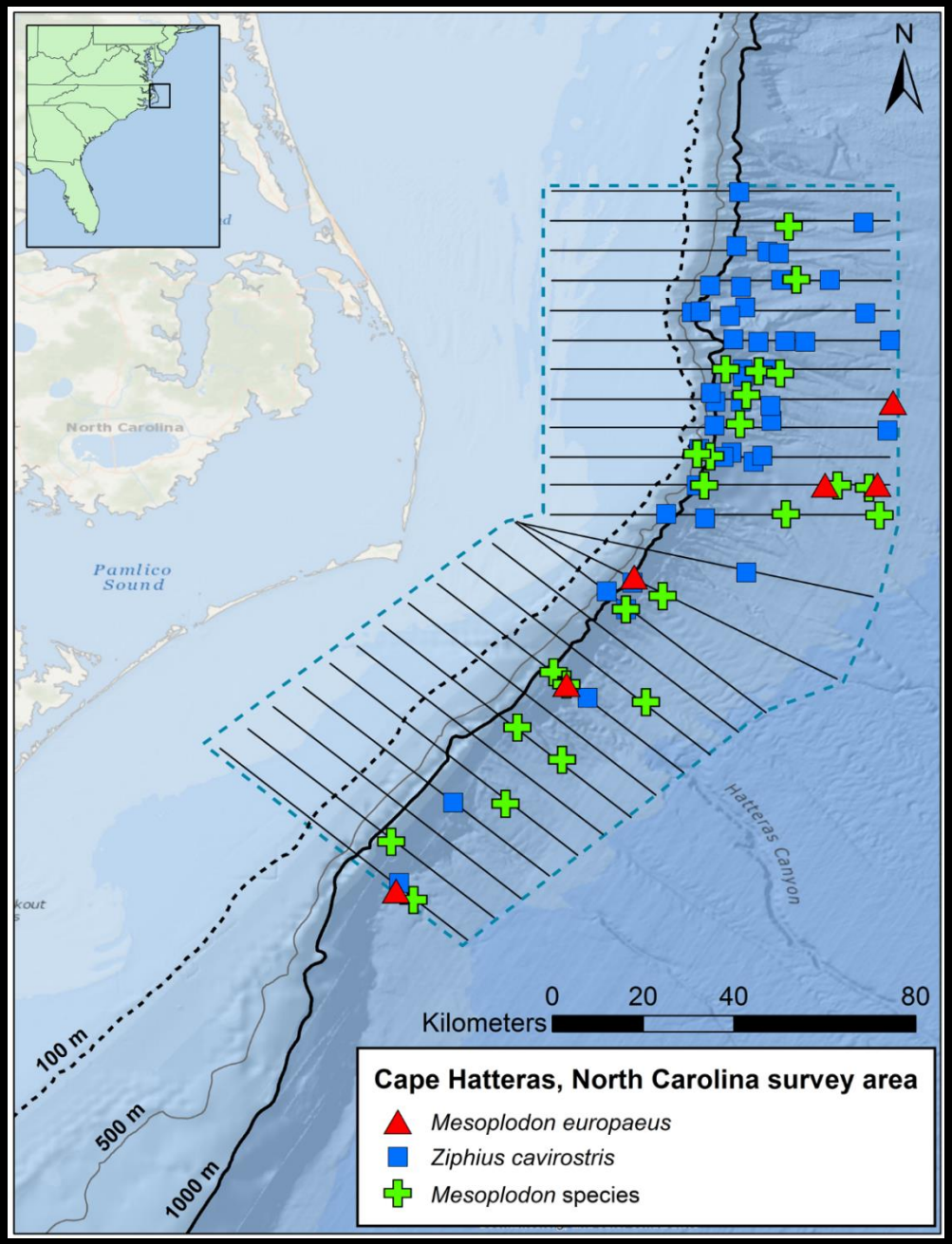


Gervais' Beaked Whale (*Mesoplodon europaeus*)

Gervais' Beaked Whale
Mesoplodon europaeus

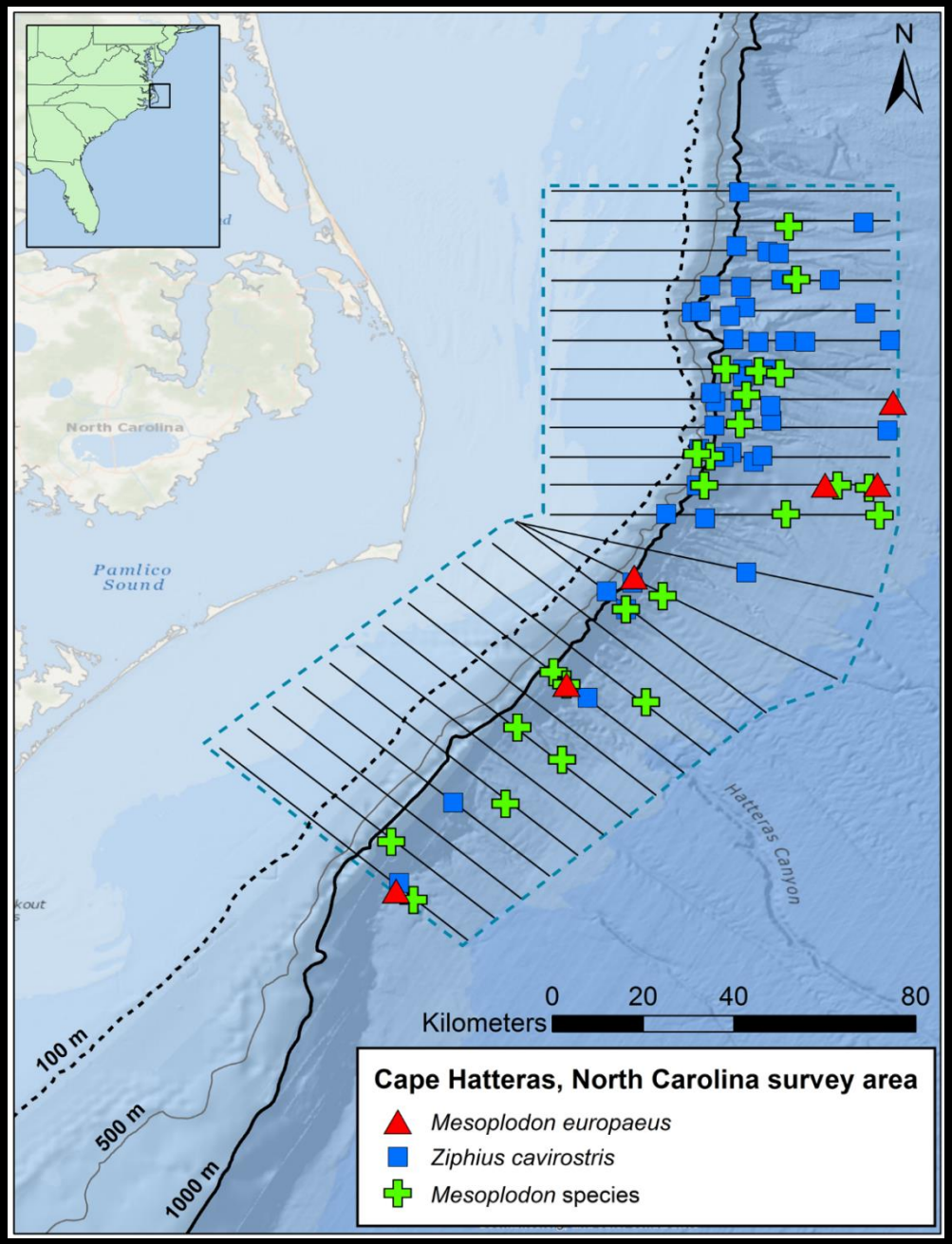
Mesoplodonts sighted in 10 of 12 months





Distribution

- 86% (64/74) sightings at or beyond 1,000 m isobath



Distribution

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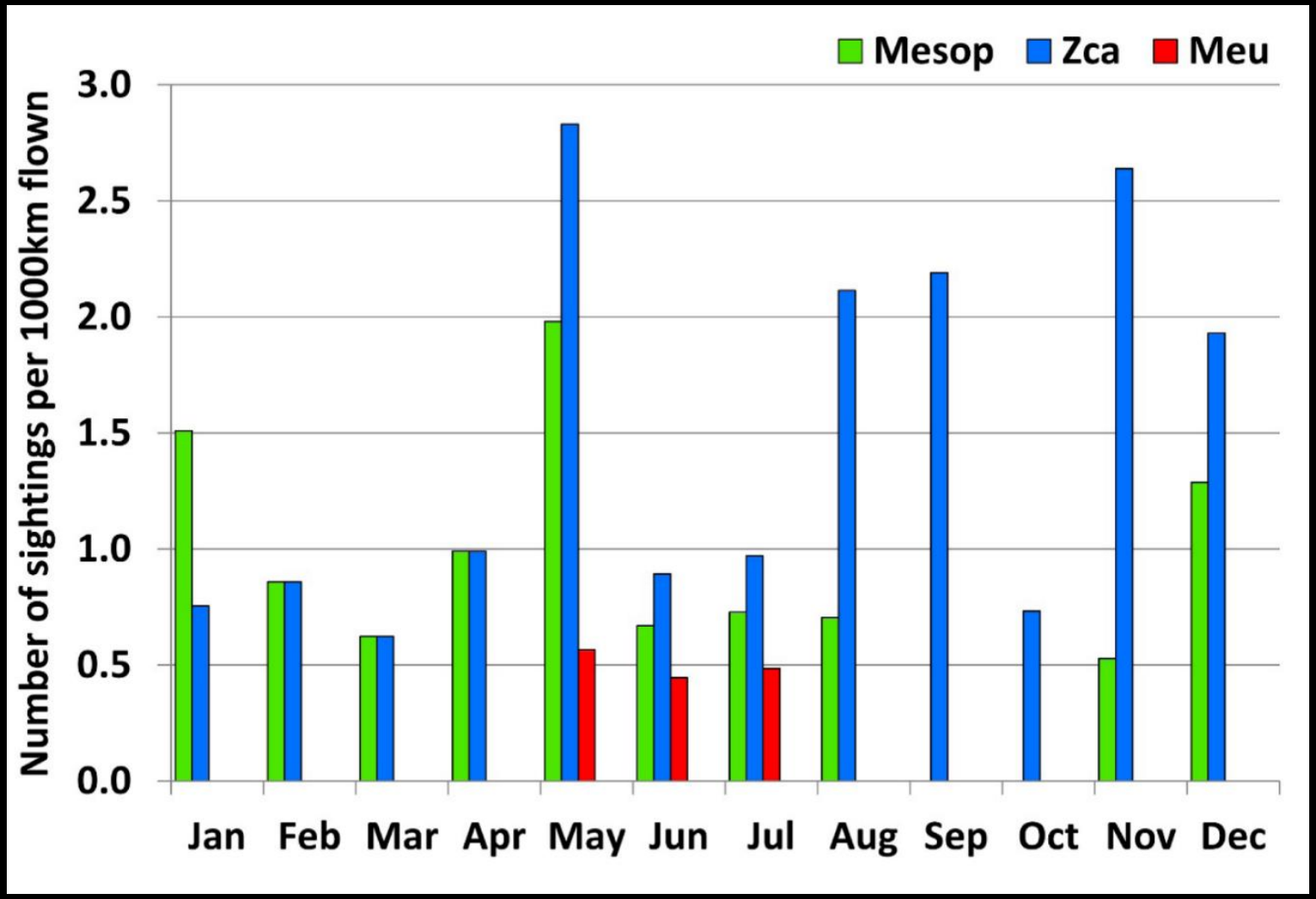
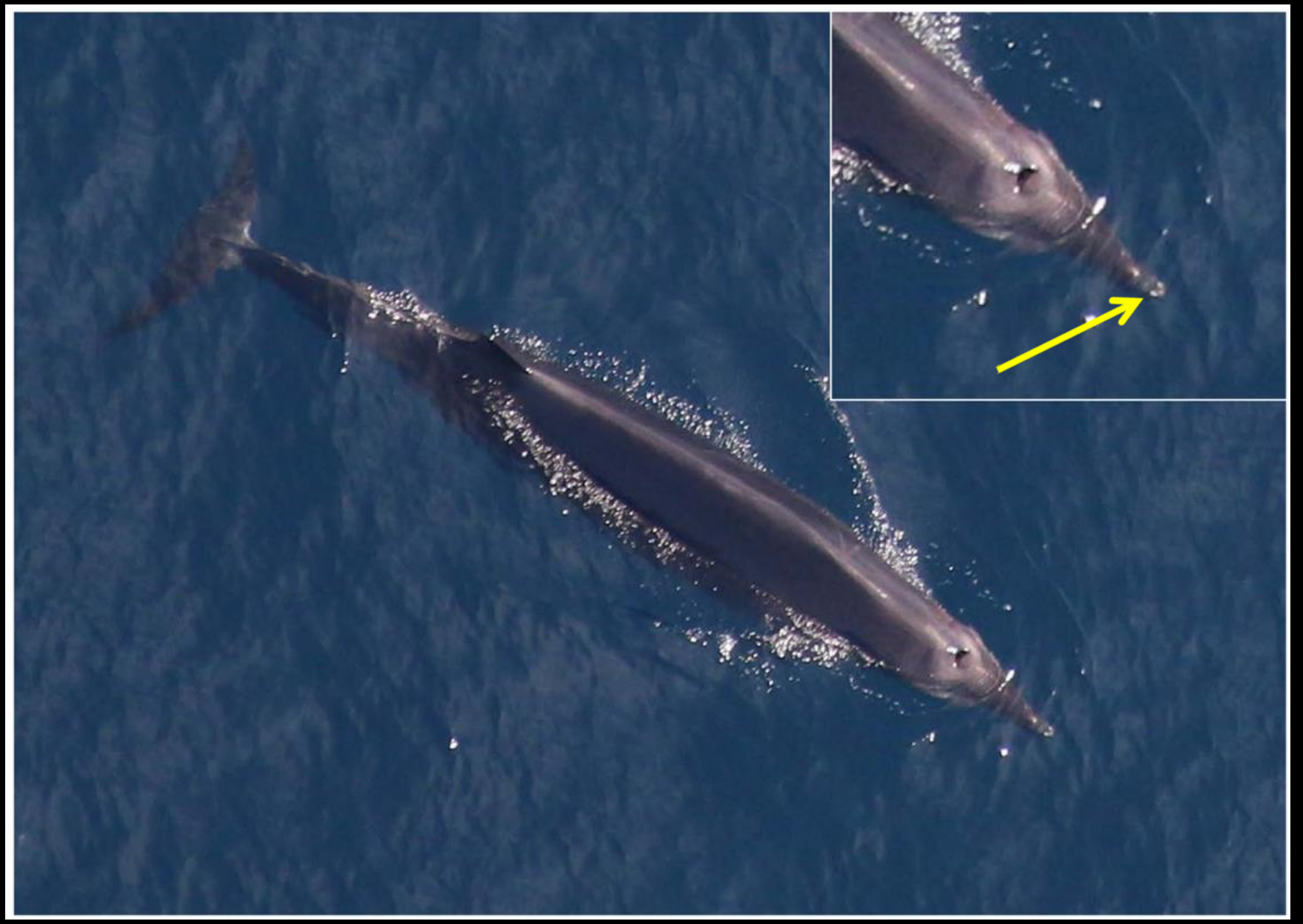
60% sightings:
Z. cavirostris

32% sightings:
Mesoplodon spp.

8% sightings:
M. europaeus



Z. cavirostris **– every month of the year**
***Mesoplodon* spp.** **– 10 months**
M. europaeus **– 3 months**



True's Beaked Whale (*Mesoplodon mirus*)

Density Estimates

Five years of monthly, species specific, data collected using Distance Sampling techniques allowed

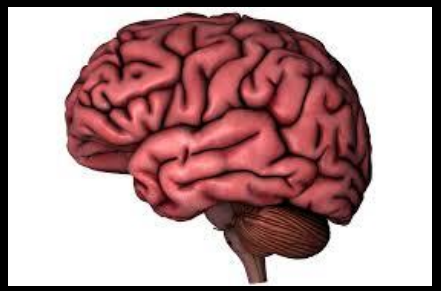
Multiple models to determine-
Density Estimates

Density Estimates

Five years of monthly, species specific, data collected using Distance Sampling techniques allowed

Multiple models to determine-
Density Estimates

Charles Paxton, CREEM conducted all analyses



Density Estimates

Distance sampling methods

- modeled detection function (truncation 900 m)

  Buckland *et al*. (2001) and Hedley *et al*. (2004)

- estimated surface densities $g(0) = 0.95$ (Forney *et al.* 1995)

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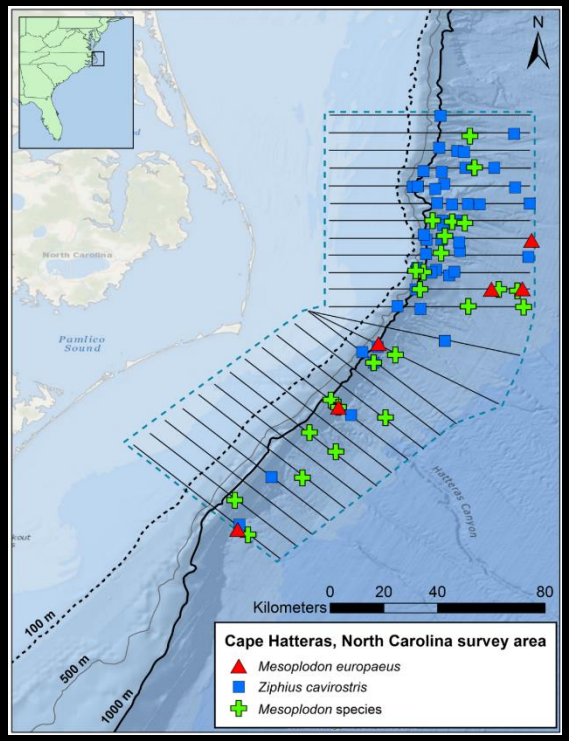
Stratified by Depth

- entire area
- subarea > 1,000 m



(Barlow *et al.* 2006)

Density Estimates

Index of Availability

- utilized information on diving behavior

(our thanks to Natacha Aguilar de Soto, Mark Johnson, Stacy DeRuiter and Peter Tyack)

- modeled group availability on surfacing synchrony

Density Estimates

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- modeled group availability on surfacing synchrony

Synchrony = 0, 0.5, 1.0

Density Estimates

Subarea >1,000 m

All Beaked Whales	Estimated density animals/km²
Surface only	0.007 (0.005 – 0.011)
Whales surface individually	0.019 (0.012 – 0.030)
Whales surface such that half the pod comes up individually	0.034 (0.022 – 0.054)
Whales surface as one group	0.042 (0.026 – 0.066)

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Surface density estimate higher than all but two estimates from *around the globe* corrected for both perception and availability bias (Barlow *et al.* 2006).

Density Estimates

Subarea >1,000 m

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Density estimates that account for availability of whales at the surface are 2-5 times higher than the highest densities reported (Barlow *et al.* 2006).

Density Estimates

Subarea >1,000 m

Ziphius cavirostris	Estimated density animals/km²
Surface only	**0.004** (0.002 – 0.007)
Whales surface individually	**0.008** (0.006 – 0.017)
Whales surface such that half the pod comes up individually	**0.013** (0.009 – 0.029)
Whales surface as one group	**0.017** (0.012 – 0.038)

Density estimates that account for availability of whales at the surface are 1.2-2.2 times higher than the *highest densities* reported (Barlow *et al.* 2006).

Density Estimates

Subarea >1,000 m

All Beaked Whales	Estimated density animals/km²
Surface only	0.007 (0.005 – 0.011)
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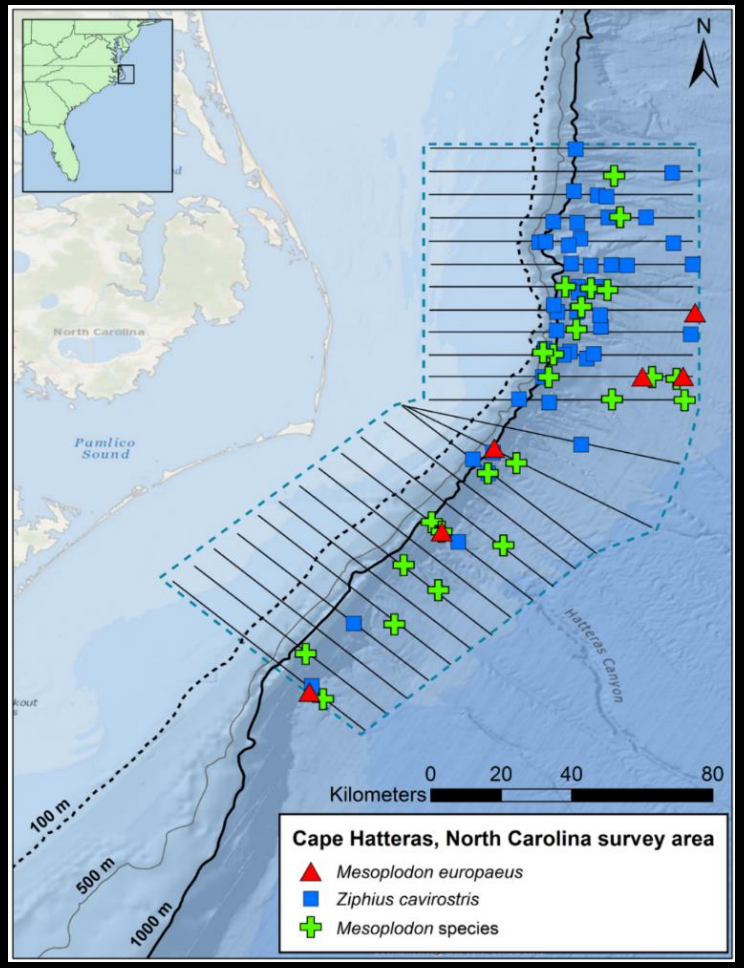
VERY HIGH DENSITIES!



Cape Hatteras is an important <u>year-round</u> habitat for multiple species of beaked whales

Effective management and conservation of cetaceans requires knowledge of their distribution and abundance in areas where they are vulnerable to anthropogenic activities (Hammond *et al.* 2013).

Acknowledgements:

Orion Aviation: Ed Coffman &pilots Bob Sticle, Ron Schrek, Dave Huddle, Larry Latshaw, Colin Mendenhall and Wayne McKendry, Rich Waterman, Stan Huddle, and John Estes; Jene Nissen, US Fleet Forces Command; Jen Dunn, Duke University; Dan Engelhaupt, HDR.

All surveys were conducted with the authorization of the US National Oceanographic and Atmospheric Administration (Scientific Permits to UNCW: No. 948-1692-00 and No. 16473 and General Authorizations to Duke University: No. 808-1798-01 and No. 16185).

Surveys were funded by US Fleet Forces Command.