

Killer whales of the Aleutian Islands



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3 types of killer whales in the North Pacific

**“Residents”
Fish-eaters**



Variation in gray saddle patch
Dorsal fin falcate

**“Transients”
Mammal-eaters**



Uniform large gray saddle patch
Dorsal fin triangular

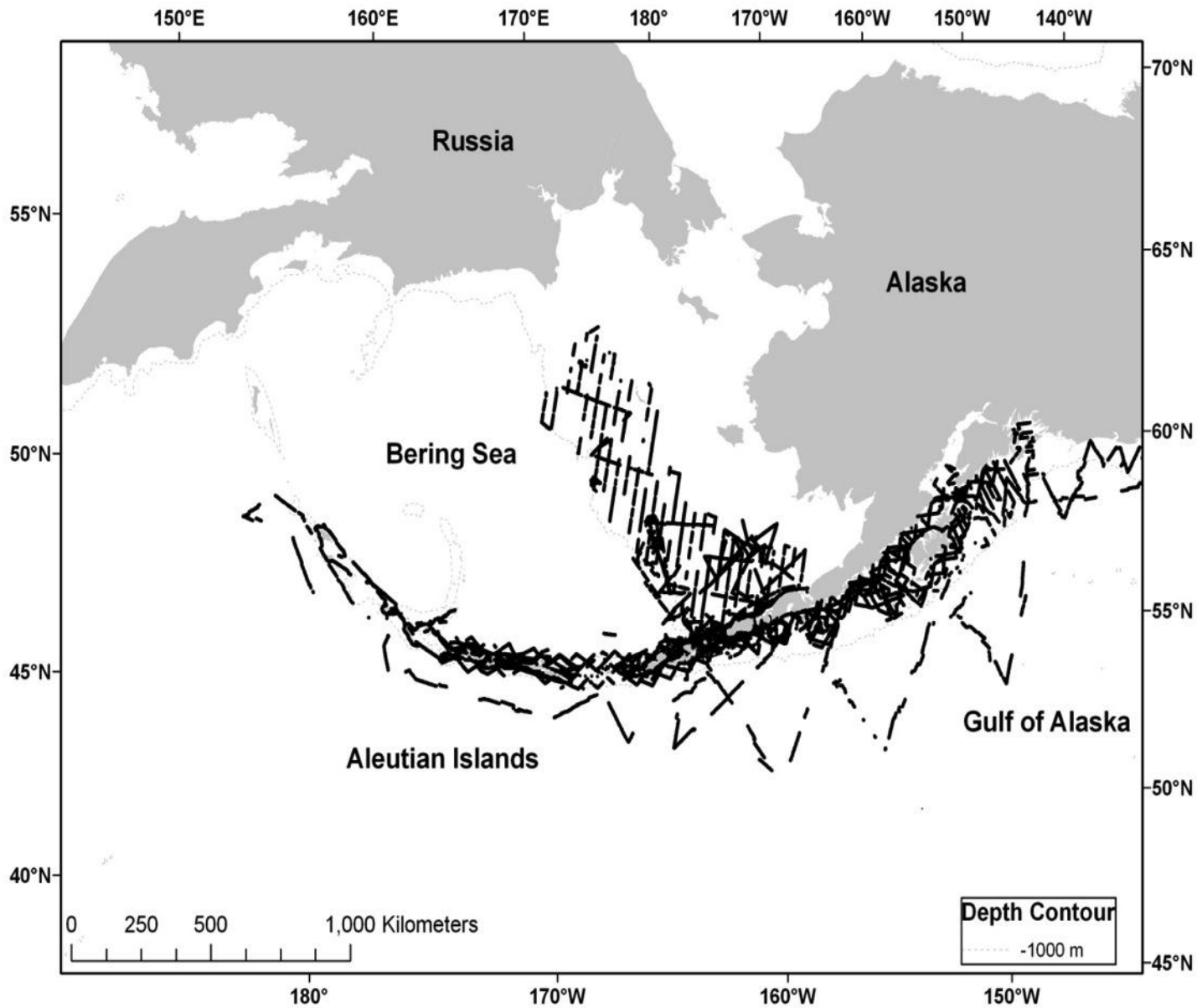
**“Offshores”
Upper-trophic fish
such as sharks**



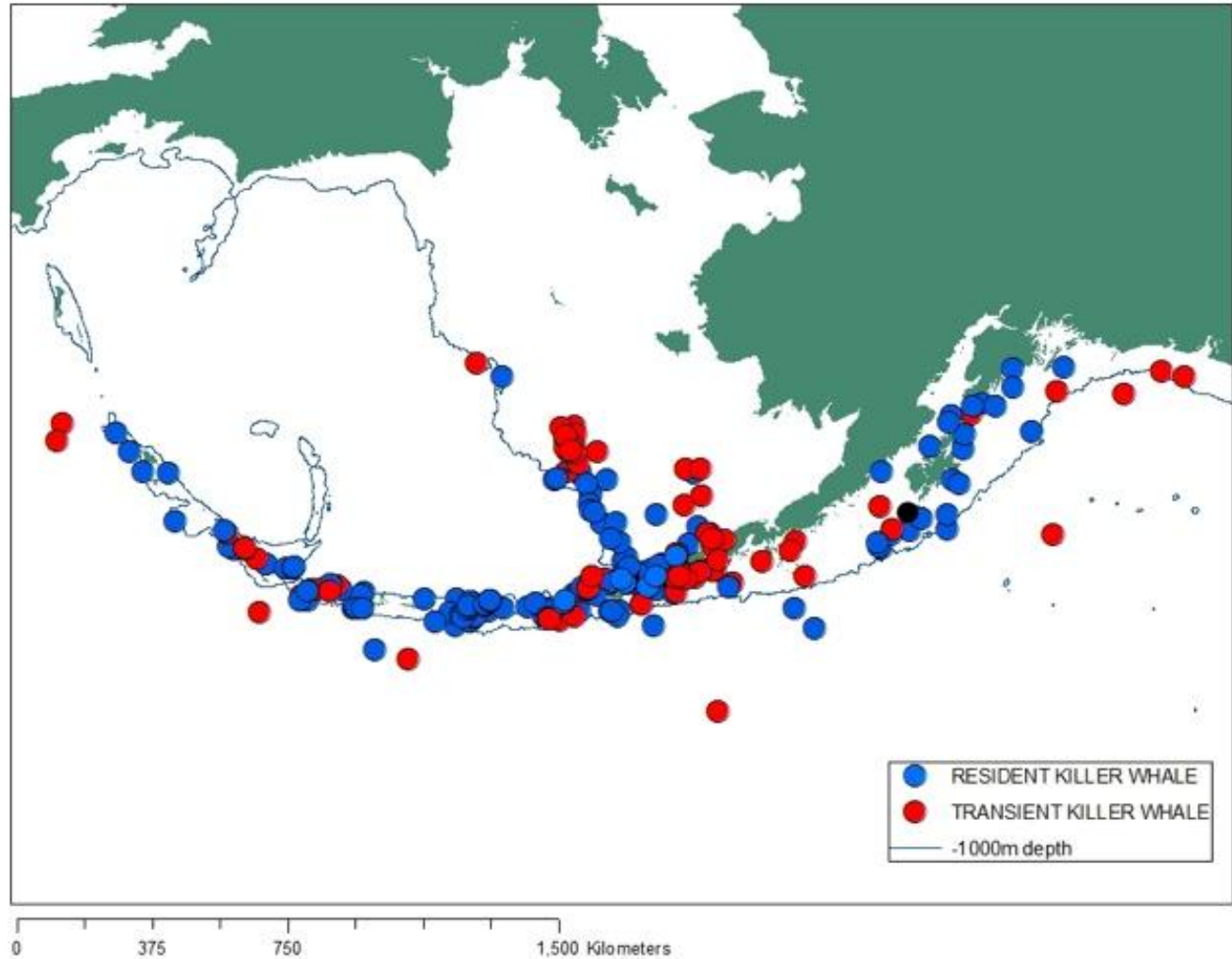
Dorsal fin rounded at tip
Often multiple nicks in fin

Killer whale studies in the Aleutian Islands by NMML 2001-2010

- 2001-03
 - Systematic line transect surveys (as far west as Amchitka Pass/Delarof Islands)
- 2004-05
 - Focused surveys for transient photo-ID and biopsy for chemical studies
 - Obtained data from a few encounters west of Amchitka Pass during a SPLASH humpback whale survey in 2004
- 2006
 - First NMML survey west of Amchitka Pass, surveyed out to Attu Island
 - Added satellite tagging
- 2008-10
 - Added acoustic monitoring at Steller sea lion rookeries
- 2010
 - Second survey of western-half of the Aleutians



>330 Encounters with killer whales 2001-2010



“Resident” type killer whales



- **>220 encounters**
- **Seen more frequently than transients in the Aleutians**
- **Average group size 19**
- **Nearly exclusively fish-eaters**
- **Dark pigment intrusions into the saddle patch on some whales in the group are diagnostic to residents or offshores**

“Transient”-type killer whales in the North Pacific are a species that separated from other killer whales ~700,000 years ago

(Morin et al. 2010. *Genome Research* 20:908-916)

Complete mitochondrial genome phylogeographic analysis of killer whales (*Orcinus orca*) indicates multiple species

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Killer whales (*Orcinus orca*) currently comprise a single, cosmopolitan species with a diverse diet. However, studies over the last 30 yr have revealed populations of sympatric “ecotypes” with discrete prey preferences, morphology, and behaviors. Although these ecotypes avoid social interactions and are not known to interbreed, genetic studies to date have found extremely low levels of diversity in the mitochondrial control region, and few clear phylogeographic patterns worldwide. This low level of diversity is likely due to low mitochondrial mutation rates that are common to cetaceans. Using killer whales as a case study, we have developed a method to readily sequence, assemble, and analyze complete mitochondrial genomes from large numbers of samples to more accurately assess phylogeography and estimate divergence times. This represents an important tool for wildlife management, not only for killer whales but for many marine taxa. We used high-throughput sequencing to survey whole mitochondrial genome variation of 139 samples from the North Pacific, North Atlantic, and southern oceans. Phylogenetic analysis indicated that each of the known ecotypes represents a strongly supported clade with divergence times ranging from ~150,000 to 700,000 yr ago. We recommend that three named ecotypes be elevated to full species, and that the remaining types be recognized as subspecies pending additional data. Establishing appropriate taxonomic designations will greatly aid in understanding the ecological impacts and conservation needs of these important marine predators. We predict that phylogeographic mitogenomics will become an important tool for improved statistical phylogeography and more precise estimates of divergence times.

Bigg's Killer whales (“transient”-type)

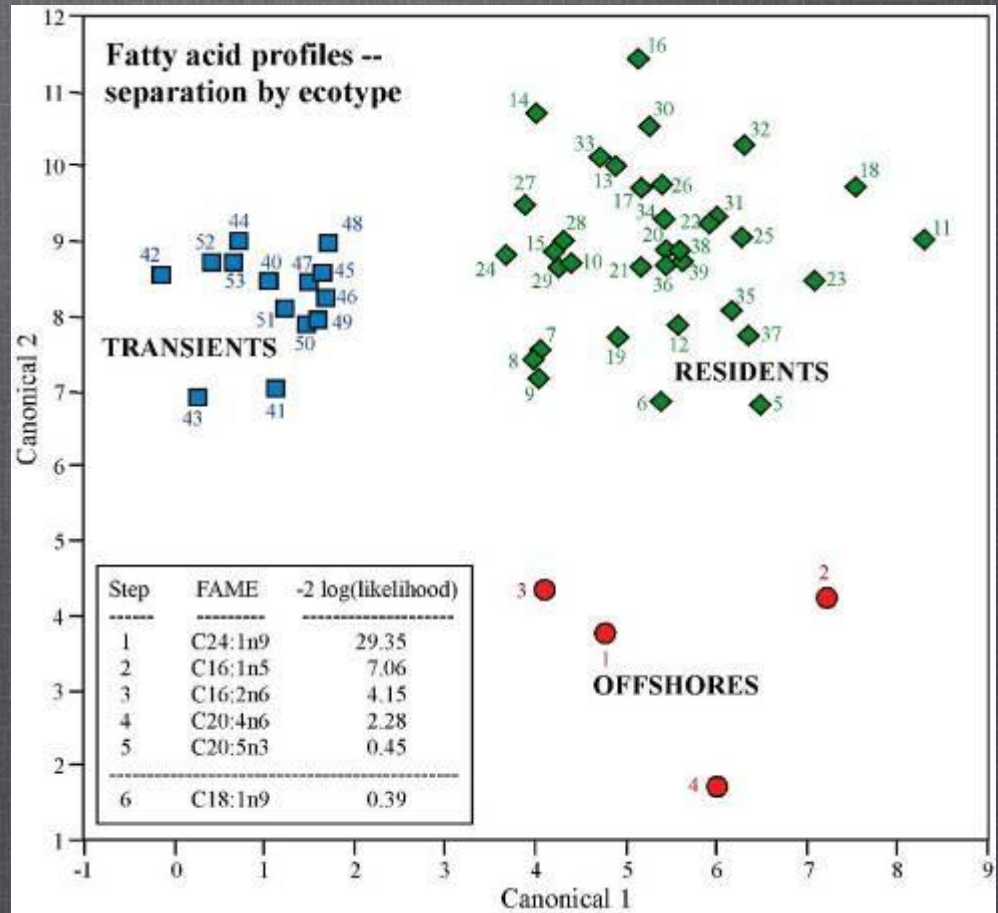


- **>115 encounters**
- **Average group size ~4-5**
- **Nearly exclusively marine-mammal eaters**

Ecotype prey-specialization

Clear distinction in fatty acids between the 3 types.

For example, Residents and Offshores have much higher levels of Omega-3s than transients



Herman et al. 2005, *Marine Ecology Progress Series*, 302: 275-291

Ecotype prey-specialization

The 3 types can also be easily distinguished by their contaminant concentrations.

Contaminants reflect dietary differences over the entire lifetime of the whales

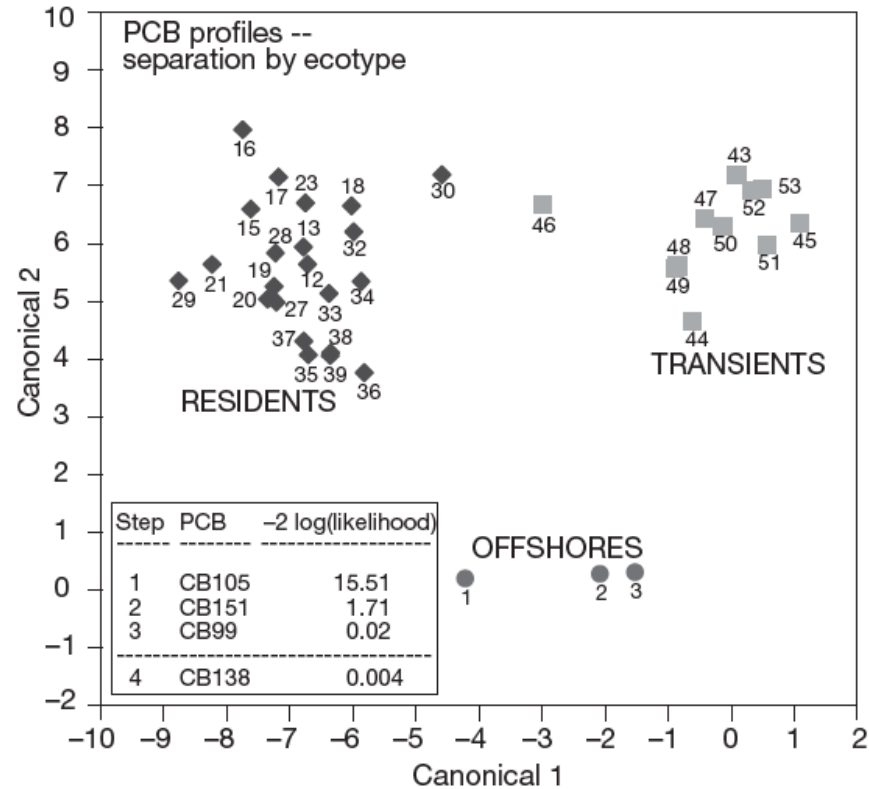


Fig. 3. *Orcinus orca*. First 2 discriminant functions showing separation of killer whale ecotypes based on the PCB patterns of the blubber biopsies

Herman et al. 2005, *Marine Ecology Progress Series*, 302: 275-291

Zerbini et al. 2006. Estimating abundance of killer whales (*Orcinus orca*) in the nearshore waters of the Gulf of Alaska and the Aleutian Islands using line transect sampling

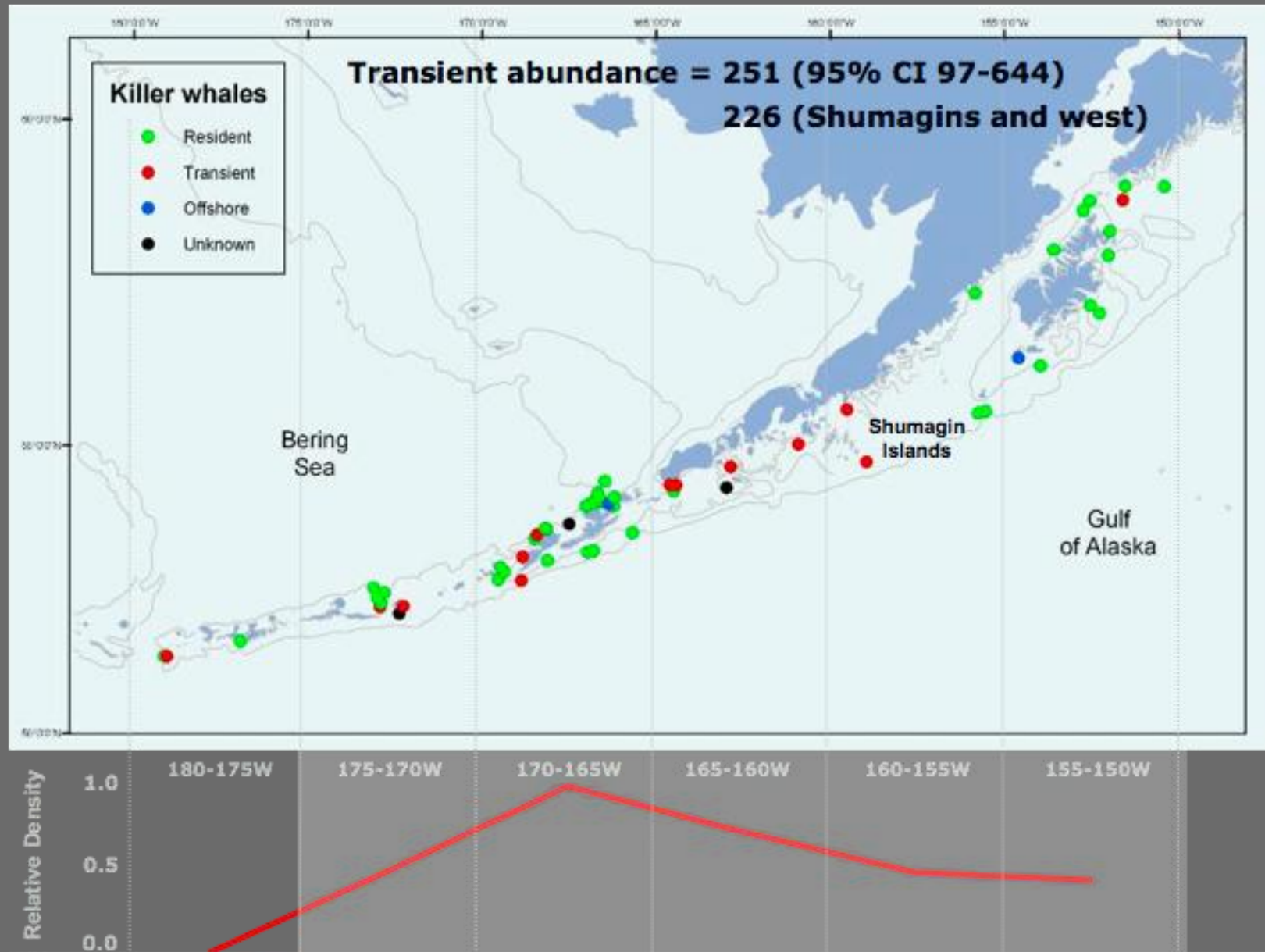
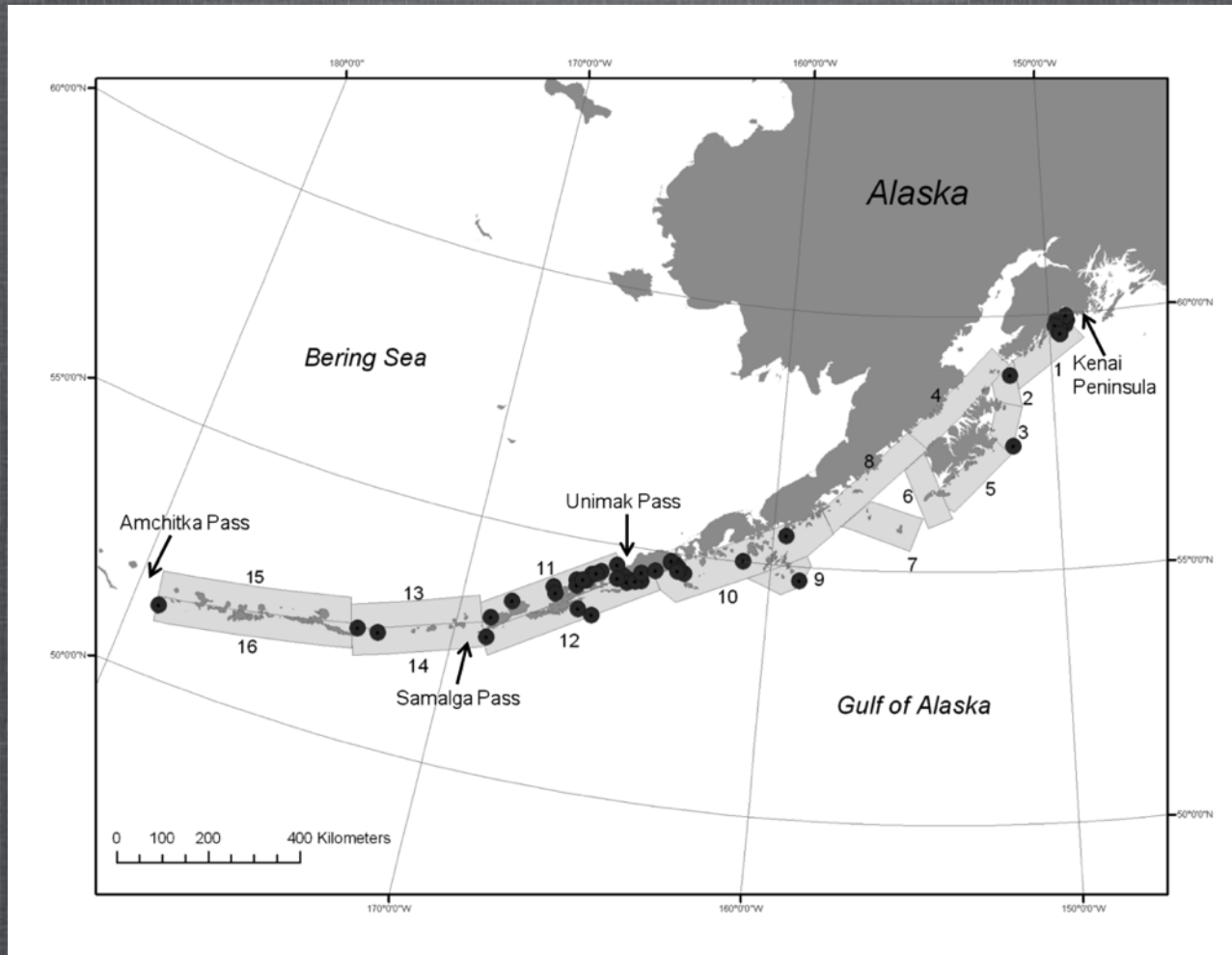


Photo-ID mark-recapture estimate of abundance (Durban et al. 2010 Marine Biology)



**Transient abundance estimate of 345 (255-487)
For the same area and time (2001 to 2003)**

Mark-recapture abundance estimate of transient killer whales (Durban et al. 2010 Marine Biology)

- Mark-recapture estimate: 345 (95% CI 255-487)
- Line-transect estimate: 251 (95% CI 97-644)
- Different interpretations
 - M-R is an estimate of all whales using the area rather than just the number of whales in the area during the survey
 - Also, M-R includes 59 individuals only seen on the spring False Pass survey (52 of which were not seen on any other survey)
- Abundance of fish-eating killer whales much higher
 - Line-transect estimate: 1587 (95% CI 608-4140)
 - Joint photo-ID catalogue between NMML and NGOS > 1400 whales

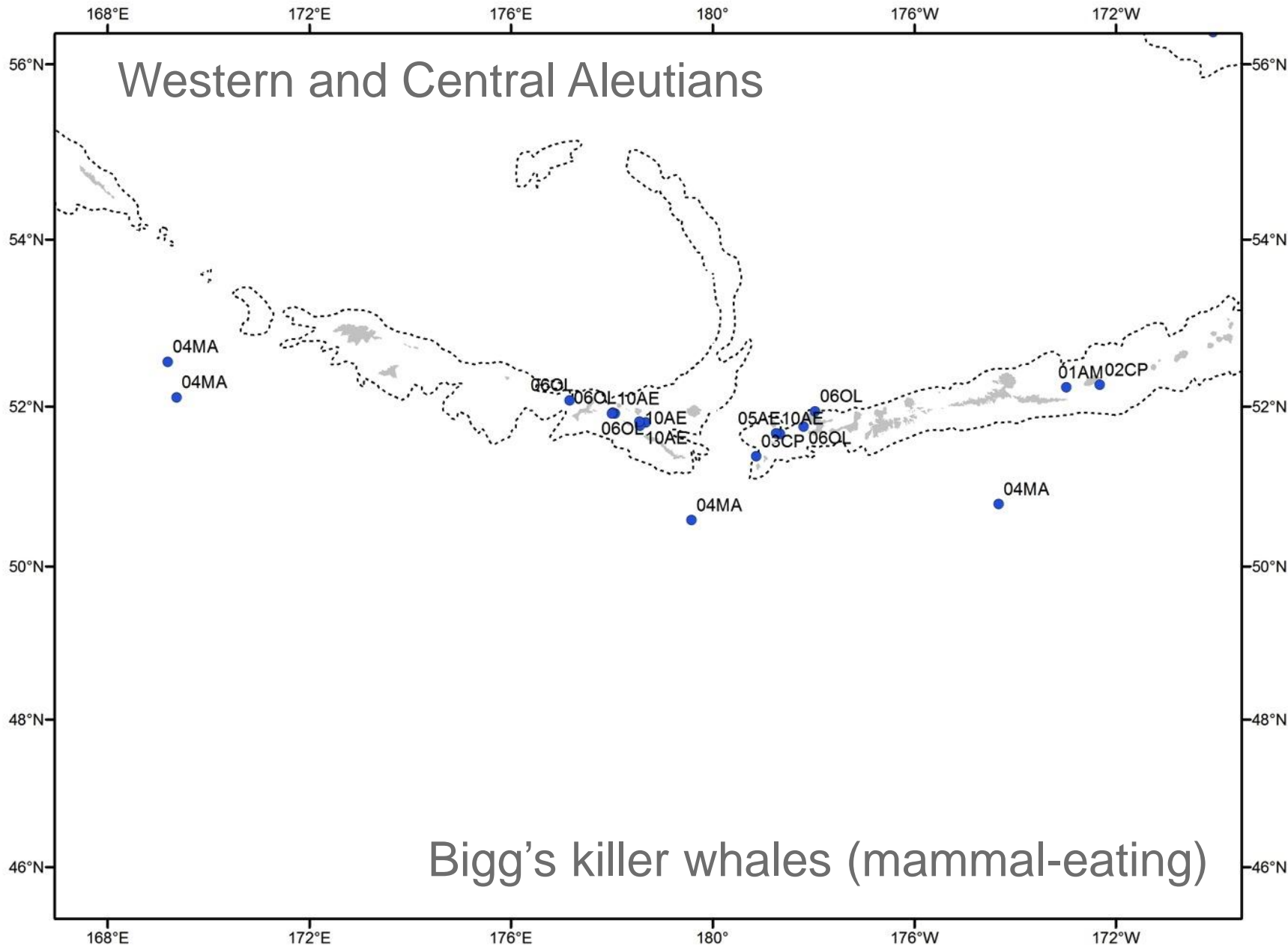
Matkin, Barrett-Lennard, Yurk, Ellifrit, Trites 2007 Ecotypic variation and predatory behavior among killer whales (*Orcinus orca*) off the eastern Aleutian Islands, Alaska. Fish. Bull. 105:74–87 2007

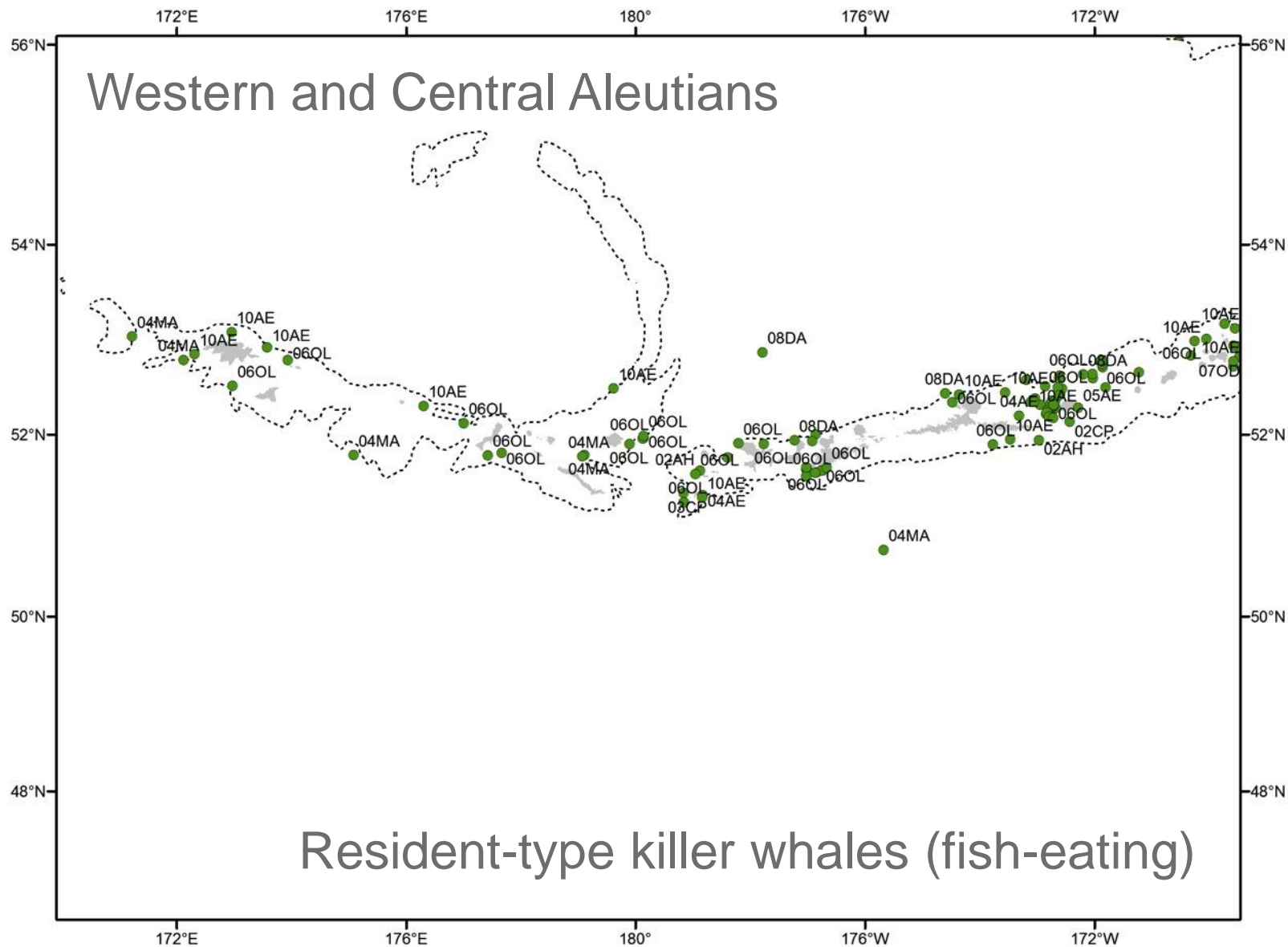
- **Identified 114 transient killer whales in False Pass in spring (2001-2004)**
 - **Preying exclusively on calf/juvenile gray whales on migration (18 kills documented)**
 - **Great majority of these whales are not seen in this area in summer**

- **Identified 51 transient killer whales in the eastern Aleutians in summer (with only 6 whales also seen in False Pass)**
 - **Predation documented on:**
 - **57% N. fur seals (4)**
 - **29% minke whale (2)**
 - **14% Steller sea lion (1)**
 - **Attacks on Dall's porpoise also seen**

Aleutians and Bering Sea NMML/NMFS prey observations June-August

Species	Number of predation observations (includes kills, attacks, and feeding on carcass)	Percent
Northern fur seal	7	39%
Steller sea lion	1	6%
Minke whale	1	6%
Gray whales	4	22%
Baird's beaked whale	1	6%
Dall's porpoise	3	17%
Squid	1	6%

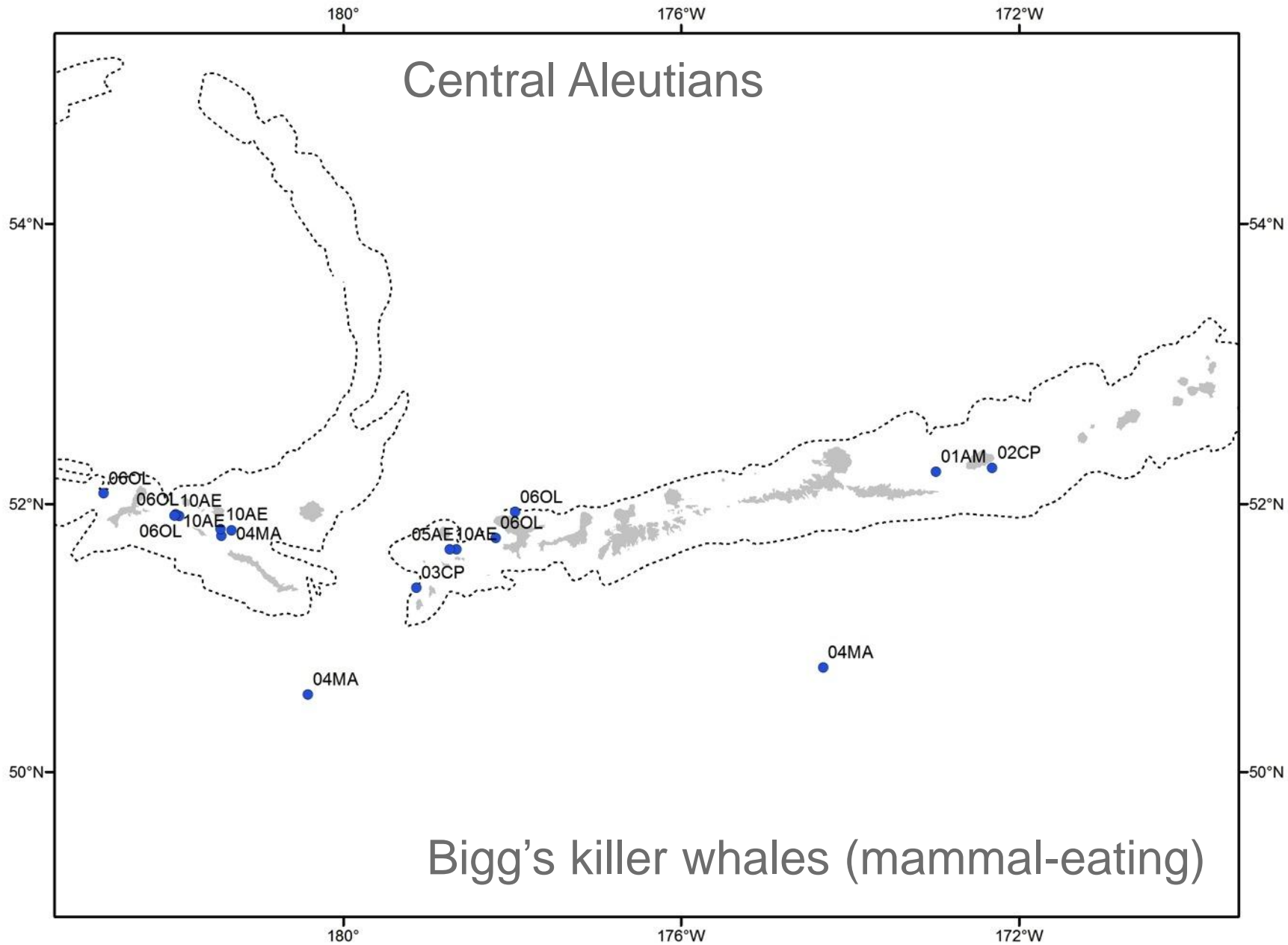




Summary of Bigg's killer whales ("transient"-type) in the far Western Aleutian Islands (Buldir to Attu)

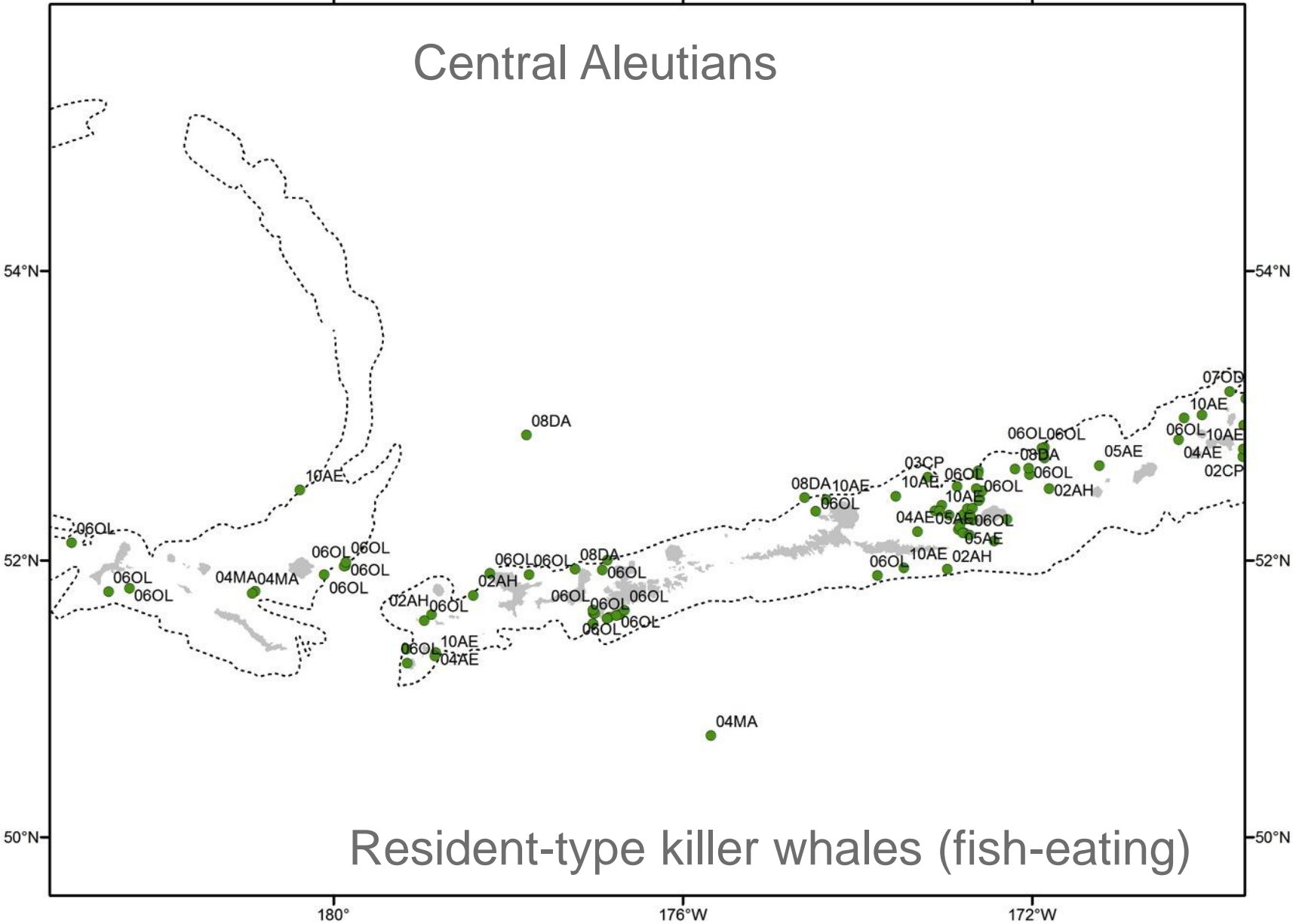
- **2004 SPLASH humpback survey by SWFSC**
 - Two encounters ~ 150 miles west of Attu
 - During one of the encounters, the killer whales attacked and killed two Dall's porpoise
- **2006 NMML survey**
 - No encounters
- **2010 NMML survey**
 - No encounters
- **Mark-recapture abundance estimate is therefore zero**
- **Density is relatively low**
- **Genetic study indicates Bigg's killer whales from Amchitka Pass to Russia are a single population (K. Parsons et al. in prep.)**

Central Aleutians



Bigg's killer whales (mammal-eating)

Central Aleutians



Resident-type killer whales (fish-eating)

Summary of Bigg's killer whales ("transient"-type) in the central Aleutian Islands (Samalga Pass to Kiska)

- **2001-2003 line-transect estimate (Zerbini et al. 2007)**
 - **87 (95% CI 19-391)**
 - **Note this is for (Samalga Pass to Delarofs only)**
- **2004-2010 Mark-recapture abundance estimate (Wade and Durban unpublished)**
 - **90 (95% CI 48-184)**
- **Density is relatively medium to high**

Summary of Bigg's killer whales ("transient"-type) in the central Aleutian Islands (Samalga Pass to Kiska)

- Nitrogen stable isotope values of Bigg's KWs here are lower than in the eastern Aleutians indicating the whales are feeding at a lower trophic level (but may be confounded by lower values at base of food chain)

Wade et al. 2006. Investigations into dietary specialization of Killer Whales (*Orcinus orca*) in the Bering Sea and Aleutian Islands. NPRB Project 0411/0535 Final Report.

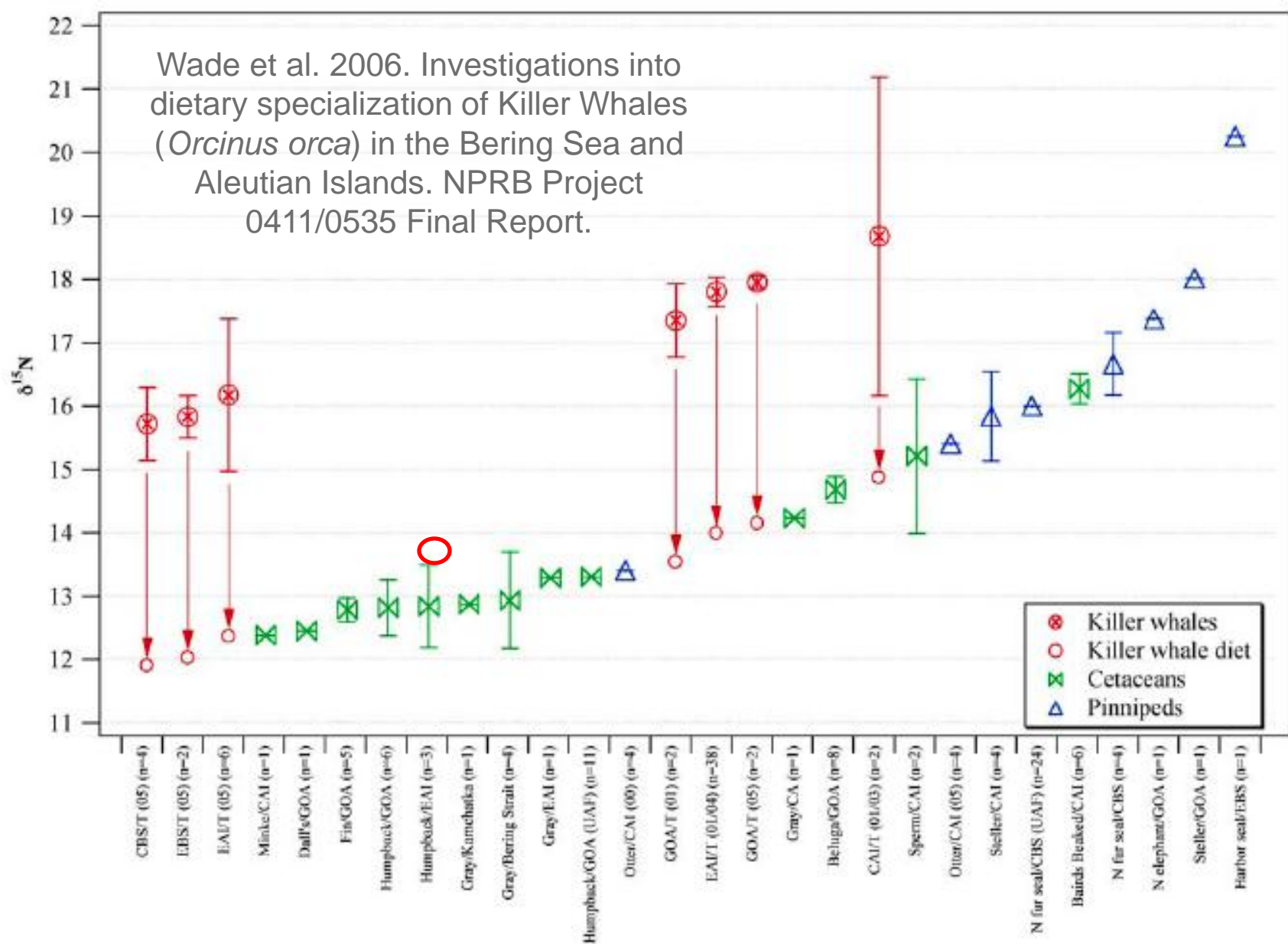
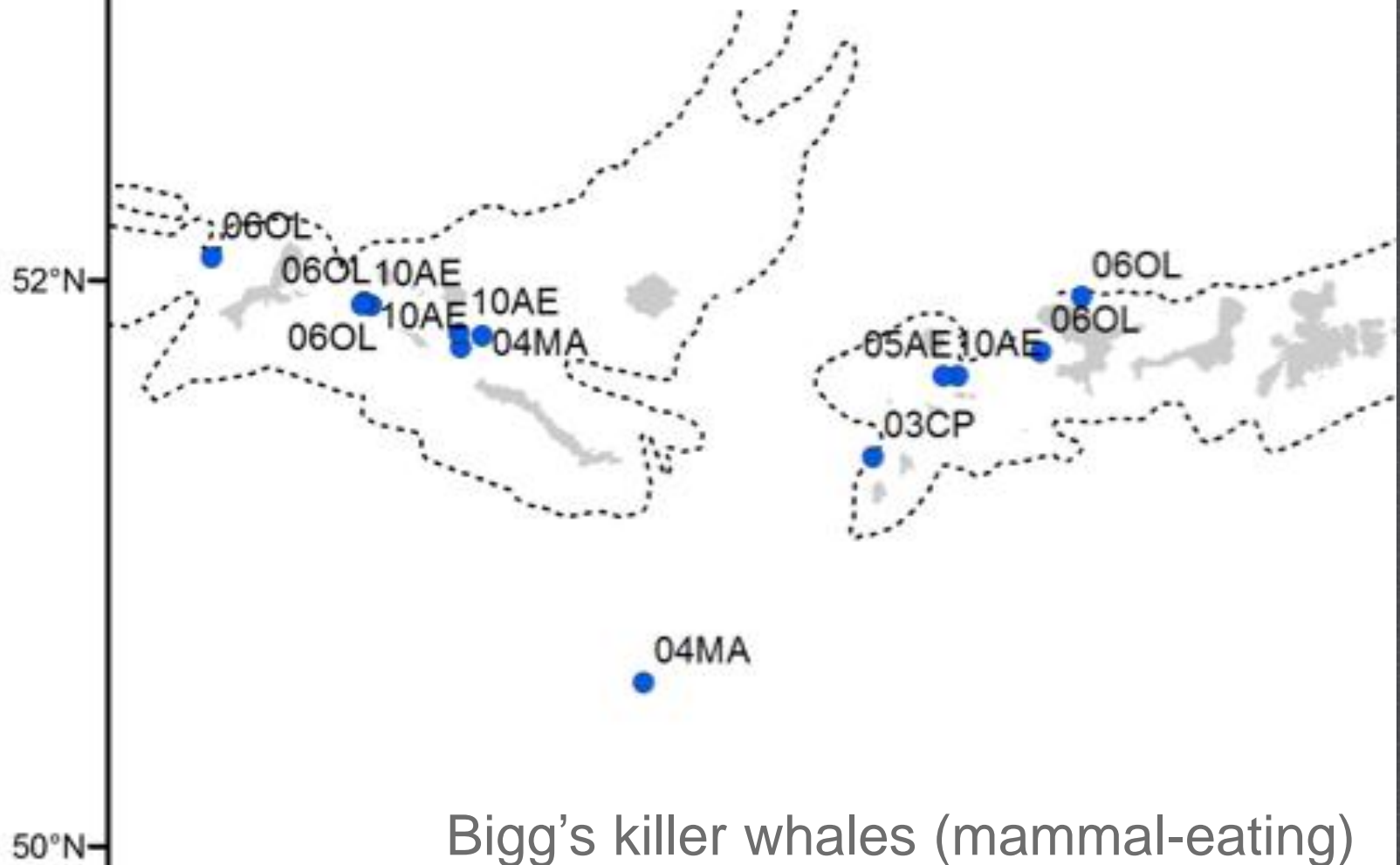


Figure 5. Nitrogen isotope ratios ($\delta^{15}\text{N}$) for transient killer whales and potential prey species from the Bering Sea, Aleutian Islands and the Gulf of Alaska. The arrows pointing to the circles indicate the position of estimated diets for the killer whale groups. The error bars show the 95% confidence intervals.

Two areas with multiple sightings: (1) Kiska and the Rat Islands and (2) Delarof Islands and Tanaga Island

Central Aleutians (Kiska to Adak)

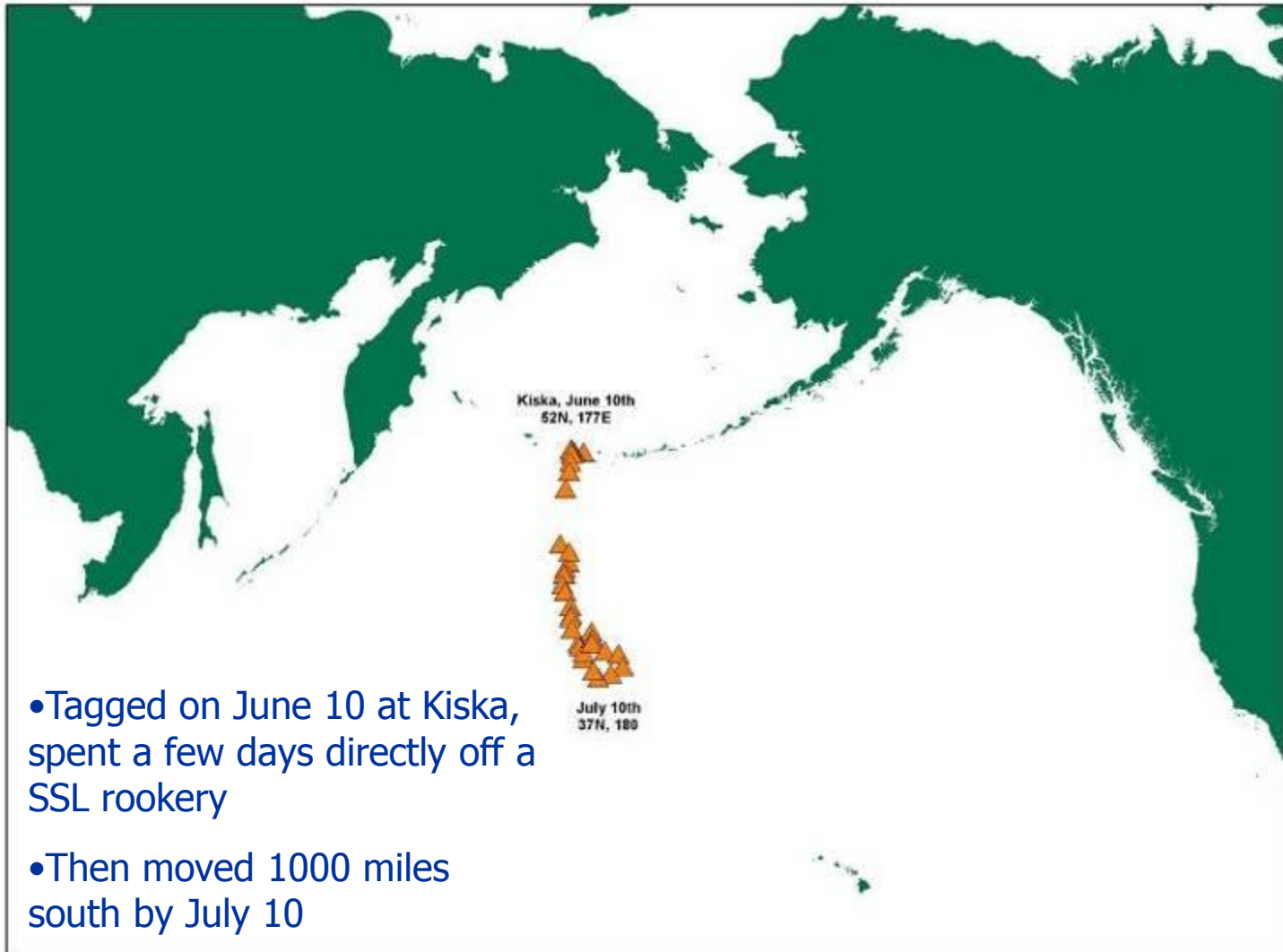


Kiska and the Rat Islands

- **We observed a Bigg's KWs near Kiska in 2006 with a large squid in it's mouth (also received similar reports from bird researcher on Kiska)**
- **We satellite-tagged two Bigg's KWs near Kiska in 2006. They remained there for ~2 weeks, then traveled ~1000nm south to the North Pacific convergence zone**

2006 Satellite tagging from NMML Survey

Aleutian transient transitions!



Durban (NMML), Andrews (ASLC) and Matkin (NGOS). Unpublished Data.

P. Wade, NMML/AFSC/NMFS/NOAA

Kiska and the Rat Islands

- **In 2010 we observed Bigg's KWs attack and kill a Baird's beaked whale in the Rat Islands**

Apparent killer whale rake marks on a Baird's beaked whale photographed south of Amlia Island in the Aleutian Islands. Photo by P.R. Wade.

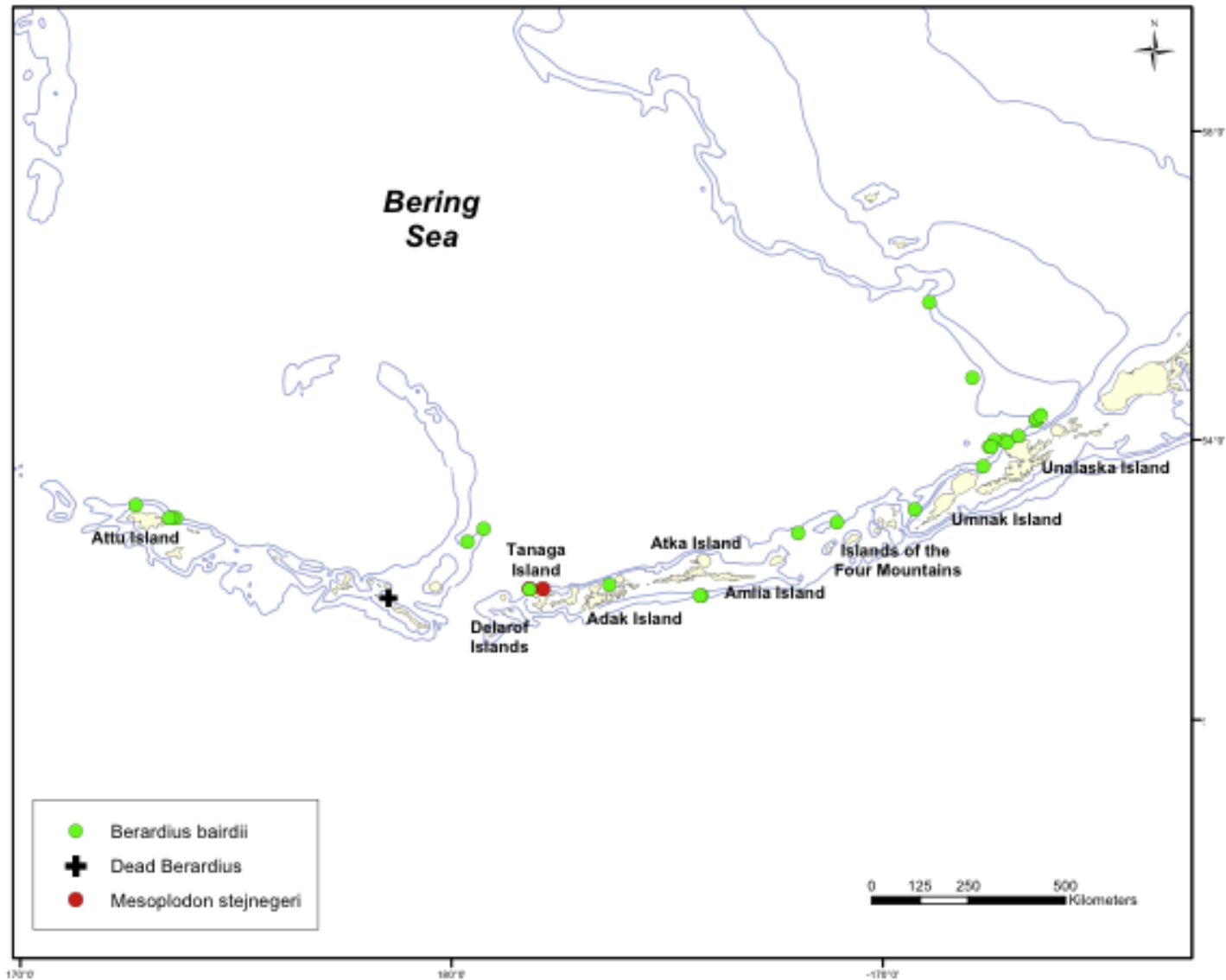


Transient killer whale with a carcass of a Baird's beaked whale in the Rat Islands in the central/western Aleutian Islands. The species identification was made through the use of molecular genetic analysis of a prey sample. Photos by David Ellifrit.





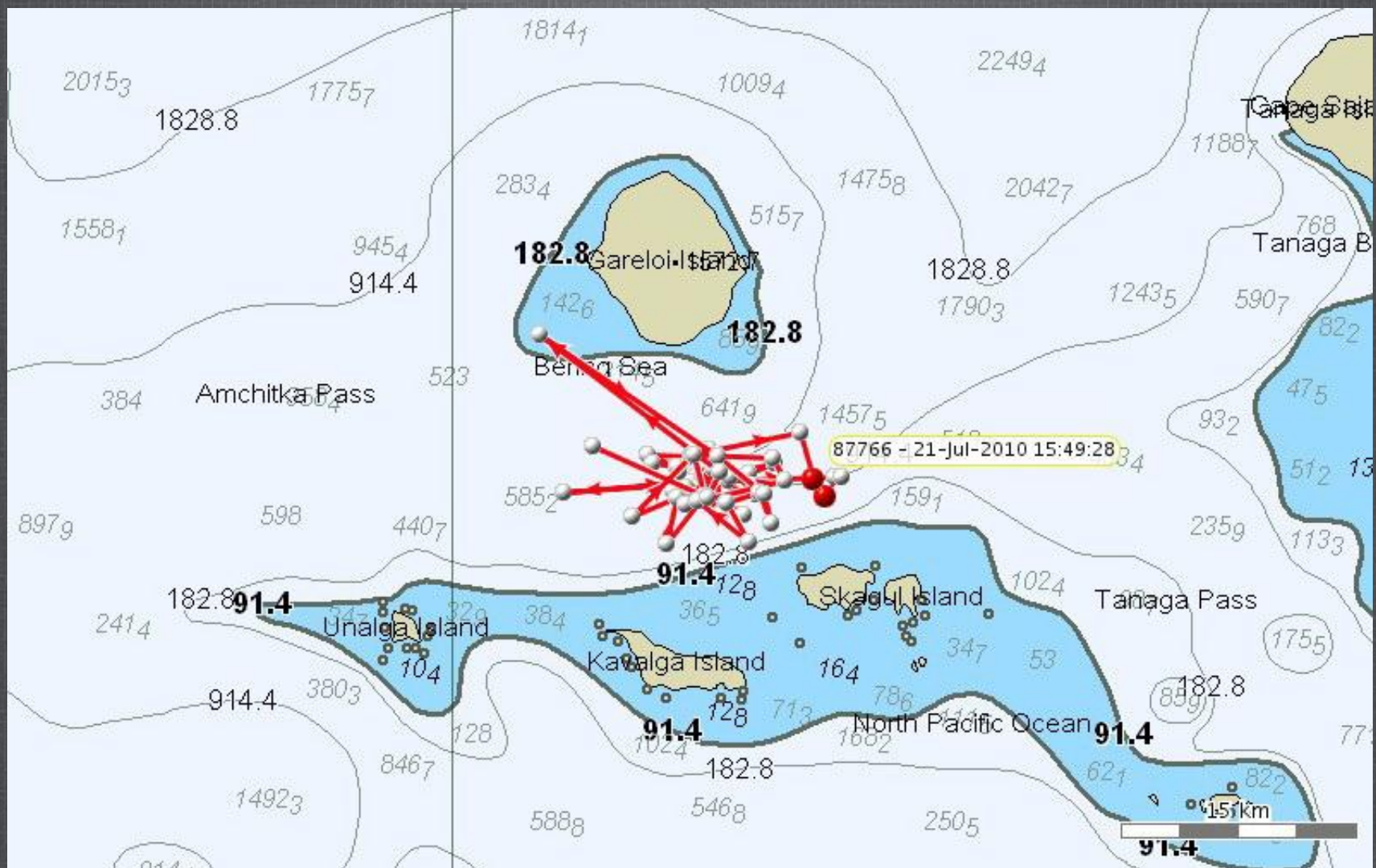
Map of sightings of Baird's beaked whales (*Berardius bairdii*) and Stenjerger's beaked whale (*Mesoplodon stejnegeri*) during NMML killer whale surveys from 2001-2010. The dead Baird's beaked whale in the Rat Islands was killed by Bigg's (transient-type) killer whales



Delarofs Islands and Tanaga Island

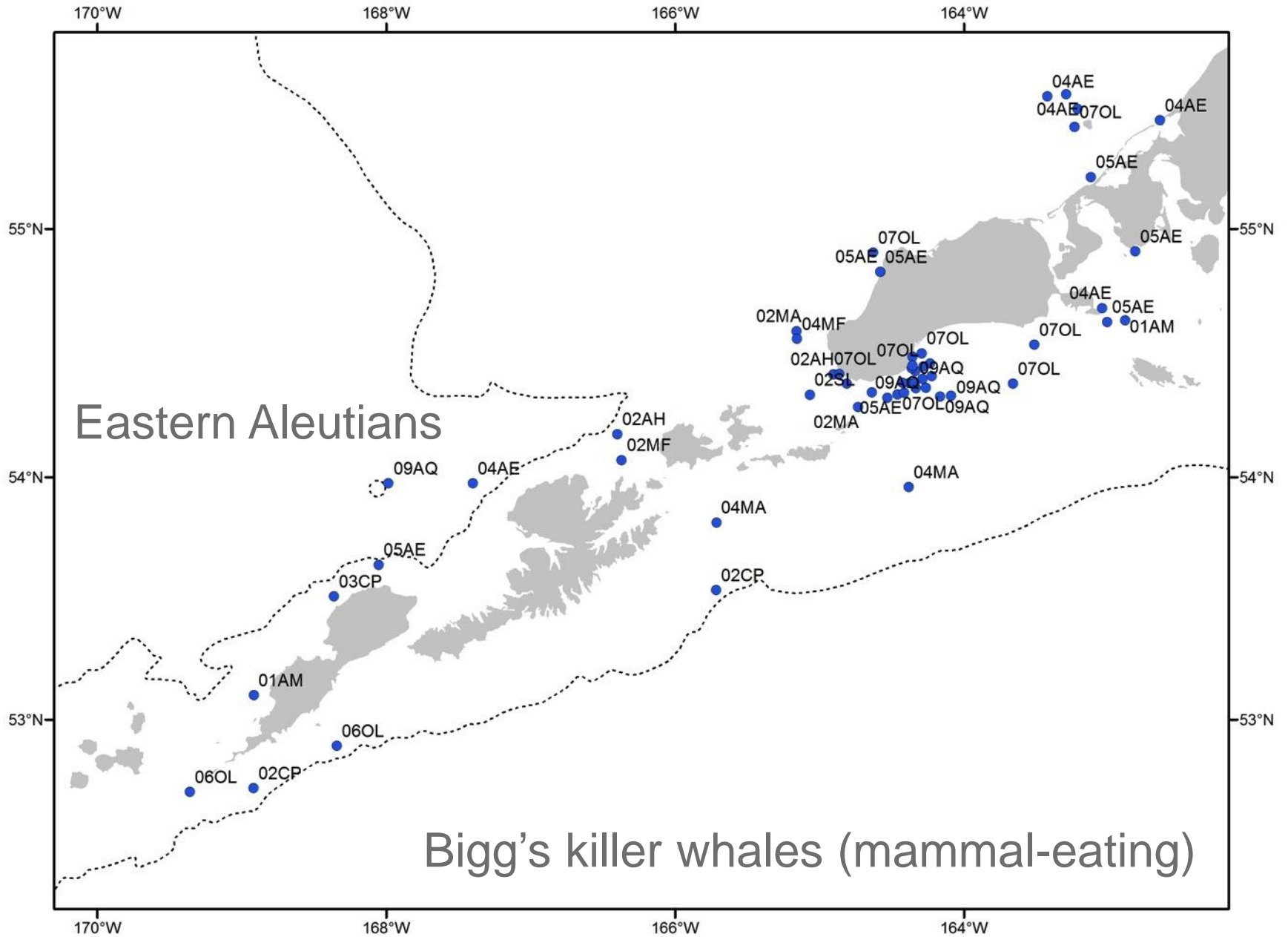
- **We have re-sighted in the Delarofs (between Gareloi and Skagul) a group first seen in 2000 by Tim Tinker (USFWS) near Adak, implicated by him as possible predators on sea otters**
- **We satellite-tagged one of these whales, and it stayed in a limited area in deep water at the head of a submarine canyon for ~ 1 month**
- **We speculate they were feeding on beaked whales or squid**

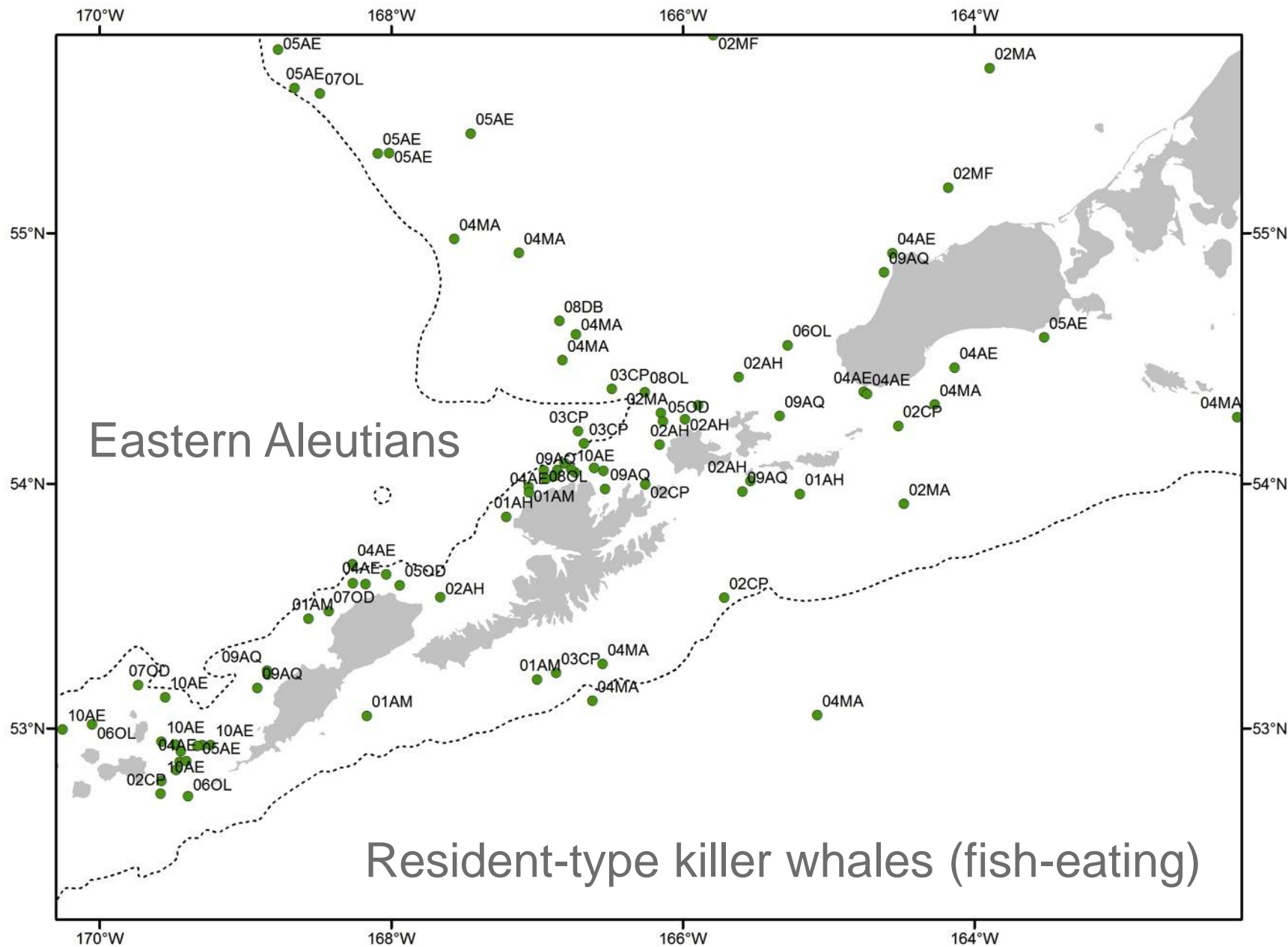
Satellite-tag locations for week of July 21 2010 in the Delarof Islands



Satellite-tag locations for week of August 8 2010 in the Delarof Islands







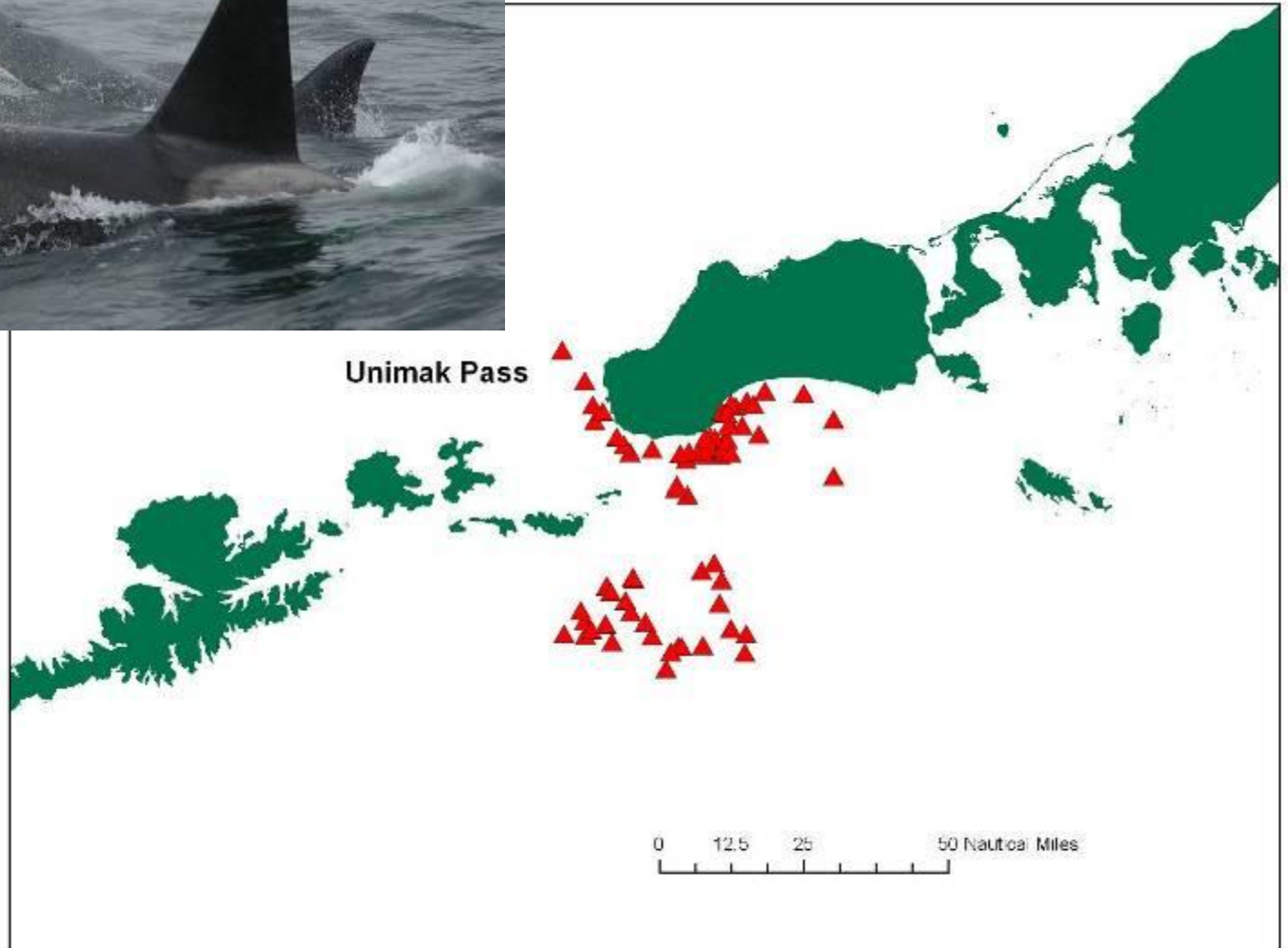
Summary of Bigg's killer whales ("transient"-type) in the eastern Aleutian Islands (Samalga Pass to False Pass)

- **2001-2003 line-transect estimate (Zerbini et al. 2007)**
 - **88 (95% CI 20-373)**
 - **Estimate is for July-August**
- **2004-2010 Mark-recapture abundance estimate (Wade and Durban unpublished)**
 - **176 (95% CI 130-252)**
 - **Estimate is for June-August**
 - **Note this estimate includes photographs from June when Bigg's KWs are still aggregated around Unimak Island to prey on migrating gray whales and fur seals**
- **Density is relatively high**

Summary of Bigg's killer whales ("transient"-type) in the eastern Aleutian Islands (Samalga Pass to False Pass)

- We have observed predation on gray whales, fur seals, Steller sea lions, and minke whales
- Stable isotope values are consistent with these observations (Krahn et al. 2005), and indicate Steller sea lions are not a dominant prey item
 - the killer whale nitrogen value is only slightly above Steller sea lions, not 3.8 above as it would if they fed exclusively on sea lions
- A satellite-tagged whale spent June on the south side of Unimak Island, then moved to south of Unimak Pass/Ugamak Island in July

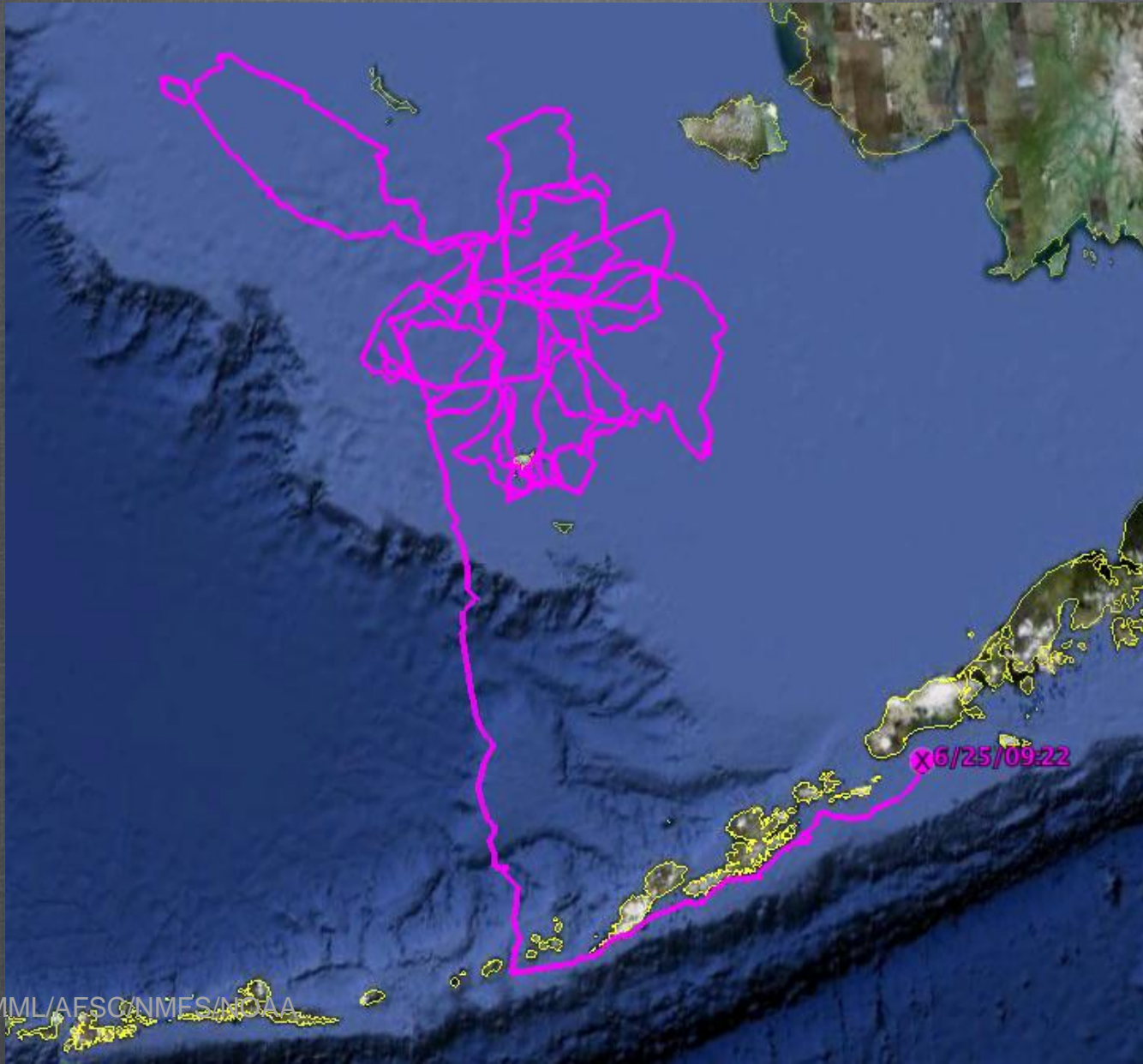
*2006 from NMML Survey
Mid-June to Mid-August*



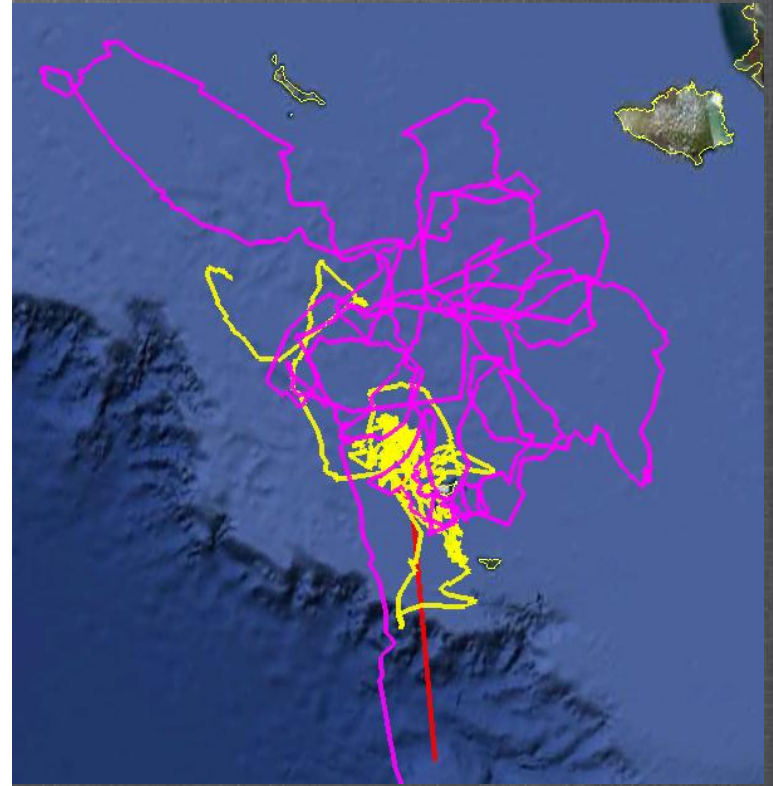
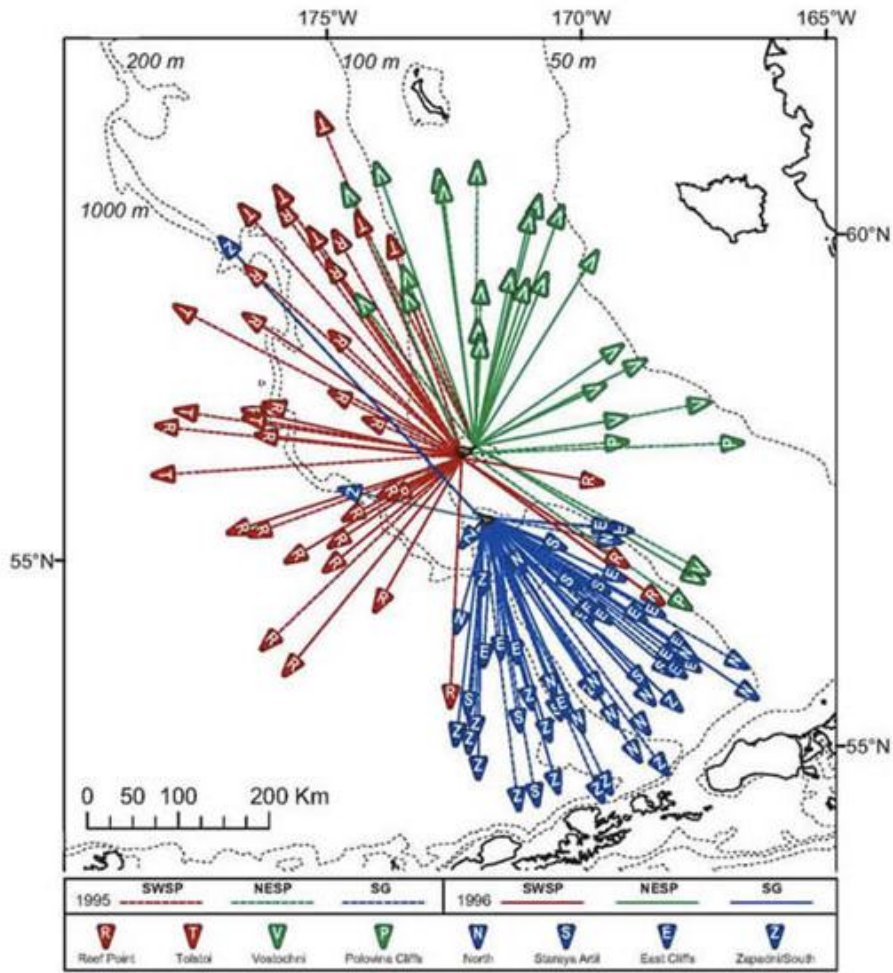
Summary of Bigg's killer whales ("transient"-type) in the eastern Aleutian Islands (Samalga Pass to False Pass)

- A Bigg's killer whale satellite-tagged on the south side of Unimak Island while feeding on a gray whale carcass traveled west to Samalga Pass and then north to the Pribilofs, where it then foraged extensively

Adult female tagged 6/29/09 on a gray whale carcass south of Unimak Island



Northern fur seal and killer whale foraging



Twice have observed resident killer whales feeding on Atka mackerel in the central Aleutians

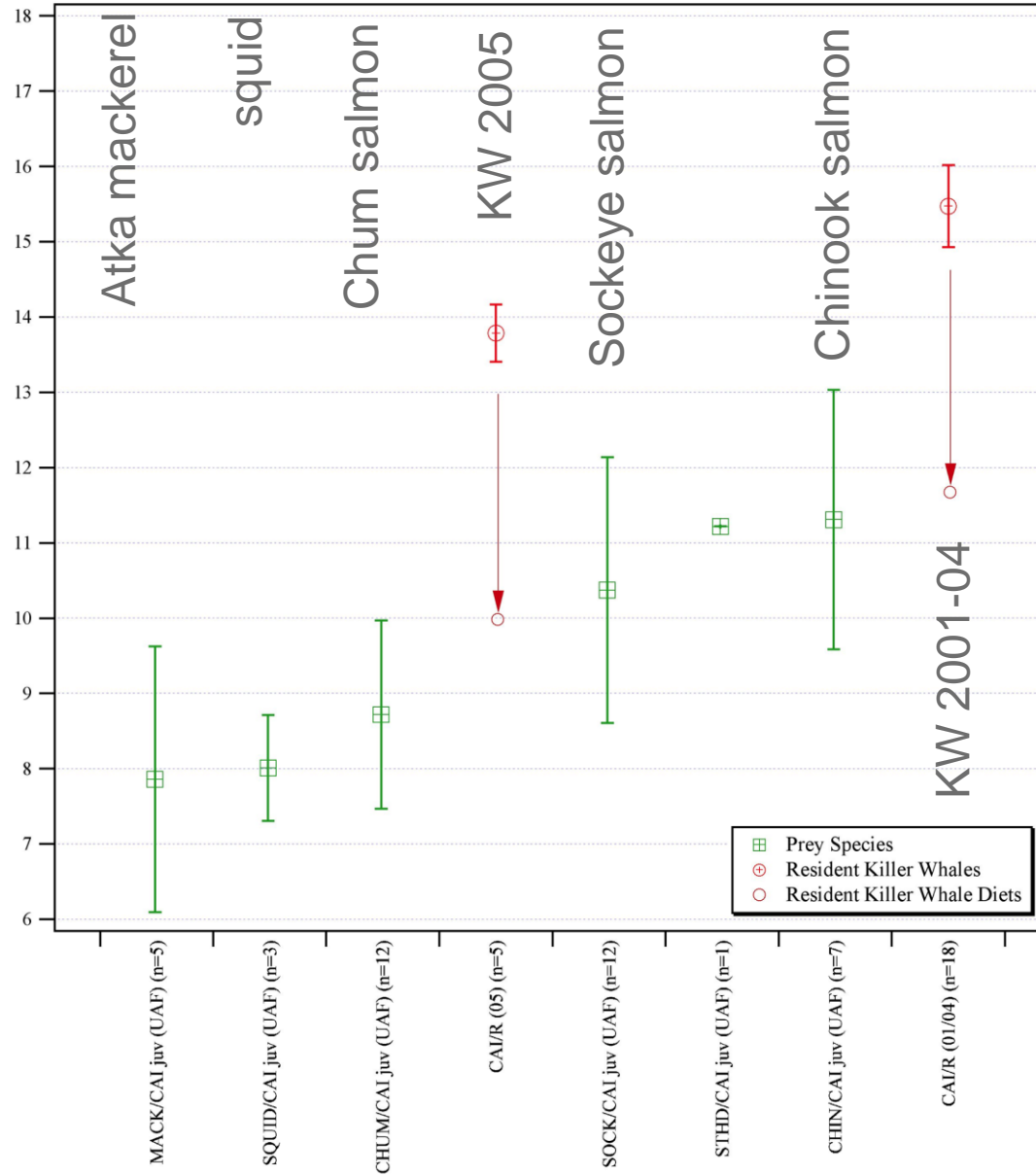


Simple hypothetical example of killer whale energetic demand for the western and central Aleutians and potential consumption of Atka Mackerel

Number of KWs	500	500
KW Kcal/day	140000	140000
Days	365	365
% AM in diet	0.1	0.5
Kcal/g AM	1.2	1.2
fraction cons	0.75	0.75
Atka mackerel metric tons	2839	14194

CentralAleutians

Wade et al. 2006. NPRB Final Report



Eastern Aleutians Wade et al. 2006. NPRB Final Report

