Alaska Fisheries Science Center

Protected Species Science Program Review

Theme 5: Small Cetacean Science

Killer Whales

Cetacean Assessment and Ecology Program

Paul R. Wade and Marilyn E. Dahlheim

16-20 March 2015

Alaska Killer Whales

Legal Status: Protection under the MMPA

Potential Threats:

1. Habitat degradation
2. Climate change
3. Bycatch

Mandates: Stock Assessments

Bigg's ("Transient"-type) killer whales in the North Pacific are a sub-species or species that separated from other killer whales ~700,000 years ago (Morin et al. 2010. *Genome Research* 20:908-916)

Taxonomy Committee of the Society of Marine Mammalogy recognizes transients and residents as un-named sub-species of *Orcinus orca*

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

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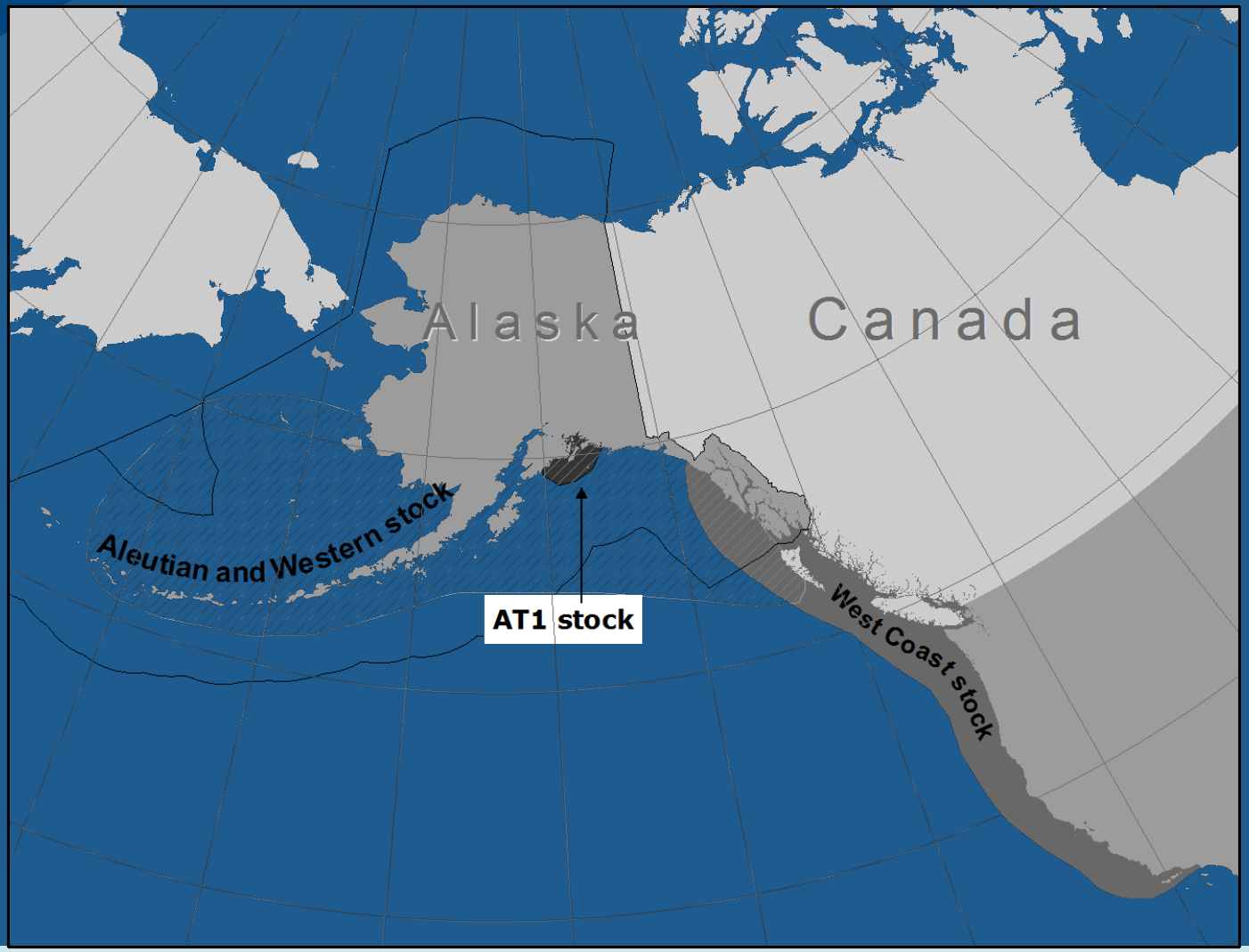
Killer whales (*Orcinus orca*) currently comprise a single, cosmopolitan species with a diverse diet. However, studies over the last 30 yr have revealed populations of sympatric "ecotypes" with discrete prey preferences, morphology, and behaviors. Although these ecotypes avoid social interactions and 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 (transient-type) Killer Whales



Transient killer whale predation studies in the Aleutian Islands and Bering Sea

Objectives: Bering Sea & Aleutian Islands

- Abundance and distribution of both ecotypes
  - Line-transect surveys
  - Mark-recapture estimation from photo-identification data
- Prey preferences and foraging behavior
  - Visual observations of predation
  - Chemical ecology from skin/blubber biopsies
  - Satellite tagging for movements and diving behavior
  - Passive acoustic recorders at SSL rookeries
- Population structure
  - Genetics
  - Acoustic call catalogues

Partnerships

- North Gulf Oceanographic Society
  - Sharing Aleutian photos and biopsy samples (Craig Matkin)
  - Collaborative genetics studies (Kim Parsons)
  - Acoustic studies with funding from North Pacific Fisheries Foundation (Manuel Castellote)
- North Pacific Wildlife Consulting (Vladimir Burkanov)
  - Sharing Russian photos and biopsy samples
- UAF/Alaska Sea Life Center (Russ Andrews)
  - Collaborative project on satellite tagging with funding from the Pollock Conservation Cooperative Research Center
- SWFSC (John Durban and Robert Pitman)
  - Surveys and Satellite tagging
- NWFSC (Gina Ylitalo, David Herman, Douglas Burrows)
  - Chemical ecology studies

Abundance

Line-transect estimates of abundance for transient-type (N=250, CV=0.52) and resident-type (N=1,590, CV=0.51) killer whales

Mar Biol (2007) 150:1033–1045
DOI 10.1007/s00227-006-0347-8

RESEARCH ARTICLE

Estimating abundance of killer whales in the nearshore waters of the Gulf of Alaska and Aleutian Islands using line-transect sampling

Alexandre N. Zerbini · Janice M. Waite · John W. Durban · Rick LeDuc · Marilyn E. Dahlheim · Paul R. Wade

Received: 31 October 2005 / Accepted: 14 April 2006 / Published online: 9 August 2006

Abstract Killer whale (*Orcinus orca* Linnaeus, 1758) abundance in the North Pacific is known only for a few populations for which extensive longitudinal data are available, with little quantitative data from more remote regions. Line-transect ship surveys were conducted in July and August of 2001–2003 in coastal waters of the western Gulf of Alaska and the Aleutian Islands. Conventional and Multiple Covariate Distance Sampling methods were used to estimate the abundance of first sighting, and post-encounter group size (PEGS) corresponded to estimates made after closely approaching sighted groups. 'Resident'-type (fish-eating) killer whales were more abundant than the 'transient'-type (mammal-eating). Abundance estimates of resident killer whales (991 [95% CI = 379–2,585] [IGS] and 1,587 [95% CI = 608–4,140] [PEGS]), were at least four times greater than those of the transient killer whales (200 [95% CI = 81–488] [IGS] and 251 [95%

Abundance

Durban et al. 2010. Mark-recapture estimate of transients (N=345, CV~0.18)

Mar Biol (2010) 157:1591–1604
DOI 10.1007/s00227-010-1432-6

ORIGINAL PAPER

Photographic mark-recapture analysis of clustered mammal-eating killer whales around the Aleutian Islands and Gulf of Alaska

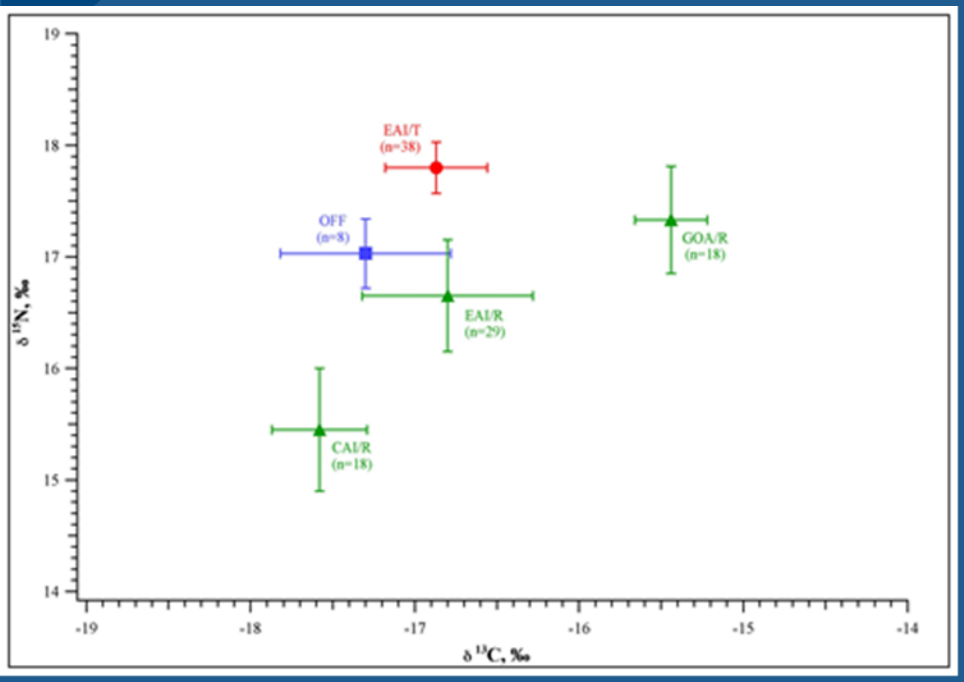
J. Durban · D. Ellifrit · M. Dahlheim ·
J. Waite · C. Matkin · L. Barrett-Lennard ·
G. Ellis · R. Pitman · R. LeDuc · P. Wade

Received: 22 July 2009 / Accepted: 18 March 2010 / Published online: 6 April 2010

Abstract We used photographic mark-recapture methods to estimate the number of mammal-eating "transient" killer whales using the coastal waters from the central Gulf

Monte Carlo methods were used to sample identification probabilities across the distribution of clusters to estimate a total of 345 identified and undetected whales (95% prob-

Three papers on stable isotopes, fatty acids, and contaminants Two more in prep. on regional (population) differences in residents and in transients



Herman et al.. 2005. Feeding ecology of eastern North Pacific killer whales from fatty acid, stable isotope and organochlorine analyses of blubber biopsies. Marine Ecology Progress Series 302:275-291.

Krahn et al. 2007. Use of chemical profiles in assessing the feeding ecology of eastern North Pacific killer whales. Marine Environmental Research. 63:91–114

Herman et al. 2008. Assessing age-distributions of killer whale (*Orcinus orca*) populations from the composition of endogenous fatty acids in their outer-blubber layers. Marine Ecology Progress Series. 372:289-302

Passive acoustic mooring off a Steller sea lion rookery reveals regular occurrence of transient killer whales at the rookery in winter

Population structure of resident-type killer whales

Population structure of both transients and residents

Journal of Heredity Advance Access published July 11, 2013

Journal of Heredity
doi:10.1093/jhered/est037

Geographic Patterns of Genetic Differentiation among Killer Whales in the Northern North Pacific

KIM M. PARSONS, JOHN W. DURBAN, ALEXANDER M. BURDIN, VLADIMIR N. BURKANOV, ROBERT L. PITMAN, JAY BARLOW, LANCE G. BARRETT-LENNARD, RICHARD G. LEDUC, KELLY M. ROBERTSON, CRAIG O. MATKIN, AND PAUL R. WADE

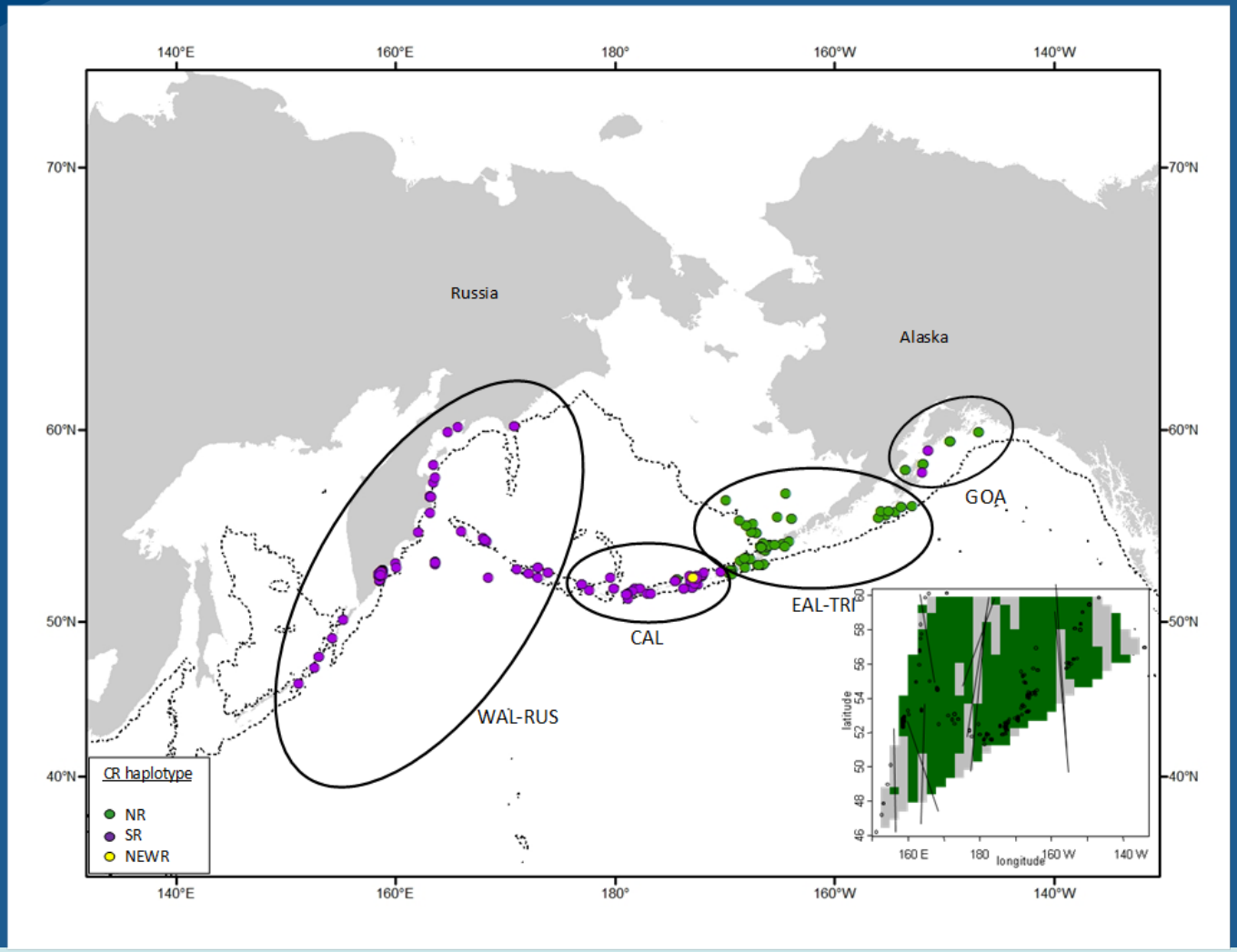
From the National Marine Mammal Laboratory, Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration, 7600 Sand Point Way NE, Seattle, WA 98115 (Parsons, Durban, Burkanov, and Wade); Protected Resources Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, California (Durban, Pitman, Barlow, LeDuc, and Robertson); Kamchatka Branch of the Pacific Institute of Geography RAS, Petropavlovsk-Kamchatskiy, Russia (Burdin); Vancouver Aquarium Marine Science Centre, Vancouver, British Columbia, Canada (Barrett-Lennard); and North Gulf Oceanic Society, Homer, AK (Matkin).

Address correspondence to Kim M. Parsons at the address above, or e-mail: kim.parsons@noaa.gov.

Abstract

The difficulties associated with detecting population boundaries have long constrained the conservation and management of highly mobile, wide-ranging marine species, such as killer whales (*Orcinus orca*). In this study, we use data from 26 nuclear microsatellite loci and mitochondrial DNA sequences (988 bp) to test a priori hypotheses about population subdivisions generated from a decade of killer whale surveys across the northern North Pacific. A total of 462 remote skin biopsies were collected from wild killer whales primarily between 2001 and 2010 from the northern Gulf of Alaska to the Sea of Okhotsk, representing both the piscivorous "resident" and the mammal-eating "transient" (or Bigg's) killer whales. Divergence of the 2 ecotypes was supported by both mtDNA and microsatellites. Geographic patterns of genetic differentiation were supported by significant regions of genetic discontinuity, providing evidence of population structuring within both ecotypes and corroborating direct observations of restricted movements of individual whales. In the Aleutian Islands (Alaska), subpopulations, or groups with significantly different mtDNA and microsatellite allele frequencies, were largely delimited by major oceanographic boundaries for resident killer whales. Although Amchitka Pass represented a major subdivision for transient killer whales between the central and western Aleutian Islands, several smaller subpopulations were evident throughout the eastern Aleutians and Bering Sea. Support for seasonally sympatric transient subpopulations around Unimak Island suggests isolating mechanisms other than geographic distance within this highly mobile top predator.

Parsons et al (2013): four genetic subdivisions in resident-type killer whales from the GOA to Russia

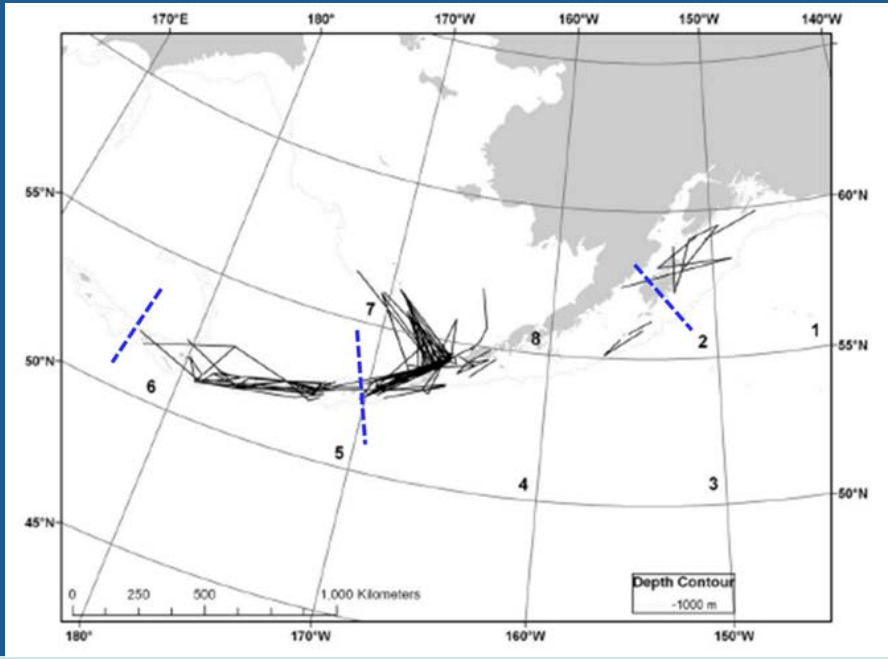


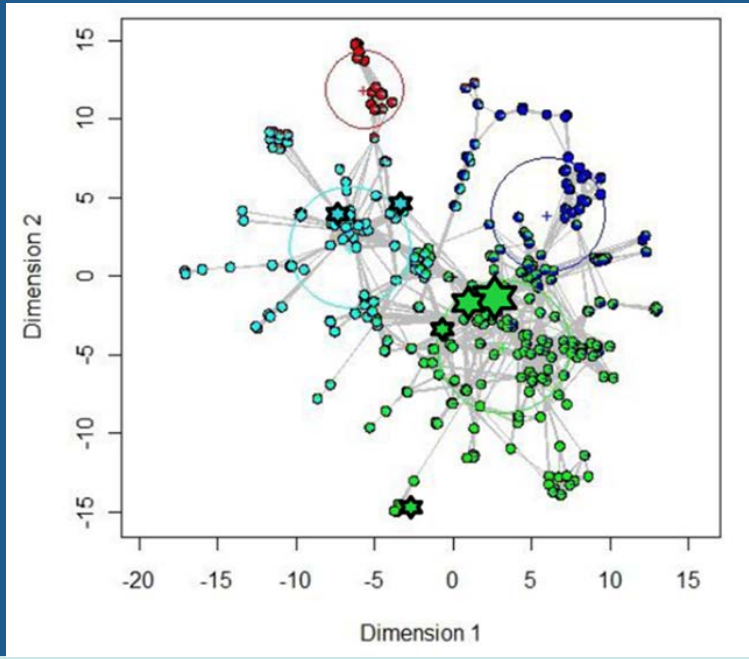
Mar Biol
DOI 10.1007/s00227-013-2351-0

ORIGINAL PAPER

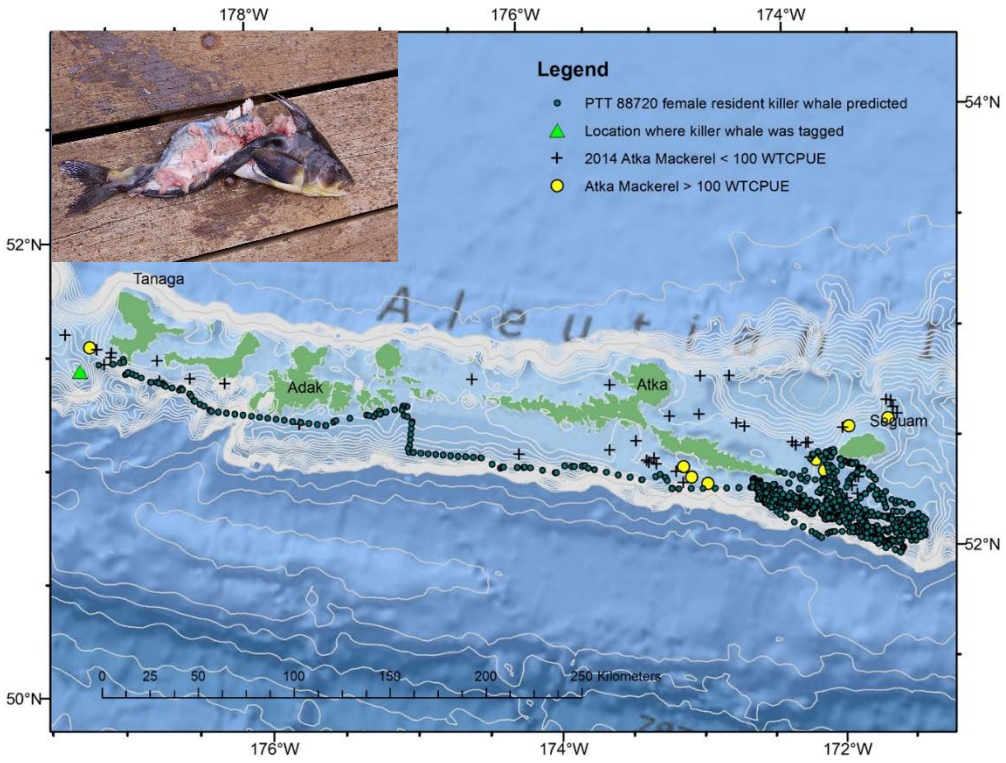
Spatial and social connectivity of fish-eating "Resident" killer whales (*Orcinus orca*) in the northern North Pacific

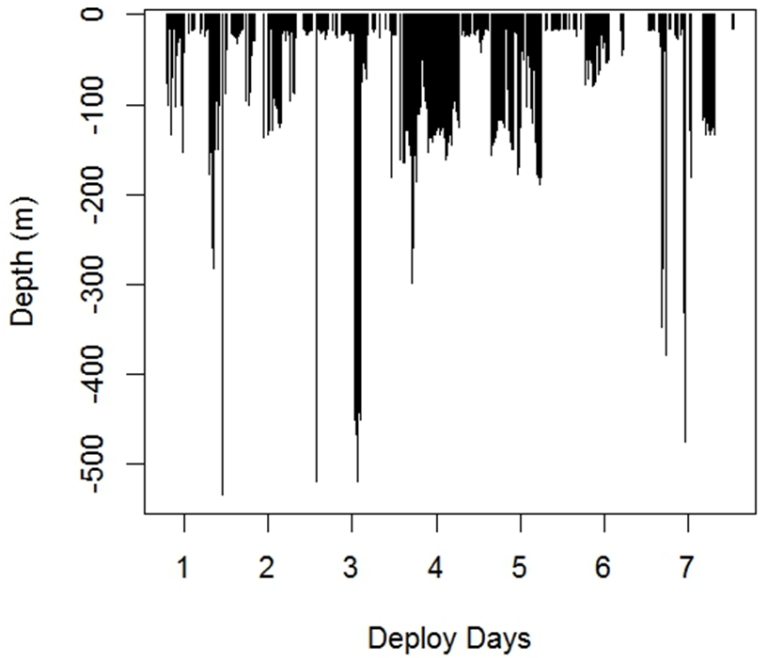
Holly Fearnbach · John W. Durban · David K. Ellifrit · Janice M. Waite · Craig O. Matkin · Chris R. Lunsford · Megan J. Peterson · Jay Barlow · Paul R. Wade



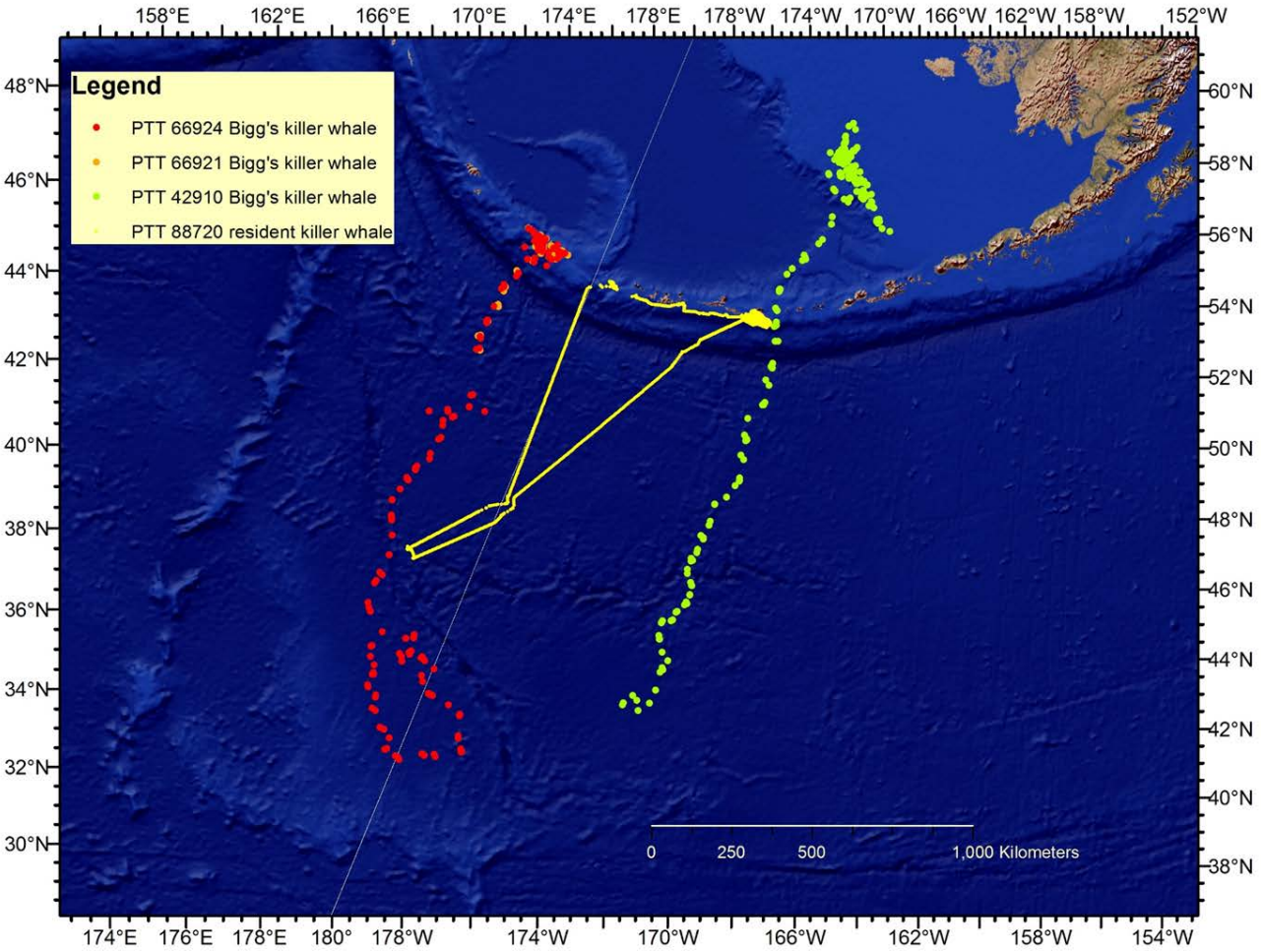


Foraging and diving behavior of residents: major competitors with SSLs for Atka mackerel in the western and central Aleutians?





Satellite tagging reveals rapid long-range movements to lower latitudes, similar to what is seen in the Antarctic



Weaknesses and Issues

- Virtually no internal funds available for additional cetacean research
- AFSC funding for Aleutian and Bering Sea killer whale surveys and research ended after 2010
- Currently piggy-backing on Steller sea lion research cruises in the western Aleutians
  - Exceptionally cost-effective, focused on area where SSLs are still declining
  - Continuing satellite tagging and acoustic research with external funding
  - Have received great support from Program Leader Tom Gelatt
  - But the natural consequence of piggy-backing on a different research project means there is relatively limited time for killer whale work
  - Have applied for additional funding for satellite tagging and stable isotope work in the current funding cycle of the North Pacific Research Board.

Objectives: Southeast Alaska

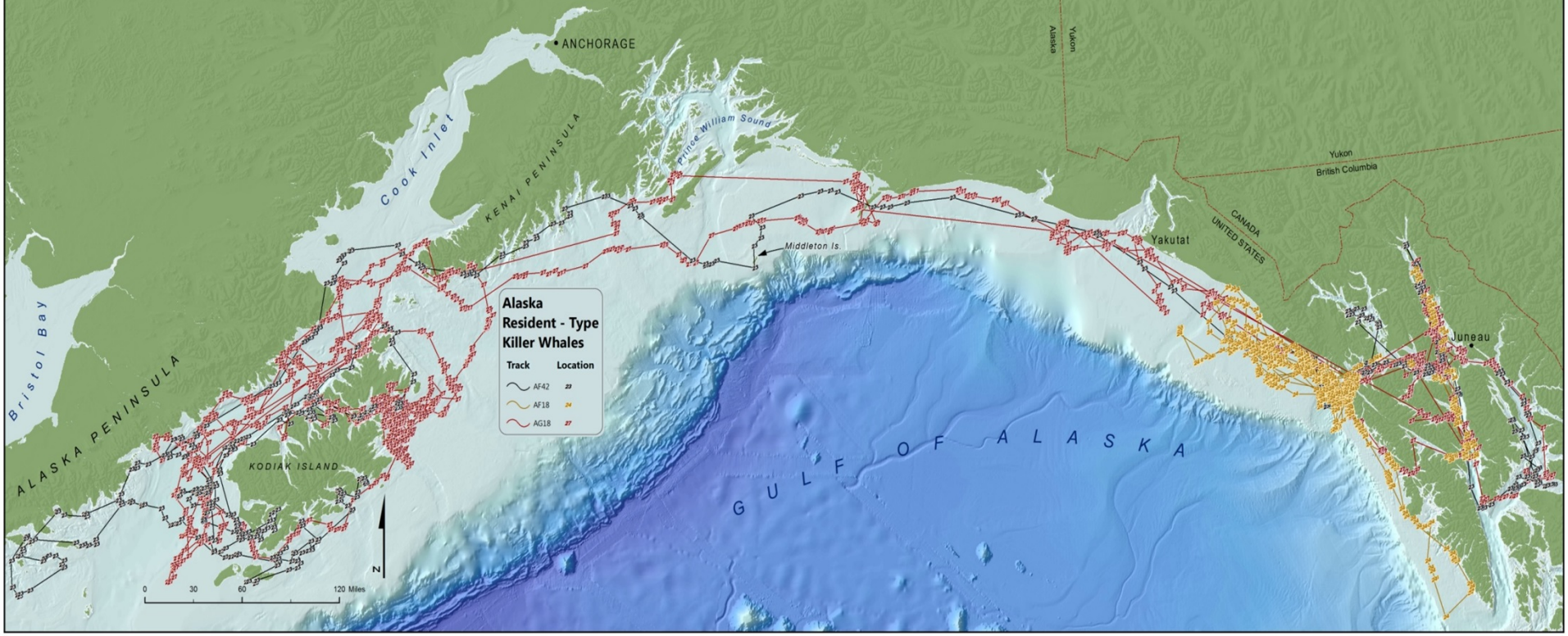
Long-term studies of resident- and transient-type killer whales in the inland waters of SE Alaska (1991-2014)

1. Seasonal distributional data
2. Abundance & trends through photo-identification studies
3. Genetic investigations – biopsy sampling
4. Predation studies via focal follows
5. Movements & home range – satellite tagging

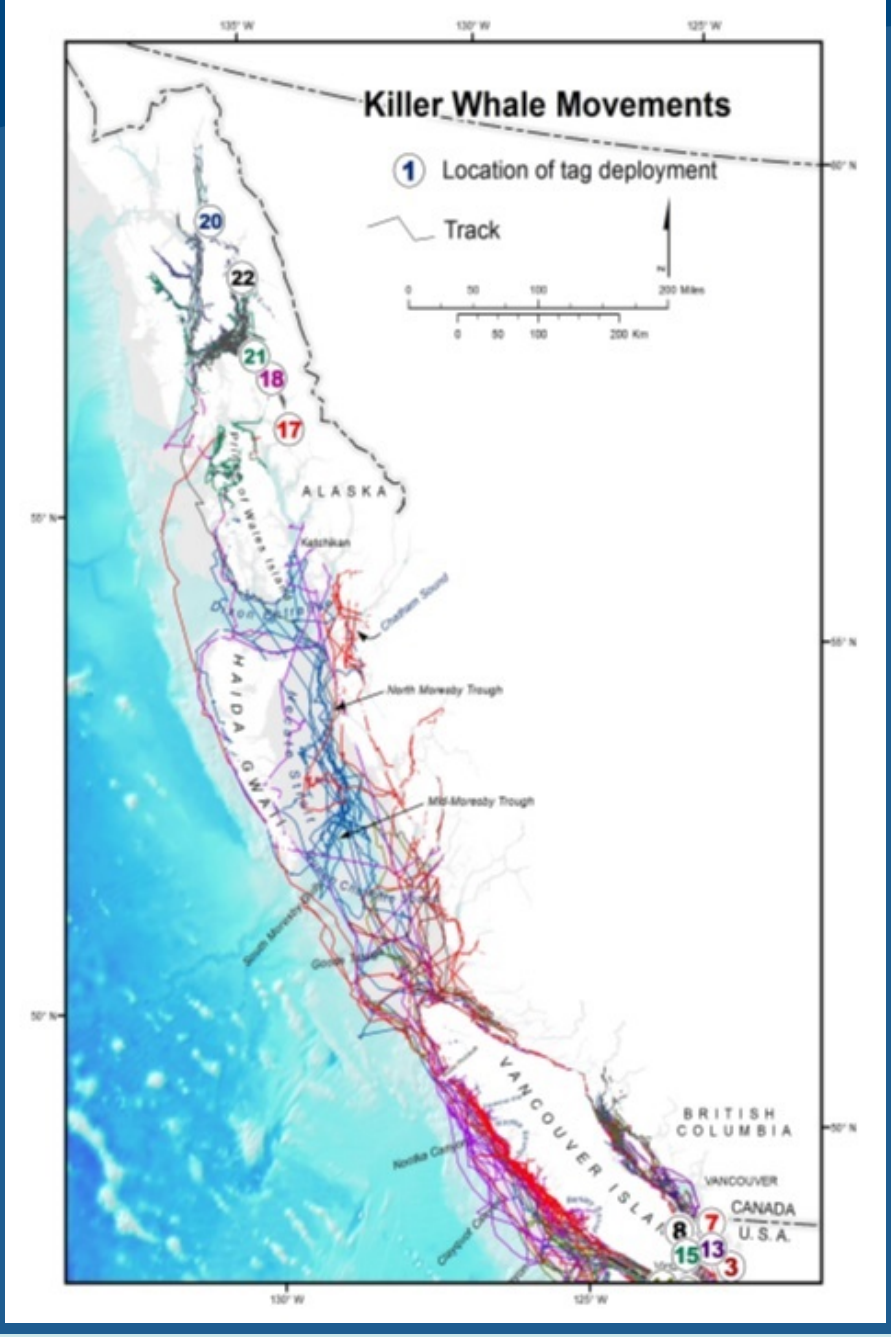
Southeast Alaska:
Movements and home range

How “resident” are resident-type killer whales in Alaska?

Recent data reveal extensive movement patterns during autumn



Transient killer whale movements in Southeast Alaska



Southeast Alaska: Movements

Partners:	NWFSC, Cascadia Research Collective, North Gulf Oceanic Society, Alaska Sea Life Center, and University of Alaska Fairbanks
Methods:	Remotely deployed satellite tags
Data Quality:	Frequency of data collected provides sufficient analytical accuracy
Strengths:	Tagging of known individuals. Exceptionally cost effective. Long-term monitoring of movements and information collected from pelagic regions
Weaknesses:	Currently piggy-backing on harbor porpoise research cruises in SE Alaska; no internal funds available to support killer whale research.

Alaska Fisheries Science Center

Protected Species Science Program Review

Theme 5: Small Cetacean Science

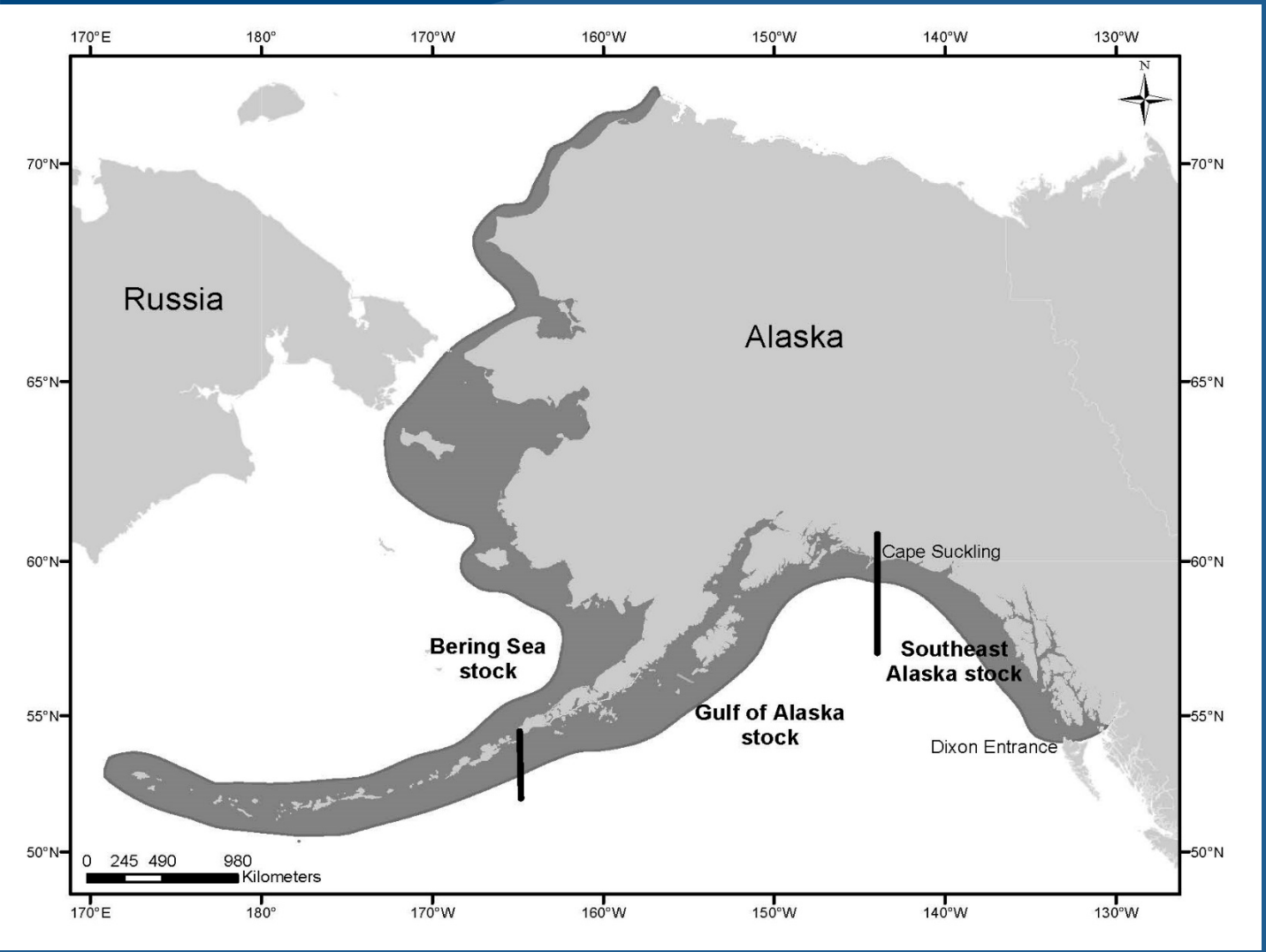
Harbor Porpoise

Cetacean Assessment and Ecology Program

Marilyn E. Dahlheim, Alex N. Zerbini, and Janice M. Waite

16-20 March 2015

Harbor Porpoise



There are currently three recognized stocks of harbor porpoise in Alaska.

Aerial Surveys in all areas: 1991-1993 and 1997-1999

Vessel Surveys in inland waters of southeast Alaska: 1991-2014

Harbor Porpoise

- Legal Status: Protection under the MMPA

- Potential Threats (all stocks):
  1. Fisheries by-catch
  2. Habitat degradation
  3. Climate change
  4. Predation

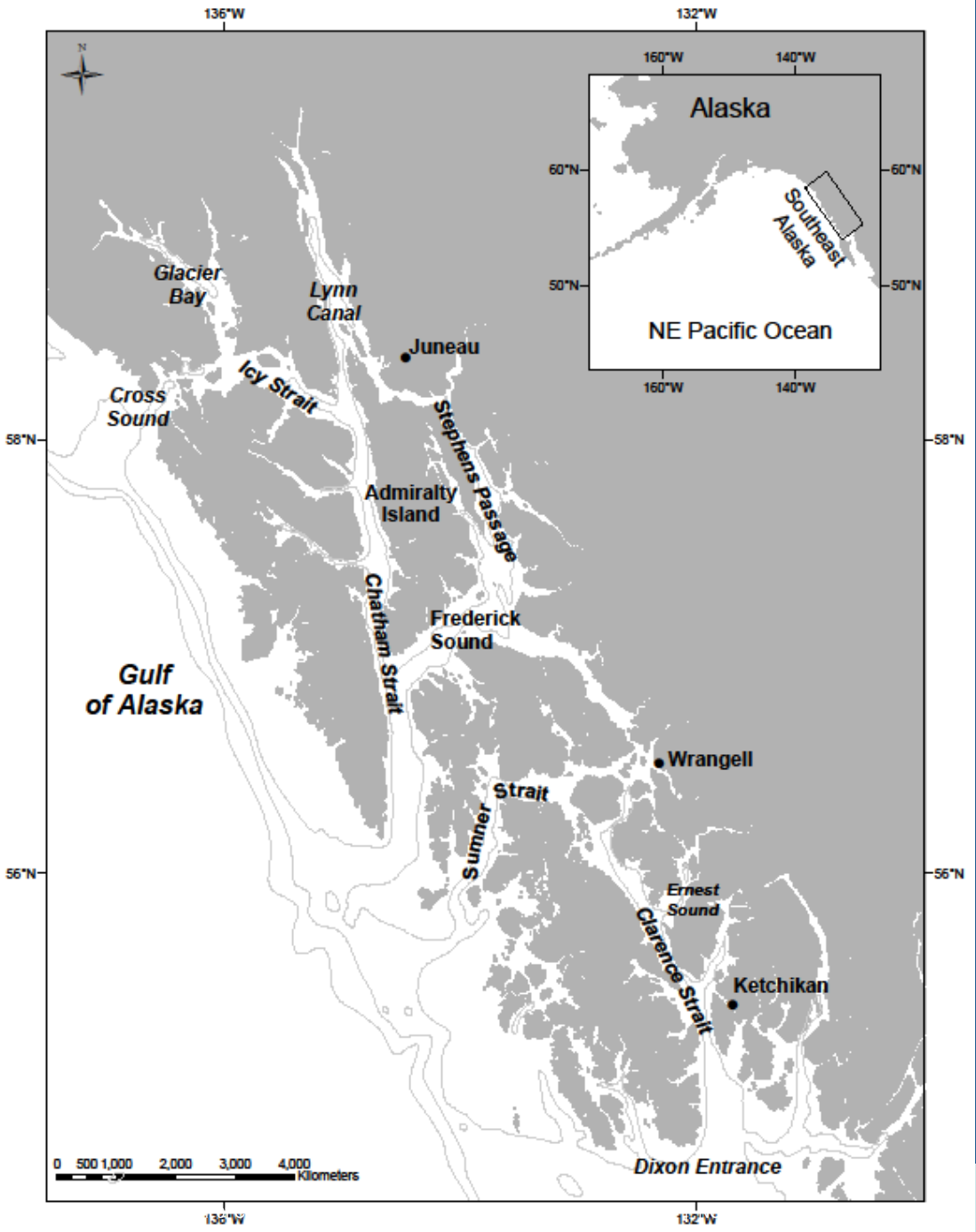
- Mandates: Stock Assessments

Harbor Porpoise

Overview of AFSC Research

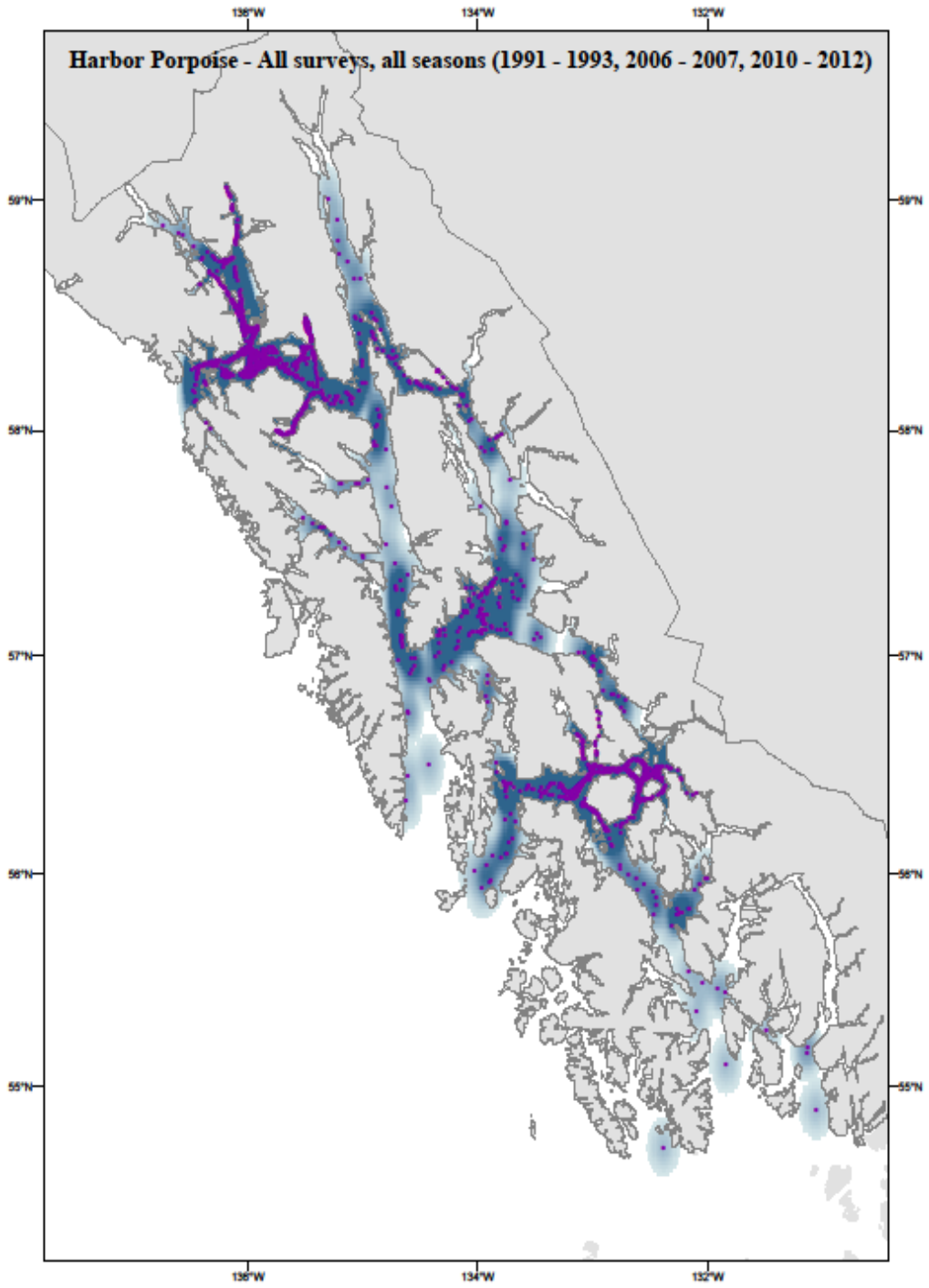
Long-term studies in the inland waters of Southeast Alaska (1991-2014).

1. Distribution
2. Abundance & trends
3. Stock structure



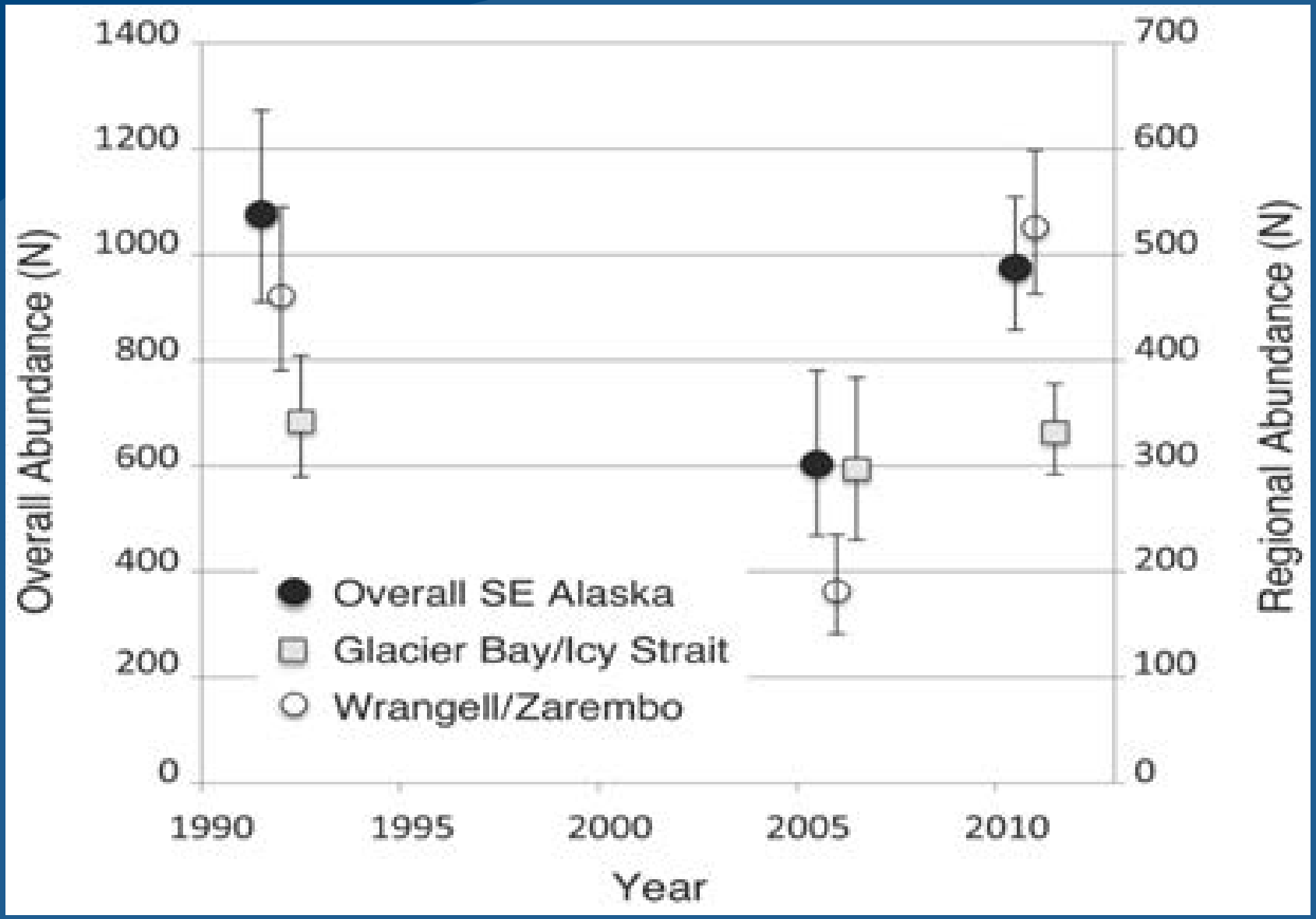
NOAA FISHERIES

Harbor Porpoise:
Distribution



NOAA FISHERIES

Harbor Porpoise: Abundance & Trends



Harbor Porpoise: Abundance & Trends

Partners:	NWFSC, and Cascadia Research Collective
Methods:	Line-transect surveys employed.
Data quality:	Frequency of data collected provides sufficient analytical accuracy
Strengths:	Expertise on NMML staff in survey design/data collection/analysis; experienced observers; and value of long-term database to evaluate population trends
Weaknesses:	Size of vessel to accommodate adequate number of observers to carry out g(0) experiments. Financial support required to conduct both aerial and vessel surveys to obtain stock estimates for entire range of harbor porpoise (3 stocks)

Harbor Porpoise: Stock Structure Studies

Partners: NMML, SWFSC, NWFSC, AKR, Alaska Stranding Network, and contractors.

Methods: Genetic analysis of stranded harbor porpoise tissue samples archived at SWFSC; attempt biopsy sampling of free-ranging animals. Possible capture operations to collect tissue samples for genetic analysis and placement of satellite tags to monitor porpoise movements.

Data Quality: Investigate statistical rigor needed to genetically assess stock structure. Sample size dependent upon genetic diversity.

Strengths: In-depth knowledge of seasonal distribution of harbor porpoise, abundance, and trends; experienced researchers in all phases of research planned.

Weaknesses: Small and elusive cetacean. Difficulties inherent when conducting research on this species.

Access to Research Results
Publications

- Killer whale photo-identification catalogues
- Four papers on killer whales genetics
- Cetaceans of Southeast Alaska
- Offshore killer whale movements (Bering Sea/Southeast Alaska to California)
- Transient killer whale abundance and trends, prey preferences, foraging strategies, and estimated kill rates
- Harbor porpoise abundance and trends (1991-2014)

Small Cetaceans: Recommendations

1. Stock structure studies on harbor porpoise in Southeast Alaska
   - Would allow interpretation of long-term abundance and trend estimates, as well as assessing the impact of bycatch in Wrangell-Zarembo and other areas
2. Photo-id, satellite tagging and acoustic studies of killer whales in the Aleutian Islands
   - Would provide important data on the occurrence, movements and population structure of killer whales, and relative to potential prey
3. Range-wide abundance surveys for harbor porpoise in Southeast Alaska
   - Cape Suckling to Dixon Entrance: simultaneous aerial (coastal waters) and vessel (inland waters) surveys to include g(0) experiments
   - Would allow PBR determinations