

RANGE-WIDE GRAY WHALE SCIENCE SYMPOSIUM



September 9-10, 2026

Hatfield Marine Science Center

Newport, Oregon



Oregon State University
Marine Mammal
Institute

Session 2

Changing Ecology and Pacific Coast Feeding Group

*Moderator: **Dave Weller**, NOAA Fisheries, Southwest Fisheries Science Center*



Photo credit: NOAA Fisheries/Dave Weller

Session 2

Panel discussion: Eastern North Pacific gray whale regional ecology



KC Bierlich



Erin Foster



Steven Swartz



Lauren Wild



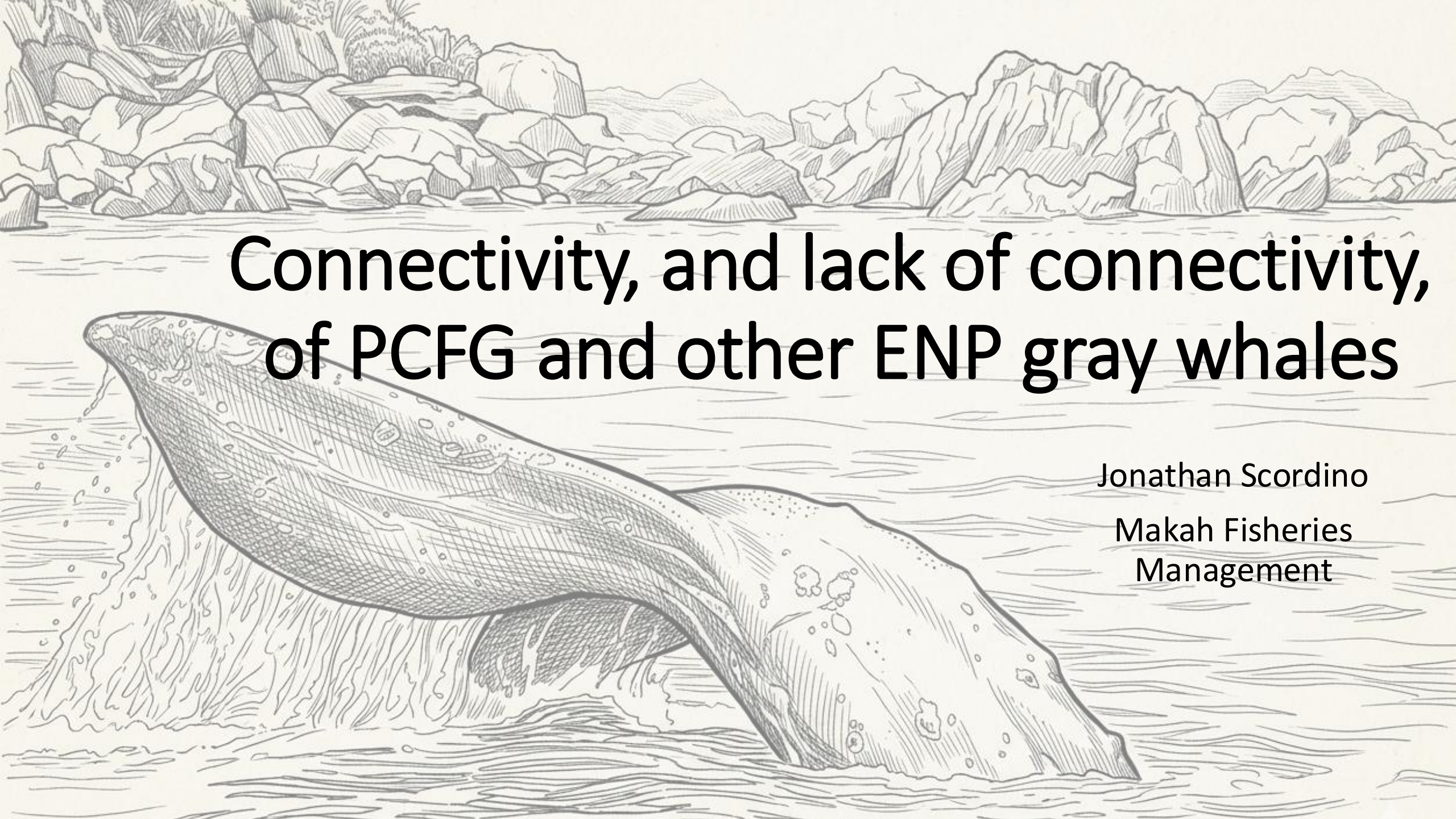
John Calambokidis



Alisa Schulman-Janiger



Andy Szabo



Connectivity, and lack of connectivity, of PCFG and other ENP gray whales

Jonathan Scordino
Makah Fisheries
Management

Who is the Pacific Coast Feeding Group

- Gray whales that do not make the full migration to Arctic feeding grounds
- IWC defines PCFG as gray whales that are observed in at least two feeding seasons (June-November) between 41-52° N (excluding Puget Sound)
- Objective of this talk is to discuss lines of evidence of their connectivity and lack of connectivity of PCFG gray whales with other ENP gray whales and management responses to the studies

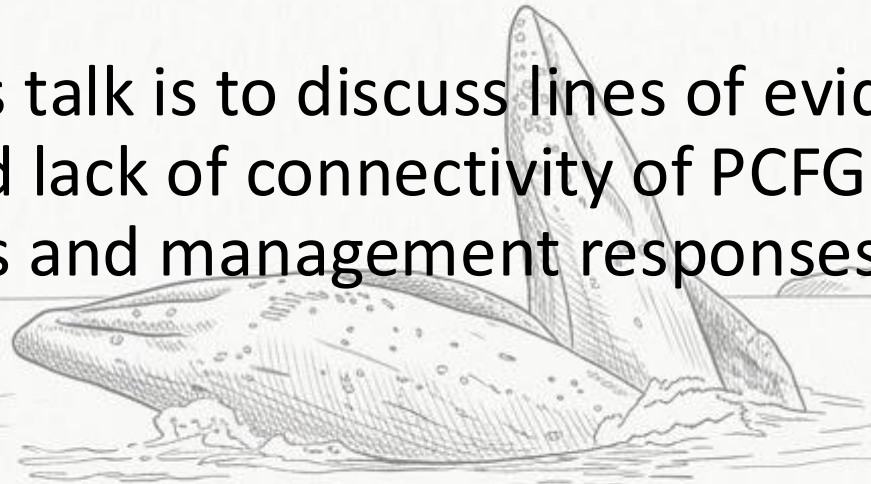


Photo-identification evidence of connectivity

- Within the PCFG range from 1999 to 2022, an average of 27.2 (range: 7 - 67) new non-calves were observed each year. Of these new non-calf whales, an average of 9.9 (range: 1 - 28) whales returned and were observed in subsequent years and recruited into the PCFG (Harris et al. 2025).
- Many PCFG whales have years in which they are not observed within the PCFG range and often when observed are only seen for part of feeding season (Harris et al. 2025). This suggests that the whales could be using areas outside the PCFG range for foraging.
- PCFG whales are frequently observed outside their defined range; 28% of whales photographed at Kodiak Island during the feeding season have been identified as PCFG whales (Calambokidis et al. 2025).
- 1 of 9 whales photo-identified near Utqiagvik, AK was a PCFG whale (CRC 850) (Calambokidis et al. 2012).

Photo-identification evidence of lack of connectivity

- Many whales within the group have shown annual fidelity to the feeding area and are seen throughout most of the feeding season (Harris et al. 2025).
- 65% of calves born to PCFG females have recruited into the PCFG; most have shown fidelity to the feeding group (Calambokidis and Perez 2017b) showing the importance of internal recruitment.

Genetic studies that show connectivity

Lang et al. (2014) and D'Intino et al. (2013) found no significant differences in the nuclear DNA of PCFG and ENP gray whales.

- Result shows no genetic evidence that PCFG whales are interbreeding exclusively within the PCFG

Simulations by Lang and Martien (2012) found that observed differences in haplotype mtDNA frequencies of PCFG and non-PCFG whales was most consistent with simulations that included 1-8 immigrants from the ENP to the PCFG each year.

Genetic studies that show a lack of connectivity

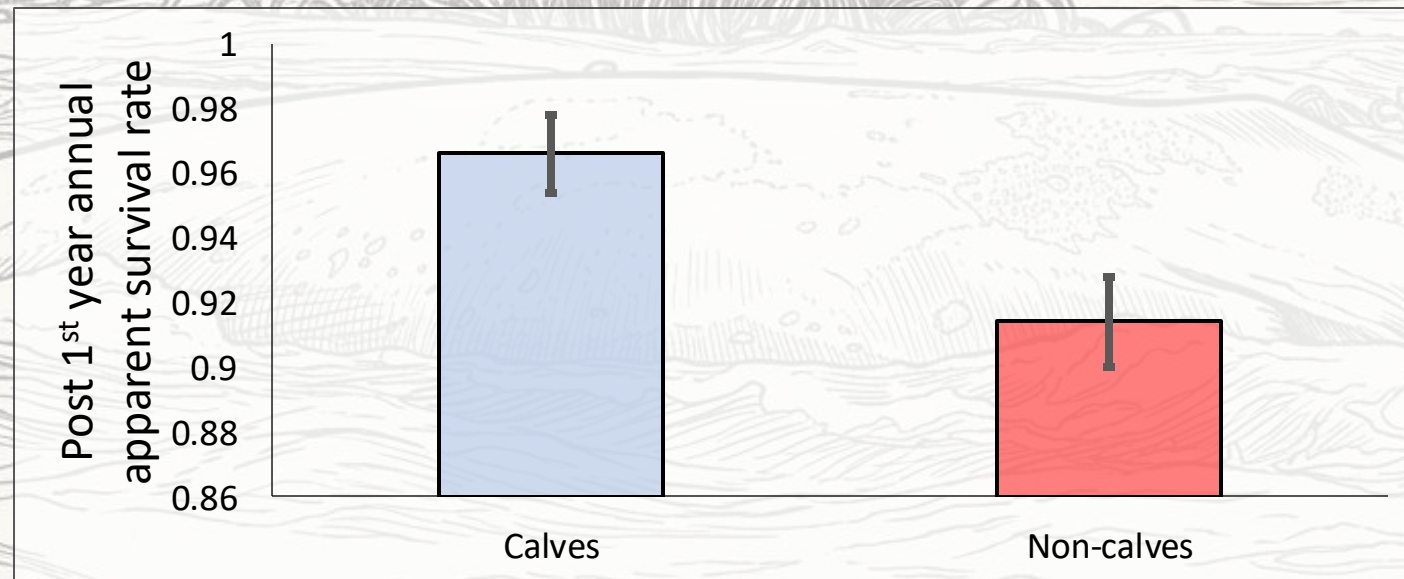
Frasier et al. (2010, 2011) found, and Lang et al. (2014) later confirmed, that PCFG whales have significant differences in haplotype frequencies of mtDNA from other ENP gray whales.

- Result shows that matrilineal recruitment influences the population dynamics of PCFG whales

Frasier et al. (2010, 2011) found significant different estimates of Θ between PCFG and non-PCFG whales

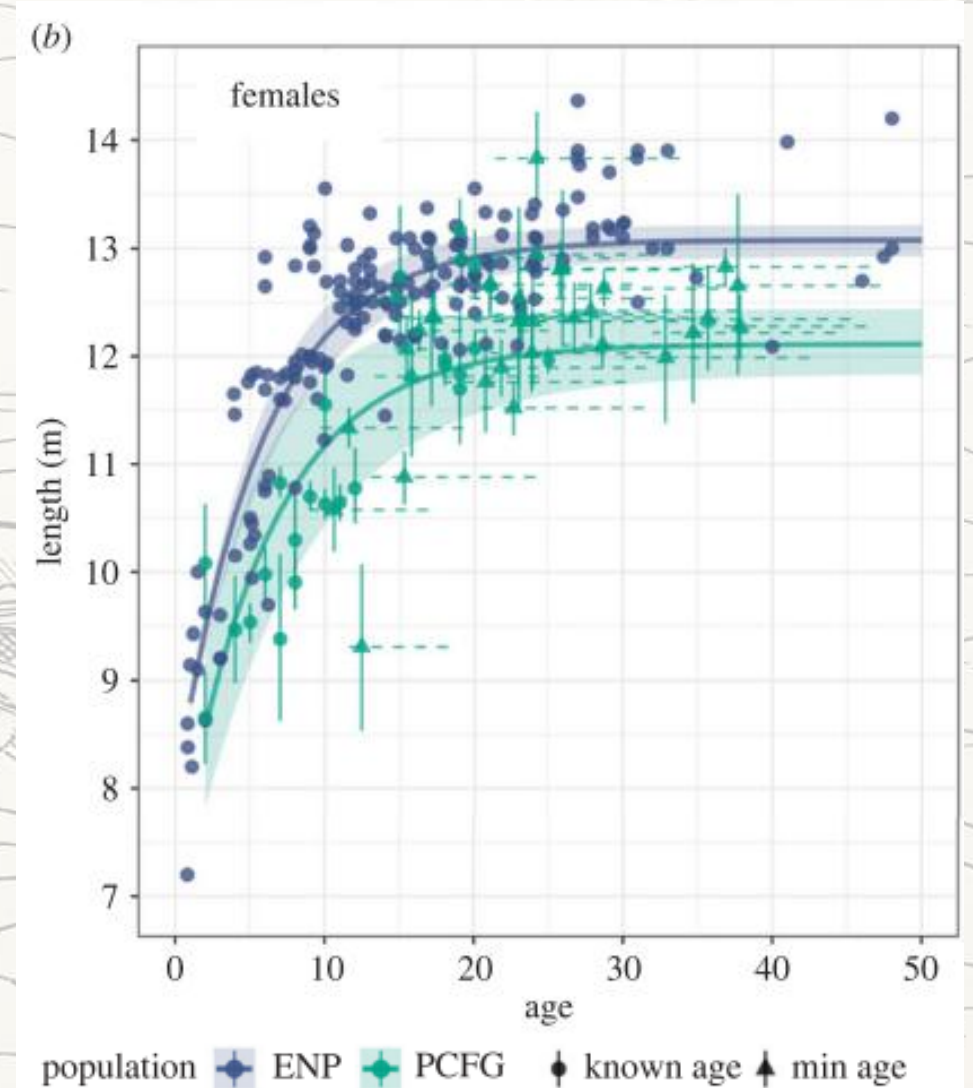
Other lines of evidence of connectivity

- The most parsimonious mark-recapture estimates of PCFG annual has substantially different estimates of post-first year annual survival rates for PCFG whales first observed as a non-calf ($\Phi=0.914$ se=0.006) as compared to PCFG whales first seen as a calf ($\Phi=0.966$ se=0.012) (Harris et al. 2022).



Other lines of evidence for lack of connectivity

Bierlich et al. (2023) found that PCFG reach shorter asymptotic lengths than other ENP gray whales and that they have smaller heads and flukes.



Management response

- The US (Weller et al. 2013) and IWC (2019) found that there was insufficient evidence to classify the PCFG as a stock. COSEWIC (2017) has recommended that Canada recognize the PCFG as a stock.
- IWC, NOAA, and Makah Tribe treat the PCFG as a management unit.
 - NOAA estimates PBR for the PCFG within the ENP gray whale stock assessment report (Carretta et al. 2021).
 - NOAA and Tribe have proposed control rules to the Makah gray whale hunt management plan to ensure impacts on PCFG whales are sustainable.
 - Temporal and spatial closures
 - Strike limit
 - Minimum abundance threshold of PCFG to have a hunt
 - IWC has rigorously evaluated the impact of aboriginal subsistence on PCFG whales as well as ENP and WNP gray whales. During 2026, found that the proposed Makah hunt has sustainable impact (IWC 2026).

Next steps

Aimee Lang of NOAA SWFSC is leading an effort to conduct a genetic relatedness evaluation of PCFG whales to quantitatively evaluate the contribution of internal and external recruitment.



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*** Background figures created by having Google AI implement the program Nano Banana 2 to convert whale photographs taken by Makah Fisheries to line drawings. ***

Gray whale adaptation and resilience in a changing ocean with insights from the PCFG

Leigh Torres

Professor, Oregon State University

Dept. Fisheries, Wildlife, Conservation Sciences



Oregon State University
Marine Mammal
Institute

A message of hope for the resilience of gray whales

History shows that gray whales can adapt

Abundance of gray whales has undergone dramatic historical oscillations due to environmental change^{1,2,3}.

Demonstrates gray whales possess traits effective for promoting fitness and survival during periods of rapid environmental change⁴.

Behavioral plasticity critical response to climate change

Behavioral adaptation can lead to improved fitness^{4,6}, influencing individual survival and future population structure and dynamics.

Gray whales are capable of behavioral plasticity

Possess cognitive capacity⁵ and advanced sensory processes to find prey resources⁶ to facilitate survival⁵.



Example of gray whale adaptation: The Pacific Coast Feeding Group (PCFG)

Unsure exactly when PCFG was founded, but possibly between 1920s and 1960s^{1,2,3,4}.

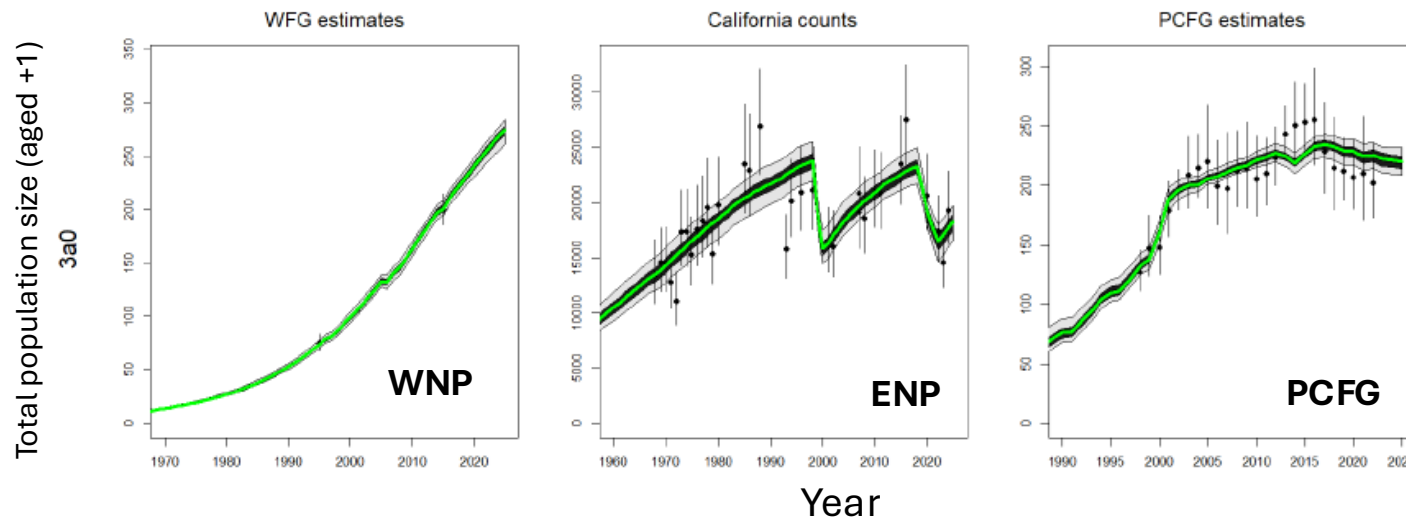
IWC/NOAA definition:

Gray whales observed between 1 June and 30 November, between 41°N to 52°N, in two or more years

→ Based on these parameters, PCFG population size is currently 213 individuals (SE = 15.55)⁵

Diverging abundance trends between the ENP, PCFG and WNP

- WNP shows consistent increase
 - ENP has oscillating increases and decreases;
 - PCFG abundance shows no population increase in over 20 years and an 18.8% decline since 2017
- Concerning population trend for PCFG



From Punt et al. (2025)

¹Pike 1962; ²Hatler & Darling 1974; ³Sumich 1984; ⁴Scordino et al. 2011; ⁵Harris et al. 2025

A Quick Primer on PCFG Ecology

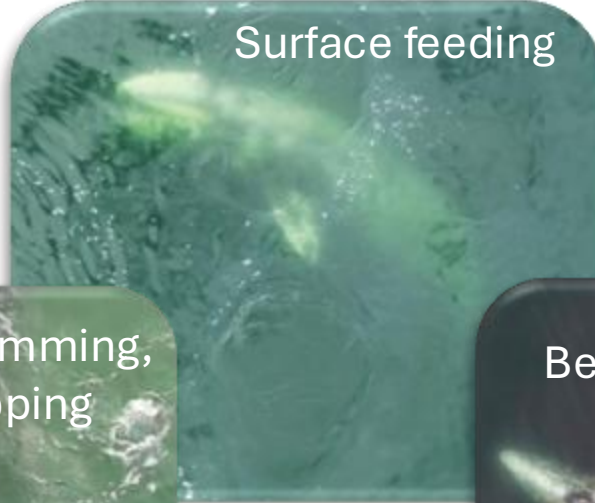
- High site fidelity across decades^{1,2}
- High residency rates within feeding seasons^{3,4}
- Consistent maternal (internal) recruitment⁵
- Calves of PCFG whales show long-term natal fidelity²
- mtDNA different between PCFG and ENP^{6,7,8}

- PCFG use diverse foraging strategies^{9,10,11}
- Targeting diverse prey^{12,13,14,15}
(e.g., amphipods, mysids, herring eggs, crab larvae)

Headstanding



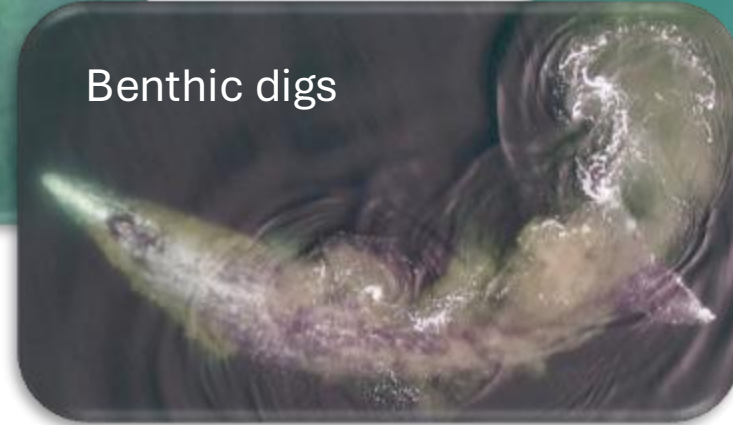
Surface feeding



Side-swimming,
jaw snapping



Benthic digs



Bubble blasts



The PCFG is an example of behavioral adaptation to exploit novel prey resources outside the Arctic/Sub-Arctic.

¹Calambokidis et al. 2017; ²Calambokidis et al. 2019; ³Hildebrand et al. 2025; ⁴Lagerquist et al. 2019; ⁵Calambokidis and Perez 2017; ⁶Frasier et al. 2011; ⁷Lang et al. 2014; ⁸Lang et al. 2022; ⁹Bird et al. 2024a; ¹⁰Bird et al. 2024b; ¹¹Colson et al. 2024; ¹²Oliver et al. 1984; ¹³Darling et al. 1998; ¹⁴Dunham & Duffus 2001; ¹⁵Newell & Cowles 2006

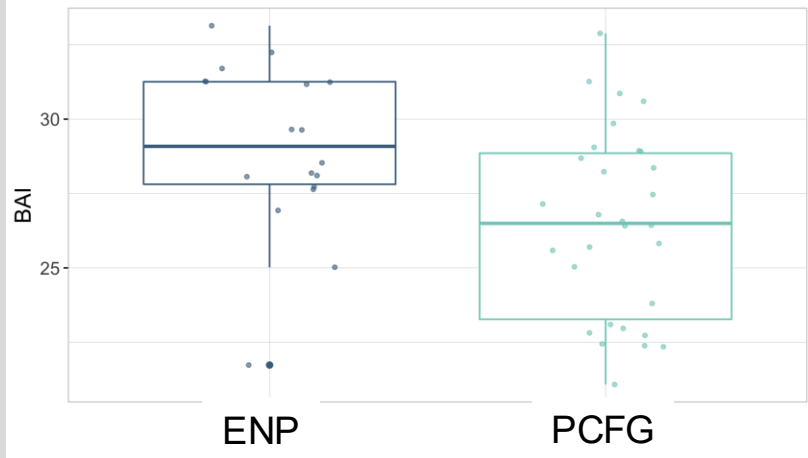
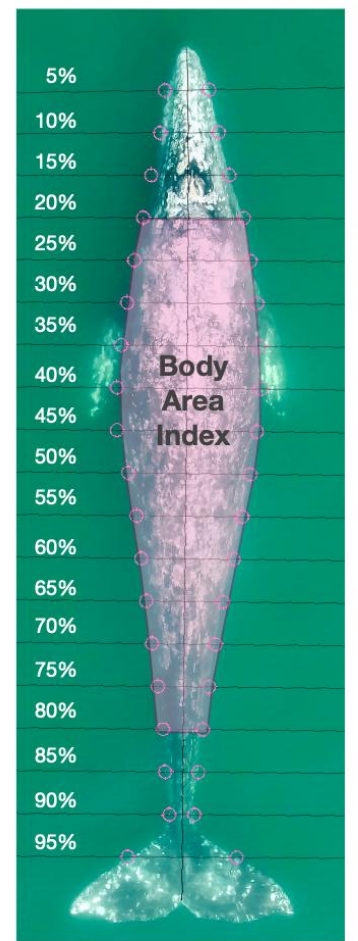
Impacts from coastal threats

- Many observation of fisheries entanglement and vessel strike scars ^{1,2}
- Evidence of high microplastic pollution ³
- Impacts of vessel traffic and noise on behavior ⁴ and stress physiology ^{5,6}



Signs of PCFG morphological response to environmental change

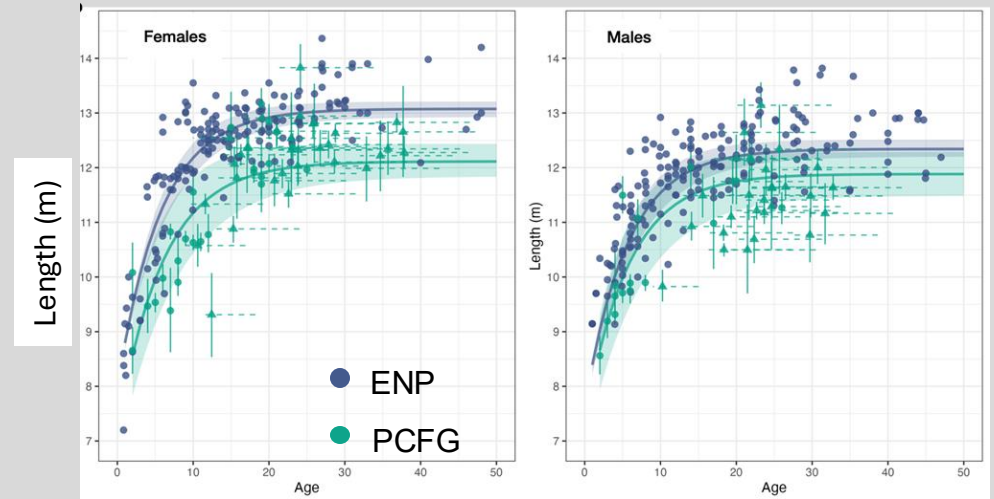
PCFG whales are skinnier than ENP whales¹



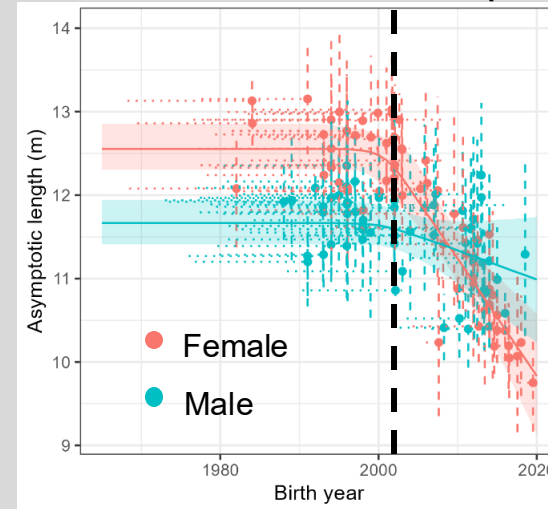
...And PCFG body condition varies with environmental conditions²

- Hypoxia
- Upwelling + Relaxation dynamics
- Kelp cover
- PDO

PCFG whales reach shorter asymptotic lengths than ENP³



PCFG whales have declining asymptotic lengths since around 2000, particularly in females⁴



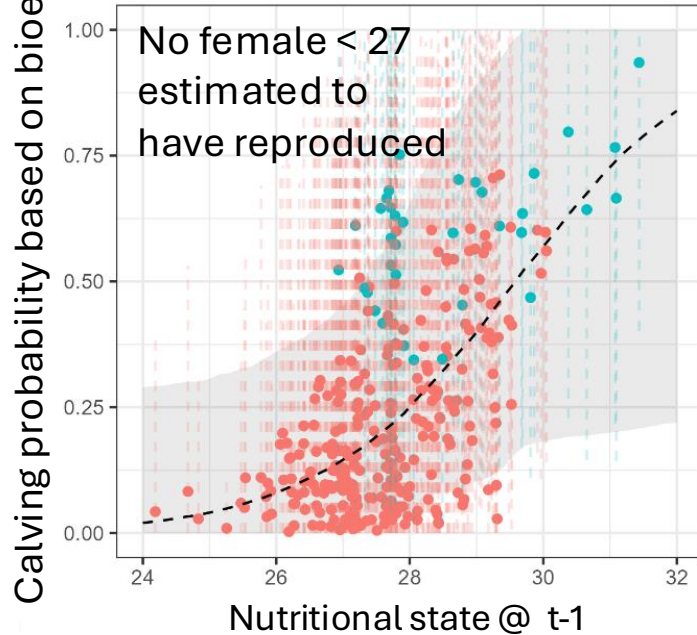
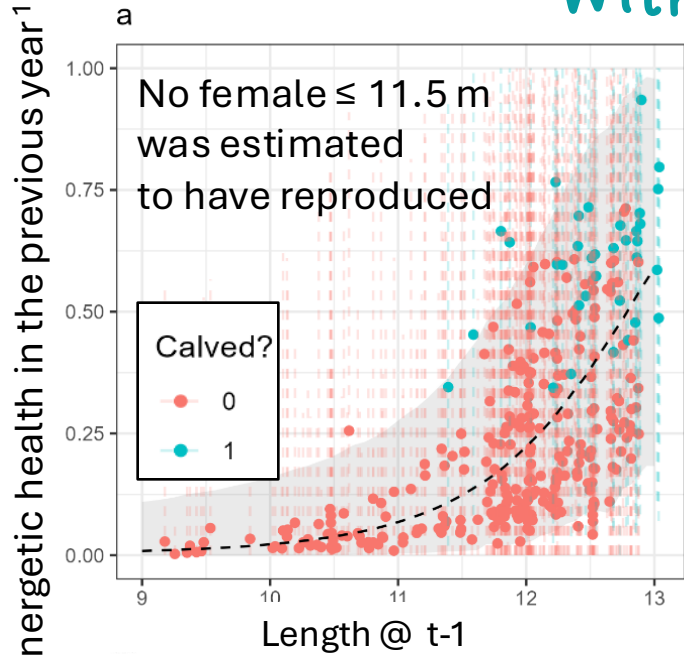
- Correlations with
- PDO
 - Upwelling + Relaxation

Indicates a plastic response to environmental change

¹Torres et al. 2022; ²Bierlich et al. in revision; ³Bierlich et al. 2023;

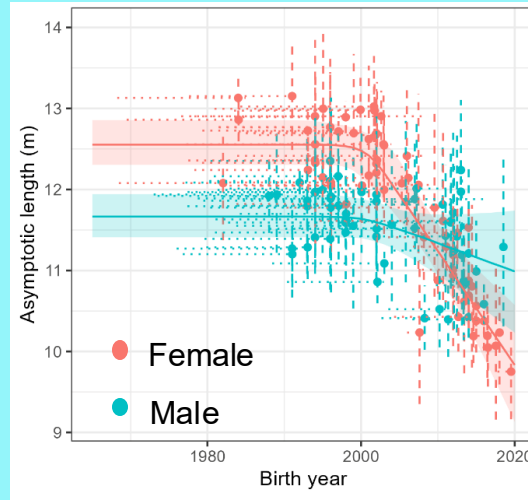
⁴Pirotta, Bierlich et al. 2024

With signs of impacts on reproductive rates



Decreasing length of female PCFG

➡ Lower predicted calving probability

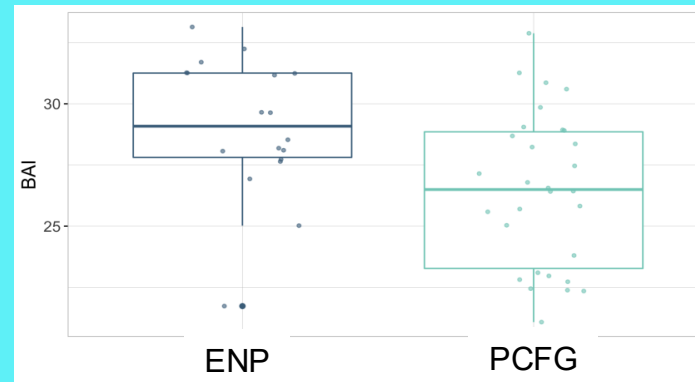


Longer females born before 2000 =
0.41 [0.09 – 0.86]

Females born after 2020 =
0.07 [0.00 – 0.27]

Lower body condition of PCFG relative to ENP

➡ PCFG predicted to have lower calving probability



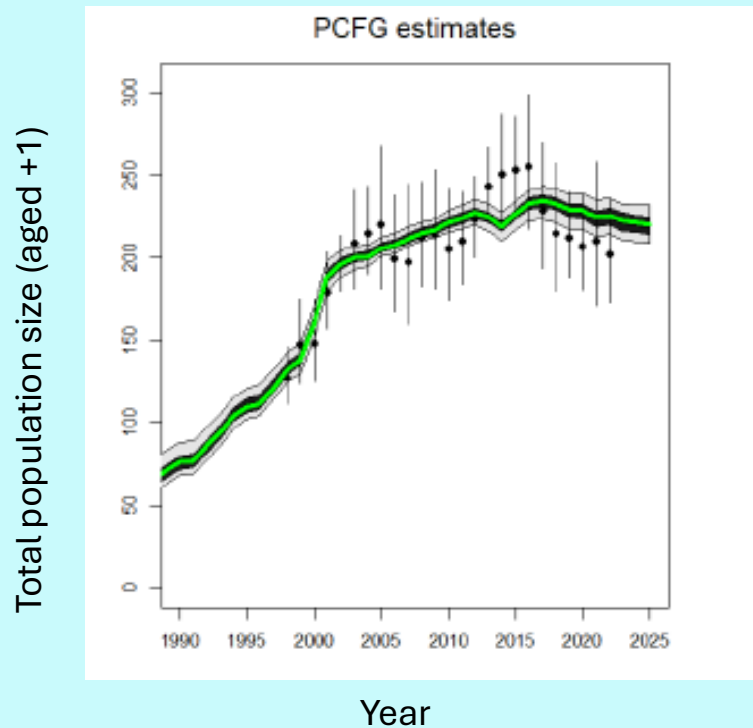
Predicted calving probability

ENP = 0.41 [0.10 – 0.90]

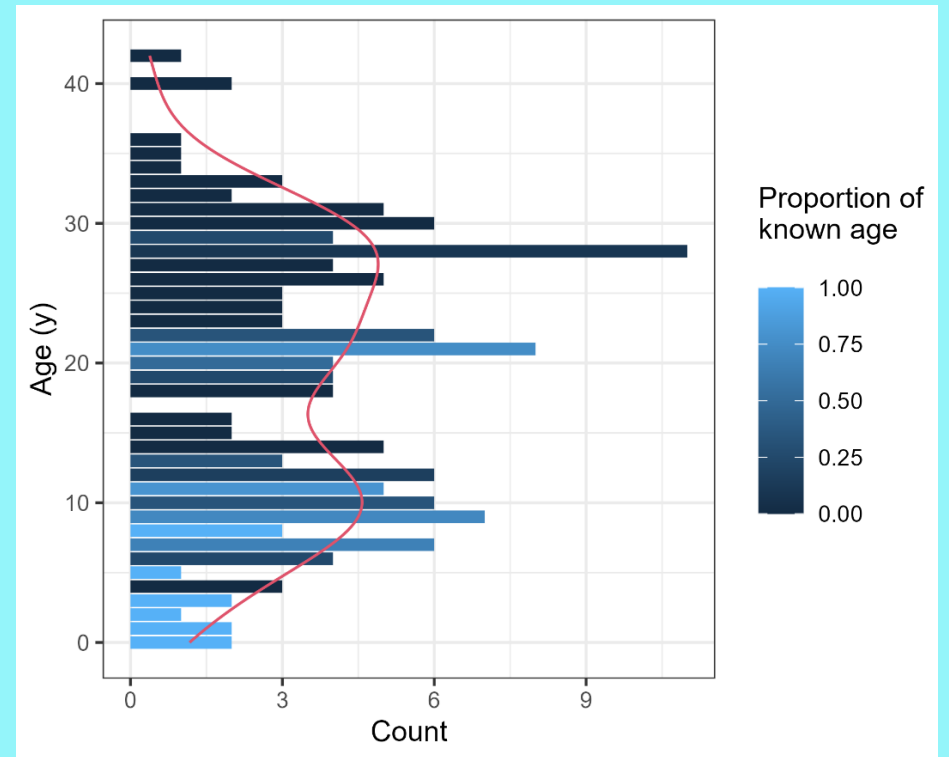
PCFG = 0.11 [0.00 – 0.39]

Potentially already seeing signs of impacts on PCFG reproductive capacity

Stagnant and recently declining population trend¹



Smaller observed juvenile age class²



The PCFG may represent how an ecological opportunity can shift to an ecological trap due to environmental change.

¹ Punt et al. 2025; ² Pirotta et al. 2025

In USA, PCFG is not recognized as own management unit e.g., Stock or Demographically Independent Population (DIP)

Canada: PCFG distinct management unit and endangered under COSIWIC.

USA: NOAA considers the PCFG a sub-group of the ENP (has its own abundance estimate and PBR).

No dedicated regulatory framework or efforts in US waters to protect PCFG from their unique set of threats.

PCFG Stock/DIP status not evaluated since 2012¹



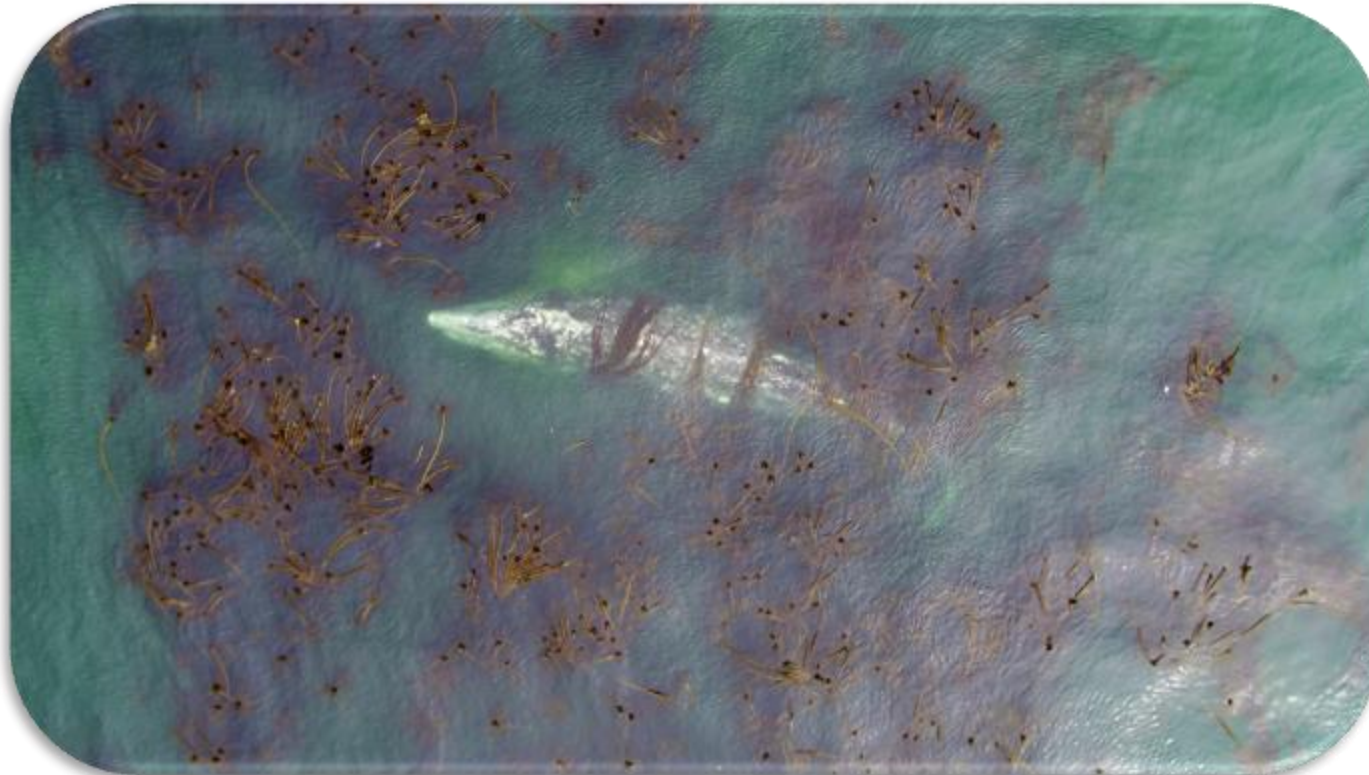
¹Weller et al. 2013

We reviewed literature and evaluated the DIP status of the PCFG

(Torres et al. in revision, JCRM)

We applied:

- The Guidelines for Assessing Marine Mammal Stocks (GAMMS; NMFS 2023) definition of a DIP
- NMFS multiple Lines of Evidence criteria (Martien et al. 2019) for delineation of a Demographically Independent Population (DIP)



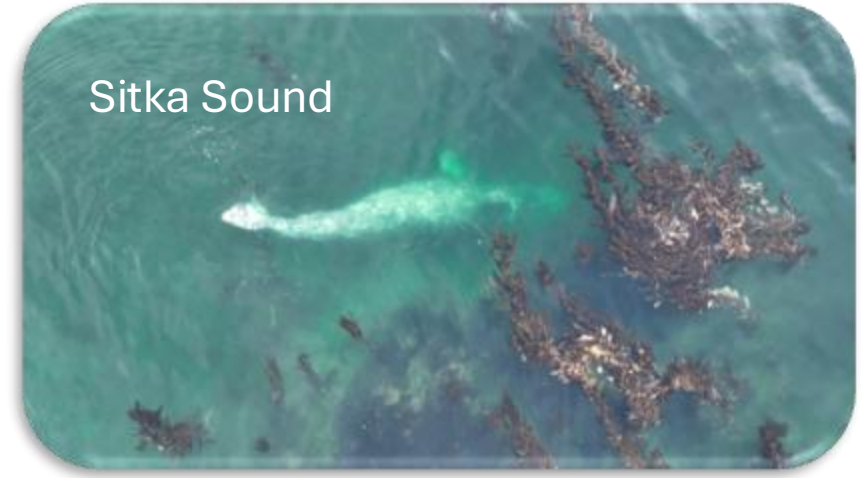
Strong research support for the PCFG as a DIP¹ based on Six of 11 Lines of Evidence as described by Martien et al. (2019)

Line of Evidence	Research support	Author Proposed DIP Delineation
Morphology	Strong	Distinct
Genetics	Strong	Distinct
Distribution	Strong	Distinct
Differences in targeted prey (Stable isotopes and fatty acids)	Strong	Distinct
Trends in abundance	Strong	Distinct
Oceanographic differences in habitat	Strong	Distinct
Movements	Strong	Moderate
We recommend - NMFS convene a formal assessment to re-evaluate the DIP status of the PCFG - These findings be considered in management decisions regarding gray whales		
Acoustics	Moderate	Not Distinct

¹Torres et al., in revision, JCRM

Changing PCFG and ENP health in response to environmental change

Compare body condition comparison across foraging sites¹: PCFG, ENP, Sitka Sound



- PCFG whales along Oregon coast
- May-June, 2016-2023
- Foraging on mixed diet (mysids, crab larvae, amphipods)

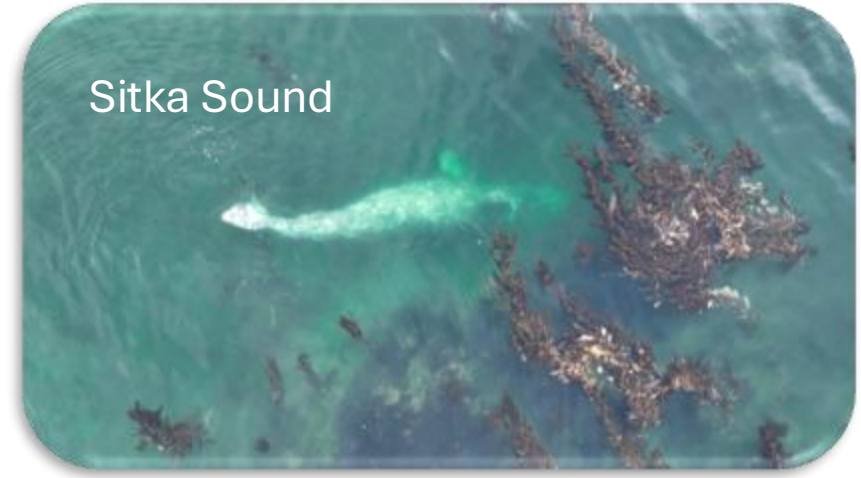
- NOAA Fisheries 32-year dataset (1987-2019)²
- Whales measured in 16 yrs
- Northbound migrating whales
- March off California coast
- Assumed to be ENP whales

- Whales in Sitka Sound, Alaska³
- 14-16 April 2026
- Targeting herring spawn
- Since 2019 – *concurrent with die-off* – abrupt increase of whales feeding on springtime herring spawn³

¹Torres et al., in review, Biology Letters; ²Stewart et al. 2023; ³In collaboration with Lauren Wild and Jan Straley

Changing PCFG and ENP health in response to environmental change

Compare body condition comparison across foraging sites¹: PCFG, ENP, Sitka Sound

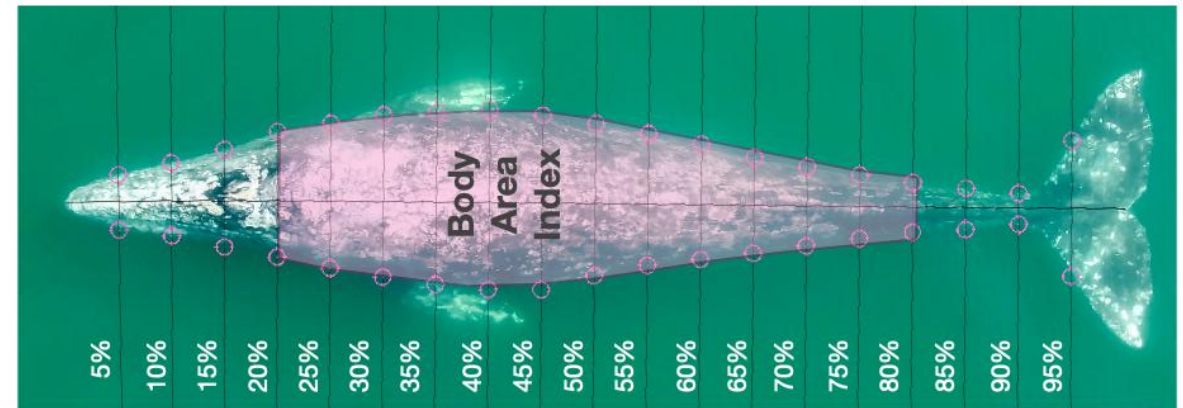


While these datasets are not temporally aligned

Capture gray whale body condition during progression of northbound migration on to feeding ground

Enabling comparison of nutritive condition after winter fasting.

Calculated the Body Area Index (BAI) for each whale in the three datasets



¹Torres et al., in review, Biology Letters

Sitka high, PCFG lowest, ENP oscillating Body Condition¹

Mean BAI differed significantly between sites ($p < 0.0001$)

- ENP: greatest variation
- PCFG: **significantly lower BAI**
- Sitka: **significantly higher BAI**

Behavioral adaptation to feed on herring spawn in Sitka appears promotes individual fitness.

Herring spawn short duration resource

During crucial period when energetic storage is lowest

May provide critical energetic boost to increase resiliency during migration

Unpublished image
Not yet available

¹Torres et al., in review, Biology Letters

Gray Whale Resilience Through Behavioral Flexibility

Atypical gray whale feeding areas (e.g., Sitka Sound, PCFG) may provide critical alternative feeding opportunities

Gray whales' neophilic tendency (openness to new resources) is likely linked to their survival strategy.

Other similar undiscovered refugia may also enhance resiliency and population persistence

Like the PCFG, new strategies and foraging niches may lead to distinct population structure with different management needs

We need to respond rapidly to monitor and manage these refugia to support their persistence

Like their Latin name implies (*Eschrichtius **robustus***), gray whales are robust.

We should take hope in their behavioral adaptability and quickly adapt our own conservation and management strategies to support their survival.





KC Bierlich, Lisa Hildebrand, Clara Bird, Alejandro Fernandez Ajo, Nat Chazal, Enrico Pirota, Leslie New, Kathleen Hunt, Loren Buck, John Calambokidis, Joe Haxel, Samara Haver, Lauren Wild, Jan Straley

Many Thank Yous to Collaborators, Partners, Funders

Data collected under NMFS permit #s 21678, 27426; IACUC authorization from OSU: 0388



Session 2 Discussion

Changing Ecology and Pacific Coast Feeding Group



Jonathan Scordinio



Leigh Torres