

# Migratory destinations of humpback whales that feed off the US West Coast: Implications for management under the newly recognized Distinct Populations Units

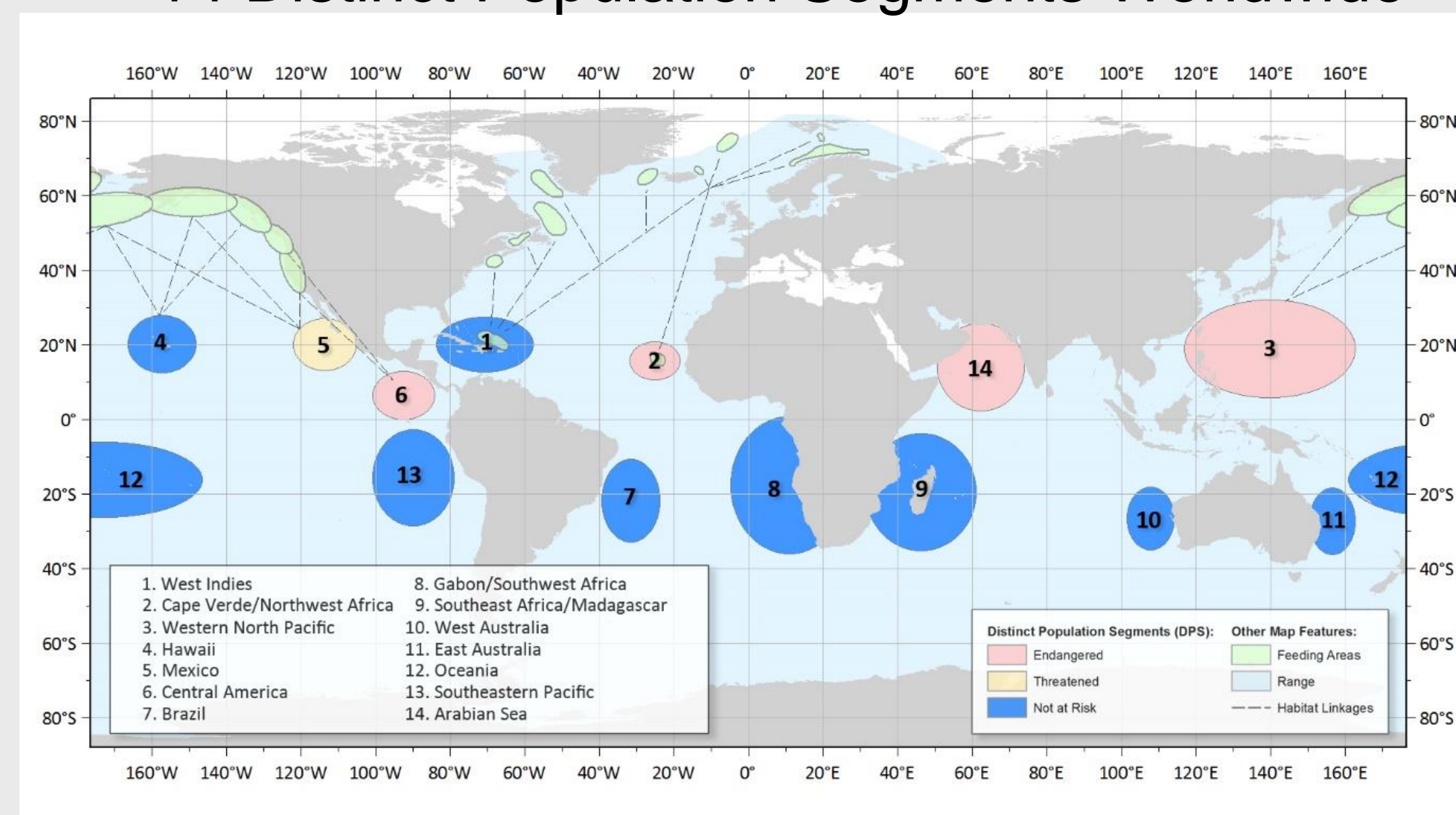
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## Background

The status of humpback whale populations under the Endangered Species Act (ESA) was changed recently to remove the species level-listing of endangered and, instead, recognize 14 Distinct Populations Segments (DPS) with their own ESA status, including three in the central and eastern North Pacific with Hawaii delisted, Mexico threatened, and Central America endangered. Although DPSs are based on their breeding population regions, humpbacks spend most of their time on feeding areas where they show strong site fidelity and where most human impacts occur. Therefore, management actions are critical on feeding areas. This is important for the whales in the US West Coast feeding area which include animals coming from the delisted Hawaiian, threatened Mexican and endangered Central American DPSs and where fisheries have entanglements increased dramatically since 2015. Here we examine interchange rates on a finer geographic than those defined in previous studies.

## 14 Distinct Population Segments Worldwide



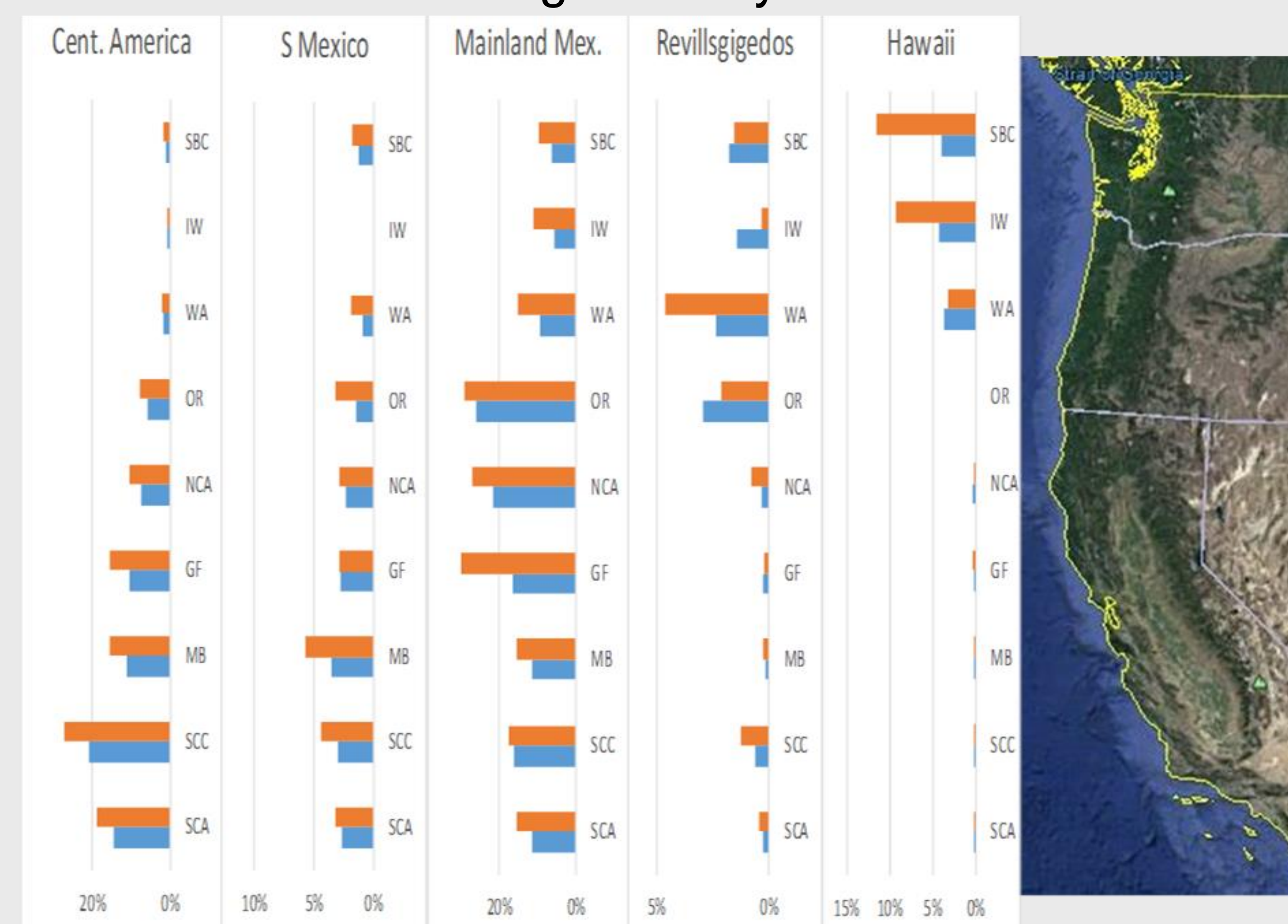
For the four DPSs in the North Pacific, Hawaii (4) was not listed, Mexico (5) was listed as threatened, and Central America (6) and the Western North Pacific (3) remain endangered. From NOAA maps.

## Approach

We examine interchange of humpback whales from US West Coast feeding areas to different breeding areas using both photo-identification and mtDNA genetic data. Data were drawn in part from the North Pacific Basin-wide photo-identification study (SPLASH) between 2004-2006 and the longer term photo-identification data collected off the US West Coast from 1986 and 2014. Results are from genetic analysis conducted at Hatfield Science Center at Oregon State

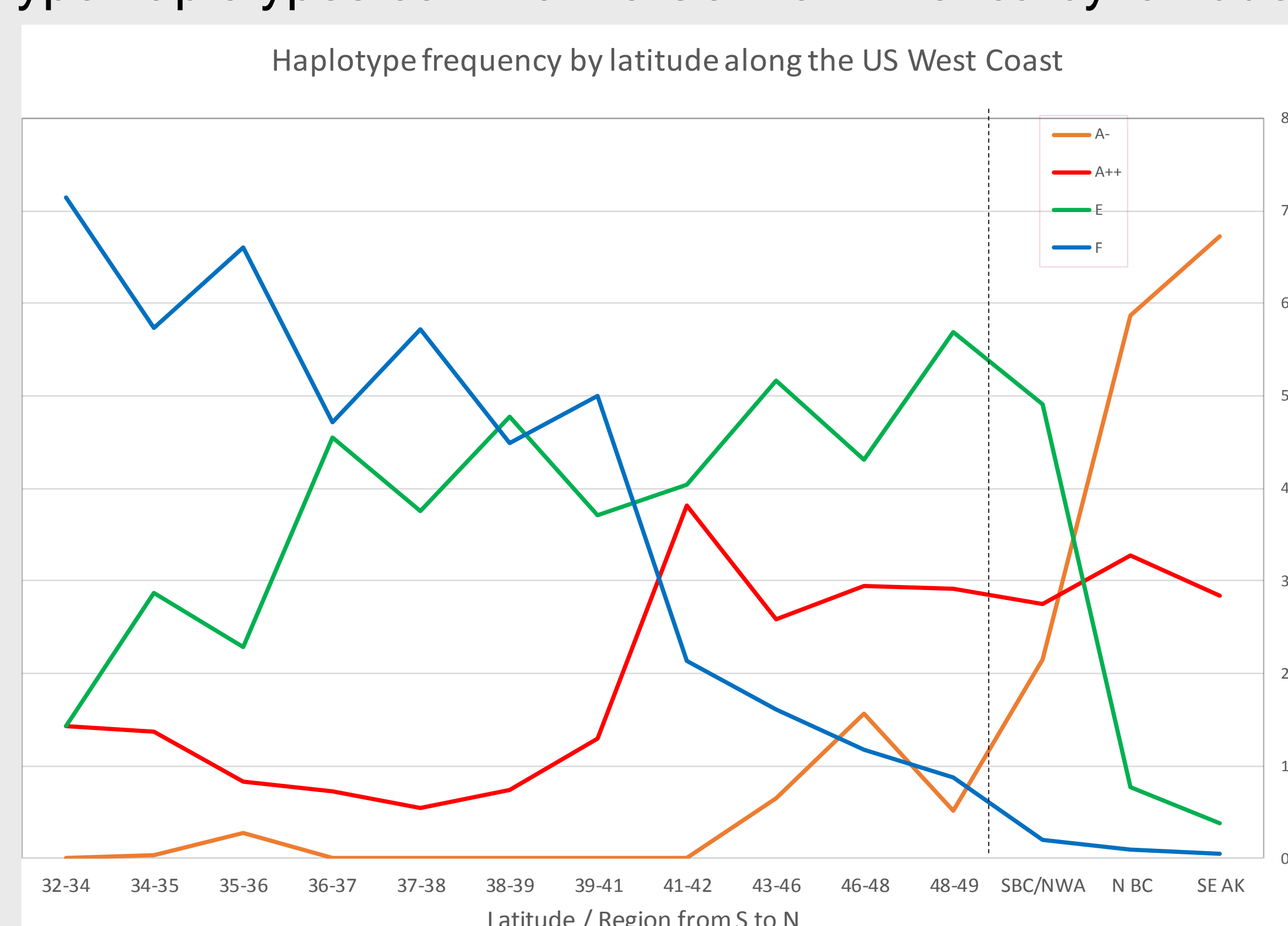
Region	# Encounters	Unique IDs	HI	Revilla Arch. MX	Mainld MX	Southern MX	Cent Am.
Southern BC	580	293	13	6	21	4	3
Inland WA	329	125	6	2	8	-	1
WA Outer Coast	893	464	17	11	43	4	8
Oregon	188	138	-	4	36	2	8
N California	1,296	620	2	2	134	14	46
Gulf of Farallones	7,010	1,589	3	4	261	43	166
Monterey Bay	7,083	1,445	1	2	165	51	158
Southern/Central CA	1,193	479	1	3	77	14	100
S Calif Bight	3,864	760	1	2	85	20	109

Proportion of photo-ID matches between breeding grounds show shifting proportions going to different breeding areas by latitude



The proportions of humpback whale photographs from different feeding areas that match different wintering areas showing shifting proportions with latitude even within feeding area boundaries. Blue bars show the percentage of unique individuals and orange bars show the percentage of encounters in each area known to match each wintering area. The higher rate of matching based on encounters is likely because this measure is weighted toward individuals with high resighting rates which would likely be a better proxy for risk of entanglement.

Proportion of mtDNA haplotypes show decreasing F-type haplotypes common to Central America by latitude



Proportions of mtDNA haplotypes along the US West Coast by latitude (left of the dashed line) and as reported from SPLASH in Baker et al. 2009 for areas to the north (right of dashed line). To provide additional geographic resolution for US West Coast, proportion are based on total encounters of identified individuals with known haplotypes (not just where collected), this included 266 haplotypes of identified whales applied to 3,755 encounters of these whales, plus 127 haplotype determinations of animals not identified applied to the location they were collected.

## Conclusions

- The proportion of animals on the US West Coast feeding area from Central America and Mexico varied not only by feeding area but also among finer-scale subareas by latitude along the coast with the highest proportion of whales from the Central American DPS occurring off southern California and decreasing northward.
- Composition of mtDNA haplotypes showed a similar trend with F-type haplotypes common of Central America occurring at highest proportions in the southernmost feeding areas and decreasing northward.
- The delineation of the Mexican and Central American DPSs requires further investigation given that humpback whales from southern Mexico share more in common with Central America than those from the principal Mexican breeding regions.
- These findings have implications for allocating anthropogenic mortality to DPSs and comparing mortality to Potential Biological Removal limits under the US Marine Mammal Protection Act.



Humpback whale entanglements off the US West Coast have increased dramatically since 2015 (NOAA 2017) and will likely

## Acknowledgments

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