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Line-transect estimates of humpback whale abundance along the US west coast

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Introduction

Visual line-transect surveys of cetacean abundance were conducted along the US West Coast in 1991, 1993, 1996, 2001, 2005, 2008 and 2014 (Barlow 2016). That report includes detailed results for many species. Here I briefly summarize the results that are relevant to humpback whales.

Methods

Traditional line-transect survey methods were used to estimate density and density along the transect line was extrapolated to the 1.14M km^2study area. This is typically referred to as a design-based approach and relies on a systematic sampling design (independent of the distribution of any species) to justify this extrapolation. Surveys uniformly covered the entire study area from the Canadian Border to the Mexican border and from shore out to approximately 300 nmi offshore, except in 1991 and 1993 when waters off Oregon and Washington were not surveyed. Abundance estimation is group-based, and individual density is estimated from group density by multiplying by mean group size. Four geographic strata were used: Southern California, Central California, Northern California, and Oregon/Washington. The effective strip width (ESW) was estimated by fitting a half-normal detection model (with covariates) to the distributions of observed perpendicular distances. Survey years were pooled to increase sample size for ESW estimation. The probability of detecting a group of whales on the transect line (*g(0)*) was assumed to be 1.0 in the best survey conditions (Beaufort 0), andtrackline detection probabilities at other Beaufort states were estimated based on changes in "apparent" density with sighting conditions using a new approach (Barlow 2015).

Results

Transects surveyed and humpback whale sighting locations in 2014 are shown in Figures 1 & 2. Estimates of humpback abundance for the three California strata (1991 & 1993) and for all four strata (1996 and later) are given in Table 1.

Discussion

Estimates of humpback whale abundance along the US west coast show a generally increasing population size, but the high coefficients of variation make this difficult to interpret. Mark-recapture estimates for abundance for the same area are typically much more precise and show a more consistent upward trend (Calambokidis and Barlow 2013). Humpback whales now appear to be more common than blue whales in west-coast waters (Barlow 2016).

Literature Cited

Barlow, J. 2015. Inferring trackline detection probabilities, *g(0)*, for cetaceans from apparent densities in different survey conditions. Marine Mammal Science 31(3):923-943.

Barlow, J. 2016. Cetacean abundance in the California Current estimated from ship-based line-transect surveys in 1991-2014. NOAA Southwest Fisheries Science Center Administrative Report LJ-16-01. 63pp.

Calambokidis, J. and J. Barlow. 2013. Updated abundance estimates of blue and humpback whales off the US west coast incorporating photo-identifications from 2010 and 2011. Document PSRG-2013-13 presented to the Pacific Scientific Review Group, April 2013. 7 p.

Table 1. Estimates of humpback whale group size, ESW, g(0), and abundance. Estimates for 1991 and 1993 do not include the Oregon/Washington stratum which was not surveyed in those years.

Year	# Sightings	Mean Group Size	Mean ESW (km)	Mean *g(0)*	Abundance	CV Abundance
1991	9	4.3	3.8	0.75	568	0.75
1993	17	1.7	3.8	0.77	703	0.52
1996	59	1.9	3.5	0.74	1742	0.53
2001	24	2.3	3.7	0.73	1295	0.59
2005	50	1.7	3.8	0.73	1623	0.52
2008	44	2.1	4.3	0.73	1313	0.60
2014	61	2.1	3.5	0.72	3064	0.82

Figure 1. Transect lines completed during the 2014 survey in calm (Beaufort states 0-2), moderate(Beaufort 3) and rough (Beaufort 4-5) survey conditions. Bold black lines indicate the boundaries ofthe four regional strata.

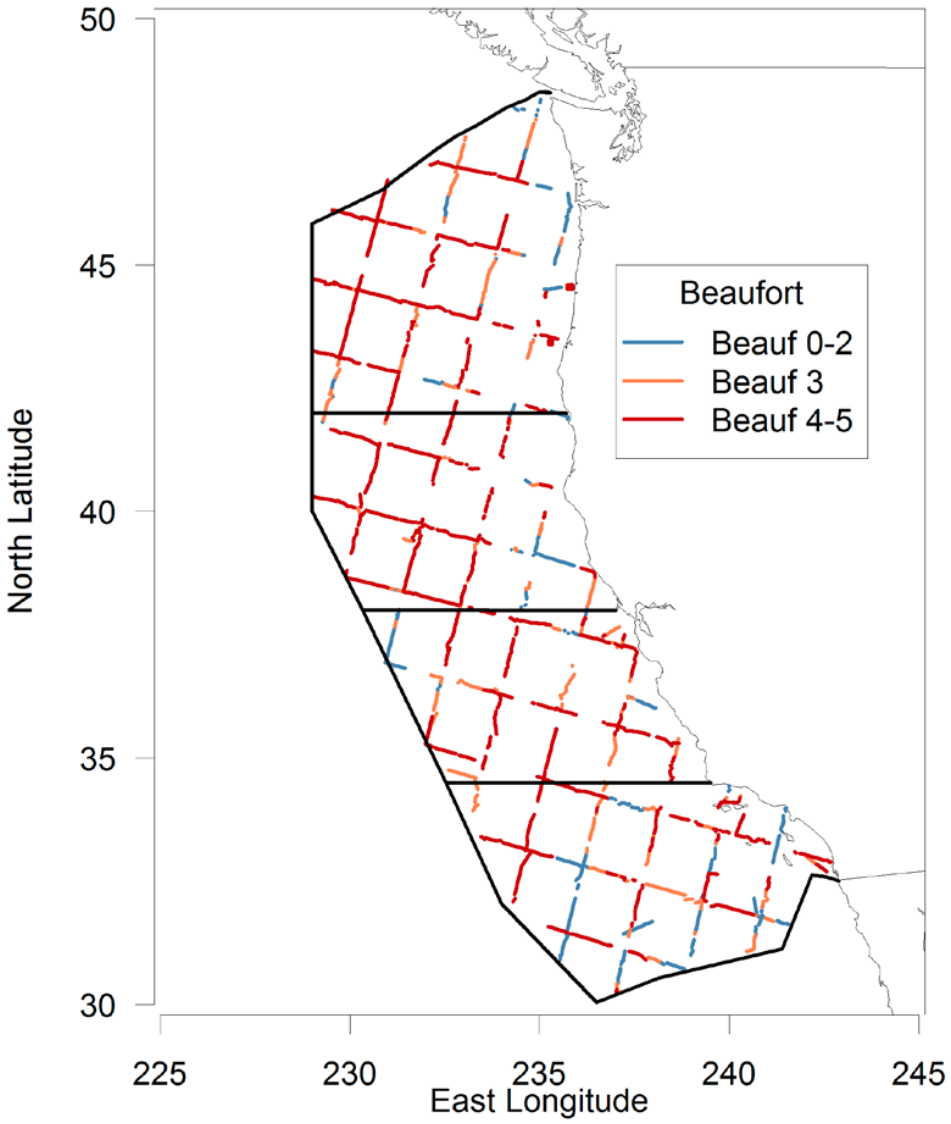

Figure 2. Locations of humpback whale sightings in 2014, including off-effortsightings that are not used for abundance estimation. Light blue lines indicate surveyed transect lines.