Progress on a two-stock catch allocation model for reconstructing population histories of east Australia and Oceania

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ABSTRACT

Humpback whales breeding along the coast of east Australia (E1) and near the islands of Oceania, South Pacific (E2, E3 and F) are thought to feed primarily in Antarctic Areas V and VI (120E to 110W). These breeding stocks were subject to intensive exploitation by pelagic and coastal whaling operations throughout much of the 20th century and have shown apparently variable levels of recovery. While east Australia has shown high rates of population increase, breeding stocks of Oceania, including those around Fiji and those that migrate past New Zealand, virtually disappeared and have yet to show signs of strong recovery. Reconstructing the history, and subsequent recovery of these populations is hampered by the difficulty of allocating historical feeding ground catch to each breeding ground population. Here we present progress on a two-stock Bayesian density-dependent logistic population model, developed to explore the influence of different catch allocations on the recovery of east Australia and Oceania. Probability distributions of carrying capacity (K), growth rate (r_{max}) and current abundance ($N2008$) were determined for all whales breeding within east Australia (E1) and Oceania (E2, E3, F). Estimates of current abundance were provided by capture-recapture modeling, using individual identification photographs collected from 1999-2004. Sensitivity of the population model estimates to prior distribution choice, catch allocation (Naïve and Fringe 'maximum') and minimim past abundance (N_{min}) were investigated. Median posterior estimates of carrying capacity for east Australia and Oceania were 26,383-31,400 and 16,022-22,957 respectively. Median recovery estimates ($N2008/K$) for the two-stock model with variable catch ranged from 27-31% (east Australia) and 20-25% (Oceania).

INTRODUCTION

Within the south Pacific, several breeding sub-populations of humpback whales (*Megaptera novaeangliae*) are recognized. These breeding populations migrate south annually to feeding grounds in Antarctic Areas V and VI (120E to 110W). Breeding stock E encompasses whales breeding off the coasts of east Australia (E1), New Caledonia (E2) and Tonga (E3) while breeding stock F encompasses whales breeding in the Cook Islands and French Polynesia. Population subdivisions within E and F are supported by analyses of maternal genetic differentiation (Olavarría *et al.* 2006). Discovery marks and photo-identification have linked eastern Australia stock E1 with Antarctic Area V (Chittleborough 1959; Dawbin 1964; Franklin *et al.* 2007)). Within Oceania, satellite tagging has connected Cook Islands whales with Area VI (Hauser *et al.* 2007), while genotype matching has confirmed connections between New Caledonia and Area V and Tonga and Areas VI and I (Steel *et al.* 2008).

Commercial fleets have been hunting humpbacks in the southern ocean since the start of the 20th century. Within Area V and VI, over 44,000 animals were killed between 1900 and 1978. Coastal whaling was also active in New Zealand, Norfolk Islands, east Australia and locally across a number of the Pacific islands. While whaling officially ceased in 1966, the Soviet Union continued illegal whaling throughout the Southern Ocean until 1973 (Yablokov *et al.* 1998). Many of the regional populations of south Pacific humpbacks underwent a severe decline in abundance, marked by the collapse of coastal fisheries throughout the Pacific and Australia in 1963.

Within the south Pacific, matching of humpback fluke photographs suggests that there is a more substantial sub-division between humpbacks wintering off east Australia (breeding population E1) and within Oceania (breeding populations E2, E3 and F). Photo-ID comparisons among the islands of Oceania (n=679 individuals) have documented 20 incidents of interchange (Garrigue *et al.* 2007a). However, recent comparison between this Oceania catalogue and a substantial catalogue from east Australia (Harvey Bay and Byron bay, n=1,242) found only four incidents of interchange (Garrigue *et al.* 2007b). The low level of interchange both within and between these regions supports the genetic data in suggesting that movement of humpbacks between these breeding populations is restricted.

Further evidence for demographic isolation between breeding populations in the south Pacific is provided by large differences in apparent recovery between populations. Comparisons of historical sightings data and whaling records (Dawbin 1956; Dawbin 1959; 1964) with recent sightings surveys from Fiji, New Zealand and Norfolk Island (Childerhouse and Gibbs 2006; Gibbs *et al.* 2006; Paton *et al.* 2006) suggest a lack of recovery and very slow return of humpbacks to these regions, while in east Australia the population is increasing at the rate of 10-11% per annum (Noad *et al.* 2008).

Conducting an assessment of the status of humpback populations in the south Pacific region is complicated by the challenge of catch allocation; all humpbacks share feeding grounds in Areas V and VI, where the substantial proportion of catches were taken. The division between Areas V and VI is directly due south of the Tongan (E3) population, one of the most abundant populations in the region (Baker *et al.* 2006). Microsatellite genotyping has connected animals from Tonga with three feeding Areas (Steel *et al.* 2008), illustrating the difficulty of allocating feeding Area catches to individual breeding populations with accuracy. Previous population assessments of humpbacks wintering in the south Pacific have focused on population E1 (Johnston and Butterworth 2005) and stocks E and F combined (Jackson *et al.* 2006). We present here preliminary progress on a two-stock model for assessing the status of south Pacific humpbacks. In this model, the two 'stocks' considered are east Australia (E1) and Oceania (E2, E3 and F).

In this preliminary population assessment we develop a Bayesian logistic 'HITTER' model to accommodate scenarios where the two stocks share a common population growth rate (r) but subject to different levels of historical catch, different constraints on minimum past abundance (N_{min}) and recover towards different current abundances. We present results from an approach where feeding Area catches are allocated by a fixed ratio (similar to that described by Johnston and Butterworth (2005)) and discuss future progress and directions for further analysis of these stocks. Key goals for future work to complete an assessment are identified in the discussion.

METHODS

A handful of population assessment scenarios were considered and explored for sensitivity to Antarctic catches (IWC Naïve and 'Fringe maximum' catch scenarios) and population growth rates over the full range of historical catch allocation ratios (0-100%).

Catch Data

Catches south of 40°S

Pelagic catch data from the Soviet Antarctic whaling operation, detailing the magnitude and location of catches made in the 1960s, were presented previously by Yablokov *et al.* (1998). The present updated catch series (Allison pers. comm.) represents the most comprehensive catch information covering 20th century whaling in the Antarctic. A Naïve catch allocation scenario was explored (IWC 2006a) in which all catches taken between 120E-110W were included in the population model. In order to reflect recent work showing that some humpbacks from within Oceania feed outside Feeding Areas V and VI (Hauser *et al.* 2007; Steel *et al.* 2008), we also applied a maximal catch scenario ("Fringe maximum", as suggested in (IWC 2006b)) where all catches between 110E-100W were included in the population model (Table 1).

Catches north of 40°S

Recent evidence links New Zealand both to east Australia (Franklin *et al.* 2008) and Oceania stock E2 (Constantine *et al.* 2007) but the strength of these connections has not yet been quantified. Allocation of New Zealand and Norfolk Island coastal catches (Allison pers. comm.) to the two stocks was therefore fixed at 50%, assuming equal use of these regions as a migratory corridor by both stocks.

Coastal catches from east Australia (E1) and Tonga (E3) were allocated to east Australia and Oceania stocks respectively.

Abundance Estimates

A number of capture-recapture analyses have been reported for Oceania both in combination and by region (Baker *et al.* 2006). The M_{th} closed capture-recapture estimate for the combined multi-year 1999-2004 abundance of E2, E3 and F (n = 3,827; C.V. = 0.12) was chosen from among the estimates reported because it was considered to be the most robust model for these data (Baker *et al.* 2006).

Abundance of the east Australian stock in 2004 was approximated by a recent shore count estimate n = 7,090 (95% confidence intervals +/- 660) by Noad *et al.* (2006). This estimate was assumed to conform to a normal distribution in the logistic model.

Population Dynamics Model

The logistic population dynamic 'HITTER' model used in this study is conceptually similar to that presented by Zerbini (2004). Integration of prior distributions on the parameters and the likelihood function was approximated using the Sampling-Importance-Resampling (SIR) algorithm of Rubin (1988), as described in Zerbini (2004). An initial sample of 100,000 parameter combinations from the data was re-sampled 2,000 times with the SIR algorithm. Posterior distributions were then summarized over these 2,000 re-samples.

The density-dependent age-aggregated generalized logistic equation used to model the dynamics of this population follows the standard form

$$N_{y+1} = N_y + r\,N_y \left(1 - \left(\frac{N_y}{K} \right)^{z} \right) - C_y$$

Where N_y represents the population abundance in year y, K the population initial carrying capacity (N_y in year 0), z the density dependent exponent (fixed at 2.39) and C_y the total catch in year y. Parameter r represents the intrinsic growth rate of the population.

Catch is modelled as follows:

Stock A:

$$C_{y+1} = C_{yC} + C_{yP}\,C_r$$

Stock B:

$$C_{y+1} = C_{yC} + C_{yP}\,(1 - C_r)$$

Where C_r represents a uniform prior bounded between [0-1] and catch parameters C_{yC} and C_{yP} represent annual coastal (north of 40ºS) and pelagic (south of 40ºS) catches respectively (Table 1).

Prior Distributions

Two priors on population growth rates were used; one uninformative (U[0.00-0.12]) and one informative (N[0.067, 0.04]). The latter informative prior was bounded by the limits of the uninformative prior, recognizing that humpback growth rates over 12.6% are extremely unlikely (e.g. Clapham *et al.* 2006). The prior, N[0.067, 0.04], previously used by Zerbini (2004), is based on the average growth rate estimated from a hierarchical meta-analysis of growth rates of large baleen whales (Branch *et al.* 2004).

Initial prior distributions on *N2004* were set at U[6,000-9,000] for east Australia and U[2,000-5,000] for Oceania. These were then subject to importance re-sampling against the normally-distributed abundance estimates provided in the *Abundance* section above.

Genetic Constraints for N_{min}

Humpbacks of the south Pacific have maintained substantial mitochondrial diversity despite a severe whaling history (Olavarría *et al.* 2007). A total of 42 haplotypes have been identified in east Australia (Olavarría *et al.* 2006) and a total of 78 in Oceania (Olavarría *et al.* 2007). In the preliminary assessment of this population, a hard lower boundary of 4 x haplotypes was used as a constraint on minimum past abundance (N_{min}). This is an underestimate of the N_{min} value that would be obtained by rarefaction and proper correction (see Branch and Jackson 2008; Jackson *et al.* 2008). Sensitivity of the model to each these boundaries was also explored by repeating analyses with and without each constraint.

RESULTS AND DISCUSSION

The assessment scenarios explored in this study are shown in Table 1 while a summary trajectory of the population history reconstructed under scenario 3 is shown in Figure 1. Posterior distributions of model parameters are shown in Table 2. Low estimates of population growth are strongly favoured by the model (median estimates 3.6-4.9%) and are increased by ~1% when the normally-distributed 6.7% prior is imposed. The model was also relatively insensitive to the effect of increased historical catches (~3,000 whales) provided by the 'Fringe maximum' scenario. Estimates of pre-exploitation abundance were slightly higher for east Australia (median range 26,383-31,400 for Oceania, 16,022-22,957 for east Australia), while 10,000 more east Australian animals were estimated to have been killed in total (median catch estimates ~35,000 and 25,000 for east Australia and Oceania respectively for coastal and pelagic catches combined). Posterior values of *K* and Antarctic catch ratio are bounded by extremely wide confidence intervals (15 orders of magnitude), reflecting the range of catch scenarios explored (0-100% catch allocated to each region). The distribution of recovery rates is shown for Scenario 3 in Figure 2. In every output there was a reasonable percentage of re-samples where estimated recovery was 100% and the posterior catch ratio was 100% to one stock. As these scenarios were considered historically implausible we truncated these by excluding those outputs which provided >90% of catch to one stock. Posterior distributions were recalculated for catch ratios between 10-90% and are shown in Figure 2 and Table 3.

Minimum past abundance

The year of minimum population abundance occurred in 1968 for both stocks in all scenarios. Posterior estimates of *N1968* for east Australia are substantially higher than the N_{min} boundaries imposed in the model. This is because Oceania is currently the smaller of the two stocks yet has a much larger constraint on minimum abundance (312 as opposed to 168), which limits the plausible population growth rates compatible with its population history (Appendix 1). Since these population histories are connected by a shared growth rate the estimated population trajectory for east Australia is therefore much higher than its own minimum boundary (Figure 1). The model was more sensitive to the removal of the N_{min} boundary for Oceania than to the removal of the boundary in east Australia. With either floor removed, a 2-3% increase in median posterior growth rate is seen and median K (east Australia) is reduced by ~10,000 (18,888-20,933). With the Oceania N_{min} constraint removed, median N_{min} (Oceania) is 400 and N_{min} (east Australia) is 1,230.

Future directions

Population growth rates and trend information

In this preliminary assessment, a common population growth rate was applied to both stocks. Such an approach will be improved by the addition of available historical trend information (Brown *et al.* 1997; Baker *et al.* 2006; Chittleborough 1965; Noad *et al.* 2008; Paterson *et al.* 2004). Population growth rates can then be allowed to vary independently between the stocks as in Johnston and Butterworth (2005). At present however, there is much less information on rates of increase for Oceania. We propose further refinement of this model to include recent trend information from east Australia (Noad *et al.* 2008), exploring this information both directly in the prior on r_{max} and as a weighting on current observed growth rates in the model (Zerbini 2005).

In the Bayesian 'HITTER' model described here, normally distributed priors on current abundance (Noad *et al.* 2006; Baker *et al.* 2006) were used. However by IWC convention such priors are usually log-normally distributed (examples in Zerbini (2005), Johnston and Butterworth (2005)). The priors used a full comprehensive population assessment of the region will be log-normally distributed in recognition of this.

Recent studies suggest that a proportion of females over-winter on feeding grounds, an effect which may explain the observed skew in humpback sex ratios towards males both on wintering grounds (Craig and Herman 1997; Pomilla and Rosenbaum 2006) and on migratory routes (Brown *et al.* 1995). In order to explore the effect of this bias on the population model, future modelling scenarios for Oceania will include a male-only population reconstruction, using sex-specific mark-recapture abundance estimates obtained from genetic markers.

Historical catches

The impact of the whaling industry in Tonga (E3) cannot be fully accounted for due to a lack of records (p37; IWC 2006). Additionally anecdotal information suggests that Soviet whalers may have hunted whales in Fiji and Tonga in the 1960s (Ivashchenko *et al.* 2007). The assumption that New Zealand catches took roughly 50% of each stock may also be erroneous. More information regarding location of capture and time of year might enable a more reasoned allocation to be made. For example Franklin *et al.* (2008) have suggested that humpbacks travelling toward or from different breeding populations adhere to geographically separate migratory streams as they pass through New Zealand.

In the current model all Area V and Area VI catches have been grouped and allocated among the two stocks. However there is very little evidence connecting east Australian whales with Antarctic Area VI. Sensitivity of the model to allocation of all Antarctic Area VI catches to the Oceania is yet to be explored. The allocation of Antarctic Area catches according to a mixed-stock analysis of current mtDNA distributions could be informative (Albertson-Gibb *et al.* 2008).

Effect of N_{min}

The N_{min} values used as lower boundaries in this model underestimate the values that would be obtained by rarefaction and proper correction (see Branch and Jackson (2008) and Jackson *et al.* (2008)). Future modeling should attempt to improve this.

Further modelling scenarios

We have also developed a second HITTER two-stock model scenario to explore catch allocation. In this model the ratio of Antarctic pelagic catch allocation between the two stocks in year n is provided by the ratio of breeding ground abundances in year ($n - 1$). Yearly catches are described by

$$C_{y+1} = C_{yC} + C_{yP} \left(\frac{N_{yA}}{(N_{yA} + N_{yB})} \right)$$

Where catch parameters C_{yC} and C_{yP} represent annual coastal (north of 40ºS) and pelagic (south of 40ºS) catches respectively (Table 1) and N values represent abundances of stocks A and B in year y. This could be developed as a further means of testing the influence of catch allocation on the estimated recovery of these populations. This model also lends itself to further development as a multi-stock assessment where feeding ground catches cannot be easily determined.

Conclusions

A number of additional scenarios need to be explored in order to provide a fuller picture of the current status of the humpbacks of Oceania. A full assessment of each sub-stock is limited by the substantial uncertainty surrounding the historical catches attributable to each stock. However, some inter-annual interchange has been found among humpbacks wintering in Oceania, suggesting that an assessment of the combined region is plausible. We describe two modelling approaches by which an assessment of this region may be performed and identify those model parameters for which further exploration is necessary.

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TABLES

Table 1. Scenarios explored in a preliminary assessment of the two-stock model of catch allocation. Boundaries of Naïve and Fringe "max" catch allocation are shown in Appendix 1.

Scenario	Growth rates (*r*)	Antarctic catch allocation
1	Uniform [0-0.12]	Naïve (120E-110W)
2	Uniform [0-0.12]	Fringe max (110E-100W)
3	Normal [0.067, 0.04]	Naïve (120E-110W)
4	Normal [0.067, 0.04]	Fringe max (110E-100W)

Table 2. Posterior estimates of parameters of interest for stock E1 and combined stocks E2+E3+F. 95% posterior probability intervals are shown in square brackets. Recovery estimates are based on between-stock catch ratios between 10-90%.

	Median posterior estimates					
East Australia (E1)						
Scenario	K	N_{min}	N_{2004}	N_{2008}	$N_{2008} : K$ all CR	$N_{2008} : K$
1	30,597	1,939	7,191	8,212	0.280	0.280
	[10,998-53,344]	[309-6,981]	[6,152-8,523]	[6,689-10,561]	[0.141-0.753]	[0.150-0.164]
2	31,400	1,891	7,157	8,202	0.270	0.270
	[10,481-55,212]	[356-6,876]	[6,165-8,419]	[6,668-10,383]	[0.130-0.771]	[0.141-0.631]
3*	29,480	1,428	7,136	8,501	0.295	0.308
	[10,602-49,934]	[397-6,013]	[6,133-8,498]	[6,827-10,680]	[0.165-0.809]	[0.172-0.677]
4	26,383	1,588	7,185	8,326	0.323	0.293
	[7,091-49,295]	[478-6,509]	[6,152-8,465]	[6,662-10,390]	[0.152-0.997]	[0.148-0.635]
Oceania (E2, E3, F)						
Scenario	K	N_{min}	N_{2004}	N_{2008}	$N_{2008} : K$	
1	20,788	1,292	3,882	4,349	0.220	0.212
	[3,672-42,438]	[337-3,867]	[3,105-4,801]	[3,325-5,759]	[0.090-1.000]	[0.095-0.767]
2	22,957	1,199	3,864	4,379	0.201	0.197
	[3,843-46,031]	[334-3,884]	[3,080-4,750]	[3,312-5,847]	[0.086-1.000]	[0.091-0.712]
3*	16,022	840	3,917	4,506	0.281	0.251
	[3,737-37,812]	[326-3,508]	[3,107-4,815]	[3,408-5,949]	[0.105-1.000]	[0.114-0.886]
4	21,133	861	3,872	4,487	0.220	0.214
	[3,681-41,791]	[327-3,541]	[3,063-4,801]	[3,321-12,158]	[0.095-1.000]	[0.101-0.764]

Table 3. Posterior estimates of parameters common to both stocks and total catches allocated to each population. 95% posterior probability intervals are shown in square brackets.

		Median posterior estimates		
Scenario	r_{max}	Catch ratio O / EA	Median total catch EA	Median total catch Oceania
1	0.038	0.523	34,618	24,013
	[0.002-0.091]	[0.029-0.984]	[12,813-54,932]	[3,698-45,817]
2	0.036	0.500	35,086	26,475
	[0.002-0.075]	[0.022-0.981]	[12,564-57,681]	[3,880-48,997]
3	0.047	0.531	34,968	23,663
	[0.005-0.085]	[0.034-0.980]	[13.062-54,792]	[3,839-45,569]
4	0.049	0.517	35,887	25,674
	[0.004-0.090]	[0.027-0.983]	[12,808-57,799]	[3,762-48,753]

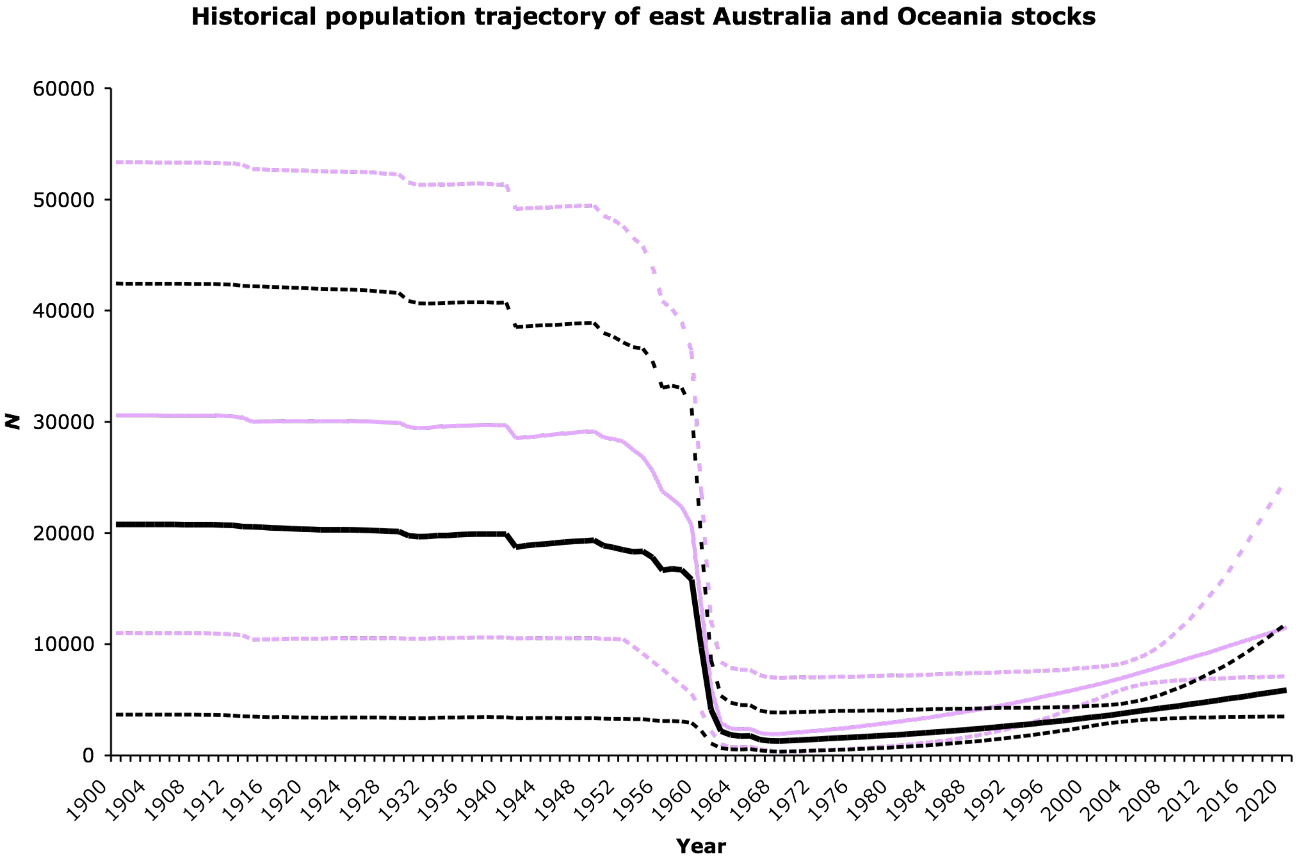

Figure 1. Population trajectories for Oceania and east Australia (Naïve model and uninformative growth rate prior *r*; Scenario 1) showing changes in population abundance (*N*) over time. Median trajectory (solid line) and 95% posterior probability intervals (dashed lines) are shown in bold for Oceania and pale for east Australia.

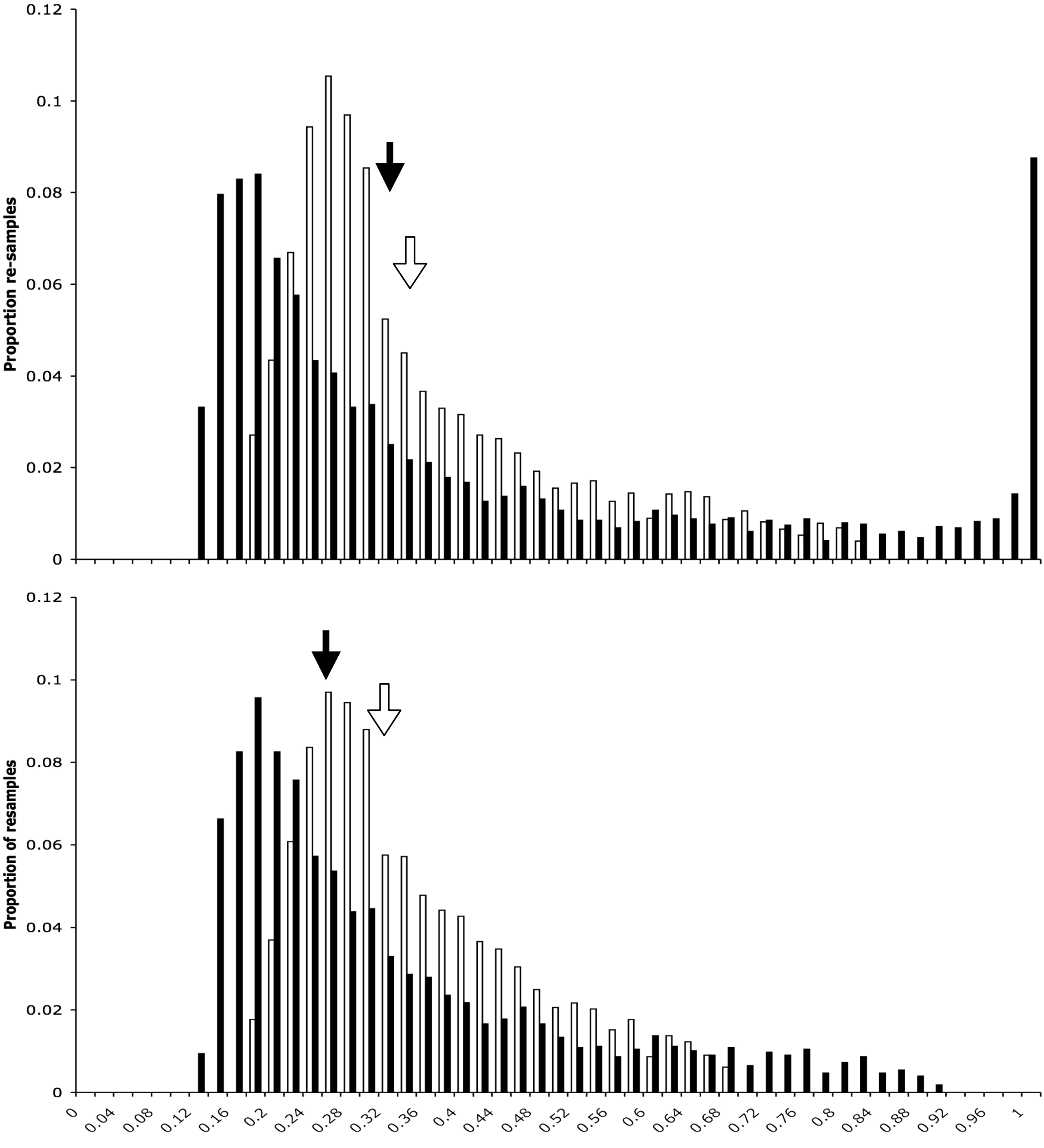

Figure 2. 95% posterior distribution of recovery estimates (*N2008/K*) under the Naïve catch allocation scenario and subjected to a normally distributed prior on growth rates N[0.067, 0.04] (Scenario 3). Black bars represent Oceania, clear bars east Australia. The top figure shows distributions with extreme catch allocation scenarios included (> 90% to one stock), the bottom figure shows the posterior distribution after exclusion of these scenarios. Arrows (black for Oceania, white for east Australia) indicate the median values of each distribution.

APPENDIX

Appendix 1. Record of catches taken for southern hemisphere humpback whales feeding in Areas V and VI (south of 40°S) and coastally in this region (north of 40°S) between 1900-1978 (Allison pers. comm.). Naïve catches for the region encompassed 120E-110W and Fringe "maximum" catches for the region encompassed 110E-100W. Coastal catch from east Australia was allocated to E1, catch from New Zealand was divided 50% to E1 and 50% to E2+E3+F. All catches from Tonga (Dawbin 1997) were allocated to E2+E3+F.

Latitude	110E-120E	120E-130E	130E-170W	Ross Sea	170W-120W	120W-110W	110W-100W	East Australia	New Zealand	Tonga
Naïve	D	E	E	E	F	F	G	E1	Both	Oceania
Fringe	DE	DE	E	E	F	FG	FG			
1900	0	0	0	0	0	0	0	0	8	0
1901	0	0	0	0	0	0	0	0	8	0
1902	0	0	0	0	0	0	0	0	8	0
1903	0	0	0	0	0	0	0	0	8	0
1904	0	0	0	0	0	0	0	0	8	0
1905	0	0	0	0	0	0	0	0	8	0
1906	0	0	0	0	0	0	0	0	8	0
1907	0	0	0	0	0	0	0	0	8	0
1908	0	0	0	0	0	0	0	0	8	0
1909	0	0	0	0	0	0	0	0	16	0
1910	0	0	0	0	0	0	0	0	77	0
1911	0	0	0	0	0	0	0	0	77	0
1912	0	0	0	0	0	0	0	27	197	0
1913	0	0	0	0	0	0	0	348	92	0
1914	0	0	0	0	0	0	0	0	93	0
1915	0	0	0	0	0	0	0	0	106	0
1916	0	0	0	0	0	0	0	0	82	0
1917	0	0	0	0	0	0	0	0	94	0
1918	0	0	0	0	0	0	0	0	90	0
1919	0	0	0	0	0	0	0	0	119	0
1920	0	0	0	0	0	0	0	0	107	0
1921	0	0	0	0	0	0	0	0	89	0
1922	0	0	0	0	0	0	0	0	57	0
1923	0	0	0	0	0	0	0	0	79	0
1924	0	0	0	0	0	0	0	0	107	0
1925	0	0	0	0	0	0	0	0	96	0
1926	0	0	0	82	0	0	0	0	78	0
1927	0	0	0	16	0	0	0	0	127	0
1928	0	0	0	17	0	0	0	0	105	0
1929	0	0	0	775	0	0	0	0	102	0
1930	0	1	234	0	0	0	0	0	78	0
1931	0	0	0	0	0	0	0	0	109	0
1932	0	0	0	0	0	0	0	0	18	0
1933	0	0	0	0	0	0	0	0	44	0
1934	0	0	0	0	0	0	0	0	52	0
1935	0	0	4	0	0	0	0	0	57	0
1936	0	0	0	0	0	0	0	0	69	0
1937	129	32	0	0	0	0	0	0	55	0
1938	180	24	24	0	0	0	0	0	75	0
1939	0	0	0	0	0	0	0	0	80	0
1940	0	0	2394	0	0	0	0	0	107	0
1941	0	0	0	0	0	0	0	0	86	0
1942	0	0	0	0	0	0	0	0	71	0
1943	0	0	0	0	0	0	0	0	90	0
1944	0	0	0	0	0	0	0	0	88	0
1945	0	0	0	0	0	0	0	0	107	0

Latitude	110E-120E	120E-130E	130E-170W	Ross Sea	170W-120W	120W-110W	110W-100W	East Australia	New Zealand	Tonga
Naïve	D	E	E	E	F	F	G	E1	Both	Oceania
Fringe	DE	DE	E	E	F	FG	FG			
1946	0	0	0	0	0	0	0	0	110	0
1947	0	0	0	0	0	0	0	0	101	0
1948	0	0	0	0	0	0	0	0	92	0
1949	10	109	908	0	0	0	0	3	141	0
1950	0	0	171	0	317	0	0	0	79	0
1951	170	232	359	0	38	0	0	0	111	0
1952	0	0	517	0	13	0	0	600	121	0
1953	0	0	14	0	136	0	0	700	109	0
1954	0	0	940	0	340	0	0	718	180	0
1955	508	411	1962	0	334	0	0	720	112	0
1956	0	0	0	0	10	27	39	870	143	0
1957	12	0	220	0	167	31	0	841	184	16
1958	1276	882	1183	0	0	0	0	840	183	16
1959	41	44	12319	0	439	74	7	960	318	16
1960	171	71	9165	0	2758	0	0	980	361	16
1961	120	14	1557	0	2278	54	44	901	80	16
1962	118	58	415	0	285	18	24	177	32	0
1963	24	0	284	0	0	0	0	0	9	0
1964	17	1	85	0	0	0	0	0	0	0
1965	9	9	345	0	477	0	0	0	0	0
1966	26	7	49	0	237	0	0	0	0	0
1967	5	7	27	0	111	0	0	0	0	0
1968	0	0	1	0	0	0	0	0	0	0
1969	0	0	0	0	0	0	0	0	0	0
1970	0	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	3	0	0	0	0
1972	0	0	2	0	0	0	0	0	0	0
1973	0	0	0	0	0	0	0	0	0	3
1974	0	0	0	0	0	0	0	0	0	4
1975	0	0	0	0	0	0	0	0	0	8
1976	0	0	0	0	0	0	0	0	0	4
1977	0	0	0	0	0	0	0	0	0	4
1978	0	0	0	0	0	0	0	0	0	11
Total	**2816**	**1902**	**33179**	**890**	**7940**	**207**	**114**	**8685**	**5714**	**114**