

**APPENDIX THREE**  
**Potential Biological Removal**



## APPENDIX 3: POTENTIAL BIOLOGICAL REMOVAL

1 The Potential Biological Removal (PBR) level is the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population.<sup>1</sup> The PBR is calculated by the following formula:

$$\oplus \text{PBR} = N_{\text{MIN}} \frac{1}{2} R_{\text{MAX}} F_{\text{R}}$$

Where:

$\oplus N_{\text{MIN}}$  = the minimum population estimate of the stock;

$\oplus \frac{1}{2} R_{\text{MAX}}$  = one-half the maximum theoretical or estimated net productivity rate of the stock at a small population size; and

$\oplus F_{\text{R}}$  = a recovery factor between 0.1 and 1.0<sup>2</sup>

2 The term Optimum Sustainable Population means, with respect to any population stock, the number of animals that will result in the maximum productivity (Maximum Net Productivity Level – MNPL) of the species, population, subpopulation or stock in question, keeping in mind the carrying capacity of the habitat and the health of the ecosystem of which they form a constituent part. For marine mammals, this level is thought to be between 50% and 85% of carrying capacity (K) and is more likely to be at the lower end of that range.<sup>3</sup>

3 The minimum population estimate of the stock ( $N_{\text{MIN}}$ ) is defined as the 20<sup>th</sup> percentile of a log-normal distribution based on an estimate of the number of animals in the stock. This is equivalent to the lower limit of a 60% 2-tailed confidence interval.<sup>4</sup>

4 The default maximum theoretical productivity rate is 0.04 for cetaceans. This value is used as a default in the absence of species specific information. When data are available on the productivity rate, they should be used.

5 The recovery factor is intended to compensate for uncertainty and possible unknown estimation errors. A recovery factor of 0.1 often is the default used for endangered stocks of marine mammals.<sup>3</sup> A recovery factor of 0.5 has been suggested for stocks of indeterminate status.<sup>5</sup>

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<sup>1</sup> The PBR is a technique that was developed by the US National Marine Fisheries Service in response to the US Marine Mammal Protection Act. The PBR was never intended to be used to close a fishery; rather, it provides a trigger value, after which a Take Reduction Team was convened to identify ways to reduce the number of human-caused marine mammal mortalities to a level below the calculated PBR value.

<sup>2</sup> Wade, P.R. 1998. Calculating limits to the allowable human-caused mortality of cetaceans and pinnipeds. *Marine Mammal Science* 14(1): 1-37.

<sup>3</sup> Taylor, B.L. and D.P. DeMaster. 1993. Implications of non-linear density dependence. *Marine Mammal Science* 9: 360-371.

<sup>4</sup> Barlow, J., S.L. Swartz, T.C. Eagle and P. Wade. 1995. U.S. marine mammal stock assessments: Guidelines for preparation, background, and a summary of the 1995 assessments. NOAA Technical Memorandum NMFS-OPR-95-6. September 1995.

<sup>5</sup> Wade, Paul R. and Robyn P. Angliss. 1997. Report of the GAMMS workshop: April 3-5, 1996, Seattle, Washington, NOAA Technical Memorandum NMFS-OPR-12.

6 The MNPL goal of the PBR approach was developed to achieve the goals given in the US Marine Mammal Protection Act, *i.e.*, to maintain the population above its maximum net productivity level. This level will be at 50% – 85% of carrying capacity.

7 The Recovery-Rate goal allows a population known to be at a low level relative to its pre-exploitation level to recover at a rate close to its maximum as possible. In this case, a recovery factor ( $F_R$ ) of 0.15 will achieve the goal of not delaying the time to recovery by more than 10% with 95% probability.

8 Earlier studies suggested an  $R_{MAX}$  of about 1.8. The Hector's dolphin Technical Working Group meeting of 31 August 2006 suggested that an  $R_{MAX}$  of 3.4% is appropriate based on the modelling work of Davies and Gilbert (2003).<sup>6</sup> MFish and DOC propose to have the Hector's dolphin PBR analysis independently reviewed to resolve the issue around which  $R_{MAX}$  is most appropriate for Hector's dolphins<sup>7</sup>.

9 As applied here, values calculated by the PBR approach should be seen as indicative only and should not be taken as absolute values of maximum allowable Hector's dolphin human caused mortality.

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<sup>6</sup> Davies, N.M. and D.J. Gilbert. 2003. A risk analysis of an endangered dolphin subspecies using a temporal-spatial age-structured model. Final report for MFish Research Project MOF2002/03D, Objectives 1, 2, & 3 (revised). November 2003.

<sup>7</sup> As part of this review, it is proposed that the recovery factor chosen for all of the Hector's dolphin populations is also reviewed for appropriateness.