INTERNATIONAL COURT OF JUSTICE

WHALING IN THE ANTARCTIC
(AUSTRALIA v. JAPAN)

Supplement to An Assessment of Japanese Whale Research Programs Under Special Permit in the Antarctic (JARPA, JARPA II) as Programs for Purposes of Scientific Research in the Context of Conservation and Management of Whales*

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*I have prepared this supplementary report pursuant to the request by the Court, communicated by letter dated 17 October 2012, for full texts of expert statements to be submitted by 15 April 2013. This statement supplements my original expert opinion ('An Assessment of Japanese Whale Research Programs Under Special Permit in the Antarctic (JARPA, JARPA II) as Programs for Purposes of Scientific Research in the Context of Conservation and Management of Whales', Mangel 2011; Appendix 2 in the Memorial of Australia). These two documents together constitute my full expert statement to the Court.

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1. INTRODUCTION

1.1. I have been asked by the Government of Australia to consider my assessment of Japanese Whale Research Programs Under Special Permit in the Antarctic (JARPA, JARPA II) as programs for 'purposes of scientific research' in the context of conservation and management of whales in light of the Counter-Memorial (CM) of Japan, dated 9 March 2012.

1.2. It is not possible to discuss JARPA II as a program for 'purposes of scientific research' without having a definition of such activity. The Scientific Committee of the International Whaling Commission (SC-IWC) has never provided such a definition. Taking into account the *International Convention for the Regulation of Whaling* (ICRW), the practice of the SC-IWC, the Revised Management Procedure (RMP), drawing on my own experience in basic and applied ecology[1] and consistent with the general practice of science, I previously concluded that a program for 'purposes of scientific research' in the context of conservation and management of whales (Mangel 2011, para 4.39):

> (a) has defined and achievable objectives that aim to contribute knowledge that is important to the conservation and management of whale stocks;
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> (b) uses appropriate methods that are likely to achieve the stated objectives, including:
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> (i) lethal methods only where the objectives of the research cannot be achieved by any other means (for example, by the analysis of existing data and/or the use of non-lethal research techniques);
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> (ii) setting sample sizes using accepted statistical methodology; and
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> (iii) linking mathematical and statistical models to data consistently;
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> (c) includes periodic review of research proposals and results, and adjustment in response to such review; and
>
> (d) is designed to avoid adverse effects on the stocks being studied.

1.3. These are minimum criteria that reflect established practice, and also take into account the approach and criteria of the IWC. All of these criteria are required for an activity to be considered a program for 'purposes of scientific research' in the context of

[1] My experience includes working on Southern Ocean krill since 1986 (I am one of the first two invited experts to CCAMLR and served on the US delegation to CCAMLR in 1991, as a visitor in 2006, and organizing a 2007 meeting on resolving uncertainties in krill fishery management models), membership of the Committee of Scientific Advisors of the US Marine Mammal Commission 1990-1996, member of the delegation of the United States to the Scientific Review of Large-Scale Pelagic Driftnetting, member (2004-2011) and chair (2008-2011) of the Special Committee On Seals, a statutory committee that advises the British Government on the conservation and management of seals, and numerous publications in both basic and applied ecology.

conservation and management of whales. I am unaware of authoritative alternative views (e.g. that science does not require testable hypotheses or that sample sizes should not be set in a consistent manner using appropriate statistical methodology); such views would be far from the mainstream of modern science.

1.4. A central issue brought into focus by the CM is whether each Party to the ICRW can decide for itself, on the basis of its own subjective criteria, what is a program for 'purposes of scientific research' in the context of conservation and management of whales, or whether this can be done only on the basis of objective criteria. The proper characterization of an activity as a program for 'purposes of scientific research' must be based on sound and accepted principles and not subjective assertion. The determination of what constitutes 'science' is to be assessed by reference to boundaries of practice and principle, applying objective criteria; from a scientific perspective, if those boundaries are crossed the practice cannot amount to 'science'.

1.5. In this supplement, I first provide general observations about the CM, and then explain that: (i) JARPA II is not for 'purposes of scientific research'; (ii) the data obtained by lethal means over a 26 year period have not contributed to the RMP and are not likely to contribute to it in the future; and (iii) the data obtained by lethal means could be obtained by other methods. I then return to the Objectives of JARPA II (CM para 5.20) and provide a reassessment of them in light of my previous report, the CM, and this current report. I conclude once again that JARPA II is not a program for 'purposes of scientific research' in the context of conservation and management of whales.

2. GENERAL OBSERVATIONS ABOUT THE COUNTER-MEMORIAL

2.1. As a practicing scientist actively involved in peer-review, both as author and editor,[2] I had expected a point-by-point response in the CM to my analysis. With the exception of my comments about the Allee effect (Mangel 2011, paras 5.64-5.67; CM para 5.86), the CM lacks such a response. Furthermore, the CM introduces a number of points that I consider to be irrelevant or erroneous, including by omission.

2.2. Among the most substantive missing or irrelevant points in the CM are the following:

- The response in the CM to the fundamental criteria in para 1.2 above is cursory. The CM describes them as 'arbitrary' (CM, para III.15) and suggests that the criteria are no more than my personal opinion (CM, para 9.10). However, the CM puts forward no authority for these assertions other than stating that Japan too has scientists. The CM fails to set out any alternative criteria for what qualifies as a program for 'purposes of scientific research'. With this approach, any activity that Japan chooses to undertake can be characterized as science.

- The response in the CM to my conclusion that JARPA II generally lacks hypotheses, except for the krill hypothesis (which is not so much tested in JARPA II as assumed to be true) is

> JARPA II, however, does not purport to verify the validity of the krill surplus hypothesis. What it tries to do is to incorporate data on other animals/fish that prey on krill in order to develop a "model of competition among whale species", considering several hypotheses explaining changes in abundance of baleen whale species including the krill surplus hypothesis[657]. Australia's allegations that JARPA II is not designed or not conducted to verify the validity of the krill surplus hypothesis[658] are thus beside the point. (para 5.31)

However, none of these 'several hypotheses' are described, leaving the reader to guess what they might be.

- The CM provides no analyses illustrating why lethal take is necessary; rather this is simply asserted, as has been done since the outset of JARPA.

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[2] I currently serve on the editorial board of the following scientific journals: *The American Naturalist, Environmental and Ecological Statistics, Evolutionary Ecology Research, Israel Journal of Ecology and Evolution, Oecologia, and Theoretical Population Biology*, and am on the Senior Advisory Council, *Natural Resources Modeling.* From 1994 to 1999, I served as co-editor of *Behavioral Ecology.* I held a variety of editorial positions previous to that.

- The CM introduces extraneous information that distracts from the main points. The question of whether JARPA II is a program for 'purposes of scientific research' in the context of conservation and management of whales is not informed by discussion in the CM on: (i) whether minke whales in the Antarctic can sustain a take, or are endangered or threatened with extinction (CM, para 40); (ii) whether minke whales should be harvested or not; this is an ethical question (as well as a policy question) not amenable to the methods of science (e.g. Weinberg 1972); or (iii) the policy position of Australia on the resumption of commercial whaling (CM, Footnote 318).

- The elaborate description of telomeres (the ends of DNA molecules) as a means of aging (CM para 4.67) and why they will not work is the needless introduction of a straw man, since I did not raise the possibility and telomeres are not mentioned elsewhere in the Memorial of Australia.

- On the other hand, the CM is silent about using blood samples to assess reproductive hormones (for example, CM para 4.70) and brushed away the notion of using biopsy to measure pollutants with the comment that biopsy sampling "would not be possible for all contaminants" (for example, CM para 4.79). However, lacking a conceptual framework through testable hypotheses we have no idea which contaminants are important or why.

3. JARPA II IS NOT FOR 'PURPOSES OF SCIENTIFIC RESEARCH'

JARPA II Lacks Testable Hypotheses

3.1. JARPA II follows in the tradition of JARPA as a program for the collection of data with the assertion that it will somehow inform the conservation and management of whales in the Southern Ocean, but without the requisite conceptual framework to make this outcome even likely.

3.2. Nearly all of the quotations provided in the CM in support of JARPA and JARPA II as programs of science are actually more consistent with it being nothing more than concept free data collection, without defined and achievable objectives or based upon clearly testable hypotheses.[3]

3.3. However, collecting data can only be a part of scientific research when such collection is associated with a hypothesis. As I previously noted (Mangel 2011, paras 4.9–4.13), a program for 'purposes of scientific research' requires a testable and operationally defined hypothesis. In other words, one needs both a hypothesis (or hypotheses) and a means to test it so that one can learn about nature.

3.4. Lacking these requirements, the program may collect data but is not one of scientific research. Simply taking such measurements does not constitute a program for 'purposes of scientific research'. Even induction (the process of forming or developing the relevant question as data collection proceeds, rather than having it clearly articulated from the outset) requires some sense of question if it is to be anything other than the mere collection of data.

3.5. For example, serious bird-watchers are well known to assemble 'life lists' of birds that they have seen, yet nobody would consider such life lists any kind of scientific program exactly because such lists lack hypotheses and a conceptual framework.

3.6. Similarly, it is well understood that monitoring is an essential component of environmental protection. Although such monitoring for environmental protection helps safeguard both human health and the environment, monitoring itself is never suggested by proponents to be a program for 'purposes of scientific research'.

[3] Examples in the CM include paras 4.15, 4.30, 4.49, 4.54, 4.90, 4.114, 4.152, 5.98, 5.101, 8.68.

3.7. This principle is well accepted in the scientific community. One long-term goal of the philosophy of science in the 20th century was to establish how to demarcate science from non-science.[4] It is now generally accepted that "[t]he common thread in all science is the ability to produce and test hypotheses based on systematically collected empirical data (via experiments *or* observations)" (Pigliucci 2010, p. 23). That is, it is now a well-established principle accepted in the scientific community that a testable hypothesis or conceptual framework is an indispensable component of scientific research. The mere collection of empirical data without a testable hypothesis simply cannot be treated as 'scientific research'. By formulating a problem, hypothesis or rigorous conceptual framework that can be tested, we create scientific propositions. However, "[p]ropositions [i.e. hypotheses or objectives] that are so loosely framed as to be untestable are very slippery indeed" (Foster and Huber 1999, p. 233) since they can never be assessed.

3.8. It is thus well accepted in the scientific community that the mere collection of data does not amount to science. Rather, one requires a hypothesis and a means for testing the hypothesis in order to learn from the outcome. Peters (1991, p. 223) noted that the first step for the scientist "is to identify a relevant question or hypothesis to test as the goal of the research". Similarly, Karban and Huntziger (2006, p. 60) write

> The first step in doing research is to have a clear question or hypothesis in your mind. If you are vaguely interested in a system (an organism or an interaction), you are not ready.... You must be able to formulate your ideas into a clear question. Without a clear question, there is no end to the data (relevant or otherwise) that you may feel compelled to collect.[5]

3.9. Without the conceptual framework created by hypotheses, one cannot do science. One could, of course, collect lots of data, as in JARPA and JARPA II, but as Platt (1964, p. 349) noted, "years and decades can easily be wasted on the usual type of 'low-information' observations or experiments if one does not think carefully in advance about what the most important and conclusive experiments [or observations] would be". This point has been well understood and accepted by the scientific community long before JARPA began 26 years ago.

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[4] This philosophical effort is associated with the intellectual giants Karl Popper, Thomas Kuhn, Imre Lakatos, and Michael Polanyi, among others.

[5] Other authorities supporting this view include Angier (2007, p. 32), Casti (1989, p. 11-14), Chalmers (1999, p. 59-73), Cromer (1993, p. 20), Giere (1997, p. 29-38), Rigler and Peters (1995, p. 16), Shermer (2001, p. 133), Ziman (1991, p. 32).

3.10. In summary, lacking testable hypotheses, long-term programs may collect data (even in considerable amounts), but they cannot properly be considered to be programs for 'purposes of scientific research'. As I have stated previously (Mangel 2011), and which was not rebutted in the CM, JARPA II lacks testable hypotheses that are the foundation of science (Mangel 2011, para 5.22); it is, at best, nothing more than a program for the collection of data (Mangel 2011, paras 6.1, 6.19).

Sample Sizes in JARPA II Are Set Without Consistent Application of Accepted Methodology

3.11. Lacking any testable hypotheses, it is impossible to set sample sizes in a proper manner, because sample size is properly set by reference to what is required to answer the focal question. That is, without a focal question, one lacks the necessary touchstone to determine how big the sample needs to be. I noted that JARPA and JARPA II lacked clarity in the setting of sample sizes (Mangel 2011, paras 5.38-5.48). Although the CM gives more detail on sample sizes (para 5.57-5.71), there is no improvement in clarity.

3.12. The additional detail in the CM concerning sample size is a reference to a table published by *The Research Advisors* (and available at http://research-advisors.com/tools/SampleSize.htm) (CM Footnote 712) and Appendices of the JARPA II proposal (CM Footnote 715).

3.13. The table from *The Research Advisors* is used in CM para 5.58 to show that if a population size of 761,000 is assumed, along with a margin of error of 3.5%, and a confidence interval of 95%, then the required sampled size is 783 – which happens to be very close to the sample size used in JARPA II. However, in this simple example, no explanation is given of why a margin of error of 3.5% is selected – that is, why would one need this level of margin of error when other choices are available? For example, if the margin of error were 1.0%, then the sample size will be about 9400, but if the margin of error were 5.0% then the required sample size would only be 384 – nearly 25 times different. And if the margin of error were 10.0% (while not included in the table, this can be a legitimate scientific choice for certain purposes), then the required sample would be even smaller. Even though this is an example, Japan offers no explanation as to how and why one would decide that a margin of error of 3.5% is chosen to be appropriate. Without having a focused question, one cannot decide on the appropriate

choice; the appropriate margin of error can only be selected in light of what is needed to answer the focused question.

3.14. Simply put, knowing which margin of error to apply requires knowing the question that is intended to be answered, which in turn requires a hypothesis.

3.15. The CM then turns (paras 5.59 ff) to three examples (age at maturity, pregnancy rate, and rate of change of blubber thickness) illustrating how sample size is determined. Without reference to hypotheses that would indicate tolerable margins of error, the CM concludes that the sample sizes for these are, respectively, from 594 to 1288 [CM para 5.67], from 663 to 1617 [CM para 5.68] and from 818 to 971 [CM para 5.69].

3.16. The CM continues that for just these three items the necessary sample size is somewhere between 594 and 1617, that for most of the myriad of data collected (more than 100 per whale; CM para 5.59) the necessary sample size is around 800 per year (CM para 5.70) and that 850 was finally adopted as the JARPA II sample size (CM para 5.71). For those items for which this sample size is too small, the CM asserts that the compromised accuracy will be mitigated by "comprehensively integrating many different data and analyses" (CM para 5.71).

3.17. Although a sample size of 850 might seem reasonable from a superficial analysis (and roughly matches sample sizes of JARPA), the choice is not fully explained and cannot therefore be taken as being correct. Rather, the upper limit of the range of sample sizes identified for each research item—namely 1617—would be the value chosen by a program for 'purposes of scientific research' since any smaller value will result in samples that do not meet the criteria of margin of error or confidence interval for at least some of the research items. By using a sample size smaller than the upper limit, one is essentially changing either the margin of error or the confidence interval for those research items Japan had previously concluded required sample sizes above 850 in an arbitrary and ad hoc fashion.

3.18. To be clear: I am not suggesting that more whales should be killed, because it is in fact not necessary to kill any whales for 'purposes of scientific research' in the context of conservation and management of whales. Rather, I am explaining the lack of consistency in the application of methodology.

3.19. These examples illustrate the flexibility that is misused in the statistical methods adopted by Japan. For example, the table referred to above specifies a required sample size as a function of the size of the population sampled, the margin of error one is willing to accept (1%, 2%, 3.5%, or 5%), and the confidence that one is correct (95% or 99%). Flexibility arises because the margin of error and level of confidence are matters of judgment and choice. Although there are accepted approaches regarding their choice (as stated above, this must be linked to the question being asked), Japan provides no explanation regarding its choices.

3.20. The same kind of flexibility in terms of exercising judgment and choice, and which is equally capable of misuse, applies to the more complicated examples given concerning age at maturity, pregnancy rate, and blubber thickness. Indeed, there is even more flexibility in these more complicated examples because, in addition to the choices in the previous paragraph, there is the anticipated level of change and the interval over which that change is intended to be detected. The overall result is that without a conceptual framework in which data collected are embedded, one can select almost any sample size and describe it as being required by way of retrospective reference to unexplained choices of each of the parameters. This appears to be what is done in JARPA II.

3.21. The actual takes, reported in CM para 5.72, are far below the target of 850 except in 2005/06, thus suggesting that the entire set of samples from 2006/07 onwards are compromised. Although the CM tries to explain the reasons for the reduced take, it makes no effort to explain how the comprised accuracy will be mitigated by "comprehensively integrating many different data and analyses" (CM para 5.71).

3.22. In summary, it is still unclear how sample sizes are set in JARPA II. The only point that can be made clearly is that they are not set in a manner consistent with the proper conduct of a program for 'purposes of scientific research'.

Models and Data – Especially Lethally Collected Data – are Not Connected in JARPA II

3.23. JARPA II also fails to meet the requirement of a program for 'purposes of scientific research' in the context of conservation and management of whales that models and data are to be linked in a consistent fashion.

3.24. In ecology, models are used in a variety of ways, including: (i) for synthesis and integration of data; (ii) to provide guidance to empiricists; and (iii) for prediction. Complicated models are not necessarily more useful, or better, than simpler models.[6] Indeed, in many cases more complex models will often give less accurate answers than simpler variants (Ludwig and Walters 1985).

3.25. The CM is not consistent in its approach to models and data: Japan asserts one thing in its objectives (the development of a model of the ecosystem), and then does another in the methods it chooses and the actual conduct of its program (focusing on a small component of the ecosystem). A simplified version of the Southern Ocean ecosystem is found in Figure 5-1 of the CM. I have reproduced that figure here (Figure 1 below).

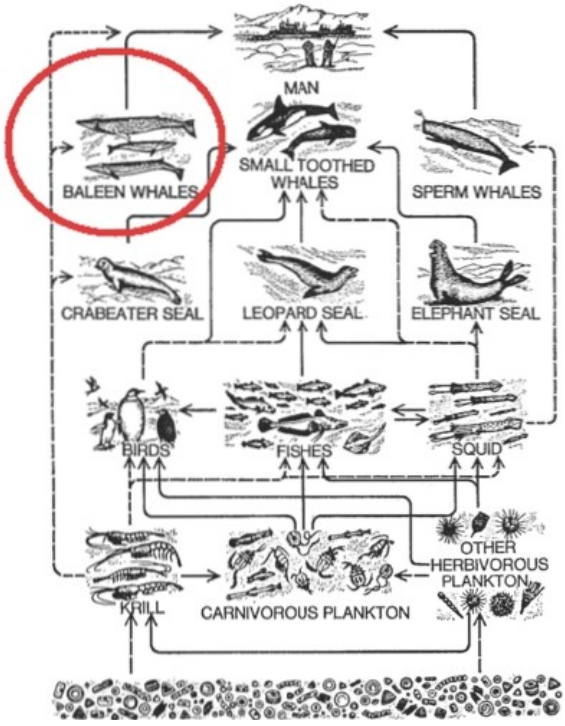

Figure 1: The simplified view of the Southern Ocean ecosystem, from the CM and based on Beddington and May (1982). Note that JARPA II collects data on only a single species of one component of the ecosystem (the baleen whales, red circle).

3.26. The CM reinforces the inconsistent approach within JARPA and JARPA II regarding the development of the ecosystem model. Japan asserts: (i) that JARPA II

[6] Additional authorities supporting my expert opinion include Giere (2006, p. 60), Johnson (2001, p. 105 ff), Karban and Huntzinger (2006, p. 25-27), Oreskes (2003), Rastetter (2003), Taper and Lele (2004), van Fraassen (2010, p. 13), Ziman (1991, p. 77 ff).

will lead to the development of a management model for the whales of the Southern Ocean ecosystem; and (ii) that lethal take of minke whales is required for the development of this model because non-lethal methods are insufficiently accurate.[7]

3.27. However, JARPA II almost exclusively focuses data collection on minke whales (some data are also collected on fin whales, and on some occasions krill), which is but one small component of the ecosystem. The outcome is that JARPA II workers will have a large amount of supposedly necessary data on that single species in its ecosystem model, while nearly all of the other components of the model (e.g. the other baleen whales, birds, mammals) will be characterized in some unknown way. By the logic of the CM, the resulting model cannot possibly provide any useful results in assessing the ecosystem.

3.28. Second, JARPA II workers are themselves inconsistent in the assertion that generally accepted non-lethal methods are not accurate enough for the purposes of ecosystem modeling. For example, Tamura and Konishi (2006), two JARPA II workers, compared estimates of krill consumption using daily changes in stomach content (a lethal method) with estimates using classic (Kleiber 1947) methods that do not require lethal take and concluded that the "results showed that estimated daily prey consumptions were similar between the above two methods" (p. 1) and that although both methods were subject to errors "the estimates based on two independent methods were coincidence well [sic] each other" (p. 6-7). This paper was submitted for the JARPA review in 2006. A somewhat different version was published later in a peer-reviewed journal (Tamura and Konishi 2009). Although data on stomach contents are discussed in the later paper, only the non-lethal method is used to compute an estimate of prey consumption. Thus, JARPA II workers themselves have shown that non-lethal methods are equally as accurate as the lethal ones and when writing for scientific colleagues chose to use the non-lethal ones.

[7] For example, the CM states that: "Non-lethal allometric techniques[451] can only produce rough and indirect estimates of food consumption, which are not reliable enough for use as input data in ecosystem models" (CM para 4.72; a similar comment is made in para 4.76).

JARPA II Generally Lacks Bona Fide Peer-Review and Most Peer-reviewed Papers are Not Relevant to the Conservation and Management of Whales

3.29. As described previously (Mangel 2011), true peer-review (the periodic review of research proposals and the results, and adjustment in response to such review) is an essential component of a program for 'purposes of scientific research'. The reason is that science is the development of consensual knowledge. Ziman (1991, p. 3) wrote "... scientific knowledge is the product of a collective human enterprise to which scientists make individual contributions which are purified and extended by mutual criticism and intellectual cooperation … the goal of science is a consensus of rational opinion over the widest possible field". Peer-review plays a key role in the development of such consensual knowledge.

3.30. A key component of proper peer-review is that it is independent and lacks bias. This is important because

> The experts in a particular field can become so indoctrinated and so committed to the current paradigm that their critical and imaginative powers are inhibited, and they cannot 'see beyond their own noses'. In this circumstance scientific progress may come to a halt -- knowledge may even regress -- until intellectual intruders come through the interdisciplinary frontiers and look at the field without preconceptions. (Ziman 1991, p. 134).

3.31. The indispensable nature of adequate peer-review to a program such as JARPA and JARPA II is evident in the following statement:

> Every scientific paper and report has to go through the critical scrutiny of other experts: peer review. Scientific authors are required to take reviewers' comments and criticisms seriously, and to fix any mistakes that may have been found. It's a foundational ethic of scientific work: no claim can be considered valid – not even *potentially* valid – until it has passed peer review (Oreskes and Conway 2010, p. 3-4).

3.32. Oreskes and Conway (2010, p. 269) also note "[i]n science, you don't get to keep harping on a subject until your opponents just give up in exhaustion". Yet this pretty much seems to be what happens in the SC-IWC. Additional authorities supporting the essential nature of unbiased peer-review are found throughout the entire scientific community.[8]

3.33. The CM considers that peer-review outside of the SC-IWC is time consuming (paras 4.108, 4.109) and by implication not worth the effort and delay. To be sure,

[8] For example: Casti (1989, p. 14), Cromer (1993, p. 145), Legendre (2004, p. 53), Shermer (2001, p. 317).

peer-review may sometimes be lengthy, but it is also the only way we know to establish unbiased assessment of research work. The most effective peer-review is anonymous and often requires mandatory changes before work can go forward (in the case of proposed research) or be published (in the case of completed research). As described in the CM (paras 4.108, 4.109) and in Clapham et al. (2003), review in the SC-IWC does not have these features. Indeed, Clapham et al. (2003, p. 212) note that in SC-IWC the authors of a proposal play a major role in writing the resulting evaluation. JARPA II fails to be a program for 'purposes of scientific research' on the criterion of peer-review.

3.34. Even so, the CM (paras 4.112-4.114) describes a total of 195 documents from JARPA/JARPA II between 1988 and 2009, of which 107 are said to be peer-reviewed papers. I previously analyzed the material presented in CM Footnote 511 (Mangel 2011, paras 5.58, 5.59). I noted that: (i) publications from JARPA/JARPA II generally do not appear in peer-reviewed journals outside of the IWC; (ii) that only about 1/6 of the articles were peer-reviewed and broadly relevant to conservation and management of whales; and (iii) that nearly 40% of the peer-reviewed articles related to lipid biochemistry or reproductive physiology, thus irrelevant to the conservation and management of whales and to the stated objectives of JARPA II.

3.35. The CM (para 5.99) notes that two peer-reviewed publications from JARPA II have been published and that "a larger number … are expected" in the future. The two papers published at that point, described in CM Footnote 774, are about whale morphology and reproductive physiology – i.e. they are totally irrelevant to the conservation and management of whales and to the stated objectives of JARPA II.

3.36. Given the promise of forthcoming peer-reviewed publications in para 5.99 of the CM, it is instructive to consider once again the 'scientific contributions' from JARPA and JARPA II. To do this, I accessed the ICR website http://www.icrwhale.org/scJARPA.html on 4 April 2013 and downloaded the report *Scientific Contribution from JARPA/JARPA II* (December 2012), which lists written documents by year. This is an updated version of the document referred to in Footnote 511 of the CM. Based on document titles, it is not clear which ones relate to JARPA or JARPA II, and so I do not distinguish in my analysis. Documents are

identified as peer-reviewed or as 'unpublished'. In light of the essential nature of peer-review discussed above, I again focus on Japan's peer-reviewed documents.

3.37. Focusing on the additional 'contributions' after 2009 (I have already analyzed the contributions up to 2009, see paragraph 3.34 above), it is claimed that JARPA/JARPA II have produced 25 documents between 2010 and 2012, of which 15 are peer-reviewed. Of these 15, one is in Norwegian and 11 are in Japanese, making them generally inaccessible to scientific colleagues (no English translation has been provided). Furthermore, based on the citation information, seven of the 11 papers in Japanese appear to be two pages and one of the 11 appears to be three pages; they appear to be nothing more than abstracts of work rather than full analyses.

3.38. The three remaining peer-reviewed papers are about: (i) stock structure and migratory routes of Antarctic minke whales, using lethal and non-lethal methods (as I describe below in Section 5, this work could have been done with only non-lethal methods); (ii) abundance estimates of humpback whales from sighting surveys using non-lethal methods; and (iii) genetic diversity in blue whales, determined using biopsy samples collected by Japanese vessels during the IDCR/SOWER cruises rather than from JARPA or JARPA II (Sremba et al. 2012, p. 3). This last paper in particular demonstrates that when JARPA researchers wish to, they are able to make use of non-lethal methods (for discussion on non-lethal methods, see section 5 below).

3.39. As such, of the 15 peer-reviewed papers devised from JARPA and JARPA II between 2010 and 2012, 12 are inaccessible to the scientific community for peer-review and three either in fact use, or could have achieved the same results using, entirely non-lethal techniques. On this basis the 15 papers do not provide any support to Japan.

3.40. Clapham et al. (2003, p. 211) – all of whom were members of SC-IWC – writing about this trend in JARPA note that there are many peer-reviewed articles "on topics of no value to management" and that "JARPA's failure to publish in international refereed journals says much about the quality and motives of its science".

4. THE DATA OBTAINED DURING 26 YEARS OF JARPA AND JARPA II HAVE NOT CONTRIBUTED TO THE RMP

Goal of the RMP

4.1. The RMP is designed to correct the two major problems of previous management regimes: (i) to prevent the depletion of whales; while (ii) maintaining the stability of catches at as high a level as possible, consistent with (i). In doing so, the SC-IWC put aside the disproven and futile notion that Maximum Sustainable Yield (MSY) and Maximum Sustainable Yield Level (MSYL)[9] can be measured in the field. Instead, the SC-IWC recognized that we will always have only approximate knowledge of stock levels and recruitment curves so that a successful management regime must be robust to these uncertainties.

4.2. Contrary to the assertion in the CM, the RMP is not complicated. It can be best understood as a simulation of whaling using a computer model. The number of whales in a population in the following year will be determined by the number this year, the net productivity (new whales produced minus natural deaths), and the take, if there is one (for more details on the dynamics of populations, see Mangel 2011, paras 3.8-3.14). For whale populations in nature, we generally do not know the precise pre-exploitation population size (the historical population size before whaling commenced), the current level of depletion from the pre-exploitation level, or the productivity, and can only measure current population size inaccurately.

4.3. However, computer simulations allow us to ask: "what would the dynamics of a whale population be if we assume values for pre-exploitation population size and productivity as a function of population size?" We can then compare the predicted dynamics of the whale population with the inaccurately observed estimates of abundance and, by repeating this process over and over again, learn about more likely and less likely values of productivity and current levels of depletion. The RMP includes a decision rule (para 4.5 below) that sets the catch based on our estimates of productivity and population size.

[9] For explanation of these two terms, see Mangel 2011, para 3.12.

The RMP Uses Management and Operating Models

4.4. The approach taken by SC-IWC when developing the RMP, in which it undertook computer simulation testing of management procedures to determine the management measures that would achieve the two goals referred to in para 4.1, is now generally known as Management Strategy Evaluation (MSE; Smith et al. 1999, Mangel 2010). In MSE, one tests a management model against a variety of 'operating models'. The idea is that each of the operating models is a different – and potentially very complex – description of how the world might work. We seek a management model that is effective, regardless of which of these operating models best characterizes the natural world (it is almost a surety that none of the operating models are exactly correct, and therefore the management model must be robust to all of them).

4.5. The management model in the RMP is known as the *Catch Limit Algorithm* (CLA). The CLA is based on the recognition that the true state of the stock (level of depletion/current abundance and productivity) is unknown. For this reason, the population model in the CLA is extremely simple. Neither the population model nor the parameter values in it are intended to give an accurate representation of the dynamics of a whale population; this is not their purpose. Rather, the model has been shown by simulation trials to allow robust calculation of catch limits (IWC 1999). Furthermore, the CLA is designed to learn about the key parameters of the managed stock – productivity and depletion – as the RMP is applied without the need for lethal take other than historical records of levels of past commercial catch.

4.6. The CM asserts that biological parameters collected by JARPA/JARPA II are 'essential' for certain elements of the RMP (CM para 4.165). When testing the CLA, it is possible, of course, to use extremely complicated 'operating models' based upon a great deal of biological detail. The only constraint on operating models is the creativity of the workers developing it. However, lethally obtained data are not necessary for the development of such operating models. By focussing on the operating model, as is done in JARPA II and the CM, an unlimited amount of biological data can be collected by lethal take with the claim of making a better operating model. However, the same can be achieved without lethal take as explained in Section 5 below.

4.7. The RMP is conservative because a procedure that takes into account large ranges of uncertainty and a wide range of operating models must be conservative. A policy

that leaves one 'extra' whale in the ocean, or a policy that kills one whale too many will both miss the target by one individual. However, in general, these errors are not symmetrical—in this simplified example, the one extra whale left behind can still be whaled next year (that is, the error can be corrected), but the one extra whale taken cannot be replaced (the error cannot be corrected). The RMP captures this asymmetry as well.

4.8. The strength of the simulation testing in the RMP is that it eliminates the need for detailed biological data obtained through lethal take (Kirkwood 1992, Cooke 1995).

Required and Ancillary Data

4.9. The data required for the RMP are: (i) numbers of all past catches; (ii) relative abundance data; and (iii) estimates of absolute abundance (IWC 1994, 1999; Kirkwood 1991). That is, the simulations in the RMP (para 4.2, 4.3 above) use only numbers of individuals (catch and abundance). The SC-IWC considered including additional data when developing the RMP, but decided against it (Kirkwood 1991).

4.10. In summary, the RMP is a simple and elegant means for learning about the uncertainty inherent in the natural world. It operates by collecting appropriate data and comparing those data with predictions of well-understood models. None of the biological parameters – such as natural mortality rate, pregnancy rate, age at sexual maturity – that are collected by JARPA II through lethal take are required by the RMP. Nor can it be said that they assist in the operation of the RMP, or that they can contribute to the improvement of the RMP.

Implementation Simulation Trials and Lethal Take

4.11. The IWC management boundaries do not necessarily reflect the actual biology and stock structure of whales. This is called the 'stock identity problem' and is solved in the RMP by dividing the management areas into small regions (called 'small areas') in which the CLA is separately applied. The premise is that the area is small enough such that either only one stock occupies it or that when multiple stocks are present they are well mixed within the small area. The SC-IWC has developed a sequence of *multi-stock rules* to implement the CLA consistently with this premise.

4.12. To test the multi-stock rules, the SC-IWC conducts simulations called *Implementation Simulation Trials* (ISTs). These can be viewed as a variant of the approach that underpins the RMP. One develops a series of hypotheses about how many stocks are present and how the whales move about and mix. For each hypothesis one can then determine a catch limit from the CLA. Using computer simulation, one can then test how the catch limit that has been determined using one hypothesis performs against alternative hypotheses. This process can be repeated over and over again, such that each potential catch limit is tested against every alternative hypothesis. Ultimately, the catch limit arrived at is the one most robust to the range of uncertainty that is unavoidably present (since the true state of nature is always unknown).

4.13. This is a form of risk analysis in which consequences are explored as a function of the difference between the true and assumed states of nature. It is a well-regarded and powerful tool for environmental protection. In the case of the RMP, it allows us to determine a catch rule that is robust across the potential states of nature.

4.14. Contrary to the assertion in the CM paras 4.164, 4.165 and Figure 4-12, none of the biological parameters – such as natural mortality rate, pregnancy rate, age at sexual maturity – that are collected by JARPA II through lethal take are essential for the ISTs. Rather they are ancillary, since one can develop the hypotheses for the ISTs without them, using non-lethal data (examples are given in Section 5). Indeed, the assertion in the CM that lethal take data are essential for the RMP or any element of it is in fact contrary to the fundamental design of the RMP that lethal take other than catch levels from past commercial harvest is not required.

Refinement and Revision of the RMP

4.15. The RMP is intended to apply to all baleen whales, rather than just minke whales. In order to do so, the starting point of the simulations of population numbers considers a wide range of productivity, current depletion (ranging from virtually extinct stocks to unexploited ones), and inaccuracies of surveyed abundance. As the RMP is applied to a particular stock in a particular area, and data are obtained, there is an in-built process in the RMP of learning about that focal stock (this is called the 'joint posterior' of depletion and productivity; see IWC 1994, p. 148).

4.16. Even if achievable, using fieldwork to shrink the range of productivity that forms the starting point of the RMP, which is one of the objectives of JARPA II, would in fact undermine the applicability of the RMP to other species of baleen whales. That is, we expect that the different species of whales will have differing productivities, determined by their differing biology. To constrain the starting point of the RMP so that it 'fits' minke whales is likely to make it fail for other species of whales.

4.17. On the other hand, if Japan wanted to achieve the same outcome of 'improving' the RMP for Antarctic minke whales only, it could do so by performing repeated 'dry runs' of the RMP in a small area and allowing the model's inbuilt learning mechanism to make any appropriate adjustments. This could be done using entirely non-lethal data, since only sighting surveys for abundance are required for the RMP.

5. THE DATA OBTAINED BY LETHAL MEANS COULD BE OBTAINED BY OTHER METHODS

5.1. The CM continues Japan's long-standing tradition (e.g. Ohsumi 1995) of asserting that lethal methods are required as part of JARPA and JARPA II. At no point, it seems, has Japan genuinely explored alternative non-lethal methods. Rather, it takes lethal means as an accepted proposition, and then asserts that lethally acquired data are essential for the RMP, which they are not. In doing so, JARPA II uses exactly the same methods as JARPA, as if 25 years of scientific and technological development had not occurred.

5.2. In the CM, non-lethal methods are presumed in advance not to be workable. The CM relies on statements from others such as the conclusion that logistics and abundance "probably preclude their [non-lethal methods] successful application" (CM, para 4.61). It claims that skin biopsy is not practicable because a new and heavier projectile, for use in open water rather than coastal areas, would be required and that "[t]he use of heavier projectile units would necessitate the use of more powerful delivery units in order to obtain the necessary range and trajectory. However, adding mass and power to the projectile unit increases the risk of unwarranted penetration and damage to the target animal [454]" (CM para 4.75). It is a perplexing logic that rules out by assertion a method on the basis that it is preferential to kill an animal with certainty rather than to risk possible damage to it.

5.3. In contrast to the CM, I consider that there are three particularly important non-lethal research methods – tagging, biopsy and photography – that have greatly advanced during the time of JARPA and JARPA II. These three methods are particularly useful to scientific research in the context of conservation and management of whales

Tagging

5.4. The CM asserts (paras 5.49, 5.50; Footnotes 696, 697) that tagging minke whales is not practicable, thus requiring lethal take. The JARPA proposal (Japan 1987, p. 43) noted "[i]f mark and mark recapture could be available both in the low latitude (breeding ground) and the high latitude (feeding ground), this method [mark-recapture] would certainly produce information with the highest accuracy ever obtained by any other methods ever adopted in the past for ascertainment of stock movement, migration, and identification".

5.5. This older technique of mark and mark recapture has now been long overtaken by the superior method of satellite tagging, which pursues the same research items of ascertaining stock movement, migration and identification. In satellite tagging, marine mammal scientists have achieved the goal posited in the JARPA proposal. Mate et al. (2007) provided a review of the advances in satellite tags. In Figure 2, I reproduce their data, which shows that tag longevity has increased over the last decade to the point of achieving the standard that Japan called for in the original JARPA proposal. Although they have not yet tried to tag minke whales, Mate et al. (2007) reported the tagging of a calf humpback, which is about the same size as a minke whale. In particular, in response to my question about the feasibility of tagging minke whales, Prof Bruce Mate, Director of the Marine Mammal Institute, University of Oregon wrote to me: "[t]he tags we are working with now can be made in a smaller length, which may be more appropriate for minkes. We have not tagged minkes, but you will see in the attached paper [Mate 2007] having tagged a calf humpback (even with the older and larger tag) by mistake that seemed to have worked out very well indeed." (email correspondence 16 November 2010; Appendix 1). Other scientists have used satellite tagging in the Antarctic to suggest revision of the management boundary for humpback whales without recourse to lethal take (Dalla Rossa et al. 2008).

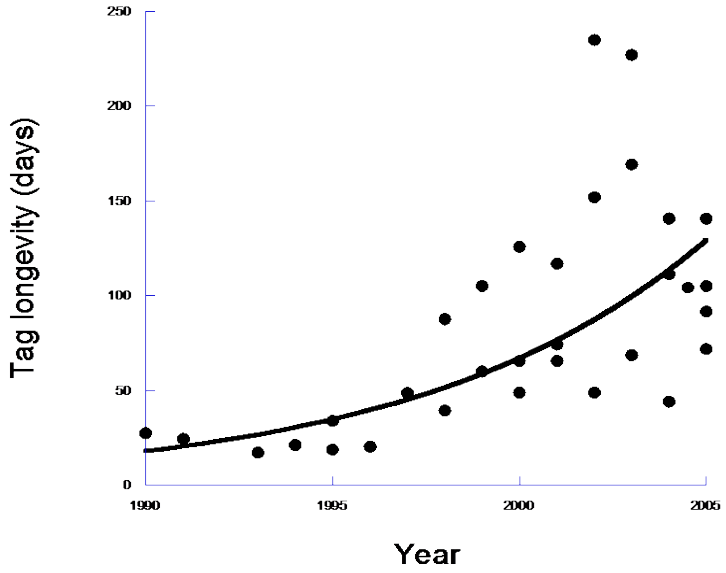

Figure 2: Tag longevity has increased over the last decade to the point of achieving the standard that Japan called for in the original JARPA proposal. Rather than embracing these technologies, JARPA II workers have resisted them.

5.6. Lockyer (2007) noted that VHF and satellite tags and time depth recorders have in recent years been able to collect data remotely from cetaceans on dive patterns, swim speeds and foraging bouts. Lockyer also noted that ingested transmitters can provide information about stomach temperature, indicative of feeding.

5.7. In February 2013, a group of scientists including Dr Nick Gales were successful in tagging 18 Antarctic minke whales with four different types of tags. A further 19 Antarctic minke whales were also biopsied (email correspondence between Dr Gales and myself of 20 March 2013; Appendix 2).

5.8. Although these advances may seem both recent and modest (when compared to the number of whales involved in the lethal take of JARPA II), they do show that these methods are not only feasible, but successful when effort is put into their development and implementation. This also shows clearly that, if JARPA II was a program for 'purposes of scientific research' in the context of conservation and management of whales, it too would have put considerable efforts into advancing tagging methodology.

Biopsy

5.9. The CM is similarly dismissive of biopsy (para 4.75, Footnote 453), which has several applications including providing non-lethal information on pregnancy status as well as pollutants (Mangel 2011, para 5.33). Recent work also suggests that the mixture of fats in the blubber obtained by biopsy tagging can be used to assess age distributions of whales (Herman et al. 2008, 2009).

5.10. Shortly after the moratorium and barely into JARPA, Hoelzel and Amos (1988) showed that one could apply methods of molecular genetics to small (about 2-tenths of a gram) skin samples collected from free-ranging whales using a dart-tipped arrow, fired from a cross-bow and retrieved with a fishing line (this was the precursor to today's biopsy techniques). Thus, from the start of JARPA, techniques for identification of individuals and fundamental information about populations were available, but not developed by JARPA scientists.

5.11. In the same interview quoted in Footnote 418 of the CM, Dr. J. Zeh (University of Washington and then Chair of SC-IWC) was asked whether a non-lethal method could provide the same data that the lethal methods were providing. She answered "[w]ell,

many scientists are using biopsy sampling, and that works very well for humpback whales. It's been a little less successful for minke whales, and I'm not sure that's because it hasn't been tried sufficiently and the best techniques worked out, or whether – I suspect that maybe it's somewhat more difficult to biopsy minke whales than humpback whales". A dozen years later, JARPA II has brought us no closer to the answer, even though as Clapham et al. (2003 p. 212) – all of whom were members of SC-IWC – noted "if a whale can be hit with a harpoon, the same target can just as easily be struck with a biopsy dart". The viability of taking biopsy samples from Antarctic minke whales in the Southern Ocean has indeed now been demonstrated, including through the 19 animals successfully biopsied in the recent research expedition involving Dr Nick Gales (see para 5.7 above, and email correspondence in Appendix 2).

Photography

5.12. Regarding non-lethal sampling in observation ecology, Sagarin and Pauchard (2012, p. 98) note

> Digital photography offers the opportunity to inexpensively archive many details of organisms that are then left to go on living in the field. Genetic data can be collected and archived based on small, non-lethal tissue samples, even in the case of endangered species. For example, whales can be sampled both by photographing their distinct markings and by obtaining small samples for genetics research by lancing blubber samples when they surface.

5.13. Photography is also an important, non-lethal technique that is summarily dismissed by Japan (CM, paras 4.62, 4.70). Nearly 25 years ago, Hoelzel et al. (1989) used photographic methods to individually identify minke whales and then study their individual foraging specializations. JARPA II workers, rather than embracing and enhancing these new technologies as would happen in a program for 'purposes of scientific research', resisted them to continue business as usual.

Summary

5.14. Changing tagging technology, biopsy methods, or photography have been and continue to be technological revolutions that allow us to sharply break with the past (one needs to simply think about the technological advances between 1990 and today). A program of science should embrace these technologies rather than summarily dismiss them to continue business as usual. JARPA II is characterized by a manifest refusal to innovate by using new tagging technologies and biopsy methods, and instead doggedly

pursues the continued and unnecessary killing of whales, without assessing whether alternatives are available. Finally, in the absence of a testable hypothesis it is impossible to know why non-lethal alternatives to lethal take would not be adequate.

5.15. Corkeron (2009), commenting on the lethal field work in JARPN II (the North Pacific version of JARPA II), characterizes the basic design of the work as "an unsophisticated approach to investigating the foraging ecology" of baleen whales, that the analyses of data "were simplistic" and that non-lethal studies using far fewer resources "have produced more definitive information" (p. 305). The same is true for JARPA II.

6. REASSESSMENT OF THE OBJECTIVES OF JARPA II

6.1. It is now possible to reassess the objectives of JARPA II (CM para 5.20) in light of my previous report, the CM, and this supplementary report.

6.2. The first objective of JARPA II is

(1) Monitoring of the Antarctic ecosystem
  (i) Monitoring of whale abundance trends and biological parameters
  (ii) Monitoring of krill abundance and the feeding ecology of whales
  (iii) Monitoring of the effects of contaminants on cetaceans
  (iv) Monitoring of cetacean habitat

6.3. Reassessment: This objective is broad and general, without clear and testable hypotheses (Mangel 2011, paras 5.9–5.10). As I have explained above (paras 3.1–3.10) monitoring in the absence of clear testable hypotheses is merely the collection of data, and the collection of data in itself cannot be considered as being for 'purposes of scientific research'. Furthermore, of the elements set out in items (i) – (iv) above, monitoring whale and krill abundance, the feeding ecology of whales, effects of contaminants and cetacean habitat do not require lethal take. Moreover, monitoring biological parameters is both entirely unnecessary for the conservation and management of whales, and has proven to be unattainable to any useful level of accuracy.

6.4. The second objective of JARPA II is

(2) Modelling competition among whale species and future management objectives
  (i) Constructing a model of competition among whale species
  (ii) New management objectives including the restoration of the cetacean ecosystem
    - Establishing future management objectives
    - Estimating surplus production (and hence allowable catch) by species, under some of the management objectives
    - Contribute towards a multi-whale-species management

6.5. Reassessment: As I have explained above (para 3.25–3.27), workers in JARPA II are collecting insufficient data to achieve item (i), because of the focus on only a small component of the Southern Ocean ecosystem and the lack of broad collaboration with other scientific programs. Furthermore, workers in JARPA II themselves have demonstrated (para 3.28) that lethal take is not required to develop the models. The sub-items under item (ii) are both vague and not for 'purposes of scientific research' but

an attempt to revise the RMP outside of the procedures set by the IWC. In light of the proven inability to determine parameters such as productivity to necessary levels of accuracy, as the SC-IWC learned through its failed attempts to implement its previous management regime (the New Management Procedure; NMP), significant elements of item (ii) are also highly unlikely to be achieved.

6.6. The third objective of JARPA II is

(3) Elucidation of temporal and spatial changes in stock structure

6.7. Reassessment: As explained above (para 3.1–3.10), lacking testable hypotheses, this objective cannot be for 'purposes of scientific research'. That is, merely monitoring changes in stock structure over space and time, without addressing any broader question that such monitoring is expressly aimed at addressing, does not amount to 'scientific research'. Furthermore, given the advances that have occurred in tagging (para 5.4–5.8), biopsy (para 5.9–5.11), and other non-lethal methods (para 5.12) over the last 25 years, there is no need for lethal take.

6.8. The fourth objective of JARPA II is

(4) Improving the management procedure for Antarctic minke whale stocks
- Improvement of MSYR (maximum sustainable yield rate) estimates for Antarctic minke whales
- Re-definition of appropriate management Areas
- Incorporation of effects arising from the inter-species relationships among the whale species.

6.9. Reassessment: As I explained above (para 4.1–4.8), the RMP is designed to learn about MSYR without recourse to lethal take (except for commercial whaling) and in fact was designed with the explicit goal of not trying to measure MSYR in the field (something that both JARPA and the attempts of the SC-IWC to implement the NMP demonstrated was essentially impossible). Re-definition of the management areas is again not a question for 'purposes of scientific research'. In any event, as explained above, it does not require lethal take because of developments in tagging and biopsy. The last item ('incorporation of effects arising from the inter-species relationships among the whale species') is extremely vague, but suggests movement towards a completely new kind of multi-species management procedure. To the extent that this seeks to look at interactions between whale species, it also suffers from the fatal flaw of

actually only studying one species (see para 6.5 above). Again, this item is not for ‘purposes of scientific research’.

7. CONCLUSION

7.1. JARPA II follows in the tradition of JARPA as a program for the collection of lethal data with the assertion that it will somehow inform the conservation and management of whales in the Southern Ocean. However, JARPA II lacks hypotheses, is inconsistent about the determination of sample sizes, does not connect models and data appropriately, and generally lacks bona fide (or, in many respects, any) peer-review.

7.2. The reason that JARPA/JARPA II publications are generally irrelevant to their own stated objectives is clear: JARPA II is not a program for 'purposes of scientific research' in the context of conservation and management of whales. Rather it is a program of data collection. The data collected by lethal means have, after 26 years, not contributed to the RMP and it is unlikely that they will so contribute in the future. Furthermore, any data that are in any way relevant to the conservation and management of whales can be collected by non-lethal means.

7.3. Burnett (2012) reviewed the history of failed attempts at science in the 20th century that lead to the destruction of the great whales, particularly the now discredited *Discovery Committee*, which was a series of ship-based and land-based expeditions in the Southern Ocean, with a focus on whales, between 1925 and the 1940s. The core of this work consisted of: (i) flensing platform studies of the anatomy and reproductive physiology of whales; and (ii) open-ocean 'marking' expeditions in which whales were shot with a numbered steel dart that was recovered in the course of commercial whaling ('marking surveys'). Burnett notes that the *Discovery* work "eventually made whalemen of scientists" (p. 30).

7.4. JARPA and JARPA II, in which attempts are made to have commercial whaling look like science (the converse of the *Discovery* effect), share many of the characteristics of the work of the *Discovery Committee*. Based on Burnett's descriptions of the *Discovery Committee's* activities and the early years of the SC-IWC, I draw out the following characteristics they share with JARPA/JARPA II: (i) the conflation of 'science' and whaling;[10] (ii) publication outside of general peer-reviewed outlets; [11] (iii) vagueness about how the data collection would contribute to

[10] Burnett (2012), p. 29, 174.
[11] Ibid. p. 138.

management;[12] (iv) confusion about the collection of data and the process of science;[13] (v) data collection that could not contribute to the conservation and management of whales and not changing the goals in the face of criticism;[14] (vi) the tradition of no matter what, keep going in the same direction;[15] and (vii) ignoring alternative, non-lethal methods.[16]

7.5. My conclusion remains the same in light of the CM: JARPA II is an activity that collects data in the Southern Ocean. However, it is not a program for 'purposes of scientific research' in the context of conservation and management of whales.

[12] Ibid, p. 173.
[13] Ibid, p. 430.
[14] Ibid, p. 448, 476.
[15] Ibid, p. 496.
[16] Ibid, p. 399.

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Appendix 1: Correspondence with Prof Bruce Mate Concerning Tagging Whales 16 Nov 2010

Bruce Mate <bruce.mate@oregonstate.edu> 11/16/10

to Marc

Hi Marc,

This should help you get started. The tags we are working with now can be made in a smaller length, which may be more appropriate for minkes. We have not tagged minkes, but you will see in the attached paper having tagged a calf humpback (even with the older and larger tag) by mistake that seemed to have worked out very well indeed.

I guess I have to encourage Mike to be in touch so we can move forward with this thoughts.

Bruce

Bruce Mate
Director, Marine Mammal Institute
Oregon State University
Hatfield Marine Science Center
2030 SE Marine Science Drive
Newport, OR 97365

On Nov 16, 2010, at 7:14 AM, Marc Mangel wrote:

Hi Bruce

I writing something in which I would like to provide an assessment of putting simple, long-lived tags (e.g. giving, date, whale identifier, and location) on minke whales. Mike Fedak suggested that I could contact you for information on what you have done on some of the larger whales and your opinion about doing the same on minkes. If you could send a few papers that would be terrific.

Mike says hello, and also that he still would like to try attaching some of his tags using your attachment methodology.

Thanks in advance

Marc

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Marc Mangel
Distinguished Professor, Applied Mathematics and Statistics
Jack Baskin Endowed Chair, Technology and Information Management
Director, Center for Stock Assessment Research

Appendix 2: Correspondence with Dr Nick Gales Concerning Tagging Whales 20 March 2013

from:	**Nick Gales** <Nick.Gales@aad.gov.au>
to:	"msmangel@ucsc.edu" <msmangel@ucsc.edu>
date:	Tue, Mar 19, 2013 at 9:14 PM
subject:	Minke whale tagging [sec=unclassified]
mailed-by:	aad.gov.au

Dear Mark,
Further to our discussion, in this email I provide you with details of the tagging and and other work we conducted with minke whales in February 2013.
As you know, up until this summer no Antarctic minke whales had been tagged. During February this year I spent about 10 days on board the NSF Research Vessel Point Sur working with a group of US scientists led by Dr Ari Friedlaender. The project was supported by the US Antarctic Program and formed part of a collaborative research project of the IWC's Southern Ocean Research Partnership.

The aim of the voyage was to deploy location-only satellite tags and suction-cup mounted data-logging tags on humpback and minke whales off the Western Antarctic Peninsula. These tags had been successfully deployed on humpback whales as part of this project during earlier seasons. This was the first season that minke whales were targeted.

I successfully deployed 10 location only, blubber implantable satellite tags on minke whales. The tags were deployed from our standard air-powered gun at ranges from 4-10m. All deployments were from a small rigid-hulled inflatable boat. The tags themselves were a shortened modification of implantable tags we routinely deploy on larger whales such as humpback, blue and southern right whales. They are similar to the type of tags that Bruce Mate deploys.

Drs Robert Pitman and John Durban were also present on Point Sur during our voyage. They were studying killer whales and were deploying a type of dorsal-fin mounted tag that is fired onto the side of the dorsal fin and held in place by two pins which penetrate the cartilage. Dr Durban deployed 3 of these types of tags on minke whales as part of our work. Two of these tags included depth sensors, so also transmitted dive summaries along with position information. The tags were deployed by a cross-bow.

Drs Pitman and Durban had spent some time earlier in the summer in the Ross Sea and had successfully deployed three of these tags on minke whales at that location as well.

Two suction cup mounted tags were also deployed on minke whales. These tags are designed to stay on for a short time (<1 day) and provide dense data on the three dimensional movements of the whale during that period. These data are of sufficient precision to determine when and how often the whale lunge feeds during dives. Contemporaneous with the deployment of these two tags we conducted surveys of the prey-field using scientific echosounders.
Nineteen minke whale biopsies were also collected as part of this work, but many more samples would have been possible if we had assigned more time to this task.

Thus, in total, 18 minke whales were tagged (3 in the Ross Sea, 15 in the Western Antarctic Peninsula) with 4 different types of tags. A further 19 were biopsied.

We found that when the whales were in small groups (the larger the better, but generally >2) and were either feeding or exhibiting some social behaviour, they were relatively easy to approach in a small boat if we took our time. The habitat type was generally open water with ice floes and the weather conditions were calm. These type of conditions and habitat can be encountered throughout Antarctica, and so I believe this work indicates that tagging is practical in most Antarctic areas when the wind is low. During research voyages focusing of humpback and blue whales in East Antarctica, we have shown that launching small boats for tagging work

on the high seas is practical and successful.

The data from the work this summer will be presented to the IWC during the June meeting on Jeju Island, South Korea and will then be published in peer reviewed papers.

With best regards,

Nick

Nick Gales
Chief Scientist
Australian Antarctic Program
