Draft Recovery Plan for the Blue Whale – Revision: ID376

Peer Review Comments

We solicited review of the *Draft Recovery Plan for the Blue Whale (Balaenoptera musculus)* from five potential reviewers. Three people agreed to be reviewers and three provided reviews. Reviewer responses to the terms of reference questions compiled below are not in the order of the reviewer identification list below.

Reviewers (listed alphabetically):

Dr. Trevor Branch
Associate Professor
School of Aquatic and Fishery Sciences, University of Washington

Dr. Asha de Vos
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Dr. Cole Monnahan
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Responses to Terms of Reference Questions

Reviewer #1:

1. *Is the information presented in the background sections accurate and current? If you are aware of additional or more current relevant information, please provide the suggested reference(s) and, if possible, a copy of the paper(s).*

   B.5.1 Feeding and Prey Selection*:* This section only mentions krill as a source of food but the Northern Indian Ocean population is now known to feed on Sergestid shrimp. There is value in adding this research in because it shows the adaptations of these different subspecies in their specific areas (de Vos *et al.* 2018).

   B.5.2 Reproduction: Calving was documented in 1948 in the Trincomalee harbor on the east coast of Sri Lanka (Deraniyagala 1948)

   C. Zoogeography: You can add this paper (de Vos *et al.* 2014) as a reference at the end of the following paragraph in the draft recovery plan:

   "Blue whales avoid the oligotrophic central gyres in the Indian, Pacific, and Atlantic Oceans, but are common where phytoplankton densities are high, and where there are

dynamic oceanographic processes such as upwelling and oceanic fronts (Branch et al. 2007b)."

G.2.2: The recovery plan states "Specifically, most blue whale feed in productive upwelling areas off Somalia and southern Arabia during the southwest monsoon (approximately May-October), while some feed off the southwest coast of India and the west coast of Sri Lanka. The whales then disperse during the northeast monsoon (approximately December-March) to areas such as the east coast of Sri Lanka, west of the Maldives, the Indus Canyon, and parts of the southern Indian Ocean (Anderson et al. 2012)."

There are plenty of records from the south coast during the North-east monsoon. In fact that is the most popular time of year for whale-watching off southern Sri Lanka due to the presence of blue whales. During the south-west monsoon as well there are records of blue whales off southern Sri Lanka that don't seem to be accounted for in this paragraph.

Here are just two references you should add (the first describes the circulation patterns that encourage blue whales to stay on the south coast during the north-east monsoon):

i. de Vos A., Pattiaratchi, C.B. and Wijeratne, E.M.S. (2014*) Surface circulation and upwelling patterns around Sri Lanka,* Biogeosciences Special Issue: Current biogeochemical and ecosystem research in the Northern Indian Ocean, 11: 5909-5930.
ii. de Vos A., Pattiaratchi, C.B. and Harcourt R.G. (2014) *Inter-annual variation in blue whale distribution off southern Sri Lanka between 2011 and 2012*, Journal of Marine Science and Engineering, 2: 534-550.

C. Zoogeography: The recovery plan states 'However, blue whales have been acoustically detected year-round in some locations, suggesting resident populations or portions of populations that do not migrate each year (Stafford et al. 1999a, Širović et al. 2004, Širović et al. 2009, Samaran et al. 2010, Stafford et al. 2011, Samaran et al. 2013).'

Some of the references in the paragraph below should also be included in the above section:

Unlike other blue whale populations, the NIO population does not undertake long-range migrations between cold feeding areas and warm breeding and calving areas, but remains in warm, tropical waters year-round (Alling et al., 1991; de Vos et al., 2012). This subspecies has a restricted range with the Bay of Bengal apart from the southwestern most extent, around the east coast of Sri Lanka. Year-round sightings, photo identification records, and stranding data suggest that at least a portion of this population remains resident within Sri Lankan waters (Afsal et al., 2008; Alling et al., 1991; Branch et al., 2007; de Vos et al., 2012; Deraniyagala, 1948; Ilangakoon, 2006b; Leatherwood & Reeves, 1989)

G.3 Feeding and Prey Selection: The research we conducted on prey in the northern Indian Ocean must be included in this section. Please reference de Vos et al. 2018.

Table 1: Loss of prey base due to climate and ecosystem change

The following paper (linked below) cites that the Indian Ocean has lost 20% of phytoplankton in the last X years – this likely results in a decrease in the species that the blue whales depend on (https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2015GL066979)

H.1.2. Ship strikes: This report (linked below) by Brownell, de Vos and Illangakoon submitted to the IWC in 2017 states that there is not enough data to confirm ship-strike caused death in many cases. There are really only two confirmed cases.

https://arabianseawhalenetworkdotorg.files.wordpress.com/2017/05/sc_67a_him_11_large-whale-entnaglements-from-sri-lanka.pdf

H.1.3. I would add:

"While not quantified a proportion of the blue whales in the population do have entanglement scars or trail some evidence of a net on them. Not all cases appear to be fatal which can be the result of their large size. However, it is clear that entanglement is a threat to these blue whales in Sri Lankan waters."

(please reword – we are waiting to get feedback from members of IWC on whether or not some of the markings we see are in fact entanglement scars).

2. *Does the discussion of potential threats and other stressors accurately consider and reflect the risk to this species?*

   No answer.

3. *Are the management units identified appropriately?*

   No answer.

4. *Do you have any comments or concerns regarding the proposed recovery criteria?*

   No answer.

5. *Do recovery action priorities presented in the plan's Implementation Schedule reflect a biologically sound conservation approach for blue whale recovery?*

   No answer.

6. *Are the proposed research, monitoring, and management recovery actions appropriate and sufficient?*

No answer.

7. *Are there other recovery actions that should be considered for inclusion in the plan?*

   No answer.

Reviewer #2:

1. *Is the information presented in the background sections accurate and current? If you are aware of additional or more current relevant information, please provide the suggested reference(s) and, if possible, a copy of the paper(s).*

   I believe the background information is accurate and current, and have no suggested references to add. Defining appropriate management units is difficult in this case, but the uncertainty is clearly stated and the relevant studies cited. I have no suggestions how to improve these definitions until further research is done.

   At the top of page 14 (E.1) states that blue whales produce two distinct call types and this has been used to distinguish the two populations (ENP vs. WNP). While true, it should be noted that these AB call types are only produced by lone traveling males. Further, there are other call types, such as "D" used during feeding. For the purposes of stock identification I suggest clarifying that you are talking about the AB songs, produced by a subset of the population, and acknowledging the D and other call types produced by blue whales. As stated it sounds like AB are the only songs they make.

   In the paragraph about length frequencies it may be worthwhile to note that Monnahan et al. (2014) found geographic separation by song type was corroborated by length frequencies.

   At the top of p.31 (H.1.2) the Rockwood et al. (2017) is cited as suggesting caution interpreting the results of Monnahan et al. (2015) because they estimated higher rates of ship strikes. However, Monnahan et al. (2015) explored scenarios with higher rates of ship strikes, and an additional sensitivity analysis was conducted for the IWC in 2015 (Monnahan and Branch 2015, SC/66a/IA/15; attached with review and full citation below). I do not contend the results of Rockwood et al. (2017), nor the general warning in this draft review about interpretation. But I do note that the assessment accepted by the IWC was found to be insensitive to much higher levels of ship strikes, among other things, which was not acknowledged by Rockwood et al. in their discussion.

   Monnahan, C. C. and T. A. Branch (2015). Sensitivity analyses for the eastern North Pacific blue whale assessment. Scientific Committee of the International Whaling Commission. SC/66a/IA15.

2. *Does the discussion of potential threats and other stressors accurately consider and reflect the risk to this species?*

   No answer.

3. *Are the management units identified appropriately?*

   No answer.

4. *Do you have any comments or concerns regarding the proposed recovery criteria?*

   The criterion for delisting ENP blue whales is a population size of greater than 2,500. However, based on Monnahan et al. (2015) this might be above the carrying capacity and thus unrealistic.

5. *Do recovery action priorities presented in the plan's Implementation Schedule reflect a biologically sound conservation approach for blue whale recovery?*

   As an assessment modeler, determination of population structure and continued monitoring of abundance trends are the key pieces of information for determining status. As such, I fully support the steps 2 and 3 in the recovery outline.

6. *Are the proposed research, monitoring, and management recovery actions appropriate and sufficient?*

   No answer.

7. *Are there other recovery actions that should be considered for inclusion in the plan?*

   No answer.

Reviewer #3:

1. *Is the information presented in the background sections accurate and current? If you are aware of additional or more current relevant information, please provide the suggested reference(s) and, if possible, a copy of the paper(s).*

I have included a list below of additions or revisions to the various sections of the report.

<u>Page 1:</u>"Pygmy blue whales, a subspecies of blue whales, may only reach 21 m in length when mature." Their maximum recorded body length is 24.2 m (Omura 1984), not 21 m.

<u>Page 1:</u> "At birth, blue whales can be 8 m long". The generally quoted average length at birth is about 7 m for Antarctic blue whales (Mackintosh and Wheeler 1929, page 428).

Page 2: “its pleated throat expands to accommodate the enormous intake of seawater and food”, suggest adding this “its pleated throat expands to accommodate an enormous intake of up to 200 metric tons of seawater and food (Fossette et al. 2017, Fig 5)”.

Section B.5.2: “Blue whales typically reach sexual maturity beginning at an average length of 23 m, which corresponds to between five and ten years of age”. It would be more accurate to say “Female blue whales typically reach sexual maturity beginning at an average length of 19.2-23.5 m depending on the subspecies (Branch & Mikhalev 2008, Mackintosh & Wheeler 1929), at about ten years of age in both males and females (Branch 2008a, Rice 1963, Ohsumi 1979, Valenzuela-Molina et al. 2018).” Recent work based on hormone biopsies, resighting histories, and earplug laminae all conclude that 5 yr is too low, and are consistent with 10 yr being the age at sexual maturity.

Section B.5.2: “with a gestation period lasting approximately ten to twelve months (Christensen et al. 1992).” The citation does not refer to gestation periods. The general understanding is that gestation periods are less than 12 months, best summarized as “10 to 11 months (Mackintosh & Wheeler 1929, p. 428)”

C: “some areas with historical catches show an apparent lack of recovery, including parts of the eastern North Atlantic Ocean (Christensen et al. 1992), western North Pacific Ocean (Forney & Brownell 1996), and eastern South Atlantic Ocean (Branch et al. 2007b).” Lack of recovery can only be inferred from repeated surveys in the same places, especially for populations as depleted as some blue whale populations are. For the population in the North Atlantic, Christensen et al. (1992) notes a 5% rate of increase in Iceland, one place with a time trend of abundance estimates. In the eastern South Atlantic, the population is Antarctic blue whales, which are increasing at 7% per year (Branch 2007).

D.1: there have been some recent photo matches between the Gulf of St. Lawrence and the Azores, suggesting a bit more mingling of eastern and western North Atlantic blue whales. Nothing is published yet though.

D.2: There was a blue whale reported at Cristobal, Panama, that entered the Panama Canal in January 1922 (Harmer 1923).

D.5: “Only nine blue whale calves were observed from 1970 – 1990 along the north shore of the Gulf of St. Lawrence”. This has been updated to 13 blue whale calves from 1979 to 2002 (Ramp et al. 2006).

D.6: Recently, nine blue whales were killed by ice entrapment off Newfoundland, e.g. https://globalnews.ca/news/1261749/heavy-ice-may-have-crushed-9-blue-whales-to-death-off-newfoundland/

E.1: Discovery marks do show links between the western and central North Pacific, and between the Aleutian Islands and Gulf of Alaska, reinforcing the idea that western and central North Pacific blue whales comprise one population (Figure 6, Branch et al. 2018a), although not showing evidence of links with Japan. A large number of marks placed in blue whales off Mexico were not recovered by whalers, operating at the time only in the western

and central North Pacific, adding evidence that eastern North Pacific blue whales are separated from those in the western/central North Pacific (Branch et al. 2018a).

E.2: "and waters off Vancouver Island, Canada (Omura & Ohsumi 1964, Ivashin & Rovnin 1967, Ohsumi & Masaki 1975, Branch & Mikhalev 2008)." Based on acoustic records (Monnahan et al. 2014), satellite tags and photo-id recaptures (Calambokidis et al. 2009), these blue whales are most likely eastern North Pacific blue whales. The citation Branch & Mikhalev (2009) should be removed.

E.5: An addition: Rice (1963) estimated age at first parturition of 9-11 yr and inter-calf intervals based on ovulation rates, of every 2.0-2.4 yr.

E.7: Abundance estimates for Western/Central North Pacific. The IWC's POWER surveys (https://iwc.int/power), and JAPAN's JARPN cruises, will cover almost the entirety of the western/central North Pacific population (Branch et al. 2018a). The JARPN and JARPNII cruises have sighted 374 blue whale schools, many close to Japan, with abundance estimates ranging from 38 to 958 during 2008-2014 (Hakamada & Matsuoka 2016). The POWER cruises sighted 20 blue whales during 2010-2017 covering 170°E to 135°W and 20°N northwards to the Bering Sea, but no abundance estimate is forthcoming yet. Additional surveys of this population are also listed in Branch et al. (2018a).

F.1: The newest genetic data support a single Antarctic blue whale population based on whole genomes (Bell 2018, p. 21-24 report by Attard et al.).

F.2: line 1 Citation should be Branch et al. (2007a, 2007b, 2009).

F.2: "the region off southwest Africa could be a breeding location based on seasonality of Antarctic blue whale historical catches there (Branch et al. 2007a, Branch et al. 2007b), but since the cessation of whaling, there have been only two recorded blue whale sightings there (Branch et al. 2007b)." Since this publication there have been several more unpublished sightings off South Africa, unpublished acoustic detections off South Africa, and some sightings off Angola (Figueiredo & Weir 2014). Perhaps "…there have been few recorded blue whale sightings there (Branch et al. 2007b, Figueiredo & Weir 2014)."

F.2 final paragraph: Most Antarctic blue whales caught in winter shore whaling stations in the SE Atlantic were immature individuals, suggesting the possibility that migrations are age-dependent to some extent (e.g. Mackintosh & Wheeler 1929, Branch et al. 2018b).

F.5: "However, Lockyer (1984) argues that they may reach sexual maturity as young as five years old, which is more consistent with other baleen whales." Thinking has changed so that 10 yr is considered more consistent with other large baleen whales, especially for humpback whales, because it is now accepted that each growth layer in ear plugs represents one year, rather than two being laid down per year. I would suggest deleting ", which is more consistent with other baleen whales." For discussion, see Best (2011).

F.7: Although Branch (2008c) is more recent than Branch et al. (2004), the former is unpublished and (as speaking as the author) contains some assumptions about minimum

possible abundance that have not been verified. It would be better to use the results from the peer-reviewed 2004 paper: "…reduced the population from 239,000 (95% credibility interval 202,000-311,000) in 1904 to a low of 360 (150-840) animals in the early 1970s, which is just 0.15% (0.07-0.29%) of pre-exploitation levels…" and "…estimated to be increasing at a rate of 7.3% per year (95% credibility interval 1.4-11.6%)…". Also, the pre-exploitation year for this population is 1904 and not the 1920s.

G.1: "Australia and New Zealand blue whales are not genetically separated (Sremba et al. 2015)". A new paper outlines the evidence for New Zealand blue whales being a separate population, combining movements, genetics, acoustics, and other evidence, including a significant genetic difference based on mitochondrial DNA (Barlow et al. 2018).

G.2.1: "Pygmy blue whales mainly remain north of the Antarctic Circumpolar Current (55° S) and are most abundant in waters off Australia, Madagascar, and New Zealand (Reilly et al. 2008)." Consider changing to "52-56°S" given the results in Branch et al. (2007a, 2009, 2018b).

G.2.1: New Zealand. Some updating is needed here to reflect the genetic differences between New Zealand and Australia/Indonesia populations, the low genetic diversity within the New Zealand population, and the year-round acoustic presence in New Zealand waters reported in a new paper (Barlow et al. 2018).

G.2.2: "A lack of recent records from the northeast Arabia Sea and north of the Seychelles, however, suggests that whales there may have been extirpated by Soviet whalers in the 1960s (Anderson et al. 2012)." I would suggest deleting this, since there has been no search effort in the NE Arabian Sea. Acoustic recorders off NW Madagascar near the Seychelles found blue whales (Cercio et al. 2018), and it seems likely they are still present given acoustic records in the Indian Ocean (e.g. Samaran et al. 2013).

G.2.3: "The whales then migrate to lower latitude areas including the Galapagos Islands and the Eastern Tropical Pacific (ETP)". Replace the unpublished citation (Hucke-Gaete et al. 2016) with the published version (Hucke-Gaete et al. 2018).

G.2.3: There is a gap between two clusters of sightings in the ETP between 0° and 7°N despite extensive search effort from the SEFSC surveys (Branch et al. 2007b, LeDuc et al. 2016), which likely represents the boundary between the Chilean and NE Pacific populations.

G.3: "*Euphausia vallentini*… and likely peaks in late summer (Croll et al. 2005)" The cited reference does not mention this krill species or region.

G.5: "female pygmy-type blue whales in the Indian Ocean are approximately 19 m and 9.9 years old when sexually mature (Branch et al. 2007a, Branch & Mikhalev 2008)" Change to 18.4-19.9 m, and replace Branch et al. (2007a) with Branch (2008a).

G.7.1: "would yield a maximum of 2,950" should be "would yield a minimum of 2,950".

G.7.1: "The small size of the New Zealand photo-identification catalog precludes development of a mark-recapture abundance estimate at this time (IWC 2016a)." Replace

with “A conservative abundance estimate based on photo-identification mark-recapture is 718 (95% CI 279-1926) (Barlow et al. 2018).”

G.7.1: “Catch records from illegal Soviet whaling throughout the 1960s indicate that more than 12,500 pygmy blue whales were caught in the southern Indian Ocean, indicating a minimum population size for that time period (Branch et al. 2004).” Some of this whaling was legal Japanese whaling, some was in the northern Indian Ocean, and some was from the New Zealand population. A better description would be “Catch records from the northern and southern Indian Ocean through to New Zealand, 97% coming from Japanese and illegal Soviet whaling in the 1960s and early 1970s, indicate that 12,104 (Branch et al. 2018b) or 13,022 (Branch et al. 2008) pygmy-type blue whales were caught in this region, indicating a minimum population size for this region. There is some uncertainty in assigning these catches to individual populations, but preliminary estimates suggest that median catches of 1,228 came from the northern Indian Ocean, plus pygmy-type catches of 6,889 from the south-west Indian Ocean (Madagascar), 3,646 from the south-east Indian Ocean (Australia/Indonesia), and 421 from the south-west Pacific Ocean (New Zealand) (Branch et al. 2018b).”

G.7.1: “It is possible that the current combined estimate of nearly 3,000 whales (see above) represents less than 25% of the historical population size.” to this should be added the New Zealand abundance estimates, thus “Given combined minimum estimates of nearly 3,700 whales for pygmy-type blue whales compared to catches of about 11,000 (see above), current population sizes could be as low as 25-33% of the historical population size under logistic model growth. The New Zealand population is likely to be the least depleted of these three populations.” [Based on a logistic model assuming increase rates of 0-7.3%, with catches taken in 1965 and abundance estimates in 2010. Current abundance likely to be considerably higher given large unsurveyed regions.]

G.7.2: “There is no current abundance estimate for northern Indian Ocean blue whales.” Should be replaced with “The only abundance estimate for northern Indian Ocean blue whales comes from repeated surveys in a 7500 km^2 area south of Sri Lanka in 2014 and 2015, which estimated there to be 270 individuals (CV=0.09, 95% CI 226-322) (Priyadarshana et al. 2016).”

G.7.3: “Chile, Peru, and Ecuador (Williams et al. 2011), with an estimated 4,288 from Chile alone (Branch et al. 2007c).” Replace with “Chile, Peru, and Ecuador, with an estimated 4,288 from Chile alone (Williams et al. 2011).”

G.7.3 and C.1: “while Williams et al. (2011) estimate approximately 2,00-6,200” should be “while Williams et al. (2011, erratum) estimate approximately 1,500-5,000”. Ref: Williams et al. (2017) Erratum Conservation Biology 31:490-491.

G.7.3:“A minimum abundance estimate for the Chiloé Island feeding ground in southern Chile in mid-2008 is 450 animals (CV 0.17) for an open population or 576 (CV-0.16) for a closed population, based on a model that allows for a mixture of resident and transient whales (IWC 2016a).” This should be replaced with “An abundance estimate for the Chiloé

Island feeding ground in southern Chile in 2012 is 762 (95% CI 638-933) based on left side pictures and 570 (95% CI 475-705) animals based on right side pictures, allowing for a mixture of resident and transient whales (Galletti Vernazzani et al. 2017)."

2. *Does the discussion of potential threats and other stressors accurately consider and reflect the risk to this species?*

Yes. The major threat is a resumption of whaling on blue whales. No blue whale has been whaled since 1978. Some nuances are mentioned below.

H.1.1: "although illegal Soviet whaling continued through the 1970s (Yablokov 1994, Mikhalev 2000)." could be modified as follows: "although illegal Soviet whaling continued through to 1973 (Yablokov 1994, Mikhalev 2000), and Spanish whalers caught 11 blue whales after the moratorium, the last in 1978, before becoming IWC members (Aguilar & Sanpera 1982)."

H.1.1: "There is no evidence of illegal whaling of blue whales in recent years." To this could be added ", although a number of blue-fin hybrids have been caught by whalers (e.g. Bérubé & Aguilar 1998), most recently in Iceland in 2018."

H.1.2: "For example, the opening of the Northwest Passage and Northern Sea Route may bring an increase in the volume of vessel traffic through polar waters and corresponding lower latitude waters including the Bering Sea, North Pacific, and North Atlantic Ocean blue whale habitat." Since blue whales are not present in the Northwest Passage, Northern Sea Route or Bering Sea, it is probable that the threat to blue whales would decrease as a result of shipping moving out of areas with higher densities of blue whales.

H.1.2: "However, Rockwood et al. (2017) suggest caution in interpreting these results, since the conclusions of Monnahan et al. (2015) are based on lower numbers of annual ship strikes than were estimated by Rockwood et al. (2017)". Monnahan et al. (2015, Fig. S3) looked at the effects of up to 100 ship strikes per year. At the levels estimated by Rockwood of 18-40 ship strikes per year, Monnahan et al. (2015, Fig. S3) conclude that the population on average would be at 85-95% of pre-whaling levels in 2050.

H.1.4.3: Missing here is discussion of the effects of seismic air guns on food for blue whales. McCauley et al. (2017) found a widespread lethal zone around air guns for zooplankton. This could greatly reduce food availability for blue whales in regions close to seismic exploration and have population-level effects on abundance.

H.2.2: Missing from here is the mass mortality event that killed 343 sei whales in southern Chile and has been blamed on harmful algal blooms (Häussermann et al. 2017). The region of interest is just south of the major feeding grounds of Chilean blue whales around Chiloe Island and potentially a major concern for blue whales.

H.2.4: While I agree with the sentiment that the benefits of research far outweigh risks to the population, there are two instances where caution is advised: (1) satellite tagging can occasionally harm whales, for example the recent death of a killer whale in Washington state

that had been tagged. (2) Scientific whaling is allowed by the charter of the IWC, and could be used by member nations to bypass the moratorium on catching blue whales.

3. Are the management units identified appropriately?

There is substantial uncertainty and debate among scientists about the most appropriate classification of blue whale populations and subspecies, which is reflected in the Draft Recovery Plan. I agree with the designation of populations, although it can be debated whether northern Indian Ocean blue whales or Chilean blue whales should be regarded as separate subspecies; similarly, North Pacific and North Atlantic Ocean blue whales are unlikely to be the closely related despite being regarded as the same subspecies. Further notes follow.

Management Units are defined on page vii and section G.1, and reflect the most up to date knowledge for subspecies and population boundaries. However, there has been a recent move (e.g. Branch et al. 2018, Širović et al. 2018) to name the populations in the Southern Hemisphere by ocean region and not country name, as for Northern Hemisphere populations, i.e. Northern Indian Ocean, Southwest Indian Ocean, Southeast Indian Ocean (i.e. Indonesia, western and southern Australia), Southwest Pacific (i.e. New Zealand, Pacific islands, eastern Australia) and Southeast Pacific (i.e. Chile/Peru/Galapagos). See Fig. 8 from Branch et al. (2018) below.

The biggest question mark for nomenclature is whether northern Indian Ocean blue whales are distinct enough to qualify as a separate subspecies from pygmy blue whales in the southern Indian Ocean through to the southwest Pacific Ocean. There is little evidence for morphological or genetic differences between these two regions.

4. Do you have any comments or concerns regarding the proposed recovery criteria?

The criteria for minimum abundance need adjusting for the Eastern North Pacific, where the pre-whaling population is estimated to be 2,200 (95% interval of 1,800-3,700 individuals, Monnahan et al. 2015). According to the criteria in section C.1, since the pre-whaling level is less than 2,500, downlisting should be at 500 and delisting at 1000 individuals. This seems an arbitrary jump in thresholds as prewhaling abundance declines from 2501 to 2499 individuals. It would be better to set downlisting at a percentage of pre-whaling abundance, e.g. 50% or 60%, and delisting at a higher percent, e.g. 80%. For eastern North Pacific these levels would correspond to 1,100 for downlisting and 1,700 for delisting, rather than the 2,000 for downlisting and unattainable 2,500 for delisting for this population.

Similarly, for Antarctic blue whales, downlisting at 2,000 whales and delisting at 2,500 whales is inappropriate. This was by far the largest of all populations, numbering 239,000 before whaling (Branch et al. 2004), and 90% of all historical catches (346,000) came from this population (Branch et al. 2008). Furthermore, this population remains by far the most genetically diverse (e.g. Sremba et al. 2012). Under the recommendations, they would be

delisted after reaching just more than 1% of pre-whaling abundance. If instead, the 50%/80% guideline was used, downlisting would be at 120,000 and delisting at 190,000 individuals.

The minimum and delisting abundance thresholds for the other populations seem reasonable given historical catches and best estimates for current abundance levels, but should be revisited as assessments are conducted for each population.

C.1: "Pre-exploitation abundance estimates for (b) Eastern North Pacific (2,210 individuals, 95% Bayesian credible interval 1,823-3,721; Monnahan et al. 2015) and (h) Chilean (2,100-3,600 individuals, Jackson 2016; or 2,000-6,200 individuals, Williams et al. 2011) management units are not clearly above the 2,500 threshold, but catch information supports applying this higher threshold. In the Eastern North Pacific, an estimated 3,411 whales (95% range 2,593-4,113, (Monnahan et al. 2015) were caught from 1905-1971, while 4,288 were caught off Chile from 1908-1967 (Williams et al. 2011)." Given that an assessment estimate of pre-whaling numbers is available that already account for historical catches, the last part of this section of text should be deleted. The Eastern North Pacific is below 2,500. However, since Chilean blue whale current abundance is a minimum estimate, the pre-whaling abundance is going to be higher than the assessment estimates, and it is appropriate to use 2,000/2,500 as a basis for downlisting/delisting. Given this, I suggest the following text for the C.1 section: "Pre-exploitation abundance estimates for (b) Eastern North Pacific (2,210 individuals, 95% Bayesian credible interval 1,823-3,721; Monnahan et al. 2015) are below 2,500 and warrant using a lower threshold. For (h) Chilean blue whales, pre-exploitation abundance (2,100-3,600 individuals, Jackson 2016; or 1,500-5,000 individuals, Williams et al. 2011 erratum) is a minimum estimate and most of the estimate falls above 2,500. Therefore 2,000/2,500 should be used for downlisting/delisting of Chilean blue whales."

C.1: "There are no estimates of pre-exploitation abundance for blue whales around (g) New Zealand, but Brownell et al. (2015) suggest that Soviet catches might provide a minimum estimate, since most of the catches were made during a relatively short period of time. Catches appear to be less than 2,500 individuals, based on data presented in Branch et al. (2007b)." This needs updating given recent information to the following: "There are no estimates of pre-exploitation abundance for blue whales around (g) New Zealand, but an estimated minimum current abundance of 718 (95% CI 279-1926) (Barlow et al. 2018) combined with relatively low historical catches of 421 in all years (Branch et al. 2018), suggests pre-exploitation abundance was likely well below 2,500."

C.1: "the minimum abundance thresholds themselves are not linked to historical abundance." For reasons discussed above, this decision is capricious. On this basis, Antarctic blue whales (currently at 1-2% of historical levels) are likely to be delisted completely, while eastern North Pacific blue whales (at 97% of historical levels) but at less than 2,500 individuals, will remain listed.

5. *Do recovery action priorities presented in the plan's Implementation Schedule reflect a biologically sound conservation approach for blue whale recovery?*

   Yes.

6. *Are the proposed research, monitoring, and management recovery actions appropriate and sufficient?*

   Under Table 2, item 3.2 I am concerned that insufficient money is budgeted for surveys, which are quite expensive.

7. *Are there other recovery actions that should be considered for inclusion in the plan?*

   Under item IV B 3.0-3.3 there is no mention of population assessment models which are vital to estimate past, present, and future abundance trends. These models account for all information (catches, abundance, biological parameters) to determine what the pre-exploitation abundance is, and what the most likely current abundance is, plus account for associated uncertainty. Assessment models are also key to understanding whether human-induced mortality such as ship strikes and fishing gear entanglement threaten blue whale populations, as mentioned in section 5.2.4. Plans to include them are missing from the recovery plan and should be added as a new item 3.4, with budgetary implications.

<u>Editorial Comments</u>

Reviewer #1

The reviewer did not provide any editorial comments.

Reviewer #2

The reviewer did not provide any editorial comments.

Reviewer #3

Overall, most editorial comments focused on providing minor clarifications, additional information and corrections to certain pieces of information throughout the document, including potential typos, grammar corrections, corrections to citations, suggestions on use of specific Figures, etc.

Page 3, last paragraph:
"recently recognized, unnamed subspecies that generally occurs off Chile in". This subspecies annually migrates to waters off Peru, Ecuador and up to the Galapagos Islands (e.g. Hucke-Gaete et al. 2018), and is perhaps best called the Southeast Pacific blue whale.

Page 5, first paragraph:
"NMFS recognizes three stocks in United States waters: the western North Atlantic Ocean and the central and eastern North Pacific Ocean stocks". Should be "NMFS recognizes three stocks in United States waters: the western North Atlantic Ocean, the

western and central North Pacific Ocean stock, and the eastern North Pacific Ocean stock".

Page 6, second paragraph:
"Weaning likely occurs six to seven months after birth en route to, or after whales arrive at, summer feeding areas (Reeves et al. 1998)." The citation here should be to Mackintosh & Wheeler (1929) and not a secondary source.

Figure 1:
An alternative map projection would bring the size of the polar regions more in line with other parts of the globe.

Page 7, second paragraph:
"throughout the entire the North Atlantic Ocean" remove the second occurrence of "the".

Page 14, third paragraph:
add a citation to Monnahan et al. (2014, Fig 14) who found that mature female eastern north Pacific blue whales are shorter by 0.91 m on average than the western/central North Pacific population.

Page 15, first paragraph:
"where they seasonally overlap with the central North Pacific stock". It would be a good idea to standardize terminology to western/central North Pacific throughout the report.

Page 16, first paragraph:
"others years" should be "other years".

Page 18, lines 1-3:
Should be changed to "North Pacific blue whales was estimated to range from 0.93 – 0.95 (Ohsumi & Wada 1974), which is lower than that of blue whales in the North Atlantic and Indian Oceans (Branch 2008a, Branch 2008b, Ramp et al. 2006)."

Page 20, line 3:
Add reference to Branch et al. (2007b, Fig 8-9, Appendix 4).

Page 22, second paragraph:
Last sentence needs rewording for grammar.

Page 26, line 2-3:
Should be "Antarctic blue whale calls have been acoustically detected in the ETP"

Page 30, third paragraph:
"(Priyadarshana et al. 2015)2016 #855}(Priyadarshana et al. 2015)" should be "(Priyadarshana et al. 2015)"

Page 39, second paragraph:
"(U.S. Department of the Navy 2008)" should be deleted, seems out of place.

Page 48, second paragraph:
"(SPLASH, (Calambokidis et al. 2008a) Year of the North Atlantic Humpback, (Palsbøll et al. 1997, Smith et al. 1999)" needs editing.