Report of the Scientific Committee

Nairobi, Kenya, 10-23 May 2019

Annex D

Report of the Sub-Committee on *Implementation Reviews* and *Simulation Trials*

This report is presented as it was at SC/68A.
There may be further editorial changes (e.g. updated references, tables, figures) made before publication.

International Whaling Commission

Nairobi, Kenya, 2019

Annex D

Report of the Sub-Committee on *Implementation Reviews* and *Simulation Trials*

Members: Donovan (Convenor): Allison, Aoki, Baba, Bironga, Bjørge, Buss, Butterworth, de Moor, Debrah, Fujise, Givens, Goodman, Goto, Hakamada, Haug, Hoelzel, Hosoda, Iñíguez, Jimenez, Kim, Kishiro, Kitakado, Lang, Lee, Lent, Lundquist, Mallette, Matsuoka, Miyashita, Morishita, Morita, Moronuki, Mueni, Mwabili, Nelson, Nio, Øien, Palka, Pastene, Punt, Reeves, Sohn, Suydam, Suzuki, Taguchi, Takahashi, Tiedemann, Walløe, Weller, Wilberg, Witting, Yasokawa, Yoshida, Zerbini.

1. INTRODUCTORY ITEMS

1.1 Convenors' opening remarks
Donovan welcomed the participants. He noted that this is a new sub-committee. The main work of the Standing Working Group on the Aboriginal Whaling Management Procedure (AWMP SWG) was completed last year. That, and the fact that the work, and personnel, of the AWMP SWG and the previous sub-committee on the Revised Management Procedure were very similar, led to the decision to form a new sub-committee combining much of the work of those two groups. This sub-committee will therefore deal with quantitative matters dealt with by both the old RMP sub-committee and the AWMP SWG, including:

(1) general assessment and modelling issues;
(2) RMP and AWMP *Implementation Reviews*;
(3) the finalisation of the East Greenland *SLA* for common minke whales*;* and
(4) any remaining quantitative matters from carryover and interim relief simulations as part of the Aboriginal Whaling Scheme.

1.2 Chair and rapporteurs
Donovan was elected Chair; Punt acted as the rapporteur.

1.3 Adoption of Agenda
The adopted Agenda is shown in Appendix 1.

1.4 Available documents
The documents considered by the sub-committee were SC/68A/IST/01-04, and SC/68A/Rep/04.

2. GENERAL ASSESSMENT AND MODELLING ISSUES

2.1 Evaluate the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
MSYR is a key parameter in the *Implementation Simulation Trials* used to evaluate the conservation and catch performance of alternative RMP and AWMP variants for specific species and regions. In recent years, the Committee has been reviewing progress on an individual based energetics model (IBEM) to provide insights into the relationship between $MSYR_{1+}$ and $MSYR_{mat}$. Last year, the Committee established a workplan to continue to develop a model to emulate the IBEM and compare yield from the IBEM and the emulator model. The results of this work are expected to lead to guidelines for how to use an emulator model as the basis for a multi-stock, multi-area population dynamics model and how such a model could be conditioned given available data. However, no papers on this topic were presented to the Committee this year. The sub-committee **agreed** that the workplan from last year would be carried forward to 2020 and looked forward to new papers on this important topic.

Attention: SC
*The sub-committee **agrees** that work continue to: (a) develop an emulator model; (b) assess whether it is possible to represent the trajectories from the IBEM using an emulator model;(c) compare the yield curves from the IBEM with those from the emulator model; and (d) develop guidelines for how to use an emulator model as the basis for a multi-stock, multi-area population dynamics model and how such a model could be conditioned given available data.*

2.2 Implications of *IST*s for consideration of species' and populations' status
During the 2017 meeting, the Committee had agreed that the results of a set of *Implementation Simulation Trials* should be summarised using three statistics to provide information on status (IWC, 2018a, p.44). The question of

providing information on status was primarily covered this year by the Standing Working Group on abundance estimates, stock status and international cruises (ASI SWG). They examined initial results for two cases and on this basis revised the proposed summary statistics and other information that needs to be provided for the Committee to develop consistent broad information on status (see Annex Q Item y) as detailed in the recommendation below. This information will be provided for the whole Regions and for stocks and areas as requested by the Committee.

Attention: SC
In order to provide the information necessary to allow the Committee to provide a summary of the status of populations considered in the context of the RMP or the AWMP, it was ***agreed*** *that Allison and Punt should modify the control programs used for* Implementation Simulation Trials *to report the following:*
(1) current depletion (number of animals aged 1 and older relative to 1+ carrying capacity);
(2) current 1+ abundance; and
(3) a plot of the time-trajectory of historical 1+ abundance (median and 90% intervals).
The work conducted intersessionally will be reviewed at SC68B.

2.3 Progress on previous recommendations and on the workplan
Progress relative to evaluating the energetics model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$ and the use of *Implementation Simulation Trials* to evaluate status are summarised under Items 2.1 and 2.2. Last year, the Committee had suggested some possible additional work with respect to changes to specifications to the model in [SC/67B/RMP03] to further investigate the levels of information collected during Special Permit programmes needed to show improved management performance. No papers were received on this topic this year [in light of discussions under plenary Item 19 it was not added to the workplan for next year.

2.4 Work plan 2020-21

Table 1

Work plan for general assessment and modelling issues

Topic	Intersessional 2019/20	2020 Annual Meeting (SC/68B)	Intersessional 20/21	2021 Annual meeting(SC/69a)
Item 2.1: Work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$	(a) Continue to assess whether it is possible to represent the trajectories from the IBEM using the emulator model (de la Mare); (b) Compare the yield curves from the IBEM with those from the emulator model (de la Mare); and (c) Develop guidelines for how to use an emulator model as the basis for a multi-stock, multi-area population dynamics model and how such a model could be conditioned given available data (de la Mare).	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$	Conduct follow-up analyses	Continue to work to evaluate the energetics-based model and hence the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
Item 2.2: Use of ISTs for consideration of status	Modify control programs used for *Implementation Simulation Trials* to report the three measures of status (Allison & Punt)	Review the work conducted.		

3. RMP *IMPLEMENTATION*-RELATED MATTERS

3.1 Completion of the *Implementation Review* of western North Pacific Bryde's whales
The *Implementation Simulation Trials* (Appendix 2) for North Pacific Bryde's whales are based on sub-areas 1 and 2 of the western North Pacific (Fig. 1). The trials consider two general stock structure hypotheses (Fig. 2):

(1) Stock structure hypothesis 2. There are two stocks of Bryde's whales. One stock is found in sub-area 1 and the other is found in sub-area 2.

(2) Stock structure hypothesis 5. There are two stocks of Bryde's whales. One stock is found in sub-areas 1W and 1E while the other is found in sub-areas 1E and 2. Sub-area 1E is a region of mixing.

Allison reported that she and de Moor had run all of the trials and had run the 'equivalent single-stock trials' that are needed to apply the 'Requirements and Guidelines for Implementations under the Revised Management Procedure (RMP)' to determine the acceptable variants (see IWC, 201.

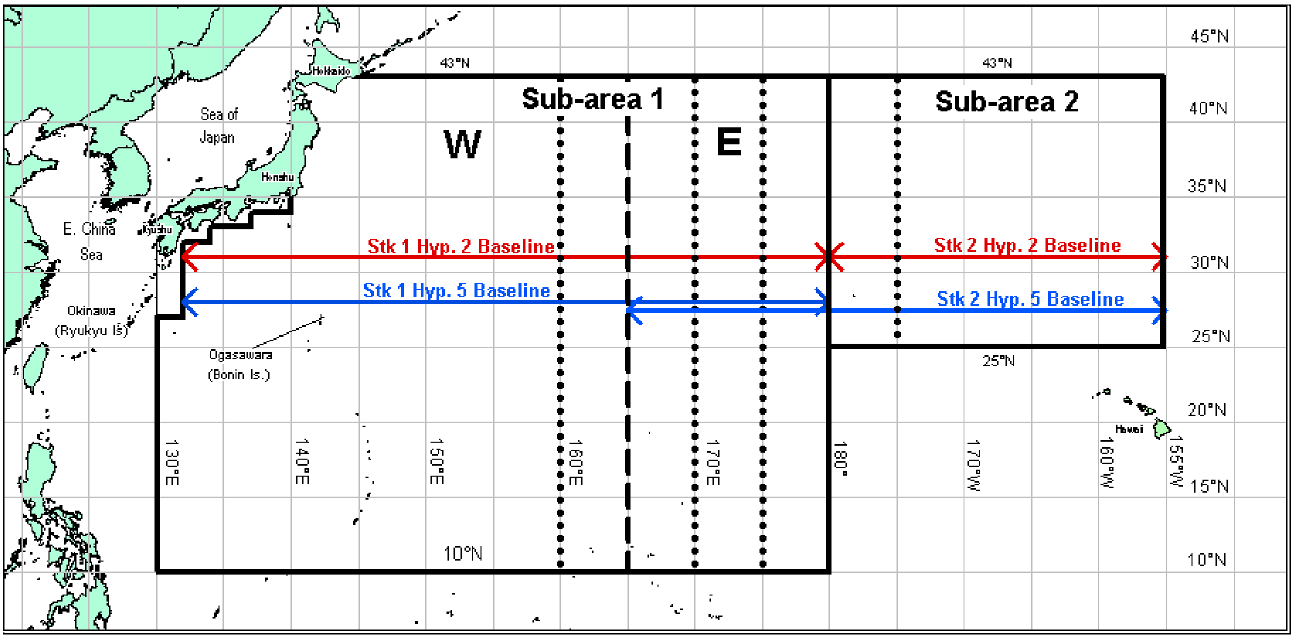

Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales. The ranges of the stocks for Hypotheses 2 and 5 (baselines) are also shown. The boundary between the sub-areas 1W and 1E at 165°E, indicated by a dashed line, is a management boundary (used by the RMP). The dotted lines at 160°E, 170°E, 175°E and 175°W denote the boundaries between the "Component-areas" and are used for trials in which the true boundary between the stocks differs from the boundary on which the RMP is based. The staggered border to the south of Japan is used to ensure that no catches of the inshore form of Bryde's whales are included in these trials.

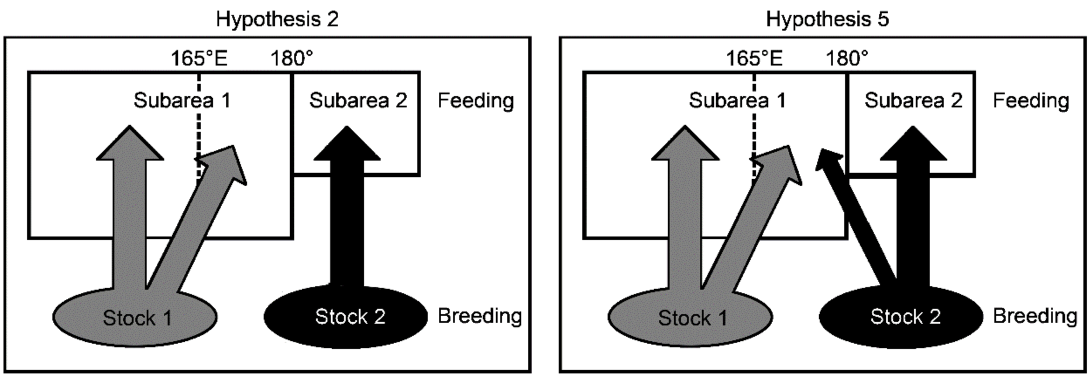

Fig. 2 The two hypotheses considered in the *Implementation Simulation Trials*

3.1.1 Results of trials

The Committee had agreed that the *Implementation Simulation Trials* listed in Table 2 should be run for two potential future survey strategies (shown in Table 3).

Table 2

The *Implementation Simulation Trials* for the Western North Pacific Bryde's whales. Note that all 1% trials were considered medium plausibility. The remaining trials were high plausibility

Trial	Stock structure hypothesis	MSYR[1]	Additional variance	Catch series	Western boundary of Stock 2	Eastern boundary of Stock 1	Comment
Br1-1	2	1	Baseline	Best	180°	180°	Baseline stock structure hypothesis 2
Br1-4	2	4	Baseline	Best	180°	180°	Baseline stock structure hypothesis 2
Br2-1	5	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br2-4	5	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br3-1	5	1	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br3-4	5	4	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br4-1	5	1	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br4-4	5	4	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br5-1	5	1	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br5-4	5	4	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br6-1	2	1	Baseline	Best	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
Br6-4	2	4	Baseline	Best	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
Br7-1	5	1	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br7-4	5	4	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br8-1	5	1	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br8-4	5	4	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br9-1	2	1	Baseline	Best	180°	180°	Density-dependent *M*
Br9-4	2	4	Baseline	Best	180°	180°	Density-dependent *M*
Br10-1	5	1	Baseline	Best	165°E	180°	Density-dependent *M*
Br10-4	5	4	Baseline	Best	165°E	180°	Density-dependent *M*

[1]MSYR=1% is related to the 1+ component; MSYR =4% is related to mature component
[2] Based on alternative mixing proportion data

Table 3
Sighting survey plan. All surveys are conducted in July-August.

Season	Option 1 130°-165°E	Option 1 165°E-180°	Option 1 180°-160°W	Option 2 130°-140°E	Option 2 140°-152.5°E	Option 2 152.5°-165°E	Option 2 165°E-180°	Option 2 180°-160°W
Sub-Area	1W	1E	2	1W	1W	1W	1E	2
2017								
2018								
2019								
2020	Yes			Yes				
2021					Yes			
2022		Yes				Yes		
2023							Yes	
2024			Yes					Yes
2025				Yes				
2026	Yes				Yes			
2027						Yes		
2028		Yes					Yes	
2029								Yes
2030			Yes	Yes				
2031					Yes			
2032	Yes					Yes		
and so on in this pattern								

3.1.1.1 EVALUATION OF RMP VARIANTS: OVERVIEW OF PROCEDURE TO FOLLOW

The procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance agreed by the Committee (IWC, 2012a) involves conducting the following steps for each stock (or sub-stock) in an *Implementation Simulation Trial*.

(1) Construct a single stock trial, which is 'equivalent' to the stock. For example, if a particular stock in the *Implementation Simulation Trial* involved carrying capacity halving over the 100-year projection period, the 'equivalent single stock trial' will also involve carrying capacity halving over the next 100 years.

(2) Conduct two sets of 100 simulations based on this single stock trial in which future catch limits are set by the *CLA*. The two sets of simulations correspond to the 0.60 and 0.72 tunings of the *CLA*. Rather than basing these calculations on a single initial depletion, the simulations for each stock shall be conducted for the distribution of initial depletions for the stock concerned in the *Implementation Simulation Trial* under consideration.

(3) The cumulative distributions for the final depletion and for the minimum depletion ratio (the minimum over each of the 100-year projections of a trial of the ratio of the population size to that when there are only incidental catches) shall be constructed for each of these two tunings of the *CLA*.
(4) The lower 5%-ile of these distributions shall form the basis for determining whether the performance of the RMP (i.e., the RMP variant under consideration) for the *Implementation Simulation Trial* is 'acceptable' - A, 'borderline' - B or 'unacceptable' - U, as follows:
    (a) if the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than for the equivalent single stock trial with the 0.72 tuning of the *CLA* (or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than 0.999), the performance of the RMP variant shall be classified as 'acceptable';
    (b) if performance is not 'acceptable' and either the 5%-ile of the final depletion or the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* is greater than for the equivalent single stock trial with 0.60 tuning of the *CLA*, the performance of the RMP variant shall be classified as 'borderline'; and
    (c) if performance is neither 'acceptable' nor 'borderline' and if the 5%-ile of the final depletion and the 5%-ile of the minimum depletion ratio for the *Implementation Simulation Trial* are less than those for the equivalent single stock trial with 0.60 tuning of the *CLA*, then performance of the RMP variant shall be classified as 'unacceptable'.

If the performance for a small number of medium weight trials is 'borderline' but close to 'acceptable', then performance of the variant can be considered 'acceptable without research'. A flow chart summarising the decision process that should be followed is given as Fig. 3.

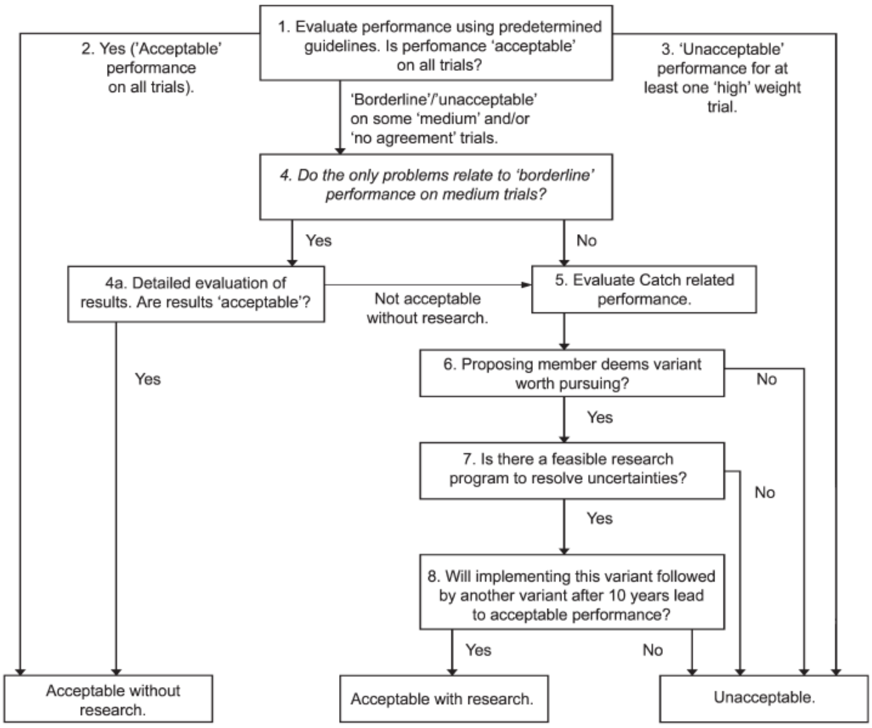

Fig. 3. Flowchart summarising the procedure for review of ISTs (from IWC, 2005).

The sub-committee reviewed the results of the *Implementation Simulation Trials* based on the above guidance and experience gained during recent *Implementations* and *Implementation Reviews*. Summary tables are provided below for each trial and RMP variant[1].

(1) A table showing for each RMP variant: the average over the trials of the lower 5%-ile, and median of catch in total and for sub-area 1W for the first 10 years of the projection period and over the entire projection period and a summary of the application of the procedure for defining 'acceptable' - A, 'borderline' - B and 'unacceptable' - U performance (Table 4).

[1] The master set of plots and tables is archived by the Secretariat and available to members of the Scientific Committee on request.

(2) A table showing the detailed results for each trial and RMP variant. The following information is included in this table:
    (a) median catch over the entire projection period and median and lower 5%-ile over the first 10 years;
    (b) lower 5%-ile and median of the final depletion distribution (by stock);
    (c) lower 5%-ile and median of the minimum depletion ratio distribution (by stock); and
    (d) lower 5%-ile and median of the initial depletion distribution (by stock).

    This table also includes the values for the thresholds for each performance statistic and stock for the trials and the outcomes of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance.

3.1.1.2 EVALUATION OF RMP VARIANTS: REVIEW TRIAL RESULTS

The five management variants to be considered were as follows:

(1) V1 Sub-areas 1W, 1E and 2 are *Small Areas* and catch limits are set by *Small Area*.
(2) V2 Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area.* For this management option, all of the future catches in sub-area 1 are taken from sub-area 1W.
(3) V3 Sub-area 2 is taken to be a *Small Area* and sub-area 1 is taken to be a *Combination area*. Sub-areas 1W and 1E are *Small Areas*, with catch-cascading applied.
(4) V4 Sub-area 1W is taken to be a *Small Area* and sub-areas 1E and 2 (combined) are taken to be a *Combination Area*. Sub-areas 1E and 2 are *Small Areas*, with *catch-cascading* applied.
(5) V5 Sub-areas 1 and 2 (combined) are taken to be a *Combination area*. Sub-areas 1W, 1E and 2 are *Small Areas*, with *catch-cascading* applied.

Projections were originally conducted for four assumptions regarding how future surveys are conducted (and see Table 3):

(1) 1_10: Survey option 1 with surveys in sub-areas 1W and 1E conducted south to 10˚N
(2) 1_20: Survey option 1 with surveys in sub-areas 1W and 1E conducted south to 20˚N
(3) 2_10: Survey option 2 with surveys in sub-areas 1W and 1E conducted south to 10˚N
(4) 2_20: Survey option 2 with surveys in sub-areas 1W and 1E conducted south to 20˚N

Japan indicated that based on logistical considerations and the results of preliminary analyses, it only wished to consider assumptions 1_20 and 2_20.

There are a number of possible scenarios to consider when evaluating the trials, and it is at this stage that a degree of judgement is required, including consideration of the overall balance of the trials and the characteristics of the specific trials for which performance is questionable. The conservation performance of the RMP variants is evaluated for trials with $MSYR_{1+}$=1% i.e. the 'Medium' plausibility trials since the performance on the 4% $MSYR_{mat}$ trials was satisfactory. Table 5 summarises the application of the rules for evaluating conservation performance discussed above. The sub-committee noted that:

(1) only variant 1 for the 2_20 survey assumption achieves 'acceptable' performance for all trials (step 1) but that none of the remaining RMP variants performed 'unacceptably' on a 'high' weight trial so step 4 of the flowchart is applied;
(2) after considering the conservation performance for each variant for each borderline trial in detail, conservation performance was only marginally different from 'acceptable' in each case (Fig. 4).

3.1.2 Recommendations for acceptable variants

Based on the results of the *Implementation Simulation Trials*, variants 1, 2, 3, 4 and 5 for survey options 1_20 and 2_20 are acceptable in terms of conservation performance and thus 'acceptable without research'. Of these variants, variants 2 and 5 achieve the best performance in terms of catch (the former for sub-area 1W and the latter for sub-area 5 (Table 4).

The sub-committee noted the considerable work that has been undertaken to complete the *Implementation Review*, which involved revising the stock structure hypotheses and hence the *Implementation Simulation Trials*. The collaborative nature of this work was acknowledged. The sub-committee particularly recognised the work of Allison, de Moor, and Punt who coded and ran the trials and Donovan who led this *Implementation Review*.

Attention: Commission

The sub-committee ***advises*** *the Committee that this concludes its work on the* Implementation Review *for western North Pacific Bryde's whales. Variants 1, 2, 3, 4 and 5 for survey options 1_20 and 2_20 are acceptable in terms of conservation performance. Of these variants, variants 2 and 5 achieve the best performance in terms of catch.*

Table 4
Summary of the conservation and annual average catch performance of the five RMP variants for the Western North Pacific Byde's whales

Var	Option	Number of Trials			Total catch All years		1W catch All years		Total catch 1 st 10yr		1W catch 1 st 10yr	
		Acceptable	Borderline	Unacceptable	5%	Med	5%	Med	5%	Med	5%	Med
V1	1_20	9	1	0	94	130	16	45	64	76	18	30
V1	2_20	10	0	0	99	136	19	49	60	82	14	37
V2	1_20	9	1	0	92	138	71	111	120	120	109	109
V2	2_20	4	6	0	103	151	74	127	120	120	109	109
V3	1_20	9	1	0	93	138	34	62	119	119	63	71
V3	2_20	8	2	0	103	151	41	72	119	119	57	72
V4	1_20	5	5	0	103	143	16	45	90	102	18	30
V4	2_20	5	5	0	109	148	19	48	86	108	14	37
V5	1_20	9	1	0	100	155	42	69	151	152	72	82
V5	2_20	4	6	0	109	165	48	76	151	152	65	83

Table 5
Summary statistics for the *Implementation Simulation Trials*. The catches are reported as annual averages.

Trial	Var	Option	Total catch All years		1W catch All years		Total catch 1 st 10yr		1W catch 1 st 10yr		P final		P min		Combined		All
			5%	Med	5%	Med	5%	Med	5%	Med	S1	S2	S1	S2	S1	S2	
BR01-1	V1	1_20	94	128	15	44	64	76	18	30	A	B	A	B	A	B	B
BR01-1	V2	1_20	91	136	70	110	120	120	109	109	A	B	A	B	A	B	B
BR01-1	V3	1_20	91	136	33	61	119	119	63	71	A	B	A	B	A	B	B
BR01-1	V4	1_20	103	141	15	43	90	102	18	30	A	B	A	B	A	B	B
BR01-1	V5	1_20	99	153	41	67	151	152	72	82	A	B	A	B	A	B	B
BR01-1	V1	2_20	98	135	18	48	60	82	14	36	A	A	A	A	A	A	A
BR01-1	V2	2_20	103	151	75	127	120	120	109	109	A	A	B	A	A	A	A
BR01-1	V3	2_20	102	151	41	70	119	119	57	72	A	A	B	A	A	A	A
BR01-1	V4	2_20	107	147	18	47	86	108	14	36	A	B	A	B	A	B	B
BR01-1	V5	2_20	108	164	47	75	151	152	65	83	B	B	B	B	B	B	B
BR02-1	V1	1_20	93	128	16	45	64	75	18	30	A	A	A	A	A	A	A
BR02-1	V2	1_20	91	136	70	109	120	120	109	109	A	A	A	A	A	A	A
BR02-1	V3	1_20	92	136	34	61	119	119	63	71	A	A	A	A	A	A	A
BR02-1	V4	1_20	103	142	15	44	90	102	18	30	A	B	A	B	A	B	B
BR02-1	V5	1_20	99	153	41	67	151	152	72	82	A	A	A	A	A	A	A
BR02-1	V1	2_20	98	135	19	48	60	82	14	37	A	A	A	A	A	A	A
BR02-1	V2	2_20	103	151	74	126	120	120	109	109	B	A	B	A	B	A	B
BR02-1	V3	2_20	103	151	41	72	119	119	57	72	A	A	B	A	A	A	A
BR02-1	V4	2_20	108	147	19	48	86	109	14	37	A	B	A	B	A	B	B
BR02-1	V5	2_20	108	164	47	76	151	152	65	83	B	B	B	B	B	B	B
BR03-1	V0	1_20	0	0	0	0	0	0	0	0							
BR03-1	V1	1_20	91	125	15	43	63	76	18	30	A	A	A	A	A	A	A
BR03-1	V2	1_20	89	133	67	106	120	120	109	109	A	A	A	A	A	A	A
BR03-1	V3	1_20	89	133	32	59	119	119	63	71	A	A	A	A	A	A	A
BR03-1	V4	1_20	99	138	14	42	90	102	18	30	A	B	A	B	A	B	B
BR03-1	V5	1_20	95	149	40	66	151	152	72	82	A	A	A	A	A	A	A
BR03-1	V1	2_20	96	132	17	46	60	81	14	36	A	A	A	A	A	A	A
BR03-1	V2	2_20	99	146	70	121	120	120	109	109	B	A	B	A	B	A	B
BR03-1	V3	2_20	99	146	39	69	119	119	57	72	A	A	A	A	A	A	A
BR03-1	V4	2_20	105	144	17	46	86	108	14	36	A	B	A	B	A	B	B
BR03-1	V5	2_20	105	159	45	73	151	152	65	83	A	B	B	B	A	B	B
BR04-1	V0	1_20	0	0	0	0	0	0	0	0							
BR04-1	V1	1_20	98	134	18	48	64	76	18	31	A	A	A	A	A	A	A
BR04-1	V2	1_20	97	142	75	116	120	120	109	109	A	A	A	A	A	A	A
BR04-1	V3	1_20	97	143	36	65	119	119	64	72	A	A	A	A	A	A	A
BR04-1	V4	1_20	109	148	17	47	90	103	18	31	A	B	A	B	A	B	B
BR04-1	V5	1_20	104	161	44	72	151	152	72	82	A	A	A	A	A	A	A
BR04-1	V1	2_20	105	142	22	54	60	82	14	37	A	A	A	A	A	A	A
BR04-1	V2	2_20	109	158	81	135	120	120	109	109	B	A	B	A	B	A	B
BR04-1	V3	2_20	109	158	45	78	119	119	57	72	B	A	B	A	B	A	B
BR04-1	V4	2_20	114	154	21	53	86	109	14	37	A	B	A	B	A	B	B
BR04-1	V5	2_20	115	172	51	81	151	152	65	83	B	B	B	B	B	B	B
BR05-1	V0	1_20	0	0	0	0	0	0	0	0							
BR05-1	V1	1_20	96	139	19	51	61	76	16	31	A	A	A	A	A	A	A
BR05-1	V2	1_20	98	150	76	124	120	120	109	109	A	A	A	A	A	A	A
BR05-1	V3	1_20	98	150	36	69	119	119	62	72	A	A	A	A	A	A	A
BR05-1	V4	1_20	106	154	19	51	88	103	16	31	A	A	A	B	A	A	A
BR05-1	V5	1_20	105	169	42	76	151	152	70	83	A	A	A	A	A	A	A
BR05-1	V1	2_20	100	138	19	48	60	82	14	37	A	A	A	A	A	A	A

BR05-1	V2	2_20	102	153	73	129	120	120	109	109	A	A	A	A	A	A	A
BR05-1	V3	2_20	101	154	40	71	119	119	57	72	A	A	A	A	A	A	A
BR05-1	V4	2_20	112	152	18	48	86	109	14	37	A	A	A	A	A	A	A
BR05-1	V5	2_20	113	167	47	76	151	152	65	83	A	A	A	A	A	A	A

Trial	Var	Option	Total catch All years		1W catch All years		Total catch 1 st 10yr		1W catch 1 st 10yr		P final		P min		Combined		All
			5%	Med	5%	Med	5%	Med	5%	Med	S1	S2	S1	S2	S1	S2	
BR06-1	V0	1_20	0	0	0	0	0	0	0	0							
BR06-1	V1	1_20	94	128	15	44	64	75	18	30	A	A	A	A	A	A	A
BR06-1	V2	1_20	92	136	69	108	120	120	109	109	A	A	A	A	A	A	A
BR06-1	V3	1_20	91	136	34	61	119	120	63	71	A	A	A	A	A	A	A
BR06-1	V4	1_20	103	142	15	44	90	101	18	30	A	B	A	B	A	B	B
BR06-1	V5	1_20	99	153	41	67	152	152	72	82	A	A	A	A	A	A	A
BR06-1	V1	2_20	99	135	18	49	59	82	14	36	A	A	A	A	A	A	A
BR06-1	V2	2_20	103	150	73	124	120	120	109	109	B	A	B	A	B	A	B
BR06-1	V3	2_20	103	150	41	70	119	120	57	72	A	A	B	A	A	A	A
BR06-1	V4	2_20	108	147	18	48	85	107	14	36	A	B	A	B	A	B	B
BR06-1	V5	2_20	109	164	47	75	152	152	65	83	B	B	B	B	B	B	B
BR07-1	V0	1_20	0	0	0	0	0	0	0	0							
BR07-1	V1	1_20	95	128	18	45	64	75	18	30	A	A	A	A	A	A	A
BR07-1	V2	1_20	92	135	70	108	120	120	109	109	A	A	A	A	A	A	A
BR07-1	V3	1_20	92	135	36	61	119	120	64	71	A	A	A	A	A	A	A
BR07-1	V4	1_20	102	142	18	44	89	102	18	30	A	A	A	A	A	A	A
BR07-1	V5	1_20	101	153	43	67	152	152	72	82	A	A	A	A	A	A	A
BR07-1	V1	2_20	98	136	21	49	59	82	14	36	A	A	A	A	A	A	A
BR07-1	V2	2_20	102	150	73	125	120	120	109	109	B	A	B	A	B	A	B
BR07-1	V3	2_20	102	151	41	71	119	120	58	72	B	A	B	A	B	A	B
BR07-1	V4	2_20	107	148	21	48	85	107	14	36	A	A	A	A	A	A	A
BR07-1	V5	2_20	107	166	48	75	152	152	65	83	B	A	B	A	B	A	B
BR08-1	V0	1_20	0	0	0	0	0	0	0	0							
BR08-1	V1	1_20	88	128	15	44	64	76	18	30	A	A	A	A	A	A	A
BR08-1	V2	1_20	90	136	67	108	120	121	109	109	A	A	A	A	A	A	A
BR08-1	V3	1_20	90	136	34	61	120	121	63	71	A	A	A	A	A	A	A
BR08-1	V4	1_20	98	142	15	43	90	101	18	30	A	A	A	A	A	A	A
BR08-1	V5	1_20	98	153	42	67	151	152	72	82	A	A	A	A	A	A	A
BR08-1	V1	2_20	99	135	20	48	60	82	14	36	A	A	A	A	A	A	A
BR08-1	V2	2_20	101	150	72	124	120	121	109	109	B	A	B	A	B	A	B
BR08-1	V3	2_20	103	151	41	70	120	121	58	72	A	A	B	A	A	A	A
BR08-1	V4	2_20	108	147	19	47	85	106	14	36	A	A	A	A	A	A	A
BR08-1	V5	2_20	109	166	48	76	152	152	65	83	B	A	B	A	B	A	B
BR09-1	V0	1_20	0	0	0	0	0	0	0	0							
BR09-1	V1	1_20	94	128	15	44	64	76	18	30	A	A	A	A	A	A	A
BR09-1	V2	1_20	92	137	71	111	120	120	109	109	A	A	A	A	A	A	A
BR09-1	V3	1_20	92	137	34	61	119	119	64	71	A	A	A	A	A	A	A
BR09-1	V4	1_20	104	142	15	44	90	102	18	30	A	A	A	B	A	A	A
BR09-1	V5	1_20	99	154	42	68	151	152	72	82	A	A	A	A	A	A	A
BR09-1	V1	2_20	99	136	18	48	60	82	14	37	A	A	A	A	A	A	A
BR09-1	V2	2_20	103	151	76	128	120	120	109	109	A	A	A	A	A	A	A
BR09-1	V3	2_20	103	151	42	71	119	119	57	72	A	A	A	A	A	A	A
BR09-1	V4	2_20	108	147	18	48	86	109	14	37	A	B	A	A	A	A	A
BR09-1	V5	2_20	108	165	47	75	151	152	65	83	A	A	A	A	A	A	A
BR10-1	V0	1_20	0	0	0	0	0	0	0	0							
BR10-1	V1	1_20	94	129	16	45	64	76	18	30	A	A	A	A	A	A	A
BR10-1	V2	1_20	92	137	71	111	120	120	109	109	A	A	A	A	A	A	A
BR10-1	V3	1_20	93	137	34	62	119	119	63	71	A	A	A	A	A	A	A
BR10-1	V4	1_20	104	143	15	44	90	102	18	30	A	A	A	A	A	A	A
BR10-1	V5	1_20	99	154	42	68	151	152	72	82	A	A	A	A	A	A	A
BR10-1	V1	2_20	99	136	19	49	60	82	14	37	A	A	A	A	A	A	A
BR10-1	V2	2_20	104	151	75	127	120	120	109	109	A	A	A	A	A	A	A
BR10-1	V3	2_20	103	151	42	73	119	119	57	72	A	A	A	A	A	A	A
BR10-1	V4	2_20	109	148	19	48	86	109	14	37	A	A	A	A	A	A	A
BR10-1	V5	2_20	109	165	48	77	151	152	65	83	A	A	A	A	A	A	A

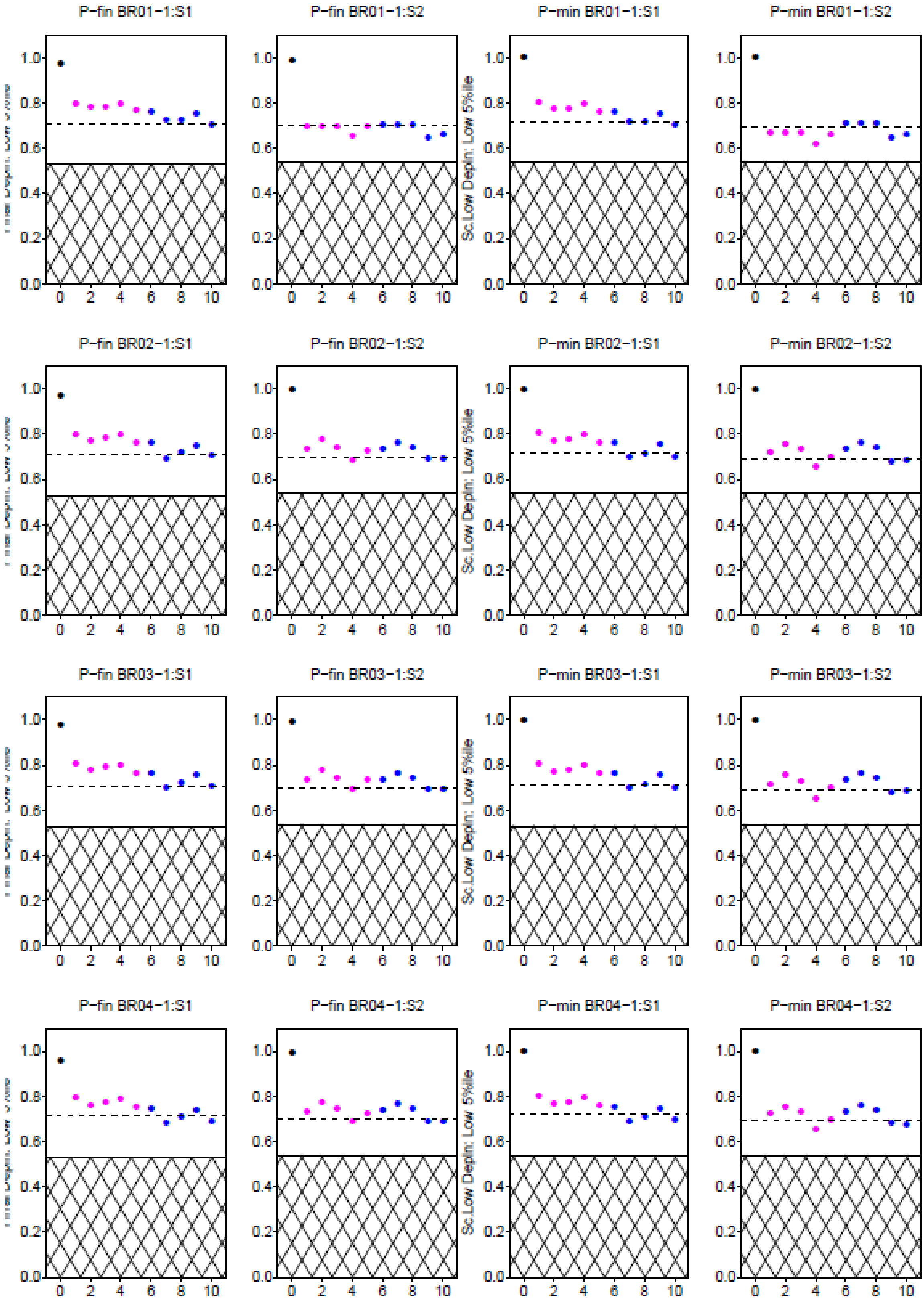

Fig. 4. Summary of the performance of the no-catch variant (0 on the x-axis) and the 10 RMP variants. The results for variants 1-5 for the 1_20 survey assumption are 1-5 on the x-axis (pink points) and those variants 1-5 for the 2_20 survey assumption are 6-10 on the x-axis (blue points). 'Acceptance' performance is a point above the dashed line, 'borderline' performance is a point between the dashed line and the hashed area, and 'unacceptable' performance in a point in the hashed area.

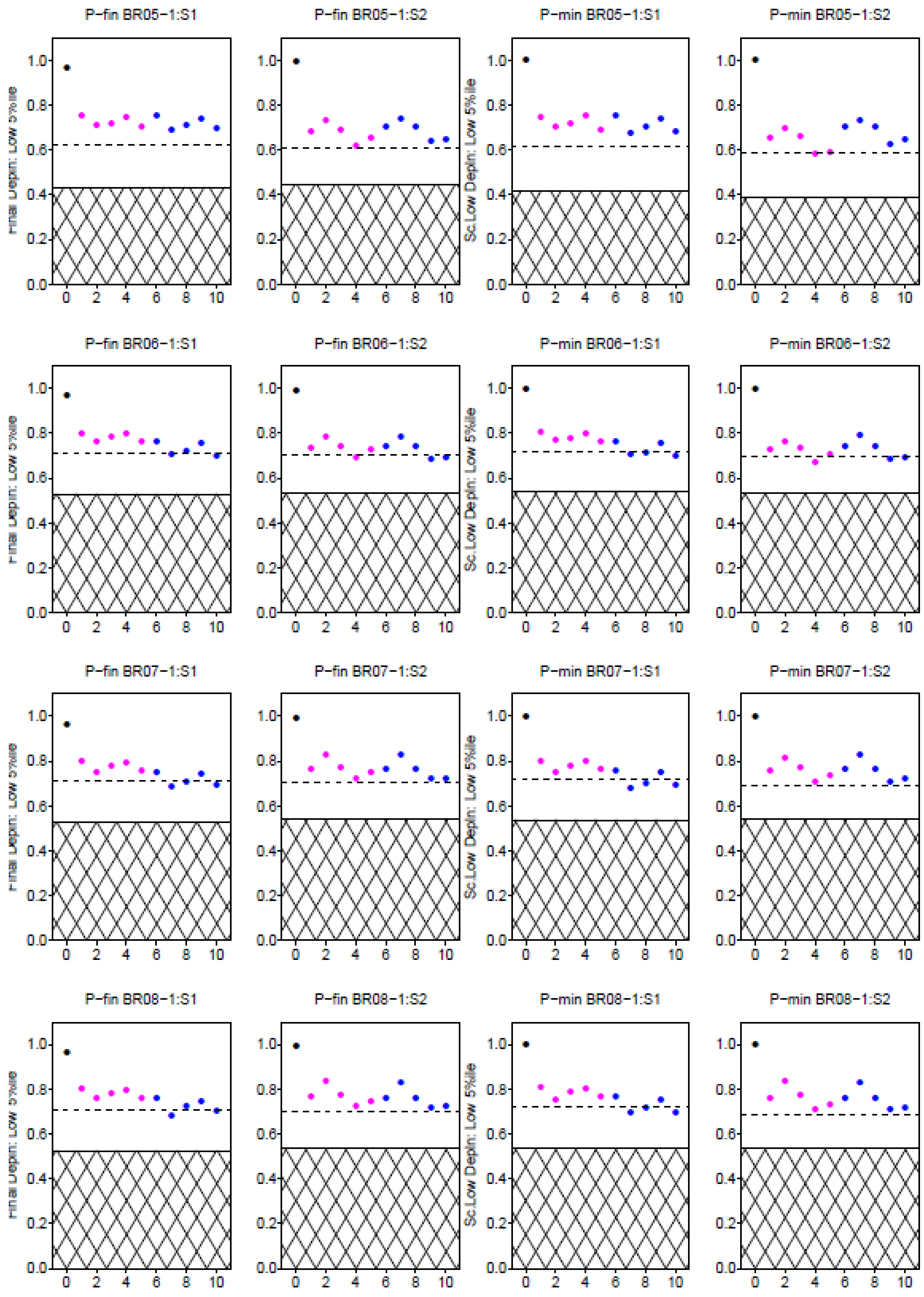

Fig. 4. Continued. Summary of the performance of the no-catch variant (0 on the x-axis) and the 10 RMP variants. The results for variants 1-5 for the 1_20 survey assumption are 1-5 on the x-axis (pink points) and those variants 1-5 for the 2_20 survey assumption are 6-10 on the x-axis (blue points). 'Acceptance' performance is a point above the dashed line, 'borderline' performance is a point between the dashed line and the hashed area, and 'unacceptable' performance in a point in the hashed area.

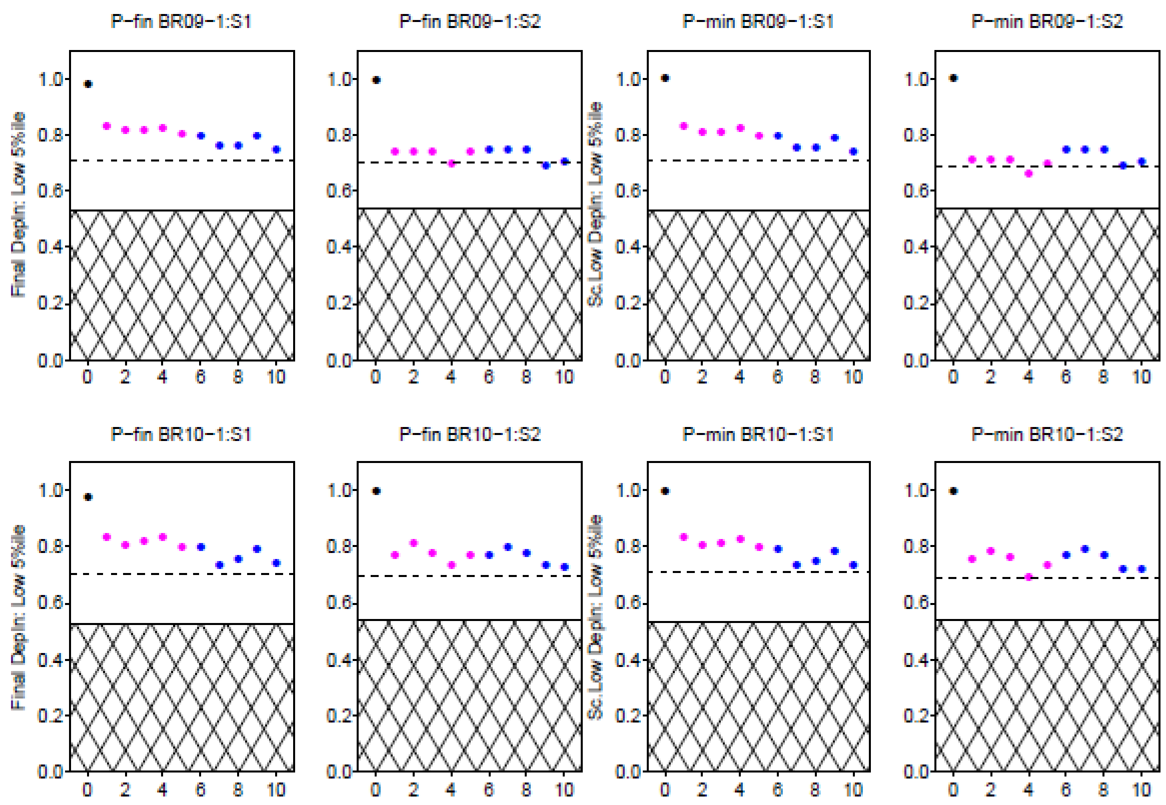

Fig. 4. Continued. Summary of the performance of the no-catch variant (0 on the x-axis) and the 10 RMP variants. The results for variants 1-5 for the 1_20 survey assumption are 1-5 on the x-axis (pink points) and those variants 1-5 for the 2_20 survey assumption are 6-10 on the x-axis (blue points). 'Acceptance' performance is a point above the dashed line, 'borderline' performance is a point between the dashed line and the hashed area, and 'unacceptable' performance in a point in the hashed area.

3.2 *IMPLEMENTATION REVIEW* OF WESTERN NORTH PACIFIC COMMON MINKE WHALES

3.2.1 Review report of the intersessional workshop

Donovan summarised the work of the First Intersessional Workshop on the Implementation Review for western North Pacific minke whales (SC/68A/Rep04) held in Tokyo, Japan from 25 February – 1 March 2019. In accordance with its Requirements and Guidelines (IWC, 2012a), the primary objectives of the 'First Intersessional Workshop' are:

(1) review plausible hypotheses and eliminate any hypotheses that are inconsistent with the data – this will take into account the probable management implications of such hypotheses to try to avoid unnecessary work in the precise specifications of hypotheses for which these are very similar;

(2) examine more detailed information on expected operations, including whether coastal, pelagic, on migration, on feeding, on breeding or combinations of these - when providing such information, users and scientists may provide options or suggest modifications to the pattern of operations;

(3) review the small geographical areas ('sub-areas') that will be used in specifying the stock structure hypotheses and operational pattern; and

(4) specify the data and methods for conditioning the trials that will be carried out before the next annual meeting.

Donovan noted that a major part of the work of the workshop related to objective (1) regarding stock hypotheses and the report of the workshop on that topic was summarised (and discussed) in the report of the working group on stock definition and DNA testing (Annex I, item 4.1.1) and is not repeated here.

The Workshop also compiled a list the available abundance estimates for use in the review (annex J to SC/68A/Rep04) and identified a number of surveys for which estimates should be developed and presented at the 2019 Annual Meeting. Potential future survey plans for Korea and Japan were also received.

There was some discussion of the removals data and the Workshop updated the catch and bycatch data available. It also received information on numbers of set nets in operation to the extent that such data were available. The methods to use to extrapolate bycatches outside the available time periods for the 2013 *Implementation Review*were reviewed and confirmed for use in the present *Implementation Review* (including for Chinese waters where there are few data). The Workshop agreed that at present it was acceptable to assume that ship strikes were zero but that the situation should be monitored.

In light of the available information the Workshop then developed a list of factors to be considered in the trials, factors to be considered in conditioning, a set of draft trials (see tables 7 and 8 of SC/68A/Rep04) and discussions relating to the development of mixing matrices. The Workshop received preliminary information on possible whaling operations from Japan.

Finally, the Workshop developed a workplan for the period leading up to the Annual Meeting.

Donovan concluded that the intersessional Workshop was held in an excellent spirit of co-operation among the participants including collaboration on analyses. This led to substantial progress in refining the hypotheses for inclusion in the *Implementation Simulation Trials* and analyses that should be taken forward as well as an ambitious workplan. Some analyses based on the Workshop recommendations were presented at SC/68A. The sub-committee thanked Donovan for chairing the meeting, the Government of Japan for providing excellent facilities and all the participants for their co-operation, collaborative spirit and contributions to progress the *Implementation Review*.

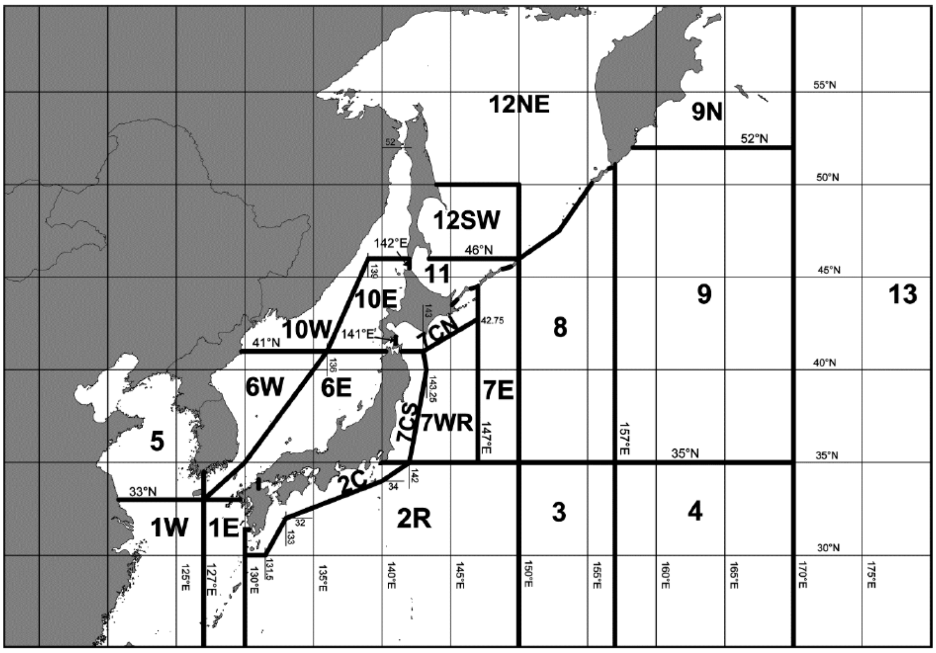

Fig. 1. The 22 sub-areas used for the *Implementation Simulation Trials* for North Pacific minke whales.

3.2.2 Undertake the work allocated to the 'First Annual Meeting' following the Requirements and Guidelines

3.2.2.1 REVIEW CONDITIONING RESULTS

The trials are still being developed so no conditioning results are available

3.2.2.2 PLAUSIBILITY OF HYPOTHESES

3.2.2.2.1 STOCK HYPOTHESES

The First Intersessional Workshop had agreed that the trials for the western North Pacific common minke whales should be based on three stock structure hypotheses:

(1) there is a single J stock distributed in sub-areas 1W, 1E, 2C, 5, 6W, 6E, 7CS, 7CN, 10W, 10E, 11 and 12SW, and a single O stock in sub-areas 2C, 2R, 3, 4, 7CS, 7CN, 7WR, 7E, 8, 9, 9N, 10E, 11, 12SW, 12NE and 13 (referred to as Hypothesis A as it was in 2013);

(2) as for hypothesis A, but there is a third stock (Y) that resides in sub-area 1W, 5 and 6W and overlaps with J stock in the southern part of sub-area 6W (referred to as Hypothesis B as it was in 2013); and

(3) there are four stocks, referred to Y, J, P, and O, two of which (Y and J) occur to the west of Japan, and three of which (J, P, and O) are found to the east of Japan and in the Okhotsk Sea (a new hypothesis referred to as Hypothesis E). Stock P (earlier termed "purple") is a coastal stock.

The SDDNA working group had reviewed the work of the intersessional workshop as well as additional work undertaken intersessionally and their extensive discussions can be found in Annex I, Item 4.1.1. In summary, they endorsed the stock structure hypotheses proposed by the intersessional workshop, noting that stock hypothesis E is based on genetic assignment of individuals to clusters taking spatial occurrence into account (as implemented in the software GENELAND; SC/68A/Rep04).

Based on Parent-Offspring relationships found both across J and P stocks and across P and O stocks (SC/68A/SDDNA/01) and further genetic characteristics of the inferred P stock (i.e., departure from Hardy-Weinberg-Equilibrium; genetic affinity of some P stock individuals to J stock, others to O stock; SC/68A/SDDNA/02), it was further concluded that hypothesis E can only be maintained, if P is not a closed stock, but receives dispersal from J and O stocks. The SDDNA working group agreed that it was necessary to implement such transfer of individuals among J and P stocks as well as among P and O stocks in the *Implementation Simulation Trials*.

An approach to estimate the rate of transferred individuals (relative to stock size) from the inferred Parent-Offspring pairs within and across stocks was developed (see Appendix 3) and this will be refined and implemented intersessionally.

In conclusion, the sub-committee noted that the available genetics data support demographic dispersal between the P, J and O stocks for stock hypothesis E. Thus, the specifications of stock hypothesis E were modified to allow for such demographic dispersal. No single hypothesis was completely supported by all of the different analyses. With respect to plausibility it was agreed that hypotheses A and B are plausible while hypothesis E was considered sufficiently plausible to continue to be included in the *Implementation Simulation Trials* at present.

Attention: SC

With respect to the plausibility of stock structure hypotheses, the sub-committee ***agreed*** *to take three Hypotheses forward at present as summarised below.*

(1) *Hypothesis A. This hypothesis is considered 'high' plausibility. There is overwhelming support for there being at least two stocks of common minke whales in the western North Pacific (J and O), including evidence from both genetic and non-genetic methods.*
(2) *Hypothesis B. This hypothesis is considered 'high' plausibility, primarily because it is in essence the same as Hypothesis A but with a separate Y stock (as had been included in the 2013 Implementation). There was no new information on Y stock provided during this Implementation Review. The sub-committee* ***agreed*** *that the available Korean genetics data should be analysed with the Japanese genetics data.*
(3) *Hypothesis E. Support for this hypothesis is provided by the GENELAND analyses, although it was noted that some recommended genetic analyses have yet to be completed. Some members expressed concerns that the hypothesis may be inconsistent with the observed age/sex/size structure. Some members also believed that this hypothesis was less compatible with the non-genetic data. The sub-committee therefore* ***agreed*** *that it is not possible to evaluate plausibility until the results of the conditioning process become available.*

In addition to examining the conditioning results for hypothesis E before assigning plausibility, the sub-committee ***agreed*** *that further analyses of genetics data would assist in this matter including analysis of the combined Korean and Japanese samples; interpretation of the results of the application of GENELAND with admixture and application of coalesecent methods to further investigate when the P stock diverged from common ancestors*

3.2.2.2.1 MSYR

Two values for MSYR are considered in the trials: 1% defined in terms of the total (1+) component of the population, and 4% defined in terms of the mature female component of the population. These choices for MSYR are based on the outcomes of the MSYR review (IWC, 2014a; 2014b), with the trials with $MSYR_{mat}$=4% assigned high plausibility and those with $MSYR_{1+}$=1% assigned medium plausibility. Last year (IWC, 2019), the Committee noted that information on bycatch rates by stock may provide information about MSYR and the First Intersessional Workshop agreed that papers on this topic should be presented to SC/68A. However, no papers were presented.

3.2.2.2 FINAL TRIALS
Allison and de Moor reported on progress with coding the *Implementation Simulation Trials* since the February 2019 workshop. This led to identification of several queries regarding the specifications agreed during the First Intersessional Workshop (SC/68A/Rep/04). The sub-committee discussed the queries and **agreed** the following changes to the specifications (see Appendix 3):

(1) there should be different gamma parameters for sub-areas 7CN and 10E in the baseline mixing matrix for the O stock;
(2) the mixing data for sub-areas 7E and 7WR should be combined because animals assigned to J stock are found in sub-area 7WR but not sub-area 7E; and
(3) the presence of J stock in sub-area 1W in stock hypotheses B and E was an error and should be removed

Appendix 3 lists the final trials and includes specifications for how to include parent-offspring pairs in the model likelihood when conditioning the operating model for stock hypothesis E. The sub-committee agreed that trials should conducted under the assumption that the numbers dispersing from the P to the J stock and the P to the O stock were the same at unexploited equilibrium. It further **agreed** that initial evaluations assume that the proportion of calves dispersing from the P to the J and O stocks is the same.

The abundance estimates used for conditioning will be updated in light of the discussions undertaken in the ASI SWG (see Annex Q).

Attention: SC

In conclusion, the sub-committee **agreed** to the final trial specifications provided in Appendix 3. It re-established the Steering Group (Allison (Chair), Butterworth, de Moor, Donovan, Hakamada, Hoelzel, Pastene, Punt, Taguchi, Tiedemann, Wilberg) to guide the work and review additional changes to the trial specifications.

3.3 RMP *Implementation Review* Workplan
The sub-committee noted that in the light of Japan's withdrawal from the Commission, work on the Western North Pacific Bryde's and common minke whales may not continue in an RMP context depending on discussions in plenary. A consolidated workplan for the remaining RMP and AWMP *Implementation Reviews* is discussed under Item 6.

4. AWMP IMPLEMENTATION-RELATED MATTERS
4.1 SLA development for the common minke whales off East Greenland
Last year, the Committee agreed that it should consider development of an *SLA* for the hunt of common minke whales off East Greenland based on operating models used when developing the West Greenland common minke whale *SLA*. This was agreed by the Commission. Witting proposed the *SLA* agreed for common minke whales off West Greenland (the *WG common minke SLA*) and tested this proposed *SLA* using the *Evaluation Trials* for the North Atlantic common minke whales (SC/68A/IST04).

4.1.1 Conclusions and workplan
Given the overall satisfactory performance in the *Evaluation Trials* with respect to meeting the Commission's conservation and management objectives, the sub-committee agreed that a single *SLA* (renamed the '*G common minke SLA',* was the best way to provide management advice for the East Greenland hunt of common minke whales subject to final review of *Robustness Trials*.

Attention: SC, C
Last year it had been agreed that an SLA *should be developed for the hunt of common minke whales off East Greenland. Based upon work considered at this meeting the sub-committee:*

(1) agreed that the WG common minke SLA *tested for East Greenland minke whales performed satisfactorily in terms of the Commission's conservation and need objectives;*
*(2) agreed that this '*G-Common minke SLA*' was therefore appropriate to provide management advice to the Commission on the both the West and East Greenland common minke whale hunts;*
(3) thanked Witting for the development work and Allison and Punt for their work refining the operating models; and
(4) requested that Allison and Punt develop a single simulation testing framework for the North Atlantic common minke whales and provide a synthesis paper at next year's meeting that includes results for all Evaluation *and* Robustness *trials as well as the evaluation of carryover and interim allowance for the East and West Greenland minke whales.*

4.2 Progress with testing outstanding carryover provisions for some *SLA*s and consequent updates to the Aboriginal Whaling Scheme

Carryover is a provision to enable (some) strikes not used in one year to be used in a subsequent year or years, in order to allow for the inevitable fluctuations in the success of hunts. The Committee has evaluated carryover provisions for the *Bowhead SLA* and the *WG-Humpback SLA* for:

(1) baseline case – all strikes taken annually (i.e. no need for carryover);
(2) 'frontload' case – strikes taken as quickly as possible within block (+50% limit annually until the block limit is reached); and
(3) two alternative scenarios where carryover strikes are accrued for one or three blocks, followed by a period of carryover usage subject to the +50% limit.

SC/68A/IST01 conducted analyses for the *WG-Minke SLA*, the *WG-Bowhead SLA* and *WG-Fin SLA* for the scenarios considered previously for the *Bowhead SLA* and the *WG-Humpback SLA*. The sub-committee **agreed** that the Commission's conservation objectives were met for all three *SLA*s for all of the options above. The impacts of carryover will be tested for eastern NP gray whales as part of the 2020 *Implementation Review* for that stock (see Item 4.4).

Attention: C

The Committee had been requested by the Commission to undertake simulation trials to investigate the carryover provisions for common minke, bowhead and fin whale hunts of West Greenland. In the light of results presented this year, it advises that the Commission's conservation objectives are met for a carryover provision in which allowance is made for the carryover of unused strikes from the previous three blocks, subject to the limitation that the number of such carryover strikes used in any year does not exceed 50% of the annual strike limit. Donovan will update the provisions of the AWS accordingly.

4.3 Progress with testing outstanding interim relief allocation provisions and consequent updates to the Aboriginal Whaling Scheme

A variety of factors, including environmental conditions, beyond the control of the hunters may prevent the completion of a successful whale population abundance estimate. A third quota block begun after the 10-year limit has expired is termed a 'grace period' and the Committee has endorsed the use of an 'interim allowance', namely a grace period strike limit equal to the limit produced by the applicable *Strike Limit Algorithm*, without reduction, for a single block. This approach has been simulation tested for B-C-B bowhead and WG humpback hunts to confirm that it meets the conservation and need satisfaction goals of the Commission (IWC, 2016a, p.190-3, 2016b, p.471-84; 2017a, p.498) and the results were summarised in IWC (2017b; 2018b, p.159) showing that the approach was satisfactory.

SC/68A/IST02 and SC/68A/IST03 evaluated the implications of implementing the interim allowance approach for WG minke, bowhead and fin whales using the same approach used for the B-C-B bowheads and the WG humpbacks. The results for WG bowhead and fin whales (SC/68A/IST02) confirm that 'interim allowance' meets the conservation and need satisfaction goals of the Commission. The results for the WG minke whales are more complex as catches in the region also occur due to the (simulated) application of the RMP in some areas. Nevertheless, the simulations confirm that implementing 'interim allowance' for the WG minke whales still meets the Commission's objectives. The interim allowance approach will be tested for eastern NP gray whales as part of the 2020 *Implementation Review* for that stock.

Attention: C

The Committee had been requested by the Commission to undertake simulation trials to investigate the interim allowance approach for common minke, bowhead and fin whale hunts of West Greenland. In the light of results presented this year, it advises that the Commission's conservation objectives are met for the interim allowance approach included in the AWS. Donovan will update the provisions of the AWS accordingly.

4.4 Preparation for 2020 *Implementation Review* for North Pacific gray whales

Originally it had been intended to undertake the *Implementation Review* for North Pacific gray whales at the present meeting but for a variety of reasons it has been agreed to postpone it until the 2020 meeting.

4.4.1 New data available or likely to become available in time given the data availability rules including abundance estimates, catch/removals data and Expected analyses
Weller advised the sub-committee that updated estimates of Pacific Cost Feeding Group (PCFG) and Western North Pacific (WNP) abundance should be available for the *Implementation Review*. The next survey off California is scheduled for December 2019 – February 2020, but the results will not be analysed for the 2020 *Implementation Review*. The photo-ID catalogue for ENP gray whales will be revised and updated and used to update information on ENP-WNP ocean basin movements. No new genetic analyses are expected. Estimates of removals (US, Russia) will be updated for the review, including an update the review of human-caused mortality for 1924-2015.

The sub-committee noted that the models developed for Rangewide Review will be available to, and could be updated for, the 2020 *Implementation Review*.

4.4.2 Carryover and interim allowance
The *Implementation Simulation Trials* developed as part of the rangewide exercise for North Pacific gray whales (IWC, 2019) include two reference trials and many sensitivity tests (Punt, 2019). However, evaluating carryover and interim allowance for the ENP gray whales is more complex because there are two management schemes in operation in the *Implementation Simulation Trials*, the *Gray Whale SLA* and the Makah Management Plan. The latter does not include the concepts of carryover or interim allowance. Thus, the focus for the evaluation of carryover provisions and the interim allowance approach should therefore only consider the *Gray Whale SLA*. It is assumed that photographs (and thus abundance estimates) of PCFG whales continue to be obtained annually and also that photographs (and thus abundance estimates) of western gray whales are regularly obtained.

With respect to evaluating carryover and interim allowance for the *Gray whale SLA*, the sub-committee **agreed** that this should be designed to allow removals under the Makah Management Plan to be unaffected by the simulated scenarios regarding carryover and interim allowance. It should explore equivalent scenarios to those considered in SC/68A/IST1-3; and adjust the carryover and interim allowance protocols such that three strikes are available annually irrespective to enable the Makah Management Plan to be implemented.

4.4.3 Workplan including consideration of a workshop or pre-meeting and DAA deadlines
The sub-committee established a Steering Group (Donovan (Chair), Weller, Punt, Litovka, Scordino, Lang, Urban, and Kato) to assist with preparations for the *Implementation Review*.

In accordance with the DAA (IWC, 2004) and the AWS (IWC, 2019), scientists from the country or countries undertaking the hunts, or others intending to submit relevant analyses, shall develop a document or documents that explains the data that will/could be used for the *Implementation Review* as soon as possible after the Annual Meeting. The document should

(1) outline the data that will be available, including by broad data type (e.g. sighting data, catch data, biological data): the years for which the data are available; the fields within the database; and the sample sizes;
(2) provide references to data collection and validation protocols and any associated information needed to understand the datasets or to explain gaps or limitations; and
(3) where available, provide references to documents and publications of previous analyses undertaken of data.

The data themselves shall be available in electronic format one month after the close of the Annual Meeting i.e. 24 June 2019. Requests for the data should be submitted via the DAG (chair Zerbini: alex.zerbini@noaa.gov).

With respect to new analyses, papers using novel methods should be available at least 3 months in advance of the Annual Meeting (i.e. 12 February 2020), papers using standard methods should be available at least 2 months before the Annual Meeting (i.e. 12 March 2020) and papers responding to such analyses at least 1 month before the meeting (i.e.12 April 2020).

4.5 Work plan 2020-21
The workplan for AWMP *Implementation* matters is given as Table 6.

5. REVIEW OF PAST RECOMMENDATIONS
The sub-committee noted that most of the recommendations made last year had been successfully completed. The only area in which progress was not made related to the evaluation of the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$ under Item 2.1.

Table 6

Work plan for AWMP Implementation Matters

Topic	Intersessional 2019/20	2020 Meeting	Intersessional 20/21	2021 meeting
4.1 SLA development for the common minke whales off EastGreenland	Develop a single simulation testing framework for the North Atlantic common mine whales and provide 68B with a synthesis paper that includes results for all Evaluation and *Robustness trial*s as well as the evaluation of carryover and interim allowance for East and West Greenland minke whales (Punt and Allison)	Review results of trials.	n/a	n/a
4.4.1 Conduct the *Implementation Review* for the Eastern North Pacific gray whales	Develop papers in accordance with the timetable under the guidance of the Steering Group	Conduct the *Implementation Review*	Follow-up work (if needed)	Complete review if needed
4.4.2 Evaluate carryover and interim allowance for the Eastern North Pacific gray whales	Conduct evaluation of carryover and interim allowance for the Eastern North Pacific gray whales (Punt)	Review results of analyses and complete		

6. CONSOLIDATED WORKPLAN

The sub-committee noted that its future work plan should try to develop a consolidated workplan for both RMP and AWMP *Implementation Reviews.* One potential workplan is provided in Table 7 below.

Table 7

Potential long term workplan for *Implementation Reviews*

Species/area	Year *Implementation* (*IR*s) completed	Next *Implementation Review*
Chukotka gray whales	2004 (2010)	Start 2020
Makah gray whales	2013 (2018)	
West Greenland humpback whales	2014	Estimated start 2021
North Atlantic common minke whales	1993 (2003, 2008, 2017)	Estimated start 2022
North Atlantic fin whales	2009 (2016)	Estimated start 2023
West Greenland fin whales	2018	
West Greenland bowhead whales	2015	Estimated start 2024
Alaskan and Chukotka bowhead whales	2000 (2007, 2012, 2018)	Estimated start 2025
West Greenland common minke whales	2018	Estimated start 2026
East Greenland common minke whales	2019	

7. REVIEW OF BUDGET REQUESTS IN LIGHT OF THE TWO-YEAR BUDGET AGREED LAST YEAR AND THE CONSOLIDATED WORKPLAN

There are no additional budget requests for this year. The sub-committee noted that if the plenary session decides that the *Implementation Review* for western North Pacific common minke whales should become an in-depth assessment, then the budget assigned for the Second Intersessional RMP workshop could be transferred to an in-depth assessment workshop for the same species/area.

8. ADOPTION OF REPORT

The report was adopted at 11.22 on 18 May 2019. The sub-committee acknowledged the considerable work undertaken by Allison, de Moor and Punt during the intersessional period and at this meeting to ensure that the Committee was in a position to complete the *Implementation Review* for the western North Pacific Bryde's whales. It also acknowledged the excellent work of Punt as rapporteur. The sub-committee expressed its deep appreciation to Donovan who led to sub-committee through a complex agenda.

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Appendix 1

AGENDA

1. INTRODUCTORY ITEMS
1.1 Convenors' opening remarks (Donovan)
1.2 Chair and rapporteurs
1.3 Adoption of Agenda
1.4 Available documents

2. GENERAL ASSESSMENT AND MODELLING ISSUES (IST)
2.1 Evaluate the energetics-based model and the relationship between $MSYR_{1+}$ and $MSYR_{mat}$
2.2 Implications of ISTs for consideration of species' and populations' status
2.3 Progress on previous recommendations and on the workplan
2.4 Work plan 2020-21

3. RMP IMPLEMENTATION-RELATED MATTERS
3.1 Completion of the Implementation Review of western North Pacific Bryde's whales
3.1.1 Results of trials
3.1.2 Recommendations for acceptable variants
3.2 Implementation Review of western North Pacific common minke whales
3.2.1Review report of the intersessional workshop
3.2.2 Undertake the work allocated to the 'First Annual Meeting' following the Requirements and Guidelines
3.3 RMP Implementation Review Workplan

4. AWMP IMPLEMENTATION-RELATED MATTERS
4.1 SLA development for the common minke whales off East Greenland
4.2 Progress with testing outstanding carryover and interim relief allocation provisions for some SLAs and consequent updates to the Aboriginal Whaling Scheme
4.3 Progress with testing outstanding interim relief allocation provisions for some SLAs and consequent updates to the Aboriginal Whaling Scheme
4.4 Preparation for 2020 Implementation Review for North Pacific gray whales
4.4.1 New data available or likely to become available in time given the data availability rules including abundance estimates, catch/removals data and Expected analyses
4.4.2 Carryover and interim allowance
4.4.2 Workplan including consideration of a workshop or pre-meeting and DAA deadlines
4.5 Work plan 2020-21

5. REVIEW OF PAST RECOMMENDATIONS

6. CONSOLIDATED WORKPLAN

7. REVIEW OF BUDGET REQUESTS IN LIGHT OF THE TWO-YEAR BUDGET AGREED LAST YEAR AND THE CONSOLIDATED WORKPLAN

8. ADOPTION OF REPORT

Appendix 2

THE SPECIFICATIONS FOR THE IMPLEMENTATION SIMULATION TRIALS FOR WESTERN NORTH PACIFIC BRYDE'S WHALES

C. Allison and C.L. de Moor

A. Basic concepts and stock-structure

The trials detailed below consider the implications of alternative variants of the RMP for Bryde's whales in sub-areas 1 and 2 of the western North Pacific (Fig. 1). Sub-area 1 is sub-divided into sub-areas 1W and 1E at 165°E. The trials model two stocks (Stocks 1 and 2) and explore alternative placements of the boundary between them and the area of overlap (if any). The sub-areas are further divided into smaller "Component-areas" (see Fig 1 and Table 1) to enable these alternatives to be tested.

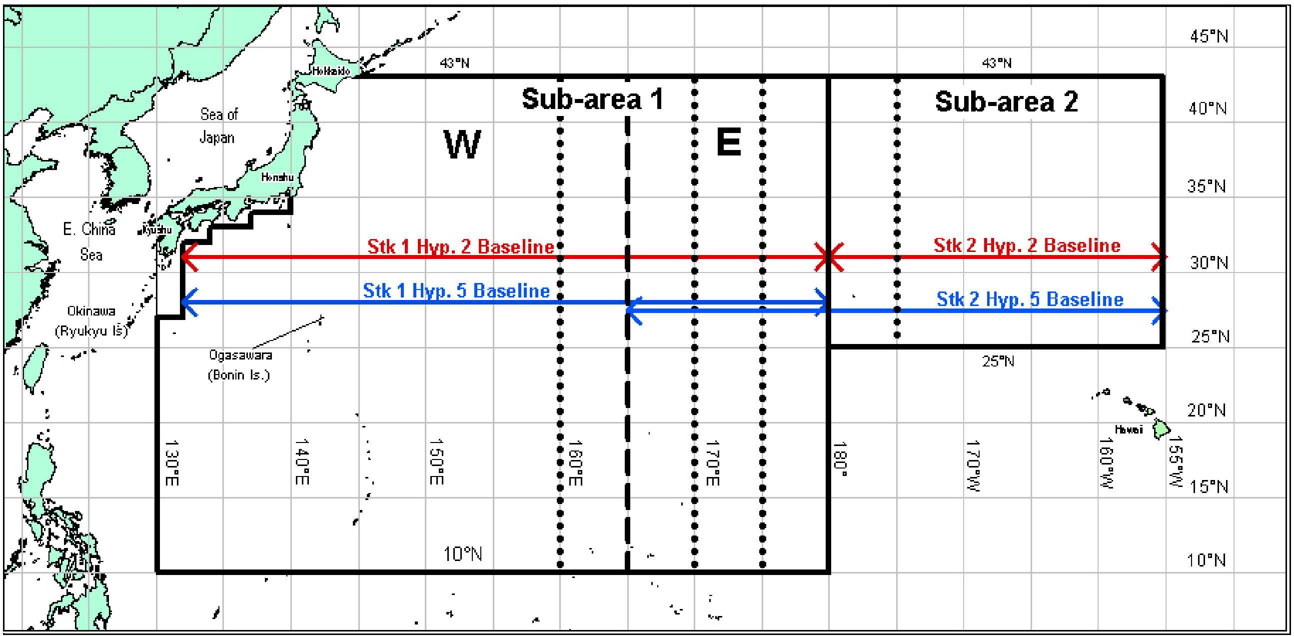

Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales. The ranges of the stocks for Hypotheses 2 and 5 (baselines) are also shown. The boundary between the sub-areas 1W and 1E at 165°E, indicated by a dashed line, is a management boundary (used by the RMP). The dotted lines at 160°E, 170°E, 175°E and 175°W denote the boundaries between the "Component-areas" and are used for trials in which the true boundary between the stocks differs from the boundary on which the RMP is based. The staggered border to the south of Japan is used to ensure that no catches of the inshore form of Bryde's whales are included in these trials.

There are two general hypotheses regarding stock structure[2]:

(1) Stock structure hypothesis 2. There are two stocks of Bryde's whales. One stock is found in sub-area 1 and the other is found in sub-area 2. The trials investigate sensitivity to the position of the boundary between the stocks.

(2) Stock structure hypothesis 5. There are two stocks of Bryde's whales. One stock is found in sub-areas 1W and 1E while the other is found in sub-areas 1E and 2. Sub-area 1E is a region of mixing. The trials explore various assumptions regarding the regions of mixing.

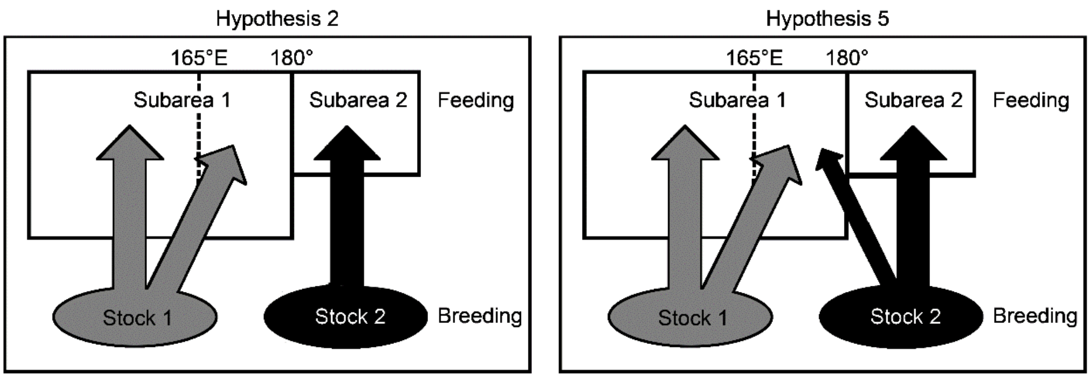

Fig. 2 The two hypotheses considered in the *Implementation Simulation Trials*

[2] Note that stock structure hypotheses 1, 3 and 4 developed in the previous *Implementation* are not carried forward here; for consistency the hypothesis numbers have not been changed.

B. Basic dynamics

The dynamics of the animals in stock j are governed by equation B.1:

$$N^{g,j}_{t+1,a} = \begin{cases} 0.5\, b^j_{t+1} & \text{if } a = 0 \\ (N^{g,j}_{t,a-1} - C^{g,j}_{t,a-1})\tilde{S}^j_{t,a-1} & \text{if } 1 \le a < x \\ (N^{g,j}_{t,x} - C^{g,j}_{t,x})\tilde{S}^j_{t,x} + (N^{g,j}_{t,x-1} - C^{g,j}_{t,x-1})\tilde{S}^j_{t,x-1} & \text{if } a = x \end{cases} \tag{B.1}$$

where $N^{g,j}_{t,a}$ is the number of animals of gender g and age a in Stock j at the start of year t;

$C^{g,j}_{t,a}$ is the catch (in number) of animals of gender g and age a in Stock j during year t (whaling is assumed to take place in a pulse at the start of each year);

b^j_t is the number of calves born to females from Stock j at the start of year t;

$\tilde{S}^j_{t,a}$ is the survival rate = $e^{-M^j_{t,a}}$ where $M^j_{t,a}$ is the instantaneous rate of natural mortality for animals of age a in Stock j during year t (assumed to be independent of gender); and

x is the maximum age (treated a plus-group);

Note that t=0, the year for which catch limits might first be set, corresponds to 2017.

C. Births

For most trials (including the baseline trials), density-dependence is assumed to be a function of the 1+ component of the population[3].

$$b^j_t = B^j N^{f,j}_t \{1 + A^j(1 - (N^{D,j}_t / K^{D,j})^{z^j})\} \tag{C.1}$$

where B^j is the average number of births (of both sexes) per year for a mature female in Stock j in the pristine population;

A^j is the resilience parameter for Stock j;

z^j is the degree of compensation for Stock j;

$N^{\mathrm{f},j}_t$ is the number of 'mature' females in Stock j at the start of year t

$$N^{\mathrm{f},j}_t = \sum_{a=a_m}^{x} N^{\mathrm{f},j}_{t,a} \tag{C.2}$$

a_m is the age-at-first-parturition (the convention of referring to the mature population is used here, although this actually refers to animals that have reached the age of first parturition);

$N^{D,j}_t$ is the number of whales in the density-dependent component of Stock j at the start of year t. In these trials:

$$N^{D,j}_t = \sum_{a=1}^{x} (N^{\mathrm{f},j}_{t,a} + N^{\mathrm{m},j}_{t,a}) \tag{C.3}$$

and

$K^{D,j}$ is the number of whales in the density dependent component of Stock j in the pristine (pre-exploitation written as t=-∞) population.

$$K^{D,j} = \sum_{a=1}^{x} (N^{\mathrm{f},j}_{-\infty,a} + N^{\mathrm{m},j}_{-\infty,a}) \tag{C.4}$$

The values of the parameters A^j and z^j for each stock are calculated from the values for $MSYL^j$ and $MSYR^j$ (Punt, 1999). Their calculation assumes harvesting equal proportions of males and females.

D. Natural mortality

Natural mortality is assumed to be density-dependent in trials Br9 and Br10, i.e.:

$$M^j_{t,a} = M_a X^j_t \tag{D.1}$$

where M_a is the rate of natural mortality for an animal of age a in the pristine population;

X^j_t is the density-dependence term for natural mortality (Johnson and Punt, 2015):

$$X^j_t = \frac{1 + A^{\mathrm{M},j}(N^{D,j}_t / K^{D,j}_t)^{z^{\mathrm{M},j}}}{1 + A^{\mathrm{M},j}} \tag{D.2}$$

[3] This was changed at the Feb 2018 workshop. In earlier RMP trials, density-dependence was assumed to be a function of the mature female component of the population. The control program retains the option to act on the mature female component.

$A^{\mathrm{M},j}$	is the resilience parameter for Stock *j*; and
$z^{\mathrm{M},j}$	is the degree of compensation for Stock *j*.

In these trials the number of calves born becomes:

$$b_t^j = B^j N_t^{f,j} \tag{D.3}$$

E. Catches

It is assumed that whales are homogeneously distributed across a Component-area. The catch limit for a Component-area is therefore allocated to stocks by gender and age relative to their true density within that Component-area and a mixing matrix *V* (that is independent of year, gender and age in these trials), i.e.:

$$C_{t,a}^{g,j} = \sum_k F_t^{g,k} V^{j,k} S_{t,a}^k N_{t,a}^{g,j} \tag{E.1}$$

$$F_t^{g,k} = \frac{C_t^{g,k}}{\sum_{j'} V^{j',k} \sum_{a'} S_{t,a'}^k N_{t,a'}^{g,j'}} \tag{E.2}$$

where

$F_t^{g,k}$	is the exploitation rate in Component-area *k* on recruited animals of gender *g* during year *t*;
$S_{t,a}^k$	is the selectivity on animals of age *a* in Component-area *k* during year *t*;
$C_t^{g,k}$	is the catch of animals of gender *g* in Component-area *k* during year *t*; and
$V^{j,k}$	is the fraction of animals in Stock *j* that is in Component-area *k* during year *t*.

The historical (pre-2017) catches by Component-area and year are set to one of three series (see Adjunct 1); or, in the future, are determined using the RMP. There are no incidental catches. The sex ratio for future catches is assumed to be 50:50.

F1. Mixing

The entries in the mixing matrix *V* are selected to model the distribution of each stock at the time when the catch is removed. Mixing is deterministic. Table 1 lists the mixing matrices for each of the stock structure hypotheses.

Table 1

The catch mixing matrices. The γs indicate that the entry concerned is to be estimated during the conditioning process. The shaded areas show the areas in which the stocks mix.

Stock structure hypothesis	Component Area	Sub-Area						
		1W		1E			2	
		1Wa 130-160°E	1Wb 160-165°E	1Ea 165-170°E	1Eb 170-175°E	1Ec 175°E-180°	2a 180°-175°W	2b 175-155°W
2. Baseline.	Stock 1	4	1	γ_1	γ_1	γ_1	0	0
	Stock 2	0	0	0	0	0	1	4
2. Trial Br6	Stock 1	4	1	γ_1	γ_1	0	0	0
	Stock 2	0	0	0	0	Y	1	4
5. Baseline	Stock 1	4	1	γ_1	γ_1	γ_1	0	0
	Stock 2	0	0	γ_2	γ_2	γ_2	1	4
5. Trials Br7	Stock 1	1	γ_3	γ_3	γ_3	0	0	0
	Stock 2	0	γ_4	γ_4	γ_4	Y	1	4
5. Trials Br8	Stock 1	4	1	1	$Y\gamma_5$	$Y\gamma_5$	γ_5	0
	Stock 2	0	0	0	$Y\gamma_6$	$Y\gamma_6$	γ_6	1

Notes:

- The 4:1 ratios used in sub-area 1W are calculated from the ratio of the areas of sub-area 1Wa and 1Wb, but ignoring the area to the South of Japan between 130 -140^{0}E as very few Bryde's whales are seen there.
- Y is calculated using the ratio of the number of degrees of latitude covered by the two areas 1Ec and 2a, i.e. Y=33/18.
- For Hypothesis 2, the ratio of the number of Stock 1 whales in sub-area 1W to that in 1E is estimated during conditioning using the relative abundance in the two sub-areas. In trials Br6, the boundary between the two stocks changes from 180° to 175°E.
- For Hypothesis 5, the density of each stock is assumed to be uniform across the mixing area band.

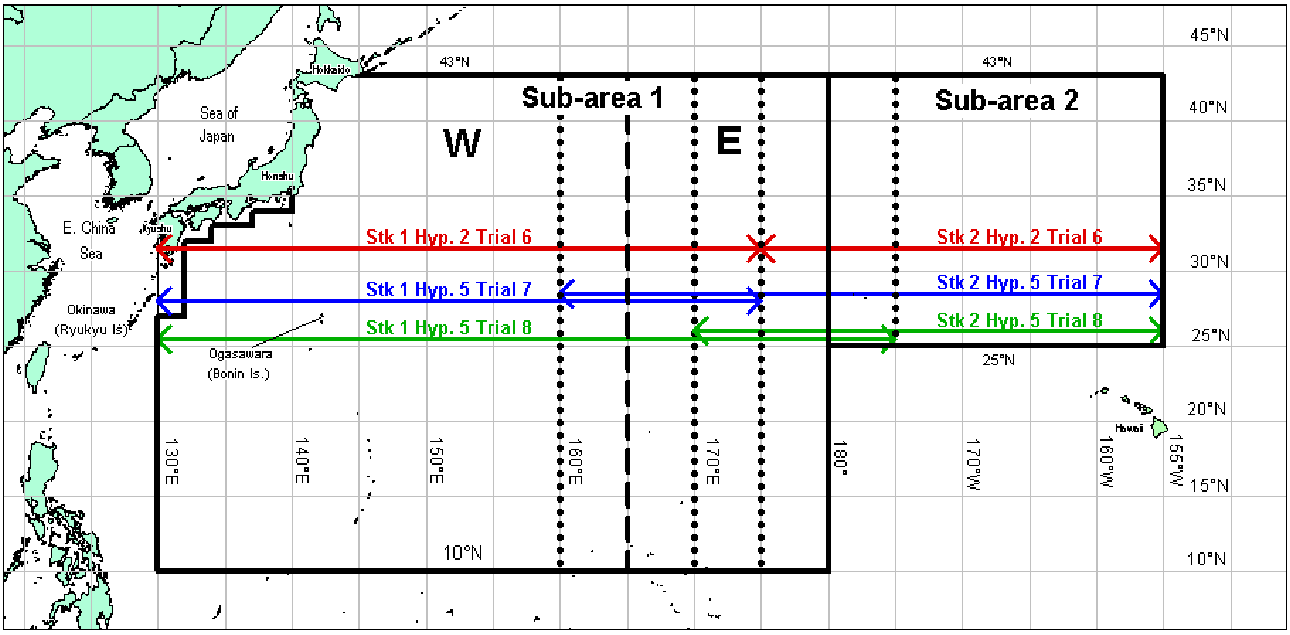

Fig. 3. The ranges of the stocks tested in trials 6, 7 and 8

F2. Boundary

The management boundaries (i.e., the boundaries used by the RMP) are fixed at 165°E and 180° for all trials. In the baseline trials, the boundary between sub-areas 1W and 1E and that between 1E and 2 used when modelling the true population dynamics is the same as that used when applying the RMP i.e. at 165°E and 180°, respectively. However, different stock boundaries are used for some of the trials. TheBr6 trials assume the boundary between Stocks 1 and 2 is at 175˚E (Fig.3). Stock structure hypothesis 5 assumes mixing between Stocks 1 and 2 in an intermediate area. This intermediate area corresponds to sub-area 1E for the baseline version of hypothesis 5. In the Br7 trials the intermediate area is 5° further west than for the baseline trial, while in trials Br8 the intermediate area is 5° further east (Fig. 3).

G. Generation of Data

The actual historical estimates of absolute abundance (and their associated CVs) provided to the RMP are listed in Table 2. Four ways of generating future survey data are considered. This allows for two alternative survey plans (Table 3) and two alternative southern survey boundaries in sub-areas 1W and 1E (at 10˚N and 20˚N). When future surveys are assumed to be conducted to 10˚N in sub-areas 1W and 1E, future surveys are assumed to cover each of sub-areas 1W, 1E and 2 in their entirety. This may be a simplification of reality for future survey option 2 (Table 3). The trials assume that it takes two years for the results of a sighting survey to become available to be used by the RMP, i.e. a survey conducted in 2020 could first be used for setting the catch limit in 2022.

The future estimates of abundance for a survey area *E* are generated using the formula:

$$\hat{P} = P\,Y\,w/\mu = P^{*}\,\beta^{2}\,Y\,w \qquad \text{(G.1)}$$

where Y is a lognormal random variable $Y = e^{\varepsilon}$ where $\varepsilon \sim N(0;\sigma_{\varepsilon}^{2})$ and $\sigma_{\varepsilon}^{2} = \ell n(\alpha^{2}+1)$;

P is the current total (1+) population size in survey area *E*:

$$P = P_t^{E} = \sum_{k\in E}\sum_{j} V_t^{j,k} \sum_{g}\sum_{a\geq 1} N_{t,a}^{g,j} \qquad \text{(G.2)}$$

w is a Poisson random variable with $E(w) = \text{var}(w) = \mu = (P/P^{*})/\beta^{2}$, Y and w are independent; and

P^{*} is the reference population level, and is equal to the expected total (1+) population size in the survey area prior to the commencement of exploitation in the area being surveyed (where the expectation is taken with respect to inter-annual variation in the mixing matrix).

Note that under the approximation $CV^{2}(ab) \cong CV^{2}(a) + CV^{2}(b)$, $E(\hat{P}) \cong P$ and $CV^{2}(\hat{P}) \cong \alpha^{2} + \beta^{2}P^{*}/P$.

For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; IWC 1994, p.85-6), the ratio $\alpha^{2} : \beta^{2} = 0.12 : 0.025$, so that:

$$CV^{2}(\hat{P}) = \tau(0.12 + 0.025P^{*}/P) \qquad \text{(G.3)}$$

The value of τ is calculated from the survey sampling CV's of earlier surveys in survey-area *E*. If $\overline{CV^{2}}$ is the average value of CV^{2} estimated for each of these surveys, and $\overline{P}$ is the average value of the total (1+) population sizes in area *E* in the years of these surveys, then:

$$\tau = \overline{CV^{2}}/(0.12 + 0.025P^{*}/\overline{P}) \qquad \text{(G.4)}$$

Note therefore that:

$$\alpha^2 = 0.12\tau \qquad \beta^2 = 0.025\tau \tag{G.5}$$

The above equations apply in the absence of additional variance. In these trials, an additional variance CV_{add}, is incorporated by making the following adjustment:

$$\sigma_\varepsilon^2 = \ell n\left(1+\alpha^2+CV_{add}^2\right) \tag{G.6}$$

CV_{add}, = 0.335 in the baseline trials (SC/67a/RMP04), while for trials Br5, CV_{add} = 0.737 [see item 3.2.3 of IWC (2019) [SC/67b/Rep02]].

An estimate of the *CV* is generated for each sighting survey estimate of abundance $\hat{P}$:

$$CV\left(\hat{P}\right)_{est}^2 = \sigma^2\chi^2 / n \tag{G.7}$$

where $\sigma^2 = \ell n\left(1+\alpha^2+\beta^2 P^*/\hat{P}\right)$, and

χ^2 is a random number from a Chi-square distribution with *n* degrees of freedom (where *n*=10 as used for the North Pacific minke whale *Implementation Simulation Trials*; IWC, 2004).

Table 2

The estimates of abundance and their sampling errors. These estimates of abundance correspond to an western boundary of 130˚E for sub-area 1W and a southern boundary of 10˚N for sub-areas 1W and 1E. Additional estimates corresponding to the smaller area with a southern boundary of 20˚N are also provided for sub-areas 1W and 1E. The methods used to derive these values from the original abundance estimates in cases where the survey area differed from the area used here, were agreed in IWC (2019) [SC/67b/Rep02]. The estimates of abundance in sub-areas 1E and 2 exclude the portion of the sub-area north of 40˚N (see Annex F, IWC (2019)), with the corresponding assumption that a negligible number of whales are found in this area. Survey-specific g(0) values are used (Hakamada *et al*., 2018) with an assumed constant g(0) CV = 0.25.

			Southern boundary of 10˚N in sub-areas 1W and 1E				Southern boundary of 20˚N in sub-areas 1W and 1E			
			g(0) = 1		Survey-specific g(0)		g(0) = 1		Survey-specific g(0)	
Sub-area	Year	Survey-specific g(0)	Estimate	Sampling CV	Estimate	Sampling CV	Estimate	Sampling CV	Estimate	Sampling CV
1W	1995[4]	0.671	8,152	0.329	12,149	0.413	5,110	0.192	7,604	0.315
	2000	0.719	4,957	0.398	6,894	0.470	4,222	0.317	5,872	0.404
	2011	0.613	24,536[1]	0.313	40,026	0.401	20,386[2]	0.274	33,256	0.371
1E	1995[4]	0.689	10,814	0.342	15,695	0.424	7,246	0.479	10,517	0.540
	2000	0.584	11,213	0.498	19,200	0.557	9,251	0.295	15,841	0.387
	2011	0.721	6,914[3]	0.211	9,589	0.327	6,716	0.216	9,315	0.330
2	1995[4]	0.659	2,860	0.372	4,340	0.448				
	2000	0.712	4,331	0.553	6,083	0.607				
	2014	0.641	4,161	0.264	6,491	0.364				

[1] This estimate was revised from15,422 [CV=0.289] to account for unsurveyed areas between 130-140˚E and 10-20˚N (Adjunct 2).

[2] This estimate was revised from 15,422 [CV=0.289] to account for unsurveyed areas between 10-20 ˚N (Adjunct 2).

[3] This estimate was revised from 6,716 [CV=0.216] to account for unsurveyed areas between 10-20 ˚N (Adjunct).

[4] The 1995 estimates are only used in conditioning and in the calculation of x_{1W} and x_{1E} .They are not passed to the RMP.

Future surveys covering smaller areas than historical surveys

When future surveys are assumed to be conducted south to 20˚N in sub-areas 1W and 1E, the future survey estimates of abundance in these sub-areas is given by $\hat{P}_{k'} = x_k\hat{P}_k$, where $\hat{P}_k$ is provided by equation (G.1) for sub-area *k*, and the proportions are generated from normal distributions $x_{1W} \sim Beta(0.77, 0.12^2)$ and $x_{1E} \sim Beta(0.82, 0.15^2)$. These normal distributions are given the mean and standard deviations of the proportions of the three historical survey estimates of abundance in these sub-areas that was north of 20˚N.

Table 3
Sighting survey plan. All surveys are conducted in Jul-Aug.

Season	Option 1			Option 2				
	130°-165°E	165°E-180°	180°-160°W	130°-140°E	140°-152.5°E	152.5°-165°E	165°E-180°	180°-160°W
Sub-Area	1W	1E	2	1W	1W	1W	1E	2
2017								
2018								
2019								
2020	Yes[1]			Yes				
2021					Yes[2]			
2022		Yes				Yes		
2023							Yes	
2024			Yes					Yes
2025				Yes				
2026	Yes[1]				Yes[2]			
2027						Yes		
2028		Yes					Yes	
2029								Yes
2030			Yes	Yes				
2031					Yes[2]			
2032	Yes[1]					Yes		
and so on in this pattern								

[1] The survey effort in 1W will be double that of the past and thus $CV^2(\hat{P}) = \tau(0.12 + 0.025P^* / P)$ in equation (G,3) is replaced by $CV^2(\hat{P}) = \tau(0.12 + 0.025\, P^*/P)/\sqrt{2}$, prior to CV_{add} being incorporated in equation (G.7).

[2] Future surveys of sub-area 1W will be modelled to occur in a single year, although in practice it will take 3 years to survey the whole sub-area. Assuming the whales are distributed equally throughout the three part-areas of sub-area 1W surveyed, the variance from each of these annual surveys would be $(P/3 * SE)^2 = (P^2/9)(CV^2 + CV_{add}^2)$. The variance for 1W will thus be 3 times this, giving an effective CV of $\sqrt{(CV^2 + CV_{add}^2)/3}$, and equation (G.6) is replaced by $\sigma_\varepsilon^2 = ln[1 + (\alpha^2 + CV_{add}^2)/3]$. For this future survey plan, the additional CV increases to $CV_{add} = 0.767$ for sub-area 1W and for Trials Br05 to $CV_{add} = 1.516$ (Adjunct 3).

Table 4
The values for the biological and technological parameters that are fixed.

Parameter	Value
Plus group age, x	15 yrs
Natural mortality, M_a	0.08yr^{-1}
Age-at-first-parturition, a_m	9 years (See Annex I of IWC (2018) [SC/67a/Rep07]: calculated as 8.6)
Selectivity (historical)	
Sub-area 1W:	Knife-edged at age 5 (IWC, 2000, 2005)
Sub-areas 1E & 2:	Knife-edged at age 9 (IWC, 2000, 2005)
Selectivity (future)	Knife-edged at age 5 (IWC, 2007 p415)
Maximum Sustainable Yield Level, *MSYL*	0.6 in terms of the1+ component of the population

H. Parameters and conditioning

The values for the biological and technological parameters are listed in Table 4. In relation to selectivity, historically a 35ft (10.7m) legal minimum size limit applied to coastal whaling and a 40ft (12m) limit applied to pelagic operations. These size limits correspond to ages of five and nine years respectively (Ohsumi, 1977). The size limits are implemented by making selectivity depend on sub-area. Historically, pelagic whaling occurred in sub-areas 1E and 2, and coastal whaling in sub-area 1W. Therefore, selectivity is assumed to be knife-edged at age five for sub-area 1W, while selectivity for sub-areas 1E and 2 is assumed to be knife-edged at age nine. All future catches are assumed have a knife-edged selectivity at age five (hence the t-subscript on S in equations E.1 and E.2).

The 'free' parameters of the above model are the initial (pre-exploitation) sizes of each of the stocks and the values that determine the mixing matrices. The process used to select the values for these 'free' parameters is known as conditioning. The conditioning process involves first generating 100 sets of 'target' data, detailed in steps (a) and (b) below, and then fitting the population model to each (in the spirit of a bootstrap). The number of animals in Component-area k at the start of year t is calculated starting with guessed values of the initial population sizes and projecting the operating model forward to 2017 to obtain values of abundance by stock and mixing proportions for comparison with the generated data.

(a) The 'target' values for the historical abundance by survey-area are generated using the formula:

$$P_t^E = O_t^E \exp[\mu_t^E - (\sigma_t^E)^2 / 2]\,;\ \ \mu_t^E \sim N[0;(\sigma_t^E)^2] \tag{H.1}$$

where P_t^E is the abundance for survey-area E in year t;

O_t^E is the actual survey estimate for survey-area E in year t (Table 2, 10°N southern boundary); and

σ_t^E is the CV of O_t^E (Table 2).

(b) The ‘targets’ for the mixing proportion in the mixing area trials based on stock structure hypothesis 5 are generated from normal distributions (mean and SD given in Table 5), truncated at 0 and 1.

Table 5.

Estimates and asymptotic standard errors for the mixing proportions between Stocks 1 and 2 in Hypothesis 5 trials (Punt 2018)

Area	Average proportion of Stock 1 between 2004-2014 (from JARPNII/POWER samples)	Standard Error	Proportion of Stock 1 in 1979 (from commercial samples)	Standard Error
Baseline: 165°E-180°	1.000	0.114	0.851	0.132
Trial Br7: 160°E-175°E	0.900	0.065	0.933	0.057
Trial Br8: 170°E-175°W	0.644	0.144	1.000	0.467

I. Calculation of the Likelihood

The likelihood function consists of two components. Equations H.2 and H.3 list the negative of the logarithm of the likelihood for each of these components so the objective function minimised is L_1+L_2, where L_2 only applies for Hypothesis 5. An additional penalty is added to the likelihood if the full historical catch is not removed.

Abundance estimates

$$L_1 = 0.5\sum_n \frac{1}{(\sigma_n)^2}\ell n\left(P_n / \hat{P}_n\right)^2 \tag{H.2}$$

where $\hat{P}_n$ is the model estimate of the 1+ abundance in the same year and survey-area as the n^{th} estimate of abundance P_n (the target abundances).

Mixing proportions

$$L_2 = 0.5\frac{1}{\sigma_{79}^2}\left(p_{79} - \hat{p}_{79}\right)^2 + 0.5\frac{1}{\sigma_{04}^2}\left(p_{04} - \hat{p}_{04}\right)^2 \tag{H.3}$$

where $\hat{p}_{79}$ is the model estimate of the proportion of Stock 1 animals in the mixing area[4] in 1979,

$\hat{p}_{04}$ is the average of the model estimate of the proportion of Stock 1 animals in the mixing area[3] over 2004 to 2014, and

p_{79} and p_{04} are the ‘target’ mixing proportions from commercial samples in 1979 and JARPNII/POWER survey samples between 2004-2014, respectively, given in Table 5.

[4] The mixing area is sub-area 1E (165˚E-180˚E) for the baseline trials, but changes to 160˚E-175˚E for trials Br7, and 170˚E-175˚W for trials Br8.

J. Trials

The *Implementation Simulation Trials* for the western North Pacific Bryde's whales are listed in Table 6. All of the trials are based on the assumption g(0)=0.672. Table 7 lists the factors used in the trials. These trials will be run under the following four future survey options:

(1) Future survey option 1 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 10˚N
(2) Future survey option 1 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 20˚N
(3) Future survey option 2 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 10˚N
(4) Future survey option 2 (see Table 3), with surveys in sub-areas 1W and 1E conducted south to 20˚N

Table 6

The *Implementation Simulation Trials* for the Western North Pacific Bryde's whales

Trial	Stock structure hypothesis	MSYR[1]	Additional variance	Catch series	Western boundary of Stock 2	Eastern boundary of Stock 1	Comment
Br1-1	2	1	Baseline	Best	180°	180°	Baseline stock structure hypothesis 2
Br1-4	2	4	Baseline	Best	180°	180°	Baseline stock structure hypothesis 2
Br2-1	5	1	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br2-4	5	4	Baseline	Best	165°E	180°	Baseline stock structure hypothesis 5
Br3-1	5	1	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br3-4	5	4	Baseline	**Low**	165°E	180°	Stock hypothesis 5 with low catches
Br4-1	5	1	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br4-4	5	4	Baseline	**High**	165°E	180°	Stock hypothesis 5 with high catches
Br5-1	5	1	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br5-4	5	4	**Upper CI**	Best	165°E	180°	Stock hypothesis 5 with higher additional variance
Br6-1	2	1	Baseline	Best	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
Br6-4	2	4	Baseline	Best	175°E	**175°E**	Stock hypothesis 2 with alternative boundaries 1
Br7-1	5	1	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br7-4	5	4	Baseline	Best	**160°E**	**175°E**	Stock hypothesis 5 with alternative boundaries 1[2]
Br8-1	5	1	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br8-4	5	4	Baseline	Best	**170°E**	**175°W**	Stock hypothesis 5 with alternative boundaries 2[2]
Br9-1	2	1	Baseline	Best	180°	180°	Density-dependent *M*
Br9-4	2	4	Baseline	Best	180°	180°	Density-dependent *M*
Br10-1	5	1	Baseline	Best	165°**E**	180°	Density-dependent *M*
Br10-4	5	4	Baseline	Best	165°**E**	180°	Density-dependent *M*

[1]MSYR=1% is related to the 1+ component ; MSYR =4% is related to mature component
[2] Based on alternative mixing proportion data

Table 7

Factors considered in the revised trials. The values in bold are the baseline values

Factor	Values considered
Stock structure hypotheses	**2**, **5**
MSYR	$\boldsymbol{MSYR_{1+}}$ **= 1%;** $\boldsymbol{MSYR_{mat}}$**=4%**
Catch series	Low, **Best**, High
Additional variance	**Baseline = 0.335**, Upper 5%ile = 0.737
Western boundary of Stock 2	160°E, **165°E**, **180°**, 170°E
Eastern boundary of Stock 1	175°E, **180°**, 175°W

K. Management Options

In all cases, the boundary between sub-areas 1W and 1E is defined as 165°E and that between sub-areas 1E and 2 at 180° irrespective of the true boundary used to define the structure of the populations in the operating model. The following five management options will be considered.

All future catches from sub-area 1W will be simulated to only be taken in component area 1Wa (closest to the coast of Japan)

V1 Sub-areas 1W, 1E and 2 are *Small Areas* and catch limits are set by *Small Area*.

V2 Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area.* For this management option, all of the future catches in sub-area 1 are taken from sub-area 1W.

V3 Sub-area 2 is taken to be a *Small Area* and sub-area 1 is taken to be a *Combination area*. Sub-areas 1W and 1E are *Small Areas*, with catch-cascading applied.

V4 Sub-area 1W is taken to be a *Small Area* and sub-areas 1E and 2 (combined) are taken to be a *Combination Area*. Sub-areas 1E and 2 are *Small Areas*, with *catch-cascading* applied.

V5 Sub-areas 1 and 2 (combined) are taken to be a *Combination area*. Sub-areas 1W, 1E and 2 are *Small Areas*, with *catch-cascading* applied.

The simulated application of the RMP is based on using the "best" catch series (see Adjunct 1).

L. Output Statistics

Population-size and continuing catch statistics are produced for each stock and catch-related statistics for each sub-area.

(1) Total catch (TC) distribution: (a) median; (b) 5th value; (c) 95th value.
(2) Initial mature female population size (P_{initial}) distribution: (a) median; (b) 5th value; (c) 95th value.
(3) Final mature female population size (P_{final}) distribution: (a) median; (b) 5th value; (c) 95th value.
(4) Lowest mature female population size (P_{lowest}) distribution: (a) median; (b) 5th value; (c) 95th value.
(5) Average catch by sub-area over the first ten years of the 100 year management period: a) median; b) 5th value; c) 95th value.
(6) Average catch by sub-area over the last ten years of the 100 year management period: a) median; b) 5th value; c) 95th value.

Plots are produced showing following types of outputs for all variants and the no-catch scenarios:
(a) the median population size trajectories by stock;
(b) the 5%-ile, median and 95%-ile of the population depletion trajectories by stock from year 2000 to the end of the projection period);
(c) the median catch trajectories from year 2000 onwards; and
(d) ten individual population trajectories for each stock.

In addition, plots and tables are produced summarising the application of the procedure for defining 'acceptable' - A, 'borderline' - B and 'unacceptable' - U performance, by comparison with the equivalent single stock trials –see IWC 2005 p84-92.

M. References

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Punt 2018 Annex F of March 2017 workshop report. Estimates of mixing proportions for subarea 1E using mtDNA haplotype data.

Adjunct 1

The catch series used in the trials (L=low, B=best, H=high)

Year	1Wa M	1Wa F	1Wb M	1Wb F	1Ea M	1Ea F	1Eb M	1Eb F	1Ec M	1Ec F	2a M	2a F	2b M	2b F
1906	6	7	0	0	0	0	0	0	0	0	0	0	0	0
1907	17	18	0	0	0	0	0	0	0	0	0	0	0	0
1908	39	42	0	0	0	0	0	0	0	0	0	0	0	0
1909	23	24	0	0	0	0	0	0	0	0	0	0	0	0
1910	26	29	0	0	0	0	0	0	0	0	0	0	0	0
1911	75	81	0	0	0	0	0	0	0	0	0	0	0	0
1912	38	43	0	0	0	0	0	0	0	0	0	0	0	0
1913	58	66	0	0	0	0	0	0	0	0	0	0	0	0
1914	24	32	0	0	0	0	0	0	0	0	0	0	0	0
1915	72	97	0	0	0	0	0	0	0	0	0	0	0	0
1916	45	60	0	0	0	0	0	0	0	0	0	0	0	0
1917	88	93	0	0	0	0	0	0	0	0	0	0	0	0
1918	69	79	0	0	0	0	0	0	0	0	0	0	0	0
1919	77	84	0	0	0	0	0	0	0	0	0	0	0	0
1920	41	51	0	0	0	0	0	0	0	0	0	0	0	0
1921	40	49	0	0	0	0	0	0	0	0	0	0	0	0
1922	37	44	0	0	0	0	0	0	0	0	0	0	0	0
1923	32	43	0	0	0	0	0	0	0	0	0	0	0	0
1924	48	63	0	0	0	0	0	0	0	0	0	0	0	0
1925	55	63	0	0	0	0	0	0	0	0	0	0	0	0
1926	60	74	0	0	0	0	0	0	0	0	0	0	0	0
1927	53	65	0	0	0	0	0	0	0	0	0	0	0	0
1928	36	44	0	0	0	0	0	0	0	0	0	0	0	0
1929	29	34	0	0	0	0	0	0	0	0	0	0	0	0
1930	27	35	0	0	0	0	0	0	0	0	0	0	0	0
1931	64	71	0	0	0	0	0	0	0	0	0	0	0	0
1932	51	53	0	0	0	0	0	0	0	0	0	0	0	0
1933	39	49	0	0	0	0	0	0	0	0	0	0	0	0
1934	48	51	0	0	0	0	0	0	0	0	0	0	0	0
1935	48	48	0	0	0	0	0	0	0	0	0	0	0	0
1936	40	48	0	0	0	0	0	0	0	0	0	0	0	0
1937	60	66	0	0	0	0	0	0	0	0	0	0	0	0
1938	76	83	0	0	0	0	0	0	0	0	0	0	0	0
1939	88	105	0	0	0	0	0	0	0	0	0	0	0	0
1940	48	57	0	0	0	0	0	0	0	0	0	0	0	0
1941	64	81	0	0	0	0	0	0	0	0	0	0	0	0
1942	9	12	0	0	0	0	0	0	0	0	0	0	0	0
1943	17	13	0	0	0	0	0	0	0	0	0	0	0	0
1944	37	37	0	0	0	0	0	0	0	0	0	0	0	0
1945	5	7	0	0	0	0	0	0	0	0	0	0	0	0
1946	52	74	0	0	0	0	0	0	0	0	0	0	0	0
1947	51	60	0	0	0	0	0	0	0	0	0	0	0	0
1948	57	76	0	0	0	0	0	0	0	0	0	0	0	0
1949	101	97	0	0	0	0	0	0	0	0	0	0	0	0
1950	117	156	0	0	0	0	0	0	0	0	0	0	0	0
1951	166	141	0	0	0	0	0	0	0	0	0	0	0	0
1952	303	188	0	0	0	0	0	0	0	0	0	0	0	0
1953	25	36	0	0	0	0	0	0	0	0	0	0	0	0
1954	31	44	0	0	0	0	0	0	0	0	0	0	0	0
1955	34	60	0	0	0	0	0	0	0	0	0	0	0	0
1956	12	12	0	0	0	0	0	0	0	0	0	0	0	0
1957	12	27	0	0	0	0	0	0	0	0	0	0	0	0
1958	113	141	0	0	0	0	0	0	0	0	0	0	0	0
1959	153	110	0	0	0	0	0	0	0	0	0	0	0	0
1960	188	216	0	0	0	0	0	0	0	0	0	0	0	0
1961	83	84	0	0	0	0	0	0	0	0	0	0	0	0
1962	209	295	0	0	0	0	0	0	0	0	0	0	0	0
1963	100	110	0	0	0	0	0	0	0	0	0	0	0	0
1964	25	43	0	0	0	0	0	0	0	0	0	0	0	0
1965	1	7	0	0	0	0	0	0	1	1	2	2	0	0
1966	19	36	0	0	0	0	0	0	1	2	2	3	0	0
1967	17	28	0	0	0	0	0	0	0	0	0	0	0	0
1968	70	101	0	0	0	0	0	0	1	2	4	5	0	0
1969	34	55	0	0	0	0	0	0	6	10	16	22	0	0
1970	36	37	0	0	0	0	0	0	4	7	11	15	0	0
1971	96	121	0	0	37	54	19	19	62	93	48	70	23	29
1972	38	46	0	0	2	4	0	0	20	37	4	6	0	3
1973	185	391	5	11	6	6	7	12	7	13	4	11	16	25
1974	282	418	5	4	13	9	12	30	95	147	67	84	80	76
1975	349	331	9	12	17	37	72	76	40	54	89	119	138	89
1976	379	446	11	15	106	62	183	95	81	50	14	5	11	1
1977	182	192	234	179	66	49	10	14	2	9	0	3	2	4
1978	252	203	22	13	102	48	51	57	14	21	7	4	1	1

1979	589	517	81	53	23	13	0	3	0	0	0	0	0	2
1980	401	354	0	0	0	0	0	0	0	0	0	0	0	0
1981	249	236	0	0	0	0	0	0	0	0	0	0	0	0
1982	275	207	0	0	0	0	0	0	0	0	0	0	0	0
1983	403	142	0	0	0	0	0	0	0	0	0	0	0	0
1984	353	175	0	0	0	0	0	0	0	0	0	0	0	0
1985	249	108	0	0	0	0	0	0	0	0	0	0	0	0
1986	217	100	0	0	0	0	0	0	0	0	0	0	0	0
1987	256	61	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1995	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1998	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	20	23	0	0	0	0	0	0	0	0	0	0	0	0
2001	17	33	0	0	0	0	0	0	0	0	0	0	0	0
2002	25	25	0	0	0	0	0	0	0	0	0	0	0	0
2003	18	28	1	3	0	0	0	0	0	0	0	0	0	0
2004	14	23	5	2	1	6	0	0	0	0	0	0	0	0
2005	21	26	0	3	0	0	0	0	0	0	0	0	0	0
2006	12	7	6	13	3	10	0	0	0	0	0	0	0	0
2007	23	25	0	0	0	2	0	0	0	0	0	0	0	0
2008	30	20	0	0	0	0	0	0	0	0	0	0	0	0
2009	15	18	1	1	2	13	0	0	0	0	0	0	0	0
2010	3	5	17	11	5	9	0	0	0	0	0	0	0	0
2011	17	24	1	4	2	2	0	0	0	0	0	0	0	0
2012	10	17	1	3	0	3	0	0	0	0	0	0	0	0
2013	12	13	1	2	0	0	0	0	0	0	0	0	0	0
2014	6	19	0	0	0	0	0	0	0	0	0	0	0	0
2015	14	11	0	0	0	0	0	0	0	0	0	0	0	0
2016	7	14	4	1	0	0	0	0	0	0	0	0	0	0

ADJUNCT 2: A STRATEGY TO ESTIMATE ABUNDANCE FOR CONDITIONING

D. Palka

For conditioning, abundance estimates for the entire area for the entire historical time series are required. The entire area is defined as the sub-areas 1W, 1E and 2, less the hatched region between 165°E and 165°W in the northeast (Fig. 1). The abundance time series consists of three sets of abundance surveys where the abundance estimates are centred on, and therefore time stamped 1995 (1988-1996; Shimada et al. 2008 (SC60/PFI2); Figs 2-3), 2000 (1998-2002; Kitakado et al. 2008 (SC60/PFI3); Fig 4) and 2011 (2008-2015; Fig 5).

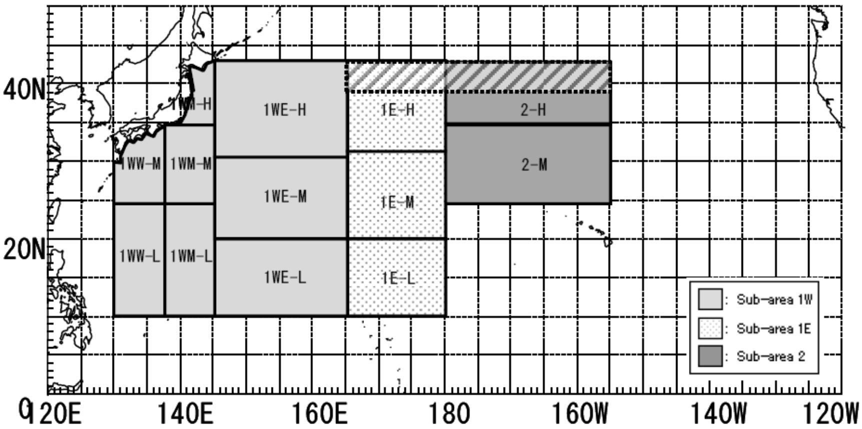

Fig. 1. Sub-areas and blocks used for the abundance estimation. "H", "M" and "L" mean high, middle and low latitudes. The northern parts (shaded) in the two blocks, 1E-H and 2-H, were excluded from the estimation of abundances, which means any detections and effort in those parts were not included in the analyses, and the abundance estimates in those blocks were calculated for the southern parts of 1E-H and 2-H. A more detailed explanation is given in Shimada et al. (2008).

The abundance for the entire area has already been estimated (and agreed by the Committee) for the first two sets of surveys that were time stamped 1995 and 2000. However, the set of surveys time stamped 2011 did not cover the whole of the 1W sub-area. Thus the previously reported abundance estimates for 1W and 1E for the 2011 set of surveys represents only a partial estimates for the 1W and 1E sub-areas, respectively. Therefore, to make the 1W and 1E abundance estimates from the 2011 set of surveys comparable to the earlier two sets of surveys, the partial 1W and 1E abundance estimates from the 2011 set of surveys must be expanded by adding an approximate estimate of the abundance in the unsurveyed areas.

The best abundance estimate for an unsurveyed sub-areas for the 2011 set of surveys was derived from the abundance estimates for these sub-areas as calculated from the 1995 and 2000 previous sets of surveys. It was assumed that for each set of surveys, the ratio of the abundance in the 2011 unsurveyed areas to the abundance in the 2011 surveyed areas were similar. Since there are two sets of previous surveys, the average ratio of unsurveyed to surveyed abundance estimates from the two previous sets of surveys was assumed to be the most representative number to use to expand the 2011 partial abundance estimates using:

$$N_{tot2011} = N_{part2011} + \left(N_{part2011} \cdot Average\left[\frac{N_{unsurv.i}}{N_{surv.i}}\right]\right) \qquad \text{eq. 1}$$

where $N_{unsurv.i}$ is the abundance in the 2011 unsurveyed sub-areas from the ith set of surveys
$N_{surv.i}$ is the abundance in the 2011 surveyed sub-areas from the ith set of surveys
i is the set of surveys time stamped either 1995 or 2000.

The CV of $N_{tot2011}$ was estimated using the delta method.

The best estimates used to represent the 2000 set of surveys are the abundance estimates derived from a combination of the surveys conducted during 1998-2002, as reported in Kitakado et al. 2008, Table 3. Because combined abundances for each sub-sub-area was not available for the 1995 set of surveys, the most represent set of sub-sub-area abundance estimates was from the single year 1993 as reported in Shimado et al. 2008, Table 8a.

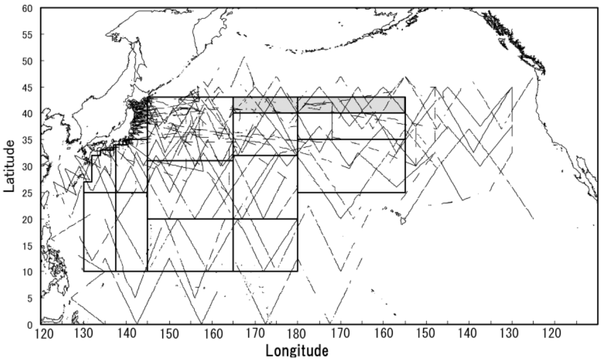

Fig. 2. Pre-determined cruise track lines on effort during the past sightings surveys in August and September, 1988-1996 (time stamp 1995). The northern part (north of 39° N) of 1E-H and 2-H block excluded this abundance estimation to keep consistency of estimation in the recent surveys that were not covered enough, shown as gray color

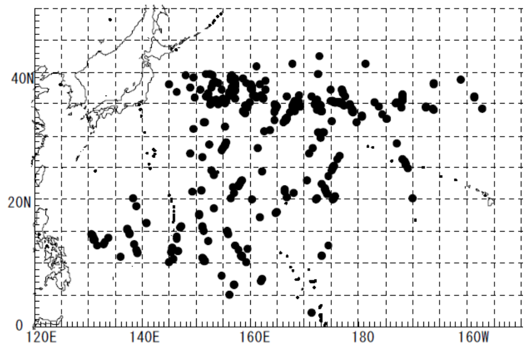

Fig. 3. Primary sighting positions of Bryde's whale during the past sighting surveys in August and September, 1988-1996 (time stamp 1995).

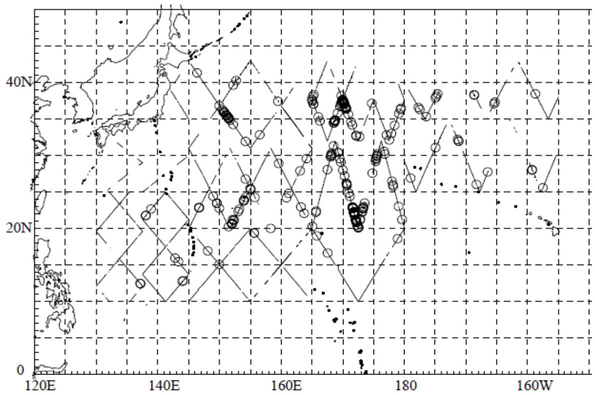

Fig. 4. Primary sighting positions of Bryde's whale and track lines on effort for surveys in August and September, 1998-2002 (time stamp 2000)

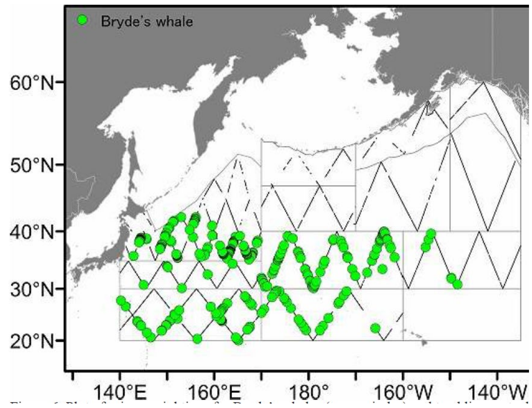

Fig. 5. Plot of primary sightings for Bryde's whales (green circles) and tracklines actually surveyed during 2008-2015 (time stamp 2011)

Results

1W sub-area: The partial abundance estimate for the surveyed regions from the 2011 set of surveys in 1W is $N_{1W\text{-}part2011}$=15,422 CV=0.289. The 1W sub-sub-areas not surveyed during the 2011 set of surveys and where there were Bryde's whales are between 130°-140°E (sub-sub-areas 1WW-M, 1WW-L and 1WM-L) and between 10°-20°N (sub-sub-area 1WE-L). Sub-sub-areas 1WM-M and 1WM-H were also not surveyed in 2011, but there were no Bryde's whales detected in the earlier two set of surveys (Fig 3 and 4), so it is assumed that there were no Bryde's whales in these sub-sub-areas during the 2011 set of surveys.

Using equation 1, the expanded 2011 abundance estimate for the entire 1W sub-area, $N_{1W\text{-}tot2011}$ (including 130°-140°E and 10°-20°N) was estimated to be 24,536 (CV=0.313; Table 1A). The expanded 2011 partial abundance estimate that represents the 1W sub-area that includes 130°-140°E, but no 10°-20°N is 20,386 (CV=0.274; Table 1B).

1E sub-area: The partial abundance estimate for the surveyed regions from the 2011 set of surveys in 1E is $N_{1E\text{-}part2011}$=6,716 CV=0.216. The 1E sub-sub-area not surveyed during the 2011 set of surveys is between 10°-20°N (sub-sub-area 1E-L).

Using equation 1, the expanded abundance estimate for the entire 1E sub-area, $N_{1E\text{-}tot2011}$ was estimated to be 6,914 (CV=0.211; Table 2).

References

Kitakado, T., Shimada, H., Okamura, H. and Miyashita, T. 2008. CLA abundance estimates for western North Pacific Bryde's whales and their associated CVs with taking the additional variance into account. Paper SC/60/PFI3 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 27pp. [Paper available from the Office of this Journal].

Shimada, H., Okamura, H., Kitakado, T. and Miyashita, T. 2008. Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and CLA application. Paper SC/60/PFI2 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 34pp. [Paper available from the Office of this Journal].

Table 1.

Estimate of abundance for the entire 1W sub-area for the 2011 set of surveys ($N_{tot2011}$). Estimates representing the 1995 set of surveys were taken from the 1993 single year's estimates from the base case in Shimada et al. 2008 (SC60/PFI2; Table 8a). Estimates from the 2000 set of surveys were taken from run 1, Model 4 in Kitakado et al. 2008 (SC60/PFI3; Table 3).

		Unsurveyed sub-areas in 2011 set of surveys				Surveyed sub-areas in 2011 set of surveys									
		130°-140°E			10°-20°N										
Timestamp year		1WW-M	1WW-L	1WM-L	1WE-L	1WE-H	1WE-M	$N_{surv.i}$	$N_{unsurv.i}$	total	unsurveyed/ surveyed	average extra bit	1W $N_{part2011}$	2011 Unsurveyed sub-areas	**1W $N_{tot2011}$**
A. Adding in unsurveyed regions between 130°-140°E and 10°-20°N															
1993	Abun	110	2132	792	3002	3531	3450	6981	6036	13017	0.8646	0.59095	15422	9113.6	**24535.6**
	CV	0.6682	0.5812	0.5627	0.7114	1.2805	0.5348	0.6995	0.4158	0.4218	0.8138	0.6225	0.289	0.6863	**0.3130**
2000	Abun	0	348	439	407	1238	2525	3763	1194	4957	0.3173				
	CV	0	1.0632	0.784	0.7379	0.6371	0.6149	0.4628	0.4923	0.3708	0.6757				
B. Adding in unsurveyed regions between 130°-140°E															
1993	Abun	110	2132	792	0	3531	3450	6981	3034	10015	0.4346	0.32185	15422	4963.6	**20385.6**
	CV	0.6682	0.5812	0.5627	0	1.2805	0.5348	0.6995	0.4347	0.5051	0.8236	0.6125	0.289	0.6773	**0.2738**
2000	Abun	0	348	439	0	1238	2525	3763	787	4550	0.2091				
	CV	0	1.0632	0.784	0	0.6371	0.6149	0.4628	0.6421	0.3985	0.7915				

Table 2.

Estimate of abundance for the entire 1E sub-area for the 2011 set of surveys ($N_{tot2011}$). Estimates representing the 1995 set of surveys were taken from the 1993 single year's estimates from the base case in Shimada et al. 2008 (SC60/PFI2; Table 8a). Estimates from the 2000 set of surveys were taken from run 1, Model 4 in Kitakado et al. 2008 (SC60/PFI3; Table 3).

Timestamp year		Unsurveyed in 2011 (10°-20°N) 1E-L	Surveyed sub-areas in 2011 set of surveys 1E-H	total	unsurveyed/ surveyed	average extra bit	1E $N_{part2011}$	2011 Unsurveyed sub-areas	**1E $N_{tot2011}$**
1993	Abun	622	13634	21388	0.03	0.02945	6716	197.8	**6913.8**
	CV	0.7428	0.7427	0.6442	0.9958	0.675	0.216	0.7087	**0.2108**
2000	Abun	315	3480	11213	0.0289				
	CV	0.7646	0.5967	0.4765	0.908				

ADJUNCT 3: FUTURE SIGHTING SURVEY PLAN FOR NORTH PACIFIC BRYDE'S WHALE

-ADDITIONAL CV FOR THREE LONGITUDINAL BLOCKS IN SUB-AREA 1W

T. Hakamada and T. Miyashita

One of the options in Japan's future sighting survey plan for North Pacific Bryde's whale is sub-area 1W divided into three longitudinal blocks:1)130ºE-140ºE, 2) 140ºE-152º30'E and 3) 152º30'E-165ºE (Figure 1). This is because the whole sub-area 1W is too large to be covered within one year survey. Estimates of additional variance for the three blocks is required.

Table 1 shows the abundance estimates and CV for estimating additional variance. In the period 2008-2015, there was no abundance estimate for 1W_1 blocks. Abundance for 1988 – 1996 was re-allocated from the value in 1993 when the surveys covered all blocks once a year in Shimada et al. 2008 (Table 8a in Skaug (2008). Abundance for 1998 – 2002 was re-allocated from those of run1, Model 4 in Kitakado *et al.* 2008 (Table 3 in Kitakado *et al.* 2008). The value 2008 – 2015 was estimated from the original sighting data by Hakamada. The total abundance is re-allocated in proportional with (Area/Effort) for each block in the cases of 1988-1996 and 1998-2002.

Since the covariances are very small (because for the abundance estimates the variance from sighting rate dominates those from the common factors of mean school size and effective search half-width), they have been neglected below in the estimation of additional variance.

Using the abundance estimate in Table 1, additional CV was estimated as 0.7670 and its upper 5th-percentile is 1.516.

Reference:

KITAKADO, T., SHIMADA, H., OKAMURA, H. AND MIYASHITA, T. CLA abundance estimates for western North Pacific Bryde's whales and their associated CVs with taking the additional variance into account. Document SC/60/PFI3.

SHIMADA, H., OKAMURA, H., KITAKADO, T. AND MIYASHITA, T. 2008. Abundance estimate of western North Pacific Bryde's whales for the estimation of additional variance and CLA application. Document SC/60/PFI2.

Skaug, H.J. 2008. Lack of spatial genetic substructure in the 2003-2006 catches of NA-minke whales. Paper SC/60/PFI1 presented to the IWC Scientific Committee, June 2008, Santiago, Chile (unpublished). 8pp. [Paper available from the Office of this Journal].

Table 1. Abundance estimates in the three longitudinal blocks of sub-area 1W for estimating additional variance.

	1W_1(130E-140E, 10N-43N)				1W_2 (140E-152.5E, 10N-43N)				1W_3 (152.5E-165E, 10N-43N)			
	Year	P	CV(P)	Areal coverage (%)	Year	P	CV(P)	Areal coverage (%)	Year	P	CV(P)	Areal coverage (%)
1988-1996	1993	2,506	0.506	90.9	1995	4,271	0.769	96.2	1995	6,239	0.675	76.1
1998-2002	2000	535	0.744	74.3	2000	2,579	0.393	89.8	2000	1,642	0.448	80.6
2008-2015					2011	7,097	0.308	63.4	2011	8,168	0.251	66.9

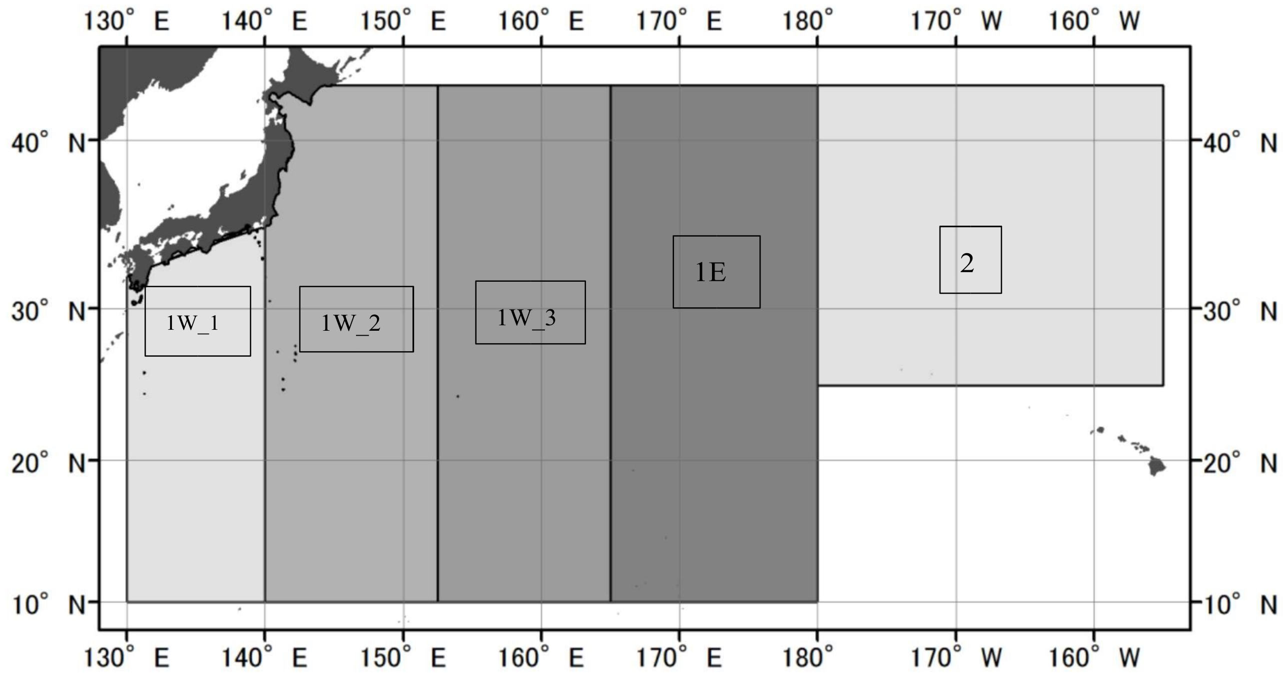

Figure 1. Three blocks (1W_1, 1W_2 and 1W_3) in sub-area 1W and sub-areas 1E and 2.

Appendix 3

THE SPECIFICATIONS FOR THE IMPLEMENTATION SIMULATION TRIALS FOR WESTERN NORTH PACIFIC MINKE WHALES

[To come]