Report of the Second Intersessional Workshop on the Western North Pacific Bryde's Whale *Implementation*

The Workshop took place at the National Research Institute of Far Seas Fisheries, Yokohama, Japan from 10-14 December 2006. The list of participants is given as Annex A.

INTRODUCTORY ITEMS

Welcoming remarks

Kawahara welcomed the participants to Japan and to Yokohama. Along with Shimada, Okamura and Miyashita, he explained the logistical arrangements for the meeting.

Election of Chair and appointment of rapporteurs

Donovan was elected Chair. On behalf of the IWC, he thanked the participants for attending, and the government of Japan for hosting the Workshop. Butterworth, Perrin, and Punt acted as rapporteurs, with assistance from the Chair.

Adoption of Agenda

The adopted Agenda is given as Annex B.

Available documents

As the primary function of the Workshop was to review trial results (see Item 1.5), there were no primary documents submitted. Trial and conditioning results were obtained during the meeting and are either included in this report or are held as the archived master set. The primary background documents available to the workshop were the relevant extracts from the 2006 reports of the Revised Management Procedure (RMP) sub-committee and of the Scientific Committee (IWC, 2007), the Report of the First intersessional Workshop for the western North Pacific Bryde's whale *Implementation* held in October 2005 (IWC, 2006), and the Requirements and Guidelines for *Implementations* (IWC, 2005).

Objectives of Workshop

The primary objective for the Workshop (IWC, 2005, p. 87) was to review the results of the final trials and develop recommendations for consideration by the full Committee on:

(1) management areas;

(2) RMP variants (e.g. catch-cascading, catch-capping);

(3) associated operational constraints (e.g. temporal restrictions);

(4) suggestions for future research (either within or outside whaling operations) to narrow the range of plausible hypotheses / eliminate some hypotheses; and

(5) 'less conservative' variants(s) with their associated required research programs and associated duration.

PROGRESS SINCE ANNUAL MEETING

Conditioning

Allison reported that she had repeated the conditioning of the trials that were presented and discussed at the 2006 Scientific Committee meeting because the definition of the boundary between the stocks when fitting to the tagging data had been changed during that meeting, and because some of the catch data had been revised.

Trials

Allison reported that for the trials that have been conditioned, simulations had been conducted and the results were available.

Thresholds for defining performance in *Implementation Simulation Trials* (*ISTs*)

During its 2006 Annual Meeting, the Scientific Committee developed a draft amendment to the Requirements and Guidelines for *Implementations* that specifies how the thresholds used for defining the performance of RMP variants are to be calculated. The Scientific Committee also agreed that additional work was needed to fully evaluate these criteria, particularly with respect to the consequences of judging performance as 'acceptable' or 'borderline' based on just one of two risk criteria, but did not specify how such an evaluation could be conducted (IWC, 2007 and Item 7). This is discussed further below.

2.4 Other

Allison reported that the catch data series had been updated. The Workshop **recommended** that the document that outlines how the catches that are used in the final trials were determined be included with the specifications for the trials that are presented to the Scientific Committee (Annex C).

For the age dataset used to estimate natural mortality, the First Intersessional Workshop (IWC, 2006) had recommended that a 'blind' calibration exercise be conducted using earplugs from both commercial and JARPN II whales to examine potential inter-reader differences. Masaki had aged the earplugs sampled from the commercial catch. Miyashita reported that he had been unable to find the original earplugs so that no progress on the calibration had occurred since the Scientific Committee. This is discussed further under Item 6.

GUIDELINES ON REVIEW OF ISTS

Overview from the 2004 meeting
The process for reviewing the results of *Implementation Simulation Trials* (*ISTs*) that was developed during the 2004 meeting of the Scientific Committee (IWC, 2005) and modified slightly during the 2006 meeting of the Scientific Committee (IWC, 2007) involves several steps (Fig. 1). These steps are described in full detail in IWC (2005) and are summarised below.

(1) Classify the conservation performance of each combination of an RMP variant and trial as either 'acceptable', 'borderline' or 'unacceptable' using a protocol based on the lower 5th percentile of the distribution for the final depletion of the mature female population, and the lower 5th percentile of the distribution of the ratio of the number of mature females under the RMP variant to that in absence of catches.

(2) Identify any RMP variants that are classified as 'acceptable' for all trials; such variants can be recommended to the Commission without additional research.

(3) Identify any RMP variants that are classified as 'unacceptable' for any 'high' weight trials (see Table 1 for the list of trials and their weights); such trials are eliminated from consideration (although such a variant could be reconsidered during a future Implementation Review if research conducted subsequent to the current Implementation suggests that the trial(s) on which performance was unacceptable should be 'low' plausibility).

(4) Examine the performance statistics for the RMP variants that performed 'acceptably' on most of the trials, but 'borderline' for a small number of 'medium' weighted trials. If conservation performance of these trials is close to 'acceptable', such variants can be recommended to the Commission without additional research.

(5) Evaluate the RMP variants for which a decision has yet to be made and determine whether these variants fall into one of three categories 'rejected/unacceptable', 'acceptable', and 'possibly acceptable with required research'.

(6) Establish additional trials for those RMP variants which are 'possibly acceptable with required research' to examine conservation performance, assuming management is based on these variants for 10 years after which management reverts, via a five-year phase-out process, to being based on one of the acceptable variants.

Procedure to follow at this Workshop re thresholds for defining 'acceptable' and 'borderline' performance
The procedure for defining 'acceptable' and 'borderline' performance agreed by the RMP subcommittee at its 2006 meeting (IWC, 2007) involves conducting the following steps for each stock in an *IST* for which MSYR(mat)=1%:

(1) Construct a single stock trial, which is 'equivalent' to the *Implementation Simulation Trial*. For example, if a particular *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 set 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 depletion ratio (the minimum over each of the 100 year projection 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 for the *Implementation Simulation Trial* is 'acceptable', 'borderline' or 'unacceptable';

(5) If the 5%-ile of the final depletion or the 5%-ile of the depletion ratio for the *Implementation Simulation Trial* that shows better performance is less than for the equivalent single stock trial with 0.60 tuning of the *CLA*, the performance of the RMP shall be classified as 'unacceptable';

(6) If the 5%-ile of the final depletion or the 5%-ile of the depletion ratio for the *Implementation Simulation Trial* that shows better performance is greater than for the equivalent single stock trial with 0.60 tuning of the *CLA* but less than for the equivalent single stock trial with 0.72 tuning of the *CLA*, the performance of the RMP shall be classified as 'borderline';

(7) If the 5%-ile of the final depletion or the 5%-ile of the depletion ratio for the *Implementation Simulation Trial* that shows better performance is greater than for the equivalent single stock trial with 0.72 tuning of the *CLA*, the performance of the RMP shall be classified as 'acceptable'.

Note that in steps 5-7 above, 'better performance' refers to the comparison of the two 5%-iles referenced, and 'RMP' refers to the RMP variant under consideration.

In discussion, the Scientific Committee agreed that **'**some further work is needed to fully evaluate these criteria, particularly with respect to the consequences of judging performance to be acceptable or borderline based on just one of two risk criteria. The Committee will reconsider the criteria next year after their properties have been examined in a wider range of contexts' (IWC, 2007). In the absence of guidance regarding how a fuller evaluation could be conducted, the Workshop **agreed** to follow the procedure agreed by the RMP sub-committee in 2006. It also made a recommendation as to how this work could be furthered before the 2007 Annual Meeting (see Item 6).

Presentation style of results

The Workshop discussed ways to present and summarise the results of the trials to facilitate identification of the differences in performance among the four RMP variants, as well as to facilitate the application of the steps related to reviewing the results of the *ISTs* (see Item 3.1). It developed a variety of graphical and tabular summaries (see Annex D for examples). The objectives of the various plots and tables range from providing a quick graphical summary of conservation performance to listing the full set of performance statistics for each trial and RMP variant. The master set of plots and tables will be archived by the Secretariat and made available to members of the Scientific Committee on request. The plots and tables used by the Workshop in drawing its conclusions regarding the four RMP variants were:

(1) A plot showing the performance of each RMP variant and the no-catch scenario for each of the $MSYR_{(mat)}$=1% trials using the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance. This plot has panels for each stock and the two performance statistics on which the thresholds are based (the lower 5th percentile of the final depletion distribution and the lower 5th percentile of the scaled lowest depletion distribution). The values for the performance statistics for each variant (and the no-catch scenario) are represented as dots, and horizontal lines indicate the thresholds (upper line: 'acceptable'; lower line: 'borderline'). The shaded area in this plot indicates 'unacceptable' performance.

(2) A plot showing the performance of a specific RMP variant (variant 2) for one of the trials. This plot consists of the eight types of outputs:
   (a) the median population size[1] trajectories by stock for the selected RMP variant and that for the no-catch scenario;
   (b) the median catch trajectories by management sub-area for the specific RMP variant;
   (c) the 5%-ile, median and 95%-ile of the population size trajectories by stock under the specific RMP variant (1980 until the end of the projection period);
   (d) ten individual population size trajectories for each stock under the specific RMP variant;
   (e) the 5%-ile, median and 95%-ile of the time-trajectories of catch by management area (1980 to the end of the projection period);
   (f) three individual catch trajectories for each management area;
   (g) the median population size trajectories by stock (1980 to the end of the projection period) for all of the RMP variants; and
   (h) the median time-trajectories of catch by management area (1980 to the end of the projection period) for all of the RMP variants.

(3) Plots for each trial and stock showing the 5%-ile, median and 95%-ile of the time-trajectories of population size for each of the RMP variants and the no-catch scenario.

(4) A table for each of the trials for which $MSYR_{(mat)}$=1% showing for each RMP variant, the median catch (total and by management area) over the entire projection period, and a summary of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance. An 'A' in this table indicates 'acceptable' performance, a 'B' 'borderline' performance and a 'U' 'unacceptable' performance. The table shows results for each performance statistic and stock separately, results by stock (i.e. after aggregating the outcomes for two performance statistics), and results in total (i.e. after aggregating outcomes from each performance statistic and stock).

(5) A table showing the detailed results for each trial and RMP variant (and the no-catch scenario). The following information is included in this table:
   (a) median catch (total and by management area) over the entire projection period;
   (b) lower 5%-ile and median of the initial depletion distribution (by stock);
   (c) lower 5%-ile and median of the final depletion distribution (by stock); and
   (d) lower 5%-ile and median of the scaled lowest depletion distribution (by stock).

[1] Mature female numbers.

This table also includes the values for the thresholds for each performance statistic and stock for the trials for which MSYR(mat)=1% and the outcomes of the application of the procedure for defining ‘acceptable’, ‘borderline’ and ‘unacceptable’ performance using the symbols described for (4).

(6) A table that summarises the catches for each RMP variant. This table contains
  (a) the median catch (total and by management area) over the entire projection period;
  (b) the 5%-ile, median and 95%-ile of the distribution of the average catch in management area 1W over the first 20 years of the projection period;
  (c) the 5%-ile, median and 95%-ile of the distribution of the average catch in management area 1E over the first 20 years of the projection period; and
  (d) the 5%-ile, median and 95%-ile of the distribution of the average catch in management area 2 over the first 20 years of the projection period.

(7) A table showing all of the performance statistics for each trial and RMP variant (and the no-catch scenario).

REVIEW NEW CONDITIONING RESULTS

In the light of some minor coding errors detected since the Scientific Committee meeting, the changes to the trial specifications during the 2006 Scientific Committee, and the changes to the catch series as well as the results of the discussions reflected below that led to further revised specifications for certain trials, all trials were reconditioned during the meeting and the conditioning diagnostics again inspected. The final trial specifications are listed in Annex E.

Modifications to final trials

The specification of stochastic mixing in previous trials has been such that the mixing matrix each year can take one of two relatively ‘extreme’ forms. Thus, in ‘a two stocks with two feeding areas’ situation for example, in one year all of stock I might be in management area 1W, whereas in the next year 90% of stock I might be found in management area 1E, and *vice versa* for stock II. For these Bryde’s whale trials, in circumstances where other aspects of the conditioning led to very different initial sizes for two such stocks or sub-stocks, this extreme form of mixing resulted in difficulties, with catches in some years set relatively high and having to be taken from the smaller stock only, which resulted in unrealistically large exploitation rates, particularly in the past, but also under the RMP variants considered. Conditioning results also reflected questionable realism in such circumstances, with 90% probability envelopes around the abundance trend for a particular management area being much larger than the 90% CIs for the survey results in all years except those for which survey estimates were available for that area.

The Workshop considered that this behaviour was a consequence of an unrealistic specification of stochastic mixing and hence modified the specifications for trial BR05, BR06, BR13 and BR14). Instead of only one of the two “extreme” mixing matrices (M_1 and M_2) applying in a particular year, a random number x was generated from U[0,1] each year, with the mixing matrix for that year being defined by $xM_1 + (1-x)M_2$. This modified specification was found to remove the anomalous features of the existing stochastic mixing trials noted above.

The trials incorporating spatial age-dependence (BR09, BR10, BR27 & BR28) were conditioned by giving a high weight to the operating model mimicking the ratio of the survival rate estimate for sub-area 1E to that for sub-area 1W, i.e. S_{1E}/S_{1W}, indicated by the analyses of the commercial and JARPN II catch-at-age data for ages of 15 and above. It was not possible to fit the survival rates themselves accurately because natural mortality M is a fixed input to all the trials. The Workshop considered that fitting the ratio was adequate for purposes of this *Implementation* because the associated trials preserved the possibility that the different age structures found are real and arise from differential past harvest proportions on different stocks/sub-stocks. However it was **agreed** that during the intersessional period, Allison and Punt will check that changes to the input value of M, such that the operating model is able to mimic the survival rates in absolute terms as well as reflect their ratios, do not make appreciable differences to the results of these trials under the RMP variants being considered.

4.2 Consideration of results of updated conditioning

The representative selection of the diagnostic plots for the updated conditioning of the trials is shown in Annex F (the full set of results is available from the IWC Secretariat).

In discussing these results, the Workshop noted that there was a tendency for an appreciable part of the upper half of the confidence interval for some abundance estimates to fall above the 90% probability envelope for the population size trajectories, particularly for trials BR07 and BR08 and other trials for which stock I comprised two sub-stocks (hypothesis 4, mixing matrix D). This is not surprising, as the conditioning takes account of more information (such as tag recapture data) than the survey abundance estimates alone, and this further information could improve the precision with which the population model estimates abundance in comparison to the survey estimates.

The Workshop noted that the diagnostic plots were very similar to those previously considered and found satisfactory at the last Scientific Committee meeting. Standardised residuals for the fits to abundance indices were generally small compared to 1, and differences between tag recovery numbers input to and predicted by the models amounted at most to four tags. For the trials incorporating spatial age dependence, the fitting procedure had clearly succeeded in its intent of reflecting the estimated ratio of different total mortality rates in management areas 1W and 1E very closely.

The Workshop **agreed** that the diagnostic plots showed the conditioning to be satisfactory.

REVIEW TRIAL RESULTS

As noted earlier, the full set of results are available as a master set from the Secretariat upon request. A subset of results for all the trials are presented in Annex D. Discussion at the Workshop naturally focussed on trials for which performance for a particular variant (see Fig. 2) was 'borderline' or 'unnacceptable' (see Item 3.2). Where appropriate, some of these results are included in the main body of the report.

In discussing the results of trial BR13, the surprising result that the no-catch scenario did not achieve 'satisfactory' conservation performance for sub-stock IW in terms of the final depletion statistic was noted (see Fig. 2 in Annex D). This arises because of slight differences in demographic and selectivity specifications for the Bryde's whale *Implementation* and RMP single stock trials. Since the population trajectories are at small fractions of *K* at the start of the management period, the *CLA* takes no catches over this full 100 year period in either case. However the slight differences between the trials, result in marginally less recovery for the Bryde's compared to the RMP single stock trial, and hence formally to an 'unacceptable' conservation classification. Trajectories starting at such small fractions of *K* also lead to the further unusual feature that the 'acceptable' and 'borderline' thresholds become identical, as is evident in some panels in Fig. 2 of Annex D).

Table 2

Summary of the five trials with borderline (B) or unacceptable (U) performance. Note that all of these trials involve 2-stocks, no age-dependent mixing, the best catch series and *MSYR*=1%. Detail specifications for all of the trials are found in Table 1. Performance for all other trials was acceptable for each variant.

Trial	Borderline	Unacceptable	Mixing Matrix	Stochastic mixing	1W/1E	Process Error
Br11	All variants		D	No	155°	0.9
Br13	Variant 3	Variant 2	D	Yes	155°	BL
Br15	Variant 3	Variant 2	D	No	160°	BL
Br17	Variants 3, 4	Variant 2	D	No	165°	BL
Br25	All variants		B	No	165°	0.9

5.1 Variant 1

For variant 1, sub-areas 1W, 1E[2] and 2 are *Small Areas* and catch limits are set by *Small Area*.

The Workshop noted that this variant led to 'acceptable' performance on all seven 'high' weight trials, and on all but two of the 21 'medium' weight trials. The two trials for which performance was 'borderline' (BR11 and BR25) provided results closer to the 'acceptable' threshold than to that which defines 'unacceptable' performance, and both these trials involved process error set at a level σ_p = 0.9. It was further noted that the appropriate definition of the equivalent single stock trial when process error is present is not obvious. The calculation process used to define the thresholds for 'acceptable' and 'borderline' performance that had been used for the results reported had assumed the same amount of process error as for the base-case single stock trials (IWC, 1994, p.75) used in the development of the *CLA*. The *CLA* has been accepted to perform adequately in the presence of process error up to a higher level than that. Thus the Workshop considered that the threshold-related results reported for the trials in question with process error and $MSYR_{(mat)}$ = 1% (*viz*. BR11 and BR25) were conservative (see also Items 6.4 and 7).

In terms then of an overall evaluation of the results for this variant in terms of box 4a of Fig. 1, the Workshop **agreed** that variant 1 be classified as 'acceptable without research'.

5.2 Variant 2

For Variant 2, 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.

The Workshop noted that this variant led to 'acceptable' performance on all seven 'high' weight trials. This variant also showed 'borderline' performance for the process error trials (BR11 and BR25) as was the case for variant 1. The conservation performance of variant 2 was 'unacceptable' for three 'medium' weight trials (BR13, BR15 and BR17), all related to mixing across the boundary (perhaps incorrectly specified) of the IW and IE sub-stocks for hypothesis 4. Such results were not entirely unexpected, because variant 2 treats the whole of sub-area 1 as a single population, but the trials take all the catch from the western portion of sub-area 1 (sub-area 1W), and hence impacts the sub-stock found predominantly in management area 1W disproportionately.

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[2] Defined to be 140°E-165°E and 165°-180° irrespective of the true boundary used to define the structure of the populations in the operating model.

In terms of the box 4a of Fig. 1, the Workshop **agreed** that the overall results indicated that variant 2 was not acceptable without research, and hence required further evaluation in terms of box 5 (‘Evaluate catch related performance’). Further discussion on this is reflected below.

5.3 Variant 3

For Variant 3, 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.

The Workshop noted that this variant led to ‘acceptable’ performance on all seven ‘high’ weight trials and 17 of the 21 medium weight trials. The performance for the remainder was ‘borderline’. In terms of meeting conservation thresholds, the Workshop noted that the performance of variant 3 was almost identical to that of variant 1 (including ‘borderline’ performance for the process error trials BR11 and BR25). However, it also showed ‘borderline’ performance on one further trial (BR13 - stochastic mixing), although as with the process error trials the results for this trial were closer to the ‘acceptable’ than to the ‘unacceptable’ threshold.

Noting such ‘borderline’ performance in only three of the total of 28 trials, the Workshop **agreed** that as for variant 1, variant 3 be classified as ‘Acceptable without research’.

5.4 Variant 4

Variant 4: Sub-areas 1 and 2 (combined) are taken to be a *Combination area*, and sub-area 2 and sub-areas in 1W and 1E are *Small Areas*, with *catch-cascading* applied.

The Workshop noted that this variant led to ‘acceptable’ performance on all seven ‘high’ weight trials and 17 of the 21 medium weight trials. The Workshop noted that, in terms of meeting conservation thresholds, the performance of variant 4 was nearly indistinguishable from that of variant 3. Accordingly, it **agreed** that variant 4 be classified as ‘Acceptable without research’.

5.5 General features

The Workshop noted that the behaviour of all four variants was consistent across nearly all the trials. It further noted that not only stock structure, but also process error, had proved an important consideration in determining the acceptability or otherwise of certain RMP variants.

Some members noted that ‘borderline’ or ‘unacceptable’ behaviour had been evident only for trials based on hypothesis 4, under which stock I is comprised of two sub-stocks. They drew attention to their views expressed in earlier meetings (IWC, 2006) that this hypothesis should have been accorded low plausibility, with the consequence that all four RMP variants considered would have attained the ‘acceptable’ conservation threshold on all ‘high’ and ‘medium’ weight trials.

5.6 Catch-related performance

The Workshop noted that variant 4 led to the best catch-related performance of the four variants over the trials as a whole.

In the light of the classification above of variant 2, the associated catch-related performance for that variant was examined closely, and particularly that over the first 20 years of the management period (see for example Fig. 2 of Annex D for the BR07 trial). Japan commented that the higher catches possible in management area 1W (closer to Japan) was operationally attractive and that they might wish to pursue the option of exploring whether a feasible research programme could be developed that would allow variant 2 to be classified as ‘acceptable with research’ (see boxes 6 to 8 of Fig. 1). A decision on whether to pursue this option will be taken prior to the 2007 Annual Meeting.

In order to be able to take the matter forward at the next Scientific Committee meeting, should Japan decide to pursue this option, the Workshop specified trials to be conducted to explore conservation performance if the research programme was unable to disprove the hypotheses underlining the trials on which variant 2 attained ‘unacceptable’ performance, and hence a more conservative variant replaced variant 2 after a period of 10 years. The results of these deliberations are recorded under Item 7.

The Workshop also noted that the research programme in question would require evaluation and endorsement by the Scientific Committee at its next meeting. Three areas of likely beneficial research which such a programme might include were identified as:

(1) ageing research and in particular the work recommended in IWC (2006);
(2) surveys based on improvement of survey plans to reduce the extent of process error; and
(3) satellite telemetry and further genetic studies (the latter preceeded by a power analysis) to improve information on stock structure and mixing.

It was agreed that successful design of such a programme would be facilitated by the appointment of an intersessional advisory group (see also Item 7).

RECOMMENDATIONS FOR THE SCIENTIFIC COMMITTEE

Management Areas

The recommended management areas are shown in Fig. 2. Under the three management options recommended below, the designations are as follows:

Variant 1: Sub-areas 1W, 1E and 2 are *Small Areas*.

Variant 3: Sub-area 2 is taken to be a *Small Area* and sub-area 1 is a *Combination Area*. Sub-areas 1W and 1E are *Small Areas*, with catch-cascading applied.

Variant 4: Sub-areas 1 and 2 (combined) are a *Combination Area*, and sub-areas 1W, 1E and 2 are *Small Areas*, with catch-cascading applied.

If Japan chooses to pursue management variant 2 (see below), the following will apply:

Sub-area 2 is taken to be a *Small Area* and the complete sub-area 1 is treated as a *Small Area*.

Variant(s)

The Workshop **agreed** that management-option variants 1, 3 and 4 all performed acceptably from a conservation perspective and it **recommended** these to the Scientific Committee. It noted that over the total simulation period, variant 4 performed best from a catch perspective. It also noted that Japan may wish to pursue variant 2 and therefore may propose a programme of research for consideration at the next Scientific Committee meeting.

Inputs for *CLA*

Estimates of abundance
Additional work or evaluation of existing estimates to arrive at estimates of abundance suitable for input to the *CLA* will need to be completed at the next Committee meeting. The Workshop **recommended** that Japan provide a full paper to the next Committee meeting, presenting the best estimates and associated variance, including all relevant methodological and operational (including cruise track) details. Further, it **recommended** that a preliminary version of this paper be reviewed by a small group convened by Kitakada (additionally Miyashita, Shimada, Skaug, Wade and Butterworth) before the 2007 Annual Meeting and comments returned to the authors in advance of the meeting.

Past removals
As noted under Item 2.4, the 'best' and alternative catch series have been completed and, after final checking, will be included as part of the full specification for the trials (Annex C).

Future removals
Although not strictly input to the *CLA*, management advice presented by the Committee based on the *CLA* must take into account other anthropogenic removals. The Workshop **agreed** that neither bycatches nor ship strikes were problematic for Bryde's whales but that future scientific permit catches would need to be taken into account.

Other

Trials related to variant 2 with research option
The Workshop **agreed** that if Japan decides to pursue the 'variant 2 with research' approach, the conservation performance of variant 2 (along with the performance for the accepted variants 1, 3 and 4) should be examined for the performance of trials BR11, 13, 15, 17 and 25 (i.e. those for which variant 2 did not perform acceptably –see Table 2). These trials will involve:

(1) using variant 2 for the first 10 years of the 100-year projection period; followed by

(2) a 5-year period in which the catch is set to the weighted average of the catch limit from variant 2 and that from the acceptable variant (the weight assigned to variant 2 being 5/6 in year 11 and 1/6 in year 15); followed by

(3) the catch limit is set by the acceptable variant.

Note that variant 2 sets catch limits for all of management area 1 (sub-area 1W and 1E combined) but the other variants set catch limits for 1W and 1E separately. The catch limit for 1W and 1E during the phase-out period should be set to the average of the catch limits by management area from variant 2 and the acceptable variant.

Other additional work
The Workshop **recommended** that the following be examined further: (1) the robustness to the specifications to the matrices to the stochastic mixing trials be examined (i.e. by trying alternatives to the approach described under Item 4.1); and (2) the effect of fitting to absolute survival rates rather than only their ratios (see Item 4.1).

General issues
During the discussions, a number of general issues related to the *Implementation* process arose that warrant further investigation:

(1) examination of the appropriate *CLA* trials to use when determining threshold levels (e.g. see discussion of process error under Item 5.1);

(2) the question of specification of an acceptable variant for comparison in with-research options, if none of original variants are acceptable;

(3) further work on a final proposal for threshold criteria, taking into account the comments in the Scientific Committee report and using examples from the present trial results.

7 WORKPLAN

The Workshop agrees to the following workplan:

(1) run trials for the variant 2 with research option (see Item 6.4.1): Allison and Punt – dates (by the end of January 2007);

(2) examine stochastic mixing and survival rate issues (see Item 6.4.2): Allison and Punt – by the 2007 Annual Meeting;

(3) general issues related to the *Implementation* process (see Item 6.4.3): Allison, Cooke, Donovan, Hammond and Punt – by the 2007 Annual Meeting;

(4) preparation of paper on absolute abundance estimates for use in the *CLA* (see Item 6.3.1): Kitakada, Miyashita, Shimada, Skaug, Wade and Butterworth – by the 2007 Annual Meeting;

(5) preparation of proposed research programme in conjunction with variant 2 (if needed) – see Item 5.6: Pastene (convenor), Kitakado, Butterworth, Best, Mate, Perrin, Mate, Palsbøll, Skaug, Donovan.

8 ADOPTION OF REPORT

The Report was adopted on 14 December 2006. The Chair wished particularly to thank: Allison and Punt for their exceptional work in running the final conditioning and trials; Kawahara and colleagues for their great hospitality and provision of facilities; the rapporteurs for providing an excellent draft that led to a rapid adoption of the report; the interpreters who worked expertly in translating complex technical issues; and all participants for their co-operative approach to the Workshop. The Workshop thanked the Chair for his fair and efficient handling of the Workshop undertaken with his customary good humour.

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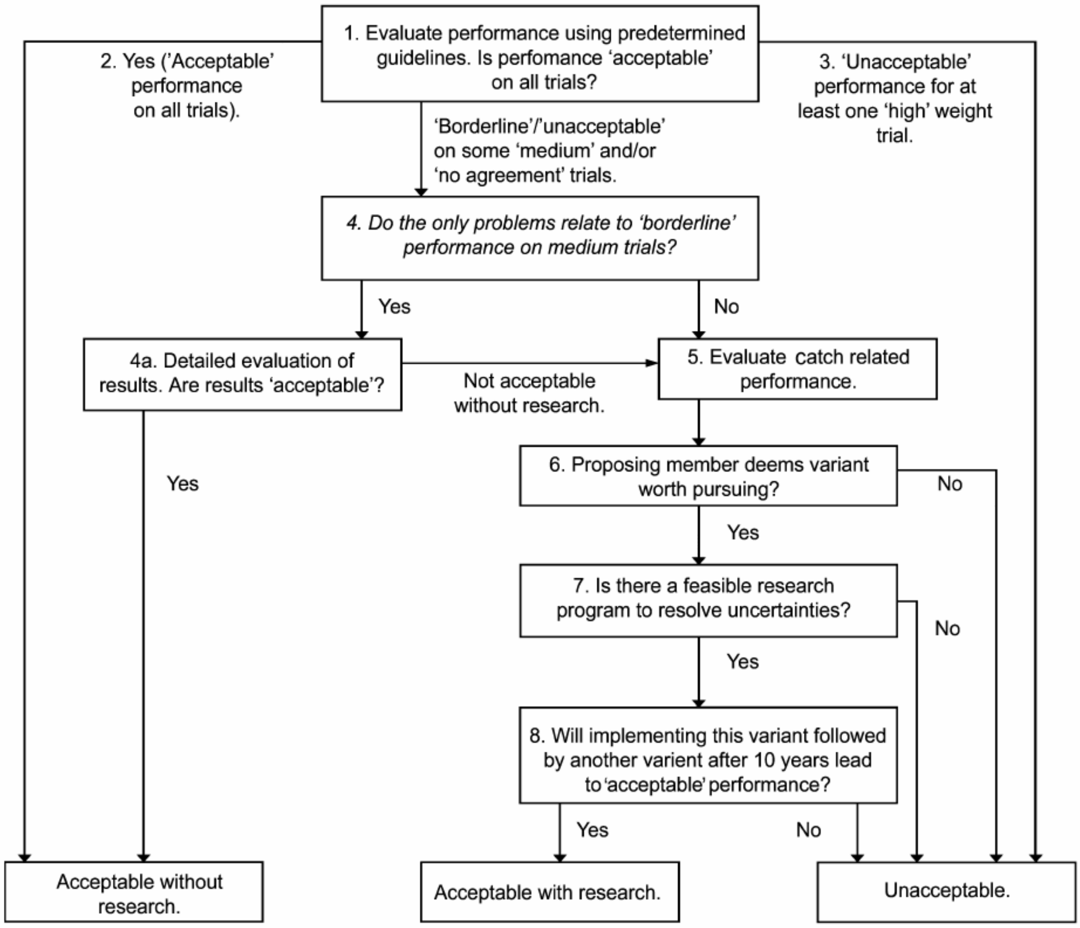


Fig. 1. Flowchart of the procedure for the review of the results of *Implementation Simulation Trials*

Fig. 2. The four RMP hypotheses.

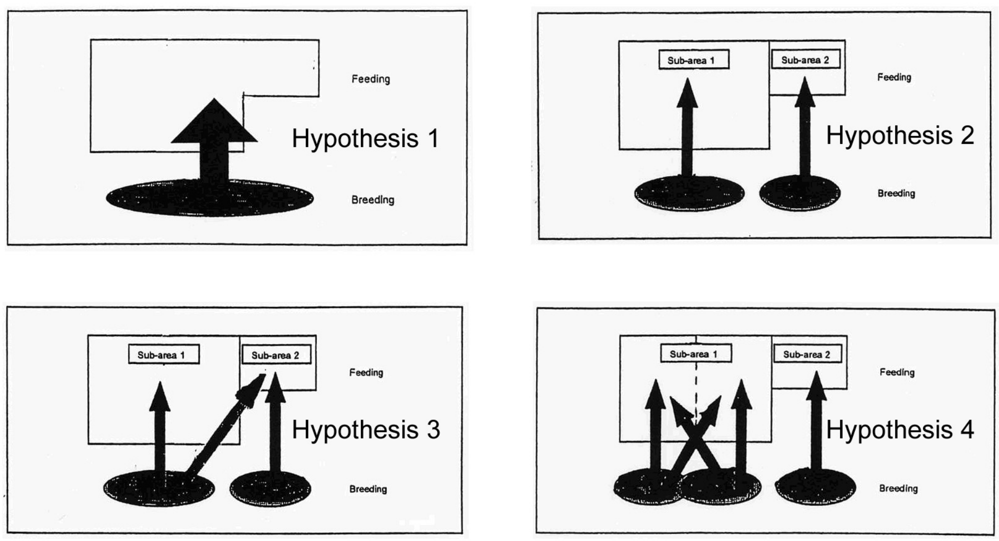


Table 1 The *Implementation Simulation Trials* for the western North Pacific Bryde's whales

Trial No.	Stocks	Sub-stocks	$MSYR_{mat}$	Mixing matrix	Process error	Stochastic mixing in 1W/1E	Catch series	Age-dependent Mixing?	1W / 1E boundary	Comment	Trial Weight
Br1	1	No	1	A	Baseline	No	Best	No	165°E	Stock structure hypothesis 1	M
Br2	1	No	4	A	Baseline	No	Best	No	165°E	Stock structure hypothesis 1	**H**
Br3	2	No	1	B	Baseline	No	Best	No	165°E	Stock structure hypothesis 2	M
Br4	2	No	4	B	Baseline	No	Best	No	165°E	Stock structure hypothesis 2	**H**
Br5	2	No	1	C	Baseline	No	Best	No	165°E	Stock structure hypothesis 3 *	M
Br6	2	No	4	C	Baseline	No	Best	No	165°E	Stock structure hypothesis 3 *	**H**
Br7	2	Yes	1	D	Baseline	No	Best	No	155°E	Stock structure hypothesis 4	M
Br8	2	Yes	4	D	Baseline	No	Best	No	155°E	Stock structure hypothesis 4	M
Br9	2	No	1	B	Baseline	No	Best	**Yes**	165°E	B + Age-dependent mixing	M
Br10	2	No	4	B	Baseline	No	Best	**Yes**	165°E	B + Age-dependent mixing	**H**
Br11	2	Yes	1	D	$\sigma_p = 0.9$	No	Best	No	155°E	D + Additional process error	M
Br12	2	Yes	4	D	$\sigma_p = 0.9$	No	Best	No	155°E	D + Additional process error	M
Br13	2	Yes	1	D	Baseline	**Yes**	Best	No	155°E	D + Stochastic mixing *	M
Br14	2	Yes	4	D	Baseline	**Yes**	Best	No	155°E	D + Stochastic mixing *	M
Br15	2	Yes	1	D	Baseline	No	Best	No	**160°E**	D + Alternative Boundary 1	M
Br16	2	Yes	4	D	Baseline	No	Best	No	**160°E**	D + Alternative Boundary 1	M
Br17	2	Yes	1	D	Baseline	No	Best	No	**165°E**	D + Alternative Boundary 2	M
Br18	2	Yes	4	D	Baseline	No	Best	No	**165°E**	D + Alternative Boundary 2	M
Br19	2	Yes	1	D	Baseline	No	**Low**	No	155°E	D + Low catch series	M
Br20	2	Yes	4	D	Baseline	No	**Low**	No	155°E	D + Low catch series	M
Br21	2	Yes	1	D	Baseline	No	**High**	No	155°E	D + High catch series	M
Br22	2	Yes	4	D	Baseline	No	**High**	No	155°E	D + High catch series	M
Br23	2	No	1	B	Baseline	No	**High**	No	165°E	B + High catch series	M
Br24	2	No	4	B	Baseline	No	**High**	No	165°E	B + High catch series	**H**
Br25	2	No	1	B	$\sigma_p = 0.9$	No	Best	No	165°E	B + Additional process error	M
Br26	2	No	4	B	$\sigma_p = 0.9$	No	Best	No	165°E	B + Additional process error	**H**
Br27	2	No	1	B	Baseline	No	**High**	**Yes**	165°E	B + Age-dep.mixing+high catch	M
Br28	2	No	4	B	Baseline	No	**High**	**Yes**	165°E	B + Age-dep.mixing+high catch	**H**

* With stochastic mixing

Annex A
Participants

Japan
H. Hatanaka
T. Hakamada
S. Kawahara
T. Kitakado
T. Miyashita
H.Okamura
L. Pastene
H. Shimada
H. Yasokawa (Interpreter)
A. Fujimoto (Interpreter)

US
R. Brownell Jr.
W. Perrin

Invited Participants
D.S. Butterworth
A.E. Punt

IWC Secretariat
C. Allison
G. Donovan

Annex B

AGENDA

1. INTRODUCTORY ITEMS
   1.1. Welcoming remarks
   1.2. Election of Chair and appointment of rapporteurs
   1.3. Adoption of Agenda
   1.4. Available documents
   1.5. Objectives of Workshop

2. PROGRESS SINCE ANNUAL MEETING
   2.1. Conditioning
   2.2. Trials
   2.3. Thresholds for defining performance in ISTs
   2.4. Other

3. GUIDELINES ON THE REVIEW OF *IST*S
   3.1. Overview from the 2004 meeting
   3.2. Procedure to follow at this Workshop *re* thresholds for defining 'acceptable' and 'borderline' performance
   3.3. Presentation style of results

4. REVIEW NEW CONDITIONING RESULTS
   4.1 Modifications to final trials
   4.2 Considering the results of updated conditioning

5. REVIEW TRIAL RESULTS
   5.1. Variant 1
   5.2. Variant 2
   5.3. Variant 3
   5.4. Variant 4
   5.5 General features
   5.6 Catch-related performance

6. RECOMMENDATIONS FOR THE SCIENTIFIC COMMITTEE
   6.1. Management Areas
   6.2. Variant(s)
   6.3. Inputs for *CLA*
      6.3.1. Estimates of abundance
      6.3.2. Past removals
      6.3.3. Future removals
   6.4. Other
      6.4.1. Trials related to variant 2 with research option
      6.4.2. Other additional work
      6.4.3. General issues

7. WORKPLAN

8. ADOPTION OF REPORT

Annex C

Catch series for western North Pacific Bryde's whales

C. Allison

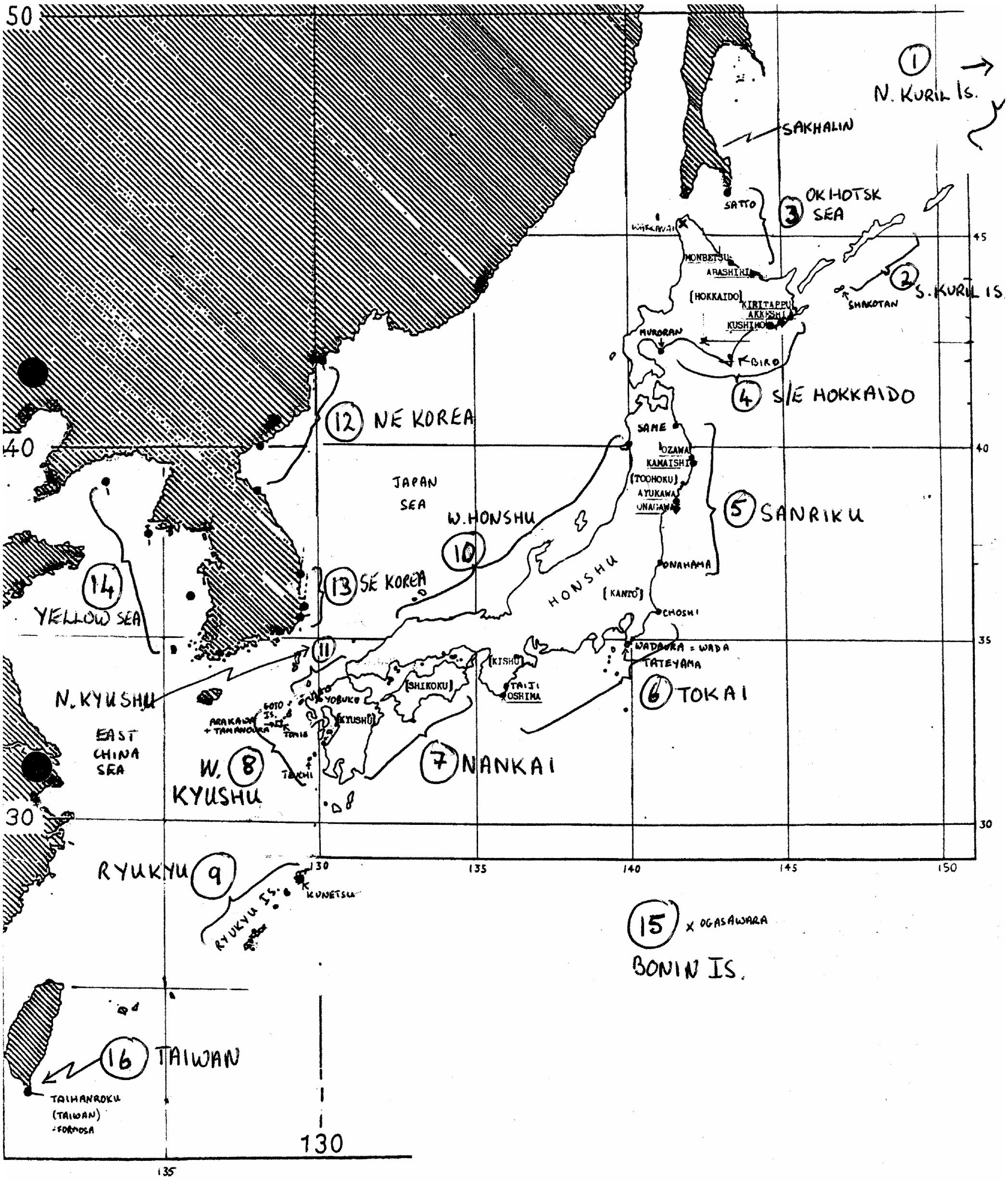
Table 1 lists the whaling operations in the Western North Pacific that could have caught Bryde's whales together with a summary of the data available for each operation and year. Operations by the USSR in the Kuril Islands (1948-1964), Norway off Kamchatka (1925-26), the People's Republic of China, the Republic of Korea and local indigenous whaling in the Philippines are not included as the operations were not in Western North Pacific Bryde's whale grounds.

Table 1. Complete list of whaling operations that could have caught Western North Pacific Bryde's whales and a summary of the extent of data available.

Key:
- Y Catch taken. See footnote.
- Y (total) Catch taken. The only available data are the total catch of all whales
- Y (A) Catch taken. Numbers of sei/Bryde's are known by area, but sei/Bryde's whales not differentiated.
- Y (I: all sei) Catch taken. Individual data (including date and sex) but sei/Bryde's not differentiated.
- Y (I: N) Catch taken. Individual data (including date and sex). but sei/Bryde's not differentiated. NP forms separate Sei and Bryde's.
- Y (I) Catch taken. Individual data (including date and sex).
- Y (Est, A) Catch taken. Number estimated. Area of operation known
- 0 Catch operation existed but Bryde's whales not taken

Year	Japan Coastal except Bonin Is	Japan: Bonin Is.	Japan Pelagic excl. Bonin Is	Rep. of China (Taiwan)	Philippines	USSR Pelagic
1899-1905	0[1]					
1906-10	Y (total)[2]					
1911-28	Y (A)[3]					
1929	Y (I: all sei)					
1930-31	Y (A)					
1932	Y (A)					Y[4]
1933-39	Y (A)					0[5]
1940-41	Y (A)		0[6]			0
1942-45	Y (A)					0
1946-51	Y (I: all sei)	Y (I)[7]				0
1952	Y (I: all sei)	Y (I)	0[8]			0
1953-4	Y (I: all sei)		0			0
1955-64	Y (I: N)		0[9]			0
1965	Y (I: N)[10]		0			0
1966-67	Y (I: N)		0			Y (I)
1968-70	Y (I)		0			Y (I)
1971-75	Y (I)		Y (I)			Y (I)
1976-79	Y (I)		Y (I)	Y (Est, A)[11]		Y (I)
1980	Y (I)			Y (Est, A)[11]		
1981-82	Y (I)	Y (I)[12]				
1983-85	Y (I)	Y (I)			Y[13]	
1986-87	Y (I)	Y (I)				
1988-93						
1994-97			0			
1998			Y (I)[14]			
1999			0			
2000-05			Y (I)[15]			

[1] Norwegian style whaling began in Japan in 1899 at land stations off SE Korea, so catch does not include any Western N. Pacific Bryde's whales
[2] Whaling in Japan expanded into new areas where Bryde's whales were probably taken.
[3] Japan began keeping records in 1911. Ohsumi provided the Secretariat with a copy of these data. Ohsumi will check whether the data are believed to be complete or if it is possible that other companies operated without submitting data.
[4] Aleut in 1932 catching in the 'tropical zone of the Pacific Ocean'. 3 sei whales caught. (Zenkovich 1955, Sleptsov 1955)
[5] Soviet factory ships operating off Kamchatka, away from Bryde's whale grounds
[6] Catching in Bering Sea, away from Bryde's whale grounds
[7] Catches by factory ships 1946-52.
[8] 1952-54: Sei/Bryde's not differentiated in data but operating north of Bryde's whale grounds.
[9] 1955-70: Catch data differentiates between sei and Bryde's but no Bryde's taken (in early period operating to north of Bryde's whale grounds)
[10] Kondo and Kasuya (2002) data for Nihon Hogei differs from official data 1965-76.
[11] Ref: Brownell RIWC 31 (1981): 132
[12] Land station at Ogasawara 1981-87. Kondo & Kasuya (2002) data differs from official data.
[13] Perrin 2006
[14] 1 whale taken by accident during special permit operation
[15] Special permit catch



1. Japanese coastal whaling

Historic catch data from Japanese coastal land stations has been collected by area using 16 areas as illustrated in Fig 1. The composition of the catches in the 16 areas is summarised in Table 2.

Table 2.

The 16 areas used in historic Japanese catch records. Areas in which Western North Pacific Bryde's whales are found are shown in bold.

Area		Composition of Sei/Bryde's catch
1	N Kuril Is	All sei whales
2	S Kuril Is	All sei whales
3	Okhotsk Sea	All sei whales
4	**S & E Hokkaido**	**Catches include Sei and small proportion of Bryde's whales**
5	**Sanriku (NE Honshu)**	**Catches include Sei and Bryde's whales**
6	**Tokai (Central S Honshu)**	**All Bryde's whales**
7	Nankai (S/E Kysushu & Shikoku)	All Bryde's whales, assumed to be from E China Sea stock
8	W Kyushu (inc. Goto Is)	All Bryde's whales, assumed to be from E China Sea stock
9	Ryukyu Is.	All assumed to be from E China Sea stock (2 whales only)
10	W. Honshu	No sei/Bryde's whales recorded in catch
11	N Kyushu	E China Sea stock
12	NE Korea	No sei/Bryde's whales recorded in catch
13	SE Korea	E China Sea stock (2 whales only taken)
14	Yellow Sea	E China Sea stock
15	**Bonin Is**	**Catches include Sei and Bryde's whales**
16	Taiwan	Catches all of local inshore form

Japanese coastal whaling before 1899

A hand harpoon fishery operated at Katsuyama, Boso (Chiba Prefecture) from the 17th to the 20th century, but was directed at Baird's beaked whales. It is unlikely that Bryde's whales were caught in this fishery.

Omura 1984 (History of gray whales in Japan) reports that net whaling was carried out off Japan in the 1800s on both the Pacific side of Japan, from Tokyo Bay to Kochi Prefecture, and on the West side of Japan off Kyushu. Omura lists a total catch of 72 Bryde's whales taken between 1874-96 in the Kochi Prefecture (Tsuro group) and a total of 81 Bryde's whales taken between 1875-96 in the Kochi Prefecture (Ukitsu group) giving an average of 9-10 whales/year. The annual catches prior to 1874 are thought to be smaller (Ohsumi SC/47/NP14 table 3). Any catches on the West side of Japan will not include Western North Pacific Bryde's whales and catches on the East side are likely to be from the East China Sea stock and so can be ignored for the pre-implementation assessment.

Japanese coastal whaling 1899 - 1954

Norwegian-style whaling by Japan began in 1899 on the eastern side of Korea in the Sea of Japan (Ohsumi SC/M05/Br7). Operations gradually extended to other areas and reached the eastern side of Japan in 1906 when land stations were built at Tateyama and Choisii (Chiba Prefecture) and Ayukawa (Miyagai Prefecture) (see Fig 1). Hence catches prior to 1906 do not include any Western North Pacific Bryde's whales. Table 3a lists the total catches of whales by Japan 1899-1911 together with the numbers taken on the East side of Japan 1906-9 (Ohsumi 2005).

The total catch from Eastern Japan in 1909 and 1910 is estimated by proration using the mean ratio of the catches in 1906-1908+1911 (the range of years for which the operational range is thought to be most similar).

The catch of sei/Bryde's whales in areas 5 and 6 in 1906-1910 is estimated from the total catches in Eastern Japan, prorated using data from 1911 (Kasahara 1950) as given in Table 3b.

Table 3a.

Total number of whales caught at land stations in Japan 1899-1911. 1899-1910 totals are taken from Tønnessen & Johnsen (1982): 735.

Year	Total Catch	Notes	Catch in Eastern Japan	Reference for Eastern Japan catch
1899	15	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1900	42	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1901	60	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1902	89	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1903	132	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1904	428	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1905	446	Only catching in areas outside W.N.Pacific Bryde's whale grounds		
1906	736	1st catch from land stations in Eastern Japan	96	Ohsumi 05 (SC/M05/BR7)
1907	1086		252	Ohsumi 05 (SC/M05/BR7)
1908	1312		597	Ohsumi 05 (SC/M05/BR7)
1909	835	+ unknown catch from a couple of smaller co.	(344)	Estimated. (Ohsumi 05 gives 96+)
1910	899	+ unknown catch from a couple of smaller co.[1]	(370)	Estimated.
1911	1938	From IWS XVI. Kasahara, 1950 lists 1919 of which 1135 from E. Japan	1135	Kasahara, 1950[2] (from areas 4,5,6)

[1] IWS: International Whaling Statistics, 1942, XVI table 1 p 91-92 gives total catch in 1910 as 968 including 156 sei whales and 436 of unspecified species.

[2] Kasahara, A. 1950 Whaling and its resources in the adjacent waters to Japan. Rep. Inst. Nippon Suisan Co. Ltd, 41, 103 + 51 (in Japanese)

Table 3b.

Catches of Sei/Bryde's whales by area 1906-10. Estimated numbers are given in brackets.

Year	Total Catch in Eastern Japan	Sei in area 4	Sei in area 5	Sei in area 6	Sei in area 15	
1906	96	0	(22)	(7)	0	Estimated
1907	252	0	(58)	(19)	0	Estimated
1908	597	0	(137)	(46)	0	Estimated
1909	(344)	0	(79)	(26)	0	Estimated
1910	(370)	0	(85)	(28)	0	Estimated
1911	1135	0	260	87	0	From Kasahara 1950

Catches by Japan are known by species and area in the period 1911-1954, but do not differentiate between sei and Bryde's whales. There are some discrepancies in the total annual catches of sei whales reported by different sources, as summarised in Table 4. Table 4 includes the agreed 'best' catch series which uses the 1920-39 catches from Tønnessen & Johnsen 1982 as these were described as revised numbers from the Whales Research Institute, Tokyo. For other years the numbers have been taken from IWS. Table 5 lists the catches of sei whales by area for the same period.

Table 4.

Catches of Sei/Bryde's whales from Japanese land stations as given by various sources, and the agreed 'best' series.

Year	K50	IWS	Tø	IWC	NH	'Best'	Notes
1911	373	375				375	
1912	?	236				236	
1913	?	361				361	
1914	239	239				239	
1915	726	723			717	723	NH 1920: 54
1916	393	419			393	419	NH 1920: 54
1917	579	581			579	581	NH 1920: 54
1918	729	739			728	739	NH 1920: 54
1919	531	532			543	532	NH 1926: 109
1920	393	393	389		393	389	NH 1926: 109
1921	474	477	474		455	474	NH 1926: 109
1922	390	391	390		390	390	NH 1926: 109
1923	488	488	492		488	492	NH 1926: 109
1924	642	642	642		642	642	NH 1927: 13
1925	492	499	491		491	491	NH 1926: 109
1926	563	568	563		455	563	NH 1926: 109
1927	531	531	551			551	
1928	299	551	309			309	
1929	381	364	364	364	364/294	364	NH 1930:161 + 164 / NH 1931: 119-121
1930	411	330	411		411	411	NH 1931: 142 gives no. by Co. and month
1931	421	418			418	418	NH 1932: 44-5 gives no. by Co. and month
1932	363	370			370	370	NH 1933: 111-112 gives no. by Co. and month
1933	349	388	337		352	337	NH 1934: 85-7 gives no. by Co. and month
1934	319	298			298	298	NH 1935: 119-120 lists 256 by Co. and month but total as 298
1935	392	380				380	
1936	352	348				348	
1937	445	435			435	435	NH 1938:206
1938	552	553			553	553	NH 1939: 183 gives no. by month
1939	678	677				677	
1940	?	429				429	
1941	623	623				623	
1942	255	255				255	
1943	352	352				352	
1944	734	734				734	
1945	74	74				74	
1946	574	574		573		574	Includes 29 from Bonin Is. IWC missing 1 from Area 5
1947	533	541		540		541	IWC no. includes 8 lost – apparently omitted from K50. IWC missing 1 from Area 5
1948	638	638				638	(IWC data from copy which appears to contain errors)
1949	871	875		875		875	IWC no. includes 4 lost – apparently omitted from K50
1950		542		542		542	
1951		699		699		699	
1952		1077		1077		1077	
1953		585		585		585	
1954		646		646		646	

K50: Kasahara, A. 1950 Whaling and its resources in the adjacent waters to Japan. Rep. Inst. Nippon Suisan Co. Ltd, 41, 103 + 51 (in Japanese)

IWS: International Whaling Statistics, 1942, XVI table 1 p 91-92 1963, XLIX:28-9 (Bonin Islands + Japan and Korea).

Tø: Tønnessen & Johnsen 1982: 735. The catches in Tønnessen & Johnsen are revised numbers from the Whales Research Institute, Tokyo. Only the catches for 1920-30 were listed as the "few errors in the 1911-19 and 1931-40 figures given in IWS are insignificant".

IWC: IWC individual database.

NH: Norsk Hvalfangst-tidende

Best: The 'best' catch series. The catches 1920-39 are taken from Tønnessen & Johnsen as these were revised numbers. For other years the numbers have been taken from IWS.

Table 5 (continued on next page).

Catches by Area (Areas 10 and 12 are not listed as no sei/Bryde's catches are recorded here). The abbreviations used are the same as for Table 4.

Year	Source	1	2	3	4	5	6	7	8	9	11	13	14	15	16	Total	Notes
1911	K50			1		260	87	13	11		1					373	
1912	K50			?		?	?	?	?		?	?				?	
1913	K50			?		?	?	?	?	?	?	?				?	Park: 1 Sei taken off Korea
1914	K50				19	202	3	6	9							239	
1915	K50		95			623	8									726	Area 2 inc areas 3 & 4; Area 6 inc. 7, 8 & 9
	NH		98			611	8									717	
1916	K50		38			345	10									393	Area 2 inc areas 3 & 4; Area 6 inc. 7, 8 & 9
	NH		38			345	10									393	
1917	K50		164			272	136				6		1[a]			579	Area 2 inc areas 3 & 4; Area 6 inc. 7, 8 & 9
	NH		164			272	136				6		1			579	
1918	K50		330			323	76									729	Area 2 inc areas 3 & 4; Area 6 inc. 7, 8 & 9
	NH		330			322	76									728	
1919	K50		149		15	269	90	7		1						531	
1920	K50		74			283	24				12					393	Area 2 inc areas 3 & 4; Area 6 inc. 7, 8 & 9
1921	K50		129	22	24	246	24	7	16		6					474	

Year	Source	1	2	3	4	5	6	7	8	9	11	13	14	15	16	Total	Notes
1922	K50		122		19	220	23	4			1	1				390	
1923	K50		150		32	272	3		29		2					488	
1924	K50		181		47	390	8	2	2		9			2	1	642	
1925	K50		96		57	279	44	1	5		6			4		492	
1926	K50		131		12	373	34	3			1			9		563	
1927	K50		104		79	304	33	3			5			3		531	
1928	K50		38		26	211	22				2					299	
1929	K50		116		90	146	23		4		1			1		381	
	IWC		116		70	149	23		4		1			1		364	IWC total matches Tø
1930	K50	2	120	1	66	208	7							7		411	
1931	K50	2	76	2	20	247	71				1				2	421	
1932	K50		80		81	134	66					1	1			363	
1933	K50		5		41	267	17				6			12	1	349	
1934	K50		44		66	142	62				2			3		319	
1935	K50		144		81	82	73							12		392	
1936	K50		35		15	256	16				4			25	1	352	
1937	K50		45		48	239	57							56		445	
1938	K50		100		49	296	75	4						27	1	552	
1939	K50		12		50	536	48							31	1	678	
1940	K50																No information
1941	K50	1	78		12	487	6				1			36	2	623	
1942	K50	4	32		144	55	5							14	1	255	
1943	K50	18	151	1	85	14	6							77		352	
1944	K50	5	133		170	177	2		100		2			145		734	
1945	K50		17		9	44					1		3			74	
1946	K50			15	66	422	2		40					29		574	=IWC
1947	K50			3	198	172			9		1			150		533	
	IWC			3	198	172			9		1			158		541	Includes 8 lost Area 15
1948	K50				178	352			2		1			105		638	
1949	K50				389	339	27							116		871	
	IWC				391	341	27							116		875	Includes 4 lost (2 in Area 4, 2 in Area 5)
1950	IWC				192	107								243		542	
1951	IWC				328	91								280		699	
1952	IWC				378	287	1							411		1077	
1953	IWC				367	218								0		585	
1954	IWC				380	264	2							0		646	

The annual sei/Bryde's catch by area is be taken to be the 'best' total listed in Table 4, prorated to area in using the figures for the relevant year from Table 5, or if there are no data, using the mean catch by area from the adjacent years (e.g. for 1912 using 1911 and 1914 catches). (The IWC individual database includes the date and sex of the catches in 1929 and 1946-54 but as the data do not differentiate between sei and Bryde's whales the method used to prorate these data is the same as for the other years).

The historic catch of Bryde's whales (1906-54) by sex is estimated by prorating the number sei/Bryde's whales by area and year (as given in Table 5) using the data from years 1953-72, as listed in table 6, which were taken from the NP1 forms for 1955-67 and from the IWC database for 1968 on. Data from 1973 on were not included in the proration because separate sei and Bryde's whale quotas were set from this time, so the data cannot be taken as a reflection of the proportion of each species in the area. Two alternative catch series will be considered in the *IST*s in which the pre 1955 catches from Area 5 (Sanriku) will be allocated using the upper and lower 5%iles of the proportion of known Bryde's whale catches 1953-72.

Table 6.

Table of catches in Areas 4, 5 and 6 showing ratio of sei:Bryde's and the sex ratios

	Area 4: S/E Hokkaido				Area 5: NE Honshu				Area 6: Central/S Honshu			
Year	Sei/Bry	Male Bry	Fem Bry	%Bry	Sei/Bry	Male Bry	Fem Bry	%Bry	Sei/Bry	Male Bry	Fem Bry	%Bry
1953	176	0	1	0.6	168	21	25	27.5				
1955	326	4	4	2.5	132	19	39	43.9	28	11	17	100
1956	512	0	4	0.8	267	12	8	7.5	0	0	0	
1957	213	0	0	0.0	259	12	27	15.1	0	0	0	
1958	235	0	0	0.0	467	74	106	38.5	74	39	35	100
1959	349	0	1	0.3	723	16	20	5.0	226	137	89	100
1960	142	1	1	1.4	415	78	95	41.7	229	109	120	100
1961	293	1	0	0.3	358	10	30	11.2	126	72	54	100
1962	351	0	5	1.4	779	167	233	51.3	99	42	57	100
1963	453	0	4	0.9	390	94	101	50.0	11	6	5	100
1964	273	1	2	1.1	594	24	41	10.9				
1965	275	0	0	0.0	182	1	7	4.4				
1966	89	0	0	0.0	190	19	36	28.9				
1967	273	0	0	0.0	258	17	28	17.4				
1968	207	0	1	0.5	768	70	100	22.1				
1969	167	0	3	1.8	383	34	52	22.5				
1970	99	0	0	0.0	451	36	37	16.2				
1971	91	1	4	5.5	340	79	88	49.1				
1972	21	1	3	19.0	259	37	43	30.9				
Total 1953-72	4545	9	33		7385	820	1116		793	416	377	

[1] 1953 figures are for examined whales only (Omura and Nemoto 1955): 48% of the catch in Area 4 and 77% of the catch in Area 5 was examined

Japanese coastal whaling 1955 - present

The catch data since 1955 differentiate between sei and Bryde's whales and are summarised in Table 6. Kondo and Kasuya (2002) report data from 1965-76 by Nihon Hogei which differs from the official catch series. However, for Bryde's whales, the new total catch of Bryde's whales is less than the official catch data, so the revised data has not been used in the catch series. [To add: data since 1972 + Kondo and Kasuya table].

Whaling by Japan in the Bonin Islands

Table 7 shows the Bonin Island catch of sei/Bryde's whales in the IWC individual database since 1946. The catch since 1951 has been identified to be 100% Bryde's whales. Before 1945, whaling in the Bonin Islands was conducted from December to May with a peak in March - see table 8 taken from Mizue 1950, table 1, which shows the catch of **all species** in the area by month. For comparison the annual catch of sei whales from the Bonin Islands as given by Kasahara 1950 is also shown.

Omura and Fujino (1954) show that the catch from the Bonin Islands in 1935-36, which was taken in the period Nov-Apr, was exclusively of sei whales (with the exception of one animal which could not be classified), in comparison with the catch in 1952 which was taken in the period May-Jun and was exclusively of Bryde's whales (see table 9 taken from Omura and Fujino, 1954 Table 6). They state that sei whales are found in the vicinity of the Bonin Islands in the period from December to the middle of April, after which they go north. Bryde's whales arrive in the middle or end of April.

An analysis of length data from the 1946-52 catch in the Bonin Islands (Ohsumi pers. comm.) confirms that the length distribution in February and March is similar to that of the sei whale, while that for May and June is similar to that of the Bryde's whale. The data in April is mixed.

Table 7.

Catch by month of sei/Bryde's whales in the Bonin Islands 1946-87 (source: IWC individual database)

Year	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Male	Female	Notes
1946	0	10	19	0	0	0	0	0	29	7	22	
1947	1	67	61	18	0	0	0	0	147	80	67	
1948	11	39	44	11	0	0	0	0	105	53	52	
1949	2	19	50	45	0	0	0	0	116	64	52	
1950	0	0	0	202	41	0	0	0	243	107	136	Same period as 1951-2 so assumed 100% Bryde's. Omura, Nishimoto and Fujino 1952 agree.
1951	0	0	0	204	76	0	0	0	280	155	125	100% Bryde's (Nisiwaki, Hibiya & Kimura 1953)
1952	0	0	0	235	176	0	0	0	411	270	141	100% Bryde's (Omura and Fujino 1954)
1981	0	0	33	122	72	77	0	13	317	174	143	All whales specified as Bryde's from here on
1982	0	0	28	75	110	166	59	0	438	258	180	
1983	0	0	63	175	147	103	20	0	508	382	126	
1984	0	0	68	206	142	55	0	0	471	322	149	
1985	0	0	10	59	120	91	24	0	304	219	85	
1986	0	0	44	101	112	58	0	0	315	216	99	
1987	0	0	19	56	92	112	27	0	306	249	57	

Table 8.

Total catch of whales (all species) by month in the Bonin Islands 1923-46 (from Mizue 1950) together with the sei/Bryde's and total catches as given by Kasahara (1950).

Year	Nov	Dec	Jan	Feb	Mar	Apr	May	Area 15 total (Mizue 50)	Year	Area 15 total (K50)	Area 15 sei+Bry (K50)
1922-23	0	3	0	0	0	0	0	3	1923	3	0
1923-24	0	3	9	29	28	17	8	94	1924	89	2
1924-25	0	0	21	17	28	23	6	95	1925	95	4
1925-26	0	0	12	19	20	12	7	70	1926	70	9
1926-27	0	0	5	5	9	2	0	21	1927	19	3
1927-28	0	5	8	9	4	4	0	30	1928	30	0
1928-29	2	0	6	6	8	0	0	22	1929	22	1
1929-30	0	14	18	3	5	0	0	40	1930	40	7
1930-31	0	1	16	12	11	0	0	40	1931	40	0
1931-32	0	5	16	13	11	0	0	45	1932	45	0
1932-33	0	1	26	25	16	0	0	68	1933	70	12
1933-34	0	11	10	16	9	4	0	50	1934	68	3
1934-35	1	13	10	16	23	1	0	64	1935	76	12
1935-36	0	5	11	22	28	25	2	93	1936	134	25[1]
1936-37	0	17	18	36	42	18	0	131	1937	168	56
1937-38	0	1	23	11	16	22	6	79	1938	126	27
1938-39	0	3	44	67	55	34	8	211	1939	207	31
1939-40	0	0	9	40	141	50	4	244	1940	?	?
1940-41	0	0	7	72	52	93	5	229	1941	229	36
1941-42	0	0	20	37	6	0	0	63	1942	63	14
1942-43	0	0	19	36	115	82	18	270	1943	270	77
1943-44	0	0	11	32	158	67	0	268	1944	268[2]	145
1944-45	0	0	0	0	0	0	0	0	1945	0	0
1945-46	0	0	0	0	59	54	0	113	1946	113	29

[1] Omura and Fujino 1954 say the catch in 1935/6 included 27 whales identified as true sei whales.

[2] Total given as 368 in K50 but appears to be a typographical error as the numbers of each species sum to 268.

Table 9.

Monthly catch of sei whales in Bonin Island waters in the seasons 1935-36 and 1952 (source Omura and Fujino 1954)

Year	Type	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1935-36	N-Type	1	1	0	2	11	12[1)]	0	0
1952	S-Type	0	0	0	0	0	0	235[2)]	176

[1] Season closed on 8 Apr. 1936; [2] Season opened on 1 May 1952

Other possible evidence concerning the proportion of Bryde's whales in the Bonin Island area catch is given by Wada 1988, who says: "The results of three Japanese sighting cruises in 1972 and 1973 (Ohsumi and Wada, 1974, RIWC 24: 114-26) and in 1974 Wada, 1975, RIWC 25:129-65) showed that there were about equal numbers of sei and Bryde's whales (73 versus 69 landed) in February and March in the Bonin Islands area. I have assumed all the 'sei' whales catch in the latter half of the season and 50% of the remaining catch to be Bryde's whales. This assumes that 75% of the 'sei' whale catch in 1911-45 were Bryde's whales." It has not been possible to confirm Wada's figures from the two references given.

Examination of JSV sightings data (ref? or add WP from NP Bryde's workshop) from 1964-1990 between February and July showed that no sei whales were seen in the vicinity of the Bonin Islands whereas Bryde's whales were seen in March, May, June and July.

Using the above data the 'best' catch series is constructed by assuming that for the pre 1946 data that (i) the fraction of sei/Bryde's whales caught in April/May is the same as that for all species and (ii) 2/3 of the historic catch of sei/Bryde's whales in April and May was of Bryde's whales. For the years 1946-49, the catch in April is allocated as for the pre 1946 data while the catch in May is assumed to be all Bryde's whales.

The uncertainties in the classification of the Bonin Island catches are such that two other catch series are used in the trials. The 'Low' catch series assumes that the historic catches in the Bonin Islands prior to 1949 do not include any Bryde's whales while the 'High' catch series assumes both the catch prior to 1946 and the catch taken in Apr-May 1946-9 to be 100% Bryde's whales. This will ensure that the full range of uncertainty is covered.

Kondo and Kasuya (2002) and Kasuya and Brownell (2001) report data from 1981-87 in the Bonin Islands which differ from the official catch series. The Kondo & Kasuya data will be used in the 'high' catch series.

2. China (Taiwan).

The estimates of the catch by Republic of China (Taiwan) are taken from Brownell (RIWC 81: 132) and are given in Table 10. Whaling ceased in 1981 (RIWC 1984:117). Brownell hopes that he may be able obtain better estimates of the catches or information on the number of vessels and area of operations, in the near future.

The current best estimates of the catch are listed in the column headed 'Best'. The 'low' catch series uses the minimum values for the years 1978-80 given in Brownell RIWC 81: 132 and the 'high' series uses the maximum values. The sex ratio from Japan pelagic operations in the sub-area is assumed to apply to these catches.

Note. Brownell suggests that samples of meat from the Republic of China catch were available in Vladivostok and should be used to confirm that these catches were of the off shore form of Bryde's whale (Dizon et al 1996 SC/48/O27).

Table 10.

Catches of Bryde's whales by China (Taiwan)

Year	Ref: Brownell RIWC 81: 132		Tillman & Mizroch 1982	
	Min. Catch	Max. catch	Catch	'Best' Catch
1976		119	119	119
1977		171	171	171
1978	186	450	118	318
1979	761	893	574	827
1980	320		448	448

3. Philippines.

The official catches were all recorded as having been taken close to Homonhon and hence would be of the inshore form Bryde's whale. The numbers are given in Table 11.. The official sex ratio is 41% female. (This compares with a sex ratio of 28% females in the Japan Bonin Island catch in the same 3 years).

Table 11.

Catches by the Philippines

Year	Male	Female	Total
1983	5	4	9
1984	25	22	47
1985	24	16	40

Perrin and Dolar (SC/50/RMP13) shows the catch was taken in more distant and deeper waters, possibly as far as the Bonin Islands. More recent information from Perrin 2006 confirms this and further shows that some catches were taken in the vicinity of the Caroline Islands and so may not have been taken from the Western North Pacific stock but rather from the Bryde's like pygmy species.

The official Philippines catch series is used in both the 'best' and the 'high' catch series, but assuming the catches came from the Western North Pacific Stock. The 'Low' catch series assumes 50% were taken from the Western North Pacific Stock (the remainder assumed to have been taken from another stock or species).

4. Pelagic data.

The revised Soviet data are shown in Table 12. As the revised data from 1970 to 1979 (Doroshenko 2000) do not differ significantly from the officially reported data, and the latter data are by individual whale, it was agreed to use the official data.

Table 12.

Soviet pelagic catches of sei and Bryde's whales and quotas (quotas taken from Ohsumi RIWC 48 (1998): 142)

Year	Bryde's: Official data	Bryde's: Revised catch	Sei + Bryde's: Official data	Sei + Bryde's: Revised catch	Bryde's Quota	Sei + Bryde's Quota
1966 (excl. S.Rossia & Aleut)	0	14	796	537		-
1968	0	22	1105	332		-
1969	0	95	1091	440		1977
1970	66	66	848	159		1797
1971	638	450	937	483		1517
1972 (IOS began)	71	67	142	122		1222
1973	657	646	760	780		983
1974	654	652	696	693		983
1975	629	629	653	653		655
1976	679	679	679	679	682	
1977	275	275	275	275	500	
1978	216	216	216	216	262	
1979	227	227	227	227	227	

5. Incidental catches

Only four incidental catches have been recorded since 1975 (ref Kishiro and Miyashita), of which one (in October 2003 from a trap net in Shizuoka) was identified as an offshore type Bryde's whale. The remaining three (in August 1978 from Oita, April 1988 from Hyogo and March 1995 from Kochi (released)) are all thought to have been inshore forms although no DNA data is available to confirm this. In addition three Bryde's whales have been stranded.

The Working Group agreed that there was no evidence to suggest that a significant number of Bryde's whales are caught incidentally and so there is no need to model incidental catches in the *IST*s.

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Table 13 (continued on next page).

Table of catches (components of the different catch series are shown in the columns on the left and the totals on the right)

By:	Japan	Japan	Japan	USSR	R.China	Philipn	All	All	All	Japan	Japan	All	All	All	All	All
Sub-area	1W	1E	2	All	1W	1W	1W	1E	2	1W	1W	1W	1W	All	All	All
Boundary	165	165					165	165		165	165	165	165			
Series	Best	Best	Best	All	Best	B and H	Best	All	All	Low	High	Low	High	Low	Best	High
1906	13	0	0	0	0	0	13	0	0	7	20	7	20	7	13	20
1907	34	0	0	0	0	0	34	0	0	19	52	19	52	19	34	52
1908	82	0	0	0	0	0	82	0	0	46	124	46	124	46	82	124
1909	47	0	0	0	0	0	47	0	0	26	71	26	71	26	47	71
1910	51	0	0	0	0	0	51	0	0	28	77	28	77	28	51	77
1911	156	0	0	0	0	0	156	0	0	87	237	87	237	87	156	237
1912	81	0	0	0	0	0	81	0	0	35	137	35	137	35	81	137
1913	125	0	0	0	0	0	125	0	0	53	209	53	209	53	125	209
1914	56	0	0	0	0	0	56	0	0	3	119	3	119	3	56	119
1915	169	0	0	0	0	0	169	0	0	6	362	6	362	6	169	362
1916	105	0	0	0	0	0	105	0	0	9	219	9	219	9	105	219
1917	181	0	0	0	0	0	181	0	0	109	266	109	266	109	181	266
1918	148	0	0	0	0	0	148	0	0	62	249	62	249	62	148	249
1919	161	0	0	0	0	0	161	0	0	90	245	90	245	90	161	245
1920	92	0	0	0	0	0	92	0	0	19	179	19	179	19	92	179
1921	89	0	0	0	0	0	89	0	0	24	165	24	165	24	89	165
1922	81	0	0	0	0	0	81	0	0	23	149	23	149	23	81	149
1923	75	0	0	0	0	0	75	0	0	3	160	3	160	3	75	160
1924	111	0	0	0	0	0	111	0	0	8	234	8	234	8	111	234
1925	118	0	0	0	0	0	118	0	0	44	208	44	208	44	118	208
1926	134	0	0	0	0	0	134	0	0	34	257	34	257	34	134	257
1927	118	0	0	0	0	0	118	0	0	35	219	35	219	35	118	219
1928	80	0	0	0	0	0	80	0	0	23	148	23	148	23	80	148
1929	63	0	0	0	0	0	63	0	0	24	110	24	110	24	63	110
1930	62	0	0	0	0	0	62	0	0	8	134	8	134	8	62	134
1931	135	0	0	0	0	0	135	0	0	71	211	71	211	71	135	211
1932	104	0	0	0	0	0	104	0	0	68	146	68	146	68	104	146
1933	84	0	0	0	0	0	84	0	0	17	176	17	176	17	84	176
1934	93	0	0	0	0	0	93	0	0	58	137	58	137	58	93	137
1935	92	0	0	0	0	0	92	0	0	71	129	71	129	71	92	129
1936	87	0	0	0	0	0	87	0	0	16	186	16	186	16	87	186
1937	122	0	0	0	0	0	122	0	0	56	245	56	245	56	122	245
1938	160	0	0	0	0	0	160	0	0	76	273	76	273	76	160	273
1939	193	0	0	0	0	0	193	0	0	48	386	48	386	48	193	386
1940	110	0	0	0	0	0	110	0	0	18	233	18	233	18	110	233
1941	144	0	0	0	0	0	144	0	0	6	321	6	321	6	144	321
1942	21	0	0	0	0	0	21	0	0	6	52	6	52	6	21	52
1943	29	0	0	0	0	0	29	0	0	7	92	7	92	7	29	92
1944	74	0	0	0	0	0	74	0	0	4	250	4	250	4	74	250
1945	12	0	0	0	0	0	12	0	0	0	25	0	25	0	12	25
1946	126	0	0	0	0	0	126	0	0	3	263	3	263	3	126	263
1947	106	0	0	0	0	0	106	0	0	2	179	2	179	2	106	179
1948	134	0	0	0	0	0	134	0	0	2	258	2	258	2	134	258
1949	199	0	0	0	0	0	199	0	0	31	321	31	321	31	199	321
1950	288	0	0	0	0	0	288	0	0	260	321	260	321	260	288	321
1951	307	0	0	0	0	0	307	0	0	283	335	283	335	283	307	335
1952	491	0	0	0	0	0	491	0	0	415	580	415	580	415	491	580
1953	61	0	0	0	0	0	61	0	0	3	128	3	128	3	61	128
1954	75	0	0	0	0	0	75	0	0	6	157	6	157	6	75	157
1955	94	0	0	0	0	0	94	0	0	94	94	94	94	94	94	94
1956	24	0	0	0	0	0	24	0	0	24	24	24	24	24	24	24
1957	39	0	0	0	0	0	39	0	0	39	39	39	39	39	39	39
1958	254	0	0	0	0	0	254	0	0	254	254	254	254	254	254	254
1959	263	0	0	0	0	0	263	0	0	263	263	263	263	263	263	263
1960	404	0	0	0	0	0	404	0	0	404	404	404	404	404	404	404
1961	167	0	0	0	0	0	167	0	0	167	167	167	167	167	167	167
1962	504	0	0	0	0	0	504	0	0	504	504	504	504	504	504	504
1963	210	0	0	0	0	0	210	0	0	210	210	210	210	210	210	210
1964	68	0	0	0	0	0	68	0	0	68	68	68	68	68	68	68

By:	Japan	Japan	Japan	USSR	R.China	Philipn	All	All	All	Japan	Japan	All	All	All	All	All
Sub-area	1W	1E	2	All	1W	1W	1W	1E	2	1W	1W	1W	1W	All	All	All
Boundary	165	165					165	165		165	165	165	165			
Series	Best	Best	Best	All	Best	B and H	Best	All	All	Low	High	Low	High	Low	Best	High
1965	8	0	0	0	0	0	8	0	0	8	8	8	8	8	8	8
1966	55	0	0	0	0	0	55	0	0	55	55	55	55	55	55	55
1967	45	0	0	0	0	0	45	0	0	45	45	45	45	45	45	45
1968	171	0	0	0	0	0	171	0	0	171	171	171	171	171	171	171
1969	89	0	0	0	0	0	89	0	0	89	89	89	89	89	89	89
1970	73	0	0	66	0	0	73	40	26	73	73	73	73	139	139	139
1971	172	109	0	638	0	0	235	443	241	172	172	235	235	856	919	919
1972	84	5	0	71	0	0	84	63	13	84	84	84	84	160	160	160
1973	40	2	0	657	0	0	592	51	56	40	40	592	592	147	699	699
1974	147	250	272	654	0	0	709	306	308	147	147	709	709	761	1323	1323
1975	116	263	424	629	0	0	701	296	435	116	116	701	701	847	1432	1432
1976	83	547	31	679	119	0	851	577	31	83	83	851	851	691	1459	1459
1977	437	63	0	275	171	0	787	150	9	437	437	787	787	596	946	946
1978	67	195	0	216	318	0	490	293	13	67	67	358	622	373	796	928
1979	195	30	2	227	827	0	1240	39	2	195	195	1174	1306	236	1281	1347
1980	307	0	0	0	448	0	755	0	0	307	307	627	755	307	755	755
1981	485	0	0	0	0	0	485	0	0	485	622	485	622	485	485	622
1982	482	0	0	0	0	0	482	0	0	482	709	482	709	482	482	709
1983	536	0	0	0	0	9	545	0	0	536	614	536	623	536	545	623
1984	481	0	0	0	0	47	528	0	0	481	757	481	804	481	528	804
1985	317	0	0	0	0	40	357	0	0	317	566	317	606	317	357	606
1986	317	0	0	0	0	0	317	0	0	317	622	317	622	317	317	622
1987	317	0	0	0	0	0	317	0	0	317	548	317	548	317	317	548
1988	0	0	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	0	0
1990	0	0	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	0	0
1992	0	0	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	0	0
1994	0	0	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	0	0
1996	0	0	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	0	0
1998	1	0	0	0	0	0	1	0	0	1	1	1	1	1	1	1
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	43	0	0	0	0	0	43	0	0	43	43	43	43	43	43	43
2001	50	0	0	0	0	0	50	0	0	50	50	50	50	50	50	50
2002	50	0	0	0	0	0	50	0	0	50	50	50	50	50	50	50
2003	50	0	0	0	0	0	50	0	0	50	50	50	50	50	50	50
2004	44	7	0	0	0	0	44	7	0	44	44	44	44	51	51	51
2005	50	0	0	0	0	0	50	0	0	50	50	50	50	50	50	50

Annex D

Examples of Graphs and Tabular Summaries[1]

This adjunct presents examples of the series of plots and tables developed by the Workshop to present and summarise the results of the trials in order both to facilitate identification of the differences in performance among the four RMP variants, as well as to facilitate the application of the steps related to reviewing the results of the *Implementation Simulation Trials* (see Item 3.1).

The plots and tables presented are:

Fig 1 A plot showing the performance of each RMP variant and the no-catch scenario for each of the MSYR(mat)=1% trials using the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance. This plot has panels for each stock/sub-stock and the two performance statistics on which the thresholds are based (the lower 5th percentile of the final depletion distribution and the lower 5th percentile of the scaled lowest depletion distribution). The values for the performance statistics for each variant (and the no-catch scenario) are represented as dots, and horizontal lines indicate the thresholds (upper line: 'acceptable'; lower line: 'borderline'). The shaded area in this plot indicates 'unacceptable' performance.

Fig 2 A plot for each trial showing the performance of all the RMP variants together with details of one of the RMP variants (usually C2). This plot consists of the eight types of outputs (for some trials some types of output are not included in this Annex, but they are included in the full set of output held by the Secretariat):

- (a) Plots for each stock/sub-stock showing the 5%^{ile}, median and 95%^{ile} of the time-trajectories of population size[2] for each of the RMP variants and for the no-catch scenario.
- (b) the 5%^{ile}, median and 95%^{ile} of the population size trajectories by stock/sub-stock under one of the RMP variants (C2) from 1980 until the end of the projection period (this is only shown in the following figures for single stock trials);
- (c) ten individual population size trajectories for each stock/sub-stock under one of the RMP variants (C2) (this is only shown in the following figures for single stock trials);
- (d) the median population size trajectories by stock/sub-stock from 1980 to the end of the projection period for all of the RMP variants (this is only shown in the following figures for single stock trials);
- (e) the median catch trajectories by stock/sub-stock for one of the RMP variants (C2);
- (f) the 5%^{ile}, median and 95%^{ile} of the time-trajectories of catch by management area from 1980 to the end of the projection period for one of the RMP variants (C2);
- (g) three individual catch trajectories for each management area for one of the RMP variants (C2) (this is not shown in the following figures for D trials)
- (h) the median catch-trajectories by management area from 1980 to the end of the projection period for all of the RMP variants;

Table 1 For each of the trials for which MSYR(mat)=1% and for each RMP variant, the median catch (total and by management area) over the entire projection period, and a summary of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance. An 'A' in this table indicates 'acceptable' performance, a 'B' 'borderline' performance and a 'U' 'unacceptable' performance. The table shows results for each performance statistic and stock/sub-stock separately, results by stock/sub-stock (i.e. after aggregating the outcomes for two performance statistics), and results in total (i.e. after aggregating outcomes from each performance statistic and stock/sub-stock).

Table 2 Catch results for each trial and RMP variant (and the no-catch scenario) including:

- (a) median catch (total and by management area) over the entire projection period;
- (b) lower 5^{ile} and median of the initial depletion distribution (by stock/sub-stock);
- (c) lower 5^{ile} and median of the final depletion distribution (by stock/sub-stock); and
- (d) lower 5^{ile} and median of the scaled lowest depletion distribution (by stock/sub-stock).

This table also includes the values for the thresholds for each performance statistic and stock/sub-stock for the trials for which MSYR(mat)=1% and the outcomes of the application of the procedure for defining 'acceptable', 'borderline' and 'unacceptable' performance using the symbols as for Table 1.

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[1] The full set of plots and tables will be archived by the Secretariat and made available to members of the Scientific Committee on request.

[2] Mature female numbers.

Table 3 A summary of the catches for each RMP variant including

(a) the median catch (total and by management area) over the entire projection period;

(b) the 5%ile, median and 95%ile of the distribution of the average catch in management area 1W over the first 20 years of the projection period;

(c) the 5%ile, median and 95%ile of the distribution of the average catch in management area 1E over the first 20 years of the projection period; and

(d) the 5%ile, median and 95%ile of the distribution of the average catch in management area 2 over the first 20 years of the projection period.

Table 4 The full set of performance statistics for each trial and RMP variant (and the no-catch scenario).

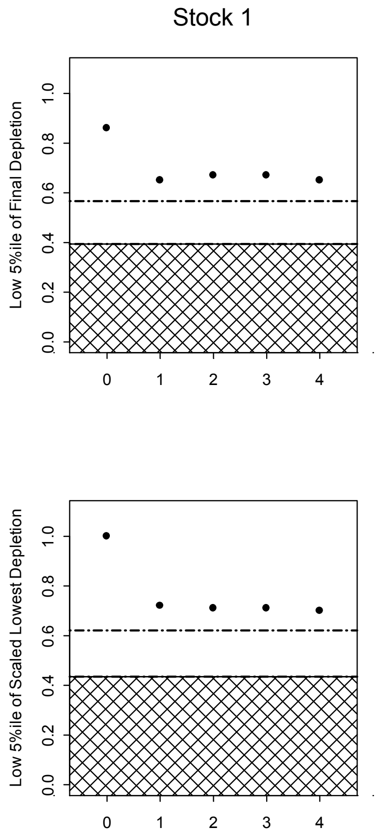
Table 1

Performance Table

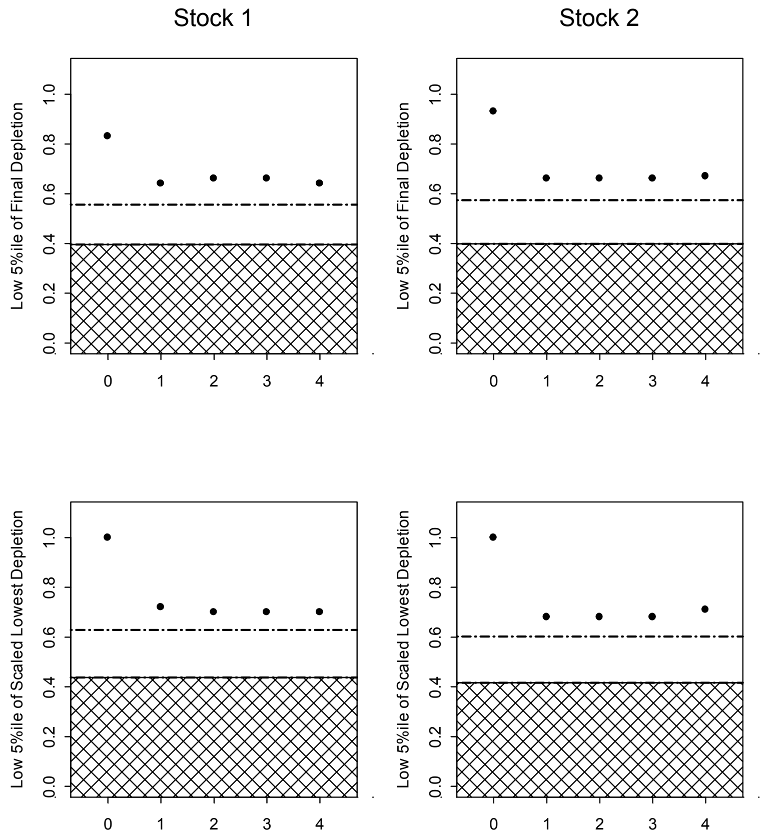
Tr	V	Median catch				Pfinal 5%			Plow(S) 5%			Overall			
		Tot	1w	1e	2	Stk1	Stk2	Stk3	Stk1	Stk2	Stk3	Stk1	Stk2	Stk3	All
Br01	C1	105	14	66	18	A			A			A			A
Br01	C2	98	78	0	18	A			A			A			A
Br01	C3	98	33	44	18	A			A			A			A
Br01	C4	103	38	48	14	A			A			A			A
Br03	C1	104	16	67	17	A	A		A	A		A	A		A
Br03	C2	98	80	0	17	A	A		A	A		A	A		A
Br03	C3	98	34	45	17	A	A		A	A		A	A		A
Br03	C4	101	38	47	13	A	A		A	A		A	A		A
Br05	C1	104	14	65	17	A	A		A	A		A	A		A
Br05	C2	97	78	0	17	A	A		A	A		A	A		A
Br05	C3	97	34	42	16	A	A		A	A		A	A		A
Br05	C4	104	37	48	13	A	A		A	A		A	A		A
Br07	C1	101	17	66	17	A	A	A	A	A	A	A	A	A	A
Br07	C2	98	81	0	17	A	A	A	A	A	A	A	A	A	A
Br07	C3	99	38	43	17	A	A	A	A	A	A	A	A	A	A
Br07	C4	102	40	45	13	A	A	A	A	A	A	A	A	A	A
Br09	C1	105	15	72	17	A	A		A	A		A	A		A
Br09	C2	98	83	0	17	A	A		A	A		A	A		A
Br09	C3	98	33	47	17	A	A		A	A		A	A		A
Br09	C4	103	35	50	12	A	A		A	A		A	A		A
Br11	C1	118	23	70	19	A	A	B	B	A	B	A	A	B	B
Br11	C2	123	101	0	19	B	A	B	B	A	B	B	A	B	B
Br11	C3	123	46	50	19	B	A	B	B	A	B	B	A	B	B
Br11	C4	126	49	53	16	B	B	B	B	B	B	B	B	B	B
Br13	C1	93	21	56	17	U	A	A	A	A	A	A	A	A	A
Br13	C2	90	74	0	17	U	A	A	U	A	A	U	A	A	U
Br13	C3	90	37	36	17	U	A	A	B	A	A	B	A	A	B
Br13	C4	93	39	39	13	U	A	A	B	A	A	B	A	A	B
Br15	C1	103	14	66	17	A	U	A	A	A	A	A	A	A	A
Br15	C2	97	79	0	17	U	U	A	B	U	A	B	U	A	U
Br15	C3	97	33	43	17	B	U	A	A	A	A	A	A	A	A
Br15	C4	102	36	46	13	B	U	A	A	A	A	A	A	A	A
Br17	C1	100	19	60	17	A	A	A	A	A	A	A	A	A	A
Br17	C2	91	75	0	17	A	U	A	A	U	A	A	U	A	U
Br17	C3	95	34	41	17	A	B	A	A	A	A	A	A	A	A
Br17	C4	99	39	45	13	A	B	A	A	A	A	A	A	A	A
Br19	C1	99	16	64	15	A	B	A	A	A	A	A	A	A	A
Br19	C2	95	79	0	15	A	B	A	A	A	A	A	A	A	A
Br19	C3	95	36	41	15	A	A	A	A	A	A	A	A	A	A
Br19	C4	97	37	44	12	A	B	A	A	A	A	A	A	A	A
Br21	C1	107	20	69	16	A	A	A	A	A	A	A	A	A	A
Br21	C2	104	88	0	16	A	A	A	A	A	A	A	A	A	A
Br21	C3	104	41	45	16	A	A	A	A	A	A	A	A	A	A
Br21	C4	107	44	50	13	A	A	A	A	A	A	A	A	A	A
Br23	C1	109	18	70	16	A	A		A	A		A	A		A
Br23	C2	104	87	0	16	A	A		A	A		A	A		A
Br23	C3	104	38	48	16	A	A		A	A		A	A		A
Br23	C4	108	40	52	13	A	A		A	A		A	A		A
Br25	C1	120	20	73	18	A	B		B	B		A	B		B
Br25	C2	122	103	0	18	B	B		B	B		B	B		B
Br25	C3	122	42	55	18	B	B		B	B		B	B		B
Br25	C4	126	44	58	16	B	B		B	B		B	B		B
Br27	C1	110	18	71	16	A	A		A	A		A	A		A
Br27	C2	106	90	0	16	A	A		A	A		A	A		A
Br27	C3	107	38	49	16	A	A		A	A		A	A		A
Br27	C4	110	40	53	13	A	A		A	A		A	A		A

Fig 1. Threshold plots.

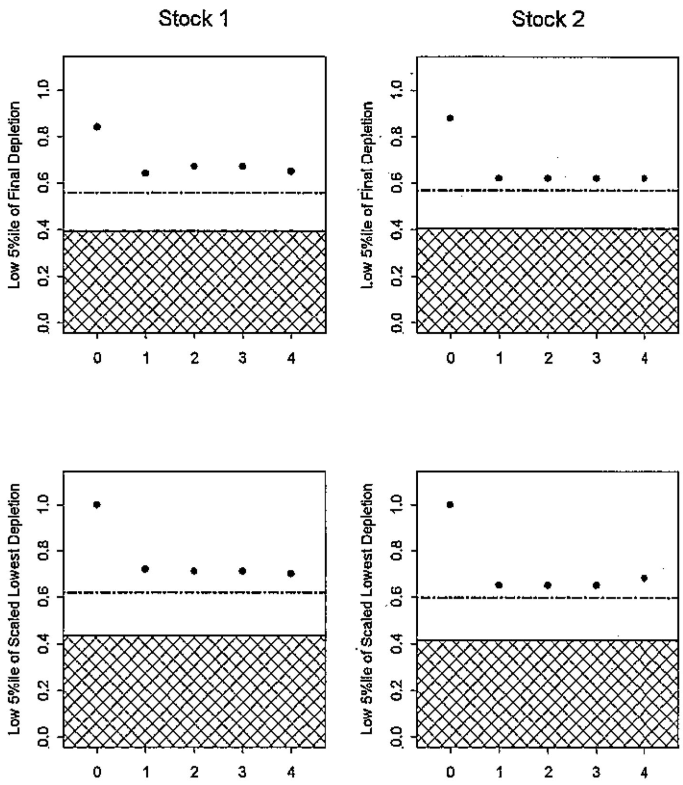
Trial BR-01



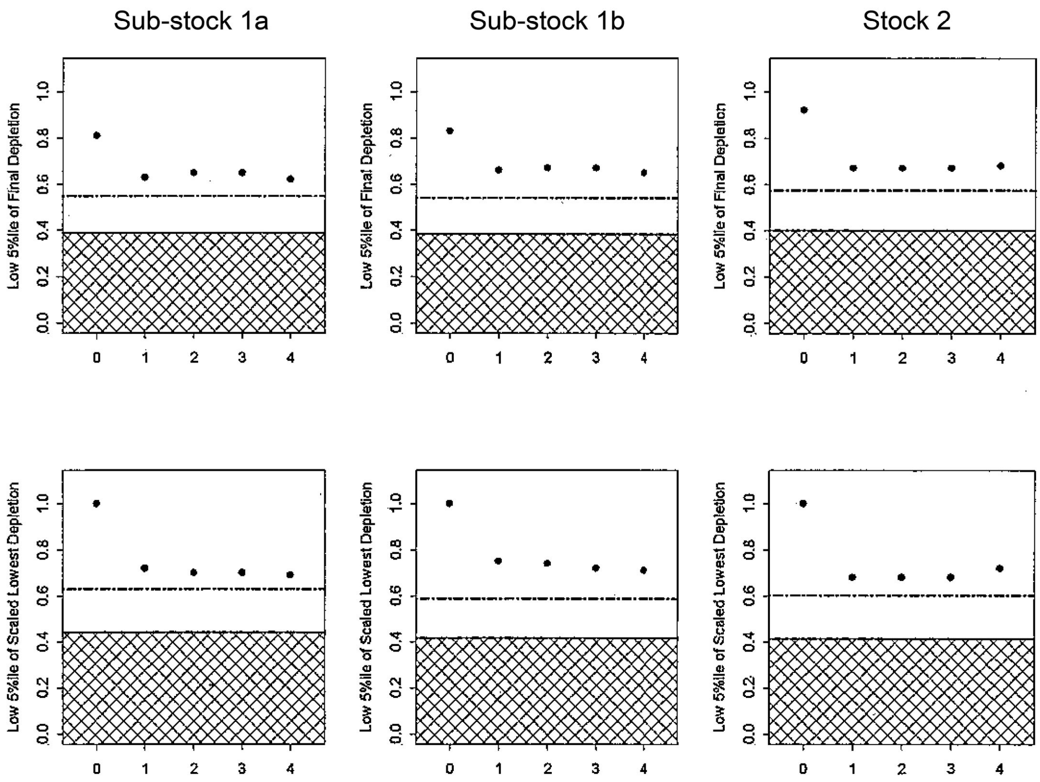
Trial Br-03



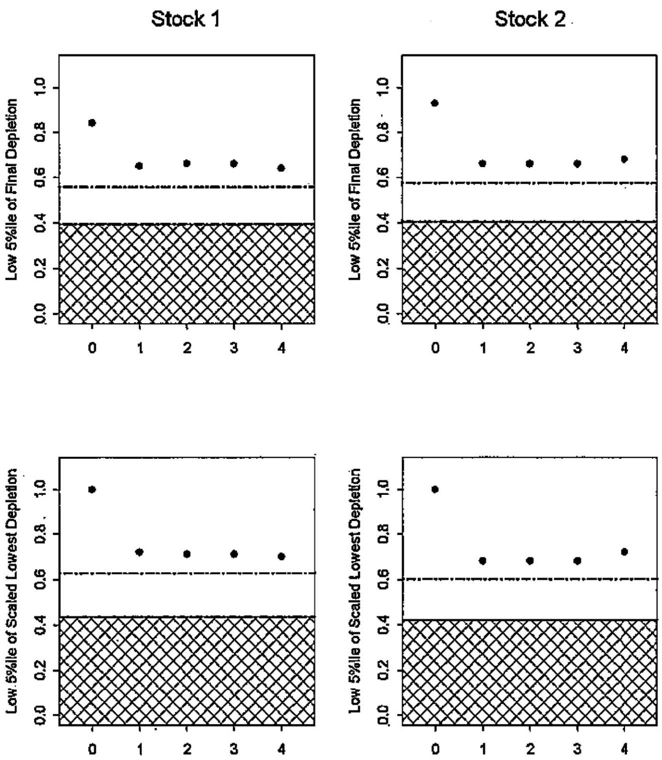
Trial BR-05



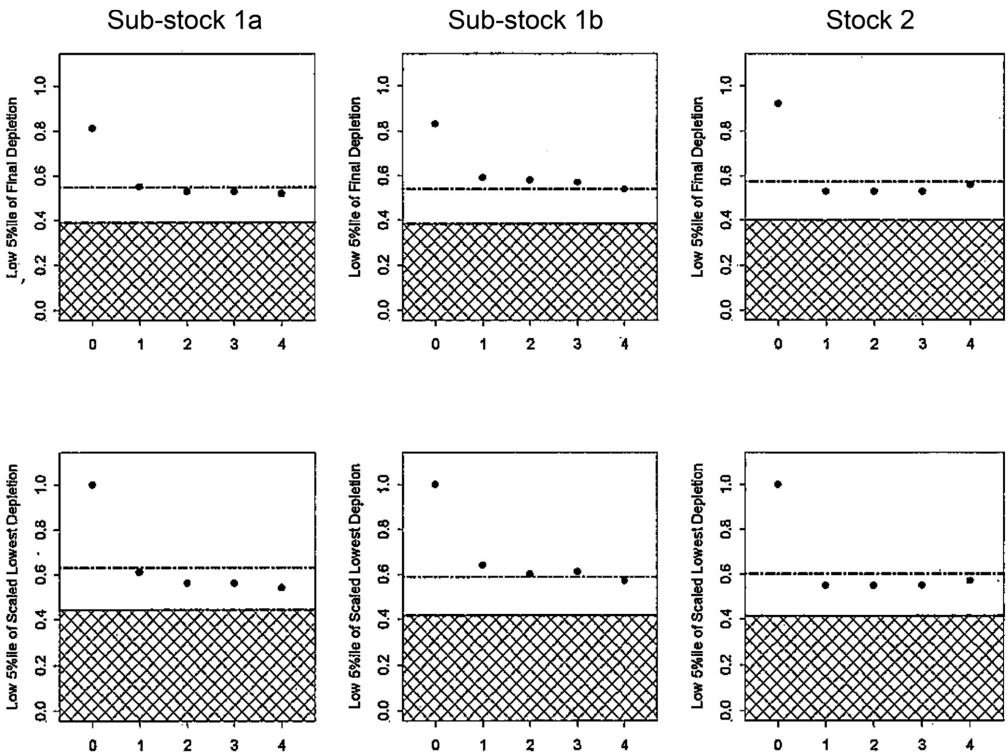
Trial BR-07



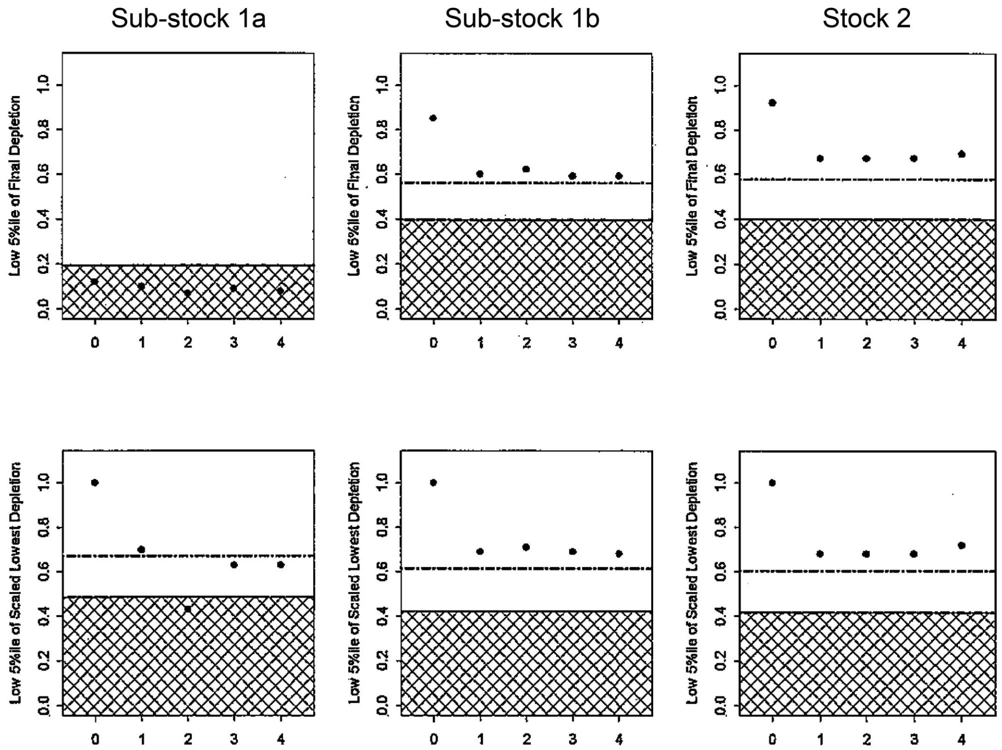
Trial BR-09



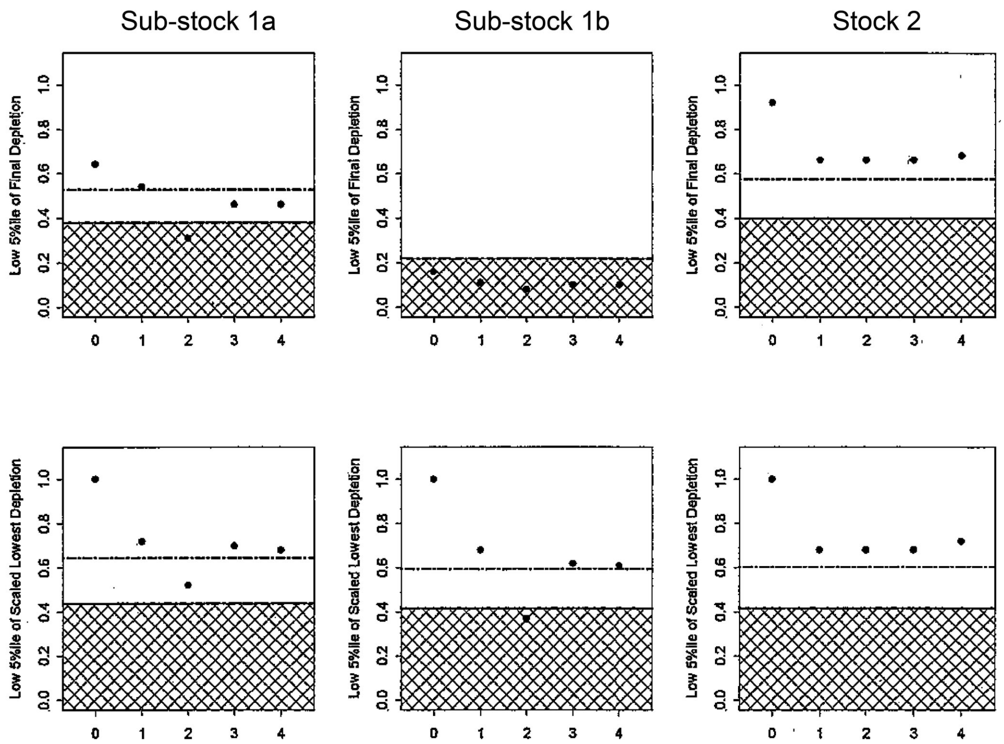
Trial BR-11



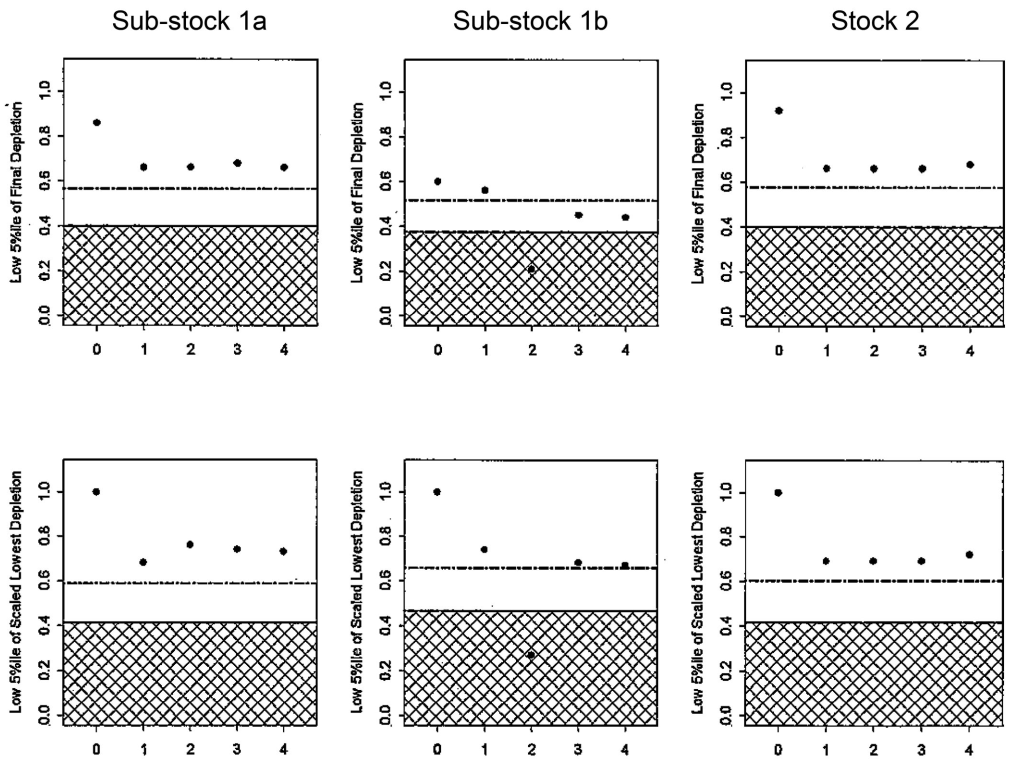
Trial BR-13



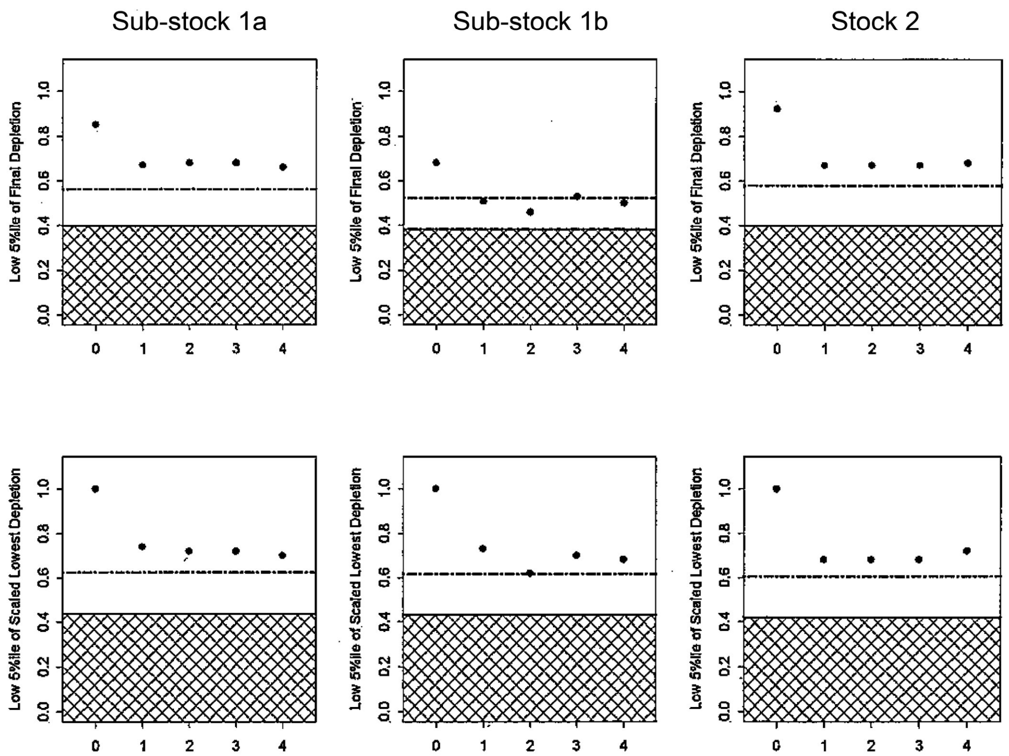
Trial BR-15



Trial BR-17



Trial BR-19



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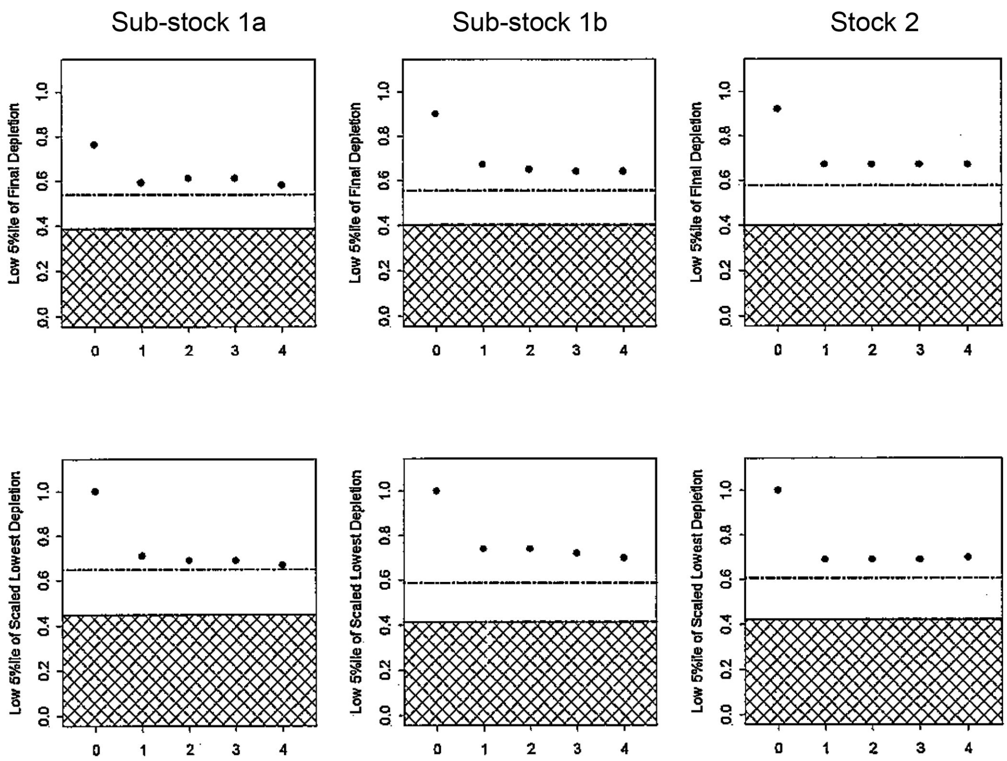

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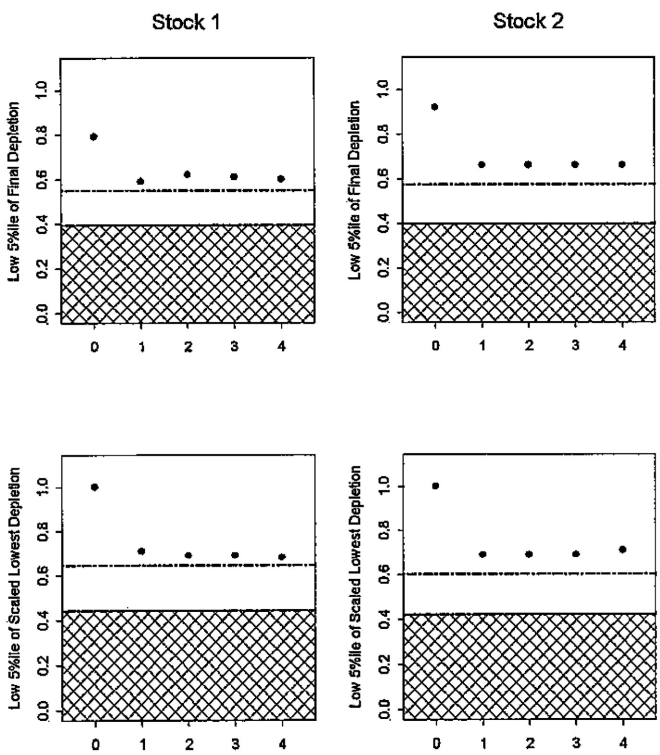
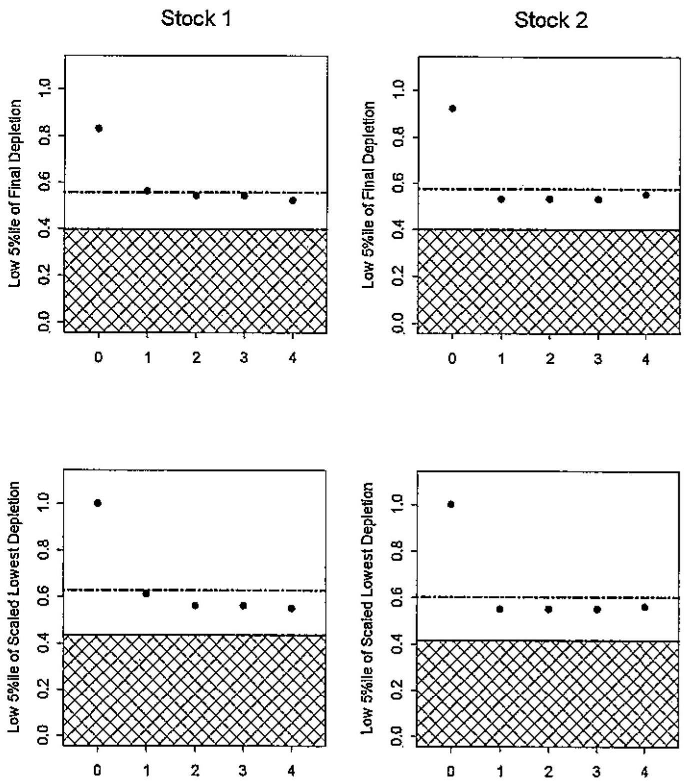


Trial BR-25



Trial BR-27

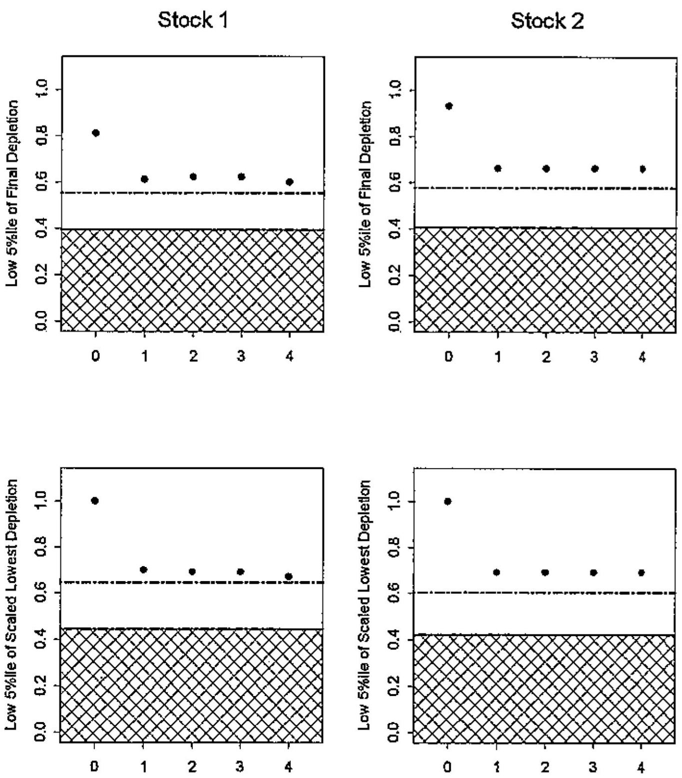


Table 2

Catch results for each trial and RMP variant (and the no-catch scenario)

Tr	V Ac	Median catch				Init Stk 1		Init Stk 2		Init Stk 3		PFinal Stk 1		PFinal Stk 1		PFinal Stk 1		PLow 5%			PLow (Scaled) 5%		
		Tot	1w	1e	2	5%	Med	5%	Med	5%	Med	5%	Med Ac	5%	Med Ac	5%	Med Ac	Stk1	Stk2	Stk3	Stk1	Stk2	Stk3
Br01	V0	0	0	0	0	.51	.61					.86	.92					.51			1.00		
Br01	V1	105	14	65	18	.51	.61					.65	.69					.51			.72		
Br01	V2	98	78	0	18	.51	.61					.67	.71					.51			.71		
Br01	V3	98	33	44	18	.51	.61					.67	.71					.51			.71		
Br01	V4	103	38	48	14	.51	.61					.65	.70					.51			.70		
Br02	V0	0	0	0	0	.78	.88					1.00	1.00					.78			1.00		
Br02	V1	110	17	69	20	.78	.88					.94	.96					.78			.91		
Br02	V2	109	85	0	19	.78	.88					.94	.97					.78			.91		
Br02	V3	109	37	49	19	.78	.88					.94	.97					.78			.91		
Br02	V4	116	41	54	16	.78	.88					.92	.96					.78			.91		
Br03	V0	0	0	0	0	.48	.58	.64	.79			.83	.90	.93	.97			.48	.64		1.00	1.00	
Br03	V1	103	15	66	17	.48	.58	.64	.79			.64	.69	.66	.72			.48	.63		.72	.68	
Br03	V2	97	80	0	17	.48	.58	.64	.79			.66	.70	.66	.72			.48	.63		.70	.68	
Br03	V3	97	34	45	17	.48	.58	.64	.79			.66	.70	.66	.72			.48	.63		.70	.68	
Br03	V4	101	38	47	13	.48	.58	.64	.79			.64	.68	.67	.78			.48	.63		.70	.71	
Br04	V0	0	0	0	0	.74	.85	.83	.97			1.00	1.00	1.00	1.00			.74	.83		1.00	1.00	
Br04	V1	111	19	70	17	.74	.85	.83	.97			.94	.96	.92	.94			.74	.83		.91	.89	
Br04	V2	110	94	0	17	.74	.85	.83	.97			.94	.97	.92	.94			.74	.83		.91	.89	
Br04	V3	111	39	50	17	.74	.85	.83	.97			.94	.97	.92	.94			.74	.83		.91	.89	
Br04	V4	117	44	55	14	.74	.85	.83	.97			.92	.96	.92	.96			.74	.83		.90	.89	
Br05	V0	0	0	0	0	.49	.59	.54	.80			.84	.91	.88	.97			.49	.54		1.00	1.00	
Br05	V1	104	14	65	17	.49	.59	.54	.80			.64	.69	.62	.71			.49	.54		.72	.65	
Br05	V2	97	78	0	17	.49	.59	.54	.80			.67	.71	.62	.71			.49	.54		.71	.65	
Br05	V3	97	34	42	16	.49	.59	.54	.80			.67	.71	.62	.71			.49	.54		.71	.65	
Br05	V4	104	37	48	13	.49	.59	.54	.80			.65	.69	.62	.76			.49	.54		.70	.68	
Br06	V0	0	0	0	0	.76	.86	.78	.95			1.00	1.00	1.00	1.00			.76	.78		1.00	1.00	
Br06	V1	108	16	67	20	.76	.86	.78	.95			.95	.96	.86	.93			.76	.77		.91	.79	
Br06	V2	105	78	0	20	.76	.86	.78	.95			.94	.97	.86	.93			.76	.77		.91	.79	
Br06	V3	105	35	44	20	.76	.86	.78	.95			.94	.97	.86	.93			.76	.77		.91	.79	
Br06	V4	114	41	51	16	.76	.86	.78	.95			.93	.96	.88	.96			.76	.77		.91	.82	
Br07	V0	0	0	0	0	.46	.57	.56	.89	.63	.79	.82	.90	.88	.99	.92	.97	.46	.56	.63	1.00	1.00	1.00
Br07	V1	102	17	65	16	.46	.57	.56	.89	.63	.79	.63	.68	.69	.79	.66	.72	.46	.56	.63	.72	.75	.68
Br07	V2	98	82	0	16	.46	.57	.56	.89	.63	.79	.65	.69	.69	.84	.66	.72	.46	.56	.63	.70	.75	.68
Br07	V3	98	37	42	16	.46	.57	.56	.89	.63	.79	.66	.69	.68	.82	.66	.72	.46	.56	.63	.70	.73	.68
Br07	V4	102	39	45	13	.46	.57	.56	.89	.63	.79	.63	.68	.65	.80	.68	.78	.46	.56	.63	.69	.71	.72
Br08	V0	0	0	0	0	.72	.85	.11	.78	.83	.97	1.00	1.00	.99	1.00	1.00	1.00	.72	.11	.83	1.00	1.00	1.00
Br08	V1	111	23	67	17	.72	.85	.11	.78	.83	.97	.95	.96	.94	.96	.91	.94	.72	.11	.83	.91	.82	.89
Br08	V2	110	93	0	17	.72	.85	.11	.78	.83	.97	.93	.97	.85	.96	.91	.94	.72	.11	.83	.91	.68	.89
Br08	V3	111	44	46	17	.72	.85	.11	.78	.83	.97	.93	.97	.91	.96	.91	.94	.72	.11	.83	.91	.78	.89
Br08	V4	119	48	51	15	.72	.85	.11	.78	.83	.97	.92	.96	.91	.96	.92	.96	.72	.11	.83	.91	.77	.89
Br09	V0	0	0	0	0	.14	.58	.65	.81			.34	.90	.93	.98			.14	.65		1.00	1.00	
Br09	V1	105	14	68	17	.14	.58	.65	.81			.33	.69	.66	.72			.14	.63		.71	.68	
Br09	V2	98	80	0	17	.14	.58	.65	.81			.32	.70	.66	.72			.14	.63		.69	.68	
Br09	V3	98	32	46	17	.14	.58	.65	.81			.32	.70	.66	.72			.14	.63		.69	.68	
Br09	V4	103	35	49	13	.14	.58	.65	.81			.29	.68	.67	.78			.14	.64		.68	.71	
Br10	V0	0	0	0	0	.66	.88	.85	.97			1.00	1.00	1.00	1.00			.66	.85		1.00	1.00	

Br10 V1	119	18	80	17	.66	.88	.85	.97			.92	.95	.92	.94			.66	.85		.90	.89	
Br10 V2	119	104	0	17	.66	.88	.85	.97			.91	.96	.92	.94			.66	.85		.90	.89	
Br10 V3	120	43	59	17	.66	.88	.85	.97			.91	.96	.92	.94			.66	.85		.90	.89	
Br10 V4	127	45	63	15	.66	.88	.85	.97			.91	.95	.91	.95			.66	.85		.90	.89	
Br11 V0	0	0	0	0	.46	.57	.56	.89	.63	.79	.82	.90	.88	.99	.92	.97	.46	.56	.63	1.00	1.00	1.00
Br11 V1	116	24	69	18	.46	.57	.56	.89	.63	.79	.55	.64	.61	.75	.53	.69	.44	.55	.51	.61	.61	.55
Br11 V2	122	103	0	18	.46	.57	.56	.89	.63	.79	.52	.64	.59	.80	.53	.69	.44	.55	.51	.55	.63	.55
Br11 V3	122	46	49	18	.46	.57	.56	.89	.63	.79	.52	.64	.58	.77	.53	.69	.44	.55	.51	.56	.60	.55
Br11 V4	125	49	53	16	.46	.57	.56	.89	.63	.79	.52	.62	.54	.74	.55	.71	.44	.54	.52	.54	.56	.56
Br12 V0	0	0	0	0	.72	.85	.11	.78	.83	.97	1.00	1.00	.99	1.00	1.00	1.00	.72	.11	.83	1.00	1.00	1.00
Br12 V1	127	28	74	19	.72	.85	.11	.78	.83	.97	.92	.96	.91	.95	.87	.94	.72	.11	.78	.85	.75	.78
Br12 V2	139	119	0	19	.72	.85	.11	.78	.83	.97	.88	.95	.76	.94	.87	.94	.72	.11	.78	.83	.59	.78
Br12 V3	140	53	57	19	.72	.85	.11	.78	.83	.97	.88	.95	.86	.95	.87	.94	.72	.11	.78	.83	.70	.78
Br12 V4	152	58	62	19	.72	.85	.11	.78	.83	.97	.87	.94	.85	.94	.88	.95	.72	.11	.77	.82	.67	.77
Br13 V0	0	0	0	0	.05	.37	.49	.71	.63	.79	.12	.73	.85	.95	.92	.97	.05	.49	.63	1.00	1.00	1.00
Br13 V1	93	21	56	17	.05	.37	.49	.71	.63	.79	.10	.56	.60	.75	.67	.72	.05	.49	.63	.70	.69	.68
Br13 V2	90	74	0	17	.05	.37	.49	.71	.63	.79	.07	.51	.62	.79	.67	.72	.05	.49	.63	.43	.71	.68
Br13 V3	90	37	36	17	.05	.37	.49	.71	.63	.79	.09	.55	.59	.78	.67	.72	.05	.48	.63	.63	.69	.68
Br13 V4	93	39	39	13	.05	.37	.49	.71	.63	.79	.08	.53	.59	.75	.69	.79	.05	.48	.62	.63	.68	.72
Br14 V0	0	0	0	0	.15	.64	.77	.94	.83	.97	1.00	1.00	1.00	1.00	1.00	1.00	.15	.77	.83	1.00	1.00	1.00
Br14 V1	108	29	60	17	.15	.64	.77	.94	.83	.97	.94	.97	.94	.96	.91	.94	.15	.77	.83	.87	.88	.89
Br14 V2	109	90	0	17	.15	.64	.77	.94	.83	.97	.86	.96	.93	.97	.91	.94	.15	.77	.83	.64	.91	.89
Br14 V3	111	50	43	17	.15	.64	.77	.94	.83	.97	.92	.96	.92	.96	.91	.94	.15	.77	.83	.80	.89	.89
Br14 V4	120	54	48	15	.15	.64	.77	.94	.83	.97	.90	.95	.91	.95	.92	.96	.15	.77	.83	.79	.89	.89
Br15 V0	0	0	0	0	.43	.87	.13	.38	.63	.79	.79	.99	.31	.73	.92	.97	.43	.13	.63	1.00	1.00	1.00
Br15 V1	97	16	62	16	.43	.87	.13	.38	.63	.79	.57	.76	.26	.59	.66	.72	.43	.13	.62	.72	.73	.69
Br15 V2	90	74	0	16	.43	.87	.13	.38	.63	.79	.56	.89	.12	.46	.66	.72	.43	.09	.62	.80	.28	.69
Br15 V3	92	32	40	16	.43	.87	.13	.38	.63	.79	.59	.82	.21	.54	.66	.72	.43	.13	.62	.74	.64	.69
Br15 V4	93	36	44	13	.43	.87	.13	.38	.63	.79	.57	.81	.20	.53	.69	.79	.43	.13	.62	.73	.63	.72
Br16 V0	0	0	0	0	.76	.91	.13	.46	.82	.97	1.00	1.00	1.00	1.00	1.00	1.00	.76	.13	.82	1.00	1.00	1.00
Br16 V1	114	22	68	17	.76	.91	.13	.46	.82	.97	.93	.95	.95	.97	.92	.94	.76	.13	.82	.90	.85	.89
Br16 V2	115	96	0	17	.76	.91	.13	.46	.82	.97	.94	.97	.83	.92	.92	.94	.76	.13	.82	.92	.63	.89
Br16 V3	116	45	49	17	.76	.91	.13	.46	.82	.97	.92	.96	.92	.96	.92	.94	.76	.13	.82	.91	.80	.89
Br16 V4	125	48	54	15	.76	.91	.13	.46	.82	.97	.92	.95	.92	.95	.92	.96	.76	.13	.82	.91	.79	.89
Br17 V0	0	0	0	0	.28	.48	.37	.88	.63	.79	.60	.83	.73	.99	.92	.97	.28	.37	.63	1.00	1.00	1.00
Br17 V1	100	19	60	17	.28	.48	.37	.88	.63	.79	.56	.67	.62	.71	.66	.72	.28	.37	.62	.75	.67	.68
Br17 V2	91	75	0	17	.28	.48	.37	.88	.63	.79	.19	.54	.50	.99	.66	.72	.18	.37	.62	.27	.61	.68
Br17 V3	96	34	41	17	.28	.48	.37	.88	.63	.79	.45	.64	.59	.82	.66	.72	.28	.37	.62	.68	.72	.68
Br17 V4	99	38	45	13	.28	.48	.37	.88	.63	.79	.44	.62	.57	.80	.68	.78	.28	.37	.62	.67	.70	.72
Br18 V0	0	0	0	0	.79	.99	.47	.76	.83	.97	1.00	1.00	1.00	1.00	1.00	1.00	.79	.47	.83	1.00	1.00	1.00
Br18 V1	114	27	66	17	.79	.99	.47	.76	.83	.97	.91	.94	.95	.97	.91	.94	.79	.47	.83	.87	.91	.89
Br18 V2	116	97	0	17	.79	.99	.47	.76	.83	.97	.95	1.00	.85	.95	.91	.94	.79	.47	.83	.92	.78	.89
Br18 V3	117	48	49	17	.79	.99	.47	.76	.83	.97	.92	.96	.93	.96	.91	.94	.79	.47	.83	.90	.90	.89
Br18 V4	124	53	53	15	.79	.99	.47	.76	.83	.97	.92	.96	.92	.95	.92	.96	.79	.47	.83	.90	.89	.89
Br19 V0	0	0	0	0	.50	.61	.51	.80	.63	.78	.85	.92	.86	.97	.92	.97	.50	.51	.63	1.00	1.00	1.00
Br19 V1	99	16	63	15	.50	.61	.51	.80	.63	.78	.67	.71	.69	.77	.66	.72	.50	.51	.63	.74	.73	.68
Br19 V2	96	78	0	15	.50	.61	.51	.80	.63	.78	.68	.73	.68	.81	.66	.72	.50	.51	.63	.71	.72	.68
Br19 V3	96	35	41	15	.50	.61	.51	.80	.63	.78	.68	.73	.68	.79	.66	.72	.50	.51	.63	.71	.72	.68
Br19 V4	97	38	44	12	.50	.61	.51	.80	.63	.78	.66	.71	.67	.77	.68	.78	.50	.51	.62	.70	.70	.72
Br20 V0	0	0	0	0	.75	.87	.07	.85	.83	.96	1.00	1.00	.94	1.00	1.00	1.00	.75	.07	.83	1.00	1.00	1.00
Br20 V1	108	22	66	16	.75	.87	.07	.85	.83	.96	.95	.96	.83	.96	.91	.94	.75	.07	.83	.91	.83	.89
Br20 V2	108	89	0	16	.75	.87	.07	.85	.83	.96	.94	.97	.64	.96	.91	.94	.75	.07	.83	.91	.63	.89
Br20 V3	108	43	45	16	.75	.87	.07	.85	.83	.96	.93	.97	.79	.97	.91	.94	.75	.07	.83	.91	.76	.89

Br20 V4	114	45	49	14	.75	.87	.07	.85	.83	.96	.92	.96	.74	.96	.92	.96	.75	.07	.83	.91	.74	.89
Br21 V0	0	0	0	0	.42	.53	.06	.42	.63	.80	.78	.87	.15	.78	.92	.97	.42	.06	.63	1.00	1.00	1.00
Br21 V1	107	19	67	16	.42	.53	.06	.42	.63	.80	.60	.65	.11	.57	.66	.72	.42	.06	.62	.71	.67	.69
Br21 V2	105	88	0	16	.42	.53	.06	.42	.63	.80	.61	.66	.08	.57	.66	.72	.42	.06	.62	.69	.50	.69
Br21 V3	105	41	45	16	.42	.53	.06	.42	.63	.80	.61	.66	.10	.57	.66	.72	.42	.06	.62	.69	.60	.69
Br21 V4	107	44	49	13	.42	.53	.06	.42	.63	.80	.59	.64	.09	.56	.66	.77	.42	.06	.62	.68	.58	.71
Br22 V0	0	0	0	0	.70	.82	.77	.98	.83	.96	1.00	1.00	1.00	1.00	1.00	1.00	.70	.77	.83	1.00	1.00	1.00
Br22 V1	119	26	70	16	.70	.82	.77	.98	.83	.96	.94	.96	.94	.95	.92	.94	.70	.77	.83	.91	.90	.89
Br22 V2	122	103	0	16	.70	.82	.77	.98	.83	.96	.92	.96	.93	.97	.92	.94	.70	.77	.83	.91	.92	.89
Br22 V3	122	49	52	16	.70	.82	.77	.98	.83	.96	.92	.96	.93	.96	.92	.94	.70	.77	.83	.91	.91	.89
Br22 V4	129	53	55	15	.70	.82	.77	.98	.83	.96	.92	.95	.92	.95	.92	.96	.70	.77	.83	.90	.91	.89
Br23 V0	0	0	0	0	.43	.53	.62	.79			.79	.87	.92	.97			.43	.62		1.00	1.00	
Br23 V1	109	18	70	16	.43	.53	.62	.79			.59	.65	.66	.72			.43	.62		.71	.69	
Br23 V2	104	87	0	16	.43	.53	.62	.79			.62	.66	.66	.72			.43	.62		.69	.69	
Br23 V3	104	38	48	16	.43	.53	.62	.79			.61	.66	.66	.72			.43	.62		.69	.69	
Br23 V4	108	40	52	13	.43	.53	.62	.79			.60	.64	.66	.77			.43	.62		.68	.71	
Br24 V0	0	0	0	0	.71	.83	.82	.97			1.00	1.00	1.00	1.00			.71	.82		1.00	1.00	
Br24 V1	118	22	75	17	.71	.83	.82	.97			.94	.96	.92	.94			.71	.82		.90	.89	
Br24 V2	120	102	0	17	.71	.83	.82	.97			.93	.96	.92	.94			.71	.82		.91	.89	
Br24 V3	120	44	55	17	.71	.83	.82	.97			.93	.96	.92	.94			.71	.82		.91	.89	
Br24 V4	128	48	59	15	.71	.83	.82	.97			.92	.95	.92	.96			.71	.82		.90	.89	
Br25 V0	0	0	0	0	.48	.58	.64	.79			.83	.90	.93	.97			.48	.64		1.00	1.00	
Br25 V1	120	20	73	19	.48	.58	.64	.79			.56	.65	.53	.69			.45	.51		.60	.55	
Br25 V2	120	103	0	19	.48	.58	.64	.79			.54	.65	.53	.69			.45	.51		.56	.55	
Br25 V3	120	42	55	19	.48	.58	.64	.79			.54	.65	.53	.69			.45	.51		.56	.55	
Br25 V4	126	44	58	16	.48	.58	.64	.79			.52	.63	.55	.72			.44	.52		.55	.56	
Br26 V0	0	0	0	0	.74	.85	.83	.97			1.00	1.00	1.00	1.00			.74	.83		1.00	1.00	
Br26 V1	128	24	79	19	.74	.85	.83	.97			.91	.95	.87	.94			.74	.77		.84	.77	
Br26 V2	135	116	0	19	.74	.85	.83	.97			.89	.95	.87	.94			.74	.77		.84	.77	
Br26 V3	135	48	62	19	.74	.85	.83	.97			.89	.95	.87	.94			.74	.77		.84	.77	
Br26 V4	148	53	67	19	.74	.85	.83	.97			.87	.95	.87	.95			.74	.76		.83	.76	
Br27 V0	0	0	0	0	.22	.54	.64	.81			.49	.88	.93	.97			.22	.64		1.00	1.00	
Br27 V1	112	17	71	17	.22	.54	.64	.81			.46	.66	.66	.72			.22	.62		.70	.69	
Br27 V2	108	92	0	17	.22	.54	.64	.81			.46	.66	.66	.72			.22	.62		.68	.69	
Br27 V3	108	36	50	17	.22	.54	.64	.81			.46	.66	.66	.72			.22	.62		.68	.69	
Br27 V4	113	39	54	13	.22	.54	.64	.81			.40	.64	.66	.77			.22	.63		.67	.69	
Br28 V0	0	0	0	0	.54	.86	.84	.97			1.00	1.00	1.00	1.00			.54	.84		1.00	1.00	
Br28 V1	129	22	86	17	.54	.86	.84	.97			.92	.95	.91	.94			.54	.84		.90	.89	
Br28 V2	130	114	0	17	.54	.86	.84	.97			.91	.95	.91	.94			.54	.84		.89	.89	
Br28 V3	130	47	66	17	.54	.86	.84	.97			.91	.95	.91	.94			.54	.84		.89	.89	
Br28 V4	138	50	69	16	.54	.86	.84	.97			.91	.95	.91	.95			.54	.84		.89	.89	

Table 3.

Table of annual catches for each trial and RMP variant over the whole management period and during the first 20 years

		Median catch over 100 years				Sub-area 1W, 1^{st} 20 years			Sub-area 1E, 1^{st} 20 years			Sub-area 2, 1^{st} 20 years		
Trial	Variant	Total	1W	1E	2	5%	Med	95%	5%	Med	95%	5%	Med	95%
Br01	1	105	14	66	18	0	15	37	28	45	90	6	10	22
Br01	2	98	78	0	18	55	84	116	0	0	0	6	10	22
Br01	3	98	33	44	18	21	37	55	29	47	78	6	10	22
Br01	4	103	38	48	14	23	40	58	32	51	86	7	13	27
Br02	1	110	17	69	20	0	18	41	31	47	91	6	11	23
Br02	2	109	85	0	19	62	90	119	0	0	0	6	11	23
Br02	3	109	37	49	19	23	39	56	32	50	79	6	11	23
Br02	4	116	41	54	16	26	43	63	34	54	87	7	15	29
Br03	1	104	16	67	17	0	15	37	28	45	90	6	10	22
Br03	2	98	80	0	17	55	83	115	0	0	0	6	10	22
Br03	3	98	34	45	17	21	37	55	29	47	79	6	10	22
Br03	4	101	38	47	13	24	40	58	32	51	82	7	13	26
Br04	1	111	19	70	17	0	19	40	31	47	91	6	10	21
Br04	2	110	94	0	17	62	91	120	0	0	0	6	10	21
Br04	3	111	39	50	17	23	40	56	33	50	79	6	10	21
Br04	4	117	44	55	15	26	43	63	35	55	86	7	14	27
Br05	1	104	14	65	17	0	15	37	27	44	87	5	10	22
Br05	2	97	78	0	17	54	83	116	0	0	0	5	10	21
Br05	3	97	34	42	16	20	37	55	28	47	76	5	10	21
Br05	4	104	37	48	13	24	40	60	31	50	83	5	13	28
Br06	1	112	18	68	18	0	18	41	30	47	90	6	10	22
Br06	2	109	86	0	18	61	90	123	0	0	0	6	10	22
Br06	3	109	37	46	18	23	39	57	32	50	79	6	10	22
Br06	4	118	42	54	15	26	43	63	35	53	85	7	14	29
Br07	1	101	17	66	17	0	17	40	28	42	71	6	10	22
Br07	2	98	81	0	17	54	84	116	0	0	0	6	10	22
Br07	3	99	38	43	17	23	39	56	26	46	68	6	10	22
Br07	4	102	40	45	13	26	42	60	29	48	70	7	13	26
Br08	1	111	23	67	16	4	22	41	30	47	73	7	10	19
Br08	2	111	93	0	16	62	91	123	0	0	0	7	10	19
Br08	3	111	44	47	16	28	43	59	31	48	70	7	10	19
Br08	4	118	48	50	15	32	46	62	32	52	73	8	13	27
Br09	1	105	15	72	17	0	15	38	28	46	90	6	10	22
Br09	2	98	83	0	17	62	84	116	0	0	0	6	10	22
Br09	3	98	33	47	17	21	37	56	28	48	79	6	10	22
Br09	4	103	35	50	12	23	40	58	32	52	82	7	13	26
Br10	1	114	18	77	17	0	19	41	34	51	85	6	10	22
Br10	2	111	95	0	17	68	93	122	0	0	0	6	10	22
Br10	3	111	40	54	17	23	40	57	34	53	79	6	10	22
Br10	4	117	44	59	14	26	42	62	38	57	82	7	13	26
Br11	1	118	23	70	19	0	21	60	25	51	117	5	11	29
Br11	2	123	101	0	19	52	97	151	0	0	0	5	11	29
Br11	3	123	46	50	19	22	42	74	26	54	94	5	11	29
Br11	4	126	49	53	16	24	45	81	26	55	104	6	15	37
Br12	1	127	28	74	19	0	25	62	23	54	119	5	11	28
Br12	2	138	119	0	19	58	101	153	0	0	0	5	11	28
Br12	3	139	53	58	19	24	45	77	27	56	97	5	11	28
Br12	4	150	59	63	18	28	48	83	29	59	102	6	15	37
Br13	1	93	21	56	17	1	20	44	23	41	66	6	10	22
Br13	2	90	74	0	17	51	83	115	0	0	0	6	10	22
Br13	3	90	37	36	17	24	41	60	23	43	65	6	10	22
Br13	4	93	39	39	13	28	45	64	23	46	68	7	13	26
Br14	1	108	29	60	17	5	24	50	23	43	64	7	10	22
Br14	2	109	90	0	17	56	90	118	0	0	0	7	10	22
Br14	3	111	50	43	17	28	45	66	23	46	66	7	10	22
Br14	4	120	54	48	15	32	48	68	26	49	67	8	13	27
Br15	1	103	14	66	17	0	14	37	28	45	92	6	10	21
Br15	2	97	79	0	17	55	84	115	0	0	0	6	10	21
Br15	3	97	33	43	17	21	36	54	28	48	82	6	10	21
Br15	4	102	36	46	13	24	39	58	31	52	87	7	13	26

Cont.

		Median catch over 100 years				Sub-area 1W, 1st 20 years			Sub-area 1E, 1st 20 years			Sub-area 2, 1st 20 years		
Trial	Variant	Total	1W	1E	2	5%	Med	95%	5%	Med	95%	5%	Med	95%
Br16	1	114	22	69	17	1	18	44	30	47	95	6	10	21
Br16	2	113	95	0	17	61	90	123	0	0	0	6	10	21
Br16	3	114	44	51	17	23	40	57	31	50	84	6	10	21
Br16	4	122	48	54	15	27	43	66	33	55	89	7	14	26
Br17	1	100	19	60	17	0	16	37	28	44	85	6	10	22
Br17	2	91	75	0	17	54	83	116	0	0	0	6	10	22
Br17	3	95	34	41	17	21	37	55	29	47	76	6	10	22
Br17	4	99	39	45	13	23	41	57	31	50	82	7	13	26
Br18	1	114	27	65	17	0	23	46	29	46	85	6	10	21
Br18	2	116	97	0	17	62	91	124	0	0	0	6	10	21
Br18	3	117	48	49	17	25	43	59	29	48	76	6	10	21
Br18	4	122	53	54	15	28	46	65	32	51	85	8	14	27
Br19	1	99	16	64	15	0	16	40	27	42	71	6	10	22
Br19	2	95	79	0	15	54	83	116	0	0	0	6	10	22
Br19	3	95	36	41	15	24	39	56	26	46	68	6	10	22
Br19	4	97	37	44	12	27	42	60	28	49	70	7	12	26
Br20	1	108	21	65	16	4	21	40	31	46	75	7	10	20
Br20	2	108	89	0	16	62	90	117	0	0	0	7	10	20
Br20	3	107	41	46	16	28	42	57	30	48	69	7	10	20
Br20	4	113	46	49	14	32	45	61	33	52	71	8	13	27
Br21	1	107	20	69	16	1	19	42	28	44	73	6	10	19
Br21	2	104	88	0	16	56	87	122	0	0	0	6	10	19
Br21	3	104	41	45	16	26	41	59	27	45	70	6	10	19
Br21	4	107	44	50	13	28	44	62	30	50	71	7	13	25
Br22	1	119	26	70	17	7	25	45	31	49	76	7	10	20
Br22	2	122	103	0	17	68	95	125	0	0	0	7	10	20
Br22	3	122	49	51	17	32	44	62	31	49	71	7	10	20
Br22	4	130	53	55	15	35	48	64	32	53	75	8	13	25
Br23	1	109	18	70	16	0	16	40	28	46	90	6	10	22
Br23	2	104	87	0	16	55	85	118	0	0	0	6	10	22
Br23	3	104	38	48	16	21	37	56	30	48	79	6	10	22
Br23	4	108	40	52	13	24	41	62	32	51	87	7	13	26
Br24	1	118	22	75	17	1	21	44	31	49	96	6	10	21
Br24	2	120	102	0	17	65	95	125	0	0	0	6	10	21
Br24	3	119	44	55	17	24	41	58	33	51	83	6	10	21
Br24	4	128	48	59	15	27	44	64	35	56	89	8	14	26
Br25	1	120	20	73	18	0	19	57	23	55	134	5	11	28
Br25	2	122	103	0	18	52	97	151	0	0	0	5	11	28
Br25	3	122	42	55	18	19	41	74	23	57	110	5	11	28
Br25	4	126	44	58	16	21	43	80	26	58	115	5	15	36
Br26	1	128	24	79	19	0	21	59	26	58	132	5	11	27
Br26	2	135	116	0	19	61	104	155	0	0	0	5	11	27
Br26	3	135	48	62	19	21	42	81	27	59	110	5	11	27
Br26	4	148	53	67	19	22	46	83	30	63	119	6	15	37
Br27	1	110	18	71	16	0	18	41	30	47	81	6	10	22
Br27	2	106	90	0	16	65	88	122	0	0	0	6	10	22
Br27	3	107	38	49	16	22	39	57	29	49	79	6	10	22
Br27	4	110	40	53	13	24	43	63	32	52	82	6	13	26
Br28	1	121	21	82	17	0	22	44	30	53	90	6	10	21
Br28	2	121	104	0	17	70	96	125	0	0	0	6	10	21
Br28	3	121	47	59	17	23	41	61	31	54	80	6	10	21
Br28	4	130	50	64	15	25	44	64	35	58	86	7	13	25

Table 4 examples

CASE: Br01 MSYR: 1 Baseline 1

Br01 C1 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.61	0.51	0.69	0.69	0.65	0.73	0.61	0.51	0.69

Br01 C1 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	14.5	0.1	36.6	29.5	0.0	74.8	1.8	0.0	27.1
1E	65.5	39.5	102.9	90.1	56.0	179.8	63.9	39.8	98.0
2	18.4	6.3	33.7	20.0	12.6	44.1	17.6	4.5	32.7

Br01 C2 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.61	0.51	0.69	0.71	0.67	0.74	0.61	0.51	0.68

Br01 C2 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	78.2	38.9	145.2	167.1	110.0	231.2	48.2	15.7	118.6
1E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	18.3	6.2	33.7	19.9	12.6	44.1	17.7	4.6	32.7

Br01 C3 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.61	0.51	0.69	0.71	0.67	0.74	0.61	0.51	0.68

Br01 C3 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	32.8	14.4	61.9	73.8	41.2	110.6	19.1	6.3	51.5
1E	44.4	19.2	81.5	93.0	57.6	157.0	24.8	8.0	76.5
2	18.2	6.2	33.6	19.9	12.6	44.1	17.9	4.6	32.7

Br01 C4 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.61	0.51	0.69	0.70	0.65	0.73	0.61	0.51	0.68

Br01 C4 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	37.6	17.3	67.3	80.3	46.6	116.8	26.0	8.4	66.0
1E	48.4	23.0	84.7	101.7	64.5	172.5	30.7	10.6	82.3
2	13.7	6.8	25.2	26.4	13.5	54.7	8.7	3.3	22.2

CASE: Br03 MSYR: 1/1 Baseline 2

Br03 C1 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.58	0.48	0.69	0.69	0.64	0.73	0.58	0.48	0.67
2	0.79	0.63	0.89	0.72	0.66	0.76	0.71	0.62	0.75

Br03 C1 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	15.8	0.3	38.1	29.8	0.0	75.0	2.6	0.0	30.1
1E	66.6	40.7	104.1	89.9	55.9	179.6	65.9	41.7	99.5
2	16.6	6.6	27.7	20.1	12.5	44.0	13.2	4.4	26.3

Br03 C2 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.58	0.48	0.69	0.70	0.66	0.73	0.58	0.48	0.67
2	0.79	0.63	0.89	0.72	0.66	0.76	0.71	0.62	0.75

Br03 C2 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	79.6	40.1	143.4	166.9	110.0	230.9	53.7	19.8	125.8
1E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	16.6	6.6	27.7	20.1	12.5	44.0	13.2	4.4	26.3

Br03 C3 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.58	0.48	0.69	0.70	0.66	0.73	0.58	0.48	0.67
2	0.79	0.63	0.89	0.72	0.66	0.76	0.71	0.62	0.75

Br03 C3 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	34.4	15.3	62.5	74.2	41.5	110.3	22.4	8.0	56.0
1E	45.2	20.7	79.6	94.0	57.6	157.3	28.6	9.8	72.9
2	16.6	6.6	27.7	20.1	12.5	44.0	13.2	4.4	26.3

Br03 C4 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.58	0.48	0.69	0.68	0.64	0.72	0.58	0.48	0.67
2	0.79	0.63	0.89	0.78	0.67	0.85	0.73	0.62	0.80

Br03 C4 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	37.9	17.3	67.2	80.8	47.4	116.8	26.3	8.2	65.0
1E	47.5	23.0	83.4	102.1	64.2	164.7	30.9	10.9	81.7
2	13.3	6.9	22.2	26.5	13.8	52.8	7.4	2.6	18.6

CASE: Br05 MSYR: 1/1 Baseline 3

Br05 C1 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.59	0.49	0.69	0.69	0.64	0.73	0.59	0.49	0.68
2	0.80	0.54	0.91	0.71	0.62	0.76	0.68	0.54	0.75

Br05 C1 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	14.1	0.0	36.1	29.9	0.0	74.7	2.0	0.0	24.6
1E	65.2	40.7	104.1	87.8	54.5	174.7	64.3	36.4	98.1
2	16.5	5.0	34.2	20.2	9.7	43.1	13.6	3.2	31.8

Br05 C2 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.59	0.49	0.69	0.71	0.67	0.74	0.59	0.49	0.68
2	0.80	0.54	0.91	0.71	0.62	0.76	0.68	0.54	0.75

Br05 C2 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	78.1	40.0	138.9	167.0	108.6	231.1	49.5	15.2	123.6
1E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	16.5	5.0	34.0	20.1	9.7	42.8	13.7	3.2	31.9

Br05 C3 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.59	0.49	0.69	0.71	0.67	0.74	0.59	0.49	0.68
2	0.80	0.54	0.91	0.71	0.62	0.76	0.68	0.54	0.75

Br05 C3 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	34.3	13.8	55.7	73.4	40.7	110.6	22.2	6.8	52.2
1E	42.5	16.0	82.2	93.2	56.6	152.2	28.0	6.6	75.3
2	16.5	5.0	34.0	20.1	9.7	42.8	13.7	3.2	31.9

Br05 C4 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.59	0.49	0.69	0.69	0.65	0.73	0.59	0.49	0.67
2	0.80	0.54	0.91	0.76	0.62	0.85	0.72	0.54	0.81

Br05 C4 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	37.3	15.8	62.6	79.7	47.1	120.4	26.2	8.7	56.7
1E	48.3	21.9	86.1	99.4	62.4	165.8	30.3	10.3	78.6
2	13.0	5.6	28.9	26.6	10.4	55.1	7.3	2.5	24.7

CASE: Br07 MSYR: 1/1/1 Baseline 4

Br07 C1 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.57	0.44	0.68	0.68	0.63	0.72	0.57	0.44	0.67
2	0.87	0.47	0.91	0.78	0.66	0.82	0.78	0.47	0.81
3	0.79	0.63	0.88	0.72	0.67	0.76	0.71	0.63	0.75

Br07 C1 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	16.8	2.5	40.1	33.5	0.2	80.2	5.3	0.0	25.6
1E	65.5	40.2	97.8	84.0	55.3	142.8	60.8	37.0	87.1
2	16.6	6.7	26.9	20.0	12.5	43.7	13.1	4.7	27.4

Br07 C2 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.57	0.44	0.68	0.69	0.65	0.72	0.57	0.44	0.66
2	0.87	0.47	0.91	0.82	0.67	0.90	0.80	0.47	0.84
3	0.79	0.63	0.88	0.72	0.67	0.76	0.71	0.63	0.75

Br07 C2 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	80.8	38.3	140.4	167.1	109.0	232.5	53.1	20.4	124.6
1E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	16.6	6.7	26.9	20.0	12.5	43.7	13.1	4.7	27.4

Br07 C3 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.57	0.44	0.68	0.69	0.65	0.72	0.57	0.44	0.66
2	0.87	0.47	0.91	0.80	0.67	0.88	0.79	0.47	0.82
3	0.79	0.63	0.88	0.72	0.67	0.76	0.71	0.63	0.75

Br07 C3 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	37.5	17.3	63.7	77.4	46.8	112.2	24.4	9.0	61.2
1E	42.5	19.2	79.8	91.3	52.8	135.1	25.4	9.9	66.6
2	16.6	6.7	26.9	20.0	12.5	43.7	13.1	4.7	27.4

Br07 C4 Stk	Initial depletion			Final depletion			- Low population -		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1	0.57	0.44	0.68	0.68	0.62	0.71	0.57	0.44	0.66
2	0.87	0.47	0.91	0.78	0.65	0.86	0.77	0.47	0.81
3	0.79	0.63	0.88	0.78	0.68	0.86	0.73	0.62	0.80

Br07 C4 Area	Av.Total Catch pa			Av.Catch 1st 20yrs			Av.Catch last 10yrs		
	Median	5%	96%	Median	5%	96%	Median	5%	96%
1W	39.5	18.9	68.9	84.3	52.4	120.2	25.5	8.5	70.0
1E	44.7	21.9	83.0	96.7	57.8	140.7	28.9	10.4	78.4
2	13.1	6.9	22.5	26.2	14.2	52.6	7.2	2.6	19.1

Annex E

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

A. Basic concepts and stock-structure

The trials outlined 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 further sub-divided into sub-areas 1W and 1E at 165°E for the bulk of the trials although sensitivity is explored to alternative placements of the boundary in some of the trials. The trials consider up to two *stocks* of Bryde's whales in the western North Pacific, one of which (Stock 1) could consist of two *sub-stocks* that mix across sub-area 1 and perhaps also sub-area 2. Sub-stocks are modelled as stocks (i.e. there is no permanent transfer of animals among sub-stocks) for ease of implementation, because it should provide a more stringent test of the RMP variants, and because there are no data to estimate rates of dispersal among putative sub-stocks nor any way to estimate dispersal rates.

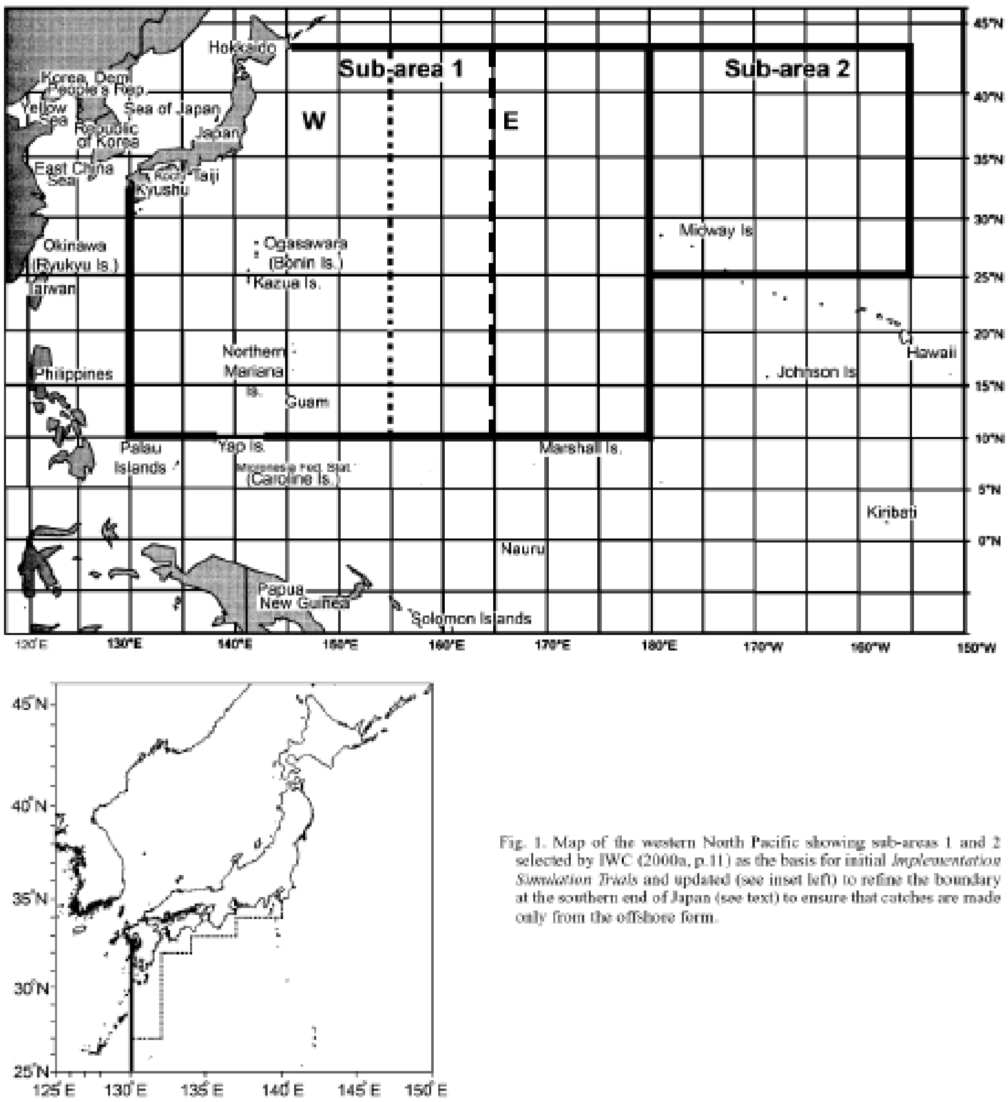


Fig. 1. Map of the western North Pacific showing the sub-areas defined for the western North Pacific Bryde's whales. Note: the boundary between the 1W and 1E sub-areas is now set at 165°E.

There are four general hypotheses regarding stock structure:

(1) There is only one stock of Bryde's whales in sub-areas 1 and 2.
(2) There are two stocks of Bryde's whales in sub-areas 1 and 2. One stock is found in sub-area 1 and the other is found in sub-area 2.
(3) There are two stocks of Bryde's whales in sub-areas 1 and 2. One stock is found in sub-areas 1 and 2, and the other is found in sub-area 2 only.
(4) There are two stocks of Bryde's whales in sub-areas 1 and 2. One stock is found in sub-area 1 and the other is found in sub-area 2. Stock 1 consists of two sub-stocks that mix in sub-areas 1W and 1E.

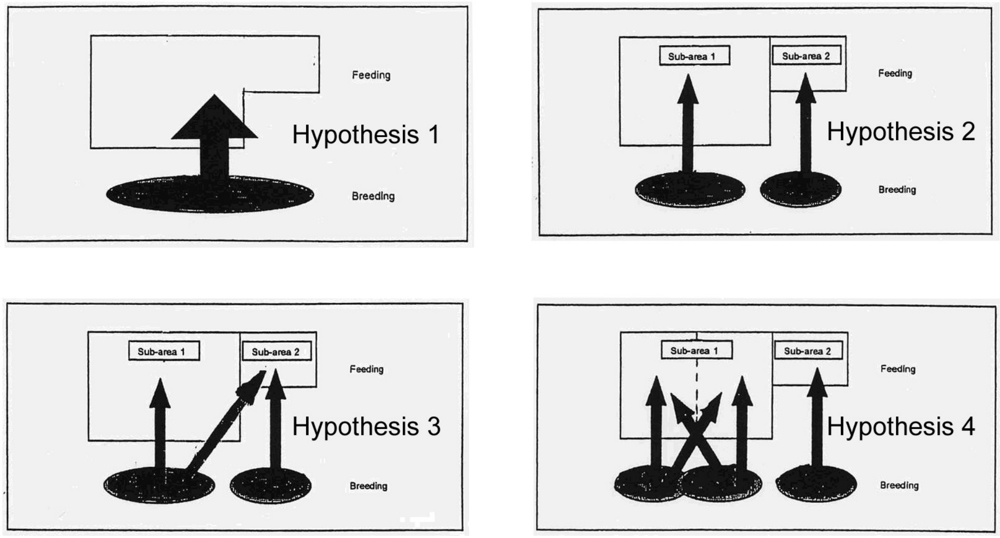


Fig. 2. Stock structure hypotheses selected by the Workshop on the *pre-implementation assessment* of the western North Pacific Bryde's whales.

B. Basic dynamics

The dynamics of the animals in stock/sub-stock *j* are governed by the equations:

$$N_{t+1,a}^{g,j} = \begin{cases} 0.5\, b_{t+1}^{j} & \text{if } a = 0 \\ (N_{t,a-1}^{g,j} - C_{t,a-1}^{g,j})e^{-M} & \text{if } 1 \le a < x \\ (N_{t,x}^{g,j} - C_{t,x}^{g,j})e^{-M} + (N_{t,x-1}^{g,j} - C_{t,x-1}^{g,j})e^{-M} & \text{if } a = x \end{cases} \tag{B.1}$$

where $N_{t,a}^{g,j}$ is the number of animals of gender *g* and age *a* in stock/sub-stock *j* at the start of year *t*;

$C_{t,a}^{g,j}$ is the catch (in number) of animals of gender *g* and age *a* in stock/sub-stock *j* during year *t* (whaling is assumed to take place in a pulse at the start of each year);

b_t^j is the number of calves born to females from stock/sub-stock *j* at the start of year *t*;

M is the instantaneous rate of natural mortality; and

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

C. Births

Density-dependence is assumed to act on the female component of the 'mature' population. 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.

$$b_t^j = B^j N_t^{\mathrm{f},j}\{1 + A^j(1-(N_t^{\mathrm{f},j}/K^{\mathrm{f},j})^{z^j})\} \tag{C.1}$$

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

A^j is the resilience parameter for stock/sub-stock *j*;

z^j is the degree of compensation for stock/sub-stock *j*;

$N_t^{\mathrm{f},j}$ is the number of 'mature' females in stock/sub-stock *j* at the start of year *t*:

$$N_t^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{t,a}^{\mathrm{f},j} \tag{C.2}$$

a_m is the age-at-first-parturition; and

$K^{\mathrm{f},j}$ is the number of mature females in stock/sub-stock *j* in the pristine (pre-exploitation written as *t*=-∞) population:

$$K^{\mathrm{f},j} = \sum_{a=a_m}^{x} N_{-\infty,a}^{\mathrm{f},j} \tag{C.3}$$

The values of the parameters A^j and z^j for each stock/sub-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. Catches

It is assumed that whales are homogeneously distributed across a sub-area. The catch limit for a sub-area is therefore allocated to stocks/sub-stocks by sex and age relative to their true density within that sub-area and a mixing matrix V which depends on year (but is independent of sex), i.e.:

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

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

where $F_t^{g,k}$ is the exploitation rate in sub-area k on recruited animals of sex g during year t;

$S_{t,a}^{k}$ is the selectivity on animals of age a in sub-area k during year t;

$C_t^{g,k}$ is the catch of animals of sex g in sub-area k during year t; and

$V_{t,a}^{j,k}$ is the fraction of animals of age a in stock/sub-stock j that is in sub-area k during year t.

Most trials assume that the mixing matrix does not depend on age. The exceptions are trials Br11 and Br12 in which there is age-dependency in the distribution across sub-area 1. The values for the entries in the mixing matrix are set using the following equation In these trials:

$$\begin{aligned} V_{t,a}^{j,1W} &= V_{t,0}^{j,1W}(1-\lambda a) \\ V_{t,a}^{j,1E} &= (1-V_{t,a}^{j,1W}) \end{aligned} \tag{D.3}$$

where λ is a parameter which determines the extent to which the mixing matrix depends on age. The value of λ is determined during conditioning (see section G(d)).

The catches by sub-area and year are either set to one of three historical (pre-2005) series (Table 2); 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.

E. Mixing

The entries in the mixing matrix V are selected to model the distribution of each stock/sub-stock at the time when the catch is removed. Mixing can be deterministic or stochastic. If mixing is stochastic, the mixing matrix is selected at random from two possibilities. Table 1 lists the mixing matrices for each of the stock structure hypotheses. Mixing is stochastic for the trials in which Stock 1 is found in sub-area 2 (hypothesis 3 e.g. trials Br5 and 6). A random number, u, is selected from U[0,1] for each year. If $u \leq 0.5$, Stock 1/ Sub-stock 1E mixes into sub-area 2 otherwise no mixing takes place. A similar scheme is used to model stochastic mixing of Sub-stocks 1W and 1E in sub-areas 1W and 1E for trials Br13 and Br14, with the 1W and 1E substocks assumed to move in phase in order to minimise or maximise the overlap (i.e. a single random number is selected and applied to both substocks).

To add: revised mixing description

In most trials, the boundary between sub-areas 1W and 1E used when modelling the true population dynamics is the same as that used when applying the RMP (and is at 165°E). However, for some of trials based on stock structure hypothesis 4, a different boundary is used.

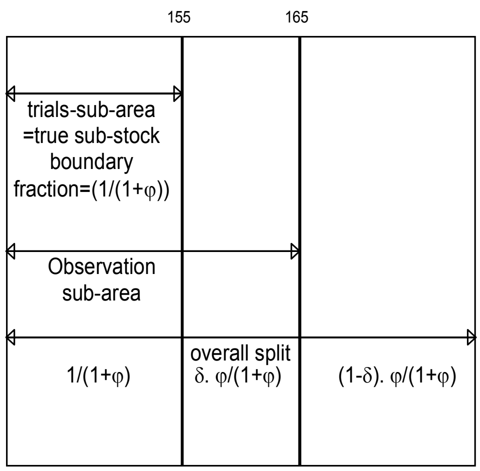


Fig. 3. Illustration of how trials sub-areas and observation sub-areas operate for trials in which trials sub-areas and observation sub-areas differ.

Consider the case in which the true boundary between the sub-stocks on which the trials are based and to which the mark-recapture data pertain (stock-sub-areas) is at 155°E while that between the sub-areas for which catches are reported and survey abundance estimates are available (management-sub-areas) is 165°E (Fig. 3). The mixing matrix for either of the sub-stocks can be expressed as the vector (1, φ) where a fraction of φ/(1+φ) of the animals from the stock are found to the east of 155°E and 1/(1+φ) are found west of 155°E. Now assume that a fraction δ of the animals in the sub-area east of 155°E are located between 155°E and 165°E. The split of the stock among the three sectors: 140-155°E; 155-165°E; and 165°E-180° is therefore 1/(1+φ), δφ/(1+φ), and (1-δ)φ/(1+φ).

The value of δ is set assuming that a stock (or sub-stock) is uniformly distributed across the area in which it is found. Thus, δ=2/5 when the stock boundary is at 155°E and the management boundary is at 165°E. (Note: the boundary used by the RMP is always coincides with the true boundary in trials when mixing is age dependent.)

The tagging data are assigned to stocks/ sub-stocks (and reported) according the stock-sub-areas and not the management sub-areas (the tagging data is used only in conditioning trials and is not used by the RMP).

F. Generation of Data

The actual estimates of absolute abundance (and their associated CVs) for 1995 (Table 3) are provided to the RMP. These abundance estimates exclude the areas identified in table 3 of IWC (2000). The future surveys are assumed to cover each of sub-areas 1W, 1E and 2 in their entirety in a single survey. This is a slight simplification of reality; the entire area will actually be covered in four years (see Table 4 for the proposed survey plan), but the westernmost part of sub-area 1W contains very few Bryde's whales so the two surveys in sub-area 1W are treated as one for the purposes of trials. The trials assume that it takes two years for the results of a sighting survey to become available to be used by the management procedure, i.e. a survey conducted in 2006 could first be used for setting the catch limit in 2008.

The future estimates of abundance for a survey area (a sub-area for these trials) (say survey area E) are generated using the formula:

$$\hat{P} = P\,Y\,w/\mu = P^*\,\beta^2\,Y\,w \tag{F.1}$$

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

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

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

$$P = P_t^E = \sum_{k\in F}\sum_j V_t^{j,k} \sum_g \sum_{a\geq 1} N_{t,a}^{g,j} \tag{F.2}$$

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); and

F is the set of sub-areas making up survey area E.

Note that under the approximation $CV^2(ab) = CV^2(a) + CV^2(b)$, $E(\hat{P}) = P$ and $CV^2(\hat{P}) = \alpha^2 + \beta^2 P^*/P$. For consistency with the first stage screening trials for a single stock (IWC, 1991, p.109; IWC 1994, p.85), the ratio $\alpha^2 : \beta^2 = 0.12 : 0.025$, so that:

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

An estimate of the CV, X, is generated for each sightings estimate:

$$X = \sigma\sqrt{(CHISQ/n)} \tag{F.4}$$

where $\sigma^2 = \ell\text{n}(1 + CV_{est}^2)$ and CHISQ is a random number from a Chi-square distribution with n degrees of freedom (where n=10 as used for NP minke - ref) and $CV_{est}^2 = \theta^2(a^2 + b^2/w\beta^2)$ where a^2 and b^2 are constants and equal 0.02 and 0.012 respectively. Note that under the approximation $E(1/w) = 1/E(w) = 1/[(P/P^*)/\beta^2] = \beta^2 P^*/P$, this gives:

$$CV_{est}^2 = \theta^2(a^2 + b^2 P^*/P) \tag{F.5}$$

The equation used to compute θ^2 for a given sub-area is:

$$\theta^2 = CV_{\tilde{P}}^2/(0.02 + 0.012P^*/\tilde{P}) \tag{F.6}$$

where $CV_{\tilde{P}}$ is the observed CV (excluding additional variance) corresponding to some model population size $\tilde{P}$. The extent of additional variance, σ_p^2 , is defined as the additional variance at $P = \tilde{P}$, i.e.:

$$CV^2(\tilde{P}) = CV_{est}^2(\tilde{P}) + \sigma_p^2 \tag{F.7}$$

The value for τ (and hence those for α^2 and β^2) can be computed from values for θ^2 , σ_p^2 , and Equations (F.5), (F.6), and (F.7) as follows:

$$\tau = \frac{CV_{\tilde{P}}^2 + \sigma_p^2}{0.12 + 0.025P^*/\tilde{P}} \tag{F.8}$$

Adjunct 1 lists the values for $CV_{\tilde{P}}$ and σ_p^2 by sub-area.

G. Parameters and conditioning
The values for the biological and technological parameters are listed in Table 5. 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**.**

The 'free' parameters of the above model are the initial (pre-exploitation) sizes of each of the sub-stocks/stocks and the values that determine the mixing matrices. The conditioning process involves first generating 100 sets of 'target' data, detailed in steps (a) to (d) below, and then fitting the population model to each (in the spirit of a bootstrap). Note that each replicate involves different realizations for the random variables that determine the mixing matrices.

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

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

where P_t^k is the abundance for sub-area *k* in year *t*;
O_t^k is the actual survey estimate for sub-area *k* in year *t* (Table 3); and
σ_t^k is the CV is O_t^k .

(b) A 'target' for the numbers of animals tagged in sub-areas 1 and 2 during 1972–85 and recaptured by the Japanese fleets is generated by selecting records with replacement from the tag-recapture data (see tables 7 and 8). The objective function used to include the tagging data when conditioning is given in Adjunct 3. The tag recapture data are assumed to be negative binomially (rather than Poisson) distributed to account for possible non-randomness in the tagging / recapture process.
(c) A target for the ratio of the number of 1+ animals from Stock 2 in sub-area 2 to those from Stock 1 in sub-area 2 (for trials that involve mixing of Stocks 1 and 2 in sub-area 2 only i.e. hypothesis 3) at pre-exploitation equilibrium – assumed to be 0.5.
(d) For the trials in which there is age-dependency across sub-area 1, estimates of total mortality are generated for sub-areas 1W and 1E+2 ($\bar{M}^{1W} \sim N(0.864, 0.027^2)$ and $\bar{M}^{1E+2} \sim N(0.891, 0.0.07^2)$ respectively in the years 1971-79 + 2000-03) and the fit to these data included in the objective function used when conditioning the operating model. The contribution of these data to the objective function is set to:

$$100(\bar{M}^{1W}/\bar{M}^{1E+2} - \hat{M}^{1W}/\hat{M}^{1E+2}) \tag{G.2}$$

The model estimate of the survival rate is based on applying the Chapman-Robson estimator to animals aged 15+ for consistency with the way the above normal distributed were derived. The model estimates of the total mortality for sub-areas 1W and 1E+2 are obtained by averaging total mortality by year over year, weighting the yearly estimates by the number of animals aged, i.e.:

$$\hat{M}^A = \sum_y Q_y^A \bar{M}_y^A / \sum_{y'} Q_{y'}^A \tag{G.3}$$

where Q_y^A is the number of animals aged in region *A* (either 1W or 1E+2) during year *y* as given in Table 9, and
$\bar{M}_y^A$ is the model estimate of the survival rate for region *A* and year *y*.

The survival rate for area *A* and year *y* is computed using the Chapman-Robson estimator, i.e.:

$$\bar{M}_y^A = (1 + 1/\tilde{a}_y^A)^{-1} \tag{G.4}$$

where $\tilde{a}_y^A$ is the amount by which the average age of the catch during year *y* in region *A* exceeds the age-at-recruitment, i.e.:

$$\tilde{a}_y^A = \sum_{a \ge 15} (a-15)(C_{y,a}^{m,A} + C_{y,a}^{f,A}) / \sum_{a' \ge 15} (C_{y,a'}^{m,A} + C_{y,a'}^{f,A}) \quad \text{DOUG CHECK} \tag{G.5}$$

H. Trials
The *Implementation Simulation Trials* for the western North Pacific Bryde's whales are listed in Table 6. All of trials are based on the assumption g(0)=1. Mixing is stochastic (see section E) for the trials in which Stock 1 or Sub-stock 1E is found in sub-area 2. A similar scheme is used to model stochastic mixing of Sub-stocks 1W and 1E in sub-areas 1W and 1E for trials Br13 and Br14.

I. Management Options
The following four management options will be considered.

Management options based on calculating catch limits by *Small Area*:
(1) Sub-areas 1W, 1E[1] and 2 are *Small Areas* and catch limits are set by *Small Area*.
(2) 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.

Management options based on applying catch cascading:
(3) 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) Sub-areas 1 and 2 (combined) are taken to be a *Combination area*, and sub-areas in 1W, 1E and 2 are *Small Areas*, with *catch-cascading* applied.

[1] Defined to be 140^{0}E-165^{0}E and 165^0-180^0 irrespective of the true boundary used to define the structure of the populations in the operating model.

The simulation application of the RMP is based on using the "best" catch series (see Table 2).

J. Output Statistics

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

K. References

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Table 1

The mixing matrices. The γs indicate that the entry concerned is to be estimated during the conditioning process.

	Stock 1	Sub-stock 1A	Sub-stock 1B	Stock 2
SINGLE STOCK HYPOTHESIS (matrix A)				
Sub-area 1W	1	-	-	N/A
Sub-area 1E	γ_1	-	-	N/A
Sub-area 2	γ_2	-	-	N/A
TWO STOCK HYPOTHESIS (matrix B)				
Sub-area 1W	1	-	-	0
Sub-area 1E	γ_2	-	-	0
Sub-area 2	0	-	-	1
TWO STOCK HYPOTHESIS (matrix C1) [note: mixing is stochastic in this trial]				
Sub-area 1W	1	-	-	0
Sub-area 1E	γ_3	-	-	0
Sub-area 2	γ_3^*	-	-	1
	Matrix C2			
Sub-area 1W	1	-	-	0
Sub-area 1E	γ_3	-	-	0
Sub-area 2	0	-	-	1
TWO STOCK HYPOTHESIS (matrix D)				
Sub-area 1W	-	1	γ_6	0
Sub-area 1E	-	γ_5	1	0
Sub-area 2	-	0	0	1

* selected so that the split of the population size at pre-exploitation equilibrium between Sub-stock 1B and Stock 2 in sub-area 2 is 50:50.

Table 2 (continued on next page)
The Catch Series used in the trials (L=low, B=best, H=high)

Sub-area	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	1E	1E	1E	1E	1E	1E	2	2
Sex:	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Boundary	155	155	155	155	155	155	160	160	165	165	165	165	165	165	155	155	160	160	165	165		
Series	B	B	H	H	L	L	B	B	B	B	H	H	L	L	All	All	All	All	All	All	All	All
1906	6	7	9	11	4	3	6	7	6	7	9	11	4	3	0	0	0	0	0	0	0	0
1907	17	18	24	28	10	9	17	18	17	18	24	28	10	9	0	0	0	0	0	0	0	0
1908	39	42	57	67	24	22	39	42	39	42	57	67	24	22	0	0	0	0	0	0	0	0
1909	23	24	33	39	14	13	23	24	23	24	33	39	14	13	0	0	0	0	0	0	0	0
1910	24	26	35	41	15	13	24	26	24	26	35	41	15	13	0	0	0	0	0	0	0	0
1911	75	81	109	128	46	42	75	81	75	81	109	128	46	42	0	0	0	0	0	0	0	0
1912	38	43	61	75	18	16	38	43	38	43	61	75	18	16	0	0	0	0	0	0	0	0
1913	58	66	94	115	28	25	58	66	58	66	94	115	28	25	0	0	0	0	0	0	0	0
1914	24	32	51	68	2	2	24	32	24	32	51	68	2	2	0	0	0	0	0	0	0	0
1915	72	97	154	208	3	3	72	97	72	97	154	208	3	3	0	0	0	0	0	0	0	0
1916	45	60	94	126	4	4	45	60	45	60	94	126	4	4	0	0	0	0	0	0	0	0
1917	88	93	124	142	57	52	88	93	88	93	124	142	57	52	0	0	0	0	0	0	0	0
1918	69	79	112	138	32	29	69	79	69	79	112	138	32	29	0	0	0	0	0	0	0	0
1919	77	84	113	132	47	43	77	84	77	84	113	132	47	43	0	0	0	0	0	0	0	0
1920	41	51	78	101	10	9	41	51	41	51	78	101	10	9	0	0	0	0	0	0	0	0
1921	40	49	72	93	13	12	40	49	40	49	72	93	13	12	0	0	0	0	0	0	0	0
1922	37	44	66	84	12	11	37	44	37	44	66	84	12	11	0	0	0	0	0	0	0	0
1923	32	43	68	92	2	2	32	43	32	43	68	92	2	2	0	0	0	0	0	0	0	0
1924	48	63	100	134	4	4	48	63	48	63	100	134	4	4	0	0	0	0	0	0	0	0
1925	55	64	93	115	23	21	55	64	55	64	93	115	23	21	0	0	0	0	0	0	0	0
1926	60	73	114	143	18	16	60	73	60	73	114	143	18	16	0	0	0	0	0	0	0	0
1927	53	65	97	122	18	17	53	65	53	65	97	122	18	17	0	0	0	0	0	0	0	0
1928	36	44	65	83	12	11	36	44	36	44	65	83	12	11	0	0	0	0	0	0	0	0
1929	29	34	49	61	12	11	29	34	29	34	49	61	12	11	0	0	0	0	0	0	0	0
1930	27	35	59	75	4	4	27	35	27	35	59	75	4	4	0	0	0	0	0	0	0	0
1931	64	71	97	115	37	34	64	71	64	71	97	115	37	34	0	0	0	0	0	0	0	0
1932	51	53	69	78	35	33	51	53	51	53	69	78	35	33	0	0	0	0	0	0	0	0
1933	37	47	79	97	9	8	37	47	37	47	79	97	9	8	0	0	0	0	0	0	0	0
1934	45	48	65	73	31	28	45	48	45	48	65	73	31	28	0	0	0	0	0	0	0	0
1935	46	46	64	64	37	34	46	46	46	46	64	64	37	34	0	0	0	0	0	0	0	0
1936	40	48	86	100	8	8	40	48	40	48	86	100	8	8	0	0	0	0	0	0	0	0
1937	59	64	122	123	29	27	59	64	59	64	122	123	29	27	0	0	0	0	0	0	0	0
1938	77	83	129	143	40	36	77	83	77	83	129	143	40	36	0	0	0	0	0	0	0	0
1939	87	105	175	211	25	23	87	105	87	105	175	211	25	23	0	0	0	0	0	0	0	0
1940	49	61	106	128	9	9	49	61	49	61	106	128	9	9	0	0	0	0	0	0	0	0
1941	64	80	145	176	3	3	64	80	64	80	145	176	3	3	0	0	0	0	0	0	0	0
1942	9	12	25	26	3	3	9	12	9	12	25	26	3	3	0	0	0	0	0	0	0	0
1943	17	12	57	35	3	3	17	12	17	12	57	35	3	3	0	0	0	0	0	0	0	0
1944	37	37	139	111	1	2	37	37	37	37	139	111	1	2	0	0	0	0	0	0	0	0
1945	5	7	11	15	0	0	5	7	5	7	11	15	0	0	0	0	0	0	0	0	0	0
1946	52	74	110	154	1	1	52	74	52	74	110	154	1	1	0	0	0	0	0	0	0	0
1947	48	58	80	99	0	1	48	58	48	58	80	99	0	1	0	0	0	0	0	0	0	0
1948	58	77	111	148	0	1	58	77	58	77	111	148	0	1	0	0	0	0	0	0	0	0
1949	101	97	152	169	15	16	101	97	101	97	152	169	15	16	0	0	0	0	0	0	0	0
1950	132	156	146	175	120	139	132	156	132	156	146	175	120	139	0	0	0	0	0	0	0	0
1951	166	141	178	157	156	127	166	141	166	141	178	157	156	127	0	0	0	0	0	0	0	0
1952	303	188	341	239	271	144	303	188	303	188	341	239	271	144	0	0	0	0	0	0	0	0
1953	25	36	54	75	1	3	25	36	25	36	54	75	1	3	0	0	0	0	0	0	0	0
1954	31	44	66	91	2	4	31	44	31	44	66	91	2	4	0	0	0	0	0	0	0	0
1955	34	60	34	60	34	60	34	60	34	60	34	60	34	60	0	0	0	0	0	0	0	0
1956	12	12	12	12	12	12	12	12	12	12	12	12	12	12	0	0	0	0	0	0	0	0
1957	12	27	12	27	12	27	12	27	12	27	12	27	12	27	0	0	0	0	0	0	0	0
1958	113	141	113	141	113	141	113	141	113	141	113	141	113	141	0	0	0	0	0	0	0	0
1959	153	110	153	110	153	110	153	110	153	110	153	110	153	110	0	0	0	0	0	0	0	0
1960	188	216	188	216	188	216	188	216	188	216	188	216	188	216	0	0	0	0	0	0	0	0
1961	83	84	83	84	83	84	83	84	83	84	83	84	83	84	0	0	0	0	0	0	0	0
1962	209	295	209	295	209	295	209	295	209	295	209	295	209	295	0	0	0	0	0	0	0	0
1963	100	110	100	110	100	110	100	110	100	110	100	110	100	110	0	0	0	0	0	0	0	0
1964	25	43	25	43	25	43	25	43	25	43	25	43	25	43	0	0	0	0	0	0	0	0
1965	1	7	1	7	1	7	1	7	1	7	1	7	1	7	0	0	0	0	0	0	0	0
1966	19	36	19	36	19	36	19	36	19	36	19	36	19	36	0	0	0	0	0	0	0	0
1967	17	28	17	28	17	28	17	28	17	28	17	28	17	28	0	0	0	0	0	0	0	0
1968	70	101	70	101	70	101	70	101	70	101	70	101	70	101	0	0	0	0	0	0	0	0
1969	34	55	34	55	34	55	34	55	34	55	34	55	34	55	0	0	0	0	0	0	0	0
1970	36	37	36	37	36	37	36	37	36	37	36	37	36	37	16	24	16	24	16	24	11	15
1971	80	92	80	92	80	92	102	133	102	133	102	133	102	133	201	305	179	264	179	264	101	140
1972	38	46	38	46	38	46	38	46	38	46	38	46	38	46	22	41	22	41	22	41	4	9
1973	179	381	179	381	179	381	185	391	190	402	190	402	190	402	31	52	25	42	20	31	20	36
1974	210	349	210	349	210	349	282	418	287	422	287	422	287	422	197	259	125	190	120	186	147	161
1975	334	307	334	307	334	307	349	331	358	343	358	343	358	343	153	203	138	179	129	167	227	208
1976	371	423	371	423	371	423	379	446	390	461	390	461	390	461	389	245	381	222	370	207	25	6
1977	164	165	164	165	164	165	182	192	416	371	416	371	416	371	330	278	312	251	78	72	2	7

Sub-area	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	IW	1E	1E	1E	1E	1E	1E	2	2
Sex:	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Boundary	155	155	155	155	155	155	160	160	165	165	165	165	165	165	155	155	160	160	165	165		
Series	B	B	H	H	L	L	B	B	B	B	H	H	L	L	All	All	All	All	All	All	All	All
1978	236	194	304	258	168	130	252	203	274	216	342	280	206	152	205	148	189	139	167	126	8	5
1979	570	499	604	531	537	466	589	517	670	570	704	602	637	537	123	87	104	69	23	16	0	2
1980	401	354	401	354	335	292	401	354	401	354	401	354	335	292	0	0	0	0	0	0	0	0
1981	249	236	324	298	249	236	249	236	249	236	324	298	249	236	0	0	0	0	0	0	0	0
1982	275	207	409	300	275	207	275	207	275	207	409	300	275	207	0	0	0	0	0	0	0	0
1983	403	142	462	161	398	138	403	142	403	142	462	161	398	138	0	0	0	0	0	0	0	0
1984	353	175	542	262	328	153	353	175	353	175	542	262	328	153	0	0	0	0	0	0	0	0
1985	249	108	428	178	225	92	249	108	249	108	428	178	225	92	0	0	0	0	0	0	0	0
1986	217	100	426	196	217	100	217	100	217	100	426	196	217	100	0	0	0	0	0	0	0	0
1987	256	61	444	104	256	61	256	61	256	61	444	104	256	61	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
1996	0	0	0	0	0	0	0	0	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	0	0	0	0	0	0	0	0
1998	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0
1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2000	20	23	20	23	20	23	20	23	20	23	20	23	20	23	0	0	0	0	0	0	0	0
2001	17	33	17	33	17	33	17	33	17	33	17	33	17	33	0	0	0	0	0	0	0	0
2002	17	19	17	19	17	19	25	25	25	25	25	25	25	25	8	6	0	0	0	0	0	0
2003	16	21	16	21	16	21	18	28	19	31	19	31	19	31	3	10	1	3	0	0	0	0
2004	0	0	0	0	0	0	14	24	18	26	18	26	18	26	19	32	5	8	1	6	0	0
2005	21	25	21	25	21	25	21	26	21	29	21	29	21	29	0	4	0	3	0	0	0	0

Table 3

The estimates of abundance and their sampling standard errors

Sub-areas	Year	Estimate	Sampling CV
1W (165 boundary)	1995	8,152	0.329
1E (165 boundary)	1995	10,814	0.342
2	1995	2,860	0.372

Table 4
Sighting survey plan (the results from surveys in the westernmost part of sub-area 1W are ignored in the trials - see section F).

Season	Sector			
	130°-145°E	145°-165°E	165°E-180°	180°-160°W
2006		Yes		
2007			Yes	
2008	Yes			
2009				Yes
2010		Yes		
2011			Yes	
2012	Yes			
2013				Yes
2014		Yes		
2015			Yes	
2016	Yes			
2017				Yes
2018		Yes		
2019			Yes	
2020	Yes			
2021				Yes

Table 5

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

Parameter	Value
Plus group age, x	50 yrs
Natural mortality, M	0.08yr^{-1}
Age-at-first-parturition, a_m	7 years (Adjunct 2)
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 (Item 3.2)
Maximum Sustainable Yield Level, *MSYL*	0.6 in terms of mature female component of the population

Table 6

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

Trial No.	Stocks	Sub-stocks	$MSYR_{mat}$	Mixing matrix	Process error	Stochastic mixing in 1W/1E	Catch series	Age-dependent Mixing?	1W / 1E boundary	Comment	Trial Weight
Br1	1	No	1	A	Baseline	No	Best	No	165°E	Stock structure hypothesis 1	M
Br2	1	No	4	A	Baseline	No	Best	No	165°E	Stock structure hypothesis 1	H
Br3	2	No	1	B	Baseline	No	Best	No	165°E	Stock structure hypothesis 2	M
Br4	2	No	4	B	Baseline	No	Best	No	165°E	Stock structure hypothesis 2	H
Br5	2	No	1	C	Baseline	No	Best	No	165°E	Stock structure hypothesis 3	M
Br6	2	No	4	C	Baseline	No	Best	No	165°E	Stock structure hypothesis 3	H
Br7	2	Yes	1	D	Baseline	No	Best	No	155°E	Stock structure hypothesis 4	M
Br8	2	Yes	4	D	Baseline	No	Best	No	155°E	Stock structure hypothesis 4	M
Br9	2	No	1	B	Baseline	No	Best	Yes	165°E	B + Age-dependent mixing	M
Br10	2	No	4	B	Baseline	No	Best	Yes	165°E	B + Age-dependent mixing	H
Br11	2	Yes	1	D	$\sigma_p = 0.9$	No	Best	No	155°E	D + Additional process error	M
Br12	2	Yes	4	D	$\sigma_p = 0.9$	No	Best	No	155°E	D + Additional process error	M
Br13	2	Yes	1	D	Baseline	Yes	Best	No	155°E	Stochastic mixing	M
Br14	2	Yes	4	D	Baseline	Yes	Best	No	155°E	Stochastic mixing	M
Br15	2	Yes	1	D	Baseline	No	Best	No	160°E	Alternative Boundary 1	M
Br16	2	Yes	4	D	Baseline	No	Best	No	160°E	Alternative Boundary 1	M
Br17	2	Yes	1	D	Baseline	No	Best	No	165°E	Alternative Boundary 2	M
Br18	2	Yes	4	D	Baseline	No	Best	No	165°E	Alternative Boundary 2	M
Br19	2	Yes	1	D	Baseline	No	Low	No	155°E	D + Low catch series	M
Br20	2	Yes	4	D	Baseline	No	Low	No	155°E	D + Low catch series	M
Br21	2	Yes	1	D	Baseline	No	High	No	155°E	D + High catch series	M
Br22	2	Yes	4	D	Baseline	No	High	No	155°E	D + High catch series	M
Br23	2	No	1	B	Baseline	No	High	No	165°E	B + High catch series	M
Br24	2	No	4	B	Baseline	No	High	No	165°E	B + High catch series	H
Br25	2	No	1	B	$\sigma_p = 0.9$	No	Best	No	165°E	B + Additional process error	M
Br26	2	No	4	B	$\sigma_p = 0.9$	No	Best	No	165°E	B + Additional process error	H
Br27	2	No	1	B	Baseline	No	High	Yes	165°E	B + Age-dep.mixing+high catch	M
Br28	2	No	4	B	Baseline	No	High	Yes	165°E	B + Age-dep.mixing+high catch	H

Table 7
Summary of the Bryde's whales marked in the western North Pacific.
This table ignores 94 animals that were marked outside of sub-areas 1 and 2.

Sub-area (Boundary):	1W (155°)	1E (155°)	1W (160°)	1E (160°)	1W (165°)	1E (165°)	2
1972	3	0	3	0	3	0	0
1973	2	7	6	3	8	1	0
1974	0	8	0	8	0	8	2
1975	9	6	9	6	9	6	14
1976	0	2	0	2	0	2	1
1977	0	0	0	0	0	0	1
1978	42	7	45	4	46	3	0
1979	72	5	77	0	77	0	0
1980	36	18	54	0	54	0	1
1981	25	7	31	1	32	0	0
1982	31	9	40	0	40	0	0
1983	28	24	43	9	48	4	0
1984	36	34	54	16	55	15	0
1985	13	0	13	0	13	0	0
Total	297	127	375	49	385	39	19

Table 8.
Marks recovered from Japanese whaling fleets within sub-areas 1W, 1E and 2.

Mark No	Date marked	Date Recovered	Position Marked	Position recovered	Sex	Length (m)
12065	12 Feb 1972	2 May 1982	24°48N 142°3E	24°25N 144°16E	M	12.6
12198	16 Mar 1973	10 Jun 1976	23°58N 156°40E	29°19N 166°45E	F	14.3
33017	15 May 1978	30 Apr 1981	25°12N 145°11E	29°51N 138°20E	M	13.3
33552	28 Jun 1979	11 May 1980	27°55N 147°46E	32°12N 137°21E	F	13.4
33565	28 Jun 1979	19 Apr 1986	27°57N 147°43E	24°13N 143°46E	M	12.8
33528	28 Jun 1979	10 Jun 1986	27°59N 147°21E	26°29N 143°13E	M	12.9
14622	11 Jun 1980	2 Jun 1981	24°55N 141°43E	25°9N 141°56E	F	12.7
14711	26 Jun 1980	28 Apr 1984	30°6N 152°36E	25°41N 144°19E	M	12.7
14725	28 Jun 1980	1 May 1986	27°18N 157°46E	25°36N 143°54E	F	12.6
14741	29 Jun 1980	21 Jun 1981	25°52N 159°14E	31°35N 142°53E	F	12.9
14776	16 Jun 1981	29 Apr 1984	26°15N 159°55E	25°55N 143°18E	F	12.2
14799	20 Jun 1981	7 Jun 1985	27°29N 150°00E	27°38N 143°17E	F	13.3
37319	21 Jun 1981	18 Apr 1982	27°39N 146°43E	25°17N 142°13E	F	11.5
37322	21 Jun 1981	12 Jun 1985	27°38N 146°34E	26°38N 143°4E	M	12.2
14380	12 Jun 1982	26 Apr 1986	25°3N 149°58E	25°14N 144°11E	M	11.9
14408	18 Jun 1982	21 Apr 1985	27°34N 156°32E	25°19N 143°50E	M	12.4
14476	18 Jun 1983	26 Apr 1986	23°5N 134°0E	25°32N 144°39E	M	12.4
14491	24 Jun 1983	12 Jul 1985	20°1N 139°24E	26°10N 144°57E	F	11.5
14801	28 Jun 1983	9 May 1984	25°28N 144°50E	26°50N 142°56E	M	11.5
14807	30 Jun 1983	14 Jun 1984	23°58N 148°25E	24°33N 142°15E	M	12.4
14994	30 Jun 1984	4 Aug 1985	26°34N 147°31E	26°59N 144°19E	F	12.3
15098	30 Jul 1984	21 Apr 1985	35°9N 146°18E	25°43N 143°34E	M	13.4

Table 9.
Sample sizes of aged whales used to calculate mortality rates (using 165° boundary)

		Sub-area 1W	Sub-area 1E	Sub-area 2
Commercial catches				
	1971	0	12	0
	1972	0	0	0
	1973	0	1	0
	1974	0	29	76
	1975	0	86	128
	1976	0	87	5
	1977	0	12	0
	1978	0	31	0
	1979	0	15	1
Scientific permit catches				
	2000	9	0	0
	2001	8	0	0
	2002	11	0	0
	2003	11	0	0

Adjunct 1

Approximate calculation of Sub-area level additional CVs based on revised abundance estimates for conditioning of *IST*s

H. Okamura, T. Kitakado, and D.S. Butterworth

Sub-area level CVs are calculated based on the method in SC/58/Rep1. CVs based on sampling errors were calculated by Tables 2 and 3 (Case 2) of SC/O05/BWI6. For example, the sampling CV for block F, $CV_S(N_F)$, is

$$CV_S(N_F) = \frac{\sqrt{(N_{F,clo\sin g}/R)^2\{CV_S^2(N_{F,clo\sin g}) + CV^2(R)\} + N_{F,pas\sin g}^2 CV_S^2(N_{F,pas\sin g})}}{N_{F,clo\sin g}/R + N_{F,pas\sin g}}.$$

where $R = 0.727$ ($CV(R) = 36.4$ %) [SC/58/Rep1, annex H]. We ignored a correlation for simplicity.

Then, $\mathrm{var}_S(N_F) = \{CV_S(N_F)\exp(\mu_F + \sigma_F^2/2)\}^2$ where μ_F and σ_F are extracted from Table 1 of SC/58/Rep1, annex H.

Total $CV_T(N_F) = \sqrt{CV_S^2(N_F) + \sigma_A^2}$ for each block, and $\mathrm{var}_T(N_F) = \{CV_T(N_F)\exp(\mu_F + \sigma_F^2/2)\}^2$.

For Sub-area 1W = F+G+H, the Sub-area level CVs are calculated as follows:

$$CV_S(\mathrm{N_{FGH}}) = \frac{\sqrt{\mathrm{var}_S(N_F) + \mathrm{var}_S(N_G) + \mathrm{var}_S(N_H)}}{N_{FGH}},$$

$$CV_T(\mathrm{N_{FGH}}) = \frac{\sqrt{\mathrm{var}_T(N_F) + \mathrm{var}_T(N_G) + \mathrm{var}_T(N_H)}}{N_{FGH}},$$

$$CV_{Add}(\mathrm{N_{FGH}}) = \sqrt{CV_T^2(N_{FGH}) - CV_S^2(N_{FGH})}.$$

Table 1

Summary of the sub-area CVs.

	Sub-area 1W (blocks FGH)	Sub-area 1E (blocks IJK)	Sub-area 2 (blocks LM)
N	8,152	10,814	2,860
$CV_{(sampling)}$ %	25.43	24.45	32.80
σ_p=0.673			
$CV_{(Total)}$ %	46.68	51.59	58.29
$CV_{(add)}$ %	39.15	45.42	48.19
σ_p=0.9			
$CV_{(Total)}$ %	58.20	65.48	72.31
$CV_{(add)}$ %	52.36	60.75	64.44

Adjunct 2

Estimation of age-at-maturity for female Bryde's whales

A.E. Punt

Four models were fitted to the data on the maturity-at-age for female Bryde's whales sampled during JARPN II (table 1 of SC/O05/BWI7). The four models are special cases of the following general model:

$$P_a = \left[\frac{\alpha}{1 + \exp[-(a - a_{50})/\delta]}\right]^\beta \qquad \text{(App.3.1)}$$

where P_a is the proportion of animals of age *a* which are mature,
a_{50} is the age-at-50%-maturity (if α=1 and $\beta = 1$),
δ is the parameter that determines the width of the maturity ogive,
α is asymptotic fraction of animals which are mature, and
β is a shape parameter.

The model is fitted using a binomial likelihood under the assumption that age and maturity determination are exact (i.e. no measurement error).

The following table lists the values for the parameters of Equation App.3.1 for each of the four models and the true age-at-50%-maturity (the age at which a proportion of α/2 animals are mature). Fig. App.3.1 shows the fit of the four models to the available data.

Although the model in which α (but not β) is treated as an estimable parameter provides the most parsimonious representation of the data, the age-at-50%-maturity is robustly estimated to be 6 years. The age-at-first-parturition corresponding to this age-at-maturity is 7 years.

a_{50}	δ	α	β	No. of parameters	$-\ell nL$	Age-at-50%-maturity
5.93	2.07	1	1	2	21.042	5.93 (0.89)
6.21	0.915	0.978	1	3	15.662	6.21 (0.55)
-23.40	2.33	1	212031	3	19.640	5.99 (N/A)
-7.42	1.25	0.999	30066	4	15.619	5.90 (0.51)

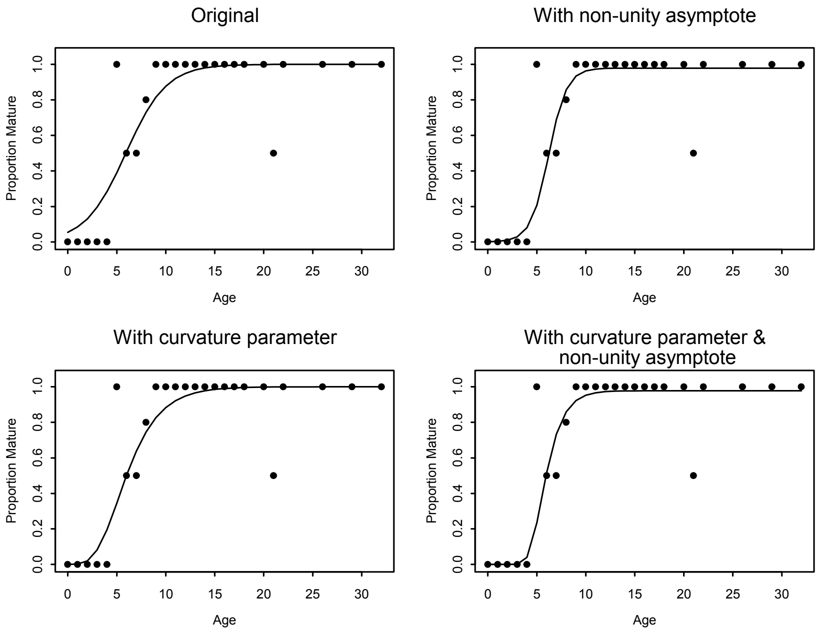


Fig. App.3.1. Fits of the four models to the data on maturity-at-age.

Adjunct 3

The dynamics of tagged animals

The dynamics of tagged animals are essentially the same as those of untagged animals, except that account needs to be taken of tagging. The following equation is used to determine the number of tagged animals of age a (for ages less than x) and sex g in stock/sub-stock j at the start of year t+1 originally tagged in sub-area k, $T^{g,j,k}_{t+1,a}$ (tagging is assumed to take place halfway through the fishing season):

$$T^{g,j,k}_{t+1,a} = [(T^{g,j,k}_{t,a-1}(1-\sum_{k'} V^{j,k'}_{t,a} S^{k'}_{t,a-1} F^{g,k'}_t) + Q^{g,j,k}_{t,a-1}(1 - S^{k'}_{t,a-1} F^{g,k}_t / 2)]\, e^{-M} \tilde{S} \tag{App.4.1}$$

where $Q^{g,j,k}_{t,a}$ is the number of animals of age a and sex g in stock/sub-stock j that were tagged in sub-area k during year t:

$$Q^{g,j,k}_{t,a} = \frac{Q^k_t C^{g,k}_t}{C^{\mathrm{f},k}_t + C^{\mathrm{m},k}_t} \frac{V^{j,k}_{t,a} N^{g,j}_{t,a}}{\sum_{j'} \sum_{a'} V^{j',k}_{t,a'} N^{g,j'}_{t,a'}} \tag{App.4.2}$$

Q^k_t is the actual number of releases during year t in sub-area k; and

$\tilde{S}$ is the rate of tag-loss (assumed to be unity for the baseline analyses).

The number of 'recruits' by age, sex and sub-stock to the tagged population therefore depends on the actual number tagged, assuming that an animal to be tagged is selected at random from the catch. Account is taken in Equation App.4.1 of mortality (both natural and fishing) from the time of tagging until the end of the year.

The observed number of animals recaptured by the Japanese fleets during year t in sub-area k that were originally tagged in sub-area k', $U^{k,k'}_t$ is given by:

$$U^{k,k'}_t = \Psi\left(\sum_g \sum_j \frac{J^{g,k}_t}{C^{g,k}_t} \sum_a \left[T^{g,j,k'}_{t,a} F^{g,k}_t S^k_{t,a} V^{j,k}_{t,a} + \tfrac{1}{2} F^{g,k'}_t S^{k'}_{t,a} Q^{g,j,k'}_{t,a}\right]\right) \tag{App.4.3}$$

where Ψ is the reporting rate parameter (assumed to be independent of sub-area) whose value is estimated during conditioning; and

$J^{g,k}_t$ is the catch of animals of sex g in sub-area k during year t by the Japanese fleets.

The second term in Equation App.4.3 only applies in the case $k = k'$.

Annex F

Diagnostic Plots for Updated Conditioning

Conditioning is the process of selecting the values for the parameters of the operating model so that this model is consistent with the existing data for the species and Region. An individual trial is composed of 100 simulations, each of which involves (1) generating a pseudo-dataset based on the information on abundance and tagging data in the sub-areas; and (2) estimating the parameter values for the operating model which provide the best fit to the maximum-likelihood value for the objective function.

This adjunct presents the series of plots designed to confirm whether the operating model fits the pseudo-datasets adequately and whether the resultant model fits appear realistic. The plots show

(1) the time-trajectories (medians and 90% intervals) of the 1+ population size in each sub-area. The abundance estimates used when conditioning are shown by the point estimate (x) with plus/minus one standard deviation.

(2) Histograms of (a) the target abundance estimates for each sub-area with an arrow showing the point estimate and (b) the standardised residuals. The targets are the same for all trials excepting trials the trails with age dependent mixing (Br09, 10, 27 and 28) for which 200 conditioning simulations were run and those with a poor fit to the data discarded. Histograms for the age dependent mixing trials are shown after those for the other trials.

(3) Histograms of

(a) the target tag recoveries for each sub-area with an arrow showing the point estimate. Plots are not shown if all target tag recoveries are zero. Plots are not shown for trials with identical targets to those displayed (the targets for trials Br02 – 06, 17, 18, 23 and 24 are identical to Br01; targets for Br08, 13, 14 and 19-22 are identical to Br07 and Br16 is identical to Br15.

(b) the absolute errors for the tag recoveries achieved by the operating model. Plots for hypotheses B and D have only 5 entries as the model does not allow the other options (i.e. no whales cross between these sub-areas)

(4) Histograms of the age data residuals for trials with age-dependent mixing (Br09, 10, 27 and 28).

Note that conditioning plots are not shown for trials Br11, 12, 25 or 26 (the trials with additional process error) because they use the same conditioning parameters as the equivalent trial without additional process error (i.e. trials Br7, 8, 3 and 4)

Fig 1. Median and 90% trajectories (x=point estimate)

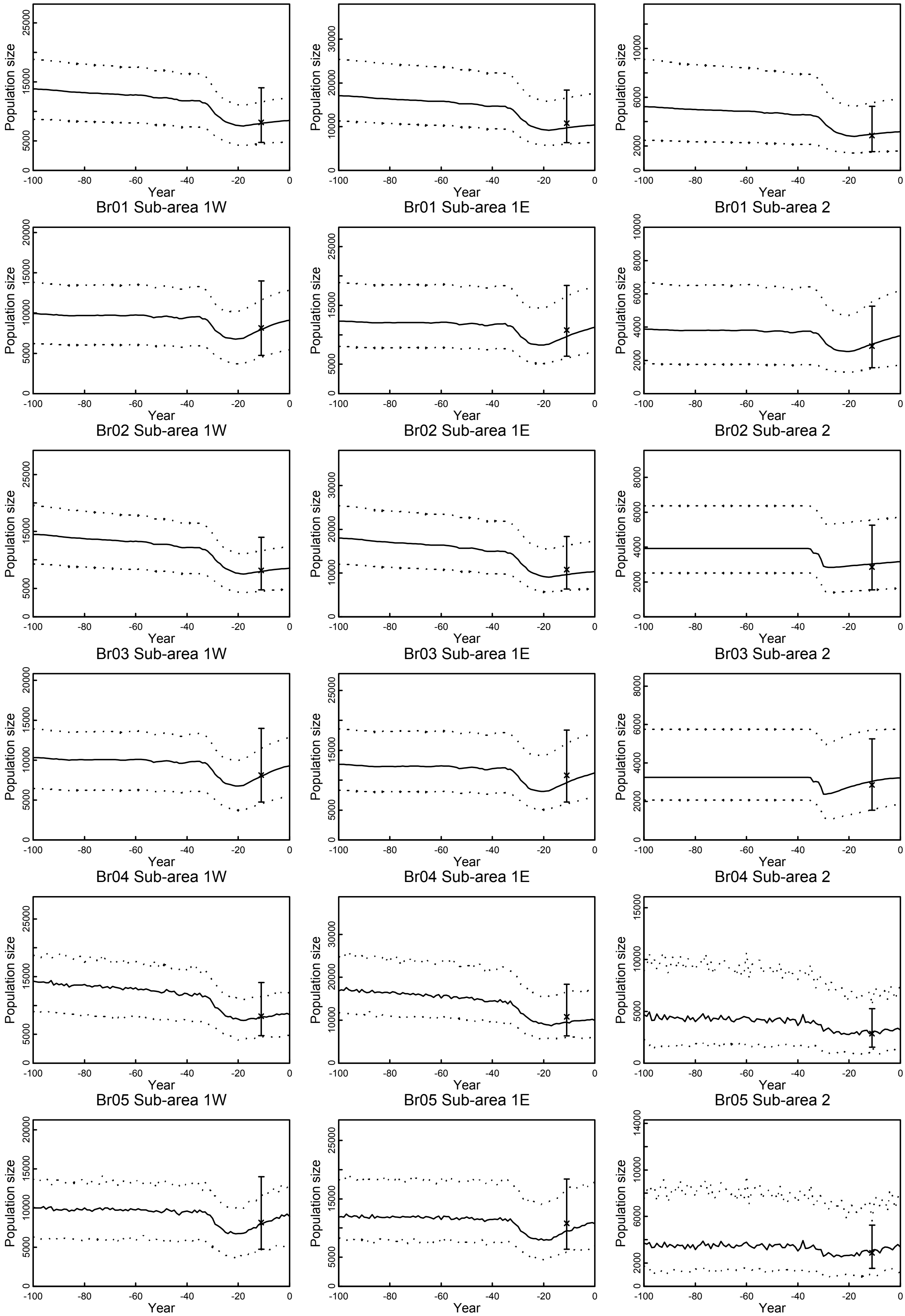


Fig 1 contd. Median and 90% trajectories (x=point estimate)

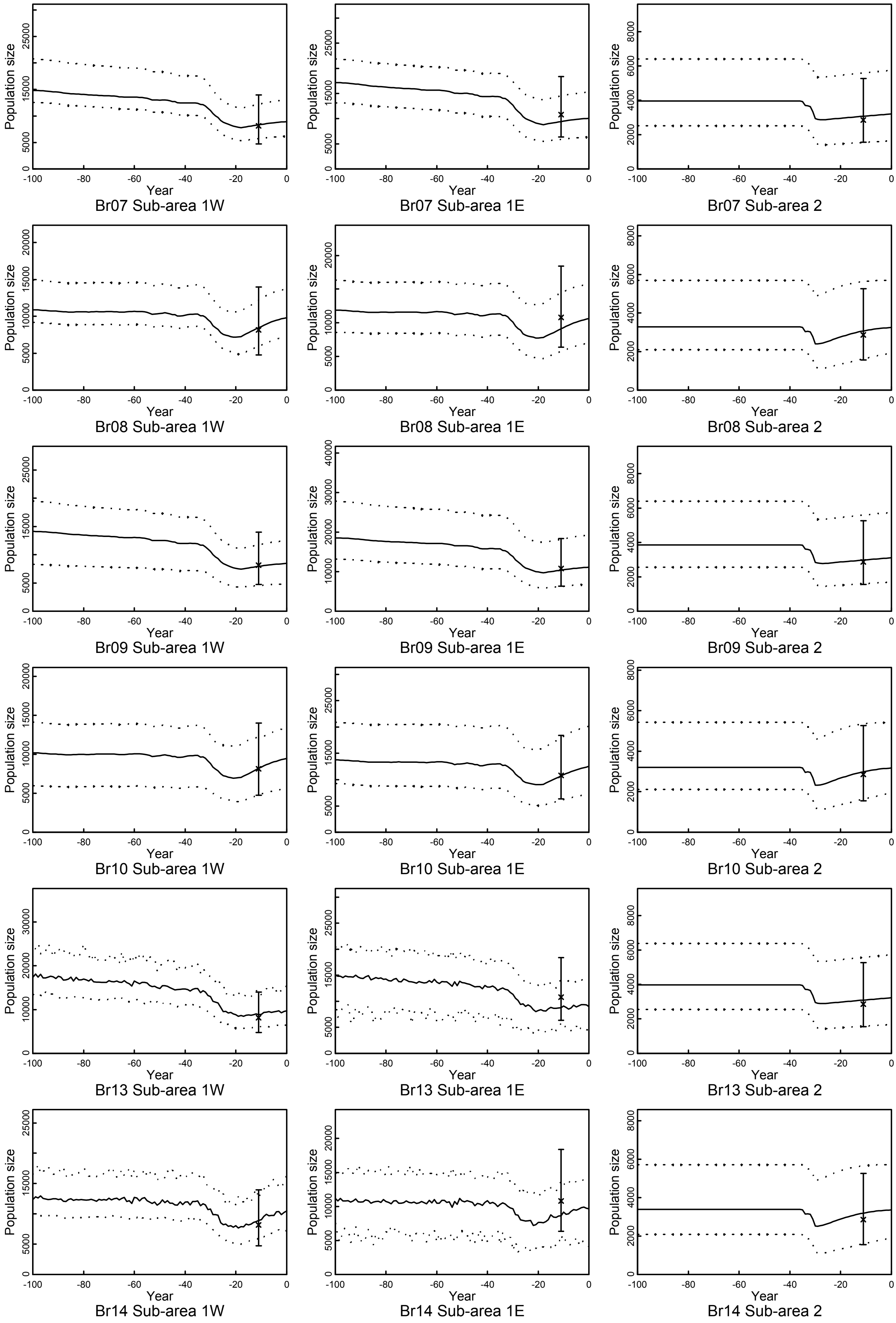


Fig 1 contd. Median and 90% trajectories (x=point estimate)

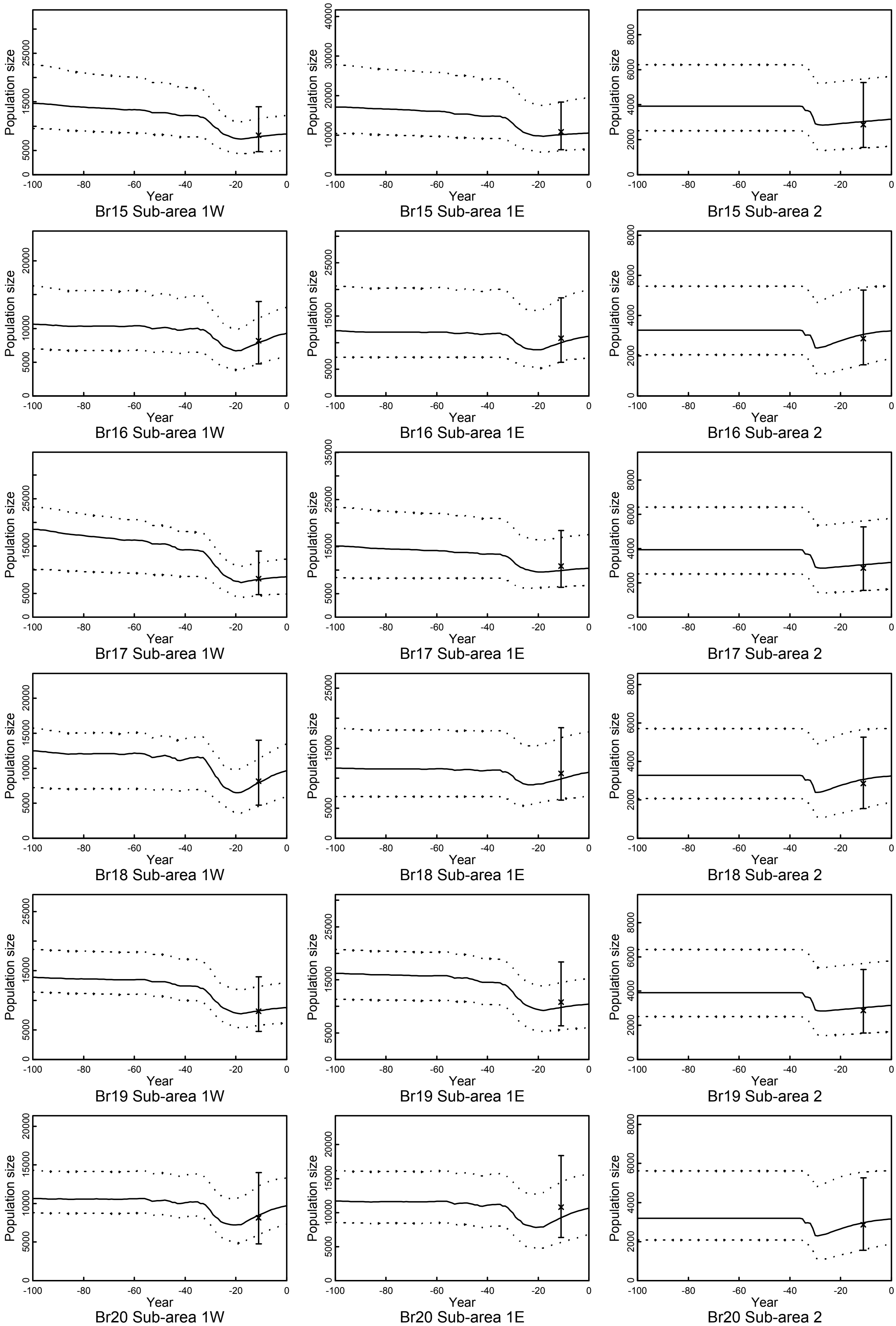


Fig 1 contd. Median and 90% trajectories (x=point estimate)

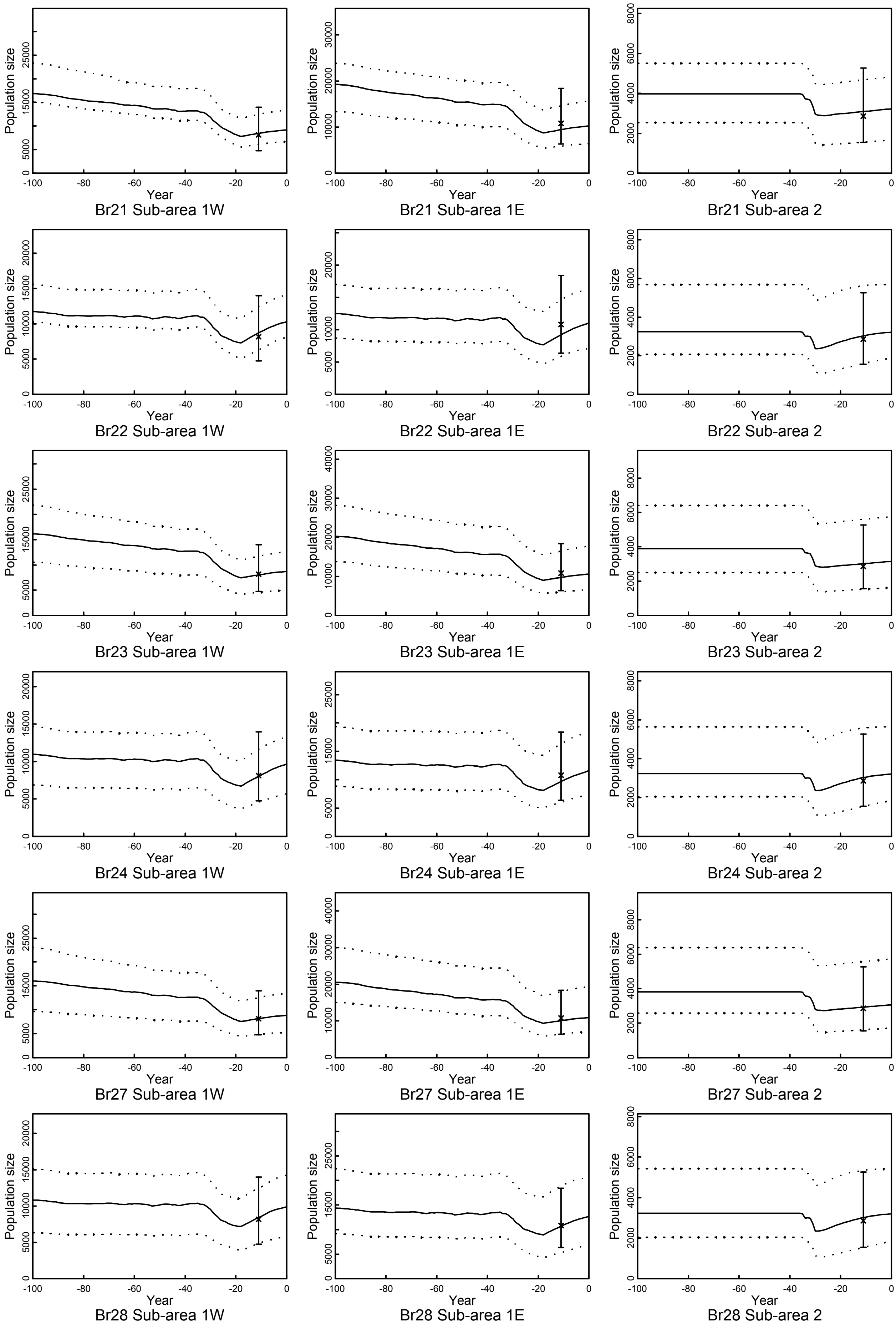


Fig 2a Target abundances (arrow shows point estimate) and Fig 2b Standardised residuals

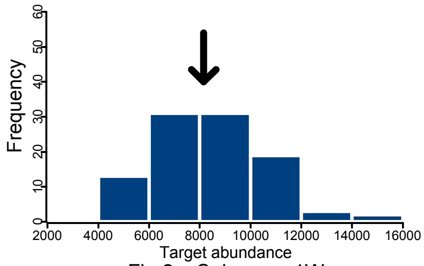


Fig 2a Sub-area 1W

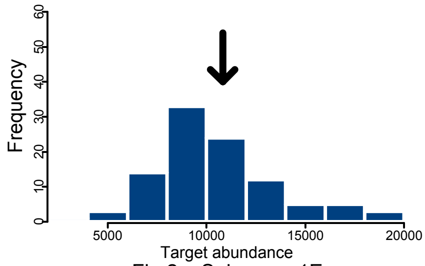


Fig 2a Sub-area 1E

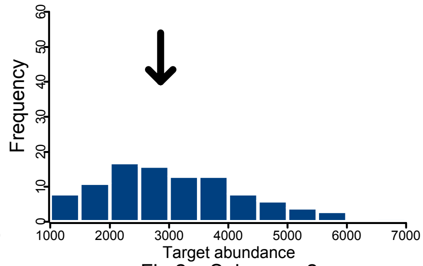


Fig 2a Sub-area 2

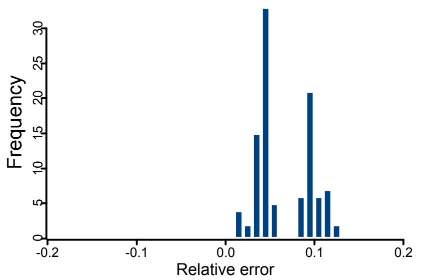


Fig 2b Br01 Sub-area 1W

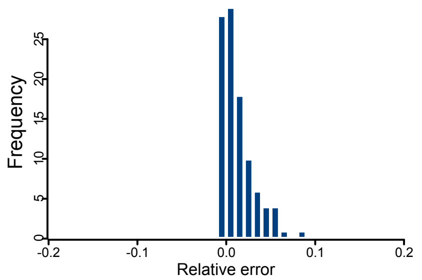


Fig 2b Br01 Sub-area 1E

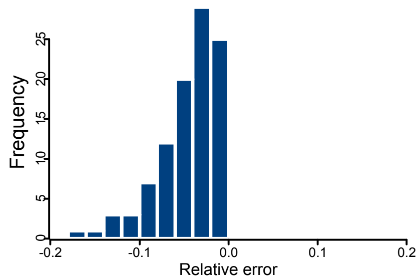


Fig 2b Br01 Sub-area 2

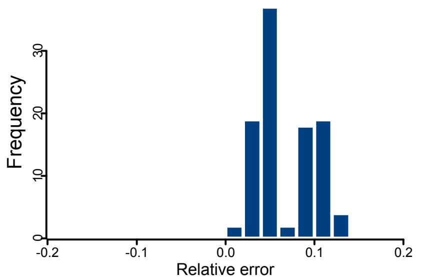


Fig 2b Br02 Sub-area 1W

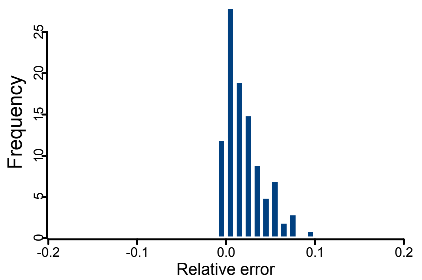


Fig 2b Br02 Sub-area 1E

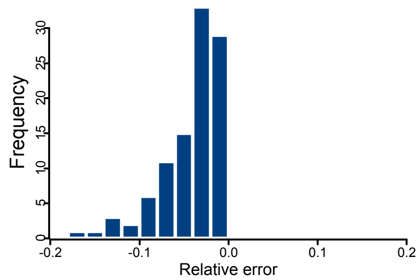


Fig 2b Br02 Sub-area 2

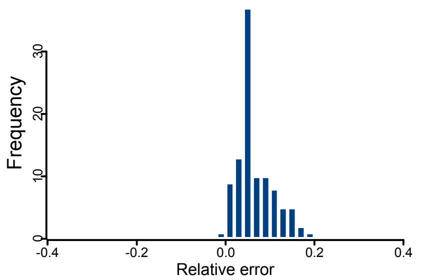


Fig 2b Br03 Sub-area 1W

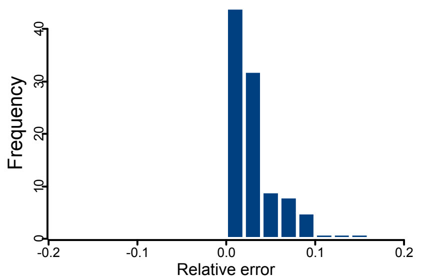


Fig 2b Br03 Sub-area 1E

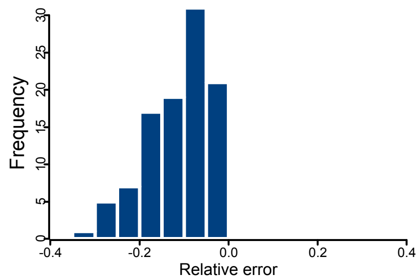


Fig 2b Br03 Sub-area 2

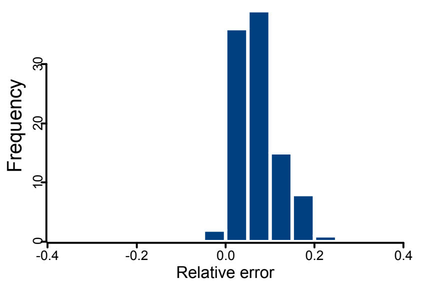


Fig 2b Br04 Sub-area 1W

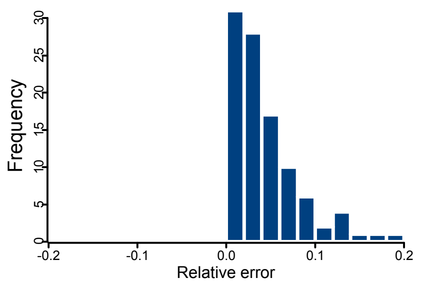


Fig 2b Br04 Sub-area 1E

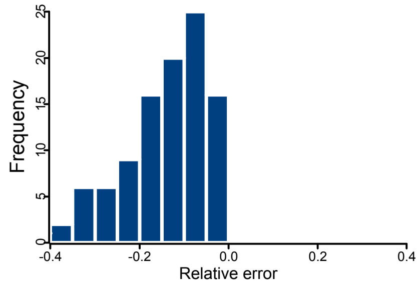


Fig 2b Br04 Sub-area 2

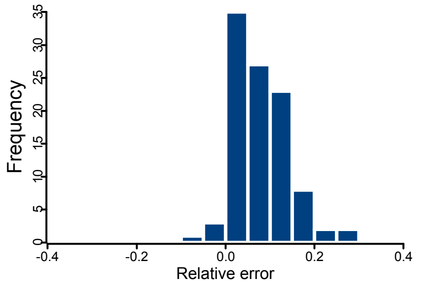


Fig 2b Br05 Sub-area 1W

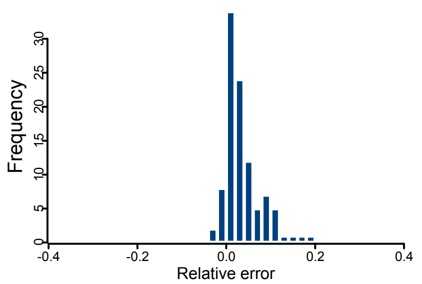


Fig 2b Br05 Sub-area 1E

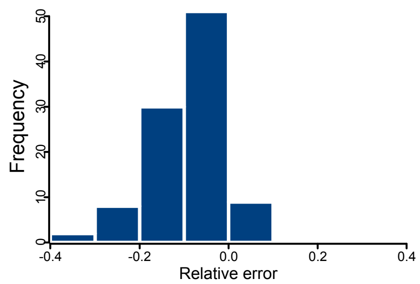


Fig 2b Br05 Sub-area 2

Fig 2b Standardised residuals   Contd.

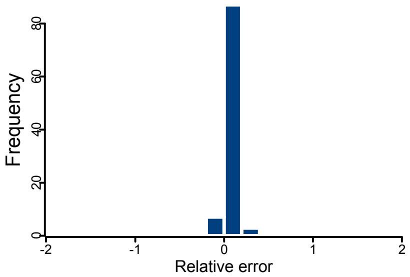


Fig 2b Br06 Sub-area 1W

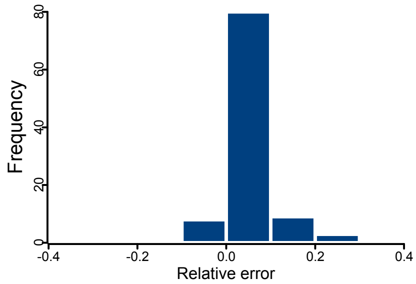


Fig 2b Br06 Sub-area 1E

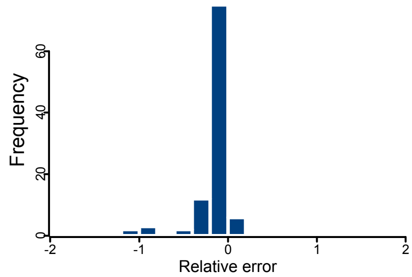


Fig 2b Br06 Sub-area 2

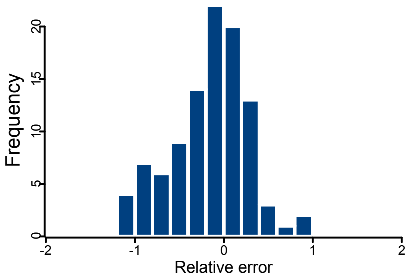


Fig 2b Br07 Sub-area 1W

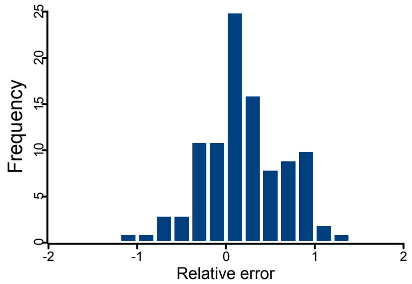


Fig 2b Br07 Sub-area 1E

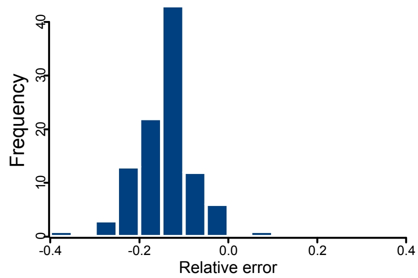


Fig 2b Br07 Sub-area 2

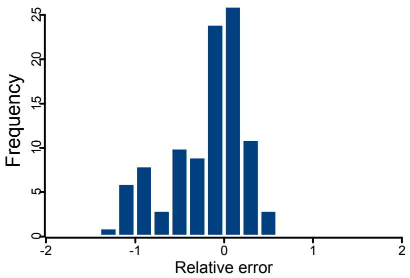
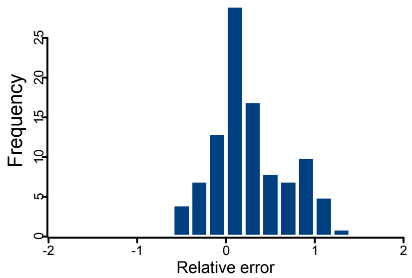


Fig 2b Br08 Sub-area 1W



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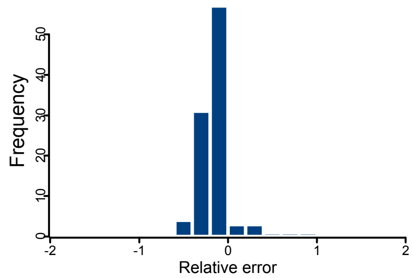


Fig 2b Br08 Sub-area 2

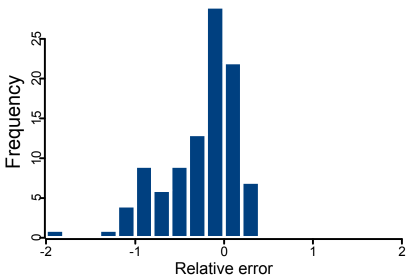


Fig 2b Br13 Sub-area 1W

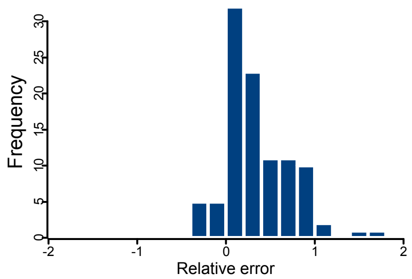


Fig 2b Br13 Sub-area 1E

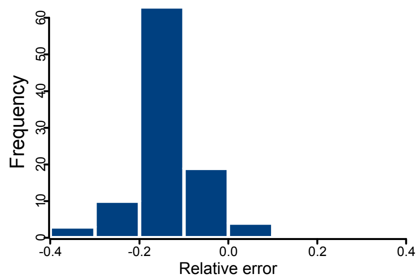


Fig 2b Br13 Sub-area 2

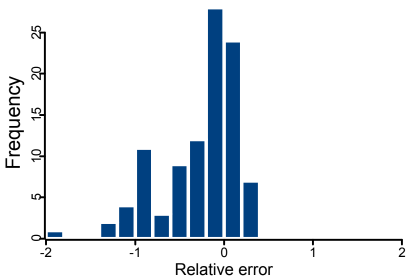


Fig 2b Br14 Sub-area 1W

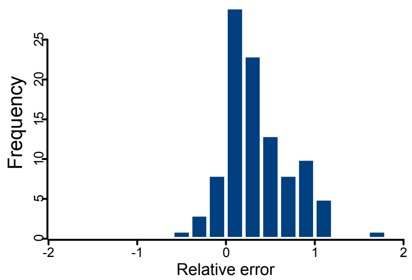


Fig 2b Br14 Sub-area 1E

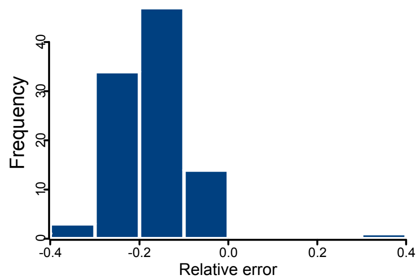


Fig 2b Br14 Sub-area 2

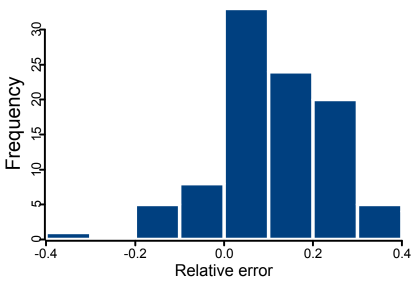


Fig 2b Br15 Sub-area 1W

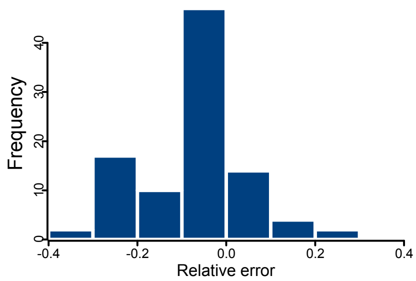


Fig 2b Br15 Sub-area 1E

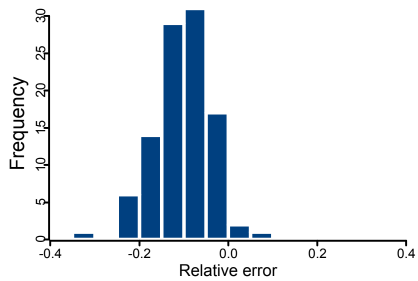


Fig 2b Br15 Sub-area 2

Fig 2b Standardised residuals   Contd.

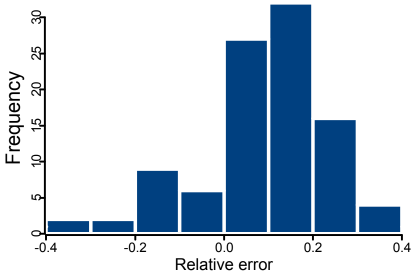


Fig 2b Br16 Sub-area 1W

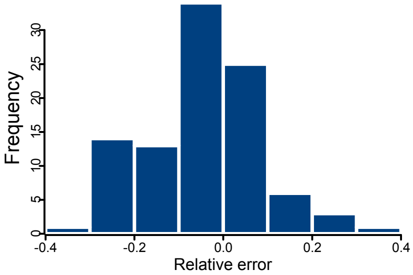


Fig 2b Br16 Sub-area 1E

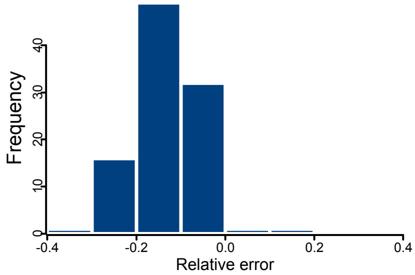


Fig 2b Br16 Sub-area 2

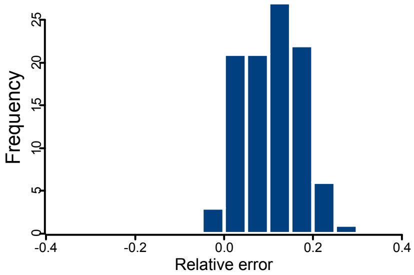


Fig 2b Br17 Sub-area 1W

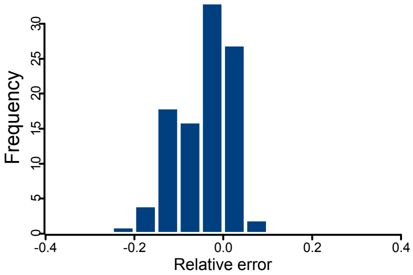


Fig 2b Br17 Sub-area 1E

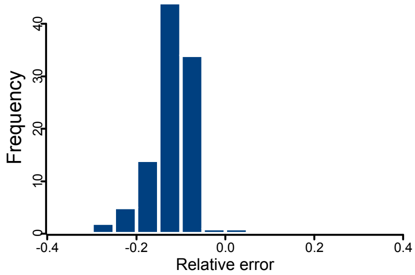


Fig 2b Br17 Sub-area 2

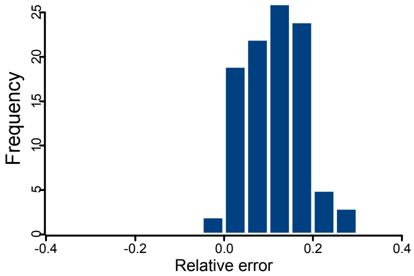


Fig 2b Br18 Sub-area 1W

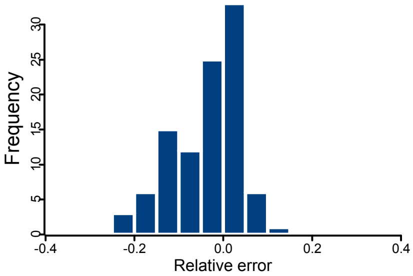


Fig 2b Br18 Sub-area 1E

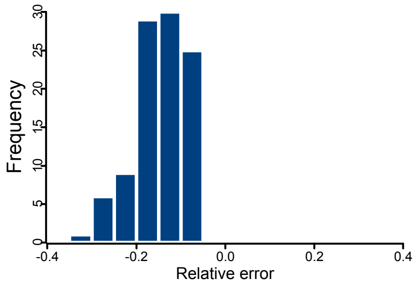


Fig 2b Br18 Sub-area 2

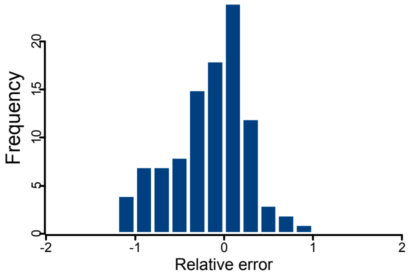


Fig 2b Br19 Sub-area 1W

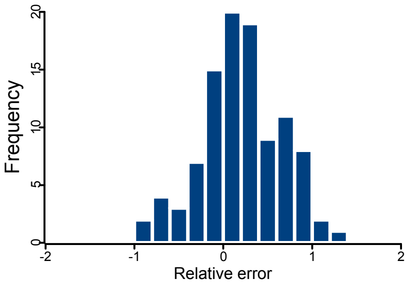


Fig 2b Br19 Sub-area 1E

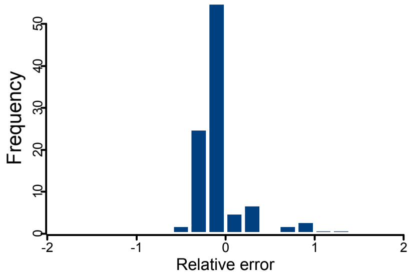


Fig 2b Br19 Sub-area 2

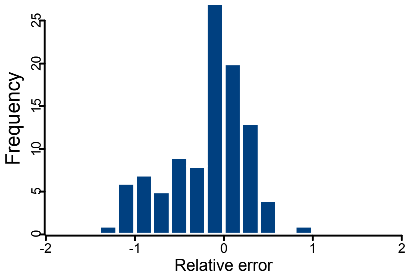


Fig 2b Br20 Sub-area 1W

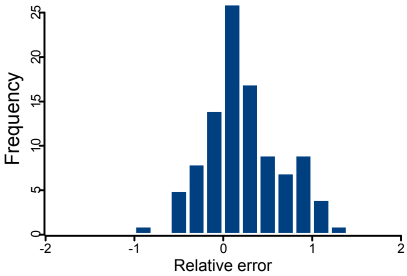


Fig 2b Br20 Sub-area 1E

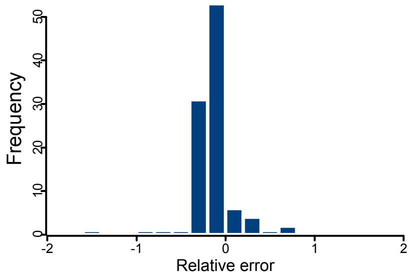


Fig 2b Br20 Sub-area 2

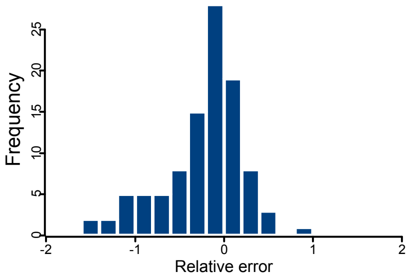


Fig 2b Br21 Sub-area 1W

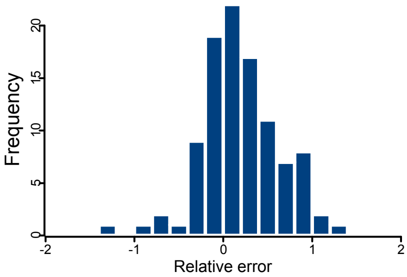


Fig 2b Br21 Sub-area 1E

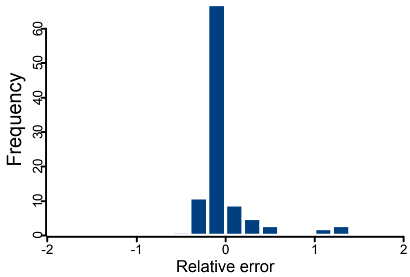


Fig 2b Br21 Sub-area 2

Fig 2a Target abundances and Fig 2b Standardised residuals Contd.

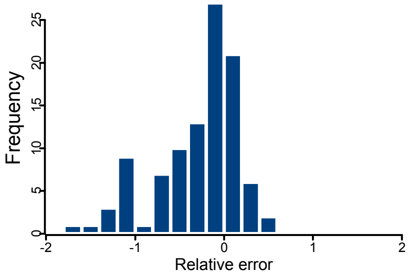


Fig 2b Br22 Sub-area 1W

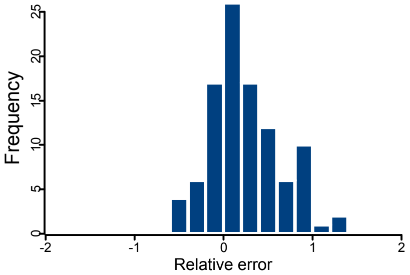


Fig 2b Br22 Sub-area 1E

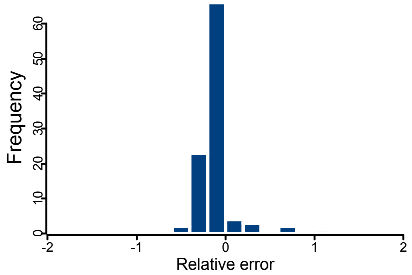


Fig 2b Br22 Sub-area 2

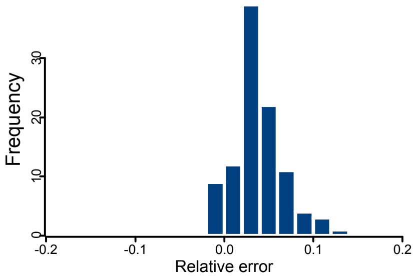


Fig 2b Br23 Sub-area 1W

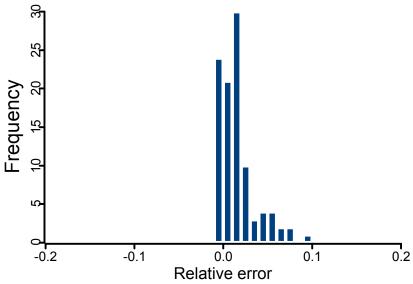


Fig 2b Br23 Sub-area 1E

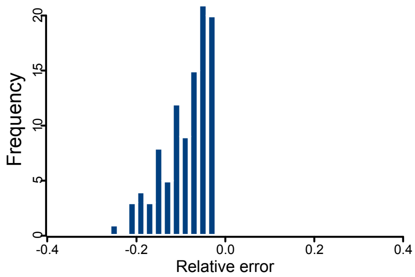


Fig 2b Br23 Sub-area 2

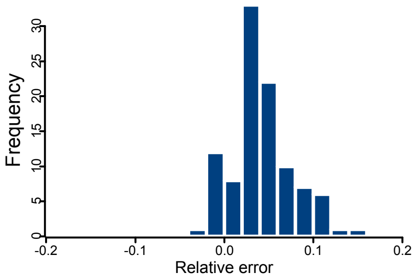


Fig 2b Br24 Sub-area 1W

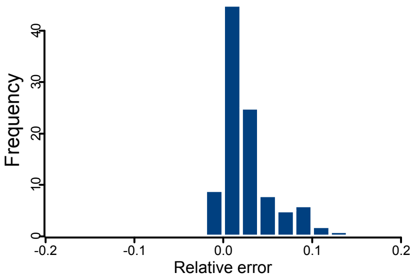


Fig 2b Br24 Sub-area 1E

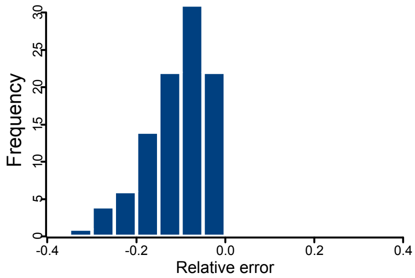


Fig 2b Br24 Sub-area 2

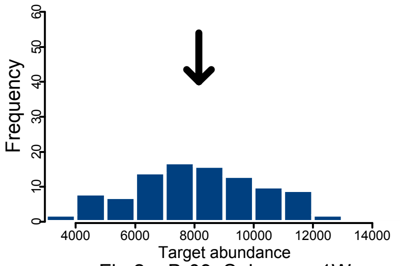


Fig 2a Br09 Sub-area 1W

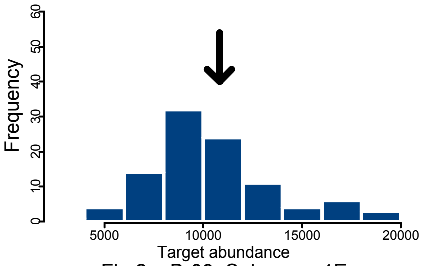


Fig 2a Br09 Sub-area 1E

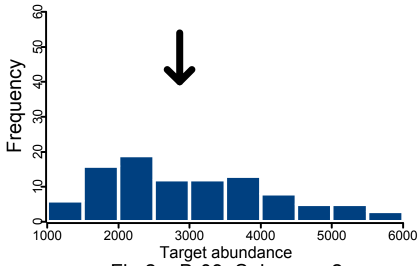


Fig 2a Br09 Sub-area 2

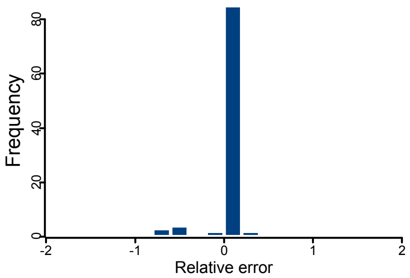


Fig 2b Br09 Sub-area 1W

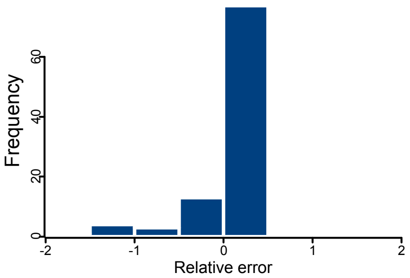


Fig 2b Br09 Sub-area 1E

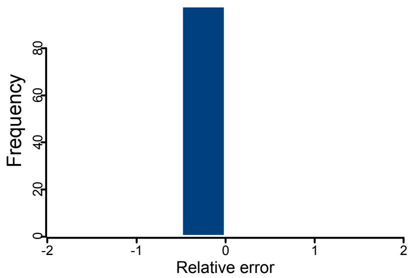


Fig 2b Br09 Sub-area 2

Fig 2a Target abundances and Fig 2b Standardised residuals   Contd.

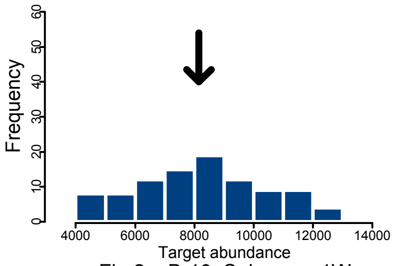


Fig 2a Br10 Sub-area 1W

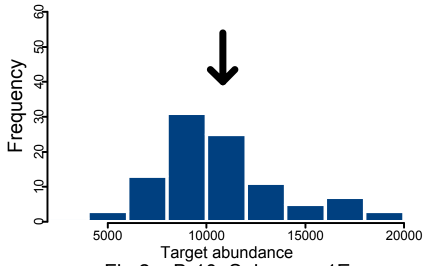


Fig 2a Br10 Sub-area 1E

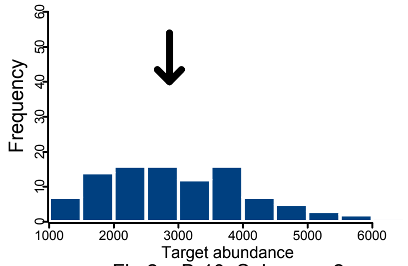


Fig 2a Br10 Sub-area 2

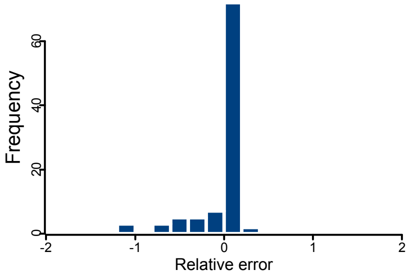


Fig 2b Br10 Sub-area 1W

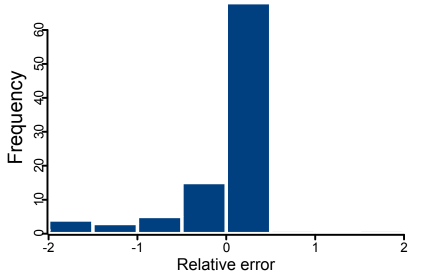


Fig 2b Br10 Sub-area 1E

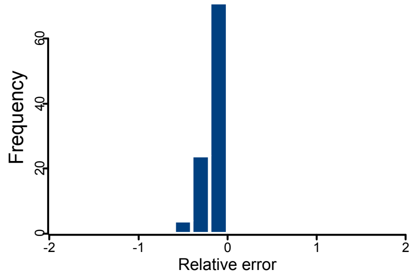


Fig 2b Br10 Sub-area 2

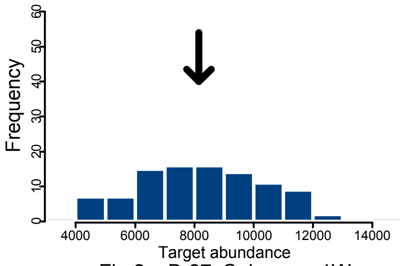


Fig 2a Br27 Sub-area 1W

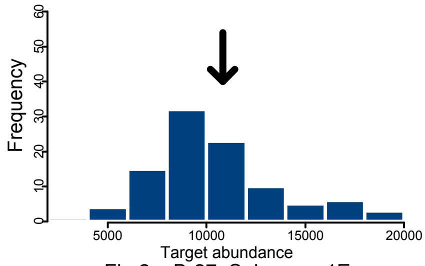


Fig 2a Br27 Sub-area 1E

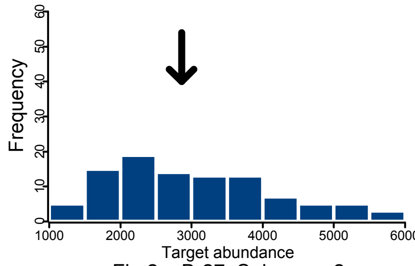


Fig 2a Br27 Sub-area 2

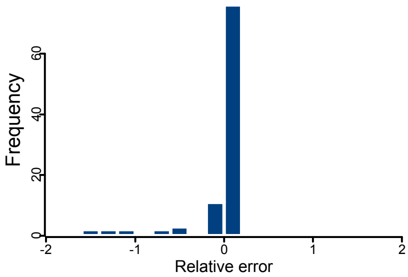


Fig 2b Br27 Sub-area 1W

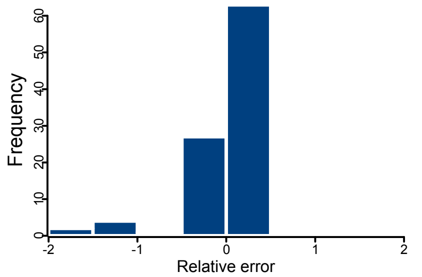


Fig 2b Br27 Sub-area 1E

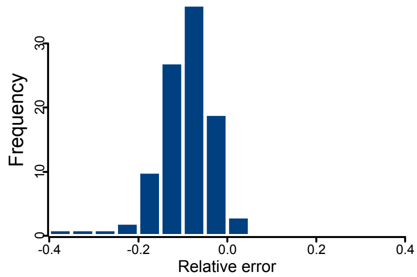


Fig 2b Br27 Sub-area 2

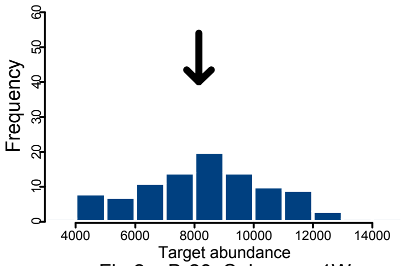


Fig 2a Br28 Sub-area 1W

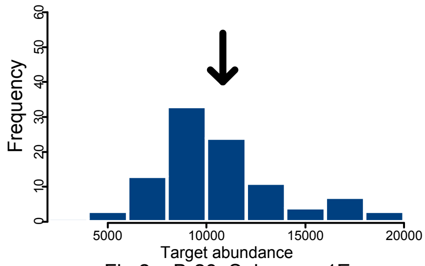


Fig 2a Br28 Sub-area 1E

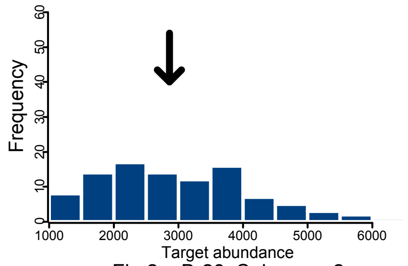


Fig 2a Br28 Sub-area 2

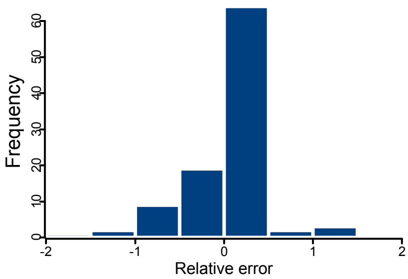


Fig 2b Br28 Sub-area 1W

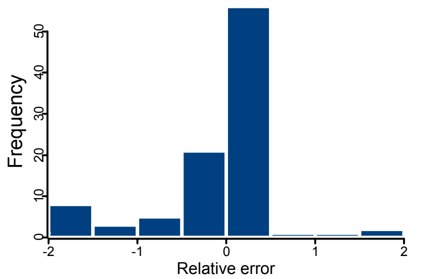


Fig 2b Br28 Sub-area 1E

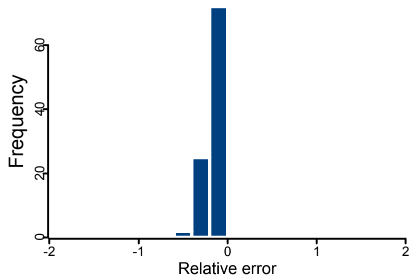


Fig 2b Br28 Sub-area 2

Fig 3a Tag recovery targets (arrow shows point estimate). Zero targets are not shown

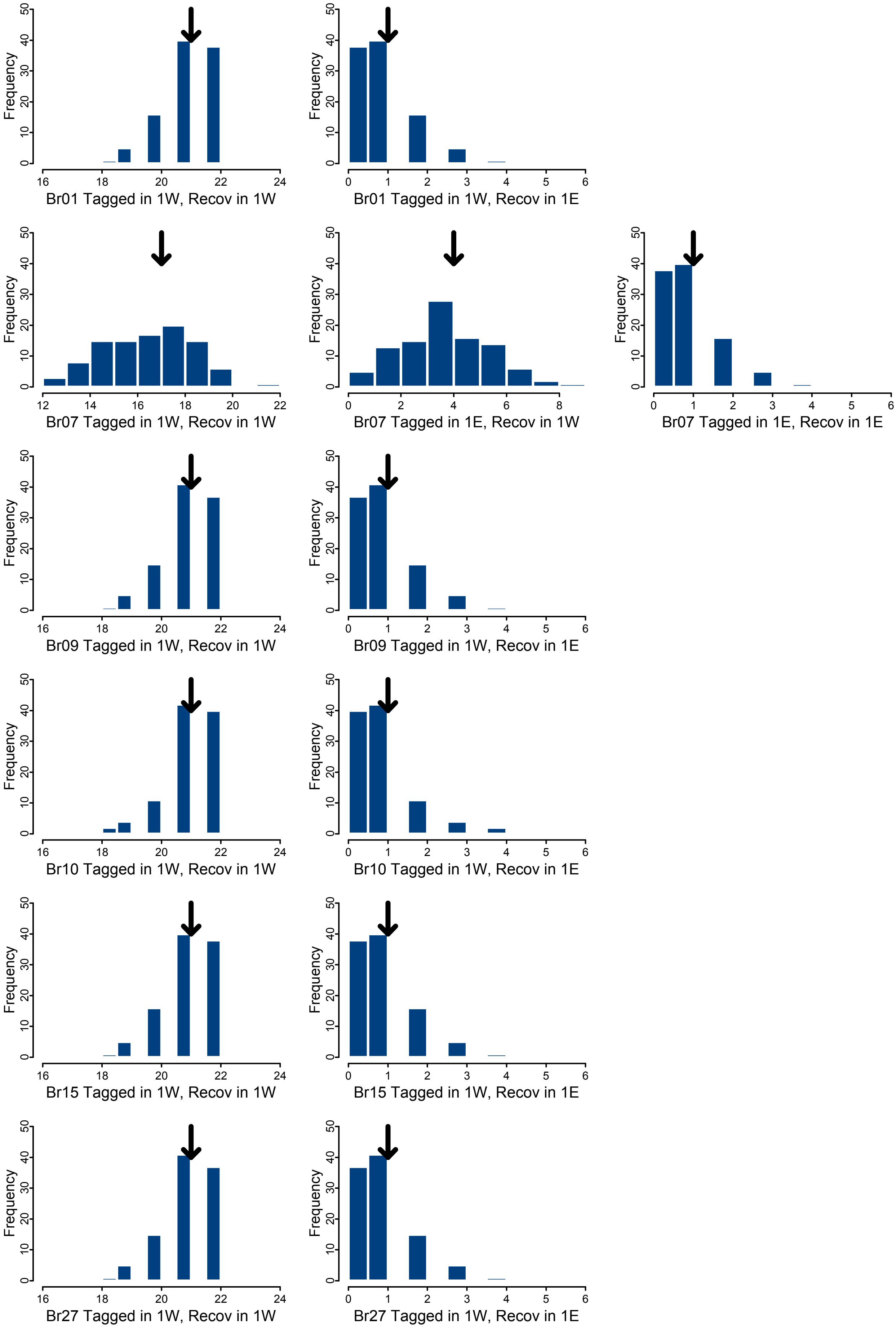


Fig 3a Tag recovery targets (arrow shows point estimate). Zero targets are not shown

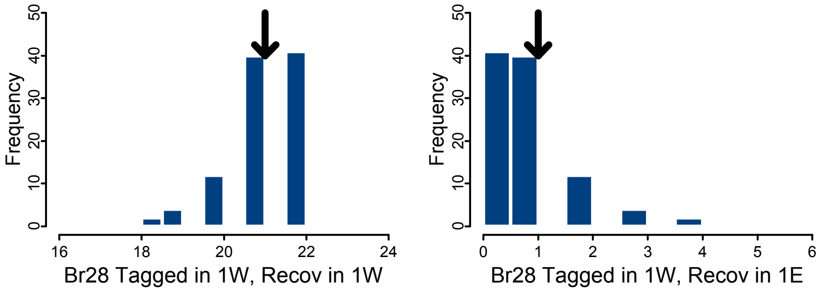


Fig 3b Absolute errors for tag recoveries

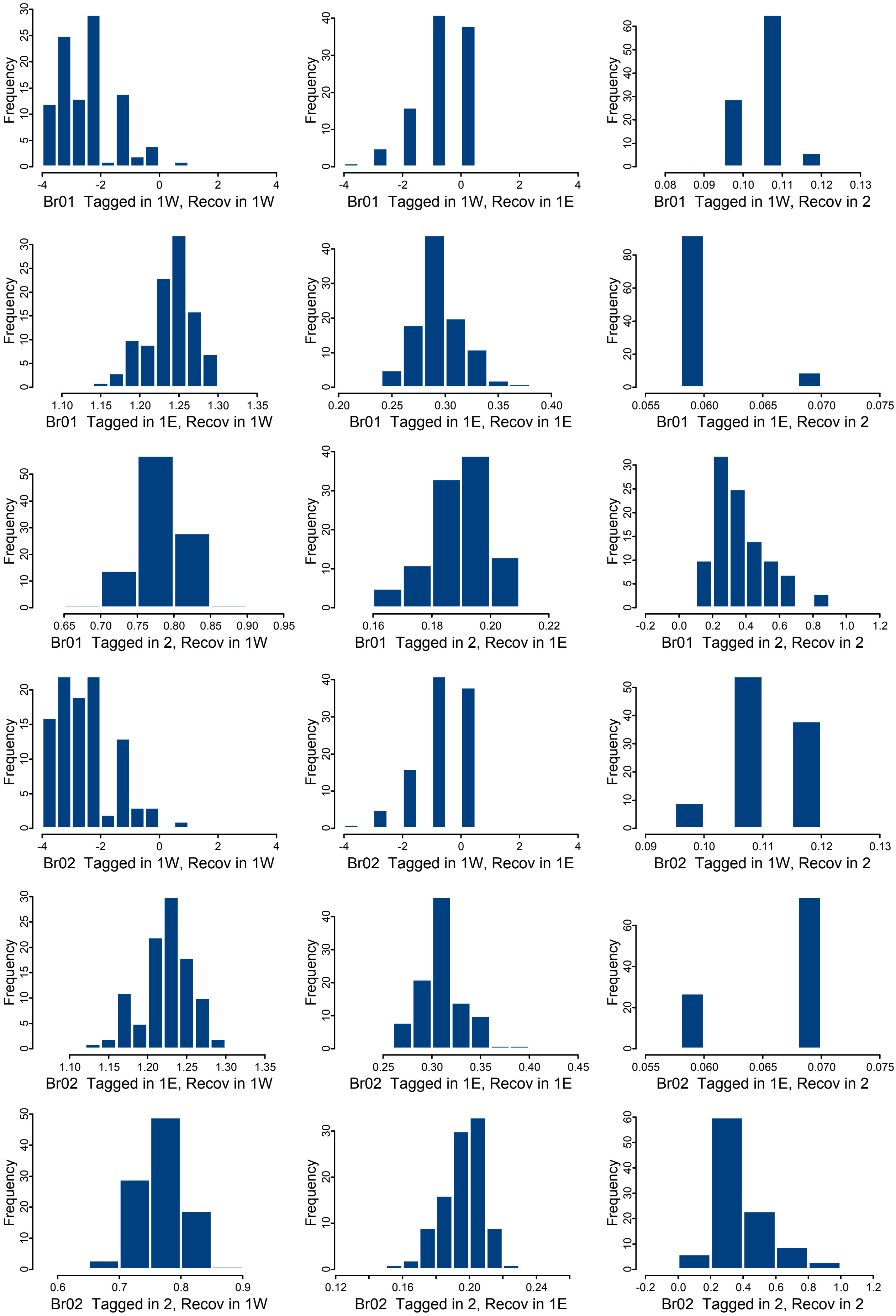


Fig 3b Absolute errors for tag recoveries

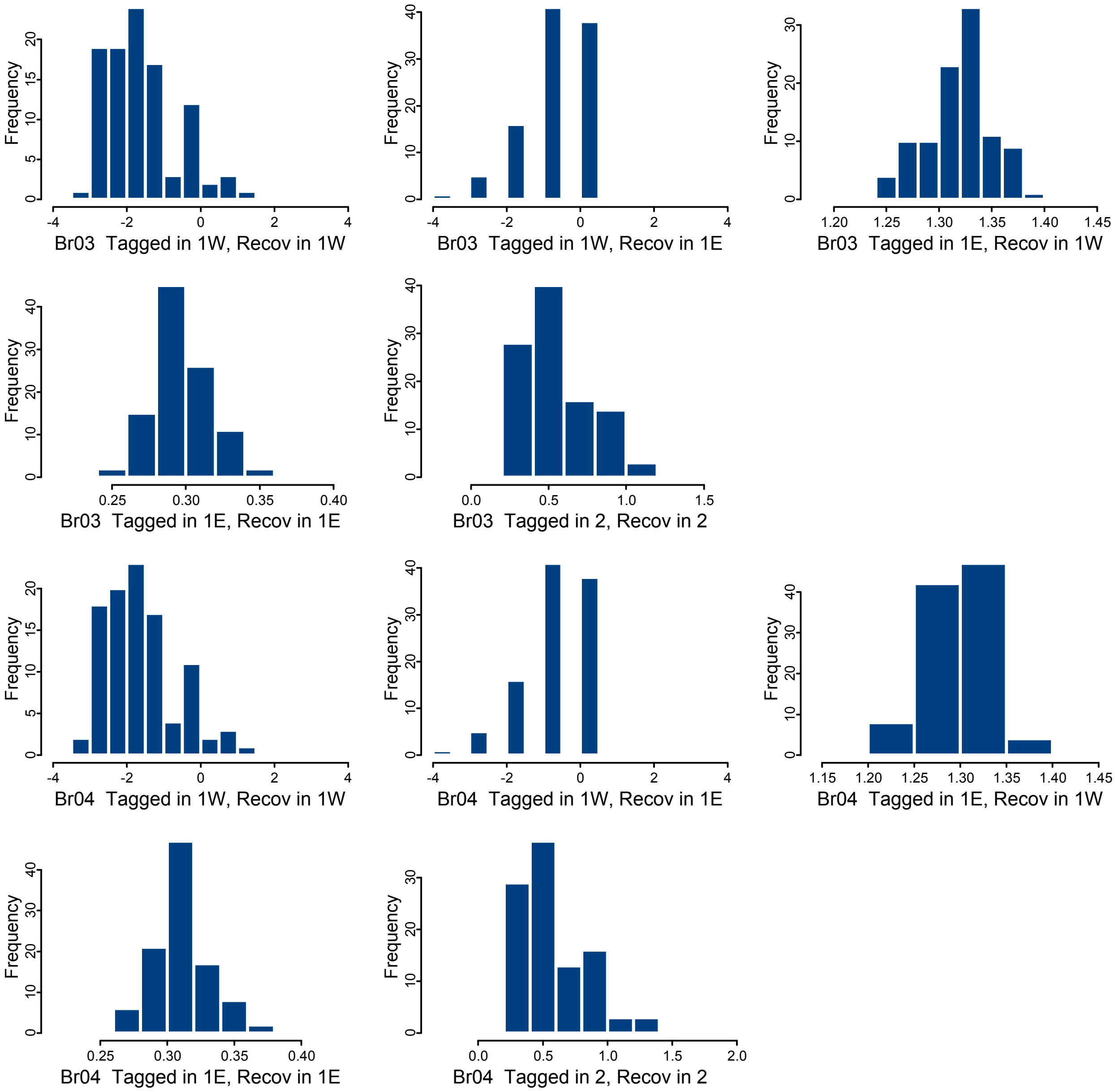


Fig 3b Absolute errors for tag recoveries

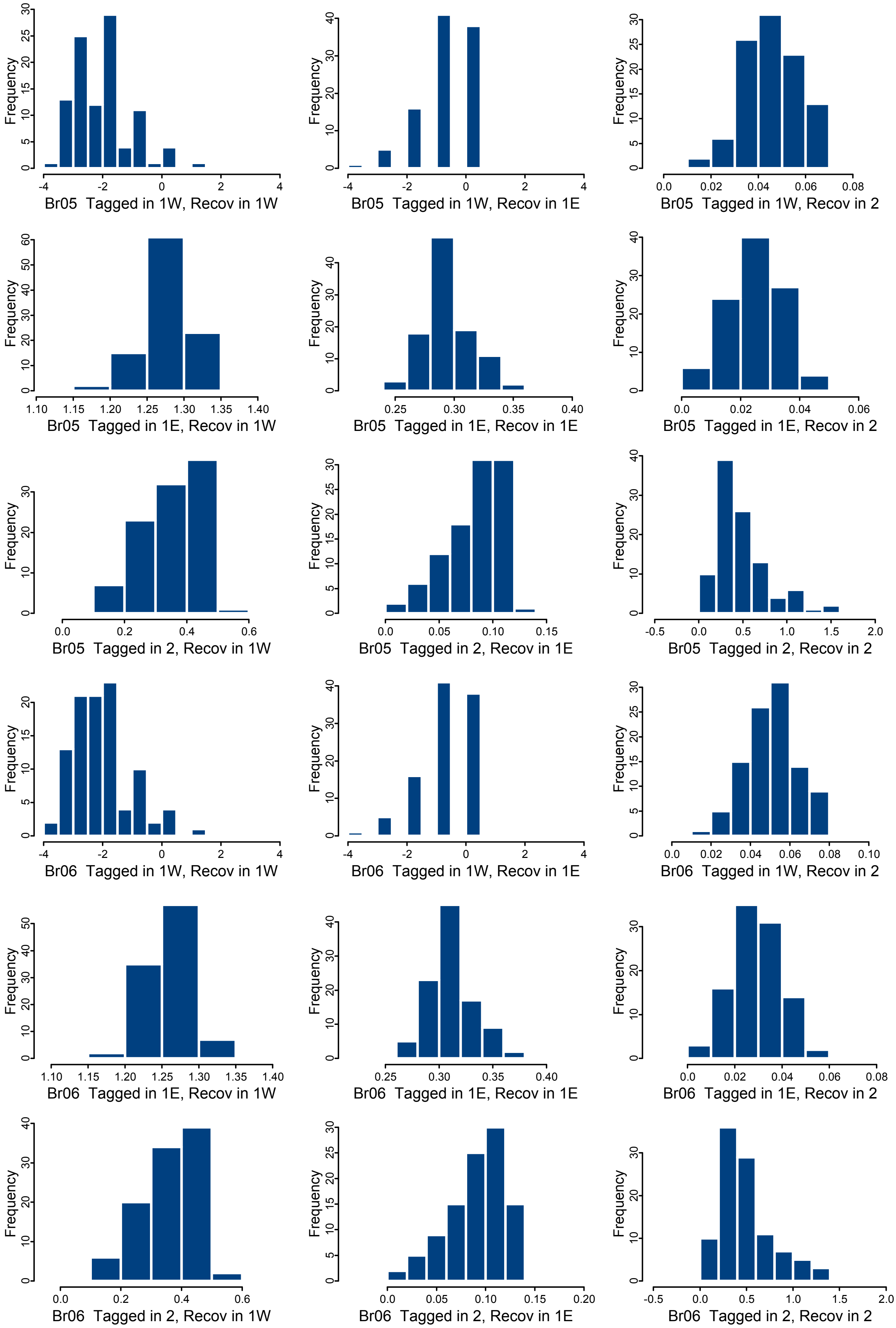


Fig 3b Absolute errors for tag recoveries

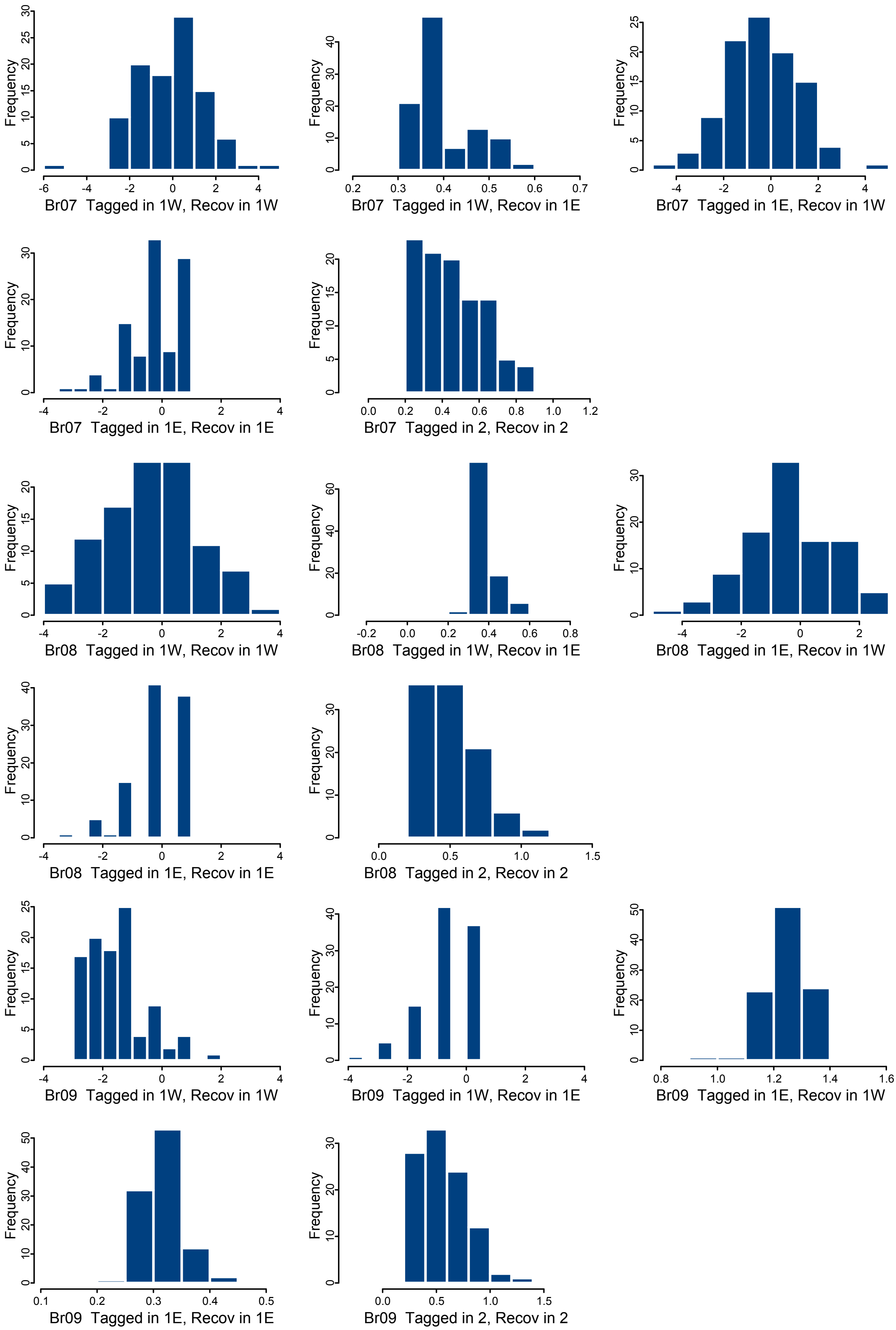


Fig 3b Absolute errors for tag recoveries

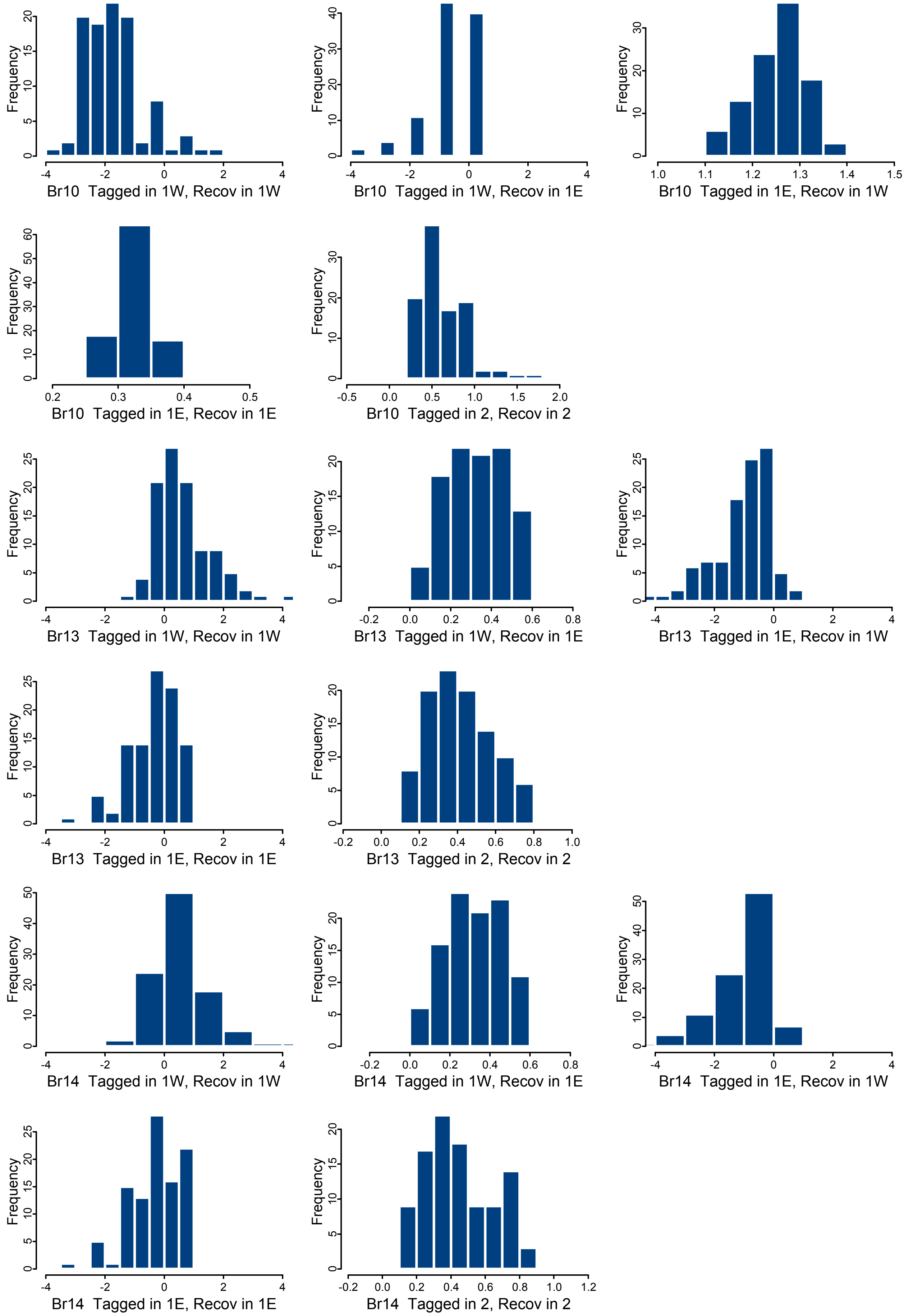


Fig 3b Absolute errors for tag recoveries

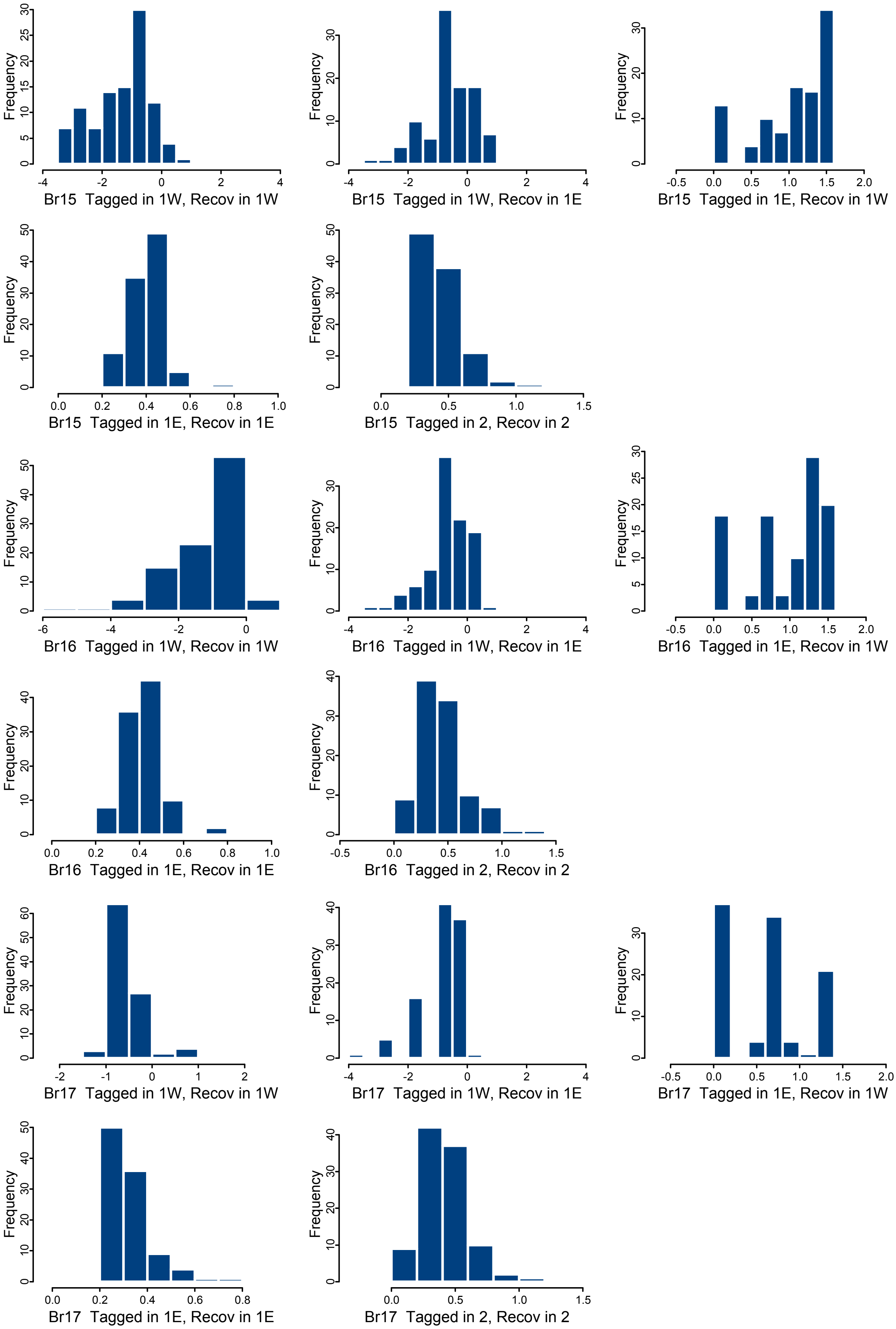


Fig 3b Absolute errors for tag recoveries

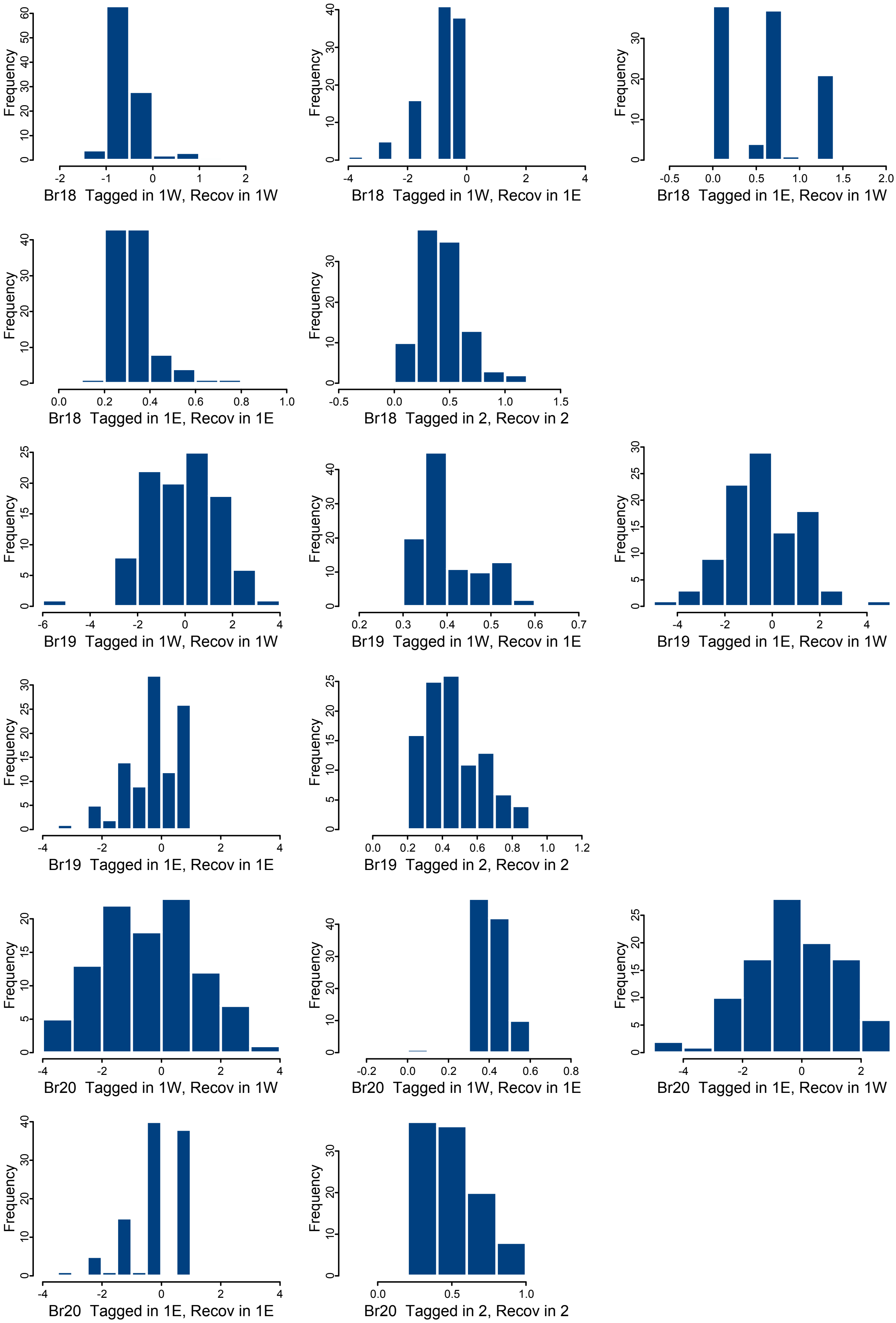


Fig 3b Absolute errors for tag recoveries

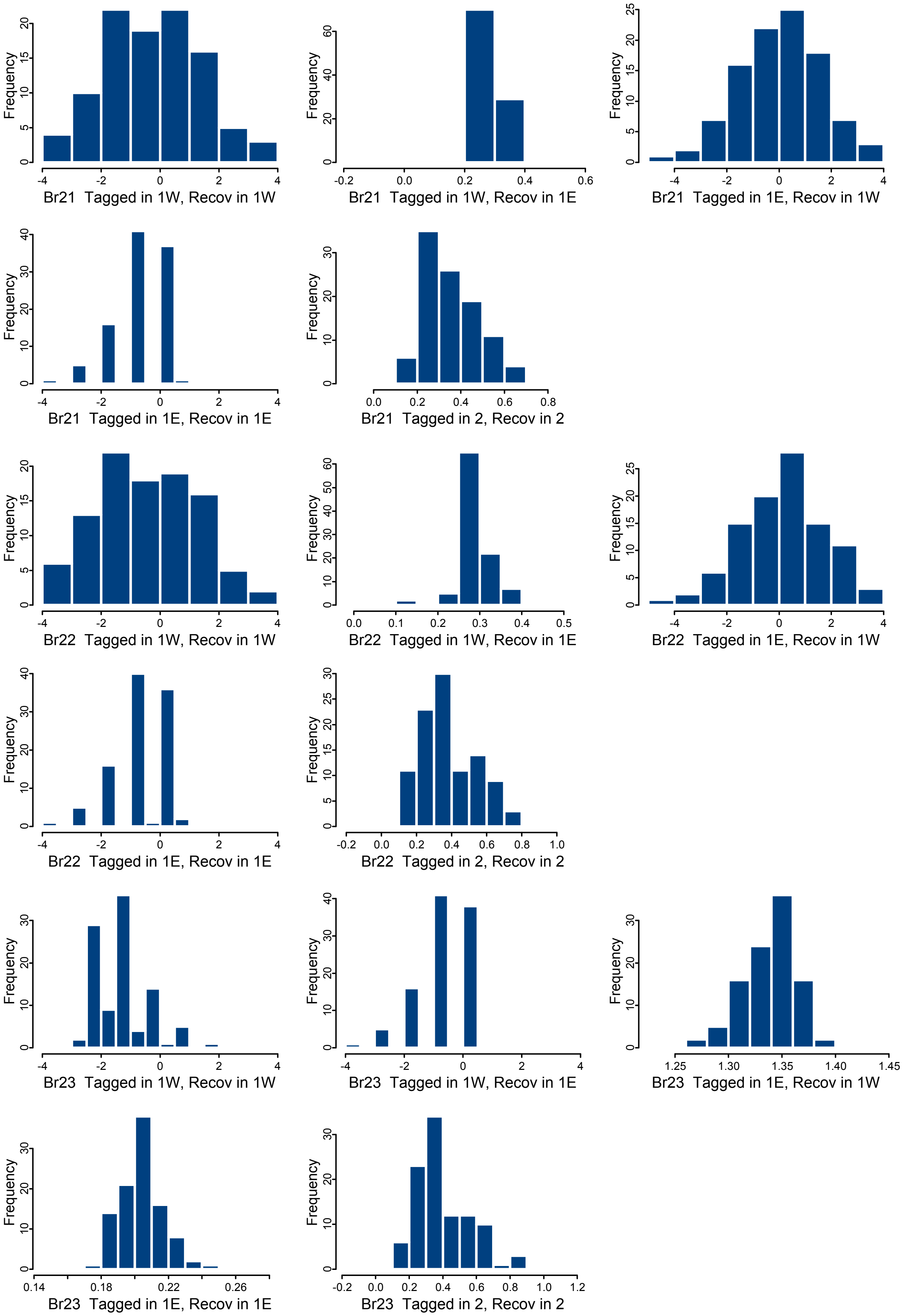


Fig 3b Absolute errors for tag recoveries

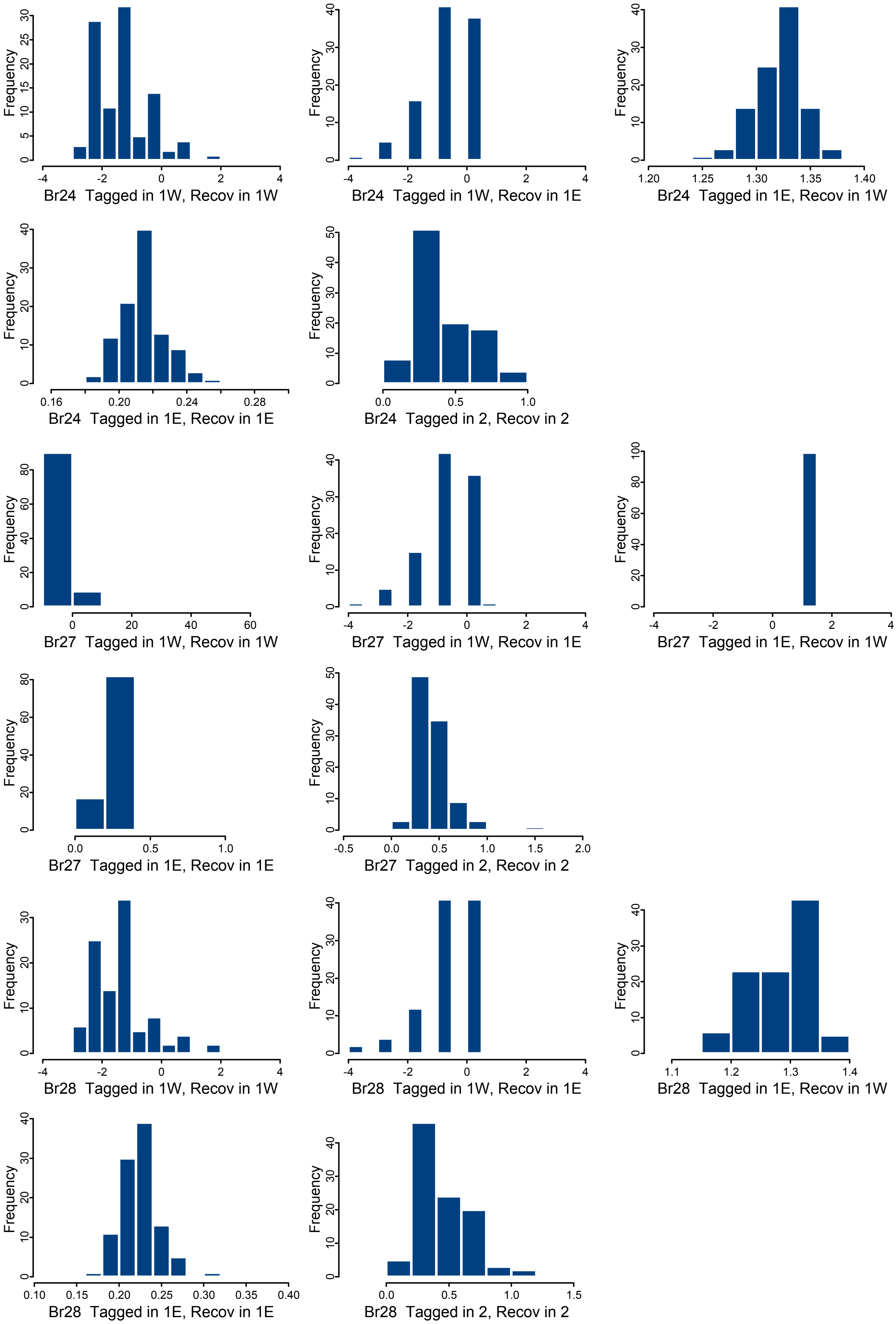


Fig 4. Age data residuals

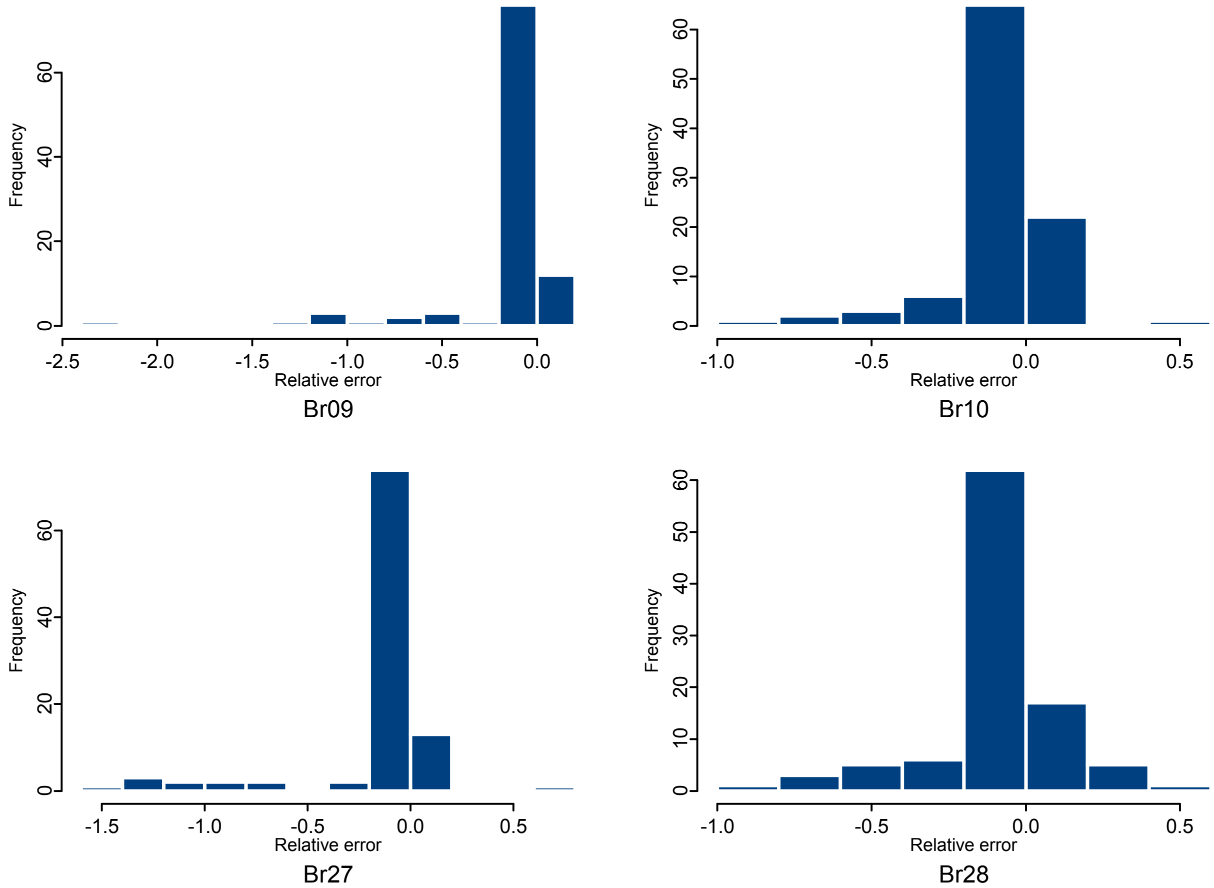
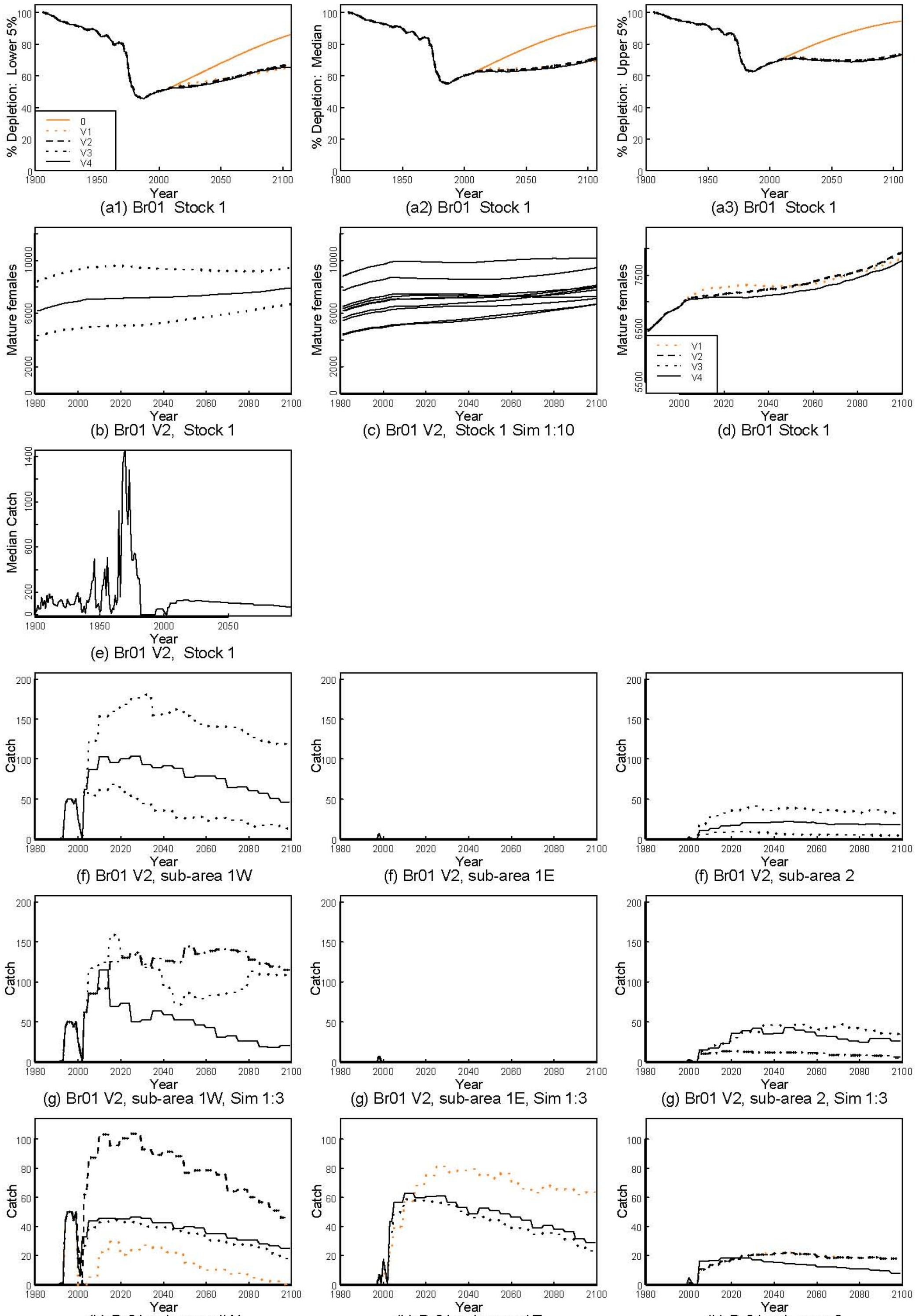


Fig 2. Br01 Mature female and catch trajectories



(a1) Br01 Stock 1 (a2) Br01 Stock 1 (a3) Br01 Stock 1

(b) Br01 V2, Stock 1 (c) Br01 V2, Stock 1 Sim 1:10 (d) Br01 Stock 1

(e) Br01 V2, Stock 1

(f) Br01 V2, sub-area 1W (f) Br01 V2, sub-area 1E (f) Br01 V2, sub-area 2

(g) Br01 V2, sub-area 1W, Sim 1:3 (g) Br01 V2, sub-area 1E, Sim 1:3 (g) Br01 V2, sub-area 2, Sim 1:3

(h) Br01 sub-area 1W (h) Br01 sub-area 1E (h) Br01 sub-area 2

Fig 2. Br02 Mature female and catch trajectories

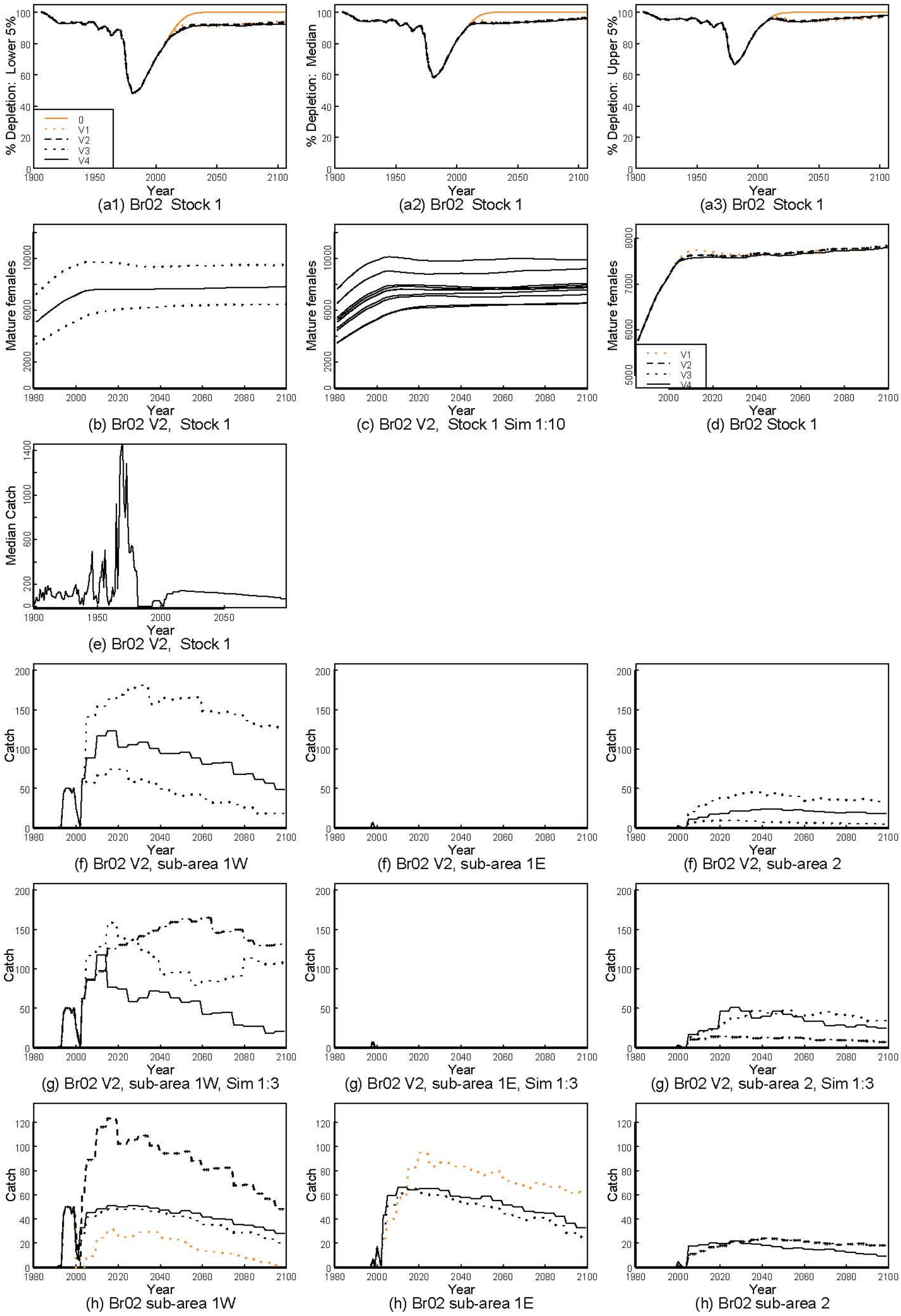
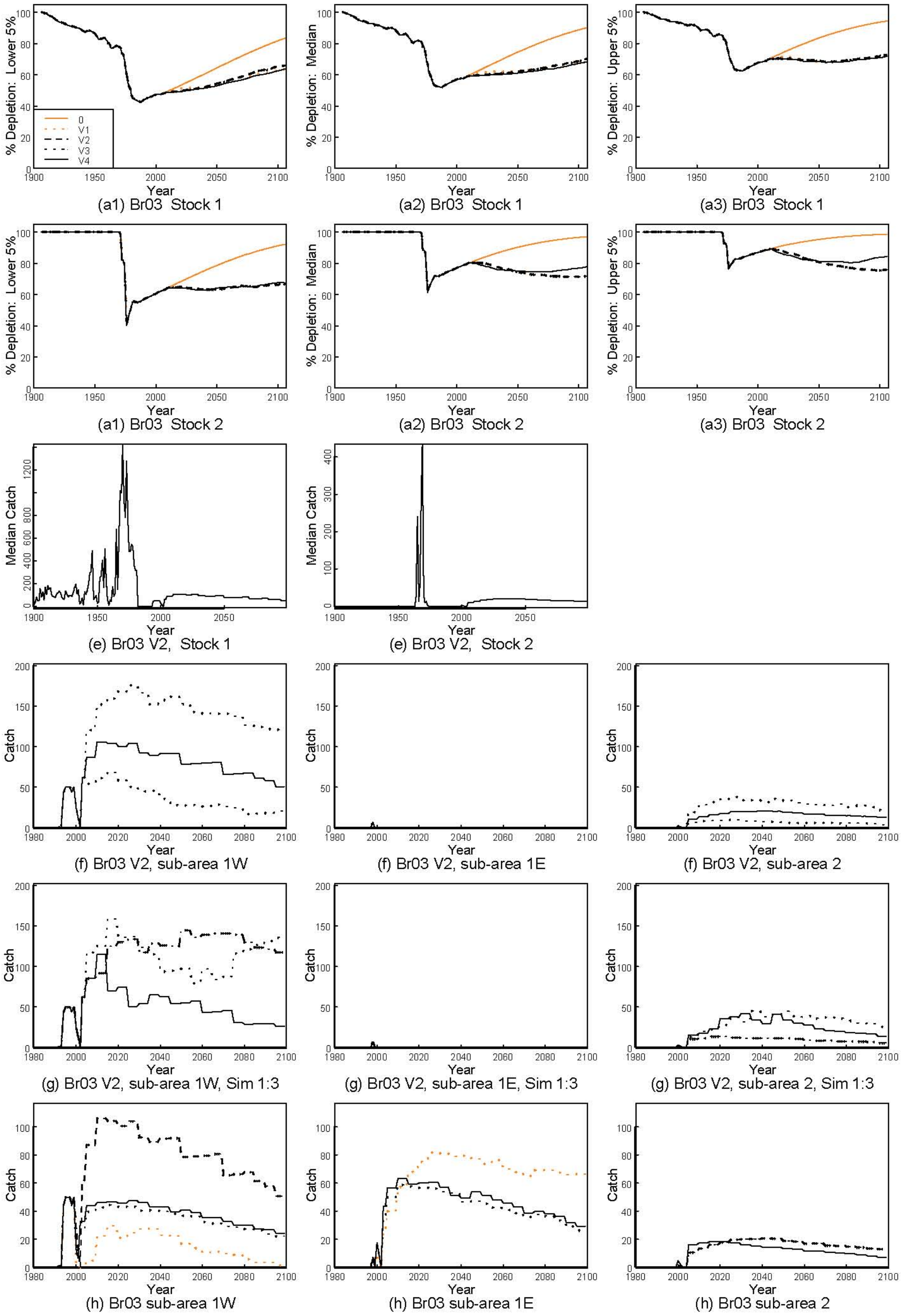


Fig 2. Br03 Mature female and catch trajectories



(a1) Br03 Stock 1
(a2) Br03 Stock 1
(a3) Br03 Stock 1
(a1) Br03 Stock 2
(a2) Br03 Stock 2
(a3) Br03 Stock 2
(e) Br03 V2, Stock 1
(e) Br03 V2, Stock 2
(f) Br03 V2, sub-area 1W
(f) Br03 V2, sub-area 1E
(f) Br03 V2, sub-area 2
(g) Br03 V2, sub-area 1W, Sim 1:3
(g) Br03 V2, sub-area 1E, Sim 1:3
(g) Br03 V2, sub-area 2, Sim 1:3
(h) Br03 sub-area 1W
(h) Br03 sub-area 1E
(h) Br03 sub-area 2

Fig 2. Br04 Mature female and catch trajectories

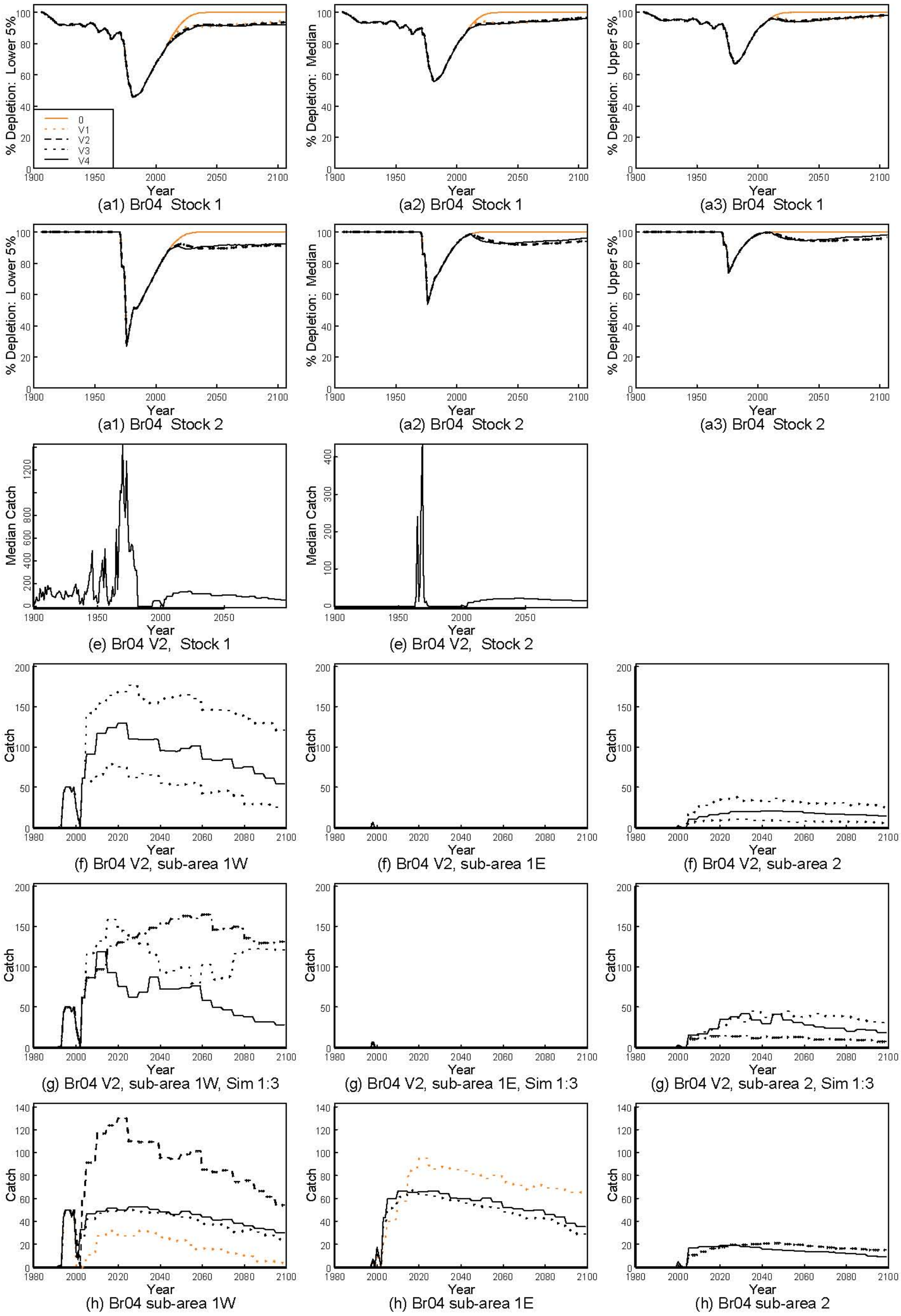
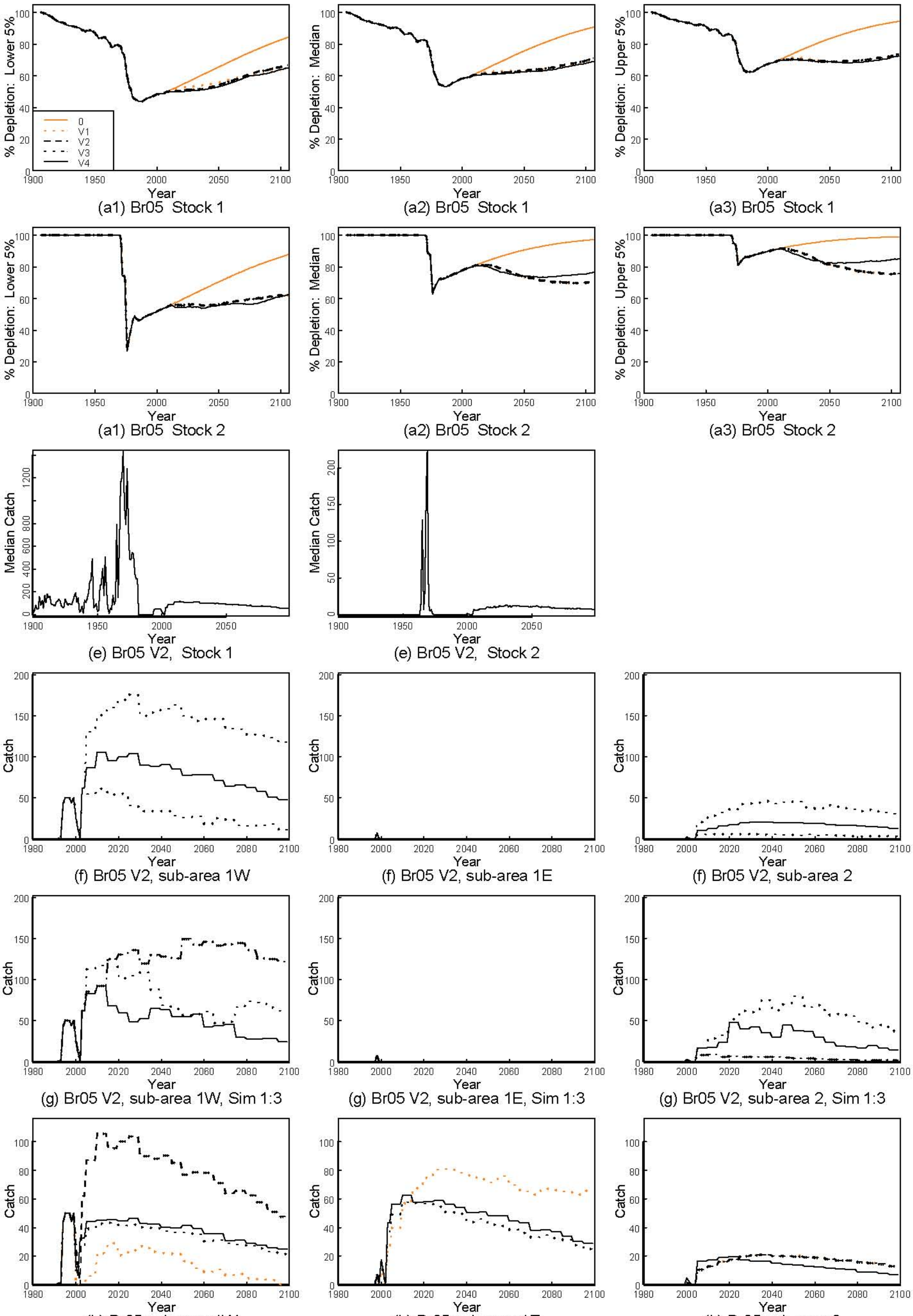


Fig 2. Br05 Mature female and catch trajectories



(a1) Br05 Stock 1 (a2) Br05 Stock 1 (a3) Br05 Stock 1

(a1) Br05 Stock 2 (a2) Br05 Stock 2 (a3) Br05 Stock 2

(e) Br05 V2, Stock 1 (e) Br05 V2, Stock 2

(f) Br05 V2, sub-area 1W (f) Br05 V2, sub-area 1E (f) Br05 V2, sub-area 2

(g) Br05 V2, sub-area 1W, Sim 1:3 (g) Br05 V2, sub-area 1E, Sim 1:3 (g) Br05 V2, sub-area 2, Sim 1:3

(h) Br05 sub-area 1W (h) Br05 sub-area 1E (h) Br05 sub-area 2

Fig 2. Br06 Mature female and catch trajectories

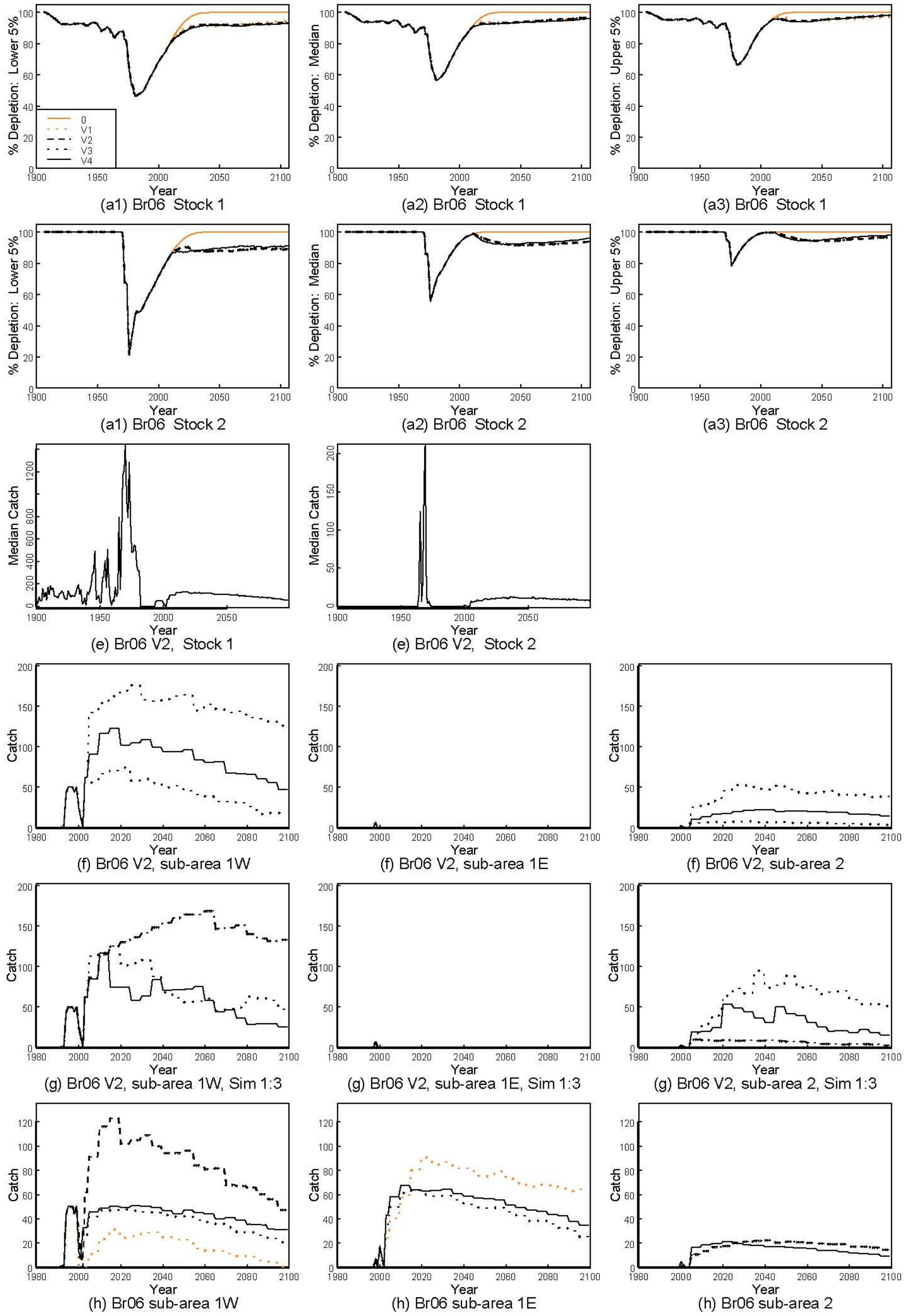


Fig 2. Br07 Mature female and catch trajectories

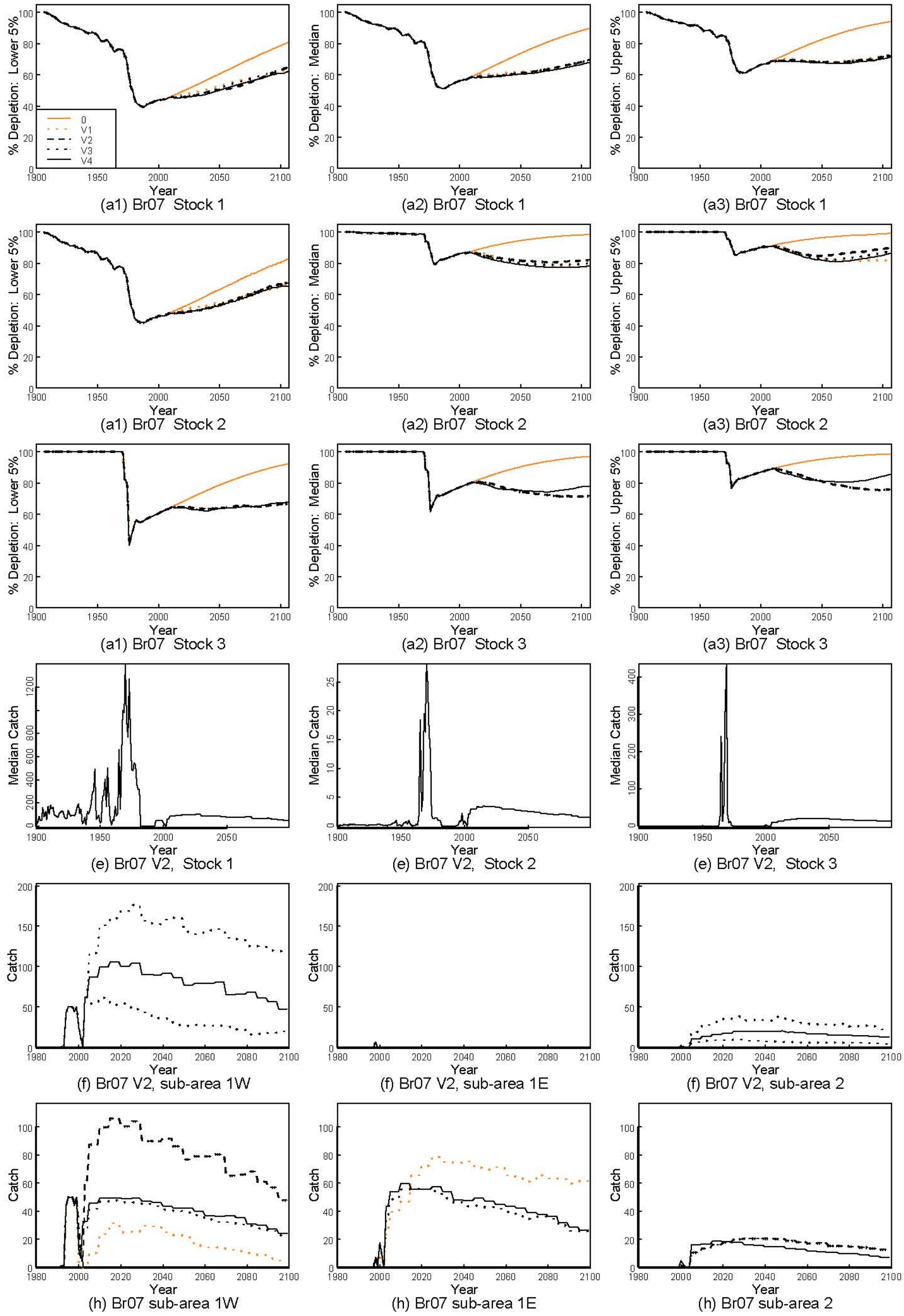


Fig 2. Br08 Mature female and catch trajectories

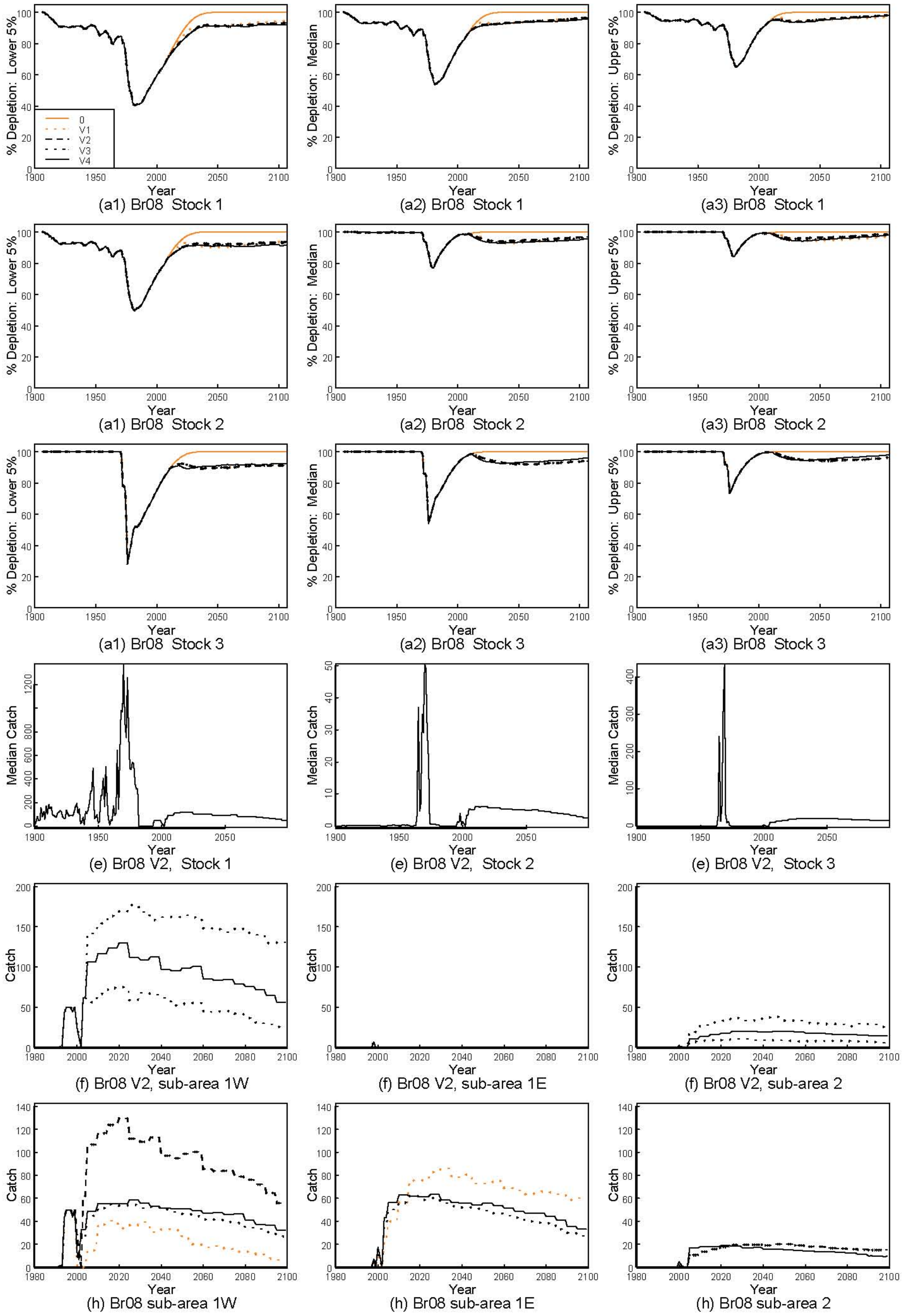


Fig 2. Br09 Mature female and catch trajectories

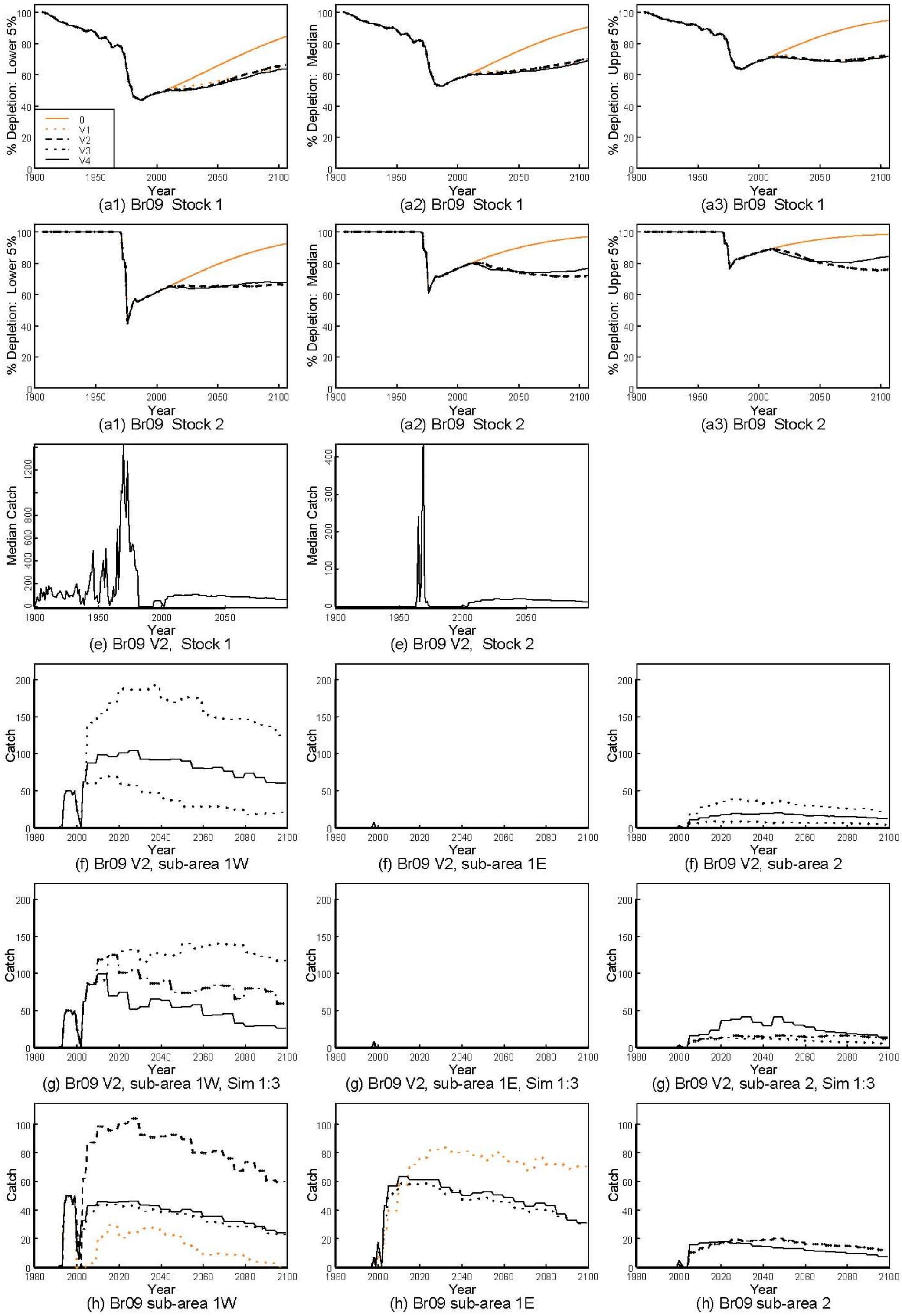


Fig 2. Br10 Mature female and catch trajectories

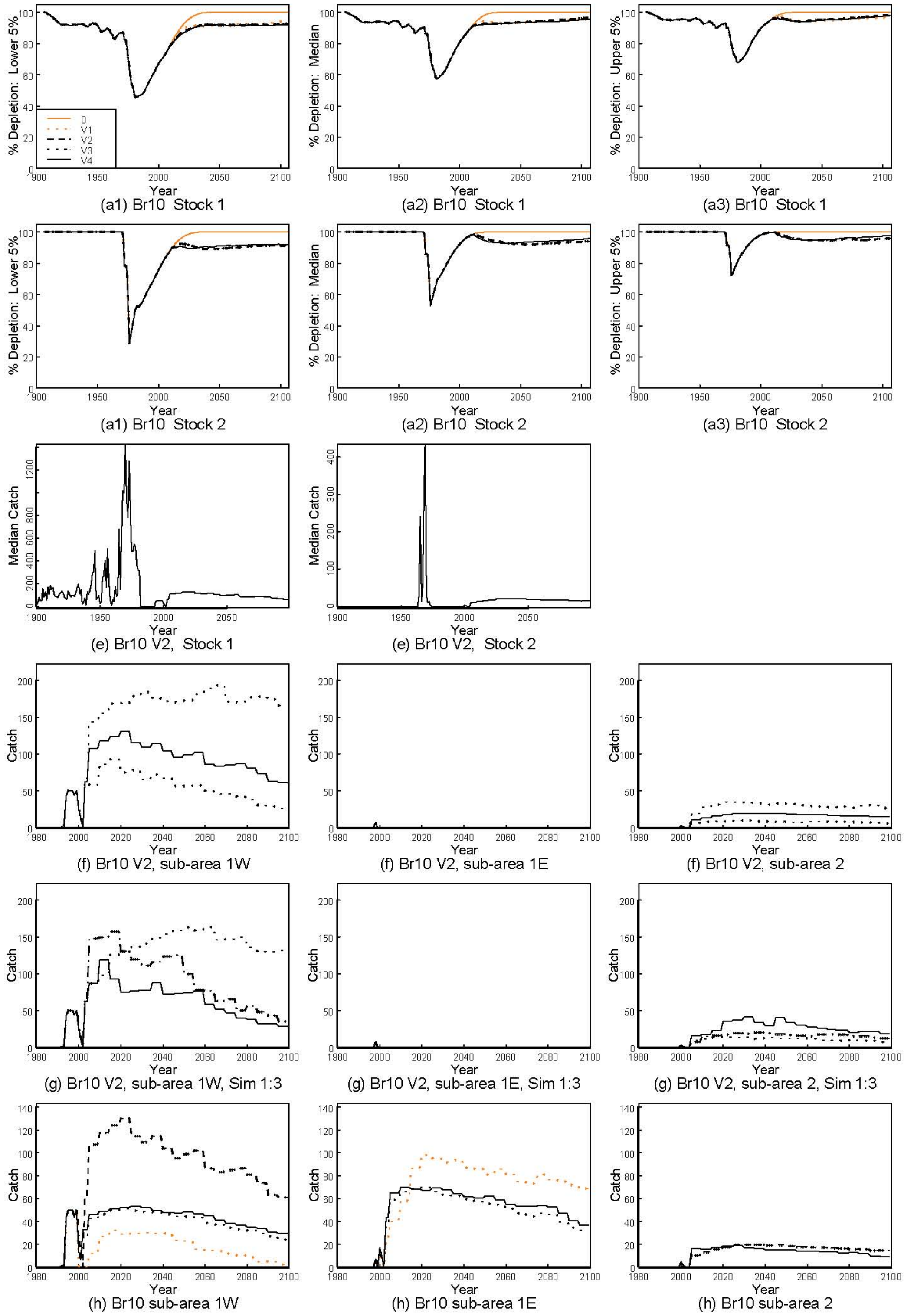


Fig 2. Br11 Mature female and catch trajectories

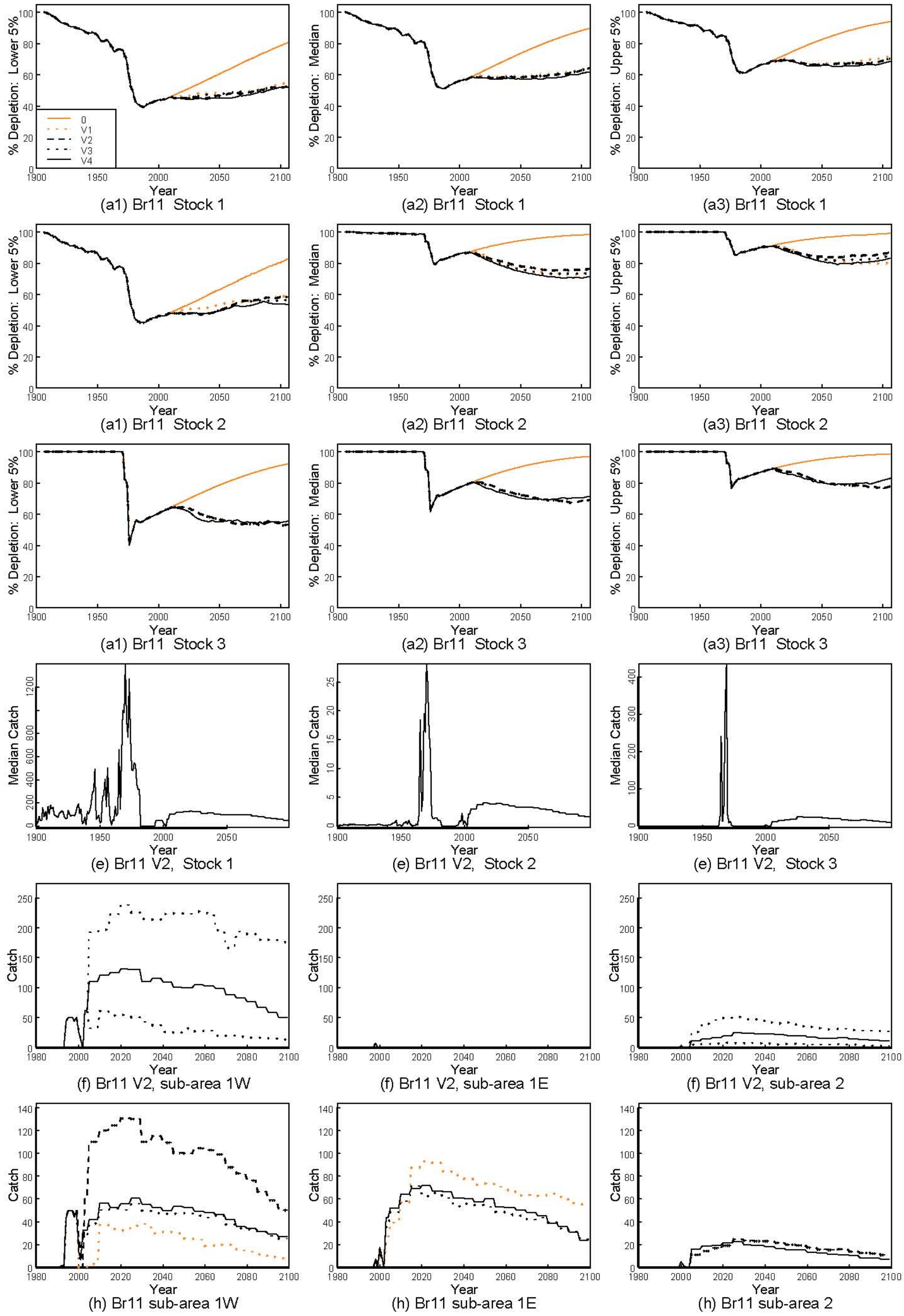


Fig 2. Br12 Mature female and catch trajectories

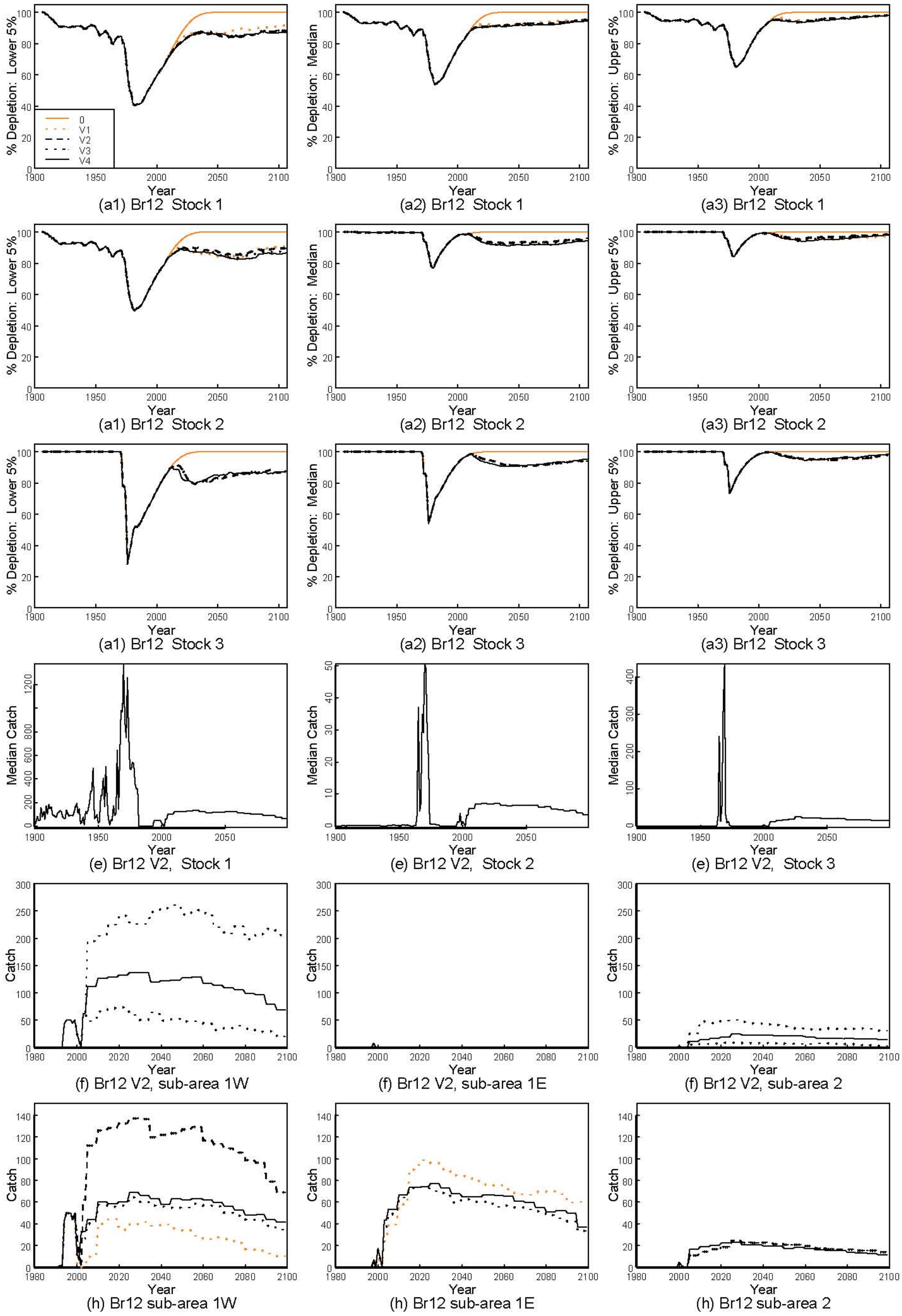


Fig 2. Br13 Mature female and catch trajectories

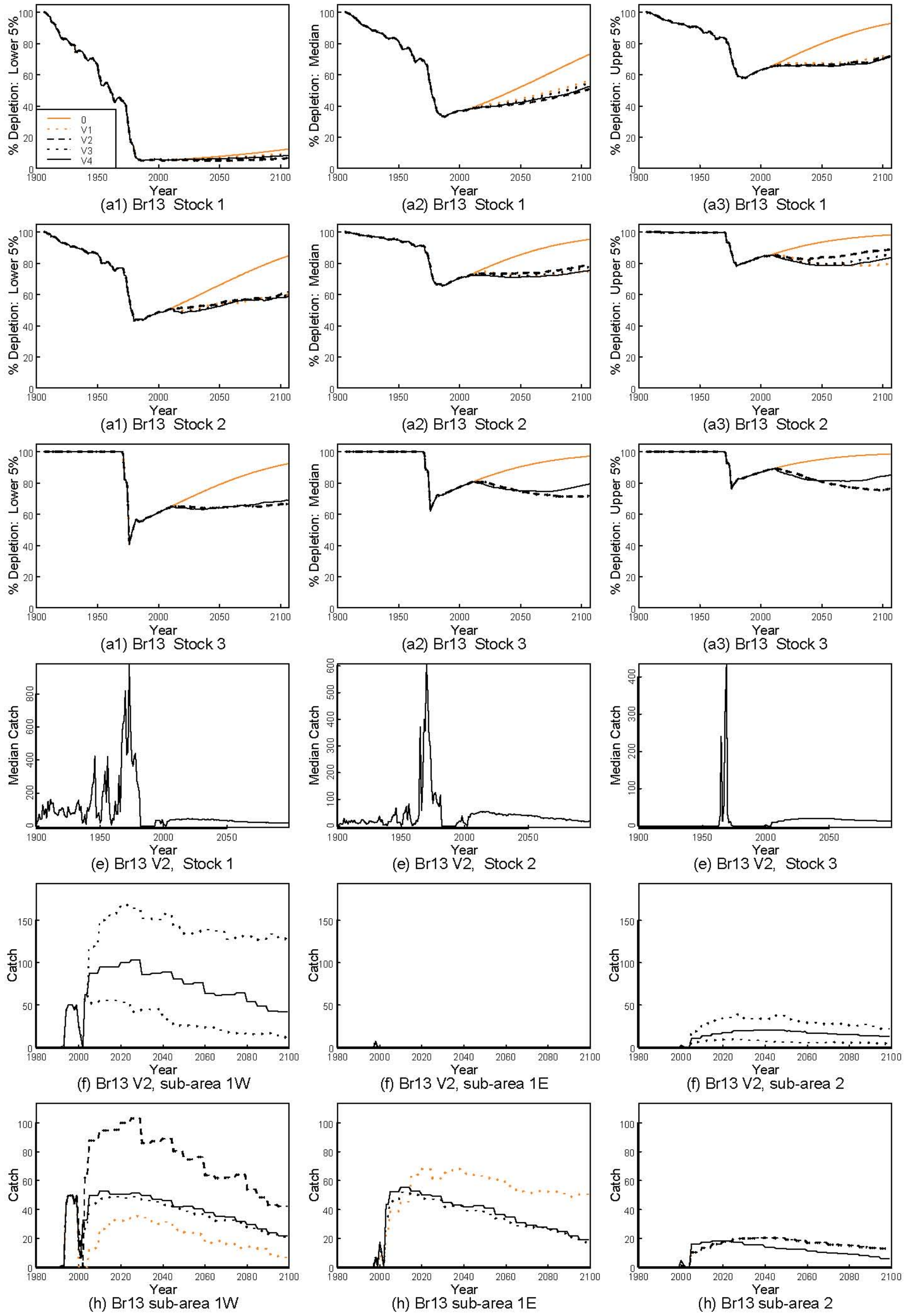


Fig 2. Br14 Mature female and catch trajectories

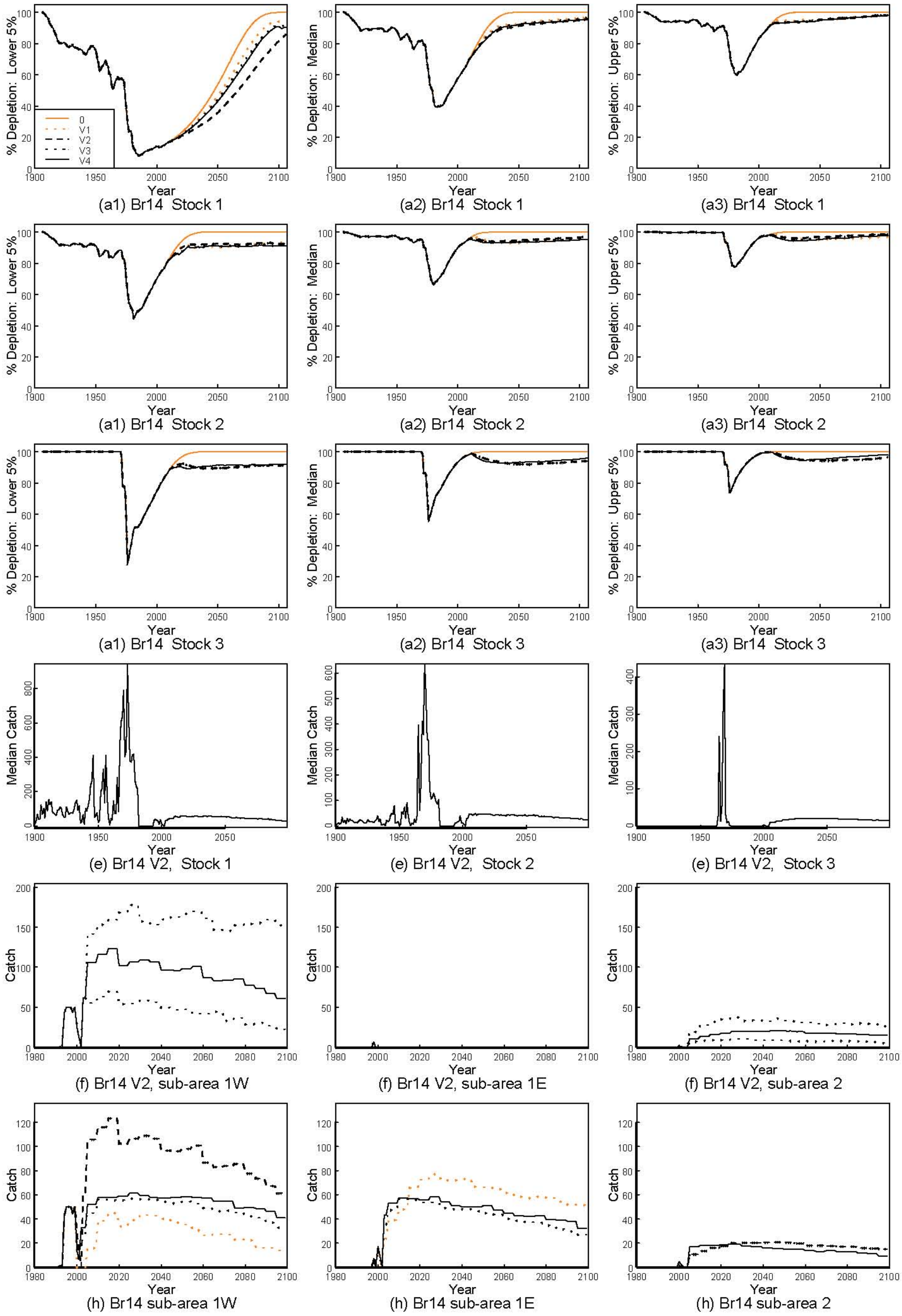


Fig 2. Br15 Mature female and catch trajectories

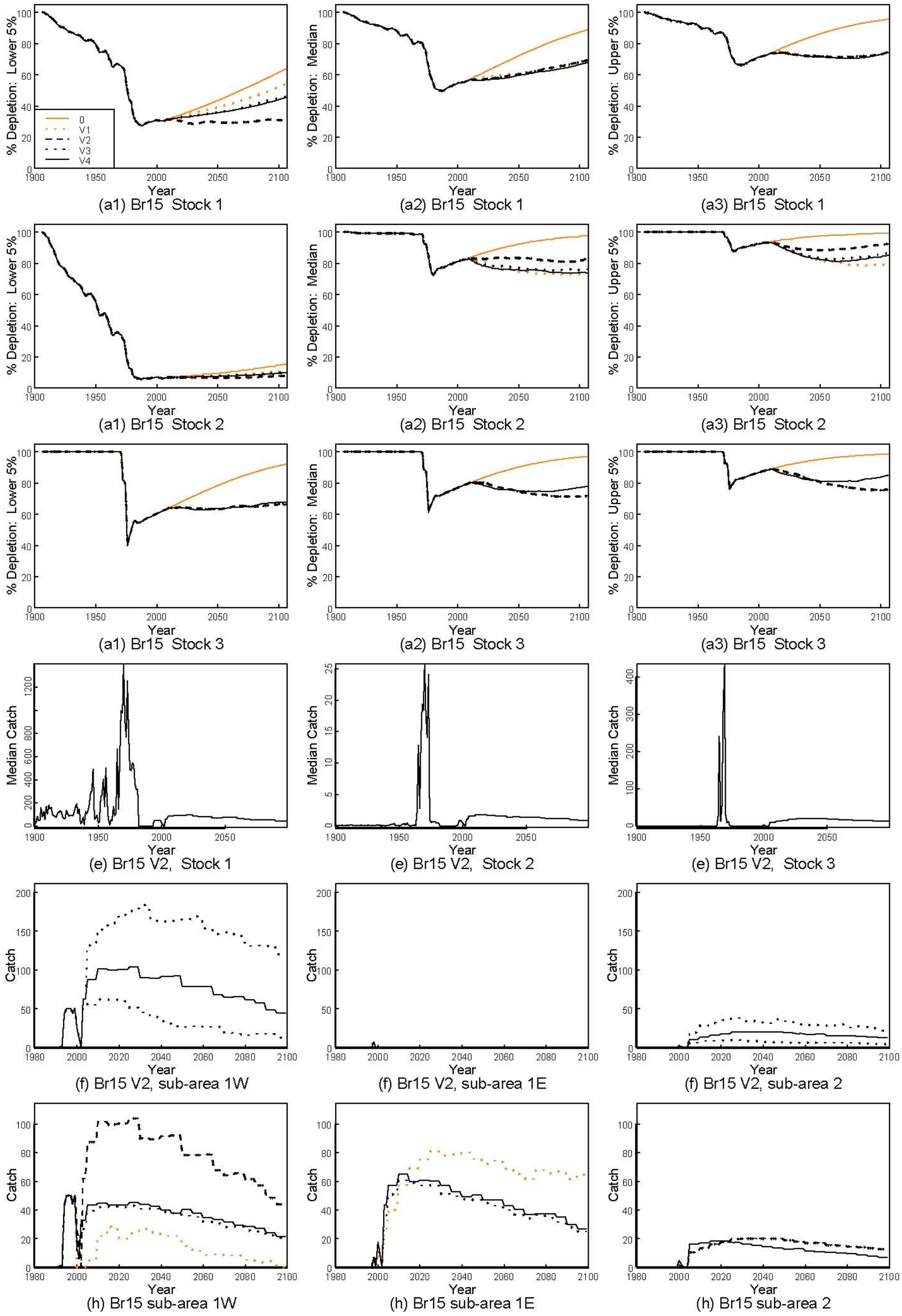


Fig 2. Br16 Mature female and catch trajectories

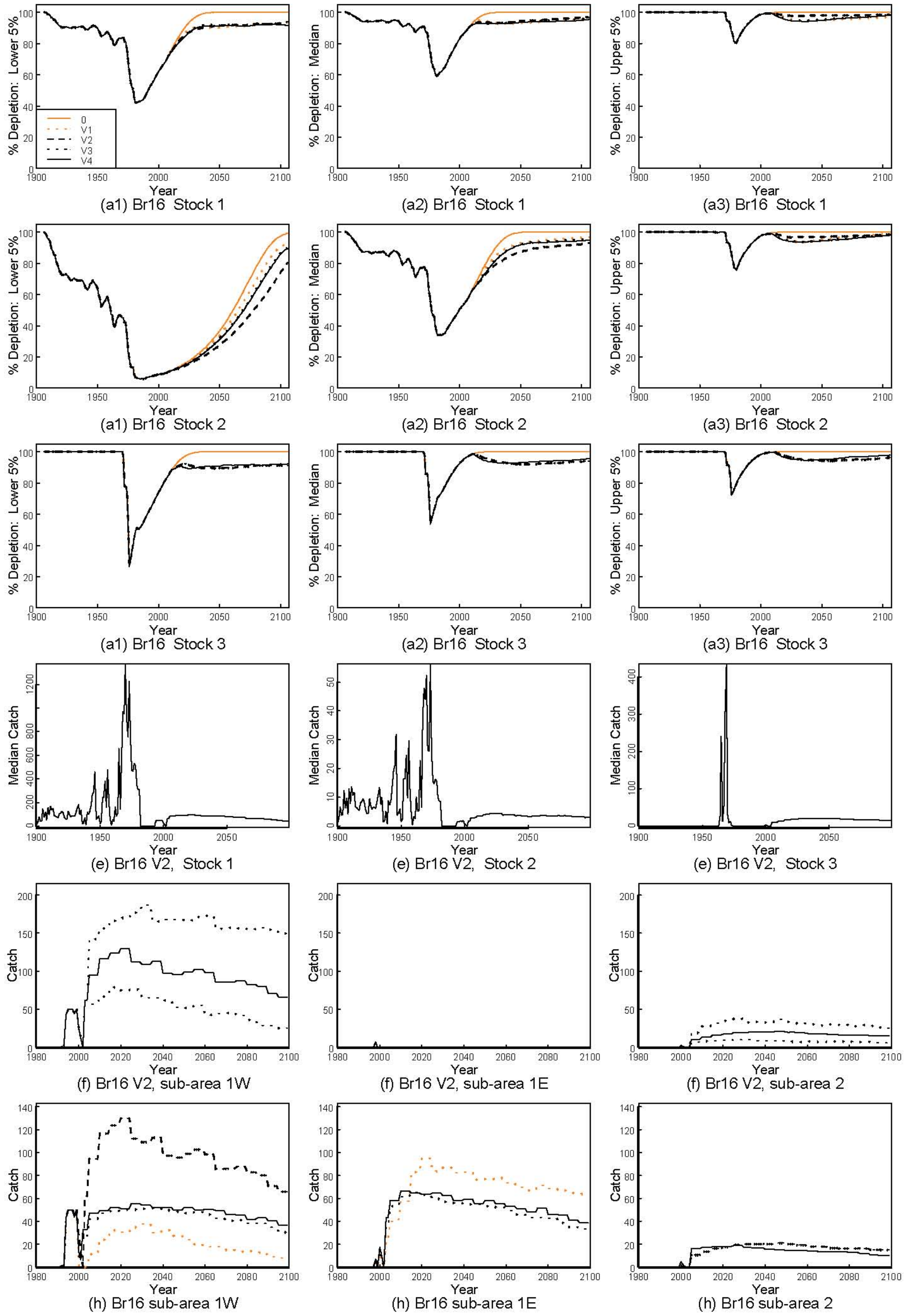


Fig 2. Br17 Mature female and catch trajectories

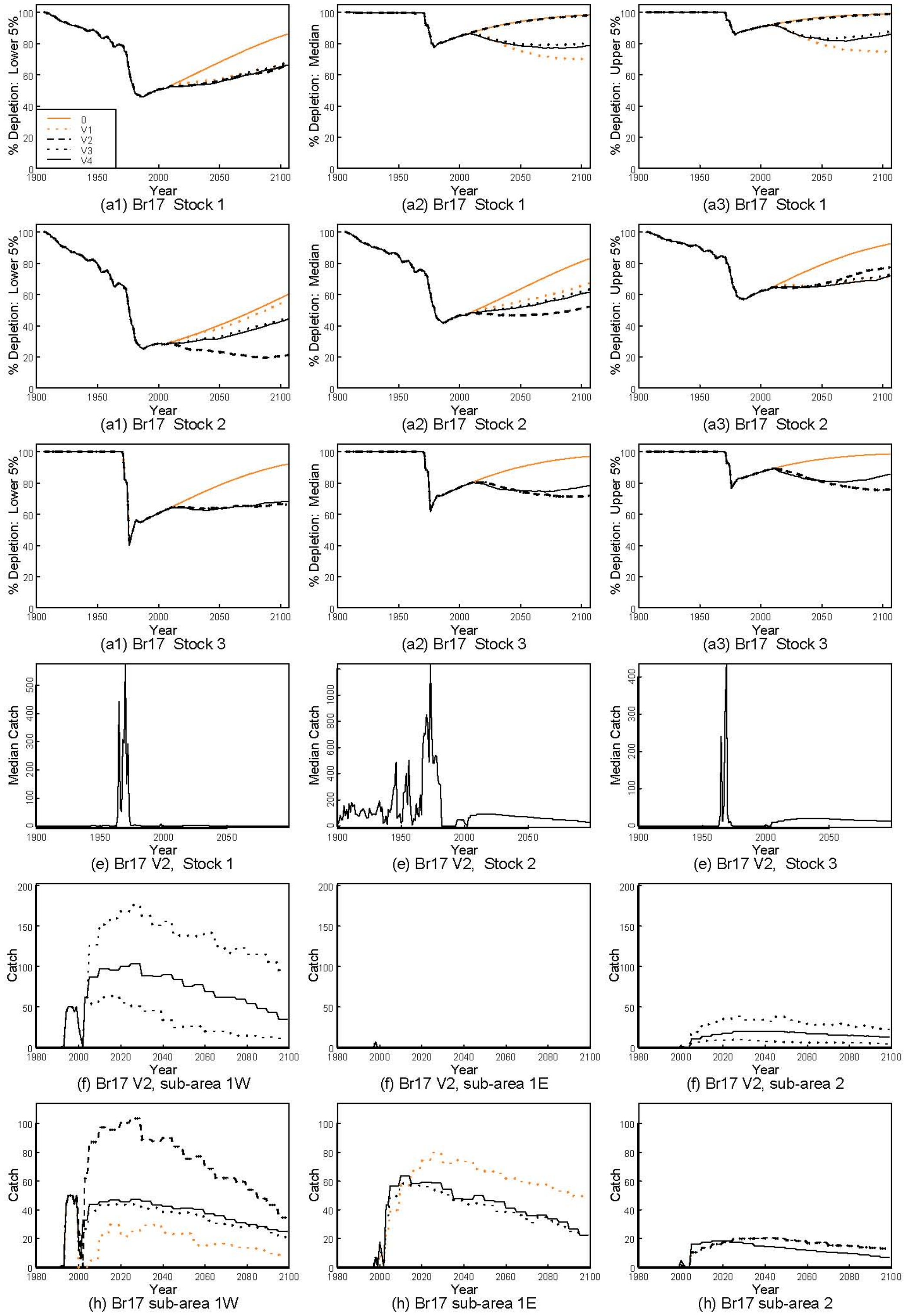


Fig 2. Br18 Mature female and catch trajectories

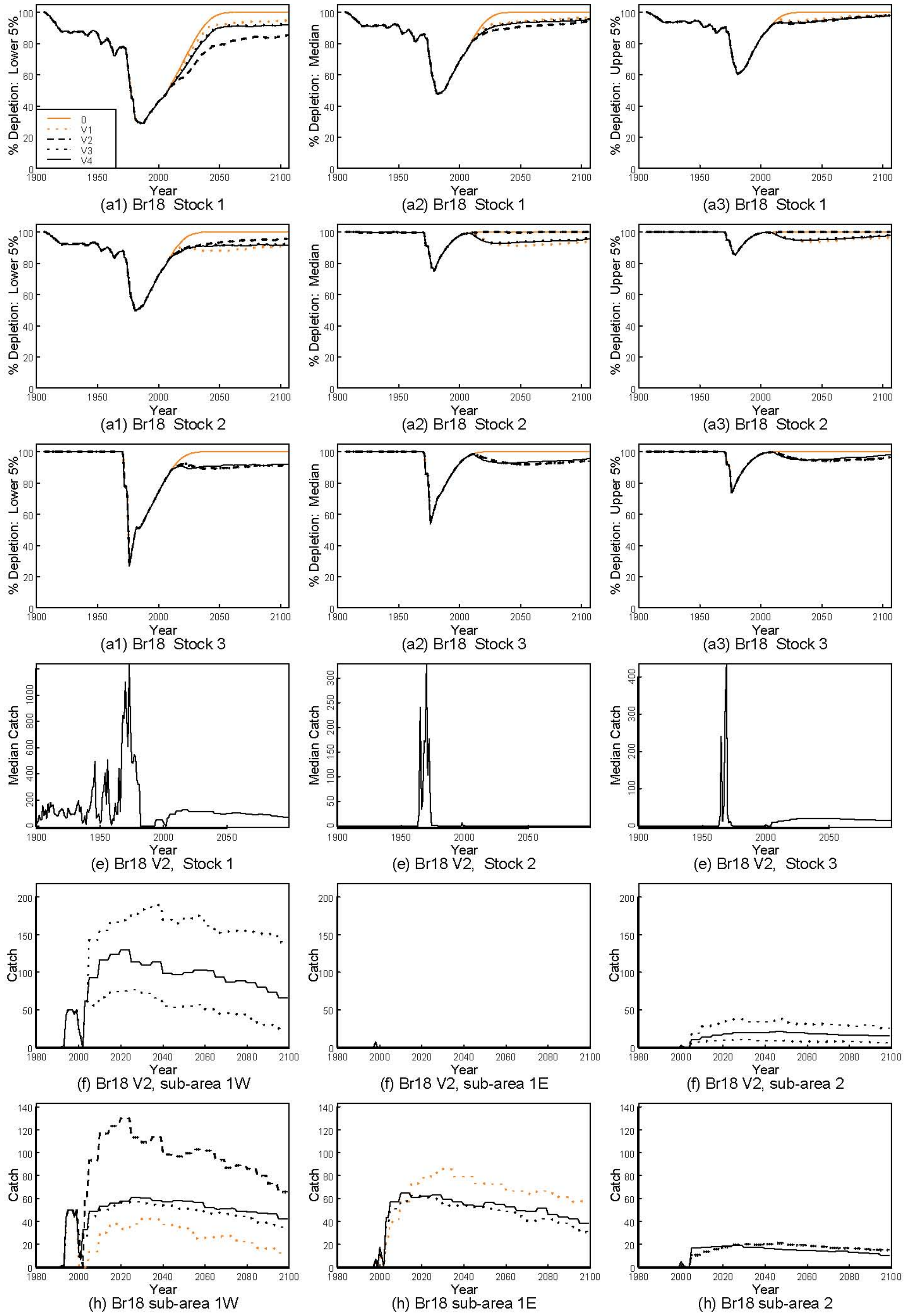


Fig 2. Br19 Mature female and catch trajectories

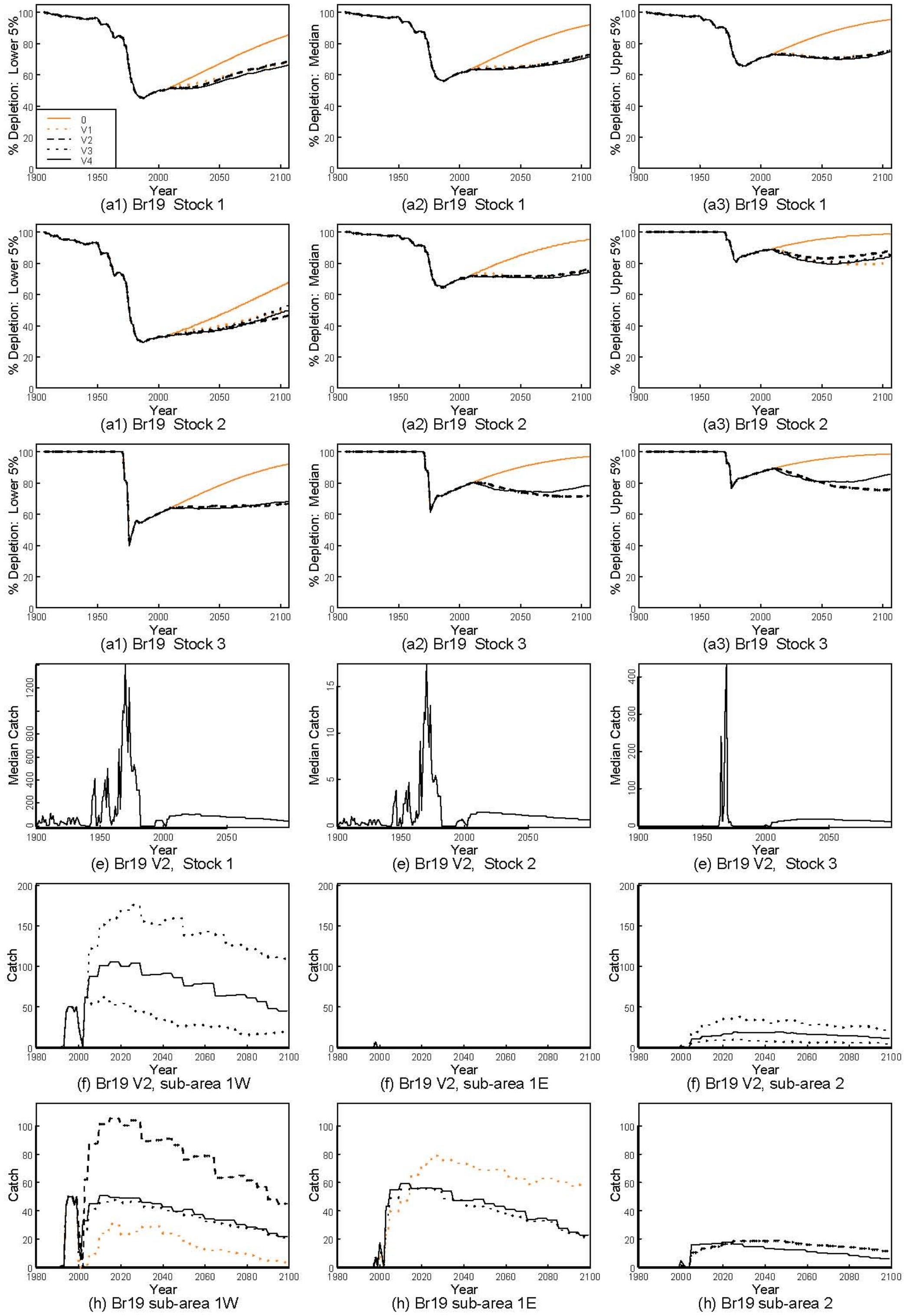


Fig 2. Br20 Mature female and catch trajectories

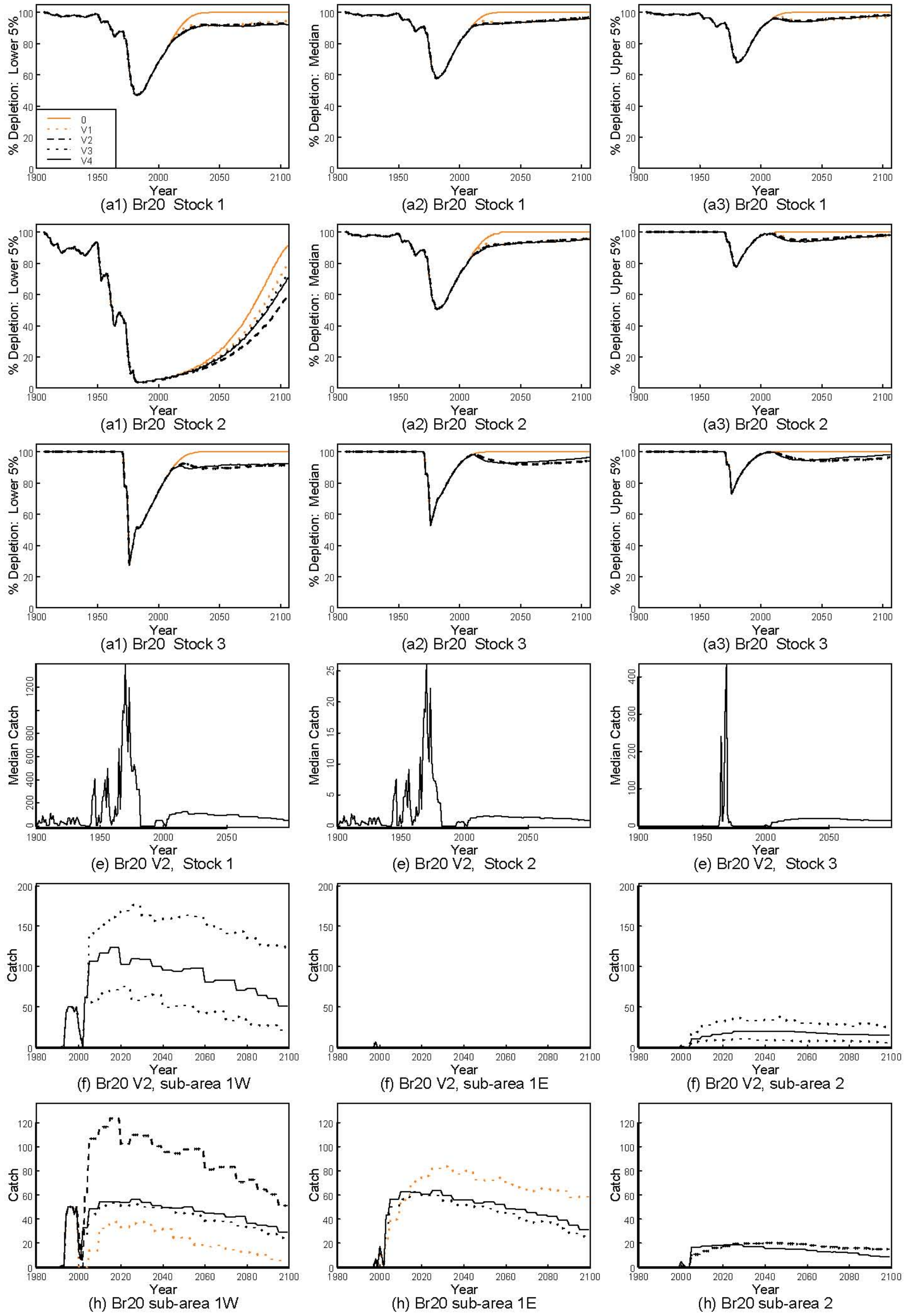


Fig 2. Br21 Mature female and catch trajectories

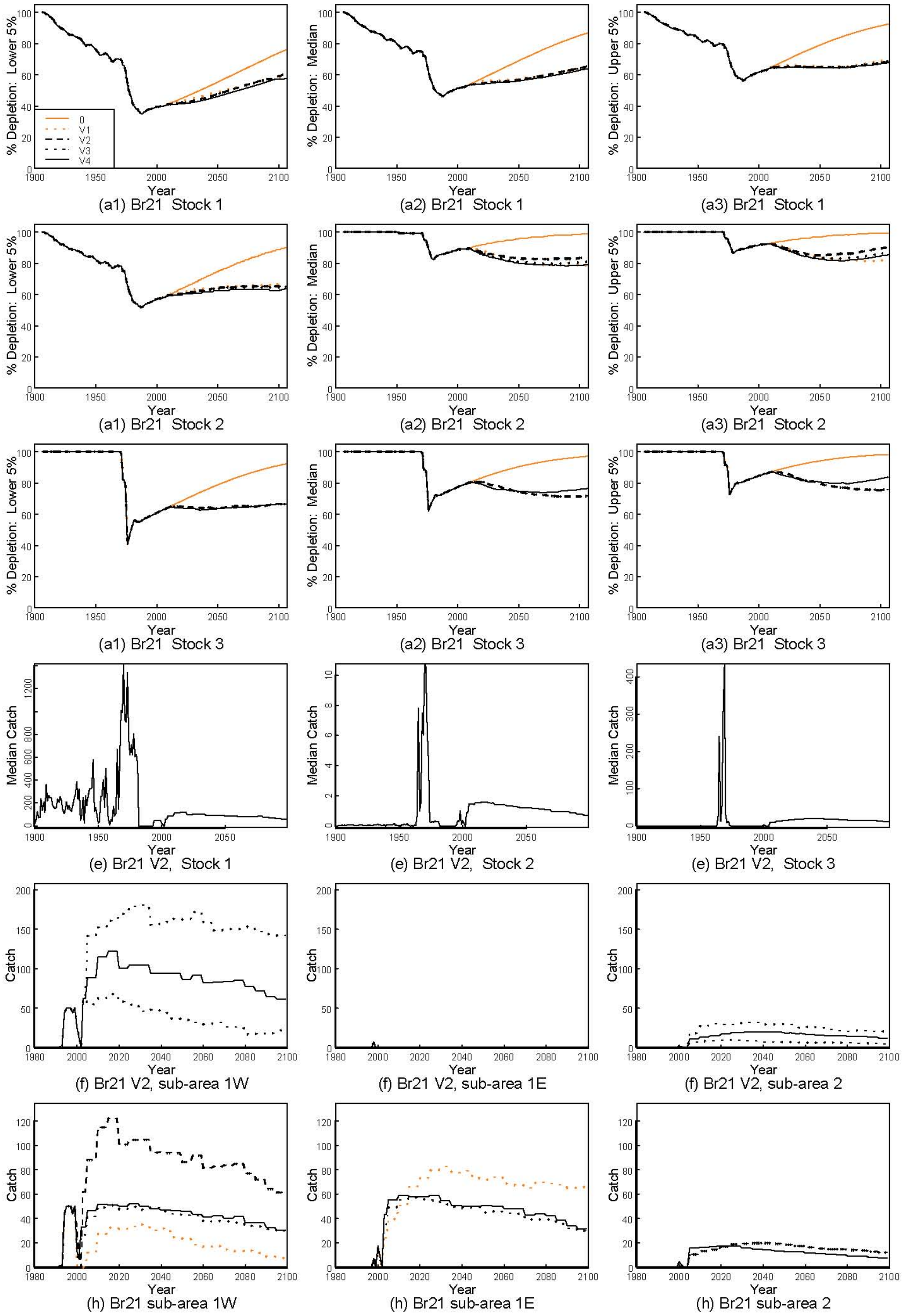


Fig 2. Br22 Mature female and catch trajectories

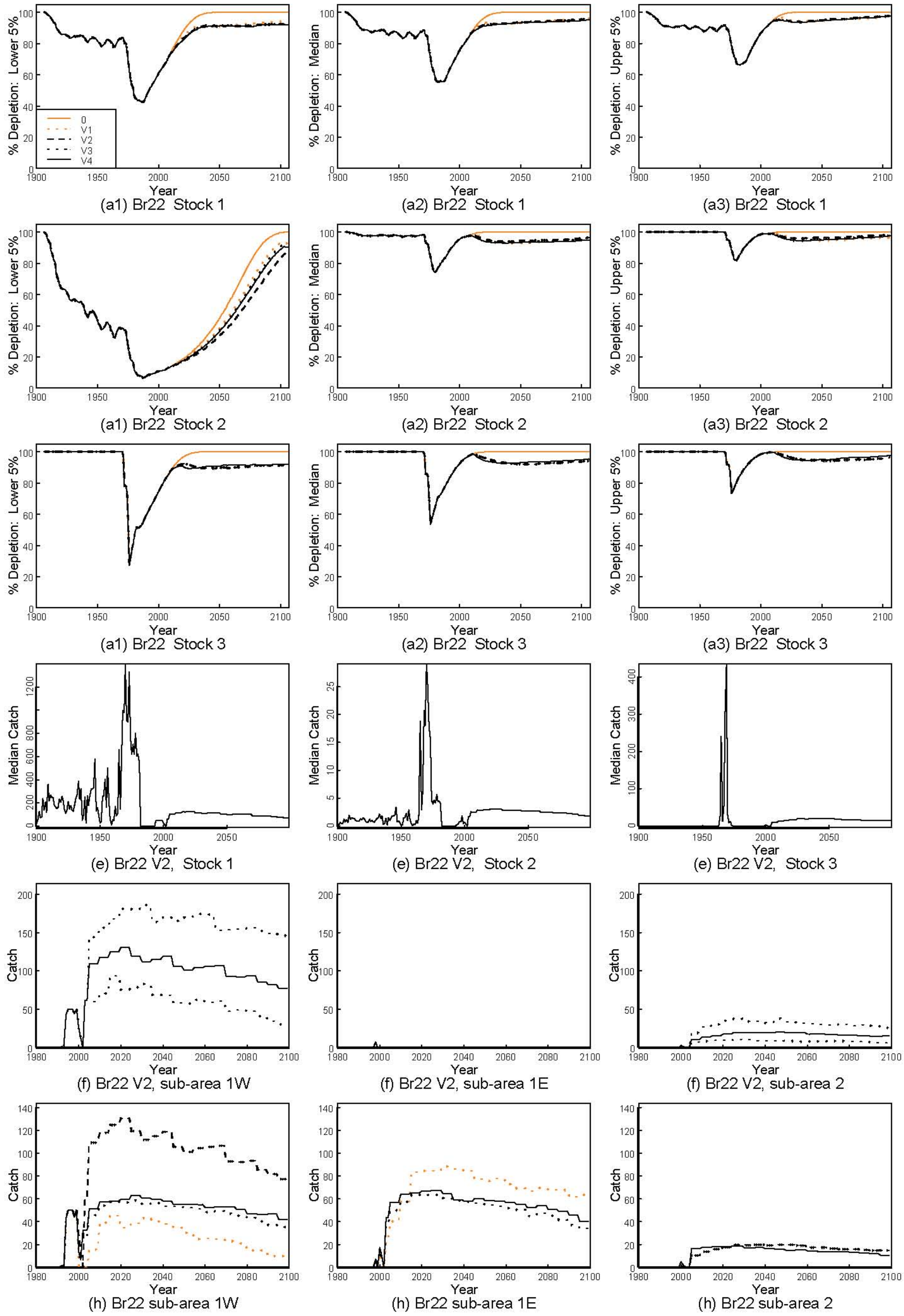
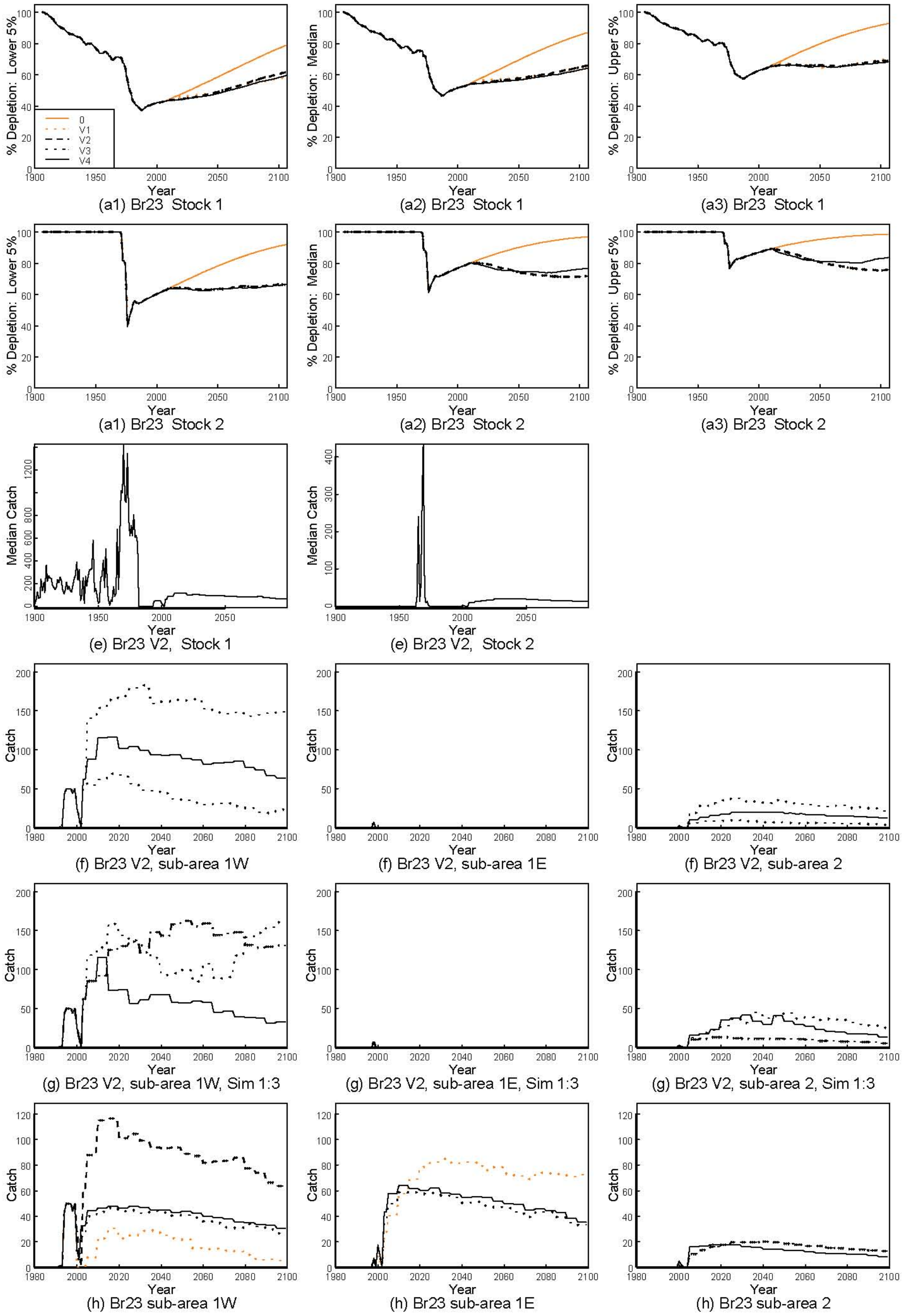


Fig 2. Br23 Mature female and catch trajectories



(a1) Br23 Stock 1
(a2) Br23 Stock 1
(a3) Br23 Stock 1
(a1) Br23 Stock 2
(a2) Br23 Stock 2
(a3) Br23 Stock 2
(e) Br23 V2, Stock 1
(e) Br23 V2, Stock 2
(f) Br23 V2, sub-area 1W
(f) Br23 V2, sub-area 1E
(f) Br23 V2, sub-area 2
(g) Br23 V2, sub-area 1W, Sim 1:3
(g) Br23 V2, sub-area 1E, Sim 1:3
(g) Br23 V2, sub-area 2, Sim 1:3
(h) Br23 sub-area 1W
(h) Br23 sub-area 1E
(h) Br23 sub-area 2

Fig 2. Br24 Mature female and catch trajectories

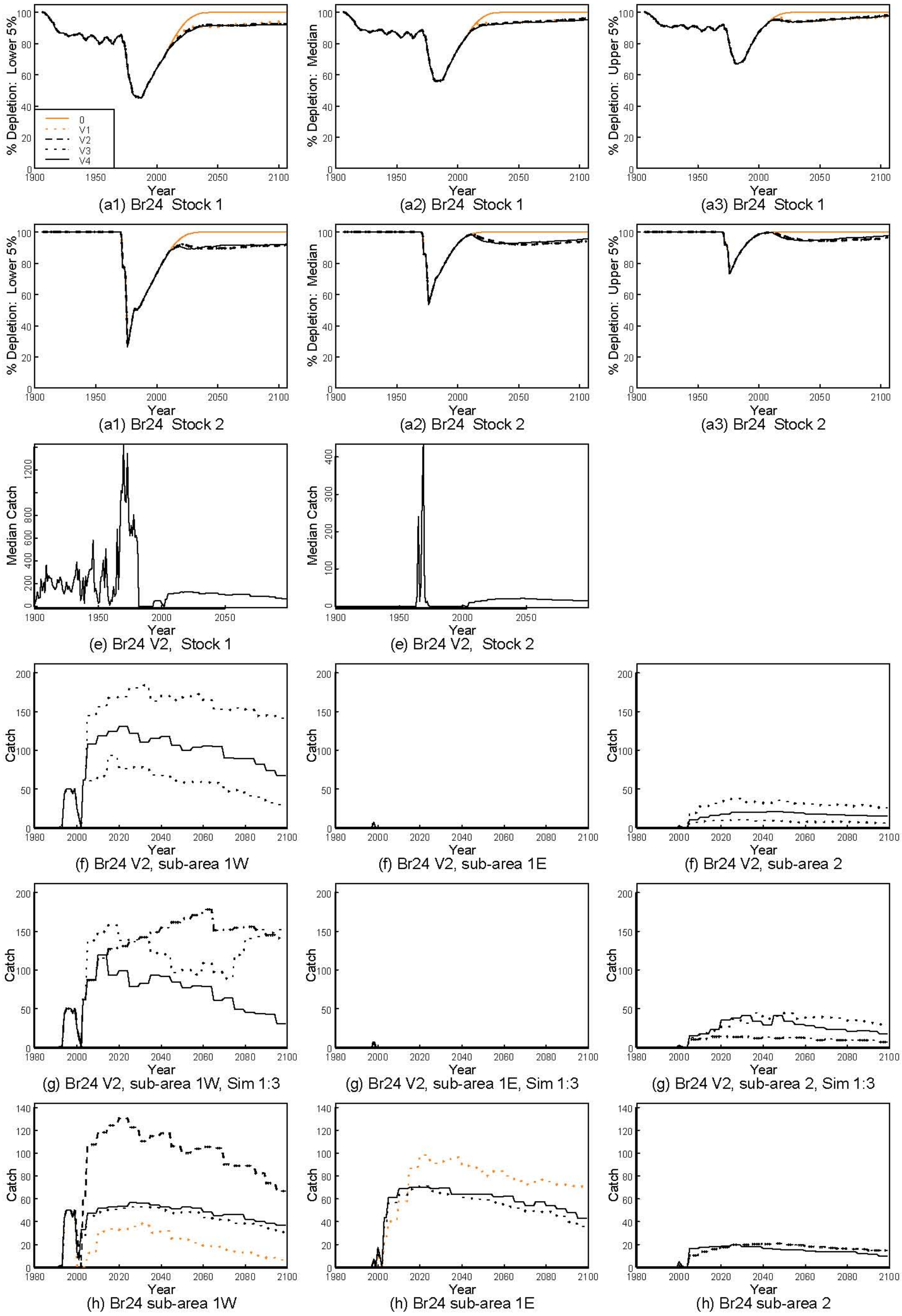


Fig 2. Br25 Mature female and catch trajectories

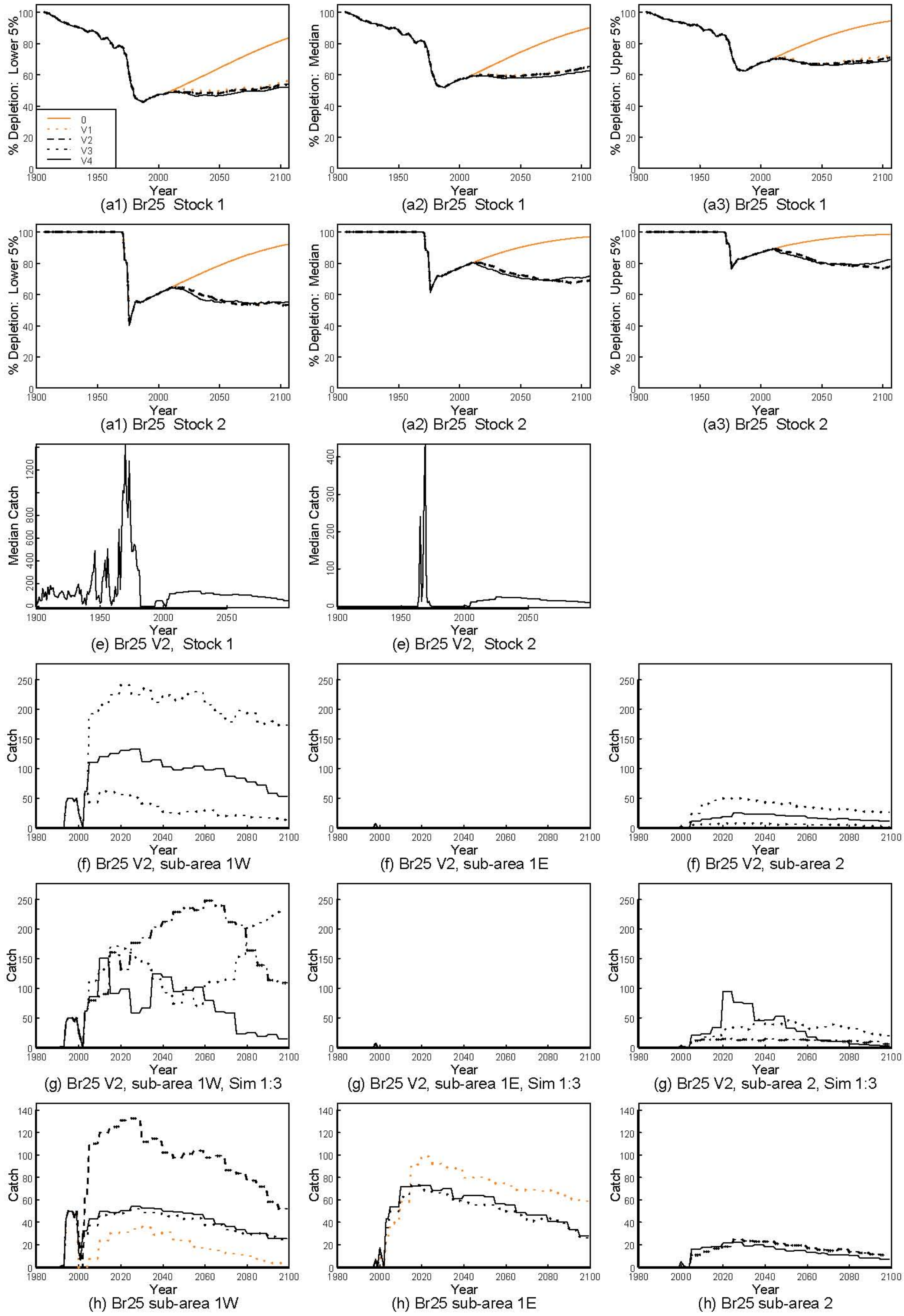
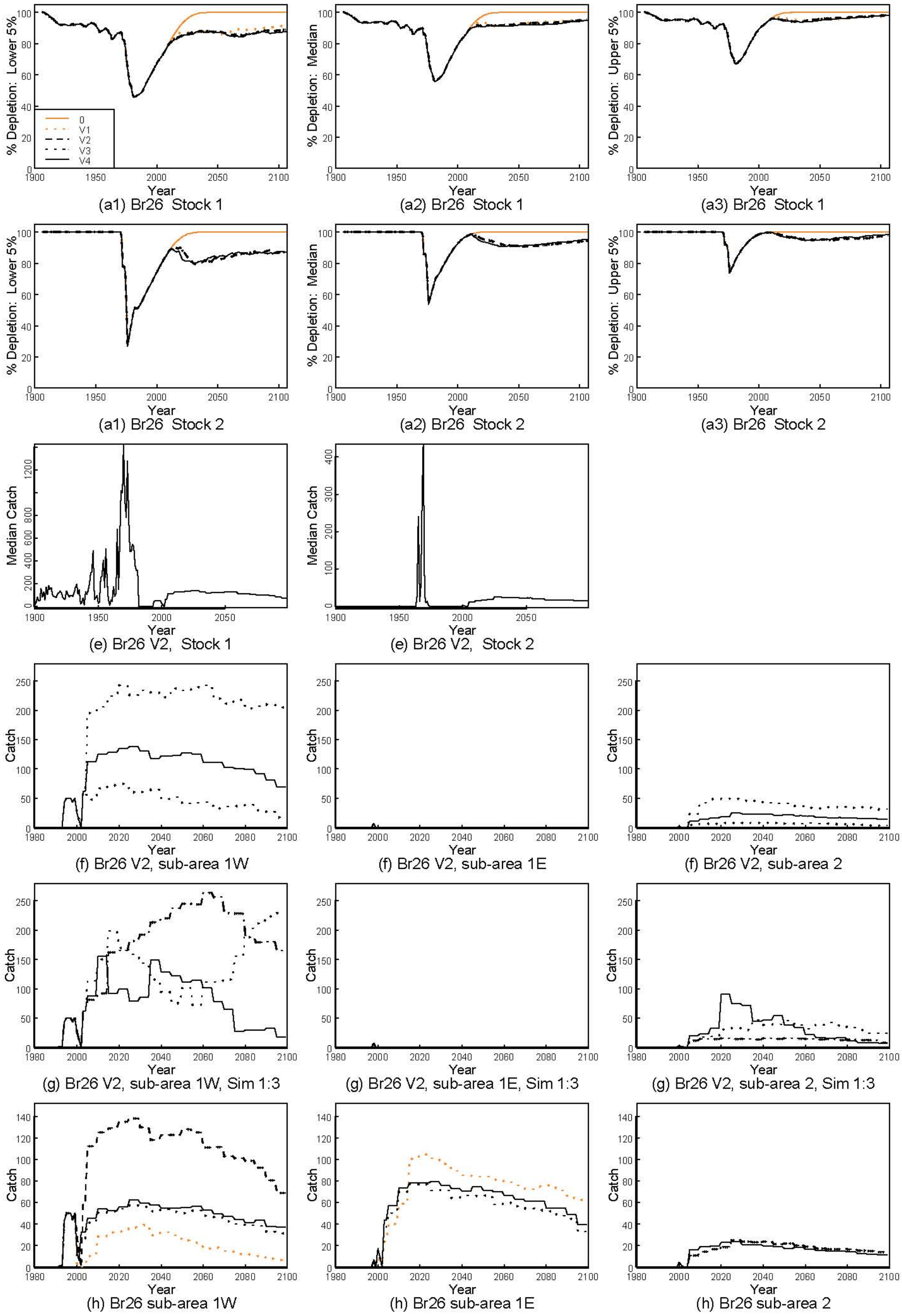


Fig 2. Br26 Mature female and catch trajectories



(a1) Br26 Stock 1
(a2) Br26 Stock 1
(a3) Br26 Stock 1
(a1) Br26 Stock 2
(a2) Br26 Stock 2
(a3) Br26 Stock 2
(e) Br26 V2, Stock 1
(e) Br26 V2, Stock 2
(f) Br26 V2, sub-area 1W
(f) Br26 V2, sub-area 1E
(f) Br26 V2, sub-area 2
(g) Br26 V2, sub-area 1W, Sim 1:3
(g) Br26 V2, sub-area 1E, Sim 1:3
(g) Br26 V2, sub-area 2, Sim 1:3
(h) Br26 sub-area 1W
(h) Br26 sub-area 1E
(h) Br26 sub-area 2

Fig 2. Br27 Mature female and catch trajectories

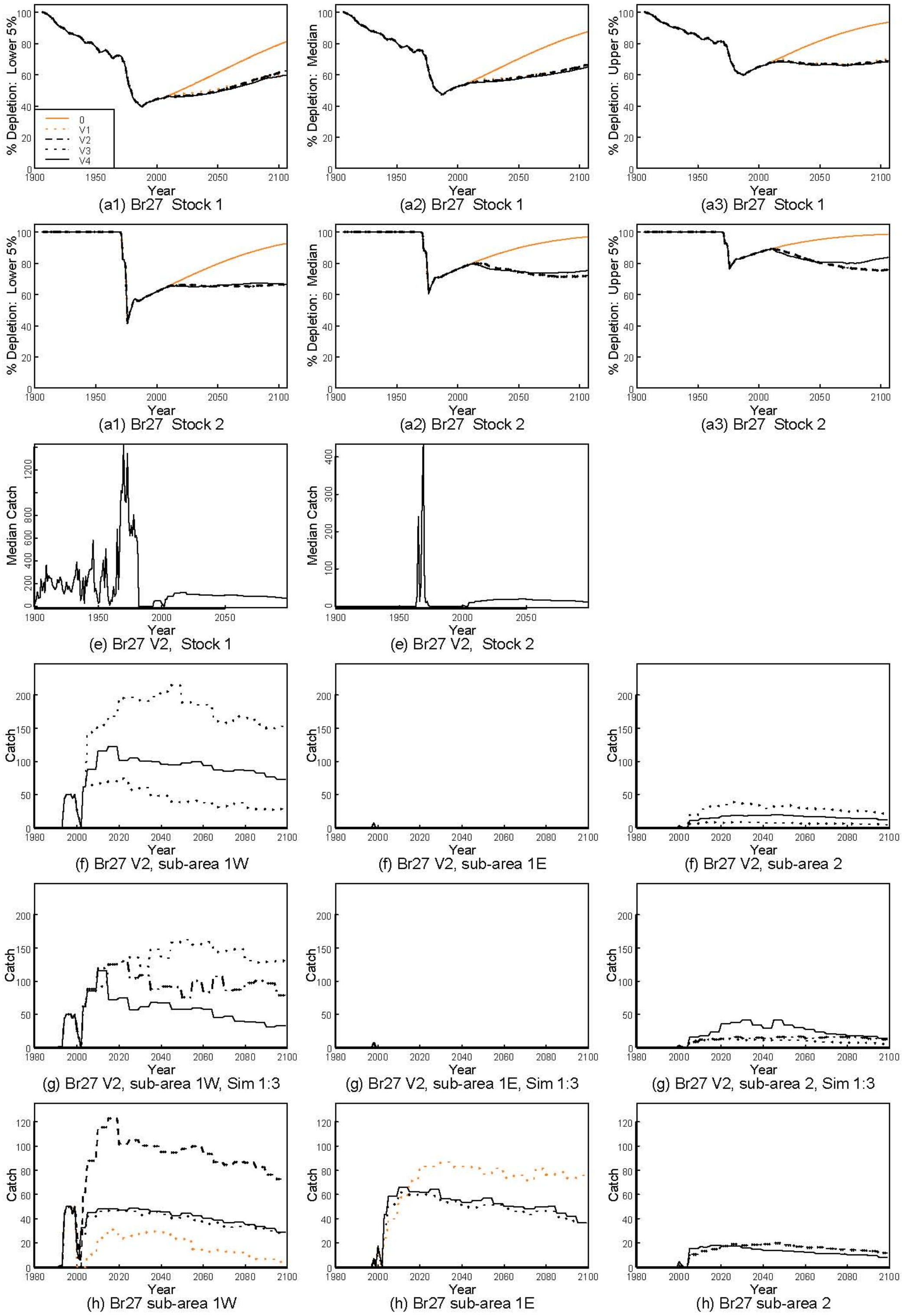


Fig 2. Br28 Mature female and catch trajectories