SC/M17/ForInfo10 Rev1

Pre-Implementation workshop

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Report of the Workshop on the *Pre-Implementation Assessment* of Western North Pacific Bryde's Whales[1]

The Workshop took place at the Institute of Cetacean Research, Tokyo, Japan from 21-24 March 2005. The list of participants is given as Annex A.

1. CONVENOR'S OPENING REMARKS

Kawahara welcomed the participants to Japan. He reminded participants that the objective of the meeting was to work for the completion of the *pre-Implementation assessment* for the western North Pacific Bryde's whales.

2. ELECTION OF CHAIR AND APPOINTMENT OF RAPPORTEURS

Donovan was elected Chair. Donovan, on behalf of the IWC, thanked the participants for attending and thanked ICR for hosting the Workshop.

In 2003, the Committee had agreed that it was in the *pre-Implementation assessment* stage with respect to western North Pacific Bryde's whales. At that time, it had agreed that it should be possible to move quickly towards completion of that stage given the amount of work that had already been undertaken (IWC, 2004a, p.13). However, for a variety of reasons it had not been possible to complete this work at the 2004 annual meeting and so the Committee had agreed to hold this intersessional Workshop to facilitate the Committee agreeing to move to the *Implementation* stage at the 2005 Annual Meeting (IWC, 2005). Thus the primary objective of the meeting was to provide advice to the Scientific Committee on whether to proceed to *Implementation* for the western North Pacific Bryde's whales.

He drew the participants' attention to the agreed 'Requirements and Guidelines' for *Implementations* (IWC, 2005) and in particular to the section describing the *pre-Implementation assessment.* The decision on whether to proceed with an *Implementation* would be based on whether sufficient information was available on the following topics:

(1) abundance estimates;
(2) catches;
(3) stock structure hypotheses;
(4) dispersal rates;
(5) data for conditioning.

During the Workshop, therefore, the goal was to determine whether sufficient information existed or, if necessary, to determine the work necessary to achieve this between the end of the Workshop and the 2005 Annual Meeting. The report follows the terminology given in IWC (2005). Thus, if the Scientific Committee agrees that the *pre-Implementation assessment* is complete at the 2005 Annual Meeting, and agrees that sufficient resources are in place, the process will be:

(1) 'First Intersessional Workshop' (after which no new data allowed) – between September 2005 and May 2006;
(2) 'First Annual Meeting' (trials finalised) – June 2006;
(3) 'Second Intersessional Workshop' – between September 2006 and May 2007;
(4) 'Second Annual Meeting' – *ca* June 2007 (at which recommendation to Commission).

Pastene outlined the logistical arrangements for the meeting. Allison, Butterworth, Pastene, Perrin and Punt acted as rapporteurs, with assistance from the Chair.

3. ADOPTION OF AGENDA

The adopted agenda is given as Annex B.

4. REVIEW OF DOCUMENTS

The documents available for the Workshop were SC/M05/Br1-6 and these are listed in Annex C.

5. REPORT OF THE INTERSESSIONAL STEERING GROUP

The Intersessional Steering Group coordinated the preparation for the Workshop. The Workshop thanked the Steering group for its work.

6. CATCHES

The Chairman reminded the group that the guidelines for *Implementation* state that the following information on catches should be available in order for the *Implementation* process to begin (IWC, 2005, p. 86):

(i) catch history to be used in the *Catch Limit Algorithm (CLA)* in the trials – as complete as possible at this stage (e.g. including incidental catch) and with sufficient spatial resolution for the *management areas* likely to be considered in the *Implementation*; and
(ii) where appropriate, alternative possible catch histories for use in *Implementation Simulation Trials* (*IST*s) in cases of uncertainty over catch history including incidental catch.

6.1 Review of information on the accuracy of catch reports

Allison outlined the catch data held in the IWC catch database, both individual data where they exist, and summary data for other operations. Catches of Bryde's whales in the region were known to have occurred by Japan (coastal and pelagic), the USSR, the Philippines, Taiwan and China. She noted that the Japanese coastal data from 1955-

[1] Presented to the meeting as SC/57/Rep3.

Table 1

Steps required to obtain a catch series for use in *IST*s.

Operation type and period	Task
Japan coastal data 1899-1910	Prorate to sei/Bryde's using 1911-1918.
Japan coastal data 1899–1945 (except 1929)	Split to sei/Bryde's and by sex using known future catches by area (1955-1987).
Japan coastal data 1929, 1946-54	Split to sei/Bryde's using future catches by area, month and sex.
Japan coastal data 1955-67	Incorporate of data to distinguish sei and Bryde's whales into the IWC database.
Republic of China 1976-80	Brownell to provide information on area of catching and revised estimates of catch numbers.
	Use sex ratio from Japan pelagic operations.
	Confirm meat samples are from off-shore form of Bryde's whale.

68 (as submitted to BIWS by Japan) do not differentiate between sei and Bryde's whales, although the two species are separated in Japanese statistics for these years. Prior to 1955, sei and Bryde's whales were not distinguished. The catch series used for the Comprehensive Assessment (IWC, 1997) used the data from Ohsumi (1995), in which the pre-1955 coastal catch was calculated using a ratio of 26% Bryde's whales in the Sanriku area.

The Workshop **agreed** that it was essential to document fully the rationale and methods used to derive any catch series for use in *IST*s. The Workshop developed a table to show all catch operations that may have taken Western North Pacific Bryde's whales and the extent of data available for each operation and year. This is given as Annex D.

SC/M05/BR7 included a summary of known catches of western North Pacific Bryde's whales by Japan prior to 1946 and estimates of total catches based on certain assumptions. These will be included as appropriate in the final catch series developed (see Item 6.3). Japan has collected data on catches by species and area since 1911.

Kawahara introduced paper SC/M05/BR2. The data from whaling operations of a Japanese coastal whaling company between 1965 and 1978 provided by Mr I. Kondo were examined and compared with other available information. The authors noted that catches for the Pacific coast of northern Japan consisted mainly of sperm and sei whales, followed by Bryde's and fin whales. The main species taken and the whaling grounds changed seasonally. They noted from a comparison of the available data that catches of Bryde's whales as reported by Kondo may have been reported in some particular years as another species, usually sei whales, i.e. some reported catches of sei whales may have been Bryde's whales. Kasuya and Brownell (2001) had noted the total actual catches off the Ogasawara (Bonin) Islands might be 1.6 times the reported catches but the original records have been lost and are not available. Based on several kinds of information, the authors believed that Bryde's whale catches reported by the USSR were reliable. In conclusion, the authors believe that the reported official catches could be used as the baseline catch history, with alternative catch histories being assumed for sensitivity tests, for example, using 1.6 times the catches from the Ogasawara Islands.

The Workshop thanked the authors for their work. The question of alternative catch histories is considered under Item 6.3.

Perrin reported that questions exist about the accuracy of the official reported commercial catch statistics from the Philippines (1983-85). While the catches were reported to have been from local waters, they may have been from more distant offshore waters, leaving open the possibility that the whales taken were of the offshore form rather than the pygmy coastal form. He will prepare a report on the question for the next Annual Meeting. Kato undertook to investigate whether any further information on the Philippines operation could be obtained from Japanese companies.

Brownell reported that he expected to be able to obtain better estimates of Bryde's whale catches from Taiwan between 1976-80 in the near future together with information on number of vessels and area of operations. Samples of meat from the Taiwanese catch are available in La Jolla. The Workshop noted that analyses of these samples may be used to confirm that these catches were of the offshore form of Bryde's whale (Dizon *et al.*, 1996). The Workshop **agreed** that in the absence of such analyses, these catches would be assumed to be of the offshore form of Bryde's whale.

The steps required to obtain a catch series for use in *IST*s were agreed and are listed in Table 1.`

6.2 Information regarding incidental catches

Kishiro and Miyashita provided information on incidental catches of Bryde's whales around Japan since 1975. Only four incidental catches have been recorded, of which one (in October 2003 from a trap net in Shizuoka) was identified as an offshore type Bryde's whale based on DNA analysis (L. Pastene, pers. comm.). The remaining three whales (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 Workshop **agreed** that there was no evidence to suggest that any significant number of Bryde's whales is caught incidentally and so there is no need to model incidental catches in the *IST*s.

6.3 Development of a set of alternative catch series for use when conditioning trials

It was emphasised that the catch series used in conditioning may be different from those used by the *CLA* in *IST*s and yet another catch series might be used when the *CLA* is ultimately applied. It is important to include all probable catches in the catch series used in conditioning.

The Workshop then examined the different subsets of the catch data for which an alternative catch series might be considered.

(1) USSR data. The revised data are shown in Table 2. As the revised data from 1970 to 1979 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 2

Soviet pelagic catches of Sei and Bryde's whales and quotas. Quotas taken from Ohsumi (1998:15)

	Bryde's whale		Sei and Bryde's whale			
Year	Official data	Revised catch*	Official data	Revised catch*	Bryde's quota	Sei and Bryde's quota
1966**	0	14	796	537		-
1968	0	22	1,105	332		-
1969	0	95	1,091	440		1,977
1970	66	66	848	159		1,797
1971	638	450	937	483		1,517
1972***	71	67	142	122		1,222
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	

*Doroshenko (2000); **excluding S. Russia and Aleut; ***IOS began.

(2) Japan coastal data 1965[2]-76. Two options were considered here:
   (i) the official data.
   (ii) $C_y \rightarrow C_y \sum_y R_{j,y} / \sum_y C_{j,y}$ where C_y = catch in year y, $R_{j,y}$ = revised data for company j in year y and $C_{j,y}$ = official reported data for company j in year y.
   An alternative option was considered ($C_y = C_y (R_{j,y}/C_{j,y})$) but was rejected as there is no reason to assume all companies will behave the same way each year (for example companies may differ in size and/or may have received differing quotas).
(3) Japan coastal data. The Workshop **agreed** that the work specified under Item 6.6 would give sufficient information to postulate alternative catch series (for example inclusion of catches from other areas or use of different ratios of sei and Bryde's whales).
(4) Japan Bonin Islands 1981-87. Two options were considered here: (i) official data; (ii) use the Kondo and Kasuya data (Kondo, 2001; Kondo and Kasuya, 2002).
(5) Republic of China (Taiwan). The base case is to use the best estimate of the number of catches. A higher and a lower series might be considered when Brownell has provided revised estimates.
(6) Philippines. The base case is to use the official catch numbers. An alternative case will omit the catches, as small-type Bryde's whales. The sexes recorded in the official statistics and the period of operation should be compared with data from the Bonin Islands to inform a decision as to the sex ratio that should be used.

The development of the final catch series and alternatives will be undertaken by the intersessional group indicated under Item 6.6.

6.4 Spatial dis-aggregation of catch

The Workshop **agreed** that even though *Small Areas* have yet to be defined for the western North Pacific Bryde's whales, the data series resulting from completion of the steps outlined in Items 6.1 and 6.6 are nevertheless sufficiently dis-aggregated both for conditioning of trials and application of the *CLA* in trials.

[2] In order to determine from when to implement the revised catch series, changes in domestic regulations should be documented as they may explain annual changes in the difference between the quota and the actual catch.

6.5 Areas and timing of future harvesting

Hatanaka reported that future harvesting of Bryde's whales by Japan will occur from May to September in Japanese coastal waters and high seas, but excluding (i) a 40 n.mile zone off the coast of southern Japan west of 140°E, (ii) the 200 n.mile zone round countries other than Japan and (iii) the area south of 20°N. The proposed timing will avoid both the breeding season (December-April; Ohsumi, 1995), and the parturition season (October-March; Ohsumi, 1995). The proposed harvest area (see Fig.1) ensures that catches will only be taken from the offshore form and excluding the area south of 20°N ensures catches are not taken from the breeding area.

The Workshop noted that some specifications regarding the division of harvests between coastal and pelagic operations may be necessary because these have different selectivities (see Item 9.2.1). Since the need or otherwise for such information will depend on the specification of sub-areas, which takes place at the First Annual Meeting, the Workshop **agreed** that further consideration of this matter should be postponed until that time.

6.6 Future work

An Intersessional Steering Group consisting of Allison (Chair), Brownell, Donovan, Kato, Ohsumi, Perrin and Punt was established to ensure that the work on catch histories is completed by the next Scientific Committee meeting. The group was given the following terms of reference:

(i) tabulate Japanese coastal catches 1899-1945 by year and land station/group of land stations;
(ii) facilitate the incorporation of data to distinguish sei and Bryde's whales 1955-68 into the IWC database;
(iii) prorate the data to obtain an agreed 'best' catch series (including location and sex);
(iv) tabulate changes over time in regulations on coastal whaling;
(v) report on revised catch statistics from the Philippines for 1983-85, including investigating whether further information on the Philippines operation can be obtained from Japanese companies;
(vi) obtain better estimates of catches from China (Taiwan) 1976-86[3] together with information on number of vessels and area of operation;
(vii) examine the data to provide alternative catch series; and
(viii) provide fully documented revised catch (and alternative) series.

7. STOCK STRUCTURE

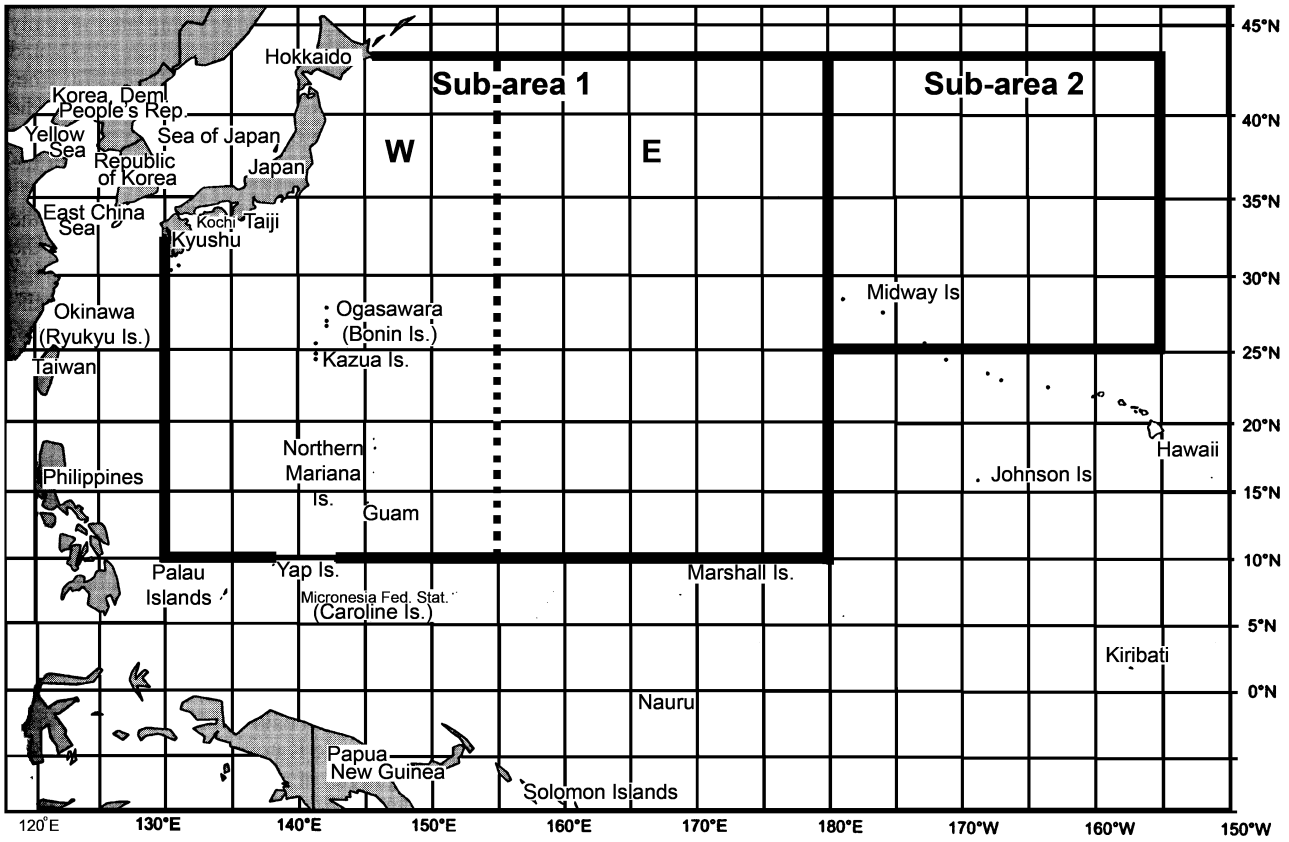
Within the context of implementing the RMP for a species and *Region*, it is necessary to identify a set of stock hypotheses for which it is deemed unlikely that collection of new data during the *Implementation* process will suggest a major novel hypothesis and, once trials have been specified based on the stock hypotheses, to assign a plausibility weight ('high', 'medium', 'low', or 'no agreement') to each trial. The selection of the inclusive set of stock hypotheses occurs during the *pre-Implementation assessment* while the assignment of plausibility weights to trials occurs during the First Annual Meeting (IWC, 2005). Analysis of genetics and other data (e.g. morphological and ecological information)

[3] Genetic analyses of meat samples from the China (Taiwan) catch held in La Jolla could be used to provide information on whether offshore Bryde's whales were involved in that fishery.

can provide information for both the establishment of stock hypotheses and how plausibility weights are assigned to each trial.

A number of studies (e.g. Donovan, 1991; DeMaster *et al.*, 2000; Swartz *et al.*, 2000) have concluded that the most effective way to address questions of stock identity is to consider results from several techniques, both genetic and non-genetic. This strategy has been used for studying stock structure in the western North Pacific Bryde's whales, and results were presented to the Comprehensive Assessment of this species in 1995 and 1996 (IWC, 1996; IWC, 1997). If similar results are found by different approaches (as has been the case for the western North Pacific Bryde's whales) then conclusions can be drawn with greater confidence.

Pastene presented a summary of Japanese and other research on potential stock structure in western North Pacific Bryde's whales. As was reported in the Comprehensive Assessment in 1995 and 1996, early comparisons of sub-areas 1 and 2 (Fig. 1) were based on both genetic and non-genetic data. Analysis of sightings data found no discontinuity across these sub-areas. A discontinuity does exist in catches within sub-area 1, but this is a result of an operational constraint: a boundary set at 159°E by the Japanese Government to protect shore-based whaling from pelagic whaling. An analysis of allozymes (Wada, 1996) did not find any differences between the sub-areas, but the power of this technique was deemed insufficient and later genetic analyses used mtDNA control-region sequence data. JARPN II collected samples from a



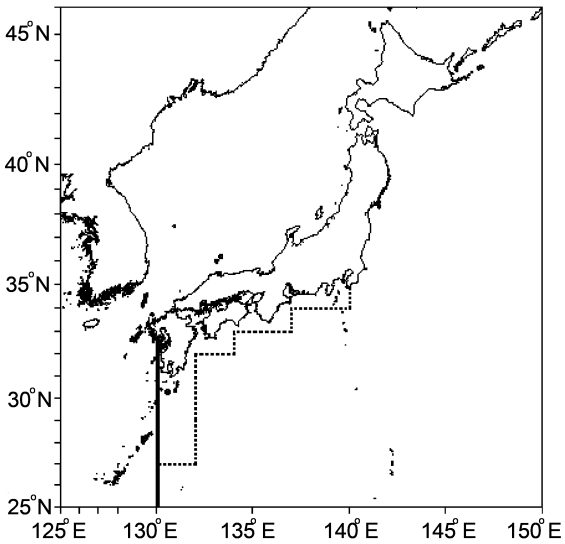


Fig. 1. Map of the western North Pacific showing sub-areas 1 and 2 selected by IWC (2000a, p.11) as the basis for initial *Implementation Simulation Trials* and updated (see inset left) to refine the boundary at the southern end of Japan (see text) to ensure that catches are made only from the offshore form.

northern region that bridged the latitudinal gap between Bonin Is. shore-based and pelagic whaling in sub-area 1. Genetic analyses started to use microsatellite data from 2001. New analyses of genetic data were presented to the 2004 meeting of the Scientific Committee by US and Japanese scientists. Based on these analyses, the Committee agreed that: (1) the limited genetic data from the Hawaiian Islands do not suggest the occurrence of a small-form Bryde's whale in those waters; (2) there is no direct evidence to support the existence of more than one stock in sub-area 1; and (3) there are too few samples in sub-area 2 to allow firm conclusions to be drawn on the basis of genetic data regarding stock structure there.

The Workshop noted that the hypothesis of a separate stock in sub-area 2 was established primarily because of the lack of genetics data for this sub-area. This situation has effectively not changed since 1998. The boundary between sub-areas 1 and 2 (180°) was selected because there are very few genetics data to the east of 180°.

During the 1998 meeting, the possibility of establishing stock hypotheses in which there is stock structure within sub-area 1 was not supported by evidence suggesting that such structure exists, but rather by the concern by some members of the Scientific Committee that sub-area 1 is very large and there is limited information for some parts of it (IWC, 2000a, p.12). The spatial distribution of genetic samples in sub-area 1 has been enhanced since 1998 through the addition of the samples from JARPN II.

7.1 New information

7.1.1 New analysis methods

SC/M05/BR5 analysed mtDNA data using two kinds of Bayesian approaches: a simple approach and a hierarchical approach. The simple approach assumed multinomial sampling as well as Dirichlet priors with known parameters. This approach showed that the Bayesian plausibility for a one-stock hypothesis was much higher than for a multiple-stock hypothesis. The hierarchical Bayesian approach extended the simple approach by incorporating a noninformative hyperprior for the parameters of the Dirichlet prior. The results of this approach also showed that the one-stock hypothesis was more plausible than a multiple stock hypothesis. The results using the two Bayesian approaches were consistent with the results using microsatellite data based on another Bayesian approach, *Structure* (Martien and Taylor, 2004).

The Workshop welcomed the approach of SC/M05/BR5 and noted that the hierarchical approach in SC/M05/BR5 includes prior distributions for the probabilities of the haplotype frequencies and the parameters of the Dirichlet hyper-prior. The values of the parameters of these priors were selected with the aim of being noninformative. However, it is unclear whether these values are noninformative in practice (i.e. in the context of selecting between one- and two-stock hypotheses using the Deviance Information Criterion (DIC)). The Workshop **recommended** that the extent to which these priors are noninformative should be examined in the context of model selection, for example by reducing the sample size and repeating the analysis. Ideally, the value of the DIC for the one and two stock hypotheses should be the same if the data are uninformative. The Workshop also **recommended** that the performance of the simple and hierarchical Bayesian approaches in SC/M05/BR5 should be evaluated using simulation before they are considered for use as the basis to assign plausibility weights to simulation trials. The simulation tests should include cases in which there are really one and two stocks in the region being sampled.

7.1.2 Power to detect differences within sub-area 1 using genetic methods

While it is relatively straightforward to interpret the results of hypothesis tests when the null hypothesis of panmixia is rejected, interpretation of the results of hypothesis tests when the null hypothesis is not rejected is difficult because failure to reject the null hypothesis may occur not only if the null hypothesis is true but also if the null hypothesis is false, but the data are insufficient to identify this (i.e. the statistical test has low power). It is therefore important to evaluate the power of statistical hypothesis tests to correctly reject the null hypothesis of panmixia if there is really more than one stock of Bryde's whales in the western North Pacific.

The results of a number of analyses presented to the 2004 meeting of the Scientific Committee meeting did not provide evidence of stock structure in sub-area 1. However, when developing the agenda for this Workshop a request was made that the power of the statistical techniques applied during the 2004 meeting should be explored (IWC, 2005, p. 108).

SC/M05/BR3 evaluated power under an island model, which is most often used in gene flow analyses. Use of this model makes it easy to control population differentiation in an alternative hypothesis using just a single parameter, F_{ST}. The results for mtDNA data indicated that statistical power was high for moderate sample sizes and for quite small values of F_{ST}. The statistical power for microsatellite data was also high and greater than for mtDNA data. These results demonstrated that the statistical power of the tests used in Pastene *et al.* (2004) is quite high for a very wide range of genetic differentiation, and therefore the statistical tests can detect differences even if the true F_{ST} is quite small. These analyses suggest that the evidence for the conclusion by Pastene *et al.* (2004) that there is only single stock of Bryde's whales in sub-area 1 is strong.

SC/M05/BR4 evaluated statistical power in a retrospective way using the estimates of haplotypic or allelic frequencies of three localities as if they are the true values. Statistical power was relatively high in this case. However, the alternative hypothesis depends on the data, and so the power may be positively biased.

The Workshop welcomed SC/M05/BR3 and SC/M05/BR4 which examined the power of the χ^2 permutation test for mtDNA and Fisher's exact test for microsatellite data. The Workshop focused on the cases in SC/M05/BR3 and SC/M05/BR4 in which the haplotype and allele frequency data which formed the basis for the mean haplotype and allele frequencies for the simulated populations were based on the actual data for the western North Pacific Bryde's whales as these results were the most relevant for the purposes of the *pre-Implementation assessment*. The Workshop believed that the approach of SC/M05/BR3 provided a more defensible means of identifying the power of hypothesis tests than that of SC/M05/BR4 because the method of SC/M05/BR3 does not rely on the estimated probabilities of alternative haplotypes and alleles in the simulated stocks to the same extent as SC/M05/BR4.

The Workshop **agreed** that the analyses presented had shown that for the sample sizes available, the power to detect genetic differences for western North Pacific Bryde's whales is high unless the value of F_{ST} is very small.

The approach of SC/M05/BR3 evaluates statistical power using the island model. However, this approach does not take into account the impact of changes over time in the demographic structure of the simulated stocks. The Workshop **recommended** that consideration should be given to evaluating power using models that explicitly include changes over time in demographics and that can be tailored to the data for the resource under consideration**.** In contrast to the approach of SC/M05/BR3 which uses only a value for F_{ST} and haplotype and allele frequencies, such an approach would require specifications for carrying capacity, mutation rate and dispersal rate. Information on which estimates for these quantities can be based is not available at present and may not be available until initial *ISTs* are conditioned.

7.1.3 Relationship between whales to be surveyed and those in the Southern Hemisphere

SC/M05/BR6 summarised previous Committee discussions on the relationship between Bryde's whales to be surveyed and harvested in the western North Pacific and those in the Southern Hemisphere. It has been suggested that the apparent equatorial concentration of whales during the austral winter may include some whales from Southern Hemisphere populations (IWC, 2005). SC/M05/BR6 argued that since mark-recapture analyses strongly indicate an annual north-south migration between northern summer grounds and southern wintering grounds, by analogy a similar pattern of movement can be postulated for Bryde's whales of the western South Pacific stock. This would minimize mixing of animals from the two stocks, although the winter ranges of the northern and southern hemisphere stocks may overlap to some small extent. There are large genetic differences, both mtDNA and microsatellites, between Bryde's whales from western North Pacific (represented by whales from east of the Kuroshio Current and west of 180°) and the western South Pacific (represented by Bryde's whales from the Fijian Islands). The possibility of some trans-equatorial movement was suggested because the two stocks share some mtDNA haplotypes (IWC, 2005). However, genetic differences would not be as extreme as observed if this was the case, and sharing of haplotypes is insufficient evidence of movement between Hemispheres given [the geological time] when the two stocks diverged. SC/M05/BR6 also noted that there is a current IWC restriction on whaling south of 20°N to protect the breeding area. This restriction, and ignoring survey data south of 10°N, is sufficient to ensure that no further attention needs to be given to the possibility of mixing across the equator.

The Workshop **agreed** with the conclusion of SC/M05/BR6 that no further attention needs to be given to the possibility of mixing across the equator.

7.1.4 Non-genetic information related to stock structure

Kishiro (1998) presented all of the mark-recapture data for western North Pacific Bryde's whales, including by-month plots and overall movements. Movements occurred between all sectors of sub-area 1. The Workshop agreed that these data do not suggest any spatial substructure within sub-area 1 and indicate considerable movement of animals within the sub-area.

Miyashita summarised the information available on the distribution and density of Bryde's whales within sub-areas 1 and 2. A summary of sighting records for 1972–90 (Miyashita *et al.*, 1995) showed a uniform region of high frequency of sightings extending across sub-areas 1 and 2. SC/M05/BR1 examined the data from sighting surveys in 2001 that covered a wide longitudinal range. The research area was 31°N-39°N, 145°E-155°W, where a high frequency of sightings of Bryde's whales was expected. Two research vessels started the survey at 175°E at the same time and went eastward and westward, respectively. The total number of primary sightings was 86 schools of 130 animals. A Generalized Linear Model (GLM) was applied to the encounter rate by day taking differences in vessels and wind force into account. The highest standardised encounter rate was observed in the central portion of the study area (170°E-180°), and decreased gradually in both longitudinal directions. No distinct hiatus was observed. SC/M05/BR1 concluded that the sightings data show no evidence of discontinuities in density that might suggest that more than a single stock occupies the study area. The data also render the suggestion of a boundary at 180° to be implausible.

The Workshop **agreed** that the sightings data do not suggest spatial substructure within sub-areas 1 and 2.

The Workshop noted and reiterated the previous **recommendation** that research (surveys and collection of biopsies for genetic analysis) be conducted in the island groups of the western and South Pacific where the small-form Bryde's whale may occur (IWC, 2000b). Miyashita informed the Workshop that opportunistic biopsy sampling for Bryde's whales in sub-area 2 would occur during sightings cruises.

It was noted that a recent survey conducted by the US around the Hawaiian Islands encountered only offshore-form Bryde's whales, suggesting future trials might redefine sub-area 2 so that its southern boundary is 10°N rather than 25°N.

7.2 Description of stock hypotheses

7.2.1 Objectives for the pre-Implementation assessment

The objective of a *pre-Implementation assessment* is to establish a set of conceptual stock-structure hypotheses that covers the entire plausible range, such that the availability of more data in the near future will not suggest additional stock hypotheses.

The Chair stressed that at this stage of the process, the objective was to develop inclusive general hypotheses that are (1) not inconsistent with the available data and (2) are sufficiently broad that no radically new hypotheses are likely to occur with the addition of new data. Any hypotheses considered at this stage however, should *not* be interpreted as necessarily needing to be included in the *ISTs*. Additionally, given the need for to be inclusive at this stage, it should *not* be interpreted that the Workshop considers all of the hypotheses put forward for consideration here as being of equal plausibility. Indeed, this is not the case, as discussed under Item 7.4.

7.2.2 Background

The 1998 meeting of the Scientific Committee (IWC, 2000b, p.87) identified several stock hypotheses for western North Pacific Bryde's whales.

(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 both sub-areas and the other is found in sub-area 2 only.
(3) 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 only.

The Scientific Committee also discussed whether the Bryde's whales in sub-area 1 consisted of more than one stock and developed trials including sub-stock structure in sub-area 1.

7.2.3 Development of inclusive hypotheses

The Workshop noted that the hypothesis of a separate stock in sub-area 2 was established primarily because of the lack of genetics data for this sub-area. This situation has effectively not changed since 1998.

The Workshop noted the considerable contribution to the Committee's work made by the genetic samples and analyses provided by Japanese scientists. The interpretation of genetic analyses that do not reveal stock structure can be difficult for the reasons discussed under Item 7.1, but the difficulties are considerably reduced when sample sizes are large, and the number of genetic samples has increased substantially since the 1998 meeting of the Scientific Committee. The results of the analyses of these samples based on various methods of analyzing genetics data presented to the 2004 meeting (Martien and Taylor, 2004; Pastene *et al.*, 2004) provided no evidence that there is more than one stock/sub-stock of Bryde's whales in sub-area 1. However, the number of samples available for sub-area 2 is much too small to conclude confidently that a separate stock does not exist in that sub-area.

The Workshop stressed that in developing the conceptual stock hypotheses for the western North Pacific Bryde's whales shown in Fig. 2, it was attempting to develop a broad range that captured scenarios that could not at this stage be considered completely inconsistent with data, rather than a scenario that was most consistent with the data. Information relating to the various hypotheses developed is given in Annex E. The Workshop **agreed** that provided there was some support[4] that a particular hypothesis was not inconsistent with the data, it should be included at this stage. This is an inevitable conclusion of the instruction that the full range of plausible hypotheses should be developed. As discussed under Item 7.4, it expected that by the time final *IST*s are agreed at the First Intersessional Workshop, the number of plausible hypotheses that would be incorporated would be smaller.

In developing hypotheses, the Workshop assumed that:

(1) the breeding grounds are in the low latitudes and that no whaling will take place on these grounds;
(2) no whaling will occur during the migration to the feeding grounds; and
(3) hypotheses could be represented using three spatial cells (sub-area 1(west), sub-area 1(east), and sub-area 2).

The Workshop **agreed** that the three conceptual hypotheses identified by the Scientific Committee in 1998, as listed above, along with hypotheses which involve two breeding sub-stocks that mix within sub-area 1 would capture a range that is sufficiently inclusive for the purposes of conducting the *Implementation* for the western North Pacific Bryde's whales (Fig. 2).

Although the stock hypotheses are displayed graphically using spatial cells, it should be noted that these stock hypotheses are *conceptual* at present and are meant to capture general broad hypotheses of stock structure. The hypotheses will be specified in detail and trials will be designed based on them by the First Annual Meeting.

[4] 'Support' in this context does not mean that any member of the Workshop believed that a particular hypothesis was the most likely hypothesis, but rather that at this stage it could not be considered completely implausible, given the data available to date.

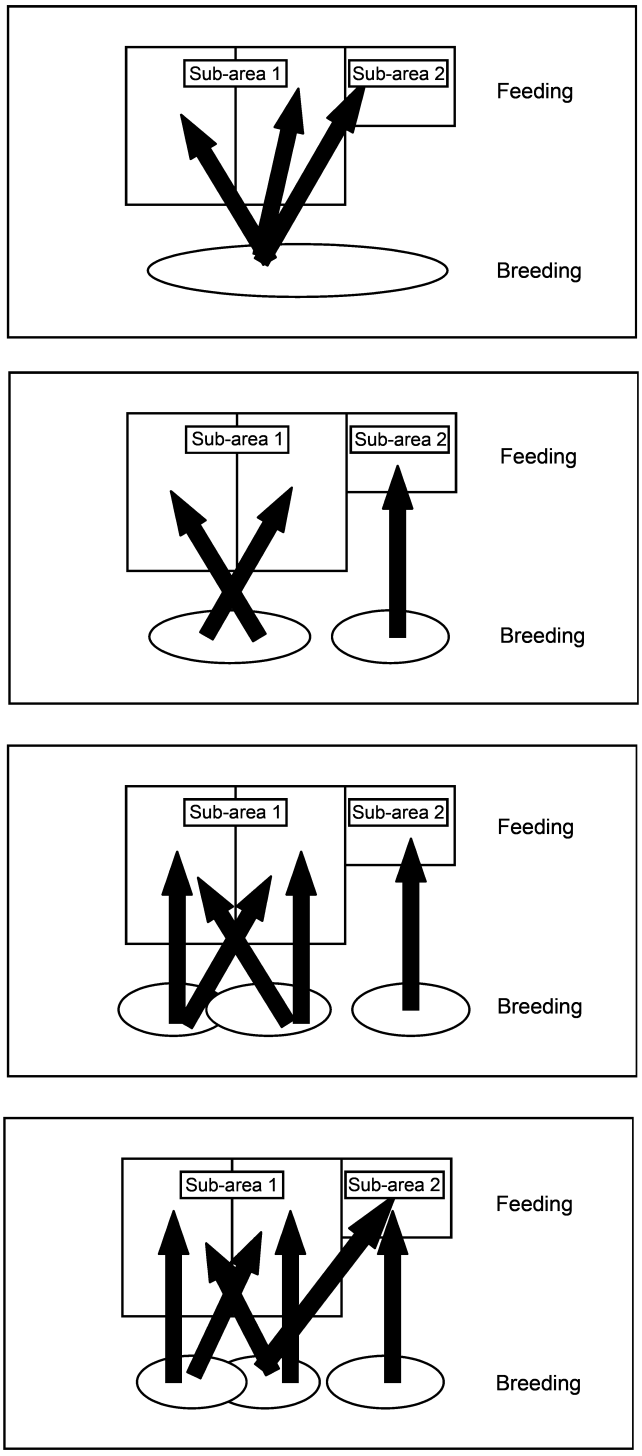


Fig. 2. Conceptual stock hypotheses for western North Pacific Bryde's whales.

The Workshop also stressed that the hypotheses that considered the possibility of two breeding 'sub-stocks' entering sub-area 1, also considered that there would be considerable spatial mixing within that sub-area (as evidenced particularly by the marking and genetic data). It is quite likely that when the degree of mixing is estimated, the implications for the results of the *IST*s for these scenarios and that with only a single breeding stock will be essentially identical. This is considered further under Item 7.4.

7.3 Results from the simple model filter

Punt illustrated the current version of the 'simple model filter' (Punt, 2003) to the Workshop. This model will need to be extended to make use of the tagging data to estimate

mixing rates (see Section 9.1). Once completed, this will prove a valuable tool for reducing the number of scenarios and hypotheses that need to included in final *ISTs*.

7.4 Assigning plausibility ranks to alternative simulation trials

It was recognised that it was not the task of the Workshop to formally assign plausibility rankings to each stock hypothesis. Rather, the Workshop noted that a plausibility rank would need to be assigned to each simulation trial during the First Annual Meeting (IWC, 2005). However, it is inevitable that during discussions to develop stock hypotheses as under Item 7, considerations regarding plausibility occur. The Workshop **agreed** that that the various stock hypotheses in Fig. 2 are not equally plausible, particularly given the further data and analyses that have become available since 1998. Specifically, the Workshop **agreed** that the currently available data on genetics, mark-recapture and sightings indicate that the hypotheses in which there are two sub-stocks in sub-area 1 are likely to be assigned much smaller plausibility weights than the other hypotheses (see Annex E).

The Workshop noted that given the currently available information and the future analyses suggested, it was likely that the Committee will either decide in Ulsan to withdraw the hypotheses that involve two sub-stocks in sub-area 1, or assign 'low' plausibility to such hypotheses during the *Implementation* process.

The Workshop noted that further work to be undertaken by the First Annual Meeting would determine the number of hypotheses that need to be taken forward as part of the trials.

In particular, it noted that analysis of the marking data in conjunction with use of the 'simple model filter', might reveal that the high mixing rates implied by the available data meant that trials based on stock hypotheses with two sub-stocks that mix would behave in a manner very similar to trials based on stock hypotheses with only one stock in sub-area 1.

The Workshop also noted that the interpretation of the power calculations in SC/M05/BR3 would be enhanced in the context of assigning plausibility ranks if a probability distribution for the value of F_{ST} for western North Pacific Bryde's whales was available, and **recommended** that such a distribution should be developed. The Workshop noted that this would not be straightforward within a likelihood framework and **agreed** that it might be possible to use a bootstrapping or a Bayesian approach for this purpose.

7.5 Future work

The Workshop identified the following research topics to facilitate the assigning of plausibility ranks to simulation trials (in priority order):

(1) develop a distribution for F_{ST} for the western North Pacific Bryde's whales to interpret the results of the power analysis;
(2) consider the feasibility of evaluating power using models which explicitly include changes over time in demographics and that can be tailored to the data for the resource under consideration;
(3) examine the extent to which the priors assumed in SC/M05/BR5 are uninformative in terms of model selection; and
(4) evaluate the performance of the Bayesian approaches in SC/M05/BR5 using simulation.

These tasks need to be completed no later than the First Annual Meeting if they are to impact the *Implementation*. However, the Workshop **agreed** that none of these research tasks were required to complete the *pre-Implementation assessment* and that they may not be needed to assign plausibility ranks to simulation trials (e.g. because other approaches, such as the use of the 'simple model filter' and the tagging data, may prove sufficient for this purpose, see Item 9.1.1).

8. ABUNDANCE ESTIMATES

8.1 General issues

The Workshop noted that the primary issues to be addressed under this item were methods for the disaggregation of estimates of abundance at small spatial resolution, and the estimation of covariances among the estimates of abundance together with the associated additional variance.

8.2 Selection of years and areas for which abundance estimates will be available for use in conditioning of trials

8.2.1 Consideration of available data and analyses

Miyashita introduced Annex F which summarised existing abundance estimates for the western North Pacific Bryde's whales based upon sighting surveys.

The Workshop **agreed** that the estimates from surveys conducted over 1998-2002, which had been subject to oversight by the IWC Scientific Committee, should be used for conditioning trials. It was also **agreed** that the set of associated blocks surveyed in the August-September period during these surveys (also Annex F) serve as a framework for including some of the results from earlier surveys as well, both to allow the estimation of additional variance and to improve the precision of model estimates of abundance forthcoming from the conditioning.

To this end, survey tracks during August-September for surveys over the 1983-1996 period were examined, to determine which of those surveys might be considered to provide adequate coverage of the blocks shown in Annex F to yield estimates acceptable for use in the conditioning. Table 3 shows two matrices indicating options for block-year combinations that might be considered acceptable. This Table commences in 1988, as no earlier surveys were deemed to provide adequate coverage of any block. It was agreed that the specific abundance estimates under each of these options for each block over the 1988-2002 period, together with the associated variance-covariance matrices and additional variances for use in the conditioning, would be computed by Japanese scientists using the mixed linear model detailed in Annex G, and reported to the forthcoming Scientific Committee meeting.

The Workshop **agreed** that common estimates of effective search half-width, *w*, would be used to calculate the abundance estimates input to the mixed linear model over the 1988-1996 and 1998-2002 periods, given concerns about the smallness of sample sizes otherwise available for some year-block combinations. It was noted that this approach would contribute to the covariance of the estimates to be used in the conditioning, and that it should be possible to use the package lmm (Anon., 2005) to implement the mixed linear model.

The Workshop also **agreed** that the sensitivity of the results obtained should be examined to pooling estimates of mean school size over blocks (similarly to the approach used for *w*), instead of calculating them separately for each block

as in previous results presented. It was noted that pooling to estimate mean school size and *w* might desirably be extended to sightings during the survey in question that were made outside the block(s) and months under consideration, in the interests of increasing sample size and hence precision.

The Workshop appointed an intersessional steering group comprised of Kitakado (Chair), Butterworth, Miyashita, Palka, Shimada, Skaug and Sohn to oversee the computations set out above. The Terms of Reference of this group are to review and advise on progress reports provided from time to time by the Japanese scientists carrying out these computations and to review abundance estimates from the 1998-2002 surveys.

The forthcoming Scientific Committee meeting should decide upon which of the options investigated to adopt to provide inputs for the conditioning process in the light of results reported from these computations.

Table 3

Blocks (see Fig. 3 for definition) for surveys prior to 1998 for which coverage might be considered adequate for inclusion in the conditioning process. There was no survey in 1997.

Season	Block												
	A	B	C	D	E	F	G	H	I	J	K	L	M
(a) Definitely adequate (y)													
1988	-	-	-	-	-	y	-	-	y	-	-	y	-
1989	-	-	-	-	-	y	y	-	y	y	-	y	y
1990	-	-	-	-	-	y	y	-	y	y	-	y	y
1991	-	-	y	-	-	-	-	-	-	-	-	-	-
1992	y	-	-	y	-	y	-	-	-	-	-	-	-
1993	-	y	-	-	y	y	y	y	y	y	y	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	y	-	-
1996	-	-	-	-	-	-	-	y	-	-	-	-	-
(b) Definitely adequate (y) and probably (?) adequate													
1988	-	-	-	?	-	y	-	-	y	-	-	y	-
1989	-	-	-	?	-	y	y	-	y	y	-	y	y
1990	-	-	?	?	-	y	y	-	y	y	-	y	y
1991	?	-	y	-	-	?	-	-	?	?	-	?	?
1992	y	-	?	y	-	y	-	-	-	-	-	-	-
1993	?	y	-	?	y	y	y	y	y	y	y	-	-
1994	-	-	-	-	-	-	-	-	-	-	-	-	-
1995	?	-	?	?	-	-	?	-	-	?	y	-	-
1996	-	?	?	-	-	-	?	y	-	-	-	-	-

8.2.2 Considerations to ensure that estimates apply to the offshore form

The Workshop considered how to exclude waters known or suspected to be inhabited primarily by the small coastal form or forms of Bryde's whales from sub-areas 1 and 2 when estimating abundance. In 1998 the Scientific Committee suggested that certain 5° blocks off southern Japan and around island groups in the tropical Pacific should be ignored when obtaining abundance estimates for the offshore 'ordinary' Bryde's whale (IWC, 1999). The area ignored was refined in 1999 to selected 2°x2° blocks in and around the Caroline Islands, Northern Marianas and Marshall Islands (IWC, 2000b, p. 86). The Workshop considered whether the previously agreed exclusion zones around the three tropical island groups should be retained and **agreed** to include and exclude these 2°x2° blocks when computing estimates of abundance. The Workshop noted that there are as many as three forms of Bryde's whales and Bryde's-like small whales in Japanese coastal waters and that Kondo reported the capture of three small Bryde's-like whales 40 n.miles off Taiji (SC/M05/BR2). The Workshop **agreed** to exclude Japanese coastal waters west of 140° out to 40 n.miles when computing estimates of abundance.

8.3 Selection of the years and areas for which abundance estimates will be available for use in the *CLA* in trials

The Workshop considered that in principle, abundance estimates for the blocks and years indicated in one or other of the options presented in Table 3 should be so available. However, a final decision (and possible further associated computations) should await further consideration by the forthcoming Scientific Committee meeting given the results of the calculations specified in Item 8.2, and giving attention also to the extent to which it is necessary to pool data to estimate *w*.

8.4 Plausible range for *g*(0)

There are no direct estimates of $g(0)$ for the western North Pacific Bryde's whales. Abundance estimates discussed in the preceding two sections are all based on the assumption that $g(0) = 1$. The Workshop **agreed** that the true value of $g(0)$ would be less than this, and noted that if values for $g(0)$ lower than this are to be considered in trials, the lower limit for the plausible range for the value of $g(0)$, which might be used in the conditioning of trials, needs to be pre-agreed before the *Implementation* process begins.

The Workshop considered that the upper bound for the plausible range for $g(0)$ could be set at 1, and that a decision on the value for the lower bound for this range should be made at the forthcoming Scientific Committee meeting, taking account of evaluations (both quantitative and qualitative) to be reported in one or more papers whose presentation at that meeting was encouraged.

The Workshop also noted that if *Implementation Simulation Trials* are to consider abundance estimates input to the *CLA* which involve estimation of $g(0)$, it is important that such trials also consider the implications of errors in those estimates.

8.5 Plans for future surveys

The Workshop noted that full coverage of the blocks shown in Annex F would require surveys spanning at least four years. Japan provided advice on such a survey plan, which is reflected in Table 4.

Given that no surveys took place in 2003 and 2004, that none is planned for 2005, and that an allowance of one year must be made for the time between a survey and the earliest date by which associated abundance estimates might become available for input to the *CLA*, it was evident that the RMP's eight-year phase-out rule would apply to catch limits computed for at least a part of the overall distributional area of the resource for both 2006 and 2007. This was considered undesirable in the context of *Implementation trials*, as it would complicate the interpretation of short-term performance statistics from such trials. However, it was also noted that the time required for the scientific components of the *Implementation* process meant that the earliest year that the RMP might be implemented for western North Pacific Bryde's whales was 2008. The Workshop accordingly **recommended** that when the specific details of trials come to be finalised, this fact be taken into account when defining performance statistics, to be able to avoid possible difficulties of interpretation arising from application of the phase out rule in earlier years.

The Workshop noted that since survey plan options for trials need to be finalised only at the stage of the 'First Annual Meeting' during the *Implementation* process, there remained the opportunity to propose further survey plans to the one suggested in Table 4 until that time.

Table 4
Sighting survey plan for the western North Pacific stock of Bryde's whales.

	Sector			
Season	130°E-145°E	145°E-165°E	165°E-180°	180°-155°W
2006		○		
2007			○	
2008	○			
2009				○
2010				
2011				
2012		○		
2013			○	
2014	○			
2015				○
2016				
2017				
2018		○		
2019			○	
2020	○			
2021				○

9. OTHER ISSUES

9.1 Reviewing the information to estimate dispersal and mixing rates

ISTs distinguish dispersal (permanent transfer of individuals between breeding stocks) and mixing (temporary movement of animals spatially). The data ideally needed to estimate dispersal and mixing rates depends on the structure of the trials being conditioned. The Workshop therefore discussed this issue fairly generically.

9.1.1 Information related to mixing rates

The information available to estimate mixing rates are the tagging data (Kishiro, 1998). The Workshop noted that the Committee identified a means of estimating mixing rates between putative sub-stocks in sub-area 1 when it developed the initial set of *ISTs* for the western North Pacific Bryde's whales. However, this approach has never been implemented. The Workshop believed that an attempt should be made to implement the approach of IWC (2000c) using the simple model filter. This will allow the Committee to evaluate whether the algorithm identified in 1999 is appropriate and the results may inform the process of developing trials. This work needs to be completed no later than the First Intersessional Meeting. A Steering Group (Punt (chair), Allison, Kishiro and Kawahara) was established to co-ordinate this work.

9.1.2 Information related to dispersal rates

The dispersal rates used in the *ISTs* for the North Pacific common minke whales were estimated using mtDNA data and estimates of the number of mature females at carrying capacity. Estimates of the latter for the western North Pacific Bryde's whales will not be available until the first simulation trials are conditioned, although preliminary estimates could be obtained using the simple model filter.

9.2 Specification of biological and technological parameters

9.2.1 Biological and technological parameters

The Workshop reviewed the specifications for the biological and technological parameters selected by the Scientific Committee in 1999 (IWC, 2000c):

(1) the selectivity pattern for the coastal fishery: knife-edged at age 5;
(2) the selectivity pattern for the pelagic fishery: knife-edged at age 9;
(3) the age-at-sexual maturity: 8 years (an age-at-first-parturition of 9 years);
(4) the sex ratio at birth: 1:1; and
(5) the rate of natural mortality: $0.07yr^{-1}$.

The Workshop **agreed** that there was no new information to revise these values and **recommended** that they be used in future *ISTs*.

9.2.2 MSYR

The Comprehensive Assessment conducted HITTER analyses for the western North Pacific Bryde's whales based on the range 0-6% for MSYR in terms of the mature female component of the population (MSYR(mature)), and agreed that 1% is a reasonable lower bound (IWC, 1997, p. 166). The *ISTs* for the North Pacific minke whales considered a range of 1-4% for MSYR(mature). The Scientific Committee discussed the relative plausibility of MSYR(mature)=1% and MSYR(mature)=4% for North Pacific minke whales in considerable detail and several views emerged. Eventually, the Committee agreed to treat trials with MSYR(mature)=4% as having a 'high' plausibility, and those with MSYR(mature)=1% as having 'medium' plausibility (IWC, 2004b, pp. 82-83).

There are no data which could be used to estimate MSYR for the western North Pacific Bryde's whales. However, it might be possible to use data on calving intervals to constrain the plausible range. The Workshop therefore **recommended** that data on calving intervals and their possible implications for the range for values of MSYR(mature) that should be used in *ISTs* should be summarised and presented to the Scientific Committee no later than the First Annual Meeting.

9.3 Future work

(1) The approach of IWC (2000c, pp. 122-123) to estimate mixing rates should be implemented using the simple model filter and the results presented to the Scientific Committee no later than the First Intersessional Workshop.
(2) Data on calving intervals and their possible implications for the range for values of MSYR(mature) that should be used in *ISTs* should be summarised and presented to the Scientific Committee no later than the First Annual Meeting.

10. OTHER BUSINESS

There was no other business.

11. INITIAL DISCUSSIONS OF EXPERIMENTAL WAYS TO DISTINGUISH AMONG COMPETING HYPOTHESES

It was **agreed** that there was no need to consider this Item at this stage.

12. RECOMMENDATIONS TO THE SCIENTIFIC COMMITTEE

12.1 Progress on the *pre-Implementation assessment*

The Workshop examined the criteria for deciding whether the *pre-Implementation* process was complete and an *Implementation* could begin as given in IWC (2005, pp.85-6) with respect to catch data, abundance, stock hypotheses, dispersal rates, data for conditioning. Provided the recommendations in this report are followed, the Workshop **recommends** to the Committee that it considers the *pre-Implementation* process completed.

13. ADOPTION OF REPORT

The Chair thanked the participants for their constructive attitude to the complex and difficult discussions at the Workshop. In particular he wished to thank the rapporteurs, the Institute of Cetacean Research for their gracious hosting of the meeting and the interpreters who worked with great good humour and patience (especially valuable when translating Doug Butterworth's interventions) for long hours.

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Annex B

Agenda

1. Convenor's opening comments
2. Election of Chair and appointment of rapporteurs
3. Adoption of agenda
4. Review of documents
5. Report of the Intersessional Steering Group
6. Catches
   - 6.1 Review of information on the accuracy of catch reports
   - 6.2 Information regarding incidental catches
   - 6.3 Development of a set of alternative catch series for use when conditioning trials
   - 6.4 Spatial dis-aggregation of catch
   - 6.5 Areas and timing of future harvesting
7. Stock structure
   - 7.1 New information
     - 7.1.1 New analysis methods
     - 7.1.2 Power to detect differences within sub-area 1 using genetic methods
     - 7.1.3 Relationship between whales to be surveyed and those in the Southern Hemisphere
     - 7.1.4 Non-genetic information related to stock structure
   - 7.2 Description of stock hypotheses
   - 7.3 Results from the 'simple model filter'
   - 7.4 Assigning plausibility ranks to alternative simulation trials
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8. Abundance estimates
   - 8.1 General issues
   - 8.2 Selection of the years and areas for which abundance estimates will be available for use in conditioning of trials
   - 8.3 Selection of the years and areas for which abundance estimates will be available for use in the CLA in trials
   - 8.4 Plausible range for $g(0)$
   - 8.5 Plans for future surveys
9. Other issues
   - 9.1 Reviewing the information to estimate dispersal rates
     - 9.1.1 Information related to mixing rates
     - 9.1.2 Information related to dispersal rates
   - 9.2 Specification of biological and technological parameters
     - 9.2.1 Biological and technological parameters
     - 9.2.2 MSYR
   - 9.3 Future work
10. Other business
11. Initial discussions of experimental ways to distinguish among competing hypotheses.
12. Recommendations to the Scientific Committee
    - 12.1 Progress on the *pre-Implementation assessment*
    - 12.2 Other
13. Adoption of report

Annex C

List of Documents

SC/M05/BR

1. Miyashita, T. and Okamura, H. Distribution of Bryde's whales in the North Pacific revealed from whale sighting surveys covering wide longitudinal rage in 2001.
2. Hatanaka, H. and Kawahara, S. An examination of the catch history of Western North Pacific Stock of Bryde's whale.
3. Kitakado, T., Kanda, N. and Pastene, L.A. A prospective evaluation of statistical power for population identification under island models.
4. Kitakado, T., Kanda, N. and Pastene, L.A. A retrospective evaluation of statistical power for population identification in western North Pacific Bryde's whales.
5. Kitakado, T., Kanda, N. and Pastene, L.A. Preliminary Bayesian analyses for population identification using mtDNA in western North Pacific Bryde's whales.
6. Pastene, L.A. Relationship between Bryde's whales to be surveyed and harvested in the western North Pacific and those in the Southern Hemisphere stock.
7. Ohsumi, S. Estimation of number of western North Pacific Bryde's whales stock caught by Japanese coastal whaling before 1946.

Annex D

List of whaling operations that could have caught Western North Pacific Bryde's whales[1] together with a summary of the extent of data available for each operation and year

Key:
Y (totals) = Catch taken. Only data are total catches.
Y (LS) = Catch taken. Numbers of sei/Bryde's known by land station, 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*) = Catch taken. Individual data (including date and sex). Data in IWC database does not differentiate sei/Bryde's but data will be supplied by Japan.
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.

Table 1

Whaling operations that could have caught Bryde's whales, 1899-2003.

Year	Japan Coastal except Bonin Islands	Japan: Bonin Islands	Japan Pelagic except Bonin Islands	Republic of China	Philippines	USSR Pelagic
1899	0[2]					
1900	0					
1901	0					
1902	0					
1903	0					
1904	0					
1905	0					
1906	Y (totals)[3]					
1907	Y (totals)					
1908	Y (totals)					
1909	Y (totals)					
1910	Y (totals)					
1911	Y (LS)[4]					
1912	Y (LS)					
1913	Y (LS)					
1914	Y (LS)					
1915	Y (LS)					
1916	Y (LS)					
1917	Y (LS)					
1918	Y (LS)					
1919	Y (LS)					
1920	Y (LS)					
1921	Y (LS)					
1922	Y (LS)					
1923	Y (LS)					
1924	Y (LS)					
1925	Y (LS)					
1926	Y (LS)					
1927	Y (LS)					
1928	Y (LS)					
1929	Y (I: all sei)					
1930	Y (LS)					
1931	Y (LS)					
1932	Y (LS)					Y[5]
1933	Y (LS)					0[6]
1934	Y (LS)					0
1935	Y (LS)					0
1936	Y (LS)					0
1937	Y (LS)					0
1938	Y (LS)					0
1939	Y (LS)					0
1940	Y (LS)		0[7]			0
1941	Y (LS)		0			0
1942	Y (LS)					0
1943	Y (LS)					0
1944	Y (LS)					0
1945	Y (LS)					0
1946	Y (I: all sei)	Y (I)[8]				0
1947	Y (I: all sei)	Y (I)				0

Cont.

Table 1 cont.

Year	Japan Coastal except Bonin Islands	Japan: Bonin Islands	Japan Pelagic except Bonin Islands	Republic of China	Philippines	USSR Pelagic
1948	Y (I: all sei)	Y (I)				0
1949	Y (I: all sei)	Y (I)				0
1950	Y (I: all sei)	Y (I)				0
1951	Y (I: all sei)	Y (I)				0
1952	Y (I: all sei)	Y (I)	0[9]			0
1953	Y (I: all sei)		0			0
1954	Y (I: all sei)		0			0
1955	Y (I*)		0[10]			0
1956	Y (I*)		0			0
1957	Y (I*)		0			0
1958	Y (I*)		0			0
1959	Y (I*)		0			0
1960	Y (I*)		0			0
1961	Y (I*)		0			0
1962	Y (I*)		0			0
1963	Y (I*)		0			0
1964	Y (I*)		0			0
1965	Y (I*)[11]		0			0
1966	Y (I*)		0			Y (I)
1967	Y (I*)		0			Y (I)
1968	Y (I)		0			Y (I)
1969	Y (I)		0			Y (I)
1970	Y (I)		0			Y (I)
1971	Y (I)		Y (I)			Y (I)
1972	Y (I)		Y (I)			Y (I)
1973	Y (I)		Y (I)			Y (I)
1974	Y (I)		Y (I)			Y (I)
1975	Y (I)		Y (I)			Y (I)
1976	Y (I)		Y (I)	Y (Est, A)[12]		Y (I)
1977	Y (I)		Y (I)	Y (Est, A)		Y (I)
1978	Y (I)		Y (I)	Y (Est, A)		Y (I)
1979	Y (I)		Y (I)	Y (Est, A)		Y (I)[13]
1980	Y (I)			Y		
1981	Y (I)	Y (I)[14]				
1982	Y (I)	Y (I)				
1983	Y (I)	Y (I)			Y[15]	
1984	Y (I)	Y (I)			Y	
1985	Y (I)	Y (I)			Y	
1986	Y (I)	Y (I)				
1987	Y (I)	Y (I)				
1988-93						
1994-97			0			
1998			Y (I)[16]			
1999			0			
2000			Y (I)[17]			
2001			Y (I)			
2002			Y (I)			
2003			Y (I)			

[1]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.
[2]Norwegian style whaling began in Japan in 1899 at land stations off the Pacific side of South Eastern Japan, so do not include any Western North Pacific Bryde's whales.
[3]Whaling in Japan expanded into new areas where Bryde's whales were probably taken.
[4]Japan began keeping records in 1911. Ohsumi will provide 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.
[5]*Aleut* in 1932 catching in the 'tropical zone of the Pacific Ocean', 3 sei whales caught.
[6]Soviet factory ships operating off Kamchatka where Bryde's whales are not found.
[7]Catching in Bering Sea where Bryde's whales are not found.
[8]Catches by factory ships 1946-52.
[9]1952-54: Sei/Bryde's not differentiated in data but operating North of Bryde's whale grounds.
[10]1955-70: Catch data differentiates sei/Bryde's but no Bryde's taken (in early period operating to North of Bryde's whale grounds).
[11]Kondo and Kasuya data for Nihon Hogei differs from official data 1965-76.
[12]Brownell, R.L. 1981. Report of the sub-committee on 'other baleen whales'. Appendix 7. Taiwan whaling. *Rep. Int. Whal. Comm.* 31:132.
[13]Last year of USSR pelagic operations.
[14]Land station at Ogasawara 1981-87. Kondo and Kasuya data differs from official data.
[15]Perrin, pers. comm.
[16]1 whale taken by accident during special permit operation.
[17]Special permit catch.

Annex E

Available Data/Information and Stock Structure Hypotheses

The data/information taken into account when the stock hypotheses were developed and which were used by the Workshop are listed below. This information will be considered further when plausibility is assigned to simulation trials at the First Annual Meeting.

1. One stock scenario
Evidence in support of the one stock scenario is:

(a) Allozyme studies found no significant genetic heterogeneity in sub-areas 1 and 2 (Wada, 1996).
(b) Analysis of body proportion data found no significant differences among whales from three localities in sub-areas 1 and 2 (Kato and Yoshioka, 1995).
(c) Analyses of biological parameters found no significant differences among three localities in sub-areas 1 and 2 (Kato and Yoshioka, 1995).
(d) Sighting distribution analyses show no clear geographical discontinuity in sub-areas 1 and 2 (Shimada and Miyashita, 1995 and SC/M05/BR1).
(e) Catch distribution analyses show no clear geographical discontinuity in sub-areas 1 and 2 apart from a gap between 150° and 160°E which is explained by operational factors (IWC, 1999, p.76).
(f) No significant DNA heterogeneity (mtDNA and microsatellites) was found among three localities in sub-area 1 (the most recent papers are Goto *et al*., 2004; Shimada, 2004; Martien and Taylor, 2004; SC/M05/BR5; analysis of power of the genetic analysis methods is presented in SC/M05/BR3, SC/M05/BR4).
(g) No significant departure from Hardy-Weinberg equilibrium from 17 microsatellite loci was found from animals sampled from sub-area 1 (Pastene *et al*., 2004). This indicates a lack of sub-stock structure in sub-area 2, but the power of the analysis approach has yet to be evaluated.
(h) Mark-recapture analysis showed annual north-south migration between northern summer grounds and southern winter grounds. Whales are widely distributed longitudinally with no clear geographical discontinuity in sub-area 1 (Kishiro, 1996; Kishiro, 1998).

2. Two stock scenario
Currently there is no scientific evidence suggesting the existence of a different stock in sub-area 2. However, the possibility of additional stock structure in that sub-area can not be ignored because there is insufficient data on DNA and mark-recaptures east of 180°.

3. Two-stock scenario with two sub-stocks that mix in sub-area 1
Currently there is no scientific evidence suggesting the existence of two sub-stocks that mix in sub-area 1. However, the possibility of such stock structure cannot be ignored because there are no genetic data for the breeding grounds.

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International Whaling Commission. 1999. Report of the Scientific Committee. Annex D. Report of the Sub-Committee on the Revised Management Procedure. *J. Cetacean Res. Manage. (Suppl.)* 1:61-116.

Kato, H. and Yoshioka, M. 1995. Biological parameters and morphology of Bryde's whales in the western North Pacific, with reference to stock identification. Paper SC/47/NP11 presented to the IWC Scientific Committee, May 1995 (unpublished). 19pp. [Paper available from the Office of this Journal].

Kishiro, T. 1996. Movements of marked Bryde's whales in the western North Pacific. *Rep. int. Whal. Commn* 46:421-8.

Kishiro, T. 1998. Further analysis of the mark-recapture data of the western North Pacific Bryde's whales by a unit of five degree square latitude-longitude. Paper SC/50/RMP18 presented to the IWC Scientific Committee, April 1998 (unpublished). 13pp. [Paper available from the Office of this Journal].

Martien, K.K. and Taylor, B.L. 2004. Analysis of population structure in western North Pacific Bryde's whales using three clustering methods. Paper SC/56/PFI3 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 10pp. [Paper available from the Office of this Journal].

Pastene, L., Goto, M. and Kanda, N. 2004. An update of the mitochondrial DNA and microsatellite analyses in western North Pacific Bryde's whale. Paper SC/56/PFI4 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 9pp. [Paper available from the Office of this Journal].

Shimada, H. 2004. Abundance estimate of the western North Pacific stock of Bryde's whales using sighting data from 1998 to 2002. Paper SC/56/PFI6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 8pp. [Paper available from the Office of this Journal].

Shimada, H. and Miyashita, T. 1995. Estimation of current population size of the western North Pacific Bryde's whale using sightings data from 1988 to 1994. Paper SC/47/NP9 presented to the IWC Scientific Committee, May 1995 (unpublished). 9pp. [Paper available from the Office of this Journal].

Wada, S. 1996. The stability of *Got-1f* frequencies of the western North Pacific stock of Bryde's whales. *Rep. int. Whal. Commn* 46:459-60.

Annex F

Information on Abundance Estimates for the Western North Pacific Stock of Bryde's Whales from Sightings Data and Maps Showing Tracklines Surveyed in the August-September Period

Table 1

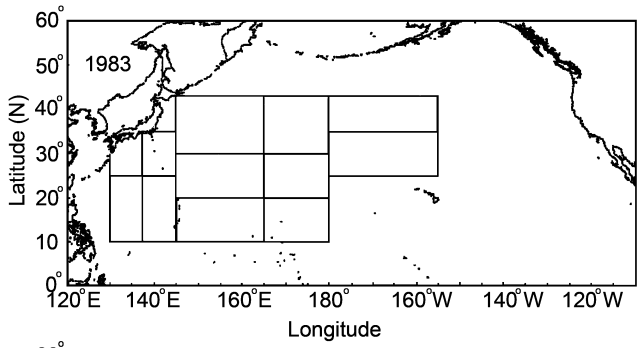
Bryde's whale abundance estimates in the western North Pacific.

Season and month	Area	Survey method	IWC SC oversight	Analytical method	Abundance est. (CV)	Ref.	Remarks
1998-2002 Aug.-Sep.	Sub-area 1 (10°N-43°N,130°E-180°), Sub-area 2 (25°N-43°N,180°-155°W)	Shipboard sighting survey systematically covered stock distribution range without overlap. The methodology was authorized by the SC.	Yes	Line-transect, no *g*(0) correction.	26,172 (0.240)	1	The survey was conducted following the Guideline for Conducting Surveys within RMS. Additional variance needs to be quantified.
1988-96 Aug.-Sep.	0°-45°N, 130°E-155°W	Shipboard sighting survey but not systematically covered the research area.	No oversight system	Line-transect, no *g*(0) correction.	21,901 (0.188)	2	Additional variance needs to be quantified.
1988-96 Aug.-Sep.	0°-45°N, 130°E-155°W	Shipboard sighting survey but not systematically covered the research area.	No oversight system	Line-transect, no *g*(0) correction, GLM analysis to take the influence of co-variates (year, ship, environmental factors) into account.	25,317 (0.184)	3	
1983 Jun.-Jul. 1984 Jun.- Aug.	20°N-40°N, 130°E-170°E (35% of Sub-area 1)	Shipboard sighting survey but not systematically covered the research area.	No oversight system	Line-transect, no *g*(0) correction.	12,545 (0.326) 10,875 (0.230)	4	

References:

1. Shimada, H. 2004. Abundance estimate of the western North Pacific stock of Bryde's whales using sighting data from 1988 to 2002. Paper SC/56/PFI6 presented to the IWC Scientific Committee, July 2004, Sorrento, Italy (unpublished). 8pp. [Paper available from the Office of this Journal].
2. Shimada, H. and Miyashita, T. 1997. Population abundance of the western North Pacific Bryde's whale estimated from the sighting data collected from 1988 to 1996. Paper SC/49/Np4 presented to the IWC Scientific Committee, September 1997, Bournemouth (unpublished). 9p. [Paper available from the Office of this Journal].
3. Okamura, H. and Shimada, H. 1999. Abundance estimation method using multi-year sighting data and the application to the western North Pacific. Paper SC/51/RMP18 presented to the IWC Scientific Committee, May 1999, Grenada, WI (unpublished). 13pp. [Paper available from the Office of this Journal].
4. Miyashita, T. 1989. Population estimate for the Bryde's whale stock western North Pacific. Paper SC/40/Ba3 presented to the IWC Scientific Committee, May 1988, San Diego, USA (unpublished). 14pp. [Paper available from the Office of this Journal].

[*Figure on following pages*]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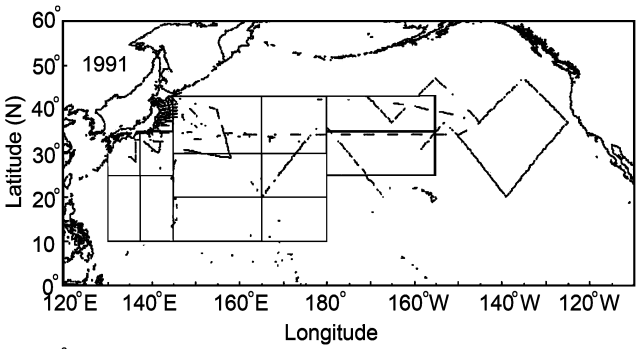
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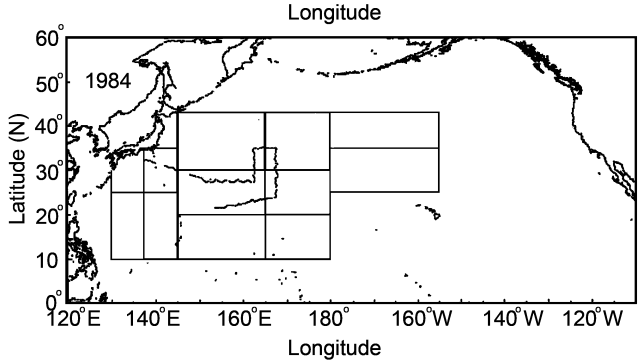
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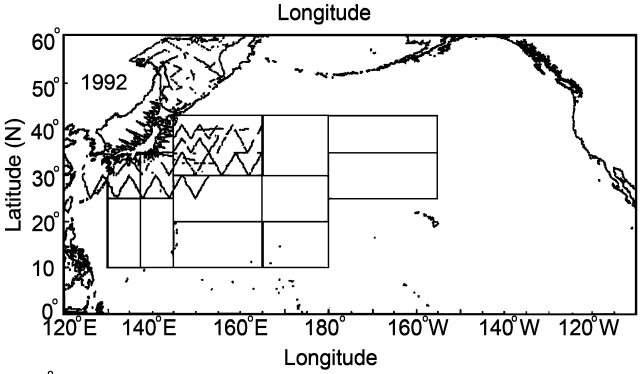
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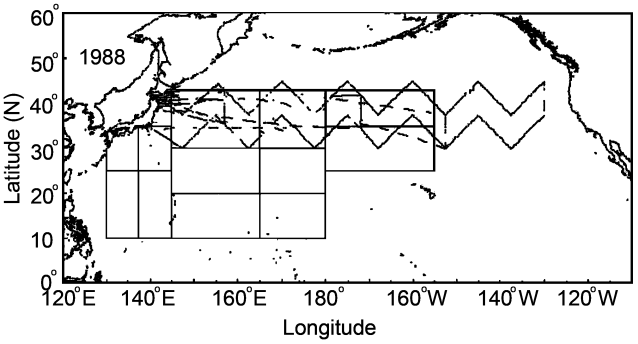
1988
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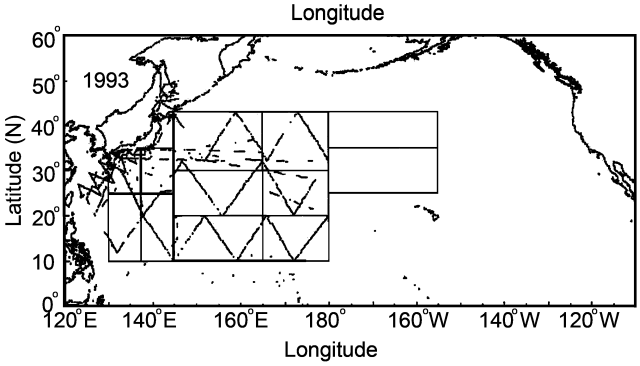
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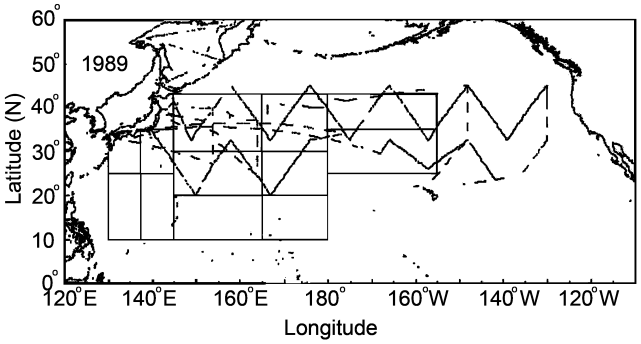
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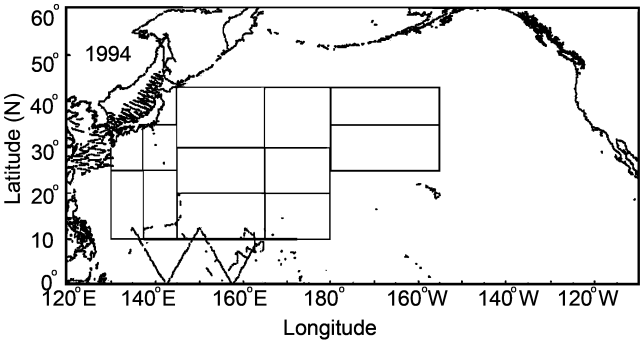
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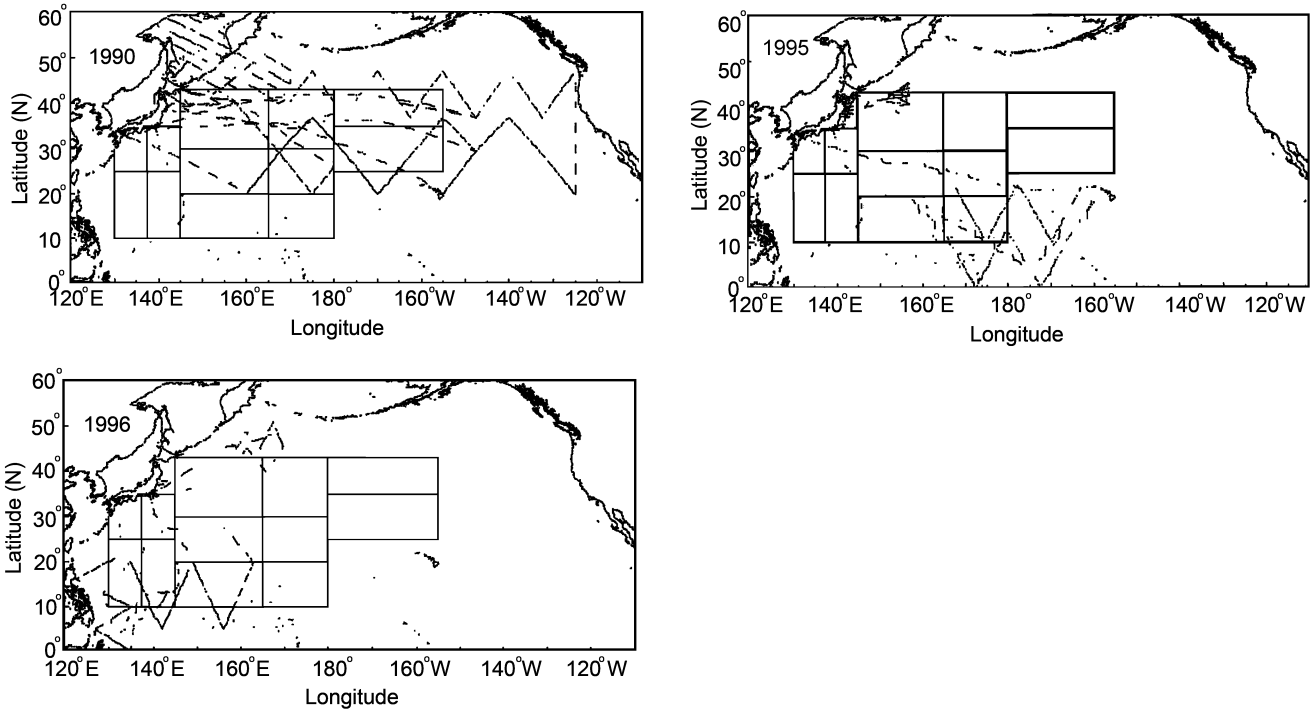

Fig. 1. Survey tracks during August-September for surveys over the period 1983-1996.

Annex G

Mixed Linear Model to be Used to Provide Abundance Estimates for Conditioning

The model to be used is:

$$\ell nN_{y,a} = \ell nN_0 + by + \mu_a + \nu_{y,a} + \varepsilon_{y,a} \quad (1)$$

where:

$N_{y,a}$ is the survey abundance estimate for year *y* and stratum *a*;

N_0, b are the parameters of assumed exponential growth in the overall abundance during the period of surveys considered (1983–2002);

μ_a is the logarithm of the expected proportion of the overall abundance in stratum *a*;

$\nu_{y,a}$ reflects random variability in the proportion of the abundance in stratum *a* from year to year, and is assumed to be distributed as $N(0,\sigma^2)$; and

$\varepsilon_{y,a}$ reflects the estimated survey sampling error for $N_{y,a}$; the associated variance-covariance matrix takes account of common estimates of effective search half-width *w* used for groups of year-stratum estimates of abundance.

The output from the model is a set of estimates for abundance in each year and stratum:

$$\hat{N}_{y,a} = \ell \mathrm{n}\hat{N}_0 + \hat{b}y + \hat{\mu}_a + \hat{\nu}_{y,a} \quad (2)$$

together with the associated variance-covariance matrix and additional variance $\hat{\sigma}^2$.

In the interests of simplicity (i.e. keeping the model linear), the random effects $\nu_{y,a}$ are not constrained to sum to zero each year. This can be considered to reflect an annually varying proportion of the overall population abundance located outside all the strata surveyed.

Estimates will be computed using the package lmm.