Updated estimation of prey consumption by common minke, Bryde's and sei whales in the western North Pacific

TSUTOMU TAMURA, KENJI KONISHI AND TATSUYA ISODA

Institute of Cetacean Research, 4-5, Toyomi-cho, Chuo-ku, Tokyo, 104-0055, Japan.
Contact e-mail: tamura@cetacean.jp

ABSTRACT

The stomach contents of common minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sei (*B borealis*) whales, sampled in the western North Pacific from May to October in 2000-2014 by the Japanese Whale Research Program under Special Permit in the western North Pacific (JARPNII) were collected and examined. The main purpose of this study was to estimate the amount of fish resources consumed by the three baleen whale species, accounting for some uncertainties. Prey species of whales were identified by examining their stomach contents, and the amount of prey consumed in the research area was estimated by using information on prey consumption *per capita* and the numbers of whales distributed. There were seasonal and geographical changes of the prey species of each whale species. The extent of differences of estimates of consumptions among several models was 2.4-3.6 times. Based on the results obtained by three equations combined and Monte Carlo simulations, the daily prey consumptions *per capita* of common minke whales were 86-94kg and 83-94kg for immature male and female; and 129-141kg and 158-166kg for mature male and female, respectively. The daily prey consumptions *per capita* of Bryde's whales were 419-434kg and 417-428kg for immature male and female; and 577-637kg and 642-707kg for mature male and female, respectively. The daily prey consumptions *per capita* of sei whales were 397-421kg and 436-468kg for immature male and female; and 524-539kg and 610-647kg for mature male and female, respectively. The CVs of the daily prey consumption consumed by whales *per capita* were in the range 0.2-0.3. The seasonal prey consumption during May-September in the two periods (2000-2007, 2008-2013) by three baleen whale species were 1.1 and 1.2 million tons, respectively. The prey consumption of Japanese anchovy, mackerels and Pacific saury by three baleen whale species in the two periods were estimated as 674-724 thousand tons, 43-70 thousand tons and 48-56 thousand tons, respectively. The CVs of the seasonal prey consumption consumed by whales were in the range 0.3-0.4. These values were equivalent to 22-48%, 5-66% and 2-7% of the biomass of each fish resources in the western North Pacific. These estimates on prey consumption will be useful as input data in ecosystem models.

KEYWORDS: COMMON MINKE WHALE; BRYDE'S WHALE, SEI WHALE, NORTH PACIFIC; SCIENTIFIC PERMIT

INTRODUCTION

Baleen whales feed on a variety of prey from small zooplankton to fish, playing an important role in the food web in the western North Pacific because of their large biomass. The Second Phase of Japanese Whale Research Program in the Western North Pacific (JARPNII) conducted samplings of baleen whale species such as common minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sei (*B. borealis*) whales that abundantly occur off the coast of Japan, and are important components of the ecosystem in their feeding grounds.

Although these three baleen whale species occur in the JARPNII research area, their feeding habits and distribution differ. Common minke whale feed on zooplankton and large sized fish and squids such as Pacific saury (*Cololabis saira*), mackerels (*Scomber japonicus*, *S. australasicus*), walleye pollock (*Gadus chalcogrammus*) and Japanese common squid (*Todarodes pacificus*) involving a wide range of prey size (Kasamatsu and Hata, 1985; Kasamatsu and Tanaka, 1992). The information on feeding habitat in the Bryde's whales was available from the commercial whaling period, and showed that krill, Japanese anchovy (*Engraulis japonicus*), Chub mackerel (*Scomber japonicus*), Japanese sardine (*Sardinops melanostictus*), and horse mackerel (*Trachurus japonicus*) were preys of this whale species in the western North Pacific (Nemoto, 1959). The sei whale is known to feed on a wide spectrum of marine animals such as krill, Japanese anchovy, chub mackerel, Pacific saury and Japanese common squid. According to Nemoto (1962), sei whales feed mainly copepods in the northern part of the North Pacific, but they likely feed on fishes and squids off the Pacific coast of northern Japan. In the southern Aleutian waters, Pacific saury was also reported as important prey for sei whales (Nemoto, 1959; Kawamura, 1982).

It should be noted that for previous studies based on commercial whaling, only qualitative information of stomach contents was available, and the quantitative information was very limited. This was due to the fact that the stomachs were usually cut in breaking the abdominal cavity to keep meat fresh.

The Japanese Whale Research Program under Special Permit in the western North Pacific (JARPN) was conducted between 1994 and 1999. JARPN had two main objectives: a) population structure and b) feeding ecology of common minke whales in the western North Pacific. During JARPN surveys, qualitative and quantitative data on prey consumption of common minke whales in the western North Pacific were obtained. Results of some feeding ecology studies on common minke whales based on JARPN are available (Tamura, 1998; Tamura *et al*., 1998; Tamura and Fujise, 2002; Lindstrom *et al.,* 1998).

Based on results of JARPN review, it was proposed that JARPN be continued and developed to a second phase: JARPNII (Government of Japan, 2000, 2002). The first objective of JARPNII is feeding ecology issues. The overall goal of the JARPNII was to contribute to the conservation and sustainable use of marine living resources including whales in the western North Pacific, especially within Japan's EEZ.

In 2009, the JARPNII review workshop was conducted by IWC/SC (IWC, 2010). Results on prey consumption by common minke, Bryde's and sei whales were presented (Tamura *et al*, 2009a, b). Regarding the prey consumption rate estimates presented (Tamura *et al*., 2009a, b, c), one of the major concern of the workshop was related to the lack of full treatment of uncertainty. As part of the treatment of uncertainty the workshop recommended that the analyses of the JARPNII data should: (a) incorporate the use of several reasonable models and include the range of possible results in reporting the work; (b) use that range in subsequent analyses (including any ecosystem modelling) that employ these daily/annual consumption estimates and (c) undertake sensitivity analyses for the range of parameter values used in the consumption equations (IWC, 2010).

The purpose of this study was to update the estimates of prey consumption by common minke, Bryde's and sei whales by taking into consideration the recommendations from the 2009 JARPNII review workshop, accounting for some uncertainties.

MATERIALS AND METHODS

Research area, year and sample size

The research area of the JARPNII comprised part of sub-areas 7, 8 and 9 (IWC, 1994) (Figure 1). A total of 1,480 minke whales, 680 Bryde's, and 1,195 sei whales were examined in this study (Table 1). After sampling, whales were brought to the research base vessel where the animals were examined by a biologist on board. All whales were sampled during daylight hours, between 06:00 and 19:00h (ship time).

Sampling and treatment of stomach contents from whales

Baleen whales have four chambered stomach systems (Hosokawa and Kamiya, 1971; Olsen *et al*., 1994). The stomach contents remain in the forestomach (1st. stomach) and fundus (2nd. stomach).

The stomach contents were removed from each compartments and weighed to the nearest 0.1kg on the ship's flensing deck after capture. The analysis of prey consumption in this study was based on data collected from the first compartment (forestomach) and second compartment (fundus). A sub-sample (1-5kg) of stomach contents was removed and frozen and/or fixed with 10% formalin water for later analyses. The stomach contents were transferred to a system consisting of three sieves (20mm, 5mm and 1mm), which were applied in the Norwegian scientific research to filter off liquid from the rest of the material (Haug *et al.* 1995).

To examine the daily feeding rhythms of the whales, the freshness of prey in the forestomach was categorized into four digestion levels:

F = fresh (prey not affected by digestion),

fff = lightly digested (prey slightly affected by digestion),

ff = moderately digested (prey moderately to highly fragmented), and

f = heavily digested (unidentifiable remains or indigestible parts only).

Data analyses

Biological data
An estimate of the daily prey consumption requires the use of some additional biological and morphometric data. Body length of the whales was measured to the nearest 1cm from the tip of the upper jaw to the deepest part of the fluke notch in a straight line. Body weight was measured using large weighing machine to the nearest 50kg. Energy requirements are different for sexual maturity classes; therefore, estimations of the daily prey consumption in this study took into consideration information on sexual maturity. Sexual maturity of each whale was defined by testis weight and ovaries observation.

Prey species identification and stomach contents weight
In the laboratory prey species in the sub-samples were identified to the lowest taxonomic level as possible. Undigested preys were identified using morphological characteristic, based on different sources: copepods (Brodskii, 1950), euphausiacea (Baker *et al*., 1990), squids (Kubodera and Furuhashi, 1987) and fish (Masuda *et al*., 1988; Chihara and Murano, 1997). The otoliths and jaw plate were used to identify the fish with advanced stage of digestion (Morrow, 1979; Ohe, 1984; Kubodera and Furuhashi, 1987; Arai, 1993).

When undigested fish and squid were found, fork length, mantle length and the weights were measured to the nearest 1mm and 1g, respectively. This data were used for restoring their stomach contents with advanced stage of digestion.

The total number of each fish and squid species in the sub-sample were calculated by adding to the number of undigested fish or squid, undigested skulls and half the total number of free otoliths. The total weight of each prey species in the sub-sample was estimated by multiplying the average weight of fresh specimens by the number of individuals. The total number and

weight of each prey species in the stomach contents were estimated by using the figures obtained from the sub-sample and the total weight of stomach contents.

Prey composition (W %) in each season and period
In order to simplify the comparison of feeding indices, prey species were divided as follow: copepods (*Neocalanus cristatus*, *N. plumchrus*, *Calanus* sp.), krill (*Euphausia pacifica*, *E. similes*, *E. gibboides*, *Thysanoessa gregaria*, *Nematoscelis difficilis*), Japanese anchovy, Japanese sardine (*Sardinops melanostictus*), Pacific saury, walleye pollock, Mackerels, oceanic lightfishes (*Vinciguerria nimbaria; Maurolicus japonicus*), other squids (Japanese common squid, minimal armhook squid (*Berryteuthis anonychus*), and others) and other fishes (Japanese pomfret (*Brama japonica*), Atka mackerel (*Pleurogrammus monopterygius*), Salmonidae).

The relative prey composition (*%*) in weight of each prey species (*RW*) in each season and period was calculated as follows:

$RW = (W_i / W_{all}) \times 100$

W_i = the weight of contents containing prey group *i*

W_{all} = the total weight of contents analyzed.

Estimation of daily and seasonal prey consumption in each whale species

Daily prey consumption

The amount of prey consumption consumed by three baleen whale species is estimated using theoretical energy requirement calculations. The uncertainties associated to the relevant parameters were treated by Monte Carlo simulations.

The daily prey consumption (D_{kg}) in each sexual maturity class was estimated from the standard metabolic rate (SMR_{kJ}) and energy deposit according to the following equations:

$D_{kg} = SMR_{kJ} / (E_{KJ} * AE)$ (1)

Where D_{kg} is daily prey consumption (kg day^{-1}), SMR_{kJ} is the standard metabolic rate (kJ day^{-1}), E_{kJ} is the caloric value of prey species (kJ kg^{-1}), and *AE* is Assimilation efficiency (%).The details of these items are described as follows:

SMR (STANDARD METABOLIC RATE, ALLOMETRIC RELATIONSHIPS)
The uncertainty in several components involved in estimating the amounts and types of prey consumed by whales was assisted by a recent review by Leaper and Lavigne (2007) and Tamura *et al.* (2009c). They considered that the appropriate consumption estimates is between the high end of Equation 1 and the low end of Equation 2. The estimate of consumption by Equation 3 was considered by the authors at the upper range of these reasonable values. Equation 4 is used by PICES for estimating prey consumption of marine mammals (Hunt *et al.*, 2000).

Equation 1: $BMR = 0.42 M^{0.67}$ (Innes *et al.*, 1986) (2)

Equation 2: $SMR = 2,529.2 M^{0.524}$ (Boyd, 2002) (3)

Equation 3: $SMR = 863.6 M^{0.783}$ (Sigurjónsson and Víkingsson, 1997) (4)

Equation 3-1: $SMR = 690.36 M^{0.783}$ (Revised from Sigurjónsson and Víkingsson, 1997) (5)

Equation 4: $SMR = 803.71 M^{0.75}$ (Perez *et al*, 1990) (6)

SMR is the daily prey consumption (expressed by KJ day^{-1}) and *M* is body mass in kg. It should be noted here that the estimates from Equation 1 depend only on the body weight data (expressed in kg). The estimates from Equations 2, 3 and 4 require body weight data (expressed in kg) and energy content of prey (expressed in KJ kg^{-1}). Equation 3.1 excluded an *AE* value of 80% from Equation 3. In this study, three equations (Equations 2, 3-1 and 4) were used in the sensitivity analysis with 10,000 Monte Carlo simulations using the electronic software package (Oracle ® Crystal Ball: Release 11.1.2.3.). The details of these parameters are described as follows:

The mean, minimum and maximum body weight were calculated for each sexual maturity stage. These weights were obtained from JARPN and JARPNII survey. Body weight of each whale species sampled in each season was shown in Table 2. The body weight distribution in each sexual maturity assumed a triangular distribution with minimum, maximum and average values.

The mean caloric value of copepod (*Neocalanus cristatus, N. plumchrus*), krill (*Eupahusia pacifica*), Japanese sand lance, Japanese anchovy, Japanese sardine, Pacific saury, Chub mackerel, walleye pollock, oceanic lightfishes and Japanese common squid, mesopelagic squids (*Taningia danae, Histioteuthis dofleini, Belonella pacifica borealis*) were measured using bomb caloric meter (Table 3). These samples were obtained from the stomach contents of whales. Prey composition (Weight of %) of whales sampled were calculated in each period and season (Table 4).

3

The energy contents consumed by whales were calculated based on their prey composition in research area based on Tables 3 and 4 (Table 5). The distribution assumed a triangular distribution with minimum, maximum and average values.

Although an Assimilation Efficiency (*AE*) of 0.8 (80%) is commonly assumed, this value clearly vary with prey condition, size and species. The range of assimilation efficiency was assumed between 0.75 (75%) and 0.85 (85%) and used randomly in the sensitivity analysis. The distribution assumed a uniform distribution between 0.75 and 0.85.

Many baleen whales are generally known to migrate between the feeding ground in high latitudinal waters in summer and the breeding ground in low latitudinal waters in winter. There are some uncertainties, because the ratio of high feeding season and low feeding season (*r*) and the proportion (*P*) of the energy intake per year during high feeding season are assumed without actual data. For example, Lockyer (1981a) indicated that around 83% of the annual energy intake in Southern Hemisphere balaenopterid species is ingested during the summer season. If the days of high feeding season (*HD*) was 120 days and the rest days were low feeding season (*LD*), *r* becomes 0.10. Leaper and Lavigne (2007) was estimated the *r* to be from 0.34 (Antarctic minke whales) to 0.62 (North Atlantic minke whales) based on other literatures.

The *r* was calculated as following:

$$r = (365(1-P)) / (365-HD))/ (365P/HD) \qquad (7)$$

P is the proportion of amount during high feeding season per annual energy intake assumed.

The daily prey consumption of high feeding season was assumed to be the feeding index of high feeding season (*H index*). If the *HD* was 150days and the proportion of amount during high feeding season per annual energy intake assumed 80% (0.8), *H index* was 1.95. *HF* is the feeding index as a multiplicative factor greater than one. The *H index* was calculated as following:

$$H\ index = 365P / HD \qquad (8)$$

The range of *H* index was assumed between 1.42 and 2.74 and used randomly in the sensitivity analysis (Table 6). The distribution assumed a triangular distribution with minimum, maximum and average values (1.95).

Based on this assumption, the daily and seasonal prey consumption of high feeding season was calculated using Equations 2, 3-1, 4 and *H index*.

$$SMR\ of\ high\ feeding\ season = H\ index * SMR \qquad (9)$$

THE BODY MASS (*M*) OF EACH SEX AND REPRODUCTIVE STATUS OF WHALES
The composition of maturity stages of whales sampled is shown in Table 7. Males of minke, Bryde's and sei whales were defined as sexually mature by testis weight (larger side) of more than 290g, 560g and 1,090g, respectively (Bando *et al*., unpublished data). Female were defined as sexually mature by the occurrence of at least one corpus luteum or albicans in their ovaries. These criteria are practical ones and confirmed biologically (Bando *et al*, per com.).

The body mass data (< 22,000kg) were obtained directly by using the large electronic weighing system in JARPNII. If the body mass was over 22,000kg, we measured it separately. This method for obtaining the body mass data was evolved one compared with past methods. With regard to the measurement of body mass by sex and reproductive status, there seems to be little uncertainty.

UNCERTAINTIES ON SEASONAL PREY CONSUMPTION IN HIGH FEEDING SEASON
In the Southern Hemisphere, immature animals and mature male of Antarctic minke whale were estimated to spend 90 days in the feeding grounds, mature female spend 120 days (Lockyer, 1981a, b). Hinga (1979) assumed that baleen whales spend 120 days in the Antarctic (feeding area).

If the proportion of the energy intake per year during high feeding season was between 70-90%, the relationship between values of residence days in feeding area and percentage of annual prey consumption is as summarised in Table 6. The range of *H index* in minke, Bryde's and sei whales were estimated to be 1.95 (Range: 1.70-2.19) during 150 days of feeding (from May to September). These indexes were applied for estimating seasonal consumption of whales in the research area.

Uncertainty of the seasonal estimated numbers distributed of whales in each period and season was treated as following. The number of whales distributed in each region and year was estimated by Hakamada *et al*. (2009) and Hakamada and Matsuoka (2016: SC/F16/JR12) (Table 8). The population of baleen whales is sometimes segregated by sex and reproductive status. For example, mature male of common minke whale distribute dominantly in the research area, especially in offshore area such as sub-areas 8 and 9. The seasonal number of whales distributed (early and late) in each sex, reproductive status in each sub area and year were calculated (Tables 7 and 8).

Prey species abundance and fisheries catch information

JAPANESE ANCHOVY
Japanese anchovy is widely distributed in the western North Pacific. Some researches on biomass are conducted by the National Research Institute of Fisheries Science based on surface trawl net and echo sounder (Table 9).

MACKERELS
Mackerels are widely distributed in the western North Pacific. Some researches on biomass are conducted by the National Research Institute of Fisheries Science based on surface trawl net and echo sounder (Table 9).

PACIFIC SAURY
Pacific saury is widely distributed in the western North Pacific. Some researches on biomass are conducted in June and July since 2003 by the Tohoku National Fisheries Research Institute based on surface trawl net (Table 9).

RESULTS

Diet of whales in the study area

Common minke whales
A total of fourteen preys, including one species of copepod, two of euphausiids, two of squids and nine of fishes were identified in 1,480 stomachs of minke whales (Table 10).

Bryde's whales
A total of eighteen preys, including five species of euphausiids, one of squid and twelve of fishes were identified in 680 stomachs of Bryde's whales (Table 10).

Sei whales
A total of twelve preys, including three species of copepods, three of euphausiids, one of squid and five of fishes were identified in 1,195 stomachs of sei whales (Table 10).

Diurnal changes in feeding activity
The composition of freshness categories is shown in Figure 2. This figure shows that the proportion of fresh and lightly digested categories was high (> 37%), and there was no trend throughout the day.

Stomach contents weight and RSC

The average and maximum weight and the ratio of stomach contents weight to body weight, expressed as a percentage (RSC) of fresh or lightly digested stomach contents (freshness category F and fff) by different reproductive classes are shown in Table 11 by whale species.

Common minke whales
The average weights were 27.1kg and 34.9kg for immature males and females, respectively and 48.8kg and 62.1kg for mature males and females, respectively. The average and maximum of RSC in each sexual maturity of whales were around 1% and 3-4%, respectively.

Bryde's whales
The average weight and RSC were 106.8kg and 76.4kg for immature males and females, respectively and 118.7kgand 157.6kg for mature males and females, respectively. The average and maximum of RSC in each sexual maturity of whales were around 1% and 3-4%, respectively.

Sei whales
The average weight and RSC were 74.2kg and 69.2kg for immature males and females, respectively and 88.4kg and 145.3kg for mature males and females, respectively. The average and maximum of RSC in each sexual maturity of whales were around 0.5% and 3-4%, respectively.

The size distribution of main prey species consumed by common minke, Bryde's and sei whales

Japanese anchovy
The size distributions of Japanese anchovy in the stomach of three baleen whales are shown in Figure 3-1. Minke whale feed on larger anchovies (fork length ranged from 54 to 155mm with a single mode at 120-130mm). Bryde's whale feed on smaller anchovies (fork length ranged from 20 to 153mm with a single mode at 50-75mm).The fork length of Japanese anchovy ingested by sei whales ranged from 24 to 143mm with a single mode at 120mm.

Mackerels
The size distributions of mackerels in the stomach of three baleen whales are shown in Figure 3-2. Minke whale fed on the largest mackerels (fork length ranged from 70 to 280mm with a single mode at 240mm).

Pacific saury
The size distributions of Pacific saury in the stomach of three baleen whales are shown in Figure 3-3. No Pacific saury was found from the stomach contents of Bryde's whale. There were two modal distributions (standard length: 200-230mm and 300mm) in Pacific saury consumed by minke and sei whales, but minke whale fed on larger Pacific saury.

The daily prey consumption estimates *per capita* of each sex and reproductive status of each whale species in each model

The daily prey consumption estimates *per capita* of each sex and reproductive status were shown in Table 12 and Appendix 1, by whale species. The estimates of Eq-3-1 were 2.4-3.6 times larger than the estimates of Eqn. 2. The results of the calculation based on three equations combined were as following (10,000 Monte Carlo simulations).

Common minke whales
In early season (May and June), the daily prey consumption *per capita* was 86kg and 83kg for immature males and females, respectively; and 141kg and 166kg for mature males and females, respectively. In late season (From July to September), it was 94kg and 94kg for immature males and females, respectively; and 129kg and 158kg for mature males and females, respectively. The CVs were in the range 0.2-0.3.

Bryde's whales
In early season, the daily prey consumption *per capita* was 434kg and 417kg for immature males and females, respectively; and 637kg and 707kg for mature males and females, respectively. In late season, it was 419kg and 428kg for immature males and females, respectively and 577kg and 642kg for mature males and females, respectively. The CVs were in the range 0.2-0.3.

Sei whales
In early season, the daily prey consumption *per capita* was 421kg and 468kg for immature males and females, respectively; and 539kg and 647kg for mature males and females, respectively. In late season, it was 397kg and 436kg for immature males and females, respectively and 524kg and 610kg for mature males and females, respectively. The CVs was around 0.2.

The seasonal prey consumption in each research period

The seasonal prey consumption estimates were shown in Table 13 and Appendix 1, by whale species. The estimates of Eq-3-1 were 2.4-3.6 times larger than the estimates of Eqn. 2. Estimate of seasonal prey consumption based on three equations combined (10,000 Monte Carlo simulations) during May-September in two periods (2000-2007, 2008-2013) by three baleen whale species were 1.1 and 1.2 million tons, respectively. The prey consumptions of Japanese anchovy, mackerels and Pacific saury by three baleen whale species in the two periods were estimated as 674-724 thousand tons, 43-70 thousand tons and 48-56 thousand tons per year, respectively. The results for each whale species were the following.

Common minke whales
The seasonal prey consumptions in the 2000-07 and 2008-2014 periods were 82 thousand tons and 70 thousand tons, respectively. The CVs were around 0.3. They fed mainly on Japanese anchovy and Pacific saury. The consumptions of Japanese anchovy in the two periods were 34 thousand tons and 15 thousand tons, respectively. The consumptions of Pacific saury in the two periods were 40 thousand ton and 25 thousand tons, respectively. The CVs were in the range 0.3-0.5.

Bryde's whales
The seasonal prey consumptions in the 2000-07 and 2008-2014 periods were 502 thousand tons and 714 thousand tons, respectively. The CVs were in the range 0.3-0.4. They fed mainly on Japanese anchovy and krill. The consumptions of Japanese anchovy in the two periods were 418 thousand tons and 511 thousand tons, respectively. The consumptions of krill in the two periods were 74 thousand tons and 176 thousand tons, respectively. The CVs were in the range 0.3-0.4.

Sei whales

The seasonal prey consumptions in the 2000-07 and 2008-2014 periods were 533 thousand tons and 442 thousand tons, respectively. The CVs were in the range 0.2-0.3. They fed mainly on Japanese anchovy, copepods and mackerels. The consumptions of Japanese anchovy in the two periods were 272 thousand tons and 148 thousand tons, respectively. The consumptions of copepods in the two periods were 78 thousand ton and 155 thousand tons, respectively. The consumptions of mackerels in the two periods were 42 thousand ton and 66 thousand tons, respectively. The CVs were in the range 0.2-0.3.

DISCUSSION

Diet of whales in the study area

This study showed that the prey species of three baleen whale species in the western North Pacific during May and September in the years 2000-2014, included various pelagic species of zooplankton, squid and fishes. Prey species of three baleen whale species varied both geographically and temporally. It was confirmed that three baleen whale species in the western North Pacific are euryphagous, similar to those in the Northeast Atlantic.

Geographical, seasonal changes of prey species

The results showed that there was geographical and seasonal change of prey species in the western North Pacific. In the offshore area, common minke whales fed on Japanese anchovy during May and June, and on Pacific saury during July to September. Minke whales feeding on Pacific saury were distributed in northern latitudes in comparison with whales feeding on Japanese anchovy, so the seasonal movement of minke whale overlap with the distribution of Pacific saury. In the north east part of sub-area 9 over the Emperor Sea Mountains, minke whale abundantly fed on minimal armhook squid in August. This result suggested that the minke whale use the feeding area near Emperor Seamounts where the minimal armhook squid occur in summer (Konishi and Tamura, 2007). Minke whale also adapted to coastal areas where large whales rarely occur. In sub-area 7, walleye pollock was one of the important prey species in addition to Pacific saury and anchovy off northern Japan. For the size of fish in the stomachs, minke whales fed on large-sized walleye pollock over the continental break and slope around 200-300m water depth.

The dominant prey species of Bryde's whale was Japanese anchovy and krill during May to September. There was no seasonal change of prey species for this whale species.

Sei whale fed on Japanese anchovy and copepods dominantly during survey season in most of the years. However they mostly fed on mackerels in the 2005 season, and this indicated that sei whale feed on most aggregated prey species near the surface. At the offshore area under the effects of Kuroshio-current extension, the prey species fed by large baleen whales depend on what the current carry in early summer.

The results showed that there was size difference of prey species. Common minke whale fed on larger Japanese anchovy, Pacific saury and mackerels than other whale species. The smaller anchovy (fork length <8cm) and mackerels (fork length <25cm) hatched in this year. These fishes distributed in the southern part of the research area. Differences in the prey size among the stomach contents of three baleen whales might reflect to geographical distribution of prey species in the research area.

Yearly change of prey species

For three baleen whale species, the most dominant prey species was Japanese anchovy in the 2000-2007 JARPNII survey years. Japanese anchovy is distributed shallower than 30m depth, where it feeds on copepods (Kondo, 1969). The anchovy are distributed widely in temperate waters of the western North Pacific. Japanese anchovy migrate to this research area to feed copepod from June through September (Kondo, 1969). However, recently years (since 2012), the occurrence of Japanese anchovy in stomach contents was decreasing.

On the other hand, the occurrences of Japanese sardine and mackerels in stomach contents were increasing. Konishi *et al* (2016: SC/F16/JR23) also noted that the common minke, Bryde's and sei whales were highly dependent on small pelagic fish, *i.e.* Japanese anchovy, Pacific saury and mackerels in addition to copepods and euphausiids. The trend of prey compositions in the three baleen whale species differ among whale species. For example, the main prey species of sei whale showed drastic change from the Japanese anchovy in early 2000s to mackerels and Japanese sardine in late 2000s. Kasamatsu and Hata (1985) reported that Chub mackerel was the most important prey species of common minke whales in western Pacific (a northern part of sub-area 8) in August. However, in our surveys, the composition of mackerels was low. Kasamatsu and Tanaka (1992) examined annual changes of prey species based on the catch records of small type whaling in the seven whaling grounds off Japan from 1948 to 1987. In Pacific coast of Hokkaido (a part of sub-area 7W) from April to October, prey species recorded were krill, squid, Japanese sardine, Japanese anchovy, chub mackerel, walleye pollock and Pacific saury and so on. They noted that the change of prey species of minke whales from Chub mackerel to Japanese sardine in 1977, from Japanese sardine to

Pacific saury in 1996, from Pacific saury to Japanese sardine in 2012 corresponded with a change of the dominant species taken by commercial fisheries in the same area in 1976, 1996, 2012, respectively. Nemoto (1959) reported that Bryde's whales fed on krill, Japanese anchovy and Chub mackerel in the Pacific coast of Japan. According to Nemoto (1959, 1962) and Nemoto and Kawamura (1977), sei whales fed mainly copepods in the northern part of the North Pacific, but they likely feed on fishes and squids in the Sanriku and Hokkaido coastal waters of Japan.

Differences in the prey composition reflected to local and seasonal changes in the relative abundance of these prey species in the research area (Tamura *et al*., 2016 (SC/F16/JR17)). Three baleen whale species feed on prey at the surface during their seasonal migration to the feeding area. The fluctuation of prey species of baleen whales seems to reflect that these baleen whales are opportunistic feeders with a broad diet and with flexible feeding habits.

Daily prey consumption *per capita* taking into account uncertainties

The estimates from three energetic models (Eq-2, 3-1 and 4) were compared to observed stomach contents weight. Leaper and Lavigne (2007) considered that the appropriate consumption estimates is between the high end by Eq 3-1 and the low end by Eq 2. It should be noted that these crude stomach contents data represented a quantity of one feeding. There are notable two points. First, the composition of freshness categories showed that there had no trend throughout the day. Secondly, in the results of the recent other research activity, some baleen whale species were estimate to dive many times for feeding in a day using data logger system (*e.g.* Fiedler *et al.*, 1998; Acevedo-Gutierrez *et al.*, 2002; Ishii *et al*, 2016 (SC/F16/JR25). Thirdly, for sei whales in particular, there is a possibility that the observed stomach contents are far less than total daily consumption, because they often feed on prey through skimming. They seem to feed continuously in the feeding grounds in a day. Then the consumption estimate from Eq. 2 seems to be underestimated, because consumption estimates by Eq. 2 is equal only to the intake of one or two time. If the average number of times of prey intake per day can be obtained, it might be possible to estimate narrower range of daily prey consumption using the data of observed stomach contents weight. Tagging technology of data logger and stomach contents information will provide such data in the future.

Seasonal prey consumption by whales taking into uncertainties

The values of Eq-3-1 were 2.4-3.6 times larger than the value of Eqn. 2. This is due to differences in body mass, and the effect is larger for large whales. The uncertainty derived from the use of different energetic models seems to be appropriately captured in the Monte Carlo simulation.

The feeding impact by whales on fisheries resources

The consumptions of Japanese anchovy, mackerels and Pacific saury by three baleen whales during May to September were estimated in 674-724 thousand tons, 43-70 thousand tons and 48-56 thousand tons, respectively. These values were equivalent to 22-48%, 5-66% and 2-7% of the each fish resources in the western North Pacific (Table 14). To evaluate the interaction between whale and fisheries, long-term information of prey composition of whales, accurate abundance of prey species and each whale, and accurate resident period of each whale are needed. Furthermore, there is a need to understand the potential for each whale to have an impact on commercial fisheries, either directly or indirectly using simulation models for specific geographical regions.

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Table 1. Numbers of whales sampled.

Year	Minke	Bryde's	Sei
1994	21	-	-
1995	100	-	-
1996	77	-	-
1997	100	-	-
1998	100	-	-
1999	100	-	-
2000	40	43	-
2001	100	50	-
2002	100	50	39
2003	100	50	50
2004	100	50	100
2005	100	50	100
2006	100	50	100
2007	100	50	100
2008	59	50	100
2009	43	50	100
2010	14	50	100
2011	49	50	95
2012	74	34	100
2013	3	28	100
2014	0	25	90
Total	1,480	680	1,174

Table 2. Body weight (kg) of each whale species sampled in each season.

Common minke whales (1994-2014)   (kg)

	IM	IF	MM	MF
Early (N)	38	19	193	14
Average	2,317.2	2,178.9	4,557.1	5,736.1
S.D.	679.2	952.1	595.7	1,104.9
Max	4,210.0	4,050.0	7,109.8	7,500.0
Min	1,300.0	1,050.0	2,950.0	3,650.0
Late (N)	29	7	193	37
Average	3,154.3	3,171.8	4,904.8	6,522.2
S.D.	1,026.9	1,436.2	588.6	786.5
Max	5,154.7	4,500.0	7,050.0	8,054.7
Min	1,300.0	1,200.0	3,300.0	4,650.0

Bryde's whales (2000-2014)   (kg)

	IM	IF	MM	MF
Early (N)	35	47	33	89
Average	9,051.7	8,567.7	15,282.3	17,618.8
S.D.	2,699.4	2,795.0	1,865.0	3,086.9
Max	15,200.0	14,559.8	18,959.8	24,874.5
Min	4,000.0	2,800.0	12,004.7	11,096.6
Late (N)	86	64	125	172
Average	9,961.3	10,268.2	15,432.1	17,849.1
S.D.	2,500.7	2,889.9	2,075.2	2,557.7
Max	15,454.7	16,300.0	21,404.0	24,450.0
Min	3,800.0	3,350.0	11,300.0	12,140.0

Common minke whales (Coastal)   (kg)

	IM	IF	MM	MF
Sanriku (N)	151	233	52	47
Average	1,776.0	1,924.1	4,125.2	5,118.7
S.D.	664.0	697.0	576.8	1,207.0
Max	3,572.0	4,390.0	5,499.6	8,352.0
Min	600.0	539.4	2,570.0	1,289.2
Kushiro (N)	205	184	166	27
Average	2,053.2	1,971.1	4,784.1	6,023.3
S.D.	806.1	806.9	695.8	1,042.5
Max	4,440.2	4,879.4	6,302.5	8,225.8
Min	662.1	659.0	2,999.2	4,302.0

Sei whales (2002-2014)   (kg)

	IM	IF	MM	MF
Early (N)	60	56	149	189
Average	13,716.2	15,831.4	19,226.7	24,590.8
S.D.	2,633.3	2,651.3	2,193.9	3,715.0
Max	18,304.7	21,344.2	24,457.0	35,001.1
Min	7,450.0	9,750.0	13,654.7	17,009.8
Late (N)	88	75	216	251
Average	14,095.4	15,984.2	20,531.8	25,249.4
S.D.	3,235.8	3,736.6	2,131.1	4,003.9
Max	19,954.7	23,918.5	26,234.7	34,564.7
Min	4,250.0	6,300.0	15,264.5	16,514.7

Table 3. Results of caloric value of dominant prey species in western North Pacific.

Common minke and sei whales

Species	Season	Analyzed Number	Energy contents (KJ/kg) Avegage	S.D
Copepods	Early	2	2,738	266
	Late	4	2,885	699
Krill	Early	3	3,929	1,235
	Late	4	3,177	396
Japanese anchovy	Early	3	7,094	716
	Late	3	6,134	1,748
Japanese sardine	Early	2	9,907	4,847
	Late	1	5,559	-
Pacific saury	Early	4	8,217	3,072
	Late	4	10,057	3,916
Chub mackerel	Early	1	6,479	-
	Late	3	8,555	4,613
Walleye pollock	Early	3	6,232	714
	Late	2	5,918	388
Oceanic lightfish	All	-	8,580	-
Sand lance	Early	4	4,663	2,098
Squids	Early	1	6,646	-
	Late	2	5,628	1,391

Bryde's whales

Species	Season	Analyzed Number	Energy contents (KJ/kg) Avegage	S.D
Krill	Early	1	3,051	-
	Late	3	3,429	616
Japanese anchovy	Early	1	3,389	-
	Late	5	4,039	945
Japanese sardine	Early	0	-	-
	Late	1	5,267	-
Chub mackerel	Early	1*	6,479	-
	Late	2	4,765	59
Oceanic lightfish	All	-	8,580	-
Squids	Early	1	6,646	-
	Late	2	5,628	1,391

Table 4. Prey composition (W %) of each whale species sampled.

Common minke whales (1996-2014: excluding sub area 11)

Sub area 7

Period	Number	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Pollock	Squids	Others
Early										
2000-07	187	0.00	13.51	63.76	0.00	0.00	0.00	22.73	0.00	0.00
2008-14	78	0.00	11.35	42.81	0.66	0.00	0.27	44.92	0.00	0.00
1996-2014	375	0.00	12.29	58.25	0.14	0.00	0.12	29.09	0.00	0.10
Late										
2000-07	125	0.00	8.83	31.14	0.00	24.06	0.84	19.56	15.57	0.00
2008-14	49	0.00	13.21	79.45	0.00	0.00	0.00	7.35	0.00	0.00
1996-2014	206	0.00	16.37	34.33	0.00	21.44	0.51	16.11	11.24	0.00

Sub areas 8 and 9

Period	Number	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Pollock	Squids	Others
Early										
2000-07	119	2.79	4.56	56.73	0.00	34.53	1.24	0.00	0.00	0.16
2008-14	17	18.90	51.35	18.03	0.00	0.00	11.72	0.00	0.00	0.00
1996-2014	247	3.28	4.18	73.68	0.00	17.77	1.01	0.00	0.00	0.08
Late										
2000-07	281	0.00	3.31	16.84	0.00	69.54	0.00	0.00	0.00	10.32
2008-14	85	0.12	4.82	24.06	0.00	68.47	0.03	0.00	0.00	2.50
1996-2014	413	0.03	3.78	16.71	0.00	71.82	0.01	0.00	0.00	7.65

All areas

Period	Number	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Pollock	Squids	Others
Early										
2000-07	306	1.39	9.03	60.25	0.00	17.26	0.62	11.36	0.00	0.08
2008-14	95	9.45	31.35	30.42	0.33	0.00	6.00	22.46	0.00	0.00
1996-2014	622	1.64	8.23	65.97	0.07	8.88	0.56	14.55	0.00	0.09
Late										
2000-07	406	0.00	6.07	23.99	0.00	46.80	0.42	9.78	7.79	5.16
2008-14	134	0.06	9.01	51.76	0.00	34.23	0.01	3.67	0.00	1.25
1996-2014	619	0.01	10.08	25.52	0.00	46.63	0.26	8.06	5.62	3.83
Year (for EwE)										
Average	1,241	0.66	9.34	41.70	0.03	31.53	0.38	10.65	3.37	2.33

Bryde's whales (2000-2014)

Period	Number	Krill	Anchovy	Sardine	Mackerel	oceanic lightfish	Squids
Early							
2000-07	121	42.51	48.41	0.00	9.08	0.005	0.0002
2008-14	49	6.95	83.94	0.00	3.49	5.62	0.00
2000-14	170	33.01	58.13	0.00	7.35	1.51	0.0002
Late							
2000-07	204	11.31	87.65	0.00	0.41	0.63	0.00
2008-14	182	27.64	69.56	0.71	2.04	0.04	0.00
2000-14	386	14.90	83.47	0.23	0.95	0.44	0.00
Year (for EwE)							
Average	556	22.13	73.43	0.14	3.43	0.87	0.0001

Sei whales (2002-2014)

Period	Number	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Squids	Others
Early									
2002-07	207	19.11	18.55	46.18	0.00	1.07	15.10	0.00	0.00
2008-14	322	53.63	9.60	14.70	3.52	3.00	15.39	0.005	0.15
2002-14	529	37.71	13.86	28.94	1.88	2.25	15.28	0.003	0.08
Late									
2002-07	282	10.73	27.59	55.43	0.00	4.63	1.62	0.002	0.00
2008-14	363	22.42	6.38	46.16	0.00	6.61	14.52	3.92	0.00
2002-14	645	16.47	17.36	50.96	0.00	5.60	7.90	1.71	0.00
Year (for EwE)									
Average	1,174	25.05	16.57	43.46	0.00	4.34	9.51	1.04	0.03

Table 5. Energy contents (KJ/kg) of prey consumed by each whale species based on Tables 3 and 4.

Common minke whales (1996-2014)

Early-Area 7

Species	Krill	Anchovy	Sardine	Saury	Mackerel	Pollock	Squids		1996-2014	2000-07	2008-14
Number	N=3	N=3	N=2	N=4	N=1	N=3	N=1				
Low	2,926	6,276	6,479	4,849	6,479	5,518	6,646		5,637	5,651	5,558
High	5,309	7,608	13,334	11,548	6,479	6,945	6,646		7,131	7,147	7,085
Average	3,929	7,094	9,907	8,217	6,479	6,232	6,646		6,450	6,471	6,366

Late-Area 7

Species	Krill	Anchovy	Sardine	Saury	Mackerel	Pollock	Squids		1996-2014	2000-07	2008-14
Number	N=4	N=3	N=1	N=4	N=3	N=2	N=2				
Low	2,720	4,268	5,559	5,272	5,309	5,643	4,644		4,499	4,696	4,165
High	3,678	7,733	5,559	13,376	13,836	6,192	6,611		7,936	8,289	7,085
Average	3,177	6,134	5,559	10,057	8,555	5,918	5,628		6,412	6,700	5,728

Early-Areas 8+9

Species	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Others		1996-2014	2000-07	2008-14
Number	N=2	N=3	N=3	N=2	N=4	N=1	N=1				
Low	2,550	2,926	6,276	6,479	4,849	6,479	8,580		5,757	5,533	3,875
High	2,926	5,309	7,608	13,334	11,548	6,479	8,580		8,041	8,721	5,410
Average	2,738	3,929	7,094	9,907	8,217	6,479	8,580		7,007	7,211	4,574

Late-Areas 8+9

Species	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Others		1996-2014	2000-07	2008-14
Number	N=4	N=4	N=3	N=1	N=4	N=3	N=1				
Low	2,174	2,720	4,268	5,559	5,272	5,309	8,580		5,260	5,360	4,986
High	3,849	3,678	7,733	5,559	13,376	13,836	8,580		11,697	11,611	11,420
Average	2,885	3,177	6,134	5,559	10,057	8,555	8,580		9,026	9,017	8,736

Bryde's whales (2000-2014)

Early

Species	Krill	Anchovy	Sardine	Mackerel	Oceanic lightfish	Squids		2000-14	2000-07	2008-14
Number	N=1	N=1	N=0	N=1*	N=1	N=1*				
Low	3,051	3,389		6,479	8,580	6,646		3,583	3,526	3,765
High	3,051	3,389		6,479	8,580	6,646		3,583	3,526	3,765
Average	3,051	3,389		6,479	8,580	6,646		3,583	3,526	3,765

Late

Species	Krill	Anchovy	Sardine	Mackerel	Oceanic lightfish	Squids		2000-14	2000-07	2008-14
Number	N=3	N=5	N=1	N=2	N=1	N=0				
Low	2,759	2,884	5,267	4,723	8,580			2,913	3,400	2,906
High	3,971	5,523	5,267	4,807	8,580			5,297	5,850	5,078
Average	3,429	4,039	5,267	4,765	8,580			3,977	4,488	3,895

Sei whales (2002-2014)

Early

Species	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Squids	Others	2002-14	2002-07	2008-14
Number	N=2	N=3	N=3	N=2	N=4	N=1	N=1	N=1			
Low	2,550	2,926	6,276	6,479	4,849	6,479	6,646	8,580	4,411	4,912	4,071
High	2,926	5,309	7,608	13,334	11,548	6,479	6,646	8,580	5,549	6,048	5,139
Average	2,738	3,929	7,094	9,907	8,217	6,479	6,646	8,580	4,998	5,515	4,610

Late

Species	Copepods	Krill	Anchovy	Sardine	Saury	Mackerel	Squids	Others	2002-14	2002-07	2008-14
Number	N=4	N=4	N=3	N=1	N=4	N=3	N=2	N=1			
Low	2,174	2,720	4,268	5,559	5,272	5,309	4,644	8,580	3,728	3,680	3,932
High	3,849	3,678	7,733	5,559	13,376	13,836	6,611	8,580	7,067	6,558	7,819
Average	2,885	3,177	6,134	5,559	10,057	8,555	5,628	8,580	5,401	5,191	5,809

Table 6. The values of the rate of *H index* for the daily consumption.

H index	*P* (Percentage of annual prey consumption)		
(Residence days)	70	80	90
120	2.13	2.43	2.74
150	1.70	1.95	2.19
180	1.42	1.62	1.83

Table 7. The composition of maturity stages of each whale species sampled.

(IM: Immature male, MM: Mature male, IF: Immature female, MF: Mature female, UM: Unidentified maturity)

Common minke whales

Area 7

Period	Numbers	IM	MM	IF	MF	UM
Early						
2000-07	192	23.4	62.0	7.3	4.2	3.1
2008-14	86	26.7	46.5	15.1	4.7	7.0
1996-14	386	22.8	60.4	9.3	4.4	3.1
Late						
2000-07	131	19.1	59.5	9.9	8.4	3.1
2008-14	51	21.6	56.9	5.9	13.7	2.0
1996-14	213	19.2	61.0	7.5	9.9	2.3

Bryde's whales

Period	Numbers	IM	MM	IF	MF
Early					
2000-07	146	16.4	16.4	21.9	45.2
2008-14	59	19.0	15.5	25.9	39.7
2000-14	205	17.2	16.2	23.0	43.6
Late					
2000-07	247	23.9	23.9	15.8	36.4
2008-14	228	12.9	31.1	13.8	42.2
2000-14	475	18.6	27.3	14.8	39.2

Common minke whales

Areas 8+9

Period	Numbers	IM	MM	IF	MF	UM
Early						
2000-07	128	12.5	71.1	6.3	4.7	5.5
2008-14	20	20.0	55.0	10.0	5.0	10.0
1996-14	259	14.3	69.5	7.3	5.4	3.5
Late						
2000-07	289	6.6	78.9	0.3	6.2	8.0
2008-14	85	5.9	68.2	2.4	11.8	11.8
1996-14	421	6.4	78.1	0.7	6.9	7.8

Sei whales

Period	Numbers	IM	MM	IF	MF
Early					
2002-07	207	15.5	30.4	13.0	41.1
2008-14	322	11.5	33.2	12.1	43.2
2002-14	529	13.0	32.1	12.5	42.3
Late					
2002-07	282	13.8	36.9	13.8	35.5
2008-14	363	13.8	32.8	10.5	43.0
2002-14	645	13.8	34.6	11.9	39.7

Average

Period	Numbers	IM	MM	IF	MF	UM
Early						
2000-07	320	18.0	66.5	6.8	4.4	4.3
2008-14	106	23.4	50.8	12.6	4.8	8.5
1996-14	645	18.5	64.9	8.3	4.9	3.3
Late						
2000-07	420	12.8	69.2	5.1	7.3	5.5
2008-14	136	13.7	62.5	4.1	12.7	6.9
1996-14	634	12.8	69.6	4.1	8.4	5.1

Table 8. Estimation numbers of whales distributed based on Hakamada *et al* (2009, 2016 (SC/F16/JR12)).

Common minke whales

Period	Numbers	CV	95% CI LL	95% CI UL
Early				
2000-2007	6,609	0.691	1,942	22,488
2008-2014	3,629	0.586	1,252	10,523
Late				
2000-2007	2,879	0.523	1,098	7,547
2008-2014	3,080	0.677	924	10,266

Bryde's whales

Period	Numbers	CV	95% CI LL	95% CI UL
Early				
2000-2007	1,559	0.860	363	6,702
2008-2014	2,957	0.394	1,404	6,226
Late				
2000-2007	9,344	0.316	5,104	17,106
2008-2014	13,306	0.569	4,712	37,570

Sei whales

Period	Numbers	CV	95% CI LL	95% CI UL
Early				
2002-2007	7,646	0.272	4,529	12,908
2008-2014	4,734	0.177	3,355	6,679
Late				
2002-2007	5,370	0.300	3,021	9,547
2008-2014	5,086	0.378	2,485	10,410

Table 9. Abundance and catch information of each prey species.

Japanese anchovy

Year	Abundance	Catch
2000	N.D.	213.0
2001	N.D.	198.0
2002	N.D.	334.0
2003	N.D.	408.0
2004	2,840.0	402.0
2005	1,520.0	238.0
2006	3,360.0	303.0
2007	2,760.0	242.0
2008	N.D.	209.0
2009	N.D.	241.0
2010	N.D.	248.0
2011	N.D.	160.0
2012	N.D.	155.0
2013	N.D.	155.0

Pacific saury

Year	Abundance	Catch
2000	N.D.	281.9
2001	N.D.	367.4
2002	N.D.	328.6
2003	2,490.5	440.3
2004	2,634.5	353.8
2005	2,355.5	469.1
2006	2,207.0	389.6
2007	1,135.5	519.3
2008	2,435.0	606.0
2009	2,097.0	469.7
2010	690.5	415.7
2011	1,248.5	448.7
2012	817.5	455.4
2013	1,008.0	404.0

Mackerels

Year	Abundance	Catch
2000	243.0	93.7
2001	152.0	55.8
2002	210.0	48.2
2003	230.0	76.7
2004	743.0	180.7
2005	868.0	226.5
2006	786.0	239.0
2007	614.0	182.1
2008	550.0	173.4
2009	649.0	127.2
2010	862.0	123.3
2011	106.0	103.0
2012	1030.0	122.0
2013	1360.0	220.0

Table 10. Prey species of each whale species sampled in JARPNII.

Common minke whale

	Species	
Main prey		
Copepods	*Calanus* sp.	
Krill	*Euphausia pacifica*	
	Thysanoessa gregaria	
Pisces	*Engraulis japonicus*	Japanese anchovy
	Sardinops melanostictus	Japanese sardine
	Cololabis saira	Pacific saury
	Scomber japonicus	Chub mackerel
	Gadus chalcogrammus	Walleye pollocke
	Brama japonica	Japanese pomfret
	Oncorhynchus gorbuscha	Pink salmon
	O. keta	Chum salmon
	Pleurogrammus monopterygius	Atka mackerel
	Ammodytes personatus	Sand lance
Squids	*Todarodes pacificus*	Japanese common squid
	Berryteuthis anonychus	Minimal armhook squid
Miner prey		
Pisces	*Paralepis atlantica*	Duckbill barracudina

Sei whale

	Species	
Main prey		
Copepods	*Neocalanus cristatus*	
	N. plumchrus	
	Calanus sp.	
Krill	*Euphausia pacifica*	
	E. similis	
	Thysanoessa gregaria	
Pisces	*Engraulis japonicus*	Japanese anchovy
	Sardinops melanostictus	Japanese sardine
	Cololabis saira	Pacific saury
	Scomber japonicus	Chub mackerel
	S. australasicus	Spotted mackerel
Miner prey		
Pisces	*Sardinops melanostictus*	Japanese sardine
Squids	*Todarodes pacificus*	Japanese common squid

Bryde's whale

	Species	
Main prey		
Krill	*Euphausia pacifica*	
	E. similis	
	E. gibboides	
	Thysanoessa gregaria	
	Nematoscelis difficilis	
Pisces	*Engraulis japonicus*	Japanese anchovy
	Scomber japonicus	Chub mackerel
	S. australasicus	Spotted mackerel
	Vinciguerria nimbaria	Oceanic lightfish
	Auxis rochei	
Squids	*Todarodes pacificus*	Japanese common squid
Miner prey		
Pisces	*Arothron firmamentum*	Starry toado
	Decapterus russelli	Russell's scad
	Diaphus theta	Lantern fish
	Tarletonbeania taylori	Lantern fish
	Starry toado	Arothron firmamentum
	Nemichthys scolopaceus	Snipe eel
	Lestidiops jayakari	

Table 11. The average and maximum weight and the ratio of stomach contents weight to body weight, expressed as a percentage (RSC) of fresh or lightly digested stomach contents (freshness category F and fff).

Common minke whale

Sex	Maturity	Number	Average weight (kg)	S.D.	Maximum weight (kg)	95%C.I. Lower	95%C.I. Upper
Male	Immature	61	27.11 (1.02%)	22.30	97.00 (3.53%)	21.40 (0.80%)	32.80 (1.23%)
	Mature	428	48.80 (1.01%)	35.90	221.40 (4.09%)	45.30 (0.94%)	52.20 (1.07%)
Female	Immature	43	34.90 (0.94%)	29.40	115.20 (2.45%)	25.90 (0.74%)	44.00 (1.14%)
	Mature	44	62.10 (1.00%)	42.00	197.60 (4.03%)	49.40 (0.77%)	74.90 (1.23%)

Bryde's whale

Sex	Maturity	Number	Average weight (kg)	S.D.	Maximum weight (kg)	95%C.I. Lower	95%C.I. Upper
Male	Immature	57	106.80 (1.10%)	110.90	461.30 (4.32%)	77.30 (0.81%)	136.20 (1.40%)
	Mature	63	118.70 (0.77%)	141.40	448.80 (3.03%)	83.10 (0.54%)	154.30 (1.00%)
Female	Immature	51	76.40 (0.80%)	82.10	288.30 (3.25%)	53.30 (0.56%)	99.50 (1.04%)
	Mature	100	157.60 (0.86%)	172.50	715.30 (3.69%)	123.40 (0.67%)	191.80 (1.04%)

Sei whale

Sex	Maturity	Number	Average weight (kg)	S.D.	Maximum weight (kg)	95%C.I. Lower	95%C.I. Upper
Male	Immature	72	74.20 (0.53%)	91.50	395.10 (3.03%)	52.50 (0.37%)	95.80 (0.69%)
	Mature	194	88.40 (0.45%)	128.10	655.50 (3.45%)	70.20 (0.35%)	106.60 (0.54%)
Female	Immature	71	69.20 (0.43%)	98.70	595.50 (3.08%)	45.60 (0.29%)	92.70 (0.56%)
	Mature	231	145.30 (0.59%)	194.90	1,270.60 (4.59%)	120.00 (0.49%)	170.60 (0.69%)

Table 12. Daily prey consumption estimates (kg) *per capita* of each sex and reproductive status of each whale species in each model.

Eq-2

Common minke whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	53	0.15	42	74
Immature female	52	0.15	40	72
Mature male	76	0.15	60	106
Mature female	86	0.15	67	119
Late (July to September)				
Immature male	54	0.20	41	87
Immature female	55	0.20	41	87
Mature male	69	0.20	51	111
Mature female	80	0.20	60	129

Bryde's whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	204	0.14	161	273
Immature female	198	0.14	156	265
Mature male	268	0.14	211	359
Mature female	289	0.14	228	387
Late (July to September)				
Immature male	193	0.18	139	282
Immature female	196	0.18	142	287
Mature male	243	0.19	173	365
Mature female	262	0.18	187	381

Sei whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	182	0.15	142	247
Immature female	196	0.15	152	269
Mature male	217	0.15	169	296
Mature female	247	0.14	192	336
Late (July to September)				
Immature male	170	0.19	124	259
Immature female	182	0.19	132	274
Mature male	208	0.19	152	313
Mature female	231	0.19	168	348

Eq-3-1

Common minke whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	108	0.15	85	150
Immature female	103	0.15	81	143
Mature male	184	0.15	143	256
Mature female	220	0.15	171	306
Late (July to September)				
Immature male	120	0.20	90	191
Immature female	120	0.20	89	193
Mature male	169	0.20	125	270
Mature female	211	0.20	159	343

Bryde's whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	590	0.14	464	792
Immature female	565	0.14	446	755
Mature male	889	0.14	702	1,183
Mature female	994	0.14	784	1,327
Late (July to September)				
Immature male	412	0.18	412	828
Immature female	586	0.19	417	855
Mature male	806	0.18	582	1,179
Mature female	903	0.19	645	1,322

Sei whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	585	0.15	456	797
Immature female	654	0.15	512	898
Mature male	762	0.15	598	1,042
Mature female	923	0.15	720	1,264
Late (July to September)				
Immature male	553	0.19	402	836
Immature female	610	0.19	442	925
Mature male	742	0.19	543	1,129
Mature female	872	0.19	635	1,318

Eq-4

Common minke whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	98	0.15	76	136
Immature female	93	0.15	72	129
Mature male	162	0.15	127	227
Mature female	193	0.15	151	268
Late (July to September)				
Immature male	107	0.20	80	170
Immature female	107	0.20	80	174
Mature male	149	0.20	112	239
Mature female	184	0.20	137	295

Bryde's whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	508	0.14	404	679
Immature female	488	0.14	386	647
Mature male	753	0.14	596	1,013
Mature female	837	0.14	659	1,121
Late (July to September)				
Immature male	491	0.18	352	718
Immature female	502	0.19	357	735
Mature male	682	0.19	485	1,000
Mature female	760	0.18	543	1,105

Sei whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	497	0.15	390	679
Immature female	553	0.15	433	754
Mature male	640	0.15	502	874
Mature female	770	0.15	602	1,048
Late (July to September)				
Immature male	469	0.19	343	716
Immature female	516	0.19	373	780
Mature male	622	0.19	456	949
Mature female	727	0.19	529	1,108

Combined

Common minke whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	86	0.20	56	125
Immature female	83	0.20	54	119
Mature male	141	0.23	84	209
Mature female	166	0.23	99	249
Late (July to September)				
Immature male	94	0.25	58	154
Immature female	94	0.25	58	155
Mature male	129	0.26	76	212
Mature female	158	0.27	91	265

Bryde's whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	434	0.24	246	637
Immature female	417	0.24	235	614
Mature male	637	0.26	330	953
Mature female	707	0.26	373	1,063
Late (July to September)				
Immature male	419	0.27	221	655
Immature female	428	0.28	225	674
Mature male	577	0.29	287	918
Mature female	642	0.29	318	1,014

Sei whales

Maturity stage	Consumption	CV	95% CI LL	95% CI UL
Early (May and June)				
Immature male	421	0.15	328	577
Immature female	468	0.15	364	640
Mature male	539	0.15	420	736
Mature female	647	0.15	503	884
Late (July to September)				
Immature male	397	0.19	288	600
Immature female	436	0.19	318	663
Mature male	524	0.19	280	797
Mature female	610	0.19	450	926

Table 13. Seasonal prey consumption (thousand tons) consumed by whales in each model.

Eq-2

Common minke whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	45	0.32	33	115
Krill	2	0.33	1	5
Anchovy	19	0.38	12	52
Saury	22	0.29	16	52
2008-2014	38	0.31	29	97
Krill	10	0.35	7	27
Anchovy	8	0.32	6	21
Saury	13	0.45	7	44

Bryde's whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	216	0.24	153	398
Krill	32	0.26	24	67
Anchovy	180	0.25	124	329
Sardine	0			
Mackerels	1	0.03	1	1
2008-2014	310	0.35	191	760
Krill	77	0.39	42	200
Anchovy	222	0.35	138	536
Sardine	2	0.40	1	5
Mackerels	2	0.40	1	5

Sei whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2002-2007	211	0.18	164	332
Copepods	31	0.18	24	49
Krill	49	0.19	37	79
Anchovy	108	0.19	83	170
Saury	6	0.23	4	11
Mackerels	17	0.22	12	28
2008-2014	176	0.21	132	292
Copepods	62	0.17	48	93
Krill	13	0.19	10	21
Anchovy	58	0.27	40	110
Saury	9	0.25	6	17
Mackerels	26	0.21	20	43

Eq-3-1

Common minke whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	107	0.31	80	270
Krill	4	0.33	3	11
Anchovy	44	0.38	28	124
Saury	52	0.29	39	125
2008-2014	91	0.30	69	233
Krill	24	0.35	16	62
Anchovy	19	0.32	14	50
Saury	33	0.45	17	107

Bryde's whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	698	0.25	494	1,296
Krill	103	0.26	78	218
Anchovy	581	0.25	397	1,050
Sardine	0			
Mackerels	1	0.08	1	1
2008-2014	990	0.36	600	2,412
Krill	244	0.26	136	631
Anchovy	709	0.35	449	1,702
Sardine	6	0.41	3	16
Mackerels	5	0.38	3	13

Sei whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2002-2007	754	0.18	581	1,188
Copepods	111	0.18	85	174
Krill	176	0.19	134	282
Anchovy	385	0.19	296	611
Saury	22	0.23	16	38
Mackerels	60	0.22	43	100
2008-2014	626	0.21	467	1,044
Copepods	220	0.17	172	330
Krill	48	0.19	37	76
Anchovy	209	0.26	144	393
Saury	32	0.25	23	59
Mackerels	93	0.20	71	154

Eq-4

Common minke whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	95	0.32	80	270
Krill	4	0.33	3	10
Anchovy	39	0.38	25	111
Saury	46	0.29	34	110
2008-2014	80	0.31	59	203
Krill	22	0.36	14	55
Anchovy	17	0.32	13	45
Saury	29	0.45	16	95

Bryde's whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	593	0.25	417	1,092
Krill	88	0.26	66	185
Anchovy	493	0.26	333	905
Sardine	0			
Mackerels	1	0.08	1	1
2008-2014	842	0.35	521	2,040
Krill	208	0.39	114	533
Anchovy	603	0.35	377	1,441
Sardine	5	0.41	3	13
Mackerels	4	0.38	2	11

Sei whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2002-2007	632	0.18	485	995
Copepods	93	0.18	72	145
Krill	148	0.19	113	236
Anchovy	323	0.19	248	512
Saury	19	0.23	13	32
Mackerels	50	0.22	36	83
2008-2014	525	0.21	392	876
Copepods	185	0.17	144	275
Krill	40	0.19	31	63
Anchovy	175	0.26	120	327
Saury	27	0.25	19	49
Mackerels	78	0.20	59	128

Combined

Common minke whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	82	0.34	55	207
Krill	3	0.36	2	9
Anchovy	34	0.41	20	96
Saury	40	0.32	27	95
2008-2014	70	0.33	47	176
Krill	19	0.39	11	48
Anchovy	15	0.35	10	40
Saury	25	0.50	12	85

Bryde's whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2000-2007	502	0.30	291	950
Krill	74	0.31	47	158
Anchovy	418	0.32	225	783
Sardine	0			
Mackerels	1	0.08	1	1
2008-2014	714	0.41	371	1,760
Krill	176	0.45	80	462
Anchovy	511	0.40	273	1,239
Sardine	4	0.46	2	12
Mackerels	4	0.44	2	10

Sei whales

Period/Species	Consumption	CV	95% CI LL	95% CI UL
2002-2007	533	0.24	332	868
Copepods	78	0.25	48	128
Krill	124	0.26	75	209
Anchovy	272	0.25	165	452
Saury	16	0.30	8	29
Mackerels	42	0.30	23	75
2008-2014	442	0.27	264	764
Copepods	155	0.24	96	243
Krill	34	0.25	21	56
Anchovy	148	0.33	80	286
Saury	23	0.31	13	43
Mackerels	66	0.26	40	112

Table 14. The comparison among the prey consumption of three baleen whale species, the catch of fisheries and the abundance of fishes.

Japanese anchovy

Year	Catch	Abundance	%	Estimated prey consumption by three baleen whale species (thousand tons)							
				Eq-2	% of biomass	Eq 3-1	% of biomass	Eq 4	% of biomass	Eq combined	% of biomass
2000	213.0	N.D.	-	307.0	-	1,010.0	-	855.0	-	724.0	-
2001	198.0	N.D.	-	307.0	-	1,010.0	-	855.0	-	724.0	-
2002	334.0	N.D.	-	307.0	-	1,010.0	-	855.0	-	724.0	-
2003	408.0	N.D.	-	307.0	-	1,010.0	-	855.0	-	724.0	-
2004	402.0	2,840.0	14.2	307.0	10.8	1,010.0	35.6	855.0	30.1	724.0	25.5
2005	238.0	1,520.0	15.7	307.0	20.2	1,010.0	66.4	855.0	56.3	724.0	47.6
2006	303.0	3,360.0	9.0	307.0	9.1	1,010.0	30.1	855.0	25.4	724.0	21.5
2007	242.0	2,760.0	8.8	307.0	11.1	1,010.0	36.6	855.0	31.0	724.0	26.2
2008	209.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-
2009	241.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-
2010	248.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-
2011	160.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-
2012	155.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-
2013	155.0	N.D.	-	288.0	-	937.0	-	795.0	-	674.0	-

Mackerels

Year	Catch	Abundance	%	Estimated prey consumption by three baleen whale species (thousand tons)							
				Eq-2	% of biomass	Eq 3-1	% of biomass	Eq 4	% of biomass	Eq combined	% of biomass
2000	93.7	243.0	38.6	17.8	7.3	61.0	25.1	51.0	21.0	43.0	17.7
2001	55.8	152.0	36.7	17.8	11.7	61.0	40.1	51.0	33.6	43.0	28.3
2002	48.2	210.0	22.9	17.8	8.5	61.0	29.0	51.0	24.3	43.0	20.5
2003	76.7	230.0	33.3	17.8	7.7	61.0	26.5	51.0	22.2	43.0	18.7
2004	180.7	743.0	24.3	17.8	2.4	61.0	8.2	51.0	6.9	43.0	5.8
2005	226.5	868.0	26.1	17.8	2.1	61.0	7.0	51.0	5.9	43.0	5.0
2006	239.0	786.0	30.4	17.8	2.3	61.0	7.8	51.0	6.5	43.0	5.5
2007	182.1	614.0	29.7	17.8	2.9	61.0	9.9	51.0	8.3	43.0	7.0
2008	173.4	550.0	31.5	28.0	5.1	98.0	17.8	82.0	14.9	70.0	12.7
2009	127.2	649.0	19.6	28.0	4.3	98.0	15.1	82.0	12.6	70.0	10.8
2010	123.3	862.0	14.3	28.0	3.2	98.0	11.4	82.0	9.5	70.0	8.1
2011	103.0	106.0	97.2	28.0	26.4	98.0	92.5	82.0	77.4	70.0	66.0
2012	122.0	1030.0	11.8	28.0	2.7	98.0	9.5	82.0	8.0	70.0	6.8
2013	220.0	1360.0	16.2	28.0	2.1	98.0	7.2	82.0	6.0	70.0	5.1

Pacific saury

Year	Catch	Abundance	%	Estimated prey consumption by three baleen whale species (thousand tons)							
				Eq-2	% of biomass	Eq 3-1	% of biomass	Eq 4	% of biomass	Eq combined	% of biomass
2000	281.9	N.D.	-	28.0	-	74.0	-	65.0	-	56.0	-
2001	367.4	N.D.	-	28.0	-	74.0	-	65.0	-	56.0	-
2002	328.6	N.D.	-	28.0	-	74.0	-	65.0	-	56.0	-
2003	440.3	2,490.5	17.7	28.0	1.1	74.0	3.0	65.0	2.6	56.0	2.2
2004	353.8	2,634.5	13.4	28.0	1.1	74.0	2.8	65.0	2.5	56.0	2.1
2005	469.1	2,355.5	19.9	28.0	1.2	74.0	3.1	65.0	2.8	56.0	2.4
2006	389.6	2,207.0	17.7	28.0	1.3	74.0	3.4	65.0	2.9	56.0	2.5
2007	519.3	1,135.5	45.7	28.0	2.5	74.0	6.5	65.0	5.7	56.0	4.9
2008	606.0	2,435.0	24.9	22.0	0.9	65.0	2.7	56.0	2.3	48.0	2.0
2009	469.7	2,097.0	22.4	22.0	1.0	65.0	3.1	56.0	2.7	48.0	2.3
2010	415.7	690.5	60.2	22.0	3.2	65.0	9.4	56.0	8.1	48.0	7.0
2011	448.7	1,248.5	35.9	22.0	1.8	65.0	5.2	56.0	4.5	48.0	3.8
2012	455.4	817.5	55.7	22.0	2.7	65.0	8.0	56.0	6.9	48.0	5.9
2013	404.0	1,008.0	40.1	22.0	2.2	65.0	6.4	56.0	5.6	48.0	4.8
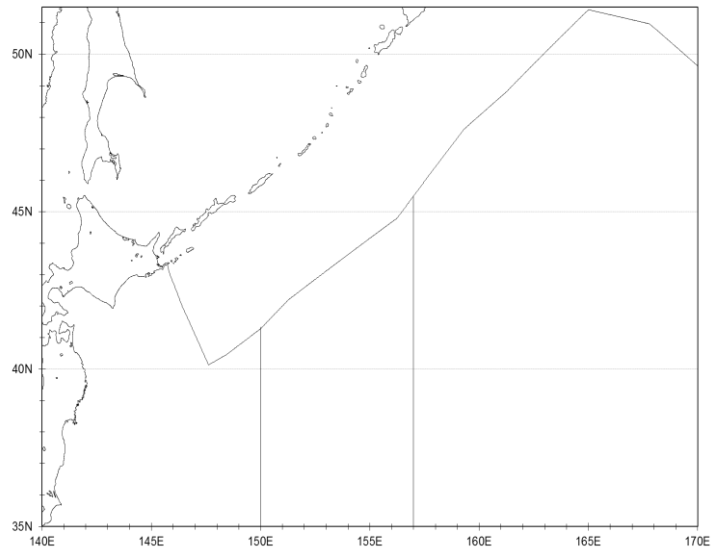
Figure 1. The definition of sub-areas for research area.
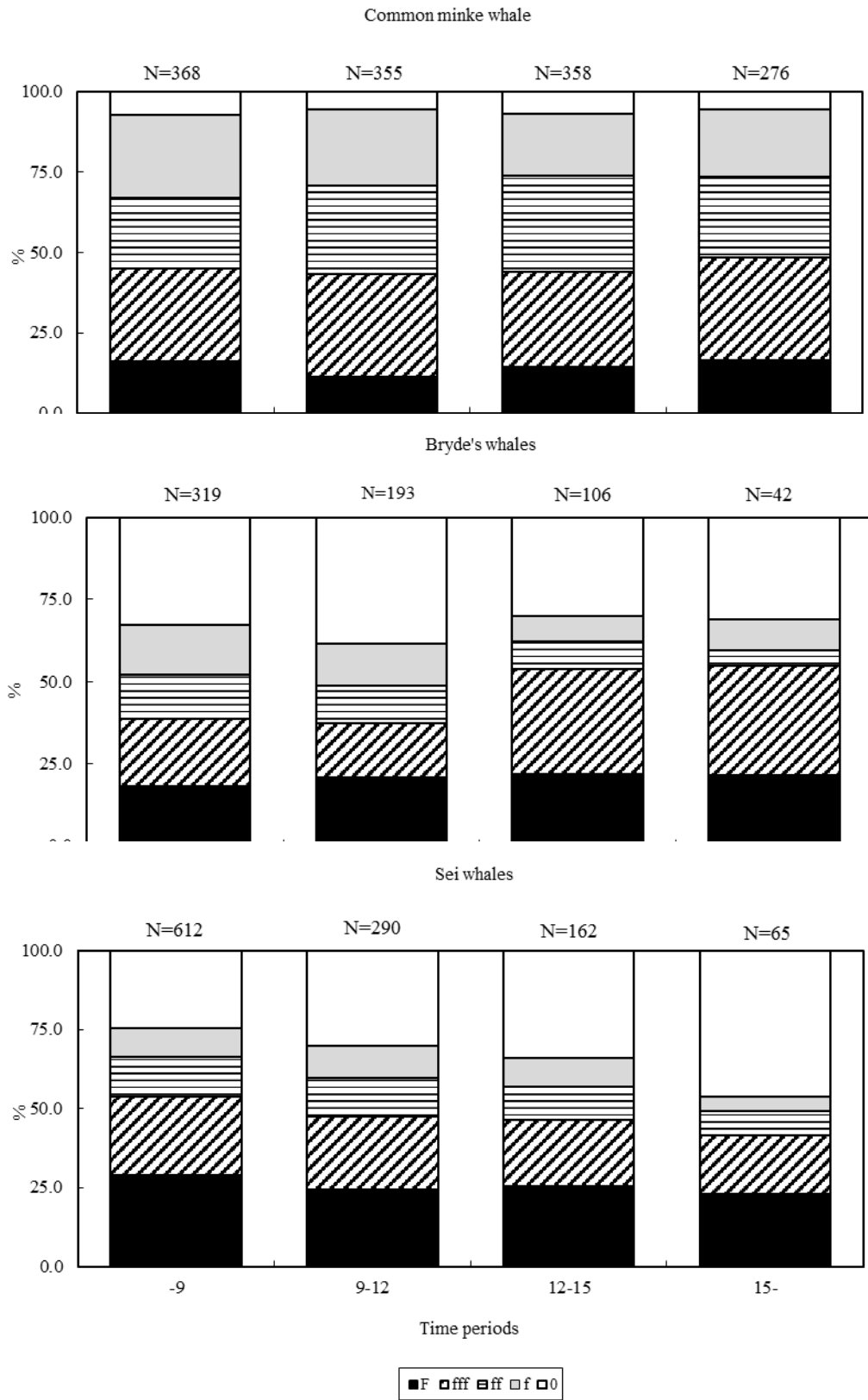
Figure 2. Composition of prey freshness categories throughout the day in each whale species
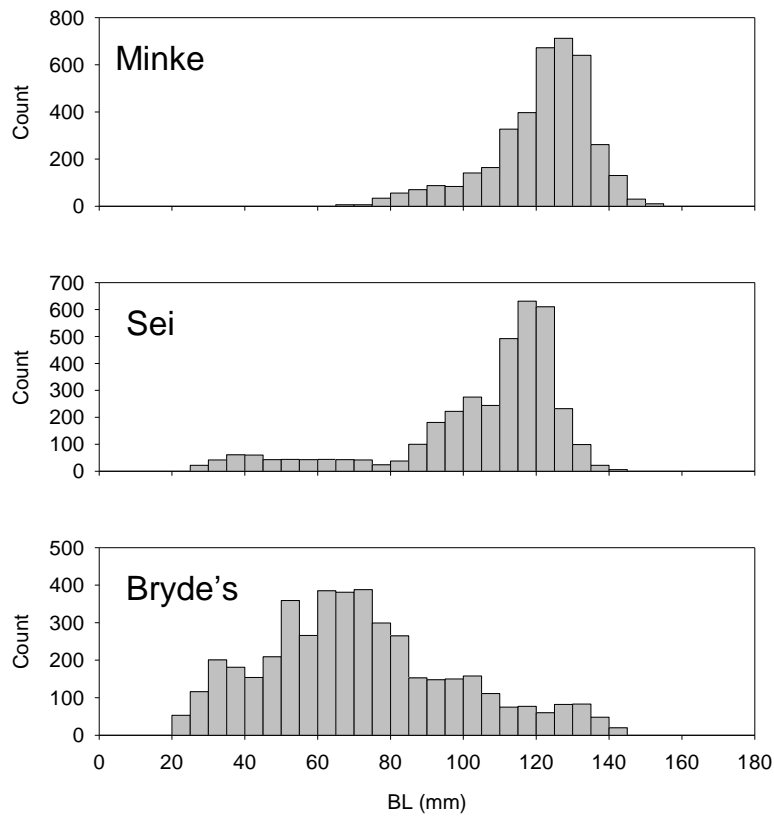
Figure 3-1. The size distribution of Japanese anchovy in the stomach contents of three baleen whale species.
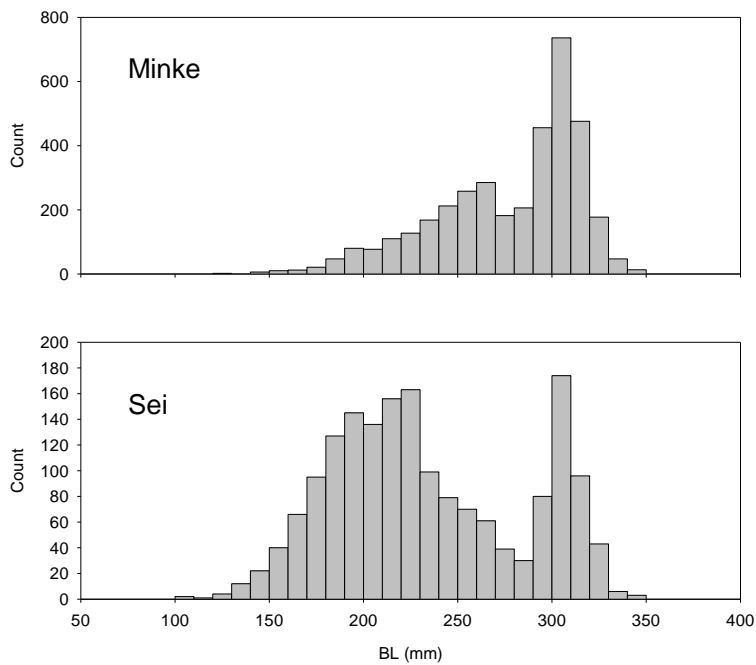
Figure 3-2. The size distribution of Pacific saury in the stomach contents of three baleen whales.
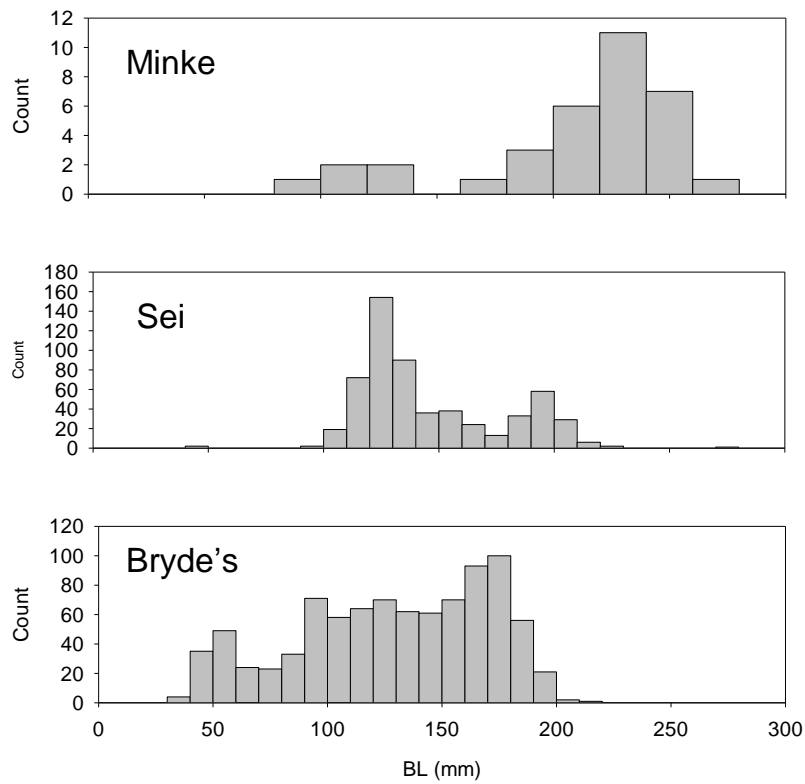
Figure 3-3. The size distribution of mackerels in the stomach contents of three baleen whales.

Appendix 1.　The results of simulations

- Daily consumption of common minke whales *per capita*
- Equation-2
- Early season (May and June)
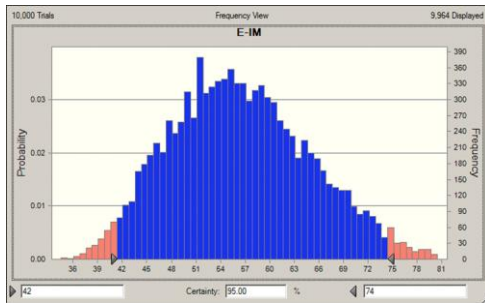
Immature male

Forecast: E-IM

Statistic	Forecast va
Trials	10,000
Base Case	53
Mean	57
Median	56
Mode	'---
Standard D	9
Variance	73
Skewness	0.3002
Kurtosis	2.72
Coeff. of V.	0.1513
Minimum	35
Maximum	89
Mean Std. I	0

Immature female
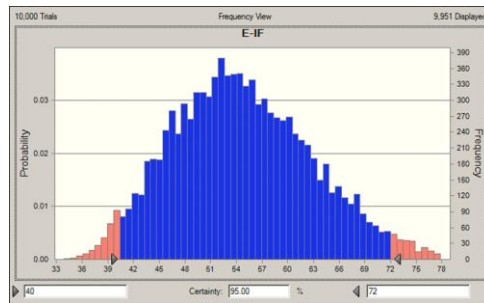
Forecast: E-IF

Statistic	Forecast va
Trials	10,000
Base Case	52
Mean	55
Median	54
Mode	'---
Standard D	8
Variance	67
Skewness	0.3433
Kurtosis	2.82
Coeff. of V.	0.1499
Minimum	34
Maximum	86
Mean Std. I	0

Mature male
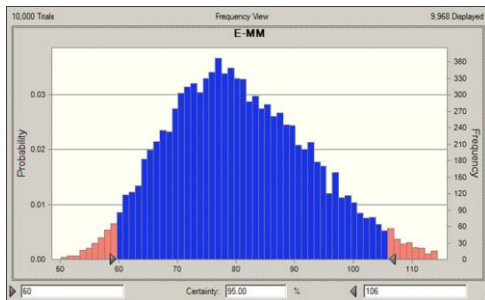
Forecast: E-MM

Statistic	Forecast va
Trials	10,000
Base Case	76
Mean	81
Median	80
Mode	'---
Standard D	12
Variance	145
Skewness	0.3214
Kurtosis	2.71
Coeff. of V.	0.1494
Minimum	50
Maximum	121
Mean Std. I	0

Mature female
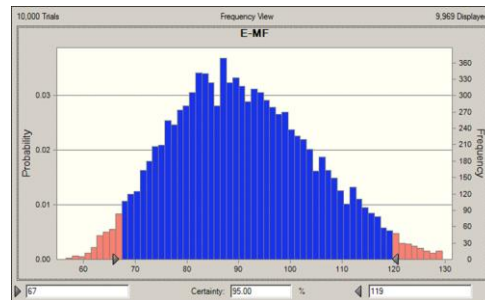
Forecast: E-MF

Statistic	Forecast va
Trials	10,000
Base Case	86
Mean	91
Median	90
Mode	'---
Standard D	14
Variance	189
Skewness	0.3165
Kurtosis	2.69
Coeff. of V.	0.1515
Minimum	57
Maximum	140
Mean Std. I	0

- Daily consumption of common minke whales *per capita*
- Equation-2
- Late season (From July to September)
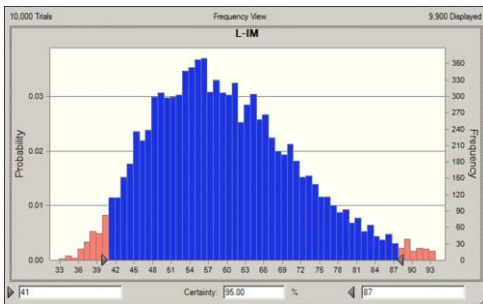
Immature male

Forecast: L-IM

Statistic	Forecast va
Trials	10,000
Base Case	54
Mean	60
Median	59
Mode	'---
Standard D	12
Variance	145
Skewness	0.647
Kurtosis	3.39
Coeff. of V.	0.2003
Minimum	33
Maximum	113
Mean Std. l	0

Immature female
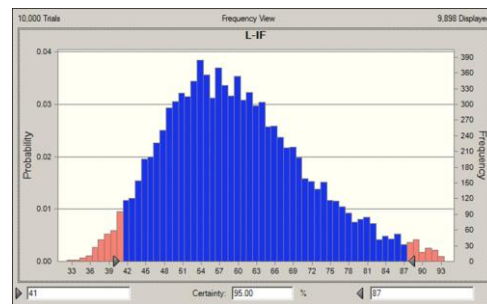
Forecast: L-IF

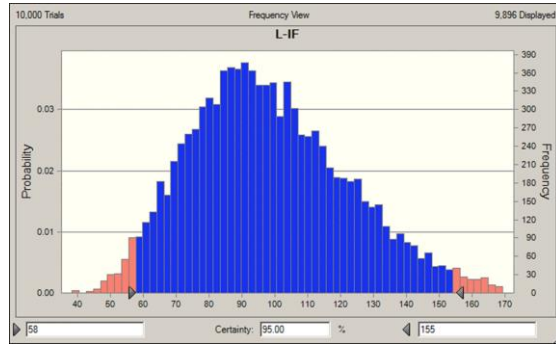| Statistic	Forecast va
Trials	10,000
Base Case	55
Mean	60
Median	59
Mode	'---
Standard D	12
Variance	142
Skewness	0.6573
Kurtosis	3.43
Coeff. of V	0.1989
Minimum	32
Maximum	113
Mean Std. l	0
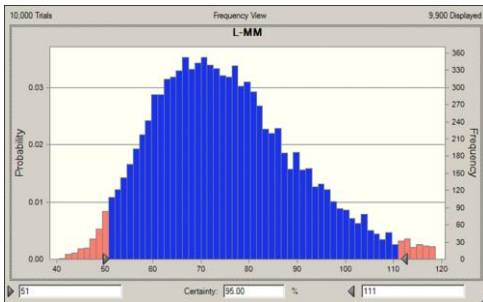
Mature male

Forecast: L-MM

Statistic	Forecast va
Trials	10,000
Base Case	69
Mean	76
Median	74
Mode	'---
Standard D	15
Variance	236
Skewness	0.668
Kurtosis	3.43
Coeff. of V.	0.2034
Minimum	40
Maximum	144
Mean Std. l	0

Mature female
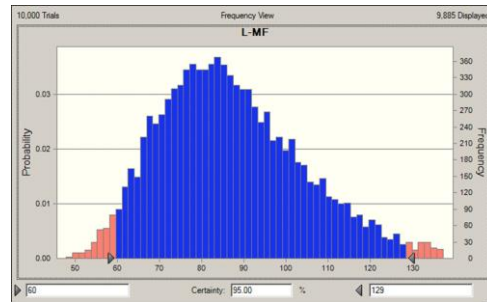
Forecast: L-MF

Statistic	Forecast va
Trials	10,000
Base Case	80
Mean	88
Median	85
Mode	'---
Standard D	18
Variance	313
Skewness	0.7169
Kurtosis	3.57
Coeff. of V	0.2018
Minimum	48
Maximum	166
Mean Std. l	0

- Daily consumption of common minke whales *per capita*

- Equation-3-1

- Early season (May and June)
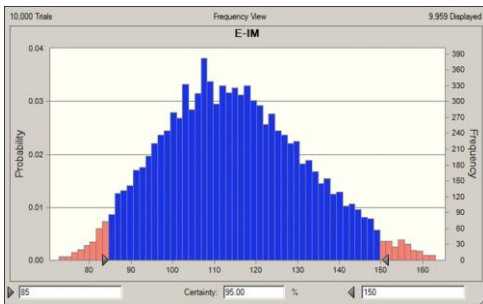
Immature male

Forecast: E-IM

Statistic	Forecast va
Trials	10,000
Base Case	108
Mean	115
Median	114
Mode	'---
Standard D	17
Variance	297
Skewness	0.314
Kurtosis	2.76
Coeff. of V.	0.1501
Minimum	73
Maximum	180
Mean Std. I	0

Immature female
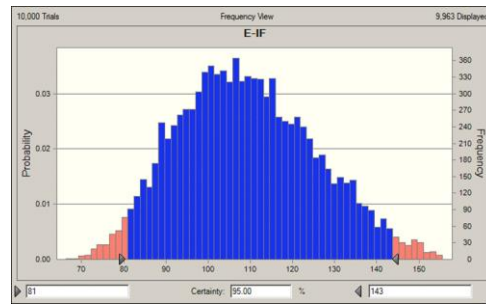
Forecast: E-IF

Statistic	Forecast va
Trials	10,000
Base Case	103
Mean	109
Median	108
Mode	'---
Standard D	16
Variance	271
Skewness	0.3159
Kurtosis	2.75
Coeff. of V.	0.1506
Minimum	66
Maximum	171
Mean Std. I	0
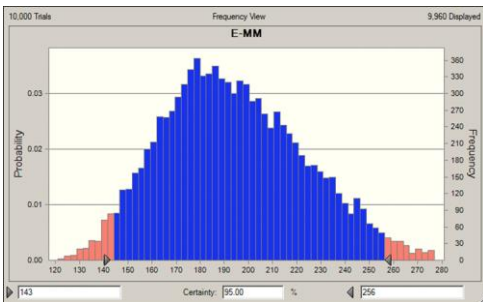
Mature male

Forecast: E-MM

Statistic	Forecast va
Trials	10,000
Base Case	184
Mean	194
Median	192
Mode	'---
Standard D	30
Variance	871
Skewness	0.3591
Kurtosis	2.79
Coeff. of V.	0.1520
Minimum	121
Maximum	311
Mean Std. I	0

Mature female
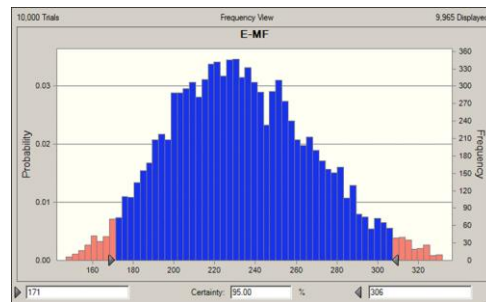
Forecast: E-MF

Statistic	Forecast va
Trials	10,000
Base Case	220
Mean	233
Median	231
Mode	'---
Standard D	35
Variance	1,232
Skewness	0.2926
Kurtosis	2.75
Coeff. of V	0.1504
Minimum	147
Maximum	356
Mean Std. I	0

- Daily consumption of common minke whales *per capita*
- Equation-3-1
- Late season (From July to September)
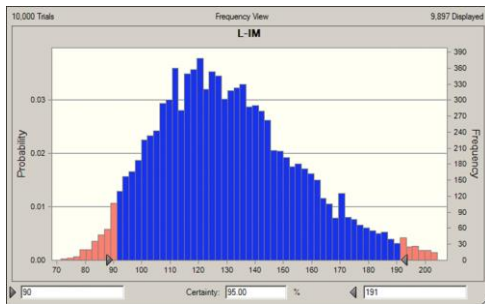
Immature male

Forecast: L-IM

Statistic	Forecast va
Trials	10,000
Base Case	120
Mean	131
Median	128
Mode	'---
Standard D	26
Variance	676
Skewness	0.6605
Kurtosis	3.42
Coeff. of V.	0.1979
Minimum	72
Maximum	245
Mean Std.	0

Immature female
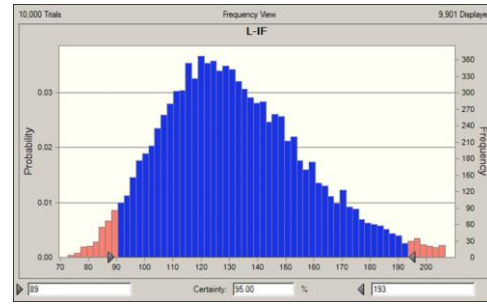
Forecast: L-IF

Statistic	Forecast va
Trials	10,000
Base Case	120
Mean	133
Median	130
Mode	'---
Standard D	26
Variance	696
Skewness	0.6502
Kurtosis	3.48
Coeff. of V	0.1988
Minimum	73
Maximum	258
Mean Std.	0

Mature male
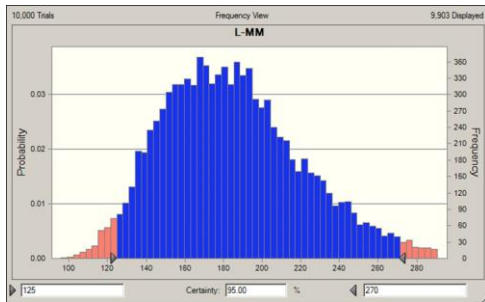
Forecast: L-MM

Statistic	Forecast va
Trials	10,000
Base Case	169
Mean	186
Median	182
Mode	'---
Standard D	37
Variance	1,397
Skewness	0.6494
Kurtosis	3.48
Coeff. of V.	0.2011
Minimum	96
Maximum	357
Mean Std.	0

Mature female
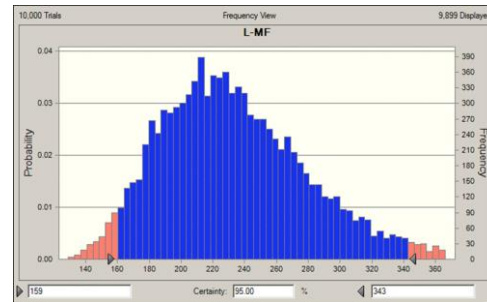
Forecast: L-MF

Statistic	Forecast va
Trials	10,000
Base Case	211
Mean	234
Median	229
Mode	'---
Standard D	47
Variance	2,214
Skewness	0.6536
Kurtosis	3.39
Coeff. of V	0.2009
Minimum	129
Maximum	459
Mean Std.	0

- Daily consumption of common minke whales *per capita*
- Equation-4
- Early season (May and June)
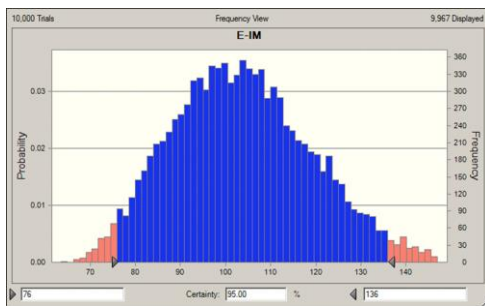
Immature male

Forecast: E-IM

Statistic	Forecast va
Trials	10,000
Base Case	98
Mean	104
Median	103
Mode	'---
Standard D	15
Variance	237
Skewness	0.292
Kurtosis	2.73
Coeff. of V.	0.1484
Minimum	64
Maximum	158
Mean Std.	0

Immature female
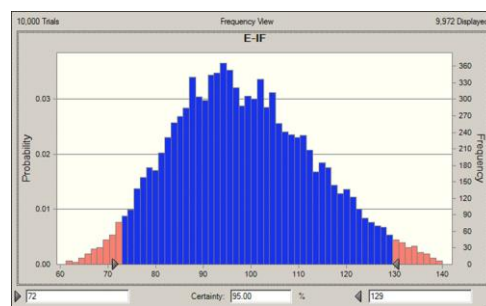
Forecast: E-IF

Statistic	Forecast va
Trials	10,000
Base Case	93
Mean	99
Median	97
Mode	'---
Standard D	15
Variance	219
Skewness	0.2972
Kurtosis	2.71
Coeff. of V	0.1503
Minimum	61
Maximum	153
Mean Std.	0

Mature male
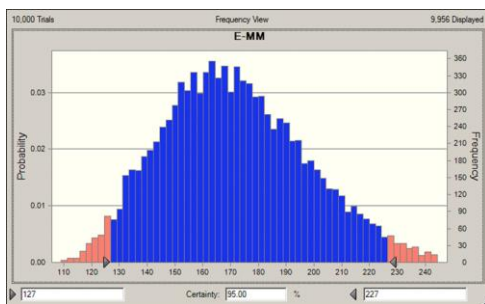
Forecast: E-MM

Statistic	Forecast va
Trials	10,000
Base Case	162
Mean	172
Median	170
Mode	'---
Standard D	26
Variance	670
Skewness	0.3656
Kurtosis	2.81
Coeff. of V.	0.1506
Minimum	109
Maximum	271
Mean Std.	0

Mature female
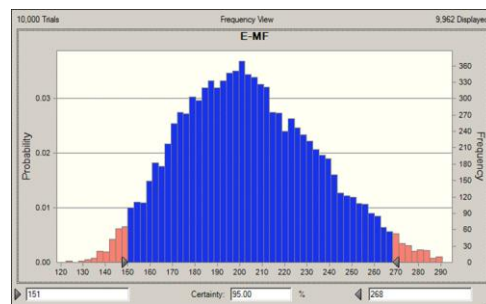
Forecast: E-MF

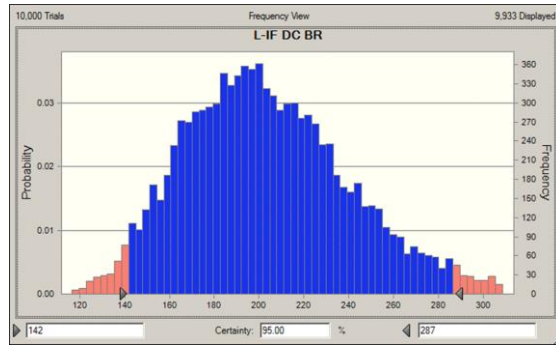| Statistic	Forecast va
Trials	10,000
Base Case	193
Mean	204
Median	202
Mode	'---
Standard D	31
Variance	947
Skewness	0.3291
Kurtosis	2.76
Coeff. of V	0.1507
Minimum	122
Maximum	318
Mean Std.	0

- Daily consumption of common minke whales *per capita*
- Equation-4
- Late season (From July to September)
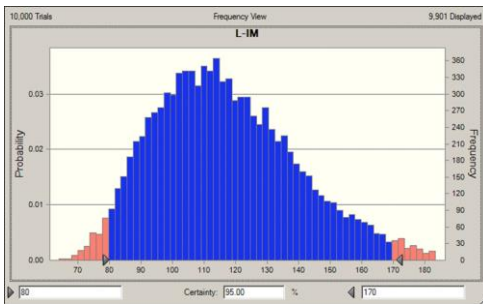
Immature male

Forecast: L-IM

Statistic	Forecast va
Trials	10,000
Base Case	107
Mean	118
Median	115
Mode	'---
Standard D	23
Variance	552
Skewness	0.6447
Kurtosis	3.38
Coeff. of V	0.1998
Minimum	64
Maximum	224
Mean Std.	0

Immature female
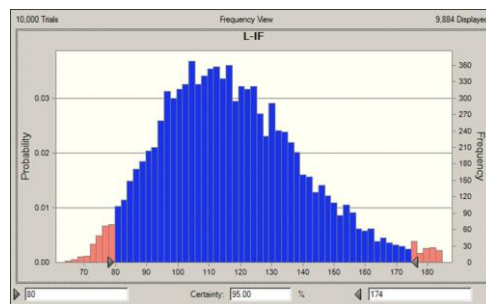
Forecast: L-IF

Statistic	Forecast va
Trials	10,000
Base Case	107
Mean	118
Median	116
Mode	'---
Standard D	24
Variance	561
Skewness	0.7055
Kurtosis	3.69
Coeff. of V	0.2005
Minimum	64
Maximum	231
Mean Std.	0

Mature male
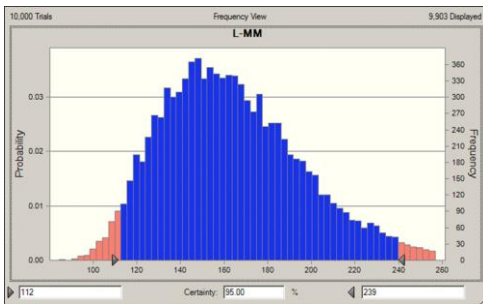
Forecast: L-MM

Statistic	Forecast va
Trials	10,000
Base Case	149
Mean	164
Median	161
Mode	'---
Standard D	33
Variance	1,086
Skewness	0.6581
Kurtosis	3.39
Coeff. of V	0.2005
Minimum	85
Maximum	325
Mean Std.	0

Mature female
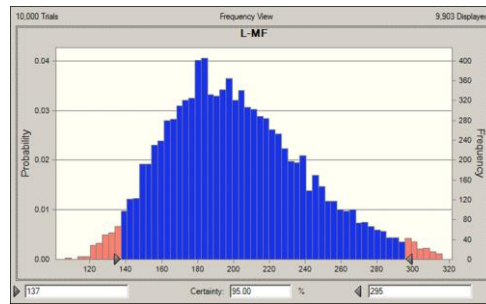
Forecast: L-MF

Statistic	Forecast va
Trials	10,000
Base Case	184
Mean	203
Median	198
Mode	'---
Standard D	40
Variance	1,637
Skewness	0.6594
Kurtosis	3.48
Coeff. of V	0.1995
Minimum	106
Maximum	394
Mean Std.	0

- Daily consumption of common minke whales *per capita*

- Equation-Combined

- Early season (May and June)
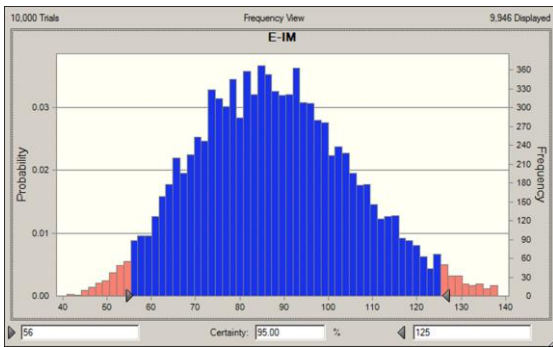
Immature male

Forecast: E-IM

Statistic	Forecast va
Trials	10,000
Base Case	86
Mean	88
Median	87
Mode	'---
Standard D	18
Variance	322
Skewness	0.3165
Kurtosis	2.91
Coeff. of V	0.2041
Minimum	41
Maximum	158
Mean Std. l	0

Immature female
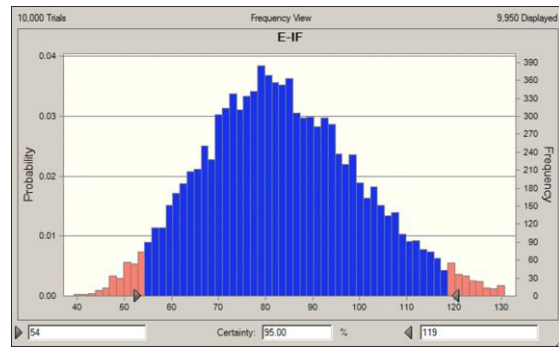
Forecast: E-IF

Statistic	Forecast va
Trials	10,000
Base Case	83
Mean	84
Median	83
Mode	'---
Standard D	17
Variance	282
Skewness	0.3272
Kurtosis	2.92
Coeff. of V	0.2007
Minimum	39
Maximum	150
Mean Std. l	0
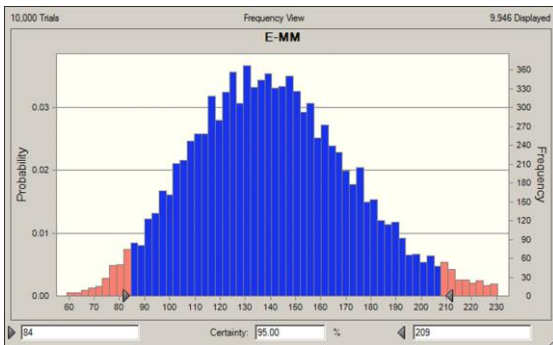
Mature male

Forecast: E-MM

Statistic	Forecast va
Trials	10,000
Base Case	141
Mean	141
Median	139
Mode	'---
Standard D	32
Variance	1,014
Skewness	0.3564
Kurtosis	2.99
Coeff. of V	0.2258
Minimum	59
Maximum	283
Mean Std. l	0

Mature female
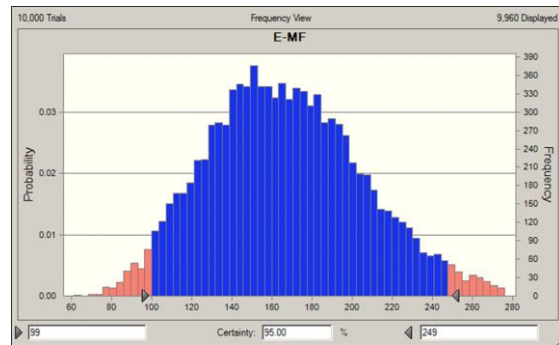
Forecast: E-MF

Statistic	Forecast va
Trials	10,000
Base Case	166
Mean	167
Median	165
Mode	'---
Standard D	39
Variance	1,510
Skewness	0.3247
Kurtosis	2.86
Coeff. of V	0.2327
Minimum	61
Maximum	314
Mean Std. l	0

- Daily consumption of common minke whales *per capita*

- Equation-Combined

- Late season (From July to September)
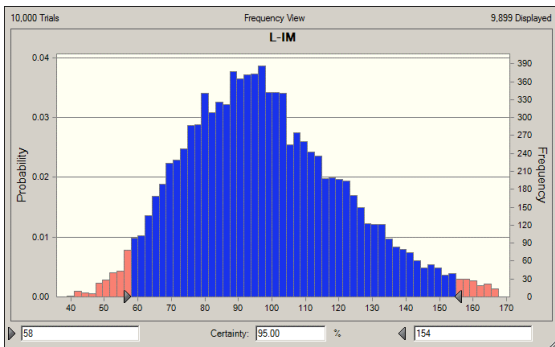
Immature male

Forecast: L-IM

Statistic	Forecast va
Trials	10,000
Base Case	94
Mean	99
Median	96
Mode	'---
Standard D	25
Variance	606
Skewness	0.6533
Kurtosis	3.61
Coeff. of V	0.2499
Minimum	39
Maximum	221
Mean Std.	0

Immature female

Forecast: L-IF

Statistic	Forecast va
Trials	10,000
Base Case	94
Mean	99
Median	96
Mode	'---
Standard D	25
Variance	628
Skewness	0.6659
Kurtosis	3.68
Coeff. of V	0.2529
Minimum	38
Maximum	235
Mean Std.	0

Mature male
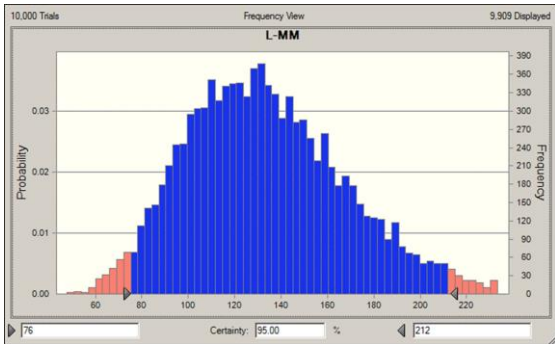
Forecast: L-MM

Statistic	Forecast va
Trials	10,000
Base Case	129
Mean	134
Median	131
Mode	'---
Standard D	35
Variance	1,248
Skewness	0.5984
Kurtosis	3.46
Coeff. of V	0.2631
Minimum	48
Maximum	306
Mean Std.	0

Mature female
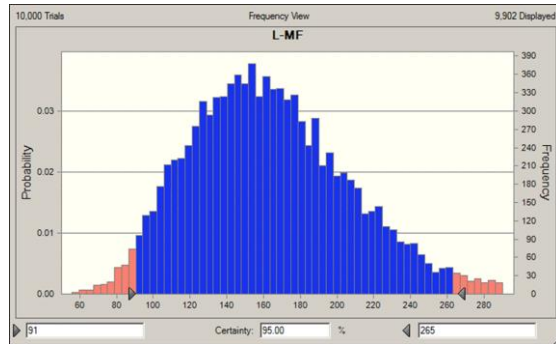
Forecast: L-MF

Statistic	Forecast va
Trials	10,000
Base Case	158
Mean	164
Median	160
Mode	'---
Standard D	45
Variance	2,008
Skewness	0.6131
Kurtosis	3.5
Coeff. of V	0.2725
Minimum	56
Maximum	387
Mean Std.	0

- Daily consumption of common Bryde's whales *per capita*
- Equation-2
- Early season (May and June)
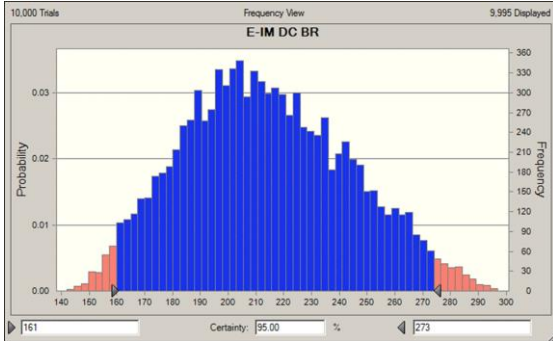
Immature male

Forecast: E-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	204
Mean	214
Median	212
Mode	'---
Standard D	30
Variance	881
Skewness	0.2192
Kurtosis	2.47
Coeff. of V	0.1389
Minimum	142
Maximum	302
Mean Std.	0

Immature female
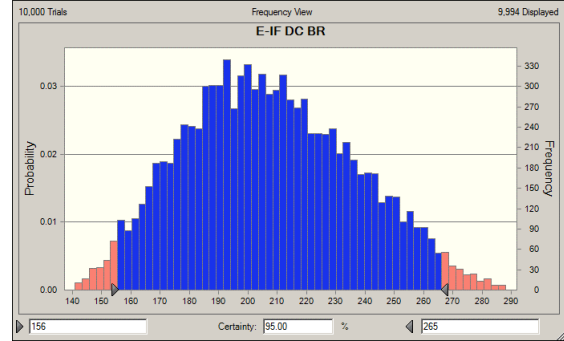
Forecast: E-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	198
Mean	207
Median	206
Mode	'---
Standard D	29
Variance	828
Skewness	0.2185
Kurtosis	2.46
Coeff. of V	0.1387
Minimum	141
Maximum	292
Mean Std.	0

Mature male
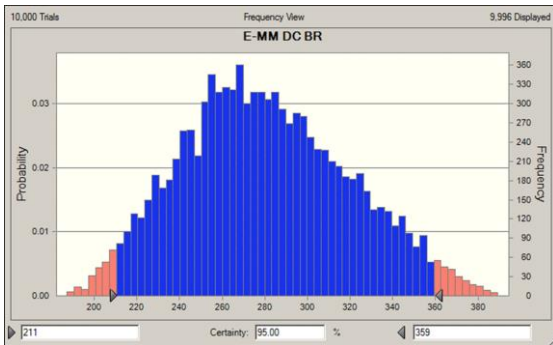
Forecast: E-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	268
Mean	280
Median	278
Mode	'---
Standard D	39
Variance	1,507
Skewness	0.2272
Kurtosis	2.51
Coeff. of V	0.1384
Minimum	187
Maximum	395
Mean Std.	0

Mature female
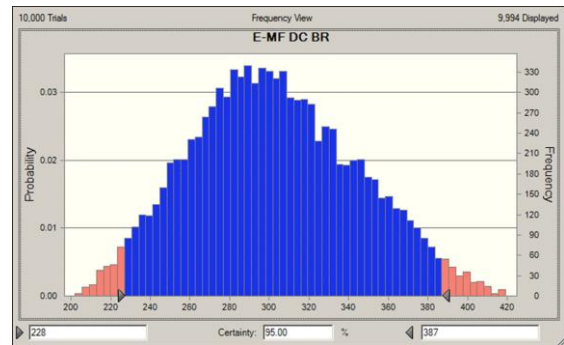
Forecast: E-MF DC BI

Statistic	Forecast va
Trials	10,000
Base Case	289
Mean	303
Median	300
Mode	'---
Standard D	42
Variance	1,728
Skewness	0.1991
Kurtosis	2.52
Coeff. of V	0.1374
Minimum	202
Maximum	427
Mean Std.	0

- Daily consumption of common Bryde's whales *per capita*
- Equation-2
- Late season (From July to September)
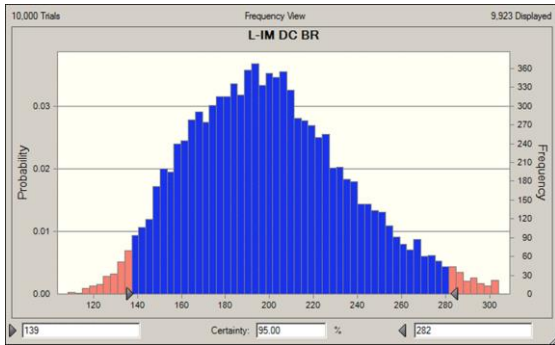
Immature male

Statistic	Forecast va
Trials	10,000
Base Case	193
Mean	200
Median	197
Mode	'---
Standard D	37
Variance	1,366
Skewness	0.4826
Kurtosis	3.08
Coeff. of V.	0.1844
Minimum	109
Maximum	343
Mean Std.	0

Immature female

Forecast: L-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	196
Mean	204
Median	200
Mode	'---
Standard D	37
Variance	1,392
Skewness	0.5155
Kurtosis	3.18
Coeff. of V	0.1828
Minimum	117
Maximum	359
Mean Std.	0

Mature male
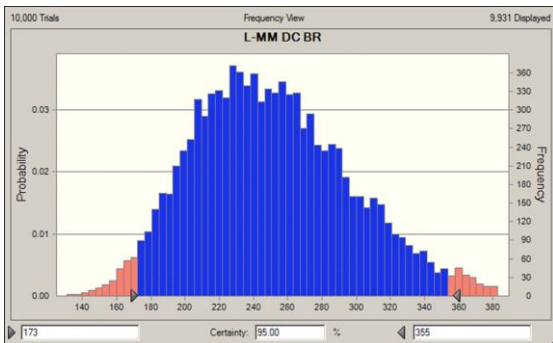
Forecast: L-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	243
Mean	252
Median	247
Mode	'---
Standard D	47
Variance	2,186
Skewness	0.4883
Kurtosis	3.12
Coeff. of V.	0.1858
Minimum	131
Maximum	458
Mean Std.	0

Mature female
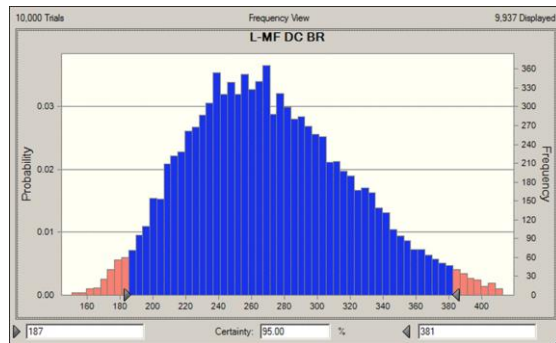
Forecast: L-MF DC BI

Statistic	Forecast va
Trials	10,000
Base Case	262
Mean	272
Median	268
Mode	'---
Standard D	50
Variance	2,503
Skewness	0.4504
Kurtosis	2.96
Coeff. of V	0.1837
Minimum	151
Maximum	490
Mean Std.	1

- Daily consumption of common Bryde's whales *per capita*
- Equation-3-1
- Early season (May and June)
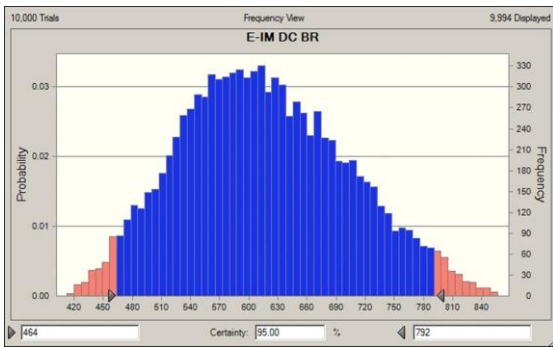
Immature male

Forecast: E-IM DC BR

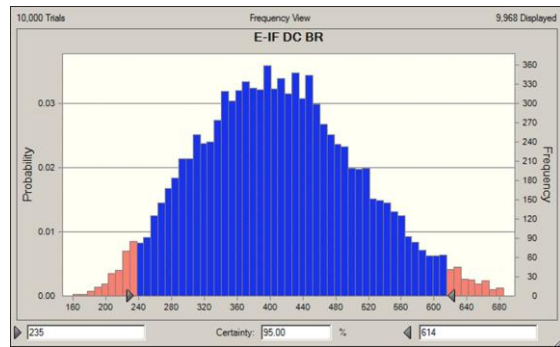| Statistic	Forecast va
Trials	10,000
Base Case	590
Mean	616
Median	611
Mode	'---
Standard D	86
Variance	7,336
Skewness	0.2367
Kurtosis	2.52
Coeff. of V	0.139
Minimum	413
Maximum	863
Mean Std. I	1

Immature female
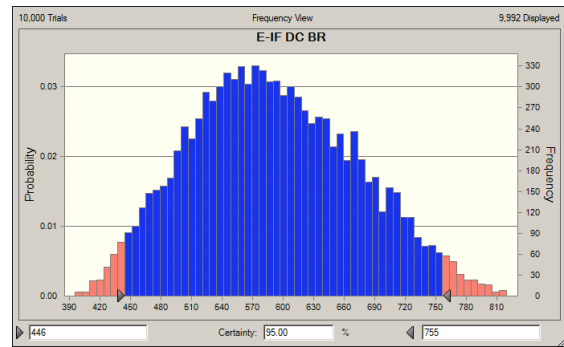
Forecast: E-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	565
Mean	591
Median	586
Mode	'---
Standard D	82
Variance	6,646
Skewness	0.216
Kurtosis	2.49
Coeff. of V	0.138
Minimum	396
Maximum	829
Mean Std. I	1
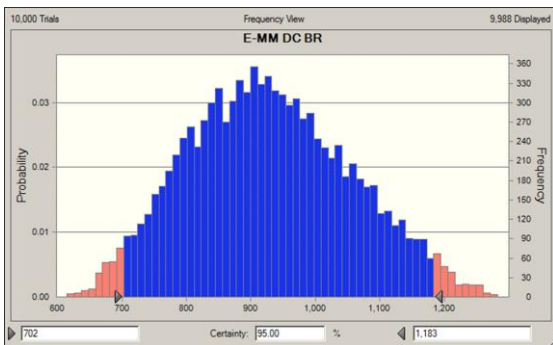
Mature male

Forecast: E-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	889
Mean	929
Median	922
Mode	'---
Standard D	126
Variance	15,890
Skewness	0.2036
Kurtosis	2.53
Coeff. of V	0.1357
Minimum	615
Maximum	1,317
Mean Std. I	1

Mature female
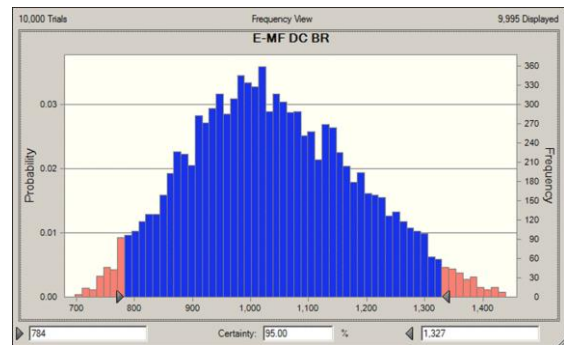
Forecast: E-MF DC BF

Statistic	Forecast va
Trials	10,000
Base Case	994
Mean	1,039
Median	1,028
Mode	'---
Standard D	143
Variance	20,387
Skewness	0.2296
Kurtosis	2.52
Coeff. of V	0.1374
Minimum	698
Maximum	1,484
Mean Std. I	1

- Daily consumption of common Bryde's whales *per capita*

- Equation-3-1

- Late season (From July to September)
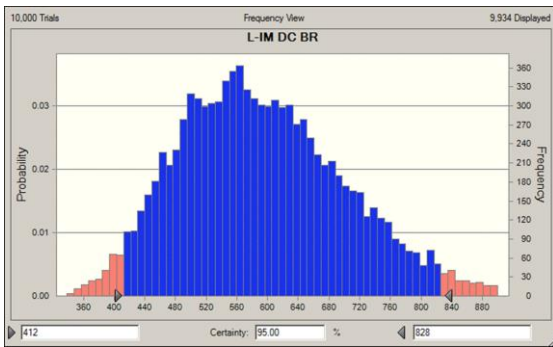
Immature male

Forecast: L-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	572
Mean	594
Median	584
Mode	'---
Standard D	109
Variance	11,856
Skewness	0.4784
Kurtosis	3.06
Coeff. of V.	0.1832
Minimum	339
Maximum	1,065
Mean Std.	1

Immature female

Forecast: L-IF DC BR

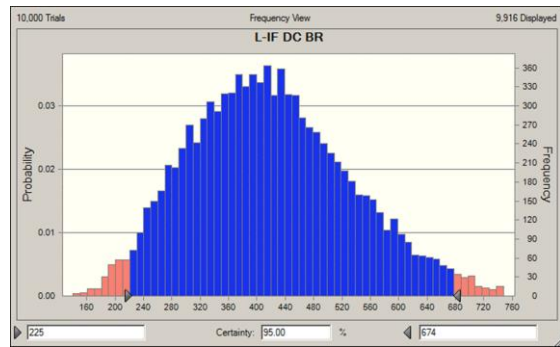| Statistic	Forecast va
Trials	10,000
Base Case	586
Mean	607
Median	597
Mode	'---
Standard D	113
Variance	12,850
Skewness	0.4908
Kurtosis	3.08
Coeff. of V	0.1867
Minimum	326
Maximum	1,105
Mean Std.	1

Mature male

Forecast: L-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	806
Mean	837
Median	821
Mode	'---
Standard D	155
Variance	23,884
Skewness	0.5485
Kurtosis	3.23
Coeff. of V.	0.1847
Minimum	468
Maximum	1,495
Mean Std.	2

Mature female
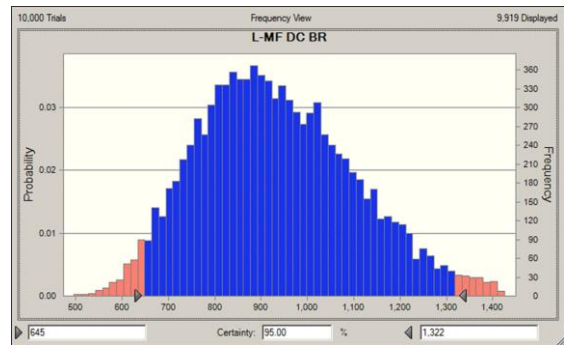
Forecast: L-MF DC BF

Statistic	Forecast va
Trials	10,000
Base Case	903
Mean	938
Median	920
Mode	'---
Standard D	174
Variance	30,262
Skewness	0.504
Kurtosis	3.15
Coeff. of V	0.1855
Minimum	497
Maximum	1,704
Mean Std.	2

- Daily consumption of common Bryde's whales *per capita*
- Equation-4
- Early season (May and June)
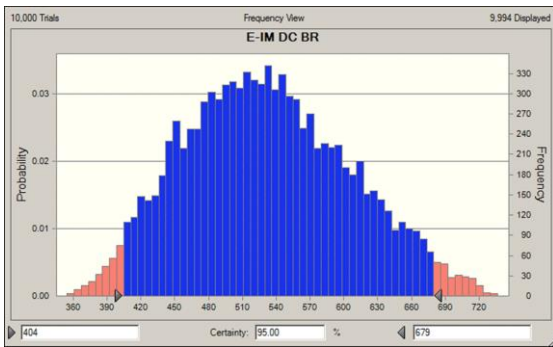
Immature male

Forecast: E-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	508
Mean	532
Median	528
Mode	'---
Standard D	73
Variance	5,324
Skewness	0.2277
Kurtosis	2.5
Coeff. of V	0.1372
Minimum	355
Maximum	750
Mean Std.	1

Immature female
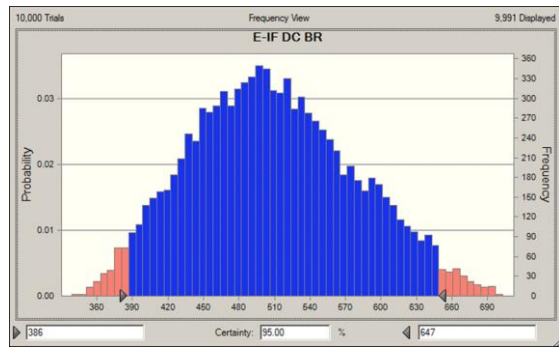
Forecast: E-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	488
Mean	509
Median	505
Mode	'---
Standard D	69
Variance	4,769
Skewness	0.2194
Kurtosis	2.52
Coeff. of V	0.1357
Minimum	339
Maximum	718
Mean Std.	1

Mature male
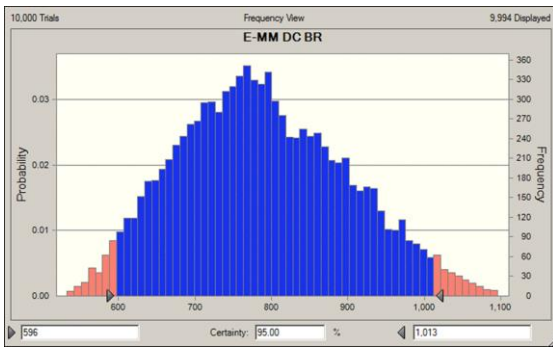
Forecast: E-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	753
Mean	789
Median	781
Mode	'---
Standard D	110
Variance	12,017
Skewness	0.243
Kurtosis	2.52
Coeff. of V	0.1390
Minimum	533
Maximum	1,103
Mean Std.	1

Mature female
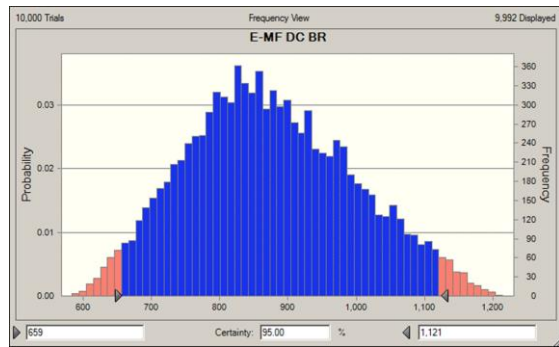
Forecast: E-MF DC BI

Statistic	Forecast va
Trials	10,000
Base Case	837
Mean	875
Median	866
Mode	'---
Standard D	121
Variance	14,655
Skewness	0.2284
Kurtosis	2.5
Coeff. of V	0.1384
Minimum	584
Maximum	1,240
Mean Std.	1

- Daily consumption of common Bryde's whales *per capita*
- Equation-4
- Late season (From July to September)
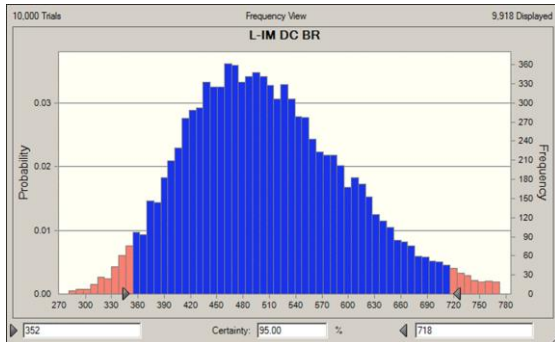
Immature male

Forecast: L-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	491
Mean	510
Median	500
Mode	'---
Standard D	94
Variance	8,795
Skewness	0.5337
Kurtosis	3.21
Coeff. of V	0.184
Minimum	282
Maximum	928
Mean Std.	1

Immature female
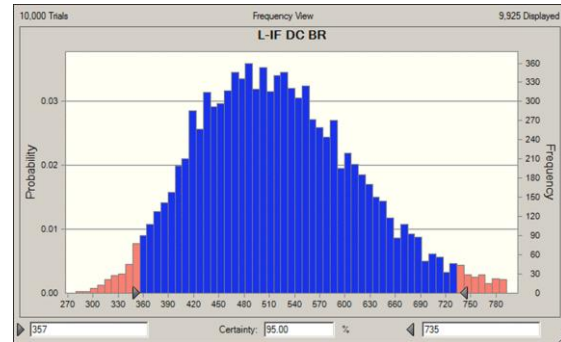
Forecast: L-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	502
Mean	522
Median	514
Mode	'---
Standard D	97
Variance	9,347
Skewness	0.4744
Kurtosis	3.09
Coeff. of V	0.1854
Minimum	280
Maximum	920
Mean Std.	1

Mature male
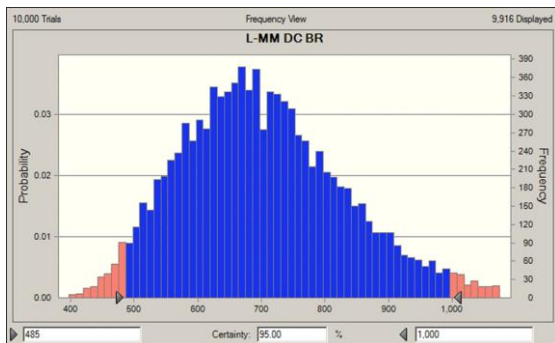
Forecast: L-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	682
Mean	705
Median	691
Mode	'---
Standard D	132
Variance	17,337
Skewness	0.5513
Kurtosis	3.25
Coeff. of V	0.1868
Minimum	398
Maximum	1,231
Mean Std.	1

Mature female
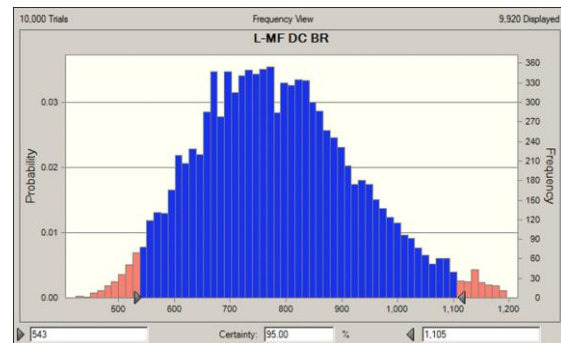
Forecast: L-MF DC BI

Statistic	Forecast va
Trials	10,000
Base Case	760
Mean	789
Median	777
Mode	'---
Standard D	145
Variance	20,962
Skewness	0.4606
Kurtosis	3.09
Coeff. of V	0.1834
Minimum	424
Maximum	1,371
Mean Std.	1

- Daily consumption of common Bryde's whales *per capita*
- Equation-Combined
- Early season (May and June)
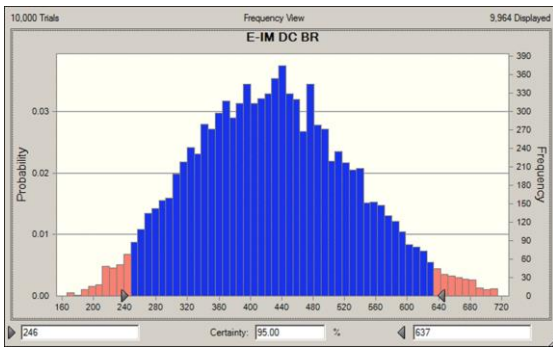
Immature male

Forecast: E-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	434
Mean	430
Median	427
Mode	'---
Standard D	102
Variance	10,369
Skewness	0.2294
Kurtosis	2.76
Coeff. of V.	0.2371
Minimum	167
Maximum	824
Mean Std.	1

Immature female

Forecast: E-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	417
Mean	411
Median	407
Mode	'---
Standard D	98
Variance	9,533
Skewness	0.2537
Kurtosis	2.72
Coeff. of V	0.2377
Minimum	160
Maximum	751
Mean Std.	1

Mature male
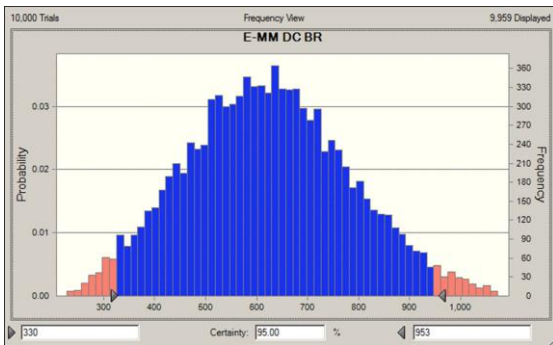
Forecast: E-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	637
Mean	624
Median	619
Mode	'---
Standard D	160
Variance	25,561
Skewness	0.2236
Kurtosis	2.81
Coeff. of V.	0.2562
Minimum	229
Maximum	1,194
Mean Std.	2

Mature female
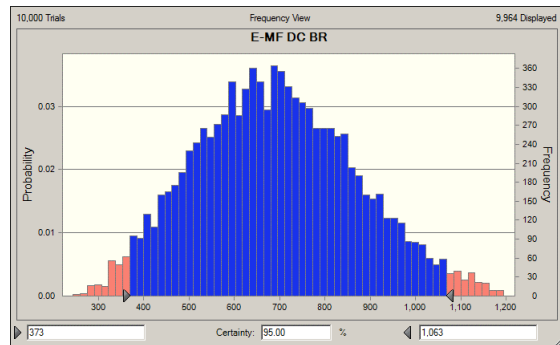
Forecast: E-MF DC BF

Statistic	Forecast va
Trials	10,000
Base Case	707
Mean	694
Median	687
Mode	'---
Standard D	179
Variance	31,923
Skewness	0.2615
Kurtosis	2.79
Coeff. of V.	0.2575
Minimum	244
Maximum	1,352
Mean Std.	2

- Daily consumption of common Bryde's whales *per capita*
- Equation-Combined
- Late season (From July to September)
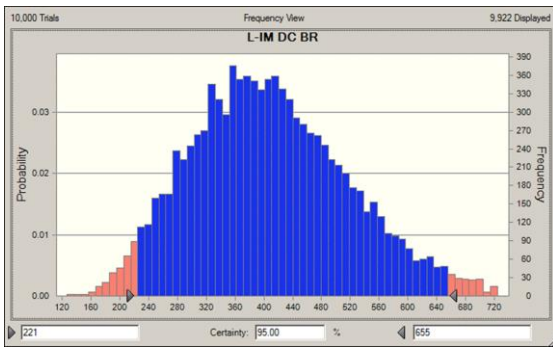
Immature male

Forecast: L-IM DC BR

Statistic	Forecast va
Trials	10,000
Base Case	419
Mean	410
Median	401
Mode	'---
Standard D	112
Variance	12,564
Skewness	0.4931
Kurtosis	3.21
Coeff. of V.	0.2732
Minimum	127
Maximum	908
Mean Std. l	1

Immature female

Forecast: L-IF DC BR

Statistic	Forecast va
Trials	10,000
Base Case	428
Mean	421
Median	412
Mode	'---
Standard D	116
Variance	13,555
Skewness	0.4894
Kurtosis	3.21
Coeff. of V	0.2763
Minimum	141
Maximum	944
Mean Std. l	1
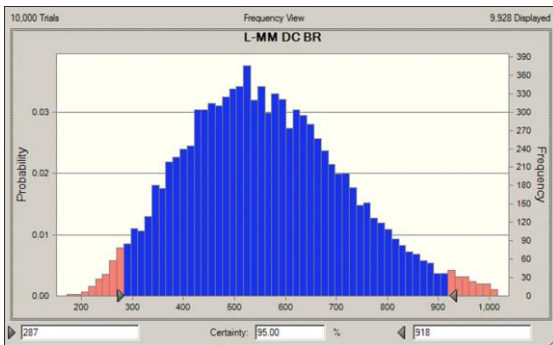
Mature male

Forecast: L-MM DC B

Statistic	Forecast va
Trials	10,000
Base Case	577
Mean	564
Median	550
Mode	'---
Standard D	161
Variance	25,965
Skewness	0.4652
Kurtosis	3.13
Coeff. of V	0.2858
Minimum	172
Maximum	1,243
Mean Std. l	2

Mature female
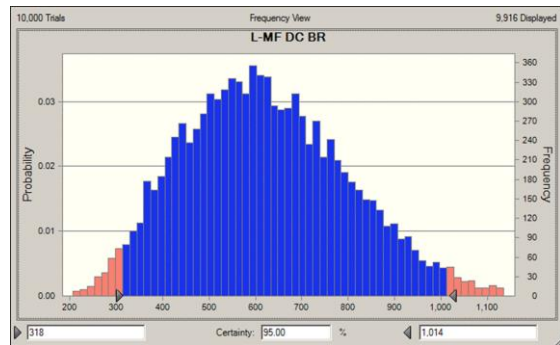
Forecast: L-MF DC BI

Statistic	Forecast va
Trials	10,000
Base Case	642
Mean	626
Median	611
Mode	'---
Standard D	182
Variance	32,981
Skewness	0.4881
Kurtosis	3.22
Coeff. of V	0.2902
Minimum	207
Maximum	1,486
Mean Std. l	2

- Daily consumption of common Sei whales *per capita*

- Equation-2

- Early season (May and June)
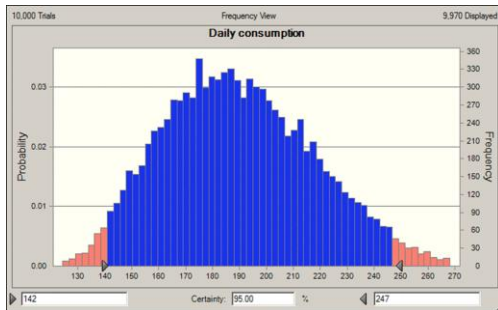
Immature male

Forecast: E IM DC

Statistic	Forecast va
Trials	10,000
Base Case	182
Mean	190
Median	188
Mode	'---
Standard D	28
Variance	777
Skewness	0.3016
Kurtosis	2.66
Coeff. of V.	0.1467
Minimum	124
Maximum	283
Mean Std. I	0

Immature female
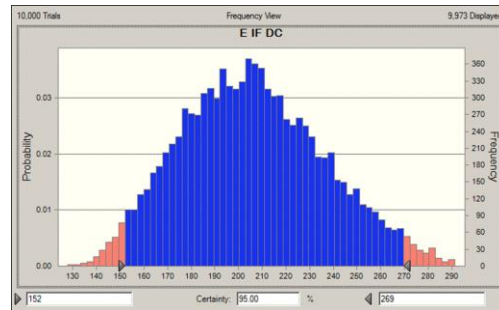
Forecast: E IF DC

Statistic	Forecast va
Trials	10,000
Base Case	196
Mean	206
Median	205
Mode	'---
Standard D	30
Variance	922
Skewness	0.2748
Kurtosis	2.68
Coeff. of V	0.1474
Minimum	128
Maximum	314
Mean Std. I	0
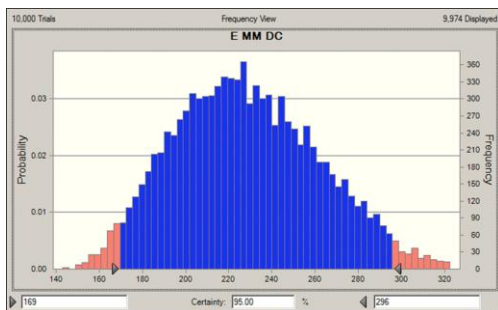
Mature male

Forecast: E MM DC

Statistic	Forecast va
Trials	10,000
Base Case	217
Mean	228
Median	226
Mode	'---
Standard D	33
Variance	1,121
Skewness	0.2658
Kurtosis	2.63
Coeff. of V.	0.1466
Minimum	143
Maximum	339
Mean Std. I	0

Mature female

Forecast: E MF DC

Statistic	Forecast va
Trials	10,000
Base Case	247
Mean	259
Median	257
Mode	'---
Standard D	37
Variance	1,397
Skewness	0.2523
Kurtosis	2.64
Coeff. of V	0.1443
Minimum	162
Maximum	394
Mean Std. I	0

- Daily consumption of common Sei whales *per capita*
- Equation-2
- Late season (From July to September)
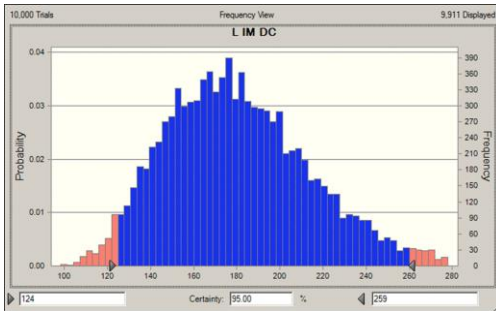
Immature male

Forecast: L IM DC

Statistic	Forecast va
Trials	10,000
Base Case	170
Mean	181
Median	178
Mode	'---
Standard D	34
Variance	1,190
Skewness	0.595
Kurtosis	3.41
Coeff. of V	0.1904
Minimum	98
Maximum	345
Mean Std.	0

Immature female
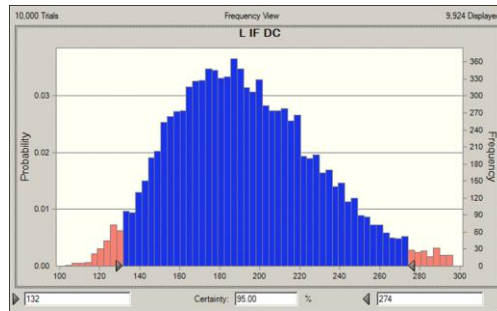
Forecast: L IF DC

Statistic	Forecast va
Trials	10,000
Base Case	182
Mean	193
Median	190
Mode	'---
Standard D	37
Variance	1,351
Skewness	0.5115
Kurtosis	3.15
Coeff. of V	0.19
Minimum	103
Maximum	339
Mean Std.	0

Mature male
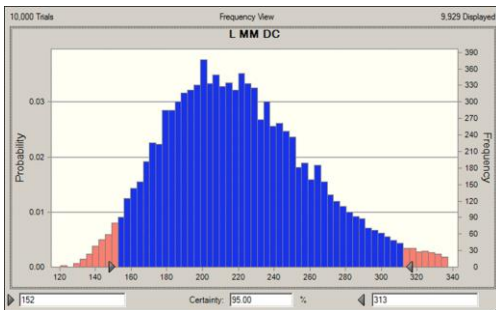
Forecast: L MM DC

Statistic	Forecast va
Trials	10,000
Base Case	208
Mean	221
Median	217
Mode	'---
Standard D	42
Variance	1,727
Skewness	0.5671
Kurtosis	3.27
Coeff. of V.	0.1883
Minimum	121
Maximum	405
Mean Std.	0

Mature female
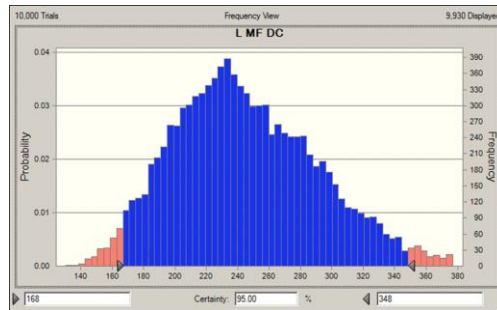
Forecast: L MF DC

Statistic	Forecast va
Trials	10,000
Base Case	231
Mean	246
Median	241
Mode	'---
Standard D	47
Variance	2,185
Skewness	0.5022
Kurtosis	3.13
Coeff. of V	0.1901
Minimum	131
Maximum	445
Mean Std.	0

- Daily consumption of common Sei whales *per capita*
- Equation-3-1
- Early season (May and June)
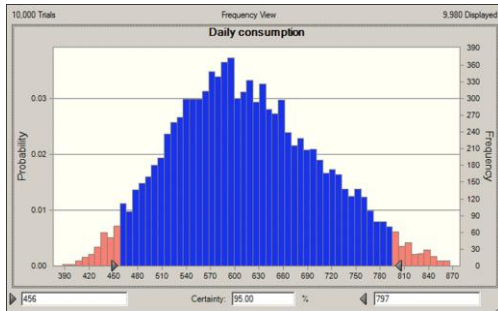
Immature male

Forecast: E IM DC

Statistic	Forecast va
Trials	10,000
Base Case	585
Mean	614
Median	608
Mode	'---
Standard D	90
Variance	8,081
Skewness	0.2727
Kurtosis	2.62
Coeff. of V.	0.1464
Minimum	387
Maximum	918
Mean Std.	1

Immature female
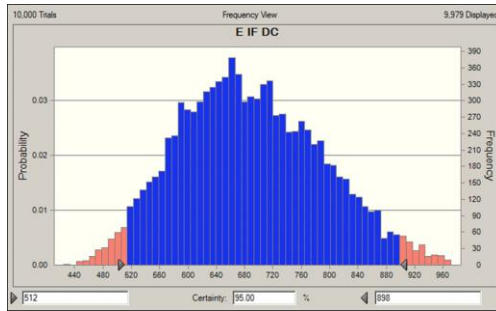
Forecast: E IF DC

Statistic	Forecast va
Trials	10,000
Base Case	654
Mean	689
Median	681
Mode	'---
Standard D	101
Variance	10,137
Skewness	0.2644
Kurtosis	2.63
Coeff. of V.	0.1462
Minimum	425
Maximum	1,042
Mean Std.	1

Mature male
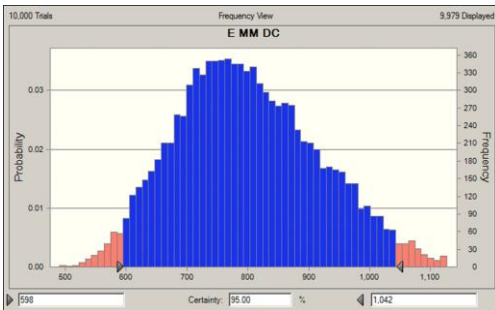
Forecast: E MM DC

Statistic	Forecast va
Trials	10,000
Base Case	762
Mean	800
Median	791
Mode	'---
Standard D	116
Variance	13,555
Skewness	0.3026
Kurtosis	2.67
Coeff. of V	0.1455
Minimum	491
Maximum	1,224
Mean Std.	1

Mature female
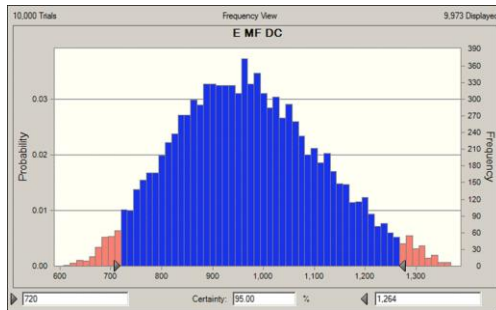
Forecast: E MF DC

Statistic	Forecast va
Trials	10,000
Base Case	923
Mean	970
Median	963
Mode	'---
Standard D	142
Variance	20,105
Skewness	0.2634
Kurtosis	2.67
Coeff. of V	0.1461
Minimum	608
Maximum	1,490
Mean Std.	1

- Daily consumption of common Sei whales *per capita*
- Equation-3-1
- Late season (From July to September)
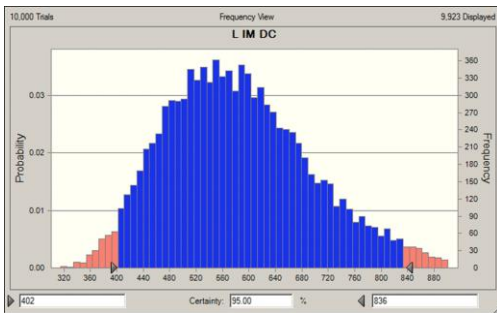
Immature male

Forecast: L IM DC

Statistic	Forecast va
Trials	10,000
Base Case	553
Mean	586
Median	575
Mode	'---
Standard D	112
Variance	12,600
Skewness	0.5428
Kurtosis	3.14
Coeff. of V.	0.1915
Minimum	315
Maximum	1,036
Mean Std.	1

Immature female
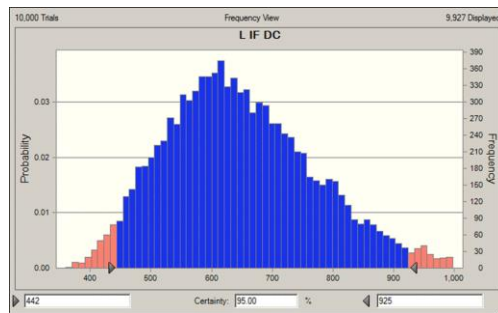
Forecast: L IF DC

Statistic	Forecast va
Trials	10,000
Base Case	610
Mean	649
Median	636
Mode	'---
Standard D	124
Variance	15,413
Skewness	0.5261
Kurtosis	3.14
Coeff. of V	0.1913
Minimum	360
Maximum	1,180
Mean Std.	1

Mature male
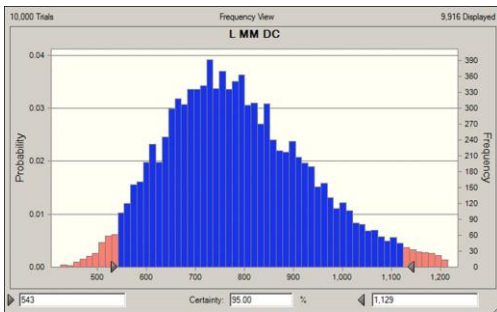
Forecast: L MM DC

Statistic	Forecast va
Trials	10,000
Base Case	742
Mean	790
Median	773
Mode	'---
Standard D	151
Variance	22,940
Skewness	0.5897
Kurtosis	3.32
Coeff. of V	0.1918
Minimum	425
Maximum	1,469
Mean Std.	2

Mature female
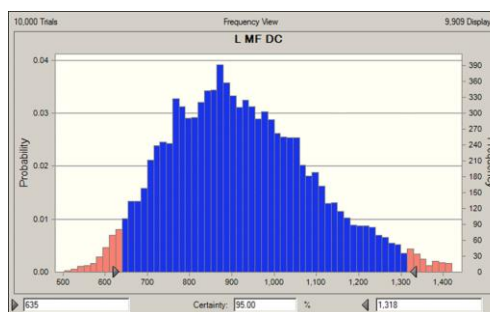
Forecast: L MF DC

Statistic	Forecast va
Trials	10,000
Base Case	872
Mean	926
Median	907
Mode	'---
Standard D	176
Variance	31,059
Skewness	0.5701
Kurtosis	3.29
Coeff. of V	0.1903
Minimum	505
Maximum	1,725
Mean Std.	2

- Daily consumption of common Sei whales *per capita*

- Equation-4

- Early season (May and June)
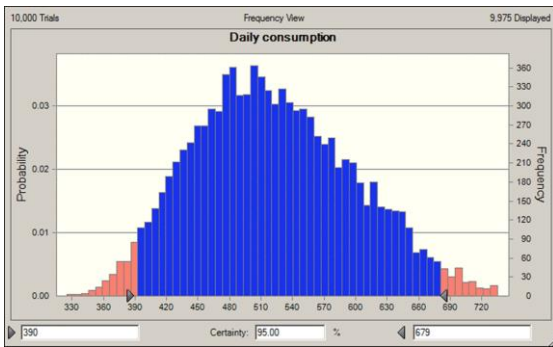
Immature male

Forecast: E IM DC

Statistic	Forecast va
Trials	10,000
Base Case	497
Mean	522
Median	516
Mode	'---
Standard D	76
Variance	5,774
Skewness	0.2922
Kurtosis	2.63
Coeff. of V	0.1455
Minimum	326
Maximum	794
Mean Std.	1

Immature female
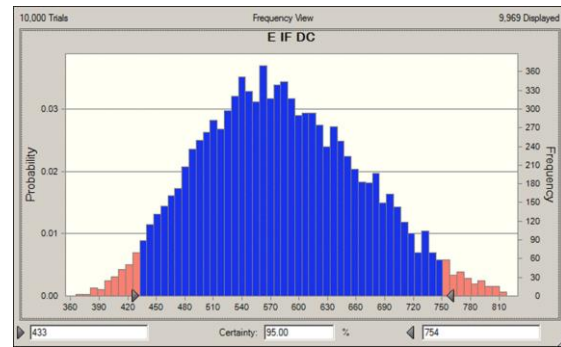
Forecast: E IF DC

Statistic	Forecast va
Trials	10,000
Base Case	553
Mean	581
Median	576
Mode	'---
Standard D	84
Variance	7,113
Skewness	0.2609
Kurtosis	2.66
Coeff. of V	0.145
Minimum	366
Maximum	869
Mean Std.	1
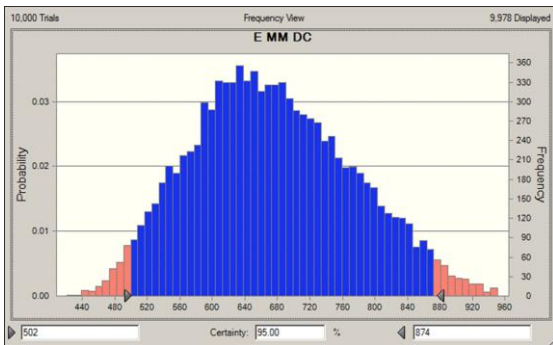
Mature male

Forecast: E MM DC

Statistic	Forecast va
Trials	10,000
Base Case	640
Mean	675
Median	668
Mode	'---
Standard D	98
Variance	9,699
Skewness	0.2745
Kurtosis	2.62
Coeff. of V.	0.1460
Minimum	422
Maximum	1,042
Mean Std.	1

Mature female
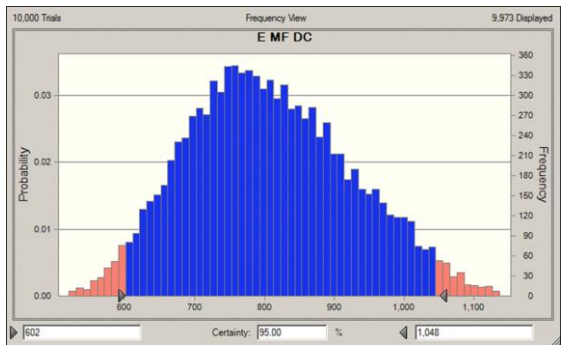
Forecast: E MF DC

Statistic	Forecast va
Trials	10,000
Base Case	770
Mean	808
Median	799
Mode	'---
Standard D	117
Variance	13,748
Skewness	0.2856
Kurtosis	2.64
Coeff. of V	0.1451
Minimum	521
Maximum	1,244
Mean Std.	1

Daily consumption of common Sei whales *per capita*

- Equation-4
- Late season (From July to September)
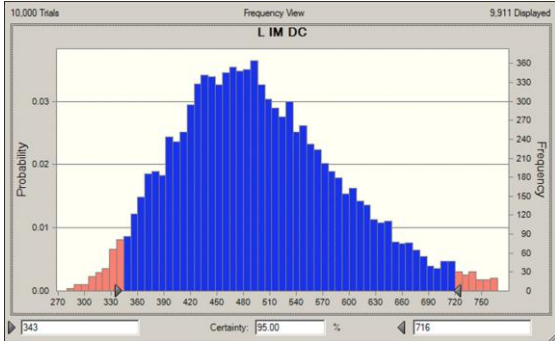
Immature male

Forecast: L IM DC

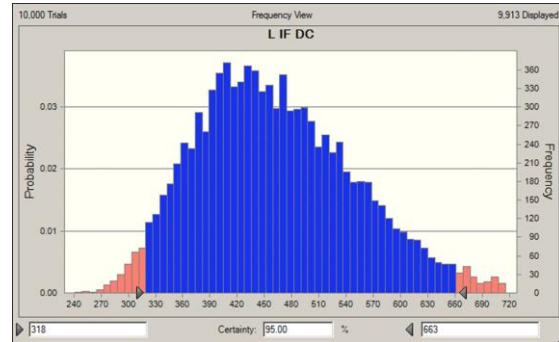| Statistic	Forecast va
Trials	10,000
Base Case	469
Mean	500
Median	489
Mode	'---
Standard D	96
Variance	9,121
Skewness	0.5877
Kurtosis	3.27
Coeff. of V	0.191
Minimum	280
Maximum	920
Mean Std.	1

Immature female
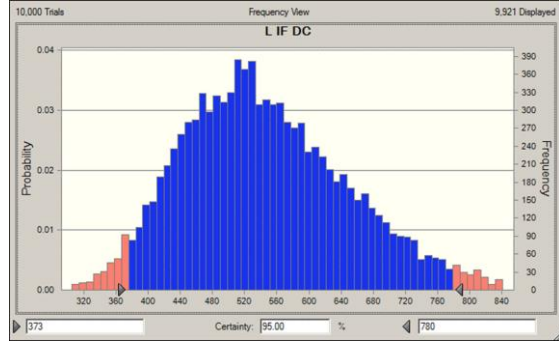
Forecast: L IF DC

Statistic	Forecast va
Trials	10,000
Base Case	516
Mean	547
Median	535
Mode	'---
Standard D	105
Variance	10,952
Skewness	0.5453
Kurtosis	3.2
Coeff. of V	0.1912
Minimum	306
Maximum	998
Mean Std.	1

Mature male
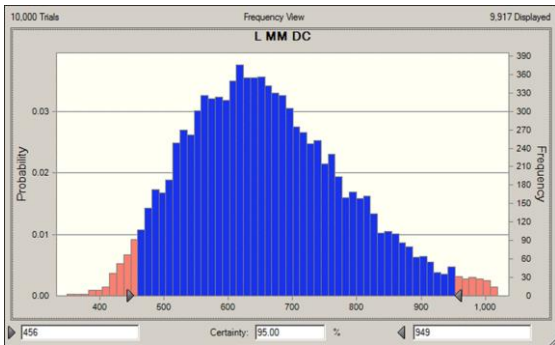
Forecast: L MM DC

Statistic	Forecast va
Trials	10,000
Base Case	622
Mean	663
Median	650
Mode	'---
Standard D	127
Variance	16,092
Skewness	0.5738
Kurtosis	3.25
Coeff. of V	0.1913
Minimum	350
Maximum	1,254
Mean Std.	1

Mature female
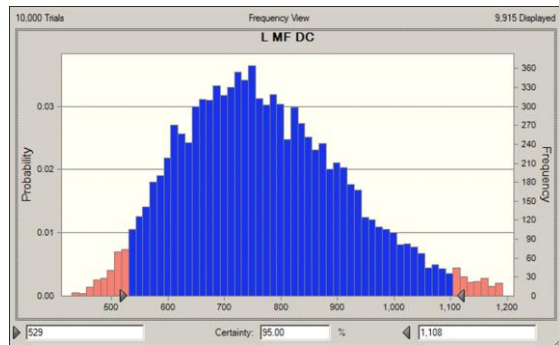
Coeff. of Variation

Statistic	Forecast va
Trials	10,000
Base Case	727
Mean	773
Median	756
Mode	'---
Standard D	149
Variance	22,300
Skewness	0.5647
Kurtosis	3.22
Coeff. of V	0.1932
Minimum	430
Maximum	1,429
Mean Std.	1

- Daily consumption of common Sei whales *per capita*
- Equation-Combined
- Early season (May and June)
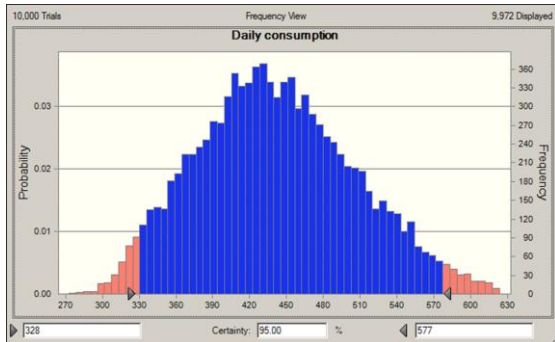
Immature male

Forecast: E IM DC

Statistic	Forecast va
Trials	10,000
Base Case	421
Mean	442
Median	438
Mode	'---
Standard D	65
Variance	4,188
Skewness	0.2754
Kurtosis	2.7
Coeff. of V	0.1463
Minimum	273
Maximum	657
Mean Std.	1

Immature female
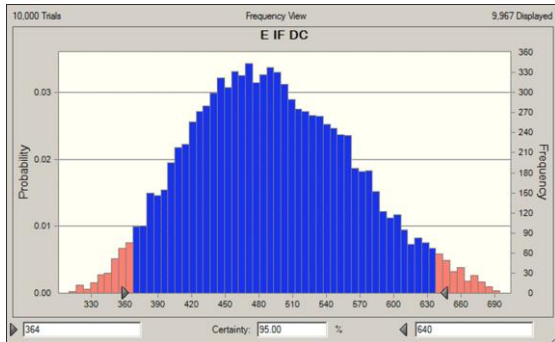
Forecast: E IF DC

Statistic	Forecast va
Trials	10,000
Base Case	468
Mean	492
Median	487
Mode	'---
Standard D	72
Variance	5,204
Skewness	0.2715
Kurtosis	2.67
Coeff. of V	0.1467
Minimum	311
Maximum	739
Mean Std.	1

Mature male
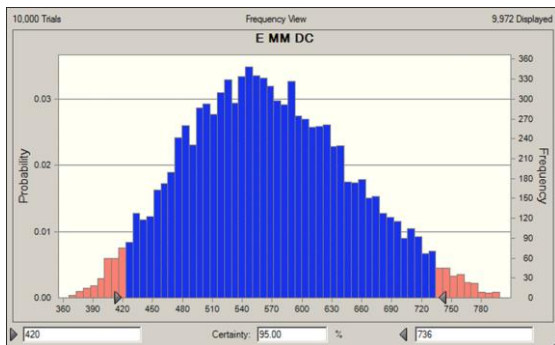
Forecast: E MM DC

Statistic	Forecast va
Trials	10,000
Base Case	539
Mean	567
Median	562
Mode	'---
Standard D	82
Variance	6,796
Skewness	0.2654
Kurtosis	2.64
Coeff. of V	0.1453
Minimum	366
Maximum	853
Mean Std.	1

Mature female
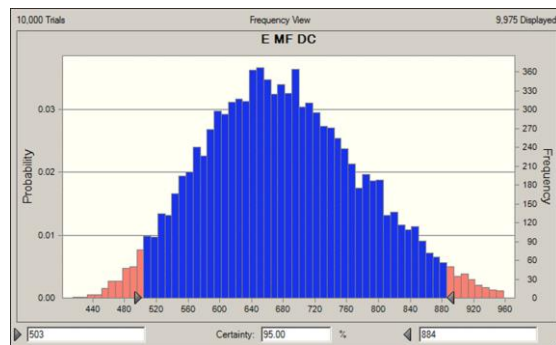
Forecast: E MF DC

Statistic	Forecast va
Trials	10,000
Base Case	647
Mean	680
Median	674
Mode	'---
Standard D	99
Variance	9,806
Skewness	0.2555
Kurtosis	2.67
Coeff. of V	0.1456
Minimum	415
Maximum	998
Mean Std.	1

- Daily consumption of common Sei whales *per capita*

- Equation-Combined

- Late season (From July to September)
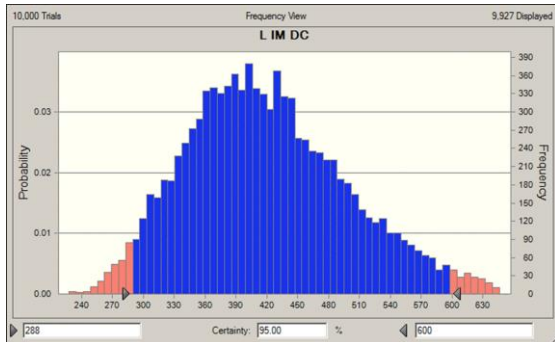
Immature male

Forecast: L IM DC

Statistic	Forecast va
Trials	10,000
Base Case	397
Mean	422
Median	413
Mode	'---
Standard D	80
Variance	6,410
Skewness	0.5494
Kurtosis	3.24
Coeff. of V	0.1899
Minimum	228
Maximum	784
Mean Std.	1

Immature female

Forecast: L IF DC

Statistic	Forecast va
Trials	10,000
Base Case	436
Mean	465
Median	455
Mode	'---
Standard D	90
Variance	8,011
Skewness	0.5457
Kurtosis	3.14
Coeff. of V	0.1926
Minimum	242
Maximum	834
Mean Std.	1

Mature male
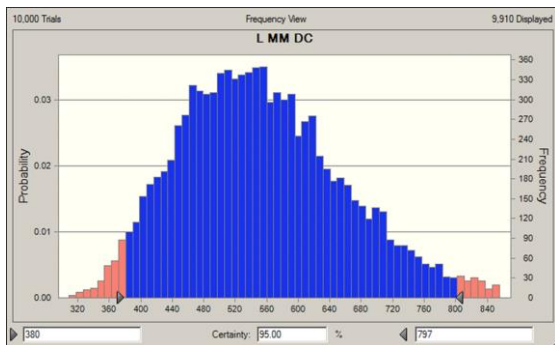
Forecast: L MM DC

Statistic	Forecast va
Trials	10,000
Base Case	524
Mean	556
Median	546
Mode	'---
Standard D	107
Variance	11,419
Skewness	0.5879
Kurtosis	3.33
Coeff. of V	0.1921
Minimum	309
Maximum	1,058
Mean Std.	1

Mature female
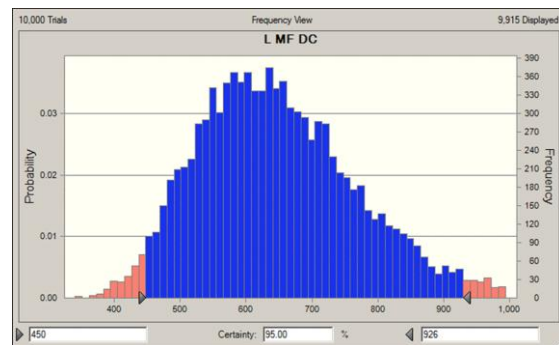
Forecast: L MF DC

Statistic	Forecast va
Trials	10,000
Base Case	610
Mean	650
Median	637
Mode	'---
Standard D	123
Variance	15,052
Skewness	0.5951
Kurtosis	3.35
Coeff. of V	0.1889
Minimum	341
Maximum	1,215
Mean Std.	1

- Seasonal consumption of common minke whales (Period: 2000-2007)
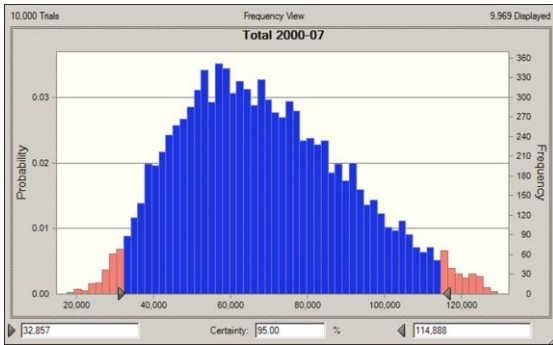
Equation-2

Coeff. of Variation

Statistic	Forecast values
Trials	10,000
Base Case	44,985
Mean	68,603
Median	66,503
Mode	'---
Standard D	21,675
Variance	469,798,585
Skewness	0.4156
Kurtosis	2.67
Coeff. of V	0.3159
Minimum	17,578
Maximum	148,832
Mean Std.	217

Equation-3-1
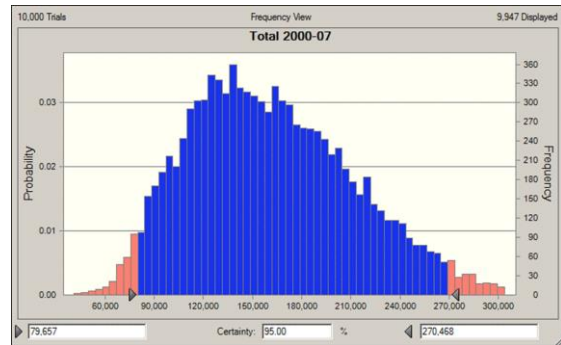
Forecast: Total 2000-07

Statistic	Forecast values
Trials	10,000
Base Case	107,358
Mean	162,045
Median	156,901
Mode	'---
Standard D	50,589
Variance	2,559,293,269
Skewness	0.466
Kurtosis	2.82
Coeff. of V	0.3122
Minimum	41,147
Maximum	343,101
Mean Std.	506

Equation-4
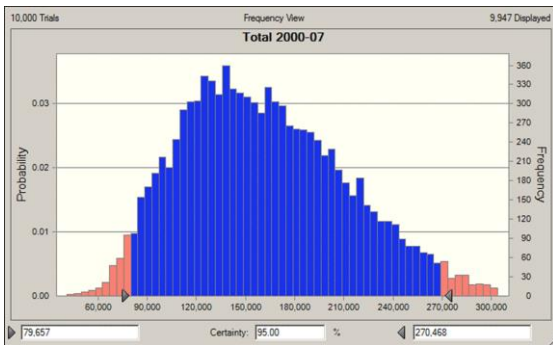
Forecast: Total 2000-07

Statistic	Forecast va
Trials	10,000
Base Case	94,773
Mean	143,941
Median	139,182
Mode	'---
Standard D	45,386
Variance	########
Skewness	0.4631
Kurtosis	2.81
Coeff. of V	0.3153
Minimum	40,932
Maximum	317,567
Mean Std.	454

Equation-Combined
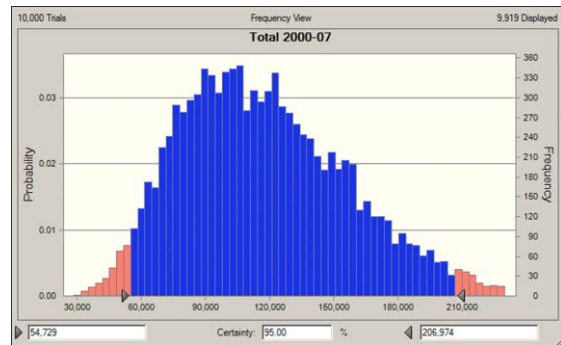
Forecast: Total 2000-07

Statistic	Forecast va
Trials	10,000
Base Case	82,372
Mean	118,250
Median	113,794
Mode	'---
Standard D	39,855
Variance	########
Skewness	0.5996
Kurtosis	3.2
Coeff. of V	0.337
Minimum	28,552
Maximum	306,867
Mean Std.	399

- Seasonal consumption of common minke whales (Period: 2008-2014)
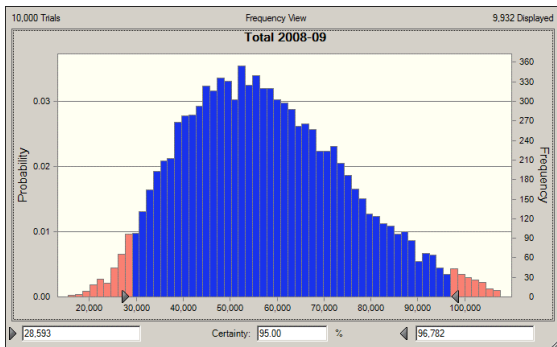
Equation-2

Forecast: Total 2008-09

Statistic	Forecast values
Trials	10,000
Base Case	38,144
Mean	57,803
Median	56,113
Mode	'---
Standard D	17,758
Variance	315,351,117
Skewness	0.5002
Kurtosis	3.04
Coeff. of V	0.3072
Minimum	15,537
Maximum	139,075
Mean Std.	178

Equation-3-1
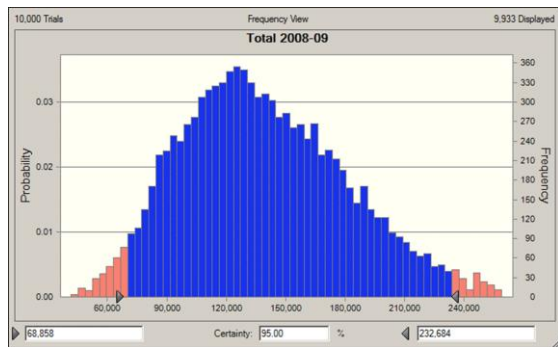
Forecast: Total 2008-0

Statistic	Forecast va
Trials	10,000
Base Case	91,124
Mean	139,842
Median	135,250
Mode	'---
Standard D	42,543
Variance	########
Skewness	0.4989
Kurtosis	3.05
Coeff. of V	0.3042
Minimum	41,740
Maximum	318,770
Mean Std.	425

Equation-4
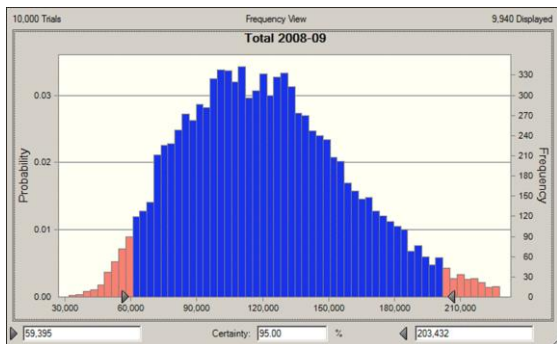
Forecast: Total 2008-0

Statistic	Forecast va
Trials	10,000
Base Case	80,430
Mean	121,961
Median	118,984
Mode	'---
Standard D	37,749
Variance	########
Skewness	0.4702
Kurtosis	2.97
Coeff. of V	0.3095
Minimum	31,983
Maximum	290,612
Mean Std.	377

Equation-Combined
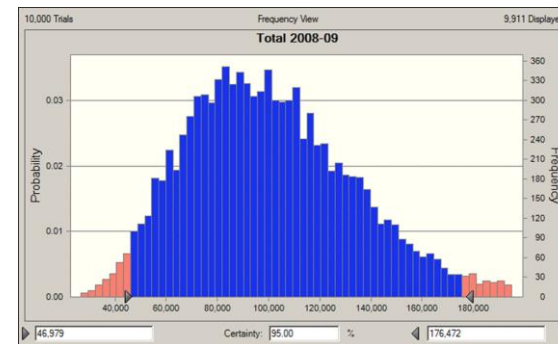
Forecast: Total 2008-0

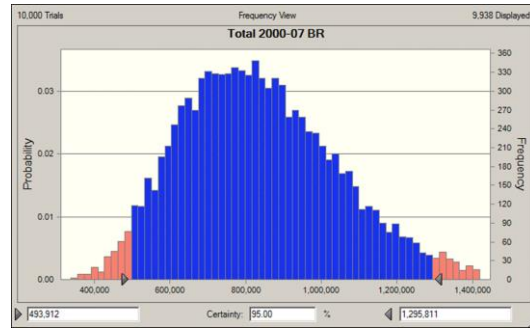| Statistic	Forecast va
Trials	10,000
Base Case	69,899
Mean	101,285
Median	97,807
Mode	'---
Standard D	33,427
Variance	########
Skewness	0.6149
Kurtosis	3.41
Coeff. of V	0.33
Minimum	26,753
Maximum	276,956
Mean Std.	334

- Seasonal consumption of Bryde's whales (Period: 2000-2007)
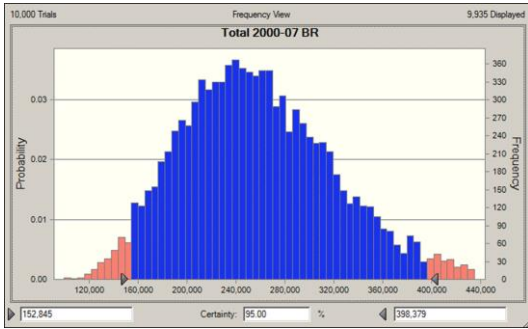
Equation-2

Forecast: Total 2000-0'

Statistic	Forecast va
Trials	10,000
Base Case	216,311
Mean	258,508
Median	252,996
Mode	'---
Standard D	62,932
Variance	########
Skewness	0.4783
Kurtosis	3.09
Coeff. of V	0.2434
Minimum	99,762
Maximum	529,349
Mean Std.	629

Equation-3-1

Forecast: Total 2000-0'

Statistic	Forecast va
Trials	10,000
Base Case	697,828
Mean	838,508
Median	820,152
Mode	'---
Standard D	206,974
Variance	########
Skewness	0.4749
Kurtosis	3.02
Coeff. of V	0.2468
Minimum	338,869
Maximum	1,772,378
Mean Std.	2,070

Equation-4
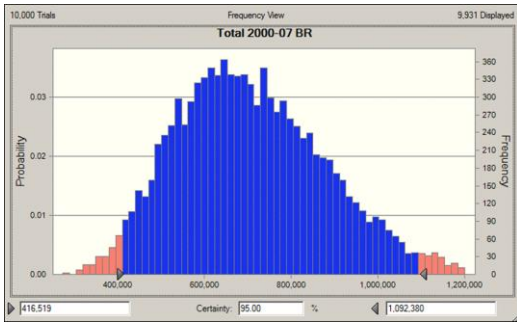
Forecast: Total 2000-0'

Statistic	Forecast va
Trials	10,000
Base Case	592,830
Mean	709,972
Median	693,478
Mode	'---
Standard D	174,757
Variance	########
Skewness	0.4718
Kurtosis	3.06
Coeff. of V	0.2461
Minimum	273,897
Maximum	1,451,402
Mean Std.	1,748

Equation-Combined
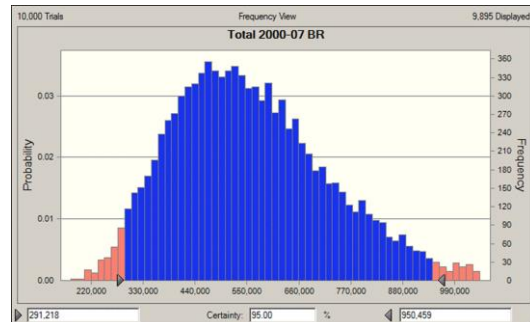
Forecast: Total 2000-0'

Statistic	Forecast va
Trials	10,000
Base Case	502,323
Mean	562,673
Median	541,658
Mode	'---
Standard D	171,384
Variance	########
Skewness	0.6805
Kurtosis	3.47
Coeff. of V	0.3046
Minimum	177,358
Maximum	1,351,787
Mean Std.	1,714

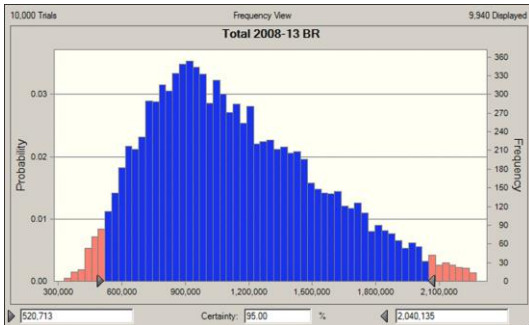- Seasonal consumption of Bryde's whales (Period: 2008-2014)
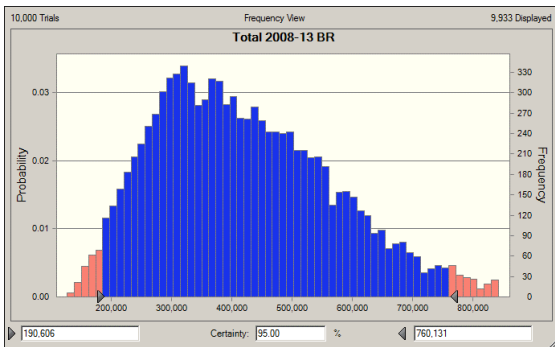
Equation-2

Forecast: Total 2008-1:

Statistic	Forecast va
Trials	10,000
Base Case	310,199
Mean	422,946
Median	402,896
Mode	'---
Standard D	149,575
Variance	########
Skewness	0.6029
Kurtosis	3.02
Coeff. of V	0.3536
Minimum	127,272
Maximum	1,069,020
Mean Std.	1,496

Equation-3-1
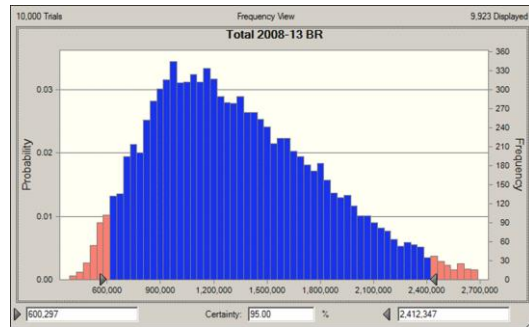
Forecast: Total 2008-1:

Statistic	Forecast va
Trials	10,000
Base Case	989,707
Mean	1,343,729
Median	1,276,498
Mode	'---
Standard D	479,734
Variance	########
Skewness	0.6218
Kurtosis	3.02
Coeff. of V	0.3570
Minimum	389,790
Maximum	3,173,438
Mean Std.	4,797

Equation-4

Forecast: Total 2008-1:

Statistic	Forecast va
Trials	10,000
Base Case	841,977
Mean	1,140,977
Median	1,076,095
Mode	'---
Standard D	404,227
Variance	########
Skewness	0.6235
Kurtosis	2.96
Coeff. of V	0.3543
Minimum	329,063
Maximum	2,881,683
Mean Std.	4,042

Equation-Combined
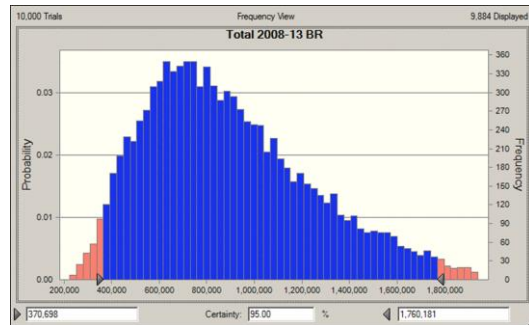
Forecast: Total 2008-1:

Statistic	Forecast va
Trials	10,000
Base Case	713,961
Mean	906,350
Median	842,016
Mode	'---
Standard D	367,968
Variance	########
Skewness	0.8607
Kurtosis	3.68
Coeff. of V	0.4060
Minimum	225,153
Maximum	2,956,664
Mean Std.	3,680

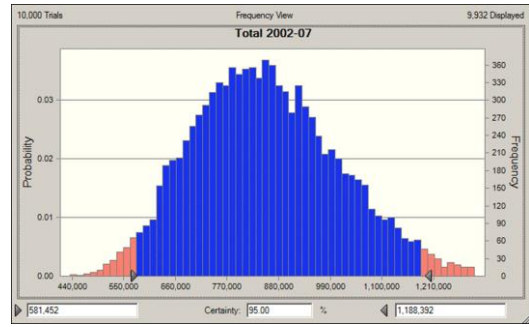- Seasonal consumption of sei whales (Period: 2002-2007)

Equation-2
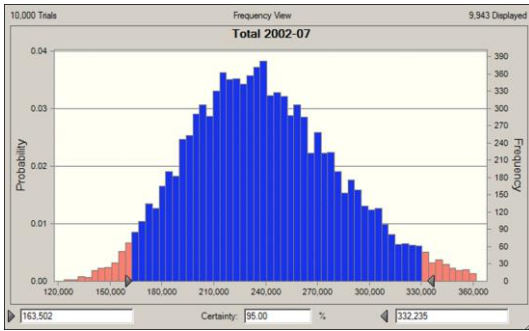
Forecast: Total 2002-0'

Statistic	Forecast va
Trials	10,000
Base Case	211,250
Mean	239,326
Median	235,921
Mode	'---
Standard D	43,653
Variance	########
Skewness	0.4008
Kurtosis	3.05
Coeff. of V	0.1824
Minimum	123,697
Maximum	433,950
Mean Std.	437

Equation-3-1

Forecast: Total 2002-0'

Statistic	Forecast va
Trials	10,000
Base Case	754,258
Mean	856,025
Median	845,364
Mode	'---
Standard D	157,301
Variance	########
Skewness	0.3927
Kurtosis	3.01
Coeff. of V	0.1838
Minimum	436,129
Maximum	1,565,693
Mean Std.	1,573

Equation-4
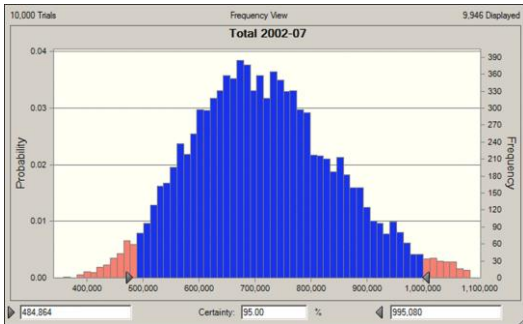
Forecast: Total 2002-0'

Statistic	Forecast va
Trials	10,000
Base Case	632,542
Mean	716,582
Median	707,782
Mode	'---
Standard D	130,651
Variance	########
Skewness	0.3829
Kurtosis	3.1
Coeff. of V	0.1823
Minimum	359,384
Maximum	1,368,727
Mean Std.	1,307

Equation-Combined
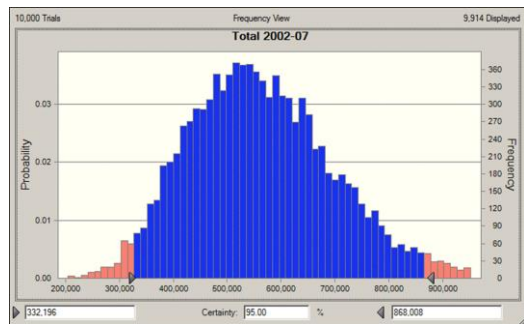
Forecast: Total 2002-0'

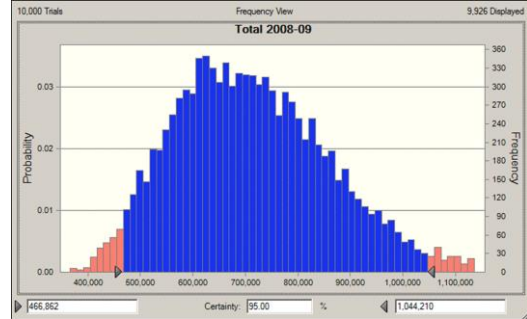| Statistic	Forecast va
Trials	10,000
Base Case	532,683
Mean	565,510
Median	553,781
Mode	'---
Standard D	137,484
Variance	########
Skewness	0.522
Kurtosis	3.4
Coeff. of V	0.2431
Minimum	205,268
Maximum	1,300,198
Mean Std.	1,375

- Seasonal consumption of sei whales (Period: 2008-2014)
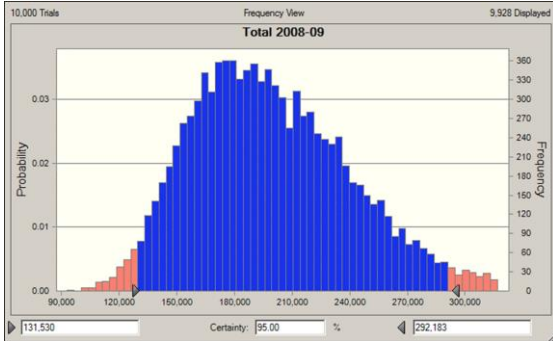
Equation-2

Forecast: Total 2008-0'

Statistic	Forecast va
Trials	10,000
Base Case	175,500
Mean	199,642
Median	195,031
Mode	'---
Standard D	41,817
Variance	########
Skewness	0.5448
Kurtosis	3.14
Coeff. of V	0.2095
Minimum	93,181
Maximum	389,023
Mean Std.	418

Equation-3-1

Forecast: Total 2008-0'

Statistic	Forecast va
Trials	10,000
Base Case	626,265
Mean	714,765
Median	701,295
Mode	'---
Standard D	150,237
Variance	########
Skewness	0.5297
Kurtosis	3.21
Coeff. of V	0.2102
Minimum	366,522
Maximum	1,413,425
Mean Std.	1,502

Equation-4
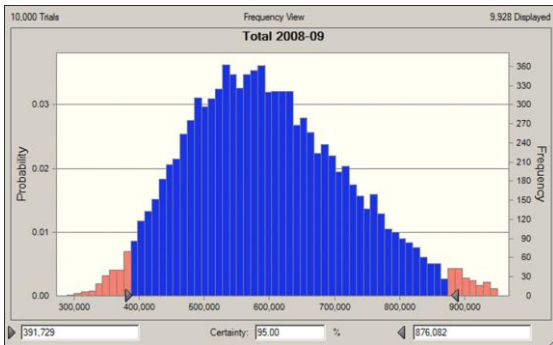
Forecast: Total 2008-0'

Statistic	Forecast va
Trials	10,000
Base Case	525,241
Mean	599,679
Median	587,368
Mode	'---
Standard D	125,095
Variance	########
Skewness	0.5036
Kurtosis	3.12
Coeff. of V	0.2086
Minimum	289,642
Maximum	1,171,361
Mean Std.	1,251

Equation-Combined
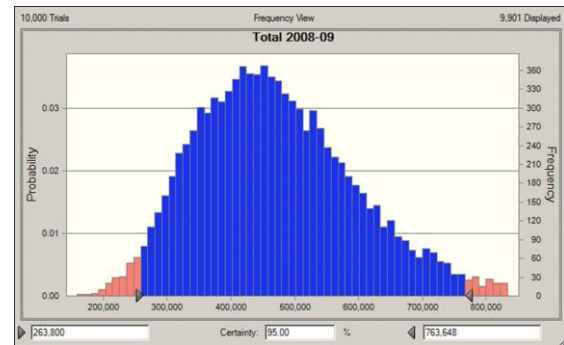
Forecast: Total 2008-0'

Statistic	Forecast va
Trials	10,000
Base Case	442,335
Mean	472,803
Median	458,633
Mode	'---
Standard D	128,594
Variance	########
Skewness	0.6325
Kurtosis	3.47
Coeff. of V	0.2720
Minimum	159,233
Maximum	1,093,408
Mean Std.	1,286