Necessity of combining lethal and non-lethal methods for whale population research and their application in JARPA

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ABSTRACT

Effective combination of lethal and non-lethal methods is needed to conduct whale population research taking into consideration the biological characteristics of the target whale species and the practicality of the research methods used. The merits and demerits on these two kinds of research methods were compared for seven biological characteristics and for four items related to their practicality.

The JARPA was conducted on the Antarctic minke whale populations by effective combination of lethal and non-lethal methods to fulfil its research objects.

KEY WORDS

Lethal method, non-lethal method, whale population research, JARPA

INTRODUCTION

Conservation and management of any living marine resources, including whales, requires a variety of biological information; growth, reproduction, recruitment, mortality, estimates of abundance, distribution of the resource, response of the resource to fishing, environmental factors, interactions with other species, and the inter-annual variability of these factors, etc. Furthermore, depending on the character of analysis, different degrees of statistical accuracy are required.

There are lethal and non-lethal methods to study wild animals. Both methods have practical merits and demerits, so that it is ideal to combine the merits of both methods in order to conduct research effectively and efficiently according to the characteristics of target whale species, its population level, available technology and the environment of the target population. However, discussions about the need for and the effectiveness of lethal and non-lethal research method have been often conducted without regard to such complexities.

The scientific research which Japan has carried out in the Antarctic (JARPA and JARPAII) and the western North Pacific (JARPN and JARPNII) are conducted using a combination of both methods. This document was prepared in order to provide a road map for the consideration of the issue of application of lethal and non-lethal research methods for JARPA.

BIOLOGICAL CHARACTERISTICS OF WHALES IN RELATION TO POPULATION RESEARCH

Among the wild animals, whales have several unique characteristics related to the applicability and effectiveness of lethal and non-lethal research methods. Research objectives and obtaining a statistically significant sample size are also factors that need to be considered in choosing the appropriate research methods. The following are examples of such considerations.

1. Whales are completely aquatic and are distributed over huge oceanic ranges
Whales are mammals which spend their entire life in huge oceanic environments. Stranding is rare and stranded animals can in no way be considered as normal individuals in terms of their health and behaviour patterns. Therefore, data from stranded animals are useful but could be heavily biased. This means that population

research must be conducted in the open sea where random sampling of normal animals is possible, and that research vessels are needed to fulfil the study.

2. Whales swim fast and migrate long distance

The breeding and feeding grounds of large whales are separated by very long distances. Whales migrate between these two grounds seasonally. They have a general characteristic to gather in the feeding ground, and disperse in the breeding ground. Whales usually swim at high speed for long periods of time. Thus, a catcher boat with high speed is needed to apply lethal methods. A research vessel and speed boat carried by the vessel is required for non-lethal research such as biopsy and biologging surveys. Research using such non-lethal methods in rough sea conditions is accompanied by considerable danger because non-lethal research usually uses small boats.

3. Many kinds of whales have few distinctive morphological characteristics and their population size is large

There are few distinctive individual body characteristics in many whales such as the Antarctic minke whale. In addition, the population size of many whales such as the Antarctic minke whale is large. This makes the application of non-lethal methods like individual identification by biopsy and photo-ID difficult for the whales with these two biological characteristics. Even if a whale species has distinctive body characteristics, the application of individual identification is not practical, when the population size of this species stock is large.

4. Whales have a relatively high age of sexual maturity, a breeding cycle over many years and a long life span

Many years of tracking the same individual are needed to obtain data on these biological parameters by use of non-lethal methods. Further, such tracking of many individuals is needed to obtain these data with statistical significance making it practically impossible and certainly not cost effective. On the contrary, lethal method is more useful for this kind of study because a large number of more accurate data can be collected in a shorter time.

5. Whales drown by anaesthesia

As the respiration of whales is controlled by voluntary muscle, they drown when anaesthetized. It is therefore impossible to hold a whale under anaesthetic to carry out non-lethal measurements or experiments as is the case for terrestrial mammals.

6. It is impractical to keep large whale in aquarium

Observation over long periods of time of large whales kept alive in an aquarium is still impractical. Even if it becomes practical, this method would be opposed by some for moral reasons.

PRACTICAL CONSIDERATIONS IN WHALE POPULATION RESEARCH

We must consider the practical matters to conduct whale research in addition to the biological characteristics of the target whale species.

1. Scale of the research

For conducting research in large areas of open sea in which rough weather and sea conditions are frequent, large sized research vessels are required. Therefore, it is not practical to conduct large scale whale research by use of non-lethal methods exclusively in the open sea, for it is very costly in such a case. On the other hand, lethal methods which could earn research cost are most desirable.

2. Practicability of research

Even if a method is theoretically reasonable, there are often practical problems to apply the method in the actual research. For example, while feces sampling may be theoretically reasonable, feces of whales are liquid and diffuse quickly and widely. Furthermore, the excretion of a whale is seldom observed. Therefore, while it is

not impossible to collect feces by chance, it is not practical to use the feces sampling method in research requiring statistically meaningful samples from a large number of animals.

3. Securing of suitable research vessels, skilful crew and researchers

The maintenance of suitable research vessels and skilled crews and researchers are needed to conduct long-term population research in the open sea. Thus, whale research is costly and it is practically difficult to keep these vessels, crew and researchers in the case in which large scale research by means of only non-lethal research is conducted over many years to continue long term research projects.

4. Cost of research

Population research of whales in the open sea requires very considerable expenditures. Such expenditures over long periods of time are almost impossible to fund without some cost recovery. The use of only non-lethal methods does not provide the possibility for cost recovery whereas most of such costs can be recovered by selling of by-products when lethal method is used. In addition, a large whale body makes it impossible for one person to take measurements or record significant data. Even in the case of non-lethal methods, the cooperation of many persons is needed. Whale research is costly and therefore lethal methods which could recover the cost for research is more desirable. Processing of by-products obtained from lethal research is an obligation under paragraph 2 of Article VIII of the ICRW.

COMPARISON OF THE CHARACTERISTICS OF LETHAL AND NON-LETHAL METHODS

Lethal and non-lethal methods each have their own characteristics that must be considered in relation to the research objectives and factors such as the target whale species, research field, research season, research period, and research cost in addition to the biological and practical factors above. The ability to utilize the resource is also a factor. These are shown in Table 1.

APPLICATION OF LETHAL AND NON-LETHAL METHODS FOR JARPA

The JARPA which was specifically designed to provide data for improving the management of whale resources was conducted using a combination of lethal and non-lethal methods as shown in Table 2 . Some of the research objectives simply could not have been achieved using only non-lethal methods because internal organs were required. In other cases, the need for a large number of samples collected over a large area and long time period in order to achieve statistically meaningful results made the use of non-lethal methods impractical, cost ineffective and prohibitively expensive.

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Table 1. Biological factors research requirements – a comparison of the applicability of lethal and non-lethal methods..

Item	Lethal method	Non-lethal method
Population size	Unsuitable for rare species	Unsuitable for large sized population
Movement of whales	Applicable for slow and fast	Generally applicable only for slow
Morphological Characteristics	applicable for species without individually distinctive characteristics	Effective for species with individually distinctive characteristics
Number of samples	Can collectable of large number of samples	Only small number of samples can be collected
Samples from body	Collectable from inside the body	Collectable only from body surface
Research field	Can be surveyed in bad conditions	Can be surveyed only in good conditions
Time of research	Day time only	Possible in night time in some cases
Possible research time period	Possible to use over long time period in a season	Can be used only for short time periods of a season
Research time required	For some research objectives, results available within relatively few years	Need to survey for long number of years
Data continuity	Data available only at time of capture	Can observe the same individual for longer time
Scale of research	Need of equipment to catch and process of whales	Catching and processing equipment not needed
Cost of research	Cost recovery possible by utilization of by-products	Large amount of cost is needed
Utilization of resources	Can utilize the resources	Cannot use the resources

Table 2. JARPA objectives, research items, application of lethal and non-lethal methods and the reason for the judgment of their effectiveness

JARPA objectives	Research items	Application for JARPA		Reasons for judgment of effectiveness of the research methods for achievement of JARPA objectives
		Lethal method	Non-lethal method	
I. The estimation of biological parameters to improve the stock management of whales	Age determination	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
				It's difficult to estimate accurate age by use of non-lethal method such as telomere other than using ear plug [3].
				The long-term observation with individual identification is not possible for A. minke whale, because of high level of abundance and absence of distinct body characteristics.
	Natural mortality	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of

				JARPA objectives with biopsy [2].
				It's difficult to estimate accurate age by use of non-lethal method such as telomere other than using ear plug [3].
				The long-term observation with individual identification is not possible for A. minke whale, because of high level of abundance and absence of distinct body characteristics.
	Age at sexual maturity	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
				It's difficult to estimate accurate age by use of non-lethal method such as telomere other than using ear plug [3].
				The long-term observation with individual identification is not possible for A. minke whale, because of high level of abundance and absence of distinct body characteristics.
				Determination of sexual maturation is difficult with feces and biopsy samples [4,5,6].
	Pregnancy rate	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
				The long-term observation with individual identification is not possible for A. minke whale, because of high level of abundance and absence of distinct body characteristics.
				Gestation period is not understood with the biopsy [5,6].
	Abundance	No	Yes	Sighting survey is useful for estimation of abundance [7].
II. The elucidation of the role of whales in the Antarctic marine ecosystem	Feeding habit	Yes	No	Prey species proportion in the stomach, feeding time etc. are not understood by feces survey [8,9,10].
	Body fatness	Yes	No	Estimation of body fatness is not accurate with photographic method [11].
	Prey species biomass	No	Yes	Echo sounder survey as well as stomach contents survey are useful for estimation of prey abundance [12,13].
III. The elucidation of the effect of environmental changes on cetaceans	Accumulation of heavy metal and organochlorines	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
				It's difficult to estimate accurate age by use of non-lethal method such as telomere other than using ear plug [3].
				Evaluation of effect of contaminants on whale as well as the monitoring of the accumulation trend is conducted in JARPA survey based on biological data such as age, body length and weight of stomach contents [14,15,16].

	Change in abundance of other whale species	Yes	Yes	Sighting survey is useful for estimation of abundance [17].
				The data of body condition by lethal survey provides powerful evidence [18].
IV. The elucidation of the range of distribution and boundary of whale stocks	Separation of stocks	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
	Detection of breeding area	Yes	Yes	Attachment of satellite tag to A. minke whale has been attempted in JARPA [19].
				Discovery type Mark-recapture is used for JARPA.
	Mixing of stocks within feeding area	Yes	No	It is difficult to collect large number of samples from whole survey area for accomplishment of JARPA objectives with biopsy [2].
				Attachment of satellite tag to A. minke whale has been attempted in JARPA [19].
V. Others	Other whale species	No	Yes	Sighting survey, biopsy sampling and photo-identification are conducted.
	Basic study of artificial insemination	Yes	No	It is impossible to collect ovum and sperm by non-lethal method.