

## Feasibility of Photo-identification Techniques for the Bottlenose Dolphins (*Tursiops truncatus*) from Jeju Island, Korea

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The feasibility of photo-identification techniques for the bottlenose dolphins from Jeju Island, Korea, and the potential for dolphin watching were simultaneously evaluated in this study. During the sighting survey, a pod of bottlenose dolphins composed of approximately 30 individuals was observed in the southwestern coastal area of Jeju Island. Among 35 suitable photographs, five bottlenose dolphin individuals were identified and cataloged using unique nicks and notches on their dorsal fins. This shows that the Jeju Island dolphins can be individually identified by the nicks and notches on their dorsal fins using photo-identification techniques. Furthermore, the Jeju Island population appears to be suitable for long-term population biology studies using this technique. The potential for dolphin watching around the island would be higher if more information on the seasonal distribution, movement, and residency of this population were obtained.

Key words: Photo-identification techniques, Bottlenose dolphin, Dolphin watching, Jeju Island

### Introduction

The recognition and identification of individuals has long been important to the study of animal ecology and behavior. Generally, large and long-lived vertebrates, such as whales, can be identified using their natural markings, and photo-identification techniques have been successfully employed to identify individuals of many cetacean species. For instance, individuals of many species, including killer whales (Bigg, 1982), Indo-Pacific humpback dolphins (Saayman and Tayler, 1973), bottlenose dolphins (Würsig and Würsig, 1977), and Hawaiian spinner dolphins (Norris and Dohl, 1980) were identified, and these individuals provided important information on the occurrence, distribution, and movement of these populations. With sufficiently good photographs, a large portion of a population can be individually iden-

tified (Würsig and Jefferson, 1990). Photo-identification techniques are very useful in studying the occurrence, distribution, abundance, migration, residency, behavior, and population biology (such as survival and reproduction) of several cetacean species. Photo-identification is most commonly used to recognize group composition and the fidelity of certain individuals to each group (Würsig and Würsig, 1977). Information on the distribution, movement, and migration of various species can be gathered if several photographs of particular individuals are obtained from more than one area (Wells and Scott, 1990). The general behavioral patterns of individuals can also be identified by the observation of recognized individuals (Würsig, 1978). Furthermore, mark-recapture studies using photo-identification techniques, which are related to the proportion of marked to unmarked individuals, can be used to obtain information on population size and trends in population size (Hammond,

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1986). Bottlenose dolphins (*Tursiops truncatus*) are widespread throughout the temperate and tropical oceans of the world (Leatherwood et al., 1983). Although several populations of bottlenose dolphins were observed in sighting surveys in Korean waters (South Sea and East Sea), only the Jeju Island population was considered potentially suitable for photo-identification due to its possible residency around the island. No previous sighting survey of bottlenose dolphins has been conducted around Jeju Island, but according to the statements of many local fishermen, bottlenose dolphins are likely distributed around the island throughout the year. This population is probably distributed near shallow coastal areas and comprises approximately 20-30 individuals, although its biology and ecology are not known due to a lack of studies. Many researchers have used naturally occurring nicks and notches on dorsal fins to identify individual bottlenose dolphins (Williams et al., 1993; Wells et al., 1996; Wilson et al., 1999). Generally, missing dorsal fin tissue provides unique markers to identify individuals within a population. Here we report the first sighting and photo-identification survey of bottlenose dolphins around Jeju Island. We also observed the behavior of the dolphins to assess the possibility of dolphin watching in this area using this species.

The goals of this study are to investigate the feasibility of photo-identification techniques for bottlenose dolphins around Jeju Island, the possibility of long-term population biology studies of bottlenose dolphins in this area using the above techniques, and the potential for wildlife watching with regard to the bottlenose dolphins of Jeju Island.

## Materials and Methods

### Data collection

Jeju Island, the largest island in Korea (approximately 1,825 km<sup>2</sup>), is located southwest of the Korean Peninsula (Fig. 1). It was selected because of statements made by many local fishermen about the possibility of year-round residency of bottlenose dolphins. Sighting and photo-identification surveys were simultaneously conducted from 16-18 August 2005 to investigate the occurrence, distribution, and behavior of the bottlenose dolphins around the island. The research vessel *Tamgu* No. 16 (39 G/T, 425 HP) was used for the sighting survey, and a 4-m outboard-powered inflatable boat was used for the photo-identification survey in shallow water. The research team consisted of a data recorder, photographer, video recorder, and boat operator. During the ob-

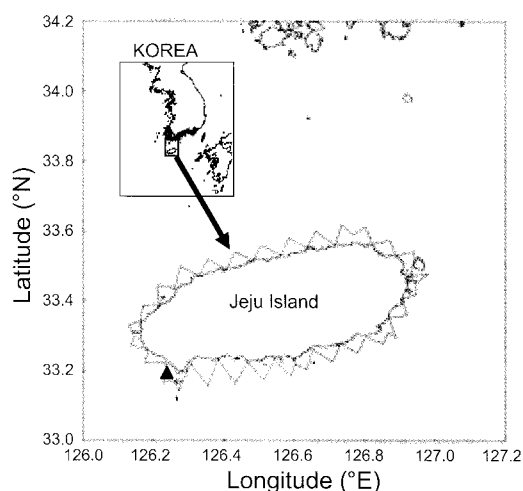


Fig. 1. Survey line and sighting location of bottlenose dolphins (triangle) in Jeju Island during the 2005 survey.

servaion of bottlenose dolphins, we slowly approached and took pictures of the dorsal fins of each dolphin at a distance of 5-10 m. The data recorder noted the location (latitude, longitude, water depth, and distance from shore), time, and number of individuals in each sighting. Photographs of dorsal fins were taken using 35 mm film cameras (Nikon D2X) with a zoom lens (80-200 mm and 100-300 mm; Nikon). The environmental data, including sea surface temperature and salinity, of the sighting position was obtained from the Jeju Fisheries Research Institute.

### Data analysis

Photographs of the dorsal fins were examined using a magnifier (4×). Each individual bottlenose dolphin was identified and cataloged using the nicks and notches of its dorsal fin. Although other studies have used additional natural markings (such as the shape of the dorsal fin, shading of the fin and upper body, scratches and wound marks) to identify individual dolphins, nicks and notches on the dorsal fin were used for exact identification due to the uncertain longevity of the other marks (Würsig and Würsig, 1977), whereas nicks and notches on the dorsal fin are generally considered to be long-lasting (Wilson et al., 1999). After identifying individuals, an identification number was assigned to each individual and a photograph of the individual was kept in a catalog. In addition to using nicks and notches, other techniques are available for analyzing and cataloging the dorsal fin photographs of bottlenose dolphins for the purpose of identifying individuals. Defran et al. (1990) defined the dorsal ratio, which is calculated

using the ratio between the distance between two notches and the distance of the lower measured notch to the top of the fin, and used it to identify individual bottlenose dolphins. We also calculated the dorsal ratio of each individual. The feasibility of photo-identification for the bottlenose dolphins around Jeju Island was evaluated according to its potential for identifying individuals.

## Results

### Field effort and occurrence of bottlenose dolphins

The sighting and photo-identification surveys were conducted around Jeju Island for a total of 173 nautical miles during 16-18 August 2005 (Fig. 1). In total, we spent 20 hrs and 5 min searching for bottlenose dolphins in good weather conditions over 3 days. On the second day of the survey (17 August 2005), a pod of bottlenose dolphins comprising approximately 30 individuals was observed in the southwestern coastal area of Jeju Island ( $33^{\circ}11'67''$ ,  $126^{\circ}13'84''$ ; Fig. 1; Fig. 2). No other pods were observed during this survey, and there was only one encounter with bottlenose dolphins. During the survey, we spent 1.5 hours on the photo-identification survey, and 246 photographs were taken. We also obtained 1.5 hrs of video tape, which was used to record the behavior of the dolphins, during this survey. The mean sea surface temperature and mean salinity of the sighting position during August 2005 was  $26.1^{\circ}\text{C}$  and 31.68 psu, respectively. Water depth ranged from 5 to 20 m, and distance from the shore ranged from 30 to 200 m. During the photo-identification survey, the pod of bottlenose dolphins moved within 200 m from the shore of Jeju Island.

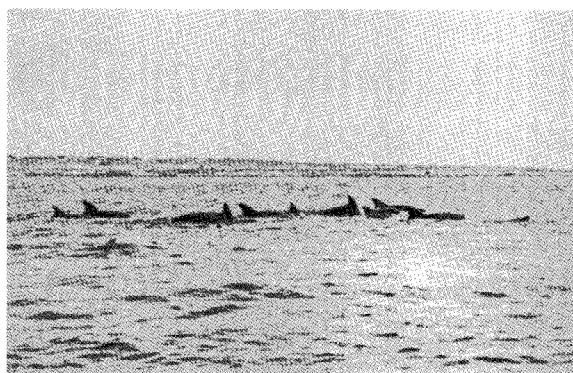


Fig. 2. Bottlenose dolphins in Jeju Island of Korea on 17 August 2005 (photo by Hawsun Sohn).

### Photo-identification

In total, 246 photographs of bottlenose dolphins were taken, and 35 were sufficiently suitable to iden-

tify individuals. We enlarged those 35 photographs for further investigation. Five individuals, corresponding to approximately 17% of the total individuals ( $n \approx 30$ ), were identified and cataloged from the unique nicks and notches on their dorsal fins (Fig. 3). Another individual, which only had skin scratches without unique nicks and notches on its dorsal fin, was not regarded as an identified individual because of the possibility of confusion with other individuals in future studies (Fig. 4). Identifying photographs were collected of the right side of four individuals (80%) and the left side of one individual (20%). These were the first bottlenose dolphins around Jeju Island, or any other Korean coastal area, to be identified in a photo-identification study. Additionally, the dorsal ratios of four individuals (20050817JJBD001, 003, 004, and 005) were 0.563, 0.463, 0.100, and 0.125, respectively (Fig. 3a,c,d,e). However, the dorsal ratio of one individual (20050817JJBD002) could not be measured because only one notch was present (Fig. 3b).

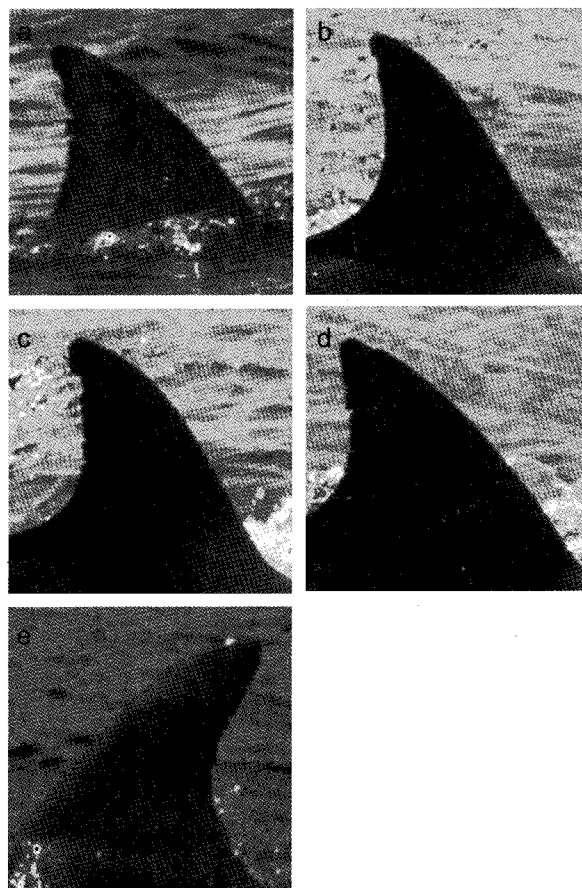


Fig. 3. Five bottlenose dolphins, 20050817JJBD001-005 (a-e), identified in Jeju Island of Korea during this study (photos by Hawsun Sohn).



Fig. 4. A bottlenose dolphin with skin scratches. This individual was not regarded as an identified individual because of the lack of information on nicks and notches of the dorsal fins (photo by Hawsun Sohn).

### Behavior

The behavior of the bottlenose dolphins of Jeju Island was observed during this survey to assess the dolphin-watching potential of this species. After finding a pod of dolphins in the southern coastal area of the island, we approached the center of the group. At the approach of our boat, they also approached and rode the bow waves for about 1.5 hrs. During the survey, when we approached the dolphins closely (approximately 5-10 m) using an outboard-powered inflatable boat, they did not avoid it (Fig. 5).

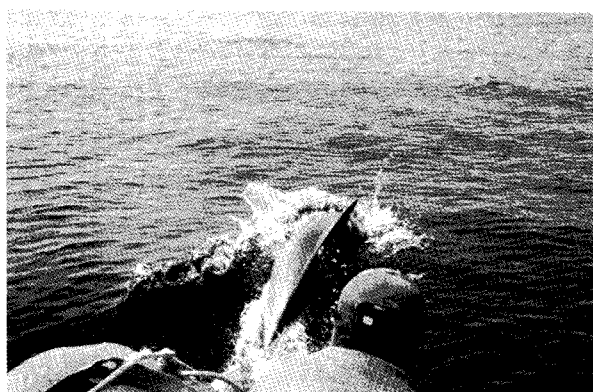


Fig. 5. Bottlenose dolphins that showed the behavior of approaching to boat during this survey (photo by Hawsun Sohn).

### Discussion

Many studies have investigated the feasibility of photo-identification techniques for various cetaceans. Although this method is not useful for some cetaceans, it could be applied to the majority of species studied. For example, Yuanyu et al. (1990) investigated whether photo-identification techniques are appropriate for the baiji (*Lipotes vexillifer*) in China. Although they collected approximately 1,000 photographs, this method was not useful for individual

identification because of the small size of this species, the brief time that it spends at the surface, and its shy behavior (Yuanyu et al., 1990). On the other hand, this method was very useful for individual identification in other species, such as the short-finned pilot whale (Miyashita et al., 1990), minke whale (Joyce and Dorsey, 1990), and Dall's porpoise (Miller, 1990). Confirmation of the feasibility of photo-identification techniques for the bottlenose dolphins around Jeju Island was obtained by the fact that individuals could be successfully identified using these techniques. In this study, it appears that photo-identification of bottlenose dolphins is applicable, as five individuals were identified by the nicks and notches in their dorsal fins. Generally, the longevity and changeability of natural markings, such as dorsal fin nicks and notches, are very important in estimating population size from mark-recapture studies, which generally require long-term observation (Würsig and Jefferson, 1990). Many studies have demonstrated that these natural marks remain sufficiently constant for reliable identification over a long period of time. For example, Wells et al. (1987) recognized several bottlenose dolphins over a period of 18 years. Also, the trailing edge of the dorsal fin is the most common identifying feature for most dolphins and porpoises (Würsig and Jefferson, 1990). Generally, more than half of the individuals in a population of bottlenose dolphins are identifiable (Würsig and Würsig, 1977), while in other cetaceans, such as Hawaiian spinner dolphins (Norris and Dohl, 1980) and pilot whales (Shane, 1984), only about 20% or fewer of the individuals are identifiable. Therefore, the nicks and notches on the dorsal fins of the dolphins around Jeju Island appear to be suitable for identifying individuals, as in other studies of bottlenose dolphins. Additionally, the dorsal ratio is a reliable, simple, and efficient method in photo-identification studies (Defran et al., 1990). Defran et al. (1990) suggested that it offers a novel way of analyzing and categorizing the dorsal fins of bottlenose dolphins and shortens the search time required to identify individuals. The best way of obtaining photographs for individual identification is to follow the groups for as long as possible, as the percent of individual identification success is correlated with encounter length (Miller, 1990). In this study, we followed the pod of dolphins for 1.5 hours during the photo-identification survey, and during our observation, they showed no avoidance of our boat. We had only a short time for the photo-identification survey due to the need to investigate other areas around the island within a limited period of time. That is, the short

study period did not result from the avoidance of our boat by the dolphins. We conclude that it would be possible to observe the dolphins for a longer period of time in future surveys.

Bottlenose dolphins are long-lived marine mammals (Leatherwood et al., 1983), and long-term studies are required to assess the trends in abundance of this species. Photo-identification represents one of the most suitable approaches for investigating long-term changes in populations. The dolphins of Jeju Island appear suitable for a long-term population biology study using these techniques because of their small group size (approximately 30 individuals) and the high possibility of a year-round stable home range around the island. Many coastal populations of bottlenose dolphins are composed of ca. 100 individuals, and the Jeju Island population appears to be similar in size (Wells et al., 1990; Williams et al., 1993). After our survey, the sighting reporting system of bottlenose dolphins of Jeju Island by the research vessel *Tamgu* No. 16 was designed and conducted. After sighting of bottlenose dolphins in our survey (17 August 2005, 30 individuals), seven pods of bottlenose dolphins were sighted and reported by the research vessel *Tamgu* No. 16 (27 October 2005, 30 individuals; 21 February 2006, 15 individuals; 19 July 2006, 10 individuals; 2 August 2006, 20 individuals; 8 February 2007, 40 individuals), a news reporter (22 March 2006, 100 individuals) and the marine police (17 May 2006, 50 individuals) through this reporting system. From these reports, the bottlenose dolphins are considered to be present during all seasons around Jeju Island (spring: 22 March 2006, 17 May 2006; summer: 17 August 2005, 19 July 2006, 2 August 2006; autumn: 27 October 2005; winter: 21 February 2006, 8 February 2007), although more information is necessary to confirm the seasonal distribution of the bottlenose dolphins in this area.

The bottlenose dolphin is a popular species for wildlife watching all over the world because it inhabits coastal areas and shows no fear of humans. Although many countries have been conducting dolphin-watching tours for a long time, this is the first study of the potential for dolphin watching in Korean waters. Our preliminary investigation of the potential for dolphin watching of bottlenose dolphins in Korean waters, particularly Jeju Island, was one of the major purposes of this study. To investigate the potential for dolphin watching, we need information on the occurrence, distribution, migration, and residency of this population, as well as their behavior with regard to boats. We determined the presence of a

pod of bottlenose dolphins during this study. However, we do not know the migration or residency patterns of this population due to the short study time. Many of the world populations of bottlenose dolphins have different distribution patterns in various areas. Some populations are resident in a specific area year-round (Wells, 1991), while some seasonally migrate (Shane et al., 1986; Wilson et al., 1998). Information on the migration and residency patterns of a population in a specific area can be obtained from resightings of identified and cataloged individuals in a photo-identification study. If most individuals are resighted in a specific area year round, then the population corresponds to a resident population. In such a case, the potential for dolphin watching is very high in that area. However, if only a few individuals are resighted, and new individuals are identified throughout the year, the population probably migrates seasonally. In that case, more precise information on the distribution patterns is necessary to ensure successful dolphin watching. We can determine the specific area and seasons for dolphin watching around Jeju Island using information on the distribution pattern gathered through additional sightings. Additionally, during the behavioral study, we found that when we approached these dolphins, they showed playing behavior and a strong interest in our boat with no signs of avoidance. However, when whale-watching boats approach killer whales, the whales swim faster and tend to swim away from the whale-watching boats (Kruse, 1991). Regarding this type of behavior, the Jeju Island dolphins appear more suitable for watching. Based on independent statements from local fishermen, we assume that bottlenose dolphins are probably continuously distributed around Jeju Island throughout the year, and actually found a pod through this survey. Therefore, the statements of local fishermen about the distribution patterns of bottlenose dolphins in this area appear trustworthy, and this information is potentially useful for the successful watching of bottlenose dolphins around Jeju Island. Although this was a short pilot study (only 1 day and 1.5 hrs of surveying), it confirms the potential for dolphin watching in the area, and the potential would greatly increase if more data on the seasonal distribution, movement, and residency of the dolphins were obtained in future studies.

The following studies remain to be conducted in the future: a long-term study of the population biology of bottlenose dolphins using photo-identification techniques, an in-depth investigation of the potential for wildlife watching of bottlenose dolphins around Jeju Island, and a study of their seasonal migration

and residency using satellite tagging.

### Acknowledgements

We wish to acknowledge many scientists of Jeju Fisheries Research Institute and many crews of the research vessel *Tamgu* No. 16.

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(Received June 2008, Accepted September 2008)