PHOTO-IDENTIFICATION STUDY TO ASSESS THE POPULATION SIZE OF ATLANTIC BOTTLENOSE DOLPHINS IN CENTRAL ABACO

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Introduction

Responsible management of natural resources must be based on sustainable yields to insure the long-term survival of species. In order to determine what exploitation levels a particular species can sustain, the population size, dynamics and stock discreteness must be evaluated. This paper introduces photo-identification techniques as a useful management tool in assessing these requirements for managing human impacts on Atlantic bottlenose dolphins (*Tursiops truncatus*) in The Bahamas.

Field biologists have used photo-identification techniques to study various aspects of cetacean life history, and they have been particularly useful for studies on the bottlenose dolphin throughout this species' range. Examples of such studies and results include: home range in South Carolina (Caldwell and Caldwell, 1972), association patterns in Argentina (Wursig, 1978), population size in southern California (Hansen, 1983), long-term residency in west Florida (Wells *et al.*, 1987), site fidelity in northwest Mexico (Ballance 1990), and behaviour in Australia (Connor and Smolker, 1985).

We (Bahamas Marine Mammal Survey) began photo-identification studies on a variety of cetacean species in The Bahamas in 1991. Herein, I report on the population size, residency status and potential stock discreteness of Atlantic bottlenose dolphins in central Abaco, as part of a long-term photo-identification study of this species in The Bahamas. The primary objective of the long-term study is to obtain data on the status, life history and population dynamics of Atlantic bottlenose dolphins in The Bahamas for comparison with other populations of this species. This may be particularly important in light of the massive die-offs of bottlenose dolphins along the eastern seaboard of North America and the Gulf of Mexico (Geraci, 1989).

Methods

Three field seasons of survey effort were conducted between 1992 and 1994 (January-June 1992; November 1992-May 1993; November 1993-April 1994). Surveys for bottlenose dolphins were made both inshore and offshore, depending upon weather conditions; but, the majority were conducted inshore in shallow waters, less than 20 feet (6 m) in depth. The study area, shown in Figure 1, extends from Great Guana Cay to Little Harbour on the eastern coast of Great Abaco within the barrier reef system, covering approximately 100 square miles (160 km^2). Additional limited survey work was conducted on the northern portion of Little Bahama Bank.

Surveys for bottlenose dolphins were made by small vessels (up to 32 ft (9.7 m)) and from land, with binoculars and a telescope. Vessel surveys were conducted randomly and in response to lan- based sightings to encounter dolphins for photo-identification purposes. Land surveys were made from a base camp on the west side of Tilloo Cay, using 20-power binoculars and a 25-power spotting scope. From the land base, the field of view encompassed 2.0 nautical miles (3.2 km), across Tilloo Bank, south to Channel Cay and north to Tavern Cay, an apparent core area for dolphins. Dolphins were seen in the observation area during more than half of the land survey days.

Whenever dolphins were encountered, identification photographs were taken of as many individuals as possible (as described in Mizroch and Bigg, 1988). Ilford HP5 black and white film (400 ASA) was shot using Nikon N8008 cameras with a 300mm F4 telephoto lens and a 70-210mm zoom lens to obtain high quality photographs of the dorsal fin of each dolphin. Whenever possible, underwater photographs were taken to document the sex of individual dolphins. Behavioural observations, dolphin associations and environmental data were recorded using a micro-cassette recorder, and the tapes were subsequently transcribed.

The black and white film was later push-processed (to 1600 ASA) at our research base on Tilloo Cay, and the negatives were analyzed by magnifying loop in order to distinguish between different individuals photographed. A photographic catalogue of individually identified dolphins was started during a preliminary survey in 1991 and photographs of individuals seen during encounters in the more recent seasons were compared with the existing catalogue. All photographs of "new" dolphins were printed for addition to the catalogue. Dolphins were assigned an alpha-numeric designation using the first letter of the genus and species name, followed by a cumulative number (eg. Tt1,Tt2,etc.). Only high quality photographs, in which at least two distinguishing features on the dorsal fin (eg. fin shape and nicks) were apparent, were included for the population estimate.

A mark-recapture population estimate was made using the Chapman modification of the Petersen estimate (Seber, 1982; Hammond, 1986). The total number of photographic encounters during all three field seasons was arbitrarily divided in half: the first sample was represented by the first sixty encounters, and the second sample by the next sixty encounters. In this way, the marked sample is equivalent to the first photo-identification sample, and the recaptured sample is eqivalent to the second photo-identification sample. The variance and 95% confidence intervals were calculated as described in Seber (1982).

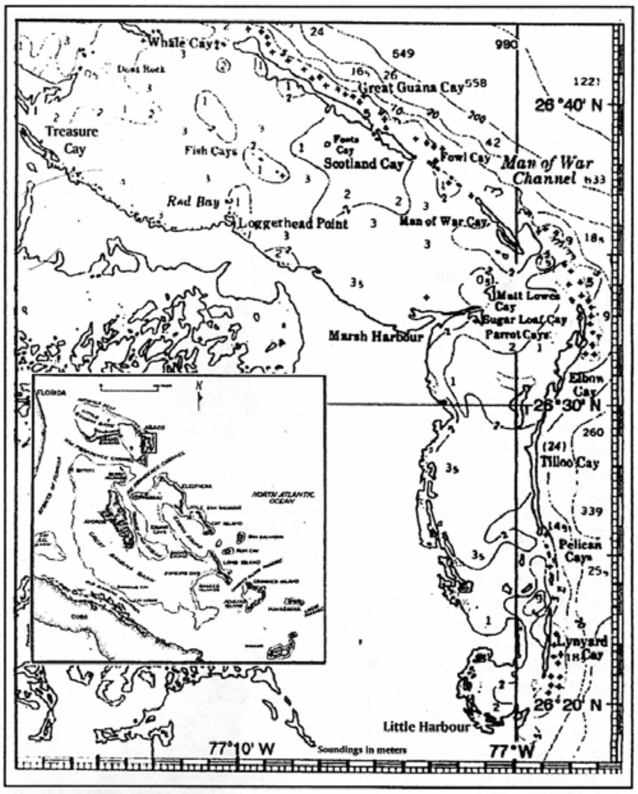

FIGURE 1. Map of the Abaco study area

Formulae are (Seber, 1982):

$$N = \frac{(n_1+1)(n_2+1)}{m_2+1} - 1$$

where,

N = population estimate

n_1= no. of individual dolphins photo-identified in 1st sample

n_2= no. of individual dolphins photo-identified in 2nd sample

m_2= no. of individual dolphins photo-identified in 2nd sample that were also photo-identified in 1st sample

$$\text{Var} = \frac{(n_1+1)(n_2+1)(n_1-m_2)(n_2-m_2)}{(m_2+1)^2(m_2+2)}$$

$$95\% \text{ C.I. for } p = \pm (1.96[p(1-p)/(n_2-1)]^{1/2} + 1/(2n_2))$$

where $p = m_2/n_2$, the confidence limit for p was then used to calculate the upper and lower bounds for N.

Results and Discussion

The photo-identification of bottlenose dolphins in central Abaco has allowed the estimation of population size and identification of a resident group of dolphins suggesting a potentially discrete stock. During the three field seasons, bottlenose dolphins were encountered and individuals were successfully photo-identified 120 times in the study area. Individual dolphins were readily distinguished by the location of natural nicks in the dorsal fin, particularly in the trailing edge. Some individuals showed no change in the dorsal fin throughout the three field seasons (Figure 2a). Other dolphins showed minor changes to a particular nick, but these individuals were still recognizable by the presence of other nick(s) that didn't change (Figure 2b). The most drastic change in the dorsal fin of an individual dolphin was apparently the result of a shark attack, in which the top of the fin was mutilated (Figure 2c). However, this dolphin was still identifiable by other nicks that remained unchanged. Scott, Wells, Irvine and Mate (1990) report natural markings in bottlenose dolphins to be long lasting and change little over several years. With subsequent annual sampling, I am confident that the central Abaco dolphin population can be monitored well into the future. Wursig and Harris (1990) found 10 dolphins physically unchanged over a 10-year period.

Of the 501 dolphin photo-identifications obtained in the 120 encounters, there was a total of 82 different individual dolphins. The rate of discovery of newly identified dolphins is shown in Figure 3. At the beginning of the study all dolphins photographed were "new" dolphins; but, as a growing proportion of the population was identified over the three field seasons the slope of the curve decreases. This decreasing slope suggests that the majority of dolphins in the population were identified by the end of the third field season, and that the population size was approximately 80-90 dolphins.

Using the Chapman modification of the Petersen population estimate (without replacement, Seber 1982), the population estimate at the end of the study period was 89 dolphins (variance = 17.56, 95% confidence interval 74-104). The limitations and assumptions of these calculations include: 1) the population is closed, 2) all animals have the same probability of being photo-identified in the first sample, 3) obtaining photographs does not affect the obtaining of subsequent photographs, 4) the second sample is random, 5) all marks are permanent, and 6) all matches are recorded (Seber, 1982; Hammond, 1986). Biases from violated assumptions may result in either overestimates (#1,4,5,6) or underestimates (#2,3,4) of the population size, but overall they appear to balance out. It is worth noting that the rate of discovery graph provides a similar population size to the Petersen estimate. When we have conducted five years of photo-

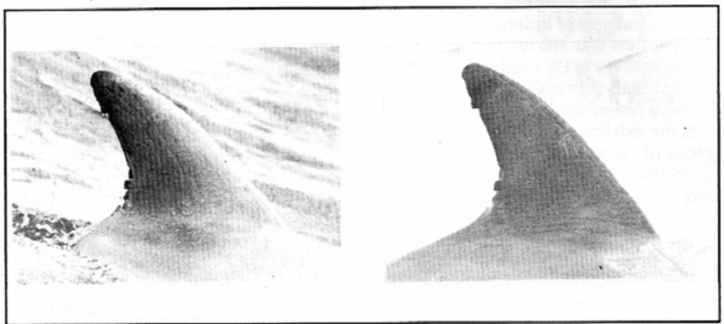

FIGURE 2a. Photo-identification photograph of dolphin Tt42, showing no change in the trailing edge of the dorsal fin between 17 February, 1992 (left) and 5 February, 1994 (right).

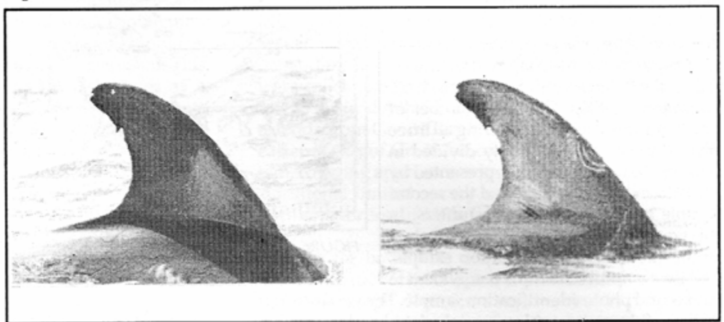

FIGURE 2b. Photo-identification photograph of dolphin Tt72, showing minor changes in the trailing edge of the dorsal fin between 19 November, 1992 (left) and 13 December, 1993 (right).

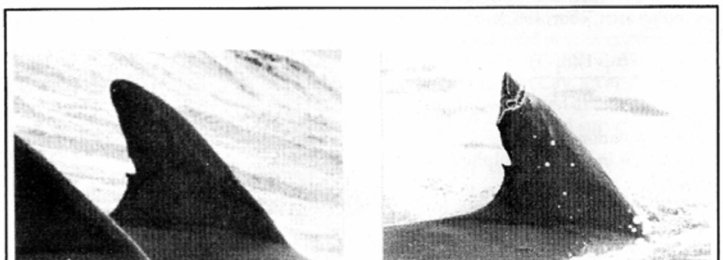

FIGURE 2c. Photo-identification photograph of dolphin Tt70, showing major changes to the dorsal fin caused by a shark attack between 17 November, 1992 (left) and 6 December, 1992 (right).

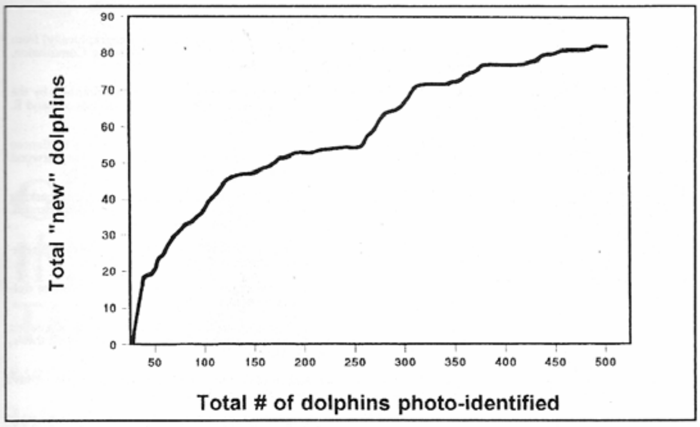

FIGURE 3. Rate of discovery of "new" dolphins.

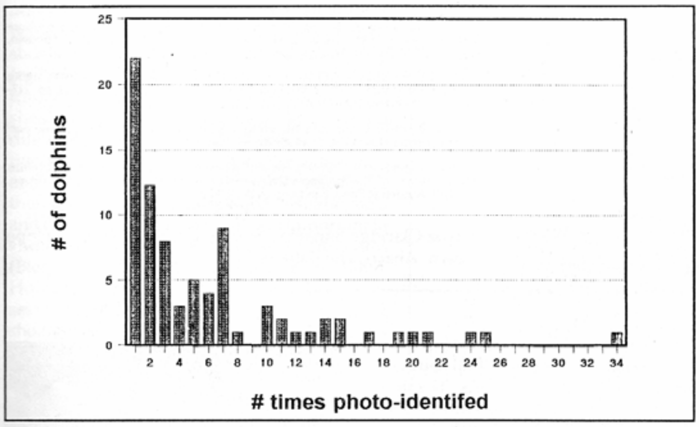

FIGURE 4. Number of times individual dolphins were photo-identified

identification effort, a Jolly-Seber estimate for an open population can be calculated between seasons which may further diminish potential biases (Seber, 1982).

Individual dolphins were found to be resident to the Abaco study area. Residency of bottlenose dolphins to a particular area has been well documented by other researchers (Wursig, 1978; Wells *et al.*, 1980, 1987; Gruber, 1981; Shane 1980; Scott, Wells and Irvine, 1990; Wursig and Harris, 1990). The number of times individual dolphins were photo-identified in the Abaco study area is shown in Figure 4, with an average of 6.1 times (range 1-34, SD=6.53, N=82). Sixty dolphins (73%) were photographed more than once, and 22 (27%) were photo-identified during all three field seasons. Individual dolphins have frequented the same area for over 20 years in western Australia (Conner and Smolker, 1985), and in west Florida since 1970 (Wells, 1991). Long-term photo-identification in central Abaco will determine the longevity of site fidelity of individual dolphins to the Abaco study area.

Preliminary surveys for bottlenose dolphins in the inshore waters of northern Little Bahama Bank (from Cooper's Town, Abaco to West End, Grand Bahama) resulted in the identification of 42 additional dolphins. There have been no sightings of these northern dolphins in the central Abaco study area, and none of the central Abaco dolphins were resighted in the northern regions surveyed, further suggesting their residency to central Abaco. Three of the northern dolphins (7%) were resighted in the same northern region where they were originally photographed,- suggesting another possible resident area. Researchers working near Matanilla Shoal on northwest Little Bahama Bank have photo-identified and resighted bottlenose dolphins in that area since 1985 (Herzing, pers. comm.), suggesting yet another resident group.

In west Florida, resident groups (called communities) are considered to be discrete stocks, with annual immigration and emigration rates of less than 3% (Wells, 1986; Scott, Wells and Irvine, 1990). If resident groups, or communities, of bottlenose dolphins occur throughout Little Bahama Bank (and other Banks or coastal areas of The Bahamas), it is probable that these, too, are discrete stocks. In order to make responsible management decisions, Scott (1990) recommends that the stock units of a population be determined, and if animals are resident to an area, the allowable removals be based on the size of each resident stock. Further surveys on northern Little Bahama Bank will allow proper assessment of both the population size on the Bank and the potential discreteness of stocks.

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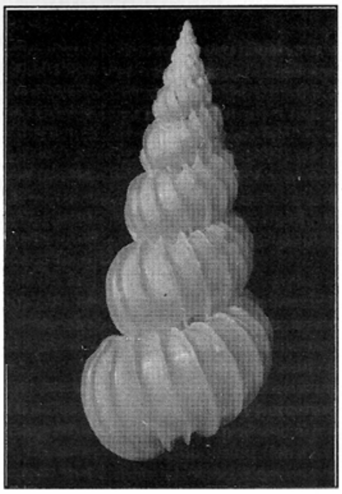
NEW SPECIES OF WENTLE TRAP

In 1982 Linda Huber of Nassau found a large unidentified shell south of Balmoral Island in 4 feet of water among a pile of octopus debris. The find was reported in *Of Sea and Shore*, Winter 82/3 (12:4, 202). Recently Robert Robertson writing in *The Nautilus* (1993, 107 (3):81-3) has identified it as a new species and suggested it be named *Epitonium worsfoldi* Robertson. He comments that "It is surprising that (such a) large shallow water species in a well-collected area should have remained undes-cribed until now. (It) shows the continuing role that amateurs play in collecting, observing, photographing, and providing material for systematic and biological studies in museums and marine stations".



The photographs show several of the attractive wentle traps found by Linda Huber, including a unique large (41mm) or 1.6") and undamaged specimen (above).