Photo-ID studies of fin whales in the North Atlantic Ocean and the Mediterranean Sea

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ABSTRACT

Stock structure hypotheses for North Atlantic fin whales, *Balaenoptera physalus*, have based largely molecular genetic analyses. This paper describes fin whale photo-identification catalogues in the North Atlantic Ocean and the Mediterranean Sea that may house data useful for testing these hypotheses. There are three independent fin whale catalogues in the western North Atlantic. The North Atlantic Fin Whale Catalogue presently contains 841 unique individuals sampled along the coast of North America, from the New York Bight north to the Gulf of St. Lawrence. Two catalogues in the Gulf of St. Lawrence, held by the Mingan Island Cetacean Study (MICS, n=430) and the Groupe de Recherche et d'Éducation sur les Mammifères Marins (GREMM, n=100), expect to begin reconcile their catalogues in the near future. A few small photo-ID holdings were identified in the eastern North Atlantic and the Europhlukes project provides an alternate option for photo-identification data across a wide range of species and institutions in the eastern North Atlantic. Finally, we describe four primary catalogues in the Mediterranean Sea. The largest (n=425 individuals) is maintained by Tethys Research Institute, and they are currently leading an effort to reconcile all four catalogues. Overall, only a few attempts have been made to match individuals among photo-ID catalogues and between oceanic areas. However, recent efforts to integrate local catalogues should improve the potential of these archives for ocean-scale comparisons.

INTRODUCTION

Stock structure hypotheses for North Atlantic fin whales, *Balaenoptera physalus*, have been constructed based on several pieces of information, and especially molecular genetic analyses. However, this species has also been studied by photo-identification (photo-ID) for nearly three decades and these alternate data may prove useful for testing stock structure hypotheses. Here, we describe several fin whale photo-ID catalogues in the North Atlantic Ocean and the Mediterranean Sea. We describe catalogue holdings, methods of matching and the degree to which these resources have been inter-matched.

REGIONAL PHOTO-IDENTIFICATION CATALOGUES

Gulf of Maine

North Atlantic Fin Whale Catalogue (NAFWC)
Many institutions collect photo-ID data on fin whales in the Gulf of Maine, but the NAFWC is the recognized regional catalogue. Seventy-four percent (3,330) of cataloged sightings come from commercial whale watch vessels and the rest from dedicated research or opportunistic platforms. Currently the NAFWC comprises of 23,655 images of 4,500 sightings, representing 841 unique individuals. Catalogue sightings span the period 1974 through 2006, with an average contribution of 232.3 sightings per year. The greatest accumulation of sightings occurred in the late 1980's. A total of 57% (2,565) of fin whales in the catalogue have been re-sighted within the same field season, while 43% (1,935) have been seen in multiple years. The maximum number of re-sightings for any individual is 64, and the average per individual is 4.9.

Sightings span nine regions of the coastal western North Atlantic, but the Gulf of Maine (5 regions) accounts for 3,145 (70%) of all sightings. Additional sightings are from adjacent regions of the New York Bight and the Gulf of St. Lawrence. Approximately 20 sightings from the Mediterranean Sea and two sightings from the Cape Verde Islands were compared to the NAFWC at one time, without a match. In light of the small number of submissions from these areas and, in the case of the Mediterranean Sea, genetic evidence suggesting against exchange (Berube *et al.*, 1998), these individuals were not added to the NAFWC.

Photographic identifications are based on natural and acquired marks documented in a photographic suite. Distinctive characters include pigmentation, scar patterns, the shape of the dorsal fin and the number and nature

of nicks in the trailing edge of the dorsal fin. Suites of images submitted to the catalogue are scored with a "capture quality" reflecting coverage of eight specific body areas: the chevron, the back, the dorsal fin and caudal regions (from both left and right sides). Sightings with insufficient coverage of these areas, or images of insufficient quality to document markings, are rejected from the NAFWC.

The NAFWC is indexed based on seven categories of dorsal fin shape and further sub-dived into nicked and non-nicked categories. Comparisons between photographic suites are conducted manually, first among sightings in the same submission, then within a single season and finally against all other catalogued individuals. If no match is made by two different experienced matchers, the whale is considered new and added to the catalogue. Matches between sightings are based on 3 to 22 distinct match points from one or both sides of individuals. Individuals with multiple characters in common with a catalogued individual are considered recaptures and a hand drawing is produced documenting the attributes of similarity. A "match quality" is assigned to quantify the level of confidence that two suites of photographs represent the same individual, based on both the number of individual marks in common (match points) and how broadly these marks are distributed across the body. Image and match quality statistics allow users to discriminate among sightings as necessary to satisfy analytical requirements and assumptions. Forty-four percent (1,174) of re-sightings of individuals were scored in the highest two categories of match quality requiring 7 or more characteristic match points derived from two or more distinct areas of the body, while 16% (441) of re-sightings were scored in the highest class of match quality requiring over ten match points with representation of both sides of the animals flanks.

Other data catalogued with image suites include sighting date, location and group affiliations. In a limited number of cases, animal sex and multilocus genotype are known from molecular genetic analysis.

Gulf of St. Lawrence

Mingan Island Cetacean Study (MICS)
The MICS fin whale catalogue contains 430 unique individuals. Most sightings come from the Mingan-Anticosti area where MICS is based. Research is occasionally performed elsewhere in the Gulf of St. Lawrence, including the Gaspe Peninsula, Sept-Iles, and the St. Lawrence Estuary. In 2006, MICS photo-identified a minimum of 230 individuals, but sample sizes more commonly range from 50-140 unique individuals per year. Over the last 3 years, 120 new individuals were added to the catalogue. Individual sighting frequencies vary greatly between individuals, ranging from 1 to about 14 years.

The average number of cow/calf pairs typically ranges from only 2-3, although unusually high numbers occurred in 2005 (n=9) and 2006 (n=13). A number of the cows observed in the latter two years were well-known adults that had never been seen before with a calf. Only two calves have been re-sighted in almost 30 years of photo-ID research in this region.

The MICS catalogue is based on documentation from the right side of the body and photo-ID techniques described by Agler et al. (1990). Each individual is represented by the best pictures of its right side including the dorsal fin, its right chevron, and any scars/markings on the body. The catalogue is organised into 8 categories based on dorsal fin shape, including 5 categories for non-nicked dorsals, and 3 for nicked dorsals. Photographic suites are first compared manually within a day and within a season to look for internal matches before being matched against the catalogue. If no match is found by three matchers, at least two of which are experienced matchers, the whale is considered new and added to the catalogue. Only suites containing high-quality images of both chevron and RSD areas are included in the catalogue. Quality is assessed based on sharpness, angle, coverage and contrast. A second catalogue containing all lower quality photographs is maintained and also checked yearly for matches with new pictures, but this catalogue is not used in analyses.

Groupe de Research et d'Éducation sur les Mammifères Marins (GREMM)
GREMM maintains a catalogue of fin whales observed in the St. Lawrence Estuary since 1986. Data are collected from both dedicated research vessels and commercial whale watching platforms. The study area spans approximately 600 square nautical miles at the head of the Laurentian Channel (lower estuary of the St. Lawrence River). As of 2001, the GREMM catalogue held 100 Class A individuals (high quality identifications) and over 100 class B animals. More than half of Class A individuals (54) have been sexed through molecular analyses, and equal numbers of males and females were found (Berube pers. comm). Between 1994-1999, sightings ranged from 23 to 40 class A individuals per year. These annual cohorts comprise 45-70% regular visitors (i.e., re-sighted in more than 5 different seasons). These regular visitors have higher within-year re-sighting rates than occasional visitors, and stay twice as long (up to 4 months) in the Estuary. The number of calves observed varied between 0 and 6 per season. Only six Class A females have been seen with a calf. Each has produced either 2 or 3 documented calves over a minimum calving interval of three years. Since 1998, the

discovery of new individual has plateau at 1% a year. A published photographic catalogue of a subset of these holdings is available from GREMM (Giard *et al.*, 2001).

Eastern North Atlantic

We used government progress reports submitted to the IWC between 2002-2007 to identify fin whale photo-identification data in the eastern North Atlantic, including those obtained from opportunistic platforms. According to these records, photo-ID data for fin whales have been obtained in just a few locations in coastal Europe and at the Azores. The Irish Whale and Dolphin Group reported having catalogued 12 catalogued fin whales by the end of 2005. Three fin whales were photo-identified in Bay of Biscay, Spain by the Euskal Izurde eta Balezaleen Elkartea in 2005. As of 2006 in the Azores, fin whale catalogues are reported to be held by Nova Atlantis (n=22) and Whale Watch Azores (n=50).

The Europhlukes project (http://europhlukes.maris2.nl) is a large-scale multi-species photo-identification catalogue that allows images and data to be queried by species, area and research group. The public database lists 40 research groups from 14 countries having contributed over 50,000 digitised images from 20 cetacean species. However, at present it lists only 20 fin whale entries for the North Atlantic, all from Atlantic Iberia and the Azores.

Mediterranean Sea

Tethys Research Institute (TRI)
TRI maintains a fin whale catalogue for the Ligurian Sea (western Mediterranean Sea) based on data collected during the summer months over a seventeen year period (1990-2006). The study area includes the continental shelf and offshore waters of the western Ligurian and Corsican Seas. Specifically, the study area is delimited by Saint Raphael (43°25'N, 6°50'E) on the French coast, Cape Mele (43°55'N, 8°10'E) on the Italian coast and Cape Corse (43°00'N, 9°25'E) and Girolata (42°20'N, 8°35'E) on the island of Corsica.

Over the past 17 years, TRI has positively identified a total of 425 fin whales, approximately 19.5% of which were re-sighted between 2-7 times. Photographic "recaptures" occurred both in the same and different years, and over a maximum interval of 14 years. Re-sighting data indicate site-fidelity by whales to this feeding ground. Within season re-sightings ranged from 1 to 90 days, indicating that at least some whales spend the entire summer in the Ligurian Sea to feed on the locally abundant Mediterranean krill. The rate of discovery of new individuals increased steadily throughout the study, supporting line-transect abundance estimates that indicated the population to be much greater than the photo-identified sample.

TRI is co-ordinating a project to merge the fin whale photo-identification data from several different research institutes into a single catalogue covering the western Ligurian Sea and Gulf of Lions. The merged catalogue will be used to produce the first mark-recapture abundance and survival rate estimates for the Mediterranean population. The following collections have already been reconciled with each other and will soon be matched against the TRI catalogue:

The *Groupe de Recherche sur le Cétacé* (GREC) contributed a total of 280 images of 138 individuals. The GREC catalogue spans the years 1990 through 1997, with a maximum effort in the period between 1992-1995. A total of 91 individuals were considered positively identified and five matches were found, resulting in a total of 86 individuals to be added to the comprehensive catalogue.

The *Ecole Pratique des Hautes Etudes* (EPHE) supplied 337 images. A total of 83 individuals were photographed in the years 1994 and 1995. Out of 68 individuals considered positively identified, two re-sightings occurred, for a total of 66 fin whales contributed to the comprehensive catalogue.

The *Centre d'Études Biologiques de Chizé* (CEBC) provided 126 digital images of 31 individual whales, of which 25 were identified.

The contribution of these three partners resulted in a total of 177 positively identified whales. The matching process between them revealed six re-sightings, resulting in 171 new photo-identified fin whales to be matched with the TRI catalogue. There have already been three matches of highly marked individuals to the TRI catalogue, but the remaining matching is still in progress.

CONCLUSIONS

Fin whale photo-identification catalogs are well established in some areas, but their present isolation makes them a difficult foundation for answering questions of ocean-scale stock structure. Few attempts have been made to reconcile photo-ID catalogues housed in the same region, and catalogues have rarely attempted to match individuals photographed outside their regular geographic scope. Western North Atlantic catalogues have not been reconciled, however 36 individual fin whales photographed off Halifax, Nova Scotia were matched to fin whale catalogues in the Gulf of Maine and the Gulf of St. Lawrence, confirming individual exchange to both adjacent areas (Coakes *et al.*, 2005). On a larger scale, holdings in the western North Atlantic, the eastern North Atlantic and the Mediterranean Sea have generally not been compared. However, approximately 20 sightings from the Mediterranean Sea and two from the Cape Verde Islands were compared to the NAFWC at one time, without a match. The Gulf of St. Lawrence catalogues plan to begin to reconcile their holdings in 2007 and, as mentioned above, this is already underway for the Mediterranean. Mediterranean collections have also been contributed to the Europhlukes project. These efforts to integrate local catalogues should improve the potential of these archives for large scale research.

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