Introduction

How many are there? How many were there? How many will there be in the future? These are the questions most asked by managers, hunters and anyone else interested in the conservation and sustainable use of wildlife. While some scientists might dismiss the estimation of abundance as a non-science akin to accounting, there is no information that is more central to the conservation and management of wildlife or the study of ecology. It is difficult to conceive of a management system that does not rely on estimates of abundance or at least relative abundance. If we wish to know and predict the consequences of hunting, pollution, climate change or other perturbations on animal populations, we must begin with information on the number of animals past and present. Indeed, the science of ecology has been defined as the study of the distribution and abundance of life. Therefore there can be no progress in ecology without reliable and consistent estimates of abundance and distribution patterns.

Whales are large, visible predators and have become iconic symbols of marine conservation. In the North Atlantic and adjacent seas, whales are hunted in the waters of several countries, including Norway, the Faroe Islands, Iceland, Greenland and Canada. In addition, cetaceans, mainly dolphins and porpoises, are subject to fisheries by-catch, sometimes in large numbers, in many areas. There is increasing concern that climate change will cause changes in the distribution and abundance of some whales. For all these reasons, information on distribution and abundance, both past and present, is absolutely required for the conservation and management of cetaceans in the North Atlantic.

This volume deals primarily with the results of a series of cetacean surveys that were initiated in 1987 and have continued up to the present, most recently with the Trans North Atlantic Sightings Survey (T-NASS) conducted in 2007. Some of the data are now 20 years old and it is relevant to ask why much of this information has not been published previously. The answer lies, I think, in the nature of international management regimes for whales, such as the International Whaling Commission (IWC) and the North Atlantic Marine Mammal Commission (NAMMCO). Much of the information in this volume has been presented as working papers to the scientific committees of either or both of these organizations in the past, and has been used to formulate management policies and decisions where required. Once the information was presented the scientists involved often had little incentive or time to develop a primary publication. I can say from hard experience as an editor that getting some of these papers completed and revised has been a difficult and frustrating task! But that does not mean that this information should not be published, quite the contrary. By publishing these papers we make the results available to a wider scientific audience that may find other uses for or inspiration from these findings. In addition, the results of these surveys will retain their value for decades to come, to be used in comparison with more recent data. As I write this, some of the results of the T-NASS project, which are not included in this volume, are beginning to be synthesized. This volume will provide a point of departure for putting these new results into their historical context.

This volume contains 3 types of papers. The majority are relatively straightforward reports on the distribution, abundance and trends in abundance of one or more species. A few other papers use non standard methods, such as spatial analysis, to link sightings data to a deeper ecological context. Finally, two papers take the results of these and other surveys and use them to formulate new hypotheses and questions about a single species, or contextualize them with the historical development of whale science and management. As this journal is published by NAMMCO and NAMMCO is a management organization, the papers tend to focus on providing information that is directly relevant to the conservation and management of cetaceans, rather than more esoteric topics.

The story of the North Atlantic Sightings Surveys (NASS) is intimately linked with the history of whaling and the international management of it. Modern whaling began in north Norway in the late 1800's with the advent of fast steam powered vessels and the invention and development of the exploding harpoon cannon (Tønnessen and Johnsen 1982). Initially whalers pursued the large blue whales which were available in good numbers near the coast, and could be hunted from shore stations. Stocks of blue whales (*Balaenoptera musculus*) were rapidly depleted, however, so the whalers soon turned to the more abundant but more widespread fin whale (*Balaenoptera physalus*), and spread their operations to other areas of the North Atlantic, including Svalbard, Iceland and the Faroe Islands. The cycle of over-exploitation continued, and whaling records and contemporary accounts suggest that stocks of all large whales were severely depleted in most areas of the North Atlantic, including Iceland and Norway, by the early part of the 20th century (Risting 1922, Tønnessen and Johnsen 1982, Jónsson 1965).

The decline of whale stocks, as well as antagonism from fishermen and others, led to outright bans on whaling imposed in Norway in 1904 and Iceland in 1915. By the time these measures took effect whaling from shore stations was barely viable in any case due to declines in whale numbers. Whaling resumed on a smaller scale in Norway in 1918 and in Iceland in 1948. Whaling in Iceland during this second period was confined to a single shore station and concentrated on fin and sei whales (*Balaenoptera borealis*). Hunting minke whales (*Balaenoptera acutorostrata*) from small vessels was a later innovation, mainly after the Second World War. Whaling continued without interruption until 1989, when research whaling ceased and the whaling moratorium came into effect. In Norway, the take of fin whales continued up to 1972, while in the Faroe Islands it continued until 1984 and in Spain until 1985. Hunting for minke whales has continued uninterrupted in Norway. In West Greenland hunting for fin and minke whales has continued uninterrupted to this day under the provisions of aboriginal subsistence whaling.

With the advent of the International Whaling Commission's moratorium on commercial whaling in 1986, member nations were urged to increase their research activities to facilitate a "Comprehensive Assessment" of whale stocks. A number of North Atlantic nations, including Iceland, Norway, Greenland, the Faroe Islands and Spain, began planning surveys to estimate whale populations in their respective areas. It was quickly realized that much more could be achieved if these national efforts were combined to eliminate overlap and coordinated in timing and methodology so that high quality, synoptic estimates covering a very large area could be produced. Consultations among these nations evolved into planning the first North Atlantic Sightings Survey, which was conducted in the summer of 1987. The second NASS was carried out in 1989, and extended farther south. The largest NASS in terms of simultaneous coverage was done in 1995. After 1995, Norway began covering a portion of their survey annually in a 6 year rotation ("mosaic" coverage). The 2001 NASS was consequently smaller, and included participation by only Iceland, the Faroe Islands and Norway.

Given that the blue whale was the most sought after species for the early modern whalers, and hence usually the first to be depleted in every area in which they operated, it is fitting that we begin the volume with this species. There are 2 major problems with conducting a ship-based survey for blue whales in the North Atlantic: 1) they are quite rare in most areas and hence it is difficult to get a sufficient number of observations, and; 2) the blue whale is difficult to distinguish from the vastly more numerous fin whale at sea. The maximum number of certain blue whale sightings in any NASS was 25 in 1995, but there are generally many more sightings with less certain identification. Pike *et al.* (2009a) address these issues firstly by combining blue whale sightings from all 4 NASS into a single detection function, including a covariate for survey year, and apply this detection function to derive estimates for each individual survey. They then repeat this procedure including less certain blue whale sightings to determine the sensitivity of the estimate to identification certainty. The results of the latter analyses suggest that inclusion of the less certain sightings has little effect on the estimate, as most of these tend to be farther from the ship. This has important methodological implications as it means that it is probably not worthwhile to use ship or observer effort to identify possible blue whale sightings.

The estimates presented by Pike *et al.* (2009a) show that blue whales remain rare in most areas of the northern North Atlantic. They were most common to the west and south of Iceland in all surveys, and tended to have a more coastal distribution than fin whales. Very few blue whales were sighted in the Norwegian sector, except for a few scattered sightings to the west of Svalbard in some years. The results suggest a total abundance of probably not more than about 1,000 animals in the entire survey area. Given the magnitude of the early takes of blue whales in these areas, it would seem that blue whales have not recovered to the same extent as other large whale species, particularly in the Northeast Atlantic where they remain very rare. On a more optimistic note there is some evidence in the data of increasing numbers around Iceland since 1987.

The minke whale has been the only object of commercial whaling in Norway in recent years. Hence large scale, shipboard sightings surveys conducted since the 1980's have been focused on this species, with a unique methodology specially adapted to this small, cryptic whale. Originally conducted as part of the overall NASS, after 1995 Norway began to survey in a "mosaic" pattern, covering a portion of the total area annually and completing the entire area over the course of 6 years. This strategy offered a host of logistical advantages at the price of a slight loss of precision and synoptic information on distribution and abundance. Abundance estimates for minke whales have been published from all surveys up to 1995 (Schweder *et al.* 1997, Skaug *et al.* 2004). Øien (2009) uses these data to elucidate the distribution and abundance of several large whales, including blue, fin, sei, humpback and sperm whales.

Somewhat surprisingly, sperm whales (*Physeter macrocephalus*) are the most abundant large whale in Norwegian waters, numbering over 6,000 animals and with a wide distribution in the Norwegian and southern Barents seas. This is even more surprising when one considers that virtually all the sperm whales in this and adjacent northerly areas are males. The estimates are not corrected for whales missed because they were underwater as the vessel passed, a substantial correction for this long diving species (see Gunnlaugsson *et al.* 2009).

Blue and fin whales were the main objects of early modern Norwegian whaling in this area. Fin whales number in the range of 5 to 6 thousand in the area, which seems low given historical harvests, which exceeded 10,000 between 1864 and 1904 with catches of over 1,000 in some years (Risting 1922). In contrast, the estimates for humpback whales of around 1,000 to 1,500 animals are consistent with the rather low historical take of this species in the area (Ingebrigtsen 1929). No evidence of any temporal trends in abundance for large whales is apparent in the Norwegian survey area.

Víkingsson *et al.* (2009) use the results of the 4 NASS conducted between 1987 and 2001 to derive estimates of abundance for fin whales in the Icelandic and Faroese survey areas. While abundance estimates have been published previously from the 1987 and 1989 surveys (Buckland *et al.* 1992), estimates from 1995 and 2001 have not previously reached the primary literature. Víkingsson *et al.* also provide new estimates from the earlier surveys with the analyses conducted in a manner consistent with the later estimates. The 14 year time span of the 4 NASS provides a rare opportunity to look at trends in abundance of a large whale species, using data collected and analyzed in a consistent manner. Víkingsson *et al.* do this by subdividing the survey area in to regions that have been surveyed more-or-less consistently over the period. The results demonstrate that fin whales are almost certainly the most numerous large whale in the North Atlantic, numbering about 30,000 animals in 2001 in the central and eastern North Atlantic. By far the highest densities are observed in the Denmark Strait and the Irminger Sea between Iceland and East Greenland, and this area alone was the summer haunt of about 14,000 fin whales in 2001. It is here too that fin whale numbers are changing most rapidly, increasing at a mean rate of 10% annually over the period. Given that all recent Icelandic whaling has been conducted in this area, some of this increase must be due to stock recovery after the cessation of whaling. However the magnitude of the increase is out of proportion to the numbers that were taken, leading the authors to speculate that ecosystem changes have created a more favourable environment for fin whales in the area.

As previously mentioned, Øien (2009) found sperm whales to be the most numerous large whale in Norwegian waters. However ship surveys for this and other long-diving species, such as beaked whales, are problematic because the animals dive for extended periods of time and are therefore likely to be missed by observers even if they are very close to the trackline. This violates a central assumption of line transect surveys, that all animals on the trackline are seen. Thus estimates for sperm whales that are not corrected for this problem will be negatively biased, probably by a considerable proportion. Gunnlaugsson *et al.* (2009) make use of the sperm whale's habit of raising it's flukes before a deep dive to develop an innovative approach using both cue–counting and standard line transect methodologies to address this "availability" bias issue.

Two serious issues have perhaps discouraged the more widespread use of cue–counting in ship surveys. First of all, there is some suspicion that whales may react to the vessel in a way that affects their cueing rate, in the case of sperm whales perhaps by initiating a deep dive (cueing). Gunnlaugsson *et al.* overcome this problem by slowing or stopping the vessel once a sperm whale is sighted, for a sufficient length of time that would have allowed the vessel to pass abeam of the sighting had the vessel continued at normal speed. Thus the whale is less likely to react to the vessel. A second objection to cue–counting is that whales that are sighted but do not display a cue, are essentially "wasted" sightings in that they cannot be used in the analysis. In this study however, all sightings are used in 3 analyses: the cue–counting analysis for those whales that do cue; a line transect analysis for those whales visible at the moment they pass abeam, corrected for availability using the estimated proportion of time they are at the surface; and a standard line transect analysis using all sightings. In this way the authors derive 2 separate corrected estimates of abundance, and one uncorrected estimate from which the availability bias can be estimated. Although primarily a methodological paper, Gunnlaugsson *et al.* do provide an abundance estimate for sperm whales in the Icelandic survey area of over 11,000 animals, likely making the sperm whale the second or third most abundant large whale (after the fin and perhaps the humpback whale) in the northern North Atlantic.

Sperm whales remain underwater and invisible much of the time, but when they are on the surface they are quite easy to spot. In contrast, the minke whale among the most difficult whales to count effectively. It is relatively small and cryptic, occurs singly or in very small groups, and surfaces for only very short periods of time. The blow is generally not visible. For shipboard surveys of minke whales, bias due to observers missing visible animals and to animals being not visible at the surface can lead to underestimates of 50% or more of absolute abundance (Schweder *et al.* 1997, Skaug *et al.* 2004).Thus specialized methods must be employed to produce unbiased estimates of abundance for this species, usually involving the use of independent observer platforms and a form of cue–counting, as is used in Norwegian ship surveys.

Until the most recent (2001) survey the non-Norwegian portions of the NASS ship survey did not use such specialized methods and therefore these severe biases for minke whales could not be quantified. Moreover, the main target species of the Icelandic portion of the survey has been the fin whale, a species with a quite different search image than the minke whale. Nevertheless even biased estimates can be used to describe trends in relative abundance, if the bias is assumed to be constant over the period. In addition, estimates that are known to be negatively biased can be used as minimum estimates for management purposes when no other estimates are available. Pike *et al.* (2009b) therefore develop standard line transect estimates of minke whale density and abundance from the Icelandic and Faroese portions of the 4 NASS ship surveys conducted between 1987 and 2001.

Minke whale densities were highest in Icelandic shelf waters, an area covered separately by aerial surveys designed to produce unbiased estimates of abundance (see Borchers *et al.* 2009). Unsurprisingly, density estimates from the ship surveys tend to be 20 to 40% of those from the aerial survey in the same area. However, Pike *et al.* present data that suggest that under ideal conditions and with high observer effort, a ship survey can approach the ideal of $g(0) = 1$ for this species. Elsewhere, minke whales tended to occur in highest densities near East Greenland and to the northeast of Iceland near Jan Mayen, an area also covered by Norwegian surveys. There was no apparent trend in what should be considered relative abundance in any area. Even disregarding the known biases, estimated abundances are still more than adequate to sustain the low present day harvests in the area.

Historically, virtually all Icelandic minke whale hunting has been done using relatively small boats in coastal waters, much in the manner of the Norwegian hunt. As previously mentioned, densities of minke whales are relatively high in Icelandic shelf waters, and in some areas, such as Faxaflói Bay near Reykjavik, they may be the highest seen anywhere in the world. Aerial surveys have been used to cover this area since 1986, and the last 3 surveys (1987, 1995 and 2001) have used the specialized methods of cue–counting. In this methodology, behavioural events, such as blows or surfacings in the case of minke whales, are counted, rather than the animals themselves. If the mean cueing rate is known, the resulting counts per unit time and area can be translated into an estimate of abundance that is not biased by whales being beneath the surface and thus unavailable for counting. Cue–counting is particularly suitable for species such as minke whales, which seldom occur in groups of more than 2 and exhibit rather stereotypical behaviour.

Unfortunately, analysis of the 3 cue–counting datasets from the Icelandic aerial component of the NASS has been plagued with problems. Hiby *et al.* (1989) provided an estimate for the 1987 survey, which included corrections for measurement error and cues missed by observers. Later work by Borchers *et al.* (MS 1997) reanalyzed the 1987 data using a more standard methodology and provided a new estimate from the 1995 survey. The resulting estimate for 1987 was more than double that produced by Hiby *et al.* (1989), and the estimate for 1995 was much higher still. This resulted in some discussion in the NAMMCO and IWC Scientific Committees, with eventual result that neither of the 2 new estimates was considered acceptable. Because of the shape of the search area, even random measurement error can result in positive bias in point counts (to which cue–counting is related), and this bias can be substantial. In addition, the NAMMCO Scientific Committee eventually concluded that a reliable estimate could not be produced for the 1995 survey because there was no data with which to estimate measurement error or the proportion of cues missed by observers.

Finally, over 20 years after the 1987 survey, Borchers *et al.* (2009), provide a revised estimate for that survey and a new estimate for the 2001 survey. The authors use a new methodology to analyze ungrouped radial distance data and incorporating corrections for measurement error and uncertain detection of cues close to the plane. The resulting estimates for 1987 and 2001 suggest that the minke whale stock has grown at a rate of about 4% annually over the period. Disturbingly, the estimate by Hiby *et al.* (1989) cannot be replicated (the new estimate is over 50% higher) and the reasons for this relate at least partially to differences in the datasets used in the 2 analyses. The explanation for this will likely never be resolved.

For the past several years, I have specialized in conducting aerial cetacean surveys, particularly cue–counting surveys for minke whales around Iceland and West Greenland. So I have a great deal of empathy for the difficulties involved in conducting these surveys. There is always the feeling that the methods are all too primitive: here we are, in the 21st century, with satellites filling the skies and digital cameras available practically for free, craning our necks out a window and measuring angles to glimpses of whales using a forestry inclinometer and a hand drawn protractor! The main expense in surveys is nearly always the usage cost of the platform, be that a ship or a plane. Therefore developing and testing new methods is very expensive, and there is considerable reluctance to do so when one has a method that may be primitive, but produces results.

While applying aerial photography to wildlife surveys is not new, its application to cetacean surveys has been limited. It has rarely been applied to species such as minke whales which spend a small proportion of their time near the surface and available for viewing. Witting and Pike (2009) provide results of a direct and simultaneous comparison between a visual survey conducted using cue–counting methods, and aerial photography. The test was conducted in Faxaflói Bay, Iceland, an area known to have high densities of minke whales. Two planes were flown: a visual survey plane flying at the conventional altitude of 239 m, and a photographic plane flying directly above the visual plane at a higher altitude (as an aside, I must relate how annoyed the pilot of the visual plane became over the constant directions from the photographic plane above: "You are slightly to the right….You are slightly to the left…"). Reported here are the results of a comparison of distances to cues as measured by observers in the conventional manner, and image-based distance measurements to the same cues. To those of us who have been conducting visual surveys the results are comforting: the deviation between the two measurements was acceptably small and there was no apparent bias in visual distance measurements. This last point is most important as bias in distance measurement leads directly to bias in abundance estimation. To date, detectability issues have precluded the wide adoption of photographic methods for cryptic whale species such as minkes, but the ever increasing resolution and decreasing cost of digital photography, along with the development of automated detection algorithms, probably means that the days of human observers are numbered.

Although only 2 of the Icelandic aerial surveys (1987 and 2001) provide sufficient data to estimate the absolute abundance of minke whales, all provide data on relative abundance and distribution. In addition, while the minke whale has been the target species of all 4 aerial surveys conducted since 1986, other species have been encountered and registered, some with sufficient frequency to provide valuable inferences about distribution, abundance and temporal trends. However the survey datasets vary in quality and extent. Realized coverage varied between years. In the early surveys, particularly 1987, less emphasis was placed on collecting distances from species other than the target minke whale. This makes comparisons between survey years problematic.

Pike *et al.* (2009b) approach this problem by developing estimates for 4 species (minke, humpback, white-beaked dolphin (*Lagenorhynchus albirostris*) and harbour porpoise (*Phocoena phocoena*)) to the fullest extent possible given the available data from each survey. For example, while fully corrected estimates of abundance for dolphins and humpback whales are feasible from the 2001 survey because of the availability of double platform data, only sighting rate data is available from the 1987 survey for the same species. The authors look at trends in relative abundance using the best available index available from all 4 surveys; for example encounter rate for dolphins and humpback whales.

The aerial surveys certainly demonstrate that Icelandic shelf waters are a dynamic area and important habitat for several species of cetaceans. While the relative density of minke whales and dolphins did not change substantially over the period, there is some evidence of a decrease in harbour porpoise numbers. However it is acknowledged that data for this very cryptic species are poor and the apparent trend may be attributable to observer bias or other factors. Perhaps the most surprising aspect of the results is the high numbers of humpback whales recorded in later surveys and the high apparent rate of increase over the period, over 10% annually. This is very near the biological limit for this species. Much of this increase can be attributed to the very high density of humpbacks seen off eastern Iceland in later surveys. It appears that this species is continuing its rapid recovery, first noted by Sigurjónsson and Gunnlaugsson (1990), in this area.

If data were only available from the Icelandic shelf area, the evidence for a rapid increase in humpback whale numbers might be less than persuasive. After all, we would have no idea what was happening in the vast areas outside these waters. Fortunately the nature of NASS as an integrated and synoptic survey effort enables us to expand the analysis to include the ship survey that covered much of the central North Atlantic concurrently with the aerial survey. Paxton *et al.* (2009) do just that by integrating the aerial and ship surveys from 1995 and 2001 in a single analytical framework. Tellingly, surveys prior to 1995 provided too few humpback sightings to warrant analysis. The authors use recently developed "spatial analysis" techniques, fitting a density surface to environmental and geographical covariates. An important advantage of this methodology over more standard "design based" methods is the potential for ecological insights based on correlations between environmental variables and animal distribution. In addition, a spatial analysis can potentially result in a more precise estimate of abundance if strong explanatory variables are available. In this case only sea surface temperature and depth were available, and the results suggest that humpback whales prefer shallow shelf waters and temperatures of 6° to 8°C in this area. The estimated abundance is over 14,000 humpback whales in the area covered by the Icelandic and Faroese vessels. This is very similar to previous design based estimates for the same area. While there is some limited evidence of increase between 1995 and 2001, there would certainly be strong evidence if the results of earlier surveys were included.

The aforementioned papers add to our already extensive knowledge about the population dynamics, migratory patterns and ecology of humpback whales in the North Atlantic. The humpback can be found in relatively coastal habitats, is gregarious, relatively slow moving, easy to spot and highly vocal; all of these things make the species much easier to study than other baleen whales. As a result we know more about humpback whales in the North Atlantic than just about any whales anywhere else. This is perhaps best illustrated by the success of the Years of the North Atlantic Humpback (YoNAH) project (Smith 1999), a cooperative international effort in which whales were "marked" and "recaptured" using biopsy sampling and genetics and/or photographic records of fluke patterning. Whales were marked in all known feeding grounds and in the Caribbean breeding grounds in 1992 and 1993. The results of this project revealed much about the ecology and complex life history of humpbacks and also produced a very precise estimate of abundance for the entire ocean basin.

With the quality and detail of the available information, one might be excused for thinking it easy to answer some very basic questions, such as: Have humpbacks fully recovered from past overhunting? What was the pre-whaling population? Are there more than 2 breeding grounds (Caribbean and Cape Verde)? In what proportions do whales from the breeding grounds mix on the feeding grounds, and does this change over time? How many whales are there on each feeding ground, and are these numbers going up or down? While some of these questions can be answered for some areas, the answers are not unequivocal and sometimes conflict with other things we think that we know about humpbacks. This makes it problematic to fully determine their conservation status.

Smith and Pike (2009) begin by describing 7 "enigmas" about the ecology of North Atlantic humpbacks, in which 2 or more pieces of information seem to be in conflict. These range from the seeming mismatch between the proportion of Cape Verde breeding humpbacks on the Icelandic and Norwegian feeding grounds and the number of whales that actually seem to use the breeding ground, to the year-round presence of whales in some northern areas. Certainly the most relevant enigma to the NASS is the very high abundance estimate for the Icelandic survey area of about 14,000 humpbacks in 2001. This exceeds (although not with statistical significance) the total estimate for the entire ocean basin from YoNAH. A substantial proportion of these animals are thought to breed at Cape Verde, but only small numbers of humpbacks have been found there. Moreover, the NASS suggest a very rapid rate of increase for the Icelandic area which seems to exceed the estimated rate for the Caribbean breeding ground and other areas. Given that a large proportion of the breeding animals must be part of the Icelandic feeding stock, it is difficult to understand how this can be so.

One result of these enigmas is that modelling efforts that seek to integrate historical harvest levels, abundance estimates from the breeding and feeding grounds, measured rates of increase and mixing ratios on the feeding grounds to infer pre exploitation population levels and describe present conservation status have not been successful. Lack of success in this context, means that the models fit reality poorly when all sources of data are included. This can mean either that the model is structurally wrong, or that some of the input values are erroneous. Smith and Pike (2009) look at this problem in detail and suggest several areas of research that would help to resolve the discrepancies in what we think we know about humpback whales. One of the most important of these is better information on the mixing rates of breeding populations on the eastern feeding grounds, particularly off eastern Iceland where very large numbers occur. While this question may be addressed through biopsy sampling and genetics, satellite tracking could also provide relevant information and possibly also reveal the existence of other breeding locations.

One of the main uses of population modelling in the cetacean research world is to estimate population levels before the same populations were, in all too many cases, decimated by whaling. A major assumption of most such models is that the ecology and behavioural patterns of whales today is much as it was in the past. In some cases enough historical information is available to indicate that this is indeed the case, but in most situations it remains just an assumption. Yet we know that we have drastically altered the ecology of the North Atlantic in the past century through the selective removal of large predatory fish, eutrophication, changes in freshwater runoff patterns and other anthropogenic changes. It seems unreasonable to expect whales to be "behavioural machines", undertaking the same migrations and occupying the same feeding areas year after year without regard to changes in environmental conditions and prey abundance. Why then should we expect whales to behave as they did 100 or more years ago?

Some clues to this conundrum are provided by the work of Skern-Mauritzen *et al.* (2009), who examine the habitat and prey selection of minke, fin and sperm whales and *Lagenorhynchus* (*albirostris* and *acutus*) dolphins in the Barents Sea over a 3 year period. Along with environmental information such as depth and temperature, data on plankton and forage fish (0- group, capelin (*Mallotus villosus*) and herring (*Clupea harengus*)) were collected simultaneously with cetacean observations. Perhaps not surprisingly, minke and fin whales and dolphins tended to be associated with areas of high plankton and/or forage fish abundance. Fin whales were confined to areas with complex bottom topography and cold water masses. Sperm whales were also associated with areas rich in small fish, perhaps because they eat the predators of these fish. However these relationships were highly dependent on scale, and limited by the resolution of the available data. Cetaceans responded differently to changes in prey abundance over the period. The distribution patterns of minke, fin and sperm whales did not change much over the 3 years of the study, despite an increasing abundance of capelin and herring in the northern part of the study area. This suggests that these species may occupy the same areas year after year, switching prey species as availability changes. In contrast, the distribution of *Lagenorhynchus* dolphins shifted northwards and appeared to track the northward shift of capelin in the area. This suggests that dolphins may have a more flexible migratory behaviour that allows them to track the distributions of preferred prey species.

These results show that cetaceans respond differently to environmental and ecological changes. While the general distributions of minke and sperm whales may be relatively invariant, that of fin whales may change with shifts in ocean currents and temperature gradients. Similarly, specialized predators such as dolphins may closely track the distributions of their prey. Unfortunately we have little long-term information on especially forage fish distributions in the open ocean, so the implications of these results for historical distribution and abundance remain unclear.

Studies such as this one hint at the potential uses of properly collected cetacean sightings data for purposes other than simply estimating abundance, as important as that is in a management context. Cañadas *et al.* (2009) continue along these lines in a distributional analysis of common dolphins, and demonstrate in the process that cetacean survey data can retain value long after its original "best before" date. The authors use survey effort from all 4 NASS up to 2001, the MICA-93 programme conducted off the French continental shelf, and the SCANS94 programme to describe the distribution of common dolphins in terms of simple geographic and environmental variables and to estimate abundance in a part of the area.

One potential difficulty in interpreting these data is the fact that the common dolphin was the target species of none of the surveys. Therefore a large proportion of the effort was conducted in conditions unsuitable for sighting small cetaceans, and little effort was made to confirm species identity or group size if they were uncertain. Moreover, much of the effort was conducted in single platform mode and consequently there is no way to correct for animals missed by observers and attraction to vessels, both of which are substantial for this species (Cañadas *et al.* 2004). Nevertheless, in a case like this where relatively little is known about the offshore distribution of the species and no dedicated survey data are available, the information is of great value. Also, for a small part of the area, the Faroese blocks from NASS-95, the data are of sufficient quality to estimate abundance.

The results confirm that the common dolphin (*Delphinus delphis*) is a temperate species that seems to prefer warmer waters and depths between 400 and 1,000 m. No common dolphins were sighted north of 57° and most were in water with a surface temperature greater than 15° C. Interestingly, group sizes showed a strong increase with depth (over 2,000 m) that may imply strategies related to feeding or social behaviour. The estimated abundance in the Faroese block was over 270,000 animals, suggesting that the common name for this species is appropriate.

We close the volume with a paper by Smith (2009), which traces the history and development of assessment methods based on "encountering whales", or to use the more common terminology, sightings surveys. Historically researchers have relied on 3 relatively independent sources of data to determine the status of whale populations: fishery-dependent catch rates, sightings surveys from dedicated or opportunistic platforms, and mark-recapture studies. It has long been known among whalers that intense whaling in a particular area leads to a decrease in the number of whales sighted, and hence to a decline in catch. But some early writers interpreted this to be a result of whales shifting their distribution in response to whaling, rather than a substantial decline in populations. There was always the sense that the sea was so vast that there was always another place where the whales might be hiding. That said, some early writers recognized clearly the destruction caused by whaling practices: witness this remark by Ingebrigtsen (1929): "If we follow the course of modern whaling from its initiation by Svend Foyn in Finnmark about the year 1870 until the present time when its operations extend to almost all the waters of the globe, we see that with few exceptions such operations sooner or later reduced the stocks of whales in the various regions so greatly that whaling had to be abandoned as unremunerative." By the mid part of the 20th century when modern whaling had spread to the last remaining areas in the Antarctic, it became apparent that there was indeed nowhere left to hide.

The first large-scale standardized collection of whale sighting data was carried out in the Antarctic by the "Discovery" expeditions of the 1940's. But when the IWC Scientific Committee first began its work in the 1950's, it relied almost entirely on catch rate data, used in much the same manner as in conventional fishery science. In the 1960s these data were used to demonstrate rather conclusively that the main species of large whales had indeed been overharvested and that populations were in decline. In the meantime concern about excessive by catch of dolphins in tuna fisheries stimulated rapid advances in visual survey methods. By the late 1970's whaling was in decline and catch rate data was becoming less available and reliable. Major efforts were developed towards developing fishery independent sources of data, most prominently the interpretation of sightings data from designed surveys. These culminated in the IDCR surveys circumnavigating the Antarctic over several years, the NASS which began in 1987 and the SCANS in 1994. The NASS in 1995 was perhaps the largest scale, most expensive and most logistically complex wildlife survey ever carried out, involving 14 vessels, several airplanes and scores of observers. The sightings survey had clearly arrived as the method of choice for assessing whale populations.

And so ends the volume, the first from NAMMCO devoted to the NASS. But the story does not end here. It seems likely that surveys of abundance will play a major role in cetacean conservation and management for the foreseeable future. Equipment and methods will surely change. For example drone aircraft and digital imaging will likely play a much larger role in the future. The recent T-NASS incorporated many innovations on the ships that had not been used in previous surveys. But the basic idea of counting whales from a moving platform will remain. Analytical methods are also constantly developing. I predict that the data from the NASS will be revisited many times in the future, using the sharper vision afforded by new analytical techniques to look at these data in new ways. The uses for these data will likely multiply as human activities and environmental change have an ever larger impact on the environment of the North Atlantic.

I am pleased to have played a role in the development of this volume, both as lead and co-author on some of the papers and as co-editor. The volume has been several years in the making and it has not been an easy task. The thematic nature of the volume meant that a range of papers covering several species and time periods was essential, and publication could not proceed until all papers were ready. This lead to interminable delays and there were times when I was ready to abandon the project. And here I must acknowledge the support of the NAMMCO Scientific Committee and express my appreciation for the confidence they had in me and my co-editor to carry this task to completion. They never lost sight of the importance of this information and the value of publishing it under the banner of NAMMCO. I would also like to thank all the authors of the papers, some of who have had their patience severely tested at times, and all the scientists who took the time to review the contributions. We believe the result is worth the wait.

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