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Connecting the Nodes: Migratory Whale Conservation and the Challenge of Accommodating Uncertainty

Ph.D. Thesis

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I, Christina Geijer, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Abstract

As endangered, flagship species, baleen whales are at the centre of cetacean conservation efforts. Whilst successful conservation requires protection throughout a species' range, current measures invariably focus on the whales' more static feeding or breeding habitats. The aim of this thesis is to analyse the challenges and prospects of protecting threatened whales during their seasonal migrations. I sought to assess the appropriateness of Marine Protected Area network initiatives and sector-specific mitigations strategies for migratory whale conservation within the context of scientific uncertainty, the threat of ship-whale collisions, and regional geopolitics. To this end, I compared and contrasted data obtained from two case studies—fin whales *Balaenoptera physalus* in the Mediterranean Sea, and North Atlantic right whales *Eubalaena glacialis* off the U.S. East coast—using a transdisciplinary, qualitative research approach based on semi-structured interviews and a theoretical framework of uncertainty analysis. The results indicate that protection of migrating whales is better pursued through a narrow sectoral route with wide geographical scope, exemplified by the International Maritime Organisation, rather than governmental cross-sectoral Marine Protected Area networks, particularly in regions with high geopolitical complexity and low political will. Principle challenges to migratory whale conservation were discerned on two levels. On a species level, high ontological uncertainty—endemic dynamism and unpredictability—surrounding whale migratory behaviour render conventional, habitat-based conservation measures unsuitable, and require more creative, dynamic, and adaptive strategies. On a people level, considerable ambiguity—different ways of understanding and conceptualising the same issue or data—between individual researchers in the absence of adequate collaboration prevents the unified actions necessary for conserving a cross-boundary species. Indeed, whilst contextual parameters matter in conservation, building researcher networks to enhance collaboration amongst conservationists emerged as a pervasive theme and as a necessary tool for migratory whale conservation.

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List of Abbreviations

ABNJ	Areas Beyond National Jurisdiction
ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area
ATBA	Area to be Avoided
CBD	Convention on Biological Diversity
CEC	Commission for Environmental Cooperation
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CSG	Cetacean Specialist Group
DMA	Dynamic Management Area
EPZ	Ecological Protection Zone
EBSA	Ecologically or Biologically Significant Area
EC	European Community
EEZ	Exclusive Economic Zone
ESA	Endangered Species Act
EU	European Union
FPZ	Fisheries Protection Zone
GFCM	General Fisheries Commission for the Mediterranean
ICMMPA	International Conference on Marine Mammal Protected Areas
IMO	International Maritime Organisation
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
MAP	Mediterranean Action Plan
MEPC	Marine Environment Protection Committee
MMPA	Marine Mammal Protection Act
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
NAAEC	North American Agreement on Environmental Cooperation

NAFTA	North American Free Trade Agreement
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
RAC/SPA	Regional Activity Centre for Specially Protected Areas
REPCET	Real-time Plotting of Cetaceans
SARA	Species at Risk Act
SMA	Seasonal Management Area
SPA/BD	Specially Protected Areas and Biological Diversity Protocol
SPAMI	Specially Protected Areas of Mediterranean Importance
TSS	Traffic Separation Scheme
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environmental Programme
WSSD	World Summit on Sustainable Development
WTO	World Trade Organisation

1

Introduction

1.1. Introduction

As charismatic flagship and umbrella species, cetaceans are often at the heart of conservation movements (Whitehead et al., 2000). Past and current threats have had huge impacts on population size and structure of numerous whale species, including the North Atlantic right whales (*Eubalaena glacialis*), Antarctic blue whales (*Balaenoptera musculus*) and Northwest Pacific gray whales (*Eschrichtius robustus*) (Roman and Palumbi, 2003; Reeves et al., 2003). Whilst cautious optimism is warranted, global and regional population trends paint a worrisome picture of the current status of the mysticeti whales (Order Cetacea, suborder Mysticeti) due to ongoing threats, that include habitat degradation, incidental capture in fishing gear, and most prominently, collisions with ships (e.g. Laist et al., 2001; Reeves et al., 2003).

Issues related to the protection of migratory whales are complex and challenging given their transboundary trajectories over vast ocean spaces and the need to establish regional cooperation for their protection. Whilst most species of large whales undertake seasonal migrations between known winter and summer sites, less is understood of their migratory life-history stages, and uncertainties surrounding their migratory pathways are often an impediment to conservation (e.g. Clapham et al., 1999; Hyrenbach et al., 2000; Notarbartolo di Sciara et al., 2003). The three-dimensional and dynamic nature of the marine environment, the inherent challenges of studying complex marine species, together with the youth of this academic and conservation discipline, further creates a wealth of endemic uncertainties (Bache, 2005), which must be explicitly addressed and communicated (Meffe et al., 1999).

For this doctoral thesis I have chosen to analyse a specific aspect of whale conservation that I believe has not received due attention: the protection of whales during their seasonal migrations, and how to proceed with conservation in the face of prevailing scientific uncertainty. Migration represents an essential life-history stage for wide-ranging whales (Hooker and Gerber, 2004), and are considered critical habitats, the protection of which are necessary for effective cetacean conservation (Hoyt, 2005; 2011).

Protection of whale populations from diverse threats over large and international ranges represents a major challenge for species protection and recovery (Hinch and De Santo, 2010). MPA networks, a novel marine conservation strategy, aim to address conservation at larger spatial scales, and represent a potential avenue for more holistic conservation of migratory whales (Hoyt, 2005; 2011; Morgan et al., 2005; ICMMPA, 2009). Whilst the expectations are high, the effectiveness and appropriateness of MPA networks as a conservation tool for migrating whales have yet to be analysed and compared to other strategies. Wider scale sectoral regulations where industry-specific activities are regulated directly—i.e. outside of MPA boundaries—to address threats encountered by whales during their seasonal migrations represent an alternative or complementary approach.

1.1.1. Introduction to the Baleen Whales

The focus of this thesis is on the mysticete or baleen whales named accordingly by the presence of several hundred plates of baleen in the mouth, which allow for the elaborate filtration of prey from seawater. The mysticete whales are currently thought to be comprised of eleven species, grouped into four families (Figure 1.1). These are: i) *Balaenopteridae* (the rorquals) (six species: Blue, Fin, Minke, Sei, Bryde's, and Humpback whales), ii) *Balaenidae* (three species: the Northern Right, Southern Right, and the Bowhead whales), iii) *Eschrichtiidae* (the Gray whale), and iv) *Neobalaenidae* (one species: the Pygmy Right whale) (Mead and Brownell, 1993).

In contrast to odontocetes (Order Cetacea, suborder Odontoceti), the social organisation of baleen whales is not characterised by the same cohesive stability, whereby individuals remain associated for long periods of time. Instead, small, unstable groups seem to be the most common feature in studied mysticetes. During feeding, large aggregations can be observed, but these are not likely to equate to an underlying social structure (Clapham, 2000). Mysticetes, which are found in different coastal, shelf, and pelagic habitats, feed on a variety of prey, which usually consists of small crustaceans, including krill (Clapham et al. 1999). Baleen whales undertake some of the most extensive seasonal migrations on the planet. In the traditional migration paradigm, whales travel between high latitude or temperate, cold, productive summer feeding grounds, and winter mating and calving areas in tropical or subtropical waters (e.g. Kellogg, 1929; Mackintosh, 1942, cited in Clapham et al. 1999: 37).

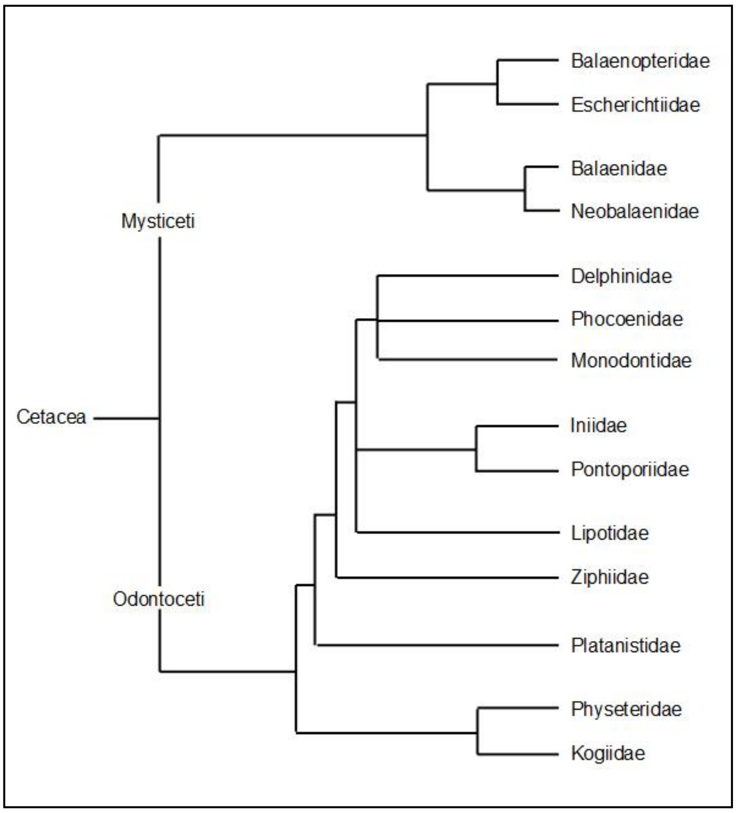

Figure 1.1. Cetacean Phylogeny and Evolution. From Mann et al. (2000).

1.2. Research Aims and Questions

I aimed to investigate the challenges and prospects of protecting baleen whales during their seasonally migrations; that is, as they travel between 'nodes' of feeding and calving aggregation areas. I explore the issues surrounding migratory routes, the threat of ship-whale collisions faced during migrations, and identify common themes of concerns, opportunities, and prospects for implementing different conservation 'tools' that can be used to conserve whales more holistically. I examine the concept of scientific uncertainty *per se*, with the aim to analyse how it is viewed and addressed, its implications for conserving migratory whales, and strategies for proceeding with policy decision-making in the face of scientific uncertainties.

To address these aims, I adopted a transdisciplinary approach consisting of an in depth analysis of the concept of uncertainty, literature analysis, semi-structured interviews with key actors, and workshop/conference participant observation. The rationale behind this methodology is to explore different perspectives among interviewees and combine analysis of empirical results from interviews with current conservation, uncertainty, and policy frameworks. An overarching aim is for this thesis to contribute insight, as well as practical recommendations, to the field of migratory cetacean conservation. It focuses particularly on the following research questions:

- What are the issues, challenges, and prospects for protecting whales during their seasonal migrations?
- Are migratory routes spatially and temporally predictable enough to allow for place-based conservation?
- To what extent are whales exposed to the threat of ship strikes during migrations?
- When are ecosystem-based MPA networks, and when are sectoral regulations, the more appropriate tools to use to protect migrating whales?
- How is scientific uncertainty viewed and addressed? What are the implications of this uncertainty for achieving effective conservation of migratory whales?

The research aims and questions are applied—with hierarchical emphasis—to the following case study contexts:

1. Fin whales *(Balaenoptera physalus)* in the Mediterranean Sea and the SPAMI network initiative in Areas Beyond National Jurisdiction.
2. North Atlantic right whales *(Eubalaena glacialis)* and the shipping-sector specific Seasonal Management Areas on the U.S. East coast.

1.2.1. Justification and Contribution

Previous work on whale conservation has focused primarily on the protection of their more static feeding, breeding, and calving critical areas. The first International Conference on Marine Mammal Protected Areas (ICMMPA) held in Maui, Hawaii, in 2009, explicitly acknowledged that conservation approaches must look 'outside the box' in order to address threats faced by migrating cetaceans (ICMMPA, 2009). However, whilst the importance of extending conservation efforts to include migration routes is often highlighted, protection of migratory corridors tends to be a second priority or even neglected.

As a novel concept, little has been researched or published on the topic of MPA networks for wide-ranging whales, and how connectivity through migratory route protection can be realised in practice on a regional scale. MPA networks are part of a general trend within conservation science to move from single-species to more holistic, ecosystem and ocean-wide strategies (e.g. Hyrenbach et al., 2000; Agardy, 2010). At the same time, alternative ecosystem approaches to management are recognised as tools to mitigate anthropogenic threats and manage cetaceans in a wider context (Hardy et al., 2012). The present PhD project addresses the research gap of how to pursue conservation of migrating whales by analysing the relative effectiveness of such large-scale ecosystem-based MPA networks and wide-ranging sectoral approaches.

Conservation of migratory whales faces numerous challenges in terms of scientific uncertainties surrounding the species and their seasonal movements. However, uncertainty and limited data should not be a reason to abandon scientific research (King et al., 1994) and policy initiatives (Ludwig et al., 1993). In the traditions of transdisciplinary research (Brown et al., 2010) and post-normal science (Funtowicz and Ravetz, 1993), uncertainty is recognised as an inevitable part of current environmental issues. Therefore, rather than solely discussing uncertainties pertaining to my research topic, I use a structured framework that examines and analyses the concept of uncertainty and its link to policy decision-making. With this new and unconventional methodological approach I aim to contribute useful recommendations on the prospects and challenges of migratory whale conservation.

1.3. Introduction to the Chapters

Key issues explored in the different chapters are as follows:

Chapter 2 comprises a comprehensive literature review on global baleen whale conservation status and the threats that are driving population trends, with a particular emphasis on ship-whale strikes. It further details paradigms of whale migration, and challenges involved in their conservation. Finally, it provides an extensive review on two conservation strategies that could be used to protect whales during their migratory life-stages: ecosystem-based MPA networks, and wider-scale sectoral regulations pertaining to the shipping industry.

Chapter 3 outlines the transdisciplinary approach adopted for this thesis, and the inevitability of scientific uncertainty in migratory whale and biological conservation. It discusses various frameworks for the conceptualisation and analysis of scientific uncertainty at the science-policy interface, and provides a discussion for bridging theoretical and policy discourses.

Chapter 4 describes the research rationale, PhD schedule, and the various methodological approaches used in the thesis. It further details methods employed for the analysis of the empirical data and the framework developed for the treatment of uncertainty. The three subsequent chapters (5-7) are collectively structured as Results and Discussion.

Chapter 5 examines the empirical data within the first case study context: migrating fin whales in the Mediterranean Sea and the basin-wide SPAMI network initiative. It analyses hypotheses and perspectives of fin whale movements within the Mediterranean in the light of the theoretical uncertainty framework. It further discusses the value of the SPAMI network initiative and limitations posed by the current geopolitical climate of the Mediterranean Sea.

Chapter 6 provides a similar analysis of the issues and challenges surrounding the protection of migrating North Atlantic right whales off the U.S. and Canadian East coasts. It describes the whales' migration, exposure to ship strike risk, and the network of Seasonal Management Areas aimed to protect the whales against collisions with ships as they migrate along the U.S. coast.

Chapter 7 discusses and compares the findings presented in the two case study chapters, and provides a more in-depth analysis of the empirical work in the light of the research questions. It reflects on the different challenges and implications of uncertainty for migratory whale conservation, the role of researcher collaboration, the issues and prospects of establishing ecologically connected MPA networks, and the inevitability of involving individual sectors for achieving effective conservation results.

Chapter 8 provides a summary of the main findings of the thesis and general recommendations for migratory whale conservation as well as avenues for future research. It ends with a self-reflection on the PhD journey taken and the impression and thoughts that have arisen during this three year project.

2

Literature Review

Overview

The purpose of this literature review is to examine areas of controversy in the literature and identify niches for investigation. I aim to take the reader through a literature journey describing the necessary background for my research, and to provide a rationale for the choice and formulation of the research questions. In the first part I discuss the conservation context of baleen whales, species status, and threats that are driving population trends. In the second section, I outline theories surrounding their migration, and the importance of protecting whales throughout their range. The third part I devote to discussing two potential conservation strategies that can be used to protect whales during the migratory life-history stages, namely regional ecosystem-based Marine Protected Area Networks, and sectoral, or industry-specific, regulations that address specific threats.

2.1. Conservation Context

2.1.1. Species and Population Conservation Status

The conservation status of the 118 recognised marine cetacean species and subspecies are described in The International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ (hereafter IUCN Red List) (Figure 2.1), and have over the last 20 years been published in three reports by the Cetacean Specialist Group (CSG) (Perrin, 1988; 1989; Reeves and Leatherwood, 1994; Reeves et al., 2003). Presently, fourteen mysticete species and subspecies are classified as having a threatened status: Critically Endangered (CR) (4), Endangered (EN) (8), and Vulnerable (VU) (2) (Table 2.1).

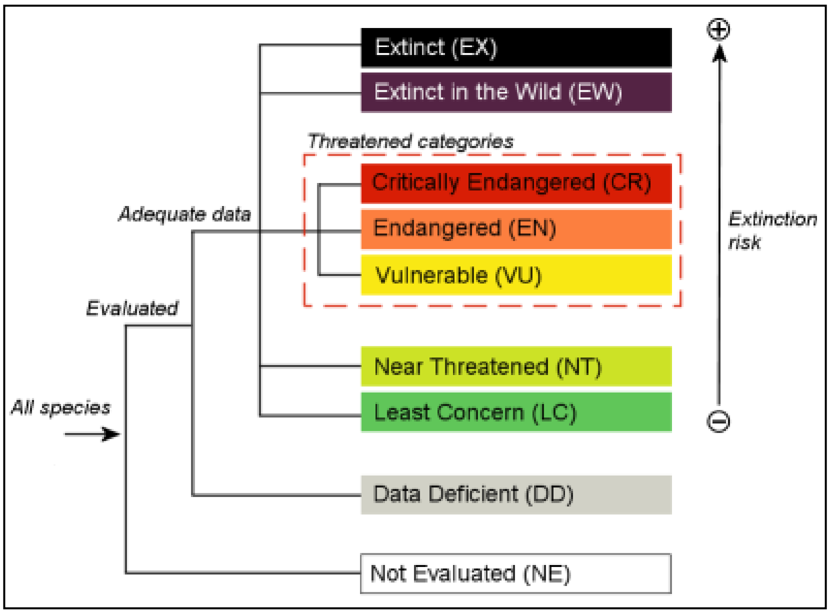

Figure 2.1. IUCN Red List designations, in descending order of threat: Extinct, Extinct in the wild, Critically Endangered, Endangered, Vulnerable, Near Threatened, Least Concern, Data Deficient, and Not Evaluated. From www.iucnredlist.org.

Numerous species that are not globally threatened are experiencing local and regional declines (Reeves et al., 2003; Currey et al., 2009; Williams et al., 2009). Rodriguez et al. (2000:241) describe IUCN global assessments as 'often giving a misleading picture of the status of a taxon', and advocate the incorporation of national, or geographical, assessments to complement the global, taxonomic evaluations. Since 2001 the IUCN has attempted to assess local trends in addition to species-level assessments by applying global Red List criteria to subpopulations, provided that they are 'isolated from conspecific populations outside the region' (Gärdenfors et al., 2001:1206). To date, only a subset of isolated cetacean populations has been evaluated, and should more subpopulations be assessed they are likely to meet the criteria for threatened status (Currey et al., 2009).

The fact that globally abundant species are subjected to strong anthropogenic impacts on the subspecies and subpopulation level may have long-term effects on the species as a whole. Hunter and Hutchinson (1994) discuss the importance of peripheral populations, and argue for a more parochial approach to species conservation. One of the virtues of parochialism is maintenance of intra-specific genetic diversity, and the fact that species with greater diversity have improved chances of adapting to environmental changes (Hunter and Hutchinson, 1994).

*Table 2.1. Currently threatened baleen whale species, subspecies, and populations, and their designated IUCN Red List status according to the three cetacean conservation action plan reports. *most recent update from www.iucnredlist.org, X = Not Evaluated or not yet recognised as subspecies, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, DD = Data Deficient.*

THREATENED MYSTICETES	1988	1994	2003	2012*
Critically Endangered				
Antarctic blue whale *(Balaenoptera musculus intermedia*)	X	X	EN	CR
Southern right whale (*Eubalaena australis)* Chile-Peru	X	X	X	CR
Bowhead whale *(Balaena mysticetus)* Svalbard-Barents Sea	X	X	X	CR
Gray whale *(Eschrichtius robustus)* Northwest Pacific	X	X	X	CR
Endangered				
North Atlantic right whale (*Eubalaena glacialis*)	EN	EN	EN	EN
North Pacific right whale (*Eubalaena japonica)*	X	X	EN	EN
Sei whale *(Balaenoptera borealis*)	X	VU	EN	EN
Blue whale *(Balaenoptera musculus)*	EN	EN	EN	EN
Fin whale *(Balaenoptera physalus)*	X	VU	EN	EN
Bowhead whale *(Balaena mysticetus)* Okhotsk Sea	X	X	X	EN
Humpback whale *(Megaptera novaeangliae)* Arabian Sea	X	X	X	EN
Humpback whale *(Megaptera novaeangliae)* Oceania	X	X	X	EN
Vulnerable				
North Atlantic blue whale (*Balaenoptera musculus musculus)*	X	X	VU	VU
Mediterranean fin whales (*Balaenoptera physalus*)	X	X	DD	VU

Upholding the full range of intra-specific behavioural and genetic diversity, and assessing and managing cetaceans on a population-by-population basis is crucial for cetacean conservation (Meffe et al., 1999; Reeves et al., 2003). As an example of the potential vulnerability of whale populations, the heavy reliance on a species of krill (*Euphasia superb*) by endangered blue whales (*Balaenoptera musculus*) in the Antarctic makes this population particularly sensitive to alterations in ocean productivity related to climate change (Clapham et al., 1999). Coupled with the fact that most blue whale populations, with the exception of the Californian/North East Pacific stock, are at high risk (Clapham et al., 1999), conservation action to support geographically distinct subpopulations is pivotal to avoid loss of intra-specific genetic diversity.

Indeed, maintaining the natural range of a species and supporting intra-specific genetic diversity is a requirement under numerous environmental policies, including the EU Habitats Directives and the Convention on Biological Diversity (CBD)[1]. Similarly, management within agencies such as the United States National Marine Fisheries Service (NMFS) and the International Whaling Commission (IWC) have geared from a genus, or species-specific, orientation towards a population-specific approach, which recognises that geographically separate whale stocks may be threatened even if the species as a whole is not. As Gerber et al. (2000:2) explain: 'what this means is that it is no longer appropriate to talk about the status of large whale "species". Rather one should refer to the status of a particular population of a whale species'.

For this doctoral research I thus emphasise the importance of the population context, which is reflected in my choice of case studies. Therefore, rather than focusing on a single mysticete species, I have chosen to examine two threatened populations of different baleen species: the Mediterranean fin whales (*Balaenoptera physalus*) and the North Atlantic right whales (*Eubalaena glacialis*).

2.1.2. Past and Current Threats

The historical reason for the threatened status and drastically reduced populations of most mysticetes is related to commercial hunting during the 20th century, which posed a huge threat to their survival (Clapham et al., 1999). The 1986 moratorium on commercial whaling imposed by the IWC allowed for an initial recovery of many baleen whale stocks (Clapham et al., 1999; Reeves et al., 2003). However, whilst some populations, such as minke whales (*Balaenoptera acutorostrata*) have steadily increased, others, including the North Atlantic right whales, bowhead whales (*Balaena mysticetus*) of the Okhotsk Sea, western gray whale (*Eschrichtius robustus*), and numerous blue whale stocks, have not (Clapham et al., 1999).

Indeed, great whale populations are still well below their pre-exploitation levels (Clapham et al. 1999), which poses numerous biological concerns, especially for species that existed and evolved in much greater population densities (Whitehead et al., 2000). Due to their life-history and demographic traits—including long lifespan, late maturity,

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[1] For example, it represents a condition for favourable conservation status in the EC Habitats Directives (Council Directive 92/43/EEC Article 1.e., 1992).

and low reproductive output, all of which rely on high rates of sub-adult and adult survival—cetaceans are especially sensitive to overexploitation and may take long to increase in population size (Whitehead et al., 1997; Lewison et al. 2004). A question mark remains as to why some populations are recovering while others are not (Gerber et al., 2000).

Restoration goals for formerly hunted whales are challenging to establish, since baseline population sizes are disputed, and the assumed historical abundance may be too low (Gerber et al., 2000; Roman and Palumbi, 2003). Based on genetic diversity studies that track population trends over time, Roman and Palumbi (2003) argue that current numbers of 'recovering' North Atlantic great whales are but a fraction of past, pre-exploitation numbers (Figure 2.2). As the authors put it, '...the possibility that vast cetacean populations existed across deep ecological time has fundamental implications not only for their management but also for our perception of the world's oceans' (Roman and Palumbi, 2003:510).

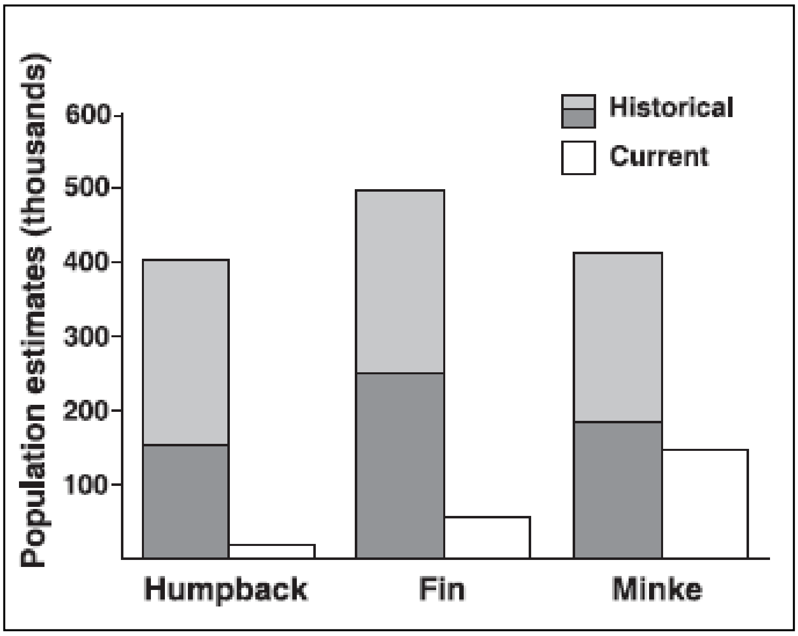

Figure 2.2. Genetic evidence and current estimations of North Atlantic Humpback, Fin, and Minke whales. Confidence intervals are shown in light grey. From Roman and Palumbi (2003:508).

Threats facing cetaceans today are numerous and often cumulative and unpredictable (Reeves et al., 2003). Bycatch, or incidental entanglement in fishing gear, have serious impact on baleen whales. Whilst whales are often able to break free of fishing gear, sustained entanglement can cause severe injury and eventual death (Knowlton and Kraus, 2001; Johnson et al. 2005). Other important threats include noise pollution, habitat loss and degradation, toxic pollutants, and global climate change (Reeves et al., 2003). Due to unpredictability and uncertainty, it is often highly challenging to predict the short-and-long-term effects of these threats on populations. For example, the level of underwater noise exposure, stemming from sources such as commercial shipping and military activities, is known to be detrimental to cetaceans but is difficult to assess (Whitehead et al., 2000). In a similar vein, global climate change is likely to disrupt marine ecosystems which may affect whale prey and change the suitability of traditional migration routes and destinations (Clapham et al., 1999; Whitehead et al., 2000).

Notwithstanding, on a global scale, the most serious threat affecting large whales today is mortality caused by collisions with ships, an underestimated threat that has proven more common than previously thought (Laist et al., 2001; Panigada et al., 2006). The first reported ship strike occurred as early as the 1850s. Whilst whale-ship collisions are known to have occurred on an infrequent basis throughout the first half of the 20th century, it was not until the 1950s–1970s, when ship numbers and speed increased, that collisions became more frequent (Laist et al., 2001).

Mortality by ship collisions is of considerable conservation concern for the survival of small whale populations, including the North Atlantic Right whale (Knowlton and Kraus, 2001; Hinch and de Santo, 2011) and Mediterranean fin whales (Panigada et al., 2006). In an endeavour to collect historical data, stranding reports and observed collisions, Laist et al. (2001) report that, whilst all types of ships may hit whales, the most lethal and serious injuries are caused by vessels that are 80 m or longer, or vessels travelling 14 knots or faster (Figure 2.3). If the strikes are not lethal (Figure 2.4), internal or external injuries are often life-threatening, as demonstrated by observed severed tails and large propeller slashes (e.g. Knowlton and Brown, 2001).

Most whales hit by ships are not seen by the crew or only seen at the last moment, or the whale may be transported long distances on the bow of the ship (Laist et al., 2001). Furthermore, numerous collisions are neither noticed nor reported, and as a result ship strike rates may be significantly underestimated (Panigada et al., 2006). The trend of increasing speed and density of commercial shipping in highly populated areas such as the Mediterranean is likely to aggravate the threat of whale-ship collisions in the future (Panigada et al., 2006).

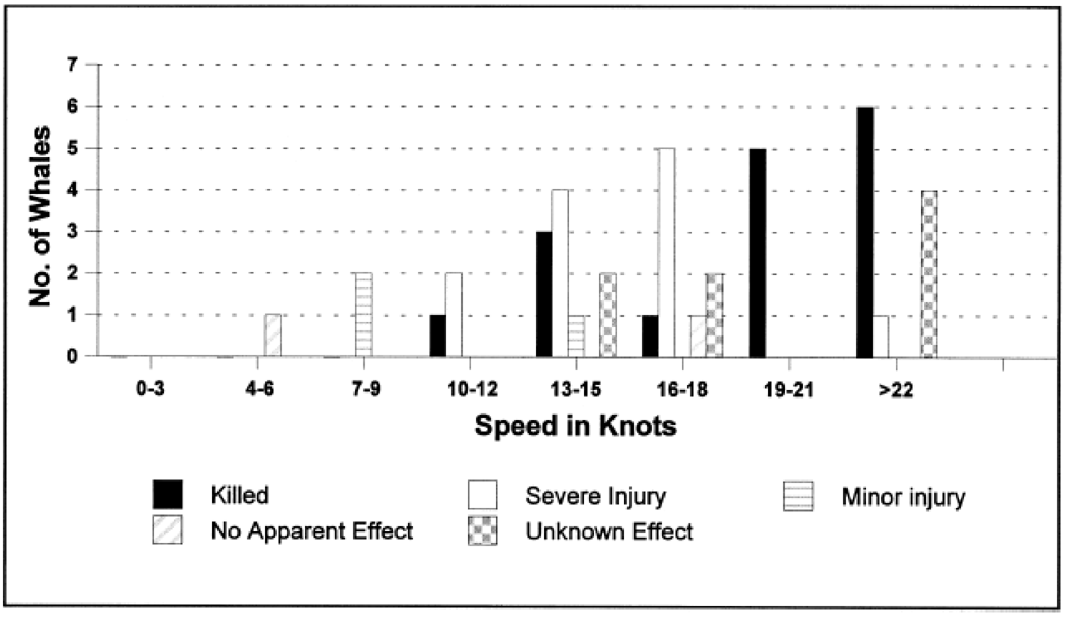

Figure 2.3. Severity of injuries to whales struck by vessels traveling at known speeds. From Laist et al. (2001).

The mysticete species most commonly hit are fin whales, followed by right whales, humpback whales, sperm whales, and grey whales. Indeed, one-third of fin whale and right whale strandings are likely to be caused by vessel collisions (Kraus et al., 2001). Reasons for whales' inability to avoid ships are still unclear (Knowlton and Brown, 2001). A study on North Atlantic right whales demonstrates that the whales do not exhibit responses to the sounds of oncoming ships (Nowacek et al., 2004). It is hypothesised that something in the behaviour of whales may not be adaptive enough, that the inability to detect vessels may be linked to physical and biological factors, and possibly habituation to vessel noise (Nowacek et al., 2004). Laist et al. (2001) theorise that whales engaged in feeding behaviour may be less responsive to approaching ships. However, the risk of ship strikes is prevalent throughout the range of many baleen whale species, including migratory routes (Knowlton et al., 2002).

Whilst I acknowledge the synergistic effects of the numerous threats facing migratory whales, time and space constraints of this thesis do not allow for a thorough examination of all potential risk factors encountered during migration. For three main reasons I have chosen to focus the PhD analysis on ship-whale collisions: because i) they represent one of the most serious threats facing large whales today, ii) strikes are known to occur throughout most whales' ranges, and iii) they are of particular conservation concern for North Atlantic right whales and Mediterranean fin whales, the two case study populations chosen for this thesis.

2.2. Migration

2.2.1. An Endangered Phenomenon

Migration is a ubiquitous phenomenon found in a wide variety of taxa on land, in water, and the air (Dingle and Drake, 2007; Hyman et al., 2011; Milner-Gulland et al., 2011). Numerous definitions for the term 'migration' exist, and the concept of migration is often viewed differently (Berger, 2004; Dingle and Drake, 2007). For example, Dingle and Drake (2007) recognise that there are various kinds and degrees of migration, including *partial* migration (only a fraction of the population migrates), *differential* migration (differences in migration patterns, for example between older and younger individuals, or between the sexes), *one-way* migration (e.g. by insects that produce offspring and die at the destination), and *nomadism* (migration does not follow a regular pattern or route linking habitats where conditions are favourable). By contrast, Hyman et al. (2011:409) discuss migration in terms of 'the cyclical, predictable, round-trip movement of the entire population, or any geographically separate part of the population'. Similarly, Berger (2004:321) uses the definition 'seasonal round-trip movements between discrete areas not used at other times of the year'.

Despite tremendous variety in modes and strategies, migration is considered a single biological phenomenon (Dingle and Drake, 2007); a phenomenon which in itself is threatened (e.g. Harris et al., 2009; Hyman, 2011). That is, regardless of the conservation status of the species or population that is migrating, the migration phenomenon *per se* has important biodiversity implications. Migrations provide significant benefits, including ecological, such as seed dispersal and nutrient transport, and economic advantages, for instance whale-watching of seasonally returning whales (Hyman et al., 2011). Thus, this thesis recognises that protection of migratory habitats and species during migration is intrinsically of great conservation value.

Migration as a phenomenon entails both its mechanism and its function (Dingle and Drake, 2007). A main purpose of this thesis is to address the issues and challenges surrounding the conservation of whales during their migration, and therefore the attention is more focused on the mechanisms of when and where whales are found in certain locations, rather than evolutionary functions and advantages for the migratory behaviour.

2.2.2. Traditional and Revisited Paradigms of Mysticete Migration

Whales are known to undertake some of the most extensive migrations on earth. The stereotypical paradigm of the baleen whale annual cycle entails distinct temporal and geographic distribution and activity patterns. The animals migrate between high latitude, cold, productive summer feeding grounds, and winter mating and calving areas in tropical or subtropical waters, where feeding activity is absent (Kellogg, 1929; Mackintosh, 1942, cited in: Clapham et al., 1999:37). The evolutionary advantage of the migratory seasonal cycle of whales is debated in the literature (Corkeron and Connor, 1999). It allows baleen whales to exploit the benefits of different habitats, giving birth in warmer and calmer waters may confer an advantage to the calves (Clapham, 2000), and low latitude waters is likely to reduce the risk of killer whale (*Orcinus orca*) predation on newborns (Corkeron and Connor, 1999).

A case can be made for the need to expand the concept of stereotypical baleen whale migration to include a wider range of migratory behaviour. Hoyt (2009) suggests that traditional paradigms of whale migration may have to be 'rewritten' based on the observed winter foraging behaviour of blue whales in the Costa Rica Dome. This hitherto unknown behavioural element is reminiscent of the Mediterranean fin whale winter feeding around the Lampedusa Islands (Canese et al., 2006), humpback whales foraging along the migratory route of eastern Australia (Stamation et al., 2007), and gray whales opportunistic feeding during their eastern Pacific migration corridor (Moore et al. 2007). Furthermore, an increasing body of evidence demonstrates that not all individuals of a population undertake classical migrations, and that sexual segregations in migratory patterns may be a common feature for baleen whales (e.g. Craig and Herman, 1997; Barendse et al., 2010).

Moreover, considerable species variation in migratory behaviour exists. For example, the extent to which migration takes place in offshore areas compared to along a continental coast, as well as the predictability of the migratory routes, may vary. Pacific gray whales undertake one of the most well-known and predictable migrations along the North American Pacific coast between summer feeding areas in Alaska and the sheltered calving grounds of the Gulf of California, Mexico (e.g. Clapham et al., 1999). By comparison, limited information is available on the predictability of the migratory routes of other baleen whales, including Atlantic Humpback whales, fin whales, and western Pacific gray whales. The traditional migration paradigm may thus be an extreme case on a continuum of different movement strategies. Since numerous sources of data suggest a more flexible paradigm of baleen whale migration, I will, for the purpose of this thesis, consider migration as a spectrum of movement patterns, in line with Dingle and Drake's (2007) framework.

Much uncertainty and speculation still surround the migratory behaviour and routes of mysticetes, which hamper conservation efforts to protect threatened whales throughout their range (e.g. Hyrenbach et al., 2000). Due to this uncertainty and the vast and transboundary migratory distances, protection against threats during migration is an extremely challenging undertaking—both on a species and policy level—and has not received due conservation priority (Hyman et al., 2011). Herein lays the complex but pivotal issue of protecting baleen whales throughout their range, and the focus of this doctoral research.

2.3. Conservation Strategies for Migratory Whales

2.3.1. Migratory Species Protection

Protecting and managing migratory animals is a more inherently complicated and challenging task than the conservation of non-migratory species. Migrants often utilise vast spatial scales, cross multiple jurisdictions, and are elusive to study. Understanding the migratory behaviour is pivotal for developing appropriate conservation strategies, since their effectiveness is often determined by the species migratory characteristics and the nature of threats affecting the population (Shuter et al., 2011).

Due to the spatio-temporal and dynamic scales involved, it is essential that conservation planning of migratory species adopts a landscape (or seascape) approach (Fryxell et al., 2011). Marine systems—like their terrestrial counterpart—need to be managed on scales that prevent habitat fragmentation (Meffe et al., 1999). Migration routes are critically important for long-term population viability for many cetacean species (Reeves, 2000), and loss of any of the seasonal dependent grounds, or the ability to reach such areas, can be devastating (Clapham et al., 1999).

Protection of wide-ranging whales thus need to include all life-history stages, such as feeding and breeding areas, as well as migratory grounds (Hooker and Gerber, 2004) (Figure 2.4). Hoyt (2005; 2011) includes migratory routes and 'rest stops' in his definition of cetacean critical habitats[2], which are considered the most important areas on which to focus conservation strategies. Notwithstanding, protection of whales during their migratory life-history stage has received less theoretical and practical attention compared to other critical habitats.

However, conservation focus on all aspects of vast baleen whale migrations is likely to be unfeasible, especially if the routes are found on the high seas, over which no single nation has jurisdiction. Herein lies a paradox: the closer to shore the migration, the higher the anthropogenic pressures tend to be, however, national waters allow for easier implementation of protection measures. By contrast, the farther offshore (i.e. on the high seas or beyond national jurisdiction) the whales migrate, the more challenging it becomes to provide effective tools to protect them, but conversely they may not be in as much need of mitigation from human threats.

Various international agreements, conventions, and multi-lateral treaties are applicable for the conservation of migratory whales. Most prominently, the Convention on Migratory Species (CMS, or the Bonn Convention, 1983)[3] aims to: 'conserve terrestrial, marine, and avian migratory species throughout their range' (CMS, 2012). Range-states can declare so called Memoranda of Understanding (MoUs), which are not legally binding, or enter into a binding Agreement to protect a migratory population

[2] 'Critical habitat refers to those parts of a cetacean's range, either a whole species or a particular population of that species, that are essential for year-to-year survival, as well as for maintaining a healthy population growth rate. Areas that are regularly used for feeding (including hunting), breeding (all aspects of courtship) and raising calves, as well as, sometimes, migrating, are part of critical habitat, especially if these areas are regularly used' (Hoyt, 2005:28).

[3] The CMS was adopted in 1979 and entered into force in 1983. It operates under the auspices of the United Nations Environment Programme.

(Shuter et al., 2011). Whilst this convention has been successfully implemented for terrestrial migrants, such as for the saiga antelope (*Saiga tatarica*), it has yet to prove its effectiveness for migratory whales. Other relevant conventions for migratory species include the Convention of Biological Diversity (CBD), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the International Whaling Commission (IWC), and the United Nations Law of the Sea (UNCLOS) (Shuter et al., 2011).

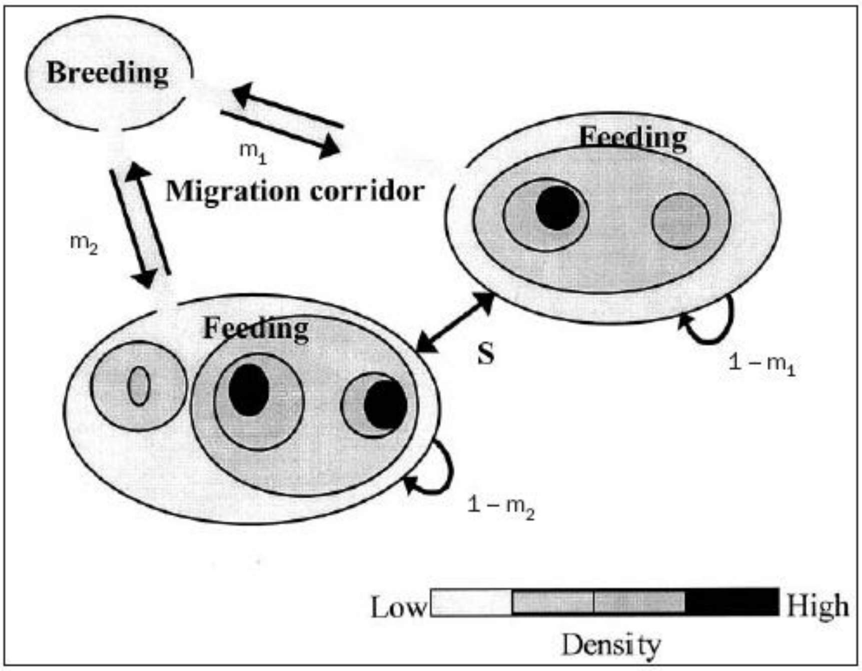

Figure 2.4. Life stages of many marine predators (e.g. baleen whales, pinnipeds, and seabirds) are separated spatially into discrete feeding and breeding areas, with migration between them. Reserves can be placed in feeding, breeding, or migratory habitats. Abbreviations: m, migration rate (m1 and m2 indicate different rates for migration to each feeding area); S, mixing between feeding areas. From Hooker and Gerber (2004).

Whilst these agreements could, in theory, be employed to protect whales throughout their range, for this thesis I have chosen to examine conservation tools that are more specific than conventions. Therefore, in order to make the analysis more grounded in practice, this thesis centres on two different approaches to protect whales during their migration, which have been, or are in the process of, being implemented: large-scale ecosystem-based Marine Protected Area (MPA) networks and sectoral regulations pertaining to the shipping industry.

2.3.2. Marine Protected Area Networks

2.3.2.1. Scaling Up From Marine Protected Areas

The main argument against MPAs for cetaceans is the mobile nature of numerous species, and that their home-ranges tend to be too large to be encompassed by existing single and small protected areas (Hoyt, 2005; Notarbartolo di Sciara, 2007a; b). An optimal protected area should encompass the year-round distribution of the cetacean population (Reeves, 2000), including all life-history stages (Hooker and Gerber, 2004). Thus, in order to achieve appropriate protection, MPAs must either be large and dynamic enough to encompass the entire migratory range, or be organised into a network of smaller MPAs that include habitats essential to different life-stages over the full migration area (Hyrenbach et al., 2000; Hinch and de Santo, 2010). The scaling up from small and isolated MPAs is therefore crucial for migratory species which tend to cross international boundaries and utilise large habitat-ranges.

The IUCN (2008:12) defines MPA networks[4] as: 'A collection of individual MPAs or reserves operating cooperatively and synergistically, at various spatial scales, and with a range of protection levels that are designed to meet objectives that a single reserve cannot achieve.' Representative and ecologically coherent MPA networks represent a novel tool within marine conservation (e.g. Kelleher and Kenchington, 1992; Agardy and Wilkinson, 2003; IUCN, 2008)[5]. The idea of 'scaling up' from small, isolated MPAs by establishing a network of representative MPAs was adopted by the IUCN in 1988 (Kelleher and Kenchington, 1992). In particular, the World Summit on Sustainable Development (WSSD) in Johannesburg, 2002, set the target to establish a global system of representative MPA networks by 2012 (UN, 2002)[6] (but see Veitch et al., 2012).

A variety of national, regional, and international targets have further been agreed upon to promote the establishment of representative and *ecologically connected* MPA networks (e.g. OSPAR, 2003; MSFD, 2008, COP10, 2010). For example, the Convention on Biological Diversity (10th Conference of the Parties, COP10, 2010) has set

[4] Numerous definitions of MPA networks exist, e.g. by Fisheries and Oceans Canada (2005), Ardon (2008) and Notarbartolo di Sciara (2004). A common and widely accepted definition would allow for more targeted objectives and management goals (ICMMPA, 2009).

[5] Networks of protected areas represent a widespread approach in connecting terrestrial areas (Bennett, 2003).

[6] The WSSD aim was subsequently adopted at the 7th Conference of the Convention on Biological Diversity (CBD) (2004, Kuala Lumpur).

the goal that: 'At least 17% of terrestrial and inland water, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscape and seascapes.'

Since large MPAs spanning international borders are too impractical for economic, monitoring, and enforcement reasons, an appropriately designed and managed network is arguably the more practical option for migratory whale conservation (Hinch and de Santo, 2010). Compared to single MPAs, MPA networks are considered to have numerous conservation advantages, for example by maintaining the natural range of species, taking into account migration corridors, and ensuring that MPAs chosen are ecologically and functionally linked (Roberts et al. 2003a; 2003b; Wells, 2006; Hinch and de Santo, 2010) (Table 2.2). By aiming to protect species throughout their range and to ensure connectivity via protected migration corridors, MPA networks have the potential to address shortcomings of current MPAs (see Agardy et al., 2010)[7], and thus contribute to wide-ranging whale conservation (ICMMPA, 2009).

Cetacean protection through such large-scale MPA networks adopts an ecosystem-based management approach to conservation. Ecosystem-based management has been defined by the Convention on Biological Diversity as 'a strategy for integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way' (Decision V/6). In ecosystem management the attention is placed on maintaining biodiversity and ecosystem processes, rather than individual species, and ensuring that all aspects of the ecosystem, including humans, are managed holistically (e.g. Cooney, 2004; UNESCO, 2009). This contrasts to the single-species approach where the focus is maintained on, particularly, endangered species (Simberloff, 1998).

[7] MPAs are suffering from numerous shortcomings, including management, enforcement, and political will. See Agardy et al. (2010) for a review of MPA shortcomings and how to address them.

Table 2.2. Criteria for individual MPAs and MPA networks as applicable to whale conservation. From Hinch and de Santo (2010). Italics added.

INDIVIDUAL MPAs
• Define boundaries based on species habitat lifecycle needs and the consideration of socio-economic and cultural factors • Manage on an ecosystem basis • Implement scientific research and monitoring programs consistent with protected area values • Protect critical whale habitats (e.g. areas for foraging, nursing, breeding, calving, socialising) • Protect habitats from human interactions (e.g. navigation, bycatch, intensive tourism, pollution run-off, marine dumping, outflows, military activities) • Ensure consistency with local, regional and international conservation strategies • Manage adaptively using a precautionary approach • Provide an effective surveillance and monitoring system • Provide educational and outreach opportunities
MPA NETWORK (all individual MPA criteria also apply to a network)
• Ensure chosen MPAs represent habitat and ecosystem types needed throughout lifecycle stages (e.g. areas foraging, nursing, breeding, calving, socialising; *migration routes and corridors*; areas important to prey; areas supporting natural processes to enhance prey productivity (e.g. fronts, upwellings, gyres); features that enhance whale foraging opportunities (e.g. seamounts, canyons) • Ensure that habitats are replicated within the networks to minimise loss risk • Maintain ecosystem resistance and resilience by protecting critical habitats from threats (e.g. activities, uses, stresses, and disturbances) that alter natural processes supporting whale lifecycle requirements • Protect vulnerable habitats (e.g. areas for foraging, nursing, breeding, calving, socialising; *migration routes and corridors*) • Provide long-term protection against threats • Maximise contribution of each individual MPA (appropriate size, shape, spacing to encompass critical habitat and ecosystem services required to support the whale population) • Ensure that MPAs chosen are *ecologically and functionally linked* to lifecycle patterns (i.e. establish and maintain connectivity, factor in adult movement patterns and range) • Participate in collaborative coordinated transboundary research and mitigation programs

Within the MPA network ecosystem-based approach cetaceans may act as focal species, a general term for species serving keystone, umbrella, indicator and/or flagship functions, and/or are sensitive and vulnerable to threats (Hooker and Gerber 2004; King and Beazley 2005) (Table 2.3). As such, they require protection, but can also further the conservation agenda of other species and ecosystems (Zacharias and Roff, 2001; Hooker and Gerber, 2004; King and Beazley, 2005). For example, a suite of focal species can be considered in marine protected area site selection and boundary delineation to provide a more holistic conservation approach (Lambeck, 1997; King and Beazley, 2005).

Table 2.3. Characteristics of different types of focal-species. From King and Beazley (2005).

FOCAL SPECIES TYPE	CHARACTERISTICS
Keystone	• Presence is critical to maintaining community organisation and diversity • Important predatory, prey, plant, link, or modifier
Umbrella	• Require large amounts of habitat or several specific habitat types • Established habitat association
Indicator	• Sensitive to human activities • Presence implies pristine or undisturbed habitat
Vulnerable and Sensitive	*Vulnerable:* • Nationally listed as endangered, threatened, or of special concern by COSEWIC • Globally listed as a species at risk by an international body, (e.g. IUCN) • Reduced or declining population size *Sensitive:* • Low genetic variation • Poor dispersal ability • Low fecundity • Dependent on patchy or unpredictable resources • Congregate in large groups • Long-distance migrations • Long-lived • Large-bodied
Flagship	• Charismatic species • Large vertebrate • Commercially or recreationally harvested species

Large-scale, ecosystem-based MPA network initiatives are likely to include critical habitats of cetaceans due to their threatened status and/or their focal species characteristics (see e.g. Morgan et al. 2005). These characteristics allow wide-ranging whales to be part of the selection process of potential ecosystem-focused MPA networks. However, few of these initiatives are comprehensive or regional enough to have a considerable impact on migratory whale protection (see Hinch and De Santo, 2010). To date, there are two regional network initiatives on a scale large enough to encompass migratory whale ranges: the Baja to Bering Sea (B2B) initiative[8] on the U.S. Pacific coast and the Specially Protected Areas of Mediterranean Importance (SPAMI) network in the Mediterranean Sea. This thesis focuses on the latter, and its potential contribution to protect seasonally migrating Mediterranean fin whales.

2.3.2.2. Connecting the Nodes

The rationale behind MPA networks is that the whole is greater than the sum of the parts. The whole is obtained through ecological connectivity between MPAs that have been strategically placed in specific locales to enhance wider ecosystem protection (IUCN, 2008; Agardy, 2010). A collection of MPAs is thus not the equivalent of an ecologically connected MPA network, and in order for a network to be biologically coherent, the 'nodes' of protected areas must be linked (IUCN, 2008). For the purpose of this thesis, 'nodes' are referred to as high use aggregation areas, such as feeding or breeding areas (see Figure 2.4 above), that tend to be the focus of protection efforts, and between which migration takes place.

Connectivity on a landscape scale is a key aspect of nature conservation in environments modified by human activities, and may be achieved by enhancing and facilitating the movement of animals through the landscape. One such example by which connectivity between protected areas is obtained is through migration corridors (Bennett, 2003). Establishment of migration corridors have numerous benefits, such as preventing habitat fragmentation, allowing for genetic exchange, and reducing the threat of demographic stochasticity to insular populations, as well as potential dangers, including spread of pathogens, toxic substances and invasive species (Simberloff and Cox, 1987).

The utility of corridors is a topic of ongoing debate among terrestrial ecologists and conservationists (see Bennett, 2003). Proponents of the corridor concept argue that biological corridors represent a strategy to retain the natural connectivity of ecosystems

[8] The B2B network initiative, ranging from Mexico to Alaska, has stalled for political reasons (Morgan, pers. comm.).

(e.g. Noss, 1987), and that 'a connected landscape is preferable to a fragmented landscape' (Beier and Noss 1998:1250). Critics maintain that little evidence exists for the utility of corridors in connecting habitats, and that they are not cost-effective compared to alternative ways of using conservation resources (Simberloff and Cox, 1987; Simberloff et al., 1992).

Whilst conservation corridors and connectivity are established concepts in terrestrial species conservation, these approaches have only recently been considered within the marine realm (Harris et al., 1996). Connectivity between MPAs stems from research on coral reef fish and larval dispersals in the 1990s (e.g. Doherty and Fowler, 1994), and was later expanded upon and developed by Roberts (1997). White et al. (2006) describe examples of marine connectivity as follows:

i. Connections of adjacent or continuous habitat (e.g. coral reeds ad seagrass beds)
ii. Connections through larval dispersal in the water column
iii. Settlement of larvae from one MPA to another that promotes population sustainability, and
iv. Adult movement of mature marine life in their home-range

In a similar vein, Palumbi (2003, cited in IUCN, 2008:52) defines marine connectivity as 'the extent to which populations in different parts of a species range are linked by the exchange of eggs, larvae recruits or other propagules, juveniles or adults'[9].

Even though maintaining an 'unfragmented' habitat is pivotal, efforts aimed at conserving dispersing species have often fallen short of addressing corridors and connectivity, both in the marine (ICMMPA, 2009) and terrestrial (e.g. Rabinowitz and Zeller, 2010) landscape. Given the wide-ranging nature of numerous cetacean species, migration routes are of great importance, and identifying and protecting corridors would ensure that linkages between nodes remain unbroken (ICMMPA, 2009).

Indeed, during the first international conference on marine mammal protected areas (ICMMPA) in Hawaii, 2009, it was established that unique protection of cetacean high use aggregation areas, is not enough, and that large-scale MPA networks (alone or

[9] Numerous definitions of connectivity exist. See e.g. NRC (2001) and Vasarhelyi and Thomas (2008).

in conjunction with other conservation tools) that connect the ‘nodes’ are crucial for addressing threats to migrating cetaceans. Hoyt (ICMMPA, 2009) outlined general advantages of MPA networks during the conference:

i. Compensating for the small size of most cetacean MPAs
ii. Protecting linkages between habitat types and therefore support species, populations and ecosystems
iii. Bringing together communities around a common interest in cetacean protection
iv. Drawing upon common legal frameworks for management, enforcement, research and monitoring
v. Helping to adapt to climate change
vi. Facilitating an ecosystem-based management approach

However, a number of challenges need to be addressed to ensure that the ecological advantages of representative and connected MPA networks can be achieved in practice. First, the concept of MPA networks to protect wide-ranging cetaceans and their migration corridors is still in its infancy (Hoyt, 2005; ICMMPA, 2009). As Hooker and Gerber (2004) point out, a rigorous theory is missing on how to select, design, and monitor MPA networks, and their efficacy in conserving cetaceans is not yet clear. To date, MPA networks have focused on fisheries management and larval dispersal (see e.g. IUCN, 2008), and whilst their effectiveness has been demonstrated in, for example, the Great Barrier Reef Marine Park (McCook et al. 2010), Jones and Carpenter (2009) challenge the idea that networks of MPAs are ecologically viable for larvae of rare species with low dispersal ranges. The issues surrounding the concept of connected MPA networks become even more challenging when considering complex marine mammals such as whales.

Second, despite the recognition of the importance of maintaining protection on a landscape scale, efforts have fallen short of addressing corridors and connectivity, which have been largely neglected in MPA network design (ICMMPA, 2009). Identification of migratory routes was highlighted during the ICMMPA conference as a key challenge to ensure networks are connected (ICMMPA, 2009). Specifically, identification and protection of corridors in the pelagic realm represents a 'daunting challenge' due to the dynamic and poorly understood nature of migratory routes (Hyrenbach et al., 2000). Nevertheless, even if migration routes were identified, a remaining question is the issue of ecological coherence, and whether MPA networks for cetaceans can be ecologically connected via migration routes.

Regional MPA networks, such as the SPAMI initiative under the Barcelona Convention (see Chapter 5, Section 5.5.2.), may be able to address such shortcomings. Indeed, in terms of migratory species conservation, Prideaux (2005) emphasises the importance of regional initiatives, which are often better able to tackle issues such as compliance, capacity building, and participation, as well as being tailored to local needs and political contexts. Notwithstanding, political will and cooperation is pivotal in order to follow through on regional commitments.

Third, policy provisions for connectivity are often lacking in legislative frameworks. As argued by Vasarhelyi and Thomas (2008), transition from ecological designs of MPA networks to their eventual implementation requires appropriate policy and law. In an analysis of international, Canadian, and U.S. marine conservation law, Vasarhelyi and Thomas (2008) conclude that little capacity exists in the legal framework, with the notable exception of Californian law, to create connectivity among core protected areas in the North East Pacific region.

Fourth, the issue of scientific uncertainty surrounding whale migration represents a critical challenge for MPA network design and implementation. Knowledge gaps are vast, both with regards to migration corridors and destinations, as well as threats encountered along the routes. Few attempts in the literature have been made to address this uncertainty within the context of MPA networks and how connectivity may be tackled in the face of such uncertainty. The concept of how to protect migration corridors through the MPA network approach, is thus a recent and, as yet, un-researched field.

2.3.3. Sectoral Regulations

For the purpose of this thesis I discuss sectoral regulations in terms of restrictions of activities by a single sector or industry. Such regulations may be place-based or wider-scale in nature. An illustration of a single sectoral, wider-scale measure is provided by the European Union (EU) ban on drift nets (Regulation 1239/98), which entered into effect in 2002 and extends to all EU waters except the Baltic Sea (Regulation 812/2004 extended the ban to the Baltic Sea). An example of place-based regulations includes the establishment of Particularly Sensitive Sea Areas (PSSA) by the International Maritime Organisation (IMO), a specialised United Nations agency established in 1948 and the widely recognised authority for international shipping. PSSAs are shipping industry specific regulations, and have *inter alia* been implemented in the Great Barrier Reef to protect against oil spills, and other forms of marine pollution (Maes, 2008). Other area-based protection tools available to the IMO include Traffic Separation Schemes (TSSs) and Areas to be Avoided (ATBA), both of which have been implemented in different parts of the world for the protection of large whales against collisions with ships (Silber et al., 2012).

Sectoral regulations can contribute to migratory whale protection by providing threat-based restrictions on a seascape level, that is; not restricted to the boundaries of MPAs. Agardy and Wilkinson (2003) discuss so called 'virtual corridors', which would protect routes used by migratory species through targeted policy reform designed to address specific threats to the species in question. Corridor protection is thus considered in terms of policy and management initiatives outside spatially designed MPAs (Agardy, 2010), and would ensure that connectivity is preserved and not degraded by direct or indirect anthropogenic impacts (Agardy and Wilkinson, 2003).

Such a place-based, sectoral-based conservation scheme has materialised for leatherback turtles during their migrations on the U.S. Pacific coast. When the density of turtles reaches a predetermined threshold along the migration corridor, fisheries are shut down to allow the animals to pass without being exposed to the risk of entanglement in fishing gear (Agardy, pers. comm. See also Shillinger et al., 2008). As will be described in Chapter 6, a similar sectoral or industry approach is further used to protect migratory North Atlantic right whales on the U.S. East coast. Area-based, sectoral regulations that specifically address the conservation of species during their migrations are rare, and the concept can be considered uncharted territory, in practice as well as in the literature. For the present PhD project I aim to examine this approach in terms of sectoral regulations pertaining to the shipping industry to determine its challenges and prospects in protecting migratory whales.

2.3.3.1. Marine Spatial Planning and Ocean Zoning

The treatment of sectoral regulations in this thesis differs from, but is related to, sectoral management approaches within Ocean Zoning and Marine Spatial Planning (MSP) contexts. MSP aims to holistically manage human uses of the ocean on a large, ecosystem scale by balancing sectoral interests (e.g. Ehler and Douvere, 2009). As a comprehensive spatial management plan it draws upon previous efforts, such as Integrated Coastal Management or Integrated Coastal Zone Management[10], and is defined as 'a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives that are usually specified through a political process'[11] (Ehler and Douvere, 2009:18).

As part of the MSP process, incompatible human uses are separated into different areas, within which activities may be restricted through place-based regulations. It is based on the premise that different areas have different values to conservation and human use, as well as different sensitivities to anthropogenic impacts by being differently resilient (Crowder and Norse, 2008). Cumulative and interacting threats to ecosystems and species are addressed by moving away from single-sector and single-species management to a holistic cross-sectoral, multiple-species approach (e.g. Halpern et al., 2008; Ehler and Douvere, 2009).

Whilst MSP is a planning process, ocean zoning[12] is the 'doing' (Agardy, 2010), or the 'regulatory tool for implementation of a plan' (Courtney and Wiggin, 2003:5). In its simplest form, ocean zoning comprises two parts; a map of the zones and a set of regulations pertaining to each zone created (Courtney and Wiggin, 2003). Agardy (2010) argues that MSP forms the framework, or 'enabling environment', that allows comprehensive ocean zoning to be pursued, and that MSP without this powerful tool is

[10] Some managers and researchers hold that MSP is simply a new label for principles of ocean governance that have been around for decades (Agardy, 2010).
[11] A commonly accepted definition of MSP has not been agreed upon (Maes, 2008).
[12] Zoning is a tool that was originally developed for land, mainly for cities and communities, to allow and restrict certain activities to specific places, as well as minimising conflicts between incompatible uses (*e.g.* Agardy, 2010).

an opportunity lost. Agardy (2010) further holds that implementation of comprehensive ocean zoning on the marine realm represents a 'paradigm shift' on how oceans are governed. She describes ocean zoning as a 'scaling up' from MPAs and MPA networks, which essentially represent '*de facto* precursors' of zones (Agardy, 2010). This 'quantum leap' to holistic ocean zoning (Agardy 2010), may help address the shortcomings MPAs[13] (Agardy et al., 2010).

According to this perspective, a ban on benthic trawling at depths below 1000 m in the Mediterranean in 2005 by the General Fisheries Commission for the Mediterranean (GFCM) (Recommendation GFCM/2005/3) can be considered a zone in future MSP endeavours. In a similar vein, Traffic Separation Schemes implemented through the IMO to decrease mortality events of large whales represent a form of zoning (Agardy, 2010). TSSs could further be viewed as, what Agardy and Wilkinson (2004) call, 'targeted policies', which spatially and temporally protect migration routes. However, this argument is based on a sector-by-sector basis of regulations: TSSs and other IMO-specific tools represent spatial managing systems that are operated by the IMO and probably always will be, regardless of the establishment of holistic MSP. Therefore, the argument can be reduced to a single sectoral approach (Jones, pers. comm.).

MSP is based on multi-sector management that entails compromises and cooperation between sectors. It represents evolving, new methodologies, but rigorous assessments and practical experience are lacking (Ehler, 2008; Agardy, 2010). Holistic MSP requires a cross-sectoral authority, which may not be advantageous for whales due to the many trade-offs that inevitably will occur, and because whale conservation may not be a high priority, particularly if uncertainty is high. In order for MSP to be an effective conservation tool for migratory cetaceans, a number of generic and specific challenges need to be addressed. For example, it is pivotal that an appropriate balance is reached between socio-economic and ecological goals so that conservation objectives are not diluted. Another critical challenge is the requirement of regional and/or international cooperation to ensure that the high seas are included in holistic MSP

[13] The authors discuss five main shortcomings of MPAs: 1) Mismatch of MPA scale to issue and context, 2) inappropriate planning or management processes, 3) Failure due to degradation of the unprotected surrounding ecosystem, 4) MPAs that cause damaging displacement and other unintended consequences, and 5) MPAs that create illusions of protection.

(Ardron et al., 2008). As Maes (2008) points out, MSP on the regional level is still 'embryonic'.

A legal authority to implement, monitor, and enforce statutory regulations pertaining to different zones is critical and to date mostly absent. A few examples exist where MSP/ocean zoning 'pioneers' have implemented zonated regulations under a common authority (Ehler, 2008), such as the Great Barrier Reef Marine Park of Australia, the North Sea of Belgium, and the sea areas of China (see Foley et al., 2010). Nevertheless, as Foley et al. (2010) argue, MSP efforts have yet to integrate all activities, and ecological goals are not fully included in planning processes.

Whilst a future MSP and/or ocean zoning endeavour may be relevant for migratory whale conservation, at present there are no such efforts that are being implemented on a scale which matches the distribution range of a migratory whale population. Since the current praxis for management of human activities is invariably done on a sector-by-sector basis, I focus the present analysis on single-sectoral regulations pertaining to the shipping industry rather than potential, future multi-sectoral MSP or ocean zoning projects. I centre the analysis on place-based single-sectoral regulations in order to facilitate comparisons with the MPA network approach.

Chapter Conclusion

In this chapter I have provided a background literature review pertaining to the PhD thesis topic, drawing on gaps in the literature and areas warranting further research. The aim has been to provide the reader with a rationale for the development of the research project.

Most baleen whale populations have been significantly reduced in the aftermath of commercial hunting. Today, the most pressing threat on small, endangered populations is collisions with large, fast-moving vessels. There is a need to broaden the conservation agenda to include migratory habitats, and confer protection to whales as they move between feeding and calving areas. However, the ability to do so is severely hampered by the many uncertainties surrounding whale migratory behaviour, and whether migratory routes are predictive enough to allow for place-based conservation measures.

It is argued that Marine Protected Areas are not sufficiently comprehensive to address all life-history stages of migratory marine mega-fauna, and the need to 'scale up' to MPA networks to adopt a more landscape-scale approach to conservation is pivotal given the wide-ranging, transboundary movements of most mysticete species. Whilst the MPA network approach appears theoretically appropriate, practical measures on how to ensure connectivity are not straightforward. Single sectoral regulations that provide a more threat-based focus represent an alternative or complementary strategy for the protection of whales during their seasonal movements. The applicability of these conservation strategies to allow for a more holistic conservation approach to migratory whales has not been properly examined in the literature.

Indeed, attempting to protect whales against threats faced during migrations is a daunting undertaking given the vast areas travelled, the cross-boundary routes taken which require legal and international coordination, and the considerable uncertainties surrounding the migratory behaviour of most whales. Nevertheless, such challenges should not be an excuse for avoiding this tricky research topic. The aim of the thesis is to contribute to the conservation literature by conducting a thorough investigation of the challenges and prospects of the two above-mentioned conservation strategies to protect whales during their seasonal migrations. In particular, I address the issue of uncertainty surrounding baleen whale migrations, and its consequences for proceeding with conservation decision-making. This focus is reflected in the theoretical framework chosen for the thesis, as discussed in the following chapter.

3

Theoretical Framework

Overview

In this chapter I explore theoretical frameworks for conceptualising and analysing scientific uncertainty. The aim is to provide an overview of the concept of scientific uncertainty in order to facilitate conservation research, communication, and decision-making. I discuss the inevitability of uncertainty in conservation and marine sciences, and the need to use a transdisciplinary approach to address these 'wicked problems'. I further explore different conceptual frameworks for the systematic treatment of scientific uncertainty in the science-policy interface, with the aim to identify the most appropriate framework for the purposes of this thesis. Finally I outline the policy view on scientific uncertainty and attempt to bridge theoretical frameworks with policy and management discourse.

The theoretical material provided in this chapter stems from the philosophy of science, policy decision-making, and biological conservation literature. The chosen framework is further refined in the methodology chapter and examined in subsequent chapters in the light of data obtained from the empirical work of this doctoral project.

3.1. The Inevitability of Scientific Uncertainty

3.1.1. Uncertainty and Conservation

Uncertainty is an inherent reality in environmental research, particularly affecting areas such as climate change (Morgan, 2003), natural resource management (Brugnach et al., 2008), and biodiversity conservation (Cooney, 2004). Proceeding in the face of scientific uncertainty is a major challenge for conservationists aiming to develop appropriate conservation strategies (Harwood, 2000). Ecosystems entail a myriad of species engaging in complex interactions with each other and abiotic factors (Cooney, 2004).

Ensuing uncertainties surrounding both species and their ecosystems make it challenging to provide reliable information for policy decision-makers, particularly with regards to complex environmental and biological systems (Cooney, 2004; Sigel et al., 2010).

Scientific uncertainties are rife in cetacean conservation, due to the limited understanding of cetacean ecology, population dynamics, effects of threats, and the fundamental challenges involved in studying marine mammal species and their ecosystems (e.g. Meffe et al., 1999; Whitehead et al., 2000). Compared to the terrestrial realm, the marine environment is a complex, three-dimensional open system with large spatial scales and less definable boundaries (Jones, 2001). Whitehead et al. (2000) discuss the role of science and how much it can contribute to the conservation and protection of cetaceans. They pose the rhetorical question: ‘what information is obtainable? How should we [the scientists] act, given what we do and do not know, and equally important, what we can and cannot know?’ (Whitehead et al., 2000:308). In a similar vein, Meffe et al. (1999:450) argue that ‘honest assessments of uncertainty’ in cetacean research are essential, and that uncertainties should be clearly communicated in order to avoid undermining the credibility and usefulness of science in the policy decision-making processes.

The contribution of science to policy-making is often limited by uncertainty relating to i) a lack of definite results, ii) limited consensus within the scientific community, and iii) a high degree of complexity and variability in the results (Bache, 2005). The science-policy interface is thus pivotal to take into account when developing conservation strategies. As Agardy et al. (2003:363) argue, ‘denying uncertainty is a huge risk we cannot afford to take’. Therefore, uncertainty must be addressed in order to enhance our understanding, treatment, and communication of it, with the aim to proceed with conservation decision-making in its inevitable presence. As Walker and Marchau (2003:2) express it: ‘Most uncertainties cannot be eliminated; they must be accepted, understood, and managed’.

3.1.2 Bringing Uncertainty in From the Cold

Because scientific uncertainty is so endemic, novel research paradigms have been developed which make uncertainty part of the very analytical core (e.g. Funtowicz and Ravetz, 1993, Brown et al., 2010). As Brugnach et al. (2008) point out, the study of uncertainty, and how to deal with it, has emerged as a topic in its own right. This emphasis on uncertainty can partly be traced to an attitudinal shift towards science, where the limitations of scientific knowledge are becoming more widely debated (Brown, 2004).

The two main research paradigms that explicitly deal with scientific uncertainty are transdisciplinary research and post-normal science. Transdisciplinary research approaches address contemporary, heterogeneous issues, or ‘wicked problems’, which tend to be highly resistant to resolution, fraught with uncertainty, and for which a ‘solution’ only generates more problems (Brown et al., 2010). Instead, the manner by which the scientists ask the research questions change and the science starts co-evolving with the problem. Transdisciplinary research requires transformative investigation, constructive problem-solving, and real-world engagement drawing on local and global expertise, as well as creativity and originality by the researcher, in order to address the uncertainties and complexities associated with ‘wicked problems’, which include global warming and biodiversity loss (Brown et al., 2010).

Transdisciplinary research is often associated with post-normal science (Brown et al., 2010), a term coined by Funtowicz and Ravetz (1993) to contrast it to ‘normal’ science in the Kuhnian sense. In post-normal science ‘new’ environmental problems are acknowledged as dynamic and complex, and have to cope with uncertainty, unpredictability, and value plurality (Funtowicz and Ravetz, 1993; 1994). This post-normal era promotes new, issue-driven methodologies for which ‘uncertainty is not banished but is managed’ (Funtowicz and Ravetz, 1993:740). As Funtowicz and Ravetz (1993:742) describe it, ‘uncertainty and quality are moving in from the periphery, one might say the shadows, of scientific methodology, to become the central, integrating concepts’.

Natural and sociological problems dealt with in conservation and marine biology tend to be wicked and post-normal. This doctoral research falls under the transdisciplinary and post-normal umbrella because I aim to investigate the complex issues surrounding migratory whale conservation, which are fraught with scientific uncertainty and socio-and geopolitical complexity. In order to provide a starting point to address the wicked issues inherent in this thesis topic, I have chosen conceptualisation and analysis of uncertainty as my theoretical framework. As a new and emerging topic there is still debate on how to provide a taxonomic and systematic treatment of scientific uncertainty in policy-decision making processes, and the literature is scarce. Here follows a review of available literature that addresses and conceptualises the multifaceted nature of uncertainty.

3.2. Theoretical Frameworks of Uncertainty Analysis

Scientifically based models tend to deal with uncertainty in terms of calculating probabilities. However, probabilistic approaches are unable to capture all aspects of uncertainty for policy decision-making (Brugnach et al., 2008). Indeed, whilst uncertainty is explicitly accounted for in conventional, experimental science, it has historically been ignored in policy analysis (Morgan and Henrion, 1990). In comparing the featuring of scientific uncertainty, Morgan and Henrion (1990) argue that in conventional science uncertainty is reported, whereas in policy analysis it is usually not reported.

The acknowledgement that uncertainty needs to be more explicitly included in the science-policy interface has led to the emergence of uncertainty, and how to address it, as a topic in its own right (Brugnach et al., 2008). A conceptual and more holistic understanding of uncertainty is a precondition for identifying appropriate strategies. To this end, uncertainty should be addressed in two ways (e.g. Walker et al., 2003; Brugnach et al., 2008, Sigel et al., 2010):

i. Characterise and systematise uncertainty, and
ii. Develop strategies to deal with uncertainty according to the analysis

For this PhD project, I address both of these action points for my overarching analysis of uncertainty in migratory whale conservation. Notwithstanding, a systematic, interdisciplinary approach to analyse uncertainty to facilitate policy decision-making processes is lacking (Walker et al., 2003; Kwakkel et al., 2010). I examine available methodologies for conceptualising uncertainty, with the aim to develop a theoretical framework to analyse the empirical data obtained through this doctoral research (see Chapter 4).

3.2.1. Uncertainty as a Matrix of Dimensions

In response to the lack of a unifying taxonomy, Walker et al. (2003) suggest a framework to provide a 'common vocabulary' for classifying and analysing uncertainty, by drawing on previous research of the scientific uncertainty—policy analysis interface (e.g. Funtowicz and Ravetz, 1990; Morgan and Henrion, 1990). In Walker et al.'s (2003) model, uncertainty is thought of as a multi-dimensional concept, appreciating that there are many different facets of uncertainty. The misunderstanding that uncertainty is a unified concept prevents a full grasp of its different characteristics and therefore strategies to address them.

As Walker et al. (2003) argue, uncertainty does not equate to a lack of knowledge, since uncertainty may prevail despite the presence of a wealth of information and more knowledge may yield more uncertainty. The authors thus define uncertainty as 'any deviation from the unachievable ideal of completely deterministic knowledge of the relevant system' (Walker et al., 2003:5). According to the proposed framework, uncertainty is further described as consisting of three dimensions; location, level, and nature (Figure 3.1).

The location refers to where the uncertainty manifests itself. It encompasses: a) the context, determined by the research questions, and where the uncertainty can be found within the boundaries of the research frame, b) the model, represented by a mathematical model or a methodological framework, and c) an external input, where neither the external force, nor the system's response to it, can be controlled. The level of uncertainty refers to where the uncertainty can be found along a spectrum of knowledge. As such, the level depicts a progressive transition which ranges from determinacy through a continuum of statistical probabilities (statistical uncertainty), a range of discrete probabilities (scenario uncertainty), recognised ignorance to indeterminacy and total ignorance.

The nature of uncertainty refers to whether the uncertainty is reducible or not, that is; whether the uncertainty is due to imperfect knowledge or inherent, unpredictable variability. Walker et al. (2003) divide the nature dimension into epistemic and ontological uncertainty, where the meanings of ontology—as a state of being—and epistemology—as a state of knowing—have their origins in the early Greek philosophy of Socrates, Plato, and Aristotle (Brown, 2004).

LOCATION		**LEVEL**			**NATURE**	
		Statistical uncertainty	Scenario uncertainty	Recognised ignorance	Epistemic uncertainty	Ontological uncertainty
Context	Natural, technological economic, social and political, representation					
Model	Model structure					
	Technical model					
Inputs	Driving forces					
	System data					

Figure 3.1. Uncertainty matrix framework. From Walker et al. (2003).

Walker et al. (2003) describe epistemic uncertainties as information gaps, or incomplete knowledge, regarding the system to be managed. The source of the uncertainty is thus due to a lack of investigation, missing, inadequate, or incomplete data, sampling error, measurement biases, or a lack of theoretical understanding. Uncertainty stemming from epistemology can in principle be ‘solved’ by more research and data gathering. A common misconception is that reducible knowledge gaps are the sole characteristic of uncertainty, and the only sources of uncertainty to address in conservation science.

Ontological uncertainty, by contrast, refers to the intrinsic variability, unpredictability and complexity of the studied system. Such systems are variable in space and time, are non-linear, and constantly adapting to new conditions. They are inherently dynamic, complex and stochastic, and predictions of outcomes are impossible or unreliable. Sources of ontological uncertainty include the inherent randomness of nature and natural processes such as weather, dynamic behaviour of species, and responses to changes by ecosystems. Other sources of ontological uncertainty are human behaviour, social, economic and cultural dynamics, and technological surprises (Walker et al., 2003).

Frequently, uncertainties in biology are of the ontological kind, and ecology and biodiversity is unlikely to become a predictive science despite a wealth of information. Conservation science tends to involve a complex interaction entailing dynamic ecosystems and human, social, economic, political and psychological factors, where policy decisions depend on the biological aspects of a species or system, as well as the human response (Cooney, 2004). Uncertainties with ontological sources are beyond control by virtue of the nature of the systems or phenomena, and as such cannot be addressed by additional investigation and data-gathering. They must be accepted as unpredictable and different strategies should be used to address them compared to epistemic uncertainties. Walker et al. (2003) recognise that the divides between the different uncertainty categories may be blurred, and in practice it may be difficult to distinguish them. Additional investigation of presumed epistemic uncertainties may unravel ontological qualities of the system, causing a shift in focus from incomplete knowledge to inherent variability.

In their proposed framework, Walker et al. (2003) subsequently connect these uncertainty dimensions into a comprehensive ‘uncertainty matrix’ (Figure 3.1). This matrix is a tool, or an inventory, by which to obtain a systematic and graphical overview of the uncertainties within a particular system of interest. Their proposition is that structuring uncertainty according to this model facilitates the identification of the most appropriate strategies to address specific uncertainties. This in turn allows for more targeted research, enhanced communication and trust between actors, and more cost-effective resource allocation, and ultimately better policies (Walker et al., 2003). Since Walker et al.’s (2003) proposition of a standard, systematic approach to address uncertainty, other methodological frameworks to suit different research domains—most derived from this original framework—have emerged (Kwakkel et al., 2010). In response to such diversity, Kwakkel et al. (2010) slightly revised the original model, outlined in Walker et al. (2003), and named it the W & H framework[14].

3.2.2. Uncertainty as Different Knowledge Frames

Alternative systematic treatments of uncertainty have addressed the fact that only the modeller's, not the decision makers' view or social processes, is reflected in Walker et al.'s (2003) framework. Decision-making in environmental contexts involve numerous actors with different research, social, economic, and cultural background as well as personal beliefs, experiences and expectations (Dewulf et al., 2005; Brugnach et al., 2008). Uncertainties can therefore arise when different stakeholders or researchers from different disciplines have disparate but equally plausible conceptions of the outside world; that is, they differ in their perception of the same data, what the boundaries and core elements of an issue are, what is uncertain, and what appropriate decisions should be (Dewulf et al., 2005).

On this basis, Dewulf et al. (2005:116) introduce the concept of ambiguity, which the authors define as 'the simultaneous presence of multiple frames of reference to understand a certain phenomenon'. Ambiguity thus refers to uncertainties that stem from conflicting perceptions by different stakeholders and can range from unanimous clarity to total confusion (Dewulf et al., 2005). In this conceptual model, the human interpretation is part of the uncertainty. Uncertainty is thus not only an objective property of a system, but also subjective, or as Weick (1995, cited in Dewulf et al., 2005:115) expresses it: 'the problem [of uncertainty] is that there are too many meanings, not too few. The problem is confusion, not ignorance'. Policy analyses should therefore consider ambiguity as an important aspect of uncertainty (Dewulf et al., 2005; Brugnach et al., 2008).

Expanding on this conceptualisation, Brugnach et al. (2008:33) define uncertainty as: '…the situation in which there is not a unique and complete understanding of the system to be managed'. The ambiguity is the result of multiple and incompatible knowledge frames, which express the specific understanding an actor has

[14] Kwakkel et al. (2010) reviewed the literature to ascertain where research models have mostly deviated from the originally proposed W & H framework *sensu* Walker et al. (2003). Accordingly, they amended the framework on two points: to include ambiguity as a third dimension to the nature of uncertainty, and to expand and rephrase the levels of uncertainty.

on the given problem or data to be dealt with. Brugnach et al. (2008) refer to this situation as 'knowing too differently', and gives the example of water shortage, which can be framed as a problem of 'excessive water consumption' by the conservationist, and 'insufficient water supply' by the farmer. Strategies that address ambiguity must therefore entail conflicting resolving approaches, communication, and dialogue learning, which offer the opportunity for a more unified framing of the issue at hand (Brugnach et al., 2008; 2011). The authors further integrate their model with Walker et al.'s (2003) framework, by proposing ambiguity as a third nature of uncertainty, alongside epistemic and ontological uncertainty. This proposition was subsequently adopted by the W & H framework (Kwakkel et al., 2010).

3.2.3. Uncertainty as Confidence of Knowledge

Brown (2004) presents a theoretical framework of scientific uncertainty based on the importance of questioning belief. In his conceptual basis, uncertainty is defined as an expression of confidence (or a lack thereof). Similarly to Dewulf et al. (2005) and Brugnach et al. (2008), Brown (2004) describes uncertainty not only as a product of 'what we think about'—which is based on logical reasoning or epistemology—but also the subjective aspect of 'how we think' and 'what we know and understand'. With regards to the latter, scientific uncertainty arises from individual interpretations of the world.

Since our knowledge of environmental systems tends to be incomplete, Brown (2004) proposes a 'taxonomy of imperfect knowledge' to analyse uncertainty. His conceptual framework distinguishes between ignorance as a lack of awareness about imperfect knowledge, and uncertainty as a state of confidence about knowledge. The spectrum of confidence, which reflects a state of awareness, ranges from certainty, to 'bounded uncertainty' (all possible outcomes are known), 'unbounded uncertainty' (some or all possible outcomes are *un*known), and indeterminacy (possible outcomes unknowable) (Figure 3.2).

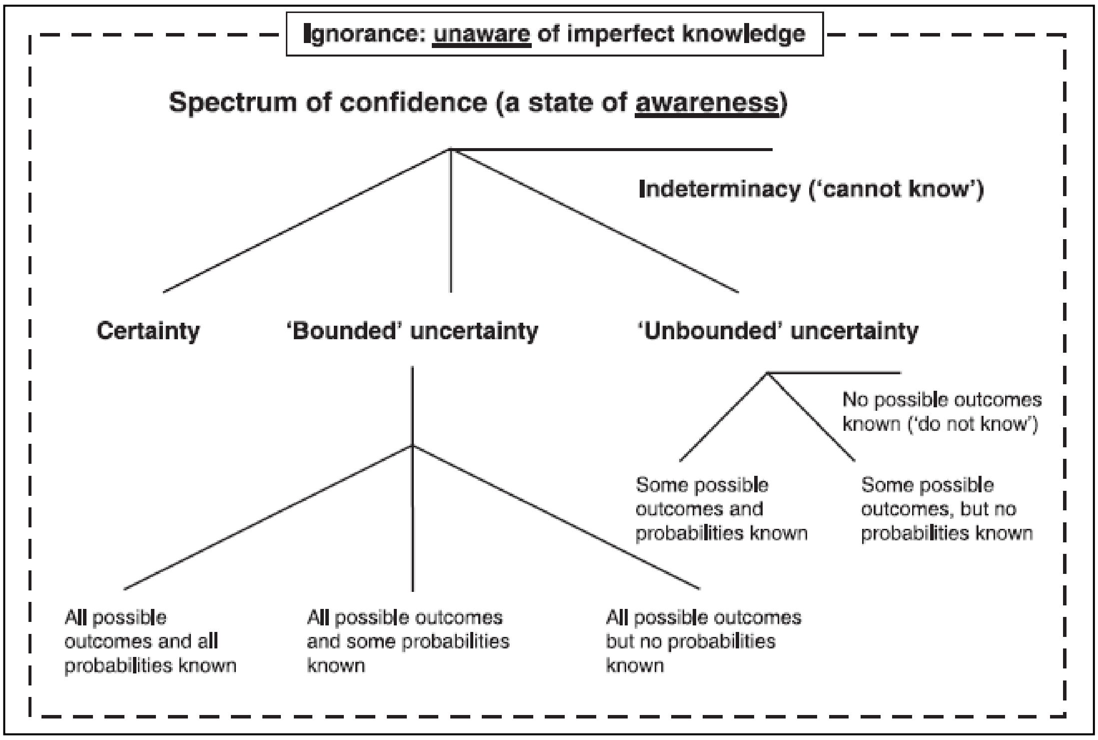

Figure 3.2. Imperfect knowledge framework. From Brown (2004).

Within the context of resources management, Refsgaard et al. (2007) combine the taxonomy of 'imperfect knowledge' proposed by Brown (2004) with the W & H framework. The authors adopt a subjective interpretation of uncertainty, whereby the focus is on the degree to which a decision maker is confident about possible outcomes and/or probabilities of these outcomes. In other words '...a person is uncertain if s/he lacks confidence about the specific outcomes of an event. Reasons for this lack of confidence might include a judgement of the information as incomplete, blurred, inaccurate, unreliable, inconclusive, or potentially false' (Refsgaard et al., 2007:1546).

In a similar vein Sigel et al. (2010:9) describe uncertainty as '...a state characterised by the reflection and confidence of a person in relation to his knowledge', where uncertainty is both subjective and objective. They argue that describing uncertainty in terms of confidence of knowledge is important as it enables decision-makers to assess the trustworthiness and reliability of the knowledge base (Sigel et al., 2010).

3.2.4. Uncertainty as a Language

Regan et al. (2002) introduce another aspect of uncertainty, termed linguistic uncertainty, which relates to the use of natural and scientific language. In their model, uncertainty is classified into two main categories, namely epistemic and linguistic uncertainty, within the context of ecology and conservation biology. In contrast to Walker et al. (2003), Regan et al. (2002) include inherent variability and unpredictability (ontological uncertainty *sensu* Walker et al., 2003) in the epistemic category alongside insufficient data and sampling limitations. Within the epistemic umbrella the authors further include 'subjective judgment', which they describe as uncertainty resulting from variable interpretation of data amongst experts, especially in circumstances when empirical data is scarce or error prone. This term is thus highly reminiscent of ambiguity *sensu* Dewulf et al. (2005) and Brugnach et al. (2008).

Linguistic uncertainty arises because our language and scientific vocabulary is vague and ambiguous (Murphy and Noon, 1991; Regan et al., 2002; Regan et al., 2005). In Regan et al.'s (2002) framework linguistic uncertainty is classified into five types; vagueness, context dependence, ambiguity (not in the sense of different knowledge frames *sensu* Brugnach et al., 2008), indeterminacy of theoretical terms, and underspecificity. Of these, vagueness is the most important type of linguistic uncertainty in practical conservation biology, and arises because the scientific vocabulary permits so called borderline cases.

The authors use the 'vague' expression 'endangered species' to provide an example of how linguistic uncertainty may arise. In reality, some species may be borderline cases since they are neither endangered nor not endangered, and consequently it is not possible to determine how many endangered species there are. Adding to this is the numerous definitions in different legal frameworks of the term 'endangered'. Regan et al. (2002) discuss the definition provided by the IUCN, where a 'critically endangered' species has fewer than 50 mature individuals. By incorporating the word 'critically', the IUCN is thus substituting a vague term with a sharp demarcation. However, the issue here is that a taxon with 50 individuals is critically endangered, but a taxon with 51 individuals is not.

Since vagueness is too permeated into our language its elimination is unlikely. Vague terms tend to be non-numerical in character, and therefore cannot be standardised or measured (Regan et al., 2002). As Regan et al. (2002) point out, most pivotal words in conservation biology, such as 'threatened', 'optimal habitat', and 'viable population' are vague by nature. To circumvent the inherent linguistic uncertainties in conservation, the authors suggest using constructions of multidimensional measures of, *inter alia*, population size, growth/decline rates, and extent of habitat decline.

Taken together, these reviewed conceptual frameworks of the systematic treatment of uncertainty open up a new dimension for addressing scientific uncertainty in conservation decision-making. For the purposes of this thesis I have chosen to adopt the W & H framework, and specifically analyse the three natures of uncertainty—epistemic, ontological and ambiguity—in the light of data obtained from the empirical work. In the methodology chapter I will in more detail outline how I aim to apply this theoretical framework in the analytical processes.

3.3. Policy View on Scientific Uncertainty

To bridge theoretical concepts of uncertainty to policy and management discourse I use the epistemic and ontological dichotomy to discuss two main policy and management tools that explicitly address uncertainty: the Precautionary Principle and Adaptive Management.

3.3.1. The Precautionary Principle and Epistemic Uncertainty

Eventual acceptance of the fundamental prevalence of uncertainty in natural systems led to the establishment of a policy framework that forces explicit attention on uncertainty in environmental decision-making. The precautionary principle—in essence 'a policy approach to scientific uncertainty' (Cooney, 2004:9)—was defined in Principle 15 of the 1992 Rio Declaration on Environment and Development (1992) as follows:

> 'In order to protect the environment the Precautionary Approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall

not be used as a reason for postponing cost-effective measures to prevent environmental degradation'.

The core characteristic of the precautionary principle/approach[15] is to 'shift the burden of proof' (e.g. Sands, 2003; Cooney, 2004). In contrast to the previous 'default state', which presumed that activities can proceed until clear evidence shows that they are damaging, the precautionary principle states—in theory—that proponents of potentially harmful activities are required to demonstrate that such activities are safe. Moreover, the precautionary principle shifts the decision-making process to a more inclusive and participatory form of governance, where decisions are increasingly influenced by local knowledge, stakeholder values, and political judgements (O'Riordan and Cameron, 1994; O'Riordan et al., 2001).

Despite its value in providing guidance for responding to scientific uncertainty, the precautionary principle remains a conscientious concept, and is interpreted and defined differently by different policy sectors and governments. The Rio definition of the precautionary principle is, for instance, inherently ambiguous, leaving terms such as '…applied by States according to their capabilities','…lack of full scientific certainty', and '…cost-effective measures to prevent environmental degradation' open for interpretation (Cooney, 2004).

The effectiveness of the precautionary principle can be discussed in terms of two aspects: its acceptance in policies and agreements on national, regional and international levels, and the translation of such acceptance into practical implementation. In terms of the former, the precautionary principle has not been consistently accepted as a governance or management tool for biodiversity conservation (Cooney, 2004), nor has it emerged as a general principle of environmental international law (Sands, 2003). Notwithstanding, a number of marine mammal related agreements have explicitly incorporated the precautionary approach, including Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) (Article II.4, reinforced in Resolution 1.12) (McCarthy, 2007). ACCOBAMS, which was concluded under the Convention on Migratory Species (CMS), has thus

[15] The terms precautionary principle and precautionary approach are used interchangeably in the Rio (1992) definition. Whilst some differences exist in the use of these two terms in fishery management, many authors now use the precautionary principle and approach interchangeably (Vanderzwaag, 2002; Cooney, 2004).

incorporated the precautionary principle, even though the principle does not explicitly feature in the original CMS treaty, since the CMS was established before the Rio convention. Similarly, whilst many regional conservation agreements were negotiated prior to the emergence of the precautionary principle, some have included the principle at a later stage, including the Barcelona Convention (Article 4) (Cooney, 2004).

In the European Union (EU), the precautionary principle has been widely accepted, and the need to incorporate scientific uncertainty has filtered down into the highest environmental policy levels (Cooney, 2004). In the 1991 Maastricht Treaty (Article 130), the European Union incorporated the Precautionary Principle as a legal obligation and required objective for environmental policy (De Santo and Jones, 2007). More recently, the EU Water Framework Directive provides an example whereby scientific uncertainty has to be addressed for the development of integrated water management plans (Brown, 2004).

However, acceptance of the principle and its incorporation into policy texts does not necessarily equate to its practical implementation and operational effectiveness. Cooney (2004) argue that 'the precautionary principle will often have little systematic impact on practice unless formulated as an obligation, and linked to specified process or outcome standards developed on a sectoral basis, with respect to, for instance, specific species, fisheries, or protected areas'. Such formulations are rarely specified, and systematic implementation of the precautionary principle has not reached beyond its infancy.

Broad management and policy approaches to implement the precautionary approach in biodiversity conservation contexts include ecosystem-based management, adaptive management, and environmental impact and risk assessment (Cooney, 2004). However, determining which specific approaches are precautionary remains a challenge, and as Cooney (2004) argues: '…while each [tool as described above] can be implemented in a precautionary fashion, they do not necessarily translate to precautionary management'. Whilst the precautionary principle charts a valuable course for governance in the face of uncertainty, at large, implementation of precautionary decisions are highly dependent on political will, and trade-offs are inevitable. Furthermore, precaution on the international level is challenged by state sovereignty issues, as well as the lack of an empowered global governance structure (Vanderzwaag, 2002).

A question remains though; is the precautionary principle designed to address all aspects of uncertainty? Indeed, definitions and discussions of the precautionary approach use a terminology that suggests that the uncertainty it aims to address is primarily epistemic in nature. Whilst the principle was intended by environmentalists to deal with intrinsic variability in environmental systems, a gap between theory, or intentions, and reality has emerged. As policy processes move from proposals to regulations and decisions, the precautionary principle tends to evaporate (Appleby and Jones, 2012). However, it can be argued that this dilution has occurred on two levels: from intention to definition, as well as from definition to implementation.

The manner in which the original Rio (1992) definition is worded—*'…lack of full scientific certainty* shall not be used as a reason for postponing…'—suggests that the first level of dilution already occurred when the principle was first coined. Cooney (2005) in her book on the precautionary principle further states that the principle 'counters the presumption that activities should proceed until and unless there is *clear evidence* that they are harmful' [italics added]. These statements imply that the knowledge is reducible, and given sufficient time and research effort, the evidence for harmful effects can be ascertained. The precautionary principle as it is phrased in policy texts thus acknowledges that sufficient data is not yet available to prove that activities are harmful, but implicitly demand that the knowledge gaps can be filled.

The application of the precautionary principle to address epistemic uncertainty is illustrated by the World Trade Organisation (WTO) Beef Hormone Case between the EU and the USA (WTO, 1998). Since the health effects of hormone-treated beef were uncertain, the EU invoked the precautionary principle as a basis for restrictions on imports from the U.S. Whilst the knowledge gaps surrounding the effects of hormones on the human body and the environment were not fully elucidated, the scientific uncertainty *per se* is reducible: even though hormone effects on the body are dynamic and complex, there will be measurable effects given the appropriate scientific inquiry, and these effects may be either harmful or not harmful.

By contrast, the precautionary principle is arguably less viable in cases where threats affect ecosystems and species which are intrinsically dynamic and stochastic, as exemplified by the migratory behaviour of numerous whale species. As De Santo (2007:127) points out: 'applying a precautionary approach to the marine environment is inherently difficult due to the physically complex and highly adaptive nature of the marine environment itself'. Invoking the precautionary principle in the face of ontological uncertainty is thus likely to be highly politically and managerially challenging, particularly since the precautionary approach is heavily dependent on political values and priorities.

3.3.2. Adaptive Management and Ontological Uncertainty

Whilst the precautionary principle may not embody a reliable policy tool to address ontological uncertainty, adaptive management represents an approach that 'expressly tackles the uncertainty and dynamism of complex systems' (Cooney, 2004). The relationship between the adaptive management approach and the precautionary principle is not obvious, and different policy sectors have different views on their inter-relatedness. For example, in wildlife conservation adaptive management is typically regarded as an alternative approach, whereas in fisheries management, it tends to be viewed as consistent with, and contributing to, the precautionary principle (Ward et al., 2003; Cooney, 2004). Adaptive management may thus represent a tool by which the precautionary approach can be implemented, however, both strategies can be independently used and for different conservation purposes.

The emergence of adaptive management represents an attitudinal shift to recognise the endemic presence of uncertainty in natural systems (Brugnach et al., 2008). Adaptive management emerged as a concept in the late 1960s (see Walters, 1986), and can be defined as the 'process of testing alternative hypotheses through management action, learning from experience, and making appropriate change to policy and management practice' (NWOS, 2001).

The adaptive management approach essentially embodies the process of 'learning by doing' (Cooney, 2004). It is thus a dynamic and experimental strategy that continually assesses and refines management action as information increases, by incorporating research into the actual management process (Salafsky et al., 2001; Oglethorpe, 2002). Walter (1986) describes it as follows: 'Treat management as an adaptive learning process, where management activities themselves are viewed as the primary tools for experimentation'. Whilst adaptive management is an on-going process of developing improved management practices in the face of continuous change and uncertainty, there may be institutional resistance to the time-frames and costs associated with learning through the experimental approach. Nevertheless, adaptive management is increasingly used in biological conservation contexts and is often embedded in overarching ecosystem-based approaches (Cooney, 2004).

The applicability of the adaptive management approach to biological conservation is based on its acknowledgement of endemic unpredictability. It can further be described as acknowledging the need for measures to be implemented without unnecessary delay caused by attempts to reduce irreducible knowledge gaps. As Brown (2004) argues, acknowledging indeterminism and unpredictability is important in managing uncertainty, because it leads to a greater emphasis on adaptive management and contingency planning rather than on improving the level of scientific certainty. As such, adaptive management is a valuable tool for the conservation and management of dynamic and inherently stochastic species and ecosystems where ontological uncertainty is rife.

Chapter Conclusion

In this chapter I have discussed the value of examining the concept of scientific uncertainty for biological conservation in general, and cetacean and marine conservation, in particular. A more holistic understanding of the multifaceted nature of uncertainty is pivotal, since it facilitates the design of more appropriate conservation strategies. Due to the persistent prevalence of scientific uncertainty in whale conservation, it is important to incorporate uncertainty analysis into the actual methodology and address different aspects of its multi-faceted nature. I have chosen to adopt a transdisciplinary and post-normal science approach to this end. Indeed, the choice of a different theoretical framework may have neglected to fully address the 'wicked problems' associated with dynamic and transboundary migrating whales.

As a novel theoretical approach, there have been various attempts to systematise and conceptualise scientific uncertainty in the literature. However, one common denominator unites the different frameworks reviewed above: there is more to the concept of uncertainty than meets the eye, and in order to deal with uncertainty in policy decision-making a better understanding is required and different strategies are necessary to address its different natures. Whilst such strategies are likely to be enhanced by an increased understanding of the multifaceted nature of uncertainty by researchers and policy-makers, it is questionable whether the policy arena takes this into account. The precautionary principle arguably demands that the sources of uncertainty are epistemic in nature. Consequently, this questions the value of the principle in addressing many conservation issues in the marine realm, where uncertainties tend to be ontological in nature. Adaptive and dynamic management approaches may be better able to address inherent unpredictability, and may or may not, be integrated into an overarching precautionary approach.

In the next chapter I outline the methodologies used for this PhD project, and describe in more depth the theoretical framework I chose in order to analyse uncertainty within the context of the empirical data.

4

Methodology

Overview

In the present chapter I describe the methodology adopted for this doctoral thesis. I provide an overview of its transdisciplinary rationale and three-tiered approach, which combines literature analysis with semi-structured interviews and participant observation at relevant conferences and in the field. I further outline the rationale for the adopted uncertainty analysis and matrix, and the methods used for the data analysis.

4.1. Research Background and Rationale

4.1.1. Research Approach

Since interdisciplinary research is considered essential for conservation science problem solving (Stem et al., 2005) and conservation success (Campbell, 2005), and since my research background involves both the natural and social sciences, I first decided to adopt an interdisciplinary approach for the methodology and theoretical framework. However, since the overarching thesis topic cannot be contained within traditional disciplinary boundaries and deals with 'wicked problems' (Brown et al., 2010), this doctoral project primarily has a transdisciplinary and post-normal science approach. In particular, due to the inherent uncertainties entailed in this research topic, I believe it inevitable to analyse uncertainty systematically using an overarching theoretical framework. In a more interdisciplinary context, uncertainty would be discussed rather than analysed as a cross-cutting subject area in its own right.

For this doctoral research I thus adopt a probabilistic approach by acknowledging that our understanding of complex biological systems and species cannot be reduced to deterministic models. Acknowledging indeterminism is important in managing uncertainty (Brown, 2004). My research attitude is in line with Kerwin's (1993) 'ignorance paradigm'[16], which fosters a questioning approach to knowledge and where the inquirer becomes a 'distinguished ignorami', or an expert who talks about what he/she does not know. As Kerwin (1993:164) puts it, '...it requires knowledge, sometimes a great deal, to be aware of our ignorance'.

4.1.2. Schedule of PhD

I conducted this PhD project within the Department of Geography from January 2010 to March 2013 (Table 4.1). The research methods I chose aim to reflect the transdisciplinary, post-normal science, and probabilistic nature of the issues explored in the thesis. The cross-cutting theme of the methodology consists of a systematic analysis of prevailing and perceived uncertainties using an uncertainty matrix framework.

Table 4.1. PhD schedule from January 2010 to January 2013.

DATE	RESEARCH ACTIVITIES
Year I (2010-2011)	• Analysis of the literature, establishing research context • Framing of methodology and research approach • Preparation of Upgrade Report
Year II (2011-2012)	• Upgrade to PhD candidacy • Participant observation at conferences and workshops • Interviews and transcription Case Study 1 • Research assistant field work with Tethys Research Institute, Pelagos Sanctuary, Italy • Preliminary analysis of data • Interviews and transcription Case Study 2 • Presented at the 2nd International Conference on Marine Mammal Protection Areas (ICMMPA II), Martinique
Year III (2012-2013)	• Final interviews, transcription and analysis of data • Publication of article in *Biological Conservation* • Lecturing at Stockholm University (Master and Bachelor Level) • Write-up of thesis (viva copy submitted January, 2013) • Two articles in preparation • Viva (March, 2013) and final thesis submission (April, 2013)

[16] The ignorance paradigm, initially developed to examine the concept of medical ignorance, states that, as our sphere of knowledge increases, so does its contact with the unknown, which is termed the zone of ignorance (Kerwin, 1993).

The methods entail a detailed literature analysis of published and non-published papers, empirical data gathering using semi-structured interviews within two case study contexts, and participant observation at relevant workshops/conferences, as well as a research assistant in the field. A schedule of time allocated to these different aspects of my research is outlined in Table 4.1.

4.1.3. Triangulation

The multiple data sources obtained from empirical investigations (interviews, participant observation), literature analysis of published articles (peer-reviewed papers in academic journals), and analysis of grey literature (e.g. institutional reports, conference papers) was validated through the triangulation method[17], with an uncertainty analysis as a cross-cutting and prevailing theme. Method triangulation dictates that information is derived from at least two different methods. In this way, researchers may improve the validity of their results by collecting different data that bear on the same phenomenon, which allows the flaws and strengths of different methods to be merged (Denzin, 1978). Triangulation may further promote creative creations of inventive methods or combination of different methodological frameworks (Jick, 1983).

As discussed by Mathison (1988), triangulation has two assumptions; i) inherent method bias is cancelled out through the use of multiple methods, and ii) various data sources and methods lead to convergent results. The author further argues that the outcomes of triangulation may be convergence, inconsistency, or contradiction. The strength of the triangulation technique thus lies in its generation of '...more and better evidence from which researchers can construct meaningful propositions about the social world' (Mathison, 1988:15).

4.1.4. Case Study Selection

I chose to use a case study approach, since it allows issues to be explored in depth, and for unique and detailed qualitative information to be derived. By providing a holistic, rather than an isolated view, encouraging the use of multiple methods, exploring

[17] Triangulation is defined by Denzin (1978:291) as 'the combination of methodologies in the study of the same phenomenon'. In addition to method triangulation, Denzin (1978) discusses source, investigator, and theoretical triangulation.

situations as they naturally occur, and allowing the researcher to 'deal with subtleties and intricacies' of complex issues, the case study approach represents an advantageous method in qualitative research (Denscombe, 2007:45), and suits the purposes of this doctoral research.

Denscombe (2007) argues how discovery of information through case studies can be led by one, or a combination of, the following categories: description (describes events, processes, and relationships in case study settings), exploration (explores key issues, such as problems and opportunities), and comparison (compares settings to learn from the similarities and differences between the case studies). Whilst the exploration category will be most pronounced in this thesis, I also aim to describe and compare the case studies where relevant.

Whilst there are no universal methodological principles by which to select a case (Flyvbjerg, 2004), case studies should be chosen based on key features and their relevance to the issues researched (Denscombe, 2007). The selection of a case study can, for example, be justified on the basis that it is typical (Flyvbjerg, 2004:396), that it represent an extreme case, a test-site for theory, and/or least likely instance (Denscombe, 2007).

The main source of criticism levelled at the case study approach is related to the credibility of generalisations that are made from the data (Denscombe, 2007). Denscombe (2007) advises the researcher to i) identify key features on which comparisons can be made, ii) demonstrate how the case study compares with others in terms of these significant features. However, within this framework it is important to recognise that 'context matters' when exploring related issues in different case studies (Edwards and Steins (1999): cited in Jones and Burgess, 2005:15).

I selected the case studies described in this thesis because of their high relevance to the research topic, and because they represent the few examples world-wide that are addressing the conservation of migratory whales throughout their habitat-range. I further selected these cases since they are on the two ends of a spectrum, both in terms of the species migratory behaviour as well as the conservation approaches adopted in the region. Comparisons and contrasts of these regional approaches will thus be valuable in addressing the research questions of this doctoral project.

I adopted an asymmetric approach during the research phase of these two case studies. Approximately double the research time and effort was devoted to the fin whale seasonal movements and the SPAMI network of the Mediterranean Sea (Case Study 1) compared to the North Atlantic right whales on the U.S. East coast (Case Study 2). For the Mediterranean case study I conducted more in depth empirical work by spending four weeks on a research boat as a field work research assistant, by conducting more interviews and through a more extended literature analysis. The reason for using this case study as the main focus relates to practical considerations, including geographical proximity to the Mediterranean as well as an established research basis in this region. Such practical factors have a bearing on case study selection in the real world of research (Denscombe, 2007).

4.2. Research Methodology

4.2.1. Literature Review

For the literature analysis I examined texts on whale migration, the topic of migration *per se*, critical habitat protection for cetaceans, cetacean population trends and threats, and the legal and policy frameworks in place to protect them. I further conducted a thorough review of generic literature on MPAs/ MPA networks, Marine Spatial Planning and Ocean Zoning, the shipping industry and its regulations, as well as geopolitical and policy contexts of the Mediterranean Sea and the U.S. This plunge into a sea of literature allowed me to find research gaps that I believe need to be bridged, and helped frame my research aims and questions, as well as identify appropriate interviewees.

I framed the research questions using a technique provided in a course termed 'Creativity and Craft for your PhD', held by John Hands at the University College London, and subsequently 'validated' them by adopting a method described by the UCL online social science methodology course[18]. The aim is for these research questions to meet the two criteria discussed by King et al. (1994:15): 1) the question should be 'important' in the real world, and 2) it should make a contribution to an existing scientific literature. I further attempted to remain grounded in marine conservation 'reality' during the

[18] Research Methods in the Sciences - Moodle Research Skills Module

elaboration of the research questions. Throughout this thesis my aim is to find a balance between building from reality upwards and from hypothetical frameworks downwards.

4.2.2. Semi-structured Interviews

For qualitative researchers, interviews constitute a core method of data collection (Silverman, 2006). Since qualitative interviews allow for the attitudes, interpretation of events, and experiences and feelings of the interviewee to be accessed (Bryman, 2004; Denscombe, 2007), interviews represent an appropriate data-gathering method for this thesis. The style of interview may vary on a continuum from structured to open-ended (unstructured) interviews (Noaks and Wincup, 2004). For all styles, the interview is collaboratively produced, whereby the interviewer and interviewee both keep active roles. Qualitative interviewers do neither seek to monopolise the conversation, nor do they remain passive. Therefore, interviews can never be equated to a simple 'conversation' (Rapley, 2004:26). However, as emphasised by Rapley (2004:26), they '...may be conversation*al*, but you as the interviewer do have some level of control. You routinely decide which bit of talk to follow-up, you routinely decide when to open and close various topics and the interaction as a whole'.

Depending on the type of interview chosen, the interviewer remains more or less active during the course of the interview. Rapley (2004) and Silverman (2006) argue that no particular type of interview can be considered as 'best' or as producing 'better data' than the other. However, semi-structured interviews—which fall on the middle point in the continuum of structured to open-ended interviews—represent the most appropriate form of interview style for this doctoral research. Since semi-structured interviews take a fluid form, and tend to vary according to the opinions, expertise, and interests of the interviewee, they serve the purpose well of exploring different perspectives among key actors. Moreover, the conversational nature of semi-structured interviews gives the interviewees an opportunity to 'speak their mind', allowing unanticipated themes to emerge (Denscombe, 2007:176). Whilst the interviewer has a prepared list of questions, or specific topics—known as the 'interview guide'—questions do not have to follow a precise order and different interviewees may be asked slightly different questions, depending on their expertise (Bryman, 2001). Denscombe (2007:176) describe semi-structured interviews as follows:

> ‘With semi-structured interviews, the interviewer still has a clear list of issues to be addressed and questions to be answered. However, with the semi-structured interview the interviewer is prepared to be flexible in terms of the order in which the topics are considered, and, perhaps more significantly, to let the interviewee develop ideas and speak more widely on the issues raised by the researcher. The answers are open-ended, and there is more emphasis on the interviewee elaborating points of interest.’

Sample size, or number of interviewees, is determined by the existence of relevant actors with the aim to obtain perspectives from different respondents (King et al., 1994; Baxter and Eyles, 1997) within the epistemic, stakeholder, and policy sectors. Recruitment of interviewees thus occurs until ‘thematic saturation’ is reached, that is, until no more informative themes emerge (Baxter and Eyles, 1997:513). I adopted the qualitative sampling strategies termed ‘purposive’ and ‘snowball’ sampling (Denscombe, 2007). In purposive sampling—the strategy used most often in qualitative research (Baxter and Eyles, 1997)—interviewees are hand-picked by the researcher. The sampling is thus conducted with a particular purpose in mind, whereby the interviewees selected are considered to be relevant and illuminating for the research (Denscombe, 2007). Denscombe (2007:17) advises the researcher to ask him-or-herself the following question: ‘given what I already know about the research topic and about the range of people or events being studies, who or what is likely to provide the best information?’

With snowball sampling, new respondents are identified by means of reference from other interviewees, and the effect is useful for accumulating a larger sample size and for identifying credible interviewees (Denscombe, 2007). For the purpose of this research, interviewees, and in particular gatekeepers, or the most prominent, respected actors in the study context, were asked if they could recommend other relevant persons to interview. This approach is particularly important for identifying appropriate representatives within the policy and stakeholder community. Due to the international scope of this thesis, a number of interviews were inevitably conducted via Skype. Whilst not the ideal scenario, as Denscombe (2007:11) describes: ’Although it [telephone interviews] forfeits the visual contact of face-to-face interviewing, it retains the ‘personal’ element and the two-way interaction between the researcher and the respondent’.

Throughout the thesis I provide quotations to illustrate interviewee perspectives. In order to preserve the anonymity of the participants, I use the following quotation codes: Research Community (RC), Policy Community (PC), and Sector Community (SC). Conventionally, researchers are described as the ‘epistemic’ community. However, to avoid confusion with the term ‘epistemic uncertainty’, I chose to use the word ‘researcher’ instead. Members of the policy community are experts on the marine and cetacean conservation policy arena, and operate at the interface between these two fields. Members of the sector community are representatives of the shipping industry (see Chapter 2, Section 2.3.3.). As an example, a quotation from a member of the research community is followed by [RC-01], and always shown in *italics*. Shorter phrases are left in the text, whereas longer quotations are in subparagraphs and indented. A letter of introduction (Appendix I) was sent to a total of 46 potential interviewees, which yielded 35 in depth interviews (Table 4.2).

I designed a general interview guide (Table 4.3), or question framework, which was used as a guiding basis for the semi-structured interviews. However, the bigger picture and key themes, as reflected in the main research questions, were first and foremost explored. The aim was to be adaptive and conversational during the interviews, and thus allow space for novel themes to emerge. Since interviewees varied in their field of expertise or sector, the interviews were slightly different in approach and questions asked. Furthermore, questions were added or deleted during the course of the interview field work following the emergence of new themes (Denscombe, 2007).

During the interview I took notes in conjunction with audio recording (if permitted). Such field notes are considered crucial, since they allow for, *inter alia*, the atmosphere of the interview, clues about the intent behind opinions made, and comments on non-verbal communication to be made (Denscombe, 2007). I drew the interviews to a close by inviting the participants to raise any additional and relevant points they think have not been covered.

Table 4.2. Interviewee affiliations and schedule for interviews.

INTERVIEWEE AFFILIATION	QUOTE	DATE	PLACE
Sound Seas	PC-01	13-Mar-11	London, UK
NOAA	RC-01	21-Mar-11	Cadiz, Spain
ICRAM	RC-02	21-Mar-11	Cadiz, Spain
ACCOBAMS	PC-02	21-Mar-11	Cadiz, Spain
CIRCE	RC-03	22-Mar-11	Cadiz, Spain
Tethys Research Institute	RC-04	22-Mar-11	Cadiz, Spain
NAMMCO	PC-03	22-Mar-11	Cadiz, Spain
CIRCE	RC-05	23-Mar-11	Cadiz, Spain
IUCN	PC-04	03-May-11	Skype
ICRAM	RC-06	11-May-11	Skype
IMO	SC-01	26-May-11	London, UK
Tethys Research Institute	PC-05	27-May-11	Milano, Italy
University of Milano	PC-06	28-May-11	Milano, Italy
ICS	SC-02	28-Jun-11	London, UK
WDCS	PC-07	11-Jul-11	Skype
CEBC	RC-07	14-Jul-11	Skype
IWC	PC-08	25-Aug-11	Skype
NOAA	RC-08	31-Aug-11	Skype
University of Genoa	RC-09	07-Oct-2011	Skype
Interferry	SC-03	21-Oct-2011	Skype
Imperial College London	RC-10	25-Oct-2011	Silwood Park, UK
NOAA	PC-09	05-Nov-11	Martinique
IWC	PC-10	07-Nov-11	Martinique
CICESE	RC-11	08-Nov-11	Martinique
NOAA	PC-11	08-Nov-11	Martinique
IWC	PC-12	09-Nov-11	Martinique
NOAA	PC-13	10-Nov-11	Martinique
Alaska Fisheries Science Center	RC-12	16-Dec-11	Skype
NOAA	RC-13	19-Dec-11	Skype
NOAA	PC-14	21-Dec-12	Skype
NOAA	PC-15	12-Jan-12	Skype
NOAA	PC-16	12-Jan-12	Skype
Jacksonville Marine Transportation Exchange	SC-04	23-Jan-12	Skype
New England Aquarium	RC-14	02-Feb-12	Skype
Dalhousie University	RC-15	02-Feb-12	Skype

Table 4.3. Interview guide.

RESEARCH AREA	TOPIC	QUESTIONS
I. Migration	Migrations	• Do whales travel along 'migration routes' in your view? • Individual variation in migration behaviour? • How predictable are the whale movements? • Challenges and prospects of protecting whales during migration?
	Uncertainty	• What are the main sources of uncertainty regarding the migration patterns and routes? • Do you believe more data will reduce the uncertainty? • Your opinion on the implications of scientific uncertainties? • How should scientific uncertainties be addressed?
II. Ship strike threat	Extent of threat	• How prevalent and serious is the ship strike threat during migrations? • To what extent do ships overlap with migration routes? • Challenges and prospects of protection?
	Uncertainty	• What are the main sources of uncertainty regarding the risk of ship strikes during migrations? • Do you believe more data will reduce uncertainties? • Your opinion on the implications of uncertainties? • How can the uncertainties be addressed? How to deal with/communicate uncertainty to the shipping sector?
III. MPA networks and sector regulations	MPA/SPAMI network	• Is it possible to connect nodes within the MPA network to protect migratory routes? • How will management of a transboundary MPA networks be realised? • What are the main challenges and prospects? • What potential impact do geopolitical situations have in protecting migratory whales?
	Sectoral regulations	• What is the shipping sector's view on the whale-ship collision issue? • Main challenges and prospects of proceeding via the sectoral route? • How important is enforcement of regulations?
	Uncertainty	• How do sector/policymakers view scientific uncertainty? • How is uncertainty addressed in the policy decision-making process?

4.2.3. Participant Observation

Participant observation, normally associated with sociology and anthropology, can be used to question people in their daily life, and observe and listen to what is done and said on a first hand witness basis. The main aim is to get insight as an insider, with minimal disruption, in order to see things as they naturally occur, and to examine events holistically and in context (Silverman, 2006; Denscombe, 2007).

Different versions of participant observations exist depending on the participation element and immersion, whereby the researcher takes a covert or openly recognised identity (Denscombe, 2007). For the purpose of this thesis, I participated overtly as a PhD candidate at relevant workshops and conferences, and adopted the interpretation of participant observation that signifies the aim to '...get an "overall feel" for the situation', in the sense of 'holistic observation' (Denscombe, 2007:219). If issues emerge as important or unusual, I explored them further by informal conversations, given the opportunity (Denscombe, 2007).

I attended the most significant conferences and workshops pertaining to my research topic, which included the Annual European Cetacean Society Conference, which was held in March, 2011. At this conference I attended a workshop particularly dedicated to the Mediterranean fin whales, and as such I was able to meet, interview, and learn from the key experts in the field. The second conference with associated workshops I attended was the 2nd International Conference on Marine Mammal Protection Areas (ICMMPA II), held in Martinique, November 2012. This conference brought together the world's leading experts on marine mammal conservation, and allowed me to enhance my knowledge of cetacean conservation in different parts of the world, interview a variety of researchers and policy experts, and participate in workshops related to my research frame. I further presented my preliminary findings at a workshop entitled: 'Scientific Information to Support MSP: MSP for Marine Mammal Conservation, as well as Considerations of Marine Mammal Science in Broader MSP' (Appendix II).

As a second and complimentary participant observation, I conducted four weeks in the field as a research assistant with Tethys Research Institute (TRI), which conducts field research on cetaceans in Italy and Greece. I was part of the research team in San

Remo, Italy, where research is carried out within the Pelagos Sanctuary. This is an area encompassing summer feeding habitats for Mediterranean fin whales, and my tasks included photo-identification and data sampling. Working and living with researchers allowed me to develop a deeper understanding of the research being conducted on fin whales, and the issues and challenges surrounding their conservation within the Mediterranean Sea.

4.2.4. Uncertainty Analysis

Reflecting the transdisciplinary and post-normal science approach of this thesis, I analyse uncertainty as an overarching and cross-cutting theme. I have chosen to use the W & H framework to analyse uncertainty for three main reasons: I believe i) it provides the most structured and logical, yet simplistic, approach to analysing and communicating uncertainty, as found in the literature; ii) it combines both the modeller's (researcher's) interpretation of the data (location, level, and nature), as well as different perceptions by key actors (ambiguity); iii) the W & H framework has been proposed as a standard, interdisciplinary treatment of uncertainty in policy analysis (Walker et al., 2003; Kwakkel et al., 2010). By following a proposed standardised framework, the results of this research may be more comparable to other studies.

Whilst the W & H framework is aimed as a standard approach, the authors recognise that generic categorisation and comprehensive use of the uncertainty matrix might not fit all research cases (Kwakkel et al., 2010). Morgan and Henrion (1990:37) urge for 'simplicity' and, allowing 'the problem to drive the analysis', as two of their ten commandments of policy analysis. Consequently, I have simplified the W & H uncertainty matrix in order to make it more congruent with the present research purposes.

Due to space and time-constraints posed by a three year PhD project, I restricted the uncertainty analysis to the Nature and Ambiguity dimensions, within the Context Location of my research frame. Thus, I did not go into the details of the Level of uncertainty, which would be too challenging and imprecise given the qualitative nature of the data.

The Nature dimension is subdivided into ontological and epistemic uncertainty (*sensu* Walker et al., 2003). The knowledge gaps related to epistemic uncertainty derive from missing, inadequate, or incomplete data, which can, technically, be 'filled' by more research and data gathering. Ontological uncertainty refers to the intrinsic variability and complexity of the studied system, for which outcomes are unpredictable and knowledge gaps cannot be remedied by additional investigation (see Chapter 3). I analysed uncertainty according to these categories within the context of the following two locations: whale migration and the risk of ship strikes during migration, which are the two topics within my research frame grounded in scientific data.

Uncertainties arising from ambiguity reflect the fact that the same data can be interpreted differently by actors as a result of different research backgrounds and knowledge frames (Dewulf et al., 2005; Brugnach et al., 2008). I explored the different ways interviewees discussed the same issues surrounding the research topics explored in this thesis, as well as their explicit views on uncertainty, its implications, and how it should be addressed. In contrast to Brugnach et al. (2008), and Kwakkel et al. (2010) I treat ambiguity as a fourth dimension in its own right, alongside the location, level, and nature of uncertainty, since I explicitly aimed to explore different perceptions by key actors.

I identified and categorised the qualitative data on scientific uncertainty obtained from the interviews into an uncertainty matrix. I classified the matrix data separately for the two case studies in order to discern uncertainties pertaining to 'whale migration', and 'ship strike threat during migration', within each context (Table 4.4).

Table 4.4. Uncertainty Matrix used to identify, categorise, and analyse uncertainty for the two case studies. Based on Walker et al. (2003) and Kwakkel et al. (2010).

LOCATION		**NATURE**		**AMBIGUITY**
		EPISTEMIC	**ONTOLOGICAL**	
Context	Whale migration			
	Ship strike threat during migration			

Whilst the matrix provides a comprehensive overview of the different dimensions of uncertainty, I acknowledge that the analysis of the empirical data is also a source of 'modeller's uncertainty', that is; bias caused by subjective interpretation by the modeller (Walker et al., 2003), or in the present case, the author of this thesis. Similarly, it is important to recognise that the qualitative data, on which this PhD analysis is based, are to a large degree derived from the views and knowledge of the interviewee participants. Furthermore, I recognise the potential bias that may arise from compartmentalising uncertainty into distinct natures, and that uncertainty is rarely absolute but rather 'tends toward' epistemology or ontology on a gradient of uncertainty (Figure 4.1). It is thus challenging to determine a line on which the uncertainty ceases to be epistemic in nature and commences to be ontological, and vice versa. Notwithstanding, whilst it is important to recognise these potential sources of bias, it is argued that categorisation of uncertainty is inescapable if it is to be efficiently addressed.

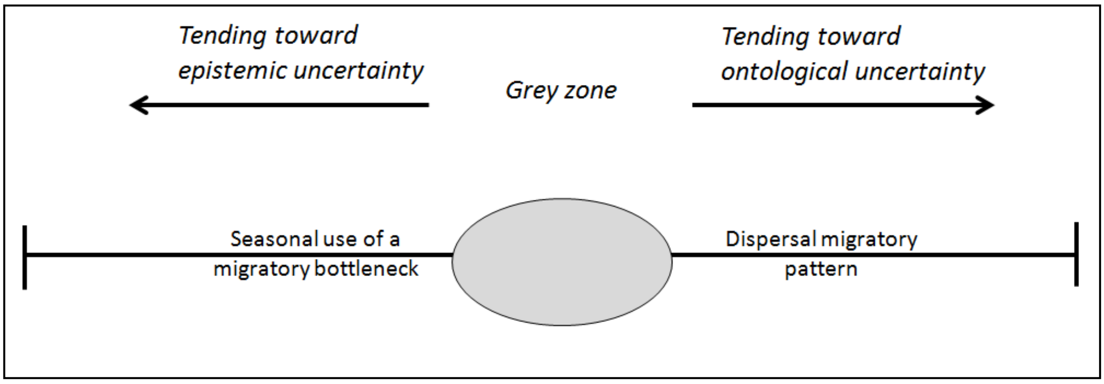

Figure 4.1. Gradient of epistemic and ontological uncertainty. It is challenging to define a line at which the uncertainty shifts from epistemic to ontological, and vice versa, as illustrated by the grey zone. The examples of uncertainty are given for illustrative purposes and will be explained in the Case Study chapters (5 and 6).

4.3. Data Analysis

Typed interview transcriptions entail a change of medium, and therefore introduce a degree of interpretation (Gibbs, 2007). Following interviews I transcribed the audio-tapes and/or field notes as soon as possible (Appendix III). In addition to a familiarisation with the data, this allows for a more accurate interpretation, since the memory of the interview will be fresh (Denscombe, 2007). The transcription process I used is referred to as the interview report approach. This technique is based on transcribing interviews by directly putting the data into context within the structure of the initial interview guide. Following the transcription of the exact words used by the interviewee, the interview report was sent to the interviewee, who was given the opportunity to verify whether his/her views have been correctly captured.

Codes can be described as labels, such as names, letters, or numbers, which are tagged to the 'raw' data (Saldana, 2009). 'Coding is a way of indexing or categorising the text in order to establish a framework of thematic ideas about it' (Gibbs, 2007:38). Codes are grouped into categories with the aim to identify themes, patterns, and relationships between them. As Denscombe (2007:292) argues, 'the task for the researcher is to ''make the link''.' Subsequent to grouping the codes, they are arranged into a coding hierarchy, which allows relationships to be seen more clearly and prevents duplication of codes (Gibbs, 2007). The coding process further enables methodological retrieval of thematically associated sections of the data. Coding and retrieval can be carried out manually or electronically using computer-assisted qualitative data analysis software (CAQDAS) (Saldana, 2009).

Cautiously using codes at an early stage of the analysis allows the researcher to reflect about the text and its interpretation (Denscombe, 2007). However, too early a focus on coding can lead to 'tunnel perspective', and it is important to remain flexible and open-minded throughout the data analysis (Axmacher, pers. comm.). I began the analytical process by making handwritten memos and codes on the transcript documents in order to get an overall feel for the data. These initial codes were subsequently combined in a hierarchical process into overarching codes and themes (Saldana, 2009).

Codes can be described as 'etic' or 'emic' (Silverman, 2006). Etic codes stem from the research focus, questions, priorities, whereas codes that emerge during the interview process are considered emic. Emic codes are thus more a reflection of interviewee perspectives and allow for the emergence of novel and unforeseen themes. Table 4.5 details the key codes that I used for the analysis.

For the process of identifying key codes I used open, qualitative manual coding, which enables a more qualitative and first-hand approach. I combined all the electronic interview transcripts into one long Word document, which allowed me to search the document for key words and phrases using the Microsoft Word 'find/replace' function. I used the 'highlight' function for relevant sections and used a colour system according to general theme. This analytical process is based on the work of de Santo (2007), who developed the method for her PhD analysis. I did not use qualitative analysis software, since it effectively creates a separation between the researcher and the primary data (Jones, pers. comm.).

Table 4.5. Key interview codes used in the data analysis.

ETIC CODES	EMIC CODES
Predictability of migratory behaviour	Inevitability of scientific uncertainty
Migration corridors	Dynamism and variability in migration
Views and implications of scientific uncertainty	Importance of researcher collaboration
Pervasiveness of ship strike threat	Importance of sector relationship-building
Ecological connectivity and the MPA network approach	Lack of political will
The SPAMI network	Cross-boundary issues and geopolitics
Shipping regulations	The International Maritime Organisation
Domestic species protection laws and international agreements	Human network precedes ecological network
Management and enforcement	Human behaviour a key factor in conservation

In the next two chapters I discuss the empirical data and analysis within the two Case Study contexts: fin whale migration in the Mediterranean Sea and the SPAMI network, and North Atlantic right whale migration along the U.S. East coast and the sectoral-specific Seasonal Management Areas.

5

Fin Whales in the Mediterranean Sea

Overview

In this chapter I provide an in depth review of fin whale movement patterns within the Mediterranean Sea. I analyse and discuss perspectives on fin whale migration and the threat of ship strikes in the light of the different natures of uncertainty and their implications for conservation. Finally, I explore the applicability of the SPAMI network initiative to protect fin whales during their seasonal migrations within the context of geopolitical complexities and lack of political will.

5.1. Conservation context

5.1.1. Population Status

A small, isolated subpopulation of fin whales *Balaenoptera physalus* (Figure 5.1) is believed to be resident in the Mediterranean Sea (Reeves and Notarbartolo di Sciara, 2006). Comparative genetic studies indicate a geographic separation between a Mediterranean and a North Atlantic stock of fin whales. The genetic analyses demonstrate isolation based on mitochondrial—but not nuclear—DNA, indicative of a male-mediated, low-recurrent gene flow between the two populations (Palsbøll et al., 1994; Bérubé et al., 1998).

The population size of the Mediterranean fin whales—the only commonly found mysticete in the basin—is estimated to approximately 3600 individuals in the western Mediterranean (except for the Tyrrhenian Sea) (Forcada et al., 1996), including 900 in the Corsican-Ligurian-Provençal basin (Forcada et al., 1995). A lack of data for the southern and eastern regions prevents a Mediterranean-wide estimate, and no recent estimates of the western basin have been undertaken. It is, however, likely that the population does not exceed 5000 individuals (Notarbartolo di Sciara and Birkun, 2010).

On a species level, fin whales are classified as Endangered by the IUCN Red List of Threatened Species (Reilly et al., 2008). The Mediterranean population of fin whales are proposed as Vulnerable VU in IUCN's Red List based on a) the genetic distinction from the North Atlantic population, b) it containing fewer than 10 000 mature individuals, c) all mature individuals are in the one population, and d) an inferred decline in numbers of mature individuals (Notarbartolo di Sciara and Birkun, 2010).

Figure 5.1. Picture of fin whales Balaenoptera physalus. From Tethys Research Institute www.tethys.org.

5.1.2. Distribution Range

Notarbartolo di Sciara et al. (2003) divided the Mediterranean Sea into seven regions and discussed fin whale presence within these areas (Figure 5.2). The sub-region of greatest importance to fin whale is the Corso-Ligurian-Provençal Basin and the Gulf of Lion. The western basin, the Tyrrhenian Basin, the Adriatic Basin, and the Ionian/Central basin were considered of intermediate significance, whereas fin whales are rare in the Aegan Seas and the Levant Basin. However, since research has been most heavily focused on the North western parts of the Mediterranean Sea, these conclusions need to be confirmed by extending survey efforts on a basin-wide scale.

Discussions surrounding the degree of contact between Mediterranean and Atlantic fin whale populations have prevailed for centuries (see Notarbartolo di Sciara et al., 2003), and the extent of overlap between the two stocks is not yet fully elucidated (Castellote et al., 2011). For conservation purposes, an important centre of debate is whether Mediterranean fin whales leave the basin for the Atlantic Ocean via the Strait of Gibraltar, or whether they remain within the basin year-round.

In a satellite tagging study of eight fin whales in French waters, one whale migrated into the Atlantic Ocean during winter, demonstrating a migratory connection between the Mediterranean and the contiguous Atlantic waters (Cotté et al., 2009). Ship-based surveys from the Strait of Gibraltar and the eastern Alboran Sea show that most fin whales exhibit travelling behaviour and a west-ward migratory direction towards the Atlantic during summer months (de Stephanis et al., 2001; Guinet et al., 2005; Gauffier et al., 2009).

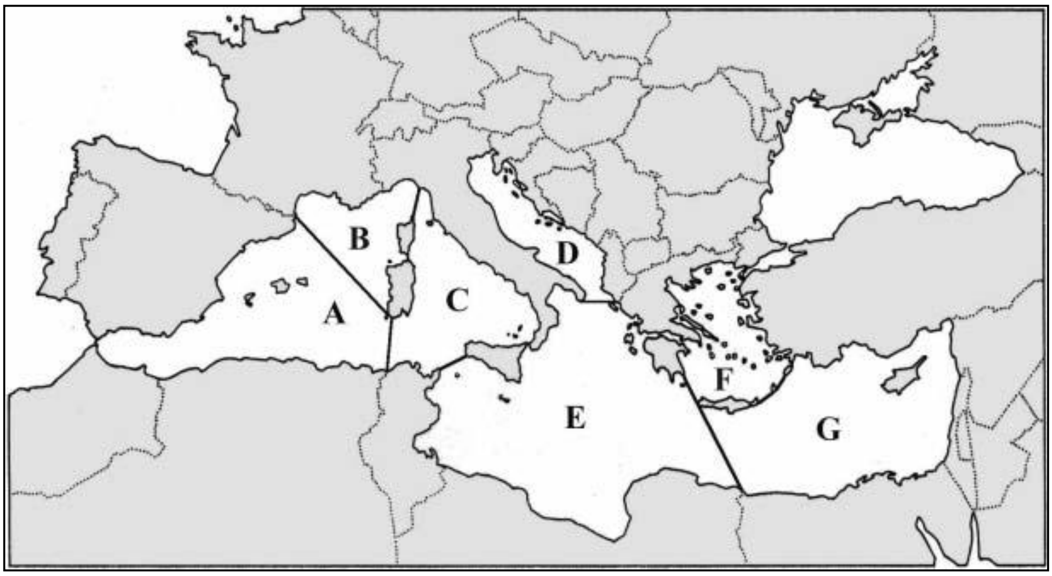

Figure 5.2. Subregions of the Mediterranean Sea. A = Western Basin (including the Alboran Sea and Strait of Gibraltar); B = Ligurian-Corsican-Provencal Basin and Gulf of Lions; C = Tyrrhenian Basin; D = Adriatic Basin; E = Ionian/Central Basin; F = Aegean Basin; G = Levantine Basin. From Notarbartolo di Sciara et al. (2003).

Furthermore, photo-identification data confirm the bidirectional use of the Strait of Gibraltar, and whilst study effort was lower in the winter, Gauffier et al. (2009) hypothesise that a small proportion of the Mediterranean subpopulation seasonally migrates into the Atlantic Ocean in the summer and return to the basin in the winter. Corroborating this, studies of stable isotopes from fin whale baleen plates (n = 11) demonstrate two isotopic signatures from both the Mediterranean Sea and the Atlantic Ocean, thus further supporting the theory that Mediterranean fin whales forage in both seas (Bentaleb et al., 2011). These authors thus challenge the idea that the Mediterranean subpopulation exhibit year-round residency within the basin.

Recent acoustic data on fin whale song characteristics refute the hypothesised movement of Mediterranean fin whales into the Atlantic Ocean, as suggested by satellite (Cotte et al., 2009), visual (de Stephanis et al., 2001; Gauffier et al., 2009), and stable isotope data (Bentaleb et al., 2011). Based on male vocalisations recorded by hydrophones deployed in the western Mediterranean, Strait of Gibraltar, and adjacent Atlantic waters, Castellote et al. (2011) identified two contrasting fin whale song patterns in the Mediterranean, indicative of two different subpopulations; one was shown to correspond to the North East North Atlantic (NENA) stock and the other attributed to a 'true' Mediterranean population. Fin whales with vocalisations belonging to the NENA population were detected crossing the Strait of Gibraltar and wintering in the Alboran Sea. By contrast, the songs of the Mediterranean fin whales were only recorded in the Northwest part of the Mediterranean basin, suggesting that males of the Mediterranean population do not include the Strait of Gibraltar and Alboran Sea within their distribution range.

The acoustic data strongly indicates that the 'true' Mediterranean population does not migrate into the Atlantic Ocean, and corroborate genetic studies (Palsbøll et al., 1994; Bérubé et al., 1998) that the Mediterranean fin whales belong to a relatively isolated population with a habitat range not extending outside of the basin boarders. This further implies that the range of the 'true' Mediterranean fin whales may be more restricted than previously thought (Castellote et al., 2011). However, movement patterns of fin whales within the basin are still puzzling, and information about their distribution outside the summer period is patchy (Notarbartolo di Sciara et al., 2003). Increasing our understanding of the migratory patterns of these whales within the Mediterranean basin is thus of great importance in order to design more effective conservation strategies for this small, isolated, and threatened population.

5.2. Migration in a Sea of Uncertainty: A Review of Hypotheses

Based on opinions and perspectives from members of the research community, together with a synthesis of published and grey literature (Table 5.1.), two overarching perspectives of Mediterranean *B. physalus* seasonal migration can be discerned. For the purpose of this thesis I refer to these two perspectives as 'directional' and 'dispersal' movement patterns. The former discusses *B. physalus* movements as discernable migration patterns that are relatively predictable in space and time, connecting summer and winter habitats. The latter perspective does not regard fin whale movements in terms of migration, but rather as large-scale, dynamic dispersal patterns throughout the basin.

5.2.1. Directional Movement Patterns

Several corroborating studies indicate a seasonal movement between northern and southern parts of the Mediterranean (Figure 5.3). Even though Mediterranean waters are mainly oligotrophic (low in nutrients)—especially in the eastern regions of the sea (Bakun and Agostini, 2001)—localised upwellings give rise to high levels of primary productivity in the Gulf of Lion, Ligurian-Provencal Basin, and the Northern Aegean (Notarbartolo di Sciara and Agardy, 2009). With high site fidelity, fin whales congregate to feed in the productive Ligurian Sea and Gulf of Lion during spring/summer (e.g. Zanardelli et al., 1999; Panigada et al., 2008). Whilst fin whale presence in the Ligurian Basin is continuous throughout the year (Gannier and Gannier, 1993; Clark et al., 2002), their abundance is cyclical and drops considerably during winter (e.g. Duguy and Vallon, 1976), suggestive of a seasonal migration away from this region by the majority of the population (e.g. Marini et al., 1996a).

Using ferries as opportunistic platforms, Marini et al. (1996a) report a seasonal increase in fin whale presence in the Tyrrhenian Sea during April-May and September-October, with a low occurrence in winter months. The seasonal pattern corresponds to the peak and trough in abundance in the Ligurian summer feeding grounds. Based on this observation, together with reported strandings of *B. physalus* in most winter months along the North African coast (see Marini et al., 1996a), Marini et al. (1996a) put forth a framework for fin whale cyclical migration patterns within the Mediterranean

Sea. Their theory states the Mediterranean fin whales are isolated from the Atlantic population and leave their primary Ligurian basin feeding areas in winter when climatic conditions become less favourable, and use the Tyrrhenian Sea as a transit area to reach southern waters that may represent breeding grounds. From North African waters the whales return in spring to their summer feeding areas in the Liguria, but also to areas in the Ionian Sea and the eastern Basin. The year-round favourable conditions in the Mediterranean thus permit the whales to expend less energy by avoiding a migration into the Atlantic Ocean (Marini et al., 1992; 1996a; 1996b).

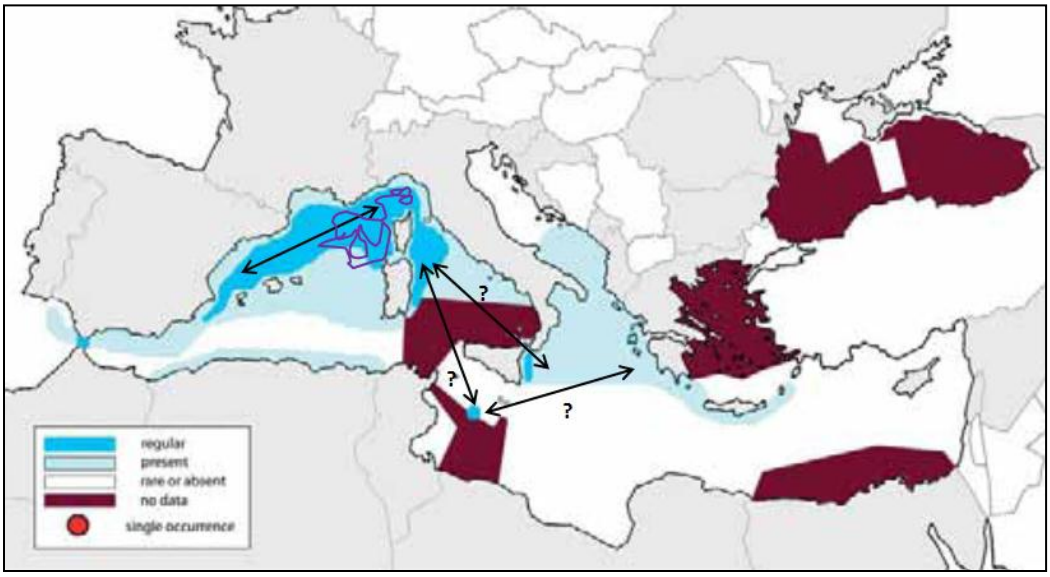

Figure 5.3. Hypothesised movement patterns of the Mediterranean fin whale population, as discussed in the text. Black arrows = movement corridors. Question marks indicate that these migratory connections have yet to be ascertained. Purple line = winter dispersals over a flexible habitat margin in the NW basin. Blue colour indicates regular presence of fin whales; light blue colour indicates presence; white colour indicates rare presence or absence, dark red colour indicates lack of data. Map of presence data from ACCOBAMS (2010) (arrows added).

Marini et al.'s (1996a; 1996b) hypothesis is further substantiated by the results of an observation programme conducted through the Italian Navy, which report that most fin whale sightings during spring occur in the Tyrrhenian Sea (Nascetti and Notarbartolo di Sciara, 1996). Continuing the work of Marini et al. (1996a) using ferry transect lines, Arcangeli et al. (2008) observe a significant difference in monthly fin whale encounter rates in the Central Tyrrhenian Sea with higher numbers being sighted at the beginning of summer (May/June).

However, continued observations between 2008 and 2010, show that *B. physalus* habitat-use of the central Tyrrhenian Sea has temporally and spatially changed since the 1990s: the two peaks of abundance as described by Marini et al. (1996a) are no longer observed (Arcangeli et al., 2011). An interviewee expresses this as follows: *'We don't find anymore the two peaks of relative abundance, but just a presence throughout summer so this has probably become a summer feeding ground in the central Tyrrhenian Sea' [RC-02].*

Furthermore, year-round monitoring of the northern Tyrrhenian Sea failed to yield any encounters of *B. physalus*, suggesting that the migratory connection between the central Tyrrhenian Sea and Ligurian summer feeding areas may no longer exist. The outcome of this observation is that the whales must either be coming from the West through the Strait of Bonifaccio or from the South to reach summer feeding areas in the central Tyrrhenian Sea, without travelling further north to the Ligurian basin [RC-02].

A complementary North—South migratory pathway is suggested by Castellote et al. based on acoustic data (2010; 2011b). Detections of Mediterranean fin whale vocalisations from seafloor recorders peak in early spring and fall in the Balearic Islands. This indicates that a large part of the Mediterranean fin whales that aggregate in the Ligurian-Provençal basin during summer migrate southwest along the French and Spanish coasts to southern Mediterranean wintering regions, potentially off the North African coast. In the words of an interviewee:

> *'The fin whales are following a migration pattern. When second productivity is finished in the Ligurian basin they move south and a big proportion of the whales are crossing between the Spanish peninsula and the Balearic Islands—the Ibiza channel—so definitely this region seems to be a clear corridor south by the end of summer and north for spring migration back towards the Ligurian Sea' [RC-01].*

The same acoustic data provide strong evidence that the resident Mediterranean fin whales do not migrate into the Atlantic Ocean (see Section 5.1.2.). As the interviewee concludes:

'It seems like there are two migration corridors: 1) parallel to the Italian coast, and 2) along the French and Spanish coast. The migration I think is more predictable and stable [compared to feeding habitats] as they always go to areas where there will be food' [RC-01].

Table 5.1. Studies of fin whale migration in the Mediterranean Sea.

STUDY AREA	TIME OF STUDY	METHOD	MAIN FINDINGS	REFERENCE
Central Tyrrhenian Sea between Civitavecchia (Rome-district) and Golfo Aranci (Sardinia)	Sept 1989 to Sept 1992	Twice weekly, year-round ferry 'platform of opportunity' by skilled observers	Whale presence year round. Peak abundance in April/May. Secondary peak Sept/Oct. Minimum abundance Nov-March.	Marini et al., (1996a)
Italian waters, Central Mediterranean Sea	April to Dec 1995	Visual and acoustic observations onboard Italian navy vessels and aircrafts	Whales scattered throughout southern Tyrrhenian Sea in spring (April/May); more concentrated in the Ligurian Sea during summer.	Nascetti and Notarbartolo (1996)
Central Tyrrhenian Sea between Civitavecchia (Rome-district) and Golfo Aranci (Sardinia)	May to Sept 2007	Weekly ferry 'platform of opportunity' by skilled observers	Whale encounter rates higher in May/June and within 50 - 90 nm of Italian coast.	Arcangeli et al. (2008)
Central Tyrrhenian Sea [and Ligurian Basin]	June to Sept 2008 to 2010	Weekly ferry 'platform of opportunity' by skilled observers	High abundance throughout summer. No spring/autumn peaks or connections to Ligurian Sea.	Arcangeli et al. (2011)
Strait of Messina and island of Lampedusa [and Ligurian Basin]	2002 to 2006	Visual boat surveys	High concentration of whales in the Strait of Messina from the end of summer to the end of autumn. Whale presence in Lampedusa from late winter to early spring.	Aissi et al. (2008)
Strait of Sicily including the island of Lampedusa	Dec to April 1994 to 1997	Ferries, oceanographic vessels and Italian Navy ships as 'platforrns of opportunity', and landbased surveys	Only 1 whale sighted. Potential bottleneck transit along migration route.	Arcangeli et al. (1997)
Island of Lampedusa	Second half of March 1996	Preliminary visual survey	High density of whales sighted, including females with calves. Feeding behaviour observed. Groups up to 10 individuals.	Marini et al. (1996b)
Island of Lampedusa	Feb 2004	Visual boat and landbased surveys	Winter feeding ground. Surface feeding on *N. couchi* established.	Canese et al. (2006)
Island of Lampedusa	Feb to April 2004-2007, 2009	Visual boat surveys	Whale sightings southeast of Lampedusa. Feeding behaviour on *N. couchi* observed.	Internullo et al. (2010)

Table 5.1. Continued.

STUDY AREA	TIME OF STUDY	METHOD	MAIN FINDINGS	REFERENCE
Strait of Sicily including the Island of Lampedusa, and Southern Ionian Sea	Nov to May 2004 and 2005	Visual boat surveys	High frequency of whale sightings in areas around Lampedusa. Feeding behaviour on *N. couchi* observed.	Tringali et al. (2010)
9 different areas of the Western Mediterranean, Strait of Gibraltar, and adjacent North Atlantic waters	2006-2009	Bottom-mounted audio recorders to analyse fin whale song attributes	Mediterranean fin whale seasonal N-S movement patterns from NW feeding areas along French and Spanish waters to S Med. regions. NEN Atlantic subpopulation migrates via the Strait of Gibraltar into SW Mediterranean.	Castellote et al. (2010; 2011a, b)
Northwest Mediterranean, waters between France and Algeria	Sept 2006 to July 2007	18 surveys on ferries from France to Algeria as platforms of opportunity.	Whales found in the NW Mediterranean, mainly north of the Balearic Islands.	Cotte et al. (2009; 2011)
Satellite tagging in French waters	Aug 2003 to June 2004	Satellite telemetry tagging of 8 whales	7 whales stayed in the NW Mediterranean; aggregated during summer and more dispersed during winter. 1 whale travelled into the Atlantic Ocean in the winter.	Cotte et al. (2009; 2011)
Atlantic and Mediterranean waters around Strait of Gibraltar, East Alboran Sea	1992 to 2000	Visual boat surveys	Whales travelling into the Atlantic Ocean during summer. Central part of Alboran Sea may be a feeding ground.	de Stephanis et al. (2001)
Strait of Gibraltar	1999 to 2008	Visual boat surveys, opportunistic platforms (e.g. whale watching boats), land based surveys	Bidirectional migration through the Strait of Gibraltar; whales travelling into the Atlantic Ocean in summer, back into the Mediterranean in winter.	Gauffier et al. (2009)
Western Mediterranean	1975 to 2002	Stable isotope measurements for 10 baleen plates from 9 whales stranded along western Mediterranean coasts	Plates of two whales from Malaga/ Strait of Gibraltar suggest foraging in both the Atlantic and the Med, consistent with regular migration between the two seas.	Bentaleb et al. (2011)
Satellite tagging in Northwestern Mediterranean (Pelagos Sancturay)	Sept 2012--	Satellite telemetry tagging of 7 whales in the Pelagos Sanctuary	As of the latest update (17th Nov, 2012), 5 whales are found in a wide habitat margin around the Pelagos Sanctuary, 2 whales are moving SW along the French/Spanish coastal corridor.	Tethys Research Institute at www.tethys.org.

In order to reach the eastern African continental shelf there are only two areas of passage, which connect the western and eastern parts of the Mediterranean basin: the Strait of Messina, and the Sicily Channel. Aissi et al. (2008) report a continuous annual presence of a small number of fin whales in the Messina strait, but note a remarkably high concentration in the strait from the end of summer to the end of autumn. Travelling behaviour was mainly observed in the autumn (80 %) and winter (70 %) months, suggestive of a migration from or through this area to other contiguous habitats by at least a portion of the Mediterranean population. As the authors describe it:

> 'The decreasing density in the Ligurian Sea from late summer coincides with the highest distribution in the Strait of Messina where whales seem to be mostly in a transfer phase from autumn to early winter' (Aissi et al., 2008:1259).

The extent to which the Sicily channel acts as a migration corridor is less conclusive. Arcangeli et al. (1997) recorded a low number of fin whales sightings in the Sicily channel during winter, and the authors speculated that the area may act as a bottleneck along the migration route. It is possible that the whales travel some distance from the southern Sicilian coast exploiting a southward current, and on their northern migration passing along the North African coast taking advantage of local northward currents (Marini et al., 1996b).

In the south of the Sicily channel on the African continental shelf, local fishermen have known of the seasonal presence of large groups of fin whales in winter months around the Italian islands of Linosa and Lampedusa [RC-06]. A preliminary survey of the waters surrounding Lampedusa in March 1996 identified a high density of fin whales all around the island, including mothers and calves, confirming the seasonal presence of fin whales in North African waters (Marini et al., 1996a). Canese et al. (2006) highlighted the island of Lampedusa as a winter feeding ground based on consistent observations of foraging behaviour. The importance of this area for feeding is corroborated by additional surveys of the region in winter time (Aissi et al., 2008; Internullo et al., 2010; Triangali et al., 2010).

Interestingly, two distinct feeding behaviours on two different plankton species has been observed in the Ligurian Basin and the Lampedusa Island. In Liguria, fin whales are predominately found in pelagic waters with depths > 2000 m (Notarbartolo di Sciara et al., 2003), engaging in deep feeding behaviour on Northern krill (*Meganyctiphanes norvegica*) (Orsi Relini et al., 1994). Around the island of Lampedusa, by contrast, the fin whales display a surface foraging activity on the crustacea *Nyctiphanes couchi* in shallower water (10 – 500 m) (Canese et al., 2006). Since the same individual has been observed feeding in both areas, it indicates that at least a proportion of the population may adapt their feeding behaviour in relation to the abundance of potential preys (Aissi et al., 2008).

Population identity of the fin whales observed in Lampedusa is yet to be ascertained. An initial attempt to compare photographs—an effective tool in elucidating habitat-use and migration exchanges (e.g. Frantzis et al., 2011)—of observed fin whales in Lampedusa did not match those of the Pelagos Sanctuary catalogue (Canese et al., 2006), although the quality of the photographs prevents any firm conclusions (Zanardelli, pers. comm.). By contrast, based on preliminary photo identification data, Aissi et al. (2008), identified the same, highly scarred and thus easily identified individual around the island of Lampedusa in February 2005, and in the Ligurian basin in late May and early September 2005. Moreover, another individual was identified both in the Ionian Sea and the Strait of Messina (Triangali et al., 2008), suggestive of a connection between the Eastern and Western parts of the basin.

Taken together, the studies and interviewee perspectives reviewed here lend evidence to the existence of migration routes, which are seasonally used by at least a proportion of the fin whale population. In particular, the potential corridor acoustically discovered along the north—southwest route warrants further research and considerations for seasonal protection measures. In the case of the Tyrrhenian Sea, it is peculiar that the migration connection with Liguria is no longer discernable. However, the whales that reside in the Ligurian Sea in summer may travel southwest rather than southeast to reach winter areas along the North African coast. Moreover, fin whales aggregating in the Tyrrhenian Sea in the summer may travel south and cross one of the two straits—the Sicily channel and Strait of Messina—to reach southern winter areas (see Figure 5.3.).

5.2.2. Dispersal Movement Patterns

Notarbartolo di Sciara et al. (2003) discuss an alternative hypothesis of fin whale movement patterns within the Mediterranean Sea. Their premise is grounded in the interpretation that the Mediterranean fin whales have adapted to the peculiar environment of this semi-enclosed basin, which is more favourable in terms of air and water temperatures compared to the major oceans. Whilst Marini et al. (1996a; 1996b) posit that the environmental characteristics of the basin allow the whales to remain in the basin year-round, Notarbartolo di Sciara et al. (1999; 2003) take the argument further by suggesting that Mediterranean *B. physalus* have modified their ecology, behaviour, and reproductive physiology for a more 'permissive' environment in the Mediterranean Sea.

The traditional paradigm of baleen whale migrations states that whales migrate from productive feeding habitats in northern latitudes to warm tropical or sub-tropical breeding and calving areas where no foraging activity takes place (e.g. Evans, 1987). In stark contrast to such stereotypical migrations, Mediterranean fin whales may thus display a different behaviour, as described by an interviewee: *'In the Mediterranean we are not really talking about [fin whale] migration as it is such a small area and it may just be a small percentage of the population moving' [RC-04].* According to this perspective the fin whales aggregate in feeding 'hot spots' during summer, and disperse in the southern and central Mediterranean basin during winter when feeding ceases to be the prime activity.

Due to the confined area of the Mediterranean, the whales are likely to remain in acoustic contact during winter, providing opportunities for locating potential mates. Since new-borns are seen in many different locations in different times of the year, it questions the existence of a critical habitat specific for breeding and calving, and suggests that fin whale breeding activities may extend into the summer (Notarbartolo di Sciara et al., 2003). One interviewee points out:

> *'The Romans called the area around the Ligurian Sea '' Costa Ballaenae'' [coast of the whales] because of the high concentration of strandings. If there was an equal concentration during winter you would expect another*

Costa Ballaenae. This has never been described and there is no anecdotal evidence that fin whales with calves are found in a particular area during winter' [RC-04].

The adaptation to the specific oligotrophic Mediterranean environment may further, in the words of an interviewee, mean that:

'Fin whales are very place-based when it comes to feeding, but perhaps they are not so picky with regards to their parturitions and mating behaviour. Perhaps the Mediterranean is an environment that doesn't impose on fin whales a rigid selection of places to go to give birth' [PC-05].

The concept of winter dispersals as opposed to directional movements between habitats is further elaborated by Cotté et al. (2009). The authors' results from satellite tagging study of eight fin whales off the French coast (see Section 5.1.3.) revealed that seven whales exhibit site fidelity to the Northwest Mediterranean north of the Balearic Islands throughout the year, albeit in a more dispersed fashion during winter months (Figure 5.3). This led the authors to suggest that Mediterranean fin whales aggregate during summer in the NW Mediterranean, engaging in foraging activity on *M. norvegica*. When krill abundance declines in winter the whales remain in this northwest area but disperse across a larger, flexible habitat margin, rather than migrating to another habitat in the southern basin. Whilst opportunistic feeding may occur this is not the main activity during winter (Cotté et al., 2009).

At present, this second perspective of fin whale movement patterns within the Mediterranean relies more on hypotheses. The French telemetry study (Cotté et al., 2009) represents too small a sample size (n = 8) to be representative of the population as a whole, in contrast to, for example, the acoustic studies of the north-southwest corridor, which detected a wealth of vocalisations (Castellote et al., 2011). Furthermore, the sheer lack of data from the southern and eastern parts of the basin, together with a lack of information-sharing with North African countries, means that an absence of critical winter habitats in these regions cannot be ascertained.

However, it cannot be ruled out that different individuals of this isolated population use different migratory strategies, and that the Mediterranean fin whales overall are more dynamic and unpredictable in their seasonal movements compared to many other baleen whale populations. Preliminary findings from a fin whale satellite tagging study (n = 7) conducted by Tethys Research Institute in September 2012, reveal, as of November 2012, varied results, with two individuals traveling southwest along the French/Spanish coastal corridor, and five remaining within the Ligurian Basin (Figure 5.4). Following their movement trajectories for the remainder of the winter and spring season will further our understanding of winter destinations and migratory corridors.

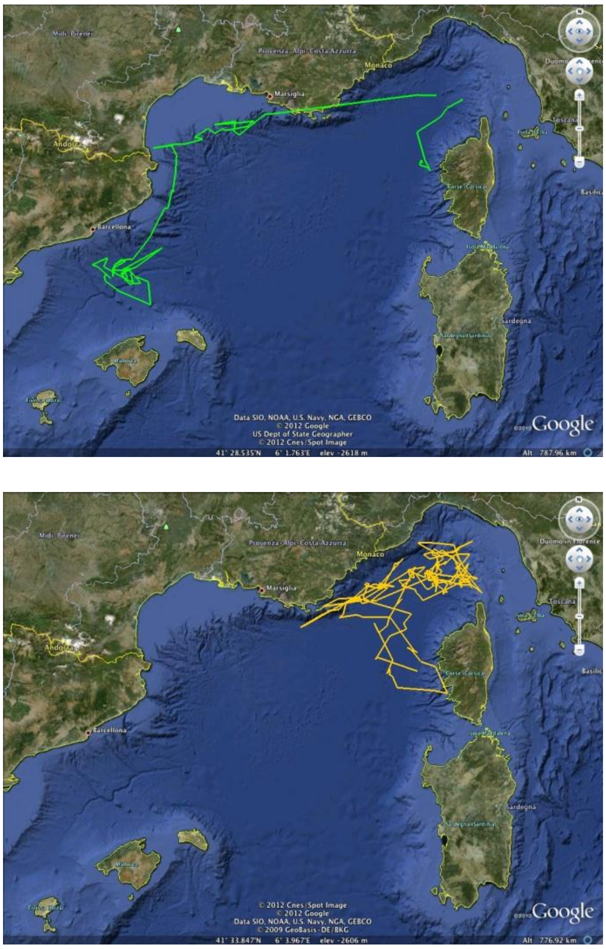

Figure 5.4. Latest update of two satellite-tagged fin whales in the Pelagos Sanctuary and their movement tracks from Sept 9 to Nov 17, 2012. The whale 'Nina' (top figure) is travelling southwest from the Pelagos Sanctuary along the proposed French/Spanish coastal corridor, and 'Viola' is remaining in the northwestern basin in a more dispersal-like fashion. From www.tethys.org.

5.3. Migration in a Sea of Intense Maritime Traffic

The Mediterranean is one of the most heavily navigated seas in the world, accounting for 30% of the world's merchant shipping whilst only covering 0.8% of the global ocean surface (Notarbartolo di Sciara et al., 2003). In addition to commercial shipping, high-speed ferries connecting the Italian, French, and Spanish mainland and Islands operate throughout the summer season, often overlapping with fin whale feeding areas (Panigada et al., 2006).

Ship strikes represent the main threat for fin whales in the Mediterranean Sea and mortality rates caused by collisions with vessles are a cause of considerable concern for this relatively isolated and vulnerable population, in particular when considered synergistically with other anthropogenic threats (Panigada et al., 2006). The annual mortality rate of fin whales struck by vessels in the Mediterranean has increased over the last three decades, and is estimated to 1.7 animals per year. However, unreported or unnoticed events, as well as incomplete necropsies, make roughly 8.4 whales per annum a more realistic estimate of fatal collisions (Panigada et al., 2006).

Lethal collisions increase during the summer months, when vessel traffic peaks, particularly in areas where fin whale are known to aggregate, such as the Ligurian basin (Notarbartolo di Sciara et al., 2003). Data obtained by Panigada et al. (2006) suggests that the Corso-Ligurian-Provencal Basin, the Gulf of Lions and the adjacent waters represent the most high-risk areas. Whilst the extent of the risk may seasonally vary, this must be considered in relation to a higher study effort and probabilities of hit whales being retrieved in the summer months. One interviewee expresses it as follows: *'The traffic is seasonal but it is also all year round. It increases in the summer, but whales are subjected to traffic all year round' [RC-04]*.

Due to the high anthropogenic naval pressure, Mediterranean fin whales are likely to be facing the threat of ship strikes during their seasonal migrations as well as in their feeding aggregation areas. For instance, the risk of collisions is high along the north—southwest migration route off the coasts of Italy, France and Spain (Castellote et al., 2011). Fast speed ferries are operating in spring and autumn—when the migration takes place—connecting the main land to the Balearic Islands and Corsica, and thus perpendicularly transecting the migratory route. An interviewee comments on this risk as follows: *'When they are migrating they are facing the threat of ship strikes. The perpendicular angle maximises changes of being hit' [RC-01]*. The same interviewee reports that from six ferry surveys in Spain, one collision was confirmed and another hit was probable but not yet confirmed.

In the Tyrrhenian Sea high speed ferries, such as those connecting Civitavecchia and Sardinia, overlap with putative migration pathways (Arcangeli et al., 2008). In addition to ferries, commercial ships and containers pose a threat to migrating fin whales, particularly in the Sicily channel and the strait of Messina, which are likely to act as bottlenecks for regular movement. An interviewee describes how: *'The straits [of Sicily and Messina] are subject to intensive maritime traffic and form key areas for economic exchange between eastern and western Mediterranean countries'* [RC-09]. In addition to hitting whales, it is further possible that ships may displace fin whales from regular migration habitats. This form of disturbance or habitat degradation is suspected to have occurred in the Strait of Messina. As described by one interviewee: *'Fin whales may have to choose a different direction or movement pattern to avoid high traffic'* [RC-06].

If the whales are individually dispersing during winter and no paths for migration exists, the risk of ship collisions will be more spatially spread out rather than localised in hot spots of high encounter risk. This scenario has implications for the applicability and prospects of mitigating ship—whale collisions.

5.4. Uncertainty

5.4.1. Implications and Contrasting Views

Uncertainties surrounding fin whale migratory patterns represent a key challenge for achieving conservation on a scale that corresponds to the scale of the population's distribution range. As outlined in Chapter 4, I have combined sources of uncertainty into an overarching Uncertainty Matrix (Table 5.2.). I further reiterate that the categorisation of these uncertainties into epistemic and ontological is not absolute (see Chapter 4, Section 4.2.4.).

Given the presence of considerable scientific uncertainty, it is not possible to rule out a mutual coexistence of the two theoretical perspectives on fin whale migration. However, the conceptual issue of a more directional vs. a more dispersal movement pattern has implications for conservation. The core issue underlying these two perspectives is whether the primary uncertainty that needs to be addressed is more epistemic or ontological in nature.

'Directional' migration is more spatially and temporally predictable and thus easier to protect using place-based conservation measures. If a proportion of the Mediterranean fin whales indeed move along identifiable migratory routes, the immediate challenge is the reduction of epistemic uncertainties—such as seasonal use, width of route, and overlap with ship traffic—by strategic and prioritised research that targets key knowledge gaps. By contrast, if the whales are following a more dispersal-like pattern away from their summer feeding aggregation areas, they inherently move with higher degrees of unpredictability. Intra-species variation in seasonal movements is likely to be greater the more dynamic the overall species migration pattern is. The ontological uncertainty is higher and with it the challenge that more research may not yield more conclusive results.

The repeated use of the same migratory locations can be discussed in terms of site fidelity (Schuter et al., 2011). Site fidelity confers numerous benefits to migrants, including familiarity with environmental conditions and resources, as well as disadvantages, for example by making them more vulnerable to threats and habitat loss compared to migrating individuals with more variable use of space (Schuter et al., 2011). In other words, if fidelity by individuals to a migratory path is low, the ontological uncertainty is likely to be higher and place-based conservation more challenging.

It is worth noting that the level of ontological uncertainty may also increase in the future due to the effects of climate change. Whilst observed changes to a warming climate can be used in predictive models, climate change *per se* and its ultimate effects on whale and whale prey behaviour are arguably dynamic, stochastic, and unpredictable to foresee. In the Mediterranean, an assessment of sea temperature effects on fin whale distribution shows that whale distribution may change in response to climate variability (Azzellino et al., 2008). Exactly how the Mediterranean environment will be effected and what consequences this will have for fin whales in terms of their seasonal migration is extremely challenging to predict. An interviewee shares this concern:

'The sea is changing very rapidly and climate change seems to be more of an issue in the Mediterranean than in other areas. The problem is that the Mediterranean is a semi-enclosed sea; if it warms up and productivity decreases and currents change the whales can't go further north, whereas in the open Atlantic they can go past Greenland if you have to reach productive feeding areas' [PC-01].

Drawing on the theoretical framework outlined in Chapter 3, the different perceptions of directional and dispersal movement patterns can also be viewed in terms of multiple knowledge frames of the same data and issues, a source of uncertainty referred to as ambiguity (Brugnach et al., 2008). It can therefore be argued that high levels of ambiguity exist within the research community regarding Mediterranean fin whale migration. With the following comments, two interviewees reflect the ambiguity well: *'In the Med we are not really talking about migration' [RC-04]*, versus: *'They are following a migration pattern' [RC-01].* The resulting ambiguity can thus be understood in terms of disparate perceptions surrounding the core issue of how fin whales seasonally utilise the basin, including what the term 'migration' entails.

The question of how to define migration is a recurring topic in the literature, as outlined in Chapter 2. In terms of Mediterranean fin whales, it is interesting to examine the term 'nomadism'. Jonzen et al. (2011) discuss migration as one end point of a continuum of large-scale movement strategies with nomadism representing the other end. In contrast to their interpretation of migration, nomadism is described as a lack of regularity in spatiotemporal movements. However, the authors (Jonzen et al., 2011:93) point out that 'the classification of a species as nomadic or not could simply reflect the amount of knowledge we have on movement patterns. Frequently, a lack of observed regularity for a given species has resulted in movements being classified as nomadic [...] Variability in migratory and nomadic movements between individuals in a population, and between years may further obscure the distinction'.

It is possible that Mediterranean fin whales have evolved a more nomadic migratory cycle. However, it is also possible that not enough studies have been conducted to ascertain on which end of the continuum fin whale movement patterns tend to fall. An increasing body of evidence is, however, indicating that nomadism, partial, and differential migration, and winter feeding are not uncommon in other populations and species of mysticetes. The 'peculiar' movement strategies of the Mediterranean fin whales may thus not be as anomalous as previously thought. Indeed, it can be argued that the traditional paradigm of baleen whale migration warrants revisions to incorporate more flexible wide-ranging movement strategies observed in a number of whale populations (Figure 5.5). To this end, greater mergence with terrestrial discourse would be valuable in order to find a common language to describe and understand these phenomena.

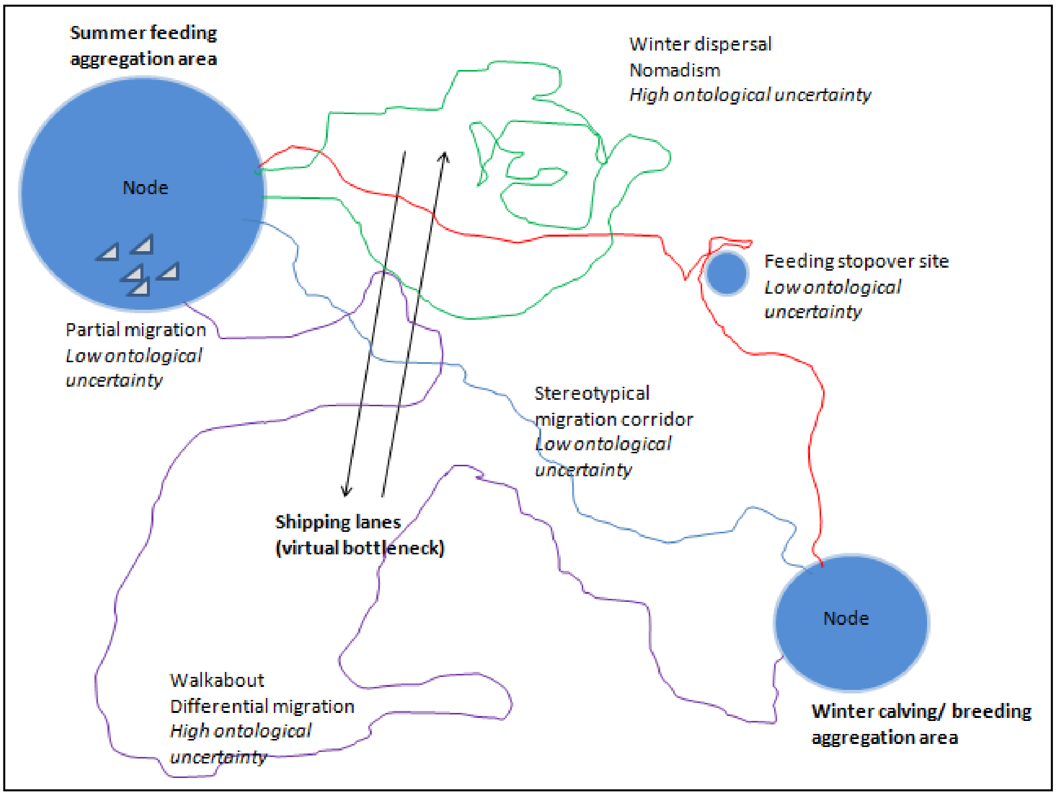

Figure 5.5. Simplified schematic of a landscape view on baleen whale seasonal migration patterns, including stereotypical migration between summer and winter nodes, and more flexible movement strategies. Lines represent imaginary whale tracks. Blue line: traditional paradigm of baleen whale migration. Red line: migration via a stopover site. Green line: dispersal over a large habitat margin. Purple line: exploration or walkabout by individual whales, often male juveniles. Small triangles represent whales that may not undertake a seasonal migration.

Another source of ambiguity relates to disparate views on the implications of scientific uncertainty for conservation. The different knowledge frames can be phrased as follows: lack of data is the primary impediment to conservation vs. conservation must proceed without scientific certainty. In the former perspective, the implicit opinion is that epistemic uncertainties constitute the greater challenge for conservation. Stressing the importance of having a strong knowledge-base for conservation may stem from a variety of factors. For example, it may reflect the concern that industries tend to demand full knowledge and that there is little tolerance of uncertainty is the policy arena (Bradshaw et al., 2000). As described by one interviewee:

> *'Policy makers always want complete information, and they always take the lack of info as an excuse to do nothing. This is very bizarre as in other dimensions of life we don't require full understanding. People are perfectly happy in business not to have absolute certainty about what's going to happen in the market for instance and they are willing to take a chance. But for some reason when it comes to environmental policy both on land and in the sea there is this desire to have complete info, and we can never have it' [PC-01].*

By contrast, the latter perspective implicitly regards ontological uncertainty as the greatest implication for effective conservation. It stresses more the importance of using available data for conservation purposes, and the need to accept the inevitability of uncertainty in whale and ocean research. An interviewee captures this view by the following statement:

> *'It's a bit frustrating as [conservation] decisions are being made with limited knowledge, we all know that, but we have to do it, we have to keep moving and we have to do the best we can with the knowledge we have, but we are dealing with a huge knowledge vacuum'[PC-07].*

Table 5.2. Uncertainty Matrix. Nature of uncertainty in relation to fin whale migration in the Mediterranean Sea and the ship strike threat during migration. It is recognised that uncertainty is rarely absolute, but rather 'tending toward' epistemology or ontology on a gradient of uncertainty (see Chapter 3, Section 4.2.4). The sources of uncertainty presented below are discussed in the text.

	NATURE		
LOCATION	**EPISTEMIC**	**ONTOLOGICAL**	**AMBIGUITY**
Fin whale migration in the Mediterranean Sea	• Winter 'end destinations'? • Existence of breeding/ calving areas? • Migration to the East from Lampedusa? • Strait of Sicily migration bottleneck? • Tyrrhenian Sea a North to South migration area? • Migration patterns adjusted to prey cycle? • Atlantic/Mediterranean fin whale migratory overlap?	• Random individual or intra-species variation in migration pattern • Unpredictable dispersals from summer areas • Climate change impacts on migration	• Fin whales are following a migration pattern vs. fin whale movements cannot be described as a migration • Lack of data is the main challenge for conservation vs. conservation waits too much for scientific information
Ship strike threat during migration	• Med-wide info on ship density and speed • Severity of threat on population level? • Extent of ship strikes in winter? • Fin whale avoidance of areas with high ship density?	• Stochastics of individual strikes ('wrong place at the wrong time')	

Another interviewee comments further:

> *'Sometimes we wait too much for scientific information; there is missing enforcement and management, not missing data or knowledge gaps. Scientists are spoiling the system because they don't want to have management decisions without full knowledge. It can take a century to get more data, and in this time you will have a change in the system due to variability'* [PC-04].

Uncertainties related to the threat of ship strikes are mainly epistemic in nature (Table 5.2). That is; whilst individual strikes can be argued to be stochastic, as they require the ship and whale to be exactly crossing each other's paths at exactly the 'right' (i.e. wrong) time, for the purpose of this thesis the relevant information relates to the overarching risk of whales being struck during their migratory journeys. Therefore, even though theoretically there may be a prolonged period without any strikes or a period with lots of strikes in areas where whales and vessels co-occur, it is the knowledge about the co-occurrence that warrants conservation action.

Knowledge of whale and ship co-occurrence in the Mediterranean is greatly impeded, since basin-wide information on shipping density, routes, and transit speed is lacking. This prevents examination of spatial and temporal patterns of animal—vessel overlap where the risk may be particularly high. In addition, it negatively influences the ability to monitor compliance with measures that may be adopted in the future (IWC—ACCOBAMS, 2010).

For reasons unknown *B. physalus* is the baleen species most commonly hit by vessels (Laist et al., 2001). Whilst a serious issue and known cause of mortality on an individual level, the extent to which ship strikes affect the Mediterranean fin whales on a population level is yet to be determined. In order to understand the impact of ship strikes at the population level, improved population trend estimates and information on the co-occurrence of whales and maritime traffic is required (Donovan and Leaper, 2010).

5.5. Conservation Strategies

5.5.1. A Sea of Geopolitical Complexities

5.5.1.1. The United Nations Convention on the Law of the Sea

The maritime jurisdictions stipulated in the United Nations Convention on the Law of the Sea (UNCLOS) treaty have significant implications for the geopolitical environment and marine conservation of the Mediterranean Sea.[19] The UNCLOS sets out, under a common legal framework, the delimitation of the marine realm into different maritime zones, and stipulates the rights as well as the obligations of states in their usage of the world's oceans. The breadth of the maritime zones is calculated according to a baseline[20] (Figure 5.6). The coastal state exerts sovereign rights over an area termed territorial seas, which extends to 12 nautical miles (nm) from the baseline[21]. Vessels of all states (coastal or land-locked) have the right of 'innocent passage' through territorial seas (Art. 17).

Beyond the territorial seas, the coastal state may continue to enforce laws related to pollution, taxation, customs, and immigration in a so called contiguous zone, which may not extend further than 24 nm from the baseline (Art. 33). In the case of States with opposite and adjacent coasts, a medial line rule is applied where every point is equidistant from the nearest points on the baselines from which the breadth of the territorial seas of each of the two States is measured (Art. 15).

Coastal states can further claim an Exclusive Economic Zone (EEZ) (Art. 55), extending up to 200 nm from the baseline limit (Art. 57). Unlike the territorial seas, the EEZ requires a proclamation by the coastal State. Within its proclaimed EEZ the coastal nation has:

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[19] UNCLOS, an international agreement stemming from the third United Nations Conference on the Law of the Sea (UNCLOS III), was developed between 1973 and 1982. The Convention was finally adopted on 10 December 1982 in Montego Bay, Jamaica, and entered into force on November 16, 1994. To date, 160 nations, Niue, Cook Islands and the European Union have ratified the convention.

[20] The baseline follows the low water line along the coast in the case of regular coastlines (Article 5). Alternatively, in the case of deeply indented coastlines and/or where there is a fringe of islands along the coast, '...the method of straight baselines joining appropriate points may be employed in drawing the baseline' (Article 7).

[21] 'The sovereignty of a coastal State extends, beyond its land territory and internal waters and, in the case of an archipelagic State, its archipelagic waters, to an adjacent belt of sea, described as the territorial sea. This sovereignty extends to the air space over the territorial sea as well as to its bed and subsoil' (Article 2).

> 'Sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds' (Art. 56).

Other states retain within a foreign EEZ the freedom of navigation, overflight, right to lay submarines and pipelines, and other lawful uses, such as those associated with the operation of ships, aircraft and submarine cables and pipelines (Art. 58).

The continental shelf is defined as the natural prolongation of the land mass to the outer edge of the continental margin, or up to 200 nm from the baseline (Art. 76). In the latter case, the continental shelf by legal definition does not correspond to the geographical continental shelf. By contrast, the continental shelf may never exceed 350 nm from the baseline or 100 nm beyond the 2 500 meter isobath[22]. Coastal nations exercise inherent sovereign rights (that is; *ipso jure* without need for proclamation) over the continental shelf to exploit its natural resources in the subsoil and living resources that are sedentary to the sea bed, but not with regards to organisms living in the water column beyond the EEZ boundary (Art. 77).

The oceans beyond national maritime zones are referred to as the High Seas, defined by UNCLOS as 'all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State' (Art. 86). All states, whether coastal or landlocked, enjoy the freedom of navigation, overflight, to lay submarine cables and pipelines, to construct artificial islands and other installations, fishing, and scientific research. The freedom of the high seas is not totally unrestricted, however, and should be exercised 'under the conditions laid down by this Convention and by other rules of international law' (Art. 87).

[22] In the context of the Mediterranean basin, where the continental shelf is generally narrow, the continental margin criterion, which presupposes a continental shelf extending beyond 200 nautical miles, is irrelevant (Cacaud, 2005).

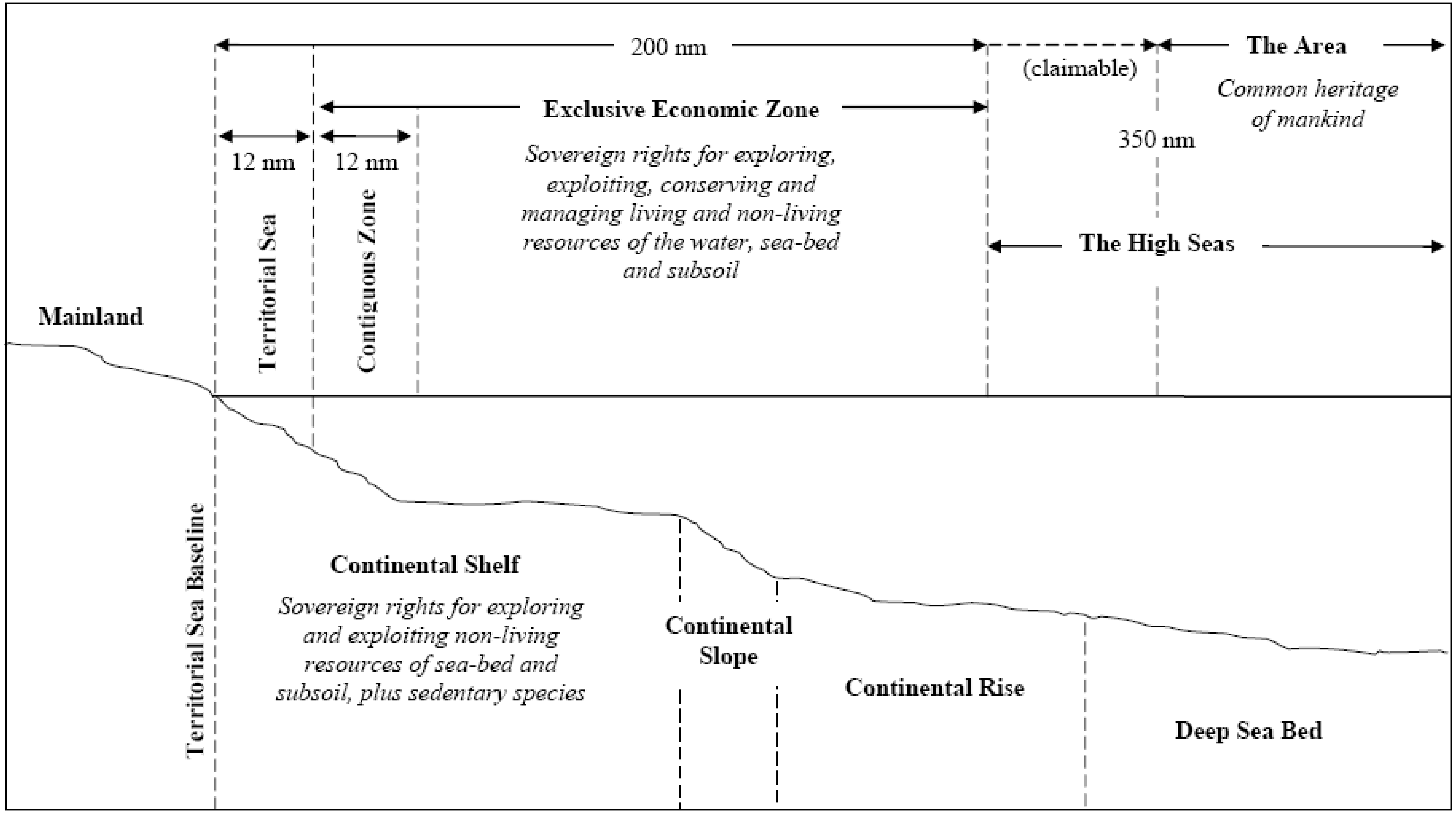

Figure 5.6. UNCLOS maritime zones. From De Santo (2007).

Nevertheless, conserving the marine environment on the high seas—which cover approximately two-thirds of the world's oceans—is a challenging task. Establishing, for example, Marine Protected Areas on waters that lay beyond the jurisdiction of any one state requires global co-operation and political goodwill, since efforts to establish protection measures must conform to international law (Gjerde and Breide, 2003).

The problem with the high seas is also one of third states. This is particularly relevant to the Mediterranean Sea, since it is heavily used for international navigation through routes crossing the Strait of Gibraltar and the Suez Canal, which, respectively, serve as the link to the Atlantic and Indian Oceans. If the flag state of a ship is not a party to a treaty covering the marine areas beyond national jurisdiction, the regulations of that treaty do not apply to the ships flying that state's flag[23] (UNEP-MAP-RAC/SPA, 2011).

5.5.1.2. Mediterranean Maritime Zones: Implications for Conservation

The Mediterranean, defined as a 'semi-enclosed sea' according to UNCLOS[24], is a bridge between three continents and one of the most heavily used and populated marine regions in the world. It is surrounded by 21 states, seven of which are European Union members[25]. Human pressures on the basin are extensive and the situation is complex given the different levels of economic development, political climate, and cultural values between the bordering countries (e.g. Notarbartolo di Sciara and Agardy, 2009).

To date, all Mediterranean countries have established the 12 nm territorial seas, as set out by the UNCLOS, with the exception of Greece and Turkey. With regards to the Aegean Sea, Greece and Turkey have not extended their territorial seas beyond a 6 nm limit owing to a complex local dispute (Cacaud, 2005). Of particular importance, Mediterranean states have been reluctant to proclaim their Exclusive Economic Zones

[23] Art. 34 of the Convention on the Law of Treaties (Vienna, 1969): "a treaty does not create either obligations or rights for a third State without its consent"

[24] Article 122 Definition of a semi-enclosed sea: 'a gulf, basin or sea surrounded by two or more States and connected to another sea or the ocean by a narrow outlet or consisting entirely or primarily of the Territorial seas and Exclusive Economic Zones of two or more coastal States'.

[25] Spain (EU), France (EU), Greece (EU), Cyprus (EU), Italy (EU), Malta (EU), Slovenia (EU), Croatia, Monaco, Bosnia and Herzegovina, Montenegro, Albania, Turkey, Syria, Lebanon, Israel, Egypt, Libya, Tunisia, Algeria, Morocco. The United Kingdom (as far as the sovereign base areas of Akrotiri and Dhekelia are concerned) would add up a 22nd coastal State. This paper does not consider the Black Sea, a semi-enclosed sea connected to the Mediterranean by the straits of Dardanelles and Bosphorus.

(EEZ) (Figure 5.7). This has resulted in a peculiar jurisdictional picture with approximately 50 per cent of the basin being regarded as the 'common' high seas (Scovazzi, 2003). The limited geographical space in the Mediterranean basin causes maritime boundary overlaps. Indeed, if the EEZ rule were adopted by all states, the entire Mediterranean waters would be subjected to national coastal state jurisdictions, as no point in the basin is located farther than 200 nm to the closest land or island (UNEP-MAP-RAC/SPA, 2011).

The existing geopolitical landscape, territorial disputes, and unsettled maritime jurisdictions have led to a complex maritime situation in the Mediterranean (e.g. Scovazzi, 2004). Presently, treaties for the delimitation of the territorial sea have been concluded between Italy and Yugoslavia (1975) with respect to the Gulf of Trieste; France and Italy (1986) with regard to the strait of Bonifacio between Corsica and Sardinia; and between Croatia and Bosnia and Herzegovina (1999). Bilateral agreements on delimitation of the continental shelf are so far in force between the following states: Italy and Yugoslavia (1968); Italy and Tunisia (1971); Italy and Spain (1974); Greece and Italy (1977); France and Monaco (1984); Libyan Arab Jamahiriya and Malta (1986); and Libyan Arab Jamahiriya and Tunisia (1988). Another agreement was signed in 1982 by Albania and Italy but has not yet entered into force (UNEP-MAP-RAC/SPA, 2011).

Spain and France have proclaimed EEZs off their Atlantic coast, but have stated that the zones do not apply to the Mediterranean Sea. Similarly, although Morocco proclaimed its EEZ in 1981, the country has yet to enter into negotiations with Spain to define the extent of the EEZ in Alboran Sea and other Mediterranean waters. Cyprus and Egypt, as well as Cyprus and Lebanon, signed an agreement on the delimitation of their EEZs in 2003 and 2007, respectively. In 2003 Syria provided for the establishment of an EEZ, and in 2005 Tunisia established an EEZ, although the modalities are to be determined by decree (UNEP-MAP-RAC/SPA, 2011).

Some nations have chosen to claim only certain rights comprised in the EEZ regime, such as those relating to fishing—Fisheries Protection Zones—(FPZ) or those relating to the protection of the marine environment—Ecological Protection Zones (EPZ). The establishment of such zones are not mentioned in the UNCLOS, but they are fully compatible with international law, since the principle is that if a state is entitled to do more (i.e. to establish an EEZ), it can also do less (*in maiore stat minus*). In practice this means that a zone may be created where the nation exercises only some of the powers granted to the coastal State under the EEZ regime (UNEP-MAP-RAC/SPA, 2011). Five Mediterranean countries—Algeria, Malta, Spain, Tunisia and Libya—have claimed FPZs that extend beyond territorial waters. France (2004) has declared an EPZ in the Mediterranean under the MARPOL anti-pollution convention, and Croatia (2004) has created an Ecological and Fisheries Protection Zone (UNEP-MAP-RAC/SPA, 2011).

However, as recent developments, France declared an EEZ in the Mediterranean in October 2012, au lieu of its Ecological Protection Zone, and Italy established an EPZ in its western waters in October 2011. Whilst Libya has only signed and not yet ratified UNCLOS, it has nevertheless declared an EEZ. Taken together, this has reduced the total area of the Mediterranean High Seas to approximately 30% (Figure 5.7) (Suarez de Vivero, 2012).

The complex geopolitical situation of the Mediterranean Sea is globally unique, only matched in terms of small island disputes in the Southeast China Sea (Scovazzi, pers. comm.). Three main factors have been discussed as reasons for the reluctance to establish EEZs by the Mediterranean states: i) geo-political difficulty of delimitation, ii) assumption that the Mediterranean basin is void of rich living resources, and, in particular, iii) the wish of most nations to have basin-wide access to fisheries (Cacaud, 2005). An interviewee from the policy community comments:

> *'The reason why certain countries are reluctant is that they give priority to fishing. They like to fish close to the coast of other states, and this would be prevented by the establishment of EEZs' [PC-06].*

The failure to settle maritime boundaries, in addition to the disparate ratification of regional and international treaties by Mediterranean states (Table 5.3), has created a 'patchwork' of legal rights and obligations on the Mediterranean high seas, impeding effective management of the marine environment by causing gaps in governance (Cacaud, 2005). The regional complexities of the Mediterranean Sea have ramifications for the protection of pelagic cetacean species, such as fin whales. Transboundary movements between summer and winter feeding sites mean that the animals are to a large degree found in the Mediterranean high seas, or Areas Beyond National

Jurisdiction (ABNJ), which are beyond the jurisdiction of Mediterranean nations to adopt and enforce laws (Scovazzi, 2003). For example, large parts of the Sicily Channel, potentially a migration bottleneck for fin whales and other migratory marine megafauna traversing between the eastern and western basins, are comprised of the high seas. With regards to the proposed migration route north—southwest along the French and Spanish coasts, it is only partly covered by the recently proclaimed French EEZ and partly by the Spanish FPZ, which is considered as ABNJ (UNEP-MAP-RAC/SPA, 2011).

The establishment of EEZs represents the best way to address the shortcomings of Mediterranean High Sea governance (Scovazzi, 2004). One interviewee comments on this need:

> *'The final result should be the elimination of the high seas in the Mediterranean, because the high seas mean lack of regulation, lack of regime, you can do whatever you want. You cannot manage a regional sea without EEZs' [PC-06].*

Since fishing fleets of foreign nations are prohibited within an EEZ, the adoption of EEZs by some states will increase the pressure of other coastal states to follow suit (Kariotis, 2007). Due to the few recent EEZ proclamations an interviewee remarks: *'I think the picture is changing and there is a trend towards establishing EEZs, but it will take a long time' [PC-04]*. Notwithstanding, in the absence of further EEZ proclamations, protection of the Mediterranean high seas marine environment requires a greater reliance on regional conventions, cooperation, and general political goodwill.

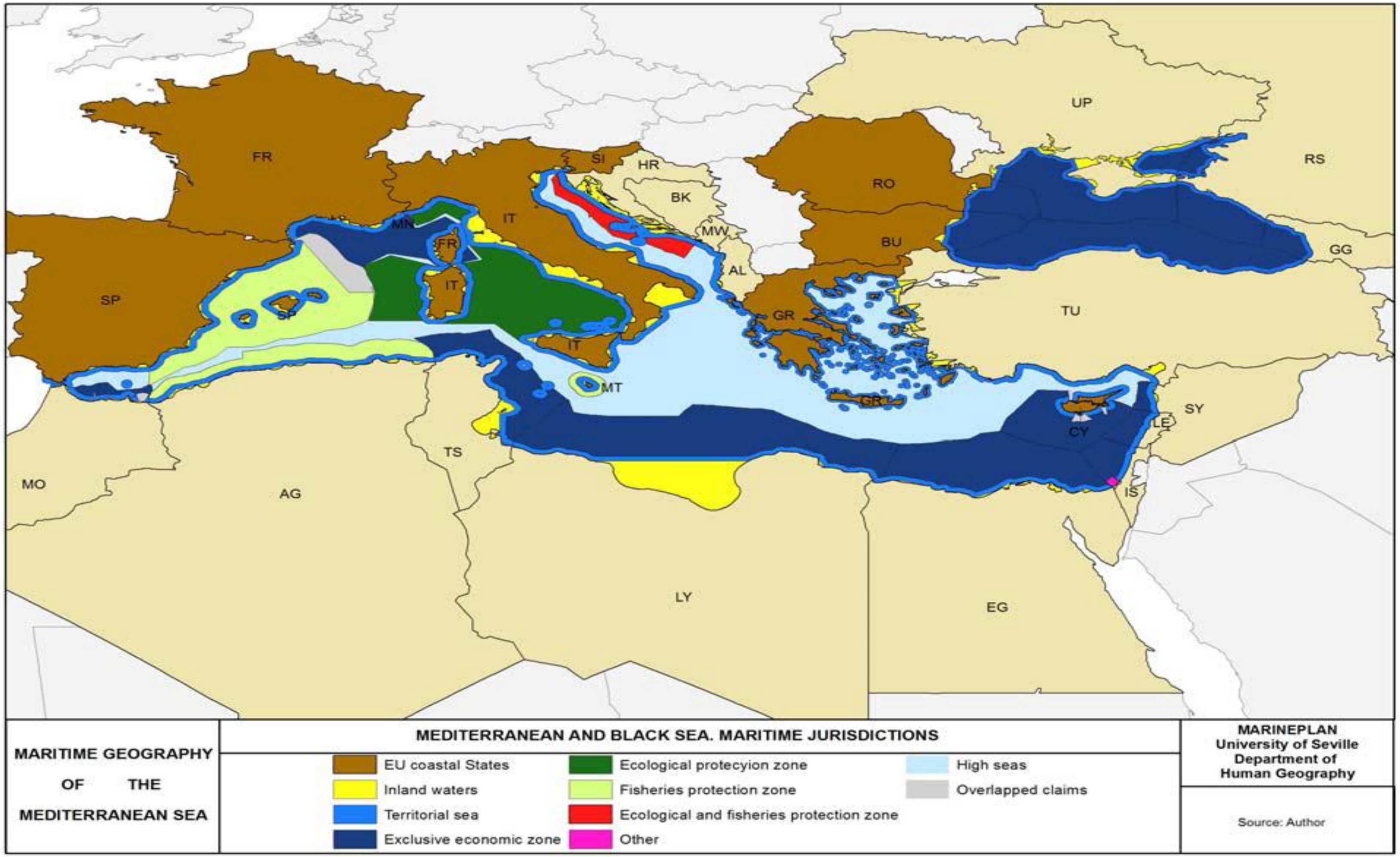

Figure 5.7. Current status of maritime jurisdictions in the Mediterranean Sea. From Suarez de Vivero (2012).

Table 5.3. States bordering the Mediterranean Sea, including the European Community, and the extent of ratification of international and regional treaties relevant to cetacean conservation. Accession refers to when a state joins a treaty after it was open for signature. Ratification, Acceptance and Approval are legal equivalences but only applicable to nations that sign a treaty when it is open for signature. BARCON = The Barcelona Convention, ACCOBAMS = Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area, IWC = The International Whaling Commission, CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora, CBD = Convention on Biological Diversity, CMS = Convention on Migratory Species, Bern = Bern Convention.

MED. STATES	UNCLOS	BARCON	ACCOBAMS	IWC	CITES	CBD	CMS	BERN
EU states								
European Community	X	X	NS	NS	NS	NS	X	X
Cyprus	X	X	X	X	X	X	X	X
France	X	X	X	X	App	X	X	X
Greece	X	X	X	X	Acc	X	X	X
Italy	X	X	X	X	X	X	X	X
Malta	X	X	X	NS	Acc	X	X	X
Slovenia	X	X	X	X	Acc	X	X	X
Spain	X	X	X	X	Acc	X	X	X
Candidate EU states								
Albania	X	X	X	NS	Acc	Acc	X	X
Bosnia-Herzegovina	X	X	NS	NS	Acc	Acc	NS	X
Croatia	X	X	X	X	Acc	X	X	X
Montenegro	X	X	X	NS	Scc	Scc	X	X
Non-EU states								
Monaco	X	X	X	X	Acc	X	X	X
Non-European states								
Algeria	X	X	X	NS	Acc	X	X	NS
Egypt	X	X	X	NS	Acc	X	X	NS
Israel	NS	X	NS	X	X	X	X	NS
Lebanon	X	X	X	NS	NS	X	NS	NS
Libya	Sig	X	X	NS	Acc	X	X	NS
Morocco	X	X	X	X	X	X	X	X
Syria	NS	X	X	NS	Acc	X	X	NS
Tunisia	X	X	X	NS	X	X	X	X
Turkey	NS	X	NS	NS	Acc	X	NS	X

Key	
X = Ratified/contracting party	Acc = Accession
Sig = Signed but not yet ratified	Apv = Approval
NS = Not signed/ not a contracting party	Succ = Succession

5.5.2. The SPAMI Network

The network of Specially Protected Areas of Mediterranean Importance (SPAMIs) in Areas Beyond National Jurisdiction is an initiative under the Specially Protected Areas and Biological Diversity (SPA/BD) Protocol of the Barcelona Convention.

5.5.2.1. The Barcelona Convention and the SPA/BD Protocol

The Barcelona Convention—the legal component of the United Nations Environment Programme (UNEP) Mediterranean Action Plan (MAP)—represents the main regional conservation tool that is able to address marine conservation and MPA designation on the Mediterranean high seas. Subsequent to the 1972 United Nations Conference on the Human Environment, the UNEP Regional Seas Programme was established in 1974. In 1975 the MAP, representing the first-ever Regional Seas Programme under UNEP's umbrella[26], was adopted by 16 Mediterranean countries and the European Community. The same Parties signed the Convention for the Protection of the Mediterranean Sea Against Pollution in 1976, known as the Barcelona Convention, which entered into force in 1978.

Following the Rio Conference on Environment and Development (1992), in 1995 the Contracting Parties agreed to replace the Mediterranean Action Plan of 1975 with the Action Plan for the Protection of the Marine Environment and the Sustainable Development of the Coastal Areas of the Mediterranean, which entered into force in 1999[27]. Simultaneously, the Contracting Parties adopted an amended version of the 1976 Barcelona Convention, which was renamed the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean. Notably, the amended version included provisions for the precautionary principle and the polluter pays principle (Art. 4, Para.3), and measures to protect and preserve biological diversity (Art. 9A, renumbered as Art. 10).

The Barcelona Convention, which includes all Mediterranean coastal states and the European Community as contracting parties, consists of Seven Protocols, which aim to address specific aspects of Mediterranean environmental conservation:

[26] Other examples of Regional Seas Programmes include OSPAR in the North Eastern Atlantic, the Helsinki Convention in the Baltic, and the Bucharest Convention in the Black Sea.
[27] MAP Phase II, revised after the conclusions of the third Earth Summit in Rio de Janeiro, Brazil, in 1992.

i. Dumping Protocol (from ships and aircraft)
ii. Prevention and Emergency Protocol (pollution from ships and emergency situations)
iii. Land-based Sources and Activities Protocol
iv. Specially Protected Areas and Biological Diversity Protocol
v. Offshore Protocol (pollution from exploration and exploitation)
vi. Hazardous Wastes Protocol
vii. Protocol on Integrated Coastal Zone Management

Of relevance for cetacean conservation, in general, and fin whale conservation, in particular, is the Protocol concerning Specially Protected Areas and Biological Diversity Protocol (SPA/BD Protocol), which replaced the Protocol concerning Mediterranean Specially Protected Areas of 1982 (Geneva, 1982). The Regional Activity Centre for Specially Protected Areas (RAC/SPA), established in Tunis in 1985 by decision of the Contracting Parties to the Barcelona Convention, is responsible for implementing the SPA/BD Protocol.

The SPA/BD Protocol applies to all waters, irrespective of legal designation, the sea-bed and its subsoil and the terrestrial coastal areas designated by each of the parties (Art. 2). The inclusion of the high seas was considered by the Contracting parties as a necessary step to improve the conservation of cetaceans and other migratory marine species (Scovazzi, 2004)[28]. The Protocol stresses, *inter alia*, the importance of establishing specially protected areas for the conservation of threatened species[29]. It stipulates (Art. 12) that 'the Parties shall adopt cooperative measures to ensure the protection and conservation of the flora and fauna listed in the Annexes to this Protocol relating to the List of Endangered or Threatened Species'[30]. For migratory species, with ranges extending to both sides of a national border, the relevant Parties shall cooperate with an aim to ensure the protection of such a species (Art. 12, para. 5).

[28] The 1982 Protocol did not include the high seas.
[29] Threatened species is defined as 'any species that is likely to become extinct in the foreseeable future throughout all or part of its range and whose survival is unlikely if the factors causing numerical decline or habitat degradation continue to operate'.
[30] The procedures for the establishment and listing of SPAMIs are outlined in Article 9.

As a legal instrument, the Protocol provides for the establishment of specially protected areas in the marine and coastal zones subjected to a Party's sovereignty and jurisdiction (Art. 5). It further stipulates that Parties shall draw up a 'List of Specially Protected Areas of Mediterranean Importance', referred to as the 'SPAMI List' (Art. 8, para. 1.). Criteria for eligible inclusion in the SPAMI list entail, *inter alia*, 'presence of habitats that are critical to endangered, threatened or endemic species'[31].

The decision to include a site in the SPAMI list is taken by consensus by the Contracting parties, which also approve the management measures (Art. 9, para. 4c). SPAMIs may be established either in maritime zones subjected to the sovereignty or jurisdiction of the Parties, and/or zones partly or fully in the high seas (Art. 9, para. 1). The proposal to list an area located on the high seas as a SPAMI must be made by two or more neighbouring parties concerned. Once an MPA is included in the SPAMI list, all parties to the Barcelona Convention must comply with the measures and objectives applicable to the SPAMI.

As to the relationship with third countries, the contracting parties shall 'invite States that are not Parties to the Protocol and international organizations to cooperate in the implementation' of the SPA Protocol (Art. 28, para. 1). This is a necessary provision with regards to SPAMIs situated on the high seas, since the SPA/BD Protocol can produce regulations only among the contracting parties to the Barcelona Convention (UNEP-MAP-RAC/SPA, 2011).

The first 12 SPAMIs were inscribed in the list during the 12th meeting of the parties in Monaco in 2001. As of 2009, a total of 25 SPAMI sites have been designated. To date, the only SPAMI site that includes the high seas beyond 12 nm territorial zones is the French-Italian-Monegasque Pelagos Sanctuary for marine mammals, which is the first ever high sea MPA to be established (see Notarbartolo di Sciara et al. (2008) for a review of the Sanctuary).

5.5.2.2. Contribution of the SPAMI Network to Fin Whale Conservation

The Mediterranean represents one of the few regions in the world where countries are cooperating under a regional legal framework to develop a network of MPAs (Agardy,

[31] Annex II lists endangered and threatened species and include all cetacean species found in the Mediterranean

2010). This initiative, implemented by the RAC/SPA, aims to create a network of Specially Protected Areas of Mediterranean Importance on the high seas, or Areas Beyond National Jurisdiction. Within the SPAMI network context, the Mediterranean high seas are considered to be 'all seas beyond the riparian nations' territorial waters (except for Greece and Turkey, where the territorial waters end at 6 nm from the coast)' (Notarbartolo di Sciara and Agardy, 2009:6).

The initial phase of the project used a three-step hierarchical process to delineate areas of considerable conservation importance:

1. Identification of large scale ecological subregions within the Mediterranean. A total of eight subregions—Alboran Sea, Algero-Provencal Basin, Tyrrhenian Sea, Adriatic Sea, Ionian Sea, Tunisian Plateau-Gulf of Sidra, Aegaean Sea, Levantine Sea—were distinguished for the purpose of this project.
2. Selection of sites of priority conservation areas, known as Ecologically or Biologically Significant Areas (EBSAs), within each ecological subregion. To this end, selection criteria as outlined in the SPA/BD protocol was used and adapted with additional criteria from other conventions, including the Convention on Biological Diversity (CBD) for the identification of EBSAs, the International Maritime Organisation (IMO) for Particular Sensitive Sea Areas (PSSAs), and the EU Habitat Directive. Ten EBSAs—Alboran Sea, Gulf of Lion area, Nile Delta area, Aegean Sea, Ionian Sea, Tyrrhenian Sea, Balearic Islands area, Tunisian Plateau, Levantine Sea, and Adriatic Sea—were identified across the eight subregions.
3. Application of further analysis in order to identify potential sites [within the EBSAs] that could be protected as SPAMIs, with the aim of preparing a SPAMI short list for presentation to the contracting parties of the Barcelona Convention. In total 15 potential SPAMI sites within the ten EBSAs and across the eight subregions were identified (Figure 5.8).

In the absence of systematic data on the Mediterranean high seas, GIS analyses were not feasible for the identification process of these areas. Instead, key experts on different taxonomic groups were employed to draw polygon maps covering the most important areas supporting their particular taxon. These maps were subsequently overlapped in order to capture areas supporting the largest degree of the different taxonomic groups, according to expert opinion (Notarbartolo di Sciara and Agardy, 2009). Criteria for SPAMI site selection entailed, *inter alia*, presence of habitats that are critical to endangered, threatened or endemic species (Criteria V). Species formally allocated such status are listed in Annex II[32] of the SPA/BD Protocol of the Barcelona Convention. *B. physalus*, as an Annex II-listed species, was therefore explicitly taken into account during the selection process of the SPAMIs.

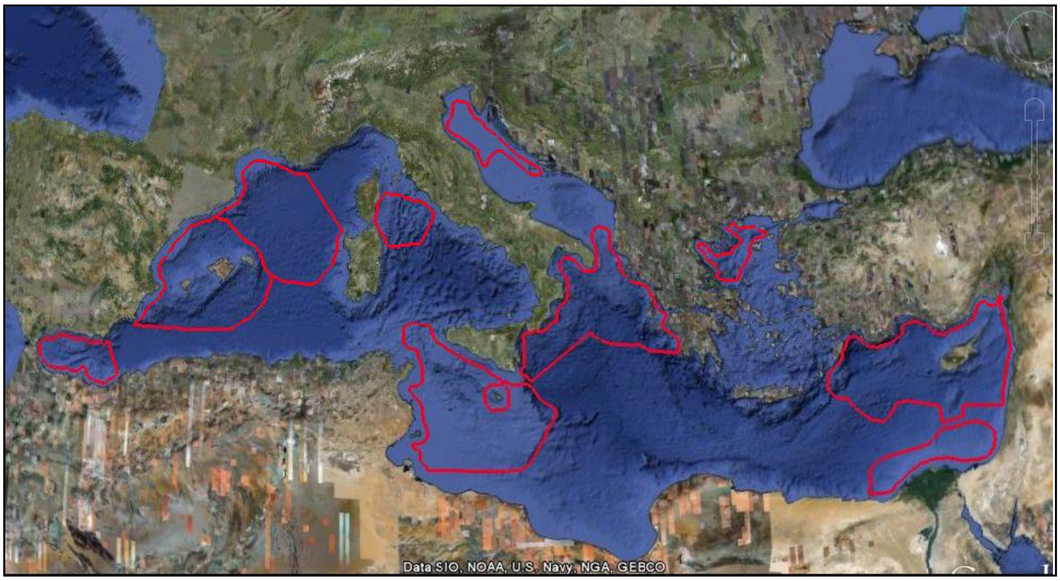

Figure 5.8. Prospective EBSA sites, within which 15 high sea SPAMIs have been proposed. At this stage of the process the exact size or boundaries of the 15 proposed SPAMIs have not been determined. From Notarbartolo di Sciara and Agardy (2009).

The locations of known fin whale critical habitats were incorporated in the selection process of three EBSAs: Gulf of Lion Area, Tunisian Plateau, and the Ionian Sea (Notarbartolo di Sciara and Agardy, 2009). Three additional EBSAs—Alboran Sea, Balearic Islands Area, and Tyrrhenian Sea—are likely to contain key habitats for fin whales. Within the EBSAs, at least five proposed SPAMIs include fin whale critical habitats. These are: Gulf of Lion shelf and slope, Northeast Ionian, Northern Strait of Sicily, Tunisian Plateau, and Southwest Alboran Sea.

The 2005 meeting of the Convention on Biological Diversity in the Azores detailed criteria for ensuring MPA network connectivity, which permeated into the

[32] Eighteen cetacean species are in total included in the SPA/BD Annex II List of Endangered or Threatened Species.

SPAMI network initiative (Agardy and di Sciara, 2009). Notarbartolo di Sciara (2007) discusses how networks of connected MPAs may circumvent issues inherently related to migratory species and provide additional conservation benefits over single MPAs. The prospective high sea SPAMIs that cover fin whale critical habitats, including the existing Pelagos Sanctuary SPAMI, can be considered as 'nodes' which could be connected into a coherent MPA network.

However, whilst the identification of EBSAs allows for the SPAMI network to be *representative*, the question of how the network will be *ecologically coherent* through connectivity remains unanswered. Discussions are currently lacking on how ecological sites, including habitats of migratory cetaceans, could be synergistically linked in theory as well as practice. Without a degree of connectivity it is challenging to envision how migratory species will benefit from greater protection during their seasonal movements.

Next steps in the process of establishing the SPAMI network include socio-economic and legal analyses, feasibility assessment, analyses to determine optimal spatial management (including zoning), the appropriate governance regime, and how areas should be monitored and regulations enforced. Furthermore, a strategic plan aimed at prioritising the potential SPAMI sites will be developed, in order to indicate which of the sites should be the focus of immediate attention from RAC/ SPA and the Conference of the Parties to the Barcelona Convention (Notarbartolo di Sciara and Agardy, 2009).

5.5.2.3. An Unfortunate Dependency on Political Will

On a legal basis, the Barcelona Convention represents a strong regional treaty for conservation despite the complex geopolitical maritime situation of the Mediterranean Sea (UNEP-MAP-RAC/SPA, 2011). Since the European Community (EC) is a ratified party, Member States are implicitly obliged to treat the convention as Community law (De Santo and Jones, 2007). Moreover, international agreements to which the EC is a signatory have the provision for an arbitral tribunal—the European Court of Justice—and thus a unilateral and central authority to ensure enforcement (Matisoff, 2010).

Notwithstanding, the Barcelona Convention is subjected to the general limitations of international conventions, for which targets invariably represent broad political commitments, and the consequences of failure to meet objectives are political rather than judicial. However, conventions such as the Barcelona Convention and the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) (see below) do form international platforms for cooperation with ensuing political pressures to comply (Lyster, 1985; Sands, 2003).

Parties to the Barcelona Convention are required to jointly ensure management and enforcement of SPAMI sites on the high seas, a process which will require considerable political dedication and collaboration. According to the SPA/BD Protocol (Art. 9, para 3), neighbouring parties making proposals for a SPAMI shall provide the management plans and the means for their implementation, and shall consult each other to ensure the consistency of the proposed protection and management measures. As such, the creation of a functioning management regime will require the political will to cooperate and invest resources by relevant parties. A member of the policy community comments:

> *'There can't be a SPAMI unless there is dedication of money and human resources to manage and protect the areas, so they [the contracting parties to the Barcelona Convention] don't open up to this lightly as there will be a requirement of spending money on the sites. They are nervous about the ABNJ, and part of it I think is a legitimate recognition of who will manage these areas if established' [PC-01].*

Notarbartolo di Sciara (2009:2) discusses how a future SPAMI network under the current SPA/BD Protocol 'raises the question of whether a management mechanism appropriate for MPAs in the Mediterranean ABNJ can be envisaged within the existing legislative framework, or whether there is a need for more advanced juridical creativity which will account for the likely multi-national nature of such protected areas'.

A SPAMI network on the high seas will have the benefit of including more fin whale critical habitats within a protected environment. Furthermore, since a legal framework is already in place, adopting measures within a SPAMI will be easier than in the *bona fide* high seas. Notwithstanding, a general scepticism towards the SPAMI network among the members of the research and policy communities exists as a result of the failure to effectively manage the single SPAMI currently established on the high seas; the Pelagos Sanctuary (Figure 5.9).

The Pelagos Sanctuary (Figure 5.9)—spanning waters of different jurisdictions (see Figure 5.7)—covers an area of considerable biodiversity, including known feeding areas of the eight resident cetacean species in the Mediterranean[33], and has the specific objective to protect marine mammals. The Agreement of the Pelagos Sanctuary was signed in Rome in 1999 by the three countries and entered into force in 2002 under great expectations (Notarbartolo di Sciara et al., 2008).

The Sanctuary is inscribed in the SPAMI list, thus making the measures applying in it an obligation for all contracting parties to the Barcelona Convention. The question of whether third states can be forced to comply with measures is ambiguous in the Agreement text[34], and can be interpreted either as i) rules applying in the sanctuary cannot be enforced with regards to foreign ships, since such an action would be an encroachment upon the freedom of the high seas, or ii) when establishing the Sanctuary the parties exercised certain rights which are included in the broad concept of the EEZ, and the parties are therefore entitled to enforce provisions also in respect of foreign ships which are found within its boundaries (UNEP-MAP-RAC/SPA, 2011).

In a legal context the Pelagos Sanctuary can thus be viewed as a model for international cooperation and a joint establishment of a high sea SPAMI. However, in crucial ways the Pelagos Sanctuary arguably represents a model of how *not* to manage a SPAMI. Whilst the parties to the Agreement are required to adopt measures to ensure a favourable conservation status of marine mammals and to protect them and their habitat from direct and indirect negative impacts (Art. 4), the Sanctuary is undermined by the lack of an empowering management structure, and the absence of mitigation measures to address threats posed by *inter alia* fishing activities, maritime traffic, and coastal construction. Indeed, ten years after its creation a management body has yet to be established, with the undermanned Agreement Secretariat acting as a management body surrogate. It is becoming increasingly clear that the lack of political dedication to manage this landmark MPA is causing its failure to meet the primary objective of

[33] Fin whale (*Balaenoptera physalus*), sperm whale (*Physeter catodon*), Cuvier's beaked whale (*Ziphius cavirostris*), long-finned pilot whale (*Globicephala melas*), striped dolphin (*Stenella coeruleoalba*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*) and Risso's dolphin (*Grampus griseus*).

[34] Art. 14, para. 2, of the Agreement allows the parties the right to enforce its provisions on the high seas with respect to ships flying the flag of third States 'within the limits established by the rules of international law'.

improving the conservation status of the Sanctuary's cetacean species (Notarbartolo di Sciara, 2009).

Figure 5.9. Location of the Pelagos Sanctuary in the northwest Mediterranean Sea. From Notarbartolo di Sciara (2009). Note that the recently established EEZ by France, and the Ecological Protection Zone by Italy (Suarez de Vivero, 2012), has changed the maritime jurisdictions within the Sanctuary (see Figure 5.7).

The lack of political will to manage the Pelagos Sanctuary paints a picture of the challenges a future SPAMI network are facing, as expressed by an interviewee:

> *'Management and enforcement is a huge problem. They should use the Pelagos as a laboratory to experiment with creative management regimes. Use Pelagos to find out how to do sensible management in the Mediterranean high seas! It's political incompetency and lack of interest' [PC-05].*

Indeed, as an expression of low political dedication, Mediterranean states have already got 'cold feet' [PC-05] to designate potential high sea SPAMIs of the network. The initial phase of the SPAMI network project was adopted at the RAC/SPA

Extraordinary Meeting of the Focal Points for SPAs in Istanbul, Turkey, 1st June 2010 (RAC/SPA, 2010). However, one proposed SPAMI—the Eratosthenes Seamount—was excluded from the list of future high sea SPAMIs. The representative of Cyprus emphasised that this potential SPAMI site falls entirely within the Exclusive Economic Zone of Cyprus and is therefore an area under its jurisdiction in accordance with UNCLOS provisions. According to the SPA/BD Protocol the concerned Party [in this case Cyprus] should propose the area for inclusion in the SPAMİ List. Cyprus accordingly argued for the Eratosthenes Seamount to be removed from the group of potential SPAMİs proposed by RAC/SPA for the Mediterranean high seas network (RAC/SPA, 2010). The reason for this withdrawal is explained by an interviewee:

> *'Cyprus decided they didn't want a SPAMI in the Eratosthenes Seamount as they found oil. And now things are stuck. People are saying it's too difficult to create SPAMIs in the high seas' [PC-05].*

Moreover, if mitigation measures and regulations are to be adopted within a SPAMI the Barcelona Convention is unable to proceed in isolation. Since it is not within the mandate of the convention to regulate, for instance, fishing or shipping activities, involvement of other regional or international organisations is inevitable. For example, parties to the Barcelona Convention can establish a SPAMI, but the General Fisheries Commission for the Mediterranean (GFCM) (1949)—the main regional institution to manage and conserve Mediterranean fisheries—must be engaged to adopt measures to limit fishing efforts within the SPAMI borders. Similarly, with regards to shipping regulations a member of the regulatory community comments:

> *'You have to establish a close cooperation with the International Maritime Organisation (IMO), because it is almost impossible to touch shipping activities without involving the IMO. Measures have to be established on the one side by the parties to the SPAMI, and on the other side they should proceed through the connection to the IMO. It is inevitable to involve the IMO' [PC-06].*

In a similar way that the IMO is considered a specific international forum for shipping, the Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS)[35] represents the regional forum for the protection of cetaceans. The geographic scope of ACCOBAMS covers the Mediterranean, the Black Sea and a contiguous Atlantic area west of the Strait of Gibraltar. Contracting parties to ACCOBAMS shall 'take co-ordinated measures to achieve and maintain a favourable conservation status for cetaceans' (Art. II, para. 1).

In 2007, the parties adopted a Resolution (3.22), which recommends the creation of eighteen marine protected areas for cetaceans (for example, in the Alboran Sea, in the Strait of Sicily, in the Eastern Ionian Sea and the Gulf of Corinth), an initiative that was confirmed in 2010 (Resolution 4-15, Marine Protected Areas of Importance for Cetacean Conservation). However, if these MPAs are to be situated in the ABNJ, the process of establishment must proceed through the SPA/BD Protocol and SPAMI listing. As such, ACCOBAMS is strongly linked to, as well as dependent on, the Barcelona Convention with regards to the specific protection of cetaceans on the high seas (Scovazzi, pers. comm.).

As an organisation specifically devoted to cetaceans, ACCOBAMS could represent a vehicle for more targeted conservation, such as protecting a specific migratory route. However, this organisation is arguably undermined by political inertia, due to a lack of commitment by member states. Furthermore, it lacks the means by which to enforce regulations and make parties comply with adopted recommendations. As one member of the policy community comments:

> *'I don't think that ACCOBAMS can work because of its inherent structure, the way it has been set up. Limitations including lack of fixed budget for the scientific committee, the lack of a work-plan... It's an organisation that was born not to be functional' [PC-03].*

[35] ACCOBAMS was created in November 1996 and entered into force in 2001. The ACCOBAMS Agreement results from consultation between the Secretariats of the three Conventions: the Barcelona, the Bonn Convention on the Conservation of Migratory Species of Wild Animals and the Bern Convention relative to the Conservation of European Wildlife and Natural Habitats. The Bucharest Convention on the protection of the Black Sea Against Pollution joined the group of Conventions later.

Chapter Conclusion

In this chapter I examined the complex situation in the Mediterranean Sea, both in terms of fin whale migration, as well as the geopolitical and legal climate for marine conservation. I provided an in-depth review of Mediterranean fin whale movement patterns, and whilst conclusions regarding their seasonal use of the basin is challenging, the opinion expressed here is that their proposed 'anomalous' migratory behaviour may not be as uncommon as dictated by traditional paradigms of baleen whale migration.

The general lack of unity between researchers (high ambiguity) regarding fin whale migratory patterns is mirrored by a lack of cooperation between Mediterranean states to establish a functional SPAMI network. Whilst the SPAMI network under the Barcelona Convention is able to promote conservation in the face of the peculiar Mediterranean geopolitical context, the scientific, legal, and political bases need to be solid in order for such a network to be successful.

The scientific foundation, which represents the design level of the network, is sound for the environment in general. However, the scientific basis is less solid with regards to how different SPAMIs are to be connected into an ecological coherent network. In particular, ontological uncertainties surrounding fin whale movement patterns make it challenging to include their migratory habitats within the MPA network.

Through the SPA/BD Protocol of the Barcelona Convention an adequate legal framework exists. However, its adequacy is weakened by general flaws of international treaties, and in order for regulations to be adopted within a SPAMI involvement of other regional or international organisations is required. Therefore, whilst forming a strong regional framework *per se*, implementation and management of a functional future SPAMI network on the high seas are highly dependent on state cooperation and political goodwill. Given the disappointing track record of Mediterranean states to conjure political will to protect cetaceans, this dependency is unfortunate.

As one of the research questions, I sought to investigate the appropriateness of MPA networks to protect migratory whales. On an ecosystem-based level, the network may confer benefits to some of their more static critical habitats (an analysis which is beyond the scope of the present PhD project), but in terms of addressing threats posed to migrating fin whales, its effectiveness, both in terms of design and management, is questionable.

In the next Chapter I discuss North Atlantic right whale migration along the U.S. eastern seaboard, and examine a targeted sectoral measure that has been implemented to protect whales against collisions with ships during their migration.

6

North Atlantic Right Whales off the U.S. East Coast

Overview

In this chapter I examine a unique and unprecedented sectoral approach that aims to protect endangered North Atlantic right whales against collisions with ships. I discuss how right whales migrate along a corridor off the U.S. eastern seaboard, and that a network of Seasonal Management Areas (SMA) has been established under United States environmental law to regulate shipping speed in migratory areas. I further examine the challenges met in the establishment of these SMAs and their effectiveness as a tool for migratory whale conservation.

6.1. Conservation Context

6.1.1. Population Status

The western North Atlantic (NA) right whales (*Eubalaena glacialis*) (Figure 6.1) are one of the most threatened whales in the world (Kraus et al., 2001), classified as Endangered by the IUCN Red List (Reilly et al., 2008). The NA right whales are genetically distinct and isolated from the North Pacific (*E. japonica*) and Southern Hemisphere (*E. australis*) right whales (e.g. Kraus and Rolland, 2007; Reilly et al., 2008). The population was almost brought to extinction by centuries of commercial whaling, prompting international protection by the IWC in 1935. At this point in time, the population may have numbered only 100 individuals, based on back calculations using present population size and growth rate (NOAA, 2010).

Following an initial, albeit slow recovery (Knowlton et al., 1994), the population showed signs of declining in the 1990s (Best, 2001; Fujiwara and Caswell, 2001). This trend was attributed to decreased survival probability of reproductively mature females, resulting in lower population growth rate, life expectancy, and calving intervals

(Fujiwara and Caswell, 2001; Kraus et al., 2001). However, recent figures suggest a small positive trend in population size, which is currently estimated to 361 individuals (NOAA, 2010).

Figure 6.1. Image of a North Atlantic right whale. From www.sahfos.ac.uk.

6.1.2. Distribution Range

Prior to the extensive exploitation of NA right whales, the historic habitat range of the species extended to the eastern parts of the Atlantic. The population in this part of the ocean is now considered functionally extinct, and sightings in areas such as western Norway, Ireland, and Spain are rare (Jacobsen et al., 2004). The eastern and western populations were not genetically distinct (Rosenbaum et al., 2000), and surviving whales are likely to only utilise the southwest periphery of their original range (Kenney et al., 2001).

NA right whales are mainly observed along the eastern seaboard of the United States (U.S.) and Canada. Their seasonal distribution in the western North Atlantic extends, at its extreme, from the Gulf of Mexico to Iceland (e.g. Knowlton et al., 1992; NOAA, 2010). However, the vast majority of whales range from the Southeast U.S. to Nova Scotia, Canada, and congregate in six major know habitats: i) coastal Florida and Georgia (SEUS), ii) the Great South Channel, iii) Georges Bank/Gulf of Maine, iv) Cape

Cod and Massachusetts Bays, v) the Bay of Fundy, and vi) the Scotian Shelf (including Roseway Basin) (e.g. Kraus and Rolland, 2007; NOAA, 2010).

The only known calving ground is found in the coastal waters of SEUS in winter months. The other areas primarily represent feeding aggregation habitats, where the whales' main prey, the copepod *Calanus finmarchicus*, is abundant (Baumgartner and Mate, 2003). In the Bay of Fundy, which is considered a nursery area, mother-calf pairs are mainly seen in the summer/autumn, whilst such sightings are rare in Roseway Basin (Kenney et al., 2001). A recently discovered region in Jordan Basin, Northeast U.S., is strongly indicated to represent a mating ground for NA right whales (Timothy et al., 2009).

6.2. Migration along a Predictable Corridor

6.2.1. The U.S. Mid-Atlantic Migration Route

Individual movements between and within these major critical areas are extensive, demonstrating the highly mobile nature of the whales (Mate et al., 1997; Baumgartner and Mate, 2005). Compared to the fin whales in the Mediterranean, more information exists on the migration routes of the NA right whales. Notwithstanding, it is still the least known and studied part of their range (e.g. Knowlton et al., 2002; Schick et al. 2009).

The mid-Atlantic—the region adjacent to the eastern seaboard of North America—has been identified as a migratory corridor between the SEUS calving ground off the coast of Jacksonville, Florida, and the northern feeding grounds in New England. The northerly migration takes place in late winter, with the whales reaching feeding areas in Cape Cod Bay and the Great South Channel in early spring. By mid-summer the animals migrate to Canadian waters, where they remain through the summer and into the fall months before traveling south in late autumn (Kenney et al., 2001; Knowlton et al., 2002) (Figure 6.2).

The part of the population that migrates along the mid-Atlantic region tends to be mature and pregnant females, juveniles, and calves (Ward-Geiger et al., 2005). Since an estimated protection of two females per year will allow the population growth to increase (Fujiwara and Caswell, 2001), understanding and protecting the migratory routes is needed to ensure the continued survival of the species (Firestone et al., 2008).

Most of the sightings from the mid-Atlantic migratory route have been obtained opportunistically rather than as a result of dedicated research, and surprisingly few peer-reviewed articles on NA right whale migration exist (Table 6.1). In an analysis of all existing sightings obtained from different survey sources, Knowlton et al. (2002) determined that a migratory corridor can be defined in the mid-Atlantic region, and that management measures can be proposed to protect the whales from ship strikes during their migrations.

Figure 6.2. Known North Atlantic right whale migration route along the U.S. and Canadian eastern seaboard. Black shadings show critical habitats or conservation areas. Blue shadings show migratory zones.From NARWC (2012).

Table 6.1. Studies related to the migration of North Atlantic right whales in the northwest Atlantic.

STUDY AREA	TIME FRAME	METHODS	MAIN FINDINGS	REFERENCE
U.S. East coast	Since 1980	Visual sightings and photo ID comparison of 303 identified individuals.	Whales sighted in Cape Farewell Ground, Labrador Basin, and the Atlantic coast of Newfoundland all belong to the western NA right whale population. Labrador Basin potentially a summer 'nursery' area.	Knowlton et al. (1992)
Bay of Fundy (BOF), Canada	Sept-Oct 1989-1991	Satellite radio-tags tracking 9 right whales in the BOF	Movements out of BOF: SW along the New England coast to the Gulf of Maine and Cape Cod Bay, far offshore (700km) and East around Nova Scotia.	Mate et al. (1997)
Mid-Atlantic region of the U.S. East coast	Not mentioned	A collection of different data sources (satellite tagging, NARW consortium database and catalogue, opportunistic sightings)	Migratory corridor geographically and temporally predictable. The majority of sightings (94%) and tagged animals (80%) occurred within a corridor 30 nm of land.	Knowlton et al. (2002)
Northern Norway	Sept-Oct 1999	Opportunistic visual observation and photo ID comparison	Photo ID match of a NA right whale observed in Norway with U.S. catalogue. Whales may revisit historic habitats in E Atlantic more often than previously thought.	Jacobsen et al. (2004)
Scotian Shelf, Canada	2004-2005	Passive acoustic survey at Roseway West and Emerald South (eastern Scotian Shelf)	Seasonal presence of whales between July and Dec. Later presence (until Dec) than has been recorded by visual surveys. Substantial whale presence at Emerald South.	Mellinger et al. (2007)
Mid-Atlantic region of the U.S. East coast	1762 to 2004	Modelling of northerly migration. Opportunistic data (99% of observations since 1968)	Early to mid-March departure from calving grounds, average travel time of 21–24 days. Mother-calves migrate later than right whales without calves.	Firestone et al. (2008)
U.S. East coast	1996; 2000	Movement model to estimate migratory habitat suitability. Data from two satellite tagged females.	Habitat suitability for migrating right whales extends farther offshore than previously thought (14 to 200 km distance from shore).	Schick et al. (2009)
Cape Farewell Ground (CFG), SE Greenland	2007-2008	Passive acoustic survey at five sites in the region of CFG	Whales arrive in CFG in July, move northeast of the historic CFG, then return southwest in autumn. The study onfirms the use of a historically important area for this species.	Mellinger et al. (2011)

The authors show that the vast majority of sightings are within 30 nm from shore, suggesting that the whales use a narrow, coastal migratory route that can be predicted in time and space. Even though research efforts extended offshore, sightings further than 50 nm off the coast are rare. One interviewee comments on the predictability of the NA right whale migration behaviour: *'I think they are very predictable, and they are quite unusual in that way. They are very coastal and well-studied' [PC-14]*.

Since sightings in the mid-Atlantic have primarily been obtained opportunistically, they may be biased to near-shore areas (Firestone et al., 2008). To address some of the data shortages, Firestone et al., (2008) conducted predictive modelling of where and when the whales are likely to occur in the mid-Atlantic corridor. Their statistical analyses indicate that the whales depart from the calving grounds early-to-mid March with an average travel time of 21-24 days to reach New England. In a similar vein, Schick et al. (2009) modelled suitable migratory habitats, and suggest that the corridor may be broader and more offshore than previously thought. These approaches present spatial and temporal windows for management of ship strikes in the mid-Atlantic migratory route that need to be verified by dedicated surveys (Firestone et al., 2008).

6.3. Migration along a Coast of Intense Maritime Traffic

Similarly to the Mediterranean, the East coast of North America is one of the most densely trafficked regions worldwide (Enderson et al., 2003). Ship strikes represent the main factor preventing the recovery of this highly endangered species together with entanglement in fishing gear (e.g. Knowlton and Kraus, 2001; NOAA, 2010). Of confirmed deaths, ship strikes account for the largest number: since 1970 at least 24 mortalities have been documented (Knowlton and Brown, 2007), and between 2004 and 2008 the average reported mortality and serious injury to right whales due to ship strikes was 2 whales per year, a level which is not sustainable for this small population (NOAA, 2010).

The overlap of high levels of ship traffic, especially near the many port entrances, and the coastal distribution of the right whales is a particularly lethal combination (Knowlton and Brown, 2007). Indeed, all of the whales tagged in a telemetry study in Canada and New England were located in or near shipping lanes (Mate et al., 1997). As an interviewee comments:

> *'NA right whales are 'fortunate' enough on the one hand to spend most of their lives in the waters of the U.S. and Canada, both of which have reasonable environmental protections. That's the good news. The bad news is that they are travelling up and down the east coast of North America, which is one of the most heavily industrialised regions in the world and an area of tremendous shipping traffic' [RC-12].*

Ship-struck carcasses have been retrieved close to shipping lanes and around specific ports throughout the right whale habitat range. The risk of collision is high both in main aggregation areas as well as in migration routes (Knowlton and Kraus, 2001). Of all reported ship strikes, 28% have occurred in the mid-Atlantic migratory areas (Knowlton et al., 2002). An interviewee comments on the risk of ship strikes during migration: *'As they migrate very close to shore, it is likely that the threats encountered along the migratory routes represent a significant contribution to the whale mortalities' [PC-12].*

Addressing the risk of ship strikes along the mid-Atlantic corridor represents one of the main challenges for conservationist and policy-makers (Firestone et al., 2008). The movement of migration runs perpendicular to shipping traffic entering some of the busiest ports in the U.S. (Figure 6.3), putting the whales—in particular females and calves—in considerable danger of being struck. Reducing the risk of collisions in this migratory corridor is thus pivotal under current management obligations (Knowlton et al., 2002; Firestone et al., 2008; Schick et al., 2009).

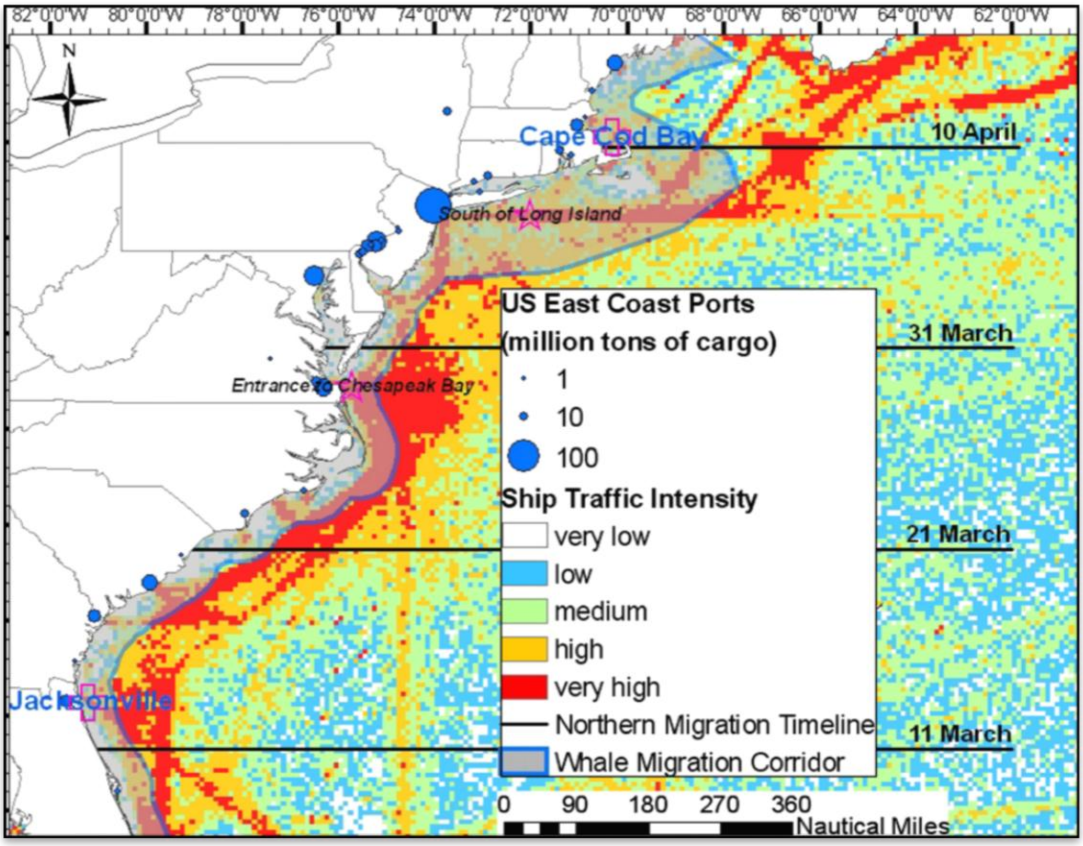

Figure 6.3 Predicted northerly migration of right whales with calves in relation to major ports and commercial traffic density. From Firestone et al. (2008).

6.4. Uncertainty

6.4.1. Prevailing Uncertainties and the Inevitability of Outliers

The NA right whales are one of the most intensely studied cetaceans in the world. Whilst a comparative wealth of information exists, survey efforts have primarily been focused on the main right whale aggregation areas, and important knowledge gaps still surround their migratory behaviour and habitats (Kraus and Rolland, 2007) (Table 6.2), albeit on a smaller scale compared to the Mediterranean fin whales.

Since right whales are known to regularly travel north beyond known aggregation zones, an important epistemic uncertainty is the northern extent of migration, destination areas north of Nova Scotia, and potential routes taken to reach such areas (Knowlton et al., 1992). As an interviewee comments:

‘Whilst most right whales migrate up along the coast of the U.S. and Canada, we also know that some go up to the Gulf of St Lawrence, over to the Gaspé peninsula of Quebec, and towards the south coast of Newfoundland, and we also know that some go as far north as between Iceland and Greenland in the Denmark Strait. But that still remains a huge unknown’ [RC-14].

Due to the epistemic uncertainties related to northern migratory routes, the risk of ship strikes in these areas represents a further unknown, and no measures have been put in place north of Nova Scotia even though ports on the coast of Canada could represent a considerable risk. Furthermore, future shipping lanes connecting North America and Europe via the southern tip of Greenland will transect migratory routes of any right whales that occupy the area around Cape Farewell Ground (Mellinger et al., 2011). A member of the research community [RC-14] describes that the northern-most ship strike mortality reported is off the coast of Halifax. Similarly, little research has been carried out on the migration between protected areas in New England and the Canadian aggregation habitats further up the coast, and no protection is currently in place in this cross-border region, despite the presence of dense ship traffic.

Another crucial gap in knowledge is the winter destination of a segment of the population—mainly adult males—that does not travel to the SEUS, as well as the summer destination of females that do not bring their calves to the Bay of Fundy (Kraus and Rolland, 2007). Based on genetic and photo ID data, Schaeff et al. (1993) suggest that roughly one third of the females do not migrate to the Bay of Fundy. These so called ‘non-Fundy mothers’ or ‘suburban cousins’ thus take their calves to a hitherto unknown nursing area, which is likely to be situated further offshore and/or in un-researched northern areas (Kraus and Rolland, 2007:20). Since the end destinations are unknown, knowledge of migratory routes and overlap with shipping lanes is consequently limited.

With regards to ontological uncertainty, it is recognised that whilst the right whale migration route along the U.S. coast can be relatively well predicted, there are ‘outliers’ around this norm (Hamilton et al., 2007). For example, Brown and Marx (2000) describe how a juvenile male made a round-trip migration to the Southeast U.S. and back to Cape Cod Bay at least twice during a winter season. The whale was first photographed off Florida on 12 January, then eleven days later in Cape Cod Bay, again three weeks later in the waters of Georgia, and back in Cape Cod Bay after a month. An interviewee comments on this variability in movement patterns: *'For mammals it is not unusual for juvenile males to go around on these kinds of walkabouts. Juvenile males are always unpredictable' [RC-14].*

With reference to the unknown winter habitats of primarily adult males, an interviewee discusses the possibility that the whales are more dispersed during winter, reminiscent of the theories of fin whale dispersal movements in the Mediterranean. Such dispersal behaviour may affect the risk of being struck by vessels, as a member of the research community explains:

> *'When you look at risk and threat it's a combination of the whales being there and the vessels being there so if the whales are dispersed there might not be as high a threat than if they were congregated if you look at it in terms of probabilities. But it's definitely still an issue and strikes can happen anywhere along the migratory route' [RC-15].*

However, as demonstrated by the recent discovery of the Jordan Basin calving ground (Timothy et al. 2009), absence of data does not equate absence of predictable habitats. Understanding the level of ontological uncertainty surrounding whale migrations is thus important in order to assess the level of threat exposure, whether conservation measures are warranted, and, if so, which mitigation strategies are most appropriate. As argued in Chapter 5, a more dispersal-like migratory behaviour with high ontological uncertainty makes it more challenging to protect whales through place-based measures. However, the need for mitigation may also be lower in such circumstances, since the risk of ship strikes may be lessened and more subjected to chance in terms of being in the wrong place at the wrong time.

Table 6.2. Uncertainty Matrix. Nature of uncertainty in relation to NA right whale migration in the North Atlantic, and the ship strike threat during migration. It is recognised that uncertainty is rarely absolute, but rather 'tending toward' epistemology or ontology on a gradient of uncertainty (see Chapter 3, Section 4.2.4). The sources of uncertainty presented below are discussed in the text.

	NATURE	
LOCATION	**EPISTEMIC UNCERTAINTY**	**ONTOLOGICAL UNCERTAINTY**
NA right whale migration	• Extent of migration north of Nova Scotia? • Migration route to reach areas north of Nova Scotia? • Extent of whales in U.S. offshore areas? • Migration route between U.S. and Canadian aggregation areas? • Winter area for the part of the population unaccounted for in calving areas (mainly adult males)? • Location of non-Fundy mother summer nursery area?	• Individual variation in migration, especially with regards to juvenile males ('walkabouts') • Adult male winter dispersal patterns? • Predictability of migration routes altered with climate change?
Ship strike risk during migration	• Risk and overlap during migration north of Nova Scotia? • Risk between U.S. and Canadian aggregation areas? • Risk for part of population with unknown winter and summer destinations?	• Stochastics of individual strikes ('wrong place at the wrong time')

Right whale migration patterns may further be impacted by climate change—a potentially underestimated source of ontological uncertainty in whale conservation—which is likely to affect spatial and temporal aspects of feeding areas (see Chapter 5, Section 5.4.1.). As with fin whales in the Mediterranean Sea, NA right whales are under considerable risk of changing prey dynamics under a warming climate, which may further affect prey availability, movement patterns, and ultimately reproduction rates and species recovery (Greene and Pershing, 2004). Whilst predictions of these effects could be attempted using modelling techniques, there are nevertheless considerable elements of stochasticity and unpredictability involved in climate change calculations.

6.4.2. The Importance of Researcher Collaboration

Ambiguity between right whale researchers is low with regards to the topics explored in this thesis. A demonstration—or perhaps a result—of the absence of ambiguity is considerable collaboration between U.S. and Canadian conservationists.

Cullen et al. (1999) distinguishes between the terms 'cooperation' and 'collaboration' in science. Whilst cooperation may simply entail an agreement on the boundaries of, or the decision to jointly undertake, a project, collaboration requires a higher level of commitment and active participation by individuals. Sonnenwald (2007:4) defines scientific research collaboration as '…human behavior among two or more scientists that facilitates the sharing of meaning and completion of tasks with respect to a mutually-shared superordinate goal and which takes place in social contexts'.

The extent of collaboration between North American whale researchers is exemplified by the annually held North Atlantic right whale consortium (NARWC), at which data, new techniques, management strategies, and other aspects of right whale conservation are exchanged and discussed. Moreover, the NARWC consists of different stakeholders including researchers, non-governmental and governmental organisations from both the U.S. and Canada, and is viewed as 'an invaluable resource' to the conservation of these whales. One interviewee expresses it as follows:

> *'The level of cooperation between researchers is high, very high. There is a right whale consortium, and it is as good as it gets as a model of*

cooperation. They all talk to each other and share data and information to try and crack solutions to protect the right whales' [RC-12].

Research collaboration is of tremendous value for solving complex issues in many areas of conservation science (Cullen et al., 1999), as well as for furthering political, economic, and social agendas (Sonnenwald, 2007). Cullen et al. (1999:140) argue that:

> 'Collaboration is the key to future research because it breaks down traditional barriers, optimizes intellectual expertise and available funding, and advances science along lines of consensus rather than personal beliefs. Effective collaboration will also enhance more objective research and reduce personal biases because team members represent various viewpoints'.

6.5. Conservation Strategies

6.5.1. Seasonal Management Areas on the U.S. East Coast

6.5.1.1. The Endangered Species Act

The Seasonal Management Areas (SMAs) are implemented in U.S. territorial waters and EEZ through the Endangered Species Act (ESA) (16 USC 1531-1544). The ESA, together with the Marine Mammal Protection Act (MMPA) (1972, amended in 1994) and the Wildlife Protection Act represent, in the words of an interviewee, a 'holy trinity' of U.S. environmental legislation [PC-07]. The North Atlantic right whale has been listed as endangered[36] on the Endangered Species Act's List of Threatened and Endangered Wildlife and Plants since 1973, and by virtue of this listing it is illegal to kill or injure the animals, including striking them with a ship (Sec. 11[A])[37] (NMFS, 2005).

The U.S. National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) has responsibility for administrating the Act with regards to the 87 listed marine species, and is required to develop a recovery plan (Sec.

[36] An endangered species is defined as any species which is in danger of extinction throughout all or a significant proportion of its range (Sec. 3[6]).
[37] The North Atlantic Right whale is also listed as Depleted under the MMPA, making it illegal to kill, harm or injure a whale (NOAA, 2012).

4[f]) to protect the population of NA right whales. Amongst the primary objectives of the recovery plan are to reduce interactions of vessels and whales, and to identify migratory movements between key aggregation areas (NMFS, 2005). The ultimate aim of the recovery plan is to ensure a sufficient recovery of North Atlantic right whales to warrant their removal from the List of Endangered species under the ESA, whereas the intermediate goal is to reclassify them from endangered to threatened.

The ESA is generally considered as an essential environmental legislation allowing for the protection of wildlife and biodiversity. Ferraro et al. (2007) argue, however, that the act of species listing *per se* does not suffice, and that the effectiveness of conservation efforts is linked to expenditures for recovery in combination with the ESA listing. Notwithstanding, Taylor et al. (2005) show that listing enhances recovery over time, and that dedicated recovery plans allow for effective conservation. The consensus among the interviewees is summed up by the following statement:

> *'The ESA and the MMPA are really valuable in the U.S. for allowing discussions to happen and hold the government to the fire. The laws allow us, the conservationists, to say that you are not doing your job by allowing for example these shipping activities to happen, it's violating these acts to protect the species. It really does give a way to have a dialogue with the industries and the governments and force them to take action to protect endangered species. I think they are very powerful' [RC-13].*

The overarching purposes of the Act are to conserve the ecosystems upon which endangered and threatened species depend, as well as provide a program for the conservation of listed species (Sec. 2[5][b]). As such the act has both an ecosystem and single-species focus for conservation. In terms of the former, the Act requires the designation of 'critical habitats'[38] (Sec. 3[5][A]), and in terms of the latter, the Act states that protective regulations, as necessary and advisable to provide for the conservation of the listed species, shall be issued (Sec. 4[8][d]).

[38] Critical habitats are defined as (i) Specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (ii) Specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

With regards to the SMAs, protection of the NA right whale migratory corridor does not fall under the ESA 'critical habitats' designation despite being area-based. Rather, the SMAs protect the animals *per se* during their migration, thus acting as a wider-scale, single-species conservation measure with associated sector-specific regulations. As explained by an interviewee:

> *'The ESA is protecting the migratory routes [of the right whales] but not as critical habitats. Under the ESA, critical habitat designation is not about the animals, it's about the environment that supports the animals, so it's really about their food. You don't put a critical habitat around an endangered species; you put it around their food supply' [RC-14]*

6.5.1.2. A Sectoral Approach to Migratory Whale Protection

The National Marine Fisheries Service has taken a number of single-species approaches to reduce the occurrence of right whale—ship collisions. These include mariner education, a regulation (62 FR 6729) in 1997 prohibiting all vessels from approaching closer than 500 yards (460 m) to any right whale, and under the ESA in 1994 (59 FR 28805) two critical habitat designations in the Northeast (Cape Cod Bay and Great South Channel Critical Habitat Area) and the Southeast U.S. (Southeast Critical Habitat Area off Florida and Georgia).

However, these measures met with limited success in reducing whale—vessel strikes, prompting the NMFS to act, *inter alia*, through the ESA to establish Seasonal Management Areas with mandatory sectoral regulations that directly address the threat of ship strikes (Figure 6.4). In 2008 the NMFS issued a final rule (73 Federal Register 60173, October 2008) to limit vessel speed in certain times and locations where right whales are most likely to occur. In these SMAs vessels larger than 65 feet (19.8 m) in length are required to travel at 10 knots or less (NMFS, 2008).

The SMAs are a novel and unprecedented measure, representing a valuable tool for right whale protection. An interviewee explains the rationale behind developing a sectoral-based conservation approach for right whales:

> *'The right whales being so endangered single-species management was kind of necessary, and when you get into single-species management you typically go into sectoral regulations rather than MPAs. In the 1990s MPAs was the buzz-word and the way to go, but it would just take too long to plan and put in place, so that's why we decided to go for more sectoral regulations' [RC-14].*

Indeed, the consensus amongst members of the research and policy communities is that these kinds of sectoral regulations are preferable to the MPA [network] approach. This general view is captured by the following statement:

> *'I don't see much value of the MPA approach actually. Least they have some built in conservation measure I am not sure I understand their utility. We can set aside areas, large or small, but unless some kinds of human activities are limited within them then they don't have much impact. If they have no 'teeth' they are meaningless' [PC-14].*

Another interviewee comments further on the need to regulate the industry rather than designate areas for protection:

> *'I have to be honest, I am never clear on what that [MPAs/MPA network approach] actually means. What do they actually do? How do they impact vessel behaviour and prevent collisions?' [PC-15].*

Acknowledging the need to protect the whales as they move between critical habitats, the mid-Atlantic portion of the SMAs are aimed at protecting right whales during their migration along the U.S. eastern seaboard (Figure 6.4). The speed limit is based upon the finding that ship speed is a crucial factor determining the likelihood of a collision being lethal to the whale (Laist et al., 2001; Vanderlaan and Taggart, 2007). Whilst the most effective way of reducing strikes is to separate the ships from the whales (for instance through Traffic Separation Schemes) (Knowlton and Brown, 2007), this is not possible for the migration corridor where vessels are entering ports at a perpendicular angle to the movements of the whales. Therefore, the second best option is to reduce the speed, thus reducing the severity of potential collision events.

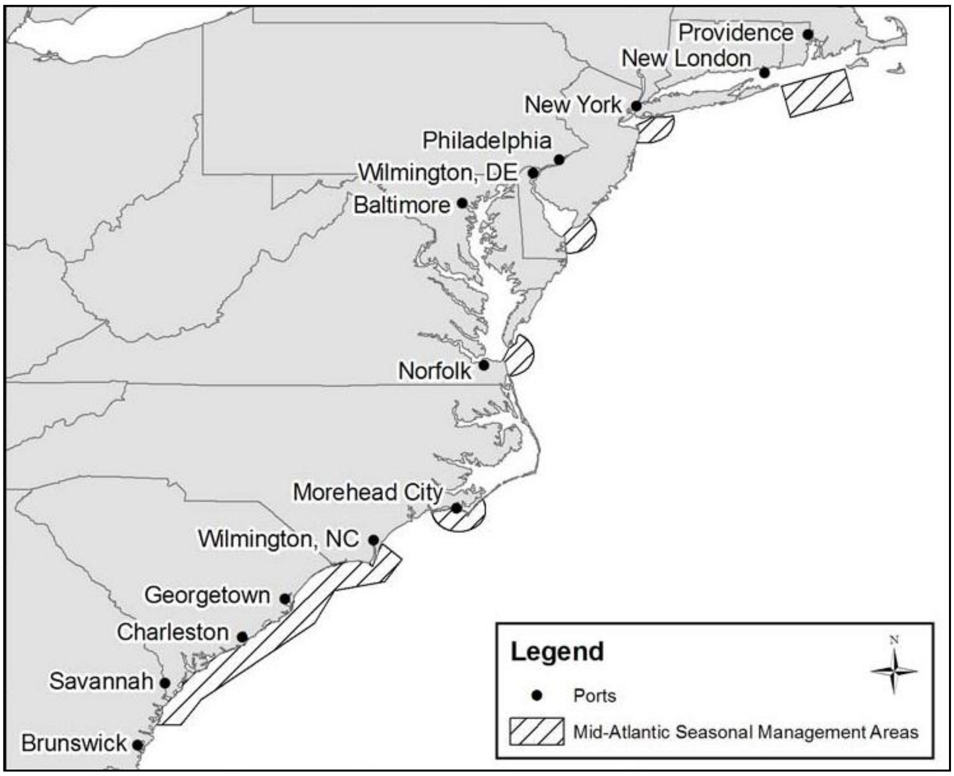

Figure 6.4. The Mid-Atlantic Seasonal Management Areas with mandatory speed restriction of 10 kn from Nov 1 through April 30. The mid-Atlantic areas are designed to protect the whales during their migration between calving/nursery and feeding habitats. From NOAA (2010).

The SMAs in the mid-Atlantic comprise a) buffer zones extending up to 20 nm from the coast around four major port or bay entrances, b) a 20 nm area tracking the coast of South Carolina State, and c) a box around Block Island Sound, with a 30 nm width extending south and east of the mouth of the sound. Within these zones, which are valid from Nov 1 through April 30, the speed restriction is seasonally mandatory for all ships entering and departing the ports (NMFS, 2008).

Even though the speed restriction extends into waters beyond state (3 nm) and territorial waters (12 nm), the U.S. is able to impose their domestic regulations on foreign vessels within their EEZ, consistent with the UNCLOS (Art. 27.2, 28.3). The speed rule applies to vessels flying foreign flags, however, not to those ships that are solely transiting through the area. The NMFS is in charge of monitoring compliance with the speed restriction, and collects data on, *inter alia*, ship speed, type of vessel, location, and estimated time of arrival at destination through the internationally mandatory Automatic Identification System (AIS[39]).

6.5.1.3. Overcoming Initial Resistance

As an interviewee comments: *'the speed rule did not sail through without resistance from the industry'* [PC-15]. Indeed, the speed measure was at first described as '*draconian'* by a member of the sector community [SC-04], which at first strongly opposed the SMA proposal. Economic interests played a considerable part in this resistance, particularly since ship operators are bound by tight schedules, and unexpected delays entering into port on allotted time-slots may increase costs for the trip (Knowlton and Brown, 2007).

As a consequence of this initial resistance, the NMFS was forced to make trade-offs to reduce the economic burden on the shipping industry while still attempting to maintain most of the conservation benefits of the SMAs. This resulted in amendments to the initially proposed rule with regards to the mid-Atlantic SMAs: a reduction in SMA size from 30 nm to 20 nm half circle zones around four port entrances, and a modification from 30 nm half circles around four major southern ports to a continuous SMA extending 20 nm from shore between Brunswick and Savannah, Georgia, to Wilmington, North Carolina. By changing to the new 20 nm restriction zones the transit times through the mid-Atlantic SMAs dropped from 46 to 28 minutes (NMFS, 2008).

This reduction in SMA size may have important conservation implications. As described in Section 6.2.1 statistical modelling of two satellite-tagged right whale movement paths demonstrate that the new 20 nm boundaries do not provide full coverage of suitable migratory habitat in the mid-Atlantic (Schick et al., 2009). The authors argue that the originally proposed 30 nm width would protect a larger portion of migratory whales, and that the SMA boundaries should be revisited (Schick et al., 2009).

[39]As of Dec 31, 2004, the International Maritime Organisation requires AIS on all vessels >300 gross tons on an international journey, as well as all tankers and passenger vessels regardless of size. For the U.S., AIS is required on all commercial vessels >65 feet (20 meters).

Other amendments to the originally proposed SMA rule include exemption of speed restriction for military or law enforcement vessels, exceptions to the rule in severe conditions where speed must exceed 10 kn to allow for safe manoeuvring, and, most crucially, a so called sunset clause. This sunset clause means that unless the rule is proven effective it will expire five years after its enactment. The final rule as it stands is thus effective from December 9, 2008, through December 9, 2013 (NMFS, 2008).

The speed rule expiration date was included as a response to the shipping industry invoking an argument based on uncertainties vis-à-vis the relationship of vessel speed and whale mortalities, and whether the speed limit will significantly reduce serious injury and deaths of the whales. An interviewee expresses opinions on the tendency of the sector to use uncertainty as an argument for resistance:

> *'The industry will exploit uncertainty to prevent regulations that might incur economical costs… if you are trying to resist a restriction, you have an option to declare the uncertainty and that you shouldn't be making any decisions because you don't have enough information yet' [RC-12].*

During the five-year period of the rule, NMFS is liable to gather additional data on ship-whale interactions to address those uncertainties and prove that the rule is effective in protecting the whales (Silber and Bettridge, 2012). However, as commented by a member of the policy community, the continuation of the SMAs in 2013 will be a reflection of political will to protect right whales rather than reducing the uncertainty:

> *'From my perspective it's much more a policy call than it is a very strong biology backing because trying to determine or detect any kind of trend in the population size or number of ship strikes is just not possible in this short time frame' [PC-14].*

In a recently published report, the NMFS assesses the effectiveness of the rule by analysing its ability to reduce strikes (the biological response) as well as compliance with the speed limit (the human response) (Silber and Bettridge, 2012). In terms of the former, the report concludes that the time-frame is too narrow to assess the effectiveness of reducing vessel strikes using speed restrictions. With regards to the latter, adherence to a 10 kn speed was unacceptably low in the first two years but improved in 2011, likely as a result of enhanced enforcement efforts since 2010 (Figure 6.5). The low compliance is mainly accounted for by foreign-flagged as opposed to domestic vessels (Silber and Bettridge, 2012).

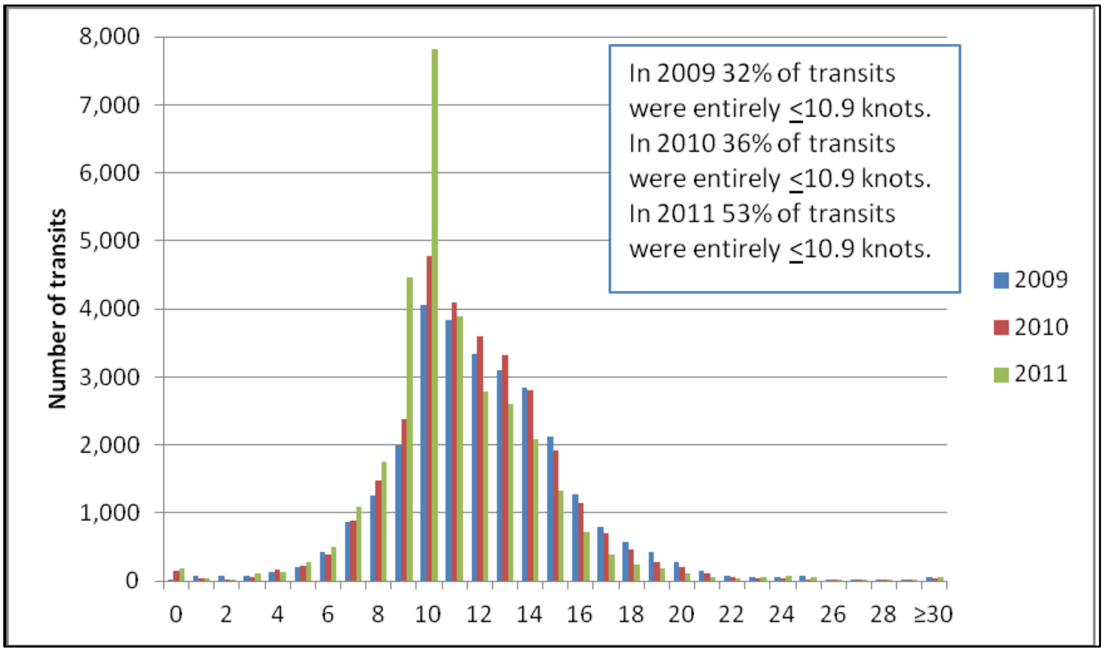

Figure 6.5. Distribution of vessel speed (knots) in all SMAs in 2009, 2010 and 2011.Compliance increased in 2011, likely as a result of stricter enforcement (Silber and Bettridge, 2012).

Despite the initial resistance to the speed rule, the shipping industry is now increasingly accepting towards the measures and is showing a more cooperative attitude. A member of the shipping community comments on the speed restriction and their changed attitude as follows:

> *'When they [the NMFS] keep pounding the message away for ten years it kind of wears people down to the point that people become complacent and then more or less resigned to the fact that these things [speed rules] are coming' [SC-04].*

An interviewee from the policy community describes how Maersk, a large European shipping company, explained that the speed limit has not posed much of a problem to them and that they have accepted the restrictions. Another interviewee hypothesises that a reason for the industry *'not barking as much'* [RC-13] since the rule was put in place is because the economic losses are not as great as suspected, at least not for the larger companies. Indeed, Maersk provides a slow and a fast option for crossing between Northern Europe and North America. The slower option is cheaper as it burns less fuel and contributes to lowering greenhouse gases [RC-14]. Another explanation is that the shipping industry is a highly regulated sector anyway with navigational routes and speed restrictions designed for safety, and adding one more restriction is not overly burdensome [PC-14].

Furthermore, a substantial degree of cooperation with the shipping industry—both in terms of the IMO and U.S. East coast mariners—has been established over the last decade, and education and outreach programmes have been a key component of the overarching efforts to tackle the ship strike issue on the U.S. East coast (Knowlton and Brown, 2007). Whilst the effectiveness of raised awareness within the shipping industry has its limits, communication and collaboration efforts have been exceedingly helpful. An interviewee admits that *'it is quite remarkable what has been achieved with shipping[40]'* [RC-12]. Another member of the regulatory community comments:

> *'With the shipping when we started this in the 90s I was told at that time ''you are crazy, you will never get a speed restriction in place''. We have established a lot of meetings with shipping industry representatives to hear their inputs and concerns and questions. This is a really important part of the process, having that dialogue' [RC-13].*

6.5.2. Transboundary Issues

The SMAs provide a means by which to protect right whales during their migrations. However, by not extending further north than New England, U.S., the SMAs only cover the southern portion of the right whale migratory corridor. As a consequence, there is a

[40] The achievements also refer to the International Maritime Organisation's Traffic Separation Schemes and Areas to be Avoided in the U.S. and Canada.

gap in protection measures for whales migrating between northeast U.S. aggregation areas and Canadian summer feeding and nursing habitats. On the Canadian side there are no measures that address the migration routes, and no efforts are in place to reduce the risk of collisions further north than Nova Scotia due to paucity of information.

Whilst the political will within the U.S. and Canada separately is relatively advanced, as shown by their progressive domestic environmental legislations—the ESA and MMPA in the U.S., and the Species at Risk Act (SARA)[41] in Canada—collaboration between these range states is limited for the protection of NA right whales. Indeed, a history of maritime delimitation disputes over Georges Bank in the region of New Brunswick (Canada) and Gulf of Maine (U.S.) (Gray, 1997)—areas pivotal to NW right whale migration—are likely to complicate prospects for cross-boundary collaboration further.

Maritime delimitation of Georges Bank, and thus access to fishing and other resources, was meant to be settled in 1979. However, ratification of the agreement was delayed due to the disparate claims over the region by the U.S. and Canada: the former argued that the natural prolongation of the continental shelf allowed the U.S. to claim all of Georges Bank, whereas the latter held that the principle of equidistance should be applied. The dispute was forwarded to the International Court of Justice, which did not fully favour either of the nation's arguments, and which determined the final boundary in 1984 (Figure 6.6) (Bowen and Hennessey, 1985).

An interviewee comments on the lack of political initiative to cooperate to protect NA right whale across the U.S. and Canadian border as follows:

> *'There is good collaboration in terms of the research being done, but not in terms of the policies put in place. Both Canada and the U.S. have North Atlantic right whales listed as endangered species, but there is no agreement between the two countries. It's going to be challenging to protect the migratory routes between the U.S. and Canada because of the transboundary issue. And we have to look at the migratory issue if we are to protect this species' [RC-15].*

[41] SARA came into force in 2002 (Bill C-5). In 2005, right whales were recognised as an endangered species under the Act, and in 2009 a recovery plan was produced.

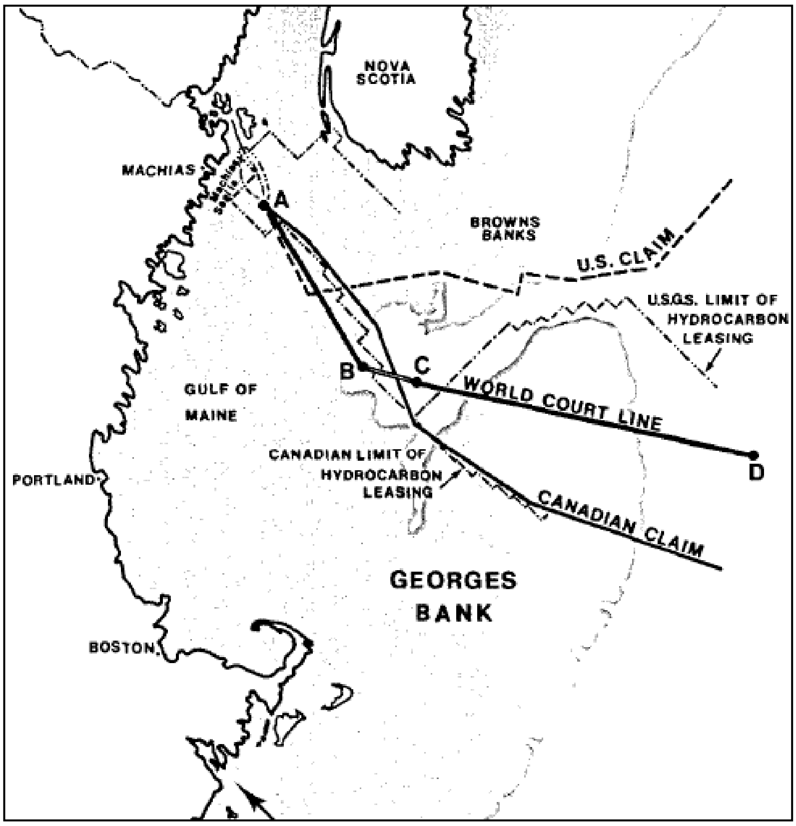

Figure 6.6 Historical EEZ dispute between the U.S. and Canada in the region of Gulf of Maine and Georges Bank. National claims and final boundary as determined by the International Court of Justice, 1984. From Bowen and Hennessey (1985).

Whilst the U.S. and Canada are still lagging behind other regions in establishing transboundary ocean management relations (Pudden and VanderZwaag, 2007), avenues for regional cooperation exist. In the ESA it is stated that the Secretary shall enter into bilateral or multilateral agreements with foreign countries to provide for conservation of listed species (Sec. 8[b][2]). Also, whilst neither Canada nor the U.S. are parties to the Convention of Migratory Species, the so called Trilateral Committee of Wildlife and Ecosystem Conservation and Management (1995)[42] between Mexico, the U.S. and Canada to conserve regional species, could serve as a basis for enhanced transboundary cooperation. Another vehicle for regional cooperation is the Commission for Environmental Cooperation (CEC), which carries out the provisions under the North

[42] The Trilateral Committee of Wildlife and Ecosystem Conservation and Management was established in 1995, and is headed by the Canadian Wildlife Service (CWS), the U.S. Fish and Wildlife Service (USFWS), and the Ministry of Environment and Natural Resources of Mexico (SEMARNAT).

American Agreement on Environmental Cooperation (NAAEC), which in turn represents the environmental complement of the North American Free Trade Agreement (NAFTA).

Indeed, in order to conserve the transboundary Monarch Butterfly (*Danaus plexippus*), Canada, Mexico, and the U.S. have collaborated to produce a North American Monarch Conservation Plan (NAMCP) and the Trilateral Monarch Butterfly Sister Protected Area (SPA) Network, under the CEC and the Trilateral Committee. The Monarch butterflies have a unique and complex multigenerational migration, recognised by the IUCN as an 'endangered biological phenomenon'. The SPA network, initiated in 2006, aims to protect migration corridors and habitats over the entire North American continent, and provides a coordinated programme for research, monitoring, and public education and outreach (NAMCP, 2008).

Chapter Conclusion

Tremendous effort has been invested into the study and protection of North Atlantic right whales by virtue of their endangered status under U.S. and Canadian environmental law. The relatively low ontological uncertainty surrounding right whale migration along the U.S. East coast corridor is likely to have facilitated implementation of area-based protection measures. Whilst some uncertainties (epistemic and ontological) still prevail, the NMFS has nevertheless been able to proceed with conservation under U.S. national law. An important question to ask is thus: where do you draw the line of what scientific uncertainty is acceptable? It is clear that this line may be drawn differently in different regions and countries depending on the political will to implement measures in the absence of scientific 'certainty'.

Whilst the measure is too new to ascertain its effectiveness, the Seasonal Management Area network represents an unprecedented mitigation strategy to protect whales during their migratory life-history stage. Interestingly, the SMAs are area-based, but not MPAs, nor are they protecting the migration corridor as a critical habitat. Instead, the SMAs are a network of protection zones that target a specific sector and a specific species. The general consensus amongst the interviewees is that such a sectoral-based conservation strategy is more effective and appropriate for addressing key threats faced by migrating whales compared to MPAs or MPA networks.

Collaboration—which as a concept entails more active participation than cooperation—for conservation purposes is extremely valuable and can be thought of on many levels: between [conservationist] researchers, between researchers and the sector and/or policy makers, and between range countries. The success of establishing the SMAs can arguably to a large degree be attributed to the collaborative effort between North American researchers, backed up by national governmental law. Collaboration between conservationists and members of the shipping industry has further been a pivotal ingredient for NA right whale conservation. However, efforts do not seem to extend to the international governmental arena, where the political will for transboundary collaboration arguably falters.

In the next chapter I will provide an overview of the main points of similarities and contrasts between the two case studies, and investigate the empirical results in greater depth in the light of the research questions.

7

Discussion and Comparison

Overview

In this penultimate chapter, I pull together the different strings of arguments presented in previous chapters to provide an overall analysis of the research questions. I commence with a brief overview of the main points of comparisons and contrasts between the two case studies to consolidate the results discussed in Chapters 5 and 6. Subsequently, I discuss key challenges and prospects for migratory whale conservation, as seen through a lens of uncertainty according to the theoretical framework presented in Chapters 3 and 4. Finally I examine the applicability of MPA networks and sectoral regulations to protect migrating whales, set in the context of complex geopolitical situations, human cooperation, and political will.

To remind the reader, the research questions of the PhD thesis are:

- What are the issues, challenges, and prospects for protecting whales during their seasonal migrations?
- Are migratory routes spatially and temporally predictable enough to allow for place-based conservation?
- To what extent are whales exposed to the threat of ship strikes during migrations?
- When are ecosystem-based MPA networks, and when are sectoral regulations, the more appropriate tools to use to protect migrating whales?
- How is scientific uncertainty viewed and addressed? What are the implications of this uncertainty for achieving effective conservation of migratory whales?

7.1. Case Study Comparison

For the majority of comparative points, the case studies represent two extreme scenarios, both in terms of the conservation and policy context, as well as the species-and-human factors (Table 7.1). With species factors I refer to the migratory behaviour of the whales, the different scientific uncertainties surrounding the migration, and the extent to which whales are subjected to the risk of ship collisions. With human factors, I consider the geopolitical climate, political will, and the interplay between researchers, and between researchers and the shipping sector. Both species and human factors are integral to the discussion on migratory whale conservation. Below I discuss the most important comparative and contrasting points in reference to the research questions, and as emerged in the case study analyses.

One of the research questions I set out to explore was whether migratory routes are spatially and temporally predictable enough to allow for place-based conservation strategies. As discussed in Chapter 6, the migration route of the North Atlantic right whales was deemed predictable enough to prompt the establishment of sectoral, area-based mitigation measures. By contrast, fin whales in the Mediterranean seem to display a more dynamic migratory behaviour, although parts of the population are likely to utilise more predictable routes. Indeed, the contrast between the migratory patterns of the North Atlantic right whales and the Mediterranean fin whales can be seen through a lens of uncertainty, in particular the ontological nature of uncertainty: North Atlantic right whales do not display the same high levels of ontological uncertainty in their migratory behaviour compared to the Mediterranean fin whales.

Also seen through the lens of uncertainty are the contrasting levels of ambiguity—and associated researcher collaboration—between the two case studies (see Section 7.2.2). In the Mediterranean, there is an absence of evidence for basin-wide collaboration initiatives, such as data-sharing and joint research projects, to conserve fin whales. By contrast, through the discussion in Chapter 6, it is evident that researcher collaboration on the U.S. and Canadian East coast was an important part on the road towards implementation of mitigation measures to protect NA right whales.

Table 7.1. Comparisons and contrasts between the two case studies in terms of conservation context, and species and human factors. The comparison is relative and descriptive categorical, since the data does not support an alternative cardinal or numerical scale of comparison.

FACTORS FOR COMPARISON	**CASE STUDY 1: Fin whales in the Mediterranean Sea**	**CASE STUDY 2: NA right whales on the U.S. East coast**
Conservation Context		
Whale species	Fin whale *Balaenoptera physalus*	North Atlantic right whale *Eubalaena glacialis*
Population size (estimated)	5000	350
Population status (IUCN)	Vulnerable	Endangered
Conservation approach	MPA network: SPAMIs on the high seas	Sectoral regulation: Seasonal Management Areas
Ecosystem scale	Mediterranean Sea	U.S. East coast
Maritime zones (UNCLOS)	High seas or Areas Beyond National jurisdiction	EEZ of U.S.
Policy framework	Barcelona Convention	Endangered Species Act
Protocol/Plan	Protocol 5, Specially Protected Area/Biological Diversity	73 Federal Register 60173
Administrative body	Regional Activity Centre for Specially Protected Areas	National Marine Fisheries Service
Framework scope	Regional	National
Legal strength	International convention. Mandatory for EU states	Mandatory U.S. law
Species Factors		
Migration route predictability	Low	High
Epistemic uncertainties	High	Low
Ontological uncertainties	High	Low
Ship strike risk	High	High
Human Factors		
Ambiguity researchers	High	Low
Researcher collaboration	Low	High
Collaboration with shipping sector	Low	High
Geopolitical complexity	High	Low
Political will	Low	High
International collaboration	Low	Low

Whilst two important workshops on Mediterranean fin whales have taken place (IWC-ACCOBAMS 2005, 2010), they represent a small effort in comparison to the regularity and scope of the NA right whale consortium. As discussed in Chapter 5, ambiguity between Mediterranean researchers is rife, but should be viewed in the light of cultural, linguistic, historical, political, and socio-economic discrepancies between the Mediterranean states (see Table 7.2). For example, an interviewee of the policy community [PC-02] explains that attempts to obtain permits to conduct research in the waters of southern Mediterranean military states are usually refused by these governments for security reasons. However, the same interviewee expresses a frustration over the fact that researchers from northern countries do not attempt to collaborate more with scientists from southern states.

Additional explanations for the difference in collaboration between researchers of the two case studies may include the fact that the need to cooperate is more pressing in the U.S., considering the extremely endangered status of the NA right whales, and that the overall scientific uncertainty is smaller. Furthermore, in contrast to the situation in the Mediterranean, more funding is available for conservation research in North America, counteracting territoriality and competition for funding resources. A researcher comments on territoriality in the Mediterranean as follows:

> *'There is limited funding for this type of [whale] research, so people are fighting and competing to get this money and it creates territoriality and it doesn't enhance collaboration between teams, and then research is not coordinated' [RC-01].*

Indeed, Cullen et al. (1999) discuss competition between researchers as a primary barrier to collaborative efforts, and as an inhibition to the building of interpersonal communication and trust, which are necessary aspects of effective collaboration.

Another research question posed for this doctoral project is the appropriateness of MPA network initiatives relative to sectoral regulations to protect whales during their migration. As discussed in Chapter 5, establishment of an international MPA network, such as the SPAMI network, is highly dependent on political will and governmental cooperation. The Mediterranean is a sea full of inherent geopolitical complexities, numerous political disputes, variable socio-economic situations, and a general lack of political will to preserve the marine environment. In addition, there is a considerable gap between many Mediterranean countries in terms of governance capacity and socio-economic factors (Table 7.2). Since governmental metrics impact MPA governance (Jones et al., 2011), and a strong causal relationship between better governance and better development outcomes has been demonstrated (Kaufmann et al., 2009), these differences are likely to have an effect on the ability of Mediterranean countries to cooperate to govern SPAMIs on the high seas.

By contrast, the right whale migration takes place almost exclusively within the U.S and Canadian EEZs. On a political, socio-economic, and governance capacity level the U.S. and Canada are more equal, and both score higher on the metric scale compared to the Mediterranean states (Table 7.2). Yet, U.S. conservationists chose to proceed via domestic national legislation and the shipping sector rather than establishing MPAs. Great effort has been invested in relationship-building with members of the shipping sector as well as the International Maritime Organisation, an approach which has not been as emphasised in the Mediterranean.

Despite a wealth of dissimilarities between the case studies, there are important similarities. Firstly, in both contexts the whales are redlisted by the IUCN, anthropogenic pressures are high, and the risk of ship strikes is prevalent throughout the species' ranges. The second similarity relates to the issue of transboundary cooperation. In the Mediterranean, the socio-political, cultural, and historical differences between nations can to a certain degree explain the challenges involved in international cooperation. Between the U.S. and Canada, these challenges are less pronounced (Table 7.2), and it is surprising that not more has been done to develop a cross-boundary action plan for the protection of right whales. In its absence there are numerous protection gaps in the border region between these two states. The lack of collaboration between two such 'close' range states as the U.S. and Canada highlight the challenge of achieving tangible international governmental cooperation to protect migratory species.

The analysis of these two cases studies has been greatly informative. Since the U.S. is more advanced in their conservation efforts to protect North Atlantic right whales, this case study has provided ample opportunity for 'lessons learnt', which can be applied to the Mediterranean case study and other contexts. The remainder of the discussion chapter focuses on the central findings of the thesis, interwoven with an examination of key lessons learnt from the U.S. case study and their applicability for Mediterranean fin whale conservation.

Table 7.2. Governance metrics demonstrating the difference in governance capacity and socio-economics between Mediterranean states and between Case Study 1 and Case Study 2 nations. The data is based on 2011 figures and was obtained from the following sources: National Per Capita Gross Domestic Product (GDP): Central Intelligence Agency (CIA) World Factbook (https://www.cia.gov/library/publications/the-world-factbook/index.html). Human Deveopment Index (HDI): United Nations Development Programme (http://hdr.undp.org/en/statistics/). Governance Indicators: the Worldbank, based on Kaufmann et al.'s (2009) calculation of six Worldwide Governance Indicators (http://info.worldbank.org/governance/wgi/sc_country.asp). The Governance Scores (ranging from -2.5 to +2.5) are averaged according to the approach adopted by Jones et al. (2011).

CASE STUDY 1	**PER CAPITA GDP (US$)**	**HUMAN DEVEL. INDEX**	**GOVERNANCE INDICATOR**
EU states			
Cyprus	27,500	0.84	1.07
France	35,100	0.88	1.22
Greece	26,300	0.86	0.36
Italy	30,500	0.87	0.52
Malta	25,600	0.83	1.14
Slovenia	28,800	0.88	0.92
Spain	30,500	0.88	0.93
Candidate EU states			
Albania	7,800	0.74	-0.20
Bosnia-Herzegovina	8,100	0.73	-0.42
Croatia	18,000	0.80	0.38
Montenegro	11,500	0.77	0.11
Non-EU states			
Monaco	N/A	N/A	N/A
Non-European states			
Algeria	7,300	0.70	-0.93
Egypt	6,500	0.64	-0.74
Israel	31,500	0.89	0.59
Lebanon	15,500	0.74	-0.64
Libya	6,000	0.76	-1.34
Morocco	5,100	0.58	-0.33
Syria	5,100	0.63	-1.10
Tunisia	9,400	0.70	-0.18
Turkey	14,400	0.70	-0.02
CASE STUDY 2	**PER CAPITA GDP (US$)**	**HUMAN DEVEL. INDEX**	**GOVERNANCE INDICATOR**
USA	48,300	0.91	1.24
Canada	40,500	0.91	1.62

7.2. Through the Lens of Uncertainty

Challenges involved in protecting migrating whales are found on numerous levels. An overarching aim of this thesis was to examine the views and implications of scientific uncertainty as one of the greatest challenges for achieving effective conservation. However, stepping beyond just naming uncertainty as a source of conservation challenge, I have attempted to scrutinise this issue further. Given the multi-dimensional nature of uncertainty, are some uncertainties more challenging than others? [How] can they be overcome, and if so, what are the prospects?

7.2.1. Ontological Uncertainty: A Species Challenge

Based on the analyses of previous chapters the argument presented here is that not all aspects of the multi-faceted concept of uncertainty are equally challenging to address. Ontological uncertainty surrounding migratory whale behaviour is a more daunting challenge for conservation than knowledge gaps that fall under the epistemic umbrella. An interviewee describes the inherent challenge of conserving inherently dynamic whales as follows:

> *'They [baleen whales] have tremendously dynamic behaviour that we don't understand. Protecting them with this uncertainty is a tremendously difficult thing to do. Whales are so dynamic, so complicated, and so…* obscure *that we cannot possibly do the research we need to do in order to understand them' [PC-09].*

The more extensive the ontological category of uncertainty, the greater the challenge to i) find a tool to protect the migratory species and/or the migratory habitat, ii) establish a solid scientific foundation on which to base conservation arguments, iii) convince an industry or government that conservation must proceed in the face of uncertainty, and iv) accept that obtaining reliable and desirable scientific data may be an unrealistic goal.

Two examples from the Mediterranean fin whale case study demonstrate this dynamic behaviour well. First, through aerial surveys Pandigada et al. (2011) show how fin whale summer distribution patterns in the Northwest Mediterranean have recently changed. Whilst the last 20 years have seen fin whales within the Pelagos Sanctuary borders, the whales are now favouring areas southwest of the Sanctuary, likely, but not necessarily, due to changes in prey distribution. Second, as described in Chapter 5, evidence for fin whale movement between the Tyrrhenian Sea and the Ligurian basin are no longer conclusive. Based on year-round observations from ferry platforms, fin whales do not venture further north than southeast of the Sanctuary, an area that now seems to act as a summer feeding habitat [RC-02].

As mentioned in Chapter 3, Walker et al. (2003) emphasise the need to address epistemic and ontological uncertainty using different strategies. Below I outline potential conservation strategies applicable to cases of high ontological uncertainty, where migration routes are not particularly identifiable.

7.2.1.1. Dynamic Management for Dynamic Species

In circumstances where whales display dynamic and unpredictable behaviour, dynamic management measures are required to match. Whilst adaptive and dynamic management are not equivalent terms, in order for management to be adaptive it must also be dynamic. In addition to Seasonal Management Areas to protect migrating right whales, the NMFS under the ESA has developed a complementary conservation tool: the so called Dynamic Management Areas (DMAs), which are established when right whales are observed outside of SMAs. The DMAs are designed 'to protect unpredictably occurring aggregations', while also minimizing economic impacts to the shipping sector (Silber and Bettridge, 2012). The DMAs thus provide a buffer against inherent variability in whale distribution patterns, and as such represent a strategy to address ontological uncertainty.

The DMAs are temporally and spatially dynamic zones triggered by a 'reliable sighting' of three or more right whales within 75 square nm of each other (density $\geq$ 0.04 right whales per nm^2). Such sightings are derived primarily from systematic aircraft surveys performed by NOAA (Adams et al., 2011). Temporary zones, which consist of a circle with a radius of at least 3 nm (5.6 km), are created around the observed group, and remain in effect for 15 days. The DMA automatically expires after this period, although it can be extended for an additional 15 days should the whales be re-sighted in the same area.

Within these dynamic management areas, the speed rule limit of 10 knots applies. However, in contrast to the SMAs, travelling through the DMAs at 10 knots or less is voluntary for mariners. During the 2008 ESA rule revision process in response to mariner complaints (see Chapter 6), the proposed rule of compulsory speed restrictions within the DMAs (in addition to SMAs) had to be revised to voluntary. In Silber and Bettridge's (2012) evaluation of the effectiveness of the SMA rule, Adams et al. (2011) assessed industry compliance of the 66 DMAs established between December 2008 and June 2011, and found that mariner adherence to the voluntary speed restriction rule was minimal.

NOAA has made great efforts to notify mariners about DMAs, for instance through Weather Radio broadcast, reminder e-mails to a distribution list of hundreds of maritime interest groups and individual recipients, through maps of current DMAs regularly updated on the NMFS-NOAA website (Figure 7.1), and also a new iphone/ipad application—WhaleALERT—which informs mariners of the most current information to reduce the risk of ship and right whale collisions, including the location of SMAs, DMAs, as well as other right whale conservation measures. On the basis of this extensive outreach, Silber and Bettridge (2012) speculate that lack of compliance is related more to the voluntary nature of the DMA speed rule rather than to a lack of awareness of the temporary zones. Since the DMA program is likely to have had minimal operational impact in reducing the occurrence of ship strikes (Adams et al., 2011), Silber and Bettridge (2012) suggest that the NMFS should either i) do away with the DMAs, ii) make the speed rule mandatory, or iii) expand the mandatory SMAs into locations and in times where DMAs tend to recur.

Even though the DMAs are currently lacking in practical effectiveness, the fact that a management strategy like the DMAs has been put in place in the U.S is arguably a unique achievement. Ingredients required for making such a dynamic, adaptive conservation approach feasible are—at present—lacking in the Mediterranean context: resources for aerial surveys, monitoring, and enforcement, issues surrounding the high seas, lack of political will and regional cooperation, and the absence of a NOAA/NMFS-equivalent organisation which has powerful mandate to protect the marine environment on a Mediterranean-wide scale. As an interviewee from the policy community comments: *'In the Mediterranean, right now you don't know who to address for conservation'* [PC-03]. The interviewee argues that in theory ACCOBAMS is in charge of coordinating management actions, but due to its inherent structure and limited power, the agreement does not achieve this in practice. The prospects are thus slim of using a similarly designed dynamic management strategy to protect dynamic and wide-ranging whales in the Mediterranean.

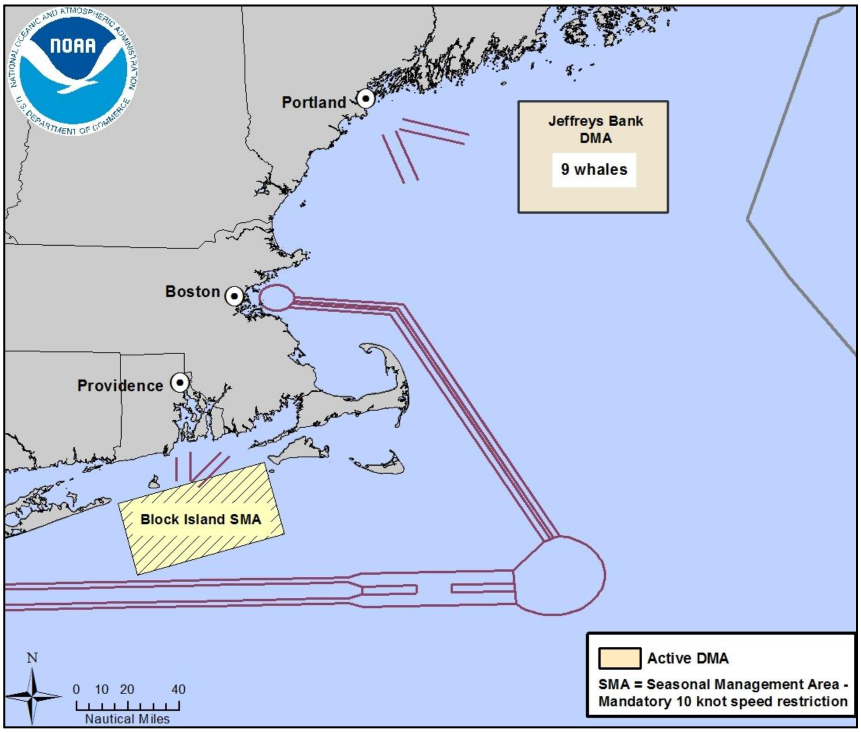

Figure 7.1. The most recent active DMA, in effect through December 19, 2012, as displayed on the NOAA website (NOAA, 2012), accompanied by the text: 'Mariners are requested, but not required, to either avoid DMAs or travel through them at 10 knots or less.'

7.2.1.2. Real-time Detection Technology

Wider-scale measures that limit collisions with individual whales represent another potential strategy in contexts where whales are not predictably following certain migration routes, but are known to migrate over a larger area of high ship traffic density. Such wider-scale, shipping-sector specific measures can include modifications to vessel design and onboard technologies aimed at detecting whales real-time, or near real-time, which would have the additional advantage of limiting impacts to maritime activities (Silber et al., 2009).

In 2008, NOAA hosted a workshop to identify and assess technologies to reduce ship strikes of large whales (Silber et al., 2009). The participants discussed pros and cons of available detection technologies, which include SONAR, RADAR, visual observers, passive and active acoustic measures, and infrared technologies that detect whale blows. One such endeavour, the Real-time Plotting of Cetaceans (REPCET) computer-based system, is currently being developed and implemented in the Pelagos Sanctuary in the Mediterranean Sea to limit the risks of collision between whales and vessels. REPCET allows for semi-real-time warning of the presence of whales. Sightings of large whales by observers on board a vessel equipped with REPCET is transmitted by satellite to a land-based server, which centralises the data and re-sends an alert to equipped vessels that are likely to be affected (REPCET, 2012).

Whilst the idea of real-time detection technologies represent an appealing strategy to address ontological uncertainty, the 2008 workshop concluded that there are no technological ‘fixes’ to the complex issue of whale-ship collisions. No technologies currently exist or are expected to be developed in the near future that will be effective enough to reduce ship strikes to zero, and no single technology is likely to fit all circumstances (Silber et al., 2009).

The main issue with current technologies is the low whale detection rates as well as effective range constraints to allow for sufficient warning and response time. For example, whilst passive acoustics represent a non-invasive, relatively cheap detection option, the approach is constrained by only detecting vocalising whales and not always allowing for specific locations to be determined. Development, installation, and maintenance of putative technologies may further be expensive. With regards to REPCET there are many challenges to its effectiveness as a tool to mitigate ship-whale collisions, including its application only for daylight hours and in good weather, and the lack of directives on how mariners are expected to utilise the information the system provides on whale presence.

The issue with REPCET underlines a second main limit to the technology approach: aside from the ability of a technology to reliably detect whales, mariners must take action (and must want to take action) to avoid whales once detected. Avoidance ability by mariners is dependent on adequate response time and communication systems. For larger vessels, a considerable distance may be required to alter the course of a ship or to slow down to avoid hitting a whale in its course. Moreover, evasive action of a vessel may inadvertently steer it toward undetected whales in its proximity (Silber et al., 2009). An interviewee discusses this issue as follows:

> *'For me the ultimate bottom line is that, even though you detect whales you still haven't told the mariners what to do with that information. Do we expect them to stop? Do we expect them to slow down or avoid the area? I think that even if you have 100 % detection you still haven't got a solution. What does "avoiding a whale" mean?' [PC-14].*

At best, technological wider-scale measures thus represent a partial solution. In a worst case scenario, they may provide shipping companies with an excuse to feign cooperation to protect whales.

However, the most promising variation of a technological fix, according to the workshop, is advanced voyage planning using predictive habitat modelling to avoid certain areas, as opposed to reacting to whales in the near field. Furthermore, employing models using remotely-sensed oceanographic features to predict whale presence together with passive and active acoustics can provide both enhanced far-and near field detection ability for voyage planning (Silber et al., 2009).

7.2.1.3. Breaking up the Movement Range into Manageable Pieces

Many populations of whales migrate over immense distances, and protection throughout their range may be unfeasible and unnecessary. If whales cannot be protected throughout their range, and if their movement patterns tend to be unpredictable, it may be possible to break up the migration pathway into manageable pieces, which can be more readily protected.

For example, for migratory birds so called stopover sites, which provide the animals with the opportunity for rest and accumulation of energy-reserves, allow for place-based protection along the migratory journey (Alerstam and Hedonström, 1998). Sawyer et al. (2009), in their discussion of ungulate (hoofed animal) migration, differentiate between stopover sites and *bona fide* migration corridors, the aims of which are to facilitate movement between stopover sites. Similarly to many whales, ungulates do not always migrate along a single well-defined corridor. A more common scenario is multiple routes used by different parts of the population to reach summer areas that are more expansive compared to winter areas (Sawyer et al., 2009). Sawyer et al. (2009) argue that not all sections of the migration pathway need to be identified and protected since they are not equally important to protect. Focus should be directed towards identifying and protecting stopover areas, and different management strategies may be required for the corridors of movement (Sawyer et al., 2009) (Figure 7.2).

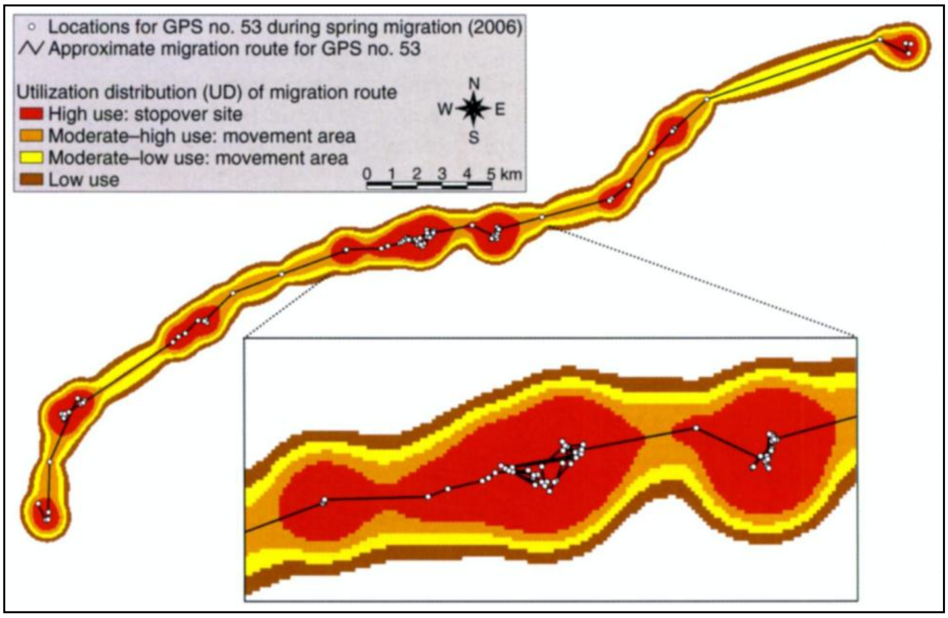

*Figure 7.2. Distribution of mule deer (*Odocoileus hemionus*) during spring migration. Mule deers spent most time in stopover sites, or high-use areas (red). Moderate-use areas (yellow) correspond to migratory segments where the deers travelled quickly in one direction. Low-use areas reflect uncertainty in the entire route. From Sawyer et al. (2009).*

In a similar vein, there may be bottlenecks—narrow corridors of habitat connecting two ranges—perfurating the migratory route. In narrow bottlenecks animals tend to be more vulnerable to threats, and by virtue of geographic restrictions the migration becomes more predictable, at least in space (Berger, 2004). As a member of the research community comments: *'Where you have bottlenecks of corridors it is easier, as for example for some populations of elephants and the Mongolian saigas'* [RC-

10]. Similarly to whales migrating in open ocean systems, the interviewee describes the migration of other populations of saiga antelopes: *'The general orientation is quite predictable, but it is a very large open area. It's difficult, because it means that you have to do conservation on a landscape scale, and a lot of conservation is done at the local scale only' [RC-10].*

The existence of stopover sites and bottlenecks for migratory baleen whales is likely to depend on both species and geographic contexts. Atlantic fin whales migrating south from Arctic areas have been shown to stop and feed in the productive areas around the Azores Islands (Visser et al., 2011). Similarly, the Lampedusa Island may serve as a stopover site for Mediterranean fin whales, since they only remain in the area for a limited period of time (Canese et al., 2006). In terms of bottlenecks, the Sicily channel and the Strait of Messina provide geographic limitations to fin whale movements. Therefore, despite a vast and/or unpredictable migratory behaviour, there may be localised areas along the migratory journey that lend themselves better to place-based protection.

Along the migration route, especially if it runs parallel to a coastline with high anthropogenic pressures, there may be v*irtual* bottlenecks where threats and routes most overlap, as is the case for migrating right whales and port entrances on the U.S. East coast. Indeed, identifying hot spots of threats is equally important as identifying hot spots of animal occurrence. An interviewee from the research community stresses that: *'I am more interested in where the threats are [than identifying specific habitats]. Take the threats and address them throughout the range' [PC-10].*

For species with highly dynamic migratory behaviour, focusing the attention on identifying and protecting potential stopover sites, bottlenecks, and hotpots of threat—migration overlap represent a valuable, landscape-based approach, which may also be the most feasible strategy for conserving fin whales throughout the Mediterranean Sea.

7.2.2. Ambiguity without Collaboration: A Human Challenge

A key lesson learnt from the North Atlantic right whale case study is the importance of researcher collaboration. Collaboration and data-sharing between North American scientists has served as a unifying force and foundation for the implementation of measures to reduce right whale-ship collisions. An interviewee reflects on the importance of researcher collaboration as follows:

> *'There are good relations and cooperation between [North American] researchers, and when you have these really good human relations between researchers from different countries, this personal connection where you are able to work properly together with respect, then things are a lot easier. I really promote international collaboration in research' [RC-11].*

Establishing a collaborative climate between researchers is pivotal to move the conservation agenda forward and to foster advocacy potential. Indeed, Bradshaw et al. (2000:6) argue that 'diversity of opinion may signal confusion and ignorance, thereby supporting a rationale for inaction'. The authors discuss how the inherently complex dynamics of climate change give rise to widely different and mutually exclusive recommendations to the U.S. government by different scientists. Considerable ontological uncertainty can thus arguably exacerbate ambiguity within the scientific camp, which in turn renders collaboration between individuals particularly important—and particularly challenging.

Expanding on Brugnach et al.'s (2008) framework (see Chapter 3, Section 3.2.2.), it can be argued that ambiguity between researcher who are ultimately 'on the same side' is value-neutral or even a necessary aspect of scientific inquiry. Indeed, plurality of opinions is the philosophical basis of scientific inquiry, allowing for alternative and diverse hypothesis building and experimentation, reassessment of established 'truths', paradigm shifts, and a general debate that spurs continual curiosity of the scientific realm (e.g. Dunbar, 1995; Ladyman, 2002). Ambiguity can further be argued to encourage self-examination and self-doubt without which scientific quality is diminished (Bradshaw et al., 2000). It is thus ambiguity without collaboration and unification around a common conservation goal that is the main issue, rather than the existence of different knowledge frames between researchers *per se*.

To illustrate this point, I draw on the core quadrant framework developed by Ofman (2007) to improve interpersonal relations (Figure 7.3). The core quality is a specific positive or value-neutral characteristic that defines the group or individual; in this context ambiguity. The pitfall is an exaggeration of the core quality, which in the present adaptation of the framework is described as an absence of clarity, direction, as well as indeterminism, resulting in a lack of a unified effort, and potential territoriality, conflict, and mistrust. The challenge, defined as the positive opposite of the pitfall, is thus to promote collaboration, communication, and coordination in the presence of ambiguity. Too much of the challenge quality causes conformism, and a loss of individual inquiry, which represent the allergy that the group and its individuals cannot tolerate.

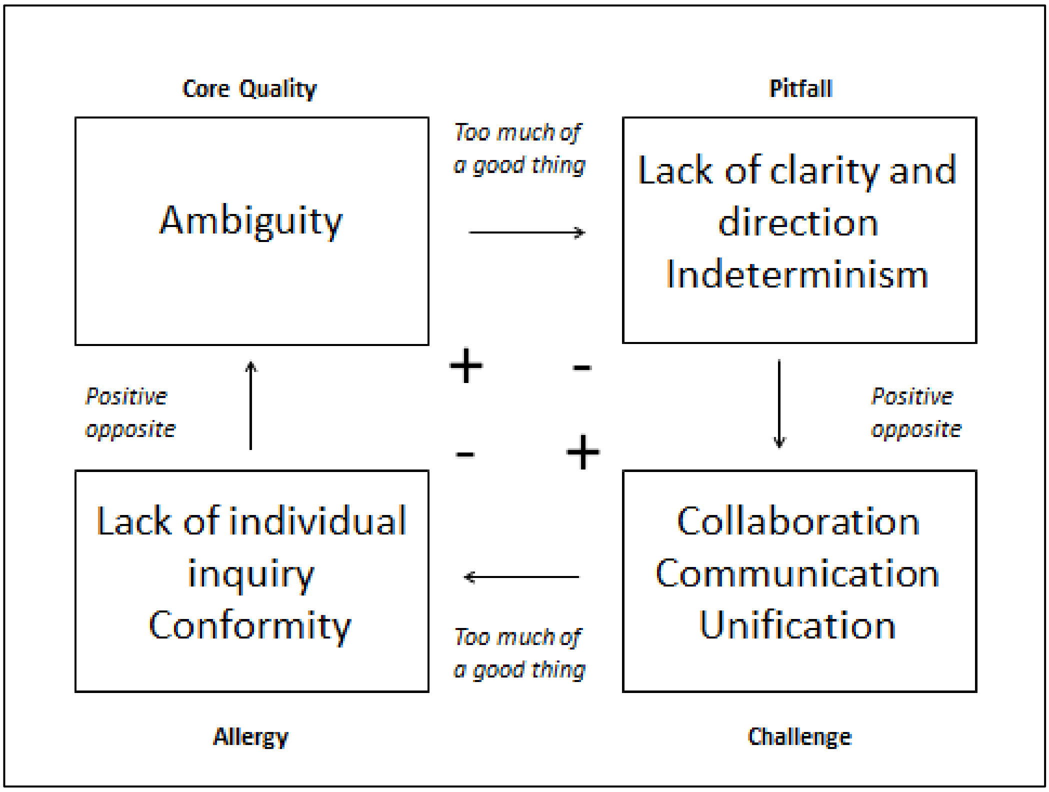

Figure 7.3. Core quadrant framework to conceptualise Mediterranean researcher ambiguity in the context of fin whale conservation. Inspired by Ofman (2007).

To promote collaboration it must be recognised that different individuals bring certain strengths and weaknesses to a collaborative setting. In order to avoid inevitable frustration and conflicts, interpersonal relations and leadership qualities thus need to be strengthened and built (Cullen et al., 1999). Since strong leadership is crucial for successful collaboration, professional consultants that help promote leadership and interpersonal skills should be considered to facilitate collaborative efforts (Sonnenwald, 2007). As Cullen et al. (1999:131) express it: ‘interactions between individuals lie at the heart of an effective collaboration’.

Thus far, I have not raised the issue of epistemic uncertainties, which tends to be the main source of scientific uncertainty considered in biological conservation contexts (Cooney, 2004). The argument I present here is that many epistemic uncertainties impeding our knowledge of Mediterranean fin whale movement patterns are not tremendously challenging to address *if* the challenge of collaboration in the face of considerable ambiguity were addressed in earnest. It is therefore not the epistemic knowledge gaps *per se* that pose the greater challenge.

Indeed, some of the epistemic uncertainties outlined in Chapter 5 (see Table 5.2) can be envisioned to be addressed through cost-effective means. For example: i) research efforts could be aimed at the potential migration bottlenecks Straits of Bonifaccio, Sicily, and Messina using ferry lines; ii) a photo identification pilot study in the Lampedusa Island during a winter season with the aim to obtain high quality photographs would allow for a preliminary comparison with the Pelagos Sanctuary catalogue[43]; and iii) seasonal monitoring of whale movements along the proposed Italian/French/Spanish route would help ascertain the fidelity to this migratory pathway and its overlap with high-speed ferry lines. Whilst not an exhaustive list, the argument presented is that there are many opportunities for collaborative research efforts to address key epistemic uncertainties.

7.3. Conservation Tools

As stated throughout the thesis, protecting whales throughout their range is an ambitious, complicated, and challenging undertaking and no single conservation tool will provide protection toward all threats posed to migrating whales. Given the numerous challenges detailed above, when are MPA network initiatives and when are sectoral regulations the appropriate tool to use to protect migrating whales?

[43] As part of the PhD I attempted to arrange a fin whale photo ID comparison project using photographs obtained by researchers in the Strait of Sicily, Lampedusa Island, and the Pelagos Sanctuary. However, this initiative was mainly met with resistance and unwillingness to share data and collaborate.

7.3.1. The MPA Network Approach

7.3.1.1. Building Human Networks

Agardy and Wilkinson (2003) point out that MPA networks have a dual nature: connecting marine areas that are deemed critical, and linking people and institutions to allow for more effective conservation. The former can be thought of as ecological networks, whereas the latter are human networks. A key emerging and recurring theme of this doctoral research is the pivotal need to develop interpersonal relations between researchers. Building on the discussion above of the importance of promoting collaboration between researchers, the finding of this doctoral research is that the real contribution of MPA networks to migratory whale conservation lays in the development of human networks.

In a workshop of 'Bilateral and multilateral agreements to facilitate partnership between MPAs' at the second International Conference on Marine Mammal Protection Areas (ICMMPA 2), the discussion centred on the Sister Sanctuary initiative—a marine mammal-specific 'MPA network' to improve conservation of migratory humpback whales. Whilst MPA networks aimed specifically at cetaceans are still in their infancy[44] (Hoyt, 2011), the Sister Sanctuary initiative, which aims to protect the end nodes of North Atlantic Humpback whales migrating between the U.S. and the Dominican Republic, has provided useful insights.

The bilateral agreement between NOAA and the Dominican Republic Ministry of Environment and Natural Resources in 2006 established the world's first Sister Sanctuary between the U.S. Stellwagen Bank National Marine Sanctuary in the Gulf of Maine and the Santuario de Mamiferos Marinos de la Republica Dominicana[45]. Humpback whales spend summer and fall feeding in the productive waters of the Gulf of Maine and migrate to the warm waters of the Dominican Republic, where the main breeding and calving grounds are located. Whilst the Sister Sanctuary focuses on the

[44] The idea took solid form at the ICMMPA I, held in 2009. See Chapter 2.

[45] This sanctuary, established by the Dominican Republic in 1986, represents the first whale sanctuary in the Caribbean region. It was expanded in 1996 and 2004 to cover the three main humpback whale breeding grounds in Dominican waters. The sanctuaries are consistent with the objectives of UNEP's Caribbean Environmental Programme (CEP), the Cartagena Convention and its Protocol on Specially Protected Areas for Wildlife (SPAW), which collectively bear many resemblances to the Barcelona Convention SPA/BD Protocol of the Mediterranean Sea.

U.S. East coast—Caribbean migratory connection, the whales migrate to additional, more northern areas scattered throughout the North Atlantic Ocean (NOAA, 2010).

A lesson learnt from the Sister Sanctuary initiative is the necessity of communication and data-sharing between researchers, establishing a shared mission, capacity building, facilitating collaboration through regular and joint workshops including all stakeholders, standardisation of research methods, and reconciliation of any political and cultural differences. Whilst a human network is most powerful if a regional, legal instrument is already in place (such as the Barcelona Convention or the Cartagena Convention) [PC-11], the building of human networks is of outmost importance in all conservation contexts, notwithstanding the migratory species and geographical context.

Similarly to the Sister Sanctuary agreement, the conservation of Mediterranean fin whales would benefit from the establishment of a comprehensive human network. An interviewee [PC-11] involved in the Sister Sanctuary agreement comments that the network is really based on research, forming a sort of research network. Given the low tendency by governments to collaborate across borders, such a 'researcher network' may have the added bonus of increasing advocacy potential and inciting inter-governmental cooperative action. As described by an interviewee: *'it is the researchers and civil society that start and make the case for the governments to take necessary steps [for conservation]'* [RC-11].

Notwithstanding its success in building human networks, the Sister Sanctuary is not protecting Humpback migratory routes, nor is it likely to do so in the near future [PC-11]. This refers us back to the question of whether MPA networks can provide protection from ship strikes and other threats posed to migrating whales. Whilst a human network is a necessary precursor of an ecological network, it is not evident that ecological connectivity with practical mitigation measures will ensue. If this aspect falters, the value of MPA networks as an effective conservation tool also falters. Whereas the building of human networks is *always* appropriate and necessary for migratory whale conservation, ecological networks are arguably a red herring, for reasons explained below.

7.3.1.2. Ecological Networks: A Red Herring

In order to protect whales during their migratory life-history stages, MPA networks need to take into account the connections between feeding and breeding nodes and provide protection for the linkages that are migratory habitats (e.g. Hooker and Gerber, 2004; Hoyt 2005; 2011). However, if MPA networks are to be ecologically connected they need to scale up not just from small, isolated MPAs, but also from representative MPA networks and human networks.

As Shuter et al. (2011:192) state: ‘For migratory organisms, the effectiveness of fixed reserves is contingent on different aspects of their migratory behaviour. Permanent reserves would be much more effective for protecting habitats of organisms that exhibit fidelity to their ranges or migratory routes’. The authors argue that long-distance migration and low site fidelity augment the chance of individuals being outside of reserve boundaries. As discussed above, unpredictable migratory behaviour (high ontological uncertainty) pose considerable challenges on MPA network management to be adaptive, flexible, and dynamic. Since MPAs are inherently more static in nature[46], it is questionable whether adaptive management in MPA contexts can be temporally and spatially dynamic enough to match the dynamism of most whales’ migratory behaviour.

In theory, the precautionary principle could be invoked to address uncertainties surrounding migratory pathways. However, as discussed in Chapter 3, it is unlikely to be applicable on an operational level for situations with high ontological uncertainty. Indeed, had the present analysis centred more on international conventions or agreements to protect migratory whales, such as the CMS, CBD, or ACCOBAMS, it is likely that the precautionary principle would have featured more in interviewee discussions. The fact that the precautionary principle was not raised by the interviewees reflects the reality of its evaporation as actual practice and decisions draw near (e.g. Appleby and Jones, 2012). Since this doctoral research analyses more practical conservation tools, it is not a surprising finding that the precautionary principle failed to feature during the empirical work.

Due to the many challenges and uncertainties involved, effective conservation of dynamic, migratory whales requires substantial political dedication. Given the

[46] Adaptive management for MPAs tends to be considered more in terms of temporal scales of a decade to deal with changes due to, for example, climate change (Jones, pers. comm.).

unpromising track record of the Pelagos Sanctuary, it is difficult to envision how Mediterranean nations will take mutual responsibility for ensuring effective management as well as enforcement of high sea SPAMIs, particularly with regards to third states that are not party to the Barcelona Convention. With reference to the right whale case study, an interviewee comments on the importance of political willpower in the face of uncertainty:

> *'The data that we used to push things forward [to implement the Seasonal Management Areas] was robust but I wouldn't say that it necessarily met some of the standards for sightings per unit effort. It was opportunistic surveys and at some point you need to get the political willpower to go forward and say: ''look, this is the best that we have and we are gonna go with it''. And everybody just has to deal with that, and I think that's very difficult for people in the Mediterranean to do because the priorities have to shift a little bit' [RC-08].*

Moreover, both case studies show that the establishment of MPA networks in general, and in the Mediterranean, in particular, is a slow and complicated process. As a member of the research community comments:

> *'When we started back in Canada we talked to fisheries and oceans of MPAs for right whales and we were advised off the record to do something else as it would take at least a decade to do the analysis to consider an area as a MPA. In the 1990s MPAs were the buzz-word and the way to go, but it would just take too long to plan and put in place, so that's why we decided to go for sectoral regulations' [RC-14].*

Indeed, as described in Chapter 5 and 6, real mitigation measures may not necessarily follow MPA proclamation, and to address threats, regulations must restrict human activities that are responsible for the threat [PC-10]. With regards to the SPAMI network, parties to the Barcelona Convention need to collaborate with sectoral organisations in order to implement specific restrictions within the MPA boundary. The discussion around the effectiveness of an ecologically connected network thus returns to the issue of sectoral regulations. Since the MPA network approach needs to proceed via the shipping industry regardless, the apparent question is: why not proceed through the sectoral route in the first place? The establishment of ecological connectivity through MPA networks is likely to be too complicated and unfeasible given high levels of ontological uncertainty surrounding migratory routes, the difficulty of managerial dynamism, and low political will to designate, manage and enforce such areas.

This thesis does not aim to evaluate the advantages and disadvantages of the MPA network approach *per se*[47], but its applicability to protect migratory whales, which is a new field of research. Linked to the discussion of the appropriateness of large-scale MPA networks is the issue of ecosystem-based versus single-species approaches to conservation (see Chapter 2, Section 2.3.2.1). Whilst a landscape-based view on migratory whale conservation, extending to habitats and prey, is pivotal (e.g. Hoyt; 2011), the findings of this thesis suggest that migratory routes do not lend themselves well to *habitat*-based protection. Indeed, area-based conservation measures do not have to equate to habitat-based strategies in the MPA sense, as demonstrated by the right whale case study.

MPA networks are still in their embryonic phase (Hoyt, 2011), and a theory is lacking on how to apply them to migratory whale protection (Hooker and Gerber, 2004). The emerging argument of this thesis is that the MPA network approach does not represent an effective tool to protect migrating baleen whales, and that ecological connectivity through ecosystem-based MPA networks is likely to be a red herring in the protection of whales against specific threats during their seasonal movements. The argument does, however, recognise that different strategies may be needed for different whale life-history stages: a landscape approach to address species-specific threats during migration can thus be embedded within an overarching ecosystem-based and multi-species approach that targets other life-history stages, habitats, and whale prey.

[47] For a wider scope of the MPA approach I refer the reader to the book 'Marine Protected Areas for whales, dolphins and porpoises' by Erich Hoyt (2011).

7.3.2. All Roads Lead to the IMO

As argued above, regardless of whether conservation proceeds through the MPA network approach or not, sectoral regulations are necessary. Based on the empirical and literature research conducted during this PhD project, I find that all roads lead to the International Maritime Organisation.

As a UN specialised agency, the IMO is the primary authority responsible for international maritime interests and their safety of navigation (Silber et al., 2012). There are many reasons why proceeding through the IMO is useful and necessary for the conservation of wide-ranging whales: The IMO i) has mandate over international shipping, which is important for areas such as the Mediterranean Sea where much of the shipping is between countries and entails third state passages, ii) has mandate to address the high seas, iii) is a widely acknowledged authority, and domestic shipping regulations invariably ensue internationally adopted measures, iv) is able to promote transboundary governmental cooperation through a mutual international forum, and v) has a wide outreach and is able to disseminate information on whale sightings and measures to reduce whale-ship collisions (see e.g. Knowlton and Brown, 2007; Vanderlaan and Taggart, 2009; Silber et al., 2012).

To date, ten IMO-adopted measures in three geographical regions have been implemented to protect large whales against ship collisions (Silber et al., 2012) (Table 7.3). Whilst these sectoral measures mainly address feeding aggregation areas, the Strait of Gibraltar TSS and recommended speed limit also benefits migrating North Atlantic fin whales, which seasonally travel through the strait [RC-03]. Therefore, even though the measures aim to reduce collisions with numerous large whales, including fin whales, killer whales (*Orcinus orca*), and Cuvier's beaked whales (*Ziphius cavirostris*) (Silber et al., 2012), they also provide protection of a NA fin whale migration bottleneck.

IMO measures can further operate on a seasonal basis to reflect whale distribution patterns. For example, the voluntary ATBA in the Great South Channel is seasonally active and globally reflected on nautical charts between April and July, conferring a calculated 63% reduction in the risk of right whales being hit by vessels (NOAA, 2012). Since mariners can take measures such as the ATBA into account in

Table 7.3. IMO-adopted measures to reduce whale-ship collisions. Proposals submitted by Member States and the dates considered and approved by the relevant Sub-Committee: Safety of Navigation (NAV), the Marine Safety Committee (MSC), Marine Environment Protection Committee (MEPC), and the date proposed actions were implemented by the Member State. From Silber et al. (2012).

PROPOSALS SUBMITTED/ACCEPTED BY THE IMO	STATE	NAV	MSC	MEPC	IMPLEMENTED
Report to MSC-IMO: vessels striking right whales	USA			Jun-97	Information 1997
Mandatory Ship Reporting (MSR): Eastcoast	USA	Jul-98	Dec-98		Jul-99
Traffic Separation Scheme (TSS): Bay of Fundy	Canada	Apr-01	Dec-02		Jan-03
Traffic Separation Scheme (TSS): Cabo de Gata	Spain	Jun-05	May-06		Dec-06
Traffic Separation Scheme (TSS) and Recommendatory Speed: Strait of Gibraltar	Spain	Mar-06	Dec-06		Jul-07
Traffic Separation Scheme (TSS): Boston	USA	Jul-06	Dec-06		Jul-07
Recommendatory Area To Be Avoided (ATBA): Roseway Basin	Canada	Apr-07	Oct-07		May-08
Traffic Separation Scheme (TSS): Boston	USA	Mar-08	Jul-08		Jun-09
Recommendatory Area To Be Avoided (ATBA): Great South Channel	USA	Mar-08	Dec-08		Jun-09
Guidance document: Measures to reduce ship strikes with cetaceans	USA			Aug-08	Information July 2009

advance voyage planning, the adverse impacts are lessened and mariner behaviour is likely to be more flexible and adaptable [PC-14].

7.3.2.1. Voluntary Regulations with a Blessing

For any conservation measures to be effective compliance must be ensured [RC-12]. Whilst it is beyond the scope of this thesis to examine the balance between top-down and bottom-up approaches to conservation, it is necessary to touch upon this debate in the light of regulations that restrict human behaviour. In certain circumstances, voluntary approaches backed by the community are preferable to top-down actions, since they do not require mandatory laws, potentially costly monitoring and enforcement, and since they can promote creative solutions by the industry or community (Khanna, 2001; Rivera and de Leon, 2004).

In terms of reducing large whale vessel strikes, Lagueux et al. (2011) demonstrate that compliance with U.S. voluntary traffic lanes in the South East U.S. has been very high (96%). However, in numerous cases voluntary measures are not effective, as for example is the case with the Dynamic Management Areas (Adams et al., 2011) described before (section 7.2.1.1). Interestingly, a member of the research community and a member of the shipping industry agree that enforceable regulations are required to ensure compliance. The former comments that: *'…agreements and conventions should be made stronger so that if you don't follow them you will be penalised. That's the only way to make things work in conservation'* [RC-01]. The latter concurs with the following statement:

> *'They [conservationists] keep on asking me ''how can we get better compliance?'' and I say you have to go out and hit people over the head, and how do you do that? You hit them in the pocket-book, it's the only thing that will get their attention really quickly' [SC-04].*

IMO-endorsed measures can be argued to provide an appropriate mix of top-down and bottom-up approaches. Due to the long-standing and widely accepted authority of the IMO, proceeding via this agency can help to circumvent the absence of mandatory laws and the need for top-down enforcement. Similarly to the ATBA on the U.S. East coast, Automatic Identification System (AIS) vessel navigation data has confirmed high levels of compliance with the voluntary and seasonally active (June through December) ATBA in Roseway Basin on the Canadian Scotian Shelf (Figure 7.4). An interviewee comments that the ATBA measure in Roseway Basin is *'voluntary with the blessing of the IMO, so it is stronger than just voluntary' [RC-14]*. Vanderlaan and Taggart (2009) show that 71% of ships complied with the Roseway Basin ATBA in the first five months of implementation, which has resulted in a considerable reduction (82%) in the risk of lethal vessel—right whale collisions. Indeed, IMO regulations are also likely to be more effective than national, mandatory laws, as described by the following interviewee:

> *'To me IMO measures seem to be more effective than national legislation, as they are able to get the information out. It used to be a right whale conservation area implemented by the Canadian government in the Roseway Basin but the ships just went straight through it. Both were voluntary measures: one implemented by the government, one by the IMO, and the IMO one works' RC-15].*

Another interviewee involved in establishment of the U.S. SMAs adds:

> *'IMO is better than domestic regulations. Even though the regulations of the IMO are voluntary and they cannot do enforcement, it has the advantage of multiple nations and the credibility of hundreds of years of trying to improve navigational safety, and because their steps are taken on behalf of navigational safety any ship at sea would be foolish not to stick to the regulations' [PC-14].*

The interviewee concludes: *'If I did it all over again I might have done it through the IMO'*.

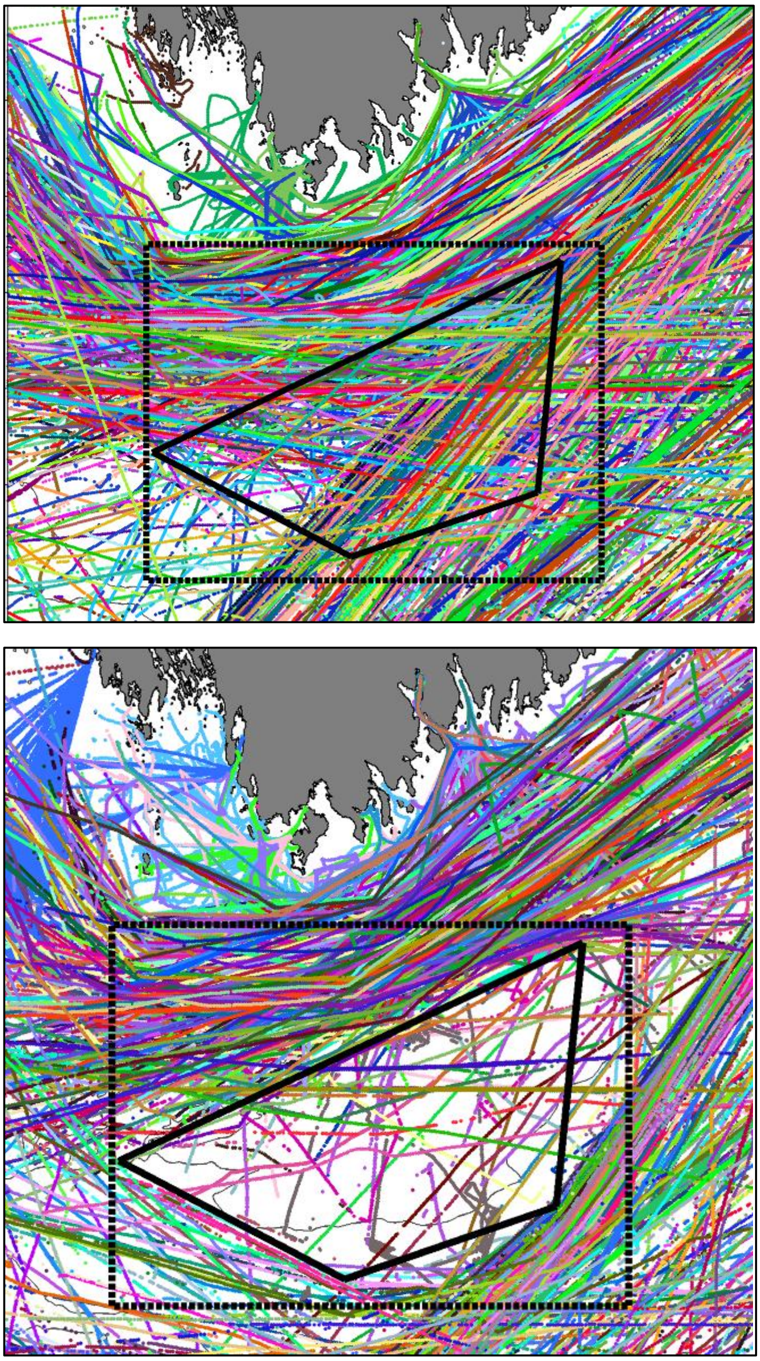

Figure 7.4. International Maritime Organization (IMO) Area to be Avoided (ATBA) (black polygon) in Roseway Basin, Canada. Coloured lines show automatic identification system (AIS)-derived navigation tracks for vessels travelling through the area from 15 June through 31 October before (top figure) (2007), and after (bottom figure) (2009), implementation of the voluntary ATBA in 2008. From Van der Hoop et al. (2012).

It is important to stress, however, that the IMO is not an enforcement or compliance body. As a member of the sector community explains:

'A regulation has to be adopted by the IMO member states and then it becomes an enforceable regulation. Enforcement is done at two levels, flag State requirements on ships to comply with international regulation, and port State requirements on ships that they permit to enter their ports' [SC-02].

Implementation through port state control may be inadequate, resulting in regulations being differently adhered to from country to country (Knudsen and Hassler, 2011). Moreover, since a nation needs to submit a proposal for a regulation to the IMO, and the regulation must be approved by other member states, the issue of governmental political will is still present. However, political will can be influenced by collaborative efforts between researchers and the industry, as demonstrated by the process leading up to the IMO-adopted measures in Canada. An interviewee explains that, in contrast to the U.S. situation, the Canadian government was not the main instigator of the TSS and ABTA proposals:

'In Canada, all of the measures for right whales were driven by non-profit groups and universities and the industry. The difference is that in the U.S., the NMFS is responsible for the right whales, but in Canada we worked with Transport Canada. We [the researchers] wrote the IMO proposal and gave it to Transport Canada. It was a nice example of scientists working with the industry. We worked with Irving Oil from the beginning, so it was scientists and industry presenting this together. It was different in the U.S., where it was taken over by the government' [RC-14].

Notwithstanding, a considerable implementation gap is the issue of who proposes regulations to reduce whale-ship collisions on the high seas, and whether IMO-measures can be approved and established in Areas Beyond National Jurisdiction. Gjerde (2001:125) points out that 'coastal States that have not declared their EEZs may propose routing measures for adoption beyond their twelve mile territorial sea, i.e. in areas that would still be considered the high seas'. Similarly, with respect to other IMO-tools, including TSSs and ATBAs, governments that have a common interest in ABNJs could jointly submit proposals, which would add 'more weight in the process' [SC-01]. Indeed, an IMO proposal for making the Pelagos Sanctuary a PSSA is currently in process (Ody, pers.comm.). Whilst practical implementation is scarce it is possible to establish IMO place-based regulations on the high seas, which has critical implications for migratory fin whales in the Mediterranean Sea.

7.3.2.2. Disconnects and Untapped Potential

Knowlton and Brown (2007) discuss three primary avenues to reduce ship strikes: i) education of mariners of whales' whereabouts and measures to be taken to avoid collisions, ii) development of detection technologies, and iii) altering vessel operations through traffic routing and speed restrictions. In the light of the current PhD findings I suggest to add 'enhanced collaboration, cooperation, and communication between researchers and members of the sector' to this list.

As emphasised in Chapter 6, measures that regulate anthropogenic activities often need to overcome [initial] resistance and change human behaviour. An interviewee explains how a participant at the first ICMMPA stated that: '*We don't' manage whales, we manage people'*. Commenting on this statement as '*interesting and revealing'*, the interviewee acknowledges that '*it did take me by surprise a little'* [PC-07]. Given the findings of the present research project, I do not find this surprising at all. Since the IMO through its long-standing authority has a strong impact on the maritime community world-wide, communication and collaboraiton is required at the IMO-level to ensure that regulations are proposed and implemented. In the U.S., discussions with the IMO (especially through late Lindsey Johnson) helped raise awareness of the whale-ship strike issue, cemented collaborative partnerships, and brought about the first IMO-endorsed measures for right whales [PC-14]. The prospect of enhanced collaboration is indeed timely since the IMO has displayed a trend of becoming 'greener' in recent years [PC-08].

Discourse on stakeholder partnership building, including science-based stakeholder dialogues, organisational learning, and various forms of communicative tools is prevalent in the literature, but beyond the scope of the present PhD. However, a point made by Welp et al. (2006:178) stands out: ‘Typical settings for dialogues are conferences and workshops… Key issues to consider are thus under what conditions such groups become learning teams, rather than debating opponents or negotiating parties, and how the process of learning can be extended beyond such meetings.’ The opinion expressed here is that this sort of ‘extra-curricular’ collaboration should receive more emphasis. As a member of the shipping industry comments: *‘I think the cooperation is there, we just have to exploit it’* [SC-02]. Indeed, the Canadian example described above demonstrates the value of establishing close collaboration with the industry and how it can further the conservation agenda despite a lack of political will. Another example of how closer cooperation can be pursued was raised by a member of the IMO:

> *‘The MEPC [Marine Environment Protection Committee] doesn’t have a scientific advisory group. There should be a report from scientists on every meeting on new developments and emerging issues…the advice may be more accurate instead of side-stepping via governments. It should be a standing body, just like the IWC has a body advising the political body…some information does come in, but it is more on an* ad hoc *basis’ [SC-01].*

Furthermore, during the ICMMPA II it was suggested that an IMO task force for the Mediterranean should be established to enhance cooperation and advance the agenda of ship-whale mitigation in this region[48]. The establishment of such working teams would also facilitate a necessary condition for dialogue, namely treating one another as colleagues (Welp et al., 2006), and ‘setting the climate’ to build successful relationships (Tamm and Luyet, 2004).

Increased collaboration and communication on this level is further important to reduce the often misaligned perception and treatment of uncertainty by scientists and decision-makers (Bradshaw et al., 2000), especially when scientific uncertainties may have large economic consequences (Barbour et al., 2008). In an ideal scenario, scientific

[48] As part of that ICMMPA II discussion group, I was asked to be one of the organisers and participants of such a task force.

knowledge and associated uncertainty is communicated undistorted and with transparency between researchers and decision-makers (Skodvin and Underdal, 2000). However, whilst uncertainty is accepted in scientific circles, policy makers and sectors invariably demand full knowledge and deterministic conclusions (Bradshaw et al., 2000), and the risk of uncertainty being used as a 'license for inaction' is ever present (de Santo, 2010).

De Santo (2010) argues that the concept of uncertainty has been misinterpreted by sector and policy communities. I expand on this argument by stating that the 'disconnect' in communication and understanding relates primarily to the concept of ontological uncertainty, and decision-makers' unwillingness to take action in the face of unpredictability and inherent dynamism. Interviewing shipping community members revealed an expectation that the amount of information available regarding whale presence in a certain area is in proportion to the amount of research effort invested. The reasoning was thus that, if a strong knowledge base is not available, the conservationists have not committed fully to the partnership, and it is not 'fair' on the industry to expect a regulation in the face of uncertainty; in other words, a view that uncertainty is solely epistemic in nature.

A real challenge is therefore to foster honest communication of the inevitable presence of ontological uncertainty in migratory whale behaviour without providing the sector or policy-makers with an excuse to proceed with business as usual. As Heazle (2004:373) points out: 'It is not uncertainty itself that determines or influences policy making so much a how we choose to use it—and that is ultimately determined by political choices about what is or is not desirable'.

Chapter Conclusion

In this chapter I sought to address the research questions in more depth and provide a discussion surrounding the key findings of this thesis. Comparing and contrasting the empirical results of the two case studies was an illuminative exercise. The cases can, on a species as well as human level, be considered as two ends of a continuum, and numerous lessons learnt from the U.S case can be applied within the Mediterranean and other contexts.

In the light of the multi-faceted concept of uncertainty, the emerging argument is that on a species level ontological uncertainty surrounding whale migratory behaviour is the most challenging to address. Whilst epistemic uncertainties are impeding conservation, they can be addressed more efficiently given researcher collaboration and unification behind a common conservation agenda—a considerable challenge in the face of ambiguity. Indeed, the emerging, common denominator of this thesis is the importance of enhancing human interactions and relations on all levels.

Whilst an MPA network initiative can trigger the establishment of human or researcher networks, the conservation tool falters on the grounds of providing ecological connectivity through migratory habitat protection. The sectoral route must be embarked on regardless, if real measures are to change human behaviour and provide protection against specific threats. In particular, the IMO is able to address the many shortcomings of the MPA network approach, including provisions for management to be more flexible and dynamic, ensuring compliance through its long-standing authority, and the potential to circumvent (to a certain degree) lack of political will through enhanced collaboration between researchers and members of the industry.

In the final, concluding chapter I discuss the significance of the main findings presented in this thesis, as well as opportunities for future research and general recommendations for migratory whale conservation. This summarising chapter ends with a brief epilogue in which I reflect upon the PhD journey undertaken.

8

Concluding Remarks

8.1. Recommendations and Avenues for Future Research

In this thesis I have attempted to bring clarity on an inherently challenging topic, namely how to improve protection of baleen whales during their migratory journeys. The topic is innately challenging for numerous reasons, and represents a *bona fide* 'wicked problem' in the transdisciplinary sense. On the level of species behaviour, it deals with tremendously dynamic and intelligent animals. On a human level, it requires collaboration and coordination on a national, regional, and sometimes global scale. On a geographical level the whales tranverse vast ocean spaces of which little known.

Ontological uncertainty, which results from whales' often unpredictable and stochastic migratory behaviour, is an endemically 'wicked issue'. In line with transdisciplinary theory, creative methodologies and problem-solving attitudes are required in the future to protect such dynamically moving targets. The theoretical framework of analysing and dissecting the concept of uncertainty proved useful and allowed for a more sophisticated understanding of the main conservation challenges involved. The present research thus adds to uncertainty and policy analysis discourse by demonstrating the applicability of an ontological-epistemological dichotomy in cetacean conservation, and by recognising the contribution of ambiguity to the body of uncertainty.

Indeed, high levels of ontological uncertainty, where migration pathways are deemed too unpredictable for habitat protection, represent a principle challenge to migratory whale protection through the MPA network approach. However, even in circumstances of low ontological uncertainty the challenges are extensive for achieving ecological connectivity through MPA networks, particularly in regions of geopolitical complexity that require international cooperation and considerable political will. The argument presented in this thesis is that proceeding directly via the sector in order to achieve changes to sectoral practices is likely to be more efficient and successful than establishing MPA networks for the protection of migrating whales. The ecosystem approach is thus better pursued through a single sectoral route which is nevertheless wide in geographical terms. That is; rather than opting for cross-sectoral and cross-boundary strategies (such as MPA networks), I advocate for a more narrow sectoral approach that has international mandate, as exemplified by the IMO. Future research must, however, centre on the legal options for proposing and establishing IMO-endorsed measures on the high seas and across national jurisdictions, especially for the protection of Mediterranean fin whales.

The issue of conserving transboundary migrating whales puts great pressure on humans to collaborate, communicate, and make compromises. In addition to the species factor of high ontological uncertainty, the remaining challenges arguably surround human behaviour. References to 'transboundary issues' or 'lack of political will' are simply different ways of describing what can be referred to as the 'human factor' in conservation. Whilst unpredictable animal behaviour is a nature phenomenon which cannot be influenced (we cannot after all change the way that whales choose to behave), we *can* and *should* address the human factor.

The common denominator of the findings of this PhD thesis is the importance of collaboration and human interrelations in order to build strong leadership in conservation. The expression to 'think outside of the box' was used at the ICMMPA I to describe the need to scale up from isolated MPAs to MPA networks in order to provide more holistic protection of migratory cetaceans. However, we must also think outside of the box in terms of how to influence human interactions in a meaningful way. In particular, the focus should centre on collaboration between researchers, and increased cooperation and communication with the sector. 'Together we are strong' is a proverb that rings true in terms of the former. With respect to the latter, involvement of the sector is inevitable since conservation invariably requires some kind of change in human activities.

Closer collaboration between researchers and the IMO (in particular the MEPC) will facilitate information-sharing, and may help identify creative solutions and new avenues for conservation action. To this end, conventional workshops are not enough: the building of better collaborative and interpersonal relations must proceed in parallel in ‘safer climates’. It is further crucial that members of the research and sector communities begin to think of each other as colleagues, and that the dialogue is directed by professional leaders in collaborative techniques. Similarly, to promote collaboration between researchers the usual avenue is to convene workshops to meet, share data, and discuss common issues. Whilst this is excellent, it has not proven enough in the Mediterranean to ensure satisfactory collaboration and unification around common conservation goals for fin whales. A likely scenario is that Mediterranean researchers do not identify themselves as a ‘group’ but rather as scattered individual scientists.

For the Mediterranean context, the challenge of collaboration as a group in the face of considerable ambiguity must be overcome in order to more efficiently address the crucial epistemic uncertainties surrounding fin whale migration. ACCOBAMS could be explored as a vehicle to bring together cetacean researchers from different countries on a regular basis with the objectives to coordinate collaboration, share data, and ultimately create a common vision for fin whale research on a basin-wide scale. Even though the expectations of ACCOBAMS to provide effective conservation management are low, the prospects are greater for the organisation to act as an international forum to enhance researcher collaboration and unity.

The U.S. case study shows that if there is a will there is a way. But the ‘will’ of the conservationists involved must be unified in order to pave for the ‘way’. Whilst many aspects of conservation are context-dependent, I argue that the building of human networks to enhance researcher collaboration is a universal principle necessary to protect baleen whales throughout their range, and a tremendous opportunity that has not been fully appreciated or acknowledged. A general recommendation for migratory whale conservation is thus to devote true effort and time to build such researcher networks. Whilst not an exhaustive list, a network of conservationists may want to consider the following points:

- What are our mutual goals for conserving the species throughout its range?
- How can we collaborate in the most efficient manner to achieve these goals?
- How do we want to be defined as a group; i.e. what is our work ethic or ‘culture’?

- How can we start building relations with members of the sector as quickly and efficiently as possible?
- Which uncertainties are more epistemic or more ontological in nature? Make research priorities to address the most urgent epistemic uncertainties. How can the ontological uncertainties best be communicated and addressed?
- How can we include researchers from a variety of disciplines, for instance legal and policy experts, to make sure that biological research is efficiently fed into an overarching conservation picture?

8.2. Epilogue: Final Reflections on the PhD Journey

During the past three years my research has taken me down several paths within the context of the overarching research topic. As my research progressed I became convinced that migratory whale protection must be put more firmly on the conservation agenda despite its inherent and tremendous challenges. Why else bother protecting the whales at their end nodes?

My initial conviction that MPA networks was a promising route by which to protect migrating whales soon felt almost naïve. It became clear that efforts must be focused on the people and industries that are posing the threats, with or without MPA networks. How to achieve a change in their behaviour—which is ultimately governed by powerful, economic factors—felt as daunting as attempting to protect migrating whales in the face of high ontological uncertainty.

The fact that what started as a conservation research project on whales ended up having a strong focus on human interrelations came as a real surprise, and can be considered a true emerging topic. Since integration of the fields of human behaviour and conservation biology is rare, I feel confident, optimistic, and excited that there is something to be gained from a greater mergence of the two disciplines. Conservation is not just about biology anymore. It is about interacting people and the need for leadership.

As a final statement, my general sentiment for the future of migratory whale protection is well captured as dangling between optimism and Malthusian depression, as so eloquently phrased by Karl Popper (The Myth of the Framework, p. xiii):

‘It is our duty to remain optimists. The future is open. It is not predetermined and thus cannot be predicted - except by accident. The possibilities that lie in the future are infinite. When I say 'It is our duty to remain optimists', this includes not only the openness of the future but also that which all of us contribute to it by everything we do: we are all responsible for what the future holds in store’.

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Appendix I

Email format sent to potential interviewees

Dear [NAME],

[Further to our previous correspondence] I am a PhD candidate at University College London (UCL), UK, working under the supervision of Dr Peter Jones. The focus of my research is on migratory whales and the challenges and prospects of different conservation tools aimed at protecting them during their migrations, particularly addressing the threat of whale-ship collisions and the issue of uncertainty. Please find attached the research aims and questions of my project: Connecting the nodes: migratory whale conservation and the challenge of accommodating uncertainty.

To date I have completed an examined research proposal consisting of an in-depth literature analysis, theoretical framing, and methodological design. I am currently in the second phase of my research, interviewing members of the research, policy and shippping sector communities in order to gain insight and collect data for my analysis. Given your [INSERT PERSONAL EXPERTISE/RELEVANCE], I would be very interested in meeting with you in person for a discussion about some of the issues that I am exploring.

UCL enforces rigorous ethical guidelines for research and therefore any information we discuss will be treated in strictest confidence and your anonymity is assured unless you agree otherwise.

Thank you very much for your time and interest. I look forward to hearing from you soon, and hopefully meeting you in the near future.

With kind regards,

Christina Geijer
PhD Candidate, University College London

Appendix II

Abstract of presentation given at the ICMMPA II, Nov. 2011.

(Published in: Hoyt, E. (ed) (2012) Proceedings of the Second International Conference on Marine Mammal Protected Areas (ICMMPA 2), Fort-de-France, Martinique, 7-11 Nov. 2011, 103 pp.)

Through the lens of uncertainty: Protecting migratory habitats. Insights from fin whale conservation in the Mediterranean Sea

Christina Geijer (University College, London)

Migration routes represent critical habitats for seasonally migrat¬ing whales. Nevertheless, very few migratory habitats currently fall under some sort of protection. One reason for this is the chal¬lenge of uncertainty and obtaining reliable scientific information to inform conservation. In examining the perspective of migra¬tory whale protection as seen through a lens of uncertainty, it is useful to look at insights from fin whale (Balaenoptera physalus) migration and conservation in the Mediterranean Sea. As a result of adaptations to a specific, semi-enclosed marine environment, resident Mediterranean fin whales exhibit uncharacteristically dynamic migratory behavior. This inherent variability coupled with extensive research gaps has left Mediterranean fin whale migration patterns in a state of uncertainty.

In order to design more appropriate and effective conservation strategies to protect fin whales throughout their range, it can be helpful to examine the concept of scientific uncertainty itself. Uncertainty can be dissected and systematized into "epistemic" uncertainty – knowledge gaps which can be reduced by gather¬ing more data – and "ontological" uncertainty – the inherent complexity and variability of a system, for which the uncertainty cannot be reduced by additional information. The main challenge to migratory habitat protection through marine protected area (MPA) networks and/or marine spatial planning (MSP) is a high level of ontological uncertainty, since migration pathways will be too unpredictable for zonation. If high ontological uncertainty prevails, it may be more appropriate to focus conservation efforts on wider-scale restrictions pertaining to the sector(s) present¬ing the major threat(s) in order to protect wide-ranging species during their migrations. By contrast, if ontological uncertainty is low, protecting migratory routes as critical habitats or zones within an area-based conservation framework is more realistic.

However, even in circumstances of low ontological uncertainty, an important question to consider is whether MPA networks or MSP should be considered the obvious choice for migratory habitat conservation? The geopolitical climate within which the science is being applied – that is, the science–policy interface – influences the choice of conservation tools. As the Mediterranean case study demonstrates, in areas of considerable geopolitical complexity and low political will, the establishment of trans¬boundary MPA networks and MSP represents a considerable – and possibly insurmountable – challenge.

Appendix III

Short extracts of full interview transcripts from a member each of the:

i) Research community:

Question: What is your view on Mediterranean fin whale migration patterns?

Reply: The first view I have is that in the Mediterranean we are not really talking about migration as it is such a small area anyway so if you compare it to regular migrations, it may just be a small percentage of the fin whale population migrating. There is evidence of fin whales that are not migrating. I would be careful calling them migrations since usually migration is from a huge concentration during a feeding period to a huge concentration during a mating period, like the gray whales. In the Med the fin whales are displaying a different behaviour, they feed mainly in the summer, but several cases that they are feeding in winter too although in different areas and on different species, e.g. Cabrera, Balearic archipelago, Sardinia, Lampedusa. When thinking about migrating species you are thinking about them only breeding in the winter. So you have to be careful with your name--maybe Mediterranean large-scale movements? Migration makes everybody think about Alaska- California, Alaska-Baja California: nothing compared to the scale of the Med and what the fin whales are doing in the Med. There are papers describing fin whales giving birth all year round with peak in winter months. It’s a question of definition—it's a relative term compared to the environment you are considering. Usually during migration you see many, many whales going in the same direction in roughly the same speed around the same period, e.g. gray whales can be seen from cliffs of California. In the Med the situation is different, they don't travel close to the coast but you never find a situation where many whales are travelling by in the same direction, apart from the Strait of Gibraltar where you see whales going in and out at different times of the year. I would call them basin-wide movements rather than migrations. With migrations everyone thinks about the big migrations, and fin whales tend to differ a bit from these large stereotypes migrations.

Question: How do you think the SPAMI network can contribute to the protection of Mediterranean fin whales?

Reply: Well it can certainly contribute. Right now we have one SPAMI—the Pelagos Sanctuary—and we have strong evidence that the Pelagos is not including the habitats of the whales because they use the area to the west and the area to the east. Having a network of SPAMIs would certainly increase the chances of them staying in a protected environment. But the point is, is a SPAMI really protecting the whales or not? Because currently the Pelagos is not protecting whales in my opinion. They are providing data to study the whales but there are no mitigation measures in place, there is no management in place, the Pelagos is lacking a secretary, there's no management body. So there is a SPAMI but nothing else.

ii) Policy community:

Question: The seasonal management areas, how effective are they in your view?

Reply: I get this question a lot. It's virtually impossible to tell if they are effective at this point as they have only been in place for a few years. It appears that the NA right whale population has increased in size so perhaps some of the management measures are working. It's too early to tell if the goals are being attained.

Question: What are the prospects of the SMAs being kept in place after 2013?

Reply: We are working on that. We are hoping we can do something, at least something au lieu of that. From my perspective it's much more a policy or management call than it is very strong biology to back because trying to determine or detect any kind of trend in population size or number of ship strike is just not possible in this short time frame.

Question: What is your view on MPAs/ networks of MPAs as opposed to more industry/sector specific regulations?

Reply: I feel I have a really strong bias on that subject. I don't see very much value of MPAs actually. They are very popular as a sort of faddish but least they have some built conservation measure I am not sure I understand their utility. That is, we can set aside areas, large or small, but unless some kinds of human activities are limited within them then they don't have much impact. If they have no 'teeth' or automatically built in conjunction with some kinds of measures then they are meaningless. If, on the other hand, they are done with a network in mind so you can capture migratory species and have islands of protection they immediately become more valuable, especially if there are specific conservation measures or guidelines and rules that accompany them. But I would much rather approach things with a scalpel than a shovel. It's not easy but we can attempt to alter the behaviour of a specific community or industry by requiring the following things as opposed to saying 'in this area be careful'. If you can identify a problem and possibly a solution and then address it, it's much more effective than saying for example don't fish in this area.

Question: How is the IMO involved with the SMAs in terms of international ships in U.S. ports?

Reply: When we set out to address the issue of vessel strikes we realised we had a number of tools and a number of mechanisms and we tried to use a number of different measures. We approached the IMO but we also decided to use domestic laws for the seasonal management areas. One reason is that all regulations through the IMO are voluntary, most biologists don't understand this. However, if you have the backing of the IMO than it is very broadly accepted. Another thing, the IMO regulations are also for navigational safety so you would be crazy not to follow them.

iii) Sector community:

Question: What is your main view on whale—ship collisions?

Reply: The shipping industry is aware of it and we have worked over the last 5 years with the IWC. We've had reports from the scientific committee within the IWC, mainly through myself to raise the awareness of the issue within the shipping industry. We've had verbal and written reports to the Marine Environment Protection Committee (MEPC), which meets three times per two years. So the first level was just to raise the awareness and to discuss the issue. I think 10 years there were discussions about whales in the navigation committee. The IMO is a specialised, international agency. Because there is so much on the agenda the work is split up into committees, e.g. Safety Committee, Legal, Environment Protection Committee. Because you can't handle all the technical information they often have sub-committees, and one of them is the navigation committee, which looks at all aspects of routing of ships, traffic separation schemes. In that committee around 10 years ago, the U.S. came with a proposal to adjust its navigational system near the Boston port. Lindsey Johnson brought it to the navigation committee and made some amendments to the rules related to ship navigations. So she had a system in place that reduced the incidents of strikes. Then she came back about 5 years ago, at a time when we were looking at it in the MEPC raising the awareness more and more, she came in and amended that navigational system that was in place in Boston to take into account new emerging data. She knew roughly when whales were around, and she managed to optimise the route into that harbour, which was really good. It's interesting because the shipping industry up until the last 10 years wasn't really aware of environmental issues that much, and it's becoming more and more, including ship strikes. About 5 years ago we were working together with the IWC to raise the profile even further and there was a group established within the MEPC to establish guidelines for shippers so they can watch out, i.e. visual spotting. I believe that package of guidelines was developed in tandem with an educational package with the IWC put together. Last month there was more communication between that group and us and I think they are going to again try to raise the level of awareness.

Question: What is the compliance with these guidelines, what has been the response of the shippers?

Reply: That's difficult to measure because the IMO is not a compliance body. They are all voluntary and it's up to the master presumably to implement them. And over time as data become more available we will see what the effects might be and if the guidelines need to be changed and amended. That is one aspect. I personally feel we are making inroads and raising the profile but it's really difficult to react to something that is really difficult to identify, and with all the other risks involved as well. If there is some type of work that could be developed that deals with those issues, the IMO will definitely take it onboard and help on these matters.