Considering Climate Change in the Development of Marine Protected Areas

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Abstract

Marine ecosystems are facing a diverse range of threats, including climate change, prompting international efforts to safeguard marine biodiversity through the use of spatial management measures. Marine Protected Areas (MPAs) have been implemented as a conservation tool throughout the world, but their usefulness and effectiveness is strongly related to climate change. However, few MPA programmes have directly considered climate change in the design, management or monitoring of an MPA network. Under international obligations, EU, UK and national targets, Scotland has developed an MPA network that aims to protect marine biodiversity and contribute to the vision of a clean, healthy and productive marine environment. This is the first study to critically analyse the Scottish MPA process and highlight areas which may be improved upon in further iterations of the network in the context of climate change.

Initially, a critical review of the Scottish MPA process considered how ecological principles for MPA network design were incorporated into the process, how stakeholder perceptions were considered and crucially what consideration was given to the influence of climate change on the eventual effectiveness of the network. The results indicated that to make a meaningful contribution to marine biodiversity protection for Europe the Scottish MPA network should: i) fully adopt best practice ecological principles ii) ensure effective protection and iii) explicitly consider climate change in the management, monitoring and future iterations of the network. However, this review also highlighted the difficulties of incorporating considerations of climate change into an already complex process.

A series of international case studies from British Columbia, Canada; central California, USA; the Great Barrier Reef, Australia and the Hauraki Gulf, New Zealand, were then conducted to investigate perceptions of how climate change has been considered in the design, implementation, management and monitoring of MPAs. The key lessons from this study included: i) strictly protected marine reserves are considered essential for climate change resilience and will be necessary as scientific reference sites to understand climate change effects ii) adaptive management of MPA networks is important but hard to implement iii) strictly protected reserves managed as ecosystems are the best option for an uncertain future. This work provides new insights into the policy and practical challenges MPA managers face under climate change scenarios.

Based on the Scottish and international studies, the need to facilitate clear communication between academics, policy makers and stakeholders was recognised in order to progress MPA policy delivery and to ensure decisions were jointly formed and acceptable. A Delphi technique

was used to develop a series of recommendations for considering climate change in Scotland's MPA process. The Delphi participant panel was selected for their knowledge of the Scottish MPA process and included stakeholders, policy makers and academics with expertise in MPA research. The results from the first round of the Delphi technique suggested that differing views of success would likely influence opinions regarding required management of MPAs, and in turn, the data requirements to support management action decisions. The second round of the Delphi technique explored this further and indicated that there was a fundamental dichotomy in panellists' views of a successful MPA network depending upon whether they believed the MPAs should be strictly protected or allow for sustainable use. A third, focus group round of the Delphi Technique developed a feature-based management scenario matrix to aid in deciding upon management actions in light of changes occurring in the MPA network.

This thesis highlights that if the Scottish MPA network is to fulfil objectives of conservation and restoration, the implications of climate change for the design, management and monitoring of the network must be considered. In particular, there needs to be a greater focus on: i) incorporating ecological principles that directly address climate change ii) effective protection that builds resilience of the marine and linked social environment iii) developing a focused, strong and adaptable monitoring framework iv) ensuring mechanisms for adaptive management.

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Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the results of my own and has not been submitted for any other degree at the University of Glasgow or any other institution.

Signature

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Abbreviations

BSAC	British Sub Aqua Club
CBD	Convention on Biological Diversity
CDFW	California Department of Fish and Wildlife
COAST	Community Of Arran Seabed Trust
DEFRA	Department for Environment, Food & Rural Affairs
EBM	Ecosystem Based Management
EEZ	Exclusive Economic Zone
EU	European Union
GES	Good Environmental Status
GHG	Greenhouse gas
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
LDMN	Least Damaged More Natural
MCS	Marine Conservation Society
MCZ	Marine Conservation Zone
MLPA	Marine Life Protection Act
MPA(s)	Marine Protected Areas
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
MSS	Marine Scotland Science
NC MPA	Nature Conservation Marine Protected Area
NGO	Non-Governmental Organisation
NTMR	No-take Marine Reserve
NTZ(s)	No Take Zone
OSPAR	the Convention for the Protection of the Marine Environment of the North-East Atlantic
PMF	Priority Marine Feature
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SFF	Scottish Fishermen's Federation
SNH	Scottish Natural Heritage
SPA	Special Protection Area
UK	United Kingdom
UN	United Nations
WCPA	World Commission on Protected Areas
WDCS	Whale and Dolphin Conservation Society
WSSD	World Summit Sustainable Development

Chapter 1 Introduction

1.1 Rationale

Large scale anthropogenic changes to the marine environment have resulted in global concern for the health of marine ecosystems (Vitousek et al. 1997, Halpern et al. 2008). The increasing pressure on marine biodiversity has prompted international effort through agreements including: the Convention of Biological Diversity (CBD), resolutions at the World Summit on Sustainable Development (WSSD) and the United Nations (UN), to safeguard marine biodiversity. Marine Protected Areas (hereafter referred to as MPAs) are a widespread spatial management tool for the conservation of marine systems (Allison et al. 1998, Lubchenco et al. 2003, Lester et al. 2009, Pollnac et al. 2010, Chuenpagdee et al. 2013) and have been utilised for varying objectives such as biodiversity conservation (Almany et al. 2009), fisheries management (Botsford et al. 2009), and are recognised as a mechanism to deliver ecosystem services (Rees et al. 2012, 2014).The ubiquity of MPAs has resulted in their inclusion in international obligations and protection targets to protect ocean health, with member states including the UK agreeing to establish networks of MPAs for marine conservation (HM Government 2011).

Progress has fallen short, however, of achieving targets set by the international organisations, such as the protection and effective management of 10% of the global marine area in MPAs by 2012 (CBD 2010) even with the recent trend towards designating increasingly large MPAs (De Santo 2013). Global MPA coverage was estimated at 2.3% in 2012, with 5.67% of Exclusive Economic Zones (EEZs) and 0.17% of the High Seas included (Spalding et al. 2012). Additionally, the functioning and effectiveness of MPAs will be further challenged by the effects of global climate change (Harley et al. 2006, Andrello et al. 2015). Anthropogenic climate change is a major concern for marine conservation, acting on extensive spatial and temporal scales (Halpern et al. 2008), simultaneously a driver of biodiversity processes (e.g. range adjustments) and a dynamic threat (e.g. reduction of habitable space that can impede range adjustments) (Pressey et al. 2007), fundamentally altering marine ecosystems (Hoegh-guldberg 2010, Doney et al. 2012). Conservation planning for climate change is challenging given the uncertainty surrounding the timing, severity, magnitude and type of impacts (Tompkins et al. 2008;

Lawler 2009) and can add an additional level of complexity to the already complicated nature of MPA implementation (Jentoft et al. 2007).

This thesis focuses on the implementation and future management of MPAs in the context of climate change, particularly from a social and political perspective. This research develops a series of recommendations specifically for the Scottish MPA process. This chapter outlines the theoretical contexts within which this research is situated and provides the reader with an overview of contemporary MPA research. Detailed attention is given to the ecological principles that guide the design of climate change resilient MPAs. The suitability and importance of participatory and qualitative approaches for including information on stakeholder perceptions are also discussed.

1.2 Marine Protected Areas (MPAs)

The establishment of MPAs is now pervasive in global environmental policy (Agardy et al. 2003, Chuenpagdee et al. 2013). However, the definition of MPAs is highly variable, and this umbrella term can cover a wide variety of spatial scales, varying degrees of management and alternate governance structures (Agardy et al. 2003). The Convention on Biological Diversity (CBD) provides the following authoritative definition that states an MPA is:

" ...*any defined area within or adjacent to the marine environment, together with its overlying waters and associated flora, fauna and historical and cultural features, which has been reserved by legislation or other effective means, including custom, with the effect that its marine and/or coastal biodiversity enjoys a higher level of protection than its surroundings*" (CBD 2004a).

The definition of an MPA from The Convention for the Protection of the Marine Environment of the North East Atlantic, (OSPAR) as relates to the contribution of the Scottish MPA network, is as follows:

"*Marine Protected Area (MPA)" means an area within the maritime area for which protective, conservation, restorative or precautionary measures, consistent with international law, have been instituted for the purpose of protecting and conserving species, habitats, ecosystems or ecological processes of the marine environment."* (OSPAR Commission 2003).

MPAs are a versatile tool that can be tailored to local circumstances; focus has rapidly shifted to fully incorporate both community, and scientific involvement in the design process (Halpern and Warner 2002). Integration of scientific criteria with social and governance considerations is increasingly important to ensure that MPAs are socially acceptable and therefore ultimately effective (Gleason et al. 2010, Voyer et al. 2012, Burt et al. 2014).

To meet broad scale conservation objectives of protecting wider ecosystems, single, isolated MPAs designed and implemented in an ad-hoc manner have been found deficient (Agardy et al. 2011). Networks of MPAs have a greater potential than individual MPAs to achieve conservation, fishery and wider ecological objectives (Keller et al. 2009, Gleason et al. 2010, Agardy et al. 2011, Grorud-Colvert et al. 2014) and are widely advocated over single MPAs to address the plethora of threats facing the marine environment (Soto 2001, Allison et al. 2003, Edgar et al. 2008, Keller et al. 2009). The CBD define an MPA network as:

"*...a portfolio of biologically connected protected areas that is fully representative of the range of target ecosystems, species, and processes including in marine areas beyond national jurisdiction*" (CBD 2009).

Networks of MPAs that are well-designed and well-managed can potentially sustain species, habitats and ecological processes across a larger geographic scale (IUCN-WPCA), and therefore deliver on some principles of Ecosystem Based Management (EBM) (e.g. reducing cumulative impacts that compromise the delivery of ecosystem services) (Halpern et al. 2010). However, whilst MPA networks are preferable, as of 2008, only half of the world's MPAs were considered to be part of coherent networks (Wood et al. 2008). Additionally, a lack of systematic conservation planning for MPA networks can lead to gaps in protection (Margules and Pressey 2000, Mora et al. 2006, Rodrigues et al. 2006). Networks require co-ordination and co-operation across scales and levels of government working towards common ecological goals (Burt et al. 2014).

1.3 A solution in the face of climate change?

There is now a significant amount of literature surrounding the core ecological principles of MPA network design; from empirical evidence and theoretical models that measure the ecological effects of MPA shape, size, and spacing (Airamé et al. 2003, Halpern and

Warner 2003, Ardron 2008, Fernandes et al. 2012), scientific reviews (Botsford et al. 2003, Foley et al. 2010) and summary reports that synthesise these principles for managers and policy makers (OSPAR 2007, IUCN-WCPA 2008, Burt et al. 2014). However, despite these broad principles, place-based conservation measures (i.e. MPAs) have not historically been designed to take into account the potential shifts in ecosystem composition, structure and function which are a likely effect of global climatic change (Lemieux and Scott 2011). Therefore, it is important to consider what measures will enable MPA networks to continue to perform effectively under future conditions.

The predicted climate change impacts on marine ecosystems: temperature increases, rising sea levels, ocean acidification, changing circulation patterns, changes in weather conditions and dissolved oxygen levels (see Hoegh-guldberg, 2010; Pörtner et al., 2014), can directly and indirectly affect species distributions and abundances, community composition, habitat quality, and changes in population dynamics (Harley et al. 2006, Cheung et al. 2009, Lawler 2009). Subsequently, the effectiveness of MPAs may be affected (Salm et al. 2006, Brock et al. 2012). The mounting threat of climate change impacts upon marine systems has therefore prompted the adaptation of the guiding ecological principles to specifically include considerations of climate change in the design of MPA networks (Salm et al. 2006, Lawler 2009, McLeod et al. 2009, Keller et al. 2009, Brock et al. 2012, Fernandes et al. 2012, Levy and Ban 2013, Green et al. 2014, Magris et al. 2014) (see Table 1.1).

Table 1.1 Principles for MPA network design to achieve ecological objectives and climate change recommendations.

Ecological Principle	General Guidelines	Climate Change Recommendations	Key References
Representation: ***Protect the full range of biodiversity and associated oceanographic environment***			
	- Protect the full range of biodiversity in the biogeographic area	- Refine to promote persistence by considering vulnerability of species and habitats	(Roberts and Andelman 2003, Salm et al. 2006, Magris et al. 2014)
Unique, Key or Vulnerable Areas: ***Protect areas of unique value, high functional importance or vulnerable areas***			
	- Protect species and habitats with crucial ecosystem roles - Protect species and habitats of conservation concern	- Protect potential carbon sinks - Protecting sites more resistant to/able to recover from CCI[1] e.g. - Protect species/habitats vulnerable to CCI that would benefit from MPAs	(Margules and Pressey 2000, Brock et al. 2012, Magris et al. 2014)
Replication: ***Provide replicates of all habitats and species protected to spread the risk of negative impacts across the bioregion***			
	- Include replicates of representative species and habitats that are spatially separated	- Refine replicate principles by considering rarity, geographic extent, distribution and severity of disturbance, dispersal processes, vulnerability to CCI	(Allison et al. 2003, McLeod et al. 2009, Magris et al. 2014)
Adequacy/Viability: ***Ensure the size and shape of sites within the network are optimum to encompass ecological processes and maintain population integrity***			
	- Individual MPAs are an optimal shape and appropriate size to provide protection for the species, habitat or ecological process	- Larger MPAs for a network designed for climate change objectives - Range of sizes and spacing to address multiple objectives (e.g. conservation and climate change)	(McLeod et al. 2009, Fernandes et al. 2012, Magris et al. 2014)
Connectivity: ***Ensure MPA sites are ecologically connected within the network***			
	- Protect ecological linkages and connectivity pathways for a wide range of species	- Larger more closely spaced reserves may achieve connectivity objectives, but not climate change objectives, therefore use a range of size and spacing	(Magris et al. 2014, Andrello et al. 2015)
Mitigating Human Impacts: ***Increase the resilience of desirable ecosystem states in the face of stressors (natural and anthropogenic)***			
	- Sufficient area is encompassed within No-Take Marine Reserves (NTMRs) - Areas beyond the MPA network boundaries are sustainably managed -Ensure long term protection	- Embed MPAs in broader Ecosystem Based Management (EBM) frameworks that address other threats external to MPA boundaries - Buffer zones should be established - NTMRs are important for resilience	(Hughes et al. 2003, McLeod et al. 2009, Keller et al. 2009, Edgar et al. 2014)

*Adapted from (Burt et al. 2014)[1]

CCI: Climate change impacts

1.3.1 Ecosystem Integrity

MPA networks have been demonstrated to provide a range of potential benefits that contribute to ecosystem integrity. Within the boundaries of an MPA, species and habitats (including critical areas e.g. nursery or spawning grounds) can be protected from direct and localised anthropogenic threats; (Allison et al. 1998); habitat complexity and structure can be restored (Turner et al. 1999); and a more natural population and community structure can be maintained (when compared to fished populations) (Roberts and Polunin 1993). Thus resulting in larger, older and more fecund individuals which can aid enhanced recruitment and breeding success (Dugan and Davis 1993, Dayton et al. 2000). Across a network, regional biodiversity (genetic, species, habitat and ecosystem) can be conserved through adequate representation of the full range of habitats types (Airamé et al. 2003, Fernandes et al. 2012, Burt et al. 2014). The ability of MPA networks to achieve these objectives is dependent on maintaining the ecological structure and function of the protected sites (Allison et al. 2003).

Whilst MPAs cannot explicitly protect against climate change related disturbances (e.g. ocean acidification), MPAs can assist in sustaining biodiversity and ecosystem processes at regional and local scales (Levy and Ban 2013). The reduction of other anthropogenic threats (e.g. overfishing) can minimise the synergistic impact of other stressors which may exacerbate detrimental changes to ecosystem health (Harley and Rogers-Bennett 2004, Harley et al. 2006, Levy and Ban 2013). It is hypothesised that the reduction of additional stressors contributes to increased ecosystem resilience in the face of climatic stress (see Bernhardt and Leslie, (2013)).

However, there is some debate: Côté and Darling, (2010) observed local stress (i.e. unprotected areas) can increase ecosystem resilience to climate change by allowing for a greater portion of disturbance-tolerating taxa (in this case, coral) to establish, whereas Carilli et al.,(2009) observed faster recovery rates following coral bleaching events with a decreased amount of local stress. Fishery-induced changes to stock structure (e.g. truncated age and size structure) have also been observed to increase the sensitivity of some fish stocks to climate change (reviewed in Planque et al. 2010)). It is proposed that stressed (overfished) fish populations exhibit greater sensitivity to climate change than healthy populations (Keller et al. 2009, Planque et al. 2010).

Concurrently, the most resilient populations and communities to climatic change are thought to be those that are stable and intact, thus protection of such areas may reduce the risk of biodiversity loss (Harley et al. 2006, Micheli et al. 2012). It has been suggested that known spatial and temporal refuges may act as buffers against climate-related stress and should be protected (Harley et al. 2006, Keller et al. 2009). These refugia can additionally act as baselines against which further changes can be measured (Dayton et al. 2000). Spatial diversity within a large connected network may also contribute to increasing buffering capacity against climate variations (Planque et al. 2010, Gaines et al. 2010); enabling species to shift their distribution across a series of strictly protected reserves spread across latitudes (Allison et al. 1998), and increasing the likelihood of some replicated areas being spared from regional scale threats by serving as larval sources for recovery of damaged areas (Almany 2015, Emslie et al. 2015). Additionally, networks of MPAs may be one of the most effective tools for increasing resilience under future scenarios of climate change impacts (Micheli et al. 2012).

Critical to the idea of maximising ecosystem resilience is to ensure a proportion of the MPA network is managed as no-take, fully protected reserves to maintain ecological processes, enhance ecological recovery and meet biodiversity conservation objectives (Halpern 2003, Roberts and Andelman 2003, Lester et al. 2009, Edgar et al. 2014). Within the literature, the benefits of no take reserves, partial protection and open access have been extensively compared (see Sciberras et al.,(2013) for a synthesis), with the highest ecological benefit (e.g. fish density and biomass) occurring in no-take reserves. This is considered particularly important in a climate change context in order to minimise the increasing pressure on natural systems from the combined and synergistic impacts of stressors (Ban et al. 2012, Levy and Ban 2013). Additionally, the importance of buffer zones of partial protection around MPAs has been discussed as it is likely that these areas will have a profound influence on the viability of MPAs (see McLeod et al., 2009).

1.3.2 Ecological coherency

A key facet of conservation planning has been to represent biodiversity features within protected areas, yet in a climate change context the persistence and long term viability of species assemblages is critical (Magris et al. 2014). Connectivity is a key mechanism underlying the persistence of populations and therefore is important for MPA design

(Magris et al. 2014, Andrello et al. 2015). However, despite this emphasis to incorporate connectivity into MPA networks and accounting for climate change effects on connectivity, this aspect of planning has so far been neglected (Magris et al. 2014, Andrello et al. 2015).

Focus on designing connected MPA networks is exemplified with the EU's commitment to design an "ecologically coherent network" (OSPAR Commission 2003). The term “ecological coherency” is used to describe maintaining connectivity and representation within a network, and involves a delicate balance of the correct size, spacing and number of individual areas (Sale et al. 2005). Employing principles of connectivity into network design requires careful consideration of the best, often limited, available data on habitat distribution (assuming habitat types can be practically defined in an ecologically coherent way), larval dispersal patterns, adult movement ranges and oceanography (Gleason et al. 2010). Data poor situations, where key life history parameters are missing are unfortunately common in marine systems, (Sale et al. 2005, Ardron 2008).

Large MPAs (>100km^2) were recommended by Edgar et al., (2014) as one of five key features that contributed to conservation effectiveness (the other four being: no-take; enforced, old, and isolated) by protecting viable population sizes or ecological processes within their boundaries. MPA networks that are designed for climate change objectives should contain a range of MPA sizes and spacing to account for uncertainty of dispersal patterns, population parameters, and species-specific movement and the additional uncertainty of how these factors will change under climate change (Halpern and Warner 2003, Fernandes et al. 2012, Burt et al. 2014, Green et al. 2014).

Ultimately, identification of the uncertainty surrounding variability in dispersal patterns and ecological connectivity can be accounted for in network design providing there are clear goals and aims, stakeholder involvement, consistent evaluation and on-going monitoring, feeding back into adaptable network management (Halpern and Warner 2003). Moving forward with MPA design, the consideration of static networks versus networks that are adaptable temporally and spatially is a key priority to conserve key species and habitats in perpetuity.

1.3.3 Considering climate change in MPA processes

Whilst MPAs appear to be particularly valuable in a time of climate change, decisions on their locations, design and management have not always considered future changes in ocean conditions and it is possible that traditional MPA design may not be sufficient to continue to protect species as conditions change (McLeod et al. 2009). There are currently only a few examples that have included ecologically connected design principles and management as a whole system into regional scale planning (Gleason et al. 2010) (but see Airamé et al. (2003); Fernandes et al. (2012)).

Considering the effects of climate change in the design, implementation and management of MPAs is important for the following reasons: i) despite international efforts to reduce greenhouse gas (GHG) emissions, some level of climate change will occur into the future (Pörtner et al. 2014); ii) climate change is already impacting the marine environment and likely the effectiveness of MPAs; iii) proactive efforts to incorporate considerations for climate change will be more cost-effective and efficient than reactive responses to reduce potential impacts (Lemieux and Scott 2011). Additionally discussions are needed to establish whether the objectives of MPA agencies can be achieved under climate change scenarios, as these objectives have generally only considered protection of current representative ecosystems, which may alter under future conditions (Lemieux and Scott 2011)

MPA network ecological design principles, including those specific to climate change, are crucial for achieving ecosystem objectives, yet the integration of social considerations as critical is also increasingly recognised (Ban et al. 2013, Salomon and Dross 2013). Additionally, principles that are tailored to suit the ecological, social and governance context for the network region are required (Burt et al. 2014).

1.4 Understanding people as part of the MPA Process

The importance of the human dimension in MPA processes cannot be understated (Charles and Wilson 2009). The success of an MPA depends not only on the biophysical and ecological factors but critically upon the incorporation of social, economic, cultural, and institutional dimensions (Charles and Wilson 2009). A key challenge in the designation of MPA networks worldwide is selecting areas for protection that are

ecologically viable whilst also minimising impacts on local communities and livelihoods, and attaining a high level of social acceptance (Sale et al. 2005, Glenn et al. 2010). In addition to the biological factors that influence network design, the implementation of a substantial network is often hampered by complex socio-political factors including: divergent interests of stakeholders, conflicting opinions of resource governance, legal difficulties in defining boundaries or protecting species that cross international borders, and the paucity of data, particularly for offshore areas (Fox et al. 2012, Fleming and Jones 2012, Fenberg et al. 2012). Negotiations could be further complicated if they are based on models of future climate scenarios due to uncertainty regarding climate change impacts and the different risk tolerances for various stakeholders (Lemieux and Scott 2011, Rice and Houston 2011, Haward et al. 2013).

The importance of maintaining high stakeholder involvement throughout the MPA design process for later compliance, acceptance and successful implementation of an MPA network, has been well illustrated (Helvey 2004, Stump and Kriwoken 2006, Richardson et al. 2006, Guénette and Alder 2007, Lédée et al. 2012). The implementation of MPAs should be seen as an ongoing process of stakeholder participation: discussion should establish objectives for the MPAs (what they are and why they are needed), location and management measures (how they should operate) (Chuenpagdee et al. 2013). However, inclusive decision making processes are not "a silver bullet" for good governance (Burt et al. 2014). Stakeholder engagement is a complex and time consuming process; as the diversity of stakeholder groups increases, the complexity can increase and discrepancies in objectives become more likely (Lundquist and Granek 2005, Gleason et al. 2010). Conflicting stakeholder interests and competing values are inevitable; governance legitimacy and ultimately the effectiveness of the MPAs depend on decisions being made in the face of these complexities (Jentoft 2000).

The different ways in which stakeholders (fishermen, biologists, conservationists etc.) interact with and experience the marine environment shape their perceptions, beliefs and held values (Poe et al. 2014). These in turn shape the views of how marine resources should be managed (in this context, their views of MPAs) (Hall-Arber et al. 2009, Brennan and Valcic 2012, Poe et al. 2014). The values and perceptions of stakeholders can also extend to their expectations for MPA performance. Whilst benefits of MPAs may be realised in the future, costs to users are often incurred immediately. Several studies have

highlighted the importance of communicating the difference in realised and expected benefits (White et al. 2008, Higgins et al. 2008). Furthermore, the lack of perceived benefits or unnecessary impacts can lead to strong objections to MPA implementation and restrictive management, particularly in the case of fishery closures or no-take reserves (Roberts and Hawkins 2000, Gell and Roberts 2003b). The diverse values and perceptions of stakeholders, may remain irreconcilable in the short term, despite involving stakeholders in a process of engagement (Rees et al. 2010).

The importance of stakeholder participation in MPA processes extends to their inclusion in the establishment of management measures and governance structure of MPAs (Burt et al. 2014). Communities situated around MPAs and stakeholders affected by their implementation must be central in future MPA management, and clearly defined management objectives should be specified early in the process (Gleason et al. 2010). The management of MPAs is a complex concept and therefore studies have recommended an iterative collaboration of scientists, managers, resource users and other stakeholders, utilising the results from monitoring and evaluation programmes to continually assess progress towards achieving the MPA objectives and to improve management practice (Sale et al. 2005, Stevens et al. 2006).

For the user groups of MPAs, the value they place on the marine environment or how they use the marine environment is likely to influence how these users or stakeholders respond to management measures, particularly use restrictions (Voyer et al. 2012, Poe et al. 2014). Conflict over the management of MPAs, specifically "no-take" reserves, is common, yet a limited understanding of the social and cultural drivers have hampered efforts to ameliorate this conflict (Agardy et al. 2003, Voyer et al. 2012). Additionally, Jameson et al., (2002) highlight that only 31% of global MPAs were meeting their management goals as they were inadequately situated or had unrealistic expectations.

Much has been written regarding evaluation of management after implementation in order to assess MPA effectiveness (see Alder et al., 2002; Himes, 2005; Pomeroy et al., 2005). Information is needed regarding: overall success of management, what methods of management are used, enforcement and the on-going monitoring of MPAs (Cicin-Sain and Belfiore 2005). Successful implementation of a network is only part of the process; adequate evaluation and understanding of the effectiveness of MPA networks, with

continuous feedback, is needed to ensure objectives are achieved (Pomeroy et al. 2005). The ecological effectiveness of MPAs is dependent upon the provision of the best available information regarding natural systems and socio-economic factors to decision makers (Pomeroy et al. 2005). In the context of climate change, the continual evaluation and appropriate adaptation of management is particularly important given the uncertainty surrounding climate change that could result in knowledge, policy and management measures becoming outdated or inappropriate (Peterson et al. 1997).

With an increased governmental commitment to a wider stakeholder participation in marine decision making (Jones 2009, Rees et al. 2010), understanding the different values and perceptions of stakeholders is fundamental to a successful MPA process. Stakeholder support for conservation policies or compliance with management actions is related to a complex mix of social, cultural, psychological and economic factors (Sawchuk et al. 2015); it is therefore important for research to address how stakeholder perceptions vary and the influence this may have on MPA network implementation and eventual effectiveness. Qualitative research methods are particularly useful for understanding and exploring these elements by allowing the researcher to gain a deep contextual understanding of the situation and capture expressive information not conveyed in quantification (Bryman 2008). Additionally, qualitative methods such as qualitative scenario development have been demonstrated as particularly apt to examine potential impacts of climate change on marine biodiversity (see Haward et al., 2013). Participatory research is also greatly suited to the problem of considering climate change in MPA processes because of the complex nature of the problem that demands transparent decision-making and the incorporation of a diversity of knowledges and values (Reed 2008). By including stakeholders in environmental decision-making processes, it is argued that there will be greater quality, durability and acceptance of decisions (Beierle 2002, Reed 2008, Reed et al. 2008).

Interdisciplinary research is a key requirement in the context of the marine environment, managers and scientists need to collaborate with stakeholders to gain understanding of this complex socioecological system (Hussain et al. 2010, Pollnac et al. 2010, Poe et al. 2014). In the face of climate change, this cross-discipline collaboration will have ever increasing importance (Keller et al. 2009). Designing an acceptable MPA network requires a combination of data types including: quantitative biological and ecological data, socio-economic information and a qualitative understanding of how people interact (e.g. value

and perceive) the marine environment. Using qualitative research methods enables the researcher to observe a process in depth (Green and Thorogood 2014); to understand why and how climate change considerations are included in the implementation of MPAs requires this in-depth exploration

1.5 Thesis Aims and Objectives

Increasing emphasis is placed on establishing MPA networks that achieve a broad range of marine conservation and management objectives. Climate change is recognised as a driver of change in marine ecosystems and therefore presents new challenges in the design, implementation and management of MPA networks. Whilst development of the ecological principles that underpin MPA design has progressed to include considerations of climate change, there is still a large knowledge gap regarding how MPAs can be managed once designated in a climate change context.

Moreover, recent research highlights the growing need to understand the differences in perceptions amongst stakeholders which can ultimately affect the ecological effectiveness of MPA networks through issues of compliance and acceptance. With the designation of the Scottish MPA network in July 2014, the development of recommendations for considering climate change in the management of the network is a timely priority. Consequently, this thesis uses a range of qualitative methods and a participatory approach to address these issues.

Objectives:

- to critically review the process used to identify and select MPAs in Scotland
- to investigate perceptions of MPA practitioners about implementing and managing MPAs in the context of climate change
- to review how considerations of climate change have been incorporated into existing international MPA processes
- to investigate the importance of including stakeholder perceptions in the MPA process

- to explore the potential of a participatory approach to incorporating considerations of climate change into the management and monitoring of MPAs.
- to develop suitable recommendations for the management, monitoring, review and modification of MPAs in the context of climate change.
- to provide advice based on the collective experience of Scottish and international MPA stakeholders on how best to manage, monitor and review the MPA network in order to ensure that it meets its objectives in the face of climate change.

1.6 Structure of the thesis

The thesis is arranged into three sections, illustrated in Figure 1.1Figure 1.1 Structure of the thesis.

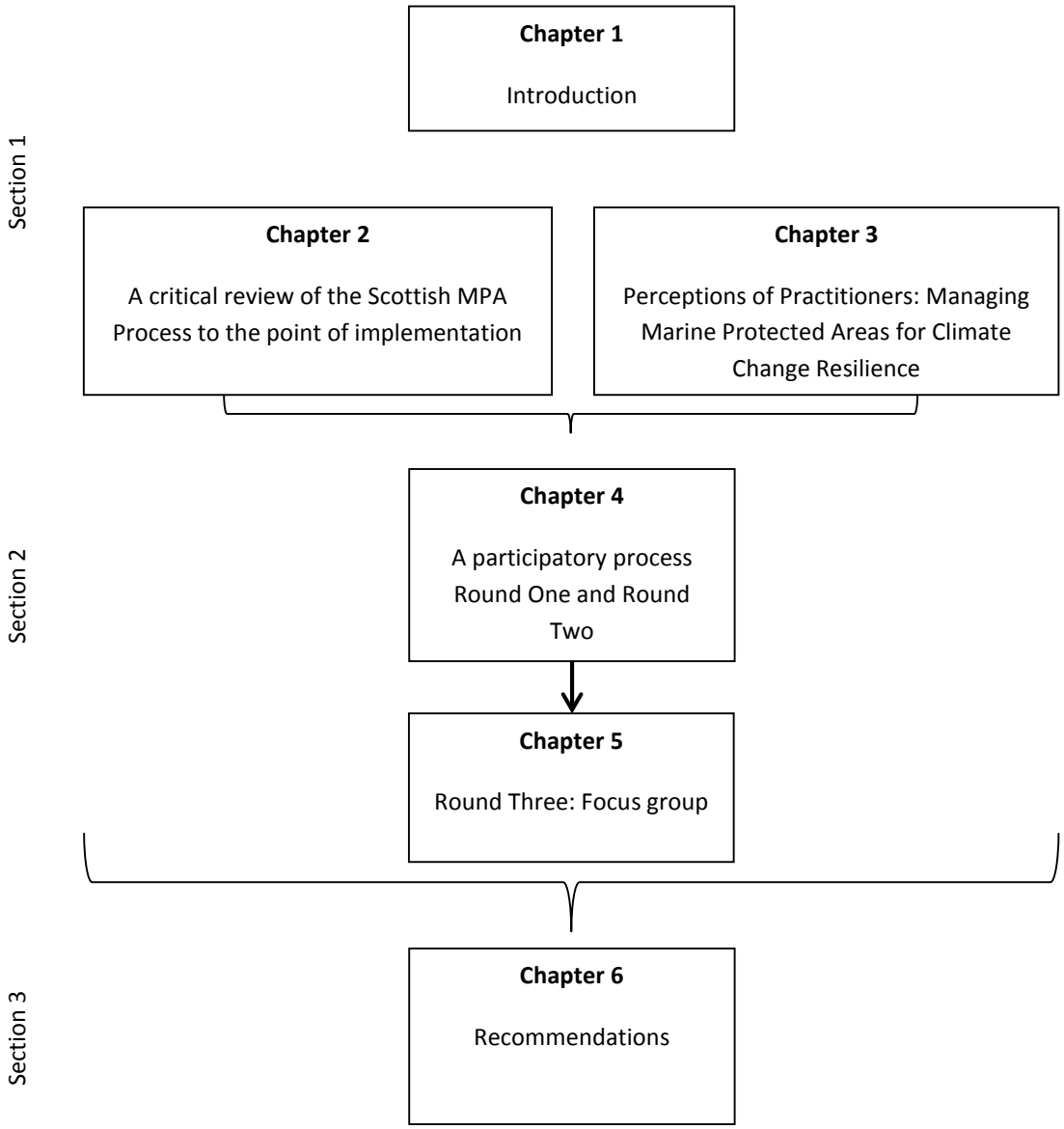

Figure 1.1 Structure of the thesis

Section 1 (comprising Chapters 1, 2 and 3) provides the context for developing recommendations for the Scottish MPA process. The introductory chapter (Chapter 1) frames the research topic and provides a rationale for the study. This is followed by a critical review of the Scottish MPA process up to the point of implementation (Chapter 2), considering the extent to which climate change was incorporated in the design process. Chapter 3 presents a series of international case studies that evaluate perceptions of how climate change considerations have been incorporated into MPA processes worldwide, providing a contextual basis for developing recommendations for Scotland. This section equips the reader with a clear understanding of the scope of the research.

Section 2 (Chapter 4 and 5) uses a participatory approach to develop recommendations for Scotland informed by the critical review in Chapter 2 and the results of Chapter 3. Chapter 4 introduces the methodology, explaining the use of a Delphi technique in this research and presents the results of the first two rounds of the process. Chapter 4 explores the perceptions of Scottish stakeholders, which is critical to the development of suitable recommendations. Chapter 5 explains the use of a focus group that enabled the researcher to further understanding of stakeholder perceptions and gather knowledge regarding possible scenarios of MPA management under climate change. The design, structure and content of each round are discussed in both chapters and a critical review of the qualitative methods employed is presented.

Section 3 (Chapter 6) concludes the thesis with a detailed discussion of the results of the Delphi process and crucially critically analyses the research in the context of current research. Chapter 6 summarises the overall conclusions of this thesis; the relevance of this research and recommendations for future work are also considered in this chapter.

Chapter 2 Scotland's Marine Protected Area Network: Reviewing progress towards achieving commitments for marine conservation

2.1 Abstract

Within Europe we face the daunting prospect of addressing the significant threats to marine biodiversity without full knowledge of the current status and health of our marine ecosystems. At a global, European, regional and national level, many policies push for increased protection through spatially explicit measures. The implementation of Marine Protected Area (MPA) Networks is one such measure to address marine biodiversity loss and pressure on the marine environment from human activities. Significant progress has been made towards implementing MPA networks in UK waters, with Scotland successfully designating 30 new Scottish MPA sites in July 2014. This chapter reviews the Scottish MPA process up to the point of implementation, summarising the process that led to the designation of the MPA network. In particular, this chapter investigates the extent to which the process: i) effectively engaged stakeholders; ii) used ecological guiding principles; and iii) considered climate change.

In doing so, this chapter highlights several key issues if the Scottish MPA network is to move beyond an administrative exercise and is able to make a meaningful contribution to marine biodiversity protection for Europe: i) fully adopt best practice ecological principles ii) ensure effective protection and iii) explicitly consider climate change in the management, monitoring and future iterations of the network.

Keywords: climate change, conservation policy; marine conservation; marine protected area networks; Scotland

2.2 Introduction

In response to international commitments and concerns regarding marine biodiversity loss, the designation of Marine Protected Areas (MPAs) within the European Union (EU), has gained impetus and member states are increasing protection through spatially explicit tools to address conservation goals for the marine environment (Metcalfe et al. 2013). European MPA coverage reached 4% in 2012 (European Environment Agency 2012). Whilst there are significant differences in coverage between inshore and offshore waters, and varying levels of protection across the different EU regions (European Environment Agency 2012), this is still significant progress towards increasing marine protection.

The coordination of such large scale, regional MPA networks is difficult. EU member states are implementing spatial marine protection on different timescales and under complex policy frameworks developed at both a European and national level (Haslett et al. 2010, Metcalfe et al. 2013). The UK is developing a network of MPAs as part of EU-wide effort to increase spatial protection and substantial progress has been made towards a network through the devolved administrations (Jones 2012). Although the final shape of the UK-wide network is yet to be determined, the English Marine Conservation Zone (MCZ) Project resulted in the designation of 27 new MCZ sites in November 2013 and the Scottish MPA Process, the designation of 30 MPAs in July 2014 (Figure 2.1). The Scottish MPA process is aiming to deliver the UK vision and Scottish Government's commitment to delivering a 'clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long term needs of people and nature' (Scottish Government 2010).

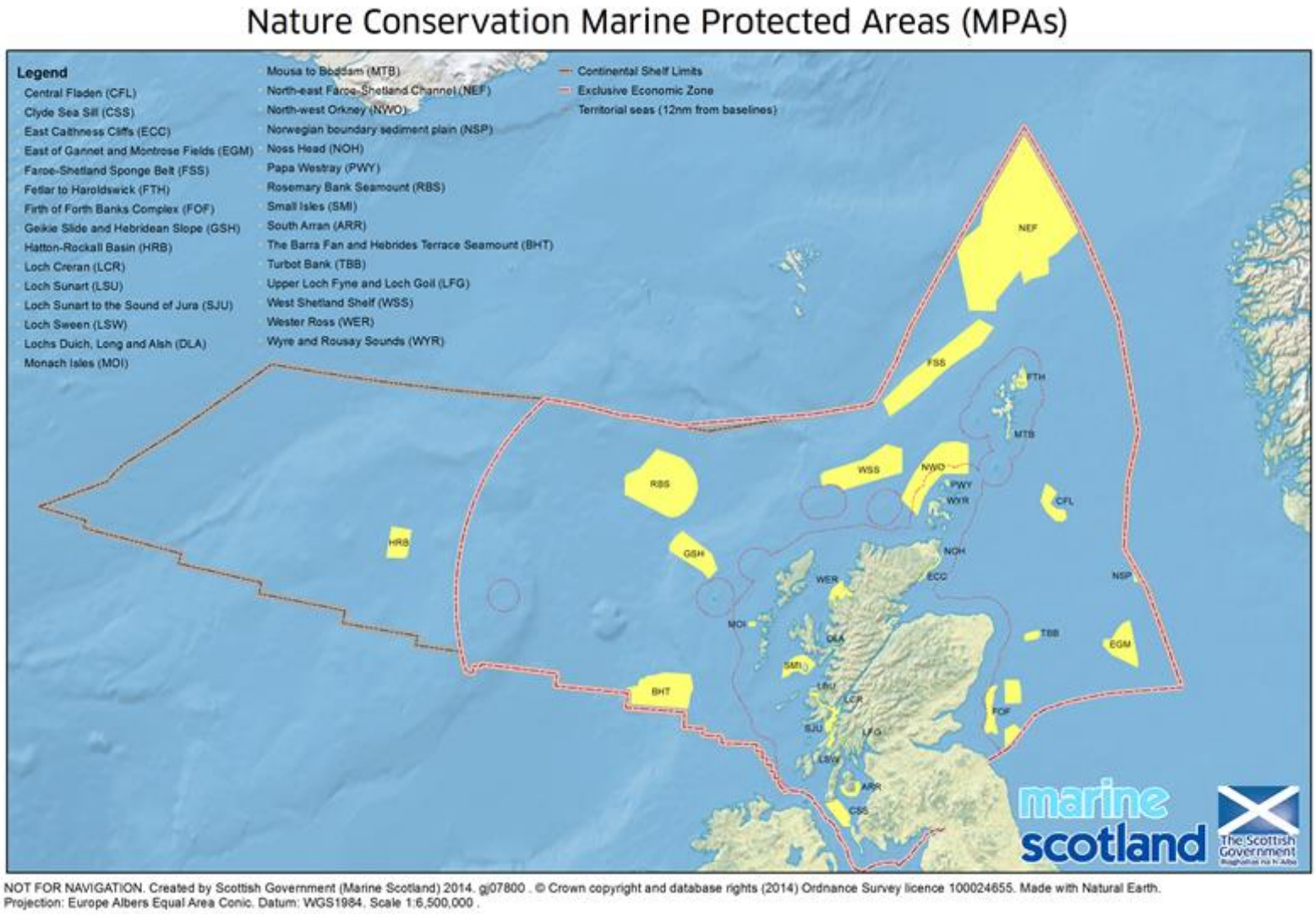

Figure 2.1 A map of the 30 new Scottish Nature Conservation MPAs designated July 2014. Reproduced with permission from Marine Scotland. Available at: http://www.scotland.gov.uk/Topics/marine/marine-environment/mpanetwork/MPAMap

However, despite the increasing implementation of MPAs worldwide, few processes are assessed in terms of the effectiveness of stakeholder engagement (but see (Voyer et al. 2012)), whether they are meeting ecological principles for network design and under the increasing threat of climate change, whether they have been designed for persistence and resilience. Consequently, this chapter reviews the Scottish Nature Conservation (NC) MPA (hereafter referred to as MPA) process up to the point of implementation by i) reviewing the policy framework under which the Scottish MPA network was developed; ii) critically examining the approach used for the selection of Scottish MPA sites; iii) highlighting future challenges for the Scottish MPA network and proposals for adapting the existing network to ensure that the network fulfils its objectives as a centrepiece for marine conservation.

2.3 Policy context

Scotland's MPA network is set against a backdrop of policy obligations and provisions at international, EU and UK levels (Table 2.1). The Convention on Biodiversity (CBD), the EU Habitats and Birds Directives and the Convention for the Protection of the Marine Environment of the North East Atlantic, (OSPAR regional seas convention) are the three key policy drivers for marine biodiversity conservation in Northern Europe (Metcalfe et al. 2013). Additionally supporting policies at the EU, UK and national level address marine protection in Scotland.

The development of MPAs in Scotland and the UK as a whole is framed by the implementation of the EU Marine Strategy Framework Directive(MSFD) (European Commission 2008), the aim of which is to manage human activities in the EU marine environment and to balance maritime development and resource use with environmental protection. It is a milestone in European marine policy (Salomon and Dross 2013) and as evidence towards the EU fulfilling its international obligations for the protection of the marine environment (Long 2011). Whilst the main goal of MSFD is to achieve "Good Environmental Status" (GES) of EU marine waters by 2020 (European Commission 2008), it gives legal force to the creation of a network of MPAs by 2012 under such obligations as OSPAR and CBD (OSPAR Commission 2003, CBD 2004a).

Table 2.1 A summary of International, European and UK marine conservation obligations and commitments

	Convention	Commitments of Contracting Parties	Commitment pertains to:	Deadline
International	World Summit on Sustainable Development (WSSD), Johannesburg, South Africa (United Nations 2002)	Recommendation for an international representative network of MPAs	Global Ocean	2012
	5th IUCN World Parks Congress, Durban, South Africa, (IUCN 2005)	Recommendation for a network of MPAs with 20-30% of total area strictly protected (IUCN 2005)	Global Ocean	2012
	7th Conference of the Parties to the Convention on Biological Diversity, Kuala Lumpur, Malaysia (CBD 2004b)	A global network of "comprehensive, representative and effectively managed national and regional protected areas" (CBD 2004b)	Areas under National Jurisdiction	2012
EU	Oslo Paris Convention, Convention for the Protection of the Marine Environment of the North East Atlantic, (OSPAR Commission 2003)	Ecologically coherent network of MPAs in inshore and offshore EU waters	North-east Atlantic Areas under National Jurisdiction Areas beyond National Jurisdiction	Ecologically coherent network by 2010 Well managed network by 2016
	Marine Strategy Framework Directive (MSFD), (European Commission 2008)	Using ecosystem-based management member states required to put in place a programme of measures to achieve "good environmental status" (GES) in EU marine waters. Approach to achieve GES should include protected areas.	EU marine area Areas under National Jurisdiction	Achieve GES by 2020 Supports creation of global network of MPAs by 2012
	Habitats Directive (Directive 92/43/EEC); Birds Directive (Directive 2009/147/EC) (EC 1979, 1992).	Implementation of marine Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) contributing to Natura 2000 network of protected area sites. Implemented in the UK by the Habitat Regulations and main source of existing protected sites.	EU marine area Areas under National Jurisdiction	-

UK	Nature Conservation (Scotland) Act 2004	Creation of Sites of Special Scientific Interest (SSSIs) applicable to the low water mark.	Scottish coastal area applicable to the low water mark	-
	UK Marine Policy Statement Jointly adopted by the devolved administrations (HM Government 2011)	Framework for preparing marine plans. Does not call for MPAs but key management instrument in MPA effectiveness at EU scale Sets out the general environmental considerations that need to be taken into account in marine planning	UK marine area	Supports targets proposed under the MSFD e.g. achieve GES by 2020. Agreed to coordinate policies and measures with other countries e.g. OSPAR ecologically coherent network by 2012
	Marine and Coastal Access Act 2009	Devolved responsibility under this Act allows MPAs to be designated out to 200 nautical miles	UK marine area	2012
	Marine (Scotland) Act 2010	Legal mechanism in Scotland for designating MPAs. Legislation states the 'Minister must designate a network of MPAs'. Climate change	Scottish marine area (includes inshore and offshore waters out to 200nm)	2012
	Scotland's National Marine Plan (Scottish Government 2015a)	Provides an overarching framework for managing marine activities. General Objective 9 outlines that development and use of the marine environment must comply with legal requirements for MPAs	Scottish marine area (includes inshore and offshore waters out to 200nm)	-

Notwithstanding the uncertainty of how and to what extent MPAs will contribute to GES, MPAs are still considered a key mechanism to be used in attempting to achieve GES (Fenberg et al. 2012). The approach Member States take in order to achieve GES should include protected areas under *Article 13 (4)* of the MSFD (European Commission 2008) contributing to a coherent and representative network of MPAs. Including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), designated under the Habitats Directive and the Birds Directive and jointly referred to as the Natura 2000 sites, Member States have made some progress towards establishing coherent MPA networks which are expected to contribute to the achievement of GES (European Commission 2008).

Under OSPAR, the primary regional seas agreement for the NE Atlantic, the UK agreed to contribute to developing an "ecologically, coherent network of well managed MPAs aiming to halt biodiversity loss in the marine environment" (OSPAR Commission 2003) in EU waters. The OSPAR Contracting Parties are responsible for nominating MPAs within their maritime boundaries and for providing progress reports towards designation. At a UK level the policy driver behind MPAs is the UK Marine Policy Statement (MPS) (HM Government 2011), the framework for preparing Marine Plans (National and Regional) and taking decisions affecting the marine environment (HM Government 2011). Joint adoption of the MPS by the devolved governments (UK Government, Scottish Government, Welsh Government and Northern Island Executive) has resulted in a high-level policy context framing the Scottish MPA process. Importantly the MPS represents a collective UK vision for the marine environment and the activities within it. Devolved legislators within the UK (Scotland, Wales, Northern Ireland) have agreed to develop planning and principles in alignment with the MPS.

2.3.1 Scotland's Vision

The Scottish National Marine Plan (Scottish Government 2015a) outlines policies for the sustainable use of marine resources in Scotland, under the guidance of the MPS. It covers both inshore waters (out to 12 nautical miles) and offshore waters (12 to 200 nautical miles) as one document but under two pieces of legislation; the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act (2009). One of the general objectives of the National Marine Plan is that marine planning should comply with legal requirements for

nature conservation, including protected areas. Importantly, through signing up to the vision of the MPS, additional powers for marine planning and establishing MPAs between the 12 and the 200 nautical mile limit were devolved to Scotland, an area originally under the jurisdiction of the UK Government under the Marine and Coastal Access Act (2009).

Scotland's vision for the marine environment is for a "clean, healthy, safe, productive and biologically diverse marine and coastal environment that meets the long term needs of people and nature" which includes the sustainable management of the sea to protect biodiversity and recover where practicable (Scottish Government 2011a). The vision for an ecologically coherent MPA network is outlined in The Strategy for Marine Nature Conservation in Scotland's Seas (Scottish Government 2011a) as part of a three pillar approach to conservation: species conservation, site protection and wider seas policies and measures which can contribute towards marine nature conservation (Scottish Government 2011a). The MPA network is intended to meet national objectives and international commitments and will consist of existing protected sites and newly designated MPAs.

The consideration of climate change is also included within the Marine (Scotland) Act 2010 with regards to the MPA network. Part 5 Section 68 (7) of the Act (Scottish Government 2010) states:
"In considering whether to designate an area, the Scottish Ministers may have regard to the extent to which doing so will contribute to the mitigation of climate change."
It is interesting to note that there is no reference to climate change adaptation either in terms of the role for MPAs in promoting resilience or in the need to take climate change into account in MPA designation or management. However, in a report to the Scottish Government providing advice to Ministers on the now proposed Scottish MPA network, the Ministerial Foreword specifically mentions climate change: "Healthy seas also assist in protecting us from climate change" (Marine Scotland, 2012). With a clear mention of climate change at the beginning of the advisory report, and the first iteration of the MPA network now complete, it is interesting to examine whether the same emphasis is given to the scientific considerations of MPAs and climate change throughout the Scottish MPA process. Additionally, the National Marine Plan deals with climate change on a sectoral basis, without particular consideration of the MPA network.

2.4 Scotland's MPA process

The Scottish MPA process was led by Marine Scotland Policy (a Directorate of the Scottish Government), with advice from Scottish Natural Heritage (SNH) and the Joint Nature Conservation Committee (JNCC) and input from Marine Scotland Science (MSS) through targeted research. In December 2012 the initial proposals for a network of MPAs surrounding Scotland were reported to the Scottish Parliament. The report from Marine Scotland outlined advice on the selection of proposed MPA sites for Scotland, reporting on the progress of a two-year process to design an MPA network for Scotland. Two additional designations that complete the Scottish MPA network: Historic MPAs and Research and Demonstration MPAs are considered by a separate process and are thus not discussed in the context of the Nature Conservation MPA process. Five stakeholder workshops represent the pre-designation phase to the MPA process and included the collation of data, exploring potential spatial designations, the role of 'less damaged sites', inclusion of community nominated sites and early discussion on the ramification for day-to-day management (Table 2.2).

Table 2.2 Summary of the five Stakeholder Workshops of the Scottish MPA Process

Workshop	Date	Key Content
1.Ecological Data	March 2011	· Presentation of the ecological data collated prior to the workshop · Discussion of data gaps
2. Least Damaged More Natural (LDMN) Locations	June 2011	· Presentation of the LDMN approach to select MPA sites
3. Developing the MPA network	October 2011	· Presentation of the contribution of existing protected areas to the new MPA network; contribution of other area-based measures; LDMN locations · Preliminary network assessment and overview of MPA search locations
4. Identification of additional MPA search locations and discussion of search feature sensitivities	March 2012	· Discussion of additional MPA search locations (including Third Party Proposals[1]) · Introduction of the use of feature sensitivities as a tool for starting discussions on potential management considerations for the future MPA sites.
5. Evolving shape of the network	June 2012	· Overview of the shape and development of the network proposals following Workshop 4 · Presentation of the process used to identify management options for the MPA sites

*Summary reports of the Stakeholder Workshops are available at: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/engagement/WorkshopReports

[1]Third Party Proposals: submitted prior to Workshop 4 covering 26 locations by organisations including: the Royal Society for the Protection of Birds (RSPB), Whale and Dolphin Conservation Society (WDCS), Marine Conservation Society (MCS) and Community Of Arran Seabed Trust (COAST), and were assessed against the MPA selection guidelines. Feedback suggested either the sites were submitted for further assessment, that further work would be needed to ascertain further assessment or that no further assessment should be made at that time (Scottish Government 2012a). Further third party proposals may be considered at the next 6 yearly review of the MPA network (Scottish Government 2012a).

2.4.1 Stakeholder engagement

Throughout the MPA network design process there was engagement in terms of strategic representation across sectors, that is, senior representatives of organisations or representation of industry clusters or interest groups (Scottish Government, 2012b). The five aforementioned stakeholder workshops operated on an invitation only process, with a limited number of stakeholder representatives in attendance due to venue size limitations and the practicalities of meaningfully engaging with participants. The discussion was tightly managed with limited time for "open ended" debate, focusing on specific questions related to the topic of each workshop, for example, the quality of existing data to support site designation. Although the stakeholder workshops were intended for key marine users, the supporting documentation was published on the Marine Scotland website.

Following the conclusion of the stakeholder workshops, the final advisory report from SNH and JNCC (Scottish Natural Heritage 2012) and the Report to Parliament on the development of the MPA Network (Scottish Government 2012b) was submitted to Ministers for consideration in December 2012 and preparation for the public consultation began. After Workshop 5 a Sustainability Appraisal was produced, comprising of a Strategic Environmental Assessment (SEA) and a socioeconomic assessment, summarising the impact of the potential individual MPAs and the potential MPA network as whole (see (Scottish Government 2012c)). Stakeholder engagement continued in the form of industry specific consultations. The public consultation was an important step in the process, likely to heavily influence the Ministerial decision. The formal consultation process on MPA proposals and the Sustainability Appraisal ran from July 2013 until November 2013 as part of a wider "Planning Scotland's Seas" consultation. The consultation documents invited comments on the development of the whole MPA network as well as site by site views and provided information on the scientific evidence for each site, the possible management options (see (Scottish Government 2013a)) and the potential socioeconomic impacts (Scottish Government 2013b). There will be further opportunities for public and community engagement with the submission of additional site proposals. This will be accepted and considered post-designation at the first review of the network in 2018.

2.4.1.1 *Critique*

The European Union (EU) 2010 Biodiversity Baseline report highlighted the great knowledge gap in determining the conservation status for marine species and habitats (European Environment Agency 2010). More than 70% of the species and 40% of the habitats of European interest in marine ecosystems are of unknown conservation status, and of those assessed only 2% of species and 10% of habitats are in a favourable state (European Environment Agency 2010). The need to improve the status of the marine environment, whilst balancing complex socio-economic and political interests is a documented facet of MPA implementation in Europe (van Haastrecht and Toonen 2011). The inclusion of stakeholders and resource users in the MPA process is important to the eventual effectiveness of MPAs (Kelleher 1999, Pollnac et al. 2010) and consultation is in many countries a democratic requirement by law or policy, with the ultimate decision-making power and funding decisions retained by the government (Day 2002). Two things will be essential in the on-going Scottish MPA process for a successful management approach and stakeholder relations: the first is continued effective engagement with stakeholders and the second is transparency and accountability over decision-making (Jentoft et al. 2007). Previous protected area processes not having a high level of openness have engendered suspicion and distrust from communities (Brennan and Valcic 2012); concerns of both the level of transparency and the representativeness of stakeholders have been raised in the English MCZ process (see Fletcher et al. (2014), Gaymer et al. (2014)).

The interpretation from attending the workshops was one where a diversity of actors and interests were ‘present at the table’ but deeper dialogue over the implications of the potential sites was generally avoided. This may be reflective of the stage in the policy cycle. While stakeholders were interested, no final sites were proposed during the workshop aspect of the process, and this level of strategic assessment may have limited detailed discussion. Controlling the nature of the discussion in this format steers the nature of the debate within the consultation process.

Engaging the parties whom MPAs will directly impact upon is often the easier task. Engaging the public throughout the process can prove more difficult, yet equitable consideration of all viewpoints is required to ensure a socially fair approach to MPA

designation (Voyer et al. 2012). The public consultation on the MPA network was embedded in a full consultation of marine spatial planning and offshore renewable energy development. Presented with such a variety of marine issues and the sheer scale of consultation documents, a pertinent question is whether this was overwhelming for an average citizen and whether the issue of MPAs was lost in the noise and technical complexity. Delegating the task of engagement in this manner, assumes the public as a stakeholder is able to understand and navigate a complex political, regulatory and bureaucratic system (Voyer et al. 2012). Another concern is that the public engagement exercise was a process of unidirectional information giving rather than an engaged two way discussion and commitment to explore communities managing their local resources. Additionally, the complexities of deeper social issues may be overlooked by framing public submissions in terms of support or opposition for the MPAs, a process that can be harnessed by large shrewd lobbying groups (Voyer et al. 2012).

The need for marine protection has been actively pushed up the political agenda through effective lobbying from the non-governmental organisation (NGO) community (Peel and Lloyd 2009). The majority of public consultation responses (14,371 out of a total of 14, 703 responses) were in the form of postcard-style campaign-text, (Mulholland and Granville 2014) in reference to 11 campaigns promoted by various organisations. Lobbying has been effective in a political sense but a clear gap remains over engagement with the general public and coastal communities who are affected both positively and negatively by the newly designated MPA network.

2.4.2 Inclusion of guiding ecological principles

The scientific guidelines for the Scottish MPA process are based on the OSPAR principles for designing an ecologically coherent network that include: representivity, connectivity and resilience (OSPAR Commission 2006). The working definition of an ecologically coherent network (as proposed by OSPAR (2007)) emphasises that the network should interact with and support the wider environment, maintain protected features and their processes/functions across their natural range (Laffoley et al. 2006) and the designated sites should function as a network rather than as individual areas of protection. Additionally, it is suggested that “[t]he network *may* be designed to be resilient to

changing conditions" (OSPAR 2007); it is interesting to note the use of " may" as opposed to "should" in the OSPAR guidance.

In the context of OSPAR's working definition and associated assessment criteria for ecological coherence, Scotland's MPA network is designed to "conserve a scientific selection of both marine biodiversity (species and habitats) and geodiversity (the variety of landforms and natural processes that underpin the marine landscapes), offering long-term support for the services our seas provide to society" (Scottish Government 2012b). Scottish MPA sites were selected using a feature based approach in which MPAs "will be used to recognise locations of habitats or species which are important, rare, threatened and/or representative of the range of features in the UK marine area" (Scottish Government 2011b). This resulted in a list of species and habitats that were considered of marine nature conservation importance for which both area and non-area based measures of protection would be appropriate (termed Priority Marine Features (PMFs)) (Howson et al. 2012). The list of PMFs was developed by SNH on behalf of Marine Scotland in order to focus marine conservation efforts, not as a replacement for previous lists (Scottish Natural Heritage 2010) and was presented at the first stakeholder workshop. The list was compiled as an amalgamation of critical species and habitats lists from varying pieces of legislation and expert opinion (see Peer review consultation Howson et al. (2012)). Public Consultation on the list of PMFs ran from July to November 2013 (see PMFs Consultation Responses, Scottish Government (2013c)). Increasingly new terminology was added to the process: a list of MPA Search Features was created which composed of selected PMFs that JNCC, Marine Scotland and SNH suggested could benefit from spatial protection measures (Scottish Natural Heritage 2010). MPA Search Locations could then be identified based on the presence of the MPA Search Features. The decisions regarding which PMFs would be MPA search features had major implications for the design of the network.

During the second workshop stakeholders were presented with the concept of selecting MPA search locations that were considered "Least Damaged/More Natural (LDMN)" (see Chaniotis et al. (2011)). An LDMN location is defined in the MPA Selection Guidelines as "a marine area in which there has been little activity and which may therefore be in a relatively natural state" (Scottish Government 2011b). This concept resulted from the

"Sustainable Seas for All" report (Scottish Government 2008) which recommended a number of broad policy approaches and suggested prioritising sites that were richest in marine biodiversity, possibly those least damaged (Scottish Government 2008). Once the MPA search locations were selected, they were then assessed against the MPA selection guidelines (Scottish Government 2011b). Additionally, upon the designation of the MPA sites, an Independent scientific review (see Earnshaw et al. (2014)) reviewed the MPA process documentation and information in order to evaluate the appropriateness of each stage of the assessments for the sites.

2.4.2.1 *Critique*

The use of OSPAR's "ecologically coherent" network design as a scientific framework is laden with challenges for assessing whether ecological coherence has been met (Ardron 2008). The guiding OSPAR principles for network design including: representation, replication, and connectivity are well cited within MPA literature as best practice (reviewed in McLeod and Salm (2008), Gaines et al. (2010)). Consequently, it is important to assess to what extent these principles have been incorporated into the design of the Scottish MPA network.

Firstly, the issue of representivity within the Scottish network has been contentious, several respondents to the public consultation suggested that the network would never be ecologically coherent without a greater representation of species and habitats present in Scotland's seas (Mulholland 2014, Mulholland and Granville 2014). Indeed, respondents criticised the selection of only 39 species offered direct protection by the network suggesting this would not be representative of the approximate 6500 species and habitats in the Scottish marine area (Mulholland and Granville 2014). Conversely, the mobile fishing industry questioned the inclusion of species and habitats that did not appear on the OSPAR Threatened/Declining List as supporting items for MPA designation (Mulholland and Granville 2014). The fishing industry also challenged the legal basis for more than two replicate MPA sites per feature; this was refuted by the Scottish Government, stating that the provision in the Acts (see above) did not limit the number of MPAs for any given feature (Scottish Government 2015b).

However, the public consultation on the list of PMFs attracted only 31 responses, 4 from individuals and 27 from organisations (Costley 2014). By comparison the public consultation on possible NC MPAs attracted 14, 703 responses, yet still with a large majority of organisation responses rather than individual comments. The timing of public consultation on the PMF list, concurrent with the MPA public consultation, meant that any meaningful changes to the list would not be in time to influence conservation action for prioritised species and habitats in the first round of MPA designation.

Additionally, the rationale for which PMFs became MPA search features is unclear. Some rationale is provided on a species level, for example, the rationale for not progressing cod (*Gadus morhua*) and whiting (*Merlangius merlangus*) from a PMF to an MPA search feature: "advice from MSS was that an extremely large area would need to be managed for these species in order to be effective" (Scottish Natural Heritage 2010). However, other highly mobile species such as basking sharks (*Cetorhinus maximus*) were included as MPA search features which suggests, at least, that this reasoning has not been applied consistently.

The MPA network is part of the Scottish Government's three-pillar approach to conservation, and spatial protection is only one part of the programme of measures contributing to the achievement of GES across the suite of marine biodiversity under the MSFD. It is therefore important to assess whether the network is truly representing the suite of marine biodiversity in order to maintain ecosystem function across the network. Ecological processes that are difficult to define spatially (De Santo and Jones 2007) which are not included in a species and habitats lists, but are important to the functioning of the ecosystem are a key component in ecological coherence. Considering how populations are connected across the network is critical in ensuring resilience of populations and ecosystem integrity within and amongst ecosystems (Botsford 2001, Gaines et al. 2003) and is increasingly recognised as a crucial element for climate change resilience (Magris et al. 2014, Andrello et al. 2015). Yet, within the Scottish process, MPA sites were chosen, proposed and approached designation prior to any formal assessment of connectivity between them. By tying individual sites to the provable presence of specific features (species and habitats), the reasons for selecting sites became difficult to criticize and enabled discussions of management and connectivity, discussions that are

usually contentious and subjective, to be pushed back to a point after which the network itself had been designated. This is suggestive of the claim that stakeholder participatory processes can become “talking shops” creating ambiguities and delaying decisive action (Reed 2008).

The independent scientific review (see Earnshaw et al. (2014)) recognises that connectivity and functional “linkages” have only been assessed for some large scale features and highly mobile species and has not been considered for static species so far. In reference to static features such as flame shell beds (*Limaria hians*), the review considers under assessment of linkages, “the feature is a significant habitat of itself”; the implication being that connectivity is not relevant to this species, despite being a biotic feature with its own population dynamics. As such no formal connectivity assessment has been conducted between the different flame shell habitats across the network, which is problematic for the conservation of habitat-forming species. Although the data requirements for assessing connectivity are large and understanding is currently limited, if consideration is not given to how different populations or habitats are connected across the network, that network will not follow guidelines for international best practice (Almany et al. 2009, Olds et al. 2012, Magris et al. 2014).

In terms of the LDMN approach, concerns were expressed both at the stakeholder workshops and through the public consultation that there would be: i) an emphasis on lower value sites, e.g. sites with less biodiversity that had therefore attracted little fishing effort; ii) a lack of coverage along the Scottish coastline where activity is intense; iii) neglect of sites that had high biodiversity value but were in need of restoration or recovery; and iv) maintenance of status quo rather than improvement of damaged areas. As the shape of the network evolved and the search locations were identified, the LDMN areas were not considered sufficient to fully complete the network (Chaniotis et al. 2011). It was therefore necessary to select further sites, perhaps in more heavily used areas, to represent the selection of species and habitats to be protected by the network. Thus, some of these initial concerns seem not to have been borne out as the design process progressed.

2.4.3 Consideration of climate change

Although a progressive step to include a reference to climate change in the Marine (Scotland) Act, the statement remains vague regarding what would constitute the extent that climate change would be considered and it also hinges on mitigation of climate change rather than adaptation or resilience. Throughout the MPA stakeholder workshops there was limited mention of climate change, with little to no reference of how climate change was influencing the design of the MPA network. There was no mention of any site being designated for a particular species or habitat that was vulnerable to climate change. Important to note is that in the fourth stakeholder workshop, three third party proposal sites, submitted by the Whale and Dolphin Conservation Society (WDCS) for the protection of white beaked dolphin (*Lagenorhynchus albirostris*) were excluded from further assessment due to "suspected changes in distribution linked to climate change" (Scottish Government 2012a).

2.4.3.1 *Critique*

The inclusion of the reference to climate change in the Scottish Marine Act is a pivotal step forward for the inclusion of climate change in marine conservation planning. Previous protected area legislation, e.g. EU Habitats and Birds Directives, only addressed climate change indirectly through other indicators of ecosystem health (Cliquet et al. 2009). Whilst there is a clear framework of robust scientific guidelines which address climate change impacts indirectly (e.g. need for robust populations and protected areas, addressing non-climatic threats to increase resilience) only recently has there been an attempt at interpreting the EU legislation from a climate change context (see Trouwborst (2011)). The prominence of this new inclusion is highlighted by the UK High Level Marine Objectives (HLMO): Gen 19 "Developers and users of the marine environment should seek to minimise emissions of greenhouse gases. Marine planning should seek to increase resilience of the marine environment to climate change impacts by reducing human pressure, safeguarding significant examples of natural carbon sinks and allowing natural coastal change where possible."

As a strategy to mitigate climate change impacts, it is recommended that significant examples of natural carbon sinks be protected. However, whilst there has been an attempt at assessing the levels of "blue carbon" across Scotland (see Burrows et al.

(2014)), there seems to be little integration with this assessment and the protection of these sites in the MPA network. A second strategy for the inclusion of climate change considerations across the network would be to ensure that the whole suite of marine biodiversity is effectively protected to increase resilience in the face of climate change impacts. Yet, it is difficult to see how the Scottish MPA network has paid specific attention to ensuring the resilience of the marine environment with reference to climate change. Additionally, the suspension of site proposals for a species (white beaked dolphin) likely to be impacted by climate change, on the basis of the requirement for further evidence raised concerns amongst stakeholders (Scottish Environment LINK 2013).This perhaps highlights that in the face of uncertainty, and a need for all decisions to be justified to a complicated and forceful stakeholder pool, an evidence-based approach was favoured over the precautionary principle.

Whilst there is a growing body of scientific literature on designing climate change resilient MPA networks (Chapter 1: section 1.3) (McLeod et al. 2009, Brock et al. 2012, Green et al. 2014, Magris et al. 2014, Andrello et al. 2015), designing the network at a policy level is at odds with practical and successful implementation if the policy fails to address some of these scientific recommendations. With climate change ever present in the consciousness of conservation planners, how the proposed Scottish MPA network will perform under changing conditions is a key question. It will be increasingly important to assess how well the network is protecting marine biodiversity and whether the network is best designed and managed to ensure climate change resilience under future scenarios. Yet, how the network will be reviewed is still unclear and without clear assessment of the designated areas in the light of the MSFD and Scottish objectives for the network, it will be difficult to comment on the effectiveness of the MPA network. Assessing how the network is performing on short and long-term time scales will be an important challenge.

2.5 Discussion

2.5.1 Successes in Scottish MPA policy

Overall, the Scottish MPA process has resulted in the successful implementation of 30 new MPA sites following a comparatively fast paced process, which built on existing areas and created a new MPA designation with a strong legal basis. The key action now is to

ensure that future iterations of the network fill in gaps in protection, adapt to changing conditions and ensure that the new designations are properly managed and enforced. There are limited examples of successful MPA processes on a regional scale (Gleason et al. 2010, Osmond et al. 2010) and it is difficult to generalise the recipe for success due to the highly context-dependent nature of such processes (Gleason et al. 2010, Bennett and Dearden 2014).

To implement an MPA or MPA network requires a complex mix of science, policy and stakeholder participation (Gleason et al. 2010), and it is perhaps better to recognise the role that each of these has in driving forward an MPA process rather than single out a specific element. Deemed a "science-led" process, perhaps the Scottish process would be better labelled "evidence based", a process that used available scientific or survey data to guide selection but with a degree of top down decision-making. However, it is also an approach that was pragmatic and robust in the face of a complicated stakeholder pool, one that had a solid legislative mandate and clear political will to push towards implementation.

2.5.2 Adopting key components of best design practice

A facet of previous successful MPA processes has been the setting of quantitative targets and goals (Metcalfe et al. 2013) essential for measuring progress towards achieving the overall rationale for the MPA network. Whilst there are broad goals for the Scottish network, individual targets for MPA habitats and species within the network have not been set (Marine Scotland 2012), and the network as a whole had no predetermined targets for the percentage of a feature needing spatial protection, or percentage area covered by MPAs. Values assigned to percentage cover are context dependent, for instance, some rare or sparsely distributed species may require higher levels of protection to ensure viability (Greathead et al. 2014) and there are cautions to following a threshold value approach (Agardy et al. 2003). The Scottish process followed an "adequacy" principle, determining the size of an MPA based on whether it would be sufficiently large enough to protect the feature and /or achieve the ecological objectives. This principle seems subjective and does not appear to be based on any formal consideration of species-area relationship, viable population sizes or movement ranges of species (Scottish Government 2011b). Because connectivity has not been formally quantified, the sites in

the network are assumed to be self-replenishing, isolated areas of protection, whereas this may not be the case.

Each MPA has an objective of either “conserve” or “recover” referring to the features for which the site is designated. These objectives are vague and difficult to measure especially under future scenarios of climate change, for example, whereby it may become increasingly difficult to achieve such an objective (Cliquet et al. 2009). Likewise, under the MSFD determining GES should be in line with prevailing conditions and the determination of GES may have to be adapted over time as these conditions change (European Commission 2008). Therefore, measures for protection (i.e. the MPAs) and management should be flexible and adaptive, and regularly updated reflecting new scientific information (European Commission 2008). As such the assessment of whether Scottish MPA sites are achieving the conservation objectives and how they contribute to GES should acknowledge the dynamic nature of marine systems. Another criticism of the network in achieving GES is the use of the Least Damaged/More Natural concept to select sites; it is unlikely that a network based on undamaged areas would aid the attainment of GES. A central facet of conservation strategies has been to protect both areas of intact undamaged biodiversity and target those areas facing high human pressure (Myers and Mittermeier 2000, Singleton and Roberts 2014).

Recovery of the marine environment through the use of MPAs is explicitly referred to in the OSPAR guidelines (OSPAR Commission 2006), and there is an obligation for restoration under the MSFD (European Commission 2008). Recovery is scientifically possible but often politically impractical and including the issue of current baseline data for recovery options, raised in the stakeholder workshops, even harder to achieve (Mee et al. 2008). With the predominant UK marine habitats being reported as “in poor status” and a risk level of moderate in terms of GES (Breen et al. 2012), recovering certain habitats under the Scottish MPA network could mean an extremely effort laden enterprise in the face of limited resources. There needs to be clarification on the link between the overall aim of the MPA network to help achieve GES and improve the wider status of species and habitats, with the conservation objectives at a site level. If the MPAs are intended to contribute widely to improving marine biodiversity rather than function as islands of protection, then a detailed consideration of the connectivity between sites and management of activities outside of those sites will be needed.

2.5.3 Ensuring effective protection

The management guidance delivered for the public consultation suggested that in most cases existing sectoral measures, such as fishery closures, would likely be enough to achieve conservation objectives (Scottish Government 2013a). There is also the presumption that MPA sites would be multiple use and additional management measures may not be required if activities (or the absence of activities) are having no impact upon the conservation objectives. However, this approach has been criticised by conservation NGOs for supporting "status quo" rather than actively regenerating biodiversity across the network (Mulholland and Granville 2014).

Within the public consultation was an opportunity for more detailed site based debate, the individual sections attracting varying responses and patchy attendance, but overall the designation and management options were seen to be supported by those who commented (Mulholland and Granville 2014). However, there were also repeated calls for clarity on management measures at the level of individual sites at the time of the public consultation. Additionally, the independent scientific review states that whilst the review agreed with proposed sites for designation, based on the available evidence, the value any MPA would be dependent upon the protection afforded by the management measures (Earnshaw et al. 2014). Site by site management discussions are now progressing, with the management approach being tied to a feature's susceptibility to different types of human activity (e.g. sensitivity to various gear types). This approach to management measures results in non-uniform regulations across the site, as specific management measures are justified on the physical presence of a feature within the site. Arguably this approach leaves little room for recovery, range expansion or risk of damage if management measures are strictly delineated on known feature presence data.

Attributing any impacts to the species and habitats within the MPAs to climate change in the face of continued human impacts and in the absence of reference areas is also likely to be extremely challenging or near impossible. The concept of "no-take zones"(NTZs) or fully protected marine reserves was explicitly and controversially ruled out in an FAQ document, early in the process (see Marine Scotland (2012)). The document specified that although there was no intention to create NTZs, certain activities may be restricted

to ensure the achievement of the MPA conservation objective. Whilst in some circumstances the designation of an NTZ neglects the uncontrolled use and persistent degradation of the marine environment outside the designated area (Agardy et al. 2003) there is a lingering question of whether it is possible to deliver ecosystem services and maintain ecosystem functions (and resilience) without some completely untouched pristine reference areas. Does there need to be more focus on ecosystem function in Scotland's approach, which throughout has been very species and habitat based highlighting the conflict between existing nature conservation policy and "the need for legal certainties for stakeholders" (Cliquet et al. 2009). It also calls into question whether a narrow focus on species and habitats rather than an ecosystem level and services approach can ever achieve ecological coherency across the MPA network.

2.6 Conclusions

Key characteristics of the Scottish MPA process are that it is feature-led and at this stage will consist of multi-use MPAs. Characteristics of successful, effective MPAs are an ecosystem focus with effective protection. Therefore, the high level objectives for marine conservation of achieving a coherent network, promoting resilience, and recovering marine areas appear difficult to achieve under this approach. Under increasing pressure from climate change impacts ensuring that the network is designed as a functioning coherent and resilient network is critical.

This chapter has highlighted that climate change has had limited consideration during the first iteration of design and implementation of the Scottish MPA network. Whilst there are guiding principles for considering climate change in the implementation of a network, it appears difficult to include the added complexity of climate change thinking. How this additional complexity has been incorporated (or conversely, why not) in other MPA processes is a concept that will be expanded on over the course of Chapter 3.

Chapter 3 Perceptions of Practitioners: Managing Marine Protected Areas for Climate Change Resilience

3.1 Abstract

Climate change is impacting upon global marine ecosystems and ocean wide changes in ecosystem properties are expected to continue. Marine Protected Areas (MPAs) have been implemented as a conservation tool throughout the world, primarily as a measure to reduce local impacts, but their usefulness and effectiveness is strongly related to climate change. MPAs may have a role in mitigation through effects on carbon sequestration, affect interactions between climatic effects and other drivers and be affected themselves as the distributions of protected species change over time. However, to date, few MPA programmes have directly considered climate change in the design, management or monitoring of an MPA network. This chapter presents a series of international case studies from four locations: British Columbia, Canada; central California, USA; the Great Barrier Reef, Australia and the Hauraki Gulf, New Zealand; to review perceptions of how climate change has been considered in the design, implementation, management and monitoring of MPAs. The results indicate that some MPA processes have already incorporated design criteria or principles for adaptive management, which address some of the potential impacts of climate change on MPAs. Key lessons include: i) strictly protected marine reserves are considered essential for climate change resilience and will be necessary as scientific reference sites to understand climate change effects ii) adaptive management of MPA networks is important but hard to implement iii) strictly protected reserves managed as ecosystems are the best option for an uncertain future. Although the case studies addressed aspects of considering climate change within MPA networks and provided key lessons for the practical inclusion of these considerations, there are some significant challenges remaining. This chapter provides new insights into the policy and practical challenges MPA managers face under climate change scenarios.

Key Words: adaptive management, climate change, conservation, marine protected areas, resilience

3.2 Introduction

Climate change in the marine environment is having a substantial impact on marine ecosystems, and there is now an extensive body of literature evaluating these impacts (see Harley et al., 2006; Hoegh-guldberg, 2010; Pörtner et al., 2014). Climate change as a stressor on the marine environment operates at a global scale and therefore cannot be removed locally (Micheli et al. 2012). Marine Protected Areas (MPAs) as spatially explicit conservation tools cannot directly influence all impacts of climate change affecting species and habitat traits, however, MPAs are still a useful tool in climate change adaptation and mitigation (McLeod et al. 2009, Côté and Darling 2010).

The cumulative effects of climate change and other local anthropogenic drivers, (e.g. fishing) can lead to complex patterns of change and result in enhanced vulnerability of natural and human systems (Halpern et al. 2008, Pörtner et al. 2014). At an ecosystem level, interactions between climate change impacts and fishing can enhance diversity loss in benthic communities (Griffith et al. 2011) and promote a change in ecosystem structure (Kirby et al. 2009). Additionally, the truncating effect of fishing on age and size structure of populations can lower population recruitment variability and reduce their ability to buffer environmental fluctuations (Perry et al. 2010). Protection of marine biodiversity from local stressors, such as fishing, can also enhance the resilience of species and habitats to climate change impacts (Micheli et al. 2012). Mitigation of global climate change may also be enhanced by protecting habitat areas that contribute to carbon sequestration, including mangroves, seagrasses, and salt marshes (Crooks et al. 2011). However, the low predictability and variability of ecosystems to climate change may undermine the effectiveness of conservation measures (Pörtner et al. 2014). As a result, there have been numerous calls to consider climate change in the establishment of MPAs to ensure marine biodiversity is protected effectively under future climatic scenarios (Salm et al. 2006, McLeod et al. 2009).

MPAs have historically been implemented on an individual basis to address local stressors, more recently, MPA networks have been planned to achieve larger scale conservation by protecting wider ecosystems and being strategically placed (IUCN-WCPA 2008). An MPA network is intended to operate more effectively and comprehensively than individual MPA sites alone and over various spatial scales (IUCN-WCPA 2008),

however, there is little evidence of MPA sites within a network performing synergistically (Grorud-Colvert et al. 2014). An additional concern is that MPA networks have not been designed with climate change in mind (Gaines et al. 2010), and therefore, are not optimising potential benefits. Overall, there has been little strategy to directly address climate change adaptation and mitigation using MPAs.

International progress towards implementation of MPA networks has varied both in terms of performance of MPAs, (see Edgar et al., (2014)) and extent (see Wood et al., (2008)). Some areas have implemented MPAs that have been designed to work coherently as a network (e.g. California, USA), whereas in other locations, MPA networks are being designed and discussed but have not yet been implemented (e.g. British Columbia, Canada) (Ban et al. 2013, 2014). In Australia, commonwealth MPAs, those outside the Great Barrier Reef Marine Park (GBRMP), have received criticism (e.g. Barr and Possingham, (2013); Devillers et al., (2014)). Commonwealth MPAs were initiated by the former Federal government, but have since been weakened by a review process from the current government that removed management restrictions (Hunt and Colbeck 2013), resulting in marine reserves that allowed economic use and access to continue.

MPA networks can consist of sites of varying levels of protection, from strictly protected areas to multiple-use areas that allow for extractive activities (Dudley, 2008). However, there is a conflict between local and national initiatives with differing priorities and differing capacities to implement MPAs or MPA networks. International and regional agreements require a network approach to MPA designation, yet these agreements rely on member states to implement the recommendations (e.g. The Convention for the Protection of the Marine Environment of the North-East Atlantic or “OSPAR Convention”). Even where legal sanctions are available, there is no clear definition of a “network”, against which MPAs could be tested. Against this background, coherent MPA networks, even those that are designed to protect the current “snapshot” of the marine environment, are rare. MPA networks that actively address climate change are scarcer still.

Understanding the perceptions of those involved in resource management and conservation is important for understanding the underlying policy process and the

subsequent success of a management or conservation action. Yet most research has focused on using the perceptions of end users to inform and improve resource management; a lack of research surrounding perceptions of environmental managers has been identified (Cvitanovic et al. 2014). Exploring the perceptions and opinions of those involved in MPA processes provides access to information regarding operational and political realities that may not be published in grey or academic literature or available through other research methods. The aim of this study was to explore perceptions and experiences in four different case study locations of how climate change is considered in MPA processes and networks. Three key objectives of this study were: i) identify how climate change considerations have been successfully included in MPA processes thus far ii) explore the perceived barriers to including considerations of climate change in MPA processes iii) provide insights into best practice advice for climate change resilient MPAs.

3.3 Materials and Methods

3.3.1 Case Study Selection

Four case study locations were selected for inclusion in this study: British Columbia, Canada; Central California, USA; Great Barrier Reef; Australia and Hauraki Gulf, New Zealand. All were English-speaking, facilitating interviewing and reading of relevant documentation. All had democratic governments with functioning law enforcement systems, free press, market capitalist economies and well-developed expertise in marine science and conservation through universities, NGOs and government agencies. The ecosystems considered varied from coral reefs to cold temperate coasts and coastal to offshore systems (see Table 3.1). The key legal instruments for the designation of MPAs in each location are summarised in Table 3.2. Case study methodology was used to gain an understanding of a real-life phenomenon in depth, but with such understanding encompassing important contextual conditions (Yin 2009). Young (1999) identifies environmental regimes as “social institutions consisting of agreed principles, norms, rules, procedures and programs that govern the behaviour of actors” and that case study based research is an appropriate and accepted method for accessing the internal complexity of such cases.

Table 3.1 Background on case studies.

Case Study	Planning region extent	Governance	Composition of MPA "network"	Climate change context	Ecological context	Key References
British Columbia, Canada	450, 000km^2 internal and offshore waters; 185 MPAs covering 28% coastline and 2.8% EEZ	First Nations Government, local, provincial and federal government responsible for proposing MPAs	MPAs designated under provincial or federal designations. Varying levels of protection from no-take areas to fisheries management areas	Recognition of climate change impacts in the marine environment in the academic and grey literature. Links between MPA network design and climate change.	Diverse and productive system; planning region incorporates inshore coastal areas and offshore seamounts.	(Ban et al. 2014, Burt et al. 2014, Government of Canada 2014)
Central Coast California, USA	2,964km^2 of state waters: ocean, estuary, and offshore waters from Pigeon Point south to Point Conception; 29 MPAs covering 18% coastline or 535km^2	CDFW[1] responsible for MPA management, work with MPA Monitoring Enterprise (a programme of California Ocean Science Trust), California Ocean Protection Council and California Sea Grant	MPA classifications from strictly protected State Marine Reserves (SMRs) to areas where select recreational take activities are permitted.	Baseline data from the MPA network monitoring programme intended to be used to inform future climate change adaptation. Clear recognition in policy documents, grey and academic literature.	Temperate, biologically productive, dynamic oceanographic conditions, shallow estuarine habitat to deep sea habitat.	(California Ocean Science Trust and California Department of Fish and Wildlife 2013, Fox et al. 2013, Saarman and Carr 2013)
Great Barrier Reef, Australia	344, 400km^2 Great Barrier Reef Marine Park	GBRMPA[2], Federal Government Agency, is responsible for managing the GBR, in addition to the Queensland Government, and numerous advisory groups and stakeholder committees.	Multi-use MPA network, zoning plans set out areas where different types of fishing are allowed. Zones vary in protection from Preservation zones ("no-go" areas; no extractive activities) to General Use Zones (provide opportunities for use)	Climate change identified as one of the greatest threats to the long term health of the GBR. Clear recognition in policy documents, grey and academic literature.	Complex and diverse coral reef system; variety of marine habitats extending over shallow estuarine areas to deep oceanic waters.	(Day and Dobbs 2013, Great Barrier Reef Marine Park Authority 2014)
Hauraki Gulf, New Zealand	1.2 million hectares Hauraki Gulf Marine Park, 6 marine reserves	Regional Council, New Zealand Government	Two categories of MPA: Marine Reserves with the purpose of preserving marine life for scientific study and other MPAs established using other management tools and have a broad definition e.g. benthic protection areas	Recognition of climate change impacts in the marine environment in the academic and grey literature. No clear link between MPAs and climate change.	Gulf area extends from deep ocean to bays, inlets. Temperate, diverse and productive system.	(Ministry of Fisheries and Department of Conservation 2008); (Ballantine 2014)

[1]CDFW: California Department of Fish and Wildlife

[2]GBRMPA: Great Barrier Reef Marine Park Authority

Table 3.2 Legal instruments for the designation of marine protected areas

	Local/State/Provincial	National/Federal/Commonwealth
British Columbia, Canada	Government of British Columbia Legislation	Government of Canada
	Ministry of Environment	Fisheries and Oceans Canada
	Park Act 1996	Oceans Act 1996
	Ecological Reserve Act 1996	Parks Canada
	Protected Areas of British Columbia Act 2000	Canada National Marine Conservation Areas Act 2002
	Environment and Land Use Act 1996	Canada National Parks Act 2000
	Ministry of Forests, Lands and Natural Resource Operations	Environment Canada
	Land Act 1996	Canada Wildlife Act 1985
	Wildlife Act 1996	Migratory Birds Convention Act 1994
	California State Legislation	Federal Laws and Programmes[1]
California, USA	Marine Life Protection Act (MLPA) 1999	National Marine Sanctuaries Act (NMSA)
		Coastal Zone Management Act (CZMA)
		Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)
		The Wilderness Act
		National Park Service Organic Act
		National Wildlife Refuge Administration Act
		Antiquities Act of 1906
Great Barrier Reef, Australia	Queensland State Legislation[2]	Commonwealth Legislation pertaining to the GBR[2]
	Marine Parks Act 2004 (Qld)	Great Barrier Reef Marine Park Act 1975
		Environment Protection and Biodiversity Conservation (EPBC) Regulations 2000
Hauraki Gulf, New Zealand	Legislation pertaining to the Hauraki Gulf	Government of New Zealand[3]
	Hauraki Gulf Marine Park Act 2000	Marine Reserves Act 1971
		Fisheries Act 1996
		Resource Management Act 1991
		Wildlife Act 1953
		Marine Mammals Protection Act 1978

[1] Other US federal laws affect the quality of the marine environment by regulating coastal and offshore activities including: the Endangered Species Act, the Clean Water Act, and the Marine Mammal Protection Act.

[2] Other Queensland Government and Commonwealth legal instruments also regulate planning, pollution and management of the Great Barrier Reef.

[3] Additional management measures are available under different legislation which can be used to address threats to biodiversity in MPA sites.

MPAs have so far been implemented on an ad-hoc, site by site basis in British Columbia, Canada, with little overall co-ordination of protected sites and jurisdictional uncertainties (Ban et al. 2014). Yet there has been progress towards the design of MPA networks (Ban et al. 2014) with some discussion of climate change resilient MPA network design (Burt et al. 2014).

The Marine Life Protection Act (MLPA) (California State Law, enacted 1999) mandated a redesign of California's existing MPAs to create a state-wide MPA network (Fox et al. 2013) and the successful implementation of California's MPA network is often used as an exemplary case for stakeholder involvement in MPA design and planning. The MLPA requires each MPA to have goals and objectives, whilst collectively the MPA network should achieve the overall goals and guidelines of the Act (MLPA 1999). A clear monitoring framework to evaluate MPA effectiveness was developed and the central California coast was the first region in the state wide network to report on the monitoring results after five years of the network being implemented (see California Ocean Science Trust and California Department of Fish and Wildlife, 2013).

The world's largest coral reef system, the Great Barrier Reef, Australia is managed by the Great Barrier Reef Marine Park Authority (GBRMPA) and is designed as a multiple use park regulating through a zoning plan. There is a clear recognition of climate change in monitoring and management of the Great Barrier Reef Marine Park as demonstrated by the development of a climate change adaptation strategy (see Great Barrier Reef Marine Park Authority, 2012) and the long term sustainability plan (Commonwealth of Australia 2015) . It is also important to note the highly sensitive political nature of the GBRMP, with recent debates over the UNESCO World Heritage status and the threats posed by continued activities on and around the reef.

New Zealand has a long history of implementing marine reserves, with the first marine reserve, Cape Rodney-Okakari Point, in the Hauraki Gulf, established in 1975 under the Marine Reserves Act, 1971. However, these marine reserves were primarily designated for local protection and were established individually and independently, not considering larger scale processes or wider biodiversity (Thomas and Shears 2013).

3.3.2 Data Collection

In-depth interviews were used to explore the range of opinions and experiences surrounding climate change and MPAs. The advantage of in depth interviews in untangling complex topics and exploring experiences and perceptions made this a particularly good method for this study (Qu and Dumay 2011). Interviews were conducted with MPA managers, academics with experience of climate change and marine conservation interventions, NGO employees with a direct link to MPA processes in each case study region and governmental staff. By interviewing different actor groups, a range of opinions could be gathered from which the main issues could be identified.

Interviewees were identified from a review of the academic literature and grey literature including government and NGO reports. Further additional identification of participants was undertaken through snowball sampling, whereby each individual contacted was asked to provide an additional relevant contact. The new contact was then cross referenced with existing literature as appropriate. Snowball sampling inevitably produces a non-random selection of actors (Cowlishaw et al. 2005). However, the purpose of this study is not to be representative in terms of statistical generalisability, which would require a different approach to interviewee selection, but rather to identify and explore the range of perceptions and practices of MPA practitioners with specific and direct knowledge relevant to this study.

The interviews were conducted using a semi structured format which allowed for an open, flexible question order and discussion format and ensured that the field of discussion was not overly narrowed (Bryman 2008, Rubin and Rubin 2012). The semi-structured format allowed the researcher to narrow the discussion topics, but the interviewees' responses determined the information produced about those topics and the relative importance of each of the topics (Green and Thorogood 2014). Five key topic sections were defined including: i) MPA network design ii) policy structure iii) management of MPAs/networks iv) stakeholder considerations v) barriers to including considerations of climate change. Interviewer bias was reduced by using only one experienced interviewer (to reduce intra and inter-interviewer bias respectively) (Choi and Noseworthy 1992); all interviews were recorded using an audio recorder and field notes were written during and after the interview recording time, location and general

impressions to improve reliability of the study. Interviewees also had the opportunity to verify transcripts via email.

3.3.2.1 *Ethical Considerations*

This study was guided by the ethical principles on non-clinical research using human participants set out by the College of Medical, Veterinary and Life Sciences, University of Glasgow. All participants received written information regarding their participation, outlining the nature of the project, how the data was to be used and details of an independent contact within the University. All participants were given the option of confidentiality in written reports and all participants provided informed consent for this study. Participants were informed that they could withdraw at any time for any reason and have their contributions removed from the project if they so wished. Ethical approval was sought and granted by the University of Glasgow for this study.

3.3.3 Data Analysis

Qualitative research and particularly in depth or semi structured interviews can generate a large amount of data (Green and Thorogood 2014). Data was firstly examined and reduced, then categorised and displayed from which conclusions could then be drawn. Any potential bias introduced in the analysis and interpretation of the data was minimised by ensuring the process was systematic, sequential, verifiable and continuous (as recommended in Miles and Huberman, (1994)). Triangulation of data sources (comparing different viewpoints in and between case studies and using academic and grey literature to complement the interview information) provided an in-depth understanding and a comprehensive account (Green and Thorogood 2014).

Each interview was fully transcribed using QSR International NVivo software (QSR International Pty Ltd 2010), which facilitated organisation, coding and retrieval of the data (Bazeley and Jackson 2013). Coding is the process of data naming or labelling (Miles and Huberman 1994). An inductive grounded theory approach to coding was chosen (as demonstrated in Alexander et al., (2013) to ensure that the codes generated remained "grounded" in the data (Corbin and Strauss 2015). Grounded theory is a research

procedure that constructs theory grounded in data (Corbin and Strauss 2015). However, as this study did not aim to create theory, rather as an exploratory study it aimed to explore the key issues surrounding MPAs in the context of climate change in some depth, the grounded theory method was only used as a coding strategy (as demonstrated in Alexander et al., (2013)). The first step in this approach is to intensely code the data through a line-by-line analysis, opening up all potential avenues of inquiry (Green and Thorogood 2014, Corbin and Strauss 2015) generating open codes or conceptual labels. These "open codes" were then grouped into focused codes by gathering those that appeared to relate to similar phenomena. The third step, more selective coding, builds relationships between categories from which the core categories or themes emerge (Figure 3.1.) Coding frameworks for each case study are available in Appendix A:. Analytical memos were written throughout the analysis, which allowed the researcher to document emerging relationships between the codes and categories (Green and Thorogood 2014).

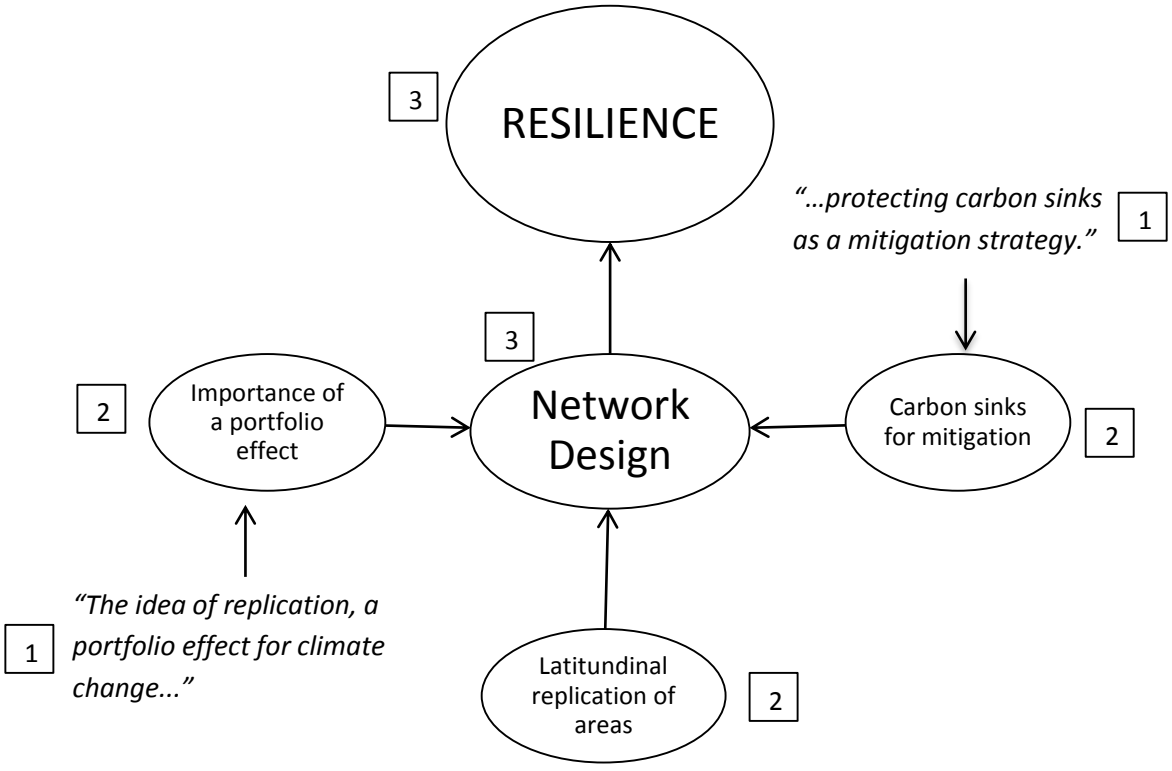

Figure 3.1 Diagram representing the coding process: (1) line by line analysis given a conceptual label or "open code"; (2) grouping "open codes" into focused codes; (3) linking focused codes into core categories and themes. Modified from Alexander et al. (2013).

3.4 Results

Twenty in depth exploratory interviews were conducted between February and April 2013, either face-to-face or using Skype software. Interviews were conducted with a mix of MPA managers, academics, NGO employees and governmental staff in each of the case study locations (Table 3.3). The type of participants in each location is indicative of those involved directly in the MPA process or having expert knowledge of climate change in the marine environment with reference to MPAs. However, overall there were a low number of interviews in some stakeholder groups and therefore the differences between stakeholder groups are not discussed. Additionally, this study recognises that some stakeholder groups (e.g. fishers/other marine users) are not included and therefore does not make comparisons between stakeholder groups in this respect. The type of participants in each location may have influenced the opinions received in the different case studies, however, this study aimed to document specific opinions and perspectives without intending to be widely generalised.

The results are presented as follows: a description of the key themes identified in each case study with illustrative quotes followed by a cross-case study comparison for which conceptually-clustered matrices (as described in Miles and Huberman (1994) have been produced.

Table 3.3 Characteristics of interview participants

Interviewee	Job Role*	Case Study Location	Identification Method
Interviewee 1	NGO Employee	British Columbia	Grey literature
Interviewee 2	Academic	British Columbia	Academic literature, referral
Interviewee 3	Academic	British Columbia	Academic literature, referral
Interviewee 4	NGO Employee	British Columbia	Grey literature
Interviewee 5	NGO Employee	British Columbia	Grey literature
Interviewee 6	NGO Employee	British Columbia	Grey literature, referral
Interviewee 7	MPA Planner[1]	Central California	Academic literature
Interviewee 8	MPA Manager[2]	Central California	Grey literature
Interviewee 9	Governmental Staff	Central California	Referral
Interviewee 10	NGO Employee	Central California	Referral
Interviewee 11	MPA Manager	Great Barrier Reef	Referral
Interviewee 12	MPA Manager	Great Barrier Reef	Referral
Interviewee 13	Academic	Great Barrier Reef	Academic literature
Interviewee 14	Governmental Staff	Hauraki Gulf	Referral
Interviewee 15	NGO Employee	Hauraki Gulf	Referral
Interviewee 16	Academic	Hauraki Gulf	Academic literature, referral
Interviewee 17	Academic	Hauraki Gulf	Academic literature, referral
Interviewee 18	Academic	Hauraki Gulf	Referral
Interviewee 19	Academic	Hauraki Gulf	Academic literature
Interviewee 20	Academic	Hauraki Gulf	Academic literature, referral

*This refers to the job role category held at the time of the interview

[1] MPA planner: Active role in planning stage of MPA development

[2] MPA manager: Role in current management (at the time of interview) of MPA/MPA network

3.4.1 British Columbia, Canada

Three key themes identified from the interviews were: future conservation values; design criteria for climate change resilience and the slow nature of the MPA process.

3.4.1.1 *Future conservation values*

How the marine environment is perceived and how marine services or biodiversity are valued under climate change scenarios was mentioned by several participants. It was suggested by one participant that in current MPA processes, there is a need to consider how marine biodiversity will change in the future.

"I think another barrier probably is that we haven't yet had clear conversations about what values we want to see into the future… But those are the types of conversation that need to happen for us not only to adequately manage the current suite of values that we have, but to understand what is the value or the service that we desire so that we can successfully manage a transition where a transition may be starting to occur." ***NGO Employee 6***

This relates to the setting of clear objectives and how these objectives might change in the future depending on how we view the marine environment and services we expect MPAs to deliver under climate change scenarios. There was recognition that as species and habitats change within MPAs, there will need to be a rethink about how we view biodiversity.

"So you might get different species there, some species might go extinct, other species, we don't call them invasive anymore, you have to call them climate refugees" ***NGO Employee 1***

By viewing species and habitat shifts due to climate change as part of an inevitable process, this could change the management of MPAs as fixed sites, with fixed species or habitat assemblages.

3.4.1.2 *Design criteria for climate change resilience*

A large amount of discussion was in reference to the scientific and ecological principles for good MPA network design. Some interviewees suggested that there were criteria that could be included in the design of the MPA network that would ensure marine biodiversity was protected under scenarios of climate change.

"The idea of replication, a portfolio effect for climate change, we don't really know what's going to happen but if we have representivity and replication then that's our way of safeguarding against climate change." ***NGO Employee 5***

More specific ideas were proposed, such as selecting sites that have a direct link to climate change impacts. There was a general agreement for protecting areas that will perhaps be more resilient to climate change, ones that are biodiversity rich, areas of high productivity or specific habitats that can act as climate change mitigation.

"I think the best thing that I've seen so far, which is climate change specific, is the idea of protecting carbon sinks as a mitigation strategy. Most of the carbon sinks are critical habitats anyway, so there's overlap there with the regular ecological principles." ***NGO Employee 5***

"So I think one way to resolve that would be to set up bigger MPAs than previously and actually encapture the area that would potentially be changing or affected under climate change." ***Academic 3***

There was some uncertainty regarding how the impacts of climate change would affect MPAs and therefore, incorporating good ecological principles was considered important. Some of strategies such as moveable MPAs were considered scientifically recommended but politically unfeasible. Additionally, in practice the implementation of the network was viewed as ad-hoc without a clear network design and therefore there was a gap between the scientific design and the reality of implementing a network.

3.4.1.3 *The slow process of implementation*

The majority of respondents commented on the slow process in British Columbia of implementing marine protected areas. This was closely related to suggestions that incorporating climate change into network design is practically very difficult because the capacity or political will to do so is limited.

"To think about designing MPAs and thinking about how things might change and how that is incorporated into the network design is going to be a huge challenge…how [governments] are going to deal with something that's going to be dynamic and changing, we just don't seem to have things set up in a way that will make that easy to do." ***NGO Employee 4***

There was a concern that the slow pace and jurisdictional complexity of the MPA process was generating confusion and that incorporating considerations of climate change would add to a general feeling of process exhaustion.

"One of the big issues in [British Columbia] right now, I think, is process exhaustion. Because there are so many layers of things happening here and there's a lot of confusion within all of the stakeholder groups. It's really hard to just keep track of what's going on and how in the end they will all integrate." ***NGO Employee 3***

Several participants emphasised the close relationship between Canadian NGOs and the establishment of MPAs. It was explained that the various NGOs have different roles; some

have an important role in providing and coordinating scientific advice for the establishment of MPAs and others have a strong lobbying role. It was viewed by some participants that NGOs and the First Nations Government were a driving force for implementation of MPAs along the BC coast.

3.4.2 Central California, US

Three key themes identified from the interviews were: clear objectives; strong monitoring framework and an adaptive approach.

3.4.2.1 *Clear objectives*

There was a consensus that clear objectives were needed in order to evaluate whether an MPA was successful. Several respondents mentioned the difference between site level, MPA objectives that often relate to stakeholder views of success, objectives that can inform monitoring effort and the overall goal of the Californian MPA network to protect marine biodiversity.

"So, objectives, here in California are a very useful and needed planning tool, but if you measure progress to those objectives you don't actually ever know if you're getting to the goals of the act, healthier oceans, so we've shied away from the objectives." ***NGO employee 8***

Monitoring objectives for climate change were thought to be needed although there was recognition that climate change specific monitoring objectives had not been explicitly stated, instead objectives for protecting functioning whole ecosystems were acting as a proxy for resilience.(See MLPA, (1999) for the six overarching goals identified in the California Marine Life Protection Act).

"In more recent years there's been more emphasis on the value of PAs, not just for productivity increases, but for resilience. They do harbour greater biodiversity and that is an important hedge against climate change impacts. Biodiversity and protecting the functions of ecosystems is one of the primary goals of the MLPA, so indirectly, there's a goal that related very strongly to climate change." ***NGO Employee 10***

A hierarchy of objectives from stakeholders setting specific objectives for individual MPAs in terms of what they want to achieve in a particular MPA, to objectives or goals for the

entire network was described. This related strongly to discussions of monitoring and the usefulness of targeted monitoring to evaluate whether objectives are being achieved.

3.4.2.2 *Strong monitoring framework*

The connection between setting clear objectives in order to be able to evaluate the success of an MPA network and a strong monitoring framework was discussed. There was an acknowledgement that resources for monitoring are often limited, which therefore made the setting of very clear objectives that were measurable and realistic, a priority. Additionally respondents discussed the value of citizen science for monitoring in relation to maximising resources and the huge task of monitoring, not only to ascertain success, but to also monitor for climate change impacts.

One participant suggested that monitoring would need to be adaptive; there may be other stressors or issues to monitor for in the future that will need to be incorporated into a monitoring framework, and that the capacity to do so exists within the Californian MPA system.

"One of the things that we recognised early on is that if we're thinking about monitoring towards broad goals like those in the MLPA, that talk about protecting ecosystems, surely we should be able to have some pieces that we can add onto the core monitoring framework that address other issues whether it's fisheries or invasive species or climate."
NGO Employee 8

There was also the recognition that in terms of climate change impacts, monitoring will have to be coordinated across the state, such that monitoring of individual MPAs should feed into broader scale monitoring of large-scale impacts. One participant also mentioned that there is one entity for managing the network state wide, therefore the capacity for monitoring climate change impacts and managing accordingly should be in place.

3.4.2.3 *An adaptive approach*

The importance of having an adaptive approach to the overall management of an MPA network was emphasised in the context of climate change and dealing with uncertainty.

"[The] basic process of design, monitor, assess and potentially adapt is inherent in the process and makes sense in a climate change scenario." ***MPA Planner 7***

Even though there was a strong consensus for the Californian process being a model for other MPA processes, there was also the suggestion that improvements could still be made. In particular, more work into understanding how adaptive management would work in an MPA context was needed.

"I think the major knowledge gap is how do we manage these things and then how do we monitor them with good questions and good metrics and answer the right questions and then based on that monitoring, how do we know how to change the network how it needs to be changed. I think that is a major area that we really need to think about more and it's going to be really tough and it's going to be critical to the network's success." ***MPA Planner 7***

"I think this notion of adaptive management is going to need a lot more thought. It's thrown around pretty easily right now." ***Governmental staff 9***

Adaptive management was discussed in relation to monitoring and how monitoring should look at *what* elements are changing, but also should be attempting to answer *why* things are changing. From answering the "why" question, discussions about adapting management can then progress, but at present it was considered that these discussions may be a little premature.

3.4.3 Great Barrier Reef, Australia

Three key themes identified from the interviews were: a clear recognition of climate change, multiple-use MPAs and a risk-based approach.

3.4.3.1 *Clear recognition of climate change*

There was a clear recognition that to manage the GBR, climate change must be recognised and be at the forefront of management and monitoring.

"…really up front recognition of climate change right from the start in as many places as possible. As in all the aspects of the planning. It's not the only consideration but it has an influence of so many aspects of what marine park management and design is all about. If

it's one of the things that's on the table at the start, it will just naturally be part of the conversations and the decisions and it's not something that has to be overlaid later." ***MPA Manager 11***

Two respondents noted that climate change was specifically addressed in reporting on the state of the network and also is recognised in relation to business and users along the GBR. Respondents also gave specific examples of adaptive management and highlighted the importance of such approaches in the face of climate change. One respondent noted the possible need for an "interventionist approach".

3.4.3.2 *Multiuse MPA network*

There was some discussion of the zoning approach to the GBR, particularly in relation to the importance of preservation "pink" zones as scientific baselines; one participant suggested that there should be more of these areas. Also, that for "green" no-take areas to be effective long term they would need to be integrated into broader scale management.

"I'm really worried when I talk to people around the world about MPAs that there seems to be a real focus on just the no-take part of it. And what I've seen is people setting up these really small no-take areas, which are really resource intensive and are set within a sea of unmanaged, overfished and polluted, and these aren't going to be viable in the long term." ***MPA Manager 12***

It was suggested that there should be an allowance for other users in an MPA network, but there should be a core of strict protection that integrates into other management. There was a sense that users should be "stewards of the reef" and therefore large-scale impacts such as climate change would require collaborative management, and the need to build good relationships with stakeholders and industries was implicit in this approach.

3.4.3.3 *Managing for climate change impacts*

There was a clear discussion of the approach needed to deal with the uncertainty relating to climate change. One participant related managing for climate change impacts to providing refugia from disturbance events, and protection of recolonisation sources to

minimise the chances of losing a whole system or MPA through a single disturbance event.

There was an emphasis on cumulative impacts and minimising these through integrated management on land and sea. However, one respondent stated that although work had begun to understand cumulative impacts, there was still a knowledge gap in terms of how impacts may interact synergistically.

"Thinking about risk based approaches, that is something we're starting to do a lot of in the way we think and some of the projects looking at cumulative impacts and multiple scale, geographically and otherwise of multiple impacts and accumulations of impacts." ***MPA Manager 11***

"[P]robably the biggest gains we can make in terms of the state of the GBR, is to better manage the catchments that feed into the lagoon to reduce sediment, nutrients and pesticides. And in doing so we would hope that, we are as far as possible mitigating the cumulative effects of anthropogenic stresses." ***Academic 13***

It was also mentioned that scientists should make as much progress as possible in understanding the operational requirements for building climate change into MPA planning and management and emphasised the implications of failing to take climate change into account in marine conservation.

3.4.4 Hauraki Gulf, New Zealand

Three key themes identified from the interviews were: marine reserves, importance of monitoring and limitations of the process

3.4.4.1 *Marine reserves*

Strong opinions were given in reference to the importance of strictly protected marine reserves (as compared to multi-use MPAs where some extractive activities are still permitted). It was suggested by the majority of respondents that marine reserves are important for climate change resilience.

"I guess one of the big things about marine reserves in relation to climate change is it's been shown that marine reserves are more resilient to change, and perturbations of

various sorts. If there is a problem they tend to recover quicker than fished areas." ***Academic 18***

In addition to the importance of marine reserves for resilience, the importance of marine reserves as reference areas was also discussed in relation to climate change.

"The other thing is that by having [marine reserves], you also provide for monitoring, so that you can actually monitor the response of ecosystems and the populations of species to a changing climate and ocean acidification in the absence of confounding factors such as human impacts." ***NGO employee 15***

Several participants commented on the importance of being able to monitor in undisturbed areas, free from extractive activities in order to understand changes without confounding effects.

3.4.4.2 *Importance of monitoring*

Several participants mentioned the importance of monitoring in order to understand whether the management action is effective. There was some discussion that in the context of long-established marine reserves, monitoring objectives have changed over time, and this should be recognised as part of an adaptive monitoring approach. Newly established reserves were monitored for initial changes resulting from protection, however, now they can form part of a long term monitoring programme to identify climate change impacts across a network. Several issues relating to the lack of monitoring and the resulting problems were raised by respondents.

"The concern is that the monitoring that's been done, isn't been done well enough; with the right methods, the right experimental design, the right replication to detect an effect, to really know if there is an effect. And also, without information prior, it's quite hard to know how effective an MPA has been". ***Academic 17***

"So the point with monitoring I guess is that where you have these big networks and lots of reserves, you need so many more resources that really understanding how your network is functioning becomes pretty hard." ***Academic 17***

A concern, however, was that there are always limited resources, and therefore the monitoring task for a large scale network is huge, and incorporating more factors (including climate change) adds to this large monitoring load.

3.4.4.3 *Limitations of the process*

The majority of respondents reported on the limitations of the Marine Reserves Act for establishing MPAs for any other purpose than for scientific research. They considered that for an MPA network to be effective into the future, New Zealand should build on the foundation of marine reserves and include conservation of biodiversity as an objective for new MPAs, in line with international policy.

"It's interesting because in New Zealand, you've got the history of setting up reserves under scientific use and most countries now, have moved to the idea of biodiversity conservation for their MPAs." ***Academic 16***

There was criticism of the MPA process in New Zealand, which most respondents felt was politically stalled with no momentum to drive forward the implementation of a functioning network of MPAs. One respondent commented that there was no "strategic oversight" for an MPA network to be created, and another respondent commented that any policy documents produced were vague and scientifically lacking.

3.4.5 Cross Case Study Comparison

Comparisons between case studies yielded emergent themes of characteristics of MPAs for climate change resilience (Table 3.4) and the perceived barriers to including considerations of climate change in MPA processes (Table 3.5). Through the cross-case study analysis four key issues were identified which are presented in the Discussion.

Table 3.4 Conceptually clustered matrix: characteristics for climate change resilient MPA networks. The characteristics in italics are discussed further in the text.

Characteristics (Based on participant responses)	**British Columbia, Canada**	**Central California, US**	**Great Barrier Reef, Australia**	**Hauraki Gulf, New Zealand**
Design				
Effective protection/Marine reserves	X	Y	Y/X– consensus for the need of them but debate around their effective inclusion	Y/X– consensus for the need of them but debate around their effective inclusion
Moveable MPAs	X			X
Adequate size	Y	Y	Y	
Forecasting resilient sites	X		-	
Buffer zones	X			-
Mitigation sites (e.g. carbon sinks)	Y	Y	Y	X
Replication/Portfolio Effect	Y	Y	Y	-
Representative	Y	Y	Y	-
Connectivity	Y	Y	Y	X
Clear, measurable objectives	X	Y	Y	-
Protecting ecosystem functions		Y	Y	-
Specific recognition of climate change in design	Y- discussions in the NGO community	X	Y	-
Coherent network		Y		X
Monitoring				
Climate change indicators	X	Y	Y	Y
Citizen science	Y	Y	Y	
Baseline data	X	Y	Y	Y
Long term monitoring	X	Y	Y	Y
Strong framework	X	Y	Y	
Monitoring coordinated as a network	X	Y	Y	
Reference sites for monitoring		Y	Y	Y
Management				
Adaptive approach	X	Y	Y	X
Incorporating updating scientific information	Y	Y	Y	-
Long term commitments		Y	Y	-
Co-operation between agencies	X	Y	Y	-
Enforcement	Y	Y	Y	-
Flexible activities management	Y	Y		

Proactive versus reactive	X	Y		
Additional management measures	X	Y	Y	-
Leadership			Y	X
Integrated planning land and sea		-	Y	-
Other				
Reviewing gaps in protection	X	Y	Y	-
Considering future values for biodiversity	Y-discussions in the NGO community			
Communication with users/stakeholders	Y		Y	-
Public engagement		Y	Y	X
Facilitating policy environment	X	Y	Y/X- consensus for the need of but debate around effective inclusion	X
Independent scientific advice	X	Y	Y	Y
Long term vision		Y	Y	-
Vulnerability assessment			Y	
Recognition of climate change in all aspects of the process		X	Y	X

Y- Characteristic referred to by respondents and considered to be included (or intended to be) in the MPA process

X- Characteristic referred to by respondents, but not considered to be included in the MPA process/not explicitly referred to in the process

- Discussed by respondents but no reference to the specific case study MPA network/process

Table 3.5 Conceptually clustered matrix: analytical codes concerning perceived barriers to including considerations of climate change in MPA process. The barriers in italics are discussed further in the text.

Characteristics (Based on participant responses)	**British Columbia, Canada**	**Central California, US**	**Great Barrier Reef, Australia**	**Hauraki Gulf, New Zealand**
Design				
Ability to adapt the network design over time	X		Y	X
Understanding ecosystem connectivity			Y	X
Counterproductive targets		Y		
Lack of scientific guidelines				X
Lack of effective protection	X		Y/X	Y/X
Different objectives for or perceptions of a successful MPA				X
Monitoring				
No clear questions for monitoring		Y		-
Resources			Y	
Need for long term monitoring				-
Management				
How climate change affects the activities being managed		Y	Y	
Bad relationships with network users		Positive relationships described	Y	-
Decision making for changing the network			Y	
Understanding cumulative impacts			Y	
Communicating scientific advice to managers			Y	
Lack of resources	X	Y		X
Lack of adaptability	X		Y	X
Other				
Scientific understanding of impacts		Y	Y	
Inflexible policy environment	X		X	X
Understanding socioeconomic impacts		Y		
Lack of communication/public engagement			Y	X
Shifting baselines			Y	
No political will			Y/X	X

Slow process	Y/X	Y	X
Understanding how to engage stakeholders	X		-
Conflict between policy departments			X

X perceived as a barrier by respondents
Y perceived as a barrier but also recognise there is capacity to overcome the barrier
Y/X perceived as a barrier but some debate from respondents as to the capacity to overcome the barrier
- Discussed by respondents but no reference to the specific case study MPA network/process

3.5 Discussion

Four key issues for incorporating climate change considerations into MPA processes emerged through in-case study analysis and cross-case comparisons (see summary table of focused theme coding 6.7ReferencesAppendix A: Table A.5) : i) effective protection is needed for climate change resilience; iii) the importance of monitoring towards achieving a set of clear objectives; iii) an adaptive approach to design, monitoring and long term management is critical; iv) when to include considerations of climate change in the MPA process is a key question. The aim of this study was to document specific perceptions and opinions in the context of each case study location, as such, the results presented are not intended to be generalised. Indeed, the success and effectiveness of MPA processes is highly context dependent. However, the key issues that emerged were comparable across case studies and are in agreement with the wider literature concerning MPAs and climate change.

3.5.1 Effective protection is needed for climate change resilience

Discussions of how MPAs could still be effective in the face of climate change centred on the concept of marine reserves; protected areas of strict protection with no extractive activities. Nearly all respondents proposed that reduction of other anthropogenic stressors (e.g. fishing pressure) through the use of marine reserves, may contribute to reducing the impacts of such a major climatic disturbance by enhancing local resilience of populations and ecosystems. In this context, resilience is seen as the ability of an ecosystem to experience disturbance without substantial biological change (Holling 1973), a change that could mean a shift to an alternative state and loss of function and/or services (Hannah 2008, McLeod et al. 2009, Côté and Darling 2010). Côté and Darling, (2010) see resistance and recovery as facets of resilience under this definition; resistance as the ability of an ecosystem to withstand change and recovery as the quick return to the original state.

Studies suggest the most resilient populations and communities to climatic change are those that are stable and intact and protection of such areas may reduce the risk of biodiversity loss (Hughes et al. 2003, Harley et al. 2006). Known spatial and temporal refuges may act as buffers against climate-related stress (Harley et al. 2006, Keller et al.

2009) and protected, less degraded coral reefs have been shown to return to their original state more rapidly after perturbations (e.g. bleaching) when compared to unprotected, damaged or degraded reefs (Côté and Darling, 2010; Halpern and Warner, 2002). However, some studies argue this may be fundamentally incorrect and such resilience-focused management may in certain cases result in greater vulnerability to climate change impacts. Micheli et al.,(2012) suggest that local stressors upon marine systems may result in the selection of resistant species and individuals and other studies have demonstrated continued climatic impacts in the presence of marine reserves. For example, Graham et al., (2008) demonstrated little difference between no-take zones (NTZs) and fished areas in coral cover declines following a bleaching event; indicating isolated, small scale marine reserves surrounded by exploited areas are not effective for climate change resilience. Mora and Sale, (2011) also discuss the importance of connectivity in MPA network design; the viability of populations within MPAs may decrease due to habitat deterioration and increasing patchiness, which agrees with results in this study, regarding ensuring marine reserves are not isolated islands but are embedded in wider marine management.

Not only was the need for strictly protected reserves discussed in relation to increasing resilience, but it was also suggested that reserves were needed as an integral part of MPA networks to function as reference sites. In New Zealand, the original purpose of many of the marine reserves was to allow scientific research to proceed in the absence of confounding factors such as fishing or other types of extraction. In the face of climate change, these reference sites will be critical for monitoring broad scale climatic impacts in the absence (or near absence) of human impacts. Disentangling the effects of protection, climate change and/or other human stressors without strictly protected reference sites could be a near impossible task.

Most interviewees were firm in their belief of the importance of strictly protected areas in safeguarding biodiversity under climate change scenarios. Additionally that these “marine reserves” should be the “backbone” of an MPA network surrounded by buffer zones of management and should be fully integrated into other marine spatial planning, and other conservation interventions. Yet, there are criticisms of processes that establish no take areas as in Australia (see Devillers et al., 2014), or “benthic protection zones” as

in New Zealand, which are already in areas where anthropogenic impacts are minimal to non-existent. These areas add little if any extra protection for biodiversity, and therefore little in the way of climate change resilience; unexploited areas also tend to be different ecosystems (Devillers et al. 2014). Additionally, the use of these areas for reference sites is limited if the goal is to understand how an area can recover from extractive activities.

3.5.2 Why monitoring for effectiveness is key

Linked to a need for effective protection is the requirement to report on the success or effectiveness of MPAs. Many processes require specific statements of the outcome they expect to achieve through MPA implementation (Syms and Carr 2001), yet few enforce strict monitoring and reporting requirements. Monitoring results are expected to feed into a cycle of adaptive management, whereby any changes in the MPA network configuration can be based on monitoring data (Pomeroy et al. 2005). However, the more adaptive the management, the more monitoring data would be required to justify changes in management.

Realistic and achievable objectives for an MPA and the measurement of their achievement are a crucial aspect of long-term management (Syms and Carr 2001). Whilst some respondents saw the setting of climate change specific objectives as important, others suggested that it adds a level of uncertainty or complexity that would be difficult to measure. Studies have highlighted that where the vision for an MPA network or objectives are not clear or apparent, the MPA process is ineffective (Guénette and Alder 2007). Several concerns were raised regarding the setting of clear objectives for individual MPAs/MPA network and many saw unclear objectives as a potential barrier to assessing whether an MPA was successful in the face of climate change. However, these objectives should recognise that biodiversity values under climate change may change, for example, if an MPA is designated for a particular species, which undergoes a range shift and is no longer present within the MPA, the MPA may be seen as ineffective. Participants suggested that discussions are needed as to how marine biodiversity is valued, either in terms of services, or species and habitats and whether these will be preserved under climate change.

The challenge is to develop targets and evaluation protocols that are robust to the many sources of uncertainty inherent in managing natural systems. Effectiveness targets must be established with the understanding that the natural world is variable, and there is a degree of uncertainty at every level of inquiry and management action (Syms and Carr 2001). A structured approach can incorporate variability into setting targets and evaluating performance, which can in turn be explicitly incorporated into management plans (Syms and Carr 2001). Additionally, monitoring strategies should offer opportunities to diverse stakeholder groups in the selection of evaluation targets as this has the potential to enhance evaluation capacity, increase credibility of management practice and MPA effects, strengthen ties between involved parties and utilise locally relevant information (Heck et al., 2012; Ban et al., 2014). Stakeholders may also hold very different views to management as to what constitutes success (Himes 2005). Indeed the results of this study suggest that there may be a mismatch between different stakeholder and MPA practitioner groups as to what contributes success at the level of the individual MPA and at a network scale, which must be addressed.

3.5.3 An adaptive approach

Respondents noted the need for adaptive management in the face of climate change, which corresponds to other studies of MPA managers (e.g. Cvitanovic et al., (2014)) that suggest adaptation would allow decision makers to develop proactive management measures. However, the results of this study suggest that there is a perception of a need for MPA processes to be adaptive, whilst in reality few can demonstrate current adaptive management or the legal or scientific capability to carry it out in the future.

New Zealand has a long history of implementing marine reserves, yet the ad hoc approach to designation of small scale reserves has not resulted in an ecologically coherent network (Thomas and Shears 2013), which could leave isolated marine reserves vulnerable to the impacts of climate change (Cicin-Sain and Belfiore 2005). Incorporating these reserves into a connected and functional network has been a priority for New Zealand for some time, yet the process is stalled and at present the singular reserves could be left vulnerable. A lack of political will or foresight in MPA management is a barrier for an adaptive approach.

Cvitanovic et al., (2014) found that Australian MPA managers considered adaptive management critically important in a climate change context, yet felt they did not have enough knowledge regarding adaption to make informed assessments. This is line with suggestions made in this study by respondents in California, proposing a possible barrier in implementing adaptation was a lack of understanding of how adaptation would work in practice. A resistance to adaptation by governments (Cvitanovic et al. 2014) and also by stakeholders (Mills et al. 2015) is another barrier. The slow process to establish an MPA, and a policy structure that would require any changes to boundaries or specific management measures, to go through an application process for a new MPA in Canada, would result in a long and complex process to make slight alterations. Adaptation is recognised in the management of the Californian MPAs, but there was also recognition from respondents that the whole concept of adaptive management would need to be more clearly defined if it was to be successful.

Tracking changing conditions through the use of moveable MPAs was suggested as an adaptive approach and the concept has had some attention in other studies (see Game et al., 2009); such moveable protection would possibly be easier to use in the marine environment (Pressey et al. 2007). However, tracking rapidly shifting species ranges (see Cheung et al.,(2009) for projections of changes in marine species distributions) may not be appropriate; MPAs designated for single species may also be deemed ineffective if a species moves beyond the protected boundaries. Most respondents in this study suggested that although moveable MPAs was scientifically feasible, it would be politically impractical. Syms and Carr, (2001) propose that by integrating science-based, realistic objectives and a strong monitoring framework that tracks the status of biodiversity, environmental conditions and how pressures or conservation needs are changing over time, with a clear strategy for adaptive management, MPAs can remain effective in changing conditions. *How* MPAs could be adaptive is still unclear beyond short term regulations or adjustments in human activities, particularly if moving MPAs as a strategy is not workable.

3.5.4 When to incorporate climate change considerations?

Throughout this study MPA practitioners suggested considerations of climate change should be included in the early design stage of the MPA process. Perceptions of what

design criteria would be important in a climate change context closely resemble the guidelines developed for climate change resilient MPA networks (see Brock et al., 2012; Burt et al., 2014) and are based on general ecological principles for MPA network design (see McLeod et al. (2009), Foley et al. (2010), Fernandes et al. (2012)). Key points raised in this study for climate change resilience were: ensure key ecological principles for good MPA network design are followed; the inclusion of strictly protected reserves is critical for resilience; and the inclusion of areas already showing signs of climate perturbation or areas having a mitigation role e.g. blue carbon stores. Several issues were raised relating to "selling" MPAs to stakeholders on the basis of requiring them for climate change resilience and whether stakeholders would understand or consider this an important reason for their designation. However, by addressing climate change resilience in terms of protecting the full suite of biodiversity and ensuring ecological principles are met, it was thought that this conflict could be avoided.

Although it was wholly considered important to address climate change in the design phase, some MPA network processes are now moving past initial designs, therefore it will be important to assess if climate change considerations can be included retroactively. Gaines et al., (2010) recommended considering whether networks designed under prevailing environmental conditions will be effective under projected spatial and temporal variation in climate impacts. As such, could networks be designed using forecasting methods and choose areas for protection that would safeguard biodiversity into the future (Johnson and Holbrook 2014). The difficulty in this approach is the inherent uncertainty; forecasting suitable areas would not work for a species-based approach where the presence of a species is required now, not at some point in the future (e.g. Scotland's MPA process). Therefore, it is likely that MPA networks will need to be adaptively managed (McCook et al. 2010)

Key principles and design criteria for good network design and management can still be incorporated through an adaptive approach. Reviewing an MPA network will allow MPA managers to fill-in the gaps in protection for climate change vulnerable habitats. However, in the context of British Columbia, there was strong recognition for good design, yet the process to establish new MPAs was extremely long and complex.

Therefore, the capacity for reviewing and including new information at a network scale needs to be increased.

MPA processes should not be seen as reaching a static endpoint; an integral ideology of adaptive management is the ability to continually incorporate new knowledge through a process of monitoring, review and redesign (Day 2008). As the scientific knowledge regarding climate change impacts, resilience and adaptation/mitigation improves, it will be imperative for the success of MPA networks that new scientific information actively informs the MPA process. Studies have shown that some MPA managers may be unaware of the breadth of scientific information, which could inform decision making (Cvitanovic et al. 2014), and participants in this study reported policy documents in New Zealand to be scientifically lacking. Therefore it will be important to improve the uptake of MPA and climate change science into policy.

There is a strong theoretical basis for including climate change considerations within current MPA networks, whether from a design starting point or retroactively adding in design or management considerations through network review or including climate change related criteria in a monitoring programme. However, most respondents in this study suggested there is only limited evidence of these lessons actively being implemented.

3.6 Conclusions

Strictly protected marine reserves are considered essential when considering climate change in MPA networks, given that complete and healthy ecosystems are thought to be more resilient to climate change. Reference areas will be critical to understand climate change impacts and effects supported by monitoring over medium to long term timescales. Adaptive management of MPAs is an idea that is good in theory, but difficult to implement due to legal or political barriers and realities. Further exploration of how adaptive MPA management occurs in different contexts is warranted including how adaptive changes affect both MPA design and users of marine resources. MPAs should be designed and implemented as a network using an ecosystem based approach; single species may move with climate change meaning MPAs sites designated under a single-species approach may be ineffective in the future. By following an ecosystem-based

approach, you may not need to move MPAs, but more strictly protected ones may be required. The less strictly protected the MPAs are, the more monitoring data will be required to ensure the MPAs are effective (depending on their criteria for success) and the more management would need to be adaptive. Therefore, given the uncertainty under climate change scenarios, the difficulties of adapting MPA networks once they are in place, limited resources for monitoring and for reiterating the policy cycle, the key question is that to protect biodiversity, do reserves with strict protection make sense?

Understanding perceptions of how climate change knowledge has been included in MPA network processes will help inform best practice advice for decision makers in the future design, monitoring and management of MPA networks. Resolution of how marine biodiversity is to be valued in the future and an understanding of how MPAs will contribute to these future values is needed. Finally, a restating of clear hierarchical objectives, which include climate change relevant objectives, and integration of these into a strong monitoring framework should be of importance. Critically these ideas need to be actively implemented through active and adaptive policy design not passively acknowledged.

Chapter 4 A participatory process to including considerations of climate change in the Scottish MPA network: Round One and Two

4.1 Abstract

As international pressure for marine protection has increased, Scotland has attempted to increase spatial protection through the development of a Marine Protected Area (MPA) network. Few MPA networks to date have included specific considerations of climate change in the design, monitoring or management of the network. This chapter presents Round One and Round Two of a Delphi technique that aimed to facilitate clear communication in order to identify specific climate change considerations applicable to the Scottish MPA network. Specifically, this chapter considers the following questions in a Scottish context: i) Are there differences in the perceptions of success between different stakeholder groups? ii) How can we effectively protect marine ecosystems under climate change scenarios? iii) What are feasible options for including climate change specific management and monitoring strategies? The first two rounds of the Delphi technique identified possible criteria against which to judge success of an MPA/MPA network in the context of climate change. Potential monitoring and management options specific to climate change were suggested and the overall the first two rounds developed the context for recommendations for the Scottish MPA network. However, the first two rounds also highlighted that differing views of success would likely influence the acceptability of various management actions. This chapter provides a context for the final focus group round of the Delphi technique and develops the discourse towards identifying a series of recommendations for the Scottish MPA network in the context of climate change.

Keywords: climate change, Delphi technique; management; marine protected area networks; Scotland

4.2 Introduction

Chapter 3 presented the results of four international case studies that examined various perceptions of how considerations of climate change had been included in the design, implementation, monitoring and management of MPA networks. Analysis of the results highlighted a number of questions to explore in a Scottish context:

- Are there differences in the perceptions of success between different stakeholder groups?
- How can we effectively protect marine ecosystems under climate change scenarios?
- What are feasible options for including climate change specific management and monitoring strategies?

Following from Chapters 2 and 3, the need to facilitate clear communication between academics, policy makers and stakeholders in order to progress MPA policy delivery and to ensure decisions were jointly formed and acceptable was recognised.

This chapter describes the methodology used to develop a series of recommendations for considering climate change in Scotland's MPA process. Firstly, a review of the Delphi technique critically examines the methodological challenges of the Delphi technique and explains the suitability of the method to this research. Following the methodological review is a discussion of how the Delphi technique has been used and adapted in this study. Subsequently, the results of the first two rounds of the Delphi technique are then presented. This chapter explains the structure and content of both rounds and provides a summary of the results, and a description of the key findings which lead to the next chapter, the final focus group round, prior to outlining a series of recommendations in Chapter 6. The presentation of the results in this manner allows for the logical presentation of ideas that were developed through the process and demonstrates how recommendations were reached.

4.3 The Delphi technique

The Delphi technique (alternatively referred to in the literature as: process, method, approach, study) typically involves an expert panel undertaking a series of iterative rounds on an issue through the exchange of information via a process facilitator (Hsu and Sandford 2007a). The Delphi technique is a method for structuring group communication to enable an effective way for a group to deal with a complex issue (Linstone and Turoff 2002). The approach allows a group of diverse people to interact, usually anonymously, thereby providing the opportunity to present and challenge alternative viewpoints without the usual "negative" aspects of group interaction, for example, dominating individuals (Goluchowicz and Blind 2011) (discussed in further detail later in this chapter). The Delphi technique can be applied at different scales from local to global issues involving representatives from different countries as a cost-effective method to engage people over large geographical distances (Mukherjee et al. 2015). There are also multiple means of implementing the technique (see subsequent explanation). However, the process is also fairly intensive, both in time and resources for the participants (Okoli and Pawlowski 2004).

The Delphi technique usually comprises two or more rounds of questionnaires, as each round of the Delphi technique is completed by the participants, responses are consolidated and analysed by the process facilitator and fed-back to participants (Mukherjee et al. 2015). Prior to the next round, participants are then able to adapt their previous responses based on this feedback (Glass et al. 2013). The role of the facilitator is to guide the process, develop the questionnaires, analyse the data and identify areas of conflict or consensus and to feed these back to panel (Glass et al. 2013). Through the feedback process, the Delphi participants are encouraged to re-evaluate their initial answers in light of contributions from other participants within the study. Therefore, specific results from previous rounds may be modified in later stages; the iterative nature of the process can stimulate ideas amongst panel members, by collectively widening knowledge and providing a "catalyst for reflection" (Mukherjee et al. 2015). Additionally, participatory processes, such as the Delphi technique, may promote social learning ((Reed 2008, Glass et al. 2013) whereby participants learn from each other, developing understanding of each other's' views, appreciating their legitimacy, building on existing relationships and transforming adversarial ones (Stringer et al. 2006, Reed 2008). A

benefit of the reflective deliberation of the Delphi technique may also be the development of more creative solutions by groups of people (Reed 2008).

In contrast to methods such as interviews, or focus groups with only one iteration, the multiple rounds and feedback process of the Delphi technique ensure more credibility by allowing the participants to readjust their responses based on new ideas, information and perspectives from other participants (Powell 2003, Mukherjee et al. 2015). The written feedback also ensures the procedure is transparent and documented which can add structure and trust to a process (Mukherjee et al. 2015).

The Delphi technique typically employs an exploratory first round, usually using open-ended questions or an unstructured approach so as to encourage free thinking to generate ideas, theories and issues (Powell 2003). It is important to clearly reflect the research objectives in the initial round as results from this first round shape subsequent rounds and thus influence both the subsequent rounds and the final results of the study (Powell 2003). The use of a semi structured first round has the advantage of focusing participants onto a specific subject whilst still allowing participants to explore the subject area without being unduly restricted (see Frewer et al., (2011)).

A successful Delphi technique should enable participants to add additional information, ideas and theories throughout the process and critique the contributions of others. A rigidly structured questionnaire approach for use in the Delphi technique has been criticised by not enabling participants to add new ideas (Tolley et al. 2001), thereby limiting participants' ability to provide unique perspectives or interpret questions according to their own experiences and understanding.

The Delphi technique is suitable for complex policy problems, particularly where there is significant uncertainty, lack of historical precedent and especially in situations where information is limited or conflicting (Mukherjee et al. 2015). As an established method in a range of disciplines including: medicine, social policy, tourism, sustainability and economics, the Delphi technique is becoming more popular in the fields of conservation and ecology. Mukherjee et al., (2015) review the use of the Delphi technique for ecological and conservation issues, highlighting the applicability of the technique to aid conservation policy (e.g. Clark et al.,(2006)), decision making (e.g. Hess and King, (2002);

Gobbi et al., (2012)), exploring options under different scenarios (e.g. O'Neill et al., (2008)) and addressing conflict in conservation issues. Even though the Delphi technique is particularly applicable to many conservation and biodiversity management issues due to their complex nature, involving a range of stakeholders and trade-offs, Mukherjee et al., (2015) find that the method has been relatively little used in these fields.

The Delphi technique has been adapted by researchers in order to answer specific problems or work towards particular outcome goals (Hasson and Keeney 2011). A particular adaptation of the Delphi technique, a "Policy Delphi" seeks to uncover both consensus and disagreements on policy issues, revealing the rationale behind the different positions of the participants, and help form potential resolutions (Hasson and Keeney 2011). Clark et al., (2006) used the technique to evaluate the conservation status of 283 bird species in New Jersey, North America. The different Delphi technique categories (or types) can also be combined to reflect the research problem (Mukherjee et al. 2015); those categories with a particular relevance to conservation issues are described below.

A Decision Delphi is primarily focused on formulating or assisting in making decisions (Hasson and Keeney 2011). For example, Gobbi et al., (2012) used the Delphi Technique to aid identification of 229 invertebrate species for conservation action where empirical data was lacking. Scenario Delphi seeks to explore alternate scenarios, and can be used to assess different management or adaptation options or clarify forecasting scenarios (Hasson and Keeney 2011). Scenario Delphi has been used to quantify the impacts of climate change on polar bear (*Ursus maritimus*) populations (O'Neill et al. 2008) being particularly applicable to complex, data poor situations (Mukherjee et al. 2015). Argument Delphi aims to uncover the various arguments and explore the different positions and the reasons for the divergent opinions (Hasson and Keeney 2011) and may be particularly suited to conservation issues where a high degree of conflict exists, helping to uncover reasons for the conflict, stimulate debate and generate new solutions or ideas (Mukherjee et al. 2015).

4.3.1 Methodological Considerations

The Delphi technique should be applied in appropriate situations, for example, the Delphi technique is not intended as a substitute for quantitative data where data are already available (Mukherjee et al. 2015), and is not appropriate in situations where questions may be answered by a thorough literature review (Kenyon et al. 2008). Yet, the Delphi technique can provide complementary or interpretive information for quantitative studies (Mukherjee et al. 2015).

Common methodological problems with the Delphi technique include: forced consensus (in consensus-driven Delphi), lack of care and planning in implementation and the effort-laden nature of the method. In consensus-seeking Delphi adaptations, the focus "may lead to a diluted version of the best opinion" (Mukherjee et al. 2015) resulting from a general leaning towards the majority opinion irrespective of feedback. Clumsy execution of the Delphi method can result in poor participant selection, inadequately designed questionnaires, disinterested participants and high attrition rates, forced consensus due to individuals feeling marginalised and inadequate or biased analysis of the results (Mukherjee et al. 2015). Additionally, the technique requires a considerable amount of effort from both participants and the researcher. Further consideration of the above and additional methodological attributes is discussed below and section 4.4 discusses how the Delphi technique was adapted for this study to minimise potential problems.

4.3.1.1 *Selection of panel participants*

The Delphi approach is not an opinion poll and does not depend on a statistical sample attempting to be representative of any population, instead it relies on "expert" opinions and therefore representative or random sampling techniques may not be appropriate (Mullen 2003). More generally, qualitative research sampling often involves small numbers of participants as the quality of the research is dependent on a sufficient depth of information to provide a deep contextual understanding of the phenomena being studied (Fossey et al. 2002). A common sampling approach is purposive; "snowball" sampling or cascade approaches are often employed for participant recruitment (Frewer et al. 2011). As such, views of the panel may not be representative of a wider population which impinges upon generalisation (Skulmoski and Hartman 2007). However, the Delphi technique can be employed when there is limited knowledge around a subject to solicit

in-depth opinions on a focused topic rather than generalisations across a wider field. Therefore, purposive sampling can enhance the credibility of the interpretations generated and the quality and completeness of the information gathered (Fossey et al. 2002). It is recommended that to increase generalisability, further studies can be conducted in other geographical locations, with another panel of participants, having knowledge of the specific area and policy context or additionally with a related set of research questions (Skulmoski and Hartman 2007).

It is critical that the panel of participants is well selected with an in-depth knowledge and understanding of the research issues to improve the reliability of the study (Okoli and Pawlowski 2004). Participants should be able to make valid contributions based on their relevant experience and credibility with the target audience (Skulmoski and Hartman 2007). The panel as a whole should be able to identify a broad range of issues and perspectives (Mukherjee et al. 2015). The criteria for an “expert” panel member have a wide variety, and are often dependent on the research questions posed or the overall aim of the study. The criteria may include years of experience, or number of peer-reviewed publications, yet it may also require direct involvement in the issue and engagement with relevant organisations (Mukherjee et al. 2015).

More recently, Delphi studies have been more inclusive of different forms of knowledge and recent studies have recommended including participants from a wider range of disciplines or backgrounds (Hussler et al. 2011). Mukherjee et al., (2015) suggests the inclusion of a greater breadth of participants (e.g. practitioners, conservationists, NGOs, policy makers and indigenous groups) can minimise information bias by any particular group (thereby enhancing quality of information), by including a wide range of perspectives on the topic under consideration. Indeed the Delphi technique can facilitate a discussion between scientists, experts and non-scientific participants, allowing for information sharing on a common platform (e.g. Glass et al., 2013). By expanding the panel in this way, and including a diversity of opinion, it is possible to minimise the possibility of overlooking “some obvious facet of a question” (Mullen 2003).

4.3.1.2 *Validity and Panel Size*

Delphi studies are not comparable with conventional survey methods that require statistically large numbers to ensure validity (Mullen 2003), the representativeness of the panel is judged on the attributes of the participants (Powell 2003). The validity of the Delphi technique is also linked to the purpose for which it is employed. For example, the Delphi technique can be used for problems that do not lend themselves to precise analytical techniques, but problems, which may benefit from subjective judgements about an issue on a collective basis (Linstone and Turoff 2002). For this reason, the Delphi technique is often applied to complex or "wicked" problems; problems that are so complex that people disagree about how to define and solve them (Chapin et al. 2008). Natural resource management issues, such as fisheries and coastal management and conservation, are increasingly being referred to as "wicked" or "messy" due their inherent complexity (Jentoft and Chuenpagdee 2009, Game et al. 2014); uncertainty about future environmental conditions, links to broader, economic and policy issues and differences in social values, make defining an optimal solution near impossible (Chapin et al. 2008). Therefore, the quality of the results can depend on the different perspectives and the expertise of participants rather than sample size (Mukherjee et al. 2015).

The Delphi panel may be modestly sized where there are a limited number of experts with the required knowledge to achieve the study objectives; validity in the outcomes is maintained by ensuring the quality of input from the participants through a well-designed questionnaire. The advantage of a smaller panel is a reduction in the amount of material produced, ensuring feedback is more accurate (Kenyon et al. 2008), as beyond a certain size, Delphi studies can become difficult to manage, data processing and analysis becomes cumbersome with little additional benefit (Skulmoski and Hartman 2007). Conversely, with a larger group, the verification of results is more convincing, however, this can be achieved in smaller studies through internal verification (Skulmoski and Hartman 2007). Arguably, panel composition is a more important factor in the validity of a Delphi study than panel size (Donohoe and Needham 2009). Additionally, the size of the panel is dependent on the nature and context of the research being undertaken.

4.3.1.3 *Number of iterative rounds*

Classic Delphi studies were usually comprised of four questionnaire rounds, however, in later studies two or three rounds have generally been preferred. More repeated rounds may lead to fatigue and a higher attrition rate of participants, and can also be time consuming (Donohoe and Needham 2009). A minimum of two rounds is needed to provide the panel opportunities for modifying responses; using different panels or by using completely different questionnaires in successive rounds also precludes the opportunity for participants to provide feedback (Mullen 2003). The total number of rounds can depend upon a pre-determined cut off, depending upon the nature of the research questions, or when the desired level of consensus or information is reached.

4.3.1.4 *Level of anonymity*

A defining characteristic of the Delphi approach is the incorporation of some level of anonymity between the participants, if only for part of the study (Mullen 2003). The strength of using an anonymous approach is that it can remove effect of status, powerful personalities and group pressure (Goluchowicz and Blind 2011) which can become counterproductive to identifying acceptable problem resolutions (Frewer et al. 2011). Participants may be more willing to propose controversial or innovative ideas without fear of repercussion which can be particularly important in cases such as climate change adaptation in protected areas where new ideas may challenge traditional planning and management (Lemieux and Scott 2011). The Delphi technique can therefore remove some of the limitations associated with face to face meetings. The process facilitator acts as a filter in order to preserve anonymity.

However, a methodological problem associated with using anonymity is the lack of accountability (Powell 2003). Respondents may not give accurate feedback as they feel they do not need to be careful in making anonymous responses (Powell 2003, Goluchowicz and Blind 2011). By combining the traditional Delphi anonymity with a face to face meeting or focus group, usually at the end of the process, this risk can be reduced (Mukherjee et al. 2015).

4.4 Use of the Delphi technique in this study

In order to ensure that recommendations for including considerations of climate change in the management and monitoring were feasible and relevant to the Scottish MPA network, a methodological approach that accounted for the perspectives of a range of stakeholders was required. The Delphi technique was considered the most effective approach for a rigorous inquiry of stakeholders to achieve the research objectives.

The Delphi technique employed here did not seek consensus, as in a conventional Delphi approach, seeking instead an improvement in understanding and clarification of the issue, therefore sharing similarities with Policy Delphi. As Rowe and Wright, (2011) suggest, the most interesting and important issues often emerge where consensus is not evident. The technique was particularly apt for this research due to it being a complex policy problem with significant uncertainty, lacking in historical precedent and exact knowledge (Donohoe and Needham 2009). Additionally, the iterative nature of the technique allowed for a more detailed exploration of the issues which would not have been gained through a more traditional questionnaire approach.

4.4.1 Selecting the panel

MPA processes involve a complex range of stakeholders from various economic, social and environmental interest groups. As such, the panel was carefully selected to reflect this diversity. Following Glass et al., (2013) a stakeholder map (Appendix B::1) was drawn up in order to identify a matrix of organisations and stakeholder interest groups in order to reduce potential bias by only involving a particular set of stakeholders and therefore ensuring the validity of the process. Sources used to identify participants included: the MPA stakeholder workshops (discussed in Chapter 2) delegate lists, academic publications/grey literature, committee membership, web searches and personal knowledge of the Scottish MPA process. Potential participants were selected if they met one or more of the following criteria (more than one desired where possible): active role in the Scottish MPA process, relevant experience in other UK MPA processes, member of a representative body, and academically relevant research to MPAs and/or marine climate change.

Potential participants were invited to participate in the process and snowball sampling of the invited participants was used to further identify and extend the list of potential participants. The advantage of this method of referral was the inclusion of potential participants who may otherwise not have been identified as willing and interested individuals, which can minimise the likelihood of participant drop out over the course of the iterative rounds (Frewer et al. 2011).

Email invitations were sent to 26 potential participants with the aim of setting up a balanced panel of approximately 15 “panellists”. Initial acceptances were received from ten invitees, two invitees declined the opportunity to participate and a further six invitees did not respond. Follow up emails resulted in further nominations of other potential participants, at this stage respondents from similar organisations nominated one person to speak on behalf of the interest group and this person became the point of contact. Reasons given for the collective input included the already heavy investment of relevant organisations involved in the ongoing MPA designation process and reshuffling of employees within the relevant organisations to different policy areas. Four participants then declined before the first round which resulted in a panel size of six panellists.

The final six panellists represented a wide selection of representative bodies, policy and decision makers, academics and NGOs (see Table 4.1). Due to the collective nature of the input from four of the panellists (Panellist 1, 2, 4, 5), the researcher viewed the panel composition as sufficiently representative of Scottish MPA interests to provide a dataset of valid qualitative information and basis for collaborative discussion. Additionally, the final panellists were either senior members of the organisation or held a key (highly relevant to the research focus) position within the organisation (Panellist 1, 2, 3, 4, 5); all panellists had been engaged in the Scottish MPA network process (or in the case of Panellist 6, had direct experience of MPAs in the UK, marine climate change and sustainable seafood).

4.4.1.1 *Ethical Considerations*

This Delphi technique was guided by the ethical principles on non-clinical research using human participants set out by the College of Medical, Veterinary and Life Sciences, University of Glasgow. The panellists received written information regarding their

participation, outlining the nature of the project, how the data was to be used and details of an independent contact within the University. Panellist answers to written questions were anonymised in subsequent rounds of the process. No individual participant is identified in written reports. Panellists were informed that they could withdraw at any time without repercussions and have their contributions removed from the project if they so wished. Ethical approval was sought and granted by the University of Glasgow for this study.

Table 4.1 Summary of panel characteristics and identification method.

Panellist[1]	(Group)	Organisation	Identification Method
1	Representative Body	Scottish Fishermen's Federation (SFF)	Stakeholder Workshop; referral
2	Representative Body; NGO	Scottish Environment Link	Stakeholder Workshop; reputation
3	Practitioner and Professional	British Sub Aqua Club (BSAC), Academic	Referral; reputation
4	Policy Makers and decision makers	Scottish Natural Heritage (SNH)	Grey literature; Referral; reputation
5	Policy Makers and decision makers	Marine Scotland	Stakeholder Workshop Referral; reputation
6	Practitioner and Professional	Academic	Referral; academic publications

[1]The numbers used to list panellists in the above table correspond to those used subsequently in this chapter

Although this study was specific to Scotland's MPA network, the variety of interest groups included in the study ensured the research outputs were widely applicable.

4.4.2 Outline of Method

The Delphi Technique adopted here used three survey iterations to allow for the potential modification of responses and in an effort to minimise panellist attrition rate (Figure 4.1). The first two rounds presented written questionnaires to the panellists and the final round was in the format of a focus group (discussed in Chapter 5). The Delphi study began in January 2014 and the focus group Round concluded the panellist input process in September 2014. Ethical approval was gained from the University of Glasgow for this study.

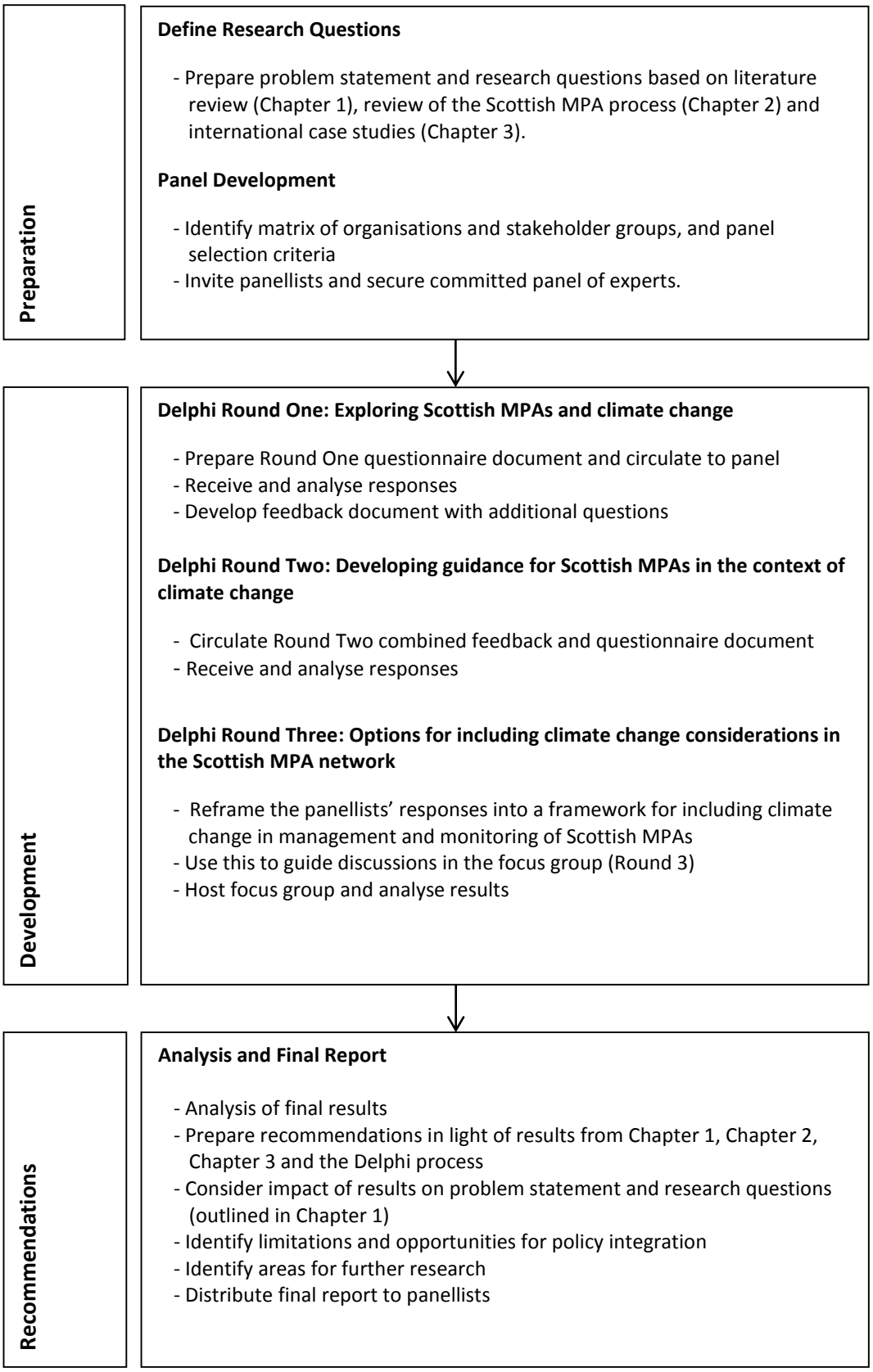

Figure 4.1 Overview of the Delphi process to identify recommendations for including climate change considerations in the Scottish MPA network. (Adapted from Lemieux and Scott (2011)).

The Round One questionnaire emailed to the panellists was accompanied by a brief overview of the research. The briefing material summarised the research aims, rationale for the research and the specific objectives of the survey, communicating clearly to panellists about the extent of their expected involvement and the intended use of the research outcomes (recommended in Hasson et al., (2000)). The Round Two questionnaire was constructed from the data gathered in Round One; the structure and content of Round Two was determined through analysis of the previous round (see Section 4.5). Both questionnaires were also accompanied by a response deadline to encourage panellist response and prevent the slowing of the research process (as recommended by Hsu and Sandford (2007b)).

4.4.3 Questionnaire Design

Following the results of Chapter 2 and Chapter 3, a questionnaire was developed for Round One. Chapter 2 highlighted that there may be differences between different stakeholder groups in perceptions of success, Chapter 3 emphasised that perceptions of success may also be affected by climate change scenarios that affect the assemblages of species and habitats. It was therefore important to situate the concepts of successful MPAs and an MPA network within the Scottish context. Round One developed the context for recommendations by exploring the perceptions surrounding successful MPAs and the role of MPAs in the wider marine environment (in the context of the policy framework discussed in Chapter 2). Both Chapter 2 and Chapter 3 illustrated the importance of considering climate change within management and monitoring measures, and demonstrated the need to identify feasible options. Round One investigated potential management and monitoring options and whether there were any barriers to their implementation (following the key findings of Chapter 3).

Round One had the following aims:

- To provide a Scottish context of a successful MPA/MPA network
- To relate “success” for the Scottish MPAs/MPA network to considerations of climate change
- To identify practical management and monitoring strategies to achieve success under climate change scenarios

- To identify any constraining or enabling factors to considering climate change within the existing framework of the Scottish MPA network

The Delphi panel was asked to respond to a series of open-ended questions structured according to the four subject areas: i) exploring perceptions of successful MPAs ii) relating criteria of successful MPAs/MPA network to climate change iii) initial explorations of climate change, management and monitoring of MPAs iv) reflections on the process. The questionnaire design reflected the results of the previous chapters yet enabled participants, through the use of open ended questions, flexibility to expand their answers. Participants could highlight areas that they deemed important or required further discussion.

For the second round, panellists were invited to comment and reflect on the results of Round One. Feedback from Round One was presented to the panellists in combination with a series of open-ended questions, through which they could restate ideas, make further suggestions or comments and challenge any of the other points raised in the previous round. This allowed panellists to expand their knowledge and critically, to analyse and evaluate their own and others' responses.

The overarching aims of the second round were:

- To give panellists the opportunity to reflect on the results of the first round
- To allow panellists the opportunity to add comments, suggest alternate ideas and critique the contributions of other panellists
- To develop the discussion into a statement of recommendations and strategies

The iterative nature of this second round enabled the researcher to further explore and understand areas of debate and consensus and highlight potential areas for subsequent discussion in the focus group round (Chapter 5).

Prior to both rounds, the questionnaires and feedback documents were reviewed and piloted to ensure that each document was understandable, clearly communicated the key themes and were well phrased and representative of the dataset (as recommended by Hasson et al., (2000)). Both questionnaires (Round 1 and 2) are available in Appendix B:.

4.5 Data Analysis

Each of the questionnaires was imported into QSR International NVivo software (QSR International Pty Ltd 2010), which facilitated organisation, coding and retrieval of the data. Analysis of the questionnaire data involved coding the question responses, with the aim of identifying key themes emerging from the data (thematic content analysis). A thematic content analysis approach is a useful approach is useful for identifying salient issues and key elements of a dataset (Green and Thorogood 2014).

Data analysis broadly followed the steps suggested by Braun and Clarke, (2006) (see Table 4.2). Each questionnaire was firstly read through in detail with the addition of analytic notes and initial ideas regarding emerging themes. The data was then coded, grouping similar data segments (e.g. a particular sentence) together under each emergent code. Similar codes were combined under key themes in conjunction with a re-reading of the dataset with the aim of identifying themes that illustrated the perceptions of the panel for each question. Areas of agreement or disagreement amongst the panellists were also highlighted. Themes were verified and refined ensuring the data was fairly represented. Coding frameworks for both questionnaires are available in Appendix C:.

Table 4.2 A description of key steps in thematic content data analysis

Steps in Analysis	Description
1 Data familiarisation	Importing the questionnaire responses, reading and re-reading the data, creating analytical memos with initial ideas.
2 Generating initial codes	Systematic coding across the entire data set, collating data relevant to each code.
3 Searching for themes	Combining similar codes into broad potential themes, re-reading across the data to gather relevant material into each potential theme.
4 Reviewing themes	Refining themes, checking the data fits the refined themes and collating similar themes to produce a final list.
5 Defining and naming themes	Final themes named and defined. Definitions included in: sources, memos, analytical memos.
6 Reporting	The final opportunity for analysis. Selection of key illustrative examples, relating the analysis to the research questions. Producing final report

Adapted from Braun and Clarke (2006).

The results of this analysis were presented to the panellists in the feedback document. As recommended by Hasson et al., (2000), wording of feedback elements was the panellists' own with only minor editing to avoid introducing researcher bias, direct quotes were used to illustrate key points and areas for further discussion (but without the originator of the quote being stated).

Recommendations were articulated differently by the panellists, ranging from brief sentences to detailed paragraphs expressing an opinion and its rationale. The results are presented as follows: i) Round One is presented as a description of the key themes identified in each section with illustrative quotes and conceptually clustered matrices produced by the researcher ii) Round Two illustrates the key themes identified in Round One that were further explored, panellists' quotes are contextualised and tables present selected areas of discussion.

4.6 Round One

4.6.1 Perceptions of successful MPAs

The first questionnaire section explored the perceptions of successful MPAs in the context of the Scottish MPA network. Panellists proposed several aspects of MPA design and management that would result in their view of success. Table 4.3 summarises the perceptions of the panel in terms of the criteria for a successful MPA/MPA network, the panellists' suggested indicators related to those criteria and illustrative comments.

Table 4.3 Clustered Summary Table: criteria of a successful MPA/MPA network and suggested indicators of success.

Criteria of a successful MPA/MPA network	Panellist suggested indicators that the criteria of success are being achieved	Examples of Panellist Comments
Objectives Setting of clear and achievable objectives	Site level objectives set for individual features Definitions of recovery and conservation for each feature/MPA site identified	*"The Scottish MPA objectives seem to be founded on a sustainable use set of criteria. Using science to determine sustainable exploitation of the MPAs rather than a concept of complete protection."* ***Panellist 3***
Healthy MPA sites/marine environment Supports a range of biodiversity and/or geodiversity features with the maintenance/recovery of healthy, biological diverse and productive seas	Biological indicators including: increases in diversity, habitat integrity, and the abundance, size, age and reproductive output of a range of species. Species/habitat conservation/recovery Aspects of wider ecosystem service provision e.g. healthy habitats supporting coastal fish and shellfish populations Improvement of biodiversity in the surrounding areas Enhanced resilience to human pressures and wider environmental change	*"The designation should be developed within the strategic context of protecting (and where appropriate enhancing) the structure, function, processes and biodiversity of marine ecosystems to enhance resilience to human pressures and wider environmental change."* ***Panellist 2*** *"There are numerous possible indicators, but the fundamental goal should be a shift towards a more natural marine ecosystem."* ***Panellist 6***
Good Design OSPAR criteria[1] for ecological coherence e.g. replication, representivity, connectivity and viability.	Presence of OSPAR criteria reflected effectively in the first iteration of the network. Protection of appropriate/representative level of vulnerable habitat and species whilst still permitting "controlled/managed" access for sustainable fisheries. MPA sites selected using sound science	*"Include assessment against relevant OSPAR network assessment tests and a more detailed consideration of connectivity between sites etc."* ***Panellist 5*** *"We strongly advocate for the need to urgently develop the evolving science which underpins these concepts, particularly connectivity and representivity."* ***Panellist 2***

Good Management Clear, enforceable and communicated effectively with requisite resources	Culture of compliance with no evidence of infringement Strong management measures that deliver a benefit as defined by other criteria	*"It is currently unclear what level of management will be put in place for features where SNH have proposed "reduce or limit" management options rather than "remove or avoid" which is a much clearer requirement."* ***Panellist 5***
Strong Monitoring Framework A monitoring programme to effectively gauge the impacts of designation	Innovative partnerships with marine users to generate publicly accessible data Capture of socioeconomic data in addition to ecological Variety of monitoring and surveillance techniques	*"Monitoring and assessment work should enable feedback to marine users on wider ecosystem services and benefits rather than only focusing on the "features" of direct conservation interest".* ***Panellist 5*** *"There must be in place a monitoring programme to effectively gauge the impacts of designation on the protected feature, expected within site and off site ecological changes over the timescales that are appropriate to the feature being monitored."* ***Panellist 2***
Stakeholder support The MPA network is supported by a range of stakeholders.	Level of local support Range of sectors/stakeholders supportive of MPAs winning over current scepticism Compliance and self-policing	*"The value and role of the individual MPAs should over time become recognised by a broad range of stakeholders for services that they can associate with, winning over current scepticism."* ***Panellist 5*** *"[with] buy in from all relevant stakeholders in a culture of support, compliance and self-policing [the] enforcement resource burden [would be] minimised- but also be strong enough to deliver a real benefit".* ***Panellist 2***
Socioeconomic Benefits Socioeconomic improvements in the wellbeing of all relevant stakeholders	Robust/sustainable fishing industry Sustainable marine tourism industry	"A gold standard MPA would offer benefits to both conservation and fisheries and other stakeholders in surrounding areas." **Panellist 6**

[1] See OSPAR ecological coherence design principles (OSPAR Commission 2006)

Panellists were asked to consider how their perceptions would apply to the Scottish MPA network, and the panel was divided as to whether the Scottish MPA network would meet their view of a successful network. Three panellists had positive comments for the Scottish MPA network in achieving the view of a successful network. One panellist had a positive view for the process towards designation.

"The process for developing MPAs has been transparent and participatory." ***Panellist 2***

Another panellist was optimistic that arrangements and measures were in place to achieve their view of an overall network. Additionally, one participant related achieving site level objectives for individual features to management.

"Assuming that the appropriate management is put in place and enforced then the individual conservation objectives for discrete features should be achieved at a site level." ***Panellist 5***

However, the majority of concerns, raised by nearly all the panellists, were related to the management of the MPAs, which at the point of survey had not been firmly decided upon. Three panellists suggested that the unclear level, feasibility and/or strength of the proposed management measures would not be enough to achieve either the site level objectives or result in effective MPAs.

"Numerous studies have shown that MPAs are most effective when they are highly protected, but this appears unlikely in Scottish waters". ***Panellist 6***

"I think that the Scottish MPA process doesn't go far enough in terms of making changes in management that will have an effect on success." ***Panellist 3***

Additionally, there were concerns about the overall network design from two panellists relating firstly to the benefit of the network/protected sites to the wider marine environment and secondly to the recovery of species and habitats.

"In my opinion the proposed Scottish MPAs will only partly succeed. This is because it is only targeted at what are considered to be rare and/or vulnerable habitats and species, rather than the ecosystem more generally." ***Panellist 6***

"[T]here is still no clarity about how the features themselves will be managed- i.e. whether buffer zones could enable recovery of the feature beyond its current extent and what the

consequent implications for adaptive management would be should this occur." ***Panellist 2***

There was a concern that the Scottish MPA network primarily protects the healthiest examples of representative biodiversity rather than aiming to recover damaged or degraded sites, resulting in a limited potential to improve health of marine environment to historical baselines. Finally, two panellists felt that fisheries management was a cause for concern.

"[T]hey are not designed with fisheries benefits in mind." ***Panellist 6***

"In some cases, the Scottish Network appears to be taking on the wider [OSPAR] network responsibilities within its own boundaries which may result in an unfair burden of restrictions on Scottish Fishermen (resulting in restricted access to sustainable fisheries)". ***Panellist 1***

It was also stated that further research would be required.

"Further research will be needed to better understand the linkages between some of the activities and pressures and the proposed protected features of the pMPAs in territorial waters." ***Panellist 5***

4.6.2 Role of MPAs in the wider marine environment

Panellists commented on the role that MPAs should have in the wider marine environment, in this context, the marine environment that is not spatially represented within the MPA network. Several panellists made comments that can be categorised under the theme of contributing to a healthy ecosystem greater than the individual MPA site.

Three panellists regarded MPAs as contributing to the wider environment through appropriate use, i.e. MPAs were not seen as appropriate management tools in all circumstances or for all species. One panellist mentioned that MPAs should be viewed within the context of the Scottish Government's 3-pillar approach.

"[MPAs] will not maintain healthy and productive seas in isolation." ***Panellist 5***

Another panellist emphasised the possible wider ecological benefits from the MPA network including: protecting ecological processes that underpin the structure and function of the wider marine environment, refuge for species struggling in non-designated areas, near and off site recovery for benthic communities, protection of movement corridors and protection of critical habitat.

It was agreed by two panellists that MPAs would provide a focus for broader marine policy by drawing attention to marine management issues and discussions and help guide developers and planners. One panellist suggested that this in turn could promote greater awareness and change public/industry perceptions when "interacting" with the marine environment as MPAs are an *"easily communicable management tool"* [Panellist 2].

Two panellists mentioned that in addition to ecological benefits of MPAs, benefits in the wider environment in terms of socioeconomic improvements for a variety of stakeholders should be included. One panellist proposed the concept of spill-over benefits for fisheries and the protection of nursery grounds for fish stocks and non-commercial species.

The use of MPAs as a monitoring tool for the wider environment was proposed by two panellists. One panellist added that this would only succeed if monitoring work was designed to be transferable to the wider environment.

4.6.3 Relating Criteria of Successful MPAs to climate change

This section began to explore what constitutes success of the MPA sites and MPA network in the context of climate change. Overall, panellists had a strong knowledge of the associated impacts of climate change in the marine environment. All panellists expected climate change to impact the Scottish MPA network and listed several effects upon species and habitats.

Whilst one panellist suggested that all species and habitats within the Scottish MPA network will be affected to a greater or lesser degree by climate change, specific examples of climate change impacts were given by other panellists including: distribution changes (the range/extent), changes in ecosystem structure due to altered competitiveness, timing of spring algal bloom affected, increased extreme weather

conditions impacting marine and coastal birds, sea level change affecting salt marsh habitat, thermal boundary change effects and prey availability changes upon marine mammals and the resultant predicted changes in the mix of biodiversity.

There were several comments regarding the uncertainty of climate change impacts in the marine environment.

"It is quite difficult to make predictions without further research and without knowing how greenhouse gas emissions/global climates will change in the future" ***Panellist 6***

"The effects of climate change in the marine environment are not fully understood, clearly not straightforward and is likely to include unforeseen feedback, in particular from ocean acidification and changes in trophic chains" ***Panellist 2***

"It is becoming increasingly clear that the impacts of climate change are complex and species specific and as such the impacts are largely unpredictable. Climate change may exacerbate the effects of other pressures currently viewed as acceptable/not damaging at low levels." ***Panellist 5***

Most panellists agreed that the Scottish MPA network would perform well under climate change if certain aspects worked in practice. The most widely mentioned factor was the ability of the management (as a result of the legislation underpinning the designations recognising climate change) to be adaptable. However, four panellists also provided caveats to success (Table 4.4).

Table 4.4 summarises aspects of the Scottish MPA network proposed by the panellists that will enable the network to perform well under climate change and a summary of those aspects which may lead to poor network performance under climate change.

Table 4.4 Clustered Summary Table: Aspects enabling the network to perform well/poor performance.

Aspects enabling the network to perform well under climate change	
Adaptable	Four panellists mentioned the network being adaptable to cope with the effects of climate change, with mentions of boundary changes, focused action when/where needed, additional designations/de-designations and the underpinning legislation recognising change will occur
Resilience / Reduction of other stressors	Panellist 4 suggested that in the short term MPAs would hopefully build resilience to the effects of climate change.
6 yearly review process	The mechanism for reviewing and resultant adaptation of the network was suggested as an enabling factor by Panellist 4.
Facilitate Monitoring	Panellist 5 commented that MPAs might facilitate monitoring that will enable us to track the effects of climate change.
OSPAR principles	By following these principles Panellist 2 suggested that this would hopefully provide over-arching protection.
Aspects of expected poor network performance under climate change	
Ocean Acidification	Panellist 6 noted ocean acidification would be very difficult to deal with.
Resilience through No-Take Zones	Panellist 3 mentioned that it would be hoped that the network would provide resilience to the effects of climate change, but only if the MPAs are genuinely protected no-take zones.
Cetaceans	Panellist 2 commented that in current network designs there was a failure to account for changes in minke whale and white-beaked dolphin due to inadequate number of sites (covering critical habitat) on the east and west coasts.
Replication	Panellist 2 suggest that having replicate sites would allow adequate buffers for populations using both areas to move both annually to account for stochastic variability in habitat/prey density and long term chronic variation.
Sufficient size	A concern over whether MPAs were of sufficient size was raised by Panellist 2 as current evidence cannot determine minimum “sufficiency”.
6 yearly review process	The adequacy of the six yearly review process was questioned by Panellist 2 if it is interpreted as a six-year monitoring repeat period i.e. nothing will change until the next review (12 years after the current iteration of the network).
Current management regimes	Panellist 2 expected current recommended regimes to perform badly, however, along with other panellist suggested that this would entirely depend on how the management of the network is initially set up and how the Scottish Government plan to review it in light of adaptive management.
Climate Effects too severe	Panellist 5 commented that MPAs cannot prevent impacts of climate change at a specific location and that ultimately if climate effects are too severe the features may fail/die back/shift range or distribution.

4.6.4 Initial explorations of climate change, management and monitoring of MPAs

Panellists were divided as to whether planned management and monitoring (at the point of survey) would account for climate change. One panellist was positive towards the adaptability of the MPAs in the face of climate change.

"There is an acknowledgement that boundaries and other aspects of MPAs may need to change in the future if our knowledge improves on the effects of climate change or the effects of climate change could be in some way mitigated by creating new MPAs." ***Panellist 3***

Two panellists thought that monitoring measures both for the Scottish MPA network and obligations under MSFD were considerate of climate change and offered recommendations for further inclusion.

"Yes- [Scotland] aims to monitor the state and condition of features in sites and at the level of the network as a whole to discern change and then identify possible reasons for change. There is also a power for ministers to take account of climate change in making a decision on MPA designations in territorial waters" ***Panellist 4***

"The monitoring of MPAs could adopt MarClim-style protocols relatively easily (some training requirements etc.) and without significant cost implications. The implementation of MSFD and the development of indicators and targets are taking climate change into account." ***Panellist 5***

However, there were also concerns and comments that during the process of MPA implementation climate change had not been considered.

"No- During stakeholder engagement there seemed to be nil or minimal reference to impacts from climate change. Focus seemed to be on human activities and their associated pressures and impacts." ***Panellist 1***

"[I]t is not clear that the network has been designed with assumptions about specific climate-induced changes in the marine environment…Planned management mechanisms do not appear to take detailed considerations of climate change into account." ***Panellist 2***

"The planned management of MPAs in the Scottish MPA network is being driven by the sensitivity of the proposed protected features to pressures arising from activities known to be taking place within the sites. Climate change scenarios really aren't informing management at this stage." ***Panellist 5***

Two panellists also made more general comments regarding monitoring and management. One panellist was unsure as to the extent that climate change had been actively incorporated into plans, whereas another panellist was advocating for stricter management measures in the face of uncertainty.

"I am not aware of any detailed plans on how the performance of the MPAs will be assessed. Monitoring of the MPAs is mentioned in the guidance documents, but there is nothing on the details or frequency of the monitoring programme." ***Panellist 6***

"It is recognised that there are limitations to the extent that network design/management can mitigate and adapt to climate change, but the main point here is that the presence of a largely unknown threat should lead to stricter planned management measures rather than a potentially de minimis *approach to protection and management which is currently a distinctly possible outcome of the MPA project."* ***Panellist 2***

"Monitoring should certainly take climate change into account, but there is very little planned monitoring work being communicated publicly or to stakeholders who have engaged with the process. ***Panellist 2***

Panellists were further asked to identify factors that they thought would enable or constrain the inclusion of climate change considerations in management and monitoring of the Scottish MPA network Table 4.5.

Table 4.5 Clustered Summary Table: Constraining and enabling factors for the inclusion of climate change considerations in the Scottish MPA network

	Comments	Example Panellist Quotes
Constraints to the inclusion of considerations of climate change		
Resources	One panellist felt that the overriding constraint was a resourcing issue, consequently resulting in some of the other factors (e.g. gaps in scientific knowledge). Additionally, other panellists referred to a lack of resourcing influencing the effectiveness of monitoring Two panellists suggested a possible constraint would be political will with sufficient funding to implement monitoring strategies Cross cutting multiagency approach to monitoring is needed	*"Resources and budgetary climate. This is probably the main overriding factor- with better resourcing of Marine Scotland to commission/direct research, climate change considerations would be easier to factor in." Panellist 2*
Scientific Knowledge	Nearly all the panel specified gaps in scientific knowledge as possible constraints: potential threats to protected features, resilience of protected features, mapping of carbon sinks/blue carbon opportunities, regional impacts for finer scale MPA management plans,	*"Reliable scientific measurement of effects solely attributed to climate change is difficult within a rapidly changing environment."* ***Panellist 3*** *"Knowledge of likely threats to features and their resilience and opportunities from Blue carbon."* ***Panellist 4***
Identification of pragmatic methodologies	Developing agreed methodologies for predicting ecological change that can drive network design Methodologies and design of long term (decadal) sampling programmes	*"Research and survey required to enable climate change effects (across the range of MPA features) to be distinguishable from other pressures. MPAs clearly have a role to play here but would require identification of pragmatic methodologies and design of long term (decadal) sampling programmes with commitment to future funding."* ***Panellist 5***
Areas of contention (identified by researcher)	Refuges/reserves vs. multi-use areas Need for acceptance of the need for better long term stewardship of our marine resources regardless of what features are actually being conserved Action on perceived problem Strength of short term economic considerations when developing network design	*"Some sectors already have significant concerns regarding the potential management consequences of MPAs associated with measures proposed where there is a very clear and well understood "cause and effect" relationship."* ***Panellist 5*** *"The continued valuation of short term economic gain risks the long term economic value which can only be underpinned by a healthier and more resilient marine environment."* ***Panellist 2***

		"Attempting to turn MPAs into refuges/reserves to slow down the effects of climate change just wouldn't be politically acceptable or ecologically justifiable at this time." ***Panellist 5***
Enabling Factors		
Adaptability	Assessment on a semi-regular basis and the ability to adapt the network over time	*"The plans to assess the performance of the MPAs on a semi-regular basis are encouraging, as is the ability to adapt the network over time. This is theory should enable managers to respond to the effects of climate change relatively effectively."* ***Panellist 6***
Scientific knowledge	Scenario mapping; mapping of species known to be vulnerable to climate change; better knowledge of likely threats to features and their resilience; opportunities from blue carbon Better understanding of need/scope/consequences of adopting different approaches to management	
Good communication with stakeholders	Processes like this one to engage relevant stakeholders in the active management and monitoring of the network.	
Design Principles	One panellist listed specific design principles that were enabling outlined by the Commission for Environmental Co-operation[1]	*"Protect species and habitats with crucial ecosystem roles, or those of special conservation concern. Protect carbon sinks. Protect ecological linkages and connectivity pathways for a wide range of species. Protect the full range of biodiversity present in the target biogeographic area."* ***Panellist 2***

[1] Commission for Environmental Cooperation's Scientific Guidelines for Designing Resilient MPA Networks in a Changing Climate

Panellists were asked to suggest practical management and monitoring options that would include considerations of climate change. Table 4.6 and Table 4.7 list the panel suggested management and monitoring options respectively.

Table 4.6 A list of practical management options in the context of climate change suggested by the panel.

Panel suggested practical management options
- Redrawing of boundaries to account for climate change and emerging evidence on ecological connectivity
- Zonal management boundaries for carbon sinks/MPA features
- Reduce other (potentially cumulative) pressures that are impacting on the features negatively impacted by climate change
- Using principles of adaptive management to add examples of healthy features to the conservation objectives of existing MPAs where those features are being adversely affected at other sites (restoring "replication")
- De-selection/Re-selection of certain sites
- Early assessment of possible mitigation options and the feasibility/practicality of implementing them
- Clarity over when the effects are climate related in order to make sensible and robust decisions
- Accepting that the mix of marine biodiversity may change over time- a representative network may need to be adapted to reflect the change

One panellist also suggested that climate change sensitive species may move beyond the protection of the Scottish MPA network.

"At no point should we spend £millions trying to maintain features within the network- either through restoration efforts or repeat MPA identification/de-notification tracking shifts in feature distribution across and out of Scotland's seas." ***Panellist 5***

Table 4.7 A list of practical monitoring options in the context of climate change suggested by the panel.

Panel suggested practical monitoring options
- Significant investment to conduct temporal and spatial biomonitoring surveys
- Survey the ranges of certain indicator species
- Flexible and adaptive to the arrival/presence of new interests (whether possible protected features of other such as invasive non-native species
- Sampling regardless of MPA status or the establishment of a network of reference sites outside MPAs if future funding/sampling have to be tied to the MPA presence
- Using a range of methods including: still camera drops, towed video, baited video surveys, diver surveys for ground trothing and sample collection where necessary and practical, satellite data for physical changes
- Destructive monitoring methods i.e. trawling, should be kept to a minimum but may be necessary in some circumstances
- Communication of monitoring work and celebration of achievements

The panel also recommended several other elements that should be monitored in order to assess whether individual MPAs or the MPA network as a whole was successful. These included: monitoring the full range of species and habitats at a site level, changes both inside and outside the MPAs, components of the ecosystem known/thought to be sensitive to climate change, socioeconomic indicators and physical changes (e.g. sea level rise, temperature).

The monitoring options suggested by the panel highlighted the conflict in monitoring for success and climate change at different spatial and temporal scales (i.e. at a site level vs. at a network level and the need for long term commitments). It was also suggested that the different obligations for monitoring the marine environment could be tackled as part of one programme.

"It is likely that Government agencies will roll its responsibilities for monitoring Natura sites, MSFD targets and the effectiveness of the MPA network into one. However, given the amount of work that has gone into the MPA strand of this work, it would be

regrettable if the MPAs themselves did not receive dedicated monitoring coverage."

Panellist 2

4.7 Round Two

The key themes from Round One that needed further discussion were identified (see Figure 4.2). The Round Two questionnaire was then designed to allow these themes to be further explored.

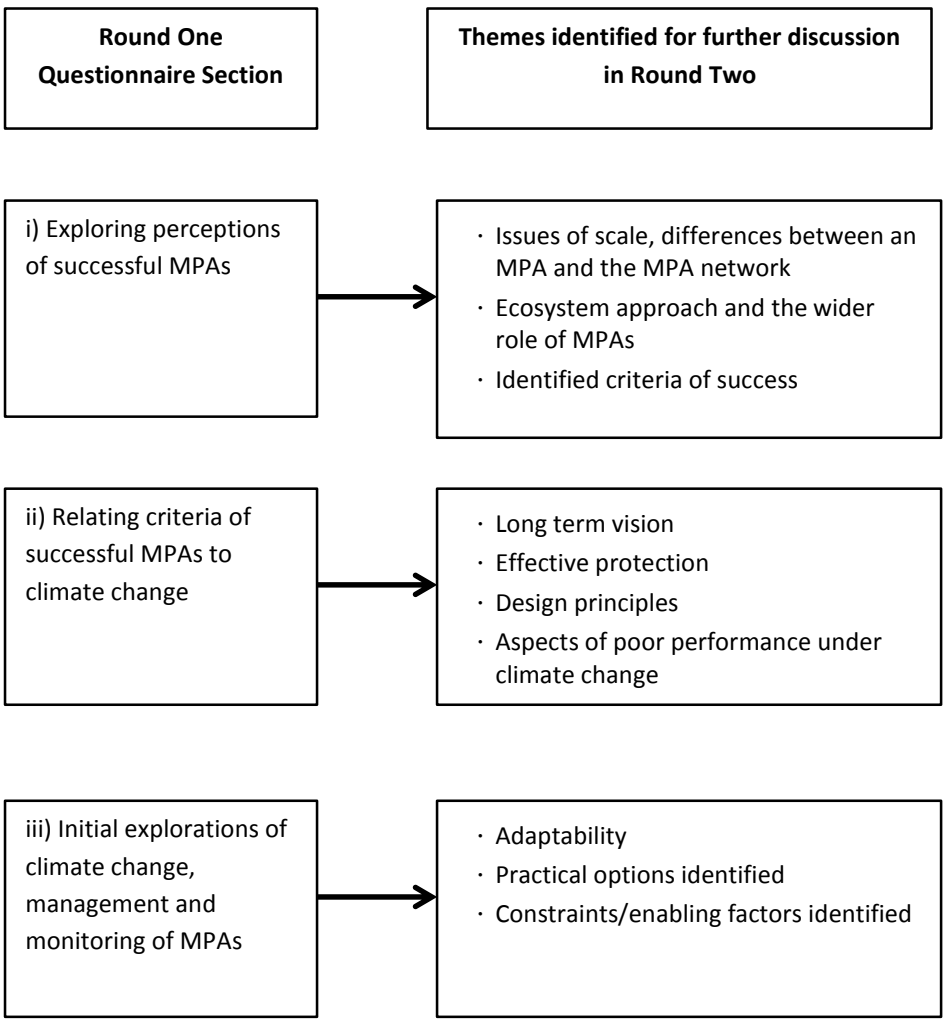

Figure 4.2 Key themes identified in Round One for further discussion in Round Two.

Four panellists responded to the Round Two questionnaire and feedback document giving detailed written responses, completing all questions. The data were analysed as above (see 4.5). Busy schedules and other commitments were major reasons for the non-

response of two panellists (Panellist 3 and 5). Whilst, this resulted in a low panel number and a loss of two perspectives (practitioner/professional and policy maker), the information provided by the remaining four panellists was detailed and illustrated in-depth thinking concerning the feedback (from Round One) and resultant questions. Additionally, there was some overlap in the remaining panellists with the non-respondents in terms of experience and background (i.e. a practitioner/professional and policy maker responded to Round Two). To counter-act the lower response rate of this round further action was taken: i) renewed efforts were made to contact the panellists to encourage them to respond to the questionnaire and subsequent round (as recommended in (Hsu and Sandford 2007b); ii) additional potential participants from the stakeholder map (Appendix B:), having experience and knowledge in the research topic were invited to participate in the Delphi focus group (discussed in Chapter 5). Subsequently, both panellists (3 and 5) confirmed their acceptance of the invitation to attend the focus group with an additional four participants (see Chapter 5).

4.7.1 Further Explorations of Perceptions of Success

In Round One, there was general agreement regarding what constitutes success in the context of the Scottish network. There was general agreement between the panellists, all recognising that the Round One comments from other panellists were “well balanced” [Panellist 1] and “perfectly legitimate” [Panellist 5]. In the second round, the panellists further explored the themes raised in the first round of scale (MPA site vs. the network as a whole) and an ecosystem approach.

One panellist specified that the conservation objectives for MPAs should address wider ecological processes, improving the biodiversity of the designated site but also having wider benefits for the marine environment. Conversely, there was a feeling that the MPAs were designated for specific purposes (to conserve or recover specific species and habitats) and that some panellists were placing too high expectations on what the network could successfully achieve.

“I am disturbed that some participants have high expectations…and, similarly some appear to be expecting measures over and above those that the management handbook suggests are necessary to protect the named features.” ***Panellist 1***

The above comment also illustrates the concern of placing additional management measures, over and above those needed to protect the species and habitats for which the MPAs are designated, to achieve the views of a successful network. However, two panellists suggested that in order to achieve success the MPAs would have to be effectively protected.

"It will be important that there is real management of damaging activities for there to be any real benefit from the designation." ***Panellist 5***

One panellist also specified following the "precautionary principle" [Panellist 2] and using best available science to determine management measures. Additionally, it was suggested further work was needed to define ecological coherence and even a working definition of what is considered an MPA network in the context of the Scottish MPA sites. Panellist 5 also restated the need for clear and realistic objectives, especially in the face of climate change with the understanding that any benefits as a result of the designated MPAs may take some time to become apparent.

"If the conservation objectives of an individual MPA are achieved then it could be argued that the MPA has been successful but you would maybe want to achieve more in terms of helping to increase resilience in the marine environment to climate change and other pressures." ***Panellist 5***

One panellist highlighted the difference between success of a single MPA site and the success of the network, raising the question of how the success of the network may be achieved if there are different objectives at a site and network level.

"The success of a network is a much more difficult concept. What is it that the network needs to achieve over and above the individual parts of the network?" ***Panellist 4***

There was an acknowledgement of the concerns of other panellists regarding the unfair burdens for certain stakeholders and that success should reflect the degree of acceptance by those living around the MPA and those exploiting the MPA.

"Pro-active effort should be made to alleviate short term impacts for any sectors to facilitate long term benefits for the sector and all other stakeholders." ***Panellist 2***

One panellist was more critical of the approach in designing the MPA sites with reference to fisheries.

"[I]t seems unlikely that the MPAs will have significant negative impacts on fisheries, because most of the MPAs will remain open to fishing. On the contrary, the potential benefits that the MPAs could offer to both conservation and fisheries may be limited due to a lack of adequate protection and little focus on potential for fisheries benefits during the design phase." ***Panellist 6***

There was some uncertainty surrounded how the MPA sites/MPA network will be judged as successful and one panellist mentioned the lack of criteria against which to judge success. There was a general concern regarding the ability to determine success, both from the lack of clarity over the definition of success and the resources needed to monitor and understand any changes as a result of the designations.

"Under the current economic situation I have reservations about the abilities of Marine Scotland to monitor the features and determine the success (or otherwise) of any management measures put in place." ***Panellist 1***

Habitat conservation or recovery was considered key, as was wider connectivity with European seas, but there was a concern that it was also unclear how this would be achieved and therefore what this would mean in terms of success. Panellists were in agreement that the MPAs should contribute to the improvement of the wider environment. One panellist went further, suggesting that the MPAs would not be sufficient in isolation and that further clarity was needed as to how the MPAs would achieve wider improvement.

"It is also not clear to what extent the network will be "ecological coherent" given that it doesn't seem to have been designed with that in mind, but rather to protect a series of key (but at times isolated) features and species." ***Panellist 6***

Building upon the comments regarding isolated areas of protection, there was recognition that the MPAs may be limited in having a wider impact.

"The MPAs will act as refugia but unless there is adequate management of damaging activities outside of the MPAs then their wider impact is likely to be limited at best." ***Panellist 5***

One panellist restated the need for equity in management to ensure that the MPAs were fully effective.

"If these MPAs are to be effective it is essential that equity is applied when determining management measures. It would not be appropriate to ban mobile fishing activity on the basis of restoring a sensitive feature or habitat while at the same time allowing another activity such as dredging and burying communication cables, or even allowing high levels of static gear activity when this is at odds with conservation objectives." ***Panellist 1***

Panellist 1 also restated the need to protect features and habitats and species where it is proven that their contribution to the marine environment lies heavily on their distribution in specific areas.

4.7.2 Relating climate impacts to management and monitoring

Panellists made comments categorised under two key themes in this section: the long-term vision needed in a climate change context and the need for effective protection. Two panellists emphasised the need for a long-term commitment to resources and towards building resilience, restating the need for a multi-faceted approach to monitoring and the need for flexibility in management. One panellist was concerned with the approach recommended by other panellists concerning protecting areas for wider ecological processes.

"I tend to agree with the general comments made and on this basis find it hard to accept any suggestions that the MPAs need to be less specifically tied to a designated feature." ***Panellist 1***

It was restated that the MPAs are selected on a feature-based approach and therefore to select a site for another purpose was unjustified. This highlighted the dichotomy in panellists' opinions for a successful network: the protection of specific features and

habitats of conservation interest versus the general improvement of the marine environment as a result of the protection and whether these are mutually achievable.

Additionally, in a climate change context one panellist referred to blue carbon, following a comment made in the previous round.

"The one additional area where MPAs could potentially help is in respect to blue carbon reserves and the potential for those key habitats and species that sequester and store carbon long term to be better protected." ***Panellist 5***

This related to the feature based approach of the Scottish network, in this context protecting key areas linked to "blue carbon" species and habitats would be justified and may help in the face of climate change.

One panellist viewed the approach to commenting on expected aspects of poor network performance as a very negative way to view the issue, stating it was too early to make judgements and unreasonable expectations should not be placed on the network as the MPAs were not specifically designated for climate change and therefore will not be able to solve all the issues.

However, three panellists made comments regarding the applicability of spatial management in the solution of some of the expected aspects of poor performance (summarised in Table 4.8) with recognition that in some cases there may be no positive action available.

Table 4.8 Summary of panellist comments regarding any mitigation or preventative measures regarding aspects of expected poor performance.

Aspects of poor network performance suggested by the panel in Round One	Example panellist comments for any mitigation or avoidance measures
Ocean Acidification	*"Almost impossible to guard against, other than to remove/reduce any other pressures as much as possible through the use of no take zones and water quality control (elimination of pollution). This approach could hopefully increase resilience of species/ecosystems, but its degree of success will depend on the magnitude of change."* ***Panellist 6***
	"Wider seas measures" ***Panellist 2***
No-Take Zones	*"Current indications are that the number of these will be very limited or non-existent. More extensive no-take zones would certainly increase the resilience of the system to climate change."* ***Panellist 6***
	"Support where appropriate within legitimate stakeholder expectations of "presumption of sustainable use"." ***Panellist 2***
Cetaceans	*"Larger connected MPAs"* ***Panellist 2***
	"It may be likely that adaptable management will be required" ***Panellist 1***
Replication	*"Higher levels would be beneficial given that impacts of climate change are likely to be unpredictable and spatially variable."* ***Panellist 6***
	"Appears sufficient across the network." ***Panellist 1***
Sufficient size	*"Larger MPAs would likely generate greater resilience."* ***Panellist 6***
	"I believe the MPAs to be adequate to meet Marine Scotland's aims (or been led to believe)." ***Panellist 1***
6 Yearly Review Process	*"This should be sufficient if monitoring conducted within each 6 year period rather than only once every 6 years (as feared by one panellist)."* ***Panellist 6***
	"This does seem appropriate but may be 2 or 3 reviews before enough information/evidence is available." ***Panellist 1***
Current Management Regimes	*"Have doubts that management will be equitable across marine sectors (users)."* ***Panellist 1***
	"Fisheries management workshops are planned and this may deliver sooner-than-anticipated management." ***Panellist 2***
Climate Change too severe	*"There will be little anyone can do to deal with this if it happens!"* ***Panellist 6***
	"Only wider policy/behavioural change can address. Need to proceed on basis of what might be possible to achieve." ***Panellist 2***

4.7.3 Refining Feasible Management and Monitoring Options

Building on the results of Round One, panellists were invited to further refine the discussion surrounding how climate change could be considered in the management and monitoring of the Scottish network. The results of the previous round suggested there was a need to further explore which options are potentially feasible and which options would be the most desirable.

Overall there was a general feeling that scientific information regarding climate change was limited and there was still a high degree of uncertainty in planned management and monitoring of the Scottish network without considering how climate change might factor into plans. Panellist 2 was also interested to note the divergence of perceptions and highlighted the importance of the research in tackling these issues.

There was a repeated statement of the perceived limited resources for monitoring and management strategies by most panellists, as well as a reiteration of the importance of monitoring to inform adaptive management by which climate change considerations could be incorporated. However, there were also clear recommendations that in light of limited resources, links to other current monitoring programmes, i.e. MCCIP indicator species monitoring, should be reinforced and used to inform the Scottish MPAs.

"I liked the suggestion of one panellist of adopting a Mar-Clim style protocol for monitoring these types of changes." ***Panellist 6***

There was a suggestion that the focus of the process so far had been on the designations, which was understandable, but it was imperative that monitoring strategies accounted for potential climate change effects. However, it was also suggested that the required long term commitment needed in order to distinguish the longer-term effects of (anthropogenic) environmental variation from shorter-term natural environmental variation, seemed unlikely.

In terms of management, one panellist commented that with so much uncertainty it seemed strange to suggest species and habitats for protection from climate change but without supporting the selection by specific management measures.

Panellists were asked to assign a priority score to each of the suggested practical management/monitoring options from Round One (listed in Table 4.9 and Table 4.10 respectively) with a score of 1 (very important), 2 (would like to have) and 3 (lower priority/not feasible). This was intended as an exercise to explore priorities (highlighting areas of potential discussion in the subsequent focus group), but it is noted that this would need much more engagement to generalise beyond the results of the four participants and therefore is not intended as such. The scores were collated and assigned a ranking.

Table 4.9 Summary of mean score, assigned rank of importance and indication of agreement amongst panellists, for each of the management options identified in Round One.

Management Option	**(n)[1]**	**Mean Scores**	**Rank (1 = very important)**	**Indication of agreement (max score-min score)**
Inclusion of emerging evidence	4	1.00	1	0
Zonal management	4	1.25	=2	1
Adaptive Management	4	1.25	=2	1
Reducing Other Stressors	3	1.33	=3	1
Assessment of management options for different impacts	3	1.33	=3	1
Redrawing Boundaries	4	1.50	4	2
Replicating features within existing sites	3	1.67	=5	2
Acceptance of changing mix of biodiversity	3	1.67	=5	1
Assessment of mitigation options	4	1.75	6	2
Additional designations/de-designations	3	2.67	7	1

[1] Some panellists made written comments rather than assign a score for selected options; these are discussed in the text.

One panellist was concerned that this approach was developing management measures ahead of any identified problem.

"My concerns are based on what I have witnessed in the stakeholder process for the MPA network where some groups have looked at the network as a means of achieving

outcomes which were never intended, even attempting to address issues such as gear conflict. Any management option must be based on robustly collected data." ***Panellist 1***

Another panellist linked the management options to the previous discussions, suggested that the priority management options would depend upon the definition of success. Panellist 6 rated all options highly and attempted to identify a couple of slightly lower priority ones.

The management options were ranked most commonly as very important, with "additional designations" selected as least important by most panellists. Interestingly, panellists all agreed that the inclusion of emerging evidence should be a top priority, which would suggest an adaptive approach to management, which was also a highly ranked option, and the need for continued monitoring incorporated into a review process.

The panel did not unanimously agree on any of the options (except the inclusion of emerging evidence). There was higher level of disagreement around the options to redraw boundaries and add additional replication of species and habitats within the network, although these options were seen as an important by some panellists in earlier discussions.

Table 4.10 Summary of mean score, assigned rank of importance and indication of agreement amongst panellists, for each of the management options identified in Round One.

Monitoring Option	(n)[1]	Mean Scores	Rank (1 = very important)	Indication of agreement (max score-min score; 0= all panellists agree)
Reference sites outside MPAs/MPA network	3	1.00	=1	0
Detailed long term monitoring at a few sites	4	1.00	=1	0
Indicator Species	4	1.25	=2	1
Communication of monitoring work	4	1.25	=2	1
Activity levels distribution	4	1.25	=2	1
Societal value and level of support	3	1.33	=3	1
Components of the ecosystem sensitive to climate change	3	1.33	=3	1
Fisheries performance	3	1.33	=3	1
Biomonitoring surveys	4	1.50	=4	1
Range of monitoring techniques used	4	1.50	=4	1
Levels of compliance	3	1.67	5	1
Flexible/Adaptive to new interests	4	1.75	=6	1
Socioeconomic well-being of stakeholders	4	1.75	=6	1
Effects of the removal of certain pressures	4	1.75	=6	2
Physical changes monitoring	4	2.00	7	0
Trawling sampling kept to a minimum	3	2.33	=8	1
Secondary ecological benefits on non-target interests	3	2.33	=8	1
Whole network monitoring	4	2.50	9	1
Monitor the full range of species and habitats	4	3.00	10	0

[1] Some panellists made written comments rather than assign a score for selected options; these are discussed in the text.

Panellist 6 commented that most options were ranked highly, but suggested it was not feasible to monitor all species at all sites and therefore this should be the lowest priority, which was in agreement with all other panellists. However, there was also the recognition for the need for some detailed monitoring for some sites otherwise there would be a danger of not collecting conclusive evidence regarding the effect of either climate change or protection as a result of the MPA.

Interestingly, the option with most agreement was the requirement for reference sites outside MPAs in order to understand the effects of MPA designation. However, Panellist 1 gave a written response of "no" in disagreement with the other panellists.

One panellist gave a written response for the monitoring option of societal value and support.

"Clearly it is difficult to measure support where campaign driven responses (to consultation) are scored higher than sectoral responses on behalf of constituted groups (Federation or association)." ***Panellist 1***

In addition, Panellist 1 also suggested monitoring levels of compliance should be a lower priority where regulations would be applied fully.

4.8 Reflections on the process

The concluding section to Round One invited panellists to comment upon the research process itself; the panellists were asked whether they felt the research process offered any particular benefits, or if they had concerns about the process and more specifically they were invited to comment on the research focus. It was important to establish an understanding of the panellists' expectations of the research in order for the facilitator to manage any expectations or concerns.

Several panellists commented on the relevance of the research with reference to continuing an inclusive process (i.e. Scottish MPA stakeholder led process) to establish the Scottish MPA network and the pressing need to take account of climate change. All the panellists provided their views on the research outcomes and what they hoped would be the result of the research. These included: a better understanding of other

stakeholders' positions and views, practical and applied advice for practitioners and a clearer understanding of how climate change pressures could be taken into consideration in the management and monitoring of the Scottish MPA network.

Two panellists raised concerns about potential outcomes of the research, highlighting the need for the research to be clearly linked to policy and practical action in order to have a useful benefit.

"If [the research] had no impact on the policy direction/design/monitoring of the emerging MPA network in Scotland" ***Panellist 2***

"The benefits of this research would only be seen if suitable monitoring programmes focus on the climate change impacts, as it appears (on the face of it) that current focus is on human activity and their associated pressures and impacts." ***Panellist 1***

Another concern referred to the conclusions of the research; if the research suggested that MPAs were not suitable in the face of climate change, it could negatively impact the Scottish process.

"[C]onclusions of the research might be all is lost and that MPAs may not serve their original stated purpose in 50 years' time. Such conclusions could lend support to calls to stall the process and to go back to the drawing board" ***Panellist 5***

A further concern regarding the research process itself was raised by one panellist, highlighting one of the methodological challenges in using an iterative process.

"If stakeholders did not collectively commit the necessary time/resources to make it a valuable process" ***Panellist 2***

However, two panellists viewed the research process as having the benefit of gathering a wide range of opinions, stakeholder knowledge and input through the use of a novel approach to heading off a potential future problem. Overall, the comments from Round One suggested that the panellists' views were generally favourable.

Panellists' reflections on the research focus and the objectives were presented as feedback in Round Two with the opportunity for additional comment. Two panellists further elaborated on points raised in the previous round. One panellist suggested that it was important for the discussion to remain pragmatic, recognising the limited resources and knowledge gaps.

"The impacts of climate change remain largely unknown for most species and the implications of climate change in the short to medium term should not be judged on the basis of the few sensitive species for which we already have some evidence of change." ***Panellist 4***

Additionally, it was suggested whether or not the research fed into the Scottish MPA project directly, that the first round of the research process had already proven useful.

"I believe this has already been a useful exercise because it has focussed the minds of the participants on a broad range of issues surrounding the MPA network, including but also well beyond climate change effects." ***Panellist 6***

"Hopefully the priorities and strategies discussed will be developed further in the upcoming workshop. If disseminated more widely, the resultant material could prove useful to the development and monitoring of MPAs not only in Scotland, but also further afield." ***Panellist 6***

The above comments suggested that at an early stage, panellists were positive towards using the research process to develop guidance for MPAs in the context of climate change, but recommended that for the research to be useful in a real world sense, the outcomes would have to be clearly communicated and disseminated within the policy environment.

4.9 Discussion

The first round of the Delphi process developed the context for recommendations. The first section of the questionnaire aimed to evaluate the perceptions of a successful MPA/MPA network in a Scottish context. Many of the panellists suggested criteria that echoed the design principles for climate change resilient MPAs (see Brock et al., (2012)).

The need for an assessment of connectivity was highlighted early in the process linking back to concerns raised over connectivity of the network in Chapter 2. Overall there was a general agreement for the abstract criteria of success. However, there was some debate with regard to whether all these criteria could be met and which ones were most important under the definition of success. These issues were further explored in Round Two.

There was also an underlying issue of scale; panellists were divided as to whether by achieving the view of a successful MPA this would in turn lead to achieving a successful network. Most panellists referred to the wider role of MPAs in the marine environment, which led to debate around the use of an ecosystem approach. This element links to the critique of the inclusion of ecological principles in Chapter 2 and to what extent MPAs can contribute to achieving GES in the wider environment.

In Round Two, several panellists revisited the notion that for MPAs to be successful under future scenarios of climate change there was a need for flexibility and adaptation. In Chapter 3 it was highlighted that although adaptive management is needed for climate change resilient MPAs, there are few examples in practice. There was a growing consensus that adaptive management would be important, yet the feasibility of different options would need to be further explored. In tandem with this, the importance of monitoring was raised, once again highlighting the theme of adaptive management, which can be altered in light of results of monitoring trends and responses. This element of the discussion closely followed discussions with international practitioners in Chapter 3. In both chapters (3 and 4) the importance of being able to clearly evaluate the effect of protection and to discern the impacts of climate change has been emphasised.

4.10 Conclusions

This chapter has introduced a flexible and iterative methodology to facilitate the identification and evaluation of incorporating considerations of climate change into the management and monitoring of Scottish MPAs. The Delphi technique was particularly suited to this research due to the complex and sometimes conflicting perceptions involved in an MPA process. Additionally, the high degree of uncertainty when dealing with climate change scenarios and adaptation options made this a particularly suitable method.

It was important to include a range of stakeholders and decision makers in the identification of suitable management and monitoring strategies, such that they may be in a position to implement realistic recommendations as a result of the research. By facilitating a dialogue between technical experts, decision makers and key stakeholders, addressing areas of conflict as well as consensus, the research has been able to focus on identifying priorities important to these groups rather than those assumed in the literature or in a context not directly applicable to the Scottish process. Even in the early stages of this process, the panellists found it a useful exercise for framing the research issues, likely increasing their awareness for management and monitoring of MPAs under climate change scenarios.

The first two rounds developed a series of themes and suggested a series of management and monitoring options that needed to be further explored in the subsequent round. In both rounds there was considerable discussion that echoed discourses of Chapter 3; this is further explored in Chapter 6. The next chapter (Chapter 5) expands on the themes and identified options raised here and explains how they were explored in a focus group format.

Chapter 5 Round Three: A Delphi Focus Group

5.1 Abstract

This chapter presents and assesses the concluding focus group of a Delphi technique used to identify a series of recommendations for the Scottish MPA network in the context of climate change. The Scottish MPA network followed a feature-led approach to identify a series of MPAs across the Scottish marine area and incorporated the diverse views of many different stakeholders. This approach has led to wide ranging opinions and understandings regarding the success of the MPA network. As a result, translating these ideas of success into a management approach in the overarching context of climate change is a complex challenge. In response, the reflective research approach applied throughout this thesis, and the use of a participatory focus group in this chapter, engaged a group of academic and non-academic stakeholders to discuss potential options that could be translated into an operational process for management of the MPA network. This chapter explores the discourse that leads to a final set of recommendations for the Scottish MPA network in the context of climate change. The chapter presents the results of discussion and highlights the production of a management matrix tool which could aid in future decisions for MPA management under scenarios of climate change.

Key Words: climate change, Delphi technique, focus group, management, marine protected area network, Scotland

5.2 Introduction

Chapter 4 introduced and summarised the first two questionnaire rounds of a Delphi process aimed at identifying recommendations for considering climate change in Scotland's MPA process. The results suggested that differing views of success would likely influence opinions regarding required management of MPAs, and in turn, the data requirements to support management action decisions. The growing consensus that adaptive management would be important in a climate change context was further explored in this round through the presentation of scenarios for the MPA designations. This allowed the participants to explore which management options would be feasible and acceptable in the various alternate states.

This chapter presents the final Focus Group Round of the Delphi process. Firstly the methodological considerations of using a focus group as the final round in the Delphi process are discussed. The format of the focus group is outlined in this context and in the influence of the previous rounds. Subsequently, the results of the focus group are presented prior to a more detailed discussion and consideration of the theoretical concepts in Chapter 6. The results of Chapter 4 and 5 provide a sound underpinning for the evolution of the recommendations, which are the focus of Chapter 6.

5.3 Focus group methodology

A focus group brings together a small group of people (usually 5-12 participants) to discuss a particular issue or topic under the direction of a facilitator (Krueger and Casey 2009, Green and Thorogood 2014). The purpose of a focus group is to gather opinions or a range of ideas in an attempt to understand the differences in perspectives and thus can produce a considerable amount of information in a relatively short space of time (Green and Thorogood 2014). The advantage of a focus group over one to one interviews, is access to interaction between participants and therefore can provide insight into the joint construction of knowledge (Bryman 2008, Green and Thorogood 2014). Indeed, the explicit use of group interaction to generate data is what distinguishes focus groups from the broader category of group interviews (Kitzinger and Barbour 1998). Consequently,

focus groups are a widely used technique to simultaneously gather data from more than one participant.

Using focus groups allows the capture of information not readily disclosed in other circumstances, for example, in a direct interview (Krueger and Casey 2009). Participants are able to directly qualify or modify a view in response to other participants' answers. Additionally, a participant may voice agreement or disagreement to a point raised that they previously had not thought of in the absence of other opinions (Bryman 2008). The challenging of each other's views, which rarely happens in conventional one to one interviewing, has the advantage of providing a realistic account of what and how people think as they are forced to review and account for their views, and possibly revise their opinions (Bryman 2008). Therefore, focus groups can be a great complimentary technique to a Delphi process of which the feedback process is such an integral part.

The aim of a focus group is to create a comfortable, permissive environment in which participants will give their opinions without judgement (Krueger and Casey 2009). The facilitator is expected to guide the session, but not be too intrusive (or too structured) as to allow the extraction of views and perspectives from the group (Bryman 2008). A facilitator should have a fairly small number of very general questions to guide the focus group session, allowing participants to bring forward issues relevant to the topic that they deem important and significant (Bryman 2008). It may be necessary for the facilitator to refocus attention onto the topic. However, this should be done with care as digressions can yield interesting information. Additionally the facilitator may direct focus to points of interest to the research questions, but not noted by the participants (Bryman 2008). Overall, a well-facilitated focus group should have the feel of an everyday discussion where dialogue is both welcomed and encouraged (Kitzinger 1995).

The choice of a facilitator is an important aspect of focus group organisation. The role of the facilitator is two-fold: allowing for a natural discussion that flows freely and enables participants to assign importance to the areas of the topic under discussion, whilst also intervening to highlight salient points, particularly ones the participants themselves may have missed (Bryman 2008).

A focus group can act as part of the process by which views are produced, rather than just collecting pre-existing opinions and ideas (Green and Thorogood 2014). This is a particular advantage if the focus group is used as a participatory process, jointly developing participants' knowledge and understanding of an issue (Bryman 2008, Green and

Thorogood 2014). A focus group is also appropriate for capturing differences in perspectives (Krueger and Casey 2009), generating ideas and testing policy (Robinson 1999).

5.3.1 Limitations of focus groups

Focus groups are not appropriate in all situations, for example, circumstances where the use of them can cause discomfort amongst the participants (Bryman 2008) or for research questions that require detailed narratives (Green and Thorogood 2014). Whilst focus groups have considerable potential, there are also limitations to using the method (Table 5.1).

Table 5.1 Criticisms and limitations of using focus groups and ways in which these are minimised and/or avoided.

Limitation/Criticism	Mechanism to minimise avoid limitations
Can produce trivial results when the topic is too complicated or the group is too large (Krueger and Casey 2009)	Group size should be restricted, between 4 and 10 participants is common (see Bryman 2008)
Dominant individuals can influence results (Krueger and Casey 2009) and can limit the expression or elaboration of less acceptable opinions or the views of those lower in the hierarchy (Smithson 2000, Green and Thorogood 2014)	A skilful moderator can minimise the risk of dominating individuals and turn into it a beneficial learning process. A critical role of the moderator is to allow participants to reflect on the various arguments without pressure (Krueger and Casey 2009)
There is less control over proceedings than in an individual interview (Kitzinger and Barbour 1998, Bryman 2008)	Less control is not seen as a disadvantage in this context as it allows greater opportunity for research participants to have ownership of the interview and research process (Green and Thorogood 2014) in line with the participatory approach selected for this research
Can be difficult to organise, there is the risk of participants that agree to attend but do not show on the day (Bryman 2008)	Over recruit where possible (Bryman 2008). Additionally where appropriate, ensure all participants are fully engaged with the research process
Data are difficult to analyse (Robinson 1999, Landeta et al. 2011)	Develop a strategy of analysis that is systematic (Robinson 1999)

5.3.2 Use of Focus Group methodology in the Delphi Approach

The Delphi technique allows for flexibility in the format and design, and this often depends on the study aims and objectives (Keeney et al. 2006). A modification of the

Delphi technique is to use a face-to-face meeting for part of the process. A drawback to the use of a completely anonymous Delphi approach is the lack of accountability (as discussed in the previous chapter). This can be countered by the use of a face-to-face meeting as one of the rounds of the Delphi process. Another methodological problem that can be minimised through the use of a focus group is the drop out between Delphi rounds as it if often difficult to maintain high panellist motivation without face to face contact (Keeney et al. 2006). The use of a focus group or concluding workshop is an accepted adaptation of the Delphi technique (Kitzinger and Barbour 1998). For example, as part of an expert panel driven process to identify deep sea ecosystem services (see Jobstvogt et al., (2014)) or as a concluding meeting after two initial Delphi rounds (e.g. Jones et al. 1992).

The use of a focus group was particularly suitable for this research as it provided the panellists an opportunity for face to face interaction, encouraging motivation to remain engaged in the process. Arguably the majority of the panellists had an adequate history of communication through the Scottish MPA process stakeholder workshops, thereby avoiding any potential discomfort and conflict. Additionally, the use of the focus group further complemented the Delphi technique by emphasising the synergy of a group for producing ideas over and above individual contributions (Krueger and Casey 2009).

5.3.3 Attendees

As with the Delphi technique, focus group participants can be purposefully selected because they have particular knowledge or experience that are helpful in addressing the research aims, or are part of a "naturally occurring group" (for example, work colleagues) (Kitzinger 1995). Smaller groups are used when topics are controversial, complex or where the participants are likely to have a large amount to say on the research topic (Morgan 1996). Larger groups lend themselves to numerous brief suggestions where participants may have little involvement with the subject matter and consequently discussion may be hard to stimulate (Bryman 2008).

A total of 17 potential participants were invited to the third round Delphi focus group. These participants were selected from the stakeholder map (as described in Chapter 4; 6.7ReferencesAppendix B:) of possible Delphi participants. Although it is unusual to

include participants who have not been part of previous Delphi rounds, there are precedents for it; Lemieux and Scott, (2011) used a two panel Delphi process whereby an initial expert panel identified a series of climate change adaptation options for terrestrial protected areas and a senior expert panel then evaluated the feasibility of the options. Additionally Jobstvogt et al., (2014) conducted a Delphi study in which additional participants were invited to a workshop to discuss deep sea ecosystem principles.

It was decided that the advantages of including additional participants would outweigh any disadvantages, an advantage of new perspectives on a complex issue versus the possible disadvantage of new participants not being as familiar with the material. As the new participants were drawn from the stakeholder map, most were part of a "naturally occurring" group, already acquainted through MPA stakeholder workshops and other work related networks. Therefore many of the participants might normally discuss the issues raised in this research with each other.

A focus group consisting of approximately 10 participants was aimed for, which would allow all participants to have the opportunity to share insights, yet be large enough to provide a diversity of perceptions. The composition of the panel of focus group attendees is presented in the results section 5.4.

5.3.4 Format of the Focus Group

The one-day focus group was arranged into four sections stemming from key questions and key themes emerging from the previous rounds: success for the Scottish MPA network, monitoring considerations, management options under scenarios of change (discussed below in section 5.3.4.2), and a summary and forecasting session.

The aims of the focus group (Round Three) were:

- to give participants the opportunity to reflect on the results of the previous questionnaire rounds
- to further elucidate the different opinions regarding success for the MPA network
- to identify monitoring resources and considerations for the Scottish MPA network specific to climate change

- to identify management actions at a site and network level for MPAs under varying scenarios of change
- to give participants the opportunity to reflect on the research and the research process

Each of the four sections was followed by a brief oral summary by each group; a spokesperson was nominated and presented a verbal summary of the key areas of discussion to the rest of the focus group. This summary synthesised and confirmed themes the participants felt were significant, participants from the nominated group were asked to verify or amend any details upon hearing the summary to ensure the main areas of interest were reported (Kitzinger and Barbour 1998).

Prior to the focus group all invited participants were emailed an itinerary for the day. At the focus group participants were given an introductory presentation by the researcher, which presented the above aims, gave background material to the project and summarised the previous rounds, format of the session and issues of confidentiality. The focus group was held in a neutral location, travel expenses were reimbursed, refreshments were provided to create a social and friendly environment (as recommended in Kitzinger & Barbour (1998)).

Participants were divided into two sub-groups of five people, making for a more easily manageable discussion (as discussed in 5.3.3). The division of participants took into consideration the different perspectives that participants were likely to have on an issue depending upon their background or current job role. The bringing together of shared experience could be productive, yet the different perspectives between participants may also be illuminating (Kitzinger 1994).

Each session took approximately 60 minutes and followed a few key prompts provided by the facilitators (see 6.7ReferencesAppendix E:). This focused participants upon a particular topic yet enabled the participants to lead the discussion themselves around their understanding of the issues. At the conclusion of the focus group, a closing statement was made that summarised the salient issues of the focus group as presented by the participants, and thanked everyone for their attendance.

Facilitators with adequate background knowledge, appropriate experience and sensitivity were selected in order to be able to place comments in perspective, follow up on critical areas of concern, and redirect discussion when appropriate. A topic guide was used to guide the discussion in a natural and logical sequence, yet, the focus was to allow participants to discuss issues they deemed important and allow for spontaneity of response. The facilitators listened carefully to participants, observed how they answered and sought clarification or further explanation of responses that were ambiguous or unclear. At the conclusion of the focus group, the facilitators were debriefed to provide an additional level of verification. The researcher remained as a non-participant observer throughout the focus group discussions.

5.3.4.1 *Ethical Considerations*

This focus group was guided by the ethical principles on non-clinical research using human participants set out by the College of Medical, Veterinary and Life Sciences, University of Glasgow. All participants received written information regarding their participation, outlining the nature of the project, how the data was to be used and details of an independent contact within the University. All participants were given the option of confidentiality in written reports and all participants provided informed consent for this study. Participants were informed that they could withdraw at any time for any reason and have their contributions removed from the project if they so wished. Ethical approval was sought and granted by the University of Glasgow for this study.

5.3.4.2 *Development of the management matrix*

The discussion identifying management options in Round One and the discussion of the feasibility of these options in Round Two allowed the researcher to reframe the results into a matrix of high-level management actions in combination with possible climate change scenarios (6.7ReferencesAppendix F:Appendix E:). In order to further develop the discussions regarding feasible management options, recognising the feature-based approach to designation of the Scottish MPAs, the panellists were presented with a series of feature-based scenarios whereby the abundance or presence of the feature changed. The purpose of presenting this matrix of scenarios was to discuss which possible

management actions were available and under which circumstances these were acceptable and feasible. The matrix focused on the high level options suggested by participants in previous rounds, rather than specific management relating to activities (e.g. types of gear restriction).

5.3.5 Data Collection and Analysis

All of the focus group sessions were recorded using an audio recorder and field notes were written by the researcher during and after the focus group recording general impressions to improve reliability of the study. Additional field notes collected by the two facilitators, and the flip charts produced by the participants during each topic session were also reviewed and used in the analysis process, providing a triangulation of data capture methods to ensure validity, rigour and reliability in capturing all participants' views. All sessions were transcribed in full by the researcher and checked for accuracy. To aid transcription and identification of individual speakers, the researcher observed and recorded the sequence of speakers at the beginning of the focus group session. The sessions were fully transcribed using QSR International NVivo software (QSR International Pty Ltd 2010) which facilitated organisation, coding and retrieval of the data (Bazeley and Jackson 2013).

Focus groups can generate a large amount of data (Bryman 2008, Green and Thorogood 2014). A systematic, sequential, verifiable and continuous approach to data analysis (as recommended in Miles & Huberman (1994) ensured any bias was minimised and ensured confidence that the findings are an accurate reflection of the focus group participants. An inductive coding strategy (as described in Chapter 3: Section 3.3.3) was used to ensure that the codes developed remained closely related to the data. Although this was not a "grounded theory" study, the use of "open coding" to generate codes and categories in the analysis provided a rich, in-depth and grounded account of the data. The results were interpreted by relating the categories to the research questions and theoretical ideas underpinning the research. Coding frameworks for each workshop session are available in Appendix E:. Matrices were generated from these data to reflect trends, comparisons and contrasts. Analytical memos were written throughout the analysis, which allowed the researcher to document emerging relationships and comparisons with the wider

literature (Green and Thorogood 2014) which are discussed in the following chapter (Chapter 6).

Care was taken throughout the analysis to situate utterances by individual participants within the interactive contexts by which they were produced (as recommended by Green & Thorogood 2014; Kitzinger & Barbour 1998). In this manner, it is important that the group rather than the individual remains the unit of analysis (McLafferty 2000) reflecting the process by the group reaches consensus and/or established positions through social interaction and group learning. Additionally it is recommended that focus groups should be analysed as discussions occurring in a specific, controlled setting (Smithson 2000).

Whilst focus groups are not used for decision making, the outputs of a focus group can be used to inform the decision making process by providing a researcher/decision maker with a deeper understanding of a topic to inform choices (Krueger and Casey 2009).

5.4 Results

The focus group was attended by 10 participants (**Error! Reference source not found.**) seven of whom had provided input into the preceding questionnaires. Although the representative from Marine Scotland had confirmed their attendance previously (see section 4.7), they were not able to attend on the day, but requested they be kept informed of the research progress. The results are presented as follows: for each section, key themes are presented, illustrative quotes are given with contextualised comments from the researcher and material is presented in analytical matrices.

Table 5.2 Participants of the Focus Group

Sub-Focus Group	Participant Number	Organisation
1	1	Royal Society for the Protection of Birds (RSPB)
1	2	Scottish Fishermen's Federation (SFF)
1	3*	Visit Scotland
1	4	Marine Conservation Society (MCS)
1	5*	Sniffer[1]
2	6	British Sub Aqua Club (BSAC)
2	7	RSPB
2	8	Scottish Natural Heritage (SNH)
2	9*	Academic
2	10	Academic

*Participant did not have input into previous Delphi rounds
[1] Sniffer: A registered charity delivering knowledge-based solutions to resilience and sustainability issues

5.4.1 Success of the MPA network

The first session, aiming to further explore success for the Scottish MPA network in the context of climate change, framed the discussion for rest of the focus group. How this session influenced the subsequent sessions is described throughout this chapter.

Elements of the discussion could be categorised into two categories (by the researcher), factors that would lead to success and the criteria that would indicate success had been achieved (Table 5.3). More discussion time was spent on the biological aspects of success, this is possibly due to a number of reasons: perhaps because panellists weighted biological aspects more important than the other aspects and accordingly afforded them more time; the biological aspects were more unclear and therefore required more discussion to establish opinions; the biological aspects were more closely related to the key objective for the network and therefore the underlying conceptual elements were explored in more depth. Discussion surrounding the socioeconomic aspects was much shorter; there was a general agreement on the criteria for socioeconomic success but an underlying conflict was apparent (discussed further in section 5.4.1.3).

Table 5.3 Conceptually Clustered Matrix: analytical codes concerning factors that lead to and criteria that indicate success

	Policy and MPA process	**Biological**	**Socioeconomic**
Factors Leading to Success	- Adaptive - Recognition of dynamism in the marine environment - Clear objectives - Any "failures" accounted for - Cross agency/department co-operation - Using best available scientific advice - Connection to land based measures - Integration with other marine legislation/wider seas measures - Establishing good management techniques - Successful interaction between stakeholders, decision makers and managers - Network review -Strong monitoring framework	- Biodiverse, healthy areas - Recognition of dynamism in the marine environment - Scientific knowledge to support measures of diversity and resilience - Connectivity (recognition) - Vulnerability assessment - Effective protection	- Engagement with the process - Stakeholders support the network - Education - Resources available to engage with the process - Collective decision making - Clear justification for sites
Criteria Indicating Success	- Meets conservation objectives - Clear objectives - Network review - Strong monitoring framework - Strong available evidence	- Areas can withstand use - Areas free from disturbance - Enhanced ecosystem health - Resilience - Connectivity (Functions as a network) - No negative biological effects of activity displacement - Ecosystem services are maintained - Sensitive/declining features/important life history areas/smaller proportions of every habitat protected - Suite of biodiversity protected - Features have increased in extent/recovered/are maintained	- Sustainable use - Productive environment that provides for various industries/activities/uses - Ownership, Pride, Stewardship - Culture of compliance - Equality use/constraint amongst stakeholders - Stakeholders support the network - No negative socioeconomic effects of displacement - Ecosystem services are maintained - Increased awareness - Engagement with the process - Enhancement of economic activity where appropriate

5.4.1.1 *Wider marine environment*

Throughout the session, numerous statements related to an overarching theme of wider ecosystem processes, and it was evident that this theme had rich conceptual links that addressed issues of MPA design, management and monitoring and more abstract concepts of valuing marine biodiversity. The importance of considering the wider marine environment with regards to success was summarised by the participants:

"So the overriding conclusion for the things being said around the table is what constitutes success for the network, the network provides wider ecosystem benefits." Participant 7

The provision of wider ecosystem benefits was collectively seen as a critical element of success for the MPA network. Closely related to ecosystem benefits was the notion of biodiversity underpinning marine health, with one participant referring to the protection of diverse benthic habitats:

"I often talk about the Sound of Canna MPA, the Small Isles MPA …it's a really important basking shark hotspot. And I think that part of that is that we have this important diverse and benthic habitat beneath which must be sending up all sorts of plantonic and larval stage features which they are feeding on. And that's sort of within a site, wider benefit is being provided there at the moment." Participant 7

A productive view of the marine environment was shared amongst the participants, and although not specifically stated in terms of the "spill-over" concept, the discussion of productivity was couched in terms of protected sites within the network replenishing both each other and the wider environment.

"But what is a network? Is it a set of sites or should they all be supporting each other, should the propagules be providing recruits for the next? That's certainly not how it's been devised." Participant 8

There was an agreement that the network should be "*greater than the sum of its parts"* [Participant 9]. However, there was a concern that the network had not been designed to consider connectivity, and therefore, it was worried that success in terms of realising

wider ecosystem health may not be accomplished. Interestingly, this area of discussion was deeply explored by participants. There was a recognition that enhancing ecosystem health would be important given the additional stress that climate change would likely have on the marine environment. Conversely, it was cautioned that the network should not just keep the "status quo" by protecting residual populations.

"From our perspective it's quite important that it doesn't just keep the status quo, it helps improve ecosystem health. There is a huge decision to be had about that." Participant 4

Additionally, this concept of "status quo" was further developed through ideas of dynamism in the marine environment, recognising that features may change in the face of climate change. Linking to dynamism, the concept of resilience stemming from protection was mentioned. Resilience was explicitly linked to the wider ecosystem by the participants and for resilience to occur, it was suggested that certain management techniques may be required. It was also noted that it would not be possible to protect MPAs from sea temperature changes, as these wider processes would not recognise the smaller scale boundaries of MPAs. Temporal scale was also mentioned in terms of recognising success of the network may be long term and therefore there was a danger of judging success too early.

Overall participants held strong opinions generally supporting the view that wider ecosystem processes were important to success. However, there was an underlying fragmentation of agreement over the extent to which the MPA network and management measures should accommodate this wider ecosystem view. These were closely linked to participants' views for the fundamental objective of the network. Industry concerns over the level of responsibility in Scottish waters were highlighted:

"So it's a balance in ensuring that the wider network is considered and from my perspective, the industry perspective, we're not taking on more than our share if you like. Does it fit into the network, or is that just somebody's guess? I'm not convinced, I don't mean the case, I can understand the need for it, but has it been really widely considered what the aim is and the joint network European science if you like, particularly the MPAs as opposed to SACs." Participant 2

Whilst the industry view was that Scotland should not take on more responsibility as this would be unfair to Scottish stakeholders, other participants thought the network scale should be more flexible, even perhaps more ambitious. There was some discussion over defining a "network", be it at a national, UK, EU or even an even larger scale. This relates to the requirement to report on European measures of success, for example Good Environmental Status (GES), which is not currently defined on a network scale. This conflict was also further evident in an industry view for spatially managing features that are not "fixed" [Participant 2]:

"I get slightly concerned when people look at the areas that have been protected or set aside to enhance wider protection of the environment. It has to be justified." *Participant 2*

This industry view tied very closely to the feature based approach for the network, the presence or absence data of species or habitat, being more easily defensible to a non-scientific audience or to a legal challenge. Additionally, the above comment also appears to contradict with the aim of the original vision for the MPA network (see Chapter 2). A linked concept was the protection of mobile species, and the protection of seabirds, which participants (particularly participants 2, 4 and 7) felt arguably needed a consideration of wider ecosystem protection. Participants highlighted the integration of the MPAs with wider planning to ensure the sites were not isolated islands of protection. This area of debate highlights the conflict of expectations for what can be achieved through spatial management. There seemed to be a presumption, particularly amongst the participants closely aligned with conservation interests that commercial fisheries and other stakeholders would receive secondary benefits (e.g. improved fisheries) through ensuring that wider marine health was enhanced through the MPA network. However, the design of the Scottish MPA network specifically did not include spill-over or fisheries enhancement in the criteria for selection (Scottish Government 2011b).

5.4.1.2 *Objectives under a feature based approach*

A portion of the discussion centred on the influence of a feature based approach on the achievement of success. Some participants highlighted that if success is judged upon the state of feature, then the success of an MPA site is dependent upon the state of that

feature. It was further stated that under climate change scenarios or alternate scenarios of decline, whereby a feature declines or possibly entirely disappears from a site, then the site might be viewed as failure. However, even in the presence of a single feature decline, the overall biodiversity or health of the site may improve, and therefore there may still be "value" to the site. This thinking conceptually links to issues of the specificity of MPA objectives, and the umbrella issue of how we "value" marine biodiversity. Under the current legislative framework, even an MPA that was high in biodiversity and contributing to wider ecosystem health would not be fulfilling its conservation objective and be considered successful if the original feature for which it was designated was no longer present.

The link between site level objectives and network level objectives was discussed. It was seen as theoretically possible that if you achieve site level objectives you would achieve network level objectives. However, one participant highlighted the difference between "bureaucratic" success and the wider view of success that was being discussed in the focus group.

There was a concern that the feature based approach had not allowed for the consideration of larger scale processes such as climate change:

“They were chosen on the basis of identifying key features, a list of key features which were not considered in terms of their vulnerability to climate change at all.” Participant 8

The implications of climate change for achieving GES at a site level were further discussed. On an individual MPA level, it was felt that a site might not succeed in the face of climate change; however, the network itself would ideally be resilient to climate change. Linking to concept of failure at a site level, the idea that species could decline over a network level was also stated.

“[I]f there are continued seabird declines for example, that shouldn’t be seen when we come to measure the success of the network, as a failure of the network because there might be climate change at play over and above being able to spatially protect areas important for seabirds”. Participant 4

It was evident that there was a conflict between feature level objectives, wider pressures, and wider ecosystem views for success. Participant 1 stated that some PMFs are themselves supposed to be representative of the wider environment. It was seen as perhaps easier to work at the scale of individual MPAs or indeed feature level species and habitats in terms of peoples' perceptions for success. Interestingly, this statement contradicted with the overall consensus (with the notable exceptions discussed throughout this chapter) towards wider ecosystem values as integral to perceptions of success.

As "recovery" was one of the two possible feature level objectives for the Scottish network, participants dedicated some time to discussing recovery in the context of climate change. There was a restating of ideas concerning resilience, and the need to ensure species and habitats had the best possible chance under climate change stressors. The concept of recovery links to the previously mentioned concepts of dynamism in the marine environment and enhancement of the wider ecosystem.

"[T]here is a bit of tension there between recognising that we need to meet conservation objectives for feature and a site might have different populations of different features with different objectives within a boundary and recognising that there's a question mark over whether meeting those conservation objectives would contribute wider enhancement." Participant 4

Participants highlighted areas of contention, with spatial scale being a large factor in determining what would constitute success. A fundamental conflict appeared to be the entrenched views for the marine environment being based either in use or conservation.

"I'm not entirely convinced that all these things are compatible with the conservation want or need without some economic impacts on the fishing industry and on other stakeholders." Participant 1

This area of discussion linked strongly back to the beginning of a division in Round Two as to what constitutes success, which became more pronounced in this session. It also conceptually links to the need for clear objectives throughout an MPA process.

5.4.1.3 *Conflict between use and conservation*

Underlying all the discussion there seemed to be a fundamental conflict between an objective of sustainable use and one of conservation for the MPAs (progressing from Round Two). Whilst the notion of sustainable use was a positive and acceptable one for all of the participants, as the discussion progressed further, the division between two polarised views became more apparent. Those in favour of stricter management measures seemed to characterise a more protectionist approach. Conversely the view for a marine environment that could also be utilised could be illustrated by the suggestion that it may be possible to identify areas that could withstand certain types of pressure. These two ideas link again to fundamental discussions of value and the concept of whether shorter-term economic success will be at the cost of long-term biological success.

However, Participant 2 did not disagree outright with limiting access for the fishing industry, but emphasised that the principle of equity was important; restating from Round One, if one damaging activity is restricted, then similar activities should also be restricted. The removal of pressures was also linked to general concerns for management, and also public perceptions regarding management actions and MPAs:

"This is why MPAs have become so well entrenched within international and national policies because when people think about them they think about a no-take zone and those kinds of levels. And in that way it's quite an easy thing to think about because instead of having to establish what is natural you're establishing the removal of an impact. Unfortunately when it comes to the actual implementation stages of that, we then hit all the complicated decisions…[W]e're a victim of having had a simple solution proposed at such high policy levels." Participant 8

There was a concern that the forthcoming management measures for the MPAs were going to be "light touch" and consequently not enough to achieve the expected view of success. Additionally, participants noted a tension between having management measures for different features, and the complexity this might cause. However, the concept of adaptive management, using the network to learn about different management regimes supported by a monitoring programme was also mentioned.

Critically, the notion of balance was referred to, in that fisheries, aquaculture, tourism and other uses, would suffer in the absence of a healthy marine environment. Participants also discussed recovery, and the need to move beyond the "status quo" and enhance the marine environment to ensure use could continue. Interestingly, this links to the concept of Least Damaged/More Natural (discussed in Chapter 2) and discussions of what we consider natural, for example, the suggestion by one participant that natural is "free from disturbance" [Participant 6].

5.4.2 Monitoring

The discussion in this session evolved from recommendations of monitoring options (Round One and Two) to a more sophisticated and deeper consideration of the conceptual issues of incorporating climate change considerations into a monitoring framework. It is interesting to note how the preceding discussion, regarding what would constitute success, influenced the discussion of monitoring. A clear linkage between the sessions could be identified; without a clear resolution for what success would look like, it was unclear would what need to be monitored in order to identify success. It was possible to identify (researcher identified) four main conceptual categories that aspects of monitoring could fall under (Table 5.4).

Table 5.4 Conceptually Clustered Matrix: analytical codes concerning aspects of monitoring grouped under the researcher defined category of monitoring. The analytical codes in italics are present in more than one category as illustrated below.

MPA Monitoring	**Climate Change Monitoring**
• Trend data for species and habitats (biological aspects e.g.: population/abundance) • Site condition • Achievement of conservation objectives • Recovery	• Gradient of sites • Indicator species • Invasive species • Physical aspects data (e.g. temperature)
Inshore vs. offshore sites	*Reference Sites*
Wider Marine Health	**Sustainable Use/Multi-use management**
• Ecosystem function • Network monitoring vs. site monitoring	• Activity/Pressure monitoring • Adaptive management

The categories largely consisted of the following: "what" would need to be monitored in order to fulfil the Scottish MPA network obligations at a site level; monitoring requirements and practicalities at a network scale; the influence of climate change on monitoring; and additionally, if success means allowing for sustainable use, how should monitoring account for activity within or around the MPA.

In terms of individual MPA or site monitoring, the expectation to report on the effectiveness and quality of each MPA was raised by participants. This relates to obligations at a national, UK and EU level. The expectation to report on the conservation objectives of either conserve or recover (see Chapter 2) was related to concepts of success (from session 1), and whether these objectives accurately reflected the effectiveness and quality of each MPA. However, participants stated, in practice there would have to be a discussion as to what merited the achievement of the objectives, recognising the dynamism of the environment in "maintaining" a feature, and perhaps the need for a qualitative discussion to define recovery for features, before deciding what data would be required.

"There will be an expectation to report on the success of the individual sites. So you can't do that by monitoring one site in Shetland and deciding that reflects the

success of all the other sites in Scotland. But if you're wanting to monitor for climate change then I think yes you could or the impacts of climate change then I think you could select a subset of sites." Participant 8

There was a concern that unless success could be clearly measured and communicated, there would be opposition for the MPAs and limited justification for their continued presence. This concern conceptually links to the concept of "burden of proof", and whether this leaned either towards wanting to remove or retain the MPAs, i.e. would evidence of failure or success be needed respectively. An additional consideration would be what would happen in the circumstance of no data to inform either scenario.

"[T]he big question is how to monitor the sites because we can't do everything, everywhere, and there's a real risk of losing support for the MPAs and the network, if we don't have at least some very well studied sites where you can actually demonstrate an effect either way in a scientifically robust fashion." Participant 10

Spatial scale was seen to influence monitoring considerations, with the link between site and network level discussed. There was a restating of the question, that if success at a site level was achieved, did this mean the network, as a whole, was successful which remained unresolved between the participants. The uneasy consensus (recognising the underlying conflict as discussed in section 5.4.1.1) that wider environmental health and processes would need to be considered influenced the discussion of what would you need to monitor in order to understand success:

Participant 7: "Just to get back on the biological would you only monitor the protected features because we were talking earlier about ecosystem benefit and ecosystem function. Would you come up with some metric?"

Participant 8: "I think we would have to find ways of translating that specific monitoring into ecosystem function."

Participants were collectively aware of the complexity involved in monitoring the ecosystem at large, and jointly produced a distinction between the success "ideal" of wider ecosystem health and the practical realisation of this ideal in terms of monitoring.

Temporal scale was also an influencing factor, with an acknowledgment that it may take years to perceive success, and the dedicated resources this may require. This fed into discussions specifically involving monitoring climate change. Participants discussed the additional monitoring requirements in order to consider climate change, and also suggested the use of Research and Demonstration MPAs (See Chapter 2) to monitor for climate change impacts.

An emerging theme from Round Two related to the data requirements for understanding success was the concept of fully protected reference sites or control areas. In this round, reference (control) sites were linked to the four researcher identified conceptually clustered categories of monitoring. Control sites were considered by the group for a variety of reasons: monitoring sites that are not protected from activities to determine what impact the MPA management is having; further determination of causality of changes e.g. a management action/protection/wider environmental health or a larger scale impact such as climate change; and in the case of areas that are used, a fully protected area would needed to be compared against. However, it was recognised that it would be very hard or near to impossible to find comparable sites. It was suggested that scientifically you could argue for the use of control sites but that some sites are not or cannot be duplicated.

By stating the above reasons for the use of reference areas, participants were confronted with the concept of an ever-increasing monitoring load. Discussion moved into practical options, whilst still recognising the limitations of what will be possible with finite resources, but with an acknowledgment of several feasible actions. A pragmatic use of existing resources and data was discussed, particularly in reference to the use of citizen science. However, there were some concerns over data quality and management with this approach.

Whilst participants appreciated the number of components to monitoring, all of the participants agreed with a concern about a lack of detail regarding the overall monitoring strategy and the view that, *"[t]he task at hand is monumental"* [Participant 10] was universally shared.

Subsequently the summary thoughts for this session were firstly, how would you use MPAs to monitor for climate change and how would you monitor whether climate change is having an impact on your MPAs. Additionally, there was the question of identifying whether the MPAs provide resilience to climate change.

5.4.3 Management

Building on the previous sessions, it was apparent that different views of success were influencing the views over the management required to achieve that view of success and although participants were seen to compromise without overtly disagreeing, it seemed there were two inherently differently perspectives of what effective management would look like. In addition, the feature based approach to site selection and management was a cause of concern for some participants.

Round One and Two began to explore what would be feasible and acceptable in terms of management options, allowing the participants to comment on the suggestions of others. The development of the matrix was intended to explore under which circumstances those options could or would likely be employed. Participants found some of the scenarios more difficult to base in realism, yet a fruitful discussion of a variety of scenarios and management options led to the production of the matrix presented below (Table 5.5).

The management matrix summarises the possible management options (from participant discussion) at a site and network level under five different scenarios of change for the MPA feature at the level of an individual MPA: i) the feature is no longer present ii) feature is decreasing iii) feature is stable/demonstrating no overall trend iv) feature is improving and v) the feature is recovered. In terms of the matrix, the above change scenarios are in absolute terms (i.e. not compared to trends in other times and places). The scenarios are also further sub-categorised for site integrity (i.e. wider biodiversity of the site in addition to the status of the feature for which the site is designated) and how the MPA feature is performing at a network level i.e. whether it is stable/declining/increasing across the network.

Table 5.5 Summary Matrix of Management Options: Condition of MPA features under different scenarios of change

MPA feature Scenario at a site level[1]	**Site Integrity[2]**	**MPA feature at a network level**	**Possible Management Actions (from participant discussion)**	**Decision Making Process (from participant discussion)**
No Longer Present	Low quality site	Still present	1. New MPA/Move MPA (Look to establish another MPA for the feature) Designate a new alternative area which may succeed, e.g. within new climatic window of feature.	- Question whether the current management actions are/were appropriate - Is there an alternative feature within the MPA? - Would maintaining this MPA fill a gap in network wide protection?
	Low/high	Still present	2. Reduce pressures in other MPAs. Look at other sites across the network where the PMF is still present within its climate window and reduce other stressors.	
	Low quality site	Still present/no longer present across the network	3. De-designate the MPA Option to give up on an area that has failed.	
	High quality site for biodiversity/other features	Still present/no longer present across the network	4. "Rebadge" the MPA (Look to designate the current site for another feature).	
Feature Decreasing	Low/high	Stable/Declining	1. Reduce pressures on PMF (further restriction to full ban on damaging activities).	- Identify the causes of a decline - Look to recover the net loss of the feature across the network
	Low/High	Stable/Declining	2. Expand the area of the MPA	
	Low quality site	Declining across the network	3. New MPA/Move MPA (Look to establish another MPA for the feature)	
Feature Stable	Low/High	Stable	1. Maintain current management measures	- Continue monitoring
Feature Improving	High quality site for feature	Stable across network/Feature common across network	1. Maintain current management measures	- Review pressures across the network - Is there clear evidence of improvement? E.g. greater extent, higher biodiversity, better age structure
	High quality for feature	Declining across the network	2. Expand the area of the MPA	
Feature Recovered	High quality for feature	Feature common across network	2. Review management of feature in other sites where it was not present previously	- Need for substantial evidence to reduce or change management - Is there clear evidence that it was the management of an activity that led to that improvement? - Is there clear evidence of improvement? E.g. greater extent, higher biodiversity, better age structure
	High quality site for feature, biodiversity and other features	Feature common across network	3. Reduce or change management e.g. is there an option for sustainable use	

[1]Change scenarios are in absolute terms (i.e. not compared to trends in other times and places).

[2]Site Integrity: Quality of the site for wider biodiversity in addition to the status of the feature for which the site is designated. This was mentioned by participants in reference to site condition monitoring for other nature conservation sites (i.e. SPAs and SACs) and therefore could be of future relevance to the MPA sites, whilst not referenced in MPA objectives.

The participants emphasised that for any of the scenarios, a balanced review would be required, and evidence to support a decision before deciding upon any action. It was also suggested that this review should take into account the whole network at appropriate timescales, which again conceptually linked this session to success at different scales. Participants suggested that a network review would be useful for a "recalibration", identifying if any gaps in feature protection were present, or if broader network scale factors (i.e. climate change) were a cause of change. However, it was recognised that identifying causal factors was often incredibly difficult, highlighting the need for a strong monitoring programme. Therefore, some participants maintained a "precautionary" approach to management (i.e. stricter management measures).

Interestingly, the term "precautionary" was also applied in reference to changing management, (i.e. ensuring a strong evidence base before changing current management measures). A review of management measures would therefore need to be incorporated to answer whether the current management had fully removed the pressure.

“But the argument we made earlier was if you remove other stressors, animals may be able to survive climate change for a bit longer. But I think the one thing that we can't aim to do is, fight climate change in the sense of trying to protect the animals specifically against climate change. It's going to happen.” Participant 8

There was a sense of pragmatism in the approach to considering changes within the marine environment and just how far spatial management would protect species and habitats into the future, recognising that in some circumstances, it may not be possible to do anything further. There was also recognition that the dynamic nature of the marine environment would need to be reflected in adaptive management:

“I think what’s key is adaptive management. Once these are set up you’re not saying that’s the status quo, or automatically keeping it at that. The whole point of managing and monitoring them is that you should be able to see what’s happening. It’s dynamic.” Participant 3

Control areas were again mentioned in reference to understanding changes. Additionally, they were conceptually linked to the notion of resilience.

Participant 3: "[I]t would be interesting to look at control areas to see if the MPAs are more resilient than elsewhere and you could base any management actions on that. Are they actually helping resilience or do you need to change your management to enhance that?"

Participant 4: "So that would hopefully give some evidence as to whether the MPAs are making sites more resilient, or features more resilient because they've got the pressure reduced from them versus a control area with pressure."

Several management options were discussed under the various scenarios of change. The management option of a new MPA (or moving an MPA) was linked to recovering net loss of a species where conditions were more favourable, or in the case of climate change, where suitable climatic conditions still prevailed. A more controversial option (from the participants' viewpoints) was to expand the area of an MPA. Although this option had been specifically mentioned in previous rounds (the conflict was highlighted in Round Two), it was further elaborated that to expand the area would need a big change in policy as the boundaries of a site are tightly drawn around the feature of interest (further discussion in section 5.4.3.1).

Maintaining the current management measures was recommended as a strategy for a scenario in which everything was improving. It was agreed that substantial evidence would be required before pressures were allowed to increase. This conflicted somewhat with a view from the industry that under certain circumstances there may be an argument for use:

"[Y]ou have this big area, how much do you need to protect, if it's in a reasonable condition and the conservation objective is to maintain. Then it may well be right we allocate this area, then a third of the area for take, and that might be effective, it might not." Participant 2

However, it should be noted that the participant was also in favour of clear evidence before any management changes were enacted.

5.4.3.1 *Problems with a Feature Based Approach*

Throughout the session on management, discussion centred on the various scenarios and the management actions that could be employed in each case. Around this discussion, problems and caveats to the options were raised and further explored. The researcher identified several problems that conceptually linked to the “Feature Based Approach” towards designation and MPA management in the Scottish MPA process.

1) Managing the MPA around a particular feature

By taking a “Feature Based Approach” (as discussed in Chapter 2), concerns were raised that this would dictate the management being closely tied to a particular feature, and measures such as buffer zones would not be accounted for in this approach. This concerned participants in relation to not accounting for an ecosystem view. Additionally, with a feature only present for a portion of the MPA site, damaging activity would not be precluded from the entire site, and therefore there was an argument for the whole MPA to be protected by the same measures rather than an MPA fragmented into various zones of management.

Participant 10: "I was just going to say an alternative or another approach to management is to say to protect that feature within the MPA, the whole MPA has to be protected from mobile gear for example, and you might say that's a bit extreme and unnecessary, but it's an argument that could be put forward."

Participant 6: "But even with my basic biological knowledge, a species cannot exist in isolation of its ecosystem and if you don't protect its ecosystem then you can't protect the species."

Participant 8: "But you're then challenging, and I wouldn't disagree with you, you're then challenging the whole concept of MPAs and the way they've been selected. We're working within very narrow constraints here certainly at a political level."

The theme of ecosystem health and wider biodiversity/ecological processes was again raised; it was suggested that wider health of the site through consequential protection is neglected through the approach of tying management to a particular feature.

2) Climate change not accounted for in this approach

In terms of climate change, it was questioned as to whether more MPAs with features that are sensitive to climate change would have been established if climate change had been considered at the beginning of the process.

Under scenarios of loss, concerns were raised that if the success or quality of the site is to be judged solely on the status of the feature, and a site were designated for a climate sensitive species (e.g. maerl) which if declined or was lost from the site, the whole site would effectively be redundant. Therefore, it may be possible that a number of sites are potentially vulnerable to the feature being lost. In this manner, the approach does not account for how assemblages of species in MPA sites may change under climate change scenarios. However, it was also suggested that sites identified for a specific habitat or biotope are unlikely to lose the whole interest under scenarios of decline. One solution proposed was to widen the designation of the site to incorporate more habitats and features however, this revisited ground covered in session one (and in previous rounds) whereby some participants were reluctant to have the MPAs broadened, stating that they should be justified.

3) Issues relating to “Rebadging” an MPA under scenarios of decline

Closely linked to the above, is the further issue of what would happen to an MPA site under scenarios of decline. Several participants raised the option of repurposing or "rebadging" the MPA. This was suggested for several reasons; firstly, if a feature is lost and you did not repurpose the MPA, you could lose consequential protection or any improvement in ecosystem health that resulted as a reduction in pressures. In other words, the site could still be performing as an MPA for other species and habitats. Additionally, there may be circumstances where data has improved and led to the identification of other PMFs or vulnerable species that could benefit from protection. Also, some participants suggested keeping the site for monitoring purposes, so as not to

abandon the data or resources invested in the site. However, there were strong industry concerns related to "rebadging" a site:

Participant 2: "[T]his one is for a specific species, with measures in place to protect that species and if for instance climate change impacted on the distribution of that species, then why would you maintain inappropriate measures for that species?"

Participant 4: "I'm sympathetic to that from the pragmatic perspective of jobs connected to the sea. I think it would be difficult to take that example in isolation because if we're allowing that the network needs to be flexible, I think we'd also have to look at how other MPAs are doing as well."

The exchange between participants highlighted strongly contrasting opinions. In terms of industry or stakeholders, it was seen as important that sites be retained for the right, justified, reasons which would require a network level review and stakeholder-determined reasons. There was a suggestion that it may be appropriate to look for a new area, although de-designation was seen as a last resort (species may not completely disappear or may have an opportunity to re-establish), but an option that should remain in the "management toolbox".

4) Need for a precautionary approach

Initial impressions of management from some participants were that it was not optimal and areas were under protected. In the light of uncertainty (from climate change and general complexity of the marine environment), there was a call for a more precautionary approach, considering wider ecosystem function and buffer zones of management. Additionally, there was still concern over the selection of sites, for example, whether the selection of features looked at richly biodiverse sites, which were considered still likely to be important under climate change scenarios.

5) Features are not self-recruiting

There was some criticism that the sites were not designed to be a connected network based on connectivity principles. The idea of self-recruiting sites again relates to wider

ecological processes and the overriding criticism of the network not having been designed as one, which was recurrently seen important in a climate change context.

6) Consideration of Ecosystem health

Ecosystem health was specifically referred to and It was suggested that a species cannot exist in isolation of its ecosystem (as above), and the feature based approach to management seems to lack the consideration of wider ecosystem health.

Participant 7: "So, instead of just taking a very specific species, feature based approach to conservation, also think about the wider ecosystem function."

Participant 8: "That's a completely different approach to the MPA process that we have at the moment. I don't disagree with what you're saying but if we're talking about the MPA network as we have it at the moment, we have to work within that feature based approach."

It was suggested that a broader view should be taken, encompassing consideration of the wider ecosystem, which is counter to the feature based approach that has led the implementation of the network. However, there was also recognition amongst the participants that the process had led to the successful implementation of sites and that the process was still on going.

5.4.4 Reflections on the process

Concluding the focus group sessions, participants were invited to reflect upon the focus group and the research as a whole, outlining their expectations for the conclusion of the research process, including forecasting possible future research actions (not within the remit or scope of this thesis) see Table 5.6

Table 5.6 Clustered Summary Table: Expectations stemming from the research outputs and recommendations for further resultant research

Output	Expectation	Example Quotes*
PhD Thesis	Focused analysis	*"I think that the advice was that you should focus on climate change and MPAs rather than trying to solve the entire problem of how to monitor MPAs." Participant 8*
	Fundamental questions addressed	*"I think there are some very fundamental questions that could be addressed." Participant 8*
	Highlight the debate	*"[T]he debate needs to be exposed and discussed…It's a really meaty piece of discussion." Participant 8*
	Giving direction not advice	*"You're not giving direction, you're giving advice" Participant 8*
Focus Group	Decision tree in its early form	*"I think the decision tree type from this is a clear output potentially which can help inform monitoring and adaptive management." Participant 4*
Policy feedback	Brief summary	*"Someone mentioned earlier, an MCCIP report card, an idiot's guide, a user friendly policy advice note for six pages" Participant 8*
	Presentation and meetings	*[I]f it can be put together as a brief user friendly document would be good, but probably the more effective way to deliver it is through some key presentations and meetings with the right people. I think you need both." Participant 10*
Further resultant research	Monitoring programme recommendations for climate change sensitive MPA features	*"I think it would be interesting to do an analysis of the features in the MPAs, and where you would maybe want to set up a series of those MPAs to help identify whether there are indications that climate change is having an effect on the marine environment. And that would marry in quite neatly with MARCLIM work" Participant 8*
	Baseline data	*"[T]o establish that kind of baseline data we talked about from trends that would be a hugely useful thing." Participant 7*
	Vulnerability assessment	*"The features were the main focus of whether a site was considered and I just wonder actually, is it time to…look at are there designated sites that are particularly vulnerable to climate change changes that should be the focus of more specific research" Participant 5*
	Stimulating further debate	*"I think that would be a really valuable contribution to the whole developing debate about how you monitor MPAs for MPA's sake as opposed to climate change sake." Participant 8*

*Participant 8 was nominated as a spokesperson to feed back a summary of expectations and recommendations

Overall, participants were optimistic with regards to the outputs from the focus group, and highlighted several key areas of further research, both in terms of what could be achieved via the summary and discussion of the Delphi process, and further work that could be undertaken to progress the key issues further.

"I think it will be useful for people to be aware of this and how important it is to be thinking about these questions as part of a network, in advance of network reviews in the context of a changing climate." Participant 4

The group reported having had a fun and enjoyable focus group, deeming it useful to have a space to talk about MPAs in the context of climate change, which had helped with other thoughts regarding MPA monitoring, wider thinking on MPAs and the formation of an embryonic decision making tool for considering high-level management options under climate change scenarios.

5.5 Discussion

Round Three of the Delphi process required participants to reflect on the results from the first two rounds with a view to refine suggestions of practical measures for the incorporation of climate change considerations in the Scottish network. A summary of the evolving nature of the discussion through the three rounds is presented below (see Figure 5.1). The structure of the focus group, with four discussion sessions: success, monitoring, management and reflections/forecasting future work was well received by participants.

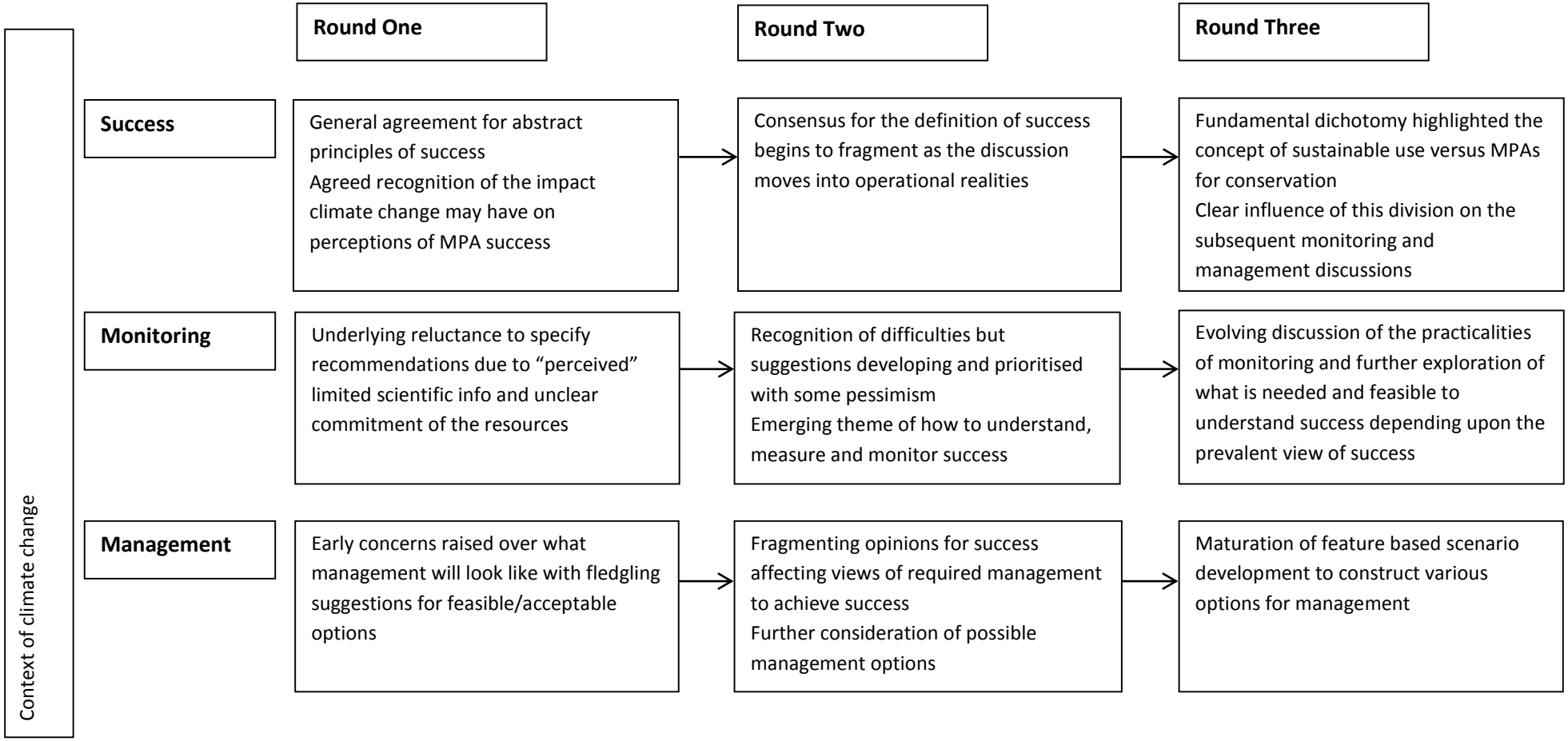

Figure 5.1 Evolution of the conceptual discussions for success, monitoring and management in the context of climate change throughout the Delphi process

Over the course of Round One and Two the Delphi panel suggested criteria for success, yet there was the overriding fragmentation of agreement with confidence in what constitutes success falling over the course of the process. Chapter 2 emphasised the problem with using a feature-based approach to select sites for the MPA network. The dichotomy of opinions in the focus group relates heavily to whether participants felt that the MPA network should strive for the minimum protection of species and habitats (features) versus MPAs enhancing the wider marine environment. This stems from an inconsistent logic in the Scottish MPA process, highlighted in Chapter 2.

It was apparent from Chapter 3 that views of success are likely to change under climate change scenarios. However, this increases the complexity of applying legal definitions of success, which may become redundant under such scenarios. The focus group demonstrated that there is a large fragmentation of opinion in what constitutes success even in the absence of considering climate change. As the discussion progressed from Chapter 4 to the focus group, the agreement of success in abstract principles broke down in the face of operational realities. A fundamental split was evident between participants sympathetic to the provision for sustainable use within the MPA network, and those participants stating that the MPA network should be primarily for conservation and enhancement of the wider marine environment.

In the context of the whole process, these discussions of success have been critical to informing the discussions relating to management and monitoring. It became apparent that which management actions were acceptable depended upon the view of success held, and that in turn affected what data would be required in order to establish whether success had been achieved. Participants were generally supportive of what had already been achieved for the Scottish MPA network, but used the focus group to raise concerns for the success of the network, particularly in the context of climate change.

The extent of the monitoring requirements in order to both discern climate change impacts and assess the effect of protection was emphasised by international practitioners in Chapter 3. It was also recognised over the course of Round One and Two that resources for monitoring were bound to be limited. Participants in the focus group expanded upon both how to monitor, whether reserves were needed to establish causality in the MPAs

(as suggested in Chapter 3), and what to monitor in order to comment on the effectiveness of the MPAs at a site and network level. The pervading issue of success from Chapter 4 and the legal requirements for monitoring and evaluation (as discussed in Chapter 2) had a clear influence on participants' views of monitoring in this chapter.

The participants were asked to work through a series of theoretical climate change MPA scenarios, which were organised at a feature level, through to site and network level. Through the use of the management matrix, participants suggested that a decision making process should also be used in conjunction to help guide select of potential actions, for example, using the results of a monitoring programme to inform decisions. In this way it was evident that participants favoured an adaptive approach (as recommended in Chapter 3 and Chapter 4), using evidence to inform management decisions in an adaptive cycle. The management matrix developed in this chapter is therefore one such tool to aid in adaptive management.

Participants made a range of constructive and insightful comments regarding the management matrix, which were analysed and presented through the course of this chapter. Specifically, participants suggested management actions that would be acceptable in each of the scenarios. However, there was a clear conflict over the "rebadging" of an MPA as one of the management options and it was possible to identify a conceptual link with the elements causing unease to the feature -based approach used by the Scottish Government (see Chapter 2).

5.6 Conclusions

Focus groups reveal the highly complex way beliefs are constructed (Kitzinger and Barbour 1998). As such, it was necessary to observe participant interaction over the course of the focus group. A direct benefit of the face-to-face interaction, was that opinions and perceptions were immediately challenged, which helped generate group -learning. Some participants were adept at summarising large parts of the discussion, hence a large portion of the illustrative quotes used in this chapter are from a smaller portion of the participants. However, these quotes were verified by the researcher to ensure that: they reflected group consensus highlighted areas of contention and/or made an interesting contribution that moved forward the discussion. Some participants disagreed with one another during the discourse, yet the atmosphere was permissive and

allowed participants to air their views unequivocally. Facilitators made clear attempts to engage all participants and all participants were respectful with extremely rare occurrences of talking over one another. When this did happen all participants were given an opportunity to repeat their viewpoint.

The wider theoretical implications of the results of the focus group are discussed in the next chapter (Chapter 6) and presented alongside a series of recommendations.

Chapter 6 Discussion and Recommendations

6.1 Introduction

The conservation of marine biodiversity is a “wicked problem”; embedded in a complex socio-ecological system with no clear boundaries and lacking a clear solution (Jentoft and Chuenpagdee 2009, Game et al. 2014). This thesis has highlighted that the implementation of an MPA network is a complex socio-ecological process that involves a mixture of stakeholder values and perceptions, multifaceted scientific evidence and political factors. Consequently, there are conflicting issues and contradictions that prevent the identification of a simple solution that will satisfy all involved. Adding the complexities of considering climate change into this mixture is an additional level of complexity and uncertainty. However, considering elements of design, management and monitoring that could enable an MPA network to perform effectively under scenarios of climate change, could also add to network improvements more generally.

The rationale of this thesis was to deepen understanding of how considerations of climate change have and can be incorporated into the implementation and management of MPA networks, particularly in the context of the Scottish MPA process. Chapter 2 addressed the thesis objective of reviewing the Scottish MPA process. Chapter 3 investigated perceptions of MPA practitioners and reviewed how considerations of climate change have been incorporated into existing international processes. Additionally, Chapter 3 highlighted the importance of including stakeholder perceptions in MPA processes, an objective that was also explored in Chapter 4 and 5. Chapter 4 and 5 also used a participatory approach to incorporate considerations of climate change into a framework of management and monitoring for the Scottish MPAs. This chapter discusses the results of the participatory Delphi technique (Chapters 4 and 5) in the context of the wider scientific literature. Additionally, this chapter considers how the preceding Chapters (1, 2 and 3) relate to these findings. Finally, this chapter achieves the final objectives of the thesis by making specific recommendations and providing advice as a result of this work that could guide the inclusion of climate change specific principles.

6.2 A Spectrum of Values: Conservation vs. Sustainable Use

MPAs are fundamentally created and function in the context of objectives that inherently reflect underlying values (Charles and Wilson 2009, Brennan and Valcic 2012, Poe et al. 2014). It is therefore necessary to understand the objectives being pursued, and how these relate to values and attitudes, in order to make any decisions regarding MPAs (Charles and Wilson 2009, Brennan and Valcic 2012). Over the course of the Delphi process (Chapter 4 and 5) there was an apparent fragmentation in agreement over what constitutes success for the MPA network, reflecting the move from abstract principles to operational realities. This is consistent with idea of a "spectrum of underlying values" for MPA establishment (Caveen 2013, Sawchuk et al. 2015) (Figure 6.1).

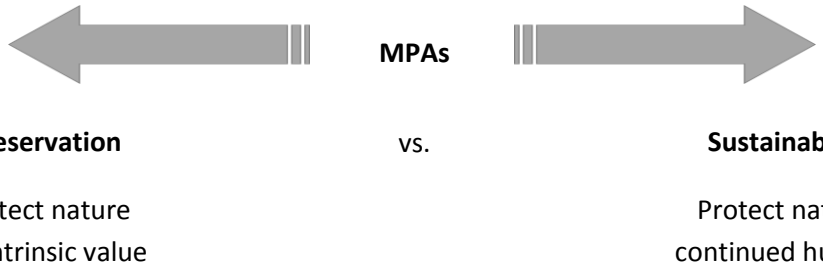

Figure 6.1 The spectrum of underlying values that underpin MPA designation (Adapted from (Caveen (2013))

Whilst there are extreme views at either end of the spectrum, Mangi and Austen, (2008) argue that there is much overlap between the values. The level of support that stakeholders have for MPAs as a conservation strategy is related to various complex and interrelated factors (e.g. economic, social, cultural) and this can vary based on the perception of the legitimacy of and need for MPAs as a strategy (Agardy et al. 2003, Sawchuk et al. 2015). Interestingly, in Chapter 5, discussions around the objectives for the Scottish MPA network considered achieving both conservation and sustainable use, reflecting the high-level objectives stemming from a top-down government approach over why an MPA network is needed (and the international obligations set out in Chapter 2). MPAs have been promoted to achieve both fisheries and biodiversity conservation objectives (Lauck et al. 1998, Gell and Roberts 2003a); the approach from the Scottish Government is to implement an MPA network for the achievement of biodiversity conservation and towards achieving a clean and healthy vision of the marine environment

to support sustainable use (see Chapter 2). However, the selection process for the MPA sites did not consider criteria for enhancing or supporting sustainable use (e.g. considering connectivity and habitat associations of commercially valuable species) rather the MPAs were designed from a conservation perspective, limiting impacts to fisheries in terms of not reducing the amount of resource that can be extracted where possible. Overall, the vision for the Scottish MPA network remains confused.

It has also been suggested that the objective of sustainable use (in terms of fisheries), conflicts with the objective of conserving or restoring biodiversity; typically through continued fishing compromising conservation (Brander 2010), which echoes statements made in Chapter 5 highlighting concerns that the two concepts may be mutually exclusive.

A healthy ecosystem underpins both social systems (Jentoft et al. 2007) and fisheries (Mangi and Austen 2008). However, benefits for conservation are longer term than fisheries resulting in a conflict between conservation and use that requires a balanced and flexible approach (Jentoft et al. 2007). Ultimately capturing one value set in an MPA process will automatically alienate others; yet by merely seeking the common denominator, the result is “toothless statements of intent” (Mee et al. 2008). Mangi and Austen, (2008) suggest that shared attitudes are not essential to the achievement of the ecological benefits from MPAs, although they are likely to reduce the costs of enforcement. A key conclusion from this thesis is that stakeholders have different views, unlikely to be resolved in the short term. However, supportive attitudes can be critical to meeting societal objectives for marine protection, and conversely, underlying attitudes have been seen to contribute to disasters such as fisheries collapse (Charles 1995). Therefore, it is important to clarify these entry values in MPA discussions and understand how they may affect the approach to implementation (Charles and Wilson 2009).

Shared perceptions amongst stakeholders on the objectives and management zoning of MPAs should simplify the management of complex marine ecosystems (Mangi and Austen 2008). Theoretically, at a network scale, it should be possible to reconcile different objectives if provisions are made for all users, however, at a site level, this could compromise the integrity of the biodiversity protection. The effect of scale on the

achievement of objectives was discussed by the participants in Chapter 5; achieving success at a site level does not automatically bring network level success. Additionally, to achieve fisheries benefits from MPAs there would need to be consideration of production zones, spill-over and meta-population dynamics for example (Halpern and Warner 2003, Roberts et al. 2005, Sale et al. 2005, Stewart et al. 2008).

6.3 Management Objectives: Wider Ecosystem vs. Feature Led

Where people sit on the spectrum of environmental values or conservation ethic, affects their view of MPA management. It became apparent over the course of Chapter 5 that perceptions of what would constitute a successful MPA influenced the subsequent discussions on management of the MPA network. Those with strongly held environmental views (i.e. the conservation community) sat towards the preservation end of the spectrum Figure 6.1 and therefore widely advocated the implementation of strictly protected NTZs. At the other end of the spectrum, those advocating MPAs for sustainable use are usually associated with less restricted areas. From a fisheries perspective, MPAs that are developed to achieve conservation objectives (e.g. the conservation of biodiversity) are seen as controversial (Pita et al. 2011) as generally, achieving these objectives requires a stricter approach to management (NTZs or restricting fishing gear) and are a tangible threat to the fishing size area (Mangi and Austen 2008).

Caveen, (2013) argues that to view management objectives at either end of the spectrum is a false dichotomy and that whether an area is fully or partially protected depends on the objective of the MPA (Agardy et al. 2003). For example, in a fisheries management context, some scientists recommend that to maintain the age structure of a fished population, a fully protected reserve would be required as even weak level of fishing can truncate the age structure (Planque et al. 2010). Whereas, for a nature conservation objective that aims to protect benthic habitats, only the restriction of towed bottom gear may be required, as the restriction of pelagic or static gear (gears which are thought to have negligible physical impacts on the benthos (Grieve et al. 2014) would not influence the conservation outcome. Interestingly this echoes discussions in Chapter 4 and 5 about concerns over the justification of management measures and ensuring equity of restriction for activities with similar impacts. This highlights the complexities that policy makers face, and the difficulties of justifying NTZs to the fishing industry, for example in

the English MCZ process, because not all fishing methods may interact with the habitat features requiring protection (JNCC and Natural England 2011). In the context of the Scottish feature-led MPA process, the approach to management resembles a more discriminating approach through the development of the feature sensitivity tool (Chapter 2), which analyses the sensitivity of a designated feature to different types of human activity. Additionally, management measures based on this sensitivity may not be required across the entirety of the site if the feature is not present across the whole of the site.

However, elsewhere there has been a move away from a species-by-species management towards broader ecosystem level strategies (Jentoft et al. 2007). It has been suggested that single species management of fisheries is unlikely to be effective at an ecosystem level because ecological processes and linkages between species are not considered. Similarly, by focusing management measures on one feature or species, impacts on other species (which may be of high ecological importance) are effectively ignored. Habitat destruction by trawling is one example of this (e.g. Kaiser et al., 2003). Better protection of MPA features could be achieved by not only managing the direct impacts (i.e. habitat destruction) but also by considering the wider factors that influence their health (e.g. water quality, prey availability and trophic links). Similarly, the use of no-take reserves across the Great Barrier Reef has been demonstrated to reduce outbreaks of crown-of-thorns starfish, having direct benefits for the coral populations with likely consequences for overall biodiversity (McCook et al. 2010). This effect is clear, even though the ecological mechanism is unclear, suggesting that it is not necessary to understand all the ecological linkages of a complex system, but that by effectively protecting the system, these linkages important for functioning remain intact.

A review of scientific knowledge (Chapter 1), international perceptions (Chapter 3) and views of stakeholders of the Scottish MPA process (Chapter 4 and 5) suggests management and protection should account for wider ecosystem links and concepts of resilience in the face of a large amount of uncertainty from climate change. Ecosystem based management (EBM) manages the human activities that have an impact on ecosystems, and takes these effects into account when making management decisions.

6.4 Management Approaches: Precautionary vs. Evidence based

Within the political context of the Scottish MPAs (the Scottish vision, international obligations for biodiversity conservation; see Chapter 2), it could be argued that in this respect MPAs correspond with the precautionary principle (Lauck et al. 1998, Chuenpagdee et al. 2013). The precautionary principle refers to erring on the side of caution in the face of imperfect knowledge, it is anticipatory by removing or reducing threats with the assumption that if they are not removed or reduced then the system will deteriorate (Lauck et al. 1998, Mee et al. 2008, McDonald and Styles 2014). Under scenarios of climate change, how to manage a dynamic environment is highly uncertain and therefore a precautionary approach is recommended (Mee et al. 2008)(Chapter 3, 4 and 5), shifting the burden of proof onto those that are potentially damaging the marine environment through continued use.

Conversely, the fishing industry claims that fishing should be allowed to continue in the absence of "robust conservation evidence" (Mee et al. 2008, Caveen et al. 2015). This statement was echoed in industry concerns (Chapter 5) and in the public consultation of the Scottish MPA network (Chapter 2). This "evidence-based" approach dominates fishing management (Mee et al. 2008), yet it often suffers because of a lack of evidence or disagreements between enforcement agencies and fishers on the quality of the evidence. Policy and legislation being mechanistic thinking, favour evidence-based action (Mee et al. 2008). In the Scottish process, the management of a protected feature for which the MPA is designated is directly linked to the sensitivity of the feature to human activities (Chapter 2). This shifts the burden of proof back across the spectrum, leading to the current difficulty in legislating fully protected MPAs (Mee et al. 2008). Whilst participants in the Delphi focus group (Chapter 5) were sympathetic to the industry perspective when implementing management measures that will potentially impact livelihoods, there was an overall agreement that without effective management that considered wider impacts upon biodiversity, the MPAs would not contribute towards a resilient environment.

Part of the difficulty in aligning a precautionary approach with that of an evidence-based one is the weighing of quantified benefits (in financial or other terms) from protection, against those of continued use (i.e. fishing or provision of other goods and services) (Mee et al. 2008). Balancing short-term adverse impacts to some user groups with less

quantifiable conservation benefits in the long-term usually results in precaution for proper longer-term protection of marine ecosystems being excluded (Salomon et al. 2011; (Mee et al. 2008). This difficulty is inherent, not only in MPAs, but in general environmental management; policies that create economic opportunities in the short term are pitted against policies for biodiversity conservation that would generate opportunities in the future (Mee et al. 2008, Salomon et al. 2011).

Both approaches, precautionary and evidence-based, require data through research and monitoring to inform decision-making. However, there are few if any examples of fully protected areas set up purely to provide for research that calculates the financial (or equivalent) benefit that it may provide (Mee et al. 2008) (but see Potts et al. (2014)).

6.5 Climate Change and MPA networks

6.5.1 Adaptation and Precaution

Adaptive management is a learning process, allowing for the incomplete knowledge base and uncertainty that is inherent in complex socio-ecological systems (Mee et al. 2008, Allen and Garmestani 2015). MPAs are likely to be implemented in the absence of high quality baseline information (Sale et al. 2005). Additionally, there is a large uncertainty regarding how climate change will affect MPAs. Therefore, as more knowledge becomes available through targeted research and monitoring, adaptive management is a necessary mechanism for incorporating new information and refining management with regards to marine protection (Mee et al. 2008, McDonald and Styles 2014). Throughout this thesis, adaptive management has been referred to in Chapter 3 as a mechanism for dealing with climate change and participants in Chapter 4 and 5 discussed adaptive management in the context of the Scottish MPA network.

The two approaches, of adaptive management and the precautionary principle may seem at odds; however, McDonald and Styles (2014) recommend a combination of the two in order to protect marine biodiversity in the context of climate change. Formal active adaptive management (i.e. the experimental approach) may be too unreliable or risky in a changing climate where shifting baselines are likely (McDonald and Styles 2014). Additionally, a strict preservationist approach that seeks to maintain conditions in status

quo or at a preconceived baseline may not make sense under scenarios of climate change (McDonald and Styles 2014). However, using principles of both that aim to minimise harm, prevent ecosystem collapse and enhance resilience is recommended. Additionally, where there is a large degree of uncertainty, as in the case of seabed mining, using the principles of adaptive management and the precautionary approach have proven effective at safeguarding biodiversity (McDonald and Styles 2014). As adaptive management is still somewhat reactive, and seabed mining is an emerging issue, this case illustrates how precaution has been used whilst allowing further research to proceed.

Several options for adaptively managing MPAs have been proposed throughout the course of this research. A list of options from Chapter 3 including: flexible boundaries, buffer zones of management, and temporary MPAs that track ecosystem processes or features and exploration of potential options in Chapters 4 and 5, highlighted how most of these options are far from a practical reality for MPAs at present. The implementation of these options was further explored with the development of the management matrix over the course of the Delphi process (Chapter 4 and 5). The management matrix was designed based on the existing feature-led approach to reflect existing political constraints within the Scottish MPA process. The iterative nature of the Delphi process highlighted the difference between proposing options and subsequently using these in a practical scenario. For example, changing MPA boundaries was proposed as an option in Chapter 4, and was discussed as politically feasible in Chapter 5. However, when confronted with implementing this option for a range expansion (for example), participants were reluctant to use boundary changes. Changing MPA boundaries was regarded by the environmental sector as too fluid a measure to provide effective long term protection, whilst the fishing sector were concerned that it would lead to long term financial uncertainty. Therefore, whilst most actors within the MPA process advocate adaptive management, it remains difficult to define how this will work in a practical sense (as suggested in Chapter 3).

The success of adaptive management is highly dependent on strong monitoring programmes that are consistent and well-funded (Mee et al. 2008), yet the Scottish MPA process is currently without a formally designed monitoring programme. Participants in Chapter 4 and 5 highlighted their concerns that the monitoring task for the MPA network

was overwhelming, both in terms of the scale of the information needed to be able to confidently state that the network was achieving its aims, and in terms of the amount of resources needed to monitor both at a site and network level. Additionally, discussions also centred on the difference between surveillance (condition monitoring that would indicate generally the health of the site) and investigative monitoring (determining the cause of deviation from an expected state) (de Jonge et al. 2006, Mee et al. 2008). A recommendation could be to design MPAs as experiments, with known control areas, surveyed with the same methods prior to implementation as after. Both of the above monitoring types would be needed within the Scottish network in order to fulfil reporting objectives under MSFD (Chapter 2), and in order to adaptively manage. Whilst the political framework is in place for the Scottish network to be adapted in light of new knowledge via the network review process (Chapter 2), there is also the requirement of political will in order to implement suitable responses (Mee et al. 2008) and robust mechanisms that ensure action is taken in light of new information, rather than a continuation of monitoring.

Stakeholders and policy makers are increasingly demanding information that can be used to evaluate the potential long-term impact of different MPA management strategies (Agardy et al. 2011) and whilst multiple evaluation methodologies have been developed, very few have been actively implemented. Consequently, knowledge of the actual effectiveness of many MPAs is limited (Heck et al. 2012). Pomeroy et al., (2005) reviewed management effectiveness methodology and indicators aimed at 18 MPAs around the world finding that clearly defined goals and objectives were often not present in management plans, showing little or no thought for evaluation or monitoring systems beyond initial implementation.

6.5.2 Resilience and Restoration

A key theme from this thesis, stemming from a review of the scientific literature (Chapter 1), perceptions of international practitioners (Chapter 3) and the discussions of the panellists in the Delphi process (Chapter 4 and 5), is the use of MPAs to promote climate change resilience in the marine environment. Several key facets that emerge are the need for a healthy marine environment and consequently a holistic or ecosystem view of management. A healthy ecosystem is considered one that contains many intricately

connected biophysical parts, and it is important to preserve biodiversity to maintain ecological functioning and integrity (Jentoft et al. 2007). MPA networks designed for protecting biodiversity are likely to be important in preserving ecological functioning and therefore contributing to ecosystem resilience (Steneck et al. 2002).

Nonetheless, the resilience of an MPA is susceptible to external anthropogenic stressors (Jentoft et al. 2007) especially climate change. A resilient system is able to absorb disturbance and resist change, and therefore is less likely to turn into an alternative, (perhaps less desirable e.g. in terms of GES) stable state; less resistance systems, close to a "tipping point" will need less pressure to cross into an alternative state (Selkoe et al. 2015). Human exploitation (i.e. intense fishing) can exacerbate the effects of climate change making tipping points more likely; the ecological effects of synergistic stressors are complex and unpredictable (Selkoe et al. 2015). Since healthy ecosystems are anticipated to provide ecosystem services for human consumption, ecosystem resilience is intrinsically coupled with social resilience (Jentoft et al. 2007, Anthony et al. 2015). Therefore, managing the interactions and feedbacks between the socio-ecological system, and preserving the complex interactions between the systems is essential for resilience (Jentoft et al. 2007, Anthony et al. 2015).

Concerns were raised by participants in Chapters 4 and 5 (and highlighted in Chapter 2) that the Scottish MPA network had not been designed to incorporate protection of ecosystem functions. But, a network consisting of strictly protected areas with no intense anthropogenic stressors (e.g. fishing) and that incorporate consideration of ecosystem function are likely to be the most resilient to climate change (Harley et al. 2006, Micheli et al. 2012). The feature based approach used in Scotland is therefore concerning as without a coherent, connected MPA network, it is unlikely to be resilient to the impacts of climate change (Olds et al. 2012, Magris et al. 2014, Andrello et al. 2015). The approach taken by other countries (Chapter 3) has been to incorporate multi-use at a network-scale but with a core of strictly protected no-take areas. MPAs that are not strictly protected, could be considered a false economy since they are more prone to sudden and unpredictable change and are likely to be harder to manage, requiring more adaptive management strategies and more detailed long term monitoring.

The European Union (EU) 2010 Biodiversity Baseline report highlighted the huge knowledge gap we face in determining the conservation status for marine species and habitats (European Environment Agency 2010). More than 70% of the species and 40% of the habitats of European interest in marine ecosystems are of unknown conservation status, and of those assessed only 2% of species and 10% of habitats are in a favourable state (European Environment Agency 2010). As a result, there has been an emphasis on the restoration of marine habitats in both the MSFD and as part of the OSPAR guidelines, and a possible site level objective for an MPA feature in the Scottish MPA process (Chapter 2), perhaps recognising a need to increase resilience in degraded ecosystems. Whilst there are strong political foundations for restoration, these do not address the scientific (and other) difficulties. Firstly, there is the technical uncertainty over if a habitat will recover, how long it will take and non-linear recovery trajectories (Mee et al. 2008). Alternative stable states of an ecosystem may exist which make restoration attempts (to restore the ecosystem to the previous desirable state) unfeasible, impractical or too expensive (Hughes et al. 2005, Selkoe et al. 2015). Additionally, the concept of shifting baselines (see Pauly (1995)) needs to be considered with regards to the desirable state of the ecosystem that the MPA should achieve. This normative issue was raised by the panellists in Chapter 5. Suggestions that qualitative discussions may need to occur to decide what past ecosystems looked like, echoed recommendations by Campbell et al., (2009) that marine restoration will need to explicitly recognise value laden judgements inherent in the decision context (Mee et al. 2008, Campbell et al. 2009). These value laden judgements also extend into judgements of what future ecosystems will look like under climate change (as suggested in Chapter 3); reference states in this context are particularly contentious in marine systems (Mee et al. 2008).

Given the connectedness of ecological and social systems, and the “wickedness” of the problem, concepts such as Ecosystem Based Management (EBM) may provide a solution by integrating conservation with spatial ecology and ecosystem functioning. EBM focuses on the protection of multiple species, ecosystem processes and societal values, taking into account the wider effects of human use on the environment (Mee et al. 2008, Campbell et al. 2009, Olds et al. 2012). Managing socio-ecological systems in an MPA context would require a management plan much larger than the MPA itself (Mee et al.

2008). However, the data requirements for this and the current political landscape may mean that EBM approaches are unlikely to be implemented in the short term.

6.5.3 Reference sites

If EBM approaches are unfeasible at present, and feature-led approaches are inappropriate for climate change, the only remaining option is the precautionary approach. It was recommended in Chapter 3 that management decisions need to be taken in light of data from reference sites in order to understand and have a baseline for changes without the confounding influence of controllable (at least to some degree) or restrictable human stressors (e.g. fishing, dredging, development etc.). Without reference sites, "expert judgement" and human perceptions of change are used to make management decisions (Mee et al. 2008). As perceptions of quality can shift over each generation (Pauly 1995) with each generation having its own reference state for what is high or "good" quality, these perceptions of quality may decrease as generally society becomes used to a lower level (Mee et al. 2008). Climate change is likely to happen relatively slowly over long temporal scales relative to human lifetimes, so subjective management decisions are unlikely to be accurate. Additionally, these reference states of quality imply judgements of what is "'good'' or ''bad'' about the natural environment (Mee et al. 2008). The development of the MPA network is therefore recommended as a practical solution, but only if this includes the implementation of strictly protected reference sites (as advocated in Chapters 3, 4 and 5). These reference sites will allow more objective assessments of GES to be made (Mee et al. 2008).

Data collection in the marine environment is very challenging, both time and resource intensive, and perhaps unachievable using conventional methods, as agreed by participants in Chapter 4 and 5. There are requirements to monitor the site condition and feature condition of all the sites in the Scottish MPA network in order to make meaningful and effective management decisions (Chapter 2, 4, 5). As the condition of the MPA site is linked to the status of the features within the site, there will be an expectation to monitor the feature. It was suggested in Chapter 5 that the features would be indicators of the wider site or ecosystem health (GES). However, there would need to be an understanding of the linkages between these species and habitats and how they relate to wider biodiversity, in addition to the need to define what is "good" about a feature, whether a

population had increased or decreased and without adequate data collection or reference states, these would have to be value-judgements.

MPA evaluation and monitoring is needed to understand and demonstrate success (Heck et al. 2012), otherwise there is the possibility of disillusionment amongst stakeholders (as suggested in Chapter 5). Additionally, adaptive management depends on a strong monitoring framework, and this ability to adapt the MPA network in the face of uncertain climate change is seen as increasingly important. Monitoring strategies should offer opportunities to diverse stakeholder groups in the selection of evaluation targets as this has the potential to enhance evaluation capacity, increase credibility of management practice and MPA effects, strengthen ties between involved parties and utilise locally relevant information (Heck et al. 2012).

6.6 Recommendations

This thesis employed a series of qualitative methods to establish a set of recommendations for incorporating considerations of climate change into MPAs. These recommendations link to a series of clear scientific principles for MPA network design specifically considering resilience and the potential effects of climate change on area-based conservation. Following the preceding discussion, the following recommendations are made for using the findings of this research more widely:

Design Considerations

- Conduct a vulnerability assessment of species and habitats with regards to climate change impacts and ensure these have adequate representation, replication and protection within the MPA network
- Continue current research and on-going work to understand the connectivity of MPA sites across the network
- Combine the blue carbon assessment with recommendations for the inclusion of carbon sinks in the MPA network
- To promote resilience, ensure that areas are strictly protected and surrounded by buffer zones of management, integrated with wider marine measures.

Monitoring

- Use the mechanism of Research and Demonstration Areas to implement undisturbed reference sites for the promotion of targeted research to understand the effects of MPAs/anthropogenic stressors, management measures and climate change
- Recognise the huge size of the minimum data requirements in order to be able to report on success and effectiveness. Act immediately to collect baseline data which allow MPA effects to be assessed quantitatively.
- Develop innovative methods for the collection of data; including the use of industry-scientific partnerships, citizen science and new technologies.
- Develop a strong, adaptable monitoring framework with a long term commitment of resources
- Set clear, hierarchical monitoring objectives that move beyond mere surveillance to targeted monitoring specifically aimed at answering questions/achieving objectives

Management

- To promote resilience, ensure that areas are strictly protected and surrounded by buffer zones of management
- Use the MPA network review process to adaptively manage the network by ensuring new knowledge/best available information is routinely incorporated into adapting the network design and/or monitoring and/or management
- Develop the matrix of management options for scenarios of increase/decline etc. in a designated feature to help guide MPA managers in management decision-making
- Incorporate principles of Ecosystem Based Management (EBM). Include ecosystem-level indicators in success criteria from the beginning and build them into the monitoring.

- Develop the means to assess contributions of MPAs to wider seas GES as a success metric, measure it and plan to monitor.
- Make ecosystem-level issues the criteria which are tested, e.g. fish abundance and diversity as proxies for ecosystem health
- Assess ecosystems, not features; protection of the features is a means to an end, not a sufficient objective in itself.

Values

- Explore the disparities in objectives for the MPA network between user groups
- Develop research into the perceptions of the MPA network and wider marine environment, both at a user and public level to further understand the societal implications for the MPA network

6.7 Conclusions

This thesis highlights that if the Scottish MPA network is to fulfil objectives of conservation and restoration, the implications of climate change in the design, management and monitoring of the network must be considered. In particular, there needs to be a greater focus on: i) incorporating ecological principles that directly address climate change ii) effective protection that builds resilience of the marine and linked social environment iii) developing a focused, strong and adaptable monitoring framework iv) ensuring mechanisms for adaptive management.

This thesis has provided a first review of the Scottish MPA network, both in light of international obligations for marine conservation and in the context of climate change. Moreover, it has demonstrated how qualitative research methods are essential for understanding the various values and perceptions of stakeholders for MPAs, and emphasised the importance of considering these in the MPA process. Additionally, this thesis has collected and evaluated examples of international experience of MPAs and climate change and developed recommendations to ensure MPA network design

considers the future challenges climate change poses to the continued protection of marine biodiversity.

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Appendix A: Chapter 3 Coding Frameworks

Table A.1 Canada Coding Framework. Initial open codes (73) refined to (55); Focused codes; Categories and themes

Open Codes	Focused Codes	Categories/Themes	Open Codes	Focused Codes	Categories Themes
Latitudinal replication of areas	Network Design	Resilience	Future marine biodiversity	Clear objectives	Valuing biodiversity
Portfolio effect			Invasive Species		
High biodiversity			Climate change refugees		
Carbon sinks for mitigation			Food security		
Seabird protection			Protecting fish		
Refuge areas			Justification for MPAs		
Marxan			MPA success		
Moveable MPAs			MPA vs. fishery closure		
Importance of spatial data			ICCAs		
Climate change impacts			Multiuse MPAs	MPA management	
Forecasting for network design			No-take zones		
Marine planning with the First Nations			Effective protection		
Considerations of climate change in MPAs			Commercial fishing		
Mapping fisheries impacts			Climate change indicators	Monitoring	Evaluating MPAs
Ad Hoc implementation	Policy Framework for resilience		Fisheries monitoring		
Adaptation or mitigation			Lack of monitoring		
Limitations of policy for incorporating climate change			Guardian watchmen		
Process exhaustion	Barriers	MPA Process	Importance of monitoring for success	MPA management	
No flexibility			Enforcement		

Uncertainty			Complex management leading to a monitoring problem		
Limited Resources					
No baseline data					
Slow process					
Complexity of process					
Political barriers					
Double standard of knowledge					
Co-operation between agencies	Enabling factors				
Adaptive approach					
Relationships to drive forward conservation					
Long term thinking					
Public engagement					
Dynamism					
Ecosystem valuation					
Remote Areas					
Difference between NGOs and academia					

Table A.2 California Coding Framework. Initial open codes (57) refined to (49); Focused codes; Categories and themes

Open Codes	Focused Codes	Categories/Themes	Open Codes	Focused Codes	Categories Themes
MLPA Goals	Policy Objectives	Clear Objectives	Adapting for climate change	Management approaches	Adaptive
Objectives/Goals for monitoring			Stakeholder Perspectives		
Scale of Objectives (MPA vs. network)			Fishermen adapting behaviour		
Views of success	MPA evaluation		Adaptive management		
Value of the network			Changing MPAs		
Assessing success			Additional Protection		
			Various MPAs		
Adaptive monitoring	Adaptive	Strong Monitoring Framework	Precautionary principle		
What and why			Finality of an MPA		
Climate change monitoring			Adding new information		
System wide view	Scale		Importance of NGOs for a process	Model System	
Site level monitoring			When to include considerations of climate change		
Monitoring Framework goals	Components of monitoring		Success at a network scale		
Reserves as reference sites			Coherent network		
Baseline data			Deeper water areas	Network Design	Model System
Citizen Science			Ecological principles		
Monitoring Enterprise			Size and spacing guidelines		
			Portfolio design		
			Climate change in the design		
			Socioeconomic data		
			Industry proposals		
			Climate change resilience		
			National Marine Sanctuaries		

	Public engagement		
	Facilitating policy environment	Enabling factors	
	Motivation		
	Long term thinking		
	Slow process		
	Climate change inaction	Barriers	
	Climate change knowledge gaps		

MLPA principle planner	
National Marine Sanctuaries	
Marine Planning	

Table A.3 Australia Coding Framework. Initial open codes (77) refined to (70); Focused codes; Categories and themes

Open Codes	Focused Codes	Categories/Themes	Open Codes	Focused Codes	Categories Themes
Adaptation pathways	Adaptive Management	Clear recognition of climate change	Rezoning	Zoning	Multi-use MPA network
Adaptive management			Structural adjustment package		
Adaptive planning			Straight boundaries		
Best available info			Green zones		
Climate change adaptation plan			Large scale		
Mitigation			No-take zones		
Review Process			Biodiversity conservation strategy	Values of marine biodiversity	
Reporting	Monitoring		Blue carbon		
Outlook report					
Clear objectives			Deep water protection		
Long term monitoring			Monetary values		
Reducing stressors	Uncertainty	Management for climate change	Offsetting		
Risk based approach			Shifting baselines		
Cumulative impacts			Communication	Enabling factors	MPA process
New objectives for climate change			Flagship		
Precautionary approach			Maintain momentum		
Operational requirements	Linking science and policy		Funding		
Science into policy			Enforcement		
Vulnerability assessment			Leadership		
Evolution of network design	Design and management approaches		Partnerships		
Connectivity			Stewardship		
Design principles			Smart targets		
Insurance factors			Prioritising resources		
Management action under climate change			Strong policy foundation		
Marxan			Critique of NGOs	Barriers	

Softer management measures			Critique of Australia MPAs		
Resilience			Box ticking		
Refugia			Double standards of knowledge		
Recolonisation and climate change			No climate change in design		
Reef resilience			Slow process		
3 dimensions of management			Jurisdiction	Policy	
Ecosystem Based Management			Public consultation/polling		
			Stakeholders and climate change		
			Protection targets		
Coastal planning					
General lessons					
NGO opinion					
Difference between academics and practitioners					
Development assessment					

Table A.4 New Zealand Coding Framework. Initial open codes (154) refined to (88); Focused codes; Categories and themes

Open Codes	Focused Codes	Categories/Themes	Open Codes	Focused Codes	Categories Themes
Climate change resilience	Resilience	Marine reserves	Level of marine protection challenges	Marine Reserves Act	Limitations of implementing a New Zealand MPA network
Reserves as insurance			Broad legislation		
Species range shifts			Policy legislation and management conflict		
Land and sea linked management			Omission of climate change in legislation and policy		
Long term protection and climate change			Criteria for protection		
Refugia and resilience			Implementation challenge		
Biodiversity conservation			MPA application process		
Reference sites	Reference sites		Small size of reserves		
Scientific research			Policy objectives and protection targets		
Species range/time series data			Ad hoc approach		
Changes at marine reserves			Slow MPA process	Policy process	
Ecosystem level effects			Protection targets		
Compliance	Management evaluation	Monitoring	Problems with policy documents		
Reference sites			Government stalling		
Monitoring for success			Challenges of high sea MPAs		
Commercial species monitoring			Data requirement halting process		
Community monitoring			Conflict with fisheries		
Outcomes monitoring framework			Indecision problem		
Baseline			Science into policy process		
Monitoring limited resources	Limitations		Conflicting policy departments		

Problems with climate change monitoring			Problems with stakeholder involvement		
Monitoring and science, policy conflict			Challenges of implementation		
Long term monitoring	Climate change		Problems with marine spatial planning		
Climate change indicators			Use of best available information		
Communities and climate change impacts			Conflicting objectives	Objectives	
Ecological integrity monitoring			Clear objectives		
Conflicting uses	Barriers	Climate change and the MPA process			
Wasted resources					
Unclear objectives					
Uncertainty climate change impacts					
Problems with flexibility					
Lack of scientific data					
Backwards process					
Enforcement problem					
Impacts on users					
Paper parks					
Size and adequacy design	Design characteristics				
Benthic protection areas					
Biogeographic classification					
Ecosystem services					
Network definition, design, connectivity and function					
Representative					
Priority areas for protection					
Climate change linked stressors	Climate change specific characteristics				

Climate change vulnerable species			
Ecological integrity and climate change			
Climate change adaptive policy			
Selecting MPAs considering climate change			
Kelp carbon store			
Precautionary approach			
Climate change impacts management			
Changing boundaries			
Flexibility	Enabling factors		
Clear scientific guidelines			
Funding for climate change research			
California example			
Reviewing policy			
Adaptive management and monitoring			
Tourism Impacts			
Context dependent			
Fishing pressure and personality			
Offshore MPAs			

Table A.5 Summary table of coding framework for key themes in discussion

Focused Categories (results)	**Discussion Themes**	**Focused Categories (results)**	**Discussion Themes**
Resilience	Effective Protection	Clear recognition of climate change	Adaptive Approach
Multi-Use MPA network		Characteristics for resilience	
Marine reserves		Managing for climate change impacts	
Characteristics for resilience		Characteristics for resilience	When to include climate change
Clear Objectives	Monitoring for effectiveness	Barriers	
Strong monitoring framework		Limitations	
Importance of monitoring		Future conservation values	

Appendix B: Chapter 4 Delphi Round One and Two Questionnaires

B.1 Stakeholder Map

Table B.1 Stakeholder Map

Group	Organisation	Attended Stakeholder Workshop	Expertise	Identification Method
A	SAMS	No*	MPA management; industry management around MPAs	Referral; Academic literature
	SAMS	No	Marine Spatial Planning	Academic literature
	MCCIP	YES	Marine Climate Change	Referral
	Heriot-Watt University	YES	Marine Climate Change	Referral
	Heriot-Watt University	YES	Marine Climate Change	Academic literature
	Edinburgh University	No	MPAs; socioeconomics of MPAs	Referral
	University of York	No	MPAs; NTZs	Academic literature; referral; reputation
B	Marine Scotland	YES	Marine Policy and decision making	Reputation
	Marine Scotland	YES	Socio-economics	Grey literature; Reputation
	Marine Scotland		Marine Planning	Referral
	Marine Scotland		Marine Planning	Reputation; referral
	Marine Scotland		Socioeconomics	Referral
	JNCC	YES	MPA design	Grey literature; reputation
	JNCC	YES	MPA design	Grey literature
	SNH		MPA design; Marine Ecology; Marine Climate Change; Marine Policy	Grey literature; reputation; referral
	SNH	YES	MPA design	Grey literature; Reputation; Referral
	SNH	YES	MPA design	Grey literature; referral
	SNH	YES	MPA design	Grey literature; referral
C	Scottish Environment LINK	YES	Marine environment; protected areas	Reputation
	MCS	YES	Marine environment; protected areas	Reputation
	RSPB	No*	Seabirds; protected areas	Referral

	RSPB	No	Seabirds; protected areas	Referral
D	SFF	YES	Industry; marine policy	Referral
	Scottish Power Renewables	YES	Industry; marine planning	
	Scottish Power Renewables	No	Industry; marine planning	Referral
	Visit Scotland	YES	Marine recreation	Grey literature; referral
	BSAC	YES	Marine recreation	Reputation; referral
	Aquaculture	YES	Industry	Grey literature
	South-West Inshore Fisheries Group (IFG)	YES	Industry; marine planning	Referral; Reputation
	Wild Scotland (tourism)	No	Marine recreation	Referral; reputation
	Scottish Salmon Producers Organisation	YES	Industry	Grey literature
	SNIFFER	No	Sustainability	Referral

Stakeholders were arranged into groups A: Academics and Consultants; B: Central Government and Agencies; C: Non-Governmental Organisations (NGOs); D: Representative Bodies

* SAMS/RSPB as an organisation attended the workshop

B. 2: Round One: Scotland's Marine Protected Area Network: Guidance for climate change resilience

Briefing Material

Aims of PhD:

- To identify suitable guidelines for the management, monitoring, review and modification of MPAs in the context of climate change.
- To provide current academic knowledge on MPAs and climate change that will inform the Scottish MPA process.
- To improve policy guidance for the future management and monitoring of Scotland's MPA network.
- To provide advice based on the collective experience of Scottish and international MPA stakeholders on how best the MPA network can be managed, monitored and reviewed in order to ensure that it meets its objectives in the face of climate change.

Rationale for the research:

- MPA implementation has rapidly increased worldwide but with limited consideration of future climate change.
- The implementation of a "well managed" network of MPAs is a key element of Scotland's marine plan and has major implications for nature conservation and commercial users of Scotland's seas.
- Given the cost of setting up the network and the opportunity costs that marine businesses may incur it is essential that the network is regularly reviewed to determine whether it is achieving its objectives.
- Climate change is likely to affect the species composition of MPAs over time and the suitability of individual MPAs for the search features they were designed to protect.
- Consideration of climate change at this point will improve the ability of Government to design the proper management, monitoring and review mechanisms to allow the network to meet its objectives
- As we have limited experience in Scotland with the long term monitoring of MPAs we sought international experience from countries with large and long-established networks. This work demonstrated problems of stakeholder engagement and in MPA review mechanisms. It is hoped that early recognition of these challenges can avoid similar problems in Scotland.

Objectives of the survey:

- Involve a representative group of interested parties with a wide knowledge and experience of MPAs and the marine environment in a climate change context.
- To use a participatory approach and dialogue between parties to reach a consensus on practical actions for incorporating considerations of climate change into the management and monitoring of MPAs.
- To develop a set of guidelines for managing and monitoring MPAs in the context of climate change.

The Survey Process:

The flowchart diagram (Figure B.1 overleaf) is given as an overview of the research process. The adaptable nature of this process may see the subject matter for each round change depending upon the responses gathered. The research process is designed to allow for the contribution of various perspectives and my role is to frame the ideas, feeding back responses and perspectives to aid discussion.

The first round is in questionnaire format and seeks an open response to the guiding questions. It is intended that as a participant you are free to elaborate on the issues presented which reduces any bias from myself as the researcher (due to the questionnaire format).

The second round will use the collated information gathered in the previous round and feed this back anonymously to each participant along with additional questions.

In the final round you will be invited to attend a one-day workshop event with myself as the researcher and the other survey participants. The aim of the workshop will be to use the responses of the first rounds to identify a series of guidelines for managing/monitoring/reviewing the Scottish MPA network in the context of climate change. You will then be asked to comment on the suitability of these guidelines.

Throughout the process you are invited to comment freely with reference to the subject matter discussed or the research process in general.

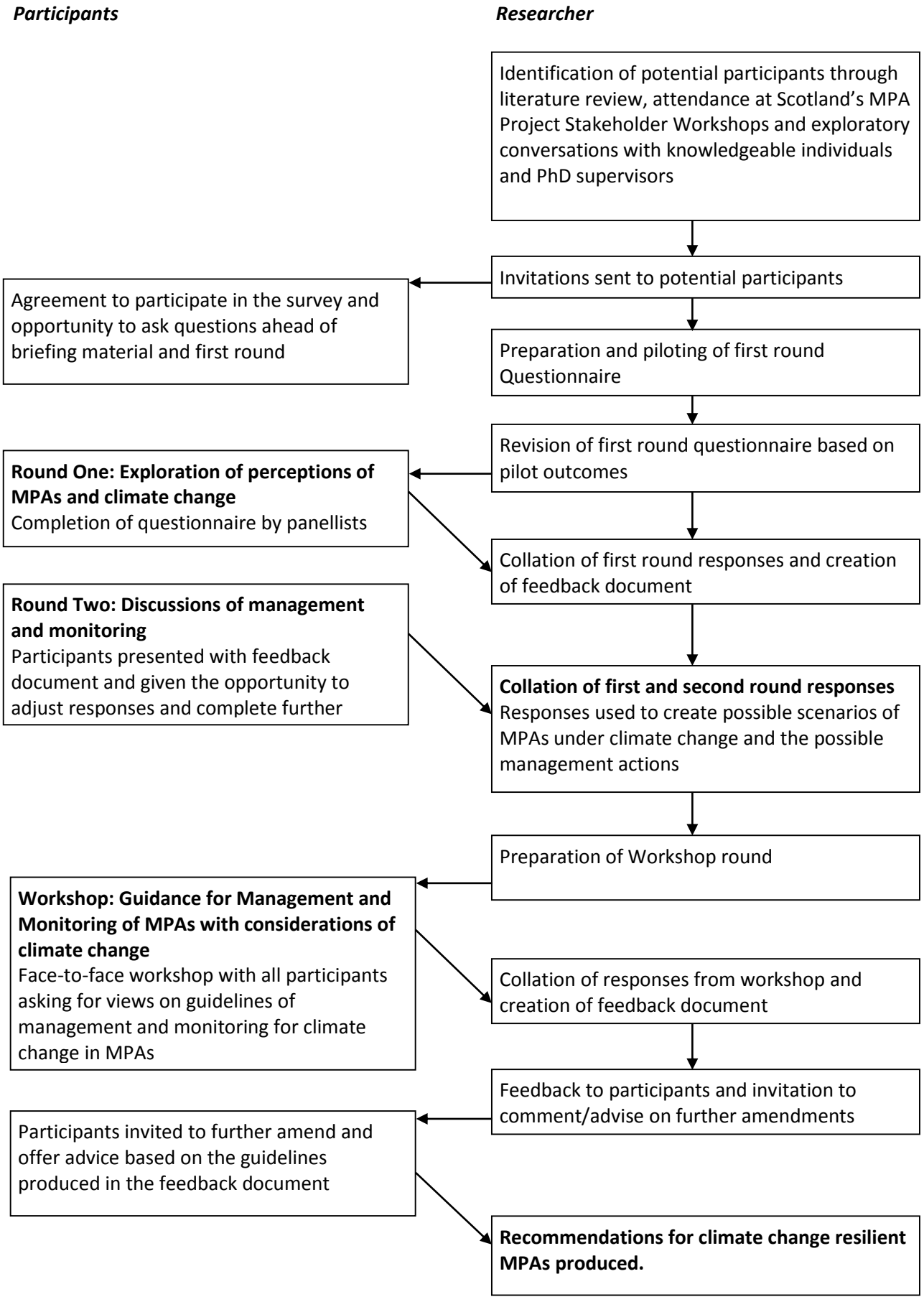

Figure B.1 Flowchart of the proposed survey process

Name of Researcher: Charlotte Hopkins

Name of Participant: _____

Please fill in the questionnaire below expanding text boxes where necessary.

We are looking for your perspective as an individual, but where you feel you can represent the wider views of people in your industry, government or NGO sector we would welcome this too.

Section 1

Exploring perceptions of successful MPAs:

· In general terms, what does a "successful MPA" mean to you?

· Do you think that the Scottish MPA network will achieve your view of a successful MPA? Please explain your response.

· What are the criteria for/ indicators of a successful MPA/MPA network?

· What role should MPAs have in the wider marine environment?

Section 2

Relating Criteria of successful MPAs to climate change:

· How do you expect climate change to impact certain marine species/features protected within the Scottish MPA network? Please use examples where appropriate.

· How do you expect the Scottish MPA network to perform under climate change?

Section 3

Initial explorations of climate change, management and monitoring of MPAs:

· Do you think that the planned management and monitoring of the Scottish MPA network will take into account climate change?

· Identify the constraints to implementing considerations of climate change into MPA management/monitoring.

· Identify the factors that will enable considerations of climate change to be incorporated into management.

· What do you think should be monitored in order to assess whether individual MPAs or the network as a whole is successful?

· Identify practical/feasible/on the ground options for management if climate change impacted upon an individual MPA/the whole network.

· Identify practical/feasible/on the ground options for monitoring if climate change impacted upon an individual MPA/the whole network.

Section 4

Reflections on the Process:

· Do you have any comments on the potential benefits of research using this survey process?

· Do you have any concerns about using this process?

· What do you see as the potential benefits/relevance of this research?

· Do you have any suggestions for improvement?

· What are your desired outcomes from this research?

· Would you like to add any additional comments?

Print Name:

Date:

B.3: Round Two: Scotland's Marine Protected Area Network: Combined Questionnaire and Feedback Document

This document summarises the findings of the initial questionnaire with six members of the panel representing a diverse range of stakeholders of the Scottish MPA project. As previously stated in Round One the ultimate aim of this research is to identify a set of appropriate **guidelines for considering climate change** in the management and monitoring of Scotland's MPA network.

The next stage of the research will begin to develop these guidelines, based on your responses to this questionnaire leading into a final workshop event. This process will ensure that the resulting set of guidelines will take into account a variety of stakeholder opinions and knowledge.

In the previous questionnaire we **developed a context** for these guidelines by exploring the perceptions surrounding successful MPAs and the **role of MPAs in the wider marine environment**. The identification of these guidelines will contribute to policy guidance on future management and monitoring of Scotland's MPA network.

This document is organised under a series of headings and uses anonymous quotations to illustrate points. This is intended to give you a general feel for the range of ideas and opinions of the panel as well as highlight areas of debate. The responses from panellists have been collated and summarised.

Below the feedback points are **9 questions**, please answer these questions and use as much space as you require. **It is recommended you read the entire document prior to answering the questions.**

By the end of this process we aim to identify:

- ***What content is needed in a set of guidelines for people responsible for MPA management and monitoring enabling them to account for climate change***

Once again thank you for your continued participation in this research!

Section 1

This section explored the panel's range of perceptions of successful MPAs in the context of the Scottish MPA Network. It is necessary to understand how the Scottish MPA Network corresponds to views on the wider marine environment in order to successfully implement management and monitoring guidelines for the network in a broader policy context.

What does a "successful MPA" mean to you?

Objectives

The panel was in agreement that clear objectives need to be set and achieved. Several panellists referred to the "conservation objectives" for individual MPAs as part of the Scottish MPA process.

Restoration

Two panellists suggested that a successful MPA would "ideally restore" *Panellist 6* and "improve in biodiversity" *Panellist 3*. It was stated by one panellist that the overall ecological decline in Scotland's seas should be addressed through the designation of the proposed MPAs.

Enforcement

Three panellists agreed that for an MPA to be considered successful it should be enforced. One panellist suggested that:

"[with] buy-in from all relevant stakeholders in a culture of support, compliance and self-policing [the] enforcement resource burden [would be minimised] - but also be strong enough to deliver a real benefit". Panellist 2

Monitoring

Two panellists mentioned monitoring as a way to assess the success of MPAs. One suggested that "monitoring and surveillance through a variety of techniques" *Panellist 3* would be needed to assess progress towards conservation objectives.

"Monitoring and assessment work should enable feedback to marine users on wider ecosystem services and benefits rather than only focusing on the "features" of direct conservation interest." Panellist 5

Wider Ecosystem

Most panellists framed the success of MPAs in the context of a wider network with some framing the network in terms of wider management. The term "ecologically coherent" *Panellist 6* was used by one participant which relates to the OSPAR advice for MPA networks.

"The designation should be developed within the strategic context of protecting (and where appropriate enhancing) the structure, function, processes and biodiversity of marine ecosystems to enhance resilience to human pressures and wider environmental change." Panellist 2

Stakeholder support

It was widely accepted amongst the panel that the success should not only be reflected in biological terms but also through the amount of support from stakeholders.

"The value and role of the individual MPAs should over time become recognised by a broad range of stakeholders for services that they can associate with, winning over current scepticism." Panellist 5

Sustainable Use

One panellist (*Panellist 1*) thought that "controlled/managed access for sustainable fisheries" was an important aspect to success.

Science

One panellist noted that "the MPAs should be identified using sound science". *Panellist 5*

Q1. Do you have any comments on the above points regarding the perceptions of MPA success? You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

Do you think that the Scottish MPA network will achieve your view of a successful MPA? Please explain your response.

Yes

Three panellists had positive comments for the Scottish MPA network in achieving the view of a successful network.

- Arrangements made to achieve each step
- Transparent and participatory process
- Site level objectives for individual features should be achieved assuming appropriate management is in place and enforced

No

There were some concerns raised by nearly all the panellists, the majority of the concerns relating to management of the MPAs.

- The level of protection is unclear. There does not seem to be enough protection or changes in current practises that will have an effect on success.
- The feasibility and strength of management measures to achieve the ambitious conservation objectives.
- Further clarity needed in terms of recovery:

  "i.e. whether buffer zones could enable recovery of the feature beyond its current extent" *Panellist 2*
- Implications for adaptive management
- Further research needed to understand the linkages between some activities/pressures and the protected features.

Additionally, there were concerns about the overall network design from two panellists.

- Targeted at rare and/or vulnerable species and a reduced list of Priority Marine Features, rather than an ecosystem approach.
- Primarily protects the best/healthiest examples of representative biodiversity rather than aiming to recover damaged/degraded sites.
- Limited potential to improve health of marine environment to historical baselines.

Finally, two panellists felt that fisheries management was a cause for concern.

- "[T]hey are not designed with fisheries benefits in mind" *Panellist 6*
- "In some cases, the Scottish Network appears to be taking on the wider network responsibilities within its own boundaries which may result in an unfair burden of restrictions on Scottish Fishermen (resulting in restricted access to sustainable fisheries". *Panellist 1*

What are the criteria for/ indicators of a successful MPA/MPA network?

The table below summarises the general themes that panellists suggested as criteria of a successful MPA/MPA network and uses the panel's suggested indicators which are related to those criteria.

Criteria	**Indicators**
Healthy MPA sites/marine environment	- Increases in diversity, habitat integrity and the abundance, size, age and reproductive output of a range of species (not likely to be linear or universal due to trophic and competitive interactions) - Species conservation/recovery (e.g. improved stock healthy as per ICES surveys) - Habitat conservation/recovery - Ecosystem service provision (e.g. healthy habitats supporting coastal fish and shellfish populations that can be sustainably harvested)
Good design	- Presence of OSPAR criteria for ecological coherence (with science developed, particularly in relation to connectivity and representivity) - Detailed future consideration of connectivity between sites - Assessment of whole network against relevant OSPAR assessment tests
Good management	- Clear, enforceable and communicated effectively to relevant stakeholders - Resources to ensure compliance leading to a culture of compliance and no evidence of infringement - Adaptive to changing status of species and habitats
Strong monitoring framework	- Appropriate timescales to the feature being monitored - Innovative partnerships with marine users to generate publicly accessible data - Socioeconomic impacts captured
Socioeconomic Benefits	- More robust/sustainable fishing industry - Thriving and sustainable marine tourism industry - Improvements in the wellbeing of all relevant stakeholders - Local support and buy in from a range of sectors supportive of the MPAs

"There are numerous possible indicators, but the fundamental goal should be a shift towards a more natural marine ecosystem" Panellist 6

"The Scottish MPA objectives seem to be founded on a sustainable use set of criteria. Using science to determine sustainable exploitation of the MPAs rather than a concept of complete protection". Panellist 3

Q2. Do you have any comments on the above points regarding the criteria and indicators of MPA success? You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

What role should MPAs have in the wider marine environment?

It is important to view the pMPAs in the context of the wider marine environment, that is to say, the marine environment that is not spatially represented within the MPA network. The following table summarises the key themes that emerged in relation to the role that MPAs should have:

Role	Comments
Healthy Ecosystem	Several panellists made comments that can be categorised under the broad theme of contributing to a healthy ecosystem greater than the individual MPA site. - Protection of ecological processes underpinning the structure and function of the wider marine environment - For species in unmanaged/non-designated areas, the pMPAs could provide a refuge/provide protection of movement corridors/ stepping stones for migratory species - Critical habitat protection for species whose range is not completely within a designated MPA, including nursery grounds for commercial fish - Recovery of certain habitats e.g. benthic communities - Increases in diversity, habitat integrity and the abundance, size, age and reproductive output of a range of species (expected to be non-linear) which contributes to the overall health of the wider marine environment.
Appropriate Use	Three panellists regarded MPAs as contributing to the wider environment through appropriate use, i.e. MPAs were not seen as appropriate in all circumstances or for all habitats or species. One panellist mentioned that MPAs should be viewed within the Scottish Government's 3-pillar approach to nature conservation and that in insolation they will not maintain the vision of a healthy, productive environment.
Socioeconomic Benefits	Two panellists mentioned that in addition to ecological benefits of MPAs, benefits in the wider marine environment in terms of socioeconomic improvements for a variety of stakeholders should be included.
Monitoring	The use of MPAs as a monitoring tool for the wider environment was proposed by two panellists. One panellist added that this would only work if to was designed to be transferable to the wider environment.
Broader policy	It was agreed by two panellists that MPAs would provide a focus for broader marine policy by drawing attention to marine management issues and discussions and help guide developers and planners. One panellists suggest that this in turn could create greater awareness and change public/industry perceptions when "interacting" with the marine environment as MPAs are an "easily communicable management tool" *Panellist 2*.

Q3. Do you have any comments on the above points regarding the role MPAs should have in the wider marine environment? You may wish to restate ideas (No word limit- please expand the text box if necessary)

Section 2

Relating Criteria of successful MPAs to climate change:

This section began to explore climate change in the context of MPAs and the Scottish MPA network. It highlighted the problems managers/monitoring agencies may face.

How do you expect climate change to impact certain marine species/features protected within the Scottish MPA network? Please use examples where appropriate.

Species/Habitat Impacts

- Anticipated that climate change will impact to a greater or lesser degree upon all of the marine species within the Scottish MPA network.
- Distributions- the range/extent of certain species will change
    - Polewards with ocean warming
    - At least one species of shellfish (the great scallop), increases in reproductive output and recruitment- similar effects possible in mussels and other shellfish which form biogenic reefs that are a focus of the proposed MPA network- possible short term benefits
    - Medium to long term loss of some MPA features/migratory species no longer utilising MPAs
    - Sea temperature changes will push "northern species" further north, beyond UK waters
    - Southern end of range of species most noticeably affected by warming
    - New species to colonise from the south
- Changes in ecosystem structure due to altered competitiveness
- Timing of the spring algal bloom affected- species could be put out of phase
- Increased extreme weather conditions impact breeding and winter survival of marine and coastal birds
- Sea level change affected salt marsh habitat
- Cetaceans-
    - Directly affected via shifting thermal boundaries e.g. white beaked and common dolphin ranges around the UK
    - In direct effects to prey species e.g. minke whale dependency in Scottish waters upon distribution and availability of sandeels, herring and sprat.
- Mix of biodiversity will change

Ocean Acidification

"[I]n the medium to longer term I am very concerned about the possible effects of ocean acidification on shellfish and other calcifying species such as cold water corals. MPAs will offer very limited protection from ocean acidification." Panellist 6

Panellist 2 mentioned that ocean acidification will affect certain species directly (e.g. reef building species such as flame shell and horse mussel) which will impact upon other species that prey on them/use the reefs as habitats.

"The knock on impacts of ocean acidification in Scotland's seas is still not well understood although research/monitoring in this area is expanding." Panellist 2

Fisheries Impacts

"There now appears to be strong views that climate change has been a significant factor in the reduction on cod stocks around Scotland and the southern North Sea." Panellist 1

"[C]hanges to the environment that stem from fisheries exploiting newly available stock, such as sea bass." Panellist 2

MPAs

"If established as refuges, with limits on the cumulative impacts of manageable pressures/activities, MPAs may provide areas that could be more resilient to these changes (and thereby help to maintain Scotland as a stronghold for the "northern species" mentioned earlier), and "stepping stone" for species experiencing range contraction/reallocation. However, for this to be successful, the purpose of the MPAs need to be less specifically tied to a designated feature, both in terms of the managed area within the site and the management measures implemented.

Wider ecosystem function needs to be considered in the establishment of these sites. By being prescriptive about the benefit/protection of specific biotypes only, the Scottish Government risks establishing a network of species and habitats that they will be mandated to retain/conserve, rather than enabling a more significant, broader ecological recovery of Scotland's marine environment." Panellist 2

General comments

"It is quite difficult to make predictions without further research and without knowing how greenhouse gas emissions/global climates will change in the future" Panellist 6

"The effects of climate change in the marine environment are not fully understood, clearly not straightforward and is likely to include unforeseen feedback, in particular from ocean acidification and changes in trophic chains" Panellist 2

"It is becoming increasingly clear that the impacts of climate change are complex and species specific and as such the impacts are largely unpredictable. Climate change may exacerbate the effects of other pressures currently viewed as acceptable/not damaging at low levels." Panellist 5

Q4. Do you have any comments on the above points regarding climate change impacts? Do you have any practical/feasible suggestions for managing and monitoring these impacts?

You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

How do you expect the Scottish MPA network to perform under climate change?

Most panellists agreed that the Scottish MPA network would perform well under climate change if certain aspects worked in practice.

Aspects enabling the network to perform well under climate change	
Adaptable	Three panellists mentioned the network being adaptable to cope with the effects of climate change, with mentions of boundary changes, focused action when/where needed, additional designations/de-designations and the underpinning legislation recognising change will occur
Resilience / Reduction of other stressors	It is hoped that the MPAs will provide resilience to the effects of climate change.
6 yearly review process	A mechanism for adapting the network
Facilitate Monitoring	MPAs may facilitate monitoring that will enable us to track these effects.
Aspects of expected poor network performance under climate change	
Ocean Acidification	Very difficult to deal with
Resilience through No-Take Zones	One panellist mentioned that it would be hoped that the network would provide resilience to the effects of climate change, but only if the MPAs are genuinely protected no-take zones.
Cetaceans	Failure to account for changes in minke whale and white-beaked dolphin due to inadequate number of sites (covering critical habitat) on the east and west coasts.
Replication	Having replicate sites would allow adequate buffers for populations using both areas to move both annually to account for stochastic variability in habitat/prey density and long term chronic variation
Sufficient size	Protected areas of sufficient size, with habitats replicated over sufficiently short distances. Current evidence cannot determine what minimum "sufficiency" is. Changes should not be assumed to be gradual.
6 yearly review process	This will not be sufficient if it is interpreted as a six year monitoring repeat period i.e. nothing will change until the next review (12 years after the current iteration of the network).
Current management regimes	Expected to perform badly with the recommended management regimes-entirely depends on how the management of the network is initially set up and how the Scottish Government plan to review it in light of adaptive management.
Climate Effects too severe	MPAs cannot prevent impacts of climate change at a specific location. Ultimately if climate effects are too severe the features may fail/die back/shift range or distribution.

Q5. Do you have any suggestions for how aspects of expected poor network performance under climate change could be prevented/mitigated? You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

Aspects of network performance	Comments
Ocean Acidification	
No-Take Zones	
Cetaceans	
Replication	
Sufficient size	
6 Yearly Review Process	
Current Management Regimes	
Climate Change too severe	

Please use this box to add any further comments about your answers or add any further options (no word limit, please expand the text box if necessary).

Section 3

Initial explorations of climate change, management and monitoring of MPAs:

This section developed ideas of climate change in management and monitoring and led to the start of identifying practical options for including considerations of climate change in the Scottish MPA network.

Do you think that the PLANNED management and monitoring of the Scottish MPA network will take into account climate change?

Yes

"There is an acknowledgement that boundaries and other aspects of MPAs may need to change in the future if our knowledge improves on the effects of climate change or the effects of climate change could be in some way mitigated by creating new MPAs." Panellist 3

"Yes- [Scotland] aims to monitor the state and condition of features in sites and at the level of the network as a whole to discern change and then identify possible reasons for change. There is also a power for ministers to take account of climate change in making a decision on MPA designations in territorial waters" Panellist 4

"Generic OSPAR principles of replication/connectivity/representativity/viability should hopefully provide some overarching protection in the face of climate change"

Panellist 2

"The monitoring of MPAs could adopt MarClim-style protocols relatively easily (some training requirements etc.) and without significant cost implications. The implementation of MSFD and the development of indicators and targets are taking climate change into account." Panellist 5

No

"No- During stakeholder engagement there seemed to be nil or minimal reference to impacts from climate change. Focus seemed to be on human activities and their associated pressures and impacts." Panellist 1

"[I]t is not clear that the network has been designed with assumptions about specific climate-induced changes in the marine environment…Planned management mechanisms do not appear to take detailed considerations of climate change into account." Panellist 2

"The planned management of MPAs in the Scottish MPA network is being driven by the sensitivity of the proposed protected features to pressures arising from activities known to be taking place within the sites. Climate change scenarios really aren't informing management at this stage." Panellist 5

Unsure/General Comments

"I am not aware of any detailed plans on how the performance of the MPAs will be assessed. Monitoring of the MPAs is mentioned in the guidance documents, but there is nothing on the details or frequency of the monitoring programme." Panellist 6

"It is recognised that there are limitations to the extent that network design/management can mitigate and adapt to climate change, but the main point here is that the presence of a largely unknown threat should lead to stricter planned management measures rather than a potentially de minimis *approach to protection and management which is currently a distinctly possible outcome of the MPA project." Panellist 2*

"Monitoring should certainly take climate change into account, but there is very little planned monitoring work being communicated publicly or to stakeholders who have engaged with the process". Panellist 2

Q6. Do you have any comments on the above points regarding planned management and monitoring and climate change? You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

Constraining Factors for considering climate change in MPA management/monitoring

Resources

One panellist felt that the overriding factor preventing climate change considerations being fully incorporated into the MPA process was a resourcing issue and that other constraints stemmed from the budgetary climate. Several other panellists agreed that resourcing was a constraining factor. Another major constraint mentioned was political will with sufficient funding to implement and the strength of short term economic considerations when developing network design.

Scientific Knowledge

"Reliable scientific measurement of effects solely attributed to climate change is difficult within a rapidly changing environment". Panellist 3

Nearly all the panel specified gaps in scientific knowledge as potential constraints:

- Likely threats to the protected features
- Resilience of protected features to climate change effects
- Mapping of carbon sinks/blue carbon opportunities
- Regional impacts for finer scale MPA management plans
- Developing agreed methodologies for predicting ecological change based on different temperature/sea level change scenarios that can drive network design

Management Considerations

"Some sectors already have significant concerns regarding the potential management consequences of MPAs associated with measures proposed where there is a very clear and well understood "cause and effect" relationship." Panellist 5

- Clarity regarding what would be managed differently and why
- Should we aim to maximise returns now before the inevitable happens or prolong returns through rigorous management delaying the inevitable?
- Attempting to turn MPAs into refuges/reserves to slow down the effects of climate change- not politically acceptable or ecologically justifiable at this stage.
- Need for acceptance of the need for better long term stewardship of our marine resources regardless of what features are actually being conserved

Monitoring Considerations

"The main constraint appears to be the fact focus on monitoring is aimed a human activity. Time period and need for continuous monitoring over a prolonged period also serves as a problem in that allocation of resources from Scottish Government may not be made available at this stage." Panellist 1

Constraints for monitoring included:

- Financing monitoring and action based on confirmed problem rather than a perceived problem.
- Resources (capacity and money)
- Establishing ongoing monitoring
- Identification of pragmatic methodologies and design of long term (decadal) sampling programmes with commitment to future funding
- Assorted physical parameters need to be measured which will require a cross cutting multiagency approach

Enabling Factors for considering climate change in MPA management/monitoring

- Assessment on a semi-regular basis
- Ability to adapt network over time
- Robust monitoring programme
- Better knowledge of likely threats to features and their resilience
- Opportunities from blue carbon
- Good scenario mapping e.g. sea level changes that could have within- near, and offsite implications for proposed MPAs
- Mapping of species known to be vulnerable to climate change impacts
- Good communication with stakeholders
- Processes like this one
- Better understanding of need/scope/consequences of adopting different approaches to management

- Include consideration of long term benefits (ecological/financial)

Design Principles

- Protect species and habitats with crucial ecosystem roles, or those of special conservation concern
- Protect potential carbon sinks
- Protect Ecological linkages and connectivity pathways for a wide range of species
- Protect the full range of biodiversity present in the biogeographic area

Q7. Do you have any comments on the above points regarding constraining/enabling factors? You may wish to restate ideas, add points or challenge points made (No word limit- please expand the text box if necessary)

What should be monitored to assess whether individual MPAs or the network as a whole is successful?

- Species and habitats that are the focus of the MPAs- both in sites and at a network level
- Monitor the full range of species and habitats at site level
- Secondary ecological benefits on non-target interests
- Components of the ecosystem known/thought to be particularly sensitive to climate change
- Monitoring change inside and outside the MPAs
- Physical changes including: temperature changes, plankton blooms, sea level rise
- Monitor the effects of the removal of certain pressures e.g. bottom impact gear
- Activity levels and distribution/compliance with agreed management measures
- Fisheries performance in surrounding areas
- Socioeconomic well-being of relevant stakeholders e.g. sustainable fisheries, ecotourism etc.
- Societal value and levels of support

"It is likely that Government agencies will roll its responsibilities for monitoring Natura sites, MSFD targets and the effectiveness of the MPA network into one. However, given the amount of work that has gone into the MPA strand of this work, it would be regrettable if the MPAs themselves did not receive dedicated monitoring coverage." Panellist 2

Practical Management Options

- Redrawing of boundaries to account for climate change and emerging evidence on ecological connectivity
- Zonal management boundaries for carbon sinks/MPA features
- Reduce other (potentially cumulative) pressures that are impacting on the features that are being negatively affected by climate change
- Using principles of adaptive management to add examples of healthy features to the conservation objectives of existing MPAs where those features are being adversely affected at other sites (restoring "replication")
- De-selection/Re-selection of certain sites
- Early assessment of possible mitigation options and the feasibility/practicality of implementing them

- Clarity over when the effects are climate related in order to make sensible and robust decisions.
- Accepting that the mix of marine biodiversity may change over time- a representative network may need to be adapted to reflect the change

"At no point should we spend £millions trying to maintain features within the network- either through restoration efforts or repeat MPA identification/denotification tracking shifts in feature distribution across and out of Scotland's seas." Panellist 5

Practical Monitoring Options

- Significant investment to conduct temporal and spatial biomonitoring surveys
- Survey the ranges of certain indicator species
- Flexible/adaptive to the arrival/presence of new interests (whether possible protected features or other such as INNS)
- Sampling regardless of MPA status or the establishment of a network of reference sites outwith MPAs if future funding/sampling have to be tied to the MPA presence
- Using a range of methods including: Still camera drops, towed video, Baited video surveys, diver surveys for ground truthing and sample collection where necessary and practical, satellite data for physical changes
- Destructive monitoring methods i.e. trawling should be kept to a minimum but may be necessary in some circumstances.
- Communication of monitoring work and celebration of achievements

For practical monitoring suggestions there were two conflicting ideas behind the time and spatial scales for monitoring. This conflict was identified by the panellists.

Site Level	Whole Network
Detailed long term monitoring of a few MPAs/species (those predicted to be most vulnerable) to spot climate change impacts	Likely to identify changes and may be more efficient
Disadvantages	
Less likely to identify changes, less efficient	Coarse granularity may miss effects on rare species

"We would need to monitor at time and spatial scales sufficient to separate out short term natural variability from longer term changes, but that will be expensive." Panellist 2

In the previous questions the panel identified a number of management and monitoring options for considering climate change.

Q8. In order to select suitable guideline options for management and monitoring, it is necessary to specify which options are most feasible/most important and those which are important but less feasible. Please use the table below to score answers using the following scale:

1= Must Have 2= Would like to have 3= Ideal (but not feasible)

Management Option	Score	Comments
Redrawing Boundaries		
Zonal Management		
Reducing Other Stressors		
Adaptive Management		
Additional designations/de-designations		
Assessment of mitigation options		
Inclusion of emerging evidence		
Assessment of management options for different impacts		
Replicating features within existing sites		
Acceptance of changing mix of biodiversity		

Monitoring Option	Score	Comments
Biomonitoring surveys		
Indicator Species		
Flexible/Adaptive to new interests		
Reference sites outside MPAs/MPA network		
Range of monitoring techniques used		
Trawling sampling kept to a minimum		
Communication of monitoring work		
Detailed long term monitoring at a few sites		
Whole network monitoring		
Physical changes monitoring		
Monitor the full range of species and habitats		
Societal value and level of support		
Socioeconomic well-being of stakeholders		
Activity levels distribution		
Components of the ecosystem sensitive to climate change		
Secondary ecological benefits on non-target interests		
Effects of the removal of certain pressures		
Fisheries performance		
Levels of compliance		

1= Must Have 2= Would like to have 3= Ideal (but not feasible)

Section 4

Reflections on the Process:

This section gave the panel an opportunity to feedback on the research method/research outcomes.

Benefits of research

Several panellists felt that the research was particularly relevant:

- useful to work in Scotland to develop and manage an MPA network that represents our seas as a contribution to wider networks- outputs supported by Marine Scotland and Scottish Government- provide a very useful indication and mandated guide for how
- stakeholders- continuing a stakeholder led approach to the design/management considerations for the MPA network

- improve ability to take account of climate change- relevance is clear that CC and its impacts are of pressing concern

Outcomes

All panellists provided their views on the research outcomes and what they hoped would be the result of this research, this is summarised below.

- Robust, effective, adaptable network of MPAs leading to healthier marine ecosystems and more profitable and sustainable livelihoods
- Document the success of creating an MPA network to justify the maintenance or expansion of the network
- Consideration of climate change:
    - In a co-ordinated monitoring scheme
    - "[C]hanges associated with climate change do not result in inappropriate management measures on human activities" *Panellist 1*
    - "[K]eep climate change contribution to the MPA process in context- may have a fundamental shaping role in the longer term" *Panellist 5*
    - Acknowledgement that climate change is a complex issue
    - "A clearer understanding of how climate change pressures could and should be taken into consideration within the wider management and monitoring of MPAs- as one of many pressures in the marine environment" *Panellist 5*
    - To avoid inefficient use of resources
    - Practical and applied advice for practitioners
- Environmental considerations adequately represented
- Better understanding of other stakeholders' positions and views

Benefits of the research process

Two panellists responded with their views on the benefits of the research process:

- novel approach to heading off a potential future problem
- useful to gather a wide range of opinions, stakeholder knowledge and insight

Concerns

Two panellists raised concerns about potential outcomes of the research.

"If [the research] had no impact on the policy direction/design/monitoring of the emerging MPA network in Scotland" Panellist 2

Or if the conclusions of the research were:

"all is lost and that MPAs may not serve their original stated purpose in 50 years' time. Such conclusions could lend support to calls to stall the process and to go back to the drawing board" Panellist 5

Two panellists raised concerns regarding the realisation of the research benefits and outcomes:

"If stakeholders did not collectively commit the necessary time/resources to make it a valuable process" Panellist 2

The panellist felt that this could potentially lead to the research having no impact (as above).

"The benefits of this research would only be seen if suitable monitoring programmes focus on the climate change impacts as it appears (on the face of it) that current focus is on human activity and their associated pressures and impacts." Panellist 1

Q9. Do you have comments you would like to make about "Reflections on the Process"? Do you have anything to add at this stage? (No word limit- please expand the text box if necessary)

Appendix C: Chapter 4 Coding Framework

Table C.1 Round One Questionnaire Thematic Coding Framework

Success			**Climate change and Success**
Objectives	Network will achieve success	**Role in the wider environment**	**Impacts**
Clear objectives	Network will not achieve success	Healthy ecosystem	Species and Habitat Impacts
Restoration	**Concerns over management measures**	Appropriate use	Ocean Acidification
Improve biodiversity	Fisheries management	Socioeconomic benefits	Fisheries Impacts
Reversal of ecological decline	Fisheries benefits	Monitoring	MPAs
Enforcement	**Concerns over network design**	Broader Policy	**Aspects enabling the network to perform well under climate change**
Compliance	Recovery (conservation objective)		Adaptable
Resources for enforcement	**Criteria and Indicators**		Resilience
Monitoring	**Healthy MPA sites/marine environment**		Review
Feedback or monitoring results	Increasing diversity		Monitoring
Monitoring features	Conservation/Recovery		**Poor performance**
Monitoring wider ecosystem services	Ecosystem services		NTZs
Wider Ecosystem	**Good design**		Cetaceans
Ecologically coherent	OSPAR criteria		Replication
Resilience	Connectivity		Sufficient Size
Stakeholder support	**Good management**		Management
Recognition of value and role of MPAs	Enforceable		Severity
Sustainable Use	Resources		
Access for fisheries	Adaptive		
Justification	**Strong monitoring framework**		
Identified using scientific evidence	Timescales		
	Partnerships		
	Socioeconomic benefits		
	Sustainable fishing		
	Tourism		
Planned Management and Monitoring			
Yes	**No**	**Constraining**	**Enabling**

Changing boundaries	Reference to climate change	Resources	Design principles
Monitoring	Network design	Scientific knowledge	Monitoring
OSPAR principles	Sensitivity of features	Management/monitoring considerations	Review/adaptable
What to monitor			
Practical Management Options	**Practical Monitoring Options**		
Redrawing Boundaries	Biomonitoring surveys		
Zonal Management	Indicator Species		
Reducing Other Stressors	Flexible/Adaptive to new interests		
Adaptive Management	Reference sites outside MPAs/MPA network		
Additional designations/de-designations	Range of monitoring techniques used		
Assessment of mitigation options	Trawling sampling kept to a minimum		
Inclusion of emerging evidence	Communication of monitoring work		
Assessment of management options for different impacts	Detailed long term monitoring at a few sites		
Replicating features within existing sites	Whole network monitoring		
Acceptance of changing mix of biodiversity	Physical changes monitoring		
	Monitor the full range of species and habitats		
	Societal value and level of support		
	Socioeconomic well-being of stakeholders		
	Activity levels distribution		
	Components of the ecosystem sensitive to climate change		
	Secondary ecological benefits on non-target interests		
	Effects of the removal of certain pressures		
	Fisheries performance		
	Levels of compliance		
Reflections			
Benefits of the research	**Outcomes**	**Benefits of the process**	**Concerns**
Relevance and usefulness	Adaptable MPAs	Gather knowledge	No impact on policy/no impact

Improvement of MPA network	Monitoring programme		Conclusions

Table C.2 Round Two Questionnaire Thematic Coding Framework

Success		**Relating Climate change to management and monitoring**	
Scale	**Concerns**	**Long-term vision**	**Effective protection**
Conservation Objectives	Concerns for stakeholders	Commitment to resources	Management measures
Management measures	Uncertainty of judging success	Building resilience	
Precautionary principle	Concerns for monitoring	Wider enhancement vs direct impact	Feature based approach
Success at site level vs network level			
Wider environmental health		**Refining Feasible Options**	
Aspects of poor performance-mitigation/adaptation		**Management Options**	**Monitoring Options**
NTZs		Uncertainty	Monitoring for climate change
Cetaceans		Limited resources	
Replication		Adaptive management	
Sufficient Size		Concerns for management approach	
Management		Depend upon success definition	
Severity		Discussion of ranking options	
Ocean acidification			
Reflections			
Benefits of the research	**Outcomes**	**Benefits of the process**	
Relevance	Disseminated widely	Already useful	
Already useful			

Appendix D: Chapter 5 Focus Group Agenda and Prompts

D.1. Facilitator Prompts

10.00 Group Discussion Session 1

- What constitutes success for the MPA network?

- Exploration of expectations for the MPA network
- Difference between feature condition, site condition and whole network

11.35 **Group Discussion Session 2**

- What data do you need to establish success of the MPA network?

- How do we know if we are achieving our view of success
- What data do we need to attribute changes to MPA management or climate change?
- What do we need to monitor for a changing climate?
- What do we have already?
- How will the review process look?
- R&D MPAs- are these a possibility for monitoring the effects of climate change?

13.20 **Group Discussion Session 3**

- What are the possible policy/management actions needed in light of different climate change scenarios?

- What might happen and what might we do about it?
- Policy/Biological/Socioeconomic implications of those choices
- E.g. Feature MPA is designated for:
  - No change
    - (ecosystem healthy/in decline)
  - Increasing/ Healthy
    - (ecosystem healthy/in decline)
  - Decreasing
    - (ecosystem healthy/in decline)
  - No longer present
    - (ecosystem healthy/in decline)

15.00 **Group Discussion Session 4**

- How do we translate these ideas into action?

- Exploration of delivery methods for these ideas
- What would be useful to you?

15.30 Feedback and Whole Group Discussion

Appendix E: Chapter 5 Coding Framework

Table E.1 Focus Group Session 1 Success Coding Framework: Initial open codes (102) refined to (91) organised by theme

Factors that lead to success	**Indicative criteria of success**	**Wider marine environment**	**Feature-based approach**
Adaptive	Areas that can withstand use	Wider ecosystem benefits/processes	Failure of a site
Recognition of dynamism in the marine environment	Biodiversity	Management measures for wider environment	Valuing marine biodiversity
Clear objectives	Areas free from disturbance	Supporting each other- connectivity	Problems with a feature based approach
Any "failures" accounted for	Enhanced ecosystem health	Status quo vs. improvement	Feature vulnerability to climate change
Co-operation	Resilience	Scale (temporal and spatial)	
Using best available information	Network review	Conflict of objectives	
Connection to land based measures	Strong monitoring framework	Mobile species	Conflict of implementing all sites at once
Integration with other marine legislation	Level of engagement	Wider marine planning	A better process?
Good management techniques	Meets conservation objectives	Secondary benefits	
Recognition of connectivity	Connectivity (function)	Recovery	
Vulnerability assessment	No negative biological effects from displacement	Network definition and design	
Successful interaction between involved parties	Maintained ecosystem services	**Conflict of use vs. conservation**	
Effective protection	Sustainable use	Positive opinions for sustainable use	**Management**
Education	Sensitive features protected	Conflict between natural and used	Management measures to achieve success
Collective decision making	Representative of biodiversity	Public perceptions of use and conservation	Feature based management
Clear justification of sites	Feature recovery/maintenance/improvement	Conflict of spatial management	Strict management measures
Stakeholders support the network	Productive environment	Negative lack of care	Expected benefit and management

Resources available	Ownership, pride and stewardship	Least damaged more natural	Concerns about management
Scientific knowledge	Culture of compliance	Outside influences on MPAs	Fisheries management
	Equity of use or restriction		Adaptive management
	Levels of support		No-take
	No negative socioeconomic effects		
	Awareness	**Climate change**	
	Enhanced economic activity	Climate change and adaptability	
		Climate change and enhancement	
Uncertainty		Climate change resilience	
Uncertainty regarding success		Concerns (climate change) and implications	
Uncertainty about populations		Climate change selecting sites	
Knowledge gaps			
How to measure success?			
Scottish Process			
Targets for protection			
Three Pillar approach			
Opportunity for research			
Priority Marine Features			
Purpose of different MPAs			
Research and Demonstration MPAs			
Legal definition of success			

Table E.2 Focus Group Session 2 Monitoring Coding Framework: Initial open codes (49) refined to (47) organised by theme

Concepts of Monitoring		**Practicalities**	
MPA monitoring	**What to monitor**	**Methods of data collection**	**Limitations**
Trend data species and habitats (biological aspects)	Impacts	Towed video	Very little understanding of species
Site condition	Health	Public collection	Overwhelming
Achievement of conservation objectives	Climate change	BACI	Uncertainty
Recovery	Changing threats	Lab experiments	
	Presence/absence	Using existing data	
Climate change monitoring	Natural cycles	Research and Demonstration MPAs	
Gradient of sites	Fisheries data		
Indicator species	Measuring productivity	**Practical considerations**	
Invasive species	Benthic habitats	Responsibilities for data collection	
Physical aspects data	Socioeconomic indicators	Common sense	
		Long term monitoring	
Wider Marine Health	**Purpose**	Good data already	
Ecosystem function	Multi-target monitoring		
Network monitoring vs site monitoring	Purpose of monitoring		
	Describing success		
Sustainable Use/Multiuse management	Increasing effectiveness		
Activity monitoring	Identifying research priorities		
Adaptive management	Education and awareness		
	Conservation objectives		
Reference sites			
Inshore/vs Offshore sites			

Feature-based approach	
Long term changes	
Feature dynamics	

Table E.3 Focus Group Session 3 Management Coding Framework: Initial open codes (56) refined to (54) organised by theme

Feature Scenarios		**Values affecting view of management**	
Feature equal inside and out	**Examples**	Sustainable use	**Evidence**
Feature improving	Sound of Canna	Under protecting areas	Gaining more knowledge
Feature decreasing	Seabirds	Valuing species	Guiding principles
No- longer present	Sandbank	Recovery	**Monitoring**
	Burrowed Mud	Precautionary approach	Lack of monitoring
	Common Skate	Resilience	Need for monitoring
	Mobile Species	Maintain status quo	Monitoring at a site level
Management Options		Industry concerns	
New MPA	**Feature-based approach**	Ecosystem health	
Rebadge MPA	Problems with a feature-based approach	Consequential protection	
Review MPA	Inappropriate management measures	Justification for MPA	
De-designate MPA	Linking management to feature	Resilience	
Expand MPA		Representative	
Stop activity	**Considerations of deciding management measures**		
Identify reasons for decline	Caution at changing management		
Change management	Trust in decision makers		
Alternate management measures	MPA objectives		
Buffer Zones	Network approach		
Control Areas	Site specific		
Flexibility			
Research and Demonstration MPAs			
Approach			

Decision Tree	
Confusion	
Flexibility of approach	
Climate change impact	
Distribution change	

Table E.4 Focus Group Session 4 Reflections Coding Framework: Initial open codes (19) refined to (18) organised by theme

PhD Thesis	**Focus Group**	**Policy Feedback**	**Further Resultant Research**
Highlight the debate	Management Matrix	User friendly	Baseline data
Giving advice not direction	Logical structure	MCCIP Report card	Vulnerability assessment
Focused		Presentations	Ideas into action
In-depth analysis			Citizen science
			Monitoring
Climate change			
Uncertainty			
Site vs. network			
Proactive approach			

Appendix F: Chapter 5 Draft Management Matrix

Table F.1 Draft Management Scenario Matrix for discussion at the Delphi Round Three focus group

Priority Marine Feature	Site Condition	Feature at a Network Level	Management Action
No change	Healthy/ Declining	Healthy/ Declining	
Increasing	Healthy/ Declining	Healthy/ Declining	
Decreasing	Healthy/ Declining	Healthy/ Declining	
No Longer Present	Healthy/ Declining	Healthy/ Declining	