CEE review 06-002

ARE MARINE PROTECTED AREAS EFFECTIVE TOOLS FOR SUSTAINABLE FISHERIES MANAGEMENT?

Systematic Review Protocol

STEWART, G.B., CÔTÉ, I.M., KAISER, M.J., LESTER, S.E., HALPERN, B.S., BAYLISS, H.R., MENGERSSON, K., KABAT, T.J. & PULLIN, A.S.

Corresponding author: G. Stewart, Centre for Evidence-Based Conservation - School of the Environment and Natural Resources - Bangor University – Bangor – Gwynedd - LL57 2UW - UK

Correspondence: g.stewart@bangor.ac.uk
Telephone: +44(0)1248 382452

Draft protocol published on website: 01 December 2006 - Final protocol published on website: 28 March 2007

Cite as: Stewart, G.B., Côté, I.M., Kaiser, M.J., Lester, S.E., Halpern, B.S., Bayliss, H.R., Mengersson, K., Kabat, T.J. & Pullin, A.S. 2007. Are marine protected areas effective tools for sustainable fisheries management? CEE protocol 06-002 (SR23). Collaboration for Environmental Evidence: www.environmentalevidence.org/SR23.html.

1. BACKGROUND

Marine protected areas (MPAs, marine reserves) are becoming widely established across the globe (Halpern 2003) in response to two related policy drivers. Firstly, traditional forms of fisheries stock management are unsustainable as evidenced by the collapse of many fisheries (FAO 1994). Secondly, traditional management such as not exceeding maximum sustainable yield estimates, do not address the multiple anthropogenic impacts on marine biota. MPAs have been proposed as a mechanism to address both these problems by maintaining sustainable fisheries, whilst simultaneously preserving biodiversity (Plan Development Team [PDT] 1990, Ballantine 1992, Dugan & Davis 1993, Bohnsack 1996, Nowlis & Roberts 1997, Allison *et al.* 1998, Lauck *et al.* 1998).

MPAs are located in coastal (Micheli *et al.* 2004) and offshore habitat (Halpern 2003), in temperate and tropical biomes, and are designed to protect a wide range of taxa from plants and invertebrates (Edgar & Barrett 1999) to whales (Gerber *et al.* 2005), as well as the target species of commercial fishing efforts (Mosquera *et al.* 2000). Their success (or otherwise) has been monitored using a range of outcome measures. Recent quantitative reviews have synthesised parameters such as biomass, species richness, density (and other abundance measures), and organism size (Mosquera *et al.* 2000, Halpern 2003, Micheli *et al.* 2004, Kaiser *et al* 2006, Halpern *et al.* in prep). Theoretical models have also been employed to predict impacts (Gerber *et al.* 2005, others reviewed by Halpern 2003). The general consensus to emerge from this work is that MPAs are effective (COMPASS and NCEAS 2001, Halpern 2003). MPAs can rebuild stocks through enhanced recruitment and spill-over effects, maintain biodiversity, buffer marine systems from human disturbances, and maintain the ecosystems that fisheries rely on (MEA). However, some studies have found that MPAs have not effectively maintained biodiversity (Hilborn et al. 2004; Edgar and Barrett 1999; Willis et al. 2003). In many cases failure was due to either not including MPAs as part of a broader coastal management system or a lack of management funding, or enforcement (MEA). In addition MPAs can simply displace fishing effort to other areas and increase the vulnerability of other stocks and endangered species (Coleman et al. 2004).

Many other questions regarding effectiveness remain unresolved, particularly with respect to the impact of ecological and methodological co-variables or effect modifiers (Mosquera *et al.* 2000, Halpern 2003, Micheli *et al.* 2004). Variation in the effectiveness of MPAs has been explored in relation to a wide range of co-variables (effect modifiers, reasons for heterogeneity).

Taxa (family or functional groups: inveterbrates, herbivorous fishes, planktivorus/invertivorus fish, carnivorus fishes) (Halpern 2003), (trophic groups: herbivores, detrivores, omnivores, invertivores, planktivores, piscivores (Froese & Pauly 2006, Micheli *et al.* 2004), and genera (Mosquera *et al.* 2000) have all explained variation in species response to MPAs. Different groupings of species produce different results because weak responses of individual species may result in greater effect sizes when species are pooled in functional groups, and conversely strong individual responses may be obscured (Micheli *et al.* 2004); (this is a compelling reason to define subgroups prior to analysis). Phylogenetic relationships also pose problems of independence (Mosqueira *et al.* 2000) that are hard to address.

Reserve size (Halpern 2003), adult mobility (range) (Kramer & Chapman 1999), community composition (similarity index, Bray &Curtis 1957) (Micheli *et al.* 2004) organism size (Mosqueira *et al.* 2000), fishing intensity (Mosqueira *et al.* 2000) and habitat (Nilsson 1998, Kaiser 2006) have also been proposed as variables influencing the effectiveness of MPAs. Interestingly, there is consensus that size of reserves has little or no proportional impact, although there are lots of arguments (with theoretical support) for the creation of larger rather than smaller reserves.

As with taxa, problems with independence and standardisation hinder interpretation of other relationships. In particular, measures of fishing intensity around reserves (Nowliss & Roberts 1997) are difficult to assess because they change over time and it is difficult to compare fishing intensities from different parts of the world (Halpern 2003). The policy community is also interested in the impacts of connectivity (JNCC *pers comm.*). This is seen as a key element in terrestrial reserve design (Williams *et al.* 2004), but despite a large literature on issues of marine connectivity there are a paucity of data in a marine context.

Here we attempt to build on the existing syntheses using systematic review methodology (Pullin & Stewart 2006) to address questions regarding the effectiveness of marine protected areas. The use of a protocol will provide clear evidence of *a priori* reasoning and will allow the marine and meta-analytical communities to comment on methodology. Broadening the scope of the quantitative analyses will provide a larger sample size providing more statistical power to address the questions regarding variation in effectiveness, whilst simultaneously reducing the probability of confounding. The use of a transparent methodology will minimise bias and allow updating of the analyses when more data and more sophisticated meta-analytical techniques become available. The review will also allow discrepancies in the magnitude of effect between the existing syntheses to be explored. Cote *et al.* (2001) found a non-significant 25% overall increase in fish density in marine reserves whereas Mosquera *et al.* (2000) indicated a statistically significant 3.7-fold overall increase and Halpern (2003) an approximate doubling. Confounded baselines have been suggested as a primary reason for this variation (Edgar *et al.* 2004), which could result in widely different policy implementation regarding marine reserves. A further problem with existing syntheses is the over-representation of MPAs in tropical reef systems. This reflects paucity of knowledge regarding the impact of MPAs in temperate non-reef systems, particularly on soft sediments, and offshore (MEA, Kaiser *et al.* 2006.). Here we will examine any variation in effectiveness across habitats using marine classification systems to define subgroups, and will explicitly search for data from soft sediment systems.

2. Objective of the Review

2.1 Primary question

Are marine protected areas effective tools for maintaining fish stocks and other biodiversity?

Table 1: Definition of components of the primary systematic review question.

Subject	Intervention	Outcome	Comparators	Designs
*Marine Protected Areas	Implementation of fishing restrictions within MPAs	Change in biomass, density (and other abundance measures), species richness (and other diversity measures) and size (maximum mass and length) Change in other measured ecological metrics will also be collated and analysed where sufficient information is presented.	No restriction on fishing activity	Any primary studies providing measures before and after implementation of an MPA, or comparing MPAs to adjacent geographical areas without MPAs.

* Geographically defined areas subject to fishing restrictions ranging from no fishing to restricting practices or catch established for any purpose.

2.2 Secondary questions

Does the impact of marine protected areas on biodiversity or exploited fish species vary in relation to taxa, reserve parameters (especially habitat type) or organism parameters (size, mobility and life-span)

Taxa subgroups defined using: genera, families, trophic group's *sensu* Froese & Pauly (2006). Phylogenetic relatedness will be investigated where possible using ANOVA (with ln*R* as outcome variable) to identify the variation accounted for by each taxonomic level as a percentage of total variation in species ln*R* (Harvey & Pagel 1991). Subsequent meta-analyses will be run at the taxonomic level that accounted for most of the variance in species lnR *sensu* Côté.

Reserve parameters defined as size (area). Fishing intensity (target/non target species, and type of fishing gear).

Variation between tropical and temperate reserves will also be explored and subgroup analyses will be run using different habitat types and degree of existing modification (where possible). This is not as straightforward as it may first appear (Lourie & Vincent 2004). Fine-scale classification will be based on JNCC biotypes (Conner et al. 2004), medium scale classification will be provided by EUNIS (http://eunis.eea.europa.eu/habitats). Global classification will be provided by combining the relevant fishbase.org. Environment/distribution data (Froese & Pauly 2006).

Organism parameters defined as adult size (length and mass), mobility (migratory status *sensu* Froese & Pauly 2006, range and life-span).

3. METHODS

3.1 Search strategy

3.1.1 General sources

The following computerised databases will be searched:
1) ISI Web of Knowledge (inc. ISI Web of Science and ISI Proceedings)
2) Science Direct
3) Directory of Open Access Journals
4) Copac
5) Scopus
6) Index to Theses Online
7) Digital Dissertations Online
8) Agricola
9) CAB Abstracts
10) ConservationEvidence.com

Searches will use the following English language search terms:

Marine Protected Area
Marine Reserve
Marine & no take
marine AND (fishing OR fished OR fisher*) AND protect*

Additional searches to identify literature relating to soft sediments will be sought using the following search terms:

benthos OR benthic OR pelagic OR "soft sediment*" AND (fishing OR fished OR fisher*) AND protect*

An Internet search will also be performed using meta-search engines and recommended sites using a combination of the following terms: ((marine protected area OR marine reserve OR (marine AND no take) OR soft sediment) AND (fishing OR fished OR fisher*)):

http://www.alltheweb.com
http://www.google.com
http://scholar.google.com
http://www.Scirus (All journal sources)
http://knb.ecoinformatics.org/knb/metacat
http://data.esa.org/

The first 50 hits (Word and/or PDF documents where this can be separated) from each internet search will be examined for appropriate data which will be retrieved. All references retrieved from the computerised databases will be exported into a bibliographic software package prior to assessment of relevance using inclusion criteria.

Bibliographies of included material will be searched for relevant references. Authors of relevant articles will also be contacted for further recommendations, and for provision of any unpublished material or missing data. Raw data from the existing syntheses (Table 1.) will also be incorporated.

3.1.2 Specialist sources

Specialist websites will also be searched for relevant information, including the websites of all organisations listed in section 6.

3.2 Study inclusion criteria

- **Relevant subject(s):** Marine Protected Areas (Marine Reserves) defined as geographically defined areas subject to fishing restrictions ranging from no fishing to restricting practices or catch.
- **Types of intervention:** Implementation of fishing restrictions within MPA.
- **Types of comparator:** No restriction on fishing activity.
- **Types of outcome:** Biomass, Density (other abundance measures), Species richness (other diversity measures), Changes in size.
- **Types of study:** Any primary studies providing measures before and after implementation of an MPA, or comparing MPAs to adjacent geographical areas without MPAs.
- **Potential reasons for heterogeneity:** Taxa subgroups defined using: genera, families, and trophic groups (*sensu* Froese & Pauly, 2006). Phylogenetic relatedness will be investigated where possible. The impact of reserve size (area), fishing intensity (target/non target species, fishing gear type), adult size (length), mobility (migratory status *sensu* Froese & Pauly 2006, range) and life-span will be assessed. Variation between tropical and temperate reserves, latitude, habitat type and the impact of meta-analytical methods will also be explored. Additional subgroup analyses will be run in an attempt to explore the impact of degree of existing anthropogenic impact on the effectiveness of marine reserves although this may be difficult to standardise.

Initial assessments of study relevance will be undertaken by one reviewer assessing study titles (and abstracts). The repeatability of study inclusion will be verified by assessing a random subset of the references for relevance using a second independent reviewer. Agreement between the two reviewers must be substantial (kappa=0.6) before assessment of study quality and data extraction from full text articles can be initiated.

3.3 Study quality assessment

Study quality assessment is required to add quality co-variates to the analyses, as well-conducted studies have less potential for bias than their poorer counterparts. Generally, meta-analyses are weighted using inverse variance (Pullin & Stewart 2006). However, a previous synthesis of marine reserve data reports that weighting by inverse variance introduces bias, as otherwise robust studies are downweighted (Mosqueira *et al.* 2000). In particular, studies that employ linear rather than point sampling techniques have fewer replicates and therefore lower weight when combined. Studies were therefore weighted by area surveyed to generate estimates of abundance (Mosqueira *et al.* 2000). Although this allows combination of different sampling methodologies, it may be related to reserve size and is problematic where size is investigated as a reason for heterogeneity.

We will explore variation in these study quality elements by running analyses weighted by inverse variance, reef area surveyed, sample size, and (where taxa are combined to maintain independence) number of taxa and with inverse variance derived across taxa. Uncertainty arising from research synthesis methodology will be clearly communicated.

Further sensitivity analyses will be run to separate BACI data, from site comparisons and time series to address the quality of evidence hierarchy (Stevens & Milne 1997). This will allow exploration of the impacts of confounding identified as barriers to synthesis in previous work (Edgar *et al*. 2004). The impact of other data quality elements, associated with bias (Pullin & Stewart 2006) will be explored where they confound results or are associated with significant heterogeneity between studies. This will allow areas of uncertainty, arsing from differential methodologies used in the primary studies to be formally identified.

3.4 Data extraction strategy

Data extraction will be undertaken using a review-specific data extraction form *sensu* Lipsey & Wilson (2001). This will be piloted prior to use, to assess repeatability using independent reviewers and a selection of literature spanning a range of outcomes and data quality. Data extraction forms will be amended as necessary to ensure repeatability. Where necessary, missing data will be imputed from summary statistics or inferred. Sensitivity analysis will be used to explore the impact of any assumptions regarding imputed data.

As previously noted, data regarding MPAs is available at different levels of aggregation. Authors of existing meta-analyses will provide data at the level of aggregation analysed in their previous syntheses. Additional data will be extracted at the minimum level of aggregation presented. Sensitivity analyses and hierarchical Bayesian models will be used to explore the impact of level of aggregation. Funding will be sought for future work to disaggregate the dataset in order to examine the impact of further species level co-variates.

3.5 Data synthesis

Existing syntheses have been undertaken using qualitative synthesis (Lizaso *et al.* 2000), quantitative synthesis (Halpern 2003), and meta-analysis (Mosqueira *et al.* 2000, Micheli *et al.* 2004, Kaiser *et al.* 2006). These reviews illustrate that sufficient data with comparators are available for meta-analysis, but that investigations of heterogeneity are limited by data availability. Our synthesis will therefore consist of meta-analyses to address the primary question with meta-regression and subgroup analyses used to investigate reasons for heterogeneity between studies.

Meta-analysis is performed using a range of effect size metrics (Osenberg *et al.* 1999), but the log mean difference is recommended for analysis of marine reserve data (Mosqueira *et al.* 2000). This effect size is designed to measure relative differences (Goldberg *et al.* 1999, Osenberg *et al.* 1999), behaves better than natural response ratios (Rosenberg *et al.* 1997), and conceptually it is also easily interpretable. As well as choice of effect size, the magnitude of biologically significant effect sizes is often the focus of debate (Pullin & Stewart 2006). Here we make an *a priori* decision to minimise bias, and arbitrarily define significant effect sizes for fisheries as x2 (e.g. a doubling of fish biomass is biologically significant) and for biodiversity as a 20% increase. Relative measures are easily interpretable although absolute measures may be more informative, particularly where baselines are confounded. Here we use relative measures as stakeholder consultation failed to determine absolute measures for defining marine protected area effectiveness.

Statistical significance requires pooled effect sizes to be different from zero with an alpha of 0.05. Subgroup analyses and regressions will be adjusted for multiple comparisons within classes. Use of other metrics will involve post-hoc analyses and will require cautious interpretation in terms of defining effectiveness.

Combination of the effect sizes will be undertaken using a random effects model. Random effects models include inter-study variability (assuming a normal distribution); thus, when there is heterogeneity, a random-effects model has wider confidence intervals on its summary effect than a fixed-effect model. Here, a random-effects model is more appropriate than a fixed effect model, as we wish to investigate reasons for heterogeneity between studies. Publication bias will be investigated by examination of funnel plot asymmetry (Egger *et al* 1997).

Univariate random effects meta-regressions based on standardised mean difference effect sizes will be performed on all effect modifiers not subject to subgroup analysis. Multivariate metaregression will be undertaken for permutations where the number of effect sizes with data exceed ten. Log mean difference will also be analysed as a dependent variable in regression analyses and will substitute for formal meta-regression where variance cannot be extracted or imputed.

Additional analyses may be undertaken to explore the impact of meta-analysing *r*-type effect size estimators (Cooper & Hedges 1994) relating change in abundance to time and space should sufficient high quality data exist (BACI design only).

Hierarchical Bayesian meta-analysis will be used to integrate the sensitivity analyses and express the uncertainty arising from the analyses in a formal transparent and repeatable manner, as an alternative to arbitrarily selecting a single analytical method.

4. ACKNOWLEDGEMENTS

The authors would like to thank CEBC colleagues for their input as well as authors and subject experts who responded to our enquiries especially Nick Dulvy and Stuart Rogers.

5 Potential Conflicts of Interest and Sources of Support

There are no potential conflicts of interest to be declared.

This review is funded by the Natural Environment Research Council, UK.

6. References

Allison, G.W., Lubchenco, J. & Carr, M.H. (1998). Marine reserves are necessary but not sufficient for marine conservation. *Ecological Applications.* **8**: 79-92.

Ballantine, W.J. (1992). *The practicality and benefits of a marine reserve network. Submitted to the workshop on managing marine fisheries by limiting access*. Center for Marine Conservation and the World Wildlife Fund. Annapolis, U.S.A.

Bohnsack, J.A. (1996). Maintenance and recovery of reef fishery productivity In *Reef Fisheries*. N.V.C. Polunin & C.M. Roberts (eds.), Fish and Fisheries Series 20, Chapmen and Hall, London, U.K. 283-313.

Bray, J.R. & Curtis, J.T. (1957). An ordination of the upland forest communities of southern Winsconsin. *Ecological Monographs*. **27**: 325-349.

Coleman, F.C., Baker, P.B. & Koenig, C.C. (2004). A review of Gulf of Mexico marine protected areas: Successes, failures, and lessons learned. *Fisheries* **29**(2): 10–21.

Cooper, H. & Hedges, L.V. (1994) (eds.) *The Handbook of Research Synthesis*. Russell Sage Foundation, New York.

COMPASS and NCEAS (National Center for Ecological Analysis and Synthesis), 2001: *Scientific Consensus Statement on Marine Reserves and Marine Protected Areas.* Available at http://www.nceas.ucsb.edu/Consensus

Conner, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O., & Reker, J.B. (2004). *The Marine Habitat Classification for Britain and Ireland Version 04.05*. JNCC, Peterborough. ISBN 1 861 07561 8 (internet version).

Dugan, J. E. & Davis, G.E., (1993). Applications of marine refugia to coastal fisheries management. *Canadian Journal of Fisheries and Aquatic Sciences.* **50**: 2029-2042.

Edgar G.J. & Barrett N.S. (1999). Effects of the declaration of marine reserves on Tasmanian reef fishes, invertebrates and plants. *Journal of Experimental Marine Biology and Ecology*. **242** (1): 107-144.

Edgar, G. J., Bustamante, R.H., *et al*. (2004). Bias in evaluating the effects of marine protected areas: the importance of baseline data for the Galapagos Marine Reserve. *Environmental Conservation* **31**(3): 212-218.

Egger, M., Davey-Smith, G., Schneider, M. & Minder, C. (1997) Bias in meta-analysis detected by a simple graphical test. *British Medical Journal* **315**: 629-34.

FAO (1994) Review of the state of world marine fishery resources. *FAO Fisheries Technical Paper*. **335**: 1-136.

Froese, R. & Pauly. D. (eds.). (2006) FishBase. http://www.fishbase.org.

Gerber, L.H., Hyrenbach, D., Zacharias, M.A. (2005) Do the largest protected areas conserve whales or whalers? *Science.* **307**: 525-526.

Goldberg, D.E., Rajaniem, T., Gurevitch, J. & Stewart-Oaten, A. (1999). Empirical approaches to quantifying interaction intensity: competition and facilitation along productivity gradients. *Ecology.* **80**: 1118-1131.

Halpern, B.S. (2003). The impact of marine reserves: Do reserves work and does reserve size matter? *Ecological Applications.* **13**(1): 117-137.

Halpern, B.S. & Warner, R.R. (2002). Marine Reserves have rapid and lasting effects. *Ecology Letters*. **5**: 361-366.

Harvey, P. H. & Pagel, M.D. (1991). *The comparative method in evolutionary biology*. Oxford University Press, Oxford.

Hilborn, R., Stokes, K., Maguire, J.J., Smith, T., Botsford, L.W. *et al.* (2004) When can marine reserves improve fisheries management? *Ocean & Coastal Management* **47**(3–4): 197–205.

Kaiser, M.J., Clarke, K.R., Hinz, H., Austen, M.C.V., Somerfield, P.J., & Karakassis, I. (2006) Global Analysis of response and recovery of benthic biota to fishing. *Marine Ecology Progress Series* **311**. 1-14.

Kramer, D.L. & Chapman, M.R. (1999). Implications of fish home range size and relocation for marine reserve function. *Environmental Biology of Fishes.* **55**: 65-79.

Lauck, T., Clark, C.W., Mangel, M. & Munro, G.R. (1998) Implementing the precautionary principle in fisheries management through marine reserves. *Ecological Applications*. **8**: 72-78.

Lipsey, M.W., & Wilson, D.B. (2001). *Practical Meta-analysis*. Sage Publications, California, U.S.A.

Lizaso, J.L., Goni, R., Renones, O., Garcia Charton, J.A., Galzin, R., Bayle, J.T., Sanchez Jerez, P., Perez Ruzafa, A. & Ramos, A.A. (2000) Density dependence in marine protected populations: a review. *Environmental conservation* **27**: 144-158.

Lourie, S.A. & Vincent, A.C.J. (2004) Using Biogeography to Help Set Priorities in Marine Conservation. *Conservation Biology* **18** (4): 1004–1020.

Micheli, F., Halpern, B.S., Botsford, L.W. & Warner, R.R. (2004) Trajectories and correlates of community change in no-take reserves. *Ecological Applications* **14**: 1709-1723.

Millenium Ecosystem Assessment. *Marine Fisheries Systems.* Chapter 18. 479-506. http://www.maweb.org.

Nilsson, P. (1998). *Criteria for the selection of marine protected areas: Report 4834*. Swedish Environmental Protection Agency, Stockholm, Sweden.

Nowlis, J.S. & Roberts, C.M. (1997). You can have your fish and eat it too: theoretical approaches to marine reserve design In *Proceedings of the eighth international coral reef symposium Smithsonian (2)*. H. Lessios & I.G. Macintyre (eds.), Tropical Research Institute, Balboa, Republic of Panama. 1907-1910.

Osenberg, C.W., Sarnelle, O., Cooper, S.D. & Holt, R.D. (1999). Resolving ecological questions through meta-analysis: goals, metrics and models. *Ecology* **80**: 1105–1117.

PDT [Plan Development Team] (1990). The potential of marine fisheries reserves for reef fish management in the U.S. Southern Atlantic. Contribution no. CRD/89-90/04. *NOAA Technical Memorandum NMFS-SEFC-261.*

Pullin, A.S. & Stewart, G.B. (2006) Guidelines for systematic review in conservation and environmental management. *Conservation Biology* (online corrected proof).

Rosenberg, M.S., Adams, D.C. & Gurevitch, J. (1997). *MetaWin: statistical software for meta-analysis with resampling tests.* Sunderland, MA: Sinauer Associates.

Stevens, A. & Milne, R. (1997). The effectiveness revolution and public health. In: G. Scally (ed.). *Progress in Public Health*. Royal Society of Medicine Press, London. 197-225.

Williams, J.C., ReVelle, C.S. & Levin, S.A. (2004). Using mathematical optimization models to design nature reserves. *Frontiers in Ecology and the Environment* **2**: 98–105.

Willis, T.J., Millar, R.B., Babcock, R.C. & Tolimieri, N. (2003) Burdens of evidence and the benefits of marine reserves: putting Descartes before des horse? *Environmental Conservation* **30**(2): 97–103.

APPENDICES - RELEVANT STAKEHOLDERS FOR CONSULTATION

Statutory/Governmental Advisory Organisations

JNCC (Joint Nature Conservation Committee)
IUCN
FAO (Food and Agriculture Organisation, section of the UN)
NE (Natural England)
CCW (Countryside Council for Wales)
SNH (Scottish Natural Heritage)
SEERAD (Scottish Executive Environment and Rural Affairs Department)
DOE(NI) (Department of the Environment, Northern Ireland)
EHS (Environment and Heritage Service, Northern Ireland)
DEFRA (Department of Environment, Food and Rural Affairs)
DARD (Department of Agriculture and Rural Development)
DAF (Departments of Agriculture and Fisheries in Jersey and Guernsey)
DAFF (Department of Agriculture and Fisheries in the Isle of Mann)
IEEP (Institute for European Environmental Policy)
EU/European Commission
CEFAS
EA (Environment Agency)
CA (Countryside Agency)
BODC (British Oceanographic Data Centre)
ICES (International Council for the Exploration of the Sea)
BEPC (Baltic Environment Protection Commission)
IOTC (International Ocean Tuna Commission)
CITES
IWC (International Whaling Commission)
CCSBT (Commission for the Conservation of Southern Bluefin Tuna)
IBSFC (International Baltic Sea Fishery Commission)
NSTF (North Sea Task Force)
US Fish and Wildlife Service
NOAA
EEA (European Environment Agency)

Charities/NGO's

MCS (Marine Conservation Society)
MarLin (Marine Life Information Network)
MSC (Marine Stewardship Council)
NASCO (North Atlantic Salmon Conservation Society)
WWF