Workshop on History of Marine Animals (H-MAP)

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Summary

A workshop to develop a research agenda and organizational structure of a multidisciplinary study called the History of Marine Animal Populations was held at the Center for Maritime and Regional History in Esbjerg, Denmark during 19-22 February, 2000. The Workshop was sponsored by the Sloan Foundation's Census of Marine Life project. The 27 participants included individuals from 10 countries with a wide range of historical, paleoecological, environmental and ecological expertise. The group received presentations of two case studies (the Grand Banks and the Baltic Sea) and nine more general reviews of fisheries historical and ecological data (cetaceans, Strait of Georgia, Northern California Current, White and Barents Seas, Japanese Islands, Latin America, South Africa, and Australian and New Zealand fisheries).

Participants developed a list of ecological and historical hypotheses that could be tested using both historical and current ecological data. They critically reviewed the H-MAP approach proposed in the prospectus by Holm, Smith and Starkey (1999), and identified refinements to the proposed methodology. They also reviewed candidate ecosystems where the H-MAP approach might be applied, identified ecological and historical hypotheses that might be tested, and identified several ecosystems for initial study.

Introduction

The History of Marine Animal Populations (H-MAP) was proposed by Holm, Smith, and Starkey ("History of Marine Animals Populations," 1999) as a long- term interdisciplinary project investigating historical and environmental archives that reflect marine animal populations over the past 500 years. The aim of H-MAP is to improve our understanding of marine ecosystem dynamics through interdisciplinary studies, specifically with regard to:

- the ecological impact of large-scale harvesting,
- long-term changes in stock-abundance,
- the role of marine resources in development.

Workshop Goals

This workshop was planned to developed a research agenda and organizational structure for H-MAP. The specific goals were to:

- articulate and agree on the aims and objectives of H-MAP, including identification of benchmarks or measures of progress,
- assess existing and potential sources of information for analyses,
- identify appropriate methods and arrangements to meet the objectives of H-MAP.

Agenda and Participants

The agenda for the workshop (Appendix 1) included presentations of case studies, review of the H-MAP prospectus, and identification of ecosystems and fisheries where the approach could most usefully be applied. The workshop included 27 participants (Appendix 2) with a wide range

of historical and scientific expertise and regional knowledge. The 19 working papers prepared for the workshop included both in-depth descriptions of the science and historical sources of better studied ecosystems and more general reviews of more poorly studied systems. These working papers, along with this report, are posted on the H-MAP website (http://www.cmrh.dk/hmapindx.html).

Case Study Presentations

Case Study 1: Implications from history on ecological effects of fishing on the Grand Banks

The three working papers were presented summarizing the ecological and historical issues for this region.

WP 1. David J. Starkey, "The Newfoundland Fisheries, c1500-1900: A British Perspective."

> The paper considers the range, quality and utility of the information relating to the fishery available in English archives and primary printed sources. Preliminary findings indicated that fish harvests fluctuated widely, attaining higher levels than previously thought. The paper concludes by suggesting that greater research effort in the English archives should produce data needed to evaluate the impact of human predation on the fishery resources of Newfoundland.

WP 2. Michael M. Barkham, "Recent Research on Spanish Fishing History: Assessing Historical Fish Catches in Spain in the 16th, 17th and 18th centuries."

> The paper reviews recent research on Spanish fishing history, outlines available archival sources, and considers the possibility of assessing fish catches during the period 1500-1800. The author concludes that while it will not be possible to obtain a complete series of quantitative data for all targeted species, additional statistical information is available that can produce a much fuller understanding of the historical Spanish fisheries.

WP 3. Ransom A. Myers, "Testing Ecological Models: The Influence of Catch Rates on Settlements of Fishermen in Newfoundland from 1710 to 1833."

> The paper argues that the settlement of fishermen in Newfoundland in the period can largely be explained by measures of performance of the fishery (*e.g.* the catch per unit effort,) and thus validate one of the predictions of the model by Gordon (1954, Economic theory of a common-property resource: the fishery. *J. Pol. Econ.* 62:124-142). The fishery appears to have been close to bionomic equilibrium over the entire time period; that is, the fishery was fully exploited for the type of gear and fishing practices used at the time.

In addition two working papers were prepared for the workshop were available but were not presented due to the withdrawal of the authors.

WP 4. Jeffrey A. Hutchings, "A Historical North American perspective of the Atlantic Cod Fishery off Newfoundland and Labrador, Including the Grand Banks."

Spatial and temporal variations in the exploitation of Northern Cod are identified in the paper. It is suggested that spatial shifts from areas of declining catch rates to areas of higher catch rates may have masked abundance declines and over fishing of local inshore stocks in the nineteenth century.

WP 5. Ernesto L pez Losa, "Fishing, Ecology and Society. A Note on Spanish Fisheries and Statistics (19th and 20th Centuries)."

The paper provides a short description of the fisheries in Spain during the nineteenth and twentieth centuries and the available data source. It is argued that sufficient data exist within official statistics and alternative sources to allow the reconstruction of longer and more informative series of general catches, and the paper briefly analyses two particular fisheries: the Spanish cod fishery in the North Atlantic and the anchovy fishery in the Bay of Biscay.

Case Study 2: Effects of aperiodic environmental fluctuations in the Skagerrak, western and eastern Baltic

The three papers were presented summarizing the ecological and historical issues for this region.
WP. 6. Brian R. MacKenzie, J rgen Alheit, and Daniel J. Conley, "Effects of Aperiodic Environmental Fluctuations in the Skagerrak, Western and Eastern Baltic: Ecological Perspective for the Historical Reconstruction of Fisheries."

The authors consider the fisheries of the Skagerrak and the Baltic, both in the medieval and modern periods, and emphasize the need for intensified historical and paleoecological research. The paper recounts previous analysis suggesting that the rise and fall of the Bohusl n herring stock was and is correlated with changes in the North Atlantic Oscillation. Variations in abundance of fish and marine mammal stocks in the 20th Century are discussed, and it is suggested that longer-term time series might elucidate the relative roles of climate and predation. The paper calls for analysis of both written and paleoecological records.

WP 7. Carsten Jahnke, "Possibilities of quantification in Medieval and Early Modern fisheries" The German Sources."

The principal German sources for reconstructing medieval and early-modern fisheries are identified: fiscal, housekeeping and private sources. The sources will allow for analysis of relative catches and fluctuations in the fisheries, but only estimates of total catches are possible.

WP 8. Poul Holm and Maibritt Bager, "Skagerrak and Baltic, historical perspective II: The Danish Sources c.1450-1800."

The paper reviews the available information on the Danish fisheries, by region, from the North Sea to the Baltic. Information gleaned from estate records revealed the diversity of Danish fisheries, the very high fishing effort of the late Middle Ages 1450-1590, and the steep decline of the fisheries in the following century. Possible causes of the decline are discussed, including climatic change, hydrological changes (especially salinity), species

competition, and economic factors such as changing dietary preferences and market competition.

Status and Potential Presentations

Eleven working papers were presented addressing ecological and historical aspects pertinent to various regions and species groups.

WP 9. Tim D. Smith, "Status and potential for reconstruction of cetacean populations."

Historical catch data have been used for reconstructing populations of eastern North Pacific gray whales, North Atlantic long-finned pilot whales and North Atlantic humpback whales. Issues concerning the data and techniques used to reconstruct pre-exploitation cetacean population sizes are reviewed. The potential for using historical catch data for testing ecological hypotheses is also described.

WP 10. Carl Chr. Kinze, "Catch statistics and catch levels of harbor porpoises (Phocoena phocoena) in the northern Little Belt 1715-1900."

Catch statistics for the 18th Century are presented as a first step in a planned re-construction of the history of the Baltic harbor porpoise.

WP 11. Villy Christensen, "Ecosystems of the past: how can we know since we weren't there?"

The use of the ECOPATH model to reconstruct past ecosystems and its application to the Strait of Georgia ecosystem is presented. The reconstruction provides a baseline to evaluate human impact on present day ecosystems.

WP 12. Robert Francis, "H-MAP and the northern California Current ecosystem."

Paleoecological analyses reveal that the abundance of commercially and ecologically important species in the Northern California Current vary due to large scale climate forcing. Plans for developing an ECOPATH model for the region are described, aiming at reconstruction of the system now, 100 years ago and 500 years ago.

WP 13. Julia A. Lajus, "Status and potential of historical and ecological studies of Russian Northern Seas."

The paper proposes to collect and analyze statistical data on the most important commercial fish species (cod, herring and salmon) in the Barents and White Seas. Reasonably valid data for these fisheries exist from the late sixteenth and early seventeenth centuries onwards. Comparison of data between different regions and different species should enable hypotheses to be tested about the key changes that have occurred in these ecosystems.

WP 14. Arne Kalland, "Historical and ecological studies of Japanese fisheries."

Japan is rich in source material for archaeologists and historians interested in the ecology of fishing. The material is, however, dispersed in semi-private archives and remain relatively

inaccessible. Few historical analyses are available, and there are structural difficulties to overcome in establishing more than local time-series before 1900.

WP 15. Hiroyuki Matsuda, "Status and Potential for Japanese Fisheries."

The paper discusses stock fluctuations using simulation theory. The model correctly predicts the replacement of the sardine by anchovy in Northwest Pacific waters, and proposes a cyclic advantage model to predict the next dominant species. Monitoring of the next two replacement events is required to evaluate the statistical significance of the hypothesis.

WP 16. Chris Reid, "Historical studies of Central and Latin American fisheries."

The paper describes the place of Latin America in modern world fisheries, and briefly considers the resources available for researching the history of the region's fisheries. Peru's fisheries are considered in some detail to illustrate several themes pertaining to fisheries development in the region.

WP 17. Lance van Sittert, "Status and potential for historical studies of South African fisheries."

The paper reviews historical records pertaining to exploitation of the marine resources of the South African west coast and Benguela coastal current. The historical data are potentially very illuminating of historical marine animal populations in the South-East Atlantic. The records of the unregulated nineteenth century fishery are the nearest thing we have to a sampling of the higher trophic levels of the system. It is proposed to compile data of marine life of a few locales drawing on the widest possible range of quantitative and qualitative records, and to compare findings against trends from similar marine environments on the west coasts of South America, North America and Australia.

WP 18. Malcolm Tull, "Status and potential for historical studies of fisheries in Australia and New Zealand."

The paper presents an assessment of sources for studying fish populations in Australia and New Zealand, including the published records of government fisheries departments and other agencies. Further research is needed to locate archival and other sources, especially in New Zealand. The paper shows that there is sufficient statistical material to establish long-term time series for the total catches, imports and exports of some major species.

Tom Polacheck supplemented Tull's working paper (WP 18) with evidence assembled by researchers at CSIRO of the existence of historical fisheries and trawl survey data dating to the beginning of the Southeast Australian shelf and slope trawl fishery around 1900. Preliminary analyses suggest that species composition may have changed following the onset of commercial fishing.

WP 19. Ransom A. Myers, "Testing Ecological Models with Historical Data: Synchronous Recruitment of Sardines (*Sardinops sagax*) across the North Pacific."

Based on historical catch data from Japan back to the mid sixteenth century and three series of scale deposition records from California and Mexico, the paper suggests that

paleoecological data may usefully be compared to historical data. The author suggests that this comparison provides evidence that synchronous fluctuations in sardines recruitment does not across the Pacific.

WP 19 was not discussed, and presents a conclusion contrary to those drawn by Alheit in WP 6. The workshop did not attempt to resolve these differences.
Finally, John Steele gave an oral presentation a on pristine ecosystem structure (Steele and Schumacher 2000, Ecosystem structure before fishing, *Fisheries Research* 44:201-5). This paper addresses the structure of marine ecosystems prior to intensive trawl fisheries, and suggests that unexploited ecosystems may have featured very slow growth rates of demersal species, very small pelagic fish populations, and/or more efficient transfer of primary production to fish.

Testable Hypotheses

The workshop developed an hierarchical list of potentially testable hypotheses about (1) the significance of anthropogenic changes in fishery patterns, and (2) the nature of ecological changes in exploited ecosystems, organized into six groups:

1. Historical records can be used to infer fish population and community structure, after accounting for anthropogenic factors;

2. Anthropogenic changes in fishery patterns include changes in socio-economic-political-demographic factors, technology, numbers of vessels and individuals in the fishery, and changes in knowledge;

3. Environmental forcing causes changes in abundance and/or spatial distribution;

4. Fishing mortality has significant impacts on population abundance and/or spatial distribution;

5. Changes in energy flows across trophic structure are due to environmental change or fishing mortality;

6. Diversity of marine animals has declined due to exploitation and habitat loss.

The first group of hypotheses is fundamental to the applicability of H-MAP. Historical records may be useful in the context of describing ecosystem structure prior to significant human exploitation, or alternately over a period of significant exploitation. The second group of hypotheses addresses those anthropogenic factors that have shaped the nature of exploitation. These factors are important to identify to understand historical settings and ecological interpretation of fishery records.

Participants discussed the relationship between the hypotheses in groups 1 and 2, noting that many hypotheses are unique to either anthropogenic of ecological processes. However, some hypotheses can be viewed from either discipline. An example is the suggestion by Myers (WP 3) and Hutchings (WP 4) that the geographic expansion of the Newfoundland cod fishery was induced by declines in catch rates. Geographic expansionThe former is usually considered an

historical question, while the latterdeclines in catch rates is usually an ecological question. Both perspectives need to be maintained to properly understand the development of the fishery.

Hypothesis groups 3 through 6 are more ecologically oriented. Group 3 addresses the effects of environmental forcing, distinguishing between amplitude and frequency of ecological changes, changes in temporal patterns, and episodic events. In contrast, group 4 addresses direct and indirect effects of exploitation on population abundance and spatial distribution.

Hypothesis groups 5 and 6 take a broader perspective, focusing on changes in overall trophic structure and species diversity, respectively. The first group identifies changes in community structure due to reduction of species in specific trophic levels (e.g. predators or prey), and due to physical habitat changes including pollutant loading. Group 6, in contrast, examines the effects of exploitation and introductions on animal diversity at both the species and population levels. Based on this discussion, the workshop participants agreed to the following list of hypotheses:

Ecological and Historical Hypotheses

1 - **Historical records can be used to infer fish population and community structure, after accounting for anthropogenic factors.** 1.1 - Records from light exploitation can be interpreted as sampling the population 1.2 - Records form heavy exploitation can be interpreted as measuring the effect of harvest
1 - **Anthropogenic changes in fishery patterns include:** 1.1 - Changes in socio-economic-political-demographic factors (e.g. price, markets, subsidies & taxation, food preferences, transportation economy, access to fishing grounds) 1.2 - Changes in technology (e.g. improvements in fish finding, navigation and catching technology, vessels, processing technology 1.3 - Changes in numbers of vessels and individuals in the fishery 1.4 - Changes in knowledge (e.g. accumulated experience, knowledge transfer, traditional knowledge, scientific knowledge)
1 - **Environmental forcing causes changes in abundance and/or spatial distribution** 1.1 - Highest amplitude variability at lower frequency (red noise spectrum) 1.1.1 - Centennial climate shifts (e.g. cooling of Greenland, mini-Ice Age) 1.2 - Widest spatial coherence occurs at lower frequencies 1.2.1 - Inter-annual fluctuations are local (e.g. reflected in year-class strength) 1.2.2 - Decadal shifts are ocean basin wide (e.g. North Atlantic Oscillation, North Pacific Oscillation) 1.3 - Changes in patterns of environmental forcing (e.g. saline intrusions to Baltic) 1.4 - Episodic events (e.g. Limfjord breaching, volcanos)

1 - **Fishing mortality has significant impacts on population abundance and/or spatial distribution** 1.1 - Direct changes: 1.1.1 - Decreases in abundance 1.1.2 - Contractions in spatial distribution 1.1.3 - Changes in age and size composition (e.g. changes in average size, changes in fish quality) 1.1.3.1 - Changes in demographic parameters 1.2 - Indirect changes in species composition: 1.2.1 - Switches in abundances of competing species (e.g. skates & flatfish North Sea; capelin-herring Iceland) 1.2.2 - Declines in predator's 'carrying capacity' due to harvest of prey (e.g. cod-capelin in Barents Sea) 1.2.3 - Changes in prey abundance due to changes in harvesting of a predator (e.g. Antarctic krill surplus, trophic cascading in Baltic)
1 - **Changes in energy flows across trophic structure due to environmental change or fishing mortality:** 1.1 - Predator switching prey (e.g. Pacific hake distribution and hence predation on forage fish) 1.2 - Changes in pathways from primary to secondary production (e.g +/- microbial loop) 1.3 - Relative abundance of demersal and pelagic species groups switches (e.g. Georges Bank, North Sea) 1.4 - Increases in invertebrate abundance (e.g. salps, squid, crabs, lobsters) 1.5 - Habitat change due to fishing or coastal and other development (e.g. NW Australia shelf) 1.6 - Changes in energy flows due to pollutant loading (e.g. Chesapeake Bay, Southern Seas, PCBs, heavy metals, sub-lethal effects) 1.7 - Megafauna structures marine communities (turtles, walruses, whales)
1 - **Diversity of marine animals has declined due to exploitation and habitat loss.** 1.1 - Changes in genetic diversity (e.g. DNA analyses of preserved specimens) 1.2 - Changes in population richness (e.g. loss of discrete spawning stocks of Atlantic herring, loss of substocks) 1.3 - Changes in species richness (number of species in the community) 1.4 I- ntroductions and invasions of species (hatcheries, starfish, zebra mussels)

Review of H-MAP Prospectus

The workshop reviewed the H-MAP Prospectus (Holm, Smith and Starkey,1999), and agreed that, based on the presentations made to the workshop, the approach outlined in the Prospectus could be implemented. Specific concerns were raised about the relationship between the historical and scientific disciplines identified in the Prospectus. The group agreed that the driving

force for H-MAP should be understanding changes in the structure and function of marine ecosystems over time, as influenced by environmental and anthropogenic factors.

Ecological, environmental and anthropogenic hypotheses are not always distinct, as noted in the discussion of the hypotheses above, for the relationship between spatial expansion and catch rates. Several other examples were given of this specific relationship (e.g. North Atlantic whaling in several centuries), and of other hypotheses that are important to both disciplines. A concern was raised about the relationship between "environmental archive" and historical archive data. Examples presented to the meeting (e.g. WP 12 by Francis) suggest that environmental archive data, such as paleoecological records, could be used to test ecological hypotheses even in the absence of significant anthropogenic effects.

The temporal definitions of the three eras identified (historical, proto-statistical, and statistical) are not specific to the time periods suggested (i.e. pre-1850, 1850, and post 1900). In some regions, for example Australia, it was suggested that the statistical period did not begin until the mid-20th century. In addition, examples presented to the workshop indicated that some anthropogenic and paleoecological data are available much earlier than 1500, the proposed beginning of H-MAP studies.

There was agreement that the time schedule for future work identified in the Prospectus needed to revised. A wider geographic perspective should be taken from the start, rather than an initial focus on the relatively better studied and perhaps better documented North Atlantic region.

There is a need for further work on the methodological aspects of testing both ecological and historical hypotheses. At the simplest level, there will be cases where ecosystem changes can be assessed using standard or extended statistical analyses. However, in many cases, more sophisticated ecological models will be required. Such modeling may involve simple mass-balance calculations (e.g. WP 11 by Christensen), or require the development of alternate static and dynamic models (e.g. Steele et al. 1999, WP 15 by Matsuda). Further attention needs to be given to appropriate methodologies, perhaps on a case-specific basis. However, analytic protocols should be identified at the outset of each project.

The group noted two possible orientations for historical studies, that of looking backward to determine what happened in getting to the present and the other of looking backward to predict what future ecosystem states might be under possible alternative management systems. The H-MAP Prospectus emphasized the former orientation, while the presentation by Christensen (WP 11) emphasized the latter. Participants agreed that while the H-MAP approach might provide information useful for management oriented approaches, they cautioned against including a management orientation because of the longer time frame required for development and testing of anthropogenic and environmental archives than for most management oriented studies. Further, management oriented studies frequently involve a much wider range of disciplines and participants, including stake holders, that required in historically oriented studies.

It was recognized that a strong central organization was required to maintain a focus on the hypotheses outlined, both within individual H-MAP studies of specific ecosystems and among studies in different systems. Such a structure will also to ensure a balance between historical and

ecological studies, especially as the emphasis between historical and ecological disciplines is likely to change over the course of multi-year studies. However, such studies will certainly require input from both disciplines. The balance between disciplines can not generally be defined in advance, but must be adjusted and fine-tuned as a project proceeds.

A steering committee is required to identify and design priority research projects, and to facilitate the organization of research teams. There is also a need for coordination among H-MAP projects to ensure that the cumulative experience is available to contemporaneous and future studies.

Regional Working Groups

Four regional working groups were defined during the workshop based on the degree of historical knowledge available: North Pacific, Southern Hemisphere, Western North Atlantic, and Eastern North Atlantic. Each group first addressed five tasks:

1. Define candidate ecosystems/fisheries.
2. Identify state of ecological knowledge for each system.
3. Identify anthropogenic and paleoecological archives.
4. Identify the types of ecological hypotheses that might be tested for each system.
5. Identifyied historical and ecological expertise.

The groups were also asked to identify one or more candidate ecosystems for initial study. and to outline the initial steps in such studies. The working group reports are included as Appendices, and brief summaries are given here.

Summary of Southern Hemisphere Working Group Report (Appendix 3)

Six candidate ecosystems or fisheries were discussed. Of these, two candidates were identified for initial study. One was the Southeast Australian shelf and slope ecosystem. Significant exploitation began in 1900, reducing the time frame involved. Further, anthropogenic archives within Australia are likely to provide a relatively complete history of catches. The task is essentially historical, however, because organized statistical procedures were not established until recent decades. In addition, fishery research trawl survey data from the beginning of the fishery have been identified. The combined use of trawl survey and fishery data were thought to be sufficient to allow some of the identified ecological hypotheses to be tested. A workshop would be the first step to determine how to proceed.

The second candidate study was identified involving a comparative study of four eastern boundary current ecosystems where paleoecological studies are underway: the California Current, the Humbolt Current, the Benguela Current, and the Canary Current. Although not all of these are southern hemisphere systems, the idea arose during this working group's discussions, and were subsequently extended by a sub-group. These highly productive systems have similar species mixes and experience strong environmental forcing. In addition, areas have been

identified where fish remains have accumulated in sediments in anoxic basins where there is little bioturbation. Fluctuations in the fish remains with depth in these sediments provide a chronology of fish population abundance, forming "secological archives" that are currently being examined. Hypotheses of similar temporal patterns of fish populations in different parts of the globe ("teleconnection") would be tested. H-MAP would provide a broader perspective to these studies, and could promote improved comparisons among the studies to allow comparative statements to be made. Initial work might be focused on establishing contact with the research groups, and encouraging other disciplinary participation.

Summary of North Pacific Working Group Report (Appendix 4)

Four candidate ecosystems were discussed. The group identified the steps required to undertake a study in this region, suggesting comparative studies between the British Columbia - Washington State ecosystem and the Sea of Japan - Inland Sea ecosystem. The importance of identifying additional expertise from a wider range of disciplines was noted, as was the need for a central organizational structure. Additional work needs to be done to determine appropriate time frames given anthropogenic effects and the environmental records relevant to physical forcing. The Working Group felt that constructing a present day (initial) model of the system, which included anthropogenic, ecological and climatological aspects would be the best place to start. Initial analyses should focus on developing anthropological snapshots, and trying to represent aspects of all human impact phases.

Subsequent to the working group discussions, it was suggested that an additional historical study of the Bering Sea would be useful to compare with the proposed Barents Sea - White Sea study proposed by another working group. Several aspects of the Bering Sea system were suggested as making it particularly worthy of study, including extensive historical fishing activity, large scale marine mammal exploitation, and excellent present day ecological studies.

Setting priorities for studies in the North Pacific will require additional discussion, and the inclusion of additional scientific and historical expertise.

Summary of North Atlantic - West Working Group Report (Appendix 5)

Three ecosystems and one fishery were discussed. The Newfoundland (including Grand Banks) system was selected for further discussion. The time period would be from 1500 AD, and encompass the area from the Davis Straits to the Scotian Shelf. Species would include cod, halibut, salmon, seals, whales, walruses and sea birds. Initial steps would include evaluation of Spanish and Portuguese archives, and evaluation of published catch and effort time series to identify future directions for archival research. It was noted that historical reconstructions of cetacean populations would most efficiently be done on an ocean basin wide basis because of the extended migration and harvesting patterns.

Summary of North Atlantic, - East Working Group Report (Appendix 6)

Twelve ecosystems were discussed, and two were selected for initial study. One was the Barents and White Seas ecosystem, and the other was the Baltic Sea. Preparatory work for the White-

Barents Seas project has already been advanced by the work of Julia Lajus. The key Russian archives have been identified and visited, and the general organization of Russian archival data has been described. Because of this preliminary work, it would be possible to conduct a feasibility study of the Russian archives at this time. Further exploratory work, including consultation with Norwegian historians and ecologists, will be required to address the Norwegian archives, but they should be substantially simpler and easier to access.

For the Baltic, the group felt that a preliminary planning workshop was needed to identify historical sources and expertise, to establish a network of experts, and to identify priorities for further work. Reports should be prepared for the workshop evaluating (1) the potential for paleoecological approaches, (2) the status of historical archives, (3) archeo-faunal evidence of fishing and marine mammal hunting, and (4) climatological evidence of environmental change.

Workshop Conclusions

Participants agreed that the approach outlined in the H-MAP Prospectus (Holm, Smith and Starkey 1999) for studying the History of Maine Animal Populations was viable, and had the potential to enhance both ecological and historical knowledge. Several specific points were noted.

1 - More specific ecological and anthropogenic hypotheses need to be identified. The workshop recognized the need to identify specific hypotheses for testing at the outset, and to incorporate these in the study design.
1 - Increased integration of scientific and historical disciplines is required as ecological and anthropogenic hypotheses are not always distinct. This integration is important to ensure that the intellectual basis for both the historical and the ecological components of such studies are both adequately accounted for.
1 - Methods of ecological analysis and modeling need to be identified, probably on a case specific basis. Although H-MAP studies may be useful in management oriented studies, the broader scope of participation required for such studies is not necessary for the application of H-MAP methodology.
1 - Completion of Phase I of H-MAP: Holm and Smith outlined plans for completion of Phase I of H-MAP. These include: 1.1 - Finalize workshop report, and post on H-MAP website (April, 2000). 1.2 - Arrange for publication of selected workshop papers in a companion volume to the International Journal of Maritime History, in book format, including overview chapter by Smith and Holm (to printers August 2000). 1.3 - Write a chapter for the Census of Marine Life funding document (by September 2000).

1 - The second phase of H-MAP should be expanded in geographic scope. More than 25 potential ecosystems and fisheries were reviewed and six systems were identified for further discussion. Initial steps were identified for projects in: 1.1 - the Barents-White Sea, 1.2 - the Baltic Sea, 1.3 - Newfoundland (including the Grand Banks), 1.4 - Southeast Australia, 1.5 - the four eastern boundary currents (Canary and Benguela Currents off Africa and Humboldt and California Currents off the Americas) 1.6 - The North Pacific, emphasizing mid-latitude near shore seas or the Bering Sea.
1 - A central organization of H-MAP is required to maintain a focus on the hypotheses developed, to identify and design priority research projects, and to ensure coordination among contemporaneous and future studies.

Holm and Smith thanked the participants for their enthusiastic participation, both in preparing papers and in spirited discussion during the workshop. This workshop is the beginning of an ongoing collaboration, and participants will be kept informed of future plans for H-MAP.