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Final Report

Recommendations for Conducting a

Collaborative Cod-Tagging Program for New England and Maritime Canada

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Conservation Department Based on input from fishermen and scientists

For consideration by the National Marine Fisheries Service and New England
Fishery Management Council Research Steering Committee

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Introduction

A number of U.S. and Canadian tagging studies have been conducted in New England and Maritime Canada's coastal waters since the 1920s as reported by Hunt and Neilson (1993) and Wise (1963). One of the more recent studies was the collaborative tagging project by Canadian and U.S. government scientists, which was conducted primarily in the Canadian Gulf of Maine from 1984 to 1997. Recently, fishermen have begun working with the University of Massachusetts/SMASST to tag fish in U.S. waters. However, there has not been a region-wide, federally-funded tagging effort in U.S. waters since Jack Wise's work in 1959.

Based primarily on an analysis of the semi-annual U.S. trawl surveys for the periods 1979 to 1981 and 1997 to 1999, National Marine Fisheries Service (NMFS) scientists have theorized that there has been a pinching down in cod distribution – that fish are compressed into a smaller area. Given the changes in historic abundance levels, and in the environmental and ecological conditions that have occurred over the past forty years since the last tagging effort, the proposed program could provide insight into whether there also have been shifts in cod distribution and migrations. It will augment the synoptic view of cod distributions in the Gulf of Maine, Georges Bank and Southern New England provided by trawl surveys. In addition, because of its large scope, it could help to address some of the data gaps in previous tagging studies.

This program also could provide short-term and long-term information on fish migration patterns, fish movement across closed area boundaries and fish growth rates. Furthermore, if some of the secondary studies are implemented, there is the potential to learn more about: 1) whether closed areas contribute to recruitment and stock recovery; 2) habitat/movement relationships; 3) finer scale inshore movements; and 4) the relationship between inshore and offshore areas.

However, what is precedent setting about this proposed tagging program is that it constitutes the first time that the fishing industry, using industry vessels, will participate as partners in such a broad-scale data collection effort. Through this multi-year program, it is hoped that existing communication barriers over data collection and usage can be overcome and relationships can be established between fishermen and governmental scientists based on trust and mutual understanding. This is particularly critical because a certain level of distrust and resistance to work together still exists among fishermen from various communities and between fishermen and government scientists as evidenced during community meetings.

Overall, the response to the program was quite favorable during the majority of local meetings conducted across New England. In some areas, 20 or more fishermen were in attendance and expressed an interest in participating in the program. Most of the support appeared to be from the inshore fishing community. Part of the reason for the lack of interest from the offshore community may be due to their high operating costs (an estimated \$3,000 to \$8,000 a day), which would probably make it infeasible for them to participate. A few members of the fishing community expressed reservations about investing money in a tagging program over other research activities (e.g., otolith studies, genetic studies, etc.). The Task Force concurred that there is tremendous value in conducting other research studies, as tagging fish alone will not answer all questions about cod. It is merely one tool for gathering more information. However, it also was recognized that when considered along with assessment data, genetic studies currently being conducted by New York University, and other existing data, tagging data could contribute to a more complete picture of the cod population. To maximize the value of the tagging effort, the Task Force strongly recommended that when each fish is tagged and recaptured that it also be measured to provide additional information on fish growth rates. It also recommended that fish samples be collected from each of the tag release sites to enable other research studies (e.g., genetics, age and growth, stomach content analysis etc. – See Ancillary Studies, in this report) to be conducted. In addition, the Task Force recommended that some funds be allocated for ancillary studies out of this year's collaborative research monies.

Some of the same fishing interests who expressed reservations about cod tagging in the first place, provided their own list of criteria that they felt must be considered if the cod tagging program is to be successful: 1) data must reside with a neutral nongovernment entity for a minimum of five years before any data collected from this program are used in policy development; 2) there be tagging consistency and that only scientists on dedicated trips be allowed to tag fish; 3) an analysis must be conducted comparing those tags from dedicated trips and returned by fishermen with those captured by scientists to ensure that the data sets are the same; 4) dedicated and paid tagging trips be used to maximize the number of fish tagged; 5) the program must be long term with assurances of long-term funding commitments; 6) prior to implementation the program design must define where, when and how many fish to tag; and 7) that tagging programs should be designed for all New England stocks.

In the development of this program, the Task Force has attempted to address these concerns to the best of their ability. Specifically, the Task Force is recommending that a neutral, non-government entity be established for housing and disseminating data over the short term; tagging be done primarily on dedicated, paid trips; and the program be long term in scope with the ultimate goal of expanding the effort to include tagging of other species. It also is providing guidance on where, when and how many fish to tag.

However, while limited offshore vessel participation may necessitate that government scientists work in concert with fishermen to tag fish in offshore areas, the Task Force maintained that the majority of the tagging should be undertaken by trained fishermen. The intent of this program is to foster working relationships between fishermen and scientists and to provide supplemental income to fishermen and a formal mechanism for them to contribute to scientific knowledge. The tagging procedure also is fairly straightforward and will require limited training. Nevertheless, the Task Force still recommends that all individuals interested in tagging undergo basic training and that a local trainer (local coordinator) accompany each fishing vessel on its first tagging trip to ensure tagging consistency.

In addition, the majority of Task Force members concurred that given that the charge of the Task Force was to define a scientifically credible research program, it was not appropriate for this group to make recommendations with management implications. So, it was not recommended that data be held for any set duration before being used in management decisions. A further point was made by one scientist that in rare instances extremely relevant information could be derived from a single fish movement. In addition, since management decisions must be based on "the best available science," any data collected from this program would have to undergo significant peer review by the Stock Assessment Review Committee (SARC) as well as the proposed Clearinghouse Steering Committee before it would be considered by fishery managers.

To further ensure the success of this program, there is a need to increase public awareness in Canada as it is anticipated that a portion of the tag returns will come from Canadian waters (some scientists estimate 20 percent or more based on previous tagging studies). Canadian fishermen must not only be made aware of this tagging effort and support it by returning tags, but also a reciprocal study should be undertaken in Canadian waters. Two members of the Department of Fisheries and Oceans and a member of the Non-Government Organization (NGO) community, the Center for Community-Based Management, have participated as members of this Task Force and have recently been awarded funding to conduct such a study. It is critical that the United States and Canada continue to collaborate after this preliminary design work is complete to ensure the coordination of these two programs should they both be funded.

This program represents the first step in a new direction for large-scale collaborative research in the region. If successful, it can provide a foundation for other tagging efforts and further cooperation among U.S. and Canadian fishermen and scientists. With every new program there may be initial resistance from some sectors, as well as technical issues that must be addressed. But generally, resistance dissipates once the program is successfully up and running (e.g., Oregon State University's FIRST Project, NMFS Southeast Cooperative Tagging Program for Highly Migratory Species and NMFS Cooperative Shark Tagging Program, etc.).

The key is to build and maintain support throughout the duration of the program. A strategic public awareness campaign can help maintain momentum. It must be made clear that the intent of this program is for research purposes -- to gather better scientific information that is understood and accepted by all parties, fishermen and scientists alike. Once the program is implemented more fishermen will begin to realize its benefits: 1) a participatory role in data collection for species on which they base their livelihood; 2) supplemental income; 3) new skills; 4) better information; 5) more timely access to information on individual fish movements; and 6) an enhanced public image of the fishing industry.

¹ Upon review of the Draft Report Recommendations for Conducting a Collaborative Cod-Tagging Program for New England and Maritime Canada, the New England Fishery Management Council urged that as soon as scientifically credible data are available, these data should be readily accessible so that fisheries can be managed effectively.

The first years of this program should be viewed in some ways as a pilot for building cooperation, gathering and turning around information to the fishing community in a timely fashion on individual fish movements and building a detailed, long-term database about cod movements and eventually other species in U.S. and Canadian waters. Ultimately, data collected through this effort can be used to help validate or alter current management measures. But that should not be the focus of this program; rather it should be a byproduct of gathering good scientific information. Lastly, this program should be part of a complementary suite of research efforts undertaken in the region, which together will enhance our understanding of this valued marine ecosystem.

Program Design

Program Objectives

- . • Develop a collaborative cod-tagging program between fishermen and scientists to build bridges and strengthen working relationships towards improved understanding of marine ecosystem functioning
- . • Improve understanding of current cod distribution and movement patterns throughout Gulf of Maine, Georges Bank, Southern New England and coastal waters
- . • Establish a foundation for future U.S./Canada, industry/scientific community collaborations to enhance understanding of shared marine resources (e.g., tagging programs for other species)

Statement of Work

Background

The New England Aquarium was contracted by the NMFS to develop recommendations for a multi-tiered cod-tagging program with corresponding funding levels. To this end, the New England Aquarium assembled a Task Force consisting of fishermen and scientists and held a series of eight Town Meetings with fishing communities in Portland, Maine; Point Judith, Rhode Island; New Bedford, Massachusetts; Gloucester, Massachusetts; Chatham, Massachusetts; Scituate, Massachusetts; Ellsworth, Maine; and Portsmouth, New Hampshire to help define research questions and key design elements of the program.

The following set of recommendations were derived from these discussions: 1) a large-scale tagging effort, using conventional (t-bar) tags in U.S. waters in the Gulf of Maine, on Georges Bank, in Southern New England waters and along coastal New England including tagging and tag retrieval inside U.S. year-round closed areas and in Canadian waters; 2) a pilot study using electronic tagging devices inside one closed area; 3) fine-scale movement studies using electronic tags in inshore areas; and 4) a reciprocal Canadian tagging study using conventional tags.

First, the proposed large-scale study will tag and release fish during the spawning season and thus recoveries should represent movement of post-spawning fish. It will sample all major spawning grounds and areas of high cod fish concentration along with some inshore areas, which historically were considered minor spawning areas in the scientific literature and where fishermen are seeing increasing numbers of cod today. In the latter case, Maine fishermen have reported seeing adult fish, over the past three years, in estuaries where they have not been seen for more than two decades.

* **Please Note:** *Italicized text denotes Author's Note or points of discussion where no consensus was reached.*

Despite a high interest in understanding the relationship between juvenile and adult distribution and movement patterns, the majority of the Task Force

recommended targeting only adult fish and opportunistically tagging pre-recruits (16 to 19 inches) throughout the duration of this tagging program. The consensus within the Task Force was that directed tagging of juveniles along with adults would expand the scope of the program, spreading limited resources over too many projects, thereby reducing the chances of collecting enough meaningful information to answer specific questions about adult movement patterns. Another concern expressed was whether there would need to be a more lengthy process to obtain experimental fishing permits if there was a directed effort to tag juvenile fish. However, it was pointed out that the need for permits might be mitigated if the fish are not retained and are returned to the water in good condition. The rationale for opportunistically tagging only pre-recruits rather than all juveniles was based on the experience of fishermen and scientists who have been involved in other tagging efforts. They found that tagging fish below pre-recruit size was much more difficult and could result in higher levels of mortality.

Nevertheless, fishermen identified spatial and temporal information about areas of juvenile concentration during the Town Meetings (See Figure 5). A hypothesis was even suggested that juvenile fish do not undergo significant movement patterns until they reach maturity. In the event that additional monies are allocated for tagging studies in the future, this list may provide a basis for determining appropriate tag release sites.

(Size range of fish is specified where it was indicated by the fishing industry)

- . • Southern New England inshore areas (Narragansett Bay)
(November to March)
- . • Little Georges (year round)
- . • Middle Bank (April)
- . • Wildcat Knoll
- . • Massachusetts Bay (in less than 20 fathoms of water, year round, 1 year old fish)
- . • In Massachusetts coastal waters from Cape Cod to Cape Ann (5 to 20 fathoms, year round, but particularly evident in winter)
- . • In Ipswich Bay (year round)
- . • Along coastal Maine (February to March, particularly in the last three years, two to three year olds, 15 inches and up)
- . • Along coast of Downeast Maine, around Vinal Haven and into Bays including Penobscot, Cobscook and Passamaquoddy (in shoal waters, out to 40 fathoms in winter months, reported to be filled with worms)
- . • Sheepscot River (most prevalent April to June)
- . • Casco Bay (most prevalent April to June)
- . • Cashes Ledge
- . • Along Jeffreys Ledge (northern section). Some fishermen refer to this as "the incubator."

Second, a recommendation also was made by the Task Force for a smaller-scale study of year-round closed areas using electronic tags. This study would

seek to answer more specific management related questions raised by the fishing industry during the Town Meetings. The industry was most interested in learning the value of closed areas and whether these areas constituted sinks (whether fish go in, but nothing comes out) or sources of recruitment and stock rebuilding.

Another advantage to this smaller-scale study is that it provides an opportunity to gather much more detailed information such as pressure and temperature, which can further aid in understanding not only where and when fish move, but why they move. It may provide new information about the relationship between habitat, in terms of environmental and oceanographic conditions, and fish movement patterns. Given the high cost of electronic tags, it is necessary to develop a more strategic approach to their deployment. This pilot project provides a cost-effective means to evaluate the use of electronic tags and to test the scientific methodology and sampling protocol. Contingent on the success of this initiative, and as costs of electronic tags come down, there may be the possibility of broader-scale application in the future.

Third, some members of the Task Force expressed an interest in understanding the role of coastal spawning areas, finer-scale movement patterns within these areas and the relationship between inshore spawning areas and larger, offshore spawning grounds. Some scientists and fishermen suggested using electronic tags in these localized studies as well. During the Town Meetings the fishing industry provided input on local movement patterns and suggestions for focus areas for smaller-scale studies.

Lastly, recommendations were made that a complementary tagging effort also be conducted by Canadian fishermen and scientists on Georges Bank/Coastal Nova Scotia, Browns Bank and in the Bay of Fundy.

Primary Study Research Questions

1. Are there multiple cod stocks throughout New England and southern Canadian waters?

1. 2. Do they undergo movement patterns between areas on a seasonal or other cyclical basis? *(Having a broad question like this allows individual project proposers flexibility in defining their own research questions. For instance, some of the specific interests identified during Task Force Meetings and Town Meetings could be asked and still contribute to answering this broader question such as: Are there movements between inshore and offshore areas? Do fish undergo significant northward migrations in the summer months?)*

2. 3. What is the rate of exchange between these areas? *(This is a more long-term question, which seeks to quantify movement patterns. It has management implications. Before it can be answered, program participants will have to answer the first two questions, which help to qualify movement patterns.)*

It is recognized that past studies have provided some meaningful information to help answer these questions. However, the coastal and marine ecosystem is a dynamic environment and there has not been a recent wide-scale tagging effort in U.S. waters. The question remains as to whether historic movement patterns of cod have changed. In addition, given the inherent distrust that exists on the part of the fishing industry over the current scientific information used to define stocks and fish movement patterns, it is imperative that a collaborative effort be undertaken between fishermen and scientists who are working together as partners to collect this information which will either validate current scientific evidence or demonstrate that there have been changes since the last U.S. tagging efforts in 1959.

Primary Study Deployment Options

For the primary study, three options are presented concerning the number of conventional (t-bar, floy) tags that could be deployed in U.S. waters. Option #1 is to deploy 25,000 tags primarily over a seven-month time frame when the thermocline is not a limiting factor; Option #2 is to deploy 50,000 tags over roughly a seven-month time frame; and Option #3 is to deploy 100,000 tags over a two-year time frame (50,000 tags per year).

The proposed tagging levels were derived from methodology developed by Robinson and Regier (1964). Assuming that the putative cod stocks are one group or a stock complex consisting of 50 million individuals, the requirements are as follows:

For $1-\alpha=.95$, $p=.5$ (assuming 50 million individuals) should be marked with 25,000 tags. For $1-\alpha=.95$, $p=.25$ (assuming 50 million individuals) should be marked with 40,000 tags. For $1-\alpha=.95$, $p=.1$ (assuming 50 million individuals) should be marked with 100,000 tags.

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This range represents various levels of precision from what the authors call “preliminary to management to research studies.” In other words, 25,000 to 100,000 tags is the range of marks as defined for doing population estimates. It would suggest less than 25,000 may be too few under most sets of assumptions and that in excess of 100,000 may be unnecessary. As this methodology is used for estimating population size, it requires a higher level of scientific rigor than may be necessary for conducting a tagging study to merely examine movement patterns. Nevertheless, since a key criticism of past U.S. tagging efforts is that there were extremely low return rates for some tagging sites, these higher deployment levels may yield a higher return rate per area and more statistically meaningful data.

Option #1 is in line with Canadian government plans to deploy 20,000 tags in

Canadian waters to coincide with the proposed U.S. program. It also is within the range of past regional tagging efforts (20,000 to 25,000 tags). Options #2 and #3, provide a higher level of precision and if the NMFS and the New England Fishery Management Council (NEFMC) would like to gather additional information to develop an independent estimate of stock abundance, they may be more viable options. However, achieving the latter will require some targeted recaptures of fish soon after they are tagged and released. It also may be necessary to gather additional ancillary data (e.g., genetics studies, age and growth studies) to complement tagging data to refine this estimate. Some genetics studies already are being conducted in the Gulf of Maine and on Georges Bank, at an estimated cost of \$100,000 annually, which should be continued and possibly expanded into coastal areas. The Task Force felt that it was critical that, at minimum, age and growth studies be conducted along with tagging for this program regardless of the level of tagging effort. Furthermore, if age and growth studies and possibly other ancillary studies are conducted, this could reduce some of the resistance to investing in a tagging program by addressing some concerns over the perceived value of tagging data alone.

There is some justification for deploying a higher level of tags -- seriously considering Options #2 and #3. First, the collective expertise (some 186 fishermen and scientists, many of whom are currently involved or have been involved in tagging projects) that attended Task Force and Town Meeting discussions recommended deploying, at minimum, 50,000 tags over the entire region. Second, the area to be covered is quite a bit larger than the area in the proposed Canadian program. Third, a higher level of tags deployed will enable a minimum of 5,000 tags to be deployed at 10 locations throughout U.S. waters, likely resulting in a higher return rate which will yield more statistically significant results. Lastly, this will enable program implementers to provide supplemental income to more fishermen because more fishermen will be needed to complete the tagging.

The Task Force also concurred that tagging in a second year would not only further enhance the precision of the tagging study results, but also provide valuable information on intra-annual variability, providing justification for why Option #3 also may be worth considering. In addition, several Task Force members maintained that 100,000 tags would provide much more detailed information about fish movement and distribution patterns and likely result in an even greater return rate.

The tags should be distributed in the Gulf of Maine, on Georges Bank, in Southern New England waters and along coastal New England primarily during the months of November through May to capture the majority of the pre-spawning and spawning aggregations. Furthermore, this time of year is thought to be the best time of year for tagging to maximize fish survival rates as water temperatures are cooler, there is no thermocline and fishermen can avoid bringing fish on decks during warmer summer months. One scientist suggested developing methodology to identify ripe-and-running fish. He maintained that in

some areas feeding and spawning fish may be intermingling. The duration of the program should be for a minimum of five years (preferably two years for actual tagging and three years for tag collection and preliminary analysis). According to Canadian government scientists experienced in cod-tagging efforts, the majority of the data will be retrieved over this timeframe: roughly 40 percent can be expected in Year 1; 20 percent in Year 2; 10 percent in Year 3; 5 percent in Year 4, etc. (personal communication with Donald Clark, Department of Fisheries and Oceans, 2001). However, it is expected that a small portion of tags may remain at liberty for a number of years. A mechanism must be in place for addressing tag returns should the program cease after five years.

In addition, a complementary study should be conducted in southern Canadian waters, which include northern portions of Georges Bank/the waters around southern Nova Scotia, Browns Bank and the Bay of Fundy. These three areas have been identified as genetically distinct stocks (Ruzante et al., 1998). Canadian government scientists who are serving on this Task Force have recently been funded to deploy 20,000 t-bar tags on various sized fish and reproductive stages at five or six sites within these broader areas. Of note are their plans to tag fish in Canadian waters adjacent to the Gulf of Maine. This is an area where Canadian fisheries have expanded in recent years and an area where further research may be warranted to provide a more realistic indication of stock affinity (i.e., the relationship between fish found in eastern Gulf of Maine waters and adjacent Canadian waters).

The U.S. may want to provide 25,000 tags (at a cost of \$ 13,750) for use in the Canadian study to ensure consistency in tags deployed and as an incentive for Canadian government support for a bilateral program. Whether or not the tags are provided by the United States, it is essential that should these programs both move forward, the same tags be used in each program. In addition, all tags should include a 1-800 phone number and both U.S. and Canadian return addresses. Just as there may be reluctance on the part of some U.S. fishermen from various regions to turn in tags, there also may be reluctance on the part of Canadian fishermen to turn in tags for a U.S. program. Providing Canadian fishermen, who most likely will capture a portion of the tag returns, with a 1-800 phone number and a national point of contact to which questions may be addressed may reduce some of the apprehension to turn in tags.

Furthermore, where possible, consistent recommendations have been made in the tagging program design for both programs (e.g., some of the Canadian program methodology has been adopted in this report and Canadian scientists also have incorporated elements of Task Force discussions in their tagging program design). As the U.S. and Canadian programs are implemented, it is important to ensure continued collaboration, perhaps requiring that all individuals who tag fish be trained in a consistent tagging technique and data collection protocol. Federal officials are encouraged to work together to help

ensure that this happens.

U.S. Tagging Locations

Tagging Studies should be conducted during the spawning season to capture migration patterns of the adult population in four regions: Gulf of Maine, Southern New England, Coastal waters and on Georges Bank. According to the Essential Fish Habitat Source Document for Atlantic Cod, *Gadus morhua*, spawning occurs year round with a peak in winter and spring. Within these broader geographic regions some potential tagging locations* and timeframes include:

| |
|---|
| GEORGES BANK REGION <i>(25-35 fathoms of water)</i> |
| <i>Northern Edge of Georges Bank</i> First Quarter, 2002 |
| <i>Along the Hague Line</i> Fourth Quarter, 2001 |
| <i>Great South Channel</i> First Quarter, 2002 |
| |
| SOUTHERN NEW ENGLAND REGION |
| <i>Coxes Ledge Vicinity</i> First Quarter, 2002 |
| <i>Nantucket Shoals</i> |
| <i>(7-20 fathoms)</i> Fourth Quarter, 2001 |
| |
| GULF OF MAINE REGION |
| <i>Massachusetts Bay/</i> |
| <i>Stellwagen/Middle Bank</i> |
| <i>(10-50 fathoms)</i> Fourth Quarter, 2001 |
| <i>Fippennies (southwest)</i> First Quarter, 2002 |
| |
| COASTAL WATERS REGION |
| <i>Ipswich Bay (25-50 fathoms)</i> First Quarter/Second Quarter, 2002 |
| <i>Casco Bay</i> End of First Quarter/and beginning of Second Quarter, 2002, to capture spawning fish |
| <i>Mt. Desert Rock/</i> End of Fourth Quarter, 2001/First Quarter/and |
| <i>Penobscot Bay</i> beginning of Second Quarter, 2002 |

* This list is not to meant to be definitive, particularly with respect to coastal waters. If a persuasive case can be made by individual project proposers during the NEFMC Research Steering Committee/NMFS Request for Proposals (RFP) process a number of other areas could be considered as tag deployment sites, as suggested in the following pages of this report.

Rationale for tagging location selections

The ten tagging locations were selected in an attempt to ensure a widespread dispersal of tags and sample inshore and offshore areas. When funding local

projects, program implementers should consider such a strategic allocation of resources to ensure adequate regional coverage. In most cases, these areas represent either major or minor spawning grounds according to historic literature, recent spring/fall trawl survey data and input from the fishing community during Town Meetings, Task Force discussions and one-on-one interviews.

The three Georges Bank locations identified, the northern edge in November through April (primarily January to April), along the Hague Line in November through April and in the Great South Channel in November through April (primarily February and March) are intended to capture major aggregations of spawning fish in this region. In Bigelow and Schroeder (1953) specific latitude and longitude coordinates were given (Lat/41° 21' to 41° 31'; Long/65° 50' to 67°) in waters less than 35 fathoms on Georges Bank. It would be interesting to see if concentrations of fish still are found at these specific coordinates. In addition, a small number of tags were deployed along the Hague Line during the Canadian tagging effort in the 1990s. Additional tagging in this area may further substantiate the preliminary findings of this latter study. Fishermen report seeing fish year round in the Great South Channel. Tagging in these locations will help to answer questions raised by fishermen and scientists about fish movement patterns into Canadian waters to the west, movement between Georges Bank and Southern New England waters (believed to be fairly substantial), the use of the Great South Channel as a migratory route north into coastal waters and whether there are other significant movement patterns which have not been detected. It also will provide some information about when these migrations are occurring. Furthermore, since two of the tagging locations are inside a closed area this will help satisfy the fishing industry request to learn more about how cod are using closed areas. In the case of the northern edge tagging location more can be learned about movement patterns into and out of the Habitat Area of Particular Concern.

The Northeast Peak of Georges Bank clearly continues to be an important area for cod spawning. Since it is in Canadian waters, it is hoped that the Canadians will include it in their tagging program.

In Southern New England waters, Coxes Ledge and Nantucket Shoals have been identified as potential tagging locations. Fishermen report the presence of cod year round on Coxes Ledge and it has been suggested that some spawning may be occurring in this area. According to the most recently published government assessment, egg densities are the highest in the general area around Coxes Ledge from November to April. Specifically, some local fishermen identified a swath of water from Block Island, southwest to Coxes Ledge and northeast to No Mans Land and Martha's Vineyard as areas where cod are present year round in small numbers. Spawning fish are reported to be around Nantucket Shoals from November through March. Bigelow and Schroeder (1953) identified Nantucket Shoals as an important spawning ground for Southern New England. Today, some fishermen

maintain that there are very few fish in the vicinity of Nantucket. Government surveys indicate that the highest concentrations of adult fish and eggs during winter and spring are found in the southwestern portion of Nantucket Shoals and to the west in the Great South Channel, up along the coast of Cape Cod from Chatham to Provincetown and into Massachusetts Bay as well as to the east along the Rhode Island coast.

Based on tagging studies conducted by Schroeder from 1923 to 1929, length frequency studies and sclerite counts of scales, it was thought that the stock of cod living on Nantucket Shoals was for the most part distinct from that of fish living to the north and east. Fall migrations were documented to Rhode Island and North Carolina. Schroeder also documented eastward movements to Chatham and the Great South Channel during certain summers. He further documented a relationship between Georges Bank and Southern New England waters which was supported by later tagging efforts. Much more needs to be learned about the relationship between Southern New England and Georges Bank and how much interchange takes place between these areas as well as about the number of fish moving northward along Cape Cod and into Massachusetts Bay. Tagging fish in the vicinity of Coxes Ledge and on Nantucket Shoals will enhance understanding of these and other critical relationships. It will provide some information about the interchange between Southern New England and Mid-Atlantic fish.

While there may be a case for tagging in both these locations, proposal reviewers are asked to remain open to other suggested locations put forth during the RFP process, provided the rationale for tagging in other locations is well substantiated (e.g., Nantucket Lightship).

A review of the scientific literature regarding the Gulf of Maine indicates that the major spawning grounds for this region can be found in Massachusetts Bay. Current trawl surveys indicate that Massachusetts Bay has large numbers of adults and high egg concentrations during the spring and fall seasons (highest egg concentrations are found here April through June and November through February), further substantiating Massachusetts Bay's value as a key spawning location today. Fishermen report seeing cod in these waters year round. Some fishermen have hypothesized that fish in these areas undergo a mini-circular movement pattern, mixing with fish from Southern New England and central Gulf of Maine waters. Tagging in Massachusetts Bay/Stellwagen (Middle Bank) may shed some light on movement patterns between this area and southern waters as well as between coastal areas to the north and with the eastern Gulf of Maine. Another possible tagging location in the Gulf of Maine is Fippennies Ledge. The area just to the southwest of Fippennies Bank appears to be an area where a reasonable number of adult fish are found in both fall and spring surveys in recent years. According to the most recent government surveys there appear to be low concentrations of eggs around this general area in late winter, spring and summer months, particularly around March/April, suggesting that some spawning

activity may be occurring in this vicinity. Further rationale for tagging in this area is that prior tagging studies were conducted here, so information collected from the current tagging program could be compared with previously collected data. Other tagging location possibilities within the Gulf of Maine include Jeffreys Ledge and Cashes Ledge. Today, some fishermen believe that Jeffreys Ledge, which historically was considered a feeding area, may serve as a “staging area,” where pre-spawning fish gather before moving inshore to spawn. Furthermore, fish are caught year round in these waters and as previously stated the northern portion of the Ledge may be a key habitat for juveniles. Given the importance of this area and scientific theory that with lower overall abundance, cod have retreated to areas of higher habitat value, tagging on Jeffreys Ledge has merit. Tagging fish on Cashes Ledge may be worthwhile to gather more information about movement among eastern, western and southern portions of the Gulf of Maine. It clearly is an important area for juvenile cod, but it is not believed to represent a major or minor spawning location. Nevertheless, it was a deployment site in previous tagging studies and the return rates were exceedingly small, so a case could be made for why it is valid to retag in this area.

During Town Meeting and Task Force discussions, Platts Bank also was identified as a possible tagging site within the Gulf of Maine. Historically, this area was identified as a feeding area not a spawning area. During the Town Meetings a few fishermen expressed concern over tagging feeding fish – stating that generally they are more vulnerable and may require special handling to improve survival rates. However, another fisherman reported that it is really an issue of what the fish have been eating that makes them vulnerable and how long the fish are on deck. He emphasized that if fish are dead, they are more susceptible to decomposition by the acidic content of the feed and ruptured stomach cavities. He also maintained that there are drawbacks to tagging just spawning fish as well -- namely that they are not as susceptible to all capture methods limiting program participation to only a few gear types. Recognizing that spawning fish may be unwilling to take baited hooks, it also has been proposed that tagging be conducted on pre-spawning aggregations. While there certainly are valid arguments for targeting fish in other locations and at other times, in an effort to keep this program reasonable in scope pre-spawning and spawning aggregations were identified as the initial focus. If the program is successful and additional monies are forthcoming, perhaps the number of tagging locations could be expanded to include feeding areas such as Platts Bank, Franklin’s Swell and other key habitats.

Tagging in coastal waters was of great interest to the fishing community. Further rationale for focusing some tagging effort in these areas is that historically coastal spawning may have contributed a great deal to the Gulf of Maine fisheries, some estimate contributions as high as 80 percent (Island Institute, 1997, Ames in press). In the Coastal Region, three locations have been identified which are believed to represent spawning grounds according to the scientific literature and fishermen’s reports: Ipswich Bay, Casco Bay and Mount Desert

Rock/Penobscot Bay. Ipswich Bay, south of the Isles of Shoals to the mouth of the Merrimack River in 25 to 50 fathoms, continues to be a center of spawning activity for cod. Generally spawning is believed to occur here in late November through July (months with highest egg concentration include: February, April, May, June and July). Fishermen report the best time to tag fish would be April and May in the northern areas of the bay. Casco Bay was listed as a minor spawning ground in Bigelow and Schroeder (1953) and is an area where fishermen are once again starting to see codfish. Fishermen report that spawning is occurring in these waters during May and June when the rolling closure is in place. It may be possible to tag fish in April, when fish are starting to aggregate or this may be one area that requires tagging during warmer months, May and June. Relative abundance estimates found in the Essential Fish Habitat Source Document for Cod indicate that all life history stages are present in Casco Bay further supporting the notion that this is a spawning ground. Ames (in press) also cites Eastern Casco Bay as an area of spawning activity.

Mount Desert Rock could be another key coastal tagging location. Bigelow and Schroeder (1953) identified Mount Desert Rock as minor spawning ground. Spawning may occur here in late fall or early winter and again in the summer months. MARMAP surveys (January to December, 1978 to 1987) show egg concentrations in this area, with peak months being October to January and May to July. Extensive tagging was conducted here from 1923 to 1929 (some 6,000 tags were deployed with an estimated 20 percent return rate). However, no results of this work were ever published. The little information that was shared stated that fish tended to stay in the tagging locality with a few wanderings eastward. Some fishermen who fish in this area have stated that they also believe a portion of the fish move northward into Canadian waters and west into Penobscot Bay. Fishermen report that there also is spawning activity in Penobscot Bay. Perhaps given its close proximity to Mount Desert Rock, a portion of the tags allocated for this area could be deployed inside the bay to examine the relationship between these two areas as well as to more clearly pinpoint spawning activity today. Tagging efforts in this area would be further complimented by the long-term oceanographic studies that have been conducted in the bay by the Island Institute.

Tagging in the proposed coastal locations may help to further understanding of movement patterns between inshore and offshore spawning grounds. Furthermore, these three coastal locations were suggested in an attempt to deploy tags to ensure the broadest possible geographic representation. However, there are certainly other locations and times that could be considered beyond what has been proposed here. For instance, there are numerous minor spawning grounds cited in the scientific literature along coastal Maine including off Cape Elizabeth (Bigelow and Schroeder, 1953); off Boothbay (Bigelow and Schroeder, 1953); in the mouths of Cobscook and Passamaquoddy Bays (Fishing Industry, 2001, Bigelow and Schroeder, 1953, Island Institute, 1997,); in Saco Bay (Department of Marine Resources, Trawl Surveys, early 1990s), near

Wood Island, off the mouth of the Saco River (Fishing Industry, 2001); and in Sheepscot River (Fishing Industry, 2001, Island Institute, 1997, Bigelow and Schroeder, 1953). In the latter case, a long-term tagging study was conducted by the Maine Department of Marine Resources from 1978 to 1983 with the majority of the recaptures made along the coast and in reasonable proximity to the tagging location (Perkins, et al. 1997). However, some fish were reported to move into Ipswich Bay in mid-winter. There may be some value to retagging in the Sheepscot River to confirm movement patterns and see what, if any, changes have occurred over the past eighteen years since that survey was concluded. Another area that was identified by Massachusetts' fishermen during one of the Town Meetings was Cape Cod Bay. According to fishermen there are aggregations of "whale" cod in the spring in Cape Cod Bay. Rhode Island and New Hampshire fishermen may know of other areas where tagging should be conducted. The key is that there is a large enough number of fish present to tag and ensure a statistically significant return rate.

Tagging Methodology

While it is expected that various local projects operating under the umbrella of a larger-scale tagging program will develop project specific methodologies, the following is meant to provide some basic guidelines that should be incorporated into these respective projects to ensure overall consistency in data collection.

Spatial and temporal tag release sites should be determined based on areas of high catch rates in government research vessel surveys as well as the location and timing of historic cod spawning activity. Some further analysis of previous tagging studies to identify data gaps also may be worthwhile. Prior to tagging, fishing trials should be conducted by the industry survey vessels to identify areas, which are currently yielding both high catch rates and at least 50 percent cod composition. In published tagging studies, as few as two and as many as 11,000 tags have been deployed per tagging location, usually over multiple years (Wise, 1962, Hunt et al, 1998). The Task Force recommended that between 5,000 and 10,000 tags should be deployed per site in order to yield statistically significant information on movement patterns. Given the lower abundance of codfish in coastal waters it may be more appropriate to deploy 5,000 tags in each of these tagging locations as tagging 10,000 fish may not be possible. To maintain program consistency, it may be prudent to tag 5,000 fish in each of the 10 proposed tagging sites. The fact that the majority of previous tagging studies marked lower numbers of fish in their respective study areas suggests that to achieve reasonable results would not require that more tags be deployed in any given area.

Program implementers may want to consider that when conducting fishing trials to identify survey sites, they should avoid areas of high concentrations of skates (*Raja* spp.) and dogfish (*Squalus acanthias*). Their abrasive skin resulted in damage to cod and poor quality specimens for tagging in a study by

Hunt et al. in 1998. However, researchers may want to weigh the value of collecting ancillary information regarding predator-prey relationships before shifting to other locations to tag fish.

Once an aggregation of cod is located, tagging will typically continue at the site for a period of one to two days (Hunt et al. 1998). Currently there are at least 80 U.S. fishermen who have been identified as having an interest in participating in this cod-tagging program. Most have expressed a willingness to participate in the tagging effort for at least one-day a month in the first year of the program. During the Town Meetings, fishermen indicated that if they were on a dedicated trip, they could tag 100 fish a day. This is corroborated by the recent Canadian tagging effort where 100 to 250 fish were tagged successfully in a given day (Hunt et al., 1998). This would provide a sufficient amount of effort to implement this program. Follow-up calls should be conducted to individuals listed in Appendix 2 of this report as a starting point for identifying fishermen to participate in local projects as many of them expressed an interest in participating in this cod-tagging program.

The vast majority of fishermen surveyed supported the notion that vessels under 60 feet should be compensated in the amount of \$1,500 (two-man crew) a day for a dedicated trip. However, it should be noted that the going rate paid for fishermen to participate in research projects ranges from \$500 for a dedicated trip and \$2.00 per returned tag (SMAST, tagging effort) to \$2,200 a day (University of Maine research project). *One scientist pointed out that when fishermen agreed to this day rate of \$1,500 they might not have considered the added costs of bringing a person onboard to train them in the tagging effort. Specifically, trainers will have to be provided with a survival suit and there may be added insurance costs for fishing vessels carrying an extra person. To ensure that \$1,500 is a reasonable rate, the cost of survival suits for all trainers has been added to the overall tagging program budget (see attached budget). In addition, it is not anticipated that fishermen will incur any added insurance costs. However, several members of the fishing community who are currently involved in tagging emphasized the need for a three-person crew to successfully tag fish, which may or may not require increased vessel funding.*

During subsequent one-on-one interviews with two members of the recreational fishing industry and a member of the commercial fishing industry in New Hampshire and Rhode Island a point was raised that rather than a lump sum being paid to fishing vessels for tagging fish, perhaps payments should be made per fish tagged. In Rhode Island, the concern was that it might be difficult to tag 100 fish a day, due to low cod abundance, unless fishermen are tagging in the Great South Channel. The Task Force had discussed this idea, but felt that a flat fee still was the best option to more adequately compensate vessels for operating costs and avoid the potential for misreporting.

Recognizing that there may be a limited number of larger, offshore vessels that are interested or can afford to participate in this tagging effort, it has been

recommended that a portion of the tagging in offshore areas be conducted by government survey vessels (federal and/or state) as part of regular spring and fall surveys to minimize costs. However, fishermen should serve as part of the crew to tag fish during these surveys. *A recommendation was made by a small group of fishermen that a separate study should be conducted, where scientists would do the tagging. This was viewed as a means to ground-truth data collected by fishermen. However, others expressed fears that should such a study be implemented, it could undermine the fishing industry tagging effort (implying that the data that fishermen are collecting are not credible). The majority of the Task Force maintained that this program was meant to provide an opportunity for fishermen, so primarily fishermen should conduct the tagging. However, if there are a lack of offshore vessels interested in participating in this program and the only means of sampling these areas is via government survey vessels then this concern may be addressed indirectly.*

A variety of fishing methods should be used to capture and tag fish so standard protocols must be followed to maximize fish survival. According to Canadian scientists, it may be best to charter otter trawlers during spawning as fish are less likely to take a hook. When otter trawls are used, tow duration should be no longer than 20 minutes (some fishing industry members suggested 10 minute tows), the trawl must be retrieved slowly and the cod end should be kept fairly loose as it is pulled in to reduce trauma to the fish. When using gillnets, length of sets should be kept to a minimum --no more than four to six hours in duration. With both these gear types, fish must be emptied into a holding tank with running water and observed to be in good condition before tagging. Cod are to be measured, tagged and immediately released. Cod captured with hook-and-line or lobster pots/traps should be processed immediately and need not be held in an on-board tank. Total elapsed time, from start to finish, for tagging fish should be kept to a minimum. Canadian scientists found that the entire tagging procedure took no more than 30 seconds and maximized fish survival. Fish should be tagged along side the leading edge of the first dorsal fin.

Fishermen are to record, at minimum, the following information on waterproof paper as part of standard tagging operations and to ensure consistency with data being collected in the Canadian fishery: position, date, time, fish length and tag number. It also would be worthwhile to collect depth, temperature and bottom type information. These data will then be transferred to spreadsheets and eventually entered into a relational database. Database structure should be consistent with Canadian researchers, so that a common database for all tagging can be maintained.

There was complete consensus by the Task Force and during Town Meeting discussions that fish should be tagged in areas where gear closures are in place. A variety of suggestions were made for how to access these areas. For instance, most fishermen supported the idea of allowing commercial groundfish vessels on dedicated trips, with an exempted fishing permit, access to the areas

to tag fish. However, some members of the recreational fishing community expressed reservations about this idea, urging that only fisheries currently allowed to operate in the areas be involved in the tagging effort inside these areas. Given that it can take at least 45 days to obtain an experimental fishing permit another suggestion was made that commercial fishermen could simply fish as recreational fishermen, provided they did not use any of the restricted gears and adhered to recreational fishery regulations (e.g., can not sell any fish, allowed to keep only ten cod or ten haddock or ten yellowtail flounder, or any combination thereof, uses only two hooks per person, where a treble hook counts as two hooks, no one is charged for fishing and all restricted commercial fishing gear is properly stowed). According to the NEFMC, there are some regulatory and management considerations for commercial fishing vessels. For instance, limited access vessels are required to sign out of a commercial fishery for a minimum of three months to be allowed to fish as party or charter vessels.

There was some support for encouraging the participation of the lobster fishing industry and recreational (charter boats) industry to gather data from closed areas. Many felt that it would be reasonable to compensate lobster boats and charter boats which were willing to tag fish during their regular fishing activities (e.g., covering cost of fuel or paying charter boats some sort of small fee --\$200 to 300 per day or allow each boat to retain one fish). These boats might be able to gather supplemental information to compliment the data collected during dedicated trips as well as additional information on juveniles. A recommendation also was made during a few of the Town Meetings to have lobster boats paid for a dedicated trip to fish for cod using hook-and-line in these areas and in other areas such as Downeast Maine where there are very few groundfish vessels left. It was added that having lobster boats on dedicated fishing trips using hook and line gear would ensure that fish were in better condition. In some instances if adult cod are caught during regular lobster fishing operations, they can be damaged by the lobsters in the traps.

Tag returns

Just as basic biological information must be gathered when fish are tagged, some complementary information also must be collected when tags are returned. It is important to collect information on date, location, gear type and fish length along with the tag return. The proposed Canadian study plans to distribute tag return envelopes to fishermen. These printed envelopes will include categories (e.g., date, location, gear type, etc.) to prompt fishermen to record pertinent information. This may be a worthwhile investment for the U.S. program because having these envelopes onboard vessels may increase the likelihood of tags being returned with corresponding information. It is recommended that an information package including details about the program's goals and objectives, contact information for returning tags and return envelopes be distributed to all federal permit holders. To ensure consistency in fish measurements, it also may be appropriate to include a standard measuring board in this package.

In addition, providing fishermen with timely information on individual fish movements via follow-up mailings and offering various incentives may further enhance the number of tag returns. Receiving prompt feedback on recaptured fish, regular progress reports and access to some of the data through the Internet are expected to build and maintain interest in the program and improve tag return rates.

Since others likely will return tags including scientists, recreational fishermen, party and charter boat operators, it may be cost prohibitive to supply them with envelopes and unreasonable to expect that they would be willing to collect additional information beyond the tag itself. At minimum, attempts must be made through various means to raise their collective awareness of the program and encourage them to turn in tags (See *Outreach Program* for details). Suggestions were made to provide a variety of incentives (e.g., hats, an annual lottery and/or a fee per returned tag).

A 1-800 number should be established that is free to both Canadian and American callers to further enhance the number of tag returns. If a fee were paid per tag, fishermen and others still would be required to mail in the tag.

A return rate of roughly 10 percent is expected based on experiences with past tagging efforts. Higher return rates may be possible (as have been obtained in a few previous area tagging studies) if enough support can be built for the program.

A representative sample of whole fish from each tagging site also should be collected as part of this program for future analysis (e.g., 100 fish per tagging site).

Training Program

A one-day, comprehensive training program should be conducted to ensure that all local projects are conducted in a consistent manner. If the actual tagging effort spans two-years then the training program should be conducted twice because there likely will be a need to train additional trainers.

The purpose of this training session should be to provide an overview of the program infrastructure (e.g., role of Clearinghouse) to individual Project Managers and local coordinators/trainers; share information about tagging technique; and provide some hands-on training for trainers in proper capture, handling, tagging and release protocols. Once trained these "trainers" would be responsible for conducting local training sessions with vessel captains and their crew who are involved in the actual tagging operations. Trainers should be required to accompany vessel crew on the first tagging attempt to ensure that they have mastered the tagging procedure. According to fishermen and scientists experienced in tagging, the procedure is fairly simple. It should be sufficient to have trainers accompany crew on a single trip to ensure that they have mastered

the tagging procedure. It is critical, given the number of individuals who may be involved in the tagging effort, that consistency be maintained in tag deployment to minimize the variability in tag retention.

A training video and background materials should be developed for use in the local training sessions. Brochures should be distributed to provide a “quick review” of tagging procedure.

Ancillary Studies

There have been a number of tagging studies conducted here and elsewhere in the world. Many of these explored various means for addressing the issue of tag shedding through double tagging in the wild and lab experimentation. It is recommended that program implementers review the results of these studies and consider whether it is necessary to incorporate a tag shedding experiment into the scope of their respective projects (cost estimates provided in attached budget).

There are currently a few ongoing studies that will further aid in understanding cod stock structure. For example, The New York University is conducting a study that looks at genetic differences between cod from Georges Bank and Gulf of Maine. A pilot study examining otoliths in the Gulf of Maine found different levels of magnesium and lithium in fish from these two areas. If there is a change in the ratio as animals’ age, it can be assumed that they are moving outside their respective areas.

Specific studies that the Task Force viewed as imperative to complement overall tagging program efforts include:

- . • Tag loss/differential mortality of tagged fish – need to consider a shedding experiment to assess survivability;
 - . • Obtain a representative biological sample from each area to (e.g., need, at minimum, 100 individual fish per area of interest);
 - a. ○ confirm age structure (otolith);
 - b. ○ conduct analysis of the fin clip for genetic differences;
 - . • Confirm maturity state (Could have a biologist dissect the fish on the deck of the boat or conduct analysis on fish sample in the lab. Fishermen also could be trained to do this. In previous Canadian tagging studies, fishermen were provided with a booklet to help them determine maturity state);
 - . • May want to collect information on surface water temperatures, season, bottom type and depth. May want to overlay with information collected from USGS or have fishermen collect as part of their daily/trip report; and
 - . • Species co-occurrence via belly samples also may be of value.
- However, a few Task Force members pointed out that quite a bit of work already

has been done on stomach content analysis to date.

It further was recommended that if monies are not diverted from this tagging effort to complete these ancillary studies, then the Sentinel Fisheries Program (Industry-based Surveys) should consider conducting them under its purview as a complement to this effort.

In addition, the Task Force identified some questions that would require more information on predator-prey relationships and habitat usage. These questions included

- . • What is role of habitat in relation to cod movement patterns and distribution? What can we learn about particular habitat utilization? Are there specific habitat types that can be associated with movement patterns? What about the role of shipwrecks, bottom types, salinity, water temperature, etc.? *(Some of this information could be gathered if secondary studies listed in this report also are conducted);*
- . • What is the relationship between adult fish and juvenile fish? *(This will require looking at kept fish vs. discards);*
- . • Is there a presence or absence of feeding fish such as herring?
- . • Are the closed areas producing spawning fish? *(The proposed studies will begin to answer this question);*
- . • Is there spawning site fidelity? *(The proposed large-scale tagging program would begin to answer this question, but it would require tagging over multiple years); and*
- . • What about the role of predator-prey relationships (e.g., dogfish)? *(This will require recording catch summaries).*

Secondary Studies

Closed Areas

1. Are closed areas sinks or sources of recruitment/rebuilding?

The primary tagging study can begin to examine the question of whether there is emigration from these areas if conventional tags are released inside closed areas. To help answer this more specific management-related question a small-scale study using electronic tags is recommended.

While Closed Area II would be sampled during the wider-scale tagging effort using t-bar tags, some members of the Task Force also thought a more intensive sampling program in at least one Closed Area as a pilot study would be appropriate given the strong interest indicated by the fishing industry during Town Meeting discussions.

There is important cod habitat in both Area I and in the Western Gulf of Maine

Closed Area (nursery habitat) that makes an intensive study compelling in either case. An advantage to selecting Closed Area I for this study is its close proximity to the Great South Channel. This could make for an interesting acoustic study to look at the relationship between an open and a closed area, both of which are perceived to be of significant value to groundfish. For example, given that conventional tagging already would be taking place in Great South Channel, this might provide a basis for comparison. An added advantage might be some economic efficiency for tag deployment. Obviously given the size of Area I (roughly 400 square nautical miles) and the high costs of acoustic technologies (receivers have to be placed roughly one mile apart if a hydrophone array is used), it would be necessary to further refine this study area. One possibility would be to deploy a fixed acoustic array along the northern boundary. This would require that an estimated 23 hydrophones (surface and bottom) be deployed. This could provide additional information about spatial and temporal movement patterns between the closed area and within the Great South Channel.

The array of hydrophones would be set up inside and outside the closed area. Several hundred large cod (80 to 110 cm) could then be tagged externally with acoustic transmitters. The transmitters would detect movement inside and outside the area. This would require regular data retrieval from the mooring buoys (e.g., monthly). In addition, it might be appropriate to have a complementary effort of tracking fish immediately following release on board commercial vessels using a mobile directional hydrophone. If the fish remain in the area, diel behavior patterns can be documented and compared with temperature and salinity information to further assess habitat usage. Additional habitat studies using a towed video array or bottom grab samples might be possible as well or could be conducted with the help of the Industry-based Surveys.

Despite the interest in using a hydrophone array and acoustic tags to monitor closed areas, some members of the Task Force expressed reservations about the high costs and obstacles to successfully conducting such an experiment in the open ocean. They felt that acoustic tags might be worthwhile to use, but not as part of a static hydrophone array. Since monitoring the effectiveness of closed areas is clearly a fishing industry priority, program implementers should remain open to proposals, which provide further justification for using either acoustic tags or other kinds of electronic tagging devices to monitor small-scale fish movement patterns inside and outside of closed areas.

Furthermore, it should be recognized that tagging studies alone will not be able to address the industry's recruitment question. Assessments of reproductive output and larval input also are necessary.

Additional Inshore Tagging Studies

1. What are some of the finer-scale cod movements?

Other studies using acoustic and archival tags may be worth considering for inshore areas. In particular, it would be worth learning more about habitat usage and what factors drive fish movement on a finer-scale in inshore waters (e.g., are there diurnal movements related to depth contours and prey availability).

The value of using electronic tags for some of these inshore studies is that they may yield more detailed information about fish movements where there are insufficient numbers of fish for conventional tagging. For example, the Department of Fisheries and Oceans has proposed conducting limited acoustic tagging in Canadian inshore waters. It also intends to minimize project costs by utilizing equipment (a broad geographic hydrophone array) of a concurrent study being conducted on Atlantic salmon movements. The U.S. also is studying salmon movements using acoustic equipment. Perhaps, individual project proposers could explore the possibilities of utilizing the existing U.S. infrastructure for their respective cod-tagging project.

Some areas and local movement relationships identified during Town Meetings and by the Task Force as possible study sites included: movement up into Grand Manan Channel and around Digby Neck; movement between Mount Desert Rock/Seal Island (out to 40 fathom line); movement up into bay areas such as Passamaquoddy Bay, Penobscot Bay, Cobscook Bay (fish are seen in these waters almost year round); movement into the Sheepscot River; movement patterns from the Isle of Shoals to the mouth of Casco Bay; and the relationship between Seguin and Kettle bottoms and Monhegan.

Unresolved Points of Discussion

There was a looming question of whether Research Days would be counted against Days at Sea. In many areas fishermen did not want Research Days to count against Days at Sea. However, in Ellsworth where the groundfish fishery is very small, there was interest in having Research Days count so that fishermen could retain their groundfishing permit. A suggestion was made about leaving the option up to individual fishermen as to whether to count days or not. A point was raised that since in either case fish could not be kept, this may be a mute point.

Another point raised was that if fishermen are to participate in this or any other collaborative research program, they should not be penalized if their catch record is lower because they gave up fishing days to participate in research efforts, what is now commonly referred to as a "research penalty". With respect to this program, since the actual number of days is fairly low over the course of an entire year, roughly one day per month, this should not have much impact on retention of fishing permits.

The issue of whether there is a need for experimental fishing permits also was

discussed during the Town Meetings. It was suggested that when collaborators are preparing their proposals for submission, they may want to secure letters of support from various interest groups (including the environmental community) if they anticipate needing experimental fishing permits to complete their work. This may help expedite the permit review process and help ensure that the research is not delayed. One industry representative even went as far as to suggest that the Task Force should recommend that a blanket experimental fishing permit be granted for the tagging program as a whole so that research could begin promptly. Since it was not possible to anticipate the scope of the work proposed by various proposal submitters, no such recommendation could be made.

An unresolved point of discussion was over the issue of whether to tag other incidentally caught species as part of this tagging effort. While there was some support for this expressed at Town Meetings and by some members of the Task Force, others on the Task Force felt that in order for tagging studies to be scientifically valid they should be tailored to individual species. For instance, flatfish generally are more vulnerable so special handling techniques may have to be employed to enhance their survival rates. However, another scientist pointed out that for species such as halibut and barn-door skate there is so little information now that any new information collected through opportunistic tagging would be beneficial.

Program Infrastructure

An infrastructure for program implementation was outlined during the second Task Force meeting and fleshed out at subsequent meetings. This infrastructure consists of: 1) a Centralized Clearinghouse for tag return data and information dispersal; 2) a Clearinghouse Steering Committee to evaluate program results and provide future direction to the Clearinghouse; 3) the Northeast Fisheries Science Center for long-term storage of data and information; and 4) local coordinators for program implementation.

Centralized Clearinghouse

Role of Clearinghouse

The impetus for the Clearinghouse is to coordinate local cod-tagging efforts and overcome existing hurdles regarding the timely release of information to the fishing community through the establishment of a regional mechanism for information exchange.

The primary role of the Clearinghouse is to provide a centralized location where tag return information could be reported and fish samples could be stored in the short term. Specifically,

- The Clearinghouse is responsible for generating a thank you letter to each fisherman who turns in a tag along with a summary report on the individual fish movement patterns. The corresponding letter and report should be distributed to the fisherman within three (3) business days or some reasonable timeframe as a means of providing an immediate reward to the fisherman for turning in the tag. In addition, the Clearinghouse is responsible for posting data on a web page on a regular basis.
During each of the Town Meetings and Task Force meeting discussions, there was genuine interest expressed by the fishing community to have access to timely information. In fact, many fishermen cited this as the primary reason for their willingness to participate in a tagging effort.
- The Clearinghouse also is responsible for reward distribution (e.g., distribution of small incentives like hats to each fisherman and administering an annual dual lottery program). *While there clearly was support for small incentives to individual fishermen, there seemed to be much more interest in an annual reward program, where the names of both the fishermen who tagged fish and the fishermen who turned in tags would be entered into an annual drawing. There was widespread support for \$1,000 being paid to the winners of the drawing. One fisherman raised the point that most of the fishermen who voiced an opinion on incentives were already eager to participate in the program. He felt that there should be a further incentive for fishermen to overcome resistance to turn in tags. He suggested paying \$20 to \$50 per tag to enhance return rates. A New Hampshire recreational fisherman*

who provided comments via email also suggested that a stipend be offered for tag returns on the order of \$25 to get recreational fishermen to turn in tags.

- *In addition, the Clearinghouse maintains a catalogue of other current tagging projects and programs. If an individual called in with a tag return from one of these other efforts, they would be directed to the appropriate coordinating group. The intent would be to minimize confusion and frustration among individuals who find tags so they know where to call to report information. A word of caution was raised by some members of the Task Force that if other tagging programs are not effectively run, the Clearinghouse and broad-scale tagging program run the risk of negative association by providing this service. Despite this concern, the feeling prevailed that providing this service was a good idea.*

While there seemed to be general agreement among Task Force members and during Town Meeting discussions that individual fishermen should have timely access to data on individual fish movements. The issue of confidentiality and who gets access to data collected first (e.g., the Clearinghouse or project scientists?) was unresolved.

It was recognized that there are clear advantages to scientists who participate in this program, such as: 1) access to a wide range of regional data that may aid them in their specific research projects; 2) assistance with timely information dissemination to the fishing community regarding individual tag returns; 3) assistance with administering a comprehensive reward scheme; and 4) assistance with raising the visibility of their respective project and the potential for a higher tag return rate because they would be part of a widely publicized, broader-scale effort.

Still there was some concern among scientists about proprietary information and ensuring the integrity of their own studies. A few scientists voiced an opinion during the last Task Force meeting that local project coordinators (e.g., scientists and fishermen) should have access to the data before they are sent to the Clearinghouse. Typically results from scientific studies are distributed to the project scientists first as a matter of protocol for immediate analysis.

While the Task Force did not reach consensus on how best to address this concern, a possible solution would be to provide rough tag and catch locations to individual fishermen and the public (e.g., on the scale of Jeffreys to Georges Bank) with the exact latitude and longitude coordinates transmitted to the individual projects/researchers. Information on fish size and dates of tagging and recapture also could be withheld. As a result, the general public would have a fairly good understanding of what is going on in the region, but only the group with the detailed information would have enough information to publish. This constraint could be relaxed after a given time period (e.g., five years), at which

time all the information would be made public. The other advantage of this approach is that it would help address the concern of some fishermen about data being used prematurely to influence management decisions.

If this option is not workable for scientists or acceptable because it would mean delays in making the complete data accessible to everyone, perhaps, it must be recognized that initially not all scientists will want to participate in this program. As the

Clearinghouse is established and expands to include tagging programs for additional species, others may see the advantages of combining resources, having more open exchange of data and information and accessing a long-term funding stream for tagging studies.

Clearinghouse Staffing

The staff can be relatively small. But, at minimum, should include a database manager (someone who is capable of establishing and maintaining the database) and an outreach person to coordinate with local groups who are administering the various projects. The outreach person also will oversee distribution of small-scale incentives, administer the annual lottery and work in conjunction with the database manager to distribute thank you letters and individual fish movement reports to fishermen.

Clearinghouse Funding

The Clearinghouse should remain in operation beyond the duration of the actual tagging effort. This will ensure that the majority of tag returns have been received, information is disseminated in a timely manner and some initial analysis is completed. Since a recommendation was made that the tagging program itself span a minimum of two years, it is anticipated that the Clearinghouse will be in existence a minimum of five years. Furthermore, if this cod-tagging program is successful then the Clearinghouse mandate should be expanded to include other tagging efforts on additional species in the future. There also may be some incentive for other non-federally funded projects to share their data with the Clearinghouse if they believe they will get a higher return rate for their respective projects. The key will be for the Clearinghouse to generate enough publicity and support from the fishing industry to ensure a high tag return rate for this program as a means of attracting other projects. With greater participation from a variety of independent efforts the database could be expanded thereby creating a more regionwide picture of species movements. If this were the case, the lifespan of the Clearinghouse would be expected to extend well beyond a five-year timeframe.

To this end, the Clearinghouse should be funded on hard money. Additional thoughts on funding include: a small portion of funding could be derived from the

private foundation community currently funding collaborative research initiatives and, eventually as the database is expanded, various user groups could be asked to pay some sort of user fee.

With respect to funding for field work (actual fish tagging), it was thought that since the operating expenses for continuing fieldwork are relatively small, compared to set-up costs, perhaps the industry could absorb some of the future costs if they deemed the program to be worthwhile.

Clearinghouse Selection Criteria

Members of the Task Force concurred that organizations interested in serving as the Clearinghouse for this program should submit a proposal under the RFP process. *The Task Force did not feel that it was appropriate to make a recommendation about which would be the most appropriate organization to serve in this capacity. However, it did agree that there are a number of reputable organizations including, but not limited to, University of Massachusetts/SMAST, Manomet Center for Conservation Sciences, the Gulf of Maine Aquarium, the Island Institute and the University of New Hampshire which may be individually qualified or may seek to collaborate in such an effort.*

To aid in this selection process, the Task Force developed the following set of Criteria for Clearinghouse Selection:

- I. Must be identifiable as an independent entity specific to this cod-tagging program, at least initially. The organization's role may be expanded in the future to incorporate other species tagging efforts depending on its initial success with the cod-tagging program.
 - A. If the Clearinghouse was established as a separate entity but still could take advantage of some of the existing infrastructure of an established organization such as SMAST, UNH, Manomet, or Island Institute, etc., this may maximize available federal monies.
- II. Should be a neutral third party with the ability to house, manage and conduct some of the analysis of the data.
 - A. Tags should not identify specific group but rather simply read, "Regional Cooperative Cod Tagging Program" with corresponding return phone number and U.S. and Canadian return addresses.
 - B. Tags should include a 1-800 phone number where U.S. and Canadian fishermen can call to report information.

- C. Tags should be coded with individual project numbers for timely reporting of information to the respective research scientist.
- III. Must serve as coordinator, as research methodologies may vary by area and/or gear type, to maximize the dispersal and return of tags.
- IV. Should have access to community-based groups to build support for the program and disseminate program results (e.g., fishing cooperatives, Northwest Atlantic Marine Alliance (NAMA), Massachusetts Fishermen's Partnership/Gloucester Fishermen's Wives Association, Bay of Fundy Marine Resources Center, and Center for Community-Based Management, etc.).
- V. Must have the capability to make the data readily accessible to all interested parties in a timely manner. Should have the technical expertise to develop a web page and the ability to establish links with existing mechanisms for data dissemination.
 - A. Need to have a plan in place for how the data will be distributed.
- VI. Should have capability to mount historic data and make these data compatible with data collected throughout this program.
- VII. Should have adequate storage space for samples (freezer) and some analytical capabilities.
- VIII. Should have the ability to coordinate International efforts or collaborate with Canadian counterparts, given that tag dispersal and returns likely will occur in Canadian waters as well.

Clearinghouse Steering Committee

This would be an overarching body consisting of scientists and fishermen to periodically review the data collected throughout the overall cod-tagging program (e.g., on a biannual or annual basis) and to evaluate program success to date. Clearly there are concerns among members of the fishing community and scientific community about data bias and the use of inadequate data for management decisions.

This body would examine the results of the tagging program, identify data gaps and make recommendations for additional tagging studies. It would provide another level of evaluation along with the SARC and the NEFMC Research Steering Committee and provide fishermen with a more active role in tagging program design and evaluation. It also would provide guidance on enhancing data dissemination and operating goals for the Clearinghouse – specifically how, when and where the Clearinghouse should manage the data.

Furthermore, the Steering Committee would continue to build trust by maintaining an ongoing working relationship between fishermen and scientists in project design and evaluation. It would consist of various groups currently involved in tagging programs including: state agencies; provincial agencies; federal scientific agencies; academic institutions; and fishing organizations. The Steering Committee should have a fixed chair and rotating member seats.

There was considerable discussion during the third and fourth Task Force meetings and during the Chatham Town Meeting about the need for quality control of data collection and data usage. While initially the thought was that this Steering Committee would only be responsible for examining the role of the Clearinghouse and how data could be more effectively distributed, during subsequent discussions the role of this body evolved into a much broader mandate as outlined above. It was recognized that such a body could provide technical advice to the NEFMC Research Steering Committee and federal and state management agencies on this and future tagging efforts.

It also was recognized that there is a clear need for long-term monitoring, particularly when and if this program ends. Perhaps if this body were established as a formal mechanism with a mission to look at the “snap-shot” of existing conditions generated by this program it might be able to provide some guidance about future spin-off tagging projects or programs that should be implemented to help understand the dynamic nature of this productive marine ecosystem.

Northeast Fisheries Science Center Role

There was fairly widespread agreement that collected data also should be shared with the Northeast Fisheries Science Center for long-term storage and further analysis. An overarching goal of this program is to collect scientifically credible data and information about cod distribution and movement patterns to complement existing data collection efforts such as the semi-annual government trawl surveys.

In addition, since the Clearinghouse is designed as a small-scale operation, it may be necessary given the volume of data that likely is to be generated to have an established facility with ample storage space to warehouse both data and fish samples.

Furthermore, in the event that long-term funding for the Centralized Clearinghouse is unavailable, this will ensure that data collected through this effort will be preserved and remain accessible to the public.

Local Coordinators

It is expected that fishermen working in concert with academic scientists and/or state scientists experienced in tagging efforts will submit proposals through an RFP process administered by the NMFS and NEFMC Research Steering Committee to implement specific projects under the umbrella of an overall cod-tagging program. This will provide a coordinated approach for funding allocation.

The Task Force recommends that each of these individual project proposals include local coordinators who will build support for the program, maximize distribution of the tags and provide another point of contact for tag returns or collection of biological samples for scientific purposes. Local coordinators could be a fisherman, a fishing cooperative, fishing organizations, non-profits, a state agency or a research entity. When the Canadian program is established there also should be similar points of contact in Canada involving Canadian NGOs and fishing organizations.

Some of the responsibilities of these local coordinators include: conducting local outreach and publicity for the program, identifying fishing vessels, paying vessels for

their time, administering training, ordering and disseminating supplies, collecting biological samples and maintaining contact with the Clearinghouse (could collect tag return information and forward it to the Clearinghouse or merely direct tag returns to the Clearinghouse).

While generally it is recognized that a variety of groups likely will implement various aspects of this program, in order to ensure consistency in tag deployment and collection efforts, all local coordinators must participate in a one-day training program and be “certified” as trainers.

Outreach

A great deal of emphasis was placed on the need to generate adequate public awareness about the benefits of the tagging program and to regularly publish program results in an effort to increase participation. A suggestion was made that a local advertising agency be contracted to develop a promotional campaign for the program pro-bono. It also was suggested that the NMFS and NEFMC should utilize existing mechanisms to build support for the program (e.g., regional press office, various publications, web page, regular industry mailings, etc.) However, given the concern that some fishermen may be unwilling to participate in this effort unless data are sent to a neutral entity, it may be necessary for government agencies to maintain a low profile with respect to this program. An alternative may be to make sure that all publicity generated surrounding the program (e.g., press releases) come from both fishing industry and government agencies. This also will help strengthen the public perception that this is indeed a “collaborative effort.”

It was recognized that there is a need for a two-phased public awareness program – 1) Building initial support for the program to ensure the broadest possible participation; and 2) Enhancing tag returns through targeted efforts towards fishermen (commercial and recreational) and the scientific community. Both phases of Outreach are equally important to the success of the program.

Phase I: Building Public Support

Outreach efforts should include everyone from multispecies permit holders to recreational fishermen. Some specific outreach efforts include but are not limited to:

- . • Strategic placement of articles announcing the start of the program --its purpose and goals --to appear in commercial fishing industry trade journals, newspapers and industry association newsletters; recreational fishing industry magazines; and local and regional newspapers. Also articles should be placed in corresponding New Brunswick and Nova Scotia publications.
- . • Bilingual promotional flyers to be prepared and distributed to all fishing industry cooperatives, fishing organizations and charter boat operators prior to the start of the fishing season for distribution to their members.
- . • Radio and television interviews to be conducted in strategic markets to pitch the program to a wider audience and reach recreational fishing and boating communities.

Phase II: Outreach to Enhance Tag Returns

- . • Weekly reminders to turn in tags to be aired on the weather channels (weather box).
- . • Regular advertisements and articles (progress reports) about the importance of turning in tags and where to turn them in should appear in trade publications, recreational fishing magazines and journals and local and regional

papers. In addition, advertisements also should appear in corresponding publications in New Brunswick and Southern Nova Scotia.

- For instance, there should be monthly reminders in Commercial Fisheries News throughout the duration of the program to encourage people to turn in tags as well as periodic articles to discuss the goals of the program and progress to date.

- All weather bilingual posters should be located at all major fish landing and processing facilities and recreational docks providing details of the program and where to turn in tags.

- A concerted effort should be made to encourage the charter boat operators to return tags, particularly those returned from offshore areas (e.g., presentations made at industry meetings, announcements made in industry publications, mailings distributed, etc.).

- Bilingual flyers should be distributed on docks and in areas frequented by recreational fishers and charter boat operators.

- Quarterly or semi-annual reports/newsletter on how the projects are going, to be distributed to all individuals who turn in a tag.

- In addition, the NMFS should distribute information packages including an announcement flyer and return envelopes to all permit holders to encourage tag returns. The goal will be to make them aware of the program, encourage a higher number of tag returns and identify future program participants. Specific information should be included about where tags should be sent, what data are needed in association with the returned tag, along with envelopes to place the tags in when they are found. Should fishermen decide that they would rather call in from their vessel to report the tag return first before mailing in a tag, they also should be provided with a 1-800 number for reporting information. State and Canadian government agencies also should distribute information about the tagging program through their regular industry mailings.

- A Web page should be established to post program results.