Northeast Fisheries Science Center Reference Document 05-02

Proceedings of a Workshop to Review and Evaluate the Design and Utility of Fish Mark - Recapture Projects in the Northeastern United States; October 19-21, 2004; Nonantum Resort, Kennebunkport, Maine

by

Workshop Organizing Committee (S. Tallack, editor, P. Rago, chairperson, T. Brawn, workshop coordinator, and (alphabetically) S. Cadrin, J. Hoey, and L. Taylor Singer)

March 2005

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Workshop Organizing Committee (S. Tallack[1,4], editor, P. Rago[2,5], chairperson, T. Brawn[1,3,6], workshop coordinator, and (alphabetically) S. Cadrin[2,7], J. Hoey[2,8], and L. Taylor Singer[1,9])

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Northeast Fisheries Science Center Reference Documents

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Acknowledgements

This workshop was made possible through funding provided by the National Marine Fisheries Service Northeast Regional Office (NERO) and the Cooperative Research Partners Initiative (CRPI). The concept of undertaking a tagging workshop had been discussed for some time by the Northeast Fisheries Science Center (NEFSC) as part of assessing all their mark-recapture projects.

On behalf of the NEFSC, the Gulf of Maine Research Institute would like to thank all those who attended for their constructive participation and collaboration in the production of these proceedings. Particular thanks are extended to Dr. Alistair Hobday and Dr. John Hoenig for lending their expertise to a number of diverse Northeast tagging programs.

We also acknowledge the dedication of the committee who worked together to ensure the success of this first Northeast fish mark-recapture workshop, both in the weeks leading up to the workshop and in the reviewing process of the workshop proceedings which follow. In particular, we would like to thank Dr. Paul Rago (NEFSC) for undertaking the role of Chairperson.

Organizing committee:

Chairperson	Paul Rago	Northeast Fisheries Science Center
Workshop coordinator	Togue Brawn	Gulf of Maine Research Institute
	John Hoey	Northeast Fisheries Science Center
	Steve Cadrin	Northeast Fisheries Science Center
	Laura Taylor Singer	Gulf of Maine Research Institute
	Shelly Tallack	Gulf of Maine Research Institute

Executive summary

Prepared by: Dr. Shelly Tallack, Gulf of Maine Research Institute

This first Northeast Region Fish Mark-recapture Workshop was held in response to a need identified by NOAA Fisheries, Northeast Regional Science Center during the winter of 2003. It was felt that cooperative tagging programs in the northeast, which focus on a number of commercially important species, would benefit from a meeting aimed at reviewing the theory and analytical details of the modeling and analysis options currently available to tagging data. The aim of the workshop was as follows:

Goal:
- Provide a forum for reviewing the capabilities and limitations of available mark-recapture models in the context of ongoing or future tagging activities in the Northeast.

Objectives:
- Review state-of-the-art models available for testing mark-recapture project hypotheses.
- Review and critique three current mark-recapture projects in the Northeast (Atlantic cod, black sea bass and yellowtail founder) and provide advice on experimental design, field protocols, model selection, database development and ancillary parameters.

The Gulf of Maine Research Institute (GMRI) was contracted to coordinate and facilitate this meeting in collaboration with the NEFSC. Planning began in August, 2004 when an organizing committee was formed to determine the core elements of this workshop, including which tagging programs should be featured, what the attendee focus should be and what structure the workshop should follow. The workshop was developed over a two-month period.

The tagging programs presented were selected for their status as cooperative research programs (involving both science and industry) in the Northeast Region; these programs ranged in longevity from ~40 years (e.g. shark tagging) to programs which are still in their planning stages (e.g. Atlantic haddock). The three key programs (Atlantic cod, yellowtail flounder, black sea bass) were identified for their common characteristics of being large-scale programs with sufficient data to present, while also being young enough that design and modeling suggestions arising from this workshop could still be implemented where necessary.

The workshop took place over the course of three days. Day One comprised of presentations of each tagging program with discussion and feedback offered within each presentation. The invited keynote speakers, Dr. John Hoenig (Virginia Institute of Marine Science) and Dr. Alistair Hobday (CSIRO Marine, Hobart, Tasmania, Australia), presented on Day Two, providing a review of the options for modeling and simulation of tagging data, in addition to some practicalities regarding tag study design. Day Three focused on reviewing the three key programs in light of the feedback offered, followed by an in depth discussion of the overarching issues which were considered applicable to most tagging programs; this discussion was led by the workshop Chairman, Dr. Paul Rago (Northeast Fisheries Science Center, Woods Hole, Massachusetts).

Feedback both during and since the workshop has confirmed that this 3-day working meeting provided an excellent and much needed opportunity for exchange of ideas and sharing of experiences between programs. The format of this workshop facilitated some open, energetic and productive discussions, through which attendees were able to collectively consider the ways in which each program could be improved and strengthened in future months. Consideration should

be given to the establishment of an ongoing working group to review progress by specific programs, develop and/or apply analytical methods for analysis of tagging data and evaluate incorporation of tagging data into stock assessments.

These workshop proceedings collate and document the core information on which the workshop was based (see Tagging program fact sheets); the detailed critiques and reviews for each tagging program presented (see Workshop discussions); the overarching issues identified (see Overarching issues); and the reviews provided by the two keynote speakers (see Keynote speaker reviews). From these proceedings, it is evident that the workshop aims were well met.

Summary of Overarching issues

Certain key regional needs were identified for tagging programs operating along the Northeastern seaboard; these are discussed in depth within the section on Overarching issues, but a brief summary of these is provided here:

Reporting rates

- Reporting rates need to be maximized.
- Heterogeneity in reporting rates leads to mis-specified models and imprecise parameters. Identification of heterogeneity is necessary and reduction of such variations is highly desirable.
- A review of rewarding techniques and options (e.g. cash rewards, sentimental rewards and lotteries) was recommended.
- Failure to reward returns over a long period of time has a detrimental effect on returns for other/future programs.
- Consideration of a central clearing house for rewarding returns.

Experimental design

- Tagging programs should aim to maximize the efficiency of the resources used and their ability to test specific hypotheses.
- Two particular tag release strategies were identified:
    1) Release tags in proportion to fishing effort;
    2) Release tags in proportion to relative abundance.
- Total cost of information from tags: the cost of the tag can be relatively minor compared to the costs of release, rewards and database management/maintenance – this point is particularly valid when considering double-tagging proportions for a study.
- Use of mission-appropriate tags: specific movement hypotheses may be more efficiently tested using a few expensive tags (e.g. electronic tags) than a large number of conventional tags.

Database design and implementation

- Database design has important implications for data entry and efficient data retrieval.
- Databases need to be versatile to current and future unidentified needs.
- The Northeast Regional Cod Tagging Program's database was judged to be the most advanced, and a potential model for other programs, and in particular was proposed as a possible cost-effective model for bridging between regional programs.
- Crucial elements of a tagging database were considered to be quality assurance and quality control (QA/QC), data visualization and data export functions for specialized software.

- The database is recognized as the primary tool for the tag reward program, and thus needs to be capable of providing timely feedback to those reporting tags and analysts.

Data analysis & model building

- Specialized analytical models and visualization tools are needed.
- Such tools should be sufficiently general to support differences between programs, e.g. differences in program design and analytical needs.
- A multi-disciplinary approach is recommended: e.g. approaches taken by oceanography and wildlife management may be of value.
- The high priority data analysis and model building needs identified were:
    - The development of appropriate analysis tools;
    - The development of diagnostic methods for validation of model assumptions and fit.
- There is a role for GIS in the visualization of tagging data.
- Historical tagging data or simulated data could be used in model development.
- There is a need to develop procedural approaches and analytical methods for incorporating tagging information into stock assessment analysis.

Archiving information and data access

- Long-term utility of tagging datasets is evident: raw data are needed, rather than just data summaries.
- Long-term storage and availability of data is needed.
- Attempts should be made to recover historical tagging data and make this information accessible.
- A standard regional data-sharing policy is needed; this should reflect professional ethics and courtesies for scientists, without constraining timely access to data for management use.
- There is an overall need for transparency, cooperation and critical review to facilitate:
    - Performance improvements of all tagging programs;
    - Justification for continued public funding of adaptive tagging programs, focused on management needs.

Workshop deliverables

In addition to program-specific needs and overarching regional needs, throughout the workshop specific points and deliverables were proposed. These can be summarized as follows:

- **Workshop proceedings:** Produce proceedings to document this first Northeast Mark-recapture Workshop and provide useful reference material for consideration by future tagging initiatives and management meetings.
- **Long-term commitment to tagging studies:** The success of any tagging program is highly dependent on achieving high reporting rates; these are in turn dependent on the appropriate outreach efforts being made by each tagging program. For the region as a whole, tagging efforts would benefit from a long-term commitment by funding bodies to support the necessary outreach needs, e.g. a region-wide capacity to support long-term reward of tag returns. It was further recommended that researchers and funding bodies see the longevity of a tagging study as being 3-10 years, depending on the aims of the study.

- **Creation of a central clearing house:** Consideration should be paid to the potential value of establishing a central clearing house for long-term: 1) rewarding of tag returns for multiple programs, and 2) database management and maintenance on a region-wide, multi-program scale.
- **Undertake a review of tag-reward programs:** This could focus in particular on assessing the efficiency of different reward options for their achievement of high return rates and quality information. A review of tag return lottery procedures should be included in this review.
- **Experimental design:** Investments in development of appropriate experimental designs are valuable for identifying attainable objectives and estimable parameters, defining feasible deployment strategies, evaluating the relative cost of tag information and selecting mission-appropriate tags.
- **Program goals and data limitations:** It is important to identify and define the limitations of each program at the outset. This should prevent disappointment upon subsequent presentation of the results to both the scientific and fishing communities.
- **Future tagging workshops:** There is a need to conduct additional fish mark-recapture workshops in the future; this will enable researchers to make progress on the areas described in the "Overarching Issues" section of this proceedings. It would be particularly timely and appropriate to hold the next mark-recapture workshop ahead of the 2008 benchmark stock assessments for Northeast groundfish (e.g. cod, haddock and yellowtail flounder). A data-oriented workshop during 2006 could provide the forum for program partners and stock assessment personnel to analyze the tagging data together, for incorporation into the 2008 stock assessments; of note, 3-4 years of tag return data would have been accumulated by this time for Atlantic cod, yellowtail flounder and black sea bass.

Introduction

Prepared by: Dr. Shelly Tallack, Gulf of Maine Research Institute

Cooperative tagging projects in the northeast include a variety of target species (Atlantic cod, yellowtail flounder, black sea bass, striped bass, Atlantic haddock, herring, halibut, pelagic and large coastal sharks, etc.) and program objectives (movement, mortality, growth and outreach). Several programs have been ongoing for many years, while others were developed more recently and are focused on answering questions of particular interest for groundfish management.

In the winter of 2003, NOAA Fisheries Northeast Fisheries Science Center (NEFSC) identified that all of these tagging programs would benefit from a review of the theory and analytical details of the state-of-the art models available for testing project hypotheses. This workshop was initiated to provide an opportunity for current tagging programs to develop timely feedback in terms of technical direction for project planning and mid-course correction on experimental design. The goal and objectives may be summarized as follows:

Goal:
- To provide a forum for reviewing the capabilities and limitations of available mark-recapture models in the context of ongoing or future tagging activities in the Northeast.

Objectives:
- Review state-of-the-art models available for testing mark-recapture project hypotheses.
- Review and critique three current mark-recapture projects in the Northeast (Atlantic cod, black sea bass and yellowtail founder) and provide advice on experimental design, field protocols, model selection, database development and ancillary parameters.

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There was an international attendance at the workshop. Two keynote speakers were invited with expertise on various aspects of tagging programs, but with particular specializations in movement studies and integration of tagging data into stock assessment applications. In addition, each of the Northeast tagging programs was represented by its principle investigators and participants. The

keynote speakers were asked to provide guidance to each of the three key programs on experimental design, field protocol, database development and estimating ancillary parameters. The emphasis was on the practical aspects of tagging and designing a study to successfully meet objectives.

The format of the workshop (see Annex 3: Workshop outline and agenda) allowed for presentations and discussion panels on the technical aspects listed above, with prescriptive advice on how to structure tagging studies. Program overviews (see Fact sheets 1-8) were prepared by field analysts and program managers of the ongoing research tagging programs prior to the meeting. These provided an overview of each program's objectives, experimental design, methods used to date, anticipated uses of the resulting data, relationship to ongoing studies, and expected duration. The summaries were compiled and sent to the keynote speakers in advance of the meeting. Keynote speakers then oriented their initial presentations toward one or more of the key ongoing studies.

All presentations were delivered in a conversational format, allowing for clarifying questions and open discussions during the course of each. Program overviews of the key three species entailed a detailed presentation by the program manager, on program aims, program design, data management, results to date, lessons learned and ancillary studies identified. These provided sufficient information for experts to tailor their deliverance the following day to specific requirements of each key program. Shorter, less detailed program overviews were given for the additional tagging programs; their focus was geared toward program aims, lessons learned, things to do and things to avoid.

These proceedings provide a dissemination of the workshop's progression, and are structured as follows:

- Executive summary;
- Project description fact sheets – information distributed during the workshop;
- Workshop discussions – reviews by each PI on the key points made about their respective program, in addition to a section on more general Overarching issues;
- Keynote speaker reviews;
- Annexes (Workshop transcript, Bibliography, Outline and agenda, Keynote speaker background and Attendee contact details).

Tagging program fact sheets

Each of the Northeast fish mark-recapture programs was briefly described before the workshop in the form of a program fact sheet. These provided background information on the core components of each program and were expanded upon during the presentations delivered by the Principal Investigator (PI) for each program. The transcript in Annex 1 provides further detail shared during the presentations, in addition to documenting the interactive discussions which ensued.

1. Atlantic cod, *Gadus morhua*

Prepared by: *Dr. Shelly Tallack, Gulf of Maine Research Institute*

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Scientific justification: Canadian and US stock assessments for Atlantic cod indicate considerable fluctuation in stock abundance and recruitment over the last 20 years. This recovering resource is regulated on a stock-by-stock basis, with varying management measures in place. Since the 1920s, a number of small-scale, independent tagging studies were conducted, but each varies considerably in spatial and geographic coverage, tagging technique, and the information collected. Furthermore, information was rarely shared between programs. The Northeast Regional Cod Tagging Program was initiated to study cod movements using a standardized technique on a region-wide scale, whilst simultaneously achieving international collaboration between fishermen and scientists. The data will compliment future stock assessments by providing current information on movement patterns and growth in the Gulf of Maine and neighboring waters.

Technical objectives (prioritized):

1) Identify the migration patterns of Atlantic cod throughout the Gulf of Maine and neighboring Canadian and US waters;
2) Identify the extent of mixing between cod in these water bodies;
3) Obtain in situ growth increment information;
4) Investigate the roles of temperature, depth and reproductive condition on migration and growth.

Tag specifications: Hallprint "TBA-2 tag" T-bar anchor tags. Two colors:

1) **Yellow tags:** 6-digit ######, NE COD TAGGING PROGRAM, 1-866-447-2111, www.codresearch.org; 10% are "double-tagged" to assess tag retention.
2) **Blue high-reward tags:** 6-digit H######, NE COD TAGGING – HIGH REWARD $$, 1-866-447-2111, www.codresearch.org. Since May 2004, 10% of cod receive a high-reward tag.

Geographic extent: Gulf of Maine and neighboring waters in Maritime Canada: Georges Bank, Nantucket Shoals, Coxes Ledge, Cashes Ledge, Fippennies Ledge, nearshore Western Gulf of Maine, nearshore Downeast Maine, ledges around Jordan Basin, Browns Bank, Digby Neck & Bay of Fundy (see Figure 1).

Geographic stratification: Cod are targeted and tagged in the general tagging areas outlined (see Geographic extent), according to their availability; certain permanent and seasonal closed areas are also targeted. A "rule-of-thumb" cap is set at 5,000 fish per tagging area, per season. In some areas this cap is easily attainable; in other areas the program has struggled to locate and tag 5,000 cod.

Timeframe of releases: Tagging in 2003 (~46,000 releases), 2004 (currently ~45,000, projected total ~75,000 releases), and planned for 2005 (projected ~20,000 releases).

Seasonality of releases: Focus is on spring and fall, but in some areas tagging continues throughout the summer. Seasonality is partially determined by when fish are in the target release areas. Spawning fish are tagged when possible (spring), but numbers found by June 2004 had not been high: n=706 of the 55,758 checked for spawning condition from all data by that time.

Size of fish: The minimum tagging size is 36cm (legal minimum size is 56cm); all fish of 36cm or greater are tagged, if their condition is strong.

Method of initial capture: **1)** Commercial otter trawls (mesh sizes 5.5", 6.0" and 6.5") and relatively short tows (~20-30 min); **2)** commercial hook gear (handline, manual rod & reel, electronic rod & reel, long-line); **3)** recreational hook gear (handline, manual rod & reel); **4)** lobster traps (very few); and **5)** gillnet (one trip only).

Method of recapture and seasonality: Recaptures from year-round commercial fishery (trawl, hook and gillnet) with some seasonal geographic closures. Recaptures also from seasonal recreational fishery (hook) (spring – fall). Cod tagged in permanent closed areas are only recaptured if they move outside the closed area, are recaptured by recreational vessels or are recaptured during a tagging trip.

Reward system:

1) **Yellow tags:** 155,000 regular tags – incentive is a T-shirt, hat or mug. In addition, all individuals reporting a minimum of date, tag #, recapture location and fish length are entered into a monthly lottery ($1,000) with 5 categories (thus, each reward = $200).
2) **Blue tags:** 10,000 high-reward ($100) tags; rewarded on receipt of tag only (began in year two).

Outreach methods: Distribution of laminated (bi-lingual: English and Portuguese) posters and information brochures. Mass-mailings (2x per year) to all multispecies permit holders, tag reporters, charter companies and processing plants (includes update letter, newsletter, flyer, mini-data sheets and SAEs). Regularly updated program website (www.codresearch.org), which gives viewers access to near real-time data via an interactive GIS mapping site (www.gmamapping.org/codmapping/). Press releases, message on NOAA weather radio, periodic TV coverage. Tag returns: toll free number (866-447-2111), prompt responses to tag returnees (letter with recapture report & map, and their reward). Annual meeting with scientists and fishermen, progress update meetings at regional industry meetings.

Data management: The data collected includes:

Trip & vessel

- Vessel name, Fed. permit # & Doc. #
- Gear type
- Trip #
- Names of Captain & crew
- Tagging Organization
- General tagging area
- Trip date range
- Total number of fish tagged
- Units of measure: Location, depth, temperature
- Haul #

Haul

- Date: at start• Time: start & end• Location: start & end
- Water depth: start & end
- Water temperature: surface/bottom• Tagger: initials only• Number of fish tagged • Haul comments

Tagged fish

Vessel name, Trip#, Tagger (full name), Units of measure (cm/"), & Are you checking for spawning condition? (Y/N)

- Haul #
- Fish count
- Tag #(s) (skin-tag checkbox)
- Fish length
- Presence of milt/eggs?
- Fish comment
- Fate of fish: Released, floater, seagull, landed

Recaptures (during tagging trip)

- Haul #
- Fish count
- Tag #(s)
- Fish length
- Presence of milt/eggs?
- Fish comment
- Fate of fish: Released, floater, seagull, landed

Recaptures (general public)

- Tag #(s)
- Date
- Fish length
- Recapture location
- Depth
- Temperature
- Presence of milt/eggs?
- Fish comment
- Fate of fish: Released, floater, seagull, landed

Non-tagged cod

- Haul #
- Fish count
- Reason not tagged: undersized/poor condition
- Fish length
- Presence of milt/eggs?
- Fish comment

Data management of the NRCTP data is undertaken by GMRI, the contracted data "clearing house". Each program partner enters their tag release data via a password protected, online, custom-made, relational database which has been developed in SQL Server. This online database avoided the need for software updates for the multiple program partners as the database evolved and increased in sophistication. Significant automated quality control (QC) tools are built into numerous fields allowing the data to be error checked as it is entered. Program partners then "submit" their data in order that GMRI can verify or "approve" it again, before committing it to the database. Recaptures are entered solely by GMRI, and again undergo a QC approval process.

Once committed, the data is accessible to the public through the online GIS mapping interface; data can be filtered to investigate different parameters. To date only partner organizations can download the raw data; the file format is a flat, tab-delimitated file. In future months, after sufficient QC and data verification, the database will be downloadable as a complete, relational Access database.

Number of releases, by time and geographic area:

Organization	Release Area	Releases by June 04	% releases
DMR, II	Cashes, Fippennies, Platts	1,995	2.5%
	Offshore Downeast	2,027	2.5%
	Inshore Downeast	953	1.2%
	Central Inshore GOM	5,979	7.5%
	Jeffreys Ledge	2,213	2.8%
	Western GOM Inshore	230	0.3%
SMAST & CCCHFA	Georges Bank	16,547	20.8%
	Cape Cod/East of Chatham	11,900	15.0%
	Nantucket Shoals	17,798	22.4%
	Great South Channel	8,998	11.3%
DFO	Digby Neck (03)	5,260	6.6%
	Yarmouth - Cape Sable (02 & 03)	5,591	7.0%
	Total	**79,491**	

Number of recaptures to date: By July 31, 2004, stakeholders had reported 1702 recaptured tagged cod (~2.0% of ~87,000 total releases to date). When added to the estimate of ~485 recaptures recorded during tagging trips, the return rate is ~2.5%. Physical tags have been received for 1,263 (74%) of the 1,702 recaptures reported by stakeholders.

- **Double-tagged fish:** 191 recaptures have been reported; little evidence of tag loss.
- **Re-releases:** 86 of recaptures reported were re-released (in addition to all recaptures from tagging trips if the fish is in good condition).
- **High-reward tags:** GMRI has processed 18 recaptures since May 2004 (~1.8% of high-reward tag releases by July 2004 (~996)), and 17 physical tags have been received by GMRI. (Note: high-reward tags were only released in year two).
- **Method of reporting:** Of the 1,702 recaptures reported, 60% came via mail (mini-data sheets), 28% by phone (1-866-447-2111), 9% via email (through www.codresearch.org), and 4% were reported in person.

Tag recaptures reported from March 2003 - July 2004; stakeholders reporting tags include Fishermen (F), Processors (P) and Observers (O). For recapture locations, see Figure 2.

		Reported by				% of
	Release areas covered	**F**	**P**	**O**	**Totals**	**releases**
DFO	Bay of Fundy, Browns Bank	146	260	9	**415**	7.1%
Isl. Inst.	Nearshore Maine & Jeffreys	19	4	1	**24**	1.6%
DMR	Cashes, Fippennies, Jordan Basin, Nearshore Maine, Jeffreys Ledge	280	48	47	**375**	2.2%
CCCHFA	Nantucket Shoals, Great South Channel, Chatham, Coxes Ledge, Stellwagen Bank	409	29	45	**483**	1.1%
SMAST	Georges Bank, Great South Channel	299	92	14	**405**	2.2%
	Totals	**1153**	**433**	**116**	**1702**	**2.1%**
	Totals with Recaptures from tagging trips				**~2187**	**2.7%**

Tag retention: 10% of fish tagged with yellow tags receive 2 tags; this will give a measure of tag retention. To date significant tag loss has not been indicated.

Tag-induced mortality: We currently have no data from which to quantify tag-induced mortality. However, use of live-wells during tagging trips indicates that some fish do not survive the fishing process (even before tagging), despite modifications to fishing techniques aimed at maximizing survivability. The tagging protocol developed recommends against tagging weak fish. The fate of the fish is noted on release and upon analysis, this will provide some indication of short-term post-tagging mortality. Very few instances of infection around the tagging site have been observed.

Analytical design: Estimate movement (and mortality) based on the number of tag returns by area and season, taking into account the reporting rate and fishing effort. Preliminary data analysis has focused on: size relationships, growth rate, distance and direction of movements, seasonal displacement, recapture reporting rate and method of reporting tags (implications for outreach efficacy).

Figure 1: Tagging locations for Atlantic cod targeted by each tagging organization: Canada Department of Fisheries and Oceans (DFO), Island Institute, Maine Department of Marine Resources (DMR), Cape Cod Commercial Hook Fishermen's Association (CCCHFA) and the School for Marine Sciences and Technology (SMAST).

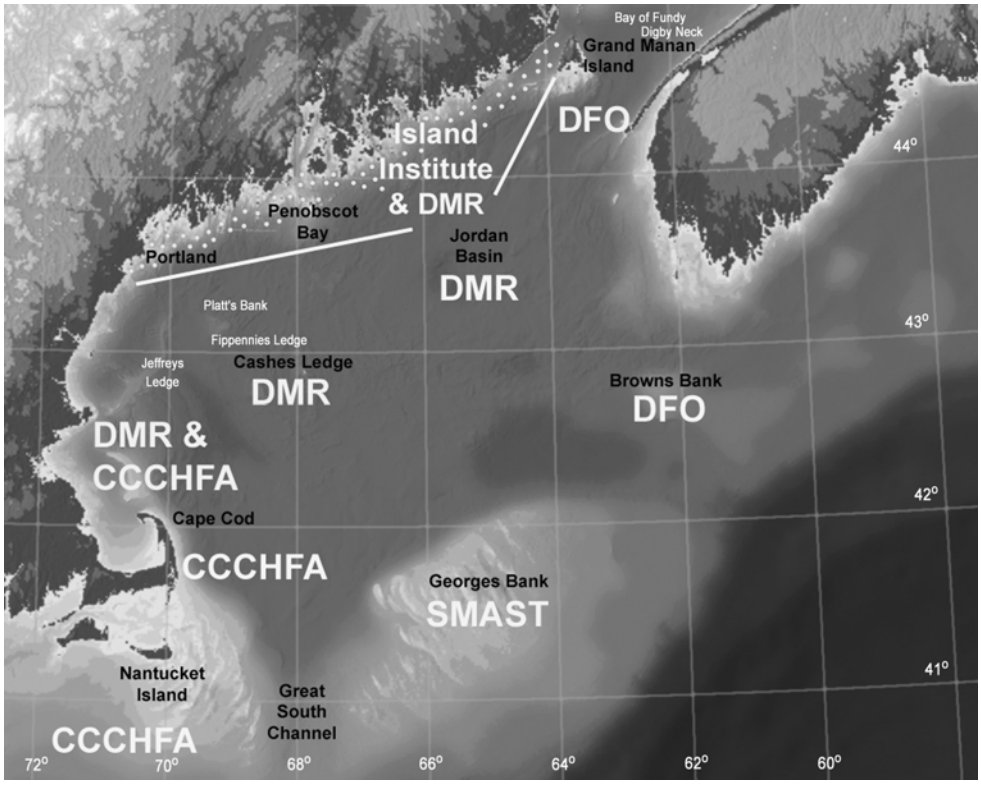
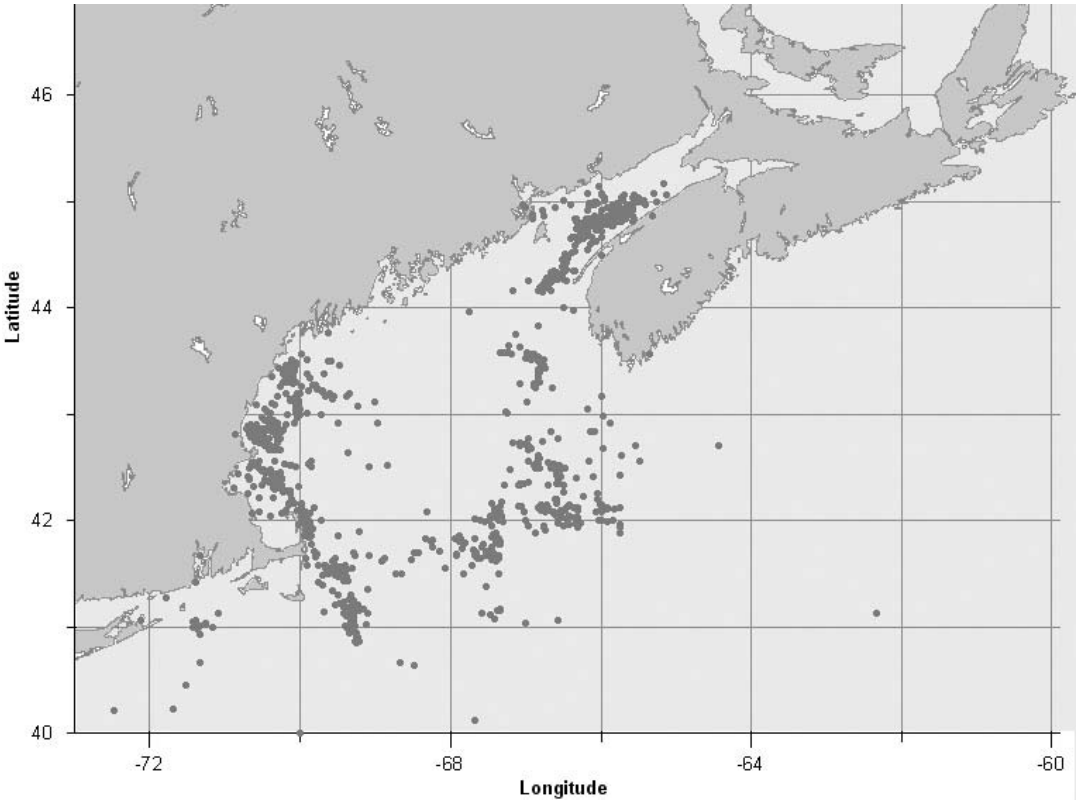


Figure 2: Recapture locations reported for the period March 2003 – August 2004 (n=1,605): recaptures are being reported from all major fishing grounds, though few have been reported from Downeast Maine waters.



2. Yellowtail flounder, *Limanda ferruginea*

Prepared by: Dr. Steve Cadrin, Northeast Fisheries Science Center

Principal investigators:

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Technical objectives (prioritized):

1) Estimate movement among stock areas
2) Determine fishing mortality rates within stock areas
3) Growth increment observations

Scientific justification: All U.S. yellowtail resources are rebuilding from overfished conditions and there are considerable uncertainties in the conventional stock assessment methods (e.g., substantial retrospective bias). The most recent mark-recapture studies for yellowtail were from the 1950s, when stock conditions and potentially movement patterns were different. The tagging study is designed to complement current sources of information for yellowtail assessments and provide an independent estimate of fishing mortality.

Tag specifications:

1) **Peterson discs;** Floy Tag 7/8" round, fluorescent pink, labeled "cooperative-tagging.org, 5-digit tag #, $1000 lottery (or $100 reward), toll free 877-826-2612, provide tags & location and date." Most fish tagged blank on blind side, scales plucked from approximately 10%, labeled tags on blind side, "take some fish scales & return to 166 Water Street Woods Hole MA 02543."
2) **Data-storage tag;** Lotek LTD 1100, 32K memory, 8mm x 16mm x 27mm; time (dynamic storage & intervals), depth (+/- 0.04psi up to 735psi) & temperature (+/- 0.19° C), 3 year battery, labeled "tag#, Mail tag, date, location to 166 Water Street Woods Hole MA 02543". Oval disc tag labeled "cooperative-tagging.org, $100 reward, toll free 877-826-2612."

Geographic extent: Three U.S. Stock areas: Cape Cod-Gulf of Maine, Georges Bank, southern New England-Mid Atlantic (see Figure 1).

Geographic stratification: Tag releases in 10 statistical reporting areas, proportional to relative abundance of yellowtail (according to NEFSC groundfish surveys).

Timeframe of releases: Tagging in 2003 (9475 releases), 2004 (projected 19,089 releases), and planned for 2005 (projected 5,000 releases).

Seasonality of releases: Nearly all releases during spawning season (May-August), some releases in autumn (820 of 28,564).

Size of fish: All legal-sized fish (>33cm), and some sub-legal sized-fish from low density tows in southern New England-Mid Atlantic.

Method of initial capture: Commercial otter trawls using large mesh (6") and relatively short tows (~30 min).

Method of recapture and seasonality: Recaptures from year-round commercial fishery with some seasonal geographic closures. The reward system involves:

- 30,000 lottery tags ($1000) with quarterly drawings;
- 200 high-value ($100) tags;
- $100 reward for data-storage tags.

Outreach methods: Reward posters (in English and Portuguese), brochures, website (cooperative-tagging.org), annual letters to yellowtail fishermen, press releases, toll free number (877-826-2612), phone call and 'thank you' letter with map with details of the tagged fish and its movements to every fisherman who reports a recapture, annual meeting with scientists and fishermen, hats for leading tag returns and collaborators.

Data management: Tag release data are recorded on two data logs, the Captain's log and the tagger's log. The two logs are keypunched by technicians into two associated data tables that can be linked using 'date' and 'tow number' fields. Recapture information from phone calls or letters are recorded on recapture logs and keypunched by technicians to a table that can be linked by 'tag number.' The resulting database has three relational tables. Copies of the updated master database are routinely copied and sent to cooperating parties.

Number of releases, by time and geographic area: (see Figure 1 for geographic depiction of statistical areas).

Area	Statistical area	Yellowtail resource	2003 releases	2004 releases	Total releases	% releases
Western Gulf of Maine	513	7%	15	1,468	1,483	5%
Mass Bays	514	13%	2,104	1,395	3,499	12%
East of Cape Cod	521	10%	2,282	66	2,348	8%
Cultivator	522	3%	724	765	1,489	5%
Southwest Part Georges	525	12%	140	4,005	4,145	15%
Northern Edge Georges	561	1%	428	446	874	3%
Closed Area II	562	43%	2,962	9,169	12,131	42%
Lightship Area	526	3%	125	605	730	3%
Southern New England	537	4%	430	368	798	3%
Mid Atlantic	613	3%	225	736	961	3%
Block Island	539	1%	40	66	106	0%
Total		**100%**	**9,475**	**19,089**	**28,564**	**100%**

Number of recaptures to date: As of June 20 2004, tags from 655 recaptured fish were reported (approximately 7% of 2003 releases) (Figure 2). Nineteen $100 tags were returned (17%).

Release Area	Recapture Area: Gulf of Maine	Cape Cod	Georges Bank	S.New England	Mid Atlantic	Total
Gulf of Maine	0	1	0	0	0	1
Cape Cod	1	384	9	2	0	396
Georges Bank	0	6	248	0	0	254
S.New England	0	0	1	0	0	1
Mid Atlantic	0	0	0	0	0	0

Tag retention: Long-term holding study in progress (no tags lost over 3 months).

Tag-induced mortality: Short-term holding experiments suggest some mortality, possibly due to transport from fishing grounds to Woods Hole. Cage studies proposed for 2005.

Analytical design: Estimate movement and mortality according to the observed number of tag returns by area and season, accounting for tag-induced mortality and reporting rate. The model has flexible spatiotemporal resolution, so that stock areas can be analyzed by stock areas annually, or by statistical areas seasonally if the number of tag returns supports such detail.

Figure 1: Statistical areas corresponding to releases of tagged yellowtail flounder.

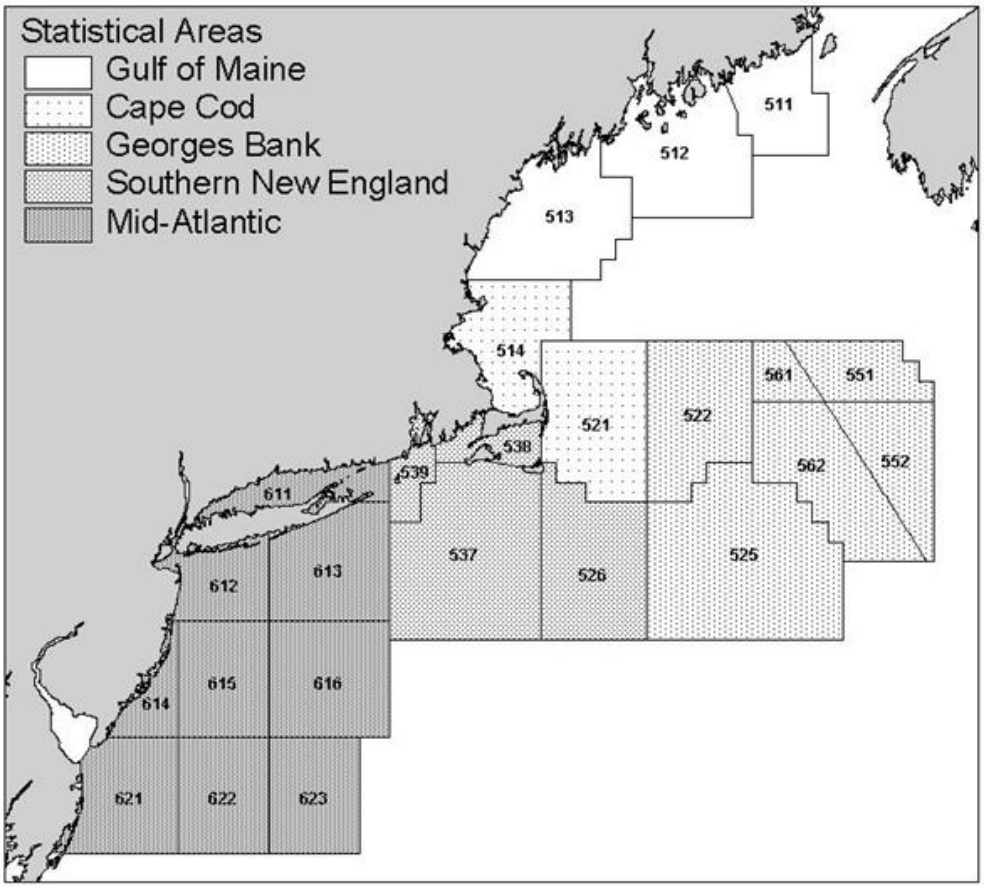
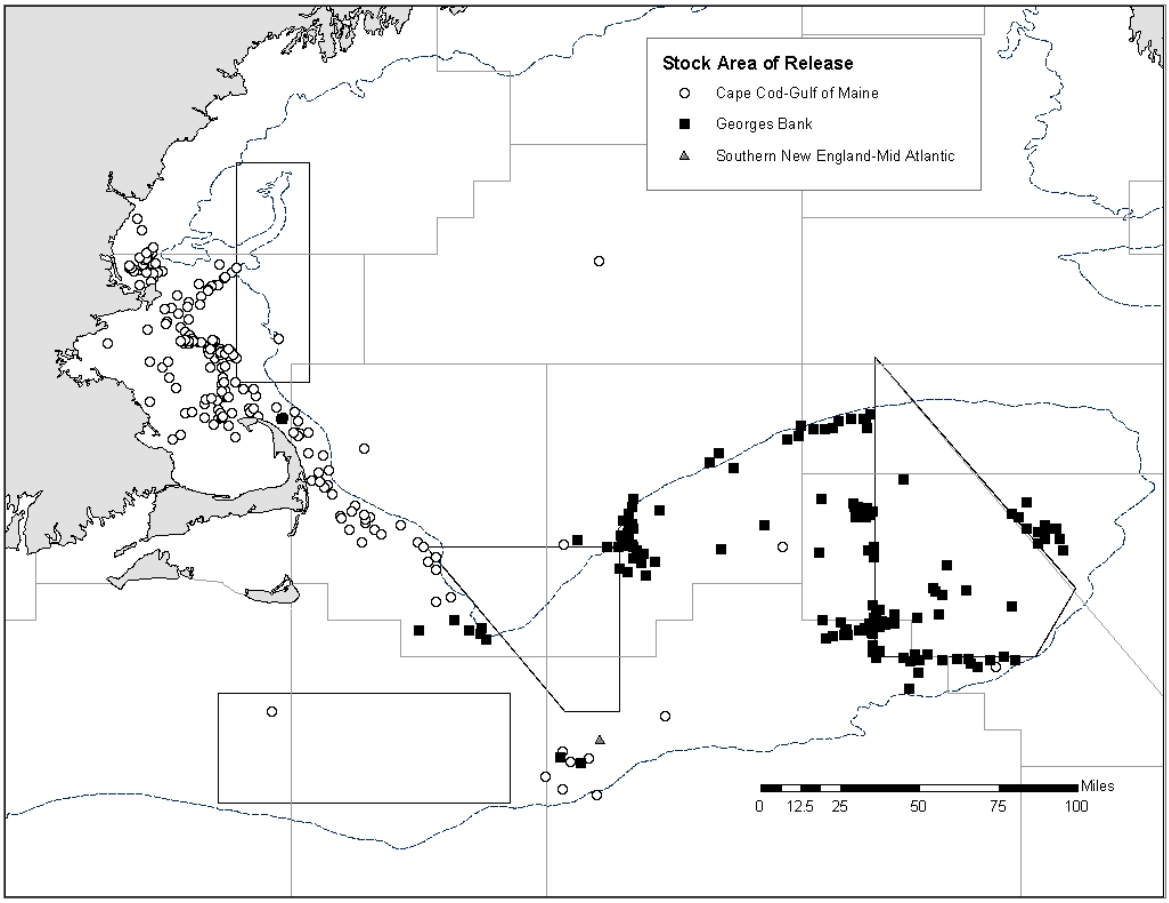


Figure 2: Recapture locations of tagged yellowtail flounder.



3. Black sea bass, *Centropristis striata*

Prepared by: Gary Shepherd, Northeast Fisheries Science Center

Principal investigators:

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Scientific justification: Black sea bass are managed as a single unit stock by the Mid-Atlantic Fisheries Management Council. Stock status has been based on trends in indices from the NMFS spring bottom trawl survey. It was recommended during a 1998 review of the assessment that alternative methods, such as tagging, be considered as a means of evaluating exploitation rate of the stock relative to biological reference points. In addition, management of sea bass as a unit stock has been questioned by user groups. A tagging project was seen as a way to evaluate the validity of the one stock approach to management.

Technical objectives (prioritized):

1) Estimate **exploitation rate** of the northern stock of black sea bass.
2) Identify the **seasonal migration** pattern throughout the stock.
3) Exam the extent of **mixing** among regional components of the stock.

Tag specifications: Floy internal anchor tags, model FM 84

1) Orange tags – 6-digit tag #, telephone number, "REWARD" (information is reversed on other side of tag with tag # at end of the tag). Internal tab has tag #, "Reward" on one side, NMFS Woods Hole, Telephone number on the other side.
2) Red tags – 6-digit tag #, telephone number, "$100 REWARD" (information is reversed on other side of tag with tag # at end of the tag). Internal tab has tag #, "$100 Reward" on one side, NMFS Woods Hole, Telephone number on the other side.
3) Data-storage tag - Lotek LTD 1100, 32K memory, 8mm x 16mm x 27mm; time (dynamic storage & intervals), depth (+/- 0.04psi up to 735psi) & temperature (+/- 0.19° C), 3 year battery, labeled "tag#, Mail tag, date, location to 166 Water Street Woods Hole MA 02543". Oval disc tag labeled "cooperative-tagging.org, $100 reward, toll free 877-826-2612."

Geographic extent: Massachusetts to North Carolina

Geographic stratification: Tag releases are stratified by state, with the release numbers in approximate proportion to reported commercial landings.

Timeframe of releases: Releases made in September 2002, May 2003, September 2003 and September 2004. Approximately 3,000 releases per season.

Seasonality of releases: Last two weeks of September (or May). Tagging has been extended into the first week of October if weather delays were encountered (hurricanes, etc.).

Size of fish: Minimum length of fish tagged was approximately 27cm (minimum legal size = 28 cm), although on occasion smaller fish were included. Below 25 cm the size of the tag appears to be too large. All fish above 27 cm were tagged if condition permitted.

Method of initial capture: Captures were made using black sea bass pots operated by commercial fishermen, commercial hook and line gear, or recreational hook and line catches from volunteer fishermen on chartered party boats.

Method of recapture and seasonality: Recaptures have come from recreational fishermen on private or charter boats, commercial hook and line fishermen, commercial sea bass pots or otter trawls.

Reward system: Each orange tag returned with information was rewarded with an embroidered baseball hat ("Cooperative Tagging Program" and a sea bass). Each red tag reported and sent to NMFS, Woods Hole was rewarded with a $100 check.

Outreach methods: Information about the tagging project was distributed to the press via a NEFSC press release. Individual letters were sent to permitted commercial fishermen and recreational fishing clubs (who also received a small poster). Posters were distributed to bait and tackle shops in ports where tagging trips were conducted. A website was developed which gives viewers updated information on the project including maps of general release and recapture locations. Information about the individual tagged fish is included in a letter sent to people reporting a recaptured tag. Also inclusion of volunteer fishermen in the release program increases general knowledge of the program.

Data management: Release data is entered into an Excel spreadsheet and contains information on: release date (month, day, year), vessel, port, site location (latitude and longitude), gear type, water depth, water temperature, tag number, tag type, tagger name, recorder name and comments. Recapture information entered into the spreadsheet includes: date (month, day, year), tag number, tag type, fish length, length unit, length quality code, fate of tag, fate of fish (disposition), number of times recaptured, reason for release, recapture site, recapture coordinates, coordinate precision code, NMFS statistical area, port, gear type, industry code (recreational, charter, etc.), target species, vessel name, reporter name, address, telephone number, tag condition, comments.

Entered data is transferred to a SAS database and release/recapture files are merged by tag number. Automated auditing of the merged file includes comparisons of dates and lengths before and after recapture and estimation of distance traveled compared to time at large. The SAS data file is updated regularly with the addition of new data and backed up daily as part of the Center data management practices. Specific release and recapture location coordinates are considered confidential information.

Number of releases, by time and geographic area: (September 2004 releases incomplete; see Figure 1 for release locations; red tags are high-reward tags).

State	September 2002		May 2003		September 2003		September 2004	
	Orange	Red	Orange	Red	Orange	Red	Orange	Red
MA - NY	1606	137	131	7	1153	80	779	39
NJ - DE	518	33	726	42	685	87	501	26
MD-NC	1354	142	1503	34	1203	129	1207	59
Total	**3478**	**312**	**2360**	**83**	**3041**	**296**	**2487**	**124**

Number of recaptures to date: The following summary includes all recaptures regardless of tag fate (removed or re-released); red tags are high-reward tags (see Figure 2 for recapture locations).

Area	Orange tag Recaptures	Red tag Recaptures	Total
MA - NY	422	48	470
NJ - DE	527	42	569
MD-NC	512	49	561
Total	1461 (13%)	139 (17%)	1600 (73%)

Tag retention: Three independent studies done holding tagged fish in aquariums. First study held 9 fish for 3-9 months with no tag losses. A second study held 31 fish 10-12 months with 3 tags lost and a third study held 30 fish for 27 days with 4 tags lost. Overall the tag loss rate was 10.1%.

Tag-induced mortality: In the three tag retention studies conducted no tag-induced mortality was observed.

Analytical design: The initial estimate of exploitation rate using tag return data was made using a Petersen model, modified to account for tag reporting and tag loss. In addition, an instantaneous rate model was fit based on expected probabilities of tag recapture. Details of the analysis and results are available in NEFSC Lab Reference Document 04-10 '*39th Northeast Regional Stock Assessment Workshop (39th SAW) Assessment Summary Report & Assessment Report'*.

Figure 1: Release locations from September 2002 – September 2003.

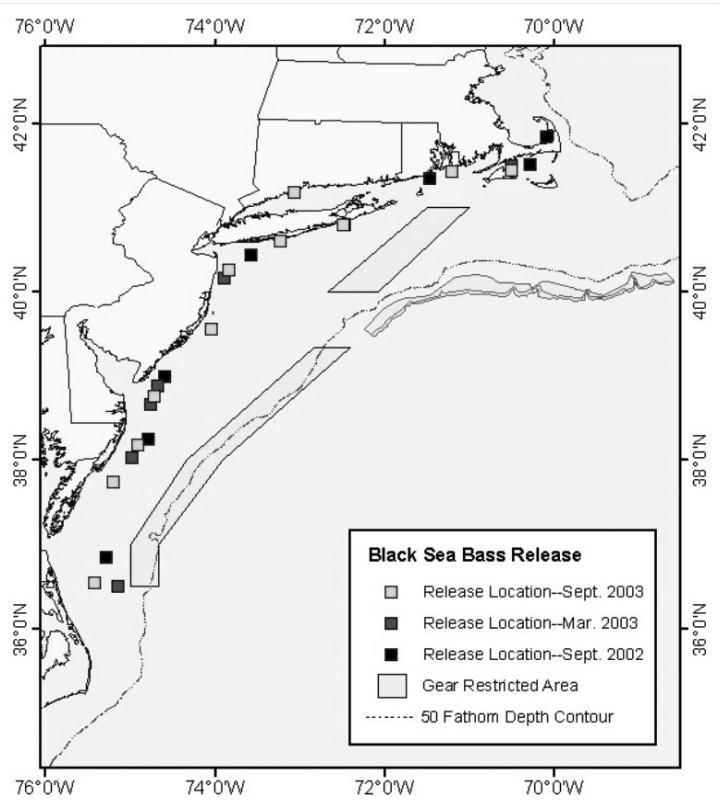
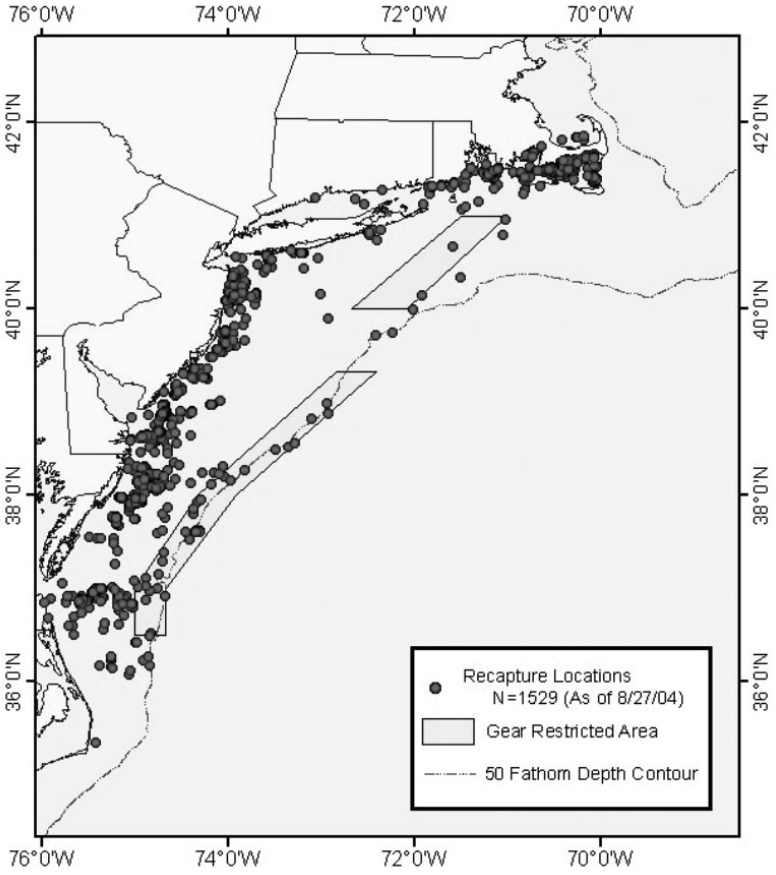


Figure 2: Recapture locations for reported by August 27 2004.



4. Atlantic shark species excluding dogfishes

Prepared by: Dr. Nancy Kohler, National Marine Fisheries Service

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Technical objectives (prioritized):

1) Investigate spatial and temporal variation in the distribution and migratory patterns of coastal and pelagic Atlantic shark species at various life history stages;
2) Delineate nursery and pupping areas and seasonal residence time;
3) Obtain individual migration, growth rates and longevity data;
4) Validate and verify age determination methods;
5) Determine stock identification and the degree of mixing between stocks;
6) Identify fine-scale factors influencing distribution, behavior, and growth including sea surface temperature and salinity;
7) Determine survival estimates; and
8) Promote conservation through catch and release.

Scientific justification: The National Marine Fisheries Service Cooperative Shark Tagging Program (CSTP) is a multi-decadal program that is part of continuing research directed to the study of the biology of large Atlantic Sharks to obtain information for rational resource management. Many shark species have wide ranging distributions, frequently traverse national boundaries, and are exploited by multinational fisheries. Their wide geographic range has made it difficult to gather basic data on distribution, movement patterns, and life histories that are essential to management.

Tag specifications: The two principal tags in use are a fin tag (Jumbo Rototag) and a dart tag ("M" tag). The rototag is a two piece, plastic cattle ear tag which is inserted through the first dorsal fin. These tags are primarily used by biologists on small sharks in the nursery areas. The "M" tag is composed of a stainless steel dart head, monofilament line, and a plexiglass capsule containing a vinyl plastic legend with return instructions printed in English, Spanish, French, Japanese and Norwegian. These dart tags, in use since 1965, are implanted in the back musculature near the base of the first dorsal fin and are the predominant tags used by cooperative taggers.

Geographic extent: North Atlantic Ocean, Gulf of Mexico, Mediterranean Sea.

Geographic stratification: Sharks are tagged throughout the areas outlined in the geographic extent, but primarily in the Northwestern North Atlantic. Recaptures occur throughout the geographic area.

Timeframe of releases: The CSTP began in 1962 with 38 releases. Since that time the program has averaged over 4300 releases a year, for a total of 181,915.

Seasonality of releases: Year round. The majority of the releases occur in the waters off the Northeast United States from late spring through fall.

Size of fish: Neonate size and greater are tagged.

Method of initial capture: Anglers using rod and reel accomplish the majority of the tagging for all species combined. Biologists, NMFS fisheries observers, and commercial fishermen using primarily longlines, handlines, and nets (gill, trawl) account for the remainder.

Method of recapture and seasonality: Commercial fishermen using longlines and net gear, and rod and reel recreational anglers are responsible for the majority of the recaptures, which occur year round.

Reward system: Initially, a five dollar reward was sent as an incentive for returning tags; since 1988, a hat with an embroidered logo has been used.

Outreach methods: Numbered tags are sent to volunteer participants on self-addressed return post cards for recording tagging information (date, location, gear, size and sex of shark), along with a tagging needle, tagging instructions, an *Anglers Guide to Sharks of the Northeastern United States*, and current management information. Annual newsletter sent to all participants prior to 1999. Program website http://na.nefsc.noaa.gov/sharks/index.html. Prompt responses to tag returnees (letter with recapture report, and their reward). Staff frequently travel to fishing centers and to fishermen's forums to publicize the shark tagging program and educate constituents on shark conservation and the benefits of tag and release.

Data management: CSTP release and recapture data are maintained in fixed column unit record files. Since the Program has been in existence for over 40 years, we have lived through various computer systems and database management programs. Early on, it was decided to retain data in flat ASCII files, which can then be imported into a variety of statistical and GIS programs for display and analysis. This has avoided many problems in data conversion when the current popular database system is abandoned in favor of a new type.

Release data are recorded by the tagger on postage paid tag event cards and mailed to the laboratory. The cards are checked for accuracy, and database numerical codes are written directly on the card. Copies of the tag cards are sent offsite for data input. Recapture data are received by mail, email, phone, or in person. Onsite staff complete a recapture event card for each recapture and directly input coded data. The resulting release and recapture files are proofread against the original data, run through quality control and mapping programs, and archived with previous years data for subsequent analysis. The original tag cards, recapture event cards, and associated original recapture information (letters, emails, etc.) are all stored onsite in file cabinets.

Number of releases, by time and geographic area: Between 1962-2003, more than 181,000 sharks of 52 species have been tagged. Eighty-six percent of the tags are represented by eight species: blue shark, *Prionace glauca*; sandbar shark, *Carcharhinus plumbeus*; tiger shark, *Galeocerdo cuvier*; dusky shark, *C. obscurus*; shortfin mako, *Isurus oxyrinchus*; blacktip shark, *C. limbatus*; Atlantic sharpnose shark, *Rhizoprionodon terrraenovae*; and scalloped hammerhead, *Sphyrna lewini*. The number of sharks tagged varies from 1 for the scoophead (*S. media*) to 97,843 for the blue shark.

Number of recaptures to date: Through 2003, 10,826 sharks of 33 species have been recaptured. Numbers of recaptures by species range from 1 for the Greenland shark (*Somniosus microcephalus)* to

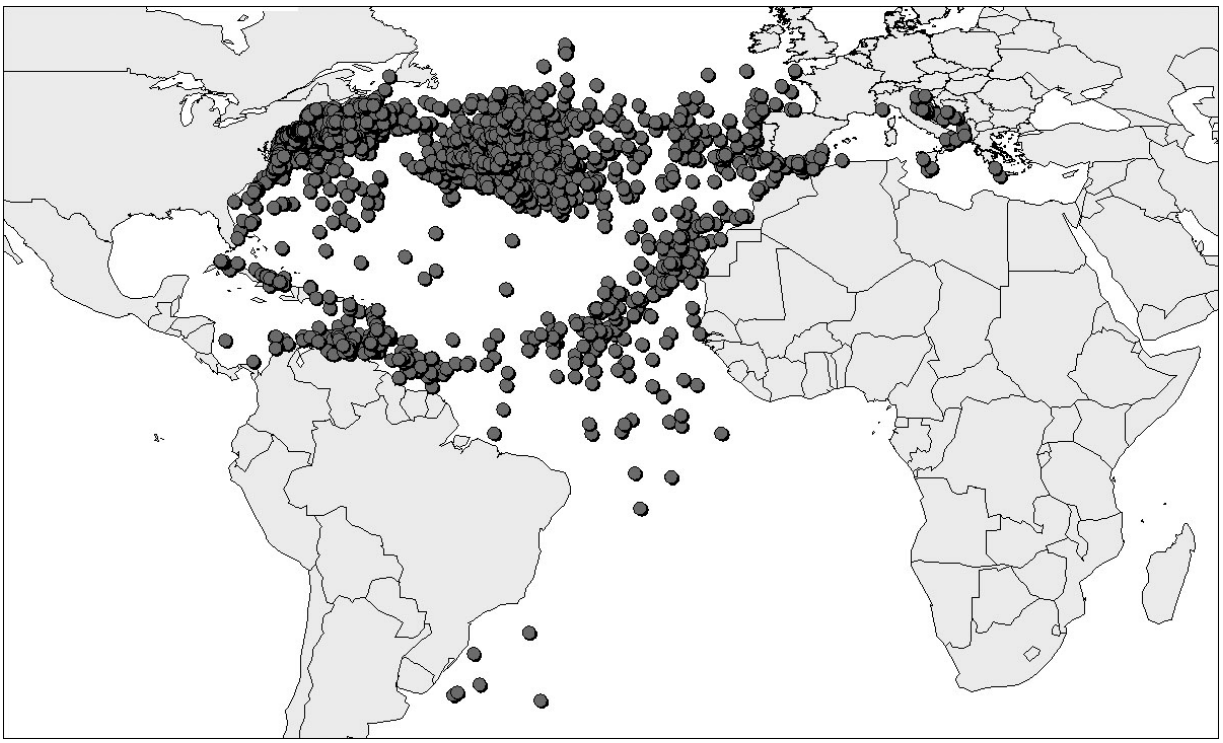
6,261 for the blue shark. Eighty-eight percent of the recaptures are made up of seven species: blue shark; sandbar shark; shortfin mako; tiger shark; lemon shark, *Negaprion brevirostris*; blacktip shark; and dusky shark. The rate of recapture ranges from 1.3% for the oceanic whitetip shark (*C. longimanus*) to 12.0% for the shortfin mako.

Tag retention: No data to estimate tag retention rate.

Tag-induced mortality: No data to estimate tag-induced mortality but post release survival studies show no mortalities and rapid recovery from the catch, tag, and release process for many shark species.

Analytical design: Analysis to date includes general migration patterns, extent of range, and growth information for multiple species. More recent analysis in progress is stock identity and survival estimates for some species.

Figure 1: Blue shark recapture locations from the Cooperative Shark Tagging Program



5. Atlantic Striped Bass, *Morone saxatilis*

Prepared by: Tina McCrobie, United States Fish and Wildlife Service

Principal investigators:

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The Cooperative Striped Bass Tagging Program is currently executed in a partnership comprised of three federal and 10 state agencies to allow continued adaptive management of this species. Tagging is conducted during various State/Federal research projects. In addition to the 13 federal and state agencies, there have been 10 other cooperating agencies since the tagging began in 1985. Overall, a larger number of personnel have worked on this program to date.

Technical objectives (prioritized):

1) Estimate survival and fishing mortality rates for Atlantic striped bass.
2) Examine movements, migration, and the nature of commercial/recreational fisheries for striped bass.
3) Characterize the distribution of striped bass harvest and discards by type of recapturing fisher and gear, for use in the striped bass virtual population analysis.

Scientific justification: Atlantic striped bass are an important resource to recreational fishermen, commercial harvesters, and their dependent communities coast wide. Declines in abundance during the late 1970's and early 1980's resulted in the enactment of the Atlantic Striped Bass Conservation Act of 1984. A component of the Act, The Emergency Striped Bass Study, led to the implementation of the striped bass tagging study, which is overseen by the U.S Fish and Wildlife Service.

Management of the species is coordinated through the Atlantic States Marine Fisheries Commission (A.S.M.F.C.), a consortium of the Atlantic coast states including the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. The A.S.M.F.C. fisheries management plan specifies target and threshold values for both fishing mortality and female spawning stock biomass. Annual stock assessments compare current reference point estimates to target values, and provide advice to the A.S.M.F.C. striped bass Management Board on recommended actions.

The tagging study provides independent estimates of fishing mortality on coastal mixed stock aggregations of striped bass as well as on spawning aggregations of striped bass from the Hudson River, Delaware River, and the Chesapeake Bay. In addition, tag recovery data is used to characterize discards in the commercial fishery by gear type.

Tag specifications: Floy internal anchor tag. Legend printed on both streamer (pink) and anchor (international orange).

Streamer legend: "REWARD PH: 1-800-448-8322" (tag number) #######
"IF UNDERSIZE CUT OFF TAG – RELEASE FISH

Anchor legend: "USFWS 177 ADMIRAL COCHRANE DR. ANNAPOLIS, MD 21401
1-800-448-8322"
"REWARD U.S. FISH & WILDLIFE SERVICE"
"TAG NUMBER #######"

Geographic extent: Along the Atlantic coast from Maritime Canada to the northern portion of Florida, inland to major barriers impassable to fish.

Geographic stratification: Tags are released during a variety of coastal research efforts from Massachusetts to North Carolina. In addition, striped bass are tagged in the major spawning reaches of the Hudson River, Delaware River, and in the Chesapeake Bay.

Timeframe of releases: Tagging of Manning State Fish Hatchery striped bass began in November 1985; projects have since released tagged striped bass annually.

Seasonality of releases: Coastal tagging programs occur mainly during the Fall, although some tags are released in parts of the coast throughout the year. Tagging in the major spawning reaches occurs mainly during Spring.

Size of fish: Minimum size of fish tagged is about 100 mm, although some programs do not tag fish below 457 mm. Fish of these sizes or greater may be tagged if their condition is suitable according to the tagging protocol guidelines.

Method of initial capture: A variety of gears are used for initial capture including hook and line, seine, gill net, trawl, pound net, and electro-shocking.

Method of recapture and seasonality: Recaptures are reported from many types of gears, and many types of fishers. Recaptures follow a seasonal pattern of coastal migration north in the Summer, returning South in the Fall. Also evident in the recovery pattern is the distribution of fishing effort throughout the year.

Reward system: The U.S. Fish and Wildlife Service provides a variety of rewards to individuals who report recaptures. Rewards include a baseball cap, a hat pin/lapel pin, or five dollars.

Outreach methods: Plastic and laminated posters identifying various species in the U.S.F.W.S. tagging program are distributed and displayed at fishing access sites, etc., throughout the Atlantic coast.

Data management: Recapture and release data is stored into a Microsoft Access database at the Maryland Fishery Resources Office(MFRO), U.S. Fish & Wildlife Service (FWS), Annapolis, MD. The database consists of three major parts: 1) tag release data entry program, 2) tag recapture data entry program, and 3) an error checking and import program.

The tag release data entry program is used by cooperating state agencies and other members participating in the FWS striped bass tagging program. The system consolidates reporting of striped bass into a single system and provides a standard system for entering data regarding the release of tag striped bass. Following the data entry, the information is saved in the proper format (Microsoft Access 2000), which then is sent to the central database at the MFRO. An agency has a choice of using this program or providing a Microsoft Access file containing the same information.

Recapture information from a tagged striped bass is coded with an agency code according to which agency tagged and released the fish, along with a NOAA code for the location of the recapture site. After coding, the data forms are entered into the database at the MFRO using a tag recapture data entry program also operated in Microsoft Access.

The striped bass error checking and import program is designed to serve as a means of gathering, error checking, and importing striped bass release data that has been sent from cooperating agencies. This data is divided into three separate tables: batch data, individual data, and other tag data. After the database containing the release data is opened by the program, each of these sections goes through an error checking by the program. After all errors have been corrected, the data is imported into the tagging database.

Release and recapture data contained in the central database is sent in various formats upon request from a cooperating agency.

Number of releases, by time and geographic area: Through July, 2004 a total of 426,576 striped bass have been tagged and released.

Number of recaptures to date: A total of 75,930 recaptures (18% of releases) have been reported through July, 2004.

Tag retention: Tag retention studies were conducted comparing various tag types, including the internal anchor tag (Dunning et. al., 1987). Tag loss, evaluated by a number of investigators is believed to be low, ranging from 0% (Goshorn et. al. 1998) , to 2% (Dunning et. al. 1987), and 2.6% (Sprankle et. al. 1996).

Tag-induced mortality: Estimates of tag-induced mortality are low (0% Goshorn et. al. 1998; 1.3% Rugolo and Lange 1993) and no adjustment is made in the analysis.

Analytical design: The A.S.M.F.C. Striped bass Technical Committee, Tag Working Group, follows a standard protocol for estimating survival and fishing mortality from tag releases and recaptures. Currently the Tag Working group is using Program MARK software, available on the World Wide Web at www.cnr.colostate.edu/~gwhite/mark/mark.htm. Readers are encouraged to contact the A.S.M.F.C. species coordinator for striped bass to obtain copies of the Tag Working Group's recent report which details the analysis protocol at www.asmfc.org.

6. Atlantic herring, *Clupea harengus*

Prepared by: *Kohl Kanwit, Maine Department of Marine Resources*

Principal investigators:

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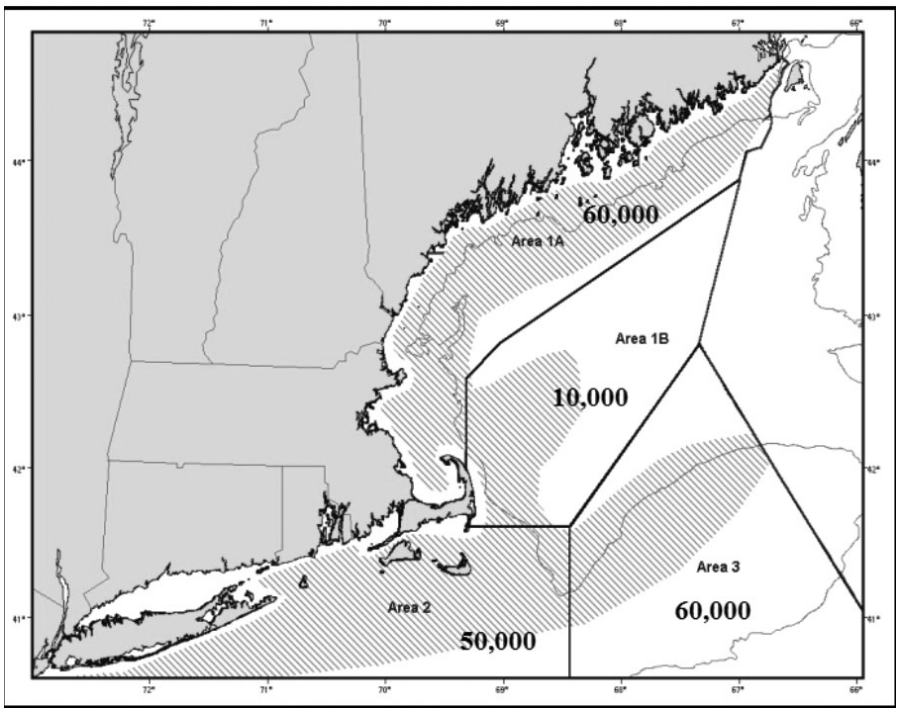
Technical objectives (prioritized):

1) Determine migration and seasonal movement patterns in the Gulf of Maine and southern New England.
2) Determine seasonal intermixing rates of spawning groups in the three existing federal management areas.

Scientific justification: Under the current Fishery Management Plans (FMP), assumptions of stock intermixing play an important role in the allocation of the resource. The New England Fishery Management Council (NEFMC) and the Atlantic States Marine Fishery Commission (ASMFC) both employ stock mixing ratios based on 20-30 year old tagging data to determine annual Total Allowable Catch (TAC) values in each of the management areas (Figure 1). Although past and present stock assessment models estimate biomass for the entire herring complex, the inshore stock component is considered the limiting factor. In recognition of this and the general uncertainty regarding the status of the inshore stock, a risk assessment approach to determining the TACs is being proposed through Amendment 1 to the NEFMC Atlantic herring FMP. This tagging project is capable of contributing current data to the risk assessment process by updating stock intermixing rates and migration patterns. This information will contribute to scientifically based determinations of the area TACs and result in better management of the herring fishery.

Figure 1: Atlantic herring distribution in US waters with management areas and associated TACs (in metric tons).



Tag specifications:

1) Hallprint T-bar anchor tags, pink: ####### $1000 LOTTERY 207-633-9535; PO Box 8 Boothbay, ME 04575
2) Floy T-bar anchor tags, yellow: ####### ME DMR

Geographic extent:

Currently: The inshore Gulf of Maine and southern New England.

Proposed: We have secured funding to expand the tagging project in 2005 to include Georges Bank and the extent of the winter feeding grounds in the mid-Atlantic.

Geographic stratification: The Atlantic herring tagging project employs a stratified sampling design based on releasing marked herring in proportion to their geographic and seasonal abundance in the Gulf of Maine and southern New England. Regional estimates of abundance were obtained from the TRAC final report and represent the most current information on stock biomass inshore and offshore. An analysis of the stock complex using hydroacoustic results, trawl survey data and prior assessments suggest that the inshore component contributes between 10-15% of the total spawning stock biomass. Therefore, this project will target a release ratio of 1000 marked offshore herring to every 150 marked inshore Gulf of Maine herring during the summer feeding/spawning temporal stratum when the stocks are assumed to be segregated. Releases in southern New England will be proportional to the total tagging effort in the inshore and offshore areas. This target is based on the assumption that both stock components utilize Area 2 during the winter feeding temporal stratum. Realistically this project can only hope to tag half of the optimal targets on Georges Bank and in southern New England, resulting in a total release of 64,500 fish. However, it is anticipated that this reduction can be corrected for in the later analysis of tag returns.

Timeframe of releases: Tagging began in 2003, continued in 2004 and is planned for 2005.

Seasonality of releases: The four temporal strata identified for this study are: spring migration (April-June), summer feeding/spawning (July-September), fall migration (October-December), and winter feeding (January-March).

The major focus of this study is on tagging pre-spawning (stage 4+) herring in the Gulf of Maine and Georges Bank during the summer feeding/spawning temporal stratum and tagging in the southern New England stratum during the winter feeding period. This approach will provide information on the potential mixing of Gulf of Maine and Georges Bank herring on the winter feeding grounds, identify stocks (including Canadian stocks) of herring that use winter feeding areas off southern New England, and identify any spawning site fidelity that may occur. Tagging will not occur in all of the defined temporal strata because returns from the migrating periods (spring migration and fall migration) have limited value to understanding the parameters of interest. Funding and resources are limited so tagging events will focus on only the most important temporal strata while attempting to cover the widest possible range of spatial strata.

Size of fish: The focus of the project will be on age 3+ fish capable of spawning in the year of marking. Generally age 3+ fish are 23 cm and above.

Method of initial capture: Herring are captured with an aquarium codend attached to a mid-water trawl net during charter trips. The specific depths and durations of the tows depend on fishing conditions. Regulated seawater flow is introduced into the holding tank of the aquarium codend after each set is hauled back. Tagging occurs directly from the holding tank to minimize handling of the herring. In order to reduce scale loss, tagging personnel use bare hands to handle the fish during the tag application procedure. All herring are selected for fitness and only tagged if they have in excess of 80% scale coverage.

Herring are also obtained for tagging using purse seines during commercial fishing trips. Generally the herring school near the boat after about ½ of the net is dried back and can be caught with a dip net. They are quickly transferred to a modified Xactix tote with a continual supply of fresh seawater. The fish are tagged directly from the holding tank in the same manner as described above.

Method of recapture and seasonality: Tagged herring are continually recovered through the commercial fishery. Tag returns come from both the food processing and bait sectors. Tags are traced to the catch vessel with a high degree of accuracy using mandatory dealer and vessel trip reports. The geographic extent of recoveries depends on the fishing effort and its relationship to the seasonal distribution of herring.

Reward system: There is a herring industry sponsored reward system with three annual drawings (1 for $1,000 and 2 for $500). The drawing is held at the Maine Fisherman's Forum in March.

Outreach methods: Posters and tag return forms are mailed annually to all herring and lobster dealers. Posters are also hung at prominent waterfront locations. Annual informational sessions are held at the Maine Fisherman's Forum. Thank you letters and maps are sent to all tag returnees. T-shirts are distributed to all cooperating captains and crews of commercial fishing vessels. We have also established a web site that provides downloadable posters/return forms and project information (http://www.state.me.us/dmr/rm/herring/herring_project.htm)

Data management: Herring tagging data are stored in a Microsoft Access Database. This database includes the following linked tables: TRIP, SET, TAG, SAMPLE, BYCATCH, and RETURN. These tables can be easily queried to obtain program information. Quality controls and defaults can be employed to insure data accuracy. We are currently developing data entry forms.

Number of releases, by time and geographic area:

Strata	2003	2004	Total
Eastern Gulf of Maine (EGOM)	6450	6925	13375
Southern New England (SNE)	4536	5875	10411
Western Gulf of Maine (WGOM)	8825	5850	14675
Total	19811	18650	38461

Number of recaptures to date:

Year	Release area	Recapture area EGOM	WGOM	MA	NB	NS	SNE	UNK	Total
2003	**EGOM**	15	5	0	4	3	1	0	28
	SNE	2	2	1	5	6	2	2	20
	WGOM	2	4	0	2	1	3	0	12
2004	**EGOM**	3	0	0	0	0	0	3	6
	SNE	0	0	0	1	0	3	1	5
	WGOM	0	3	0	0	0	0	5	8
Total		**22**	**14**	**1**	**12**	**10**	**9**	**11**	**79**

Tag retention: Attempting holding studies using a sea-pen. Past trials using wet lab facilities at Maine DMR have failed.

Tag-induced mortality: Same as above.

Analytical design: Estimate movement and migration using vector analysis. Estimate stock intermixing by using mixing models and adjusting for effort.

7. Atlantic Salmon, *Salmo salar*

Prepared by: Edward Hastings, Northeast Fisheries Science Center, Orono

Principal investigators:

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Chris Legault, Northeast Fisheries Science Center (NEFSC), Woods Hole, MA	(508) 495-2025 chris.legault@noaa.gov

Technical objectives (prioritized):

1) Identify patterns in post-smolt growth of returning Atlantic salmon in relation to prevailing near-shore oceanographic conditions immediately following release.
2) Evaluate time of emigration, smolt size distributions, seasonal distributions and relative proportions in relation to stocking date and location of emigrating stocked and naturally-reared smolts using a lower river smolt-trapping program.

Scientific justification: Declining marine survival has been implicated in the worldwide decline of Atlantic salmon stocks. Hatchery enhancement programs play an important role in Atlantic salmon restoration efforts in the Penobscot River. Adult returns to the Penobscot River were 779 and 1023 returning adults in 2002 and 2003, respectively, representing less than 10% of the adult escapement objectives for the system. Adult returns from hatchery stocked age 1+ smolts are critical to maintaining suitable returns of sea-run broodstock for future restoration efforts. Although ocean conditions affecting Atlantic salmon survival are largely beyond management control, stock enhancement programs can exert some control over the time that hatchery produced smolts encounter both in-river and nearshore marine environmental conditions. A better understanding of the interaction of in-river and nearshore marine environmental conditions in relation to smolt and post-smolt growth and survival would improve models used to assess Atlantic salmon and provide valuable information for restoration efforts.

Tag specifications: Visible Implant Elastomer (VIE), four fluorescent colors (red, green, pink, orange), applied in the adipose eyelid. http://www.nmt.us/index.htm. Secondary mark – adipose clip.

Geographic extent: From the Gulf of Maine and neighboring waters to Newfoundland and West Greenland.

Geographic stratification: Atlantic salmon smolts are tagged at a USFWS hatchery then released at four locations (~24,000 fish per location) in the Penobscot River. The release locations are Mattawamkeag (142km), Milo (120km), Howland (99km), and the West Enfield smolt ponds (101km).

Timeframe of releases: Tagged release for the Penobscot River were in 2000 (166,064 releases), 2001(173,047 releases), 2002 (172,519 releases), 2003 (197,242 releases), 2004 (196,890 releases),

and planned for 2005 (projected 200,000). Along with the Penobscot, smolts were tagged for the Dennys River (2001-04: 212,504 fish tagged) and the Pleasant River (2003 – 04: 10,629 fish tagged).

Seasonality of releases: Releases occur in the spring during the smolt emigration (April and May).

Size of fish: Fish greater than 15cm (6").

Method of initial capture: Hatchery fish used. Marking occurs at hatchery prior to release in rivers.

Method of recapture and seasonality: 1) Eight-foot rotary screw traps in river, **2)** a Norwegian designed pelagic trawl towed at the surface with a specially-designed aluminum "aquarium" cod end, making 30 minute sets at a trawling speed of approximately 4.0 knots in estuary (Sampling locations shown on Figure 1), **3)** Sampling of West Greenland Atlantic salmon catch (August and September), and **4)** recovery at the Veazie fishway adult trap (May – November) in conjunction with ASC at the head of tide (Veazie Dam) of the Penobscot River.

Reward system: None, assistance by other agencies.

Outreach methods: Presentations at local salmon clubs, watershed councils and research forums. Added to ICES NASWG release tables that document all marking programs in North America and Europe.

Data management: The data collected in the tagging program is part of a larger salmon database that is maintained in Microsoft Access. This larger database is called MaineSalmon and contains a number of conventions that allow data to be entered and accessed by a number of different agencies (National Marine Fisheries Service, US Fish and Wildlife Service, and Maine Atlantic Salmon Commission) while maintaining a consistent naming and reference system. In-river observations are geo-referenced to river kilometer and separate databases on tagging, aging, electrofishing, etc. can be cross-referenced.

Number of releases, by time and geographic area:

Penobscot Release Group	2000 Releases	2001 Releases	2002 Releases	2003 Releases	2004 Releases	Total Releases	% Releases
Mattawmkeag – early	24,619	24,557	24,614	24,619	24,638	123,047	13.6%
Mattawmkeag - late	24,671	24,513	24,685	24,685	24,511	123,065	13.6%
Milo – early	24,958	24,202	24,666	24,681	24,569	123,076	13.6%
Milo – late	25,226	26,614	24,696	49,298	49,270	175,104	19.3%
Howland – early	25,122	24,398	24,576	24,692	24,663	123,451	13.6%
Howland – late	24,783	24,418	24,663	24,610	24,576	123,050	13.6%
West Enfield – Smolt Ponds	16,685	24,345	24,619	24,657	24,663	114,969	12.7%
Total	**166,064**	**173,047**	**172,519**	**197,242**	**196,890**	**905,762**	**100%**

Number of recaptures to date: Tag captures are reported from emigration smolt trapping using rotary screw traps (RST) and post-smolt trawls (PST), and returning adults of one sea winter (1sw) and multiple sea winter (msw) fish from a fish way trap. For the adult return data the 2000, 2001 and 2002 release cohorts were used for the one sea winter fish and the 2000 and 2001 release cohorts used for multiple sea winter fish.

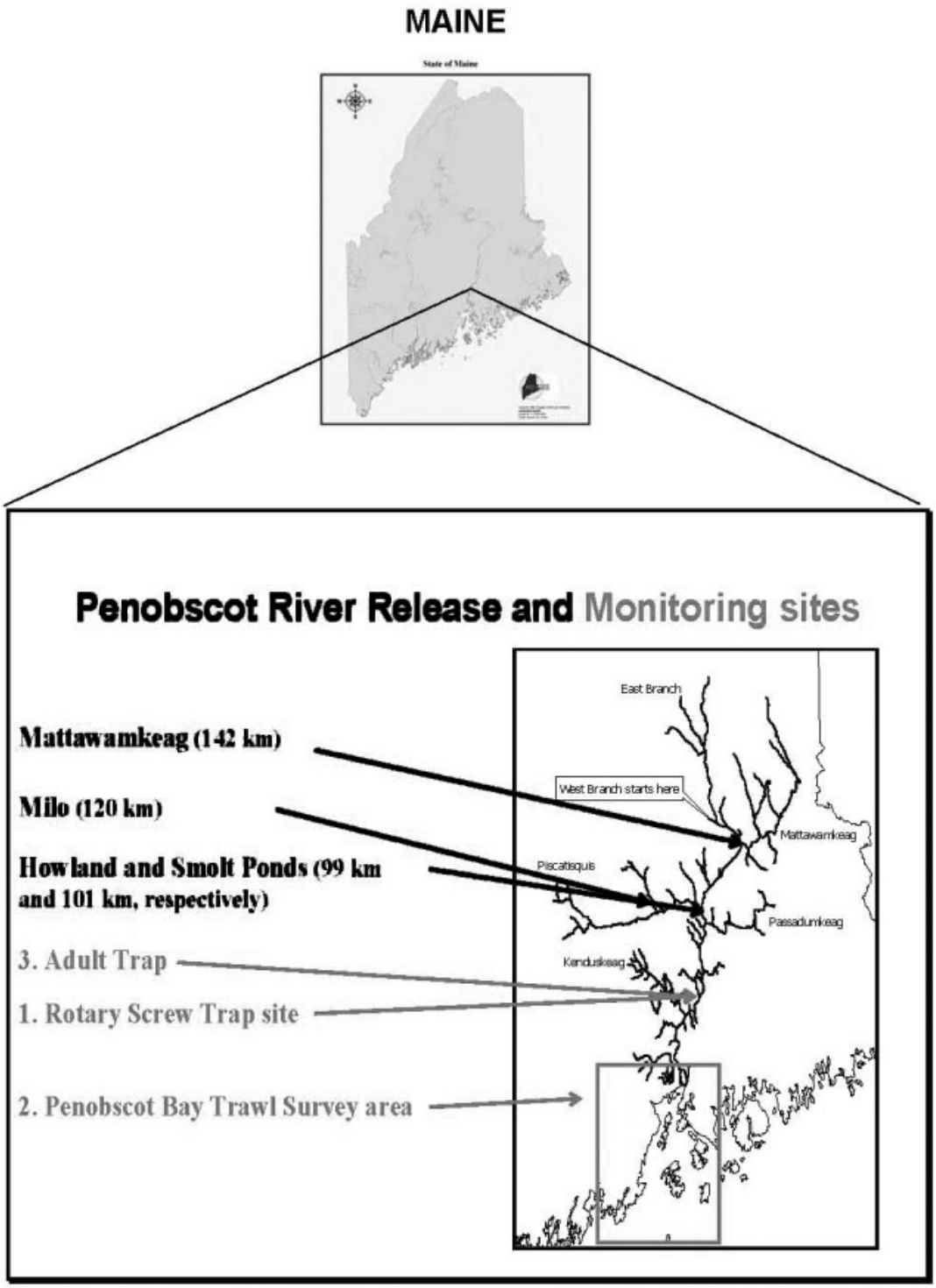
	Emigration Capture				Adult Return Capture	
Penobscot Release Group	**2000 – 04 RST** (2000 – 04 Cohort)	**% of Releases**	**2001 – 04 PST** (2001 – 04 Cohort)	**% of Releases**	**2001 – 03 Adult Trap 1sw/msw/total** (1sw: 00 – 02 cohort, msw: 01 and 02 cohort)	**% of Releases 1sw/msw**
Mattawmkeag – early	210	.17	98	.10	27 / 35 / 62	.04 / .07
Mattawmkeag - late	386	.31	129	.13	19 / 22 / 41	.02 / .04
Milo – early	242	.20	170	.17	30 / 33 / 63	.04 / .07
Milo – late	392	.22	233	.16	14 / 21 / 35	.02 / .04
Howland – early	230	.19	90	.09	45 / 56 / 101	.06 / .11
Howland – late	305	.25	211	.21	13 / 37 / 50	.02 / .08
West Enfield – Smolt Ponds	224	.19	90	.09	18 / 37 / 55	.03 / .09
Total	**1989**		**1021**		**166/241/407**	

Tag retention: Short term tag retention (2 – 20 days after tagging): 98.4% - 98.6%. Long term tag retention (multiple sea winter fish): 79% - 91%. High VIE tag retention/visualizaton rates have been reported in previous salmonid studies (Kincaid and Calkins 1992; Bryanand Ney 1994; Fitzgerald et al. 2004; Mourning et al. 1994; Niva 1995; Frenette and Bryant 1996; Zerrenner et al.1997; Catalano et al. 2001).

Tag-induced mortality: There has been low tag induced mortality (< 0.02%) over the past three years, some mortalities may be due to the handling of a large number of fish.

Analytical design: Three by two block design with three location blocks and two temporal blocks (early and late). A 7th group is spatially similar to low river release but can migrate volitionally from riverside holding ponds.

Figure 1: Sampling locations in Maine.



8. Atlantic haddock, *Melanogrammus aeglefinus*

Prepared by: Tom Rudolph, Cape Cod Commercial Hook Fishermen's Association

Principal investigators:

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Shelly M.L. Tallack, Gulf of Maine Research Institute (GMRI), Portland, ME	(207) 772-2321 stallack@gmri.org

Technical objectives (prioritized):

1) Document and improve understanding of current haddock distribution and movement patterns throughout Gulf of Maine and Georges Bank including pilot work to assess movement between management units and across closed area boundaries.
2) Develop a tagging program and related database that builds upon and integrates into the existing centralized infrastructure of the Northeast Regional Cod Tagging Program at the Gulf of Maine Research Institute.

Scientific justification: Ongoing haddock recovery is the most promising news in New England groundfish management, but despite its historical and future importance in our commercial fisheries, movement rates and patterns have not been studied since the 1950's. In particular, movement rates between the Georges Bank and Gulf of Maine management units have not been examined. Furthermore, the apparent importance of closed areas in this recovery invites further analysis of haddock movement in relation to the boundaries. This tagging program is designed to complement current sources of information and contribute to haddock stock assessments.

Tag specifications: Hallprint internal T-Bar anchor tags with program title, toll free return telephone, and website address.

Geographic extent: Two U.S stock areas- Georges Bank (GB) and Gulf of Maine (GOM).

Geographic stratification:

Management Area	Closed Area Deployments	Open Area Deployments	Total Deployments
Georges Bank	5,000	2,000	7,000
Gulf of Maine	2,500	1,000	3,500
Total	7,500	3,000	**10,500**

Timeframe of releases: Releases are planned for a 12 month period from March 2005 through February 2006.

Seasonality of releases: To the extent possible, deployed equally by quarters throughout the 12 month study period.

Size of fish: Mix of legal (19"+) and sub legal (<19") haddock, predominantly legal, with a minimum size of approximately 14".

Method of initial capture: Commercial demersal longline.

Method of recapture and seasonality: Recaptures from year-round commercial fishery with some seasonal geographic closures and probable Special Access Programs (SAPs) which allow for limited commercial effort in closed areas at certain times.

Reward system: Incentives, likely T-shirts, provided for individuals returning tags.

Outreach methods: Information packages with return envelopes, thank you letters with tagging and recapture information, Toll free telephone number at GMRI functional in US and Canada, website.

Data management: Existing infrastructure at the Gulf of Maine Research Institute for the Northeast Regional Cod Tagging Program (NRCTP) will be used to archive haddock release and recovery data. Considerable time and expense has been invested to date in the development of the NRCTP's online database and GIS mapping interface. However, with relatively minor additions and modifications, the database would also cater to the needs of the proposed study.

The current tagging system allows data to be entered into a standardized tagging database integrated with a Geographic Information System (GIS) after GMRI's Data Management and Quality Control Specialist validates them. This information provides input for the IMS map display. GMRI and Northern Geomantics have developed a password protected, on-line data administration system that allows program partners to log on, add and download data and see the results displayed on the website after data verification by GMRI. Resources have been allocated to allow for program enhancements to the current cod tagging database by Northern Geomantics to allow for haddock data to be integrated.

Number of releases, by time and geographic area: This program has not yet entered operational period.

Number of recaptures to date: This program has not yet entered operational period.

Tag retention: There are currently no plans to study tag retention within this program.

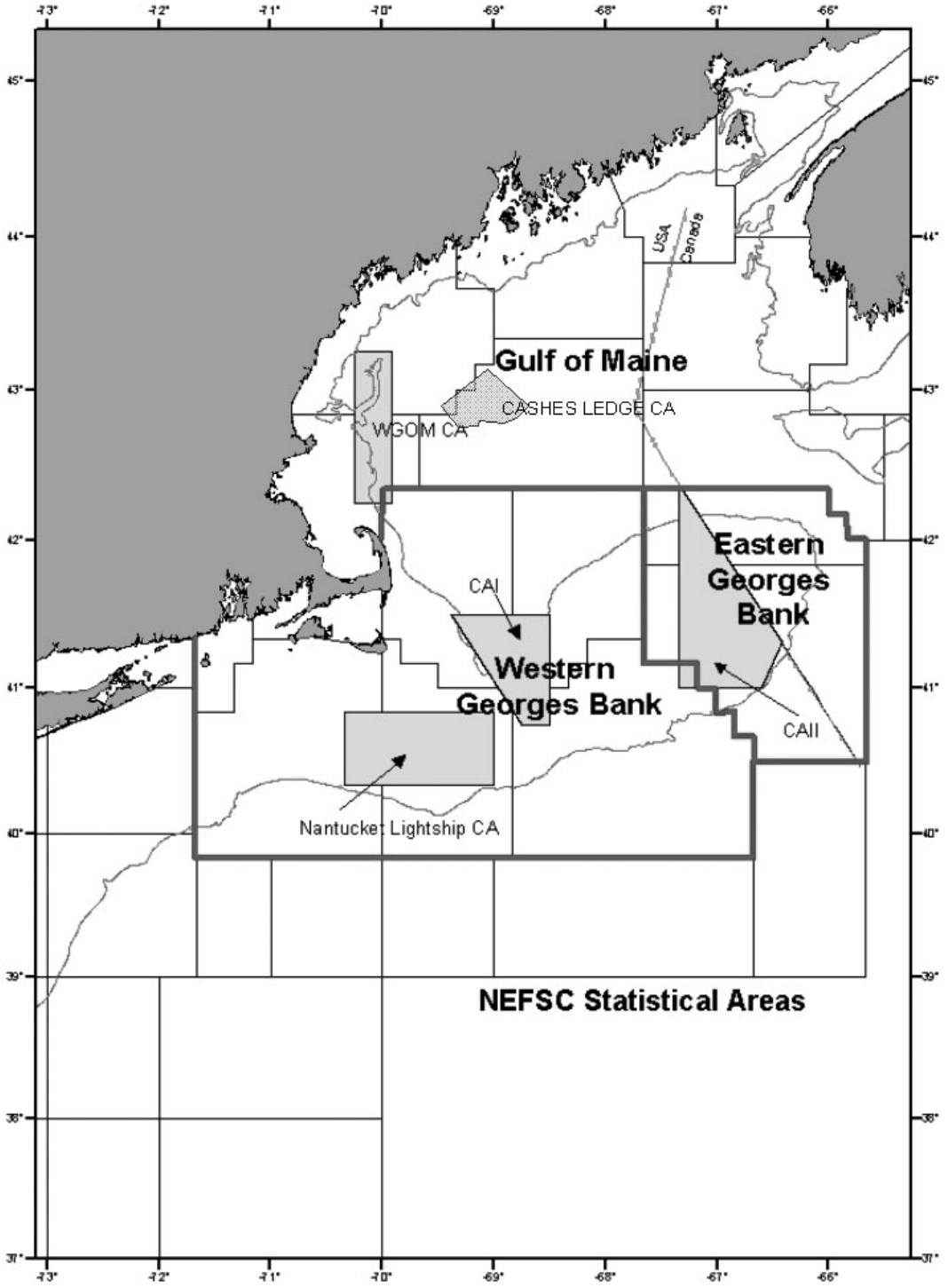
Tag-induced mortality: There are currently no plans to study tag induced mortality within this program.

Analytical design: Tag recovery data will be analyzed to determine the probability of movement between areas. If tag recaptures indicate movement from one stock area to another, posterior probabilities of haddock movement rates will be estimated using appropriate binomial or multinomial models with uninformative beta or Dirichlet priors and the WINBUGS software for Bayesian data analysis (Congdon, 2001). This approach will provide confidence intervals for movement rates that are easily interpretable by fishery managers. An alternative analysis will be conducted using the MARK software program for analysis of marked individuals with movements among multiple strata (MARK available at: http://www.cnr.colorstate.edu/~gwhite/mark/mark.htm). A likelihood-based model of haddock movement rates may also be developed to estimate movement rates if sufficient tag recoveries occur. Model structure will follow standard approaches to account for population dynamics and differences in fishing effort among areas (Hilborn, 1990; McGarvey and Feenstra, 2002).

The average direction and magnitude of haddock movements will be conducted using GIS mapping and spatial analyses to estimate density. These maps and associated analyses will be used to create graphs that show the direction and magnitude of haddock movements to stakeholders in the fishery management process.

Study Area: The study area is presented in Figure 1.

Figure 1. Spatial definition of haddock management units in the Gulf of Maine and Georges Bank region along with locations of the western Gulf of Maine closed area (WGOM CA),Cashes Ledge Closed Area, Closed Area I (CA I) and Closed Area II (CA II).



Workshop discussions

The following reviews collate the key points made regarding each individual tagging program. Where appropriate, the implications for each program have been considered within three key categories: Data collection protocol; Outreach; and Data management and analysis. In addition, more general points have also been captured, where certain discussions were applicable across species and programs.

Following each tagging program's review is a section on the Overarching issues which were identified during the course of the mark-recapture workshop.

The transcript in Annex 1 provides further detail on the dialogue which took place.

1. Discussion on the Northeast Regional Cod Tagging Program

Prepared by: Dr. Shelly Tallack, Gulf of Maine Reserch Institute

The Northeast Regional Cod Tagging Program (NRCTP) (see p.9) was presented to workshop attendees, paying particular attention to the following key aspects of the program: aims; tagging partners and tagging locations; standardized tagging technique; outreach; data management and database design; tagging progress and preliminary data analysis; lessons learned; and ancillary studies identified. The workshop proved to be a highly interactive and productive environment in which the Program's experiences were shared and attendees reciprocated with insightful feedback.

This summary documents the recommendations made during the course of the workshop by keynote speakers and others. Advice offered was based on the current status of the Program; i.e. that the NRCTP was funded for two years of tagging and is currently in its final tagging season. Funding for a third year has been secured by the Gulf of Maine Research Institute (GMRI) for maintenance of the Program's tagging infrastructure (database, responding to recapture returns, outreach and feedback) and future data analysis.

1.1 Data collection protocol

Detail on the type of data collected was presented to the group. As workshop discussions evolved, it became apparent that the following modifications to our data collection protocol could be valuable:

Standardized tagging technique

A standardized tagging technique was designed in the early months of the program. This ensures that throughout the study region, all contracted tagging participants (scientists and fishermen) would tag using one universal method. The technique was documented into a 27-page NRCTP tagging protocol, which details the methodology on fishing practices, handling techniques and tagging procedures, in addition to data collection and recording requirements. The tagging protocol was presented to workshop attendees and received considerable positive feedback. This said, it was noted that the NRCTP has not standardized the use of gloves when tagging. Program partner feedback verified that cod is not particularly prone to scale loss and that therefore, this precaution may be less vital for this species, but that future studies might want to consider standardizing handwear from the outset. It was recommended that for the remainder of the NRCTP's final tagging season, the use of gloves (and type) be recorded in the haul comments associated with each tag release, thus allowing assessment of how glove usage may affect the post-tagging survival rate and return rate of tagged cod.

Double-tagging

The NRCTP currently double-tags 10% of its fish. This measure taken was recognized but it was suggested that 10% double-tagging would not provide sufficient information (based on the current return rate ~2.2%) to really investigate the rate of tag loss, or to investigate any differences in tag shedding rates between taggers and this impact this will have on return rates. Thus, it was proposed that we consider double-tagging 100% of our cod from this point forward. It was further accentuated that the financial cost of 100% double-tagging is low (using conventional tags) relative to the quality of data it can provide. Depending on funding and production-time for new tags and datasheets, this is something the NRCTP could try to implement for its remaining tagging trips.

Spawning fish

The NRCTP has thus far observed few spawning fish during its tagging trips, despite focusing on areas where spawning is likely to occur and at times of year when spawning should be underway. It was recommended that the NRCTP not focus its remaining tagging effort on obtaining spawning fish, but that instead, it should see what spawning data it gains as "bonus" information. It is likely, however, that two of the tagging organizations will save some of their vessel days for next spring, which may improve the database's representation of spawning fish.

Aging information

It was recommended that tagging studies should also collect information for aging the fish tagged. The two proposed means were otiliths (lethal) and scales (non-lethal) with a sample size of ~100 per area. For the NRCTP the non-lethal approach would be preferred since in some areas the number of cod captured for tagging is so low that sacrificing them for otiliths would not be satisfactory. However, since aging studies are being undertaken for cod in the Gulf of Maine region (e.g. industry-based survey), it was decided that this measure might not be necessary at this point in the Program, and thus, will not be implemented for the NRCTP at this stage. New tagging programs, however, should consider obtaining this information from the outset, or should at least make sure that contemporary aging information is available for their species and area.

Genetic information

The NRCTP has been approached to assist in the collection of genetic information (e.g. finclips) for other ongoing and future studies. However, there was strong consensus among workshop attendees that the NRCTP not honor this request so late into the program (particularly without clear knowledge of how this information will be used). Particular points made include:

- Since the NRCTP was not designed with genetics as one of its key aims, it is unclear how useful samples obtained through this sampling regime would be, particularly in light of the minimal representation of spawning fish to date.
- If any tagging does continue into the spring of 2005 (not confirmed), it is likely to be undertaken by organizations working in areas where, despite considerable effort, few cod have been observed/tagged to date within this program (e.g. Downeast Maine). It was suggested that if genetic samples could only be obtained from these marginal locations, the data would be vulnerable to misinterpretation.
- It was suggested that the experimental rigor of a genetic study could be compromised if it obtained opportunistic samples through a program which had not been designed with genetic criteria in mind. For example, it was noted that genetic work on redfish had recently been rejected for incorporation into EU stock assessments, due to its post-hoc design.
- It was further reiterated that before agreeing to collect information for other researchers, participating organizations should feel comfortable with the experimental design being followed. Without information detailing the full extent of genetic work proposed, both external reviewers and program partners did not feel confident that collection of these samples would meet the general objective proposed (i.e. that of evaluating the stock structure).

The overall recommendation was that finclips should not be collected during the remaining trips and instead, program partners should focus on the needs identified as more pressing for meeting the primary objectives of this Program.

Data mapping site

One of the key aims of the NRCTP was to make the tagging data available to the public; an online GIS mapping interface (linked directly to the online database) is the vehicle developed to meet this goal. Positive feedback was received by workshop attendees on presentation of this tool. Since the "tag-locator" component requests recapture information when generating a recapture report, it was recommended that the amount of recapture information requested be increased. This will be implemented pending the availability of funds.

1.2 Outreach

The NRCTP recognizes that the success of any tagging program is hugely dependant on the stakeholders being both aware of and supportive of the Program's needs. Consequently, the NRCTP has put great effort into its outreach initiatives and this was well recognized in the feedback when

outreach techniques and materials were presented to the group. The question remains, however, whether this outreach is effective. In response to expert feedback, the NRCTP will re-visit its outreach techniques and assess them for effectiveness. Highlights of the outreach discussions follow:

Incentives

It was recommended that we review the return incentives offered and consider modifying the rewards offered. Should the "material" incentives (e.g. hats, t-shirts and mugs) be replaced by graded "monetary" incentives (e.g. set amounts, or a "scratch-card" concept)?

High-reward tagging

The NRCTP's high-reward (HR) study was implemented in year two for calibration of regular return rates. The Program's use of a different color for the HR tags (blue) was highlighted as a good decision. It was discussed whether some HR tags should also be the same color as the regular tags (yellow for this Program) to facilitate analysis of different rates of tag detection and how this might in turn affect the return rate; overall this measure was proposed as unnecessary. It was further recommended that posters for HR tagging should be separate from the regular posters and even more bold; the NRCTP has just distributed its new posters which present both tags, so this recommendation may not be adopted.

Lottery

Program participants suggested a review our current lottery procedure where winners are categorized according to geographic recapture location. To minimize the risk of bias or falsification of recapture data, should winners be categorized by release location rather than recapture location?

Website

The NRCTP website (www.codresearch.org) has always provided links to other tagging programs, but it was recognized that there is a general region-wide need for a central "splash page" which would link directly to all the Northeast tagging programs underway. It was reiterated that NOAA provides a searchable online registry of cooperative US tagging programs and that this facility could be useful. However, it was also pointed out that this registry is not particularly visible or easy to find without knowing where to look for it (http://fwie.fw.vt.edu/tagging/). Following the workshop, GMRI has added a page to the NRCTP website which links to the Northeast tagging programs (10/26/04: http://www.codresearch.org/Tagging_programs_various.htm).

Effectiveness of outreach

It was proposed that all studies could assess the effectiveness of their outreach through one-on-one conversations with stakeholders. For the NRCTP, area coordinators should increase their frequency of visiting fishermen and processing plants should also be targeted (particularly US processing plants since tag returns from these have been low to date). In addition, since the NRCTP's high-reward study was only implemented in Year 2, GMRI could test people's awareness of this study by calling a random sample of individuals (e.g. n=100) who have already reported tags and ask whether they have heard about the new HR tags and the associated reward.

1.3 Data management and analysis

Database

The NRCTP has expended considerable time, effort and funds into developing a custom-made online database with an online GIS mapping interface (www.gmamapping/codmapping) for data presentation to the public. This database was the result of a highly collaborative effort among program partners, a contracted GIS company and users of the mapping interface. A detailed overview of the database was presented, paying particular attention to its built-in error-checking and quality control mechanisms. Feedback was very positive, with particular appreciation for the database's complexity and its capacity for categorizing data as "sub-standard" when needed (i.e. if recapture date, fish length or location is "estimated"). Despite its sophistication, recommendations for improvement included: (1)

incorporating "re-released with tag" into the fish fate field, rather than entering this information as a comment; (2) being able to further "rate" the sub-standard data; and (3) incorporate additional error checks at the time of data entry to catch unrealistic fish lengths, dates and distances traveled. Should funding allow, these recommendations will be implemented.

Data analysis

The preliminary data analysis presented focused on size relationships, growth rate, distance and direction of movements, seasonal displacement and recapture reporting rates. With regard to the latter, the method of reporting tags (by phone, mail, email or in person) was quantified and the indication of outreach efficacy was discussed. For the NRCTP, it appears that the distribution of mini-datasheets in mass-mailing packages is a particularly effective means of obtaining quality tag returns; the second most utilized reporting method is the toll-free number.

Long term, as the database becomes fully populated and more recaptures are reported, the NRCTP will undertake more detailed analyses. However, recommendations for particular focus in the near future include: (1) investigate recaptures for gear selectivity; (2) undertake a more detailed investigation of the reporting rate; and (3) investigate the quality of data when numerous tags are reported together (i.e. as a "batch"), since this occurs fairly frequently for this Program.

1.4 Specific solicited feedback

The presenters for the three key tagging species requested feedback for specific aspects of their program where input was felt to be most needed. The most pertinent issues for the NRCTP were identified as follows:

Spatial distribution of tags

The NRCTP was not designed with tight experimental and statistical rigor in terms of how many tags would be released in each tagging area. Tagging areas had been selected through literature reviews and stakeholder recommendations, based on an area's historical value as fishing or spawning grounds and/or management status (i.e. closed/open). The NRCTP exerts a rule of thumb release cap of 5,000 tags per area, per year. However, with the patchy distribution of cod observed, certain areas are unlikely attain this 5,000 cod tagging cap while others already exceed it. Feedback confirmed that if future analysis shows the proportion of tags released in a given area is too low compared with biomass estimates for that area, it will still be possible to weight the tag release and recapture data sufficiently during analysis. Consequently, the remaining tagging efforts need not try to resurrect this imbalance in the Program's final tagging season.

Tagging-induced mortality

Past NRCTP meetings have identified a list of ancillary studies with which this Program could proceed in future months; of these, a tagging-induced mortality study has often been considered. However, despite the standardized tagging technique, this Program has an array of variables which could potentially impact fish survivability (e.g. gear type, season, water depth, substrate, weather, tagger, live-well usage, etc.); due to the complexity of design and costs associated, a tagging-induced mortality study has not been implemented to date. A wealth of recommendations were made at this workshop but essentially it was proposed that we: (1) do not attempt a tagging-induced mortality study at this time and instead rely on analysis of reporting rates to estimate tagging-induced mortality; or (2) we undertake a simple tagging-induced mortality study and attempt to evaluate a "worse-case" scenario. Program partners will re-visit this subject at their upcoming End of Year Two Meeting (planned for December 2004).

Tagging into Year 3

Tagging is not scheduled for a third year, although the NRCTP's significant infrastructure will be supported; GMRI will continue to manage the data through the online database, online GIS mapping interface and its thorough system for receiving, processing and rewarding tags. The focus for 2005

will be on preliminary data analysis. One core recommendation during the course of this workshop was that tagging studies need to be "long-term" (3-10 years) if the aim is to obtain reliable and useful information for incorporation into stock assessment modeling. Feedback was solicited regarding which kind of tagging efforts would be most valuable to the NRCTP in future years. It was reiterated that if the study aims to provide an estimate for fishing mortality, interruption between tagging years is not recommended – if it occurs, the two data sets cannot be combined for this estimate (i.e. tagging would need to take place in 2005 for this estimate). However, since the NRCTP's key deliverable is information on migration, it would be acceptable for there to be a gap in tagging efforts while data was analyzed and appropriate ancillary studies designed accordingly.

If future support for tagging is available for 1-2 years, then studies should focus on movement questions, e.g. pulse tagging and greater emphasis on closed area tagging.

If a long-term opportunity arises, the focus should be on mortality rates, tagging-induced mortality and reporting rates. A study using "smart" tags (e.g. data storage tags) or other more expensive tags was not viewed as a priority at present since the Program's tag return rate is currently fairly low (~2.2%).

2. Discussion on the Yellowtail Flounder Cooperative Tagging Study

Prepared by: Dr. Steve Cadrin, Northeast Fisheries Science Center

The Yellowtail Flounder Cooperative Tagging Study was presented to the workshop (see p.15), and participants offered suggestions to improve the study. The discussion was constructive and led to several possible modifications of field protocol, analytical approaches and outreach methods.

Suggestions from the group as well as aspects from other tagging studies were compiled by yellowtail tagging collaborators as issues for discussion and consideration for future work. These issues are included as numbered sections at the end of each subheading.

2.1 Data collection protocol

Several issues about experimental design were discussed. Interaction with stakeholders to identify goals and associated design elements was viewed as a strength of the project. There was general consensus that releasing tagged yellowtail in proportion to local abundance was sound. However, there was a suggestion to update the analysis of geographic distribution for future tagging.

Methods of minimizing or evaluating tag-induced mortality were suggested, including an inspection of recapture rates for fish in 'good' and 'excellent' condition. Other tagging studies use wet cotton gloves to minimize scale loss when handling fish, but scale loss is not apparent for yellowtail when using wet bare hands.

Data-storage tags

The use of data-storage tags (DST) was discussed as a complement to conventional tagging. The utility of DST information may be more associated with understanding movement mechanisms than representing movement of the population. Therefore, a strategic shift from representative DST releases to hypothesis-driven releases may more effectively complement to the representative design of disc tag releases. Particular recommendations included:

- Revise the strategy of DST releases from representative of the population to more specific hypothesis testing (e.g., saturate the edge of stock areas or closed areas).
- Evaluate the geographic distribution (currently based on 1998-2002 survey data) needs to be updated to 2000-2004.
- Increase the number of double-tagged releases to better evaluate tag retention.

2.2 Outreach

The group discussed several aspects of outreach and reporting systems. For example, indicating high-value tags with a different color may be beneficial, as long as it is at least as visible as the lottery tags. Particular recommendations included:

- Bilingual letters should be included in mailings.
- It may be better to have a high-value tag with a different color, as long as it is at last as visible as lottery tag.
- Links to more tagging websites are needed on the yellowtail website.
- More outreach to Canadian fishermen is needed (e.g., the toll-free number needs to be supported for calls from Canada, mailings directed at Canadian process plants and docks).

2.3 Data management and analysis

The movement-mortality model was a topic of discussion. To allow sequential calculations, the process equation assumes that tagged fish move to new areas at the beginning of each time step then are exploited by the fishery. This simplification may not adequately represent the actual system. The evaluation of model structure and performance using analysis of historical data was also considered to be worthwhile. The potential use of acoustic arrays for assessing tag-induced mortality was mentioned, but may be less effective for demersal fish if tags keep pinging after death. The value of double-tagging was also mentioned as an approach to evaluating tag retention. Reporting rate can be approximated by the portion of yellowtail catch from vessels that report tag recaptures to catch from vessels that catch a large volume of yellowtail but do not report recaptures. Similarly some fishing trips can be expected to have 100% reporting rate (e.g., observed trips, trips by project collaborators).

Analytical recommendations

- Permit numbers of vessels from which tag recaptures are reported and their associated catch should be tabulated and compared to catch of vessels for which there are no tag returns.
- Fishing trips that likely have 100% reporting (e.g., observers on board, project cooperators) should be identified and used as the 'gold standard' for calculating relative reporting rates.
- A comparison of return rates of yellowtail in 'excellent' or 'good' condition should be evaluated to assess tag-induced mortality.
- The sensitivity of the model assumption that movement occurs before mortality should be explored.

Database recommendations

- Methods should be developed to make audited data available to project collaborators and the public.
- Tag return envelopes should be provided with required information.
- Vessel name and permit number should be recorded as a critical information when tags are reported.
- Inspection of the mode of reporting (phone, mail, intermediate contact) may help to identify what we should do to promote reporting recaptures.
- Recaptures with less reliable information should be identified.
- More data support is needed for timely keypunching, audits, and ease of analysis.

3. Discussion on the Black Sea Bass Cooperative Tagging Project

Prepared by: Gary Shepherd, Northeast Fisheries Science Center

The results and experiences learned from the cooperative black sea bass tagging project were presented to the workshop attendees for consideration. Discussion of issues related to the sea bass project had common threads among all the programs discussed.

3.1 Data collection protocol

Tag selection and experimental design

Field work using traditional tags was completed in September 2004, consequently no recommendations were made to alter the experimental design. However, the release design for data storage tags (DST) should be considered. Smart tags provide movement information beyond point to point locations of traditional tags. In the first batch of releases, these DSTs were released in clusters in several locations throughout the range of the northern stock. The workshop recommended focusing releases in one or two areas which would provide the greatest amount of information. Environments over the migration pathway have the greatest contrast for fish moving south from the New England area. Therefore, tag releases in clusters within the northern edge of sea bass distribution may provide the most information per return.

3.2 Outreach

One objective of the sea bass tagging program was to increase confidence in the stock assessment process by involving user groups affected by the outcome. Hats have been offered as rewards for regular tags and a subset of high reward tags ($100) have been released to quantify tag reporting rates. Outreach efforts should continue as long as tags continue to be recovered, particularly payment of rewards. Attempts should be made to evaluate the effectiveness of outreach by measuring the level of awareness about the program among fishermen. Good communication with constituents may also improve the likelihood of tag recovery for other programs.

3.3 Data management and analysis

Model selection

Results of the tagging project for the first year of returns were reviewed by the 39th SARC in June 2004. That review group recommended further evaluation of the results with a Brownie-type tagging model and that recommendation was echoed at the Tagging Workshop. Specifically, mixing models would be appropriate due to the clustering effect of released fish near underwater structure. Other recommendations for data analysis included examination of recapture rates by size grouping to identify selectivity in the fisheries and adjustment for reporting rate in release numbers (M) if further estimates of exploitation with R/M are made.

Movement

Since sea bass show clear seasonal migrations, movement models were an important topic. Vectors of movement by time increment were presented to the workshop, which led to further discussion on analytical extensions to this approach. Suggested ideas included sequential vector analysis across time increments to describe a pathway, develop of polygons around the cluster of individual vectors, bootstrapping of vectors to examine the distribution of the migratory pathway, and supplementing pathway description with auxiliary data from smart tags. Simulation of movement with individual based models was also suggested as a method to further explore migratory behavior of sea bass.

Database

Data management and development of a database was a common issue among programs. Sea bass data is currently entered into a spreadsheet with auditing provided by subsequent SAS routines. Rigorous auditing was recommended for all data as well as development of additional quality control variables that could be used to subset the data in further analyses.

4. Discussion on the Cooperative Shark Tagging Program

Prepared by: *Pat Turner, National Marine Fisheries Service*
Dr. Nancy Kohler, National Marine Fisheries Service

This workshop provided a unique opportunity to benefit from the experiences and expertise of staff from other tagging programs. The use of three existing programs as a framework facilitated multiple discussions on mutual problems and goals, involving data management, tag reporting, data analysis and outreach issues, as well as an opportunity to see how solutions and innovations have worked or not worked in other programs.

Below are some of the specifics that we would like to evaluate and/or implement in the Cooperative Shark Tagging Program.

4.1 Data collection protocol

- Investigate the feasibility of returning to a monetary reward, or perhaps offering a choice of money or hat, which might improve our reporting rate; historically analyze reporting rate of hat vs. $5.00 reward.
- Use of ancillary experiments including holding and aquarium studies (survival and tag shedding), and increase use of acoustic and satellite tags for hypothesis testing.
- Use of double tags for estimating tag shedding rates. Evaluate published studies of highly migratory species for reporting and tag shedding rates.

4.2 Outreach

- Re-instate annual newsletter, distribute by mail and on website.
- Design and distribute data cards for return information with program mailing instructions to facilitate returning recapture information; include in tag instruction packet as well as on web page.
- Include complete tagging and recapture instructions on web page.
- Investigate the feasibility of sending a preliminary map of a particular recapture to both the tagger and recapturer in addition to standard information.
- Continuously update website and make more information available to public including more links to other websites (NER tagging programs, NMFS online tag database website).
- Distribute posters and decals publicizing program domestically.
- Investigate publicizing program at various overseas fisheries agencies with outreach (such as posters or recapture instructions) prepared in the native language of the country.

4.3 Data management and analysis

- Analyze existing database for estimate of overall reporting rate using standards in each fishery (e.g. observers for commercial fishery and individual rod and reel fishermen in recreational fishery).
- Analyze existing database for estimate of life status on release (fish condition) for overall database and subset from ongoing nursery ground study.
- Look at alternate database systems for long term database QA/QC, substandard data flags, outputs for statistical and GIS analysis, public access, and long term archiving.

- Expand fate of fish field to species other than blue shark to develop a capture history for each animal (migrate from a tag based to fish based recording system).
- Track tag numbers by individual to aid in determining reporting rate.
- Evaluate return rates of different gears and fisheries.

Overall, the presence of the two experts and the diversity and balance of their presentations in terms of a more theoretical and practical approach benefited this workshop. Receiving a CD with appropriate references was an additional bonus. A future workshop might address in detail more specific database and analysis programs.

5. Discussion on the USFWS Striped Bass Tagging Program

Prepared by: *Dr. Gary Nelson, Massachuessetts Department of Marine Fisheries*
Gary Shepherd, Northeast Fisheries Science Center

5.1 Data collection protocol

The striped bass tagging project is a compilation of programs operated by state fishery agencies. Collection protocols vary by agency with no coordinated experimental design. Consequently, survival is independently estimated for each program, creating potential problems in developing a single coastwide estimate. Recaptures are reported to a central location operated by the U.S. Fish and Wildlife Service. Information on the fate of the tag and the fish is collected for use adjusting model results for fish released alive after tags are removed. It was suggested that simpler models may be preferable for adjusting survival for live releases.

5.2 Outreach

Recaptured tags are reported by calling a 1-800 number on the tag. Several years after the beginning of the tag program, this 1-800 number was installed which may have created some shifts in reporting rate. Outreach has been limited to some posters and primarily word of mouth and fishermen reporting the tags are sent a hat and certificate. There is also a variety of private groups tagging striped bass so efforts have been made to coordinate tag color to avoid confusion over the origin of the tag.

5.3 Data management and analysis

Survival and recovery parameter estimation

There are several sources of uncertainty associated with the estimation of survival and recovery parameters in the tagging analysis for striped bass. The primary source involves the violation of assumptions basic to all tag recovery modeling. John Hoenig's suggestions about the analytical avenues that could be taken to investigate those issues, particularly the nonmixing assumption, were extremely helpful and will be recommended to the striped bass tagging subcommittee.

High-reward tagging

In addition, the use of a high-reward tagging study to estimate tagging reporting will be recommended as an essential tool to produce unbiased estimates of survival for striped bass. However, it was pointed out that in certain models, a precise reporting rate estimate is inconsequential if reporting is relatively high, but becomes increasingly critical as the rate declines.

Fishing mortality

The ASMFC tagging subcommittee currently estimates fishing mortality by –ln(S)-M, where S is survival and M is an assumed natural mortality. Under this formulation, the application of a constant value for natural mortality across all groups and time does not allow for potential changes in natural mortality, and dictates that changes in survival result only in changes in fishing mortality. Hoenig's instantaneous rates model will help the ASMFC striped bass tagging committee improve its estimation of fishing mortality and identify changes in M.

6. Discussion on the Gulf of Maine Atlantic Herring Tagging Project

Prepared by: Kohl Kanwit, Maine Department of Marine Resources

The workshop provided useful ideas and information for the DMR Atlantic herring tagging project. Overall the workshop was very productive and should lead to continued collaborations between project leaders. Tagging is clearly an important tool for stock assessments and the understanding of population biology.

6.1 Data collection protocol

Study design was discussed extensively and included exchanges on weighting tag releases by landings data and abundance estimates. Depending on the goals of the tagging project, either method can be implemented, each with its own set of advantages and disadvantages. Given the goals of the herring tagging project it seems reasonable to continue releasing marked herring in proportion to stock area abundance estimates generated at the TRAC meeting in 2002. An additional method of "self-weighting" tag releases was suggested by John Hoenig. This method employs selecting random strata and then tagging everything you catch. This method, although intriguing, seemed inappropriate for a schooling pelagic species such as Atlantic herring.

Double-tagging

The importance of double-tagging was also emphasized for obtaining tag shedding rates. The argument was made that the cost of conventional tags is so low that any tagging project should consider doubling tagging all their fish. If this approach is used every tag return gives you information on tag shedding. We will investigate short term tag mortality rates for double-tagged and single-tagged herring to make a determination on the feasibility of this approach.

Mortality through tagging and handling

Tagging mortality and handling mortality were discussed at length. Size effects on survival were explored and should be investigated for any project tagging multiple size or age groups. The importance of measuring tag retention and handling mortality is critical and should be an immediate focus of the herring tagging project.

6.2 Outreach

Outreach was also emphasized and the message was that you can never have too much. We need to look into; a toll free number for tag returns; improving our web site and making it more interactive; and increasing awareness through posters, publications, and public meetings.

Return rates were discussed repeatedly and seemed to jump out as a very important component of any tagging study. Our reporting rate is extremely low and we gained important insights into why that might be and how to measure and maximize our returns. We will be employing a graded reward seeding study to measure if instant rewards encourage tag returns from lobstermen who find herring tags in their bait. "High reward" tags will be explored as an alternate method of determining return rates and increasing returns in general.

6.3 Data management and analysis

Various analyses were discussed, most of which centered around obtaining population parameter estimates. The herring tagging project is not designed to obtain these estimates so population model discussions were of limited value. However, we did cover some information on migration and movement, including an expansion of vector analyses. A future workshop centered on measuring movement parameters and using spatial analysis tools would be immensely beneficial.

7. Discussion on the Salmon Tagging Program

Prepared by: Dr. Chris Legault, Northeast Fisheries Science Center

The salmon tagging program differed from all the other tagging programs presented at the meeting in one key component, scientists instead of commercial or recreational fishers recover the tagged fish. Due to this important difference, a number of topics discussed at the meeting were not directly applicable, for example, reward systems and measurement of fishing effort. However, there were still lessons learned.

The salmon tagging program appreciates the invitation to attend the tagging workshop and ability to present our program. The differences in study type did mean that some aspects of the salmon tagging program fell beyond the scope of this workshop (e.g. use of Carlin tags, coded-wire tags and finclip marks) and so were not specifically addressed.

The CD of references, articles, websites, and software packages that was distributed at the meeting will be an excellent reference collection for the salmon tagging program. The exchange of information during the program was beneficial and should be encouraged in the future.

7.1 Data collection protocol

The need for an experimental design was emphasized. While this is one of the strengths of the salmon tagging program, it is always good to review the experimental design during the project to see if improvements can be made. Furthermore, the encouragement expressed by meeting members to change the design in the upcoming year to directly estimate the variance of returns from single location/time stockings using multiple tagging groups was appreciated.

7.2 Outreach

Outreach is not a major part of this program, as recaptures come from targeted events conducted by scientists. However, outreach is important for the local communities so that they understand why the rotary screw traps are in the river and why the pair trawlers are fishing in Penobscot Bay.

7.3 Data management and analysis

The biggest lesson learned for the salmon program is to take full advantage of all the data collected. Specifically, the returns from West Greenland, although few in number, can be used to estimate when marine mortality is having its biggest impact, either before arriving in West Greenland waters or during the return trip. While this estimate will be highly uncertain due to the low sample size, it can be computed with the data currently available. Willingness to take advantage of all such calculations strengthens any tagging program and will benefit the salmon program.

Tagger effects

Comparison of tagger success is another topic that the salmon program has addressed in the past but could examine again.

8. Discussion on the Northeast Consortium Cooperative Haddock Tagging (NECCHT)

Prepared by: Tom Rudolph, Cape Cod Commercial Hook Fishermen's Association

The workshop was well conceived, energetic, informative, valuable, and most of all, timely. As cooperative research expands, it becomes ever more important that regional summits like this take place to ensure that our limited resources are maximized and enduring, successful programs are created. The regional fish tagging effort has all the key components to take the lead in a movement to streamline, centralize and entrench our cooperative research: it is high profile; it offers wonderful opportunities to maximize industry participation; it has unlimited potential to cut across management and species lines as we reach toward ecosystem management; and the mature, long running programs like shark and bass tagging offer compelling evidence of the potential for uninterrupted time series in other species to complement and support our abundance surveys.

Several key ideas, bear mention:

- Dr. Hobday's description of tagging as a means to understand the "state of the system," with its three broad areas- abundance, productivity, and distribution, was elegant and simple. Perhaps a set of broad tagging program design guidelines could be created that is based upon and tailored to which of these areas is to be studied.
- It seems clear that few if any programs achieve perfection in design in their infancy. Tagging programs with secure multi-year funding will be able to fine tune distribution, smart tag support, ancillary research, outreach, infrastructure and other design parameters as they mature, while developing valuable time series as well.
- As hard TACS come to New England, first for target species and eventually for bycatch, discard mortality data will be needed. Tagging is an important weapon in our arsenal as we seek this data. As it turns out, effective tagging programs need good data on tag and capture induced mortality. Clearly, these interrelated objectives would be best met by careful design intended to maximize efficiency and resources.

Many ideas, suggestions and concepts raised by the Workshop bear examination with respect to those programs in which CCCHFA participates as a stakeholder, administrator or investigator. Specifically, CCCHFA coordinates tagging operations locally for the NRCTP and is a co-PI for the NECCHT along with the NEFSC and GMRI. The upcoming haddock program is especially exciting because we will attempt to build upon and integrate with an existing program, perhaps creating one potential model for enhanced communication between programs. It is somewhat difficult to lay out definitive action items in this synopsis. The haddock program is bound to a budget that can only be tweaked so much, and furthermore decisions involve the input of three principal investigators and a funding entity. However, it seems clear that certain design elements can be incorporated fairly easily, and their value makes it vital that every effort be made to get them in the program. These ideas (categorized into the sections below) will be looked at in more detail as this Program unfolds.

8.1 Data collection protocol

Points for further consideration before haddock tagging data collection commences include:

- Double-tagging to assess shedding rates at a rate of 10%-20% of the fish tagged.
- Collection of biological samples to aid in growth analysis (scales or otoliths).
- Collection of condition and release behavioral indices to aid in ancillary tag/capture and discard mortality work.
- Use of gloves to reduce mucus and scale loss in sensitive haddock.

- Review distribution objectives to enhance and ensure the best spatial and temporal deployment schedule.

8.2 Outreach

There was general consensus that the outreach, return and reward commitments made by various programs must be honored indefinitely. The workshop's most important take home message was that steps should be taken to coalesce regional tagging and secure long term, committed funding to ensure that programs maintain their operational capability and infrastructure, both in terms of outreach and ensuring non-interrupted long-term data sets. Points for further consideration for haddock tagging include:

- Use of fish sale revenue to fund high-reward tagging.
- Use of straight cash rewards over "trinkets" (sentimental rewards).

8.3 Data management and analysis

One point of relevance to the haddock tagging database is that the data should be able to distinguish between the fate of a fish and the fate of a tag.

9. Overarching issues

Prepared by: *Dr. Paul Rago, Northeast Fisheries Science Center*
Dr. Steve Cadrin, Northeast Fisheries Science Center
Dr. John Hoey, Northeast Fisheries Science Center

Simultaneous consideration of several tagging programs in the Northeast made it abundantly clear that the programs are linked. The success of each program is dependent, in part, on the success of other tagging programs. More importantly, failures, or the perception of failure, in any program can have negative consequences for extant and proposed tagging experiments. In this section we attempt to address some of these issues and develop a basis for consensus of the workshop participants.

9.1 Reporting rates

All programs rely on an overlapping regional network of fisheries and harvesters and the voluntary reporting of tags. High reporting rates are a critical element for nearly all technical analysis methods. While some analyses are relatively insensitive to the magnitude of reporting rates, nearly all analytical tools are highly sensitive to heterogeneity in reporting rates. The heterogeneity can occur spatially reflecting regional differences, or temporally, reflecting the differences in the overall perception of the programs' importance. While differences in reporting rates among fishery types (e.g. gillnet vs. trawl vs. recreational) may reveal important biological properties, such differences are more likely due to differences in perception of the utility and potentially detrimental consequences of reporting a recaptured tag. At best, differences in reporting rates complicate the application of analytical methods by requiring the estimation of additional parameters or the introduction of model-adjusted recovery rates. The addition of these extraneous parameters may reduce the precision of the estimates of primary interest, such as mortality and migration. At worst, variations in reporting rates confound the interpretation of vital rates and may give erroneous results.

A review of tag reward programs is desirable, particularly with respect to lottery programs. Lottery programs are designed to increase the rate of overall reporting but their effects may be difficult to measure. Lotteries can heighten public awareness of tagging programs and provide an opportunity for media exposure. It was noted that lotteries may have lower effectiveness in states that do not support government-sponsored lotteries or in regions where forms of gambling may be less acceptable socially. The group endorsed a recommendation to examine the efficacy of lottery systems for improving reporting rates of tags. The utility of lotteries for improving participation in other contexts, e.g., marketing, might also be investigated.

Tag rewards represent another important element for improving and hopefully, estimating reporting rates. Here again, a review of tag reward programs, particularly for migratory waterfowl, may be helpful. Examples drawn from product marketing may also be useful. The group recognized that tagging programs create an expectation that rewards will be paid over a long time span. Failure or an inability to respond to reports of tag recoveries has detrimental long term effects for all programs. Creation of a clearinghouse for tag recoveries and development of a bonding system to ensure future payments of rewards should be given serious consideration.

9.2 Experimental design

Workshop participants noted that proper experimental design not only allows one to test specific hypotheses, but also can reduce total costs by more efficiently allocating tag releases. Less structured tag release programs can be informative in an exploratory mode, especially when a general paradigm of species behavior is poorly specified. Two alternative release strategies were based on the 1) distribution of fishing effort and 2) relative abundance (e.g., fishery independent CPUE or landings). It

was not possible to fully explore the relative merits of these two strategies but it was recognized that simulation modeling might elucidate appropriate applications.

An often overlooked aspect of experimental design is the total cost of information from tags. Information costs include the costs of release, rewards and the cost of the maintaining databases. For voluntary recaptures programs it is important to recognize that the cost of the tag per se is a relatively minor component of the total cost.

There was a general consensus that tagging programs need to make greater use of the concept of mission appropriate tags. Very expensive individual tags may provide critical and unequivocal information that other tag types could not provide, irrespective of sample size. Thus the total cost of information from expensive tags could be substantially less than the cost of information from inexpensive conventional tags. The group agreed that electronic tags are most cost-effective if their release is designed to test specific movement hypotheses.

9.3 Database design and implementation

The database design has important implications for the entry of data on releases and critical implications for the recovery of recapture information. Tagging programs generally require a loose assemblage of participating organizations. As many tagging programs are added to existing monitoring programs it is important that entry and retrieval of data are relatively painless but sufficient to meet both existing and as yet, undefined future needs. No one system could meet the needs of all programs, but the relational database and online audits for the cod tagging program were judged to be more advanced than others and a model of essential critical mark-recapture data elements for other programs to emulate. If these core data elements support data quality control, data visualization (GIS), and export data functions for specialized software, the design may provide a cost-effective bridge between regional programs, thereby providing systematic support for data archiving, analysis, and data dissemination. In particular, quality assurance and control procedures (QA/QC) ensure the use of the best possible data for estimation of population parameters.

The database is recognized as the primary tool for the tag reward program. As such it must be able to provide timely feedback to those reporting tags and to analysts who may require up-to-date information on releases and recoveries. The database should be designed to support data structures required by commonly used tagging analyses programs and statistical software. In particular, release-recapture matrices appropriately stratified by release and recapture periods, geographical region, and gear type are essential for proper interrogation of data, and should be easily constructed via generalized queries.

9.4 Data analysis and model building

Analysis of tag release and recapture data requires the use of specialized analytical models and visualization tools. The database and associated script processing capabilities must be sufficiently general to support a wide array of analytical methods and diagnostics. Workshop participants considered the development of such tools as a high priority. A number of novel methods for data visualization were considered at the workshop. In particular, the application of methods drawn from physical oceanography may be useful for interpretation of tag recaptures, especially data storage tags. Existing methods used for wildlife may also be useful. Several elements of conventional tagging models require ancillary studies to address issues like tag-induced mortality or tag retention.

Diagnostic methods for validation of model assumptions and evaluation of model fit were considered high priority tasks. Visual display using GIS methods would enhance one's understanding of model fit and facilitate the formulation of alternative models. One promising approach to model development and evaluation of model performance are applications to historical tagging data or simulated data.

It was recognized that overselling the utility of tagging information in the context of stock assessments was detrimental to long-term tagging programs. Short-term tagging programs are likely to have the greatest impact on stock assessments when they provide unequivocal information on a

biological mechanism that subsequently clarifies the interpretation of existing data. For example, establishing a seasonal migration path or rate among stocks might constitute such information. The use of ancillary information (e.g., spatial patterns of fishery catch and effort, research survey data) should be considered to evaluate movement and mortality. Finally, procedural approaches and analytical methods need to be developed to integrate tagging information (e.g., movement, mortality, growth) into the stock assessment process.

9.5 Archiving information and data access

The long-term utility of tagging programs was evident in several of the key species presentations, notably the yellowtail flounder program. The workshop recognized that the long-term utility of historical tagging data was best realized if the raw data are available. Summarized data in tables and reports may omit critical information necessary for future analytical methods. Plans should be developed for the long-term storage and availability of data from the current set of tagging programs and where possible, the recovery of historical tagging data. It was recognized that government organizations provide the type of institutional stability required, but private groups and universities may also be suitable given appropriate arrangements.

In some ways the desire to make tagging data relevant to contemporary management and the normal reward system (peer-reviewed publications) for scientists represents countervailing interests. There was a general consensus that this was not an insurmountable problem.

The regional tagging programs reviewed at the workshop, epitomize cooperative research with broad involvement of commercial and recreational fishermen, university, institute and agency (State and Federal) scientists. In a number of cases, funding for the tagging program was provided with explicit recognition of the need for the resulting data to be delivered in a timely manner to stock assessment working groups, plan development teams, and resource management bodies (Regional Councils and Interstate Commissions). While the legal requirements relating to public and court access to data used to support federal regulations is clear, the perception that this may undermine participating scientists interests in peer-reviewed publications must be addressed at the earliest stages of program implementation. A standard regional policy that reflects professional ethics and courtesies without constraining timely access for management use, would encourage collaboration and the broadest possible level of participation of qualified scientists. The transparency, cooperation, and critical review feedback provided by this approach would improve the performance of all tagging programs and provide justification for continued public funding of adaptive programs focused on the needs of management.

9.6 General conclusion

Each tagging project benefited from considering several concurrent tagging programs in a single workshop. The group agreed that future workshops will be the best approach to addressing the overarching issues described above. As tagging projects progress and transition from experimental design and field work to analysis and interpretation, similar multi-species workshops will help to provide feedback and refinement of methods to help meet the objectives of each project. Collaborative, task-oriented working groups should be developed to address specific problem topics; this will ensure substantive intercessional progress between the larger multi-species workshops.

1. Review by Dr. Alistair Hobday

CSIRO Marine Research, Hobart, Australia

1.1 Overview

This tagging workshop brought together the lead researchers involved in a number of conventional tagging projects in the Northeast United States and Canada. The discussion was stimulating and candid, and critical self-assessment notable by all participants. This cooperative spirit was extremely impressive, and speaks to the success of these multi-partner programs. It was also clear that one of the overarching goals of the designers of these programs, to improve the communication between scientists and fishers, has also been achieved.

The purpose of this review paper is to formally record some of the key suggestions made during the tagging workshop. Some of the recommendations apply only to a single program and these will be noted against the program. Some generic comments apply to all tagging programs in the Northeast Region and these are noted under General comments and recommendations.

1.2 Program-specific comments and recommendations

In the following subsections, I will briefly note my perception of the strengths and weaknesses of each major program presented at the workshop; Cod, Yellowtail Flounder and Black Sea Bass. A number of recommendations made at the workshop have now been noted in the post-workshop paper provided by each of the Project Leaders. These suggestions will not be revisited here, except to clarify or provide additional information. The cod and yellowtail tagging programs, with ongoing fieldwork, have the opportunity to modify both their tagging and analysis protocol, and much discussion resolved around these issues compared with the black sea bass program. This program has concluded its conventional tagging work and as a result most attention was directed towards discussing analytical approaches for this program. While each of these programs has a conclusion in the near future, it was emphasized that tag returns and hence valuable information for these relatively long-lived species will continue for several years. Suggestions for capturing this information beyond the life of the individual program are presented in the General comments and recommendations.

Atlantic cod

Tagging procedures in the cod program have been standardized and provided to the multiple tagging participants in the form of an easy-to-use handbook. A minor point was the failure to use cotton or latex gloves when handling/tagging animals. This is standard practice in a number of other tagging programs around the world and decreases the risk of scale removal or transfer of pathogens. While it was argued that glove use may only marginally reduce cod mortality, it is one suggested incremental procedure that is a part of good tagging practice, just as careful hook removal is best practice. Glove use may be more practical when large numbers of fish are being tagged (e.g. after trawl capture) than when fish are captured in small numbers throughout a day (e.g. handlining), although consideration should be given to making this minor change throughout the tagging program. Evidence for cod as a robust species was presented, however, with haddock being the next tagging program to be managed by participants in the cod program, this practice should be emphasized to this tagging community. Changing practices is difficult once entrenched and so where possible, best practice should always be followed rather than changing the rules for each situation.

Post-capture mortality can effect the estimation of growth, movement and survival, especially if post-capture mortality has a spatial or temporal component, as is likely in this program. Of concern with respect to assessing post-capture mortality is the large number of taggers and diversity of capture methods. No holding studies have been attempted to assess mortality. It is clear that given the variety of capture techniques and handlers, a "rigorous experiment" may be prohibitive. One suggestion is to test post-release mortality with a worst case experiment. If mortality is little to none in this situation, then more careful capture and handling practices should have even lower mortality. The difficulties associated with retaining animals in natural conditions (e.g. at an appropriate depth) such that

mortality could be addressed was recognized, and we suggest instead that the tag recovery rate (as a proxy for survival) should be compared between different capture and release techniques. For example, the recovery rate of fish collected by trawling could be compared to that of handlined fish. Noting the life status of the fish upon release, and releasing animals that may be in marginal condition, then analyzing the recapture rate for the different release condition can provide insight into the post-release mortality.

Double-tagging is also important to test shedding rates, particularly with a large number of taggers and can lead to variable recovery rates; again this is important where spatial and temporal variation in tagging ability may exist. Resolving the differences between recovery rate and tag loss is crucial to assess movement rates between areas. I strongly suggest that this program consider double-tagging for all remaining releases. Recall the example calculation at the workshop to demonstrate the low numbers of returns you'd get to assess tag shedding from each tagger based on current return rate if only 10% were double-tagged. Double-tagging is cheap for the information obtained, and 100% double-tagging is recommended for the remainder of the program.

The outreach component of the cod tagging program is to be highly commended, and is a model for all programs. The data management system developed as part of the program is also a world leader and initial challenges (e.g. multiple database users, quality control) have been recognized and largely overcome. The next crucial stage is analysis of the data and development of movement models. These are being addressed by the Project leader and are likely to see the objectives of the program being met.

Yellowtail flounder

This was a well designed study, with considerable attention to statistical design of the spatial tag deployment. Targeted deployment of smart tags to address specific hypotheses, such as transit across closed areas was suggested. Tag loss, via double-tagging, could be better estimated by increasing the number of double-tagged animals, but technical issues exist with double-tagging this species, and tag loss was low in trials/historical studies.

Black sea bass

Attention to mortality and tag shedding rates through consideration of current and historical data allowed estimation of these values. Issues with recapture probabilities based on release location are problematic and may need fine scale spatial analyses. This study with a two dimensional (north-south) axis of movement constrained by the coast represents a good opportunity to consider the sequential vector analysis model for creating descriptions of movement pathways. In fact the vector maps presented by the Project Leader led to stimulating discussion on how to extend this approach, and was one of the exciting science outcomes of the workshop.

1.3 General comments and recommendations

Considerable attention has been devoted to outreach components of each tagging program discussed at the workshop. The result has been an improvement in fisher-scientist relationships, and considerable community interest in the programs throughout the region. Evidence for this should be collected where possible, perhaps through follow-up to tag returnees. Collaboration between the tagging programs should continue to be fostered, perhaps through an umbrella project. One easy start is to provide information on other programs/links on web pages (even develop a splash page for the Northeast tagging programs). This coordinated approach should be oriented towards improving the ease of tag returns by the public and to facilitate the exchange of tags returned to the "incorrect" program.

All these tagging programs have raised awareness for returning tags from the general public, professional fishers, and processors. Commitment to ongoing tag management and recovery is an important issue for the northeast region, and thus how to fund tag rewards once a program is stopped. When tagging programs cease, tags will still be recovered, and it is important to maintain the

community awareness for returning tags and maintaining the quality of the return data. In essence the tagging community agrees to participate in ongoing maintenance of rewards for the completed programs in a region. A loss of "reward" will do more to penalize future programs than each new program having to reinitiate community involvement. Thus, continuing to reward tag returnees for participation in "concluded tagging programs" is vital to the future success of tagging programs.

In similar vein, and particularly for the cod program, a valuable and useful tag database has been developed for each program. The value of these will increase in future years, and thus maintenance past the end of the field component of each program is an issue. One solution may be to unite the tagging databases at the conclusion of each study into a regional database that is maintained by one of the program partners, perhaps funded by a "tax" on the current/future programs. Examples of such regional databases that have had a lifetime beyond individual tagging experiments include the coded wire tag database for Pacific Salmon (USA), or the CCSBT database for Southern Bluefin Tuna (Australia). Institutions such as NMFS and CSIRO have a greater capacity to provide funds for ongoing management, however, the various program partners should explore ways to ensure ongoing commitment to the management and updating of databases as tags continue to be recovered past the formal end of the programs. The data will continue to be valuable resource for assessment and management issues.

As discussed at the workshop, the opportunity to evaluate the success of outreach via meta-analysis of the Northeast tagging programs should not be missed. Such a project could be the first to unite the Northeast Tagging projects under a single umbrella that may act as a catalyst to further studies in the area. For example, a post-hoc analysis of outreach success by looking at patterns of tag returns when outreach stops could be used to evaluate the overall success and persistence of particular outreach efforts. Specifically, the project could consider the decline in return rates as a function of time since formal outreach ceased, compared with expected tag returns based on an estimated mortality and evaluate the success of the outreach by the temporal persistence of returns (difference between outreach and non-outreach phases). In the simplest example, there are at least three patterns that might occur, and relating the outreach method to each scenario can assist in identification of successful strategies (Table 1).

Table 1: Possible scenarios for the outreach and post-program phase of a tagging program. The return rate, or change in return rate can be used to identify programs with successful or unsuccessful outreach efforts. Programs in each scenario-type can then be examined for identification of the critical elements. Replication within each scenario type leads to greater confidence that the successful/unsuccessful elements have been identified. Differences between species and areas can also influence return rate, however, the difference in returns pre-and post program end can be standardized for comparison.

Tagging Program	Outreach phase	Post program phase (outreach ceased)
Scenario 1	High return rate (good outreach)	High return rate (persistent effect of outreach)
Scenario 2	High return rate (good outreach)	Low return rate (persistent effect of poor outreach)
Scenario 3	Low return rate (poor outreach)	Low return rate (persistent effect of poor outreach)

For all the studies evaluating growth as one of the objectives, attempts to age tagged animals should be attempted. This can be through the collection of scales or otoliths from the tagging trips, or synoptic samples by other programs. One of the key findings may be change in growth as a function of age due to changes in density or environmental conditions, and length-based growth rates will not resolve this.

Smart tags

A number of programs have deployed, or plan to deploy smart tags (archival or data logging tags). The increased expense of these tags means they are most efficiently used in regions/species with relatively high return rates. The cost also means that directed deployment to test particular hypotheses arising from conventional tag components is most likely to advance knowledge. Careful consideration of conventional tag data (available for all programs) should precede deployment decisions. Detailed discussion of smart tagging deployment and analysis was not undertaken formally at this workshop, and may be a topic for future meetings.

1.4 Conclusion

The potential for losing ground gained with regard to community outreach, tagging expertise, and database storage of tags exists, in part due to the size and complexity of the tagging programs. Attention to developing a coordinated umbrella approach to facilitate ongoing tag reward and database maintenance, and to ensure that lessons learned are passed on to future programs is strongly recommended. Identification and organization of historical tagging information for the study region may also be worthwhile. This will allow testing of potential outcomes, comparison with prior studies, and contribute to synthesis of understanding for the species of concern. Organization at this scale is not easy, however, developing a "tagging umbrella body" to represent all the tagging partner organizations should be considered.

Future workshops involving these tagging programs should consider in detail analytical approaches that can support management decisions. The small working group style may be an advantage over the presentation-focused style workshop, however, it is an advantage to see how different groups approach problems. I would recommend the regional focus again include representatives from all projects. As a goal of some of the programs is to incorporate tagging data in assessment models (or address spatial management questions), inclusion of stock assessment practitioners should be a priority at the next workshop. This should be held at least one year before the Northeast groundfish benchmark stock assessments in 2008.

2. Review by Dr. John Hoenig

Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, Virginia.

2.1 Overview

The projects demonstrate the feasibility of involving commercial fishers in large scale, coordinated tagging programs. The projects reviewed have produced important results including the development of a user-friendly, web-based system for collecting, checking and maintaining information on tags released and tags recovered, some novel modeling of mortality rates in the presence of movement, and basic information on movements of the species. The Workshop also identified an area in need of further theoretical development, namely, the effect of closed areas on the estimation of survival (from a Brownie model), exploitation rate (from a Brownie model), and fishing and natural mortality (from an instantaneous rates model). Finally, the Workshop identified programmatic components that need to be addressed at the highest levels, including:

- Provision for collecting of data, paying of rewards, and maintaining and distributing data after a program ends;
- Policy and procedural aspects of rewarding fishers for returning tags: should goods (trinkets, e.g., caps, mugs) and/or monetary rewards be used and, if monetary awards are used, can the procedures for sending the rewards be streamlined;
- Should lotteries be used to boost tag reporting rate, and how can the efficacy of such lotteries be evaluated.

It is worth noting that it is necessary to tag for two years to obtain one estimate of annual survival. If tagging takes place for K years then one can estimate K-1 survival rates (K fishing mortality rates if instantaneous rates models are used and tag reporting rate is known). Thus, it would seem that three years is a reasonable minimum length for a tagging study. Three years would enable one to obtain a survival rate and then see if the result is more or less replicable. Longer tagging studies would be considerably more valuable because they would enable one to monitor trends in survival. It is inefficient to start and stop and start and stop tagging programs.

2.2 Program-specific comments and recommendations

Atlantic cod

The web-based database system developed for the cod tagging program appears to be quite valuable. It would be a good idea to develop a project to maintain and distribute the system and provide technical support for those wanting to use the system for new tagging programs.

Yellowtail flounder

One of Ken Pollock's graduate students (M.-J. Joe) at North Carolina State University recently completed her doctorate on tagging models with spatial components. I think this work may be relevant to the yellowtail tagging program.

Black sea bass

I think the investigators for this Program are well aware of what can be accomplished with their data and where the pitfalls are. I have no specific suggestions for this project.

2.3 General comments and recommendations

1) Thought should be given to assuring that the data collected from the current programs are maintained and made available. Funds and human resources would need to be devoted to:
   - Continuing to collect and process tag returns as they accrue in the future;
   - Archiving the data;
   - Making the data available to interested parties.
2) Lotteries and high reward tagging programs are features of many of the tagging programs. Also, the use of goods ("trinkets") as an incentive to return tags – as opposed to monetary incentives – is widespread. Lotteries and trinkets are intended to increase tag reporting rate (without revealing what the tag reporting rate may be). Trinkets may also be used to avoid administrative complications of dispersing monetary rewards. High reward tags are intended to measure the tag reporting rate for standard tags. If the government is going to fund a number of tagging programs, then it would be reasonable for it to review these techniques to determine under what circumstances they are effective – or to determine how one can measure their effectiveness – with the goal of issuing guidelines and recommendations on their use. Also, if dispersing monetary rewards is procedurally cumbersome or expensive, then an agency-level solution should be sought rather than attempting to repeatedly deal with this problem on a project by project basis.
3) The use of high reward tags to measure the tag reporting rate for standard tags is predicated on the assumptions that 1) the monetary reward is a sufficient motivator to guarantee compliance, 2) fishers recognize the value of high reward tags, and 3) high reward tags are dispersed geographically so that fishers cannot fish specifically for high reward tags. The sufficiency of the reward can be assessed (at least in part) by using rewards of various values and determining the rate of return for each reward value. The recognition of the high reward tags can be evaluated by asking fishers if they are aware of the high reward program.
4) It is important to understand that when the tag reporting rate is high, it does not have to be estimated precisely to estimate fishing and natural mortality. But, if tag reporting rate is low, then it must be estimated precisely. Therefore, more consideration should be given to the type of rewards offered, their efficacy in promoting tag return, whether satiation occurs (e.g., tag reporting rate dropping off as the fishers accumulate caps), and whether tags are being returned in batches when the cumulative reward becomes high
5) An idea that arose at the Workshop for evaluating lotteries is worth noting. Three types of tags are released: 1) standard tags with just a modest reward (e.g., cap), 2) lottery tags where fishers receive the modest reward plus are entered into a lottery, and 3) high reward tags where fishers receive the modest reward, are entered into the lottery, and are given the high cash reward. By comparing the rates of returns for tag types 1 and 2 one can measure the impact of the lottery on the return rate. By comparing return rates for tag types 1 and 2 with the return rate for tag type 3 one can estimate the actual tag reporting rates. This presupposes that the fishers recognize the tag types and understand their rewards.
6) The effects of closed areas on the calculation of exploitation, survival, and components of mortality is a poorly understood aspect of tagging studies and needs some investigation in order to properly interpret the tagging data that is being collected.
7) One inference that can be made from the tagging programs is gear selectivity. This is a neglected area in most tagging studies and is worthy of attention.
8) I believe it would be advisable to build a consensus that a particular color (or possibly, a particular set of colors) will be reserved for high reward tagging programs. For example, if a

haddock fisher who has learned that red tags on haddock are valuable encounters a red tag on a cod, he or she will already be primed to check if this is also a high reward tag.

9) I believe it is a very bad idea to put an expiration date on a tag with a monetary value; it is even worse to cease paying for tags after a given date without marking that on the tag. Both of these actions would serve to frustrate and anger fishers and encourage them to think of tags as trash (if not as an outright fraud).

10) The herring tagging program experienced low tag return rates. I think it is important to investigate the reasons for this. It may be that tag-induced mortality or tag shedding is high. I think in-situ experiments in large cages might be important to evaluate this, even though this may be challenging to do. Also, increasing the reward on the herring tags and advertising the high rewards would be one way to check if lack of reporting is a problem. Planting tagged fish in the catch would also be a way of determining if processors and dealers are missing tags or failing to report them.

11) It was suggested that data on the rate of tag recovery of individual boats (i.e., recoveries per unit catch) can be used to make inference about the tag reporting rate in the fishery. I believe this could work as a variation of the observer method for estimating reporting rate. But, instead of looking at the highest recovery rates in the fleet and assuming those boats are reporting 100% of the tags, I would argue that the rate of return from boats that are believed to cooperate would be better (provided one is confident they are cooperating). If cooperators are catching 2 tagged fish per 100,000 but the fleet as a whole is catching 1 tagged fish per 100,000 then the fleet as a whole has a reporting rate of 50%.

12) Most of the programs included outreach as an important component. I believe this should be followed up at the governmental level to develop guidelines about elements to incorporate in outreach. For example, one element that should be included in any program using high rewards tags is to interview fishers to see if they are aware of the high reward programming, If they're not, then the assumption that all high reward tags are reported is likely to be violated.

13) In all programs, the person tagging the fish should be identified in the database so that rates of returns can be compared among taggers. This is one way to check if some taggers may be using methods that lead to tag-induced mortality or tag shedding.

Annexes

Annex 1: Meeting Transcription

Captured by Togue Brawn (Workshop coordinator); reviewed and corrected by workshop participants.

Disclaimer: These notes were transcribed simultaneously to the workshop presentations and dialogues. They are as accurate as possible, and have captured as much dialogue as possible, but some discussions are not fully complete.

Comments from the note-taker are given in italics. Presentations and comments by the "lead speaker" (whoever was giving the presentation) are given in normal font. Dialogue before, after, or within a presentation is indicated by the speaker's name being underlined immediately before the comment.

Day One

Day one began with an introduction by Paul Rago, Fishery Biologist, National Marine Fisheries Northeast Regional Office, who defined the purposes and goals of the workshop.

These purposes are:

1) To increase interaction/collaboration between programs.
2) To elicit feedback on current and upcoming Northeast tagging programs
3) To set the foundation for future workshops in order to increase interaction.

We're talking about the fate of almost 2 million tags released in past 20 years (this figure includes salmon tags, but not Carlin tags). This offers us a good opportunity to gain insight into how analyses can be conducted, and to see where we can have some modifications of programs, and take advantage of things in terms of design.

This workshop will cover a broad range of programs – some in place for years, some just starting. This workshop will be interactive and lively. We have a flexible schedule. The keynote speakers will apply their information to what is presented here today. Day three will allow for targeted feedback on each of the primary tagging programs. We will also try to develop a list of design recommendations for each of the programs. Where appropriate, we'll try to identify areas where we can move forward, in particular in regards to some of the ancillary experiments, such as telemetry. Alistair has a lot of experience in that.

We hope there will be "cross pollination" here. There are a lot of commonalities between the programs, and common objectives. There will opportunities here like cross training – you learn something in another form and you start to build upon that.

We're talking about observations of a cryptic animal, and most observations are of the terminal kind. There are a lot of models for mark recapture, which is often less applicable to these programs. In fisheries, they're generally killed when they're captured. In bird stuff, this method is called band recovery models. We're working on broad geographic and temporal scales. One thing that has a lot of currency in literature now is the heterogeneity of processes (how the capture process influences estimates of abundance – the capture may or may not be a random variable). We also have heterogeneous recapture processes: Release gear, recapture gear, detection, reporting rate, and continuous tagging process (recovered over course of season, interpreted at end).

We're also dealing with equivocal parameters – they're often confounded. If you recover a lot of tags in one area, this could be due to a high reporting rate, could be due to high site fidelity, or high fishing pressure. How do you remove these variables? To the extent that you can use ancillary information, you can have a lot of insight into the underlying process.

There are clever methods to filter: looking at recapture rates among fisheries might offer insight into reporting and detection. A lot of ancillary information is captured through fisheries, and there is also a lot of fisheries independent research. Embedded experiments also help. There are all sorts of things that can confound perfect implementation, and embedded experiments that get information after the fact are helpful.

We need to consider: how do we know what we think we know? We're on a spectrum in between

design and model. There needs to be a real focus on underlying assumptions, and we'll try to highlight this: what are the assumptions under these models and how well are they satisfied, and what sorts of tests can we devise to test their veracity? (shedding rates, initial mortality, etc.) We should focus on the quality of recovery information. It's important to get a large buy-in from fishermen.

We'll also examine hypothesis models – how do we go from the hypothesis to the operational model, based on how the world works? Hopefully we can also identify tools (software, etc.). There are references available on this on the disk within your packet.

Presentation 1: Northeast Regional Cod Tagging Program

Given by Shelly Tallack of the Gulf Of Maine Research Institute. She noted that the program is 20 months old, and that this workshop was the first time she'd really been able to present preliminary analysis of the data itself.

We have four goals:

1) Our primary aim is to look at movement and mixing of Atlantic cod throughout the Gulf of Maine (GOM), and byproducts of this will be information on growth and spawning grounds. They've been examined in the past, but these studies have tended to be smaller and more finely focused, and there were often many years in between studies. We will also be looking for whether there has been a change in pattern of what's been seen in past?
2) To develop a hugely collaborative program (100,000 tags deployed by fishermen and scientists working together throughout the study area).
3) To make data available/visible to public.
4) To come up with future research questions based on the findings.

This study was not designed to count cod or to give an estimate of stock abundance, but it should provide information on key biological parameters which will compliment other ongoing studies in the region.

We have been working with ~75 boats – 34% are charter vessels, 66% are commercial fishing vessels. There is a huge range of gear type, effort, etc., which means there are a lot of variables.

The tagging locations were those identified through town meetings coordinated by the New England Aquarium prior to the start of this Program. Based on discussions at our End of Year One meeting, we added one additional tagging area (Western Gulf of Maine) in Year Two. Originally it wasn't going to be included because tagging was being undertaken there by UNH, but then we decided to add it to complement what was being done while also being able to have data from the same time frame as the rest of this Program's data.

We developed a standardized tagging technique early in the program. A protocol manual was developed and given to all participants. You're working with a lot of people who aren't used to dealing with scientific techniques. This manual provides them with a reference.

Outreach:

Outreach is a large component of this program: we're working with many different people, and also depending on fishermen to return tags. We aim to increase people's awareness of the program, of the incentives offered, and we provide regular updates.

We send mass mailings to about 5,000 federal permit holders every 6 months, and also send larger information packages to processing plants. Other forms of outreach include press releases, posters, website, TV shows, and presentations at trade shows.

Rewards:

In processing plants, whoever finds the tag usually gets the reward. People who find multiple tags have sometimes schemed to use their uncle's name, aunt's name, etc. to be sure they get a reward for each tag found, even if it is e.g. 5 tags found all at once (we don't necessarily send out a reward for each tag in the envelope, but we try to reward each time someone returns tags).

High reward tags are blue (different to our regular yellow tags), and receive a $100 reward. They must be sent in to GMRI for the tag reporter to be eligible for the money; the minimum data required is Tag #, Date of capture, fish length and recapture location.

John Hoenig, Virginia Institute of Marine Science: We should come up with a decision that all high reward tags across systems are one color.

S. Tallack: One criticism of that might be the potential for variability in tag detection – is increased reporting due to increased compliance or increased detection? Would it be better to release some high reward tags with the same color as the normal tags to test for this?

J. Hoenig: It doesn't matter. You have a standard tag that has some return rate, and it doesn't matter what the color is. You compare that rate to tags with a 100% reporting rate. You want to make the assumption that no one will fail to return a high-reward tag. This method presupposes: 1) fishermen being aware of high reward program; 2) the tag is detectable; 3) the tag reward is high enough to mean something.

Also, I've always advocated for special posters for high reward programs. If you really want to know your program is working the way it's supposed to, you need to know $100 is adequate, and you can do that with rated rewards $20, $50, etc., so you can see if increasing reward increases the rate of return. You can check to see if people are aware of the high-reward tags by doing interviews at marinas, etc.

Chris Pickett, National Marine Fisheries Service: Will they disregard regular tags, if all they get is a cup?

S. Tallack: Using different reward options is something that we have done, to try to keep people interested (e.g. T-shirts, hats and mugs). Maybe we could discuss as a group the relative appeal and therefore effectiveness of each type of reward. Once you have t-shirt, do you want another one?

J. Hoenig: You should probably give out a mug and a t-shirt and a cap with your high-reward money. You're trying to make sure that everyone turns in the tags. Use all your motivations. Plus, it's advertising. And I always advocate for cash options, in case they get satiated.

P. Rago (Chair), National Marine Fisheries Service: I see an incentive group developing tomorrow: How to motivate and how you analyze it?

Lottery:

Lottery winners are selected from five categories of tag returns based on where the tag was recaptured: Northern Gulf of Maine, Georges Bank, Cape Cod & vicinity, NH & MA inshore waters, and Processors and Markets. To be eligible for the lottery, the tag return must include tag#, fish length, date and location.

John Hoenig: If a fisherman realizes that a certain category is likely to be less populated with tags, he'll see it's best to report it from that area. By doing so they increase the likelihood of being selected a winner (fewer tags reported from the area means there will be a smaller pool of tags from which you'll choose). It's public data, so sooner or later people will catch on.

S. Tallack: I'm not convinced they think that hard about it.

J. Hoenig: New Jersey had a very subtle glitch, where tags with duplicate numbers in their lottery had slightly higher odds for being selected as lottery winners, and someone figured it out.

S. Tallack: We felt when designing the lottery program that it doesn't really matter to us who wins: we've had some people who have won multiple times. The lottery gives us an ability to say you have a chance to get a reward if you return all this information. It's an outreach/PR tool.

Alistair Hobday, CSIRO Marine: He's asking why do you need to divide it in to areas? Is there an incentive to lie about it? If you're trying to get location information, why include an incentive to lie about where the tag was caught?

S. Tallack: This is another way of getting information out about the program, and it gets to all the regions.

J. Hoenig: If you did this based on where the fish was tagged, there's less incentive to lie,

there's no incentive to figure out the recapture location most likely to result in a winner.

P. Rago: we may want to pursue this later. We're trying to do two things: 1) increase overall level of reporting; 2) try to get the absolute rate of reporting based on the assumption that certain rewards will bring about a 100% reporting rate.

S. Tallack: It's certainly an interesting point, but this was chosen as a way to make sure there were winners throughout the region. The value of making regional winners is high. Local papers pick up on the press releases and publish them.

A. Hobday: You don't publish how many tags were reported. As overall reporting rate starts to approach 100% level, there may be problems with detectability. Maybe we could discuss this tomorrow in each region, right?

S. Tallack: Yes, we don't publish the number of returns per category each month, so they don't know these numbers.

Website:

Our website (www.codresearch.org) is simple but informative, and is updated regularly (every week or two). It links directly to our online mapping interface for tagged cod, where as soon as data is entered and approved, it becomes viewable. Right now, it shows just year one's data but that will change as more data gets approved. It's open to anyone. Filters of various categories are built in.

In addition to this site, we also send thank-you letters and recapture reports.

Data Collection and Entry:

We currently have 4 separate data sheets (described in slide). We started off with two, but we added two more recently with the onset of the high reward tagging and the fact that we now also collect data on non-tagged cod.

We've developed a complex online relational database. What we have now is more in line of what we thought we'd have later in the program; originally we thought we'd not be using an online database in Year 1 (we're more advanced than we thought we would be at this point).

Photocopied hard copies of all datasheets are held at GMRI: we request that the partner organizations keep the originals, but copies are sent to us.

Data gets entered by partners organizations, they enter and submit it (on line), we receive an email telling us a new trip requires verification, it gets rechecked at GMRI and then approved; this is when it becomes viewable. Quality control takes place during entry by built in tools (primarily for format, but counts etc. are also cross-checked), and also by manual checking. We're currently in phase three of database enhancement.

Bill Duffy, Northern Geomantics Inc: The data entry is very quick – you can move right along. In fact, when Cape Cod started, the program couldn't keep up with the speed that they were entering data, so we had to create a message telling them to slow down.

S. Tallack: We may have 16-20 people in different areas entering in data, on different machines and operating systems. We opted for an online database to avoid having to continually update software with program partners as the database evolved.

J. Hoenig: Bill Hearn worked in Hobart with Southern Bluefin Tuna (SBT). He discovered that on one cruise the two taggers (they took turns) had widely different return rates, one had a 19% return rate, the other a 2% return rate. No one knew why: they thought maybe this was an artifact (maybe someone recopied the data sheets). But he looked into it and found out they were original data sheets. His recommendation was that you should always keep track of who's doing tagging at all times.

S. Tallack: For haul data, we request in our protocols that you don't switch taggers within a haul, or a "capture event". We also request that no one move more than 0.5 miles before re-releasing the fish. Also, all our taggers undergo training, even on recreational vessels, there's a scientist doing tagging, or people trained in tagging.

Tom Rudolph, Cape Cod Commercial Hook Fishermen's Association: We hammer it into

them that each haul has to have the same person, and we prefer to keep the same tagger throughout [the trip and even all trips].

We allow the use of inches when collecting and entering data, in order to increase accuracy for people who aren't used to measuring metrically. But the lengths are stored in centimeters; we have a built in converter so there is less chance for human error during conversion to centimeters.

We have a new feature: we're able to assign a specific haul to a closed area, and I'll be thinking about how to change that in the past data soon. There's a dropdown list of 5 permanent closed areas in our zone. We also have auto-fill information to minimize entry time and potential for error.

We can enter up to three tags for each fish. The system checks to make sure there are 6 digits, and also looks to see if the tag has already been entered. If so, it prompts along the lines of: this is a recapture, is this right, do you want to proceed?

As for the "Fate of fish: field: The default is "released", but we also have "floaters" or potential floaters, or "seagull", "gutted", also "dead".

P. Rago: Is there an option for "beat up", etc.

S. Tallack: That goes into the comments. I looked at the comments after about 6 months of field work, and from that, created as much as possible a standardized list.

J. Hoenig: You're recognizing some fish might be released, but you're not asking about the fate of the tag, whether it was clipped off or not.

S. Tallack: If the fish is released, it's released with the tag.

J. Hoenig: There are two issues: we need to know fate of tag, and the fate of the fish.

S. Tallack: If they clip out the tag and throw it back, that's captured in fish comments.

J. Hoenig: For estimating mortality rates, you need to know the fate of both the tag and the fish. Without that, you're getting bias on survival.

S. Tallack: That's in the comment field.

J. Hoenig: The problem is you'll have to read every single comment field to extract out the information you need.

S. Tallack: So maybe we need to add this to our dropdown list, something like "released with tag" to differentiate. We must re-enter a lot of recapture information, so this would be a prime opportunity.

A. Hobday: What's the percentage of released cod that are recaptured and re-released?

S. Tallack: I have the number with me, but don't remember it off the top of my head – it appears in a later slide

P. Rago: What's the reason for re-releasing?

S. Tallack: It tends to be done by recreational guys, who have learned enough to know we'll get more information if they put the fish back. Generally speaking it's a low number. I think roughly 65 or so thus far.

T. Rudolph: They might also be sublegal.

J. Hoey: Across a variety of programs, this is a good kind of exchange for everyone to take to heart.

T. Rudolph: I've had a really hard time with the fact that fishermen are going to do what they're going to do. I've had a really hard time getting them to understand what we want them to do. We've made some complex scenarios in the past. Somewhere along the way I said it's less important that you do the right thing, as long as you tell me what you did. And they still can't do that.

J. Hoey: We need to get back to tell them "There is no right or wrong here" We just need the data (discussion of why fishermen might be afraid to report stuff, don't know what's "right"). Maybe on the third day we can come up with standardized recommendations.

S. Tallack: At our End of Year One meeting, the point was made that we really need to

request that tags get sent in, so we can verify the numbers reported. We've made a big point of encouraging this since December 2003. We still have a pretty good return rate on the actual tags from before December 2003, bearing in mind we didn't request that it specifically originally.

A. Hobday: Can they be rewarded for not submitting tag?

S. Tallack: Yes.

J. Hoenig: They can enter the lottery without returning the tag? I bet your tag numbers are sequential. People can just make up a recapture to report. What's the worst that could happen? They just say they made a mistake.

Database - Recaptures:

We've improved the database to allow us to flag substandard data on recaptures. You'll see four check boxes here (on slide). There's a check box for "didn't receive tag". There are also check-boxes for estimates rather than actual data (for date, fish length, location). For instance, if someone reports a general area of a recapture but does not give coordinates, we can give a midpoint location rather than having to completely discard this information. This categorization as "sub-standard" data allows us to filter out all of these "estimates" if necessary at a later date.

We also added a "User check" for fish length: In the first version of the database, we couldn't see the original fish length when entering a recaptured fish. Now, we can click on the fish icon to pick up a tag's history, but this must be done manually. Now, that information goes into comments "fish size was given as X on recapture, but the release size is larger". We make a note into comments, and we check "substandard" data.

Originally we did not have the ability to rate data quality, but it became obvious we needed it. But this tool developed fairly late on, and the recaptures that were entered before this now need to be re-entered. We do now have a backlog of recapture information that needs to be entered.

Kohl Kanwit, Maine Department of Marine Resources: With DMR herring tagging we have a graded system of "accuracy": level 1, 2 or 3. If a fisherman reports a fish being caught "around Mt Desert Rock", that's one level versus a larger area (such as "near shore Southern Maine").

Gary Shepherd, National Marine Fisheries Service: Do you have fishermen unwilling to give you exact coordinates?

S. Tallack: There has been some reluctance, but it's been much better lately – as time goes on, they are more willing and also more aware of exactly what we need. Pat [Pat Foote, GMRI] has a really good manner of talking to these guys, and this helps a lot. People display a huge range of attitudes. There are some who report the tags to get stuff (rewards), and there are also many who just want to get good information and aren't interested in the rewards.

P. Rago: Is there a problem with fouling or degradation of tags?

S. Tallack: No, and Hallprint tags were specifically chosen to avoid this. We've had no problems so far.

Azure Westwood, National Marine Fisheries Service: with long hauls, do you take middle coordinates or beginning, or end?

S. Tallack: We do short hauls, ~20 minutes; we record the start and the end location, but the release is associated with the end location.

G. Shepherd: How about recaptures?

S. Tallack: Fishermen report a location. We ask for one location, we don't ask for haul start and end.

Pros and cons of database (slide):

Advantages:

- All users have access to most current database.
- Data is error checked as it's entered.
- Data links directly to GIS mapping interface automatically; live.

Disadvantages:

- Can't be used at sea – can only be entered online.
- Data entry is a little slower than if working down a column in Excel, and then uploading.
- Preliminary data analysis:
- Our analysis has really only just begun (on size relationships, growth rates, displacement and dispersal/exchange between areas).

We tag down to 36 cm. We are trying to tag the entire size range above this. The largest fish we've seen so far have been 133 cm (both tagged by DMR). Fish caught by hook tend to be smaller.

Releases cover the full size range. We haven't recaptured as many of the small fish, and whilst we don't know exactly why, it is likely to be a combination of: gear selectivity and differences in catchability of small fish; and the effects of fishermen focusing on areas where they are likely to get bigger fish. It is possible also that small fish do not survive the tagging process so well? Or maybe we are seeing growth?

A number of our fish are being caught very soon after release.

K. Kanwit: if you're using contract trips, why are you getting so many back so soon?

S. Tallack: I've looked at where they're coming from within the tagging trips, and when large schools come up, it's a prime time to tag a good number of fish, but this also presents the risk of recapturing what you just tagged – these fish still get recorded as a recapture. It is also be due to fishing activity that happens to be in an area you were just in.

Movement:

We looked at displacement. It looks as if there's a slightly higher westward movement coming inshore, but no real difference north to south.

There's not much movement in the spring, but each other season has much greater movement. You definitely see interaction between north and south, between maritime waters and Georges Bank waters in other seasons.

One criticism so far is that we're not targeting spawning fish enough. I would argue that we've tried, but we haven't seen that many. It's one of our priorities, but it's not always an option.

Return Rate:

Overall we're at a 2.2% tag return rate (to date). Returns are dependent on awareness of the program, tag detection, compliance to report tag and good information, and fishing effort (4 things total). Compliance varies highly from individual to individual.

The high compliance (high return rate) in Canada is probably due to processors in Canada reporting much more. Cape Cod's rate is low, which may be due to the number of smaller fish being tagged. 4.4% of recaptures are re-released.

Our return rate is increasing. 61% of reports come in by mail, 3% in person, 27% phone, 9% by e-mail.

We primarily tag in spring and fall.

Lessons learned:

If cooperative research is key, the involvement of all stakeholders is necessary. Doing so may have delayed decisions in our program, but it's worked really well.

Attention to program design is important. It's worth putting time in to get it right, and to go back and check data.

Key tasks for future months:

Outreach will continue, tagging will continue, and finally we hope to come up with ancillary studies.

So far, ancillary studies we've begun or are considering are:

- High reward tagging.
- Also had huge discussion about bycatch issues, where our permits only allow us to work

on cod. Some fishermen were concerned with number of other species being caught. We looked into how we could also collect information on these species, so as not to completely waste them. But in the end, industry did not want to incorporate bycatch information because they feared it would come back to "bite" them.

- Potentially this fall, we might do genetic sampling – we've been requested by the Research Steering Committee to do this. At this point, we've only got one field season left.
- Maybe tagging in closed areas? Refining – already doing this.
- Tagging of spawning aggregations? Refining – already doing this, just don't have high numbers.

A. Hobday: I see three key things with this program: 1: The physical tag is acquired. 2: Raw copies of data sheets are maintained 3: The willingness to go back and change data as necessary. This is all commendable.

Laura Singer, Gulf of Maine Research Institute: Having funding available to move around (willingness of sponsors) is why we're able to do this.

P. Rago: It gets harder to re-tool as you get more inertia.

S. Tallack: Only two people can change data – it used to be only Northern Geomantics that could "fix fish," but now Shelly and Pat can do so as well.

Presentation 2: Yellowtail Flounder Cooperative Tagging Project

Given by Steve Cadrin of the National Marine Fisheries Service.

Our technical objectives focus on movement, mortality and growth.

There are three stocks of yellowtail, and each has a different history of fishery and stock development, and have different challenges. 3 stocks: Cape Cod Gulf of Maine (two within this), Georges Bank, Southern New England Mid Atlantic (2 within this). Yellowtail fishery first developed in Southern New England.

1) CC GOM: Cape Cod assessment suggests that stock has been relatively stable, in fact the spawning biomass seems to have increased despite high fishing mortality (F) rates. These rates present a problem for management. Although we've reduced mortality on other groundfish stocks, CC yellowtail sticks out like sore thumb. There are major uncertainties in coming up with F, M and stock size. Darby suggested that if M rates are that high, you should be able to confirm them with a tagging study. This was one of first impetuses for this tagging study.

Cape Cod natural mortality (M) is at 10x FMSY.

Goal One: confirm mortality rates.

2) Southern NE: Historically this was the dominant resource, but it was depleted in the early 90's. Despite closure in Nantucket, FM has not been reduced, which may be due to the lack of management in the Mid Atlantic. So another goal is to better understand the movement between the mid Atlantic and southern New England. Historically this was a way more productive resource. It's depleted right now, and we need

to better understand where fish are moving around SNE/ Mid Atlantic area.

Goal Two: examine movement patterns, specifically around SNE/Mid-Atlantic.

3) Georges Bank. The Georges Bank stock was depleted in the early 90's but is now rapidly rebuilding. After closing area 2, we had mesh size increases, and Canadians had restrictions on TAC. But we also have some technical problems. Maybe we're not aging these fish correctly. 3rd goal is to confirm age determinations, as well as understand the movement of yellowtail from the closed area.

Goal Three: confirm age determinations and understand movement patterns from closed area.

This entire project has been cooperative. Fishermen really wanted to have a tagging program. Luis Ribas, Dave Goethel, Fred Matera, Rodney Avila were the main movers for getting Yellowtail tagging on the map.

General Strategy:

Ideally, you want to have one objective, but we have multiple objectives. The only way we could meet them was to have our tagged subset of fish representative of the entire population.

Ideal Tag Distribution would be all of the US resource, and the Canadian portion of Georges Bank. We tried to relate the distribution of tags to the natural distribution of fish. We were able to slice up pie of tagging requirements into three pieces. Canadians do Canada, NEFSC does CC GBank – SMAST/Rhode Island Fish and Wildlife does SNE-MA. We base this all on days at sea.

J. Hoenig: When you want to do a tagging study, you need tagged fish to be representative of the population, so you have to:

Tag in one location, hope they distribute themselves.

Tag on random fishing trips and let the spatial differences in catches "self weight" for spatial differences in abundance.

I tell them to tag in proportion to local abundance, and judge this by catch rate. You can't tag based on locations. You should say "tag best 80% of what you catch", then it's self weighted. If you tag a certain number in each area no matter how many you catch, you weight toward marginal areas.

S. Cadrin: When (tagging) days are funded, we have a target number of fish to tag. When taggers meet the target, they move on. I don't think we're double-counting, we're always going back to number of releases.

J. Hoenig: In general if you do a trawl haul, and tag whatever is there, you're tagging more in areas with greater abundance. You're catching more there, and you're sticking around longer.

Analytical Design:

We assume observed recaptures are a function of 1) mortality in each area and 2) movement among areas.

Our model includes a process equation: the number of tagged fish in an area is a function of the survival of fish that remained there plus those that moved into the area.

J. Hoenig: Where is the time step?

S. Cadrin: That's up to us. We tried for a flexible model – three stock areas and an annual time step is minimal for what we propose. We'd like to test further and further resolution. We'd like to try a seasonal model, since people think there's a seasonal component of movement. We'd also like to look at smaller geographical segments.

This is simplest way to do it, although we may need to explore other options. The model assumes they move at the beginning of the time step (e.g. move, then either survive or die).

Movement Mortality Model:

Once we have process equation of how tags move through system, we can ultimately get to expected number of tag returns in an area at a given time. We apply the harvest equation to the results of the process equation.

Tag loss rate and tag-induced mortality are not included.

Third goal is growth, which is unrelated to movement mortality model.

Growth figures will come from marginal increment analysis. We have scale margin at time of release, we get another image of recapture after a known time at large to see how circulai are being laid down, and we look for seasonal patterns.

Marginal increment analysis is less dependent on getting an accurate length. It's more dependent on looking at annulus increments.

Field Protocol:

We relied on John Boardman (Mass DMF), who had lots of experience with the Pilgrim Power Plant study, when we came up with the field protocol. We went with Peterson disks.

We've developed protocol that goes out on every cruise – captains and chief scientists have a copy of it. How do we capture fish? Captains must put us on an area with a lot of yellowtail and conduct short tows so we don't get a lot of bycatch. If we get in an area where we're catching too

many other fish (bycatch), we move. We ensure all surfaces are wet, and minimize time out of water.
We get a good indication of fish health prior to tagging.
Yellowtail are placid, but Peterson disks require more effort, so the overall processing time is the same as for cod. They don't have a swim bladder, which is good.
There are standardized ways to tag fish. We're getting minimal tearing, and any tearing is usually on recapture. Signs so far are that tagging is going well.

Database:

Our database has a simpler structure than that of cod. We capture 1) tow (date, area, tow), Then 2) tags (tag number, tagger, recorder, time, length, sex, scales, condition observations).
3) Returns. Tag number, fisherman, vessel, address, phone email, length, date, depth, lat, lon, category (fisherman, processor, scientist), comments.
It's time-consuming to analyze with this system. Right now our audits are posterior to key punching.

Outreach:

Our outreach is very much at the grass-roots level. We understand that our lead fishermen are not a representative sample. Azure is outreach leader.
Our 2003 trips took place from Maine to the Mid-Atlantic. We distribute 30,000 lottery tags with four $1K reward drawings each year, and 200 high-value tags. We also issue a $100 reward for data storage tags.
Our high rewards tags have the same visibility as standard – same color. We want them to have the same chance of being seen, so we know any difference of rate is not due to color.
We distribute Portuguese posters in New Bedford and Provincetown.
Reporting system and reward system: these both serve dual objectives of outreach and maximizing returns. We have a toll free number, and started a dialogue (both came from striped bass recommendations). It's also important to communicate to give information back to the fishermen.
It's important to maintain a cooperative approach throughout the process. Highliners are invited to all meetings.

Model:

We looked at putting historical data into our model. In 1950's, there was tagging in the areas we're currently in. Larry Alade structured a very simple model. He had three areas and collapsed their time at large, so they all started at year zero. Simplified assumptions, tested models (single coast wide F), 6 movement rates among 3 areas, Pooled year returns, (see slide), assumed no tag loss or tag-induced mortality, ignored returns with missing location information (we may want to talk about this later).
He took a simple sum of squares estimator. (we'll probably move on from this to a likelihood model).
Larry also played with estimability of Beta parameter.
We found that overall F was fairly large but it did have some estimability. Beta (reporting parameter) had better information on it. There was enough unique information from each of them to get good information.
2004 started off with annual cooperators meeting. Reviewed preliminary data, planned 2004 tagging.
Movements from Cape Cod: had large movements (not many, but a few very large ones that we suspected were errors). We checked "suspect" fish against observer logs and found they were recorded correctly. Lesson: don't discount reported fish that seem unlikely.
We need to look at representativeness of return data.
From GB to Cape Cod we also had some large movements. But by far, most recaptures were in stock area of release. Among GB releases, there was more movements between release sites.

P. Rago: Steve brings up a point here: one of the ways we depict movement information is net

displacement vectors: an "A to B" kind of thing, but the paths they might follow are kind of interesting. We'll gain insight into this through ancillary studies.

S. Cadrin: What we really wanted to look at were patterns of our returns. This was really a function of "where are we getting recaptures from?". We'll add time at large in later on.

Data Tags:

Data tags give depth and temperature over time. Tags go out beginning with a 14 second interval where they record time, temp, depth. As it fills up, it deletes every other data point and goes to 28 seconds.

With short time at large returns, we have high resolution. One thing we see is comparison of behavior immediately after tagging with long-term behavior. It appears as though (from this particular tag) that immediately after tagging it went to very deep water. You can see spikes where it's coming up off bottom. You see diurnal patterns from tidal cycles. It appears that in the first few weeks, fish was still searching around for yellowtail habitat. We may need to consider tag-induced movement.

You can see that fish come up off the bottom to find a new depth – we don't know if there's a causality there, but you can see a distinct pattern. My perception used to be that yellowtails were clams essentially. Now we're learning that at fairly frequent intervals, they're coming up off bottom fairly close to the surface.

We could infer movement for a couple fish that had a very narrow corridor (Inferred movement slide).

We reevaluated after 2004 meeting, and agreed to maintain proportionality of coastwide tag releases. (Conclusions of 2004 Meeting slide).

In order to address the movement of juvenile yellowtail in Southern New England, we decided we'd also tag sublegal yellowtail in low density areas to look at the movement.

So far, rates of return for fish in "excellent" and "good" are similar. In future, we'd like to look at having a criteria for return rate within an area.

J. Hoenig: You should look at the ratio of excellent vs. good at time of tagging and time of recapture. If that ratio is one, it's an estimate of relative survival and retention of the tag. It says the goods are retaining the tag equally to the excellents. But if you find that the goods are retaining the tag and surviving less well, it tells you that conditions matter. Then you wouldn't be quite as confident that all fish are retaining the tags.

2004 Season:

In 2004, we have some of same fishermen, and some new ones, from Maine to the Mid Atlantic.

7% of 2003 standard discs returned, 17% of high-value discs returned.

Average time at large was 103 days, average distance traveled was 12 nautical miles, with a maximum distance traveled of 139 nautical miles.

We've had some $100 rewards from fish houses, so we know they're slipping by fishermen.

We don't have many SNE returns yet. There is some mixing between areas.

We compared our data to that of the 1950's, and found the same pattern: major pattern is residence in the same area. Although some of the movements we've seen weren't observed before. For example, our study showed the first observation of movement from GB to CC.

Time and Distance: The relationship between time and distance is not simple. Some of our longest movements happened in very short times at large.

Data Tag Analysis:

We went through over 200 off-bottom movements, and found that most of them were happening in late evening hours 18:00-22:00, which supports the fact that they get up off the bottom after they feed (visual feeders). This confirms the movement is not associated with feeding. f anything, it's cessation of feeding. It doesn't appear to be related to spawning.

Holding studies:

Experiment 1: Our first holding study experiment suggests tagged and untagged fish had

different patterns of mortality. The suggested tag-induced mortality may be substantial, but better controls are needed. This shows we need to do more experiments.

Experiment 2: In our second experiment, it appeared that mortality in holding experiments may not be related to tagging (no histological reaction at tag sites). We have a cage study proposed for 2005. We're proposing to hold fish in cages on inshore grounds.

We need to investigate the immediate versus continuous effect. Tagging can either affect a fish's health immediately after tagging, or continuously over its time at large.

Work Plan:

We've received funding for another year of tagging. We've been funded for 5000 coastwise releases, and have put forth a proposal to do holding experiments. We'll continue outreach and reporting systems.

In 2008, the groundfish science and management system is conducting benchmark stock assessments on a number of species. They'll be looking to see "what new methods can be used to evaluate stock status". A good goal for us to have is to vet results by then.

J. Hoenig: You want people to instantly report a high reward tag – they might have seen it and ignored it. The key assumption is that your high reward tags are fully visible. You need the reporting rate, but you don't need the motivation.

As for estimating returns from reporting ratio: if you're including scientific observers, that sets it off a bit.

S. Cadrin: We were very close with numbers of fish tagged to recent historical abundance.

J. Hoenig: You achieved your goal (weight according to best information for distribution), but there was a simpler way, which was to fish at random locations and tag everything. There's danger in what you're doing if the distribution of yellowtail has changed in the last 3 years. You should update this to include more recent information.

Also, when you do studies about short term mortality, temperature tends to be critical factor. If you tag in August, that could have a much bigger impact than doing it in the spring when the fish is coming from cold water to cold air. It tends to be big fish that die under summer conditions due to the smaller gill surface area to body volume ratio, so bringing them into warmth is more stressful.

S. Cadrin: We would schedule any such experiments early in the year. Even if you're keeping the fish in tanks (sucking surface water in), that (surface) water can be a lot warmer. Also a reminder: you don't want to go too late into the year for tagging operations. This results in them going through a stratified water column.

The problem of tag-induced mortality studies is that there is no "REAL" control – real control is the fish swimming around on bottom, never touched.

J. Hoenig: Your goal should be to try to get as many to survive in your trials as possible, if it's high, you probably don't have a problem.

Following are the wrap-up notes from Paul Rago:

- Linkage between tagging and fisheries independent/dependent and how that's used as basis for design.
- Operational Model (formulating an explicit hypothesis of movement between areas, linkage, processes underlying those things).
- Using Historical Data as basis for testing and exploring data.
- We're operating on censored observations (the time of the event is not necessarily recorded when we do subsequent analyses. We put them into bins, and that becomes censoring. Getting more continuous events is more important. Also, did event occur before mortality or after mortality).
- Ancillary Experiments (data tags, model-based inference, holding, information they can give you on initial mortality and behavior).
- Progressive Development, interactive aspects related to begin the experiment, get

feedback with cooperators, and refine the model.

John Annala, Gulf of Maine Research Institute: We need to standardize initial tagging process – the physical handling by the tagger has a big impact on initial mortality. Wet cotton gloves are better than bare hands, as you can introduce bacteria with bare hands.

Presentation 3: Cooperative Black Sea Bass Tagging Program

Given by Gary Shepherd of the National Marine Fisheries Service.

Impetus for doing tagging work: several years back, analytical assessment was not accepted given a lack of good information. The current assessment was based on survey data, and given their behavior (distribution inshore), there's been a question as to whether trawl gear is adequate for catching them. A push to come up with alternative assessment method resulted in tagging.

Black Sea Bass are migratory, managed as a single stock north of Cape Hatteras. In the spring, they're on the edge of the continental shelf, then during May into June, there's a northern inshore migration. Spawning takes place in Spring from MA to VA, NC. By Autumn, they're distributed on inshore rocky or artificial reef habitat close to shore.

Objectives of the program:

- Determine exploitation rate (total and regional differences).
- Determine seasonal migration patterns (using internal anchor and archival tags.
- Estimate natural mortality
- Foster cooperation with fishermen, increase confidence in stock assessment information.

With our experimental design, there were several issues we wanted to identify:

- First, to select tag types to minimize tag loss, experimental determination of tag loss, mortality.
- Release number by region proportional to landings.
- Restrict releases to limited period prior to offshore migration (tight time window) – this becomes critical in exploitation estimate in modeling – we don't want fishing mortality to change over the period of release, we picked a time in September where we could release fish prior to their moving offshore (coastwide all at the same time, which was tough due to changes in pattern over geo area).
- Fish sizes to reflect fisheries (legal or legal within year).
- Capture gear to reduce mortality.
- Include high-reward tags for reporting rate estimate.
- Outreach to increase exposure to program.

A study by MA DMF in 1988 used 1000 T-bar tags, 1000 internal anchor tags, and had a 3:1 return rate for internal tags compared to T-bar. So we opted for the internal tags.

Internal anchor tab has to go inside a cavity, so you need to cut into the abdomen as opposed to being intramuscular, so you tag in the stomach.

We conducted 3 experiments on tag retention, and found infections were from aquarium exposure, not tagging itself. In a larger study, Mary Fabrizio found no tag-induced mortality. A RI DFW study had somewhat higher tag loss. In that experiment, of a total of 70 fish kept in the aquarium, 7 tags were lost, with no mortality associated.

We estimated that once you get around 3000 or more tags, your benefits of increasing tag numbers diminishes. We were shooting for about 3000 tags annually to release. The tag release was conducted by recreational and commercial fishermen. In general, one person could tag 250-300 fish per day if fish were available.

We're chartering commercial vessels also. When we tag fish we note condition, keep in totes to monitor their condition. Sometimes we pierced the bladder and squeezed out excess air for some fish. We felt getting fish back to the bottom was more beneficial than the risks imposed by doing

this.
Tagging is a quick process, it takes 30 seconds.
We had 4 tagging periods, starting in September 2002. We tried to put proportionally more tags in MA.
In Spring 2003, our objective was to tag in the beginning as well as the end of the recreational fishing season to have a way to estimate natural mortality as well (but due to funds, we weren't able to continue).
Overall spring numbers were lower, as we weren't catching fish in RI, CT, NY.
We've also released $100 reward tags, which are red instead of orange. (Couldn't really use blue due to blue sheen on males in spring).
There's concern about releasing in well-known spots versus less-known spots given the site fidelity of these fish (some captains would take people to "secret spots"). Fishing intensity can be very localized and very variable (in one spot a bunch of fish were tagged in May, and we got all back by August).
We decided early on to use just hats as reward (logistics and cost reasons).
The sizes of fish released and the distribution of sizes mimicked landings information across all tagging periods.
Release locations: initially these were divided into four regions. That's changed since then (ultimately, it's managed as a single stock).
Most of the recoveries occur in the same areas they were released.
Different areas have different migrations (seasonal migrations). In the South, there's less movement relative to northern stocks.
We tend to get a spike in recaptures based on the minimum size. Overall, distribution is somewhat skewed reflecting the release sizes (tried to release fish from 27 cm and greater).
Reporting rate variations: looked at it regionally by fishery, (remembering some sample sizes are small). There's a relatively low reporting rate in recreational fishing vs commercial and in the North compared to further south. Overall we have a 67% reporting rate.
Came up with a Peterson estimate based on fish greater than 28cm (11"), at large greater than 7 days but less than 365 (after 7 days there were at least several fish that were released in one location and recaptured in another). Without RI recaptures within 2 weeks of release (in that period we had used a pot fisherman who had done releases, and he recaptured and returned a good number of tags). Include a 10% tag loss. Limited it only to returns associated with a dead fish.

J. Hoenig: For every two recaptures you got back in 7 days, there might have been one fish killed but not reported. Thus, if you want to eliminate fish caught within 7 days of release you need to subtract the 2 from the number of reported recaptures but 3 from the number of fish tagged. That is, ignoring reported recaptures at liberty for less than 7 days and subtracting that number from the number of fish causes a bias. The bias is small if the number of fish caught within 7 days of release is small, there was one where the fish was killed.

Since you know size of tagging for every fish, you could look at R/M ratio by size group. If it all looks like the same number, with maybe just random fluctuations due to sampling error, it's all good, and the exploitation rate applies to all. If not, you have to look at it by size group.

G. Shepherd: During course of stock assessment review, if you change assumption of high reward reporting from 100 to 80% it changes your results, but not by a lot. Maybe in the discussion, we can see if there's a way to determine the rate:

J. Hoenig: What you're doing is dividing by the tag reporting rate. If you think it's 100%, you divide by one. If it's 50%, you divide by a factor of ½; in other words, you multiply by 2. But if you thought it was 10% you're off by factor of 10. As long as reporting rate is high, it's not a big deal. But if you think it's 2% and it's actually 1%, that's a big deal. It doesn't make much difference as long as your reporting rate is up high. You're protected from errors and you don't have to know exactly what the reporting rate is.

G. Shepherd: At least half the fishermen are recreational, which means we think the rate is rather high.

J. Hoenig: It's important to talk to the fishermen to see if they know about the high reward tagging, and then check up to see if people intend to comply.

Other notes: it's good to have tag numbers on both sides – sometimes a part of the number will be illegible on one side.

Also, it's best to start high-reward tagging at the same time as your standard tagging program. Otherwise it will possibly cause the rate of reporting of standard tags to change over time.

G. Shepherd: We reduced sample size of high reward tags in high exploitation areas (*eg* Cape May).

Model: Alternative Method (Rago and Goodyear 1985 – see slide).

Results: Mortality is robust to changes in reporting rate, which would not be the case if there were a low reporting rate.

Peer Review: We decided we should move into a more analytical phase. We have three years of releases we've done. Intent is to get more captures, and do more elaborate modeling.

Some assumptions to explore: 100% reporting rate of high reward tags, site fidelity to under-exploited areas (secret or unknown sites) – it would be nice to know ahead of time what all the possible locations are and what the effort is, regional/fishery differences in reporting, and regional differences in mortality.

Discussion of problems with data tags (had a lot that didn't work)…

A. Hobday: Did you have an agreement for complete replacement with Lotek?

G. Shepherd: No, they replaced a percentage based on what they thought was reasonable. There's still a reward associated with the broken tags, so it's still costing us for recaptures of broken tags.

A. Hobday: We negotiate ahead of time what constitutes a failure, and what the actions will be.

G. Shepherd: We test them all now – deploy them in a PVC pipe and make sure they work.

A. Hobday: Yes, you need to test them first before you put it in the water.

G. Shepherd: We did get back one that seemed to have worked: it was released in November in Rhode Island, then recaptured in February off Hudson Canyon. It followed temperatures of roughly 52-54 degrees until the edge of the shelf, where the temp drops so much, there's nowhere else to go.

A. Westwood: Did you see a period of adjustment to being tagged (in archival data)?

G. Shepherd: Those fish (with data storage tags) were tagged and held in captivity (for two weeks) before they were released, so we'd be sure they'd survive.

S. Tallack: How much does something like that affect their subsequent behavior?

G. Shepherd: I don't think much at all. They were released in a group of 25 fish, not solitary.

Gary Nelson, Massachusetts Division of Marine Fisheries: Are those data tags marked with your address? How do you get them back?

G. Shepherd: Return information is located on a bright pink tab on one side. The return rate isn't very good. We don't know if the process itself is killing fish, or if the numbers are just so small.

J. Hoenig: How did your F's compare to analytical assessment?

G. Shepherd: The analytical assessment was done several years ago, and hasn't been updated. Those F's were about .5 or so, prior to updating. These F's were just below what the target F's were that management was shooting for.

J. Hoenig: Will you make this into a multi-year tagging model?

G. Shepherd: Yes, that's the goal.

This concludes the "major species presentations". The rest of the afternoon was devoted to smaller presentations, whose brief summaries follow:

Presentation 4: Shark Tagging

Given by Nancy Kohler of the National Marine Fisheries Service. A transcript of this presentation was made available and has been included here:

"Pat Turner and I work at the NMFS's Lab in Narragansett, RI in the Apex Predators Program where we run a cooperative marine research-tagging program for sharks.

The CSTP was initiated in 1962 by Jack Casey and is part of continuing research directed to the study of the biology of large Atlantic sharks. The program began with an initial group of less than 100 volunteers and has expanded in subsequent years to include over 6,500 volunteers distributed along the Atlantic and Gulf coast of North America and Europe.

A variety of tags have been used over the years, starting with the fin tags up to the dart tags still used today. The rototag is a two-piece, plastic cattle ear tag, which is inserted through the first dorsal fin. These tags were primarily used by NMFS biologists on small sharks during the first few years of the CSTP. The fish were brought on board, measured, tagged and released.

As the program expanded to include thousands of volunteer fishermen, the dart tag was developed to be easily and safely applied to sharks in the water. The "M" tag is composed of a stainless steel dart head, monofilament line, and a Plexiglas capsule containing a vinyl plastic legend with return instructions printed in English, Spanish, French, Japanese and Norwegian. These dart tags, in use since 1965, are implanted in the back musculature near the base of the first dorsal fin. More recently, the roto tags and a Hallprint tag have been used on a limited basis for use on small sharks in the nursery areas.

Numbered tags are sent to volunteer participants on self-addressed return post cards for recording tagging information (date, location, gear, size and sex of shark), along with a tagging needle, tagging instructions, and an Anglers Guide to Sharks and current management information. When a previously tagged shark is re-caught, information similar to that obtained at tagging is requested from the recapturer. Initially, a $5.00 reward was sent as an incentive for returning tags; since 1988, a hat with an embroidered logo has been used.

Between 1962-2003, more than 180,000 sharks of 52 species have been tagged and more than 10,000 sharks of 33 species have been recaptured. Maximum time at liberty is 27.8 years for a sandbar shark and longest distance traveled is 3,740 nm for a blue shark that was tagged off the Northeast US coast and recaptured south of Equator.

The number of sharks tagged varies from 1 for the scoophead to 97,843 for the blue shark. Eighty-six percent of the tags are represented by eight species: blue shark, sandbar shark, tiger shark, dusky shark, shortfin mako, blacktip shark, Atlantic sharpnose shark, and scalloped hammerhead shark.

Numbers of recaptures by species range from 1 for the Greenland shark to 6,261 for the blue shark. Eighty-eight percent of the recaptures are made up of seven species: blue shark, sandbar shark, shortfin mako, tiger shark lemon shark, blacktip shark, and dusky shark. The rate of recapture ranges from 1.3% for the oceanic whitetip shark to 12% for the shortfin mako.

Anglers using rod and reel accomplish the majority of the tagging for all species combined. Biologists, fisheries observers, and commercial fishermen using primarily longlines, handlines, and nets (gill, trawl) account for the remainder. Conversely, commercial fishermen using longlines and net gear, and rod and reel anglers are responsible for the majority of the recaptures.

Following is information on the number of tags by year, number of recaptures by year and recapture percentage by year for all species combined. The annual number of fish tagged per year varies from 38 in 1962 to 9,404 in 1996 and averages 4,300 releases per year. The number of fish recaptured by year ranges from 3 in 1963 to 702 in 1999 and averages about 300 per year. Trends in number of fish tagged and recaptured in a cooperative program must be interpreted with caution because tagging effort can vary due to annual changes in fishing effort, weather conditions,

water temperature, number of participants in the CSTP, occurrence of research cruises, opening or closure of a commercial fishery, and number of tags available. The decline in the numbers tagged in recent years may be attributed to a number of these factors including decrease in the program's visibility and number of tags available, fishermen's negative attitude towards NMFS, as well as a possible decline in numbers of available fish.

Technical objectives for the CSTP include: Investigate spatial and temporal variation in the distribution and migratory patterns of coastal and pelagic Atlantic shark species at various life history stages; this is an ongoing process and we have accomplished this to various degrees for a variety of species. For instance, this slide shows blue shark recaptures covering the North Atlantic Ocean.

The second objective is: Delineate nursery and pupping areas and seasonal residence time. COASTSPAN or the Cooperative Atlantic States Shark Pupping and Nursery survey was developed to determine the location and species composition of shark nursery grounds along the US east coast and to determine the relative abundance, distribution, and migration of sharks utilizing these nursery grounds through the use of tag and recapture data. Roto and M tags are sent to COASTSPAN cooperators from coastal states including North and South Carolina, Georgia, and Florida where they conduct longline and gillnet operations to catch and tag neonate and juvenile sharks.

The APP conducts the Delaware Bay portion of the study, which is a primary nursery ground for the sandbar shark. Tag studies in this area also include acoustic telemetry work to delimit short-term movements, niche space utilization, and tidal orientation of juvenile sandbar sharks in their primary nursery area.

Other technical objectives of the CSTP include:

- Obtain individual migration and growth rates and longevity data;
- Validate and verify age determination methods;

Release and recapture data are essential for age and growth analysis in sharks. Vertebral counts can be validated through OTC and known age recaptures as well as through traditional tag recapture analysis. We have injected tagged sharks with tetracycline like this porbeagle shark shown here. We request that all recapturers return a portion of the backbone from any recaptured shark that they are retaining. They measure the fork length and remove a 6-10 inch piece of backbone, freeze it and mail it to the laboratory.

This is an example of a vertebra from an OTC injected porbeagle shark. The fish was at liberty for 3.4 years and you can see 3 plus rings on the backbone after the OTC mark. This tag recapture graph is also for the porbeagle shark and shows individual growth from tag recaptures and a growth curve fit to the data. Thus for the porbeagle shark, we have been able to validate vertebral counts through age 11 by recaptures from OTC injected fish, known age fish and verified the growth curve through tag recapture analysis of measured fish.

Another tagging objective is: Determine stock identification and the degree of mixing between stocks. The blue shark is an Atlantic wide pelagic shark species. For analysis of the tag/recapture data, we divided the North Atlantic into four geographical areas and calculated size frequencies, and sex ratios for each region. These data in combination with the within area movements, the between area movements, and the exchange between areas determined that the blue shark constitute one stock of fish in the North Atlantic.

Another objective of the CSTP is to identify fine-scale factors influencing distribution, behavior, and growth including sea surface temperature and salinity. In addition to acoustic telemetry studies on sandbar sharks in their nursery grounds, movement studies have been accomplished for porbeagle sharks in the Gulf of Maine. Tags were attached to two fish that were tracked and information on movements and depth were obtained.

Another tag type recently in use on sharks is pop off archival satellite tags, which will collect data on depth, temperature and location. We have five tags ready to go of which two were recently attached to shortfin mako sharks off the coast of Massachusetts. Data obtained shows southerly

movement to off the Delaware coast.

The next technical objective of the CSTP is to Determine survival estimates. We are beginning to accomplish this goal for two species of pelagic sharks through a collaborative program with NMFS staff and researchers from the University of Washington and University of Rhode Island.

The objectives of this research are to:

- *Construct a time series of blue and mako shark catch rates (CPUE) from research surveys*
- *Estimate migration and survival rates using data from the NMFS CSTP*
- *Develop an integrated tagging and population dynamics model for the North Atlantic for use in stock assessment*

Another study to directly measure individual survival and recovery is underway through post release survivorship research on juvenile sandbar sharks. Tagged sharks retained in experimental tanks that were subjected to angling stress recovered in less 3 hours and subsequent recaptures of these fish showed long term survival.

The final goal listed for the CSTP is to promote conservation through catch and release. This is one of the original primary goals of the program when it was started in the early 1960's by Jack Casey. Largely through his efforts and the expansion of the program and spread of information on the biology and movements of the shark species, the old adage that the only good shark is a dead shark no longer applies."

G. Shepherd: With the hindsight that you have, where should we be going from what you saw this morning?

N. Kohler: I think there are a lot of things we could do with the database that we have.

J. Hoey: You could structure your patterns of releases so you had control over that part of the experiment. With these programs, you're using opportunistic tagging. Over 40 years, you could probably show some sort of patterns of changes, cycles. For instance, there were interesting historical things to look at (mercury shut-down of shark fishing), how do we interpret variability of tagging, recapture and effort levels over time to get at estimates of fishing mortality? In this case there's a very wide area, had 20K fish tagged, never had a trans-Atlantic recapture. Then we hit a threshold, and all of a sudden started getting returns. We need to figure out some way to match that up with reporting rates and get that out of it.

J. Hoenig: It's true that when they cross international boundaries, you need recovery instructions in so many languages, you can't get posters to all the marinas. But if you put out high-reward tags that are worth $1000, word will spread. You could use archival tags to get the most out of it.

Lunch

Presentation 5: Striped Bass Program

Given by Gary Nelson of the Massachusetts Division of Marine Fisheries.

This cooperative program's primary objective is to offer an independent estimate of annual survival. We use this to compare fishing mortality estimates from our age structured modeling that we also do.

Programs take place in MA, NY, NJ, DE/PA, MD, VA, NC.

Mass captures by hook and line, NC haul seines, NJ trawl. Electroshock in Delaware river.

Returns from Maryland tagging program range from Maine to NC. They occur from Canada to the Gulf of Mexico, but south of NC, they generally don't migrate out of their native estuary.

Our MA program has recaptures from NB to Georgia.

(US Fish and Wildlife Service) USFWS maintains release/recovery database. They have available a standard data return program. MA has its own program for data recording.

USFWS offers, hats, trinkets, and $5. In MA, we get about 22% of fish returned after 5 years.

We follow an information-theoretic approach based on Kullback-Libler information theory and

Akaike's info criterion.

You identify a priori candidate models, and then look at data, weight models based on what you have. 12 possible models, based on a number of parameters.

Each model fit to data using maximum likelihood of parameters.

Bias Adjustment: The assumption is that (with Brownie model) all fish recovered are dead. This is not true, so Smith applied a bias adjustment.

Issues:

- Violation of assumptions – non-mixing may be an issue for striped bass in first year of release (which is a violation of assumption).
- Model selection inconsistencies: depending on year reported, survival trends can change dramatically.
- In different years, different models are used, which impacts "distribution of weights". In some years, one particular model is used more than others.

P. Rago: We have this issue of deciding what is the best model – it changes often across years, and you have to question why we're seeing one sort of flip. It's probably identifying model misspecification errors in the same way that you get them with other types of modeling approaches.

J. Hoenig: The assumption being made is that an angler will catch a tagged fish and either clip off the tag and kill the fish, or clip off and release the fish. If it's not clear what happened, someone has to call to ask if it was released. As for the *ad hoc* procedure for dealing with catch and release, it's a little tortuous. There's a version of the Brownie Model that Sieber did, and the interest is based on the survival rate. To do this adjustment, you need to fit the Brownie model with a little f, and then adjust it after the fact. It met the requirements for what was needed, but not the best.

G. Shepherd: What about the fact that you might keep one fish out of five, and you're more likely to release the tagged fish for conservation reasons. Does this bias selectivity because it is tagged?

J. Hoenig: That relates to "what are we assuming about the catching process?" Assumption is that an angler will either report the tag or not. You don't have to know what the reporting rate is, but you have to assume it's the same for tags clipped and fish released vs. tags clipped and fish kept. You can guess that someone that's releasing the fish is a real conservationist, and would be more likely to report. Only way to look at that is the MRFSS data, which has data on fish released.

G. Shepherd: You have to assume there's no change in behavior of fishermen due to the tag. I'm not sure that's always the case.

Presentation 6: Herring Tagging Project

Given by Kohl Kanwit of the Maine Department of Marine Resources.

The herring fishery has changed to an offshore fishery. Stock has also changed from the last time tagging was done, which was when Georges Bank stock had collapsed. We'd like to see what's going on now that the stock seems to have recovered. If we're off on how stocks are mixing, it impacts the fishery in a real way.

Project Design:

The area is divided into special strata. Nova Scotia stock is considered separate from other stocks, so we want to see if that's true. Our areas of concern are Gulf of Maine, Georges Bank, Nova Scotia, and Southern New England.

We also have temporal strata – this is a seasonal fishery that migrates up the coast. We're focusing on summer feeding/spawning and winter stratum. They're mixing in spring and fall migration, so we focus on winter/summer.

So far we haven't touched Georges Bank – we've tagged Southern New England, Eastern GOM,

Western GOM. This presents a problem because the numbers of fish we'll have to tag is so huge – there are so many there. We're trying to tag in proportion to population.

In a day we can tag up to 3000 fish. Right now, the stock is managed as one unit. We're going to tag on Inshore GOM versus Georges, as far as where we tag in those areas it depends on where the fish are – they move so much.

Our recapture rate is very low, and a real concern. Most of our tag returns come from fish that were at large for over a month, and we've seen a real distance traveled.

Southern New England – almost all the fish tagged in SNE and then recaught went to Nova Scotia.

The herring fishery is a pumped fishery. Our reporting rate is low. We didn't go with standard tags because the likelihood of them being seen is very low. Rewards are lotteries – nothing is given for individual returns.

J. Hoeing: I'd say it's worth your while to try putting out $20 reward tags. If you don't get anything back, you haven't wasted money. If you get a lot back, you know the reward is the problem. You need to experiment with that. You've got nothing to lose by trying more.

K. Kanwit: Our biggest problem seems to be lobstermen. We're relying on lobstermen to see the tag and want to report it. Lobstermen don't bother to return it because by the time it gets to their bait bag, they think we can't possibly trace it back to where it was caught, so they don't return it (this is an incorrect assumption).

We're working on education right now. We have trip-level reporting for dealers, so we can trace it back with great accuracy.

They have shown tag-induced mortality in herring. We've tried cage studies, holding studies. The problem is they don't transport well.

J. Hoenig: You could hold them right where you've caught them.

Presentation 7: Atlantic Salmon Tagging Project

Given by Chris Legault of the National Marine Fisheries Service.

There's no capture of Atlantic salmon allowed in US waters, so this presentation will be different than the previous ones.

The Penobscot River program is a coordinated study between NOAA fisheries, ME Atlantic Salmon Commission, and the University of Maine.

Smolts are released at different times (marked), and intercepted at different times when still within fresh water. They can also be captured in West Greenland in the commercial catch, although this is unlikely. Then they pass through a weir when they return to Maine.

There are wild fish mixed in with the hatchery raised fish, but numerically there are far fewer of them. The return rate of released fish has been steadily declining for a number of years. Return rate now is less than 1%.

Overall, we'd like to know if we can improve the really low return rates by changing when and where the stocking occurs. We'd also like to get at growth rates and patterns, movement, population estimates (how many smolts are surviving the transition from fresh to marine conditions). We'd also like to evaluate tag retention, and tag event mortality. Also, we're using markers to help in physiology studies.

We can tag lots and lots of fish because of our hatchery program. We've tagged over 1M fish in past few years. These are visual implant elastomer tags, and we insert plastic behind the eye. We hire contractors who paint fish. We set up 8 different batches per year with ~25K fish per group [so, ~200K total/year]. At the same time as releasing marked fish, we also release ~350K unmarked fish. So we mark about 36% of hatchery fish.

Some marks are difficult to distinguish. Some fluoresce to make it easier.

Fish are traveling over 100km downriver before reaching the estuary. We do post-smolt trawl surveys in the estuary; after the Greenland trip, they must pass through adult traps on their way back up. On the way out to the estuary, they're caught in Rotary screw traps, information is collected, they are released, and they continue on their way.

Each group had equal numbers released, but there were very different return rates. It appears some release points are better than others. Some are very good at feeding small mouth bass. We're not using coated wire tags any more due to suggestions they reduce ability to find natal rivers.

Post-smolt trawl recoveries – also note differences in the post-smolt trawl returns. This is somewhat biased by sampling time – this is only out for about a months, so you can miss an early or late run of fish.

For adult recaptures, (at the Veazie Dam), early release fish seem to do much better than late. (which contradicts what we found in the river).

Bayesian Estimation of Emigration Rates

We want to try to come up with an estimate of how many smolts are actually leaving the estuary. Use priors for RST and PST catchability modified by environmental factors to estimate how many smolts survive to estuary.

G. Shepherd: Do you have any sort of "tagger effect" on survival?

C. Legault: Taggers are a pretty good group of people, there are differences in their quickness, but not their effectiveness.

P. Rago: Arnusson/Schwartz type models – have they been considered?

C. Legault: I think that's where we're going to start as a jumping off point and then build in the environmental covariates.

J. Hoenig: If you could sample Greenland catch and find what percentage have the elastomer from Penobscot, and then you go and see what's coming up the river, you have a fraction, and you multiply that by the known catch.

C. Legault: Starting with Greenland catch, we can use genetic information to show NA versus Europe. Then we can split out US and Canada genetically, then we can attribute the little US to Penobscot vs. all other rivers based on returns. Then we can estimate "OK, about 20 fish are being caught in Greenland from Penobscot, and of those, maybe one had a tag". Part of this is because catch has been severely reduced in Greenland.

Presentation 8: Atlantic Haddock Tagging Program

Given by Tom Rudolph of the Cape Cod Commercial Hook Fishermen's Association

This program is only funded "in theory". It's a very new project. It's a cooperative, region-wide effort.

We're really trying to figure out innovative ways to avoid wasting the bycatch from research trips. We'd like to try to sell that fish to fund further research.

We'll be working with the Cod Tagging infrastructure.

Rationale for the project: Haddock is a historically important species commercially, and will be even more so in future.

Movement rates were last studied in 1950's. Haddock is currently managed as two stocks: GOM and Georges. There's a need for better understanding of exchange rates. Also need to see if GB stock has eastern and western component (suggestions are that this is the case).

Importance of Closed areas in recovery: Closed Area One is known as the Haddock Zoo.

Social Goals:

It's important to overcome communication barriers over data collection and usage by developing working relationships between fishermen and scientists.

We also want to create supplemental income for fishermen, and create a formal mechanism for fishermen to contribute to science.

We'd like to acclimate fishermen to the concept of using fish sales as a means to match federal funds and augment cooperative research objectives.

Experimental Design:

We want to release 10,500 tags.

Dedicated trips will be on commercial longliners. Paid at fixed daily rate, with variation depending on how far from beach, and how many hooks are set. Hoping to tag 250 healthy haddock per trip. Will make sure all tagging is done by trained technicians because of the lower numbers we're tagging. All marketable bycatch will be sold and proceeds pooled back into program (unhealthy haddock, or haddock caught in such numbers that we can't get them back). So we'll have to use A DAS at sea.

We'll also use non-dedicated trips. Will capitalize on active commercial longlining trips, or other research programs. Will compensate at $5 per fish tagged. That may vary. All tagging will be done by trained technicians.

We're hoping to tag 7000 fish in GB, 3500 in GOM. Numbers based on survey tows that show roughly double haddock abundance on Georges Bank. Will be split between open and closed areas (not evenly split).

Data Management:

We hope to model as much as possible for what's already in place for cod.

Outreach and Returns:

We'll use same 800-number as cod tagging.

Data analysis:

Tag recovery will be analyzed to determine the probability of movement between areas.

If tag recaptures indicate movement from one stock area to another, posterior probabilities of haddock movement rates will be estimated.

This approach will provide confidence intervals for movement rates that are easily interpretable (see slide).

J. Hoey: To fish opportunistic trips outside closed areas, you don't need permits for that at all, correct?

T. Rudolph: Maybe a Letter of Acknowledgement for, say, guys holding juveniles in a live tank to tag them.

J. Hoey: We need to get together with enforcement on that. I'm talking about what you do in closed areas – we need to take away the incentives. Let's say you're in a closed area, and all you're doing is tagging fish. The exemption you'd want is to allow that fishermen can retain the bycatch [the revenue from which would go back into the program, not to the fisherman]. Are you being told you need to use A DAS for that operation?

T. Rudolph: Yes, we are starting to hear through channels that yes, you are.

J. Hoey: A DAS are going to become so valuable, A DAS are going to be cost prohibitive.

L. Singer: We've been told all the mortality is accounted for, and it's been distributed (in A DAS). More mortality through research must be attributed. There's no set-aside for research.

J. Hoey: We won't be able to afford boats any more soon. A DAS are too valuable, or will be soon. Can we compensate with catch [putting the revenue back into the program]? The target fishing mortality for all these stocks is tied to A DAS. It doesn't matter if some species are regulated and some aren't. They're all tied to those regulated stocks. And if we can't access closed areas then you lose temporal spatial coverage.

T. Rudolph: There must be a set-aside of A DAS for research. Or maybe research could factor in leasing.

J. Hoey: If we put together recommendations to management, that would be cogent for this meeting.

Summary of Day One

Paul Rago gave an overview of the day's discussions.

There were a few points that came up repeatedly:

- Design, selection of sample, sample size, appropriate levels of stratification.
- Ancillary experiments, testing assumptions, getting ways of interpreting assumptions in

light of small scale studies.

- Reward programs. John made point that the higher the overall level of reporting rates, the less you have to worry about some of these other concerns.
- Movement, and how we estimate, how do we distinguish dispersal from directive migrations.
- Need to develop a consensus on expectations for various programs. What are the long term products we can get, thinking in light of future funding, thinking of overselling versus underselling, where they fit into future management.
- We haven't talked too much today about sharing of data and its subsequent archives. Where do these data go when these programs go away? Look at the historical data that was used in YT. Could have done more if even more raw data had been archived.
- A lot of programs have a strong structure in how to determine how many tags to release in different areas. Cod has a huge variation in where they were released.

A lengthy discussion took place on this management/permitting issue. However, since the discussion raised larger issues which were outside the remit of the cod tagging workshop, the exact content of the full discussion was not captured here.

Gary S: You plan to tag over a 12 month period. So this is just to estimate movement. It seems that if you change the structure of your releases, you might be able to get both movement and exploitation rates so that it's in more of a discrete time frame.

T. Rudolph: Would that give you movement over the course of the whole year?

G. Shepherd: It could, if you have tag recoveries over the course of the whole year.

S. Tallack: Part of the reason for tagging over the whole year is to get fishermen money throughout the whole year, and keep people enthusiastic over the course of the whole year.

T. Rudolph: That's much less of a concern with this program than it was with others. I thought you would need to have releases and recaptures on both sides of the line over all seasons. If that's wrong, we can look into changing it.

J. Hoenig: I can see a distinct advantage of knowing how many fish are in each area. The way you find that out is by releasing them, when you know how many were put there.

G. Shepherd: But you can release them in discrete times as opposed to over the whole year.

J. Hoenig: But if you just do it in July, you don't know how many are there a few months later. If you do it regularly, you get regular updates on how many are there.

T. Rudolph: I catch your point that it's hard to get exploitation rate if you do it regularly.

G. Shepherd: I also think you have to structure your sample size: if you have 10K fish to release, and you have to spread it out over a certain time, you need to make sure you have an adequate cohort in each area, particularly if the exploitation rate is low.

J. Hoenig: Maybe consider two scenarios. Tag every two months, or twice a year, and look at what the data will look like, and you can evaluate them by simulation or something to see can you get what you want from each of those scenarios, and therefore which is better?

P. Rago: There's a whole spectrum of movement patterns we're trying to detect.

T. Rudolph: It was never our intention to trickle them out in every month. We were looking at roughly equal events in quarterly basis.

P. Rago: This points out the need for continuous modeling, to see what kind of precision you're likely to obtain.

P. Rago: Tomorrow we'll try to summarize strong points of each of the programs. They have different degrees of malleability.

Day Two

Keynote presentation 1: "Tagging inferences: beyond stock assessment"

Alistair Hobday, CSIRO Marine Research

I'll focus on things beyond assessment, and focus on things we can do, inferences we can do with the data.

Why tag?:

You want to understand the state of the system. It's defined by abundance of animals out there, productivity (incl. growth) of environment, and distribution (incl movement) of things in the environment. If you have these, you understand the system state, and you can decide how to manage it.

Historically, Abundance has been the focus, leading to stock assessment. But there are other things that can help you understand the system, and I argue that these are also important.

There are a range of tagging options. You need to figure out what variables you want to understand. There are a bunch of tradeoffs you must understand. Acoustic tracking is a choice, but that's only good for a period of time, and you must realize that you've already modified the fish's behavior by tagging it.

Acoustic monitoring – longer time, but perhaps dependent on animal staying there within range.

Archival: need to get the tags back, and the resolution is only plus or minus a degree. If you're looking on a scale of less than 60nm, you're in trouble.

Satellite – large tags, and very expensive, and tradeoffs in resolution for size of animals you can tag.

Technology Tradeoffs:

What will you get out of supplementary studies?

Spatial and temporal resolution is a concern, but what is the cost? What is your effective cost of putting out a tag? If you put out 1000 tags to get one back, one tag effectively costs the same as a 1000. Think about losing listening equipment (over the side by accident). What is the cost of rewards? What's the value of data per tag, per recovery, per day of data?

Tagging Mortality:

Tagging mortality is difficult to estimate, which is an issue for mortality, less so for movement and growth, unless mortality is size dependent. For movement/growth studies, you're just reducing sample size, not impacting results.

How could you estimate mortality?

Score life status (good, excellent, seagull). Also, you could compare return rates from excellent, good, and bad taggers.

You can conduct holding studies, but this isn't natural. Is the information you get really what you're after?

Satellite pop-up tags. There's a depth trigger so when it gets certain depth, you know it's survived to that depth. If it pops up early you know it's died.

Acoustic: If you detect the fish, you know it's survived. If you don't, you don't know if it's left the area or just moved away. You can detect and recapture, you can detect and not recapture, you can not detect, recaptured, or not detect, not recaptured. By understanding the percentages between these, you understand mortality.

Tag Shedding:

I didn't get the feeling people were all that concerned about this yesterday. Example from CSIRO: We've used 64 taggers and put out 98,000 tags. Frequency of fish that each tagger has used is shown. Tagging has been dominated by 10 people roughly. Look at these 10. Overall recapture rate is 8.97%. Some individuals are getting 13%, others, less than 1%. There's substantial variation in recapture rate between individuals. Double tags can get at this. When we look at shedding rate as a function of recovery rate, people with poor recapture rate have high shedding rate. High recovery rate people have low shedding rate.

It's worth doing a lot of tagging to understand the pattern. You need higher numbers to

understand these biases. If your focus is movement and growth, it's not a big deal, but if you're trying to understand mortality, it's worth doing.

S. Cadrin: Do you use double tags in your analytical model?

A. Hobday: Yes.

P. Rago: Then you have database issues to deal with.

A. Hobday: In our database, you have primary tag and secondary tag space.

Shedding rates are not instantaneous – they happen over time. If you don't have enough data, you might have to assume shedding is instantaneous.

P. Rago: Legibility issue also relates to shedding – progressive loss of readability. Also, I think that many times shedding is function of wound not healing, which is more instantaneous.

A. Hobday: We do 100% double-tagging, and think it's worthwhile.

Reporting rates – how do you get a handle on them?

Observers – you can assume it'll be 100% recovery.

Tag Seeding – you look at recapture rate of known number of tags introduced into the population.(with SBT, they're grown out in cages, and that shows us reporting rate – we seeded before they're put in cages).

Variable rewards (high versus low reward, assuming higher rewards higher recovery). But think about this – assumption you're making with your high reward is that you're reaching the asymptote, and people often assume it's $100. If you have variable rewards, low, medium, high, you can get a better idea of what the (reporting rate) curve looks like.

J. Hoenig: They did this in Florida, but the sample size was too small to figure this out.

A. Hobday: Steve, with yours you have low reward, high reward, and data storage, it's almost like this.

S. Cadrin: But data storage is also $100.

A sociological study may be better. What sorts of incentives will help people to return tags? What do people prefer? Canvas all permit holders.

A. Hobday: Also, you can look at areas where you know you'll have 100% recapture (like black sea bass).

S. Tallack: I've considered that, we currently have hats t-shirts mugs, the idea being that someone can get all three by turning in multiple tags. We've been thinking recently whether we can develop another product (a jacket, say), where they don't get anything until they give us a certain number.

A. Hobday: I don't know if a cumulative reward lets you get at this.

J. Hoenig: I see several issues here. One is that if you use money, you can study tag reporting rate. If you use products, you might boost your tag reporting rate, but how do you know what that rate is? For some models, you need to know the rate or you're dead in your tracks. Another thing is that if you did the cumulative thing, you might get zero tags from a fisherman until he gets 50. But now, what is the probability of a tag being returned? To model what the reporting rate is, it's a nightmare. I would not recommend a cumulative thing. You'll wind up getting batches.

S. Tallack: We already get batches.

J. Hoenig: Then I would argue that your rewards are not adequate.

B. Duffy: But in your case, you're not getting batches to get a reward.

S. Tallack: No, they're waiting for efficiency sake.

J. Hoenig: But if you have a reasonable reward, they might not hold them up.

J. Hoey: The recovery is going to be conditioned on the operation that's recapturing them. If I'm on a 30 day trip, the question is whether I can give you an exact date and location for each tag. Maybe by examining data in a batch and examining frequencies, maybe we can determine the degree of mixing.

J. Hoenig: OK, they might not remember exactly where they caught it on a long trip, but for

survival estimates and mortality estimates, you don't need an exact date. The problem with batch tags is that you don't have adequate incentives. Also, you're not spreading out your tags, maybe you're putting out clusters of tags. That doesn't cause bias in survival estimates, but it inflates your variance. You'll calculate a variance and think you have a nice estimate, but you really don't because your effective sample size is much smaller, being a cluster. It's a real trade off between what's convenient and feasible, and what gives you good results. There's a different reporting rate for someone who's captured one fish versus 10 fish.

J. Hoey: I wonder if we can look at the data we have, on types of vessels, etc., is there information we could get on recaptures that would impact the cluster issue (length of trip, type of vessel).

P. Rago: You want to encourage q high rate of reporting, but if they haven't had a chance to even acclimate, much less disperse, your chance of getting a cluster is high.

J. Hoenig: Spreading out the tags is particularly critical if you get high reward tags. Especially if you have a species that doesn't move much. (Snook example in Florida – you don't want people fishing for tags).

P. Rago: A lot of this is basic marketing as well, and there must be a lot of literature in marketing on how to create incentives to return things. Is there anyplace around, where companies leverage tings?

A. Hobday: I thought about incentives – where people want to participate, incentive can be really low – look at recycling. People do it, and it's not for the 5 cents, it's because there's a desire to recycle. I suspect there must be marketing examples, what sort of societal good do you need?

G. Shepherd: I would argue that the basic rewards are thank-you's, not rewards. If the hat was an incentive, you wouldn't return tags after your first hat. Varying the high reward ones is going to get you information, not varying the basic rewards. I suspect across the board for tagging programs, there's probably a reporting rate that's close to being a mean across everything, coming out of most programs. That may be good enough, as long as you're getting above a certain threshold.

J. Hoenig: I've yet to meet a fish biologist who told me they thought the reporting rate in the project is low. They all think they have outreach, and they talk to the fishermen so the reporting rate must be high. You can be shocked by how low the reporting rate is (for instance a student of mine anticipated an 80% reporting rate, but it was actually estimated to be 18% with a very small standard error. People say they'll send in the tags, and they might not. There's a lot of missing information – do they not see it, or do they not do it? Point is we don't know much about tag reporting rate.

A. Westwood: A large part of this is that we're not looking at psychology or sociology of tag returns. A lot of the guys that return tags are the same guys, regardless.

P. Rago: We've talked of heterogeneity on release side, but not on recapture side.

A. Hobday: Maybe they've had more observers, or more experience in tagging, etc.

N. Kohler: We've heard that commercial guys don't care about hats, but recreational fishermen do.

S. Cadrin: One of the best pieces of information we have is catch by permit. If we look at the permits that return tags, and then look at unaccounted for catch, we might get a very good sense of the return rate by permit, or reporting rate.

T. Rudolph: We have a very dramatic dichotomy going on between hook and line guys that participate in the program, and then the other half, sink gillnetters, the vast majority of whom don't return any tags – they don't throw them out, but they won't give them to us. We are fortunate enough to have two or three gillnetters that return 100%. We've thought of looking at the fishing effort of these guys, looking at their catch, then looking at remaining catch. Steve and Azure, you could do this, too: look at using that pattern to estimate your reporting rate, then do socio study to try to increase that rate. We might be a good guinea pig for that study.

G. Shepherd: The key is the marketing perspective. People might try to second guess it, what will happen if I return this data?

J. Hoenig: You can look at fishermen that return 100%. Hearn and Pollack looked at this in terms of observers. Say you have observers on one part of the fleet but not the others. If you can assume that your tagged fish are well mixed, then it doesn't matter where people are fishing. If you know from cooperating fishermen that they're catching say 2 tagged fish per 10K and you know what the landings are, you multiply by 2 per 10K. You can then say OK I should be getting this certain number, and if you're getting half, you know your reporting rate is 50% for the other fleet components. Cultivating fishermen is useful, but also dangerous – do you trust them?

G. Shepherd: How do you make the distinction between reporting rate and recovery or detection rate? Some may appear to have low reporting, but they're not seeing tags. If you put an observer in there that's looking for tags, you get a higher rate, but it's actually a detectability rate.

J. Hoenig: You want probability that tag will be reported given that it's caught - it combines detectability and reporting. If you're trying to improve reporting rate, you need to distinguish between the two. If you're looking only at stock assessment, it doesn't matter whether they're not seeing it or not reporting it.

P. Rago: To be a contrarian, you do have to consider it from fishermen's point of view – that's how they make lures.

S. Cadrin: One thing we've taken advantage of is color absorbency.

P. Rago: We can sort of decompose, getting a tag back shows that it's retained, fish lives, is caught and reported, no errors in reading information, no errors in recording data, there's a whole chain of custody issue. Some things you can work on to improve, others you can't.

A. Hobday: Summary: reason we went down here is rewards. Getting cumulative returns is bad because it shows your fish were clustered, your fishermen were catching them in clusters, or you weren't given good enough incentives – look at why you're getting batches back. Once you get tags back you're putting them in a database. Think about how you're going to maintain these beyond your programs. Can you incorporate your databases? Also, what about rewards? If you stop rewarding those tags, you're going to de-train all those people that have been trained to report. If you stop feedback, you're penalizing every researcher that goes after you. In Hobart, we've created an ongoing pool of money for this.

J. Hoenig: This is a matter of professional ethics or etiquette. If you put out $20 for a tag, it can impact programs elsewhere – raise expectations. You can create your own problems by being inconsistent. Above all, it's important to pay rewards when you've said you will.

A. Hobday: The challenge is how you can help yourself by looking ahead.

P. Rago: It's a broad-scale institutional commitment. Programs are interlinked. Failure to pay old cod tags will have implications across all tagging programs.

K. Kanwit: Exchange between programs is important, making sure tags are followed up. You don't just dump it off on someone else.

G. Shepherd: NMFS maintains a website that's a tag registry.

J. Hoenig: Old tagging programs sometimes provide useful information.

A. Hobday: Think about ways to keep recording information. Addresses change, telephone number might change – how can these tags be returned?

Don Clark, Canadian Department of Fisheries and Oceans: I find I get everyone's tags, regardless of the address. Now they know I'm the tag guy, they send everything to me. Most people don't even read the tag. They rip it out of the fish, they send it into one person regardless of what it says on it.

S. Tallack: We get a lot of others, and we used to log the data for the others as well, but now we can't (too many).

General ideas from the pelagic group:

You were wondering about how to get people to participate: SBT is a quota managed fishery, and we have a research quota. We have 15 tons that's allocated by the international management commission, which can give us access to closed areas. We can use sale of catch to support research, and we can give money from sale of catch to the crew. Science is a stakeholder, too. Maybe there's a way to join the table.

Rewards: we have a high turnover of rewards. Look at having a bunch of rewards – diversity good (companies that produce these things don't require high volume – look through catalogues of companies that produce a wide variety of trinket options).

Growth:

No one mentioned much yesterday if they were using growth rate at age or growth rate at size. How fast are two year olds growing compared to how they used to grow? As system state changes, you will see changes in growth rate.

There is evidence of changes in growth rate in many species.

If you can match this back to age, you can use growth rate as proxy for state of the system as well. You need to pay attention to how you're going to age the samples.

Collect otoliths. Even if you can't do anything with it, it's cheap to collect – you can always take scales. Start archiving that stuff. When it becomes important, you've got the collection.

Movement:

SBT: Currently overfished. It's at about 10% of virgin biomass. In Australia, it's worth 350M per year. See slide for basics.

Mature at about 10-11 years, live to about 40 years. We catch juveniles (age1-5). Migrate out, return next summer. At 5-6 years old, they go to southern ocean.

There was a quote in a paper in Australia where a researcher said "Basically it's very simple: the less tags you return, more fish there must be". This quote resulted in the need for seeding.

P. Rago: We've talked about simple tags, and a bit about pop-ups, satellite. There must be a middle ground there. I'm wondering if you have any experience with those.

A. Hobday: Well, with lobsters there are PIT tags, you have detectors in bottom of live well (lobsters are kept in live wells). You can put those on with regular tags, to get idea of reporting rate if you think you can get your fish scanned in some way. In situations where your animals are individually processed, there are opportunities to use smart tags, although I don't know of examples.

P. Rago: We tried coated wire tags with menhaden.

K. Kanwit: They're doing that on Pacific herring now, because it's a roe fishery, it's a smaller season. They've had some success.

A. Hobday: The issue is the power of the signal you're getting out of those tags. If you get greater signal, you can be farther away.

P. Rago: With a PIT tag, you send a signal to it and it responds.

S. Cadrin: It's important to show that a return in the second, third, fourth year, a return can lower fishing mortality rate. You can reduce slope of fishing mortality by having more recaptures. In a single year analysis, that misquote is true. But in multiple years, it's different. It's difficult to predict how any one tag is going to impact the model. By all means return the tag – better to get an accurate rate than to try to jimmy it one way or the other.

J. Hoenig: You do have some idea of when tags were put out. Earlier ones have lower numbers. All they have to do is figure out if they're early tags or late tags. I think it's a matter of time before someone figures this out. We do have a security flaw in the operating system, which might require a patch.

Data analysis tools:

Analysis versus visualization: There's effort to be spent in both of these areas, but be careful in how much you put into visualization. Often you go down the path of visualization and it'll never

help you analyze. Use your visual observations as a way to help you analyze.
Having big data sets is key to management. The cod database is an eye-opener for me.
You want to pick a data analysis tool that will let you do simulations. Simulations is a key thing, using historical data to look at what your results might look like, for instance.
But consider: Are you going to take someone else's package to analyze your data? This limits what you can do. I go with Matlab for programming analysis. It's used all over world for marine applications.
I think we can get abundance in other ways as well. I think you can get at it by looking at behavior.
A grad student of mine looked at conventional tagging data from SBT releases to look at changes in schooling behavior. The results of this were really easy to explain to stakeholders. We need to be able to explain results to stakeholders.
How do we apply things to benthic species? I'm familiar with schooling pelagics. Look at the basics of schooling.
Fish are known to preferentially school with others of similar size. If the school is mixed, this might be as a result of abundance (not enough available for all of similar size).
If you can understand behaviors over time, you can get at an index.
To get a school, if you have a large population, you'll have one cohort. If it's a smaller population, you might have two cohorts. If it's even smaller even, you might have three cohorts. We argue that you can create metrics from school structure that you can infer to be a population estimate.
If you can describe behavioral state, and your school comp changes as pop changes, these metrics can explain population.
You can look at the slope, variance, mean, maximum, etc. of a metric you use to describe a population, and then look at how it has changed over time. We did this, and we saw that as the population changed over time (SBT), its behavior changed.
Is there a way you can use information when you tag to get at this? Don't focus exclusively on recovery. Get creative with the ways you're using the tagging data. Know your species. You guys will know what will and won't work. What changes accompany a population change? "Monotonic changes are best".
Note that seasonal measurements can skew things (might be local in one season, but move a lot).

Archival tags:

You get very different movement data from archival tags. They can round out your data. There can be differences in where you're getting conventional tags, and where you're getting archival. The issue can come up when you get archival tags that are in areas that you don't get conventional. This is because fishermen go in certain areas. You might think there are no fish in an area, but it may just be that fishermen don't go there. Archivals really round out your data (just a small number of smart tags can round out your picture).

Conventional tags:

You want to make sure your deployment is really widespread, or you want to concentrate them, and see how they spread out. The middle between those is dangerous.

Movement issues:

Circular migrations: Recaptures in species having circular migrations look like no movement unless you have year-round captures. When analyzing the data look at mean distance versus time. If animals are dispersing and then returning, you'll see a parabolic distribution and then a decline in that – look at trying to get data at the time distance from tagging is highest (look for maxima).
-You can also weight your recaptures by total catch (recent, historical) to get proportions moving.
- With closed areas, lower recapture possible. Look at McGarvey (Australian Journal of Marine and Fresh Water Research).
-A suite of models for analysis – spatially explicit (*slides were shown giving various examples*)

Conventional tagging: Vector addition:

Consider vectors of movement, distance and direction.

Break into small time periods (need recaps from different time periods) Bootstrap.
Reconstruct the pathway.
Test with ancillary studies (eg, data storage tags).

P. Rago: Instead of plotting vectors from release to recapture for each time period, you could use vector addition over time, so that chronological recaptures are depicted as a sequence.

A. Hobday: This can also show you what ancillary studies you need to design to test your assumptions. A limited release of data tags in a particular area might pay off.

J. Hoenig: I like the approach, and it may work in some cases, although there are cases where it would fail miserably. Think of heterogeneous populations, like shark – males going north, females going south, and if you ignore sex, and calculate vectors, you'll think they're staying put. Your mean is something no one animal is actually doing.

If you have a bunch of recaptures that actually fall on that path, it's a far more compelling picture. To test whether this is reasonable, I would put in dots for recaptures. If none fall on the path, question it. If all do, or many do, you're more confident.
To build models for SBT, we've been tagging for 40,000 days of data. You can make simulations of movement based on these data.
SBT are also surveyed via airplanes, which is a good cross check. We can try to build a model to reproduce this. (showed movie of movement).

notes not taken for ~5 minutes

You can synthesize data to gather a conceptual sense rather than showing models.
You can test your models ability to show changes in abundance as a result of movement into an area. What would happen if I had 40% more, or 60% more?
We built a model based on movement rates, and interaction and came up with information on where and when to try to recapture. In tuna, you tag a school, it's a cluster. If you know the movements, or the exchange rates between those areas, you can estimate your mixing. We modeled low interaction and high interaction, in designing our tagging programs, you can start to figure out where to do your tagging, and when. Where and when you do your tagging, it's important to go upstream far enough so that by the time they get there, they're fully mixed.

Supplemental studies for movement:

Conventional tags give you low spatial and temporal resolution, start-end point information only.
Archival tags give you high temporal resolution, but medium horizontal spatial resolution (to get position you need light, or gradient in environment (depth, temp). They can give you fine scale vertical resolution.
Acoustic tags give you very high horizontal spatial resolution, low numbers, small area (see slide for more information).
We've used acoustic technology to resolve management issue in Australia. We track along the juveniles. Had to design a dedicated experiment to pick up two year olds that had "disappeared". Developed a listening station design, and whenever fish swims in certain area, it gets detected. We tagged fish upstream, and found animals actually were concentrated inshore.
In terms of designing supplemental studies to complement your conventional ones, you need to be really clever. You get good insight into the biology of the animal you're studying. Improve the advice you can provide to management. There may be a biological explanation for what you're seeing.

Keynote presentation 2: "Theory, and Practical Concerns, of Tagging Studies"

John Hoenig, Virginia Institute of Marine Science

Dr. Hoenig gave a brief presentation of the theory behind basic models used in fish tagging programs. Notes contain only a few points from this presentation, and focus on the discussions that took place during and after the presentation.

The logic of the Brownie model is simple: suppose you tag m animals each year. You'll get some

back year one, some year two, three, etc. The trick is to say what do these numbers mean? What do we expect to observe. If two cohorts of tagged fish are released one year apart and become well mixed into the population immediately, we would expect to get back equal fractions from each cohort in year 2 except for the fact that the first cohort has been at liberty for an extra year and has thus experienced more mortality. Thus, we should get back a lower proportion from cohort 1 in year 2 than from cohort 2 in year 2.

It's important to note that you have to tag for two years to get an estimate of survival in year one (Brownie Model gives you "ancient history").

What are we assuming, and what are we not assuming? Well, you're assuming your sample is representative of population, so what you measure on tagged animals is same as what's going on with untagged. For Brownie Models, we assume no chronic tag loss, but as long as the tag loss each year is constant, it's not a problem. You're looking at ratios, as long as initial tag loss is the same each year, they'll cancel each other out (one in numerator, one in denominator).

You're also assuming fates of tagged fish are independent. If you tag schools of fish instead of individuals, you can still get estimates of survival, etc, but you'll underestimate variance.

Lastly, you're assuming homogeneous survival and recovery rates within each year. You need to look at groups. If there are differences between groups, you can assume that there are differential survival rates between groups.

What you're **not** assuming: Tag reporting rate is 100%, tag reporting rate is known, tag reporting rate is constant, fishing and/or natural mortality is constant, natural mortality is known.

Testing for non-mixing:

A modest amount of non-mixing can cause a huge bias. How do you detect if non-mixing is a problem? You can fit a model assuming mixing, and fit another model assuming non-mixing. Then you get an answer of "yes there's non- mixing" or no, but this isn't good enough.

An alternative approach is to look at the geographic distribution of your tag returns. If they're well-mixed, they should have same spatial distribution. Look at individual areas, newly tagged versus previously tagged, and amount coming back across all areas and all years, to see if you're getting mixing (chi square on a contingency table).

T. Rudolph: this tells you if you have mixing between tagged animals from year one and year two: how do you tell if you have mixing between tagged and animals as a whole?

J. Hoenig: That's difficult. If there's mixing, then the fraction of the catch that has tags should be constant over space.

A. Westwood: What if you have a short tagging period, say in the spring. What if there's a period of adjustment the fish has to undergo (due to altered behavior), so they're not really mixing, because they've been tagged. Is that a problem?

J. Hoenig: It is, and there are two ways to deal with it: a quick and dirty way, and a theoretically more pleasing way. Quick: with striped bass, they tag in the spring, and if they get a recapture within 7 days, they discard it. As long as your numbers are small, and your reporting rate is high, this is OK. You subtract the number discarded from consideration in that time from those caught, as well as those marked. (If reporting rate is low, you'll subtract too few from those marked).

Nonmixing models: you pay a big penalty in terms of your precision when you do this. You're best off tagging at as many locations as you can to spread them out over the entire stock area, and tag in proportion to population density in each location. I say let your sampling gear determine what you tag: tag a certain percentage of all the fish you have in each area. This means you're assuming the gear is performing equally well. Steve's way (going by survey) uses more information. It might be more precise, but somewhat biased.

G. Shepherd: What if your fish are clustered?

J. Hoenig: There really is no good solution, unless you have tons of cash. If you get clusters of fish, you don't know how many clusters are in each area, you don't know how many fish are in

each cluster. In that case, I'd be mistrustful of a model that assumes mixing.

Estimating gear selectivity: a test for unequal catchability.

G. Nelson: How does time at large affect this model?

J. Hoenig: You want to use recaptures over as limited a period of time as possible.

Interesting cod experiment: We looked at historical data (while in Newfoundland). Noticed that in olden days, larger fish could outswim the trawl, and they can no longer do that. (Resulted in a dome shaped selectivity pattern – big ones don't get caught). This has interesting implications for management, although it wasn't noticed or shared in time to have an impact.

So you want to know how well tagged fish are surviving – are you causing tag-induced mortality? How can you determine this? You catch a bunch of fish, you apply a numbered tag, and you note condition on release (1 to 4, which is good to very poor).

Then, look at ratios of fish you get back relative to numbers tagged.

If you're willing to make the assumption that all fish in category 1 survived, then instead of saying relative to one, you can say, that a certain percent (if 95% of condition two survive, you can say 95% rather than 95% relative to condition one).

You can then look at percentage that should have survived, and multiply by number of tagged, and you can estimate how many died relative to those released. That suggests the fishery has a certain percent mortality (bycatch mortality).

This is simple, but you need to have very stringent specifications of what each condition is, etc. Movement isn't a problem, as long as all categories move equally.

P. Rago: You could develop a composite model that had these kinds of factors embedded in it. Do you favor that approach, or prefer to do this offline?

(This is addressed more fully in the Yellowtail Summary).

A. Hobday: You're also assuming here that damage has been done due to handling the animal. You can also build in a way to look at the condition of each animal in nature.

J. Hoenig: you can use this to determine survivability of any segment. You can look at females versus males, etc.

Changes in mortality rate with age: the "chop" option. As you're looking at data over time, the data from later years are different – they're older animals. You can chop off older animals. We hoped this would work with red drum, which behave differently with age (move out of the estuary), but it didn't work.

So far, all we've looked at are Brownie Models. But we'd like to get more from the data.

The key is to interpret theta, which depends upon tag retention, whether or not you're going to kill the fish when you tag it, what the exploitation rate is, and the tag reporting rate.

Closed areas: If you're using a Brownie Model and you're going to have open and closed areas, all you're going to get is the survival rate in the open areas. If you have complete mixing (between open and closed), you're going to get a survival rate that's somewhere between the survival rate in the open area and an exact mix of open and closed.

If we're going to estimate exploitation rate and we know what the overall reporting rate is, it's ok to tag in closed areas, but you must know both.

If you know your phi and you know your lamda, then you can interpret your recovery. To get the probability that a fish doesn't die when you tag it and does not shed its tag initially, there are things you can do.

To get reporting rate:

Look at your patterns from observers compared to the overall catch – you look at a percentage of the catch, compare to overall catch, multiply out reporting rate. You know Australians are catching two tags for every 1000 bluefin tuna, and you know the Japanese aren't reporting. You can figure out what they should be reporting, compare to what they actually are reporting, and you can get the Japanese reporting rate. If you have a bunch of segments, you can use all of these (you have to assume mixing). Having observers on more than one fleet allows you to check the

assumption that you have complete mixing.

Twice a year tagging. If you have a short fishery, and you tag both before and after the fishery, you've isolated a period of the year with no fishing mortality, so you can figure out natural mortality and fishing mortality.

When your tag reporting rate is high, you don't have to know what it actually is. Results are not sensitive to it when it's high.

Rewards:

I worry that trinkets lead to satiation, which means the rate of reporting changes.

Cash rewards are good – you don't have to worry about change of rates.

If your cost of tagging is high, and reporting for standard tags is low, it's better to use high reward. Don't forget to add in all the factors of cost. You have to have some kind of idea of what kind of reporting rate you'll get for your standard tags. You have to start thinking about what kind of reporting rate you'll get, and what you want to get.

> P. Rago: Generally the government isn't bonded for exposure to an enormous recovery rate. There's no real mechanism that allows you to take that risk and put out more than you have a budget for.
>
> J. Hoenig: there is one way you can get in trouble with high reward tags: if you don't spread them out you could have a massive return of high-reward tags reflecting merely the fact that the tags are not mixed throughout the population. But, if the reason you get back so many is that the fishing mortality is much higher than you thought, i.e. the stock assessment is completely wrong, then it's a great bargain – for the cost of a few tags you've learned extremely important information about the failure of your stock assessment.
>
> S. Tallack: We determined that you must submit four pieces of information in order to be eligible for a high reward. This is a risk. But otherwise you might get no information back for high reward tags other than the tag number.
>
> J. Hoenig: I would argue that you should not require that information. High reward tags are designed for one purpose: to find out what the reporting rate is.

People have been talking about the "wait and see lotteries". I don't really like the lotteries – I don't see anyone evaluating them to see if they're good. The agency ought to have some sort of policy to see if they work.

If you want the lottery idea to boost your reporting rate, you can use the scratch and play kind of lottery. If you have variable rewards on your tags, then you're getting into the scratch and play kind of mode – provides incentive to bend down and pick up the fish. Once they have it, half the work of recovering the tag is done, so it might boost your return rate that way.

Lunch

Lottery Discussion Continued:

There are drawbacks to lotteries: You don't know how much a lottery is doing for you, you don't know what the reporting rate is, and it's a problem if you discontinue it.

Somewhere along the line, you need to figure out if it's helping you or not.

Another problem is that if at the end of each year, you have one (only one lottery), you're not really giving feedback to people. You want people going into the bars, saying "I won $100", etc. That starts generating enthusiasm. Delayed gratification isn't as good to motivate as immediate gratification.

> S. Cadrin: Our fishermen said a lottery was one of the best ways to get people to return tags. When we issue a press release that we went to FISHEXPO and a congressman pulled out a tag, we get more questions about "when's your next lottery?", etc. There's a huge buzz about our lotteries. I don't know if $1K is the right number, maybe we need a survey, but I wouldn't want to discount the advantages.

J. Hoenig: Another point: if you have a variable reward program, and you want to see how response rate changes with that, it just so happens that it has an element of scratch and play built in. Is it worth bending over to pick up the fish? The element of surprise, chance, enters into it. Maybe I'm more likely to pick it up because I'm curious of how much I've won.
C. Legault: What if you use the scratch and play, and it says you get a cash reward, but they have to mail it in to see how much they get. If you tell them it's a cash reward but not how much, you're using the element of surprise to increase returns.
J. Hoenig: If you're using this to determine how the changes in rewards impact reporting, you need to tell them what the reward is.
A. Hobday: There are two things you can do with this, and you need to decide what you're after: do you want to monitor changes in reporting, or do you want to increase reporting?
D. Clark: In Newfoundland, they used $10 and $100 tags. The first year of the study, the return was 10 percent. At the end, it was 80%. The point is, if everyone knows there's a program out there, they'll send them all in. What you want to do is to get as many tags back as you can.
J. Hoenig: The reporting rate for standard tagging changes over time. And it changes if you implement a high reward tagging program. If you don't know a high reward tagging program has ended, you're protected (as long as you still pay out for them).
G. Shepherd: You see in literature about alternative rewards, or alternative methods to get return rate (mail in this postcard, sent to fishermen – if they mail it in, they've sent in a tag by proxy).
J. Hoenig: I think that's not meaningful.
A. Westwood: I'd be worried personally to be phasing out high reward tags. A lot of the work we're trying to do to improve relationships can affect it.
J. Hoenig: You're still paying them for any tags returned. Tagging intensity isn't constant, but it's still going on. There's one thing I've never heard anyone talk about: it's possible for someone to figure out a way to scam it (a technician could put a tag in his pocket), well, then you'd basically have fraud. You need to have strict control over the program.
P. Rago: Could we make some agreement that says a lottery program can be an important element of an outreach program, it is a facet that allows for a potential increase in awareness of a program and potential increase of reporting rate, but is ultimately difficult to quantify? It's an aspect that can't be necessarily embedded in a model to indicate the magnitude of its effect.
S. Tallack: My comment is more on high reward tags and your concern of how to get them out there carefully. Basically, SMAST, DMR, DFO always disperse 10% high reward tags, they're always using scientists. The other two organizations only disperse them on trips with scientists.
Plus, our database has an interesting function: if they investigate a tag, we get an e-mail that someone has investigated our that tag. If they go the next step, I get two e-mails. And we can then check for those tag numbers to see if they get reported. It gives a measure of A) how useful is the site – is it being used, and B) are they reporting it once they see if it's released.
N. Kohler: but that might reduce reporting. One incentive is to see where fish came from, and they can see that without reporting.
B. Duffy: They can't see where it was released until they fill in some information
J. Hoenig: Captains want to know where the fish are going, and if you give this information away, it removes a motivation for reporting.
S. Tallack: There are three steps: are they interested enough to go to site? Are they interested enough to fill out information to get a report for themselves? Are they interested enough to follow through and report officially. We don't get (in the unofficial page) length information, but we get some location information.

Discussion of parameters:

We get theta which gives us the u (exploitation rate), which depends on fishing and natural mortality. If you have a pulse fishery at the start of the year, natural mortality has nothing to do with fishing mortality – it all comes later. On other hand, if you have fishing and natural mortality going on all year long, you need a more complicated expression. Either way, you have two equations and two unknowns so you can solve for f and m.

If you know your phi and your lambda, you can estimate an F every year and an M every year.

S and u are unrelated in the model. Both S and u could go up from one year to the next (S survival, u exploitation rate). Normally if exploitation rate went up, s should go down. But biologically, it can happen that they both go up. If natural mortality goes down, s and u could both go up. We might want to build a model in which, if exploitation rate goes up, S goes down.

Parameter estimation: it's hard to see that all these parameters are estimable, but it's true.

We need to make some assumptions to start using these models. Some people hate the assumption that fishing and natural mortality are additive. Fisheries people use Brownie models rather than some of these land-based models because terrestrial biologists don't assume F and M are additive.

Assumption is that timing of fishing and natural mortality are known. It doesn't make much difference to track that it happens one twelfth every month. You can also assume that it all took place at once. It's remarkably insensitive to this.

You also need to assume constant M over at least two years.

F and M are not sensitive to phi lambda if phi lambda is large (reporting rate). The graphs are fairly straight until you get a really low reporting rate. The Z is even more insensitive to errors in tagging (as M goes down, F goes up).

Around 1998, we saw the natural mortality rate of striped bass go way up, and we wanted to find out why. I increased the tag reporting rate, and no matter what I did, it came out that natural mortality was really high. This showed that indeed, natural mortality had increased. It wasn't an artifact of tag reporting rate.

So then I looked at all the possible reasons that m might have gone up. One way is if the newly tagged animals are not fully mixed throughout the population. If you tag a bunch of animals in year one, but instead of an exploitation rate, they have an abnormal exploitation rate (tag boat being followed by a trawler), you get an abnormal rate. To get from the first to second year you have to say what fraction survived, which is dependent on abnormal data. The next year, they're well mixed. Things should be normal. The following year, they go through normal exploitation rate, normal natural mortality rate.

You can't get the first year mortality (nonmixed), because there's no mixing, no real fishing mortality.

Then I took the data and modified it (assumed newly tagged animals were only two thirds as likely to be caught). Created simulated data – following a year's data, fishing mortality higher – more fish to be caught because they weren't caught right off.

If you overlook nonmixing, you wind up precisely wrong. The standard error is small, even though your results are wrong. He looked at all this, to see if this was maybe why m increased in striped bass, and found that non-mixing was not the cause.

It turned out that natural mortality did indeed go up, due to (we assume) a massive outbreak of a bacterial infection (mycobacteriosis).

> P. Rago: This points out an important issue of model non-specification. You have two or more plausible candidate models to describe the data. There are several approaches (AIC for example) to determine the best model.

You prove by counterexample that if you use a model that assumes mixing when it's not there, you get biased and precise results (I might have mixed this up – I'm not sure this happens if you assume non-mixing and there is, or if you assume mixing and there isn't).

One thing about the striped bass dataset was that in the beginning, people didn't accept the

estimates. How could Z be increasing? It can't be. F must be small, how could Z be large? One of the ways the data became respectable was that by going from Brownie Model to instantaneous model, we reduced the number of parameters. With Brownie model, we had 22 parameters. For 15 years of data, we had 22 parameters. With instantaneous, u's are linked to the S's, so you have one f for every year, and however many ms you wanted, so you brought parameters down, which smoothed things out.

With instantaneous rate, you're making a lot of assumptions. The reason I was saying you could do that, was that in the stock assessment that was being done, people were making those assumptions anyway. If you're making all those assumptions anyway, you might as well use it. You can choose how small your segments are (M for one year, M for first five years, etc.).

What could cause big changes in mortality? For 1991, we had a whole row of negative residuals (mortality). What could cause all three programs (tagging programs) to have something that appears like a bad tagger? I don't really know why all three programs had that. Something very screwy happened. One possibility is that all three used the same tags. If for example, Floy tag had a bunch of lousy tags, that would explain why all three programs didn't get many tag returns back that year.

Caveat: check your tags – (he told a story of one third of someone's tags pulling apart, just before they were due to fly to Belize for the tagging project).

G. Shepherd: In examining the sensitivity to phi lambda, and subsequently using the model to estimate M, is there any circularity in the sense that the change in the condition of the fish would affect initial tag retention and survival? If at the same time you had some change, a decrease in tag retention and survival because of decreasing condition of the fish, then it would accentuate the decline so that you'd get down in a lower part of that curve? If disease is increasing, your likelihood of catching a fish that's diseased is greater.

J. Hoenig: So what you're saying is, "supposing mycobacteriosis is high, so when you tag them, the likelihood that surviving tagging goes way down, does that change my M?" Well, it would have to be a very massive change to bring it down if the philambda was low, but not if it were high. Plus, that would bring it down, and what we saw was that it went up.

G. Shepherd: How does selecting for healthy fish affect your estimate of m?

J. Hoenig: It Probably means we're underestimating it.

C. Legault: Have you looked at using a random lot for m? (estimating every year, or estimating it in lots)?

J. Hoenig: No I haven't, but I haven't really done much with this. I didn't know you could estimate for multiple for M's until recently. Three things could explain what we saw: explosion of mycobacteriosis; the population exceeded its carrying capacity (people reporting very scrawny looking fish); a big section of cool anoxic water in center of the bay that had once been a refuge became warm. The answer could be a mix of all these (warmer, so they have increased metabolism, so they need more food, so they're weak, so they're susceptible to disease).

G. Shepherd: I agree with you in the sense that in the bay, during that time period, catch has gone up. If F is steadily going down, and you're getting more and more natural mortality, wouldn't you expect that unless you're underestimating abundance, your catch is the same? If you're maintaining increased catch rate, removing proportionally more by natural mortality, then under those conditions abundance must be increasing faster than the rate of removals, yet such increases are not seen in survey indices.

J. Hoenig: I suspect that fishing mortality was so low, it was inconsequential. The natural mortality was over 0.3, and we were assuming 0.15. I think that might be what's going on although I'm not sure.

To confirm this, what I want to do is look at the tagging data for Maryland. And they also noticed mycobacteriosis in about 1997. If two different tagging programs show this, then it can't be ignored. If it doesn't show it, this might be a peculiarity to this program.

Another point: although what I say is that M is higher than people thought, most of this is just one or two ages, so I think that in fact natural mortality for 8-year-old fish is exactly what we thought it was. I suspect this is just for a few age groups. I don't mean to say that everything was wrong.

P. Rago: The take home message here is that there are a lot of potential embedded experiments within the striped bass tagging database – there are a lot of repeated experiments. If you can, consider spatially replicated systems as part of your design.

J. Hoenig: The models now are a lot more flexible than they used to be. Theory started out as simple and applicable to one or two studies. Now we're realizing that if you put the effort into it, you can build things in.

Extensions:

You can start to build a model that meets your needs. For example:

1) Strong use of effort: Everywhere you have a fishing mortality, you can replace it with a q (constant you have to estimate) times effort. In some cases, this is disastrous (recreational fishing for example, too many variables). At the other extreme, all the lobstermen use the same kind of round trap, all have same vent, etc. So he only had to estimate a q for the spring and one for the winter, I think three q's. He reduced parameters, and got much more precise estimates. He made more assumptions – what if they failed? Well, they didn't. If you know fishing effort, you can use it.

2) Catch and release. Allowing some catch and release fishing. Assume an angler catches a fish, clips off the tag, and has to decide: release or keep? Report or not?

They assumed the same reporting rate for kept and released fish (despite problems of conservation minded people being more likely to release). Then there are two types of tag returns to keep track of: those for kept fish, and those for released fish.

Ken Pollock said "Let's think of catch and release fishing as another force of mortality on the tags". Focus on the tags. A tag can be killed if the fish dies, or an angler clips off and reports it, or clips it off and doesn't report it. The tag lives only if fish is still swimming with tag in place.

Now, you're looking at kept and released fish separately. This means that when you get a bass back, you have to find out if the fish is released or killed. All these parameters relate to tags, not fish.

In some years, tag clipped and fish released is very important. If you don't consider this, you overestimate fishing mortality.

3) Multiple age classes. Age structured models. Suppose in year one I tag fish of age 7, in year 2 age 8, year 3 age 9. Some fraction of 7 year olds survive to become 8 year olds in year 2, you get things to cancel out if you do it this way. If you have ten age groups in your population, you need to do 10 tagging studies, one for each age group. Not surprisingly, no one has done this.

You can either tag all age classes, or you can tag just a few age classes.

Brownie model says that tagging one age class is useless. They're right with their model – they're not willing to assume things. But with an instantaneous rate model, you can get useful estimates due to the assumptions.

One of the downsides of just tagging one and two year-olds is that after one year, what do you know about five year olds? Nothing. You have to wait until you've built up a population of tagged five year-olds until you know anything about them. What would work well is to front load your project by starting out tagging all ages, so you have fish of all ages out there, and as time goes on, you could cut back on the number of age groups you have to tag.

Embedded studies: What do I think people could do?

A lot of people should look at gear selectivity by looking at the relative size of returns by sectors.

You also might want to measure relative survival of fish in different conditions. Is slight damage critical or not?

You could evaluate angler hooking mortality.

You could also measure the effect of taggers. Not necessarily to crucify someone, but to try to find out if there are effects of taggers, and what's causing it. You could also make up experiments – bare hands versus cotton gloves, etc.

Summary of Day Two

Paul Rago gave an overview of the day, and led a discussion of important points that had been covered in day two and/or should be covered in day three:

P. Rago: One of the omitted items that we didn't address yet is the idea of using the tag rates to estimate a migration parameter. We didn't touch on that enough – what is the magnitude of flux from area A to B in these models? Do we have the data sufficient to support that aspect?

S. Cadrin: Say we do everything right, at the end of the day we have a survival estimate. How then do we deliver that in context of other estimates?

J. Hoenig: If you're estimating exploitation rate, you can get estimate of abundance.

S. Cadrin: As an effort tuner, or as an absolute scalar?

J. Hoenig: If you come up with a really good tagging model, the first thing you'll be hit with is: "well, how does it compare to the VPA?" The way to get the tagging model accepted is to say "the VPA is lousy for estimating natural mortality rate. You need to impose some structure on the VPA by specifying selectives – how about you look at how the tagging model can provide these parameters…." Now you're starting to marry the two approaches together. If they look similar, and you're getting them accepted, then you can basically have a VPA likelihood and a tagging likelihood and you're using all the information. But with the VPA you never know variances for some things. With tagging, you assume it's a multinomial, which means variances are very small. If you're trying to combine different sources of information, one of your sources is going to get all the weight unless you manually fix it. People don't know how to weight them.

D. Clark: The cod and yellowtail assessments that I use, they're both so riddled with uncertainty, they couldn't help but be helped by this stuff. We do need to integrate these at some point.

P. Rago: I think it needs to be more than just developing these as a tuning index to a set of data, because that is again easily done in terms of creating another time series to add into the sum of squares or likelihood, but it may not properly reflect weighting or importance of information, and you end up applying weighting factors in VPA's to create importance, but it's arbitrary.

K. Kanwit: I'm interested in hearing more about exchange rates and inter mixing, especially on a seasonal basis.

S. Cadrin: How do you integrate movement information into our resource monitoring and management? In some cases, say for cod, there's going to be some movement, and we manage as if there weren't. What's the best use of this information? Is it purely descriptive, or is there a way that we can account for it?

P. Rago: although all of these studies are designed to provide evidence of movement, if we can't, what do we need to develop that aspect?

D. Clark: From a management perspective, what I need to tell them is: are there enough fish moving out of the Bay of Fundy and getting caught somewhere else, that it invalidates the information I'm giving (estimating that it's not mixing)? How much movement is going on is only important if a lot of them are getting caught. It doesn't matter how many fish I tag in the Bay of Fundy move out in the Canadian side in the winter – you can't fish there. If they go out there and come back, it doesn't affect my estimate of F. But if they go into area 2 or another area that's open, it's a problem.

Can we determine what portion of our data are unreliable? There are some data that are impossible. So with that, there are others that we think are implausible because they don't fit

our expectations. I've tried tracking those down. I had someone call on every fish that was "off". Was it the fisherman, or was it a plant worker? Was the boat even there that day, or was it two months later and they forgot where they'd gotten it? In some cases, it's impossible. Is there a way, short of phoning up everyone, is there some way of trying to estimate what portion of our tag returns might be incorrect?

J. Hoenig: People will do dastardly things, especially if it's a NMFS tag.

S. Cadrin: The danger is we might throw out things that we think are fake. Look at that yellowtail on Fippenies. I would have thrown that out, but it turned out to be true.

J. Hoenig: If it's a real phenomenon, you'd hope it would get replicated.

G. Shepherd: Sometimes it's helpful to quantify or put some quality control parameter on the data. If you get a tag reported, that alone is useful information – it's been removed from the system. But if we get location data that varies a lot – "west of Cape May", it's good enough for some analysis, but not if you're looking for fine-scale stuff. I'd be reluctant to throw out data.

A. Westwood: Alistair spoke yesterday about having a responsibility to carrying on different tagging projects: it would be interesting to brainstorm putting part of funds toward a residual funds bank account.

A. Hobday: Whatever is left over, don't roll it back.

S. Tallack: We need to discuss using A vs B day funds.

J. Hoey: I'll get this report to the people that can do something with it. If I go forward and say "I think this is a really good idea", I need background where people that are really doing this can say that what they're doing can be generalized and used to address a variety of issues. I need justification for your programs. If tagging is a fundamental tagging research tool, it has to have a fundamental long-term budget.

J. Hoenig: If you carry on projects, you must have three aspects 1) legacy pay outs of rewards 2) archival of data 3) management of data.

J. Hoey: Northeast cooperative research funds came from disaster relief funds. We have industry based surveys, study fleet, and tagging. What I need is documentation that says here are the things that we see as priorities that we'd like to see done in 05 for work we might want to see in 06 and 07. The budget cycles are set in a way that you need to plan in advance. Otherwise we're going to live off the crumbs forever. We'll start 07 and 08 budgets at the end of this year.

G Shepherd: We need to look at archiving data that's collected in such a way that 20 years from now it will still be useful. I inherited some great tagging data on bluefish. But these were all keypunch cards, and I don't have a reader.

Day Three

Paul Rago gave an introduction to day three, and discussed what he thought was important to accomplish during the day:

This is a very useful day. A lot of this energy will dissipate once we leave, and we should capture as much as possible. We have a number of topics we want to go through today (shows outline) – I just wrote down his headers:

Program Specific Reviews:

- Develop Recommendations and List of Followup Tasks.
- Exp Design, Reward Programs, Ancillary Experiments, Modeling and Model Misspecification, Movement, Identify Tools (software, diagnostics, graphics for information), Identify Technology.
- We'd like to develop a collective sense of recommendations regarding some of the key themes. This will be a reiteration of what we did yesterday. Where do we go in respect

to modeling and movement, and can we improve the tools we have to analyze data?

Important Tasks:

- Review efficacy of tag lottery programs via literature and recent experience.
- Continue and improve coordination among tagging groups in Northeast.
- Develop long term institutional commitment for long-term storage and availability of data.
- Review existing software for tagging analysis, what might be modified to make them more fisheries specific.

At this point, the principal investigators for yellowtail, black seabass, and cod gave brief presentations, in which they identified the three most important questions/issues for each of their program that had either been addressed already, or that they would like to be addressed:

Program Review 1: Yellowtail flounder – Steve Cadrin

Action Items for Yellowtail: Field protocols, modeling, database issues, and outreach. We think we have what we need, but we'd love to go back and add to these, and also people from other programs may want to put these on their own list as well. These were the four categories things fell into in going over our notes.

Field protocols:

It seems obvious that we need to look at and update our geographic distribution. We used 1998-2002 for our distribution, and we should update that to dist. Our 05 releases.

We need to evaluate having a high value tag with a different color. I guess as long as it's at least as visible as our lottery tags, we can use it to get a sense of our report rate.

We need to double tag more: I think it's worthwhile.

P. Rago: Do you need to determine a double-tag mortality study?

S. Cadrin: That's why we were thinking of maybe not using 100%, where these Peterson disks are possibly going to have a big impact on fish, we need to think of the repercussions.

We also need to think more about how to release data storage tags. We need more hypothesis testing, maybe put them in areas where we have a question about how yellowtail are behaving. It may not represent population in general, but it will maybe teach us, answer questions.

We should evaluate the use of wet cotton gloves. We need to evaluate – is it worth doing?

Modeling:

The same boats tend to return tags. It came about from discussions that maybe we can use that information – take landings from those boats in ratio to total landings for all boats, to get at reporting rate. There is information for us to look at for reporting rate.

John recommended we calculate odds ratio of excellent and good return rates. We can do this for yellowtail, that'll give us some insight into mortality for fish.

Need to look at processes equation – we need to explore sensitivity of assumption (assumption of movement before mortality).

Database:

Our data is not publicly available right now.

A. Hobday: How did you avoid that?

S. Cadrin: We have a much smaller group of taggers. We have two players, Cod has 20.

The cod tagging program uses data envelopes: our SMAST people often return data in these envelopes. We should tailor this to our needs to have all our fields on this envelope as well.

If we're going to use vessels to come up with reporting rate, the vessel name is important (not a priority now).

J. Hoey: You need Coast Guard information, as the names change – you can link that with other databases to get you owner information, etc.

S. Tallack: You need permit number.

T. Rudolph: if you have both, you can go from one to the other on an agency website.

We thought the substandard key was really useful from the cod tagging database. Maybe we should add a substandard filter.

Reporting method may give us information (phone, mail, intermediate contact). That could help us know where we should put our outreach (should we mail pre-stamped envelopes? Update phone information?).

We need more keypunching personnel. We want to get this information out as soon as possible. Management meetings come up and want to see the data. We need to be more proactive and get this entered.

Outreach:

Bilingual letters would be good (we have bilingual posters).

P. Rago: A thought to keep in mind: are there advantages of using datamodel for cod and applying it to other tagged programs (keep that in mind)? The relational data model, the data entry protocol, the crap detectors, etc. Is that an appropriate thing to think about, or is it a matter of scale? We should maybe talk about that this afternoon.

Expert Feedback on Yellowtail flounder tagging:

Alistair Hobday's comments:

Experimentally, I thought your design was really sound. As for updating your reward, it's easy to do, but I'm not sure it's meaningful.

I think it's very important to have a different color high reward tag.

Getting representative numbers but having only one tag is not useful. Saturate an area to answer key questions.

With shedding, if you're worried about double-tagging being an issue, you could use two different tags, one less invasive than the disk. Your other mark could be much more subtle.

S. Cadrin: I'm assuming 100% retention with these tags because they're beefy.

A. Hobday: You used historical data to explore what model outcomes might be. I think you could look at different scenarios, and examine whether or not you'd come up with what you need.

Stratifying your data recovery: Between fish condition, tagging from scientists via fishermen bagging (no there was something where you were getting information from three classes)>

S. Cadrin: Yes, fishermen , processors or observers. Yes – that would give you a sense of reporting rate (these were three categories of recaptures).

J. Hoenig: If it slips through fishermen it gets to fish house. It's sequential.

A. Hobday: But you could look at fishermen vs. observers. As for the vector models, I'm excited to see what you come up with in those areas.

John Hoenig comments:

1) Strategy for data storage tag releases: You said you wanted to switch from random locations to locations that test particular hypotheses. Clearly, if you have no hypothesis you want to test, this isn't a good way to go.

Clearly, if you release tags at random, you can ask the question: what fraction of fish move from closed area to another. You have a representative sample of the population, you can watch where it moves. If you do hypothesis testing, you don't get an answer to the overall parameter.

A. Hobday: I think you're trying to attack the movement question with standard tags. But if you're interested in movement with data storage tags, you can design tests. Look at movement where you have a difference in depth – they have to move through an easily identifiable area (for data storage).

You're looking at "representativeness" versus "hypothesis testing".

The issue is recapture. You're dealing with expensive tags. If you put them in a known area,

and beef up outreach, you can get them back.

2) You said something about comparing high reward with lottery tags. All your standard tags are lottery tags. That raises an interesting question. You could have three tags: standard (cap or trinket), lottery (trinket,+ lottery), and high reward tags. That way you could examine how much the lottery increases the reporting rate. The downside is that it's complicated to recognize different kinds of tags. If it's too complicated it might just be a mess.

S. Cadrin: We have a third year, and we haven't purchased any high reward tags yet, so we have the opportunity to restructure as necessary.

J. Hoenig: If you found out something about effectiveness of lotteries, people all over the world would want to know about it.

3) You talked about getting at tag reporting rate by comparing rates of return among vessels. That's intriguing, but it's got subtleties. If your tagged fish aren't mixed throughout the population, some boats will report more simply because they caught more tags. One way around that is to look at rate of return of tags that have been at liberty for at least six months. Now you could do something.

A. Hobday: If you see a change in return rate, that should tell you something about mixing in the area as well.

S. Cadrin: Yes, there's a lot of information there.

J. Hoenig: In theory you can start to get at it, but a lot of things change over time (behavior, movement, grounds, etc). If you do this, you could look at raw rates of return for other vessels, but you need to look at amount of fish – you need to normalize by tags per ton.

4) It would be great to identify *a priori* boats where you know you'll have 100% reporting (observer on board). Otherwise you're biasing things toward lucky people that happened to catch more tags. If you only assume top returners are just honest, you'll inflate the estimate of catch per ton, and compare to numbers that are biased high.

S. Cadrin: There's a probability of capture that's implicit in this. Paul suggested a Poisson distribution of tags per ton, and to make a cutoff somewhere.

P. Rago: Maybe a generalized linear model, using Poisson. The biggest danger is overinterpreting. You have to consider that these are rare events. There's a chance that some vessels just don't encounter tags. Formalize the structure to get the underlying factors.

S. Cadrin: But I like the thought of (Alistair's) using this to look at mixing. What we could do is see the dropoff rate of tags per ton for Dave Goethel to get at mixing.

A. Hobday: One dropoff is the fact that he's catching a lot (dropoff of amount of tags he's pulled out, thereby removed from the system), the other line is from mixing.

J. Hoenig: I don't think it'll be easy. I think you're better off starting at getting the tag reporting rate by catch per fisherman.

A. Westwood: Currently there's a ten percent mandatory observer coverage. Can we use this?

S. Cadrin: That's how I took John's suggestion. That's something we'd assume a 100% reporting rate from. Just as for Dave Goethel. The difference between these and other boats becomes your reporting rate.

J. Hoenig: You can test the assumption of mixing by seeing variability among observers (the 100% folks – if there's variation, it may be due to mixing).

D. Clark: You should get a list of Canadian vessels and plants and make sure they're getting outreach.

S. Cadrin: Heath Stone is good with this. One thing we need to do is to make the 800# accessible to Canadians (it's not right now).

D. Clark: I think you have to test the assumption that you can assume mixing after a certain period of time. I think you need to test first before you assume. With cod, I haven't seen this.

A. Westwood: In the first year, tagging on Georges, it was 90% females, and this year it's more

equal. And I don't know if that's something we could test. It would be interesting to know how they mix by sex.

S. Cadrin: Yellowtail is notoriously clustered, females one area, males other. We need to worry about fine-scale differences.

J. Hoey: An overarching thing is this idea of clustered releases. We've mentioned it, but I don't know if it's received the attention it might deserve. One comparison between yellowtail and cod that could be helpful is to look at patterns of return rates. One of Shelly's slides showed they got a lot from processing plants in Canada, but not in the US. Is there a way to look at international return rates across species?

K. Kanwit: We had to put our posters in Spanish because of processors. There are a lot of Spanish speakers at the plants.

Program Review 2: Black sea bass – Gary Shepherd

Our field work is done. We've had three years of releases, there's no money left, so we're done. However we do have a number of archival storage tags that we could release at will. In the past, we've tried to find a place to release them, but now we need to make a concentrated design focus to release where we get the most information. It's been our experience that in southern areas there's limited migration. In the north, the range of conditions they'll cover is greater, therefore we'll get better information about what they're doing by releasing there.

Tag loss: This fall we initiated double-tagging experiments, so hopefully we'll get information on double-tagging, tag loss.

We've tagged down to NC/VA area. There are some ideas from fishermen south of that (there's a southern stock) that they actually move north and south around Cape Hatteras in the winter. We might want to consider tagging south of Cape Hatteras.

Model considerations:

There do seem to be regional differences in movement – you could almost make the argument that there are several stocks within one management area. In considering regional differences, we ponder over the best way to define where the splits are. Is there some sort of multivariate analysis to see if we can identify discrete groups based on movement?

Once we have movement from vector analysis, how do we incorporate that into models to get something from it? We know where they move, but OK, what do we do with it?

Mixing/non mixing:

We're faced with this mixing/non mixing problem, and closed area consideration: we have areas of releases in which there's limited exploitation compared to other areas where there's a lot: we need to consider this in modeling.

Black seabass go from a non-mixed release (cluster) to an offshore migration. At some point they're mixed, but depending on the level of site fidelity, you might get back to the non-mixed condition you were at when you released them. So how do you deal with this in characterizing mixing? And maybe we should look at local movements in addition to long-distance migrations.

We're the only program that's done a coastwide tag release of seabass. There are other localized tagging programs (e.g. NJ and VA). In both cases they've used T-bar tags. Can we incorporate these into our own study? Can we use tag information from other programs? I'm hopeful given John's discussion of reporting rate [i.e. if reporting rates are above ~50% then the models are quite insensitive to the exact value], that the sea bass reporting rate is high enough that we don't have to worry. We could apply the same rate to other programs (i.e. NJ and VA) and the variation among programs would not be as critical as it would be if the reporting rate was low.

Other issues:

There's a need for increased outreach as number of tags at large decrease. I think we'll have to increase outreach because we need to keep people aware. We need to remind them the program is still ongoing.

We need to evaluate information on tagger variability. We had at least one person who was left

handed, doing tags on opposite tags.
Finally the database management. Right now we enter the data on a spreadsheet and do some SAS auditing, but there's a need for something more formal as database increases. Add fields, for instance.

A. Hobday: There is a difference on left and right handedness, weak versus strong side. This has implications on which tag will fall out (double-tagging).

A. Westwood: You're thinking of releasing more data tags: if these tags might be causing mortality, is it worth putting the rest of them out (it was commented that data tags might be causing wear, stress on animal)?

G. Shepherd: With data storage tags, we're not using them for mortality estimates, it's related to movement. If we have a higher tag-induced mortality, we want to maximize the number we get back. I'm not sure we can replicate this in the aquarium. I don't think there's any better way to put these on than the way we're doing this now.

Joshua Moser, National Marine Fisheries Service: The Data Storage Tags probably affect the movement of the fish.

P. Rago: What are the bioenergetic costs of this tag?

G. Shepherd: Potential predation. There's a light flashing on these things "eat me".

Discussion ensued: light flashes next to fish, hopefully not incredibly visible to predators.

J. Hoey: If we want to use a targeted deployment of data storage tags, would that be better to do on the northern extreme before they start migrating? We could put them out in a northern location, and see where we get them back. It would be interesting to know if they pass through certain areas to see if these (closed?) areas are impacting mortality.

G. Shepherd: In the north, we get the most contrast in the data we're getting.

J. Hoey: Would you saturate one area, or would you try to break it up distributionally?

G. Shepherd: We'd Saturate one area.

P. Rago: It might be interesting to look at recaptures by fishermen in relation to survey capture patterns. Surveys are slow motion, taken over two month period from south to north. But you might be able to deduce patterns of fishermen from (comparing these to) looking at survey captures.

A. Hobday: The repeat of the survival experiment is key, but I wasn't sure that the histological experiment was useful. Why do you care why the animal died if it means you have to re-do the experiment?

G. Shepherd: The histology thing I mentioned, that just happens because anything that dies at the aquarium is autopsied by vets. It's a free service.

Expert Feedback on Black sea bass tagging:

Alistair Hobday's comments:

Of the three species, yours is most amenable to an aquarium system.
You have a two-dimensional system. (Compared to others). With acoustic or archival tag information, you can develop some really good models and go into simulation stuff.
You think you have a break in stocks, you have Cape Hatteras as a biogeographic boundary. But you think there are breaks within that. Have a look at whether you're getting breaks in environmental signals. Are there changes in the environment that could be used to predict changes in fish behavior as well? As you get data storage tags back, you can marry with environmental data.
Whey you talked about relative mixing rates, looking at the density of data, you've got a bunch of releases. You're interested in finding out if: onshore is not mixed, offshore is mixed. You're looking at separation intervals of pairs of tags. Look: for all the possible separations (Alistair drew schematic on board, Shelly has a picture of it). You go by 10km, then you look at 20km differences. You can come up with some mean separation. In a fully mixed state, you'll see no change in the variable with distance. But if you see a difference, you can start to break out the

mixing.

J. Hoenig: I don't have anything to add on this.

S. Cadrin: I have a question: Gary said it would be desirable to get a seasonal analysis. I think I have a similar problem: I only release in one season. How would your Brownie model work if you skip a time of releases (in the triangular portion of your matrix).

J. Hoenig: well, Brownie estimates survival rate over whatever time you choose: saying a "year" is arbitrary.

S. Cadrin: We release in first, not second, then third, not fourth.

J. Hoenig: Well, you're estimating cumulative survival over first and second combined, and third and fourth combined, etc.

S. Cadrin: we would really like to get into seasonal movements, and I'm not sure we'll be able to because we only released in one season.

J. Hoenig: If you're talking about movement, not survival, you get information. It's much better if you can tag more than once during the year. It just gives you more to work with.

S. Cadrin: You lose degrees of freedom without more releases.

J. Hoenig: If you have a lot of movement going on, it makes the Brownie model more complicated because you have to worry about mixing. Movements of fish were designed by the powers that be to make our lives more difficult and interesting.

A. Westwood: What about data tags, the handful of recaptures that were at large for over a year?

S. Cadrin: I think we can descriptively study movement, but whether we can quantify exchange rates and seasonal mortality, well, I'm doubtful if we can do that without seasonal releases.

D. Clark: Can't you plot your returns on a background of landings, and then you'll have tag returns seasonally? You'll have a change in the number of tags per ton seasonally if there's a differential mortality.

S. Cadrin: We can look at seasonal patterns of landings. There is data to put into the model other than just recaptures. That will help the model along.

P. Rago: Another thing to consider in general is the issue of evidence of dispersal and interpreting that as the magnitude of transit or migration rate. We haven't really quantified the magnitude of movement here, nor have we discussed its implications for assessment. Does movement preclude single stock assessment protocol?

Program Review 3: Cod – Shelly Tallack

This is our last confirmed tagging season and it's already underway, so there are limitations on the number of modifications we can hope to implement at this stage. This said, numerous constructive comments have been made during this workshop and so I'll review some of the ideas that we can consider implementing at this point in time.

Data collection additions:

Collection of otoliths: Should we consider collecting samples for aging during tagging trips?

A. Hobday: If there is no current aging information available, you should consider collecting this data, but you can also use scales so you don't need to kill the fish. Use this as information complementary to ongoing aging studies on cod in the region. Find out first if aging information is available; if it is, this is less important. What aging studies are going on now?

D. Clark: Validating the age by taking fish where we have a reasonable estimate of age, and getting their otoliths if we know it's been in the water for three years, that'd be fun.

Collection of fin clips: We have been recommended by the Research Steering Committee to begin collecting genetic samples and to assist genetic researchers in the region by collecting fin clips during our tagging trips. This is something we need to consider.

Double-tagging: We can increase this rate to 50% or even 100% of remaining tagging efforts. Logistically, it would be easier to implement this at 100% to avoid confusion, providing we can

purchase more tags.

Spawning fish: Despite undertaking tagging at the times of year when spawning fish should be found, this program has not observed many spawning fish to date. Should we make a real attempt to get spawning fish in this final season? Should we consider delaying our remaining trips, rolling them into next year to try to tag again at a time when we're most likely to find spawning fish? The pros and cons (of winter tagging) include weather effects on fish: Fishermen have less control bringing the net up through the near-surface water column (where the pressure change is highest) in poor weather, so fish get bashed around more.

A. Hobday: At this point in the program, spawning data could be considered a bonus, but it's maybe not worth focusing just on spawning fish from this point forward.

Tagging protocol:

Glove use standardization: We should consider implementing glove use standardization, or at least, making note of whether or not each tagger uses gloves, and which type (i.e. cotton, rubber, bare hands etc.).

A. Hobday: The importance of wearing gloves can depend on how a fish is caught: if you're taking out a hook, you need to really squeeze the fish – it sounds trivial, but you can affect the animal this way.

Kevin Kelly, Maine Department of Marine Resources: The deck hands are handling fish as well, and what are they wearing (gloves or no)?

S. Cadrin: What are we trying to do with gloves? Is it scale loss? If so, I'm not concerned with Yellowtail. Scale loss is not a problem.

S. Tallack: By recording what people are wearing, we might be able to begin monitoring for any effects in cod.

J. Hoenig: If you want to look at differences, you could design a study to do this, but I suggest that before you do this, you do some power calculations. Use your common sense to see what is most likely to work, and standardize on that. I don't think it's the highest priority to figure this out (are rubber gloves better/worse than cotton), other than the scale loss issue.

J. Hoey: Putting fish in holding tanks might be a good way to spread disease.

P. Rago: Aspects of standardization should be reviewed across programs.

D. Clark: We tried bringing cod and haddock back to the lab – haddock are very susceptible to stress. Cod are not.

Database modifications: (All dependent on whether sufficient funds remain)

Fate of fish: It has been proposed that for recaptures which get re-released, we should be noting whether the cod was re-released with or without its tag. We already do this in the comments field, but it was suggested that this is insufficient and that instead the "Fish Fate" drop-down list in the database should be modified to include additional criteria, e.g. re-released with tag, and re-released without tag.

Sub-standard data: Recapture information for Tag #, Date, Fish length and Location can currently be categorized as "sub-standard" data when necessary, i.e. if the data has been estimated in any way, or the physical tag has not been returned. This tool has been commended during this workshop, with the only additional recommendation being that we should consider further rating our sub-standard data (e.g. into 2-3 levels of sub-standardness).

A. Hobday: Your need to break this down depends on the amount of sub-standard data. Maybe you can just remove sub-standard data, or maybe you need to see what of it you can save.

Additional error checks: We could re-visit strengthening the automatic error checks for e.g. distance traveled, Fish length and Date.

B. Duffy: Our initial assumption was that original releases would be entered before the recaptures. We had to do a pretty complicated check to make sure things worked the right way.

Data analysis:

Since we are only at the start of our data analysis phase, there are a number of components that we need to address. Specifically, recommendations concern:

Gear selectivity for recaptures: this is something we should assess

Tag recapture sampling trips: Should we try to schedule sampling trips in closed areas to see if fish are still there or not? The tagging trips do also record recaptures, so those which are targeting closed areas are in effect doing this anyway. Maybe this is sufficient?

G. Shepherd: I would think if you're using data for estimating exploitation, you should make note of the trips where the intent was to collect tags.

B. Neal: In some areas, there's significant recreational effort despite there being limited or no commercial effort.

Batch tag reporting: We need to assess this further re: quality of data – if people report tags in batches, does it affect the quality of data they include?

Reporting rate: We need to look into this in detail to see how it varies by region, gear type etc.

Outreach effectiveness:

This program has put a great deal of effort into outreach to date, but we need to check whether it's working and we need to reiterate to program partners the need for face to face outreach with the industry.

Incentives: We may need to re-address the incentives offered and the lottery procedure, to prevent any bias in tag reporting influenced by recapture location.

Website: We should increase the number of links to other tagging programs (reciprocal effort here will improve the visibility of each program online).

Data mapping site: The tag locator tool – we should increase the amount of information needed to create a report. Right now, they need give only date and capture location.

Solicited feedback points:

1) Spatial distribution of tags: The design of this program was not as statistically rigorous as e.g. the Yellowtail or Black sea bass studies - we didn't specify cap limits of how many tags to put where. If analysis shows that the number of tags released in some areas is too low based on historical biomass estimates, should we focus our remaining tagging effort on these areas, or continue to tag throughout the areas?

J. Hoenig: It depends on what you want. If you're interested in movement, it doesn't really matter. If you're trying to get mortality estimates, it would have been nice to get self-weighting. If you didn't get that from the beginning, I don't think you can address it now. It's an interesting question: can you modify a tagging program? From a theoretical point of view, that would be a nice research project.

BR Break: missed some conversation…

S. Cadrin: The general look of release sites looked very similar to catch data. Steve Murawski has looked at logbook data, it may be worth talking to him to see distribution of catch data. Talking to him may help evaluate areas that you might want to add in, or beef up, etc. On the other end, for the releases, in Joe Hunt's program, they weighted their recaptures by local fishing effort. I think it's important to do that: if a fish moves to a low-effort area, it should be "weighted up", and those moving to high effort areas should be "weighted down". I think it's a clever way to avoid over-weighting high effort areas.

J. Hoenig: Two things: are you estimating mortality rates, or investigating migration? As far as I know, no one has thought of how to deal with weighting for mortality. As for movement, you should express the density of fish in recaptured areas. Take the number of recaptures, and divide it by fishing effort in the areas, which I think you can get from VMS. Express the number of tags you're getting back per 100 hours of fishing in an area.

D. Clark: My concern is that it assumes equal effort. I'd prefer to weight by landings.

J. Hoenig: This would be better if you had it geographically referenced.

D. Clark: If I have certain amount of effort on Georges, and a similar amount in the Gulf of Maine, the areas available for fishing will be quite different. I would assume with the same number of fish, the catch rate will be much higher on Georges.
P. Rago: "What is effort?" is always a huge question.
J. Hoenig: This is a good discussion, and I think it's not appropriate to express recaptures per ton landed, it's better to express by amount of fishing effort. If I tag at A, and I get back 10 from the east, and 30 from west, you don't really know anything – how much effort was there in each area? Catch rate is an expression of abundance of fish. I'll grant you CPUE is not terribly well coupled to density of fish in an area, but at least there's a connection. Not so with landings.
D. Clark: How do you account for probability of capture? You use landings or effort as a proxy for fishing mortality, depending on what you have and what you need.
J. Hoenig: what I'm talking about is if 10 go east, 30 go West, what really happened. It may be that more went east than went west, but you got more back from the west, simply because there was more fishing going on. You have to do some sort of standardization for that, because catch isn't representing what you want it to represent. It's representing abundance and effort combined. Suppose in the East there's only good habitat in the summer. Nothing is resident there. Some go there for the summer to feed. In west, they're always there. When fish go west, they're diluted by what else is there. Catch of tagged fish per landed ton goes way down. You go east, and they all moved in there – you're getting only your tagged fish. Point is the density of what's there anyway, you don't want this to dilute your impressions of what's going on.
K. Kelly: Where would this effort data be? VTR's? [Vessel Trip Reports]
P. Rago: There's vessel monitoring data that provides effort measures for a subset of the fleet. And now, there are huge numbers of observers on trips. The general issue of linking all this data is important.
B. Neal: If anyone is causing this problem it's Kevin and I, in not getting enough tags out close to shore. I think it's fair to say, though, that I don't know of a single successful trip in close to shore this year or last year. There is no catch inside those yellow lines (close to shore). No one is catching any fish up there. We can't use this data to interpret mortality. The numbers are so low.
J. Hoey: The granularity of the landings, temporally and spatially, means you can't distinguish where that is in that stat zone. Then, observer patterns have changed, so it's tricky to deal with. I think this is an area that'll take a lot of work to look at these patterns to try to evaluate what's the more efficient weighting scheme to use. Catch rates based on VTRs are not going to be the same as observer observations. This will require a lot of work across programs. Maybe look at all areas: see what's appropriate for what methods. Cashes is not appropriate for draggers. It's in the DMR area, and DMR is using draggers, even though it's not appropriate for that area.
C. Legault: Currently there are two management areas (GB, GOM). Do you foresee this data being used to change that?
S. Tallack: I hope it'll be useful enough to have some impact, whether or not it's a change will depend on what the data tells us. This is another huge motivation for GB guys not to report tags. Their limits are higher right now, so they would want to not report. We're aware of this. Tom is fairly confident that there are two or three gillnet vessels that are indeed reporting tags. We talked on the first day about incorporating them into our estimation of tag returns?
D. Clark: Differences in return rates by release area is a way we can address this. An area where people aren't returning tags should show up with much lower tag return rate. Assuming there was some rationale for management to begin with, you can look at this.
Continued discussion of motivations for southern cod fishermen (GB) not to return tags.

2) Ancillary study ideas: At the Program's Year 2 six-month update meeting, the program

partners re-visited ideas for ancillary studies and then prioritized these [slide showing order of priority: 1) tagging in closed areas, 2) tag-mortality study & data-storage tagging & pulse tagging; 3) tagging of spawning aggregations & historic data; 4) acoustic/telemetry studies & habitat trawl/video survey; 4) Morphometric sex ID and Genetic studies]. We already do tag in closed areas, so I'd like to focus this discussion on tag-induced mortality estimates. We debated initiating an experiment for this at our End of Year 1 meeting, but with the sheer number of variables for this Program, it was decided that if funds were available, they would be best spent on a high-reward tagging study (implemented in April 2004). My question is what is the most efficient way of us doing this now? Do we try to design an experiment, or do we look at the data and derive it that way?

J. Hoenig: I don't see why the tag induced mortality estimate is seen as so problematic. I think you can get some cod, tag them, and put them in a cage, lower them to the bottom, come back in a few days, and see what's happening.

S. Tallack: But we have five tagging organizations with different geographical conditions, weather, depth, gear type, and numerous taggers. Trying to replicate things, fish caught same day, released same day, you need five experiments, in each season, and the funding needs would be prohibitive.

A. Hobday: You can't afford to do a multivariable experiment like that.

J. Hoenig: Pick 5 or 10 taggers at random, have them put a few cages out, 4 or 5 fish in each, and if zero shed their tag, and zero die, I wouldn't be terribly concerned. You probably don't have massive tag-induced mortality or shedding. If you do see mortality or shedding, then you have to break it down. If you don't see shedding or mortality, it's probably not a problem.

N. Kohler: We have cod in an aquarium – you could use them to investigate.

J. Hoenig: I would suggest you get a new guy with no gloves, in hot temps, etc. If you don't have a problem there, you don't have a problem anywhere, and you don't need to worry about it.

K. Kanwit: You would want to get at what happens after handling also. If you're only talking about a couple of days, you could even put them in a flooded tank on a boat, and where the volume is so high, you can keep them a few days. Longer than a couple of days gets difficult.

S. Tallack: There are a number of reasons we haven't attempted this yet. This program has so many variables (location, season, gear, etc.), getting at this would require a very sophisticated experiment. But the feedback I'm getting here today is to keep it simple.

J. Hoenig: The only reason you'd have to include all those variables is if you want to look at the effect of all those variables. But if you don't have a problem at all, why worry about it?

T. Rudolph: But you still have to do different seasons and temperatures.

J. Hoenig: Or just pick the worst: if you have no problem then, you have no problem.

G. Shepherd: I'm reminded to maintain control fish that aren't tagged so you can look at tag induced mortality as well as handling.

P. Rago: You've got a dual effect no matter what.

J. Hoenig: If none die or shed, you don't need controls.

D. Clark: There's already literature on this. For tagging itself, the effect is negligible. Fish farm studies tag every fish with no deleterious effect. They bring fish up five times a year to weigh them. There have been comparisons of tag return rates by gear type, and what you find is that you get a higher return rate from longliners than from otter trawl. Clearly there's at least some mortality for otter trawl. We also have estimates for season and depth.

A. Hobday: You guys that are doing cod are also going to do haddock, and any thinking you do now will help you on that. You might choose to design an experiment for haddock ahead of time.

The collection of genetic data was not considered a priority at the Year 2 six-month update meeting, yet the NRCTP has been requested to collect fin clips during the final tagging season for

genetics researchers in the region. There is not much time left to do this, since we are in our final season. There is a chance that some organizations (DMR, Island Institute) may have their contracts extended to allow tagging into next year, but the tagging focus will likely be Downeast Maine and other areas where it has been hard to tag fish to date.

J. Hoenig: If you do a favor for someone else and start collecting data, be careful of what it is you're collecting. If you only collect in marginal habitat, then someone can infer a large percentage of cod come from these areas; the data is vulnerable to misinterpretation. Only those who design the study should execute, (and fund) it. This program is not designed for a genetic study.

S. Cadrin: I just returned from a trip where we reviewed an EU redfish genetic program that was conducted "piggy-backed" on another study, and it was rejected because it wasn't designed to test the stock structure hypotheses. You need to be careful of the study design. Unless you're taking a certain percentage of all catch, it can be biased.

Historical data: We've also talked about trying to incorporate historical data into the NRCTP database and compare the findings. Data exists from recent studies (UNH, etc.), and also more distant ones (1920s tag releases).

J. Hoey: These are generally appropriated funds, we need to focus on getting things done as promised. There may be other venues for us to go into to obtain funds to recover historical data, but I don't want to pay for it out of the funds we have to support our ongoing cooperative research. I'd rather keep us focused on making sure our original program objectives are met. We haven't tapped into the higher level of sources for funding. If you can identify blocks of data that are in danger of disappearing, you can get money by competition.

J. Hoey: Well, what about institutional sharing of data? There have been some institutional age-based barriers (over my dead body will you get my data). It's better now – people are more willing to share.

My final question is this: GMRI has funding for a year three, but it's only to maintain the database, manage the data, undertake analysis and respond to tag returns. From the discussions over the previous two days, it seems that a third year of tagging is really necessary. If the Program was to secure more money, what should we do with it? Should we be pushing for more tagging, and if so what type? Should we look at focused study, or keep tagging the way we have been doing?

A. Hobday: I think you're further behind in your analyses than Sea Bass or Yellowtail. I think smart tagging now would be premature. You need more analyses before doing that.

J. Hoenig: I think what you should do in your third year depends on how good your crystal ball is. Possibilities I see are somehow cobbling together a third year of tagging, and then a fourth, and then a fifth, and then eventually a long-term program, and continuity of the time series is important. Another possibility is that the third year is it, in which case I'm not sure what the point is. You might want to just look at tag-induced mortality, or whatever. Another possibility is that you take a hiatus, and then some time down the road you start again. But then you can't join it up with original tagging data – you have to start again. Then you'll wish you'd settled the best way to determine tag reporting rate, and tag induced mortality rate. If you think you can do this indefinitely, then try to keep the data coming on so you don't wreck your time series. If you think there's a hiatus, then focus on answering questions as best you can.

J. Hoey: I think the important point to reflect is that we've identified that as a pilot part of this thing, there are questions that have bubbled to the top as most important: tag induced mortality and reporting rate. It's appropriate to say "if those things get addressed, and if we have reliable estimates, then this could be a very valuable time series tool to compare against other sources of data".

J. Hoenig: But only if you maintain the continuity.

J. Hoey: Yes, so Ken and I have to go to Steering Committee and let them know this. I can

argue that we should use the money we have this year to add to the programs (tagging programs) that we're doing now. We need to articulate it, and ask "Are in fact tag induced mortality and reporting rate the two critical areas?"

J. Hoenig: if you think there's a chance to do this long-term, then keep the data coming. I don't think tag-induced mortality and reporting rate have bubbled to the top. I think movement is important – are they really going here, why aren't they going here? That would require you to very quickly look at the movement data, standardize it by effort in the area, and ask if there are things that cropped up that need to be investigated further.

Lunch

Expert Feedback on Cod tagging:

John Hoenig's comments:

I would note a couple of important things:

1) in the data collection part, I think you were saying what I wanted to hear: in essence I think the fate of the fish has to be explicit (adding category fish released with tag in place), and you don't want people to confuse that with "fish was killed". I think this'll be important for any program with catch and release going on.

2) A discussion of the analysis of movement data: It's one thing to plot the movements, but to be quantitative, we need to look at movement in catch of tagged fish per unit of effort in that area. If you want to look at how many tagged fish went to an area, you have to multiply that by size of the area. That applies to all species.

Alistair Hobday's comments:

I think the most important issues are double-tagging and aging the animals (otoliths would kill the fish, if you go for scales, that's easy). From our experience, about 100 otoliths or scales in the size range for each of the areas you're considering would be good.

I'd be down on looking at spawning fish – you need to design the program differently otherwise. Don't re-design to cover that.

At the moment in the database, you have a comment field, and that included a little bit of the fate (seagull, floater, etc). There were also comments that related to what happened ("sub-groups"). At the moment, these "subgroups" are in the comment field. Now the fate field will have three things John just mentioned (released with tag, released no tag, etc) and you will need to work as quickly as you can to get these comments into fields.

You should look at these fields blind – relative scoring of good, bad, excellent (look at "seagull" "hit side of boat", etc., to see how these relate to recapture).

You implemented high reward at end of first year. Now, you could do the sociological thing that Steve was talking about. Call people that participated in year one, and ask if they heard about the high reward (test the penetration).

General comments on cod tagging:

J. Hoenig: On "fate of fish", in shark project we have a lot of guys who will recapture an animal, and then send a note telling us they caught it, but it's released with the tag in it. Others, the tag is taken out, and another tag is put in. Others, it's taken off, nothing put back.

S. Tallack: What should we be saying in our outreach? Should we tell people not to re-release a fish with the old tag in it?

A. Hobday: If the likelihood of the tag being re-caught is minimal, then it's best to cut the tag off. It depends on the sample size, the number of times a fish is likely to be caught or the likelihood of it getting caught at all. To make sure to make the best of "unusual" sightings, it's best to have the tag in your hand.

J. Hoenig: It depends on species, nature of reward, details of the program. In general, though, I

think it's best to clip off tags.

G. Shepherd: In seabass, we only require getting the tag back for the $100 tags. How do you deal with people who call in tags, but don't send the tag in? What's the way to respond to tag calls (trinkets)?

J. Hoenig: If they don't send it in, call them to remind them to send it in. If they lost it, still reward them.

G. Shepherd: How do you weight these data?

J. Hoenig: It depends on the use. For mortality, I'd include it. For movement, if they tell me something unlikely, I might need to see it.

Summary of Day Three: Overarching Issues (led by Paul Rago)

Key future tasks:

- To review efficacy of tag lottery programs via literature and recent experience.
- To continue and improve coordination among tagging groups in Northeast.
- An institutional commitment for long-term storage and availability of data.
- To review existing software for tagging analysis.
- Can we look at optimization packages for multinomial models? What about ones where we're trying to integrate oceanographic data? Database considerations: how do we create datasets that support application of alternative models?

A. Hobday: If we get coordination and a group going, there will be an availability of data issue that people will want to know about. What are the data sharing arrangements? For example, I might have a commitment to make data available, but I want to have the first crack at it.

J. Hoey: In the HQ database, we took landings from every coastal state, and until that state told us we could release it, it wasn't released. You need to have professional understanding and courtesies. If you're receiving funding from feds, you have right for first scientific publication, but you also have an obligation to get the data out there. We are attempting to coordinate language in the grants that says this. People won't get funding from NMFS if we don't get data back.

A. Hobday: You put it on a database, and only the person in charge can see it for a certain period of time, and after that, it's open. I like this idea.

P. Rago: Many of these programs are sold on the idea that they will contribute to current management. Almost by definition, they have to be used quickly.

P. Rago: Do we want a recommendation in our report directly related to this, and to suggest a mechanism for doing that?

A. Hobday: I say yes.

J. Hoenig: Someone has to be there to pay out rewards, etc. Someone has to be available to make data available when requested.

B. Duffy: Right now, anyone can download various views of the data on the cod tagging database. But Administrators have greater powers.

G. Shepherd: A lot of locations these guys are taking us to with seabass are "secret locations". These captains don't want anyone to know the areas in which these fish are released or recaptured. This is a big issue we need to be particularly sensitive to. We had to say that only I would see the lat long information, and everything else would be generalized.

K. Kanwit: Maybe we could give information to another entity (ACCSP?) for safekeeping.

J. Hoey: You're stuck with going with several institutions, or several long term contracts. You're stuck with federal, state, or interstate institutions (one that'll be around for a while). An integrated database that provides common tools, is very useful.

Experimental Design:

Steve talked about using allocation of the tags in relationship to external information. I think that would be a useful aspect. We talked about cod, relationship between effort and landings. We had

some, another principle was the double-tagging to look at shedding rate. We spent a fair bit of time on first day talking about recovery of heterogeneity, effects of clustering, using variation by fleet tags/ton; tags/effort. Using independent observers at sea.

J. Hoenig: I was recommending that you pick random stations and tag what you find there. Steve talked about historical information. I say that's fine as long as it's not out of date.

It's more critical for things that don't move around much.

Needs for all programs:

- Weblinks for all northeast programs, have a general summary.
- Incorporating fact sheets as part of that.
- Continued feedback on tags returned by other programs.
- Coordinated project to unite programs:
- Commit to ongoing tag management and recovery, through a post-hoc analysis of outreach.
- Studies of tag returns when outreach stops……. Look at decline as a function of time.
- If some program is starting to have negative implications for another one, that should be communicated as well in a constructive format.

A. Hobday: As you seek to justify "what is the umbrella that unites these programs", one suggestion is a post-hoc analysis of outreach. What's the right strategy, how many posters, t shirts, etc.? If you could know that your reporting rate was somewhere between zero and one, and you have time going along on your axis, if you had one reporting rate, and it petered off a bit after they stopped tagging, that's evidence that there was not enough outreach.. You can look at persistence, success of outreach. The opportunity of meta analysis across programs is good. Why did one program work in this way, why did the other work in another way?

And think about tagging methodology: What are the economics of tagging? What's the true cost of the information you're gathering? Make decisions on basis of that perspective rather than just saying "that tag is too expensive to put on". Look at long-term and short-term costs. It's important to have a mission-appropriate tag. Define objectives, pre-test what kind of information you're going to get.

C. Legault: It's important to do some simulations even before you put your first tag out. If nature follows our hypothesis, what will we see? Can we use that information to discover if our hypothesis is true?

S. Cadrin: Simulation will tell you whether or not you have enough years of data out there. The ability to have a flexible system for modeling pattern of observed recaptures is central to this, and to test various forms of model misspecification is an important component there.

We should investigate the formal incorporation of tagging results into stock assessment.

P. Rago: I suspect a lot of the support for models of these types is motivated on the premise that they will be able to determine flux between areas. I'm not certain that's an accurate assumption. Maybe that should be a general caveat.

J. Hoey: That will be an important one to highlight, especially for those projects that had movement as a component of their impetus.

P. Rago: Evidence of movement does not constitute evidence of flux. To make that next level of inference is still a stretch, and maybe the simulation modeling kinds of things…

A. Hobday: You should specify how things like behavior and growth are going to feed into management, and what are some realistic expectations of how quickly they could do that?

Database development:

Need to augment existing database programs to support analytical tools.

Can we do simple testing to determine where heterogeneity is likely to occur? Can we bin all the recaptures across all gear types?

We should improve standardization across programs. We need to get all the programs up to a point where transfer of information is important. Rewards and other things have implications across all programs – there are advantages of coordinating.

Analytical software: consider development of software tools that incorporate modern methods applicable to fisheries.

notes missing for ~5 minutes; discussions of having another tagging workshop underway

S. Cadrin: Give us time to do what is necessary so we can put our best foot forward in 2008.

J. Hoey: We budget for annual meetings, and I think this is important. I marked down: integration of mark-recapture models. Getting to a stage where we could then get together again. What happens when we've looked at different data. If we can put these things in longer term plans, then we give you more time to prepare.

D. Clark: I'm expected to do a benchmark next year (I started in 2001). I'd like to have some sort of "excuse", where I can say "we're going to have this meeting to figure out how to do something with this".

C. Legault: Having multiple species in one room, we don't go down one road that's unique to that one data set. Multiple datasets – fewer dead ends.

We might want to follow up on more analytical tools.

S. Cadrin: Should we provide future experts (for meetings like this) with the data for preliminary analysis? We'll have the opportunity for lead time next time, and we can ship out data and include that as part of the contract.

G. Shepherd: The objectives of the meeting should be more refined next time – analysis modeling of exploitation and so forth. I think we'll get to the point where we'll maybe diverge a little bit. Might want to be a little bit more refined.

P. Rago: But you don't want to get too refined – you might miss things – maybe the spatial process matters, and if you think it doesn't, you'll maybe miss that.

J. Hoey: I'd like to make sure that we "kick the tires" and evaluate some of the nuances for the species that'll be evaluated in 2008. I'd like for these (meetings) to be useful for that.

J. Hoenig: What you should do next in terms of outside experts and workshops depends on interests – what do you want to do?

Annex 2: Bibliography – references on the Workshop CD, plus additional suggestions.

Prepared by: *Dr. Paul Rago, Northeast Fisheries Science Center*
Dr. Steve Cadrin, Northeast Fisheries Science Center
Dr. Shelly Tallack, Gulf of Maine Research Institute

A CD containing a variety of core tagging references of relevance to this workshop was distributed to all attendees at the start of the meeting. The references (primarily PDF files) were organized within the following folders: Brownie et al 85; fw663 (Colorado State University course notes); Growth; LargeStudies; Migration; Processes and Telemetry; ProgramMark; ProgramSurph; and Reviews.

In addition, two Microsoft Word documents were added, each with lists of additional recommendations: "VariousLinks.doc" lists relevant websites and online course notes, while "Some references on tagging models.doc", contains literature recommended by Dr. John Hoenig.

The bibliography below includes all references from the CD, but also includes literature which was recommended by Dr. Alistair Hobday after the meeting for its relevance to discussions which had taken place; these references (*) are not on the CD.

Please note that all references should be cited appropriately when used.

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A Workshop to Review and Evaluate the Design and Utility of Mark-recapture Projects in the Northeast US

October 19-21, 2004
Nonantum Resort, Kennebunkport, Maine

Goals: To provide a forum for reviewing the capabilities and limitations of available mark-recapture models in the context of ongoing or future tagging activities in the Northeast.

Objectives: Review state-of-the-art models available for testing mark-recapture project hypotheses.
Review and critique three current mark-recapture projects in the Northeast (Atlantic cod, black sea bass and yellowtail founder) and provide advice on experimental design, field protocols, model selection, database development and ancillary parameters.

Background:

Cooperative tagging projects in the northeast include a variety of target species (Atlantic cod, yellowtail flounder, black sea bass, striped bass, Atlantic haddock, herring, halibut, pelagic and large coastal sharks, etc.) and program objectives. Several programs have been ongoing for many years, while others were developed more recently and are focused on answering questions of particular interest for groundfish management. All of these programs would benefit from a review of the theory and analytical details of the state-of-the art models available for testing project hypotheses. This workshop will provide an opportunity for current tagging programs to develop timely feedback in terms of technical direction for project planning.

The workshop will include invited international experts on various aspects of tagging programs, as well as the principle investigators and participants in Northeast tagging programs. Keynote speakers with specializations in movement studies and integration of tagging data into stock assessment applications will be asked to provide guidance to each of the three programs (i.e., advice on experimental design, field protocol, database development, estimating ancillary parameters). Emphasis should be on practical aspects of tagging and designing a study to successfully meet objectives.

Format:

The format of the workshop will allow for presentations and discussion panels on the technical aspects listed above, with prescriptive advice on how to structure tagging studies.

Program summaries will be prepared by field analysts and program managers of the ongoing research tagging programs prior to the meeting. These summaries will provide an overview of objectives, experimental design, methods used to date, anticipated uses of the resulting data, relationship to ongoing studies, and expected duration. The summaries will be compiled and sent to the keynote speakers in advance of the meeting. Keynote speakers will attempt to orient their initial presentations toward one or more of the ongoing studies.

Program overviews of key three species will entail a 45-minute presentation by the program manager, followed by 30 minutes of clarifying questions/open discussion (to allow experts to tailor their talks the next day to specific requirements of program).

Program overviews of additional species will be brief (10 minutes), focusing on lessons learned, things to do and things to avoid, etc.

Agenda:

Day One

8:30	Breakfast – All workshop attendees
9:15	**Introduction:** goals and objectives of workshop; agenda; schedule for the day
9:45	**Presentation:** Northeast Regional Cod Tagging Program
11:00	Break
11:30	**Presentation:** Yellowtail Flounder Cooperative Tagging Study
12:45	Lunch
1:45	**Presentation:** Cooperative Black Sea Bass Tagging Project
3:00	Break
3:15	**Presentations**: Brief presentations on other tagged species (shark, haddock, striped bass, herring and salmon).
4:45	**Summary:** Common themes/issues for further discussion; wrap-up and preview of Day Two
5:30	End of Day One
6:00	Working dinner – Organizing committee & Keynote speakers

Day Two

8:15	Breakfast
8:45	**Overview:** review of schedule for the day
9:00	**Keynote speaker:** Dr. Alistair Hobday, CSIRO Marine Research (Hobart) and University of Tasmania
10:00	Q & A for Dr. Hobday
10:45	Break
11:15	**Keynote speaker:** Dr. John Hoenig, Virginia Institute of Marine Science
12:15	Q & A for Dr. Hoenig
1:00	Lunch
2:00	**Discussion:** review list of common themes/issues identified from Day One and Two, filter and prioritize in preparation for targeted discussions on Day Three.
3:30	Break
4:00	**Discussion continued:** and plan for targeted discussions on Day Three.
5:00	End of Day Two
6:00	Dinner – All workshop attendees

Day Three

8:00	Working breakfast – Organizing committee & Keynote speakers
8:30	Breakfast – All workshop attendees
9:00	**Overview:** review of summary derived previous afternoon and schedule for the day
9:15	**Expert review and feedback:** Northeast Regional Cod Tagging Program
10:15	**Expert review and feedback:** Yellowtail Flounder Cooperative Tagging Study
11:15	Break
11:30	**Expert review and feedback:** Cooperative Black Sea Bass Tagging Project
12:30	Lunch
1:30	**Review of major points** from Day One and Day Two
3:00	Break (?)
3:15	**Wrap-up:** Final summary and next steps
5:00	End of Day Three

Annex 4: About our Keynote Speakers

Dr. John Hoenig received his BS in Natural Resource Management from Cornell University. While at the University of Rhode Island he obtained two Master's degrees (in statistics and biological oceanography), as well as his doctorate in biological oceanography, which focused on estimating mortality rates from longevity data.

He has worked in state government, as a private consultant, in the federal government of Canada, and in academia. He currently serves as a full professor of Fisheries Science at the Virginia Institute of Marine Science (part of the College of William and Mary). One of his specialties is the design and analysis of tagging studies. He has been heavily involved in research concerning the tagging of striped bass, lemon shark, and blue crabs.

He has authored or co-authored some 20 papers on the theory of tagging models in both statistics and fisheries journals.

More information may be obtained at http://www.vims.edu/fish/faculty/hoenig_j.html#res.

Dr. Alistair Hobday received his undergraduate degree in Biology from Stanford University, and his PhD in Biological Oceanography from the Scripps Institution of Oceanography. He completed post-doctoral research on white abalone, which led to its being the first marine invertebrate listed under the US Endangered Species Act. He also completed a second post-doctoral position as an NRC Fellow working on the environmental influences on marine survival of Pacific Salmon at the Pacific Fisheries Environmental Lab of the National Marine Fisheries Service.

He currently serves as the acting leader of the Pelagic Fisheries Research Group at the Commonwealth Scientific Industrial Research Organization (CSIRO) Marine Research in Hobart, Australia. His research focus is inter-disciplinary, with emphasis on environmental influences on the distribution and abundance of marine species, particularly relating to the sustainable management of Australian fishery resources, including swordfish and southern bluefin tuna (SBT). He leads the Australian Science Team in an international research program (SBT Recruitment Monitoring Program), where his projects are on the spatial distribution and movement dynamics of juvenile SBT through the use of satellite data, archival and acoustic tags and listening stations.

Dr. Hobday is also a core member of the Steering Committee for the new CMR-University of Tasmania Quantitative Marine Science PhD program that began in February 2003 (http://www.research.utas.edu.au/rhd/CSIROUTAS.htm). This program is the first natural sciences PhD in Australia with a coursework component, and caters to quantitative students in oceanography, biology, fisheries and biochemistry. He teaches in several graduate courses, including Introduction to Matlab Programming, Fisheries Science, and Ecosystem Science. Since February 2004, Dr. Hobday has held a joint appointment at the School of Zoology and is involved in undergraduate teaching (http://www.zoo.utas.edu.au/homepage.html).

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