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## Workshop discussions

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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 I provides further detail on the dialogue which took place.



## **I. Discussion on the Northeast Regional Cod Tagging Program**

*Prepared by: Dr. Shelly Tallack, Gulf of Maine Research 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 otoliths (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 otoliths 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](http://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](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.gmapping/codmapping](http://www.gmapping/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 least 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 39<sup>th</sup> 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, Massachusetts 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**

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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.