1. Review by Dr. Alistair Hobday

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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

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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

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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.