NORTHEAST CONSORTIUM
PROPOSAL COVER SHEET
2004

Project Title: **YELLOWTAIL FLOUNDER TAGGING STUDY, 2005**

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Abstract:
New England fishermen and the Northeast Fisheries Science Center request a grant of $100,000 from the Northeast Consortium for a third year and approximately 5,000 more tag releases for the yellowtail flounder tagging study. The proposal is designed to charter commercial fishing vessels to tag yellowtail flounder with conventional disc tags and data-storage tags with the objective of estimating movement among stocks areas and mortality within stock areas as well as providing growth observations. The tagging study was designed to address the major uncertainties in the Cape Cod-Gulf of Maine, Georges Bank and southern New England-Mid Atlantic yellowtail stock assessments. Recent changes in management (e.g., more restrictive days at sea limits, and access to closed areas) will likely change fishing mortality as well as distribution and movement of yellowtail. Therefore, a third year of tag releases is proposed to monitor changes in movement and mortality, evaluating the effectiveness of groundfish management and stock status.

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Rationale

Yellowtail flounder is one of the principal resources of the northeast groundfish complex, with major fishing grounds on Georges Bank, off southern New England and off Cape Cod (Figure 1). The fishery for yellowtail is among the most productive and valuable in New England, yielding 16 million lb and $15 million in 2001 to U.S. fishermen (NMFS 2002). However, with all three stocks currently rebuilding from an overfished condition, the potential yield of yellowtail is much greater than the current yield (the estimated maximum sustainable yield from the three New England stocks is 65 million lb; NEFSC 2002, 2003).

Managing the recovery of yellowtail resources and maintaining optimum yield require precise stock assessments and accurate forecasts of the population and fishery. Although yellowtail flounder stock assessments provide valuable information for fishery management advice, several sources of uncertainty persist. This proposal was developed to complement the current programmatic data collection and analytical methods to reduce uncertainty in stock assessment and management advice for U.S. yellowtail resources.

Assessments of all three New England yellowtail stocks tend to overestimate stock size and underestimate fishing mortality, leading to considerable uncertainty in catch forecasts. The source of this apparent bias is not well known, but may result from movement among stock areas, lack of information on the effect of closed areas on population dynamics, insufficient sampling of areas closed to fishing, inaccurate age determinations, misrepresentative sampling of distributional patterns, underreported catch, or inaccurate assumptions about natural mortality (NEFSC 2002, 2003; TRAC 2003).

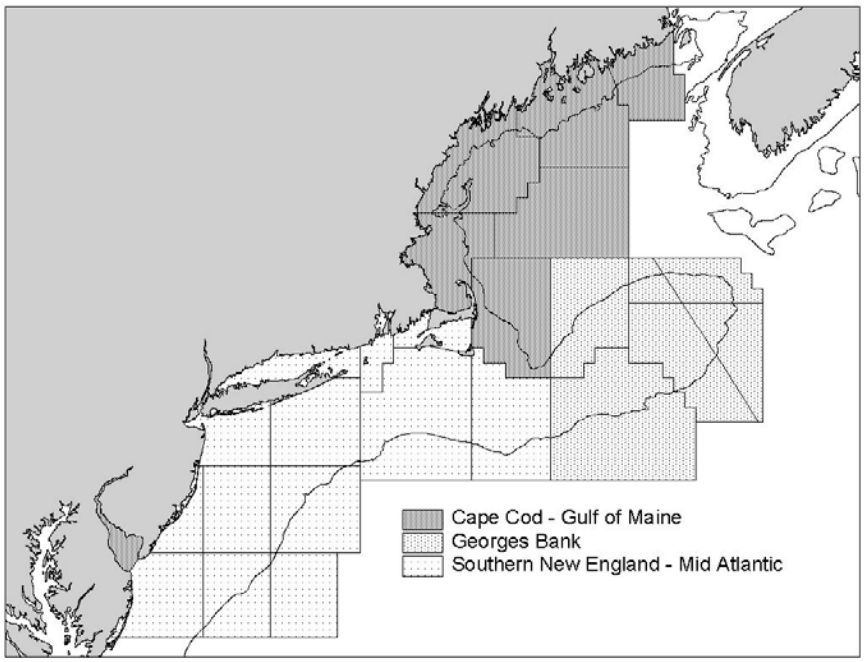

Figure 1. Yellowtail flounder management areas off the northeastern U.S.

The Georges Bank yellowtail flounder stock has demonstrated a remarkable rebuilding capacity. Management actions effectively reduced fishing mortality on the Bank since 1995, and the population responded with substantial and steady increases in biomass. The year-round closure of a large portion of U.S. yellowtail fishing grounds (closed area II) and conservative Canadian catch limits successfully limited harvests and allowed the stock to rebuild. The increasing trend in biomass and recent substantial reductions in fishing mortality can be determined with the current assessment methods, but technical problems with the assessment preclude precise estimates of fishing mortality and stock size (Stone and Legault 2003). One potential problem is that stock assessment models do not account for the closed area as a refuge for larger, older fish (e.g., 2003 tagging data indicates substantially more large yellowtail in closed area II). The Transboundary Resources Assessment Committee (TRAC 2003) recommended that a tagging study be conducted on Georges Bank and in adjacent areas to improve the understanding of yellowtail flounder distribution (especially with respect to Closed Area II), confirm age determinations, and provide an independent estimate of mortality. A similar recommendation was made by the Scientific and Statistical Committee of the New England Fishery Management Council (NEFMC 2004).

The southern New England-Mid Atlantic stock is rebuilding at a much slower rate than the Georges Bank stock, apparently because fishing mortality has not been effectively reduced, despite management restrictions like the year-round closure of the Nantucket Lightship Area since December 1994. Recent assessments of stock size have been highly uncertain (e.g., the 1999 assessment was rejected as a basis for stock projections because of inadequate sampling, Cadrin 2001). Although the stock definition of Southern New England-Mid Atlantic yellowtail was recently revised (Cadrin 2003a), information on movement of yellowtail between southern New England and Mid Atlantic areas, as well as mixing with the adjacent Cape Cod and Georges Bank resources is limited to historical studies (Royce et al. 1959, Lux 1963). The recent industry-based

survey for SNE-MA yellowtail offers a rare opportunity to locate moderate to high densities of yellowtail flounder for tagging (GMA 2002).

The status of the Cape Cod-Gulf of Maine yellowtail stock is particularly problematic for northeast groundfish management. The stock assessment has a great deal of uncertainty but suggests that recent management efforts have not effectively decreased fishing mortality (Cadrin and King 2003). Therefore, the status of the Cape Cod-Gulf of Maine yellowtail stock is a focus of groundfish management in the Gulf of Maine. The stock assessment is uniquely hampered by the relative absence of fish older than age-5 throughout the assessment and survey time series. Conventional analysis of catch at age produces extremely high mortality estimates. However, surveys indicate a relatively stable stock, suggesting that (1) mortality rates have been overestimated or (2) the stock is not a closed population. Movement of yellowtail to and from the Cape Cod grounds is not well known. Population dynamics of Cape Cod yellowtail may be greatly influenced by mixing with adjacent stocks, because the Cape Cod grounds are relatively small in comparison with Georges Bank and the Southern New England shelf (Hart and Cadrin 2004). Although data from historical tag recaptures is available (Royce et al. 1959, Lux 1963), and suggests some mixing with the southern New England and Georges Bank stocks, the studies were not explicitly designed to estimate mortality or mixing rates. These data are up to 50 years old and may not represent the current environmental or stock conditions. The likelihood of older yellowtail moving from the Cape Cod grounds to the northern Gulf of Maine is also not well known.

The yellowtail flounder tagging study was designed to address the major sources of uncertainty in yellowtail flounder assessments. The study will provide valuable information on movement, mortality and growth, thereby complementing the current state of yellowtail assessment science and improving the reliability of scientific advice for effective fishery management. Furthermore, such cooperative research is building an open working relationship between fishermen, NMFS, state and academic researchers. This proposal was developed with the interaction of fishery scientists and yellowtail fishermen. Through a series of port visits and meetings, industry leaders offered their knowledge of seasonal yellowtail distributions, fishing practices, and practical field experience, and scientists provided input on population modeling, statistical design, and technical protocols. The result is an integrated sampling and analytical plan that is both efficient in the field and technically rigorous for reliable population estimates.

Review of Previous Work

In response to the emerging importance of Cape Cod yellowtail for groundfish management, the continued poor recovery of southern New England yellowtail, and the new challenges of assessing the impact of closed areas, New England fishermen and government scientists began planning a cooperative venture to tag yellowtail in 2002. Through a series of meetings from Maine to Rhode Island, a strategy was developed and agreed upon among collaborators to tag the coast-wide resource of yellowtail flounder off New England. The NMFS Cooperative Research Partners initiative granted $100,000 to the Massachusetts Division of Marine Fisheries and the School for Marine Science and Technology to tag yellowtail in southern New England, associated with the industry-based survey being administered through Rhode Island Division of Fish and Wildlife.

In 2003, the NEFSC used Stock Assessment Improvement funds to tag yellowtail in the Gulf of Maine and on Georges Bank to complement the southern New England tagging and recent tagging by Canada Department of Fisheries and Oceans on eastern Georges Bank. In 2003, the yellowtail industry-based survey also funded tagging trips in southern New England.

In 2003, the Northeast Consortium awarded $200,000 to fund tagging in the summer of 2004, thereby expanding and improving the study. Although the cooperative yellowtail tagging study has been funded from various sources, and administered through several agencies, all collaborators agreed to cooperatively develop and adopt a single experimental design, field protocol, reporting system, rewards and outreach. Thereby, allowing for a mark-recapture study that represents all groups of yellowtail off New England which can be used to estimate movement among groups and fishing mortality within areas, as well as providing information on growth.

The cooperative tagging study used 39 days at sea in 2003 to tag nearly 10,000 yellowtail from Maine to the Mid Atlantic, approximately proportional to regional proportions of the coast-wide resource (Table 1, Figures 2 and 3). Scales were taken from 892 fish for growth analysis. In February 2004, Canada DFO double tagged approximately 200 yellowtail on eastern Georges Bank with "t-bar" tags and the cooperative study's pink disc tag. In the spring of 2004, SMAST tagged another 2,000 yellowtail in 13 days off southern New England and the Mid Atlantic. With Northeast Consortium funding, the NEFSC began tagging in June 2004 and expects to tag another 10,000 yellowtail from Maine to Georges Bank throughout the summer of 2004. In early June 2004, 1124 yellowtail were tagged in the western Gulf of Maine over five days. In late June 610 fish were tagged on Stellwagen Bank over two days. Vessels are contracted to tag more on Stellwagen Bank (2 more days in June), east of Cape Cod (1 day in July), and on Georges Bank (31 days from July to September).

Table 1. Previous and projected tagging effort for yellowtail flounder by statistical area.

Area	stat area	yellowtail resource	2003 days	2003 releases	2004 days	2004 releases		total releases	% releases
Western Gulf of Maine	513	7%	3	15	7	1,124		1,139	5%
Mass Bays	514	13%	10	2,104	4	1,220	*	3,324	15%
East of Cape Cod	521	10%	10	2,282	1	228	*	2,510	11%
Cultivator	522	3%	0.5	724	0.5	724	*	1,448	7%
Southwest Part Georges	525	12%	1.5	140	18	1,680	*	1,820	8%
Northern Edge Georges	561	1%	0.5	428	0.5	428	*	856	4%
Closed Area II	562	43%	6	2,962	12	5,924	*	8,886	40%
Lightship Area	526	3%	2	125	6	605		730	3%
southern New England	537	4%	3	431	2	249		680	3%
Mid Atlantic	613	3%	1	225	3	354		579	3%
Block Island	539	1%	1	40	2	200	*	240	1%
		101%	39	9,476	56	12,736		22,212	100%

* projected 2004 releases

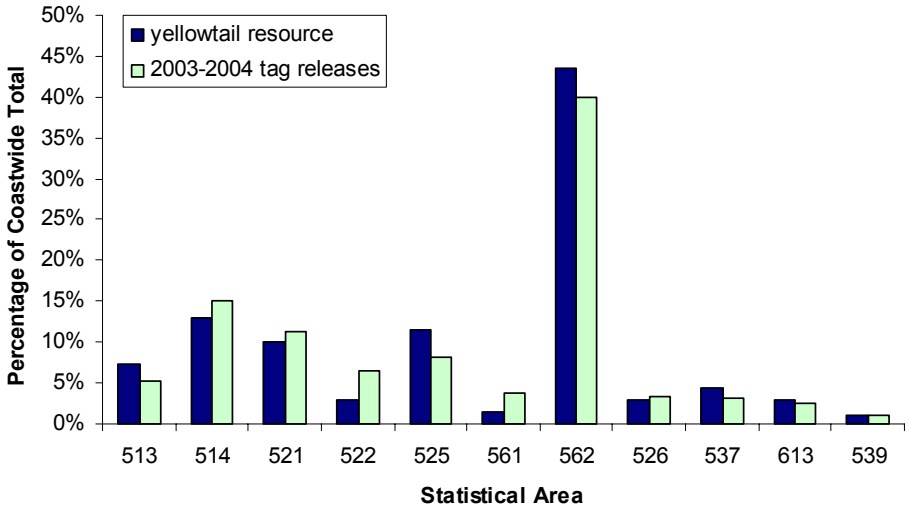

Figure 2. Proportional yellowtail tag releases and relative stock abundance (as indicated by recent NEFSC surveys) by statistical area.

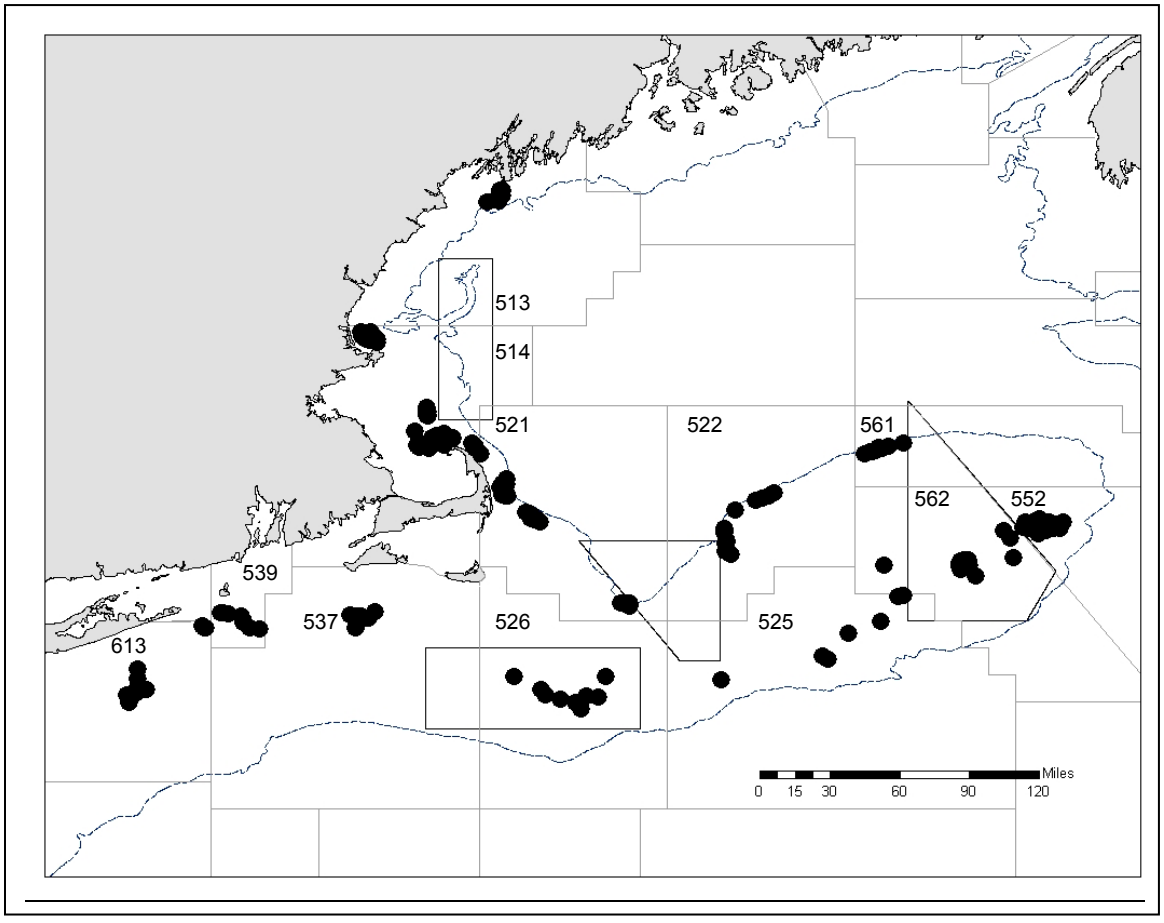

Figure 3. Locations of yellowtail tag releases in 2003.

Tag Recaptures – In January 2004, Northeast Consortium funding was used to convene a meeting of all tagging collaborators. Although it is difficult and potentially biased to make conclusions from only six months of tag recaptures, data was reviewed and examined to help form a plan for 2004 tagging (see Appendix A).

As of June 20 2004, tags from 655 recaptured fish were reported (approximately 7% of 2003 releases, with up to 350 days at large). Fishermen reported 603 recaptures (92% of all returned tags), fish dealers reported 32 tags (5%), and scientific observers reported 20 tags (3%). The average time at large was 103 days. The average distance traveled was 12 nautical miles (23 km), with a maximum distance traveled of 139 nautical miles (258 km). The relationship between time at large and distance traveled is not direct, with the maximum distance traveled in only 12 days, and some short-distance movements after nearly a year at large (Figure 4).

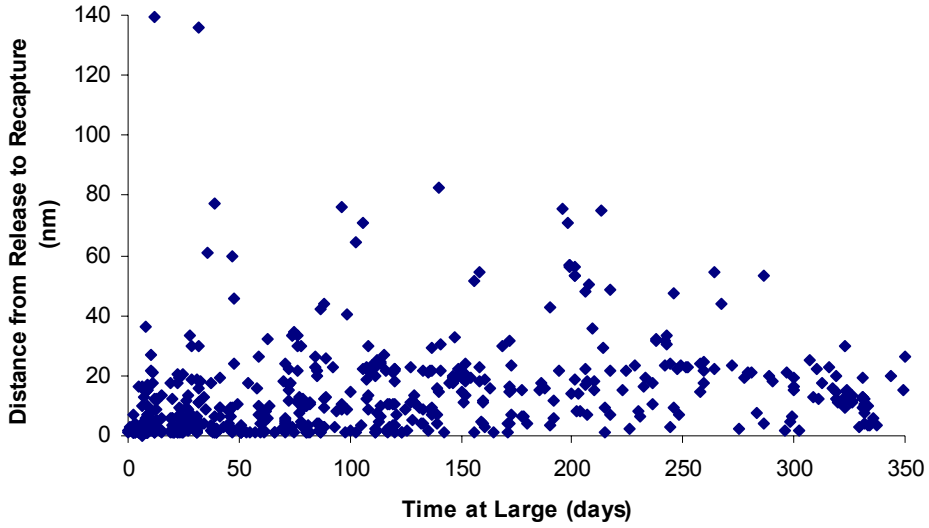

Figure 4. Distance and time at large of recaptured yellowtail.

Preliminary results indicate frequent movements within the Cape Cod and Georges Bank stock areas with a low frequency of movement between the Cape Cod grounds and Georges Bank (Figure 5). The only recapture of a yellowtail tagged in the Gulf of Maine was on Stellwagen Bank (on the Cape Cod grounds; Table 2). Nearly all of the recaptured yellowtail that were tagged on the Cape Cod grounds remained in that area (97%), with 3% moving to Georges Bank, one to Fippennies Bank (in the central Gulf of Maine) and two to Nantucket Shoals. Nearly all of the recaptured yellowtail that were tagged on Georges Bank remained in that area (98%), with 2% moving to the Cape Cod Grounds. Less than three weeks after access to area II began (June 1), 29 tags were recaptured in the area. The only recapture of a yellowtail tagged in the southern New England area was on southwestern Georges Bank.

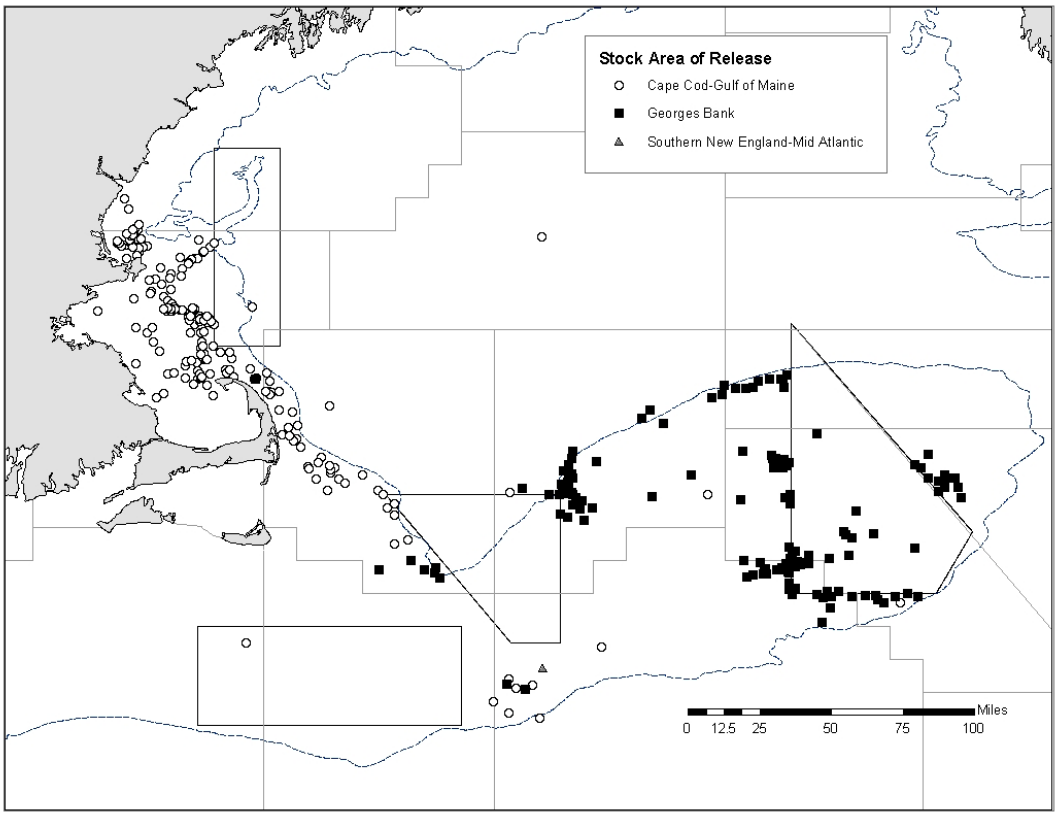

Figure 5. Locations of tagged yellowtail flounder recaptures as of June 20 2003.

Table 2. Recaptured yellowtail by area of release and area of recapture.

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

In addition to the disc tag recaptures, twelve data-storage tags have been returned, indicating distinct off-bottom movements. For example, on July 19, 2003, a 36cm (14 ½ inch) yellowtail flounder was tagged and released with a data-storage tag on the western edge of Cultivator Shoal. On September 13, 2003, the fish was recaptured on the northern edge of Georges Bank, and time, pressure and temperature data were downloaded. The semi-diurnal (i.e., twice per day) cyclical pattern of depth recordings reflects the tidal cycle on Georges Bank and indicates long periods of the fish being on the bottom, interspersed with episodes of off-bottom activity (Figure 6). The temperature records also reflect the tidal cycle, indicating that the fish was in the tidal front over the northern edge of the Bank throughout the tag deployment, with warm Bank water flooding over the slope during flood, and cold Gulf water ebbing over slope.

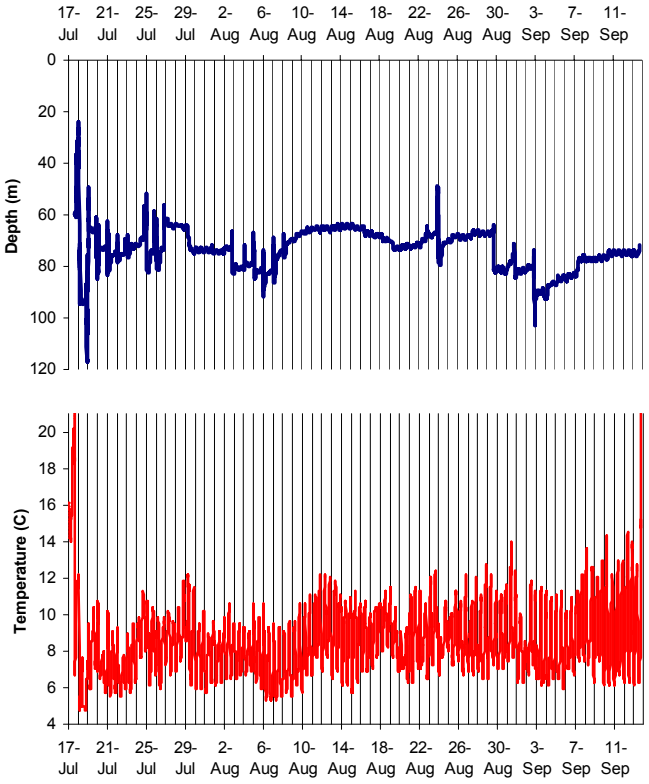

Figure 6. Depth and temperature record from electronic tag 1497.

As illustrated by all recaptured data tags to date, the pattern of changes in depth on bottom were punctuated with distinct off-bottom movements. The depth recordings from tag 1497 indicate that the fish quickly descended to 95m (52 fathoms) for less than a day, then descended again to 115m (63 fathoms), but rose 65m (36 fathoms) off the bottom to settle at a new depth of 65m. Over the next five days, the fish briefly rose off the bottom at night (between 19:00 and 02:00) to settle at a new depth. After staying at approximately 65m (36 fathoms) for two days and approximately 75m (41 fathoms) for four days, the fish moved off bottom each night over a period of six days in early August (between 19:30 and 02:30) and settled at a slightly different depth. Over the next two weeks (in mid August), the fish stayed on bottom gradually moving from 75m (41 fathoms) to 65m (36 fathoms) and back to 75m. The fish then moved to 80m (44 fathoms) and briefly to 100m (55 fathoms) with two off-bottom movements (at 21:00 and 22:00), then to 70m (38 fathoms) for the final week before capture.

Based on release location, return location, recorded depth, residence in the shelf-break tidal front, and an assumption of minimum movement per day, daily locations were approximated (Figure 7). The initial movement to deep water was probably northwest, followed by a general northeast movement along the northern edge of the Bank. This inferred trajectory is one of many that could have produced the recorded depth and temperature profile, but is the one that involves the least movement among the recorded depths. The inferred trajectory is 69 nautical miles, to travel from the release site to the recapture location, over 58 days, a straight-line distance of 49 nautical miles.

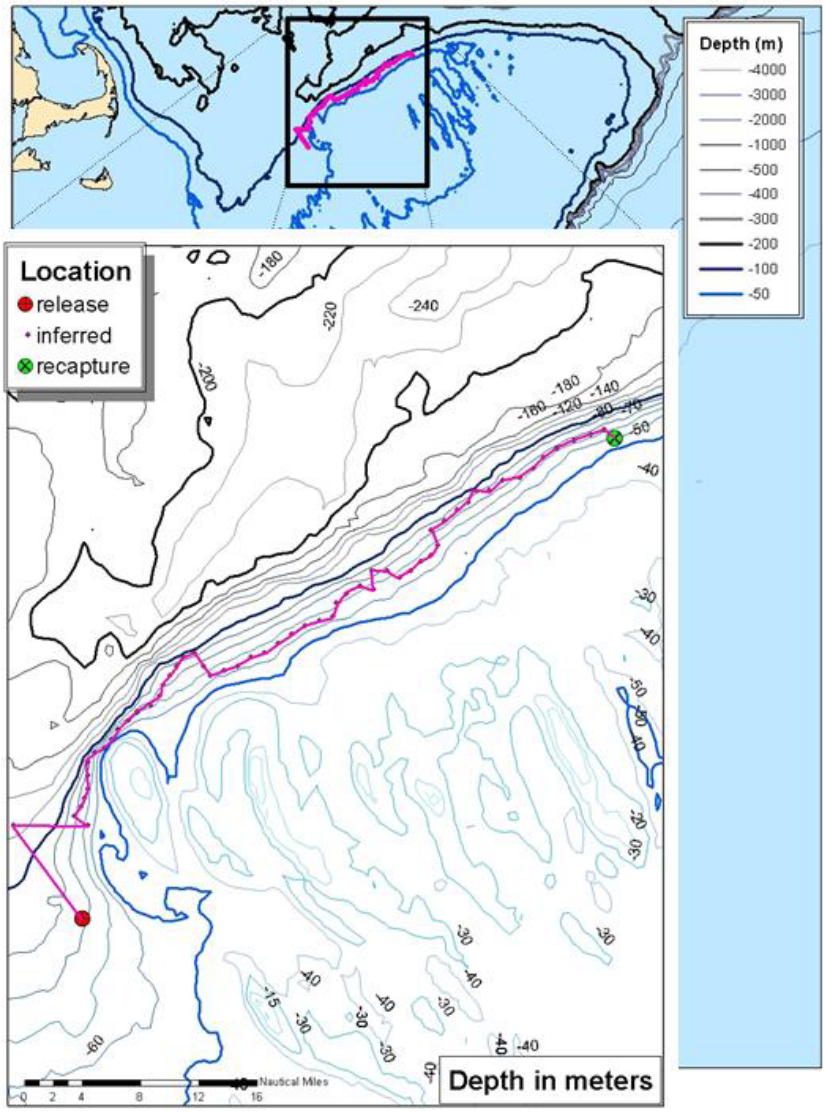

Figure 7. Inferred movement of a yellowtail flounder (tag 1497) on Georges Bank.

These results illustrate how archival tags enhance the interpretability and power of tagging studies. Until recently, the well-studied yellowtail flounder was thought to be a "sedentary" fish, feeding on epibenthic fauna and limited to relatively shallow, sandy habitats (Bigelow and Schroeder 1953, Collette and Klein-MacPhee 2002). This strict habitat preference and the discontinuous distributions of such habitats were considered to limit movement among offshore banks and shelves, thereby maintaining geographic stock structure (Royce et al. 1959, Lux 1963). The movement patterns indicated by disc tags (Figure 5) likely involves passive drift in midwater currents, similar to patterns observed for other flatfish species (e.g., North Sea plaice, Metcalfe and Arnold 1999). Therefore, the use of electronic tags reveals an important aspect of yellowtail behavior that was not apparent after decades of intense research.

Model Development – Historical data from the 1940s (Royce et al. 1959) was used to test the analytical model for current yellowtail tagging efforts. The analytical model is based on the assumption that the observed pattern of recaptures is a function of harvest rate in each area and movement among areas. If the population of tagged yellowtail is representative of the entire population, the estimates of movement and mortality will also be representative. The analytical design will relate the observed number of tag returns to a predicted number of tag returns, similar to the model developed by Brownie et al. (1993):

$$\tilde{r}_i^t = n_i^t \beta_i^t \frac{F_i^t \left(1 - e^{-(F+M+T)}\right)}{\left(F_i^t + M + T\right)}$$

and

$$n_i^{t+1} = S_i^t \sum_j \alpha_{ij}^t n_j^t$$

where

n_j^t is the number of tags present in area *j* at time *t*

β_i^t is the reporting rate in area *i* at time *t*.

F_i^t is the fishing mortality rate in area *i* at time *t*.

M is the natural mortality rate

T is the tagging-induced mortality rate

$\alpha_{i,j}^t$ is the proportion of tags in area *j* that move to area *i* at time *t*

S_i^t is the survival in area *i* at time *t* [$S=e^{-(M+F)}$]

The parameter β_i^t can be calculated as the ratio of lottery tag returns to high value ($100) tag returns, assuming that all recaptures if $100 tags are reported. The parameters $\alpha_{i,j}^t$ (movement) and F_i^t (fishing mortality) are estimated to fit model predictions to the observed frequency of seasonal returns by area. In the most aggregated form of the model, the movement matrix among the three stock (Cape Cod-Gulf of Maine, Georges Bank and southern New England-Mid Atlantic) areas is:

$$\begin{bmatrix} \alpha_{CCGOM} & \alpha_{CCGOM,GB} & \alpha_{CCGOM,SNEMA} \\ \alpha_{GB,CCGOM} & \alpha_{GB} & \alpha_{GB,SNEMA} \\ \alpha_{SNEMA,CCGOM} & \alpha_{SNEMA,GB} & \alpha_{SNEMA} \end{bmatrix} = A$$

where diagonal elements are the proportion of yellowtail that remain in the area of release, off-diagonal elements are movement rates between stock areas, and columns sum to one. The vector of abundance in each are at the end of a time step can then be calculated as the product of an initial abundance vector, a diagonal survival matrix, and the movement matrix ($n_{t+1} = n_t A_t S_t$).

Based on results from the analysis of historical data, the number of tag returns and the duration of the study will dictate how many parameters can be reliably estimated. The model has flexible spatiotemporal resolution, so that stock areas can be analyzed by statistical areas, and movements can be analyzed by season, if the number of tag returns supports such detail. Therefore, by increasing the number of tag releases proportional to

stock abundance, the proposed funding by the Northeast Consortium will improve the resolution and reliability of movement and mortality estimates, as well as the ability to detect changes in movement or mortality rates. The movement-mortality model developed for yellowtail flounder was reviewed by an independent panel of tagging experts (NEFSC 2004, Appendix B). The panel concluded that the experimental design and associated analytical model were valid for meeting our objectives, but additional experiments may be needed to evaluate tag-induced mortality (*T*).

Holding study – With the assistance of the Woods Hole Aquarium, the University of Maryland Fish Pathology lab and Great Bay Aquaculture, a pilot experiment is being conducted to assess tag-induced mortality. On the last tow of each week of field work, approximately 30 fish will be kept in a flow-through tank on board, and transported to a flow through holding tank in Woods Hole via oxygenated shipping bags maintained at approximately 10^{o}C. Fish will be fed regularly and observed daily. Tagged subsamples and control samples will be removed from the holding tank at durations of 2, 4 and 6 days. Tissue around the tag site will be preserved and analyzed for histological reaction at the UMD Fish Pathology Lab. In addition, a smaller subsample of fish will be held for longer-term observation of mortality. Any fish that die will be preserved for a complete necropsy. This pilot study should help to identify sources of tag-induced mortality.

Outreach – Fourteen high-value ($100) rewards have been awarded, and two $1000 lottery rewards were drawn at the New Bedford Fishermen's Family Assistance Center (December 2003) and the Massachusetts Bay Inshore Commercial Groundfish Association meeting (April 2004). Reward posters and project brochures were distributed to fish processors, fishing associations, NMFS port agents, sea samplers and research institutes from Nova Scotia to New Jersey. The project website (cooperative-tagging.org, Appendix C) has been maintained and is regularly updated with data and project news. Letters were mailed to all yellowtail fishermen, describing the project and instructions on how to report recaptured tags. Several press releases have been issued on field work and lotteries, and tagging news has been reported in several regional industry newspapers and newsletters. The toll free number (877-826-2612) has been maintained, and every fisherman who reports a recapture is contacted to open a dialog of communication. Everyone who reported tag recaptures also received a "thank you" letter and map with details of the tagged fish and its movements.

Project Objectives and Scientific Hypothesis

There are several objectives of the Yellowtail Flounder Tagging Study:

- estimate movement rates among yellowtail fishing grounds
- provide independent estimates of mortality for each stock area
- confirm age determinations
- foster cooperative relationships between scientists and fishermen.

The general approach is based on an experimental design that tags a representative subsample of the entire population and an analytical design that models simultaneous movement and mortality. Thereby, the experimental design corresponds to the analytical design, and population estimates support all three technical objectives (movement, mortality and growth) with one study. One hypothesis to be tested is the

expected change in fishing mortality in 2004 resulting from management changes. A third year of tag releases will provide observations to increase the power of the test.

Project Plan and Experimental Design

This proposal to the Northeast Consortium is to contract commercial fishermen and their vessels to work with scientists to tag and release yellowtail on all fishing grounds off New England, proportional to geographic patterns of abundance. The geographic design is based on statistical fishing areas, with releases in each area. Such a design will allow estimation of movement among areas and mortality by area. The proposed project is designed to continue the experimental design to detect changes in movement or mortality rates resulting from recent fishery management actions.

We propose that in spring 2005, 20 days be chartered to tag approximately 5,000 yellowtail, distributed by local abundance of fishing grounds (Figure 8). The cooperatively developed field protocol (Appendix D) will be maintained. Funding from the Northeast Consortium will provide the necessary cooperation with industry in the form of vessel contracts and local knowledge of yellowtail distribution and seasonal habits, to extend current tagging efforts to the entire U.S. range of yellowtail, and provide estimates of mixing and mortality for all U.S. stocks. A third year of releases will help to test for annual changes in fishing mortality and movement rates.

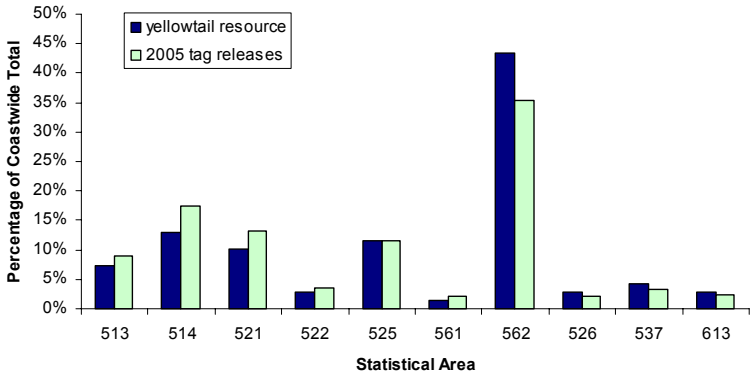

Figure 8. Proportional yellowtail tag releases and relative stock abundance (as indicated by recent NEFSC surveys) by statistical area.

Reward posters will continue to be produced and distributed to ports from Nova Scotia to the Mid Atlantic. Reporting rates will be assessed with a tiered reward system (e.g., $1,000 lotteries for most tag returns and fewer instant $100 rewards) to allow an estimate of reporting rate. All tag returns will be reported via a toll-free number (877-826-2612). Everyone who reports a tag recapture will receive a "thank you" letter with a map, giving details of the tagged fish and its movements. Tag reporters will also be acknowledged on the website, and through annual rewards ($100) to the most frequent tag reporter. Project brochures will be distributed at meetings and on the docks, and provided to fishing organizations and tagging participants for distribution. Updates on tagging results and project details will be posted online at www.cooperative-tagging.org. The tag reporting system, outreach program and database management will be maintained by NEFSC throughout the term of the study (i.e., as long as tags are being recaptured). The NEFSC

will host the second yellowtail tagging cooperators' meeting to summarize the year of tagging efforts and begin planning for 2005.

The general approach to cooperative research is to involve fishermen who are both experienced in the yellowtail fisheries and local representatives of the industry. Thus, vessel contractors not only provide sampling platforms, but are also active in project outreach to maximize tag returns. Personal outreach is essential for success of tagging studies (Bernstein and Iudicello 2000).

Available Resources

The greatest resources available to the project are its personnel. Fishermen and researchers have cooperated to develop the general approach and technical details of the tagging study through several meetings from Rhode Island to Maine. Although many fishermen have provided input and are willing to cooperate for the duration of the project, vessel contracts will go out for bid through Federal requisitions.

Co-Principal Investigators

Steve Cadrin, Northeast Fisheries Science Center, Woods Hole MA

Steve has been a fisheries biologist for 20 years, and as a member of the Population Dynamics Branch, is responsible for stock assessments of yellowtail flounder. Steve's Ph.D. dissertation was "Stock Structure of Yellowtail Flounder."

Azure Westwood, Integrated Statistics, Woods Hole MA

Azure is a marine biologist under contract with NEFSC to coordinate cooperative research on yellowtail flounder. Azure has experience in community-based fisheries science and management from American Samoa, Alaska and New England.

Rodney Avila, F/V Trident, New Bedford MA

Rodney has decades of experience in the Georges Bank yellowtail flounder fishery as an owner and operator of the F/V Trident. Rodney cooperated in developing tagging protocol and will continue to support outreach activities in New Bedford, where nearly half of the U.S. yellowtail catch is landed.

David Goethel, F/V Ellen Diane, Hampton NH

David is a Gulf of Maine groundfish fisherman with experience in cod tagging and cooperative research. David has also helped in the experimental design and will continue to help with outreach in the Cape Cod-Gulf of Maine area.

Fred Mattera, F/V Travis & Natalie, W. Kingston RI

Fred is a highliner in the yellowtail fishery and has been instrumental in the development of the industry-based survey for southern New England yellowtail. Fred also provided input for the tagging study design and will coordinate recaptures in the IBS study.

Luis Ribas, F/V Blue Skies, Provincetown MA

Luis is a leader in the Provincetown fishing fleet, with years of experience in other fisheries off Portugal and in the North Sea. Luis has helped pioneer innovative fishing gear to target flounder and reduce bycatch and was an initial proponent of tagging Cape Cod yellowtail.

Other fishermen who are involved in the yellowtail tagging study are Bill and Jason Amaru (F/V JoAnne-A III), Ed Barrett (F/V Phoenix and F/V Sirius), Steve Follette (F/V Heather Lynn), Shawn McLellan (F/V Elizabeth), Maggie and John Raymond (F/V Olympia) and Proctor Wells (F/V Tenacious).

Cooperating Research Agencies

Many people are collaborating on this study and have contributed to its design:
- *NMFS*: Steve Murawski, Fred Serchuk, John Hoey, Earl Meredith, Nathan Keith, Jonathan Duquette, Rob Johnston, Kevin McIntosh, Paul Rago, Gary Shepherd, Josh Moser, Dave Radosh, Chris Legault, Jay Burnett, Vaughn Silva, Patricia Yoos, Heather Sagar, Sarah Babson-Pike, Steve Kelly, Erin Kupcha, Katie Lovett, Joe Mello, Anthony Morales and Chris Zanni.
- *MADMF*: Jeremy King, John Boardman, Brian Kelly and David Pierce
- *SMAST*: Rodney Rountree, Dave Mattens, Russ Kessler and Darin Jones
- *RIDFW*: April Valliere
- *Canada DFO*: Heath Stone
- *University of Maryland*: Larry Alade, Eric May, Andrea Johnson
- *Manomet Center*: Chris Glass and Greg Morris

In addition to personnel resources, the proposed study will have the support of NEFSC, providing data (e.g., the commercial weighout database, logbook data, observer program information, and the NEFSC survey database) computational hardware and software, toll-free phone support, website maintenance, and scientific research permits. Industry representatives also have the ability to communicate the objectives of the project to other yellowtail fishermen, thereby maximizing the potential reporting rate of recaptured tags.

Dissemination of Results, Impacts and Deliverables

The results from this study will benefit researchers and managers and should help improve the management of yellowtail resources. New information on yellowtail movement, independent estimates of mortality and confirmation of age determinations should be useful for academic, state, and federal scientists and will be important information for fishery managers (i.e., the New England Fishery Management Council). Length distributions and sex ratios from 2003 tagging in closed area II are being used in the 2004 Georges Bank yellowtail assessment (Chris Legault, personal communication). The cooperative approach used in the experimental design will be continued throughout the data collection, analysis and interpretation stages of the study. Therefore, results and conclusions will be a product of all cooperators. Co-principal investigators and others involved in yellowtail tagging will meet annually to review results to date. Results will be posted on the website (cooperative-tagging.org) and presented to stock assessment workshops (e.g., SAW, TRAC), management meetings (e.g., groundfish committee) and industry groups (e.g., fishermens' forum, Fish Expo) in the form of technical reports and visual presentations. Information from 2003-2004 yellowtail tagging were presented at the NEFSC Science Symposium, the Transboundary Resources Assessment Committee, the 39th Stock Assessment Workshop (Appendix B), and presentations are planned for the 2004 ICES Annual Science Conference and the 2004 Flatfish Conference.

Deliverables:

- Estimates of total mortality by stock area and year, based on mark-recapture observations.
- Estimates of annual movement rates among areas.
- Confirmation of age determinations through mark and recapture observations.

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Budget and Budget Justification

A total of **$100,000** is requested from the Northeast Consortium, 75% of which is allocated to cooperating fishermen (see Appendix E for the Northeast Consortium budget format). The majority of the proposed budget is allocated to vessel contracts ($57,500 for 9 inshore days at $1,500 per day and 11 offshore days at $4,000 per day). Funding is also requested for tag rewards ($15,000), and to support cooperative meetings ($2,500). For the 2004 meeting, fishermen were paid a stipend of $150 to attend the meeting. Collaborators feel that fishermen's participation in planning and interpretation their time should be valued and compensated. A total of $25,000 is requested to purchase more disc tags, data-storage tags and tagging equipment. Other costs for the study (field and lab personnel, scientists' travel, lab facilities, support of reporting and data management systems, outreach materials) are being contributed by NEFSC. Costs have been evaluated based on a cost-effective approach to improving the yellowtail tagging study.

Vessel Charter Costs

The going rates for vessel charters for current cooperative research are categorized as inshore day-trips (e.g., $1,500 per day for cooperative cod tagging, within the range suggested for Northeast Consortium funding) or multi-day offshore charters (e.g., $5,000 per day for the yellowtail industry-based survey and CRPI yellowtail tagging). Based on concerns about the high cost of offshore trips raised by the consortium, two economic analyses are described below that justify a substantial cost differential between inshore and offshore trips. Industry leaders reviewed the economic analyses as well as their own costs and agreed that a cost of $4,000 per offshore day will be acceptable to most cooperators. The cost of $4,000 per day is also the initial rate agreed to for the yellowtail tagging and survey work (IBS 2002) before the substantial increase in fuel prices in 2003.

A query of 2002 northeast observer data for otter trawl trips indicated that the 65 observed trips that were at sea for seven days or more were more than 6 times more costly than the 205 observed day trips. Operational costs included damage, supplies, food, water, oil, ice and fuel, but did not include overhead costs (vessel cost, dockage, insurance, etc) which are also greater for larger, offshore vessels:

Table A1. Reported daily costs of observed day-trips and multi-day trips in 2002.

days	1-day trips	>7 day trips	cost ratio
trips	205	65	
crew	1.8	4.4	2.5
damage	$ .64	$ 42.96	4.5
supplies	$ .20	$ 13.65	1.9
food	$ 4.80	$ 87.81	5.9
water	$ 0.08	$ 3.93	46.6
oil	$ 8.29	$ 29.11	3.5
ice	$ 9.79	$ 05.92	10.8
fuel	$ 70.58	$ 79.28	6.8
cost	$ 20.39	$ 62.65	6.3

Similar costs were obtained from an economic survey conducted for an analysis of the economic impacts of Amendment 13 to the Groundfish Plan, (NEFMC 2003; Drew Kitts

and Eric Thunberg, NEFSC personal communication). Revenue per day was estimated as $1,521 for an inshore trawler (<50 feet) and $6,254 for an offshore trawler (50-70 feet):

Table A2. Economic analysis of vessel costs and revenues (Drew Kitts, personal communication)

Vessel Category	Average
Trawl < 50 feet: revenue per day	$ 1,521
Variable costs per day	$ 268
Yearly overhead costs	$ 30,073
Trawl 50 to 70 feet: revenue per day	$ 6,254
Variable costs per day	$ 363
Yearly overhead costs	$ 66,937

Based on these analyses, the proposed vessel costs ($1500 per day inshore and $4000 per day offshore) are justified. The current state of the yellowtail stocks is that much of the resource is offshore, on Georges Bank, where tagging is inherently more expensive. We propose that Consortium funding be used to maintain geographically proportional tag releases.

Data Storage Tag Costs

Data-storage tags are high-technology products that are expensive in comparison to conventional tags. However, the information gained from a single data-storage tag can be extremely valuable (e.g., Metcalfe and Arnold 1999). The manufacturer of the proposed tag, LoTek (based in Newfoundland), is one of three manufacturers of data-storage tags, and offers the most affordable data-storage tag on the market ($185 per tag, including a 10% government discount). Star Oddi (based in Iceland) offers a similar tag to the Lotek tag, but the cost is $368 per tag. Wildlife Computers (based in Washington state) specializes in more advanced data-storage tags that monitor heart rate and light intensity that are $750 or more. Therefore, the LoTek data-storage tag is the most cost-effective product that can meet our needs. Although prototypes of the LoTek tag had substantial failure rates (Rodney Rountree, personal communication), all 12 data tags that were recaptured downloaded data reliably, and a field test in Woods Hole Harbor indicated no data failures.

Description of Prior results

All principal investigators are involved in the 2004 yellowtail flounder tagging study funded by the Northeast Consortium:

Yellowtail Flounder Tagging Study (FY 2003)

New England fishermen and the Northeast Fisheries Science Center were awarded a grant from the Northeast Consortium to expand and improve the yellowtail flounder tagging study for yellowtail flounder in Northeast U.S. waters. The study is designed to tag yellowtail flounder aboard commercial fishing vessels with conventional disc tags and data-storage tags from Maine to the Mid Atlantic with the objectives of estimating movement among stocks areas and mortality within stock areas as well as providing growth observations.

This project coordinates several concurrent field studies with a common tagging protocol, a single experimental and analytical design, the same tag return system as well as coordinated outreach efforts. Through the cooperation of industry leaders and fishery scientists, the study was planned to reduce uncertainty in yellowtail flounder stock assessments, thereby improving fishery management. Further details on the project design and results are available online at cooperative-tagging.org.

David Goethel, a co-principal investigator has been or currently is involved in the Study Fleet Project and three projects funded by the Northeast Consortium:
Determining Groundfish Species Movement Patterns in Closed Areas (FY2000)
Collaborating with Hunt Howell, University of New Hampshire, the field study monitored movement patterns of groundfish in several areas in the western Gulf of Maine, using tag and recapture techniques. Approximately 20,000 Cod were tagged in areas 132, 133 and 156. Time/area closures, because of their relatively small size, present new challenges in resource assessment. In particular, little is known about the small-scale movements of groundfish within and between these areas, and the biological processes that occur within the closed areas are poorly understood.

Intensive Study of the Western Gulf of Maine Closure Area (FY 2002 $204,340)
Led by Raymond Grizzle, University of New Hampshire, the study is examining a combination of ecosystem factors including primary production, bottom habitat heterogeneity and temporal dynamics, and potential human impacts to the seafloor. The objective is to initiate an ecosystem-level assessment of the effectiveness of the Western Gulf of Maine Closure Area. In addition, the study will provide an opportunity to develop new approaches to habitat mapping that may have important ramifications for fisheries management. Investigators are using satellite remote sensing of primary production, multibeam acoustic mapping of the seafloor, videographic mapping of the seafloor, and grab sampling of sediments and benthos to produce detailed maps of primary production and bottom habitat characteristics for a portion of the closed area and adjacent areas. The new maps and other information will be combined with existing data from the study area to assess the potential effects of the closure on groundfish populations and overall habitat quality.

Determining Groundfish Movement Patterns In and Around the Western Gulf of Maine Area Closure (FY2002 $134,243)
Led by Hunt Howell, University of New Hampshire, the study is evaluating the western Gulf of Maine area closure. Area closures and marine protected areas are becoming increasingly popular as fisheries management tools. Theoretical benefits include: 1) providing a refuge from harvesters and a consequent reduction in fishing mortality; 2) serving as a source of eggs and larvae that can rebuild populations outside of the closed area; and 3) simplified enforcement. While it is clear that they can be effective if the closed area encompasses a large part of the available habitat and the species are largely immobile, their utility for highly mobile, migratory species is less certain. This study seeks to study the movement patterns of groundfish in and around the Western Gulf of Maine Area Closure using mark and recapture techniques. Results of the study will provide fisheries scientists and managers with detailed information about the temporal

and spatial distribution of several groundfish species, which will thus contribute towards our understanding of this closed area's effectiveness.

Other co-principal investigators also have demonstrated the ability to successfully contribute to fisheries science through various cooperative research projects:

Steve Cadrin

* Worked with other co-investigators to develop the southern New England-Mid Atlantic tagging study and the 2003 NEFFSC tagging study. Tagging demonstrations began in March 2003, with a sea-trial on the Massachusetts Survey in May 2003. Tagging began in Massachusetts Bay on June 23, 2003.
* Cooperative research on *Loligo* squid spawning and maturity in the late 1990s, working with squid fishermen to locate areas of spawning and collect samples for laboratory processing. The study led to a better understanding of *Loligo* reproductive dynamics.
* Cooperative research on lobster fecundity in the early 1990s, working with offshore lobster fishermen to collect large ovigerous females. The results improved estimates of egg production per recruit.

Azure Westwood

* Worked with other co-investigators to develop the southern New England-Mid Atlantic tagging study and the 2003 NEFFSC tagging study. Tagging demonstrations began in March 2003, with a sea-trial on the Massachusetts Survey in May 2003. Tagging began in Massachusetts Bay on June 23, 2003.
* Chief scientist on cooperative research cruises for the yellowtail industry-based survey (spring and fall 2003), the monkfish survey (2003 and 2004) and the Mid Atlantic mesh bycatch study (2004).
* Worked with outer Cape Cod hook fishermen to bridge gaps between New England fisheries stakeholders through education, creative partnerships, research, mediation and public rallies for grassroots, non-profit fisheries conservation organization.
* Presented educational workshops & lectures to fishermen, community groups, elementary to college classes, fisheries management and science communities.
* Created first Community Fisheries Action Center in New England offering technical services, education and skill workshops, resources and a comfortable meeting place for the Cape Cod fishing and coastal community.

Rodney Avila

* Currently involved in a cooperative cod tagging project with SMAST.
* Worked with other co-investigators to develop the 2003 NEFFSC tagging study. Actively involved in project outreach in New Bedford.
* Cooperated with Arne Carr, MADMF, on various gear research to decrease bycatch.

Fred Mattera

* Worked with other co-investigators to develop the southern New England-Mid Atlantic tagging study.
* Instrumental in developing the yellowtail Industry-Based Survey in the southern New England-Mid Atlantic area. Two offshore trawlers completed 300 tows (150 random

stations and 150 industry-selected stations) in May 2003, and are planned to sample another 300 stations in autumn 2003.

Luis Ribas

* Worked with the Massachusetts Division of Marine Fisheries on "Reducing Bycatch of Cod in Trawl Fishing.". He developed the Ribas net, conducted research with the Raised Foot Rope Trawl in the whiting fishery, and participated in scup and squid research.

Current and Pending Support for Principal Investigators

* Steve Cadrin is a full-time employee of NEFSC and does not derive income from cooperative research.
* Azure Westwood is under contract with NEFSC to develop cooperative research for yellowtail flounder, but does not derive income from cooperative grants.
* Rodney Avila was awarded contracts of $40,000 and $44,000 from NEFSC to tag yellowtail flounder on Georges Bank in July 2003 and August 2004. He was also awarded $15,000 to tag cod by SMAST.
* David Goethel was awarded contracts for the two Northeast Consortium studies described above, and was awarded contracts of $7,500 and $10,500 from NEFSC to tag yellowtail flounder in Massachusetts Bay in June and July 2003, and coastal Maine in June 2004. He is also funded by the Study Fleet Project.
* Fred Mattera and is not currently contracted for cooperative research.
* Luis Ribas was awarded two contracts of $7,500 from NEFSC to tag yellowtail flounder in Massachusetts Bay in June and July 2003, and July 2004.

Appendix A. Cooperative Yellowtail Tagging Annual Meeting
January 14, 2003 Woods Hole, MA
Summary of Discussions

Participants:
Larry Alade, University of Maryland
Frank Almeida, Northeast Fisheries Science Center
Bill Amaru, F/V Joanne-A III
Jason Amaru, F/V Joanne-A III
Sarah Babson-Pike, National Marine Fisheries Service Port Agent
Ed Barrett, F/V Phoenix and F/V Sirius
John Boardman, Massachusetts Marine Fisheries
Steve Cadrin, Northeast Fisheries Science Center
Jonathan Duquette, Northeast Fisheries Science Center
Steve Follett, F/V Heather Lynn
Chris Glass, Manomet Center
Dave Goethel, F/V Ellen Diane
John Hoey, Northeast Fisheries Science Center
Ambrose Jearld, Northeast Fisheries Science Center
Rob Johnston, Northeast Fisheries Science Center
Darren Jones, School for Marine Science and Technology
Nathan Keith, Northeast Fisheries Science Center
Brian Kelly, Massachusetts Marine Fisheries
Steve Kelly, National Marine Fisheries Service Port Agent
Ross Kessler, School for Marine Science and Technology
Jeremy King, Massachusetts Marine Fisheries
Erin Kupcha, Northeast Fisheries Science Center
Chris Legault, Northeast Fisheries Science Center
Katie Lovett, National Marine Fisheries Service Port Agent
Dave Martins, School for Marine Science and Technology
Fred Mattera, F/V Travis and Natalie
Eric May, University of Maryland
Joe Mello, Northeast Fisheries Science Center
Earl Meredith, National Marine Fisheries Service, Regional Office
Anthony Morales, National Marine Fisheries Service Port Agent
Gregg Morris, Manomet Center
Josh Moser, Northeast Fisheries Science Center
Rodney Rountree, School for Marine Science and Technology
Fred Serchuk, Northeast Fisheries Science Center
Gary Shepherd, Northeast Fisheries Science Center
Heath Stone, Canada Department of Fisheries and Oceans
April Valliere, Rhode Island Department of Fish and Wildlife
Azure Westwood, Northeast Fisheries Science Center
Chris Zanni, National Marine Fisheries Service Port Agent

Presentations
Frank Almeida, the acting Deputy Director of the Northeast Fisheries Center, welcomed the participants to the Woods Hole lab, and participants introduced themselves. Azure Westwood summarized the meeting plan, which involved a morning of presentations with discussions and an afternoon of planning for the 2004 field season.

Steve Cadrin reviewed the background and goals of the project: estimate mortality movement among areas and growth. He also explained how the experimental design, releasing tags in proportion to local abundance, allows for population estimates of movement, mortality and growth. Azure described the field protocol and the NEFSC cooperative tagging trips off Hampton NH, on Georges Bank, off Chatham, off Provincetown and off coastal Maine. Dave Martens described his tagging trip in the Great South Channel. Larry Alade presented his work on model development, showing that tags released in a geographic design can effectively estimate mortality and movement. Heath Stone described Canadian tagging efforts. Azure presented progress in the outreach program.

Major Discussion Issues
There were many thoughtful comments offered and interesting ideas discussed at the meeting. The following is a brief description of the decisions made at the meeting and associated discussions.

Tagging Juvenile Fish - A concern was raised that movements of juveniles are being ignored by the current experimental design and tagging protocol, because only marketable-sized fish are being tagged. According to IBS results, few sub-legal sized yellowtail were caught in the spring (none less than 19cm), but a large number of ~24cm fish were caught in the fall. This raises questions about where juvenile fish are distributed in spring.

The group recognized this as a new question that is not addressed by the original project objectives. Everyone agreed that the issue was important and worth refining the project goals and designs. It was also noted that tagging juveniles would benefit the growth objectives of the study. The group agreed that juveniles should be tagged, with both disc tags and data tags, but not at the expense of meeting the goal of tagging marketable-sized fish in proportion to local abundance. For the goal of estimating fully-recruited fishing mortality, sublegal-sized fish may have to be excluded from the analysis, because the model is currently designed for fish that fully-selected by legal fishing gear.

In discussing the allocation of 2004 tagging days, participants felt that more tags per day can be released in southern New England-Mid Atlantic, because the few tags per day released in November-December, 2003 were limited by skate and dogfish bycatch, weather and seasonal availability. Therefore, a solution was proposed in which ALL yellowtail caught in SNE-MA tagging trips (i.e., juveniles and adults) be tagged in 2004. Given the low proportion of marketable fish that need to be tagged in the area to achieve proportionality (10% of the coastwide resource and 10% of total tag releases), the group felt that we can easily extend the tagging effort to sub-legal fish and still meet the

targeted number of marketable releases. It was noted that the IBS data should be used to locate concentrations of juveniles and adults for tagging trips.

Furthermore, participants felt that juveniles should be tagged in other areas (Georges Bank and Cape Cod-Gulf of Maine) when possible, without reducing the number of marketable fish tagged. For example, for small tows there is plenty of time to tag all yellowtail (marketable and sub-legal sizes) without sacrificing any sea time. We may need to determine the minimum size fish that can be successfully tagged with discs and data tags (size at maturity is approximately 25cm, or 10 inches). Therefore, **the tagging protocol will be revised to tag sublegal and marketable yellowtail in SNE-MA, all marketable yellowtail in GB and CC-GOM, and sublegal yellowtail in GB and CC-GOM as time allows.**

Distribution of 2004 Tagging Effort

After an evaluation of 2003 release sites, the experimental design, and model results from historical data, the group decided to **maintain proportionality of coastwide tag releases relative to regional distribution of the yellowtail resource**.

The group felt that more yellowtail can be tagged off Maine (area 513) if tagging is done in May, when there is less fixed gear and yellowtail are distributed more offshore than later in the year. The group also suggested notifying fixed gear fishermen so they may move their gear, or try capturing yellowtail with flatfish gillnets or other fixed gear.

Several fishermen identified areas not sampled in 2003. For example, the Massachusetts Bays area (514) should release yellowtail on the northern part of Stellwagen Bank as well as in western Cape Cod Bay and Massachusetts Bay. The best time to tag in these areas may be during the rolling closure (April and May).

Another fishing ground that was not sampled was south of closed area 2, where a fall fishery has developed. Fishermen also noted that the western part of the Nantucket Lightship closure (area 537) should be sampled.

Fishing Gear

Fishermen discussed the relative merits of collecting fish for tagging with various fishing gear: large-mesh, small-mesh, square and diamond mesh, flatfish gillnets, etc. It became obvious that the objective of catching a moderate number of yellowtail in good condition without much bycatch requires different gear in different areas at different times of year. Therefore, the group decided that each contracted skipper is the best judge of appropriate gear, and flexibility should not only be allowed, but permitted with letters of authorization or scientific collection permits. Therefore, **Scientific Collection Permits for 2004 will include the provision for small mesh.**

Tag Retention and Induced Mortality

The group was concerned that tag-induced mortality should be considered with a complimentary holding experiment. The development of methods for such an experiment could also be used to address wider bycatch issues in northeast fisheries. Such an

experiment may be proposed as a development project by one or more partners in the project.

The group was also concerned that the 't-bar' tag used for the Canadian study may have a lower retention rate than disc tags. Therefore, it was agreed that **500 disc tags will be given to Canada DFO to double tag with discs and 't-bar' tags in the Canadian "yellowtail hole" in 2004 using the cooperative tagging protocol.**

Contracting Process

Based on a review of various offshore collaborative studies, the cost of offshore trips was discussed and the group decided that **$4,000 per day will be the cost advertised in the request for bids.**

Several suggestions for improvements to the contracting process were discussed, such as including a picture of the **deck plan** to help evaluate bids, a **pre-contracting conference** will all potential bidders, and **web support** for filing bids. The group agreed that the requests for bids should have an **April 1 deadline for bids**.

Outreach

Several suggestions were also offered to promote the project in the fishing and scientific communities, such as more **pictures** and an option for providing **comments** on the website. A **"Frequently Asked Questions"** section with a response to "Will this be used against me?" should be added to the website. Also, outreach for the Candaian tagging effort should be included on the website. **Additional port visits** were suggested for Stonington CT, Montauk NY, Shinnecock NY, and Yarmouth NS. **Plastic rulers** with outreach information may help provide a method for measuring recaptured fish. A **lottery drawing at Fish Expo** (Providence Set 30-Oct 2) was suggested. Several participants though another **general mailing** to permit holders and more **press releases** would also help

Data Analysis

The group was concerned about the effect of closed areas and seasons on model results. It was suggested that patterns of fishing effort should be included in the model development.

These and many more ideas were discussed and evaluated at the meeting. Participants offered their perspectives and opinions on many aspects of the study. There was consensus that a **third year of funding** should be proposed to continue the study. The hosts of the meeting thank all who attended and all who supported and helped the project during 2003.

Appendix B. 39th Stock Assessment Workshop, Coastal/Pelagic Working Group

A meeting of the Coastal/Pelagic Working Group was held April 27-29th in Woods Hole, MA. The main objective was to produce a stock assessment for the northern stock of black sea bass for consideration at the 39th SARC, but the movement-mortality model developed for the yellowtail flounder tagging study and application to historical tagging data was also reviewed. Participants in the meeting were:

Participant	Affiliation
Dr. Liz Brooks	NMFS, Miami Laboratory, Miami, FL
Dr. Steve Cadrin	NMFS, Woods Hole Laboratory, Woods Hole, MA
Jessica Coakley	DE Fish and Wildlife, Dover, DE
Steve Doctor	MD Dept. Natural Resources, Stevensville, MD
Dr. Mary Fabrizio	NMFS, J.J. Howard Laboratory, Sandy Hook NJ
Blanche Jackson	NMFS, Woods Hole Laboratory, Woods Hole, MA
Kohl Kanwit	ME Dept. Natural Resources, W Boothbay HBR, ME
Toni Kerns	Atlantic States Marine Fisheries Commission, Washington
Dr. Rob Latour	Virginia Institute of Marine Science, Gloucester Pt. VA
Dr. Chris Legault	NMFS, Woods Hole Laboratory, Woods Hole, MA
Dr. Chris Moore	Mid-Atlantic Fishery Management Council, Dover DE
Josh Moser	Integrated Statistics, Woods Hole, MA
Roy Pemberton	Virginia Institute of Marine Science, Gloucester Pt. VA
Dr. Paul Rago	NMFS, Woods Hole Laboratory, Woods Hole, MA
Gary Shepherd	NMFS, Woods Hole Laboratory, Woods Hole, MA
David Simpson	CT Dept. Environmental Protection, Old Saybrook, CT
Dr. David Smith	USGS, Leetown Laboratory, Leetown, WV
Dr. Mark Terceiro	NMFS, Woods Hole Laboratory, Woods Hole, MA
Dr. William Overholtz	NMFS, Woods Hole Laboratory, Woods Hole, MA
Azure Westwood	Integrated Statistics, Woods Hole, MA

Appendix D. 2004 Tagging Protocol

Capture, Handling and Observations

1. Assure Captain has a data sheets. Should be making short tows with slow haul- back. Exact tow duration can be determined by the Captain based on the area and bycatch concerns.
2. Make sure deck is wet, with running seawater flowing over it.
3. Dump tow on deck or in wet checker if available and sort out yellowtail.
4. Place yellowtail in catchments (small wading pools, totes or other holding tanks). Do not overcrowd.
5. Tagging yellowtail is first priority. If time allows, estimate remaining catch. If possible, have crew assist and/or estimate large tows.

Condition of fish appropriate to tag

1. If condition of the fish in a tow noticeably worsens after a period of delayed tagging time, do not tag fish. Release them and start another tow.

2. Minimize time out of water and handling of fish.
3. Fish size: Measure from end of snout to end of tail.
    - Southern New England tagging areas – Tag all sub-legal (less than 33cm) fish and legal (33+ cm). Gauge the size and capability of sub-legal fish to before applying data storage tags.
    - All other tagging areas – Tagging legal fish is priority. Tag sub-legal fish as time allows and not to detract or affect from the quality or progress of tagging legal fish.
4. Fish conditions ratings:

(1) EXCELLENT: Fish is lively, scale condition clean and relatively unscathed. Operculum or mouth movement noticeable. Body strong. No blood clotting around gills or operculum. Possibly flapping.
(2) GOOD: Fish generally looks healthy, some movement and no large abrasions or defects. May have some scale abrasions, but body is somewhat strong, lively.

Note: Fish is unacceptable to tag if it appears chance of survival is low, heavy abrasion, body is flaccid, little movement or reaction to handling. Do not tag or notate these fish.

5. Record fish condition, based on rating criteria on data sheet, and any unusual health observations, defects or markings on fish. Some damage conditions to look for and notate (does not necessarily mean the fish is unfit to tag):

- Active bleeding anywhere
- Anal tearing or chaffing
- Gill area hemorrhaging or tearing
- Any scaling, abrasions or cuts (note blind or eyed side)

<u>Applying Peterson Disk Tags</u>

1. After tow has been dumped on a **wet** deck and sorted, prepare to tag fish.
2. Remove fish from holding tanks, measure length and sex. Sex fish by candling (see candling protocol). Keep hands and work station wet at all times. Take scale samples if required (see reverse).
3. Locate lateral line arch on blind side of fish. Place pin with blank disk just above the middle of line arch and puncture fish.
4. Make smooth, clean puncture at a **perpendicular angle** to fish body until blank is flush with blind side.
5. Place pink disk (with side labeled "Call toll free 1-877-826-2612…") facing away from fish on nickel pin, flush with fish body.
6. To trim the pin, place needle-nose pliers slightly above flush with tag, cutting edge up and trim the pin. Should be about 1 inch of pin left once trimmed.
7. Grab end of pin with tips of needle nose pliers. Crimp pin in a U-shape. Close gap between crimp tightly. Crimp should measure approx. 3 mm.
8. Bend crimp over with pliers so it's at a perpendicular angle to the post of the pin (parallel to the fish body). **Insure there is space between tag and bend (approx. 3-4 mm, depending of fish size) to allow room for growth. For sub-legal fish, allow approx. 12-24 mm for growth, depending on fish size.**
9. Release fish immediately if it remains lively. If not, allow a minute or so of recovery in the live well before release. Try releasing fish head first to minimize re-orientation and time in warm surface waters.

Applying Data Storage Tags (DST's)

1. Hold the tag with its yellow bead thermistor to your right. The magnetic reed switch will be at the top edge of the tag. To begin a recording session, tap the tag at its upper right or left corner 4 times with one pole of a magnet. The four taps must occur within two seconds and the magnet must not come near the tag for the following two seconds. After each tap, move the magnet at least 2-inches away from the tag. The magnet does not need to actually touch the tag.

   The light-emitting diode (LED) will blink brightly to indicate that the tag has started. It will then blink at 14- and 15-second intervals (an average of once every 14.06 seconds), one blink corresponding to each sample that is taken.

   If the LED blinks approx. twice each second, the tag is in a rapid-recording test mode. To clear this, tap the tag 4 times with the magnet. The test mode will drain the battery more quickly than the normal recording mode.

2. Follow Steps 1-4 in disk tag application. Insert 2 pins instead of 1, one at a time, using 2-holed oval blanks. Take scale samples for every DST tag placed. Use scale-labeled blanks.
3. Place DST (labeled side facing out, away from fish) through the pin holes on eyed side of fish.
4. Follow Steps 6-9 in Peterson Disk application.

Data Recording and Tag Release

1. Before each cruise, insure that tagger and recorder have the following materials: Small Tupperware containing:
   a. Nickel pins (for disks, DSTs and extras)
   b. Blanks, plain and scale labeled
   c. Numbered disk tags ($1000 lottery and $100 reward)
   d. DSTs and labeled oval disks as blanks
   e. Scale envelopes
   f. Mechanical pencils, Sharpie markers, ziplocks
   g. Data sheets and clip board
   h. Measuring boards
   i. Needle nose pliers, WD 40
   j. Camera
2. If health of the fish might be jeopardized, omit scale sampling.
3. Fill out the data sheet completely. One data sheet per tow, with a continuation sheet for additional fish.
4. Record time in military time, 24 hour clock.
5. Position is where the fish was caught (release should be within ½ mile of capture location).
6. Record sex (F = female, M = male and UNK= sex unknown).
7. Indicate whether a scale sample was taken (Y or N).
8. Measure length of each fish. Measure from the end of the snout to the longest point in the tail. Use measuring boards provided by the project.
9. Captains must fill out a Captain's data sheet for each tow.
10. Record fish condition. (1- EXCELLENT and 2- GOOD)

Re-capturing a tagged fish

1. Inspect tag wound area and fish condition and note on data sheet
2. If condition is good to excellent, release fish immediately.
3. If fish condition is in poor condition, remove tag for immediate re-use. Note on data sheet.
4. If there are a large number of re-captures, move to a new area.

Collecting Scale Samples

1. Take scale samples on all fish tagged with "$100 Reward" tags, data storage tags, and a percentage of lottery tags. Use specially marked scale disk tags as the blank labeled, "take scale sample and return to…." for all $100 and scale sample lottery tags.
2. In addition to $100 tags and data tags, **scales should be taken for every 5th fish tagged**, (shaded boxes on data sheet). If taking scales will compromise fish health, take scales from next fish.
3. Only take scales from fish in excellent condition.
4. Pluck 2 or 3 scales using forceps from just above the lateral line, approx. midway on body of fish.
5. Record any comments on the data sheet.

Determining Sex

1. Nearly all legal sized females should be mature and have a large ovary extending posteriorly from the abdominal cavity.
2. Inspect the ventral area of the blind side to determine if an ovary is extending into the ventral tail meat:
   - If there is darker tissue extending from the abdominal cavity toward the caudal area, code as "female."
   - If the ventral and dorsal portions of the tail (posterior to the abdominal cavity) are identical in color, code as "male."

Appendix C: Budget Worksheet

Northeast Consortium Budget Worksheet

Organizing your budget in these cost categories will facilitate processing of your award. Your budget justification narrative should explain assumptions used to arrive at the budget amounts. Insert rows if you need additional space.

NOTE: Some cells in this worksheet are protected. If you need to add rows, you will need to turn off the protection. Click here for instructions.

Grantee: Northeast Fisheries Science Center

Project Duration (months): October 2004-September 2005

Principal Investigator: Steve Cadrin

Project Title: Yellowtail Flounder Tagging Study

	BUDGET		
COST CATEGORIES:	**Industry**	**Research Org**	**TOTAL**
1. Salaries and wages			
Principal Investigator			
(Insert Name)			
Assistants or Associates			
(Insert Name)			
List all other participants receiving salary			
(Insert Name)			
(Insert Name)			
Subtotal salaries and wages	**$ -**	**$ -**	**$ -**
2. Fringe benefits (*insert your benefits rate*)			
Subtotal personnel expenses (1 and 2)	**$ -**	**$ -**	**$ -**
3. Permanent equipment			
Insert itemized list of equipment			
Subtotal equipment	**$ -**	**$ -**	**$ -**
4. Travel			
Identify type of travel (e.g., local, regional, national, international) and rate (e.g., per mile)			
meeting stipends	$ 2,500		
Subtotal travel	**$ 2,500**	**$ -**	**$ -**
5. Supplies, materials, and other direct costs:			
disc tags (5000 with blanks, pins, etc.)		$ 3,100	
data-storage tags (100)		$ 18,500	
miscellaneous tagging equipment		$ 3,400	
lottery and high-value rewards	$ 15,000		
Subtotal supplies and materials	**$ 15,000**	**$ 25,000**	**$ -**
6. Contracts			
Inshore tagging vessels (9 days)	$ 13,500		
Offshore tagging (11 days)	$ 44,000		
Subtotal contractual	**$ 57,500**	**$ -**	**$ -**
Subtotals Direct Costs	**$ 75,000**	**$ 25,000**	**$ -**
Indirect Costs (*insert your indirect/overhead rates*)			
TOTAL	**$ 75,000**	**$ 25,000**	
			GRAND TOTAL: $ 100,000

Letter proposals for Project Development Awards do not need to demonstrate a 75% industry/25% research

TOTAL PROJECT COST	**Costs**	**Percentage of direct costs**
Commercial Fishing Industry	**$ 75,000**	**75.0%**
Research Organization	**$ 25,000**	**25.0%**