VIRGINIA RECREATIONAL FISHING DEVELOPMENT FUND
SUMMARY PROJECT APPLICATION*

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NAME AND ADDRESS OF APPLICANT:

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Virginia Institute of Marine Science
P.O. Box 1346
Gloucester Point, VA 23062

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PROJECT LEADER (name, phone, e-mail):

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Jon A. Lucy, 804-684-7166
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PRIORITY AREA OF CONCERN:

Summer flounder recreational fishery

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PROJECT LOCATION:

Lower Chesapeake Bay

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DESCRIPTIVE TITLE OF PROJECT:

Understanding localized movements and habitat associations of summer flounder in Chesapeake Bay using passive acoustic arrays

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PROJECT SUMMARY:

In Virginia, the recreational fishery for summer flounder is focused on inshore populations during spring, summer, and fall when fish inhabit estuaries and shallow coastal waters. However, relatively little is known about summer flounder distribution and movements in inshore waters. We propose to use state-of-the-art tagging technology to study habitat associations and localized movements of individual summer flounder in Chesapeake Bay. Summer flounder will be implanted surgically with individually coded transmitters and movements and habitat use of individual fish will be monitored using passive acoustic arrays in the lower Chesapeake Bay.

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EXPECTED BENEFITS:

This study will benefit the recreational fishery for summer flounder in Virginia waters by providing anglers and fishery managers with a better understanding of fish movement, particularly as it relates to fish size. We seek to better define temporal and spatial dynamics of habitat used by summer flounder in light of on-going concerns over low oxygen bottom waters during summer months. Our results will also elucidate the duration of habitat use by these fish and examine a hypothesis generated by the Virginia Game Fish Tagging Program of fidelity to structured sites targeted by anglers.

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COSTS:

VMRC Funding: ~~$ 134,306~~ **$149,906** **amended RFAB request 5/1/2006**
Recipient Funding: ~~$ 81,280~~
Total Costs: ~~$ 215,586~~

Detailed budget must be included with proposal.

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Updated 6/1/05

*This form alone does not constitute a complete application, see application instructions or contact Sonya Davis at 757-247-8155 or sonya.davis@mrc.virginia.gov : Due dates are June 15 (Jul. – Nov. Cycle) and December 15 (Jan. – May Cycle)

Proposal Submission to

VMRC RECREATIONAL FISHING ADVISORY BOARD

By

THE VIRGINIA INSTITUTE OF MARINE SCIENCE
COLLEGE OF WILLIAM AND MARY

UNDERSTANDING LOCALIZED MOVEMENTS AND HABITAT ASSOCIATIONS OF SUMMER FLOUNDER IN CHESAPEAKE BAY USING PASSIVE ACOUSTIC ARRAYS

Mary C Fabrizio
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Principal Investigator

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Chair, Fisheries Science

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Director, Marine Advisory Services

DECEMBER 2005

UNDERSTANDING LOCALIZED MOVEMENTS AND HABITAT ASSOCIATIONS OF SUMMER FLOUNDER IN CHESAPEAKE BAY USING PASSIVE ACOUSTIC ARRAYS

Mary C. Fabrizio and Jon A. Lucy
Department of Fisheries Science
Virginia Institute of Marine Science
P.O. Box 1346, Gloucester Point, VA 23062

Need:

Summer flounder *Paralichthys dentatus* are one of the most highly prized sport fishes of the eastern US seaboard. In Virginia, 642,419 kg (1,413,321 lbs) of summer flounder were harvested by saltwater anglers in 2004 (pers. comm., National Marine Fisheries Service, Fisheries Statistics Division). Although this species is also harvested commercially, the recreational fishery is focused on inshore populations during spring, summer, and fall when fish inhabit estuaries and shallow coastal waters, whereas the commercial fishery occurs predominantly in deeper waters of the continental shelf during winter months. The distribution, abundance, and status of the offshore population during winter is assessed annually with seasonal bottom trawl surveys conducted by NOAA-Fisheries Service, Northeast Fisheries Science Center. However, relatively little is known about summer flounder distribution and movements in inshore waters. For example, it appears that most of the adult summer flounder captured by bottom trawls in the mainstem of the Chesapeake Bay in recent years are female fish (R. Latour and C. Bonzek, pers. comm., VIMS). According to recent results from the Virginia Game Fish Tagging Program, fish less than the minimum size (16.5 inches or 419 mm total length [TL]) appear to exhibit some degree of site fidelity during the period of estuarine use (Lucy and Bain 2005). Thus, size and sex could be important factors contributing to variation in summer flounder estuarine distribution and habitat use in Chesapeake Bay. Growing concerns over persistent and expanding areas of low oxygen bottom waters during summer also make it important to understand areas of concentration of summer flounder in the lower Bay. We propose to use state-of-the-art tagging technology to study habitat associations and localized movements of individual summer flounder in Chesapeake Bay. Summer flounder will be implanted surgically with individually coded transmitters and movements and habitat use of individual fish will be monitored using passive acoustic arrays in the lower Chesapeake Bay.

Background:

Summer flounder occur in marine and estuarine waters from Nova Scotia to South Carolina, and support fisheries from Massachusetts to North Carolina (Bigelow and Schroeder 2002; Terceiro 2001). In the spring, adult summer flounder move inshore to inhabit coastal and estuarine waters. In the fall, fish migrate offshore towards the continental shelf break to spawn off the coast of New Jersey, Virginia, North Carolina, or south of Cape Hatteras (Kraus and Musick 2001). Larval summer flounder enter estuarine waters of Chesapeake Bay beginning in October but as late as May (Norcross and Wyanski 1994; Murdy et al. 1997). Once settled, young-of-the-year summer flounder may reside in the bay throughout their first winter, whereas in northern estuaries, juveniles are generally not found during the winter months (Kraus and Musick 2001).

Young-of-the-year summer flounder are found throughout the mainstem of the Chesapeake Bay and in the lower reaches of the James, York, and Rappahannock rivers (Montane and Lowery 2005). However, monthly survey data (e.g., VIMS Juvenile Fish and Blue Crab Trawl Survey) provide no information on movements of fish or other dynamic processes, such as emigration or changes in habitat associations.

Mark-recapture (or tagging) studies are commonly used in fisheries to understand movement of fish as well as population parameters such as survival and emigration. Tagging studies depend on the ability to mark sufficient numbers of fish to provide a good indication of population-level processes affecting the numbers, movement, and distribution of individuals. Tagging studies also rely on the reporting of the fate of recaptured fish (e.g., fish are released alive or fish are harvested or released dead). As such, these studies are typically conducted with species that support a fishery. Summer flounder from Chesapeake Bay have been examined through tagging studies, but the data are either limited due to low recaptures or have not been designed to examine specific ecological questions. Kraus and Musick (2001) used mark-recapture data from 10,607 juvenile summer flounder (<290 mm TL) tagged and released in Chesapeake Bay and Virginia coastal waters to examine the question of stock structure; most of the fish recaptured after 40 days at large moved north and were recaptured in coastal states from Maryland to Connecticut. However, these observations are based on extremely low recapture rates (0.2%) and may not reflect the movement of fish tagged from parts of the bay not studied (e.g., structured sites; Lucy and Bain 2005). Recaptures from thousands of summer flounder tagged as 229 - 381 mm [9-15 inch] fish by recreational anglers at several sites in the Virginia portion of the Chesapeake Bay indicate that these young fish may use habitats near coastal structures for extended periods of time, possibly up to 150 days (Lucy and Bain 2005). The studied sites included inlets (Rudee Inlet), bridges (e.g., Hampton Roads Bridge Tunnel) and fishing piers (e.g., Buckroe Pier [Hampton,VA], Gloucester Point Pier, and Yorktown Beach Jetties). Small fish (229-381 mm TL) may exhibit some site attachment or perhaps have small home ranges during the period of bay residency, remaining closely associated with structures or highly productive areas preferred for feeding and refuge. In addition, the length of time young fish remain in bay habitats may exceed that previously reported for New Jersey salt-marsh creeks, which was 17 days on average (Rountree and Able 1992). Young-of-the-year summer flounder (156 - 312 mm TL) released in August - October emigrated from creeks within 50 days (Rountree and Able 1992). Tagging data suggest that Chesapeake Bay habitats may be used over a longer period of time by young summer flounder than similar habitats in New Jersey. Based on trawl survey catches in Chesapeake Bay, young-of-the-year summer flounder are vulnerable to bottom trawls as early as March and remain in the system until December; however, the period of peak abundance is September through November (Montane and Lowery 2005).

In recent years, fish movements, home ranges, dispersal rates, and habitat use have been studied with ultrasonic telemetry (e.g., Hooge and Taggart 1998; Arendt et al. 2001; Bolden 2000; Buckley and Arnold 2000; Eklund et al. 2000; Cote et al. 2003; Parsons et al. 2003; Lowe et al. 2003; Heupel et al. 2004). This technology is similar to acoustic tracking technology used in wildlife studies, but uses acoustic signals in the ultrasonic range (e.g., 60-80 kHz) because higher frequency signals are absorbed rapidly in water (Pincock and Voegeli 2002). To our knowledge only three studies of summer flounder have been conducted to date with this technology. The first was applied to young-of-the-year fish (210-254 mm TL) in a New Jersey marsh creek but used only 9 fish (Szedlmayer and Able 1993). Another study occurred in the same area and was reported in December 2004 at the Flatfish Biology Conference[1]. This work included 70 fish ranging in size from 267 to 533 mm and involved both active and passive tracking of fish in and around Great Bay-Little Egg Harbor, New Jersey. These fish were reported to have undertaken limited movements in the estuary from April through November. The third study involved 24 summer flounder >265 mm TL passively monitored off the coast of New Jersey using an acoustic grid (Fabrizio et al. 2005). Although the latter work addresses summer flounder use of continental shelf habitats, results from that work may be compared with results from the proposed study and provide insights on shelf vs. estuarine habitat utilization. Our proposed study will elucidate the movements of summer flounder in lower Chesapeake Bay and examine movements and habitat use by fish from various size classes.

Movements and habitat use may be studied with ultrasonic telemetry methods, but when passive monitoring is used, the properties of the study site must be considered in designing an appropriate acoustic system. For instance, acoustic "gates" consisting of monitoring receivers positioned perpendicular to the direction of fish movement may be used in areas that are relatively narrow or otherwise confined by land on two or more sides. Gate designs are optimal for studies of fish movements in streams or rivers (e.g., to study the outmigration of Atlantic salmon smolts in Maine rivers, J. Kocik, pers. comm.). In other cases, a study site may be encircled by receivers; this type of design is suitable for studies of some marine protected areas. Other habitats require the use of an acoustic grid or a more complex arrangement of monitoring receivers that permits detection of acoustic signals within study sites of various shapes and within portions of study sites (e.g., among two or more bottom habitat types). Because the detection distance of the receiver is highly dependent on the environment (Pincock and Voegeli 2002), optimal distances between adjacent receivers must be determined prior to field implementation using a range test. This test provides site-specific information on the likelihood of signal detection by a receiver as a function of distance between the transmitter (emitting the signal) and the receiver (detecting and decoding the signal). Detection distances vary widely and are a function of the environment: for instance, shallow water, the presence of vegetation, turbidity, wave action, and the presence of soniferous organisms affect the actual results obtained. A benchmark range for saltwater environments is about 400 m (www.vemco.com). Results from a range test are then used to determine suitable placement of monitoring receivers to permit estimation of site usage.

An acoustic grid design has been used successfully by one of us (MCF) to determine habitat affinity of adult summer flounder on the continental shelf off the coast of New Jersey (Fabrizio et al. 2005). By combining information from a spatially comprehensive multi-beam survey conducted by the USGS and interpreted by the Center for Remote Sensing and Spatial Analysis at Rutgers University (R. Lathrop, pers. comm.) with information on fish occurrence from a grid of acoustic arrays, Fabrizio has developed an approach to quantitatively estimate habitat use by summer flounder (Fabrizio et al., ms. in prep). Using generalized linear models where negative

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[1]K. Able, D. Rowles, and T. Grothues (Rutgers University Marine Field Station). An evaluation of summer flounder estuarine habitat use using acoustic telemetry. Ninth Flatfish Biology Conference, Westbury, CT, December 2004.

binomial distributions are used to describe transmitter detections and habitat features are modeled as discrete variables, Fabrizio et al. (ms. in prep) are investigating the association between summer flounder occurrence and habitat features such as bottom slope, sediment type, and depth. This approach is unlike previous attempts to describe habitat associations of summer flounder using trawl survey data (e.g., Kraus 1998) in that the method using data from acoustic grids uses temporally-intensive information collected throughout the day (24 hours per day), and for as many days as fish are present in the study area. Thus, the data are free from some of the common sampling biases associated with trawl survey data such as gear (e.g., unknown catchability, efficiency), time of year (e.g., sampling restricted to a few days or weeks, at best), habitat type (e.g., sampling confined to trawlable sites), time of day (e.g., sampling only during the day), and temporal intensity of sampling.

Habitat delineation at the study sites in lower Chesapeake Bay will be obtained from VIMS annual reports of SAV distribution and abundance[2] as well as habitat descriptors from two large-scale surveys. The VIMS Juvenile Fish and Blue Crab Trawl Survey provides habitat descriptors of biogenic material (shells, sponge, hydroids, worm tubes, macroalgae, etc.), and sediment type (gravel, sand, and percent fine particles) is available from the VIMS Blue Crab Winter Dredge Survey. Together, these surveys can provide a comprehensive indication of habitat features in our study areas. Monitoring receivers will be placed within different habitats at each study site thus ensuring acoustic coverage of the variety of habitats available to summer flounder at the sites.

Objective:
The objectives of this study are to

(1) describe and compare movements of sub-legal (<16.5 inches or 419 mm TL) and legal sized summer flounder in lower Chesapeake Bay, and

(2) describe size-specific habitat use.

The description of the movement of summer flounder will include an examination of the role of tides and water temperature. This information will be provided in a final report scheduled for completion at the termination of the contract period (i.e., June 2007).

Expected Results or Benefits:
This study will benefit the recreational fishery for summer flounder in Virginia waters by providing anglers and fishery managers with a better understanding of fish movement, particularly as it relates to fish size. We seek to better define temporal and spatial dynamics of habitat used by summer flounder in light of on-going concerns over low oxygen bottom waters during summer months. Our results will also elucidate the duration of habitat use by these fish and examine a hypothesis generated by the Virginia Game Fish Tagging Program of fidelity to structured sites targeted by anglers.

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[2]For example, Orth, R. J., D. J. Wilcox, L. S. Nagey, A. L. Owens, J. R. Whiting, and A. Serio. 2004. 2003 Distribution of Submerged Aquatic Vegetation in Chesapeake Bay and Coastal Bays. VIMS Special Scientific Report #144. Available on the web at http://www.vims.edu/bio/sav/sav03/index.html

Based on previous studies of estuarine fishes, we expect that sub-legal summer flounder will exhibit stronger affinities to structured sites than larger fish and that movements of fish at all sites (structured and unstructured) will be influenced by tidal dynamics. Larger fish may exhibit limited use of inshore estuarine areas, but the presence of structure may affect the duration of habitat use. We postulate that larger fish will have higher affinities to structured sites than to unstructured ones.

Approach:
This project will be conducted in three phases:

(1) deployment of acoustic receivers [May 2006],
(2) release of summer flounder with surgically implanted transmitters [June 2006], and
(3) retrieval and analysis of acoustic data [June 2007].

Receivers, equipped with omnidirectional hydrophones, decode and record transmissions on a memory chip; a PC must be interfaced to each receiver to download acoustic data. The analysis phase will occur at the end of the field study and will culminate with the submission of a final report.

Phase (1): Deployment of acoustic receivers
To prepare for the deployment of receivers, we will conduct a range test to determine the maximum distance at which a transmitter can be detected. This test will be conducted at one of the candidate study sites. Based on a preliminary test with similar gear in a shallow, vegetated area (Lucy and Machen 2003), we estimate the detection distance to be at least 200 and up to 300 m. Detection ranges in non-vegetated waters are expected to be greater than 300 m. The range test will be conducted from a small vessel using a single moored receiver in May 2006; three people are required to deploy the gear (moored receiver and pole-mounted transmitter) and conduct the test.

We propose to examine summer flounder site fidelity, habitat use, and movement at three study sites in Virginia waters of Chesapeake Bay. These sites are Gloucester Point Piers, Kiptopeke State Park (on the eastern shore near Cape Charles), and Old Plantation Flats (on the eastern shore north of Kiptopeke), a site of similar depth but lacking structure. The two structure sites are used by summer flounder (Lucy and Bain 2005). Information from the site lacking structure will be useful in interpreting the significance of structure to habitat use and movement. Selection of deployment locations will be made to minimize interference with pier anglers and Virginia haul seine fisheries, as haul seine operations could damage, destroy or remove our acoustic gear from the site.

Each receiver will be attached to a mooring and a surface float to mark its location. In addition to the surface float, the location of each receiver will be logged according to its GPS position. The receiver-mooring array will also be equipped with temperature data loggers to record temperature at the study sites. Receivers thus deployed will passively detect, decipher, and record transmissions from ultrasonic transmitters; the information (date, time of day, transmitter identification number) is stored in the memory of the receiver. To obtain these data, the receiver and temperature data logger must be retrieved (see below) and interfaced to a personal computer. Deployment and retrieval of acoustic arrays (receiver, mooring, temperature data logger, and float) require three people.

Phase (2): Release of summer flounder with surgically implanted transmitters

In early summer (June) we intend to capture summer flounder using hook and line or by trawling, and surgically implant the fish with individually coded transmitters. The implantation procedure for summer flounder has been developed and used by one of us (MCF) and is described in Fabrizio and Pessutti (in prep.). It is similar to methods used by J. Lucy to implant transmitters in tautog. Briefly, summer flounder are anesthetized, a small incision is made on the non-ocular side (non-pigmented side), a beeswax-coated transmitter is inserted into the peritoneal cavity, and the incision is stitched using non-absorbable sutures in an interrupted pattern. While the fish is anesthetized, size and weight measurements are collected, and an individually numbered anchor tag is inserted into the dorsal musculature. Fish are then resuscitated using ram ventilation and released. In addition to providing external identification of the fish, the anchor tag will have a phone number to call should the fish be recaptured by anglers or commercial fishers. All fish will be captured at the study sites and released at location of capture. We propose to implant transmitters in 40 fish (20 sub-legal, 20 legal sized) at each of three sites for a total of 120 fish. Fish will be implanted with transmitters in June at all three sites; the timing of the field work (early to late June) will depend on when fish >265 mm TL are available to our gear (either trawl or hook and line). Summer flounder smaller than 265 mm TL should not be implanted with 30 mm transmitters; incisions through the thin tissues of small fish are difficult to do without rupturing internal organs, and mortality is high with fish of this size (Fabrizio et al. 2005). This aspect of the field work will require at least 5 people.

We will use coded transmitters (i.e., transmitters that transmit individual codes and hence, identify individual fish); these transmitters will be configured to ensure battery power for the duration of the study. Battery life is a function of the size of the transmitter, type of battery, and the length of the delay between coded transmissions (Pincock and Voegeli 2002). Excellent results were obtained by Fabrizio et al. (2005) using coded transmitters 30 mm long and 9 mm in diameter with a delay time varying between 180 and 300 seconds. With this configuration, battery life was about one year. We propose to shorten the delay time to obtain a battery life about 8 months, thus allowing tracking of individual fish from May through December.

Phase (3): Retrieval and analysis of acoustic data

Acoustic receivers must be retrieved from the environment to permit acquisition of acoustic data. Once summer flounder leave the study sites (we expect this to be in November-December), we will retrieve the receivers and download the data. Receivers will be retrieved in late December or early January. The retrieval process requires at least three people.

Following retrieval, we will analyze the acoustic data for size-specific information on habitat use and movements; site fidelity and dispersal from sites will also be examined. The influence of tidal stage and water temperature will also be explored. We propose to examine habitat use with a negative binomial model; in this approach, the number of detections at a particular receiver (the response variable) is assumed to follow a negative binomial distribution. This is a reasonable assumption because we anticipate the occurrence of zeroes in the detection data (that is, at certain times, there will be locations that are not occupied by our study fish) and because we expect the variance to be much larger than the mean. Based on our previous experience with detection data from monitoring receivers, other distributions, such as the Poisson, result in severe overdispersion, a condition that leads to underestimation of standard errors of model parameters and affects inference (e.g., Pedan 2001; Littell et al. 2002). The number of detections for a given receiver will be modeled as a function of depth, temperature, distance from shore, bottom type, habitat type, and sediment characteristics using a generalized linear model. This type of model does not require the assumption of normally distributed data nor does it require the assumption of a symmetric distribution of errors (Littell et al. 2002). Thus, the generalized linear model is a more flexible approach, allowing the investigator to stipulate the distribution of the response variable, and the nature of the relationship between the mean response and the linear predictors (through the use of a link function such as the logit or probit; Littell et al. 2002). We will use SAS to test for goodness-of-fit of the model and to obtain the maximum likelihood estimates of parameters. Movements of summer flounder from the study sites will be examined relative to tidal stage and temperature fluctuations with a repeated measures model. Because monitoring receivers record data throughout the day, observations on a given fish are serially correlated and are thus, repeated measures. We will develop an index to account for movement of fish within and among study sites and use a repeated measures ANOVA to test for equality of movement through various time periods (days, weeks, months) and across environmental changes (temperature, tide stage). Site fidelity can be examined using simple discriptive statistics that characterize length of time within a given study site. Dispersal rates, which represent movement of fish away from the site, can be estimated using the Kaplan-Meier (KM) approach (Bennetts et al. 2001). The KM method is a nonparametric approach, requiring no assumptions about the underlying hazard function. KM estimators are robust, have well described variances (Pollock et al. 1989a), and can be modified to permit staggered entry of individuals (Pollock et al. 1989b). We will use SAS to obtain maximum likelihood estimates of dispersal rates (see Fabrizio et al. 2005). Finally, we will examine results from this study and compare summer flounder habitat use and dispersal to results from Fabrizio et al. (in prep). Analysis of the data and preparation of the final report for this study will require about 6 months time; we anticipate completion of the report by June 2007.

Location:

The project will be conducted in the lower Chesapeake Bay, in the body of water known as Hampton Roads, the lower York River, and on the eastern shore, north of Cape Charles (Kiptopeke State Park).

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Estimated Cost: $ 215,586 [MRFAB = $ 134,306; VIMS matching = $ 81,280]

Personnel – $ 66,550 [MRFAB = $ 48,225; VIMS matching = $ 18,325]
We are requesting salary support of 1 month for M. Fabrizio and 0.5 month for J. Lucy; VIMS will match these personnel costs. J. Lucy is requesting 0.5 month salary support because he is currently supported by MRFAB funds for 1 month on another project and salary support for PIs should not exceed 15% of their annual salary. We are requesting support for an entry-level technician to assist in conducting the work. All salaries are supplemented by the customary 30% fringe benefit rate.

Supplies – $ 20,170
Supplies requested for this project include field surgical supplies (e.g., anesthetic, sutures, tissue adhesive, gauze pads, surgeon's gloves, surgical instruments, etc.), expendable lab supplies (e.g., waterproof paper, external T-bar tags, fishing tackle, bait, epoxy, batteries for the receivers, etc.), other lab supplies (e.g., buckets, tools, electronics cleaner, coolers, measuring boards, fids, 2 tanks, etc.). Array hardware costs are estimated at about $460 per array (we propose to construct 21 arrays) and include mushroom anchor, high-strength line (such as Spectra or Amsteel), stainless steel shackles and swivel shackles, stainless steel thimbles, cable ties, etc. We are also requesting 21 temperature data loggers to be attached to each array, foul weather gear for the field crew, and software that permits communication between the receivers and a PC.

Travel – $ 6,150
Travel costs are provided for each phase of the study: deployment, transmitter implantation, and retrieval. We anticipate using two pick-up trucks for the field work: one truck to trailer the vessel to our study sites, and another truck to transport the field surgical supplies, including 2 tanks for holding fish. We estimated costs based on current vehicle and vessel rental rates for 1 day of deployment activity, 6 days of implantation activities, and 2 days of retrieval activity per site. In addition, we included a small amount to cover local travel to local meetings such as VMRC and to distribute posters to local marinas.

Printing – $ 300
A small amount is requested for design and printing of a poster instructing anglers to report catches of tagged fish.

Equipment – $ 68,100 [MRFAB = $ 29,100; VIMS matching = $ 39,000]
We propose to purchase 21 receivers suitable for mooring in the marine environment for extended periods of time. These receivers will record the presence of fish in the study site and are the principal data-recording device for the project. Because they are specialized scientific research instruments, there are no sources for rental. We are also requesting funds to purchase a

hand-held receiver and directional hydrophone which will permit us to check the functionality of the transmitters before and after implantation. This is a critical check that ensures that fish are released with fully functioning transmitters. Although rare, transmitters have been known to fail. The hand-held receiver and hydrophone also permit checking of transmitter identification number before the fish is released. This is an important component of the data quality assurance protocol. VIMS is willing to provide $39,000 for purchasing transmitters, but the supplier requires 60-day lead time to manufacture them in time for project initiation.

Vessel rental – $ 3,500
Vessel rental rates were calculated based on the VIMS daily rate for a large Privateer (21-foot vessel). We used 1 day of deployment, 6 days of implantation, and 2 days of retrieval per site to calculate the cost of vessel rental and fuel.

Indirect costs – $ 50,516 [MRFAB = $ 26,861; VIMS matching = $ 23,955]
Facilities and administrative costs are calculated at 25% of total costs. The VIMS approved indirect cost rate is 47.45%; the remaining indirect costs are contributed as part of VIMS match for this project.

Old Budget

BUDGET

Personnel	MRFAB	VIMS	Total
M. Fabrizio (2 mon)1/1	10,938	10,938	21,876
J. Lucy (1 mon) .5 / .5	3,158	3,158	6,316
Technician (12 mon)	23,000		23,000
Fringe, 30% salaries	11,129	4,229	15,358
Supplies			
Batteries ($800), tanks (2)	2,000		2,000
Lab supplies such as waterproof paper, external tags	2,500		2,500
Field surgical supplies	3,000		3,000
Array hardware - lines, shackles, thimbles, swivels; mooring	9,660		9,660
Temperature data loggers	2,310		2,310
Foul weather gear	400		400
Software for receiver-PC interface	300		300
Travel			
Deployment	700		700
Transmitter implantation	3,700		3,700
Retrieval	1,250		1,250
Local travel	500		500
Printing	300		300
Equipment			
Transmitters (120 @$325)		39,000	39,000 **
Receivers (21 @$1100)	23,100		23,100
Handheld receiver, $4,900	4,900		4,900
Directional hydrophone	1,100		1,100
Vessel Rental			
Rental & fuel	3,500		3,500
Facilities & Administrative Costs	26,861	23,955	50,816
Total	134,306	81,280	215,586

Facilities and Administrative Costs:

F&A costs limited to 25% for funds provided by Marine Recreational Fishing Advisory Board. Institutional approved rate is 47.45%. The remaining costs are contributed as part of VIMS match for this project.

**VIMS is willing to provide the $39,000 for the transmitters, but the supplier requires 60-day lead time to manufacture them in time for project initiation.

Response to Peer-review Comments for Project L

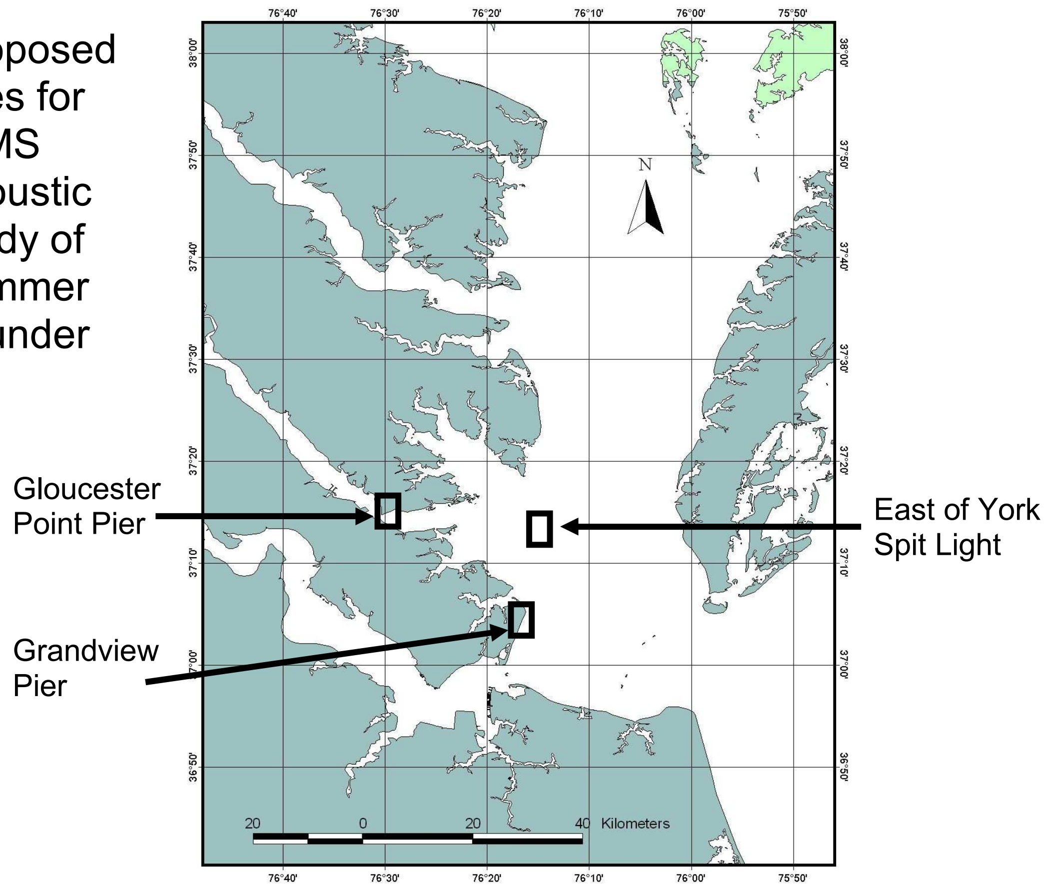
Understanding Localized Movements and Habitat Associations of Summer Flounder

Submitted by Mary C. Fabrizio and Jon Lucy, VIMS

We share the reviewer's concern about the 'size of the footprint' of our study sites (comment A 2). This limitation reflects the number of receivers (passive acoustic stations) that we proposed to purchase (n=21, $23,100). The reviewer also noted that 21 receivers comprise only 10% of the total budget, and that for an additional 5% increase ($11,000), we could increase the footprint of our study by 50% (by purchasing an additional 10 receivers) (comment D). As the reviewer indicated, this would significantly increase the amount of data that could be obtained from each of the implanted fish. The reviewer also stated that because receivers are re-usable, the additional $11,000 would provide potential benefits to future studies. We respectfully ask the Board to consider an amended budget for an additional $15,600 to be allocated in the following manner: $11,000 for the purchase of 10 additional receivers to be used in this study and $4,600 to cover costs of the array hardware (mooring, buoy, lines, shackles, etc.) necessary to deploy the receivers.

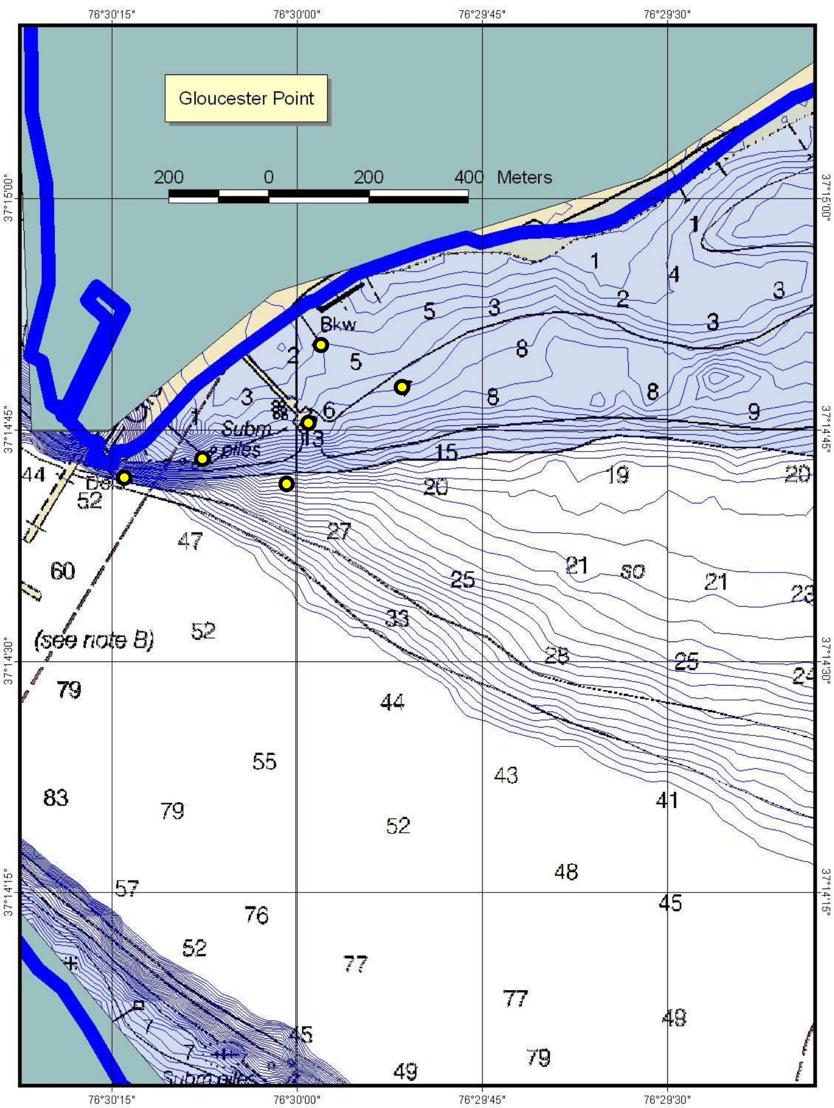
The reviewer noted that little detail was provided on the three sites selected for study (comment B 1). We regret this and offer the following descriptions of the study sites, configuration of moored receivers (acoustic arrays), and bathymetry (see figure). In our proposal we planned to study summer flounder at three sites: Gloucester Point Pier, Kiptopeke State Park, and Old Plantation Flats. We plan to substitute a study site in the Grandview Pier area for the Kiptopeke site because we are concerned with angler and boating activity at Kiptopeke. We feel that the large number of anglers and boats using the Kiptopeke site would adversely interfere with moored receivers (potentially causing loss of equipment and valuable data; if we lose a receiver, we have no data for that station and even a single loss could compromise our ability to determine habitat use in the area of Kiptopeke). The Virginia Game Fish Tagging Program has extensive data records for summer flounder tagged at the Grandview Pier site. This site has abundant submerged structure and is ideal for studying the movement and habitat use of summer flounder near structures. In addition, Old Plantation Flats was proposed as the non-structured study site; this site is near Kiptopeke, but we now plan to move the non-structured study site to an area east of York Spit Light. This area was recently identified by experienced local anglers as a productive site for summer flounder that has less interference from commercial and sport fishing activities. Because we will be marking the location of the acoustic array (receiver) with surface buoys, we wish to place the arrays in areas of minimal boat traffic and use by commercial watermen. Our third study site, Gloucester Point Pier, remains unchanged. The configuration of acoustic arrays at each of the sites, along with bathymetry, is depicted in the figure below. The necessary distance between arrays was conservatively estimated at 200 m at the structured sites and 400 m at the non-structured sites based on extensive discussions with acoustic engineers at VEMCO and our collective experience with this equipment in similar environments. We expect the actual ‘footprint’ of the arrays to increase somewhat, but the actual inter-receiver distances will be determined by *in situ* range tests which we plan to conduct in early June.

Proposed sites for VIMS acoustic study of summer flounder



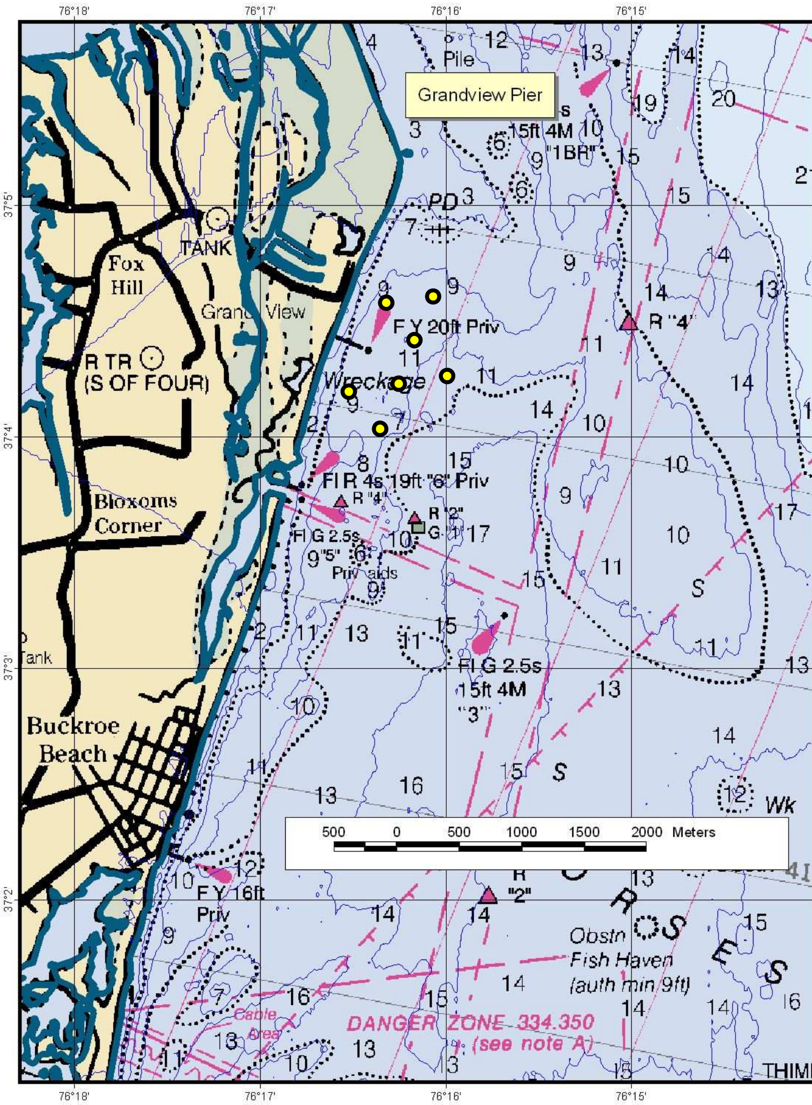
Gloucester Point Pier

- acoustic array N=6



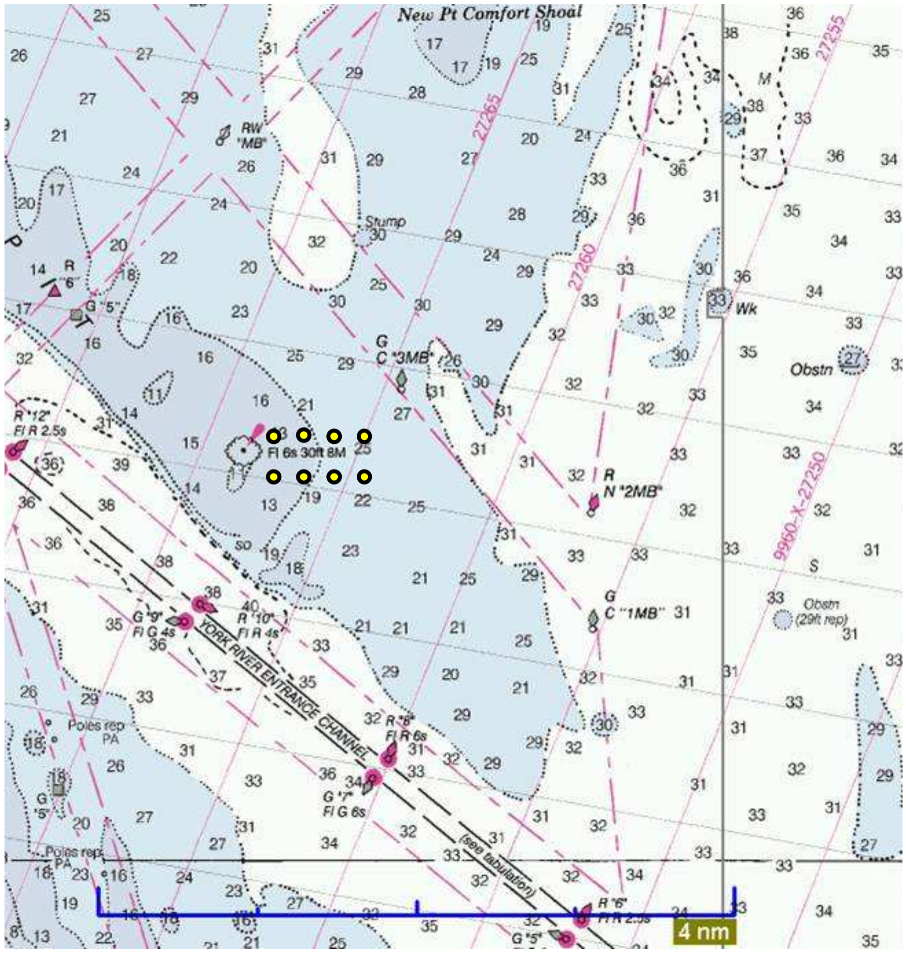
Grandview Pier

- acoustic array N=7



East of York Spit Light

acoustic array N=8



1 nm=1,852 m

BUDGET (Revised)

	MRFAB	VIMS	Total
Personnel			
M. Fabrizio (2 mon)1/1	10,938	10,938	21,876
J. Lucy (1 mon) .5 / .5	3,158	3,158	6,316
Technician (12 mon)	23,000		23,000
Fringe, 30% salaries	11,129	4,229	15,358
Supplies			
Batteries ($800), tanks (2)	2,000		2,000
Lab supplies such as waterproof paper, external tags	2,500		2,500
Field surgical supplies	3,000		3,000
Array hardware - lines, shackles, thimbles, swivels; mooring	11,140		11,140
Temperature data loggers	2,310		2,310
Foul weather gear	400		400
Software for receiver-PC interface	300		300
Travel			
Deployment	700		700
Transmitter implantation	3,700		3,700
Retrieval	1,250		1,250
Local travel	500		500
Printing	300		300
Equipment			
Transmitters (120 @$325)		39,000	39,000 **
Receivers (31 @$1100)	34,100		34,100
Handheld receiver, $4,900	4,900		4,900
Directional hydrophone	1,100		1,100
Vessel Rental			
Rental & fuel	11,520		11,520
Facilities & Administrative Costs	21,961	29,558	51,519
Total	149,906	86,882	236,788

Facilities and Administrative Costs:
F&A costs limited to 25% for funds provided by Marine Recreational Fishing Advisory Board. Institutional approved rate is 47.45%. The remaining costs are contributed as part of VIMS match for this project.

**VIMS is willing to provide the $39,000 for the transmitters, but the supplier requires 60-day lead time to manufacture them in time for project initiation.

Estimated Cost: $ 236,788 [MRFAB = $ 149,906; VIMS matching = $ 86,882]

Personnel – $ 66,550 [MRFAB = $ 48,225; VIMS matching = $ 18,325]
We are requesting salary support of 1 month for M. Fabrizio and 0.5 month for J. Lucy; VIMS will match these personnel costs. J. Lucy is requesting 0.5 month salary support because he is currently supported by MRFAB funds for 1 month on another project and salary support for PIs should not exceed 15% of their annual salary. We are requesting support for an entry-level technician to assist in conducting the work. All salaries are supplemented by the customary 30% fringe benefit rate.

Supplies – $ 21,650
Supplies requested for this project include field surgical supplies (e.g., anesthetic, sutures, tissue adhesive, gauze pads, surgeon's gloves, surgical instruments, etc.), expendable lab supplies (e.g., waterproof paper, external T-bar tags, fishing tackle, bait, epoxy, batteries for the receivers, etc.), other lab supplies (e.g., buckets, tools, electronics cleaner, coolers, measuring boards, fids, 2 tanks, etc.). Array hardware costs are estimated at about $460 per array (we propose to construct 21 arrays) and include mushroom anchor, high-strength line (such as Spectra or Amsteel), stainless steel shackles and swivel shackles, stainless steel thimbles, cable ties, etc. We are also requesting 21 temperature data loggers to be attached to each array, foul weather gear for the field crew, and software that permits communication between the receivers and a PC.

Travel – $ 6,150
Travel costs are provided for each phase of the study: deployment, transmitter implantation, and retrieval. We anticipate using two pick-up trucks for the field work: one truck to trailer the vessel to our study sites, and another truck to transport the field surgical supplies, including 2 tanks for holding fish. We estimated costs based on current vehicle and vessel rental rates for 1 day of deployment activity, 6 days of implantation activities, and 2 days of retrieval activity per site. In addition, we included a small amount to cover local travel to local meetings such as VMRC and to distribute posters to local marinas.

Printing – $ 300
A small amount is requested for design and printing of a poster instructing anglers to report catches of tagged fish.

Equipment – $ 79,100 [MRFAB = $ 40,100; VIMS matching = $ 39,000]
We originally proposed to purchase 21 receivers suitable for mooring in the marine environment for extended periods of time. As discussed with the Recreational Board additional receivers will now be purchased. These receivers will record the presence of fish in the study site and are the principal data-recording device for the project. Because they are specialized scientific research instruments, there are no sources for rental. We are also requesting funds to purchase a hand-held receiver and directional hydrophone which will permit us to check the functionality of the transmitters before and after implantation. This is a critical check that ensures that fish are released with fully functioning transmitters. Although rare, transmitters have been known to fail. The hand-held receiver and hydrophone also permit checking of transmitter identification number before the fish is released. This is an important component of the data quality assurance protocol. VIMS is willing to provide $39,000 for purchasing transmitters, but the supplier requires 60-day lead time to manufacture them in time for project initiation.

Vessel rental – $ 11,520
Vessel rental rates were calculated based on the VIMS daily rate of a larger vessel than was originally proposed. We used 1 day of deployment, 6 days of implantation, and 2 days of retrieval per site to calculate the cost of vessel rental and fuel.

Indirect costs – $ 51,519 [MRFAB = $ 21,961; VIMS matching = $ 29,558]
Facilities and administrative costs are calculated at 25% of total costs. The VIMS approved indirect cost rate is 47.45%; the remaining indirect costs are contributed as part of VIMS match for this project.