1-1-2008

Bycatch Reduction Panels Improve Catch Composition and Size Distribution of Fishes Retained in Pound Nets

Christian Hager
Virginia Institute of Marine Science

Bycatch Reduction Panels Improve Catch Composition and Size Distribution of Fishes Retained in Pound Nets

SUBMITTED TO

Virginia Marine Resources Commission
Plans and Statistics Department
2600 Washington Avenue, 3rd Floor
Newport News, Virginia 23607

BY

Christian Hager, Ph.D.
Virginia Sea Grant
Fisheries Bycatch Specialist

School of Marine Science
Virginia Institute of Marine Science
College of William and Mary
Gloucester Point, Virginia 23062

January 2008

VIMS Marine Resource Report No. 2008-01

VSG-08-01

This work is the result of research sponsored in part by NOAA Office of Sea Grant, U.S. Department of Commerce, under Grant No. NA96RG0025 to the Virginia Sea Grant Program. The U.S. Government is authorized to produce and distribute reprints for government purposes notwithstanding any copyright notation that may appear herein.

This project was financially supported by the Potomac River Fisheries Commission The author gratefully acknowledges David Bradley and William Dean for fishing expertise and Herb Austin for his contributions and advice. The project was also supported in part by the National Fisheries Service's NOAA Award #NA86FG0478. The views expressed herein do not necessarily reflect the views of any of those organizations.

Abstract

A pound net is a highly effective fish trap that captures a wide variety of recreationally and commercially important species in a large range of sizes. Fish are directed by a series of vertical barriers into a pocket or head consisting of small mesh (2″ mesh size when stretched). There, they are held unharmed until harvest. Unfortunately, due to the reduced mesh size of this chamber, a large number of sublegal fish are retained (referred to as regulatory bycatch). Past research has shown that pocket mesh size cannot be increased without drastically increasing the number of fish that become gilled in the pocket, which increases mortality and reduces catch per unit effort (CPUE). Experimental manipulations of the retention characteristics of the pocket demonstrate that retention of sublegal and undersized fish can be greatly reduced before harvest through addition of bycatch reduction panels (BRPs). Because the stationary trap design has an inherently low mortality until harvest, these alterations make pound netting an ecologically sound method of sustainable harvest. Use of BRPs reduced retention of sublegal weakfish (*Cynosion regalis*) by 83% and sublegal flounder (*Paralichthys dentatus*) by 77%, based on an assumption of equal sublegal/legal fish ratios on consecutive trial and control days. The percent of sublegal fish retained decreased by 42% and 19% respectively if no such assumption is presumed. In addition, at least 66% of bluefish shorter than 10″, 28% of spot shorter than 6″ and 100% of croaker shorter than 9″ were released when BRPs were used. These fish are legal to harvest but are of less value due to their smaller size.

Introduction

Retention of large numbers of small fish by pound-net gear has been well documented by prior investigators (Hildebrand and Schroeder 1929, McHugh 1960, Massman 1963, Meyer 1976, Austin et al. 1998). Some authors have even gone so far as to suggest that mortality of sub-adult weakfish due to the gear's design flaws has been a major factor contributing to weakfish stock reductions (Higgins and Pearson 1928). The Potomac River pound net surveys of 1996 and 1997 again highlighted how large the gear's retention of undersized weakfish (*Cynosion regalis*) and summer flounder (*Paralichthys dentatus*) can be. Surveys suggested that the mean length of weakfish landed (302.1mm) was below the minimum legal size (305mm), and although the mean flounder (356.6mm) exceeded the minimum length limit (355mm), it only barely did so and this mean was likely skewed by retention of a few very large fish (Austin et al. 1998). In light of weakfish declines, the ASMFC set a goal of reducing weakfish bycatch by 33% in Amendment four to the Weakfish Management Plan (Lockhart et al. 1996). Amendment four went on to state that any fishery that did not comply with minimum sizes limits would be closed. Since the catch-size distributions documented by Austin et al. in 1996 and 1997 (1998) of both weakfish and flounder demonstrated that a large number of undersized fishes were being landed, The Potomac River Fisheries Commission requested that VIMS researchers conduct a cooperative research effort with several pound-net fishers to engineer a solution to reduce retention of such sublegal fishes.

A pound net is a large gear that at times can result in significant catches (Figure 1). When fish are harvested, the pocket section of the net is pulled from the water from the windless side, herding the fish into one of the windward corners of the gear, a process called brailing. Once fish are pushed into this reduced area they are bailed into the boat in bulk using dip nets. Only when the entire net is emptied does culling begin. At this point most small fish have fallen between the larger ones and are crushed by the weight of the catch. Even if they are not crushed, the time it takes to get to them makes survival questionable at best. In trials where weakfish were pulled directly out of the net and released, mortality was determined to be approximately 18% (Swihart et al. 1995). With such a low survival rate under ideal conditions, for any gear engineering solution to significantly reduce bycatch mortality the design needs to release these sublegal and undersized fish prior to harvest. The ideal strategy would be to release fish passively before harvest to reduce stress.

Previous research efforts that enlarged the pocket's mesh size to enable smaller fish to escape resulted in excessive gilling and mortality and thus greatly reduced the quality of landed fish. Not only was the quality of landed fish negatively affected but the catch-per-unit-effort (CPUE) was significantly decreased because total harvest time was augmented. In fact, effort increased so much that gear efficiency became unacceptable to the fishing community (Houston 1929, Meyer 1976). Subsequent gear alteration experiments, which placed panels of enlarged mesh sizes in the pocket's sides, failed to achieve significant release of weakfish as well and resulted in no release of flounder (Gearhart 1998, Boyd 1996).

Experiments to determine ring and slot sizes that would effectively cull sublegal weakfish and flounder from the pocket and which combination of these designs maximized release began in 1998 (for more details see Hager 2000). Research continued into 2001 to reduce the bulk and cost of the device, test effects of resulting alterations in panel design and placement on release efficiencies and then continue alterations to maximize release efficiencies. Because each successive experiment grew out of the previous one's findings, methods, results and discussion for each round of experiments are presented by year in chronological order.

Methods, Results and Discussion

1998

The first bycatch reduction device (BRD) tested (Figure 1) took advantage of the funneling characteristics inherent to the gear and directed fish towards various sorting grids or panels (Figure 3) placed at the end of a funnel attached to the side and bottom of the pocket on the offshore side. Panels where constructed of round iron bars formed into rectangles and rings of specific and standard sizes. Round bars were selected as culling collars to minimize friction and resulting slime coat removal from escaping fishes. The BRD's location near the net's intersection with the river's bottom was selected because previous soft grids tested in mid-water locations (Gearhart 1998, Boyd 1996) resulted in poor weakfish release. In addition, this project's BRD was also being designed to provide for release of undersized flatfish known to stay near or on the bottom. This initial BRD design was never intended to be applied to the fishery due to its bulk and expense. It was selected because its construction maximized exposure to interchangeable panels (Figure 2) of varied dimensions and recaptured escaping fish in an external fyke. This approach provided a direct means of assessing and refining the species-specific size selectivity of rings and slots independently and in unison.

Not surprisingly, rings provided a more efficient shape for the release of weakfish and slots a more efficient shape for the release of flounder. Use of the panel containing both resulted in significant release of both sub-legal weakfish (73%) and flounder (86%), based on jack knife simulations of odds of release ratios between days given recorded catch size distributions (Hager, 2000). Unfortunately, the original 2" diameter ring and 5.125″" x 1.125″ slot also allowed release of 6% of the legal weakfish and 39% of the legal flounder. Subsequent tests of rings and slots with refined dimensions (1.875″ in diameter, 5.125″x .875″) released weakfish to 12.25″, a quarter of an inch beyond minimum legal size, and flounder to 13.6″, slightly less than the legal size of 14″. Size-selectivity improvements resulting from dimensional refinements lead to the development of subsequent bycatch reduction panels (BRPs) and release efficiency research in the following years.

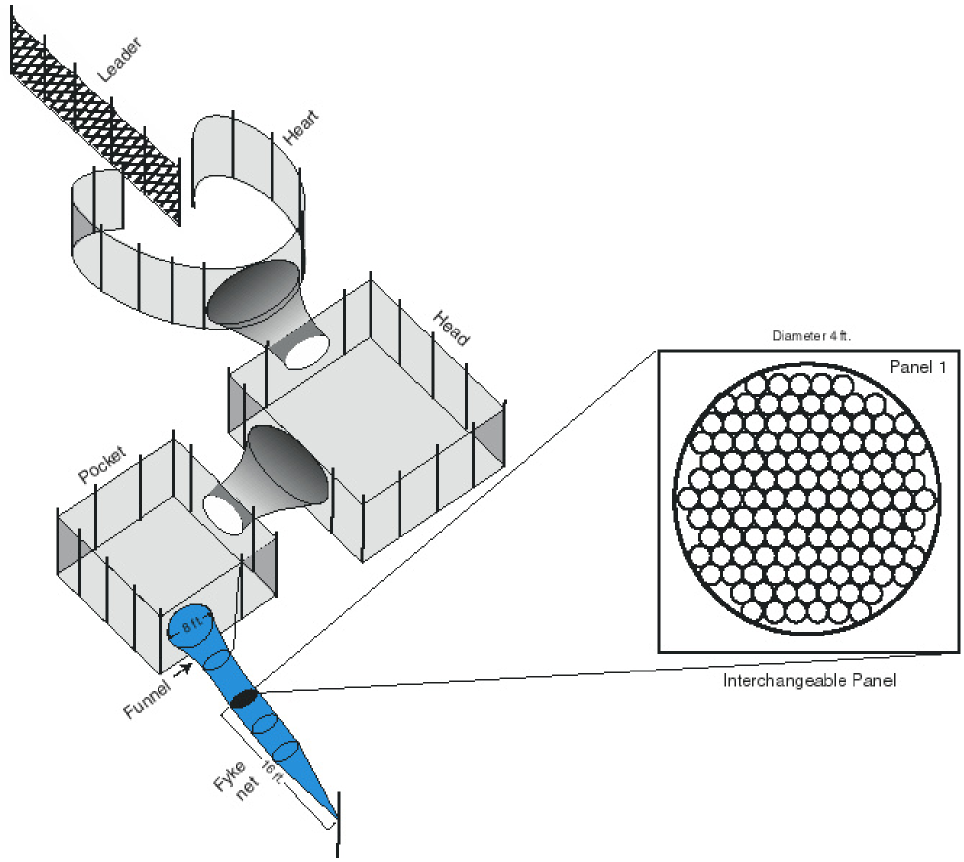

Figure 1. The shaded bycatch reduction device above was used to determine correct ring and slot sizes so that release of sublegal fish was maximized and legal fish minimized. Species-specific size distributions of catch and panel use were determined based on fishes retained in the pocket and fyke net portion of the device. Recapture of the escaping fish also provided an easy means of demonstrating selectivity to cooperating fishers.

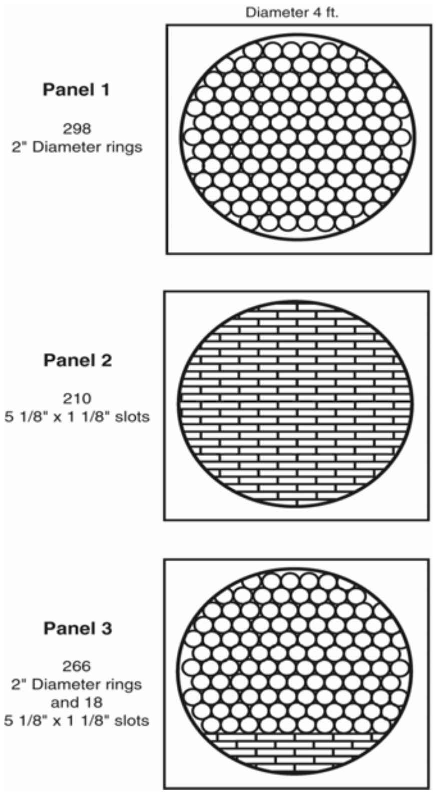

Figure 2. The three grid designs tested in 1998 provided a means of determining selectivity of rings and slots independently and in unison. The panel with reduced ring sand slot dimensions that was tested in a pilot study a the end of 1998 resembled panel three in design.

1999

In 1999, the bycatch reduction device was replaced with bycatch reduction panels (BRP) that were greatly reduced in size compared to the original BRD panels. Three BRP configurations (Figure 3) were examined and cumulative release efficiencies compared to determine the most effective design. Designs varied in total ring and slot number and panel placement in the pockets walls (Figure 4). Panel were again constructed of rings and slots made of round stainless steel rods. Data on each design's release performance was attained by testing a given design in the gear for a twenty-four-hour period and comparing resulting legal-to-sublegal fish ratios to ratios from consecutive control periods of equal duration when no panels were in use. Ratios across test and control days for like design trials were summed to determine cumulative release efficiencies (ratios) for each design. In order to minimize the effects of alterations in fish size distributions due to seasonal effects, paired days (test and then control) for each design were chosen randomly during the field season. Significance of each design's release rates was determined by comparing differences in sublegal-to-legal fish ratios between test and controls using Chi square analysis. A day open–day closed research design was preferable because a paired gear analysis is not reasonable given the gear's fixed nature and the catch variability which often occurs between fixed gears due to natural and uncontrollable spatial and temporal parameters known to effect catch rates and potentially the size distributions of such fishes.

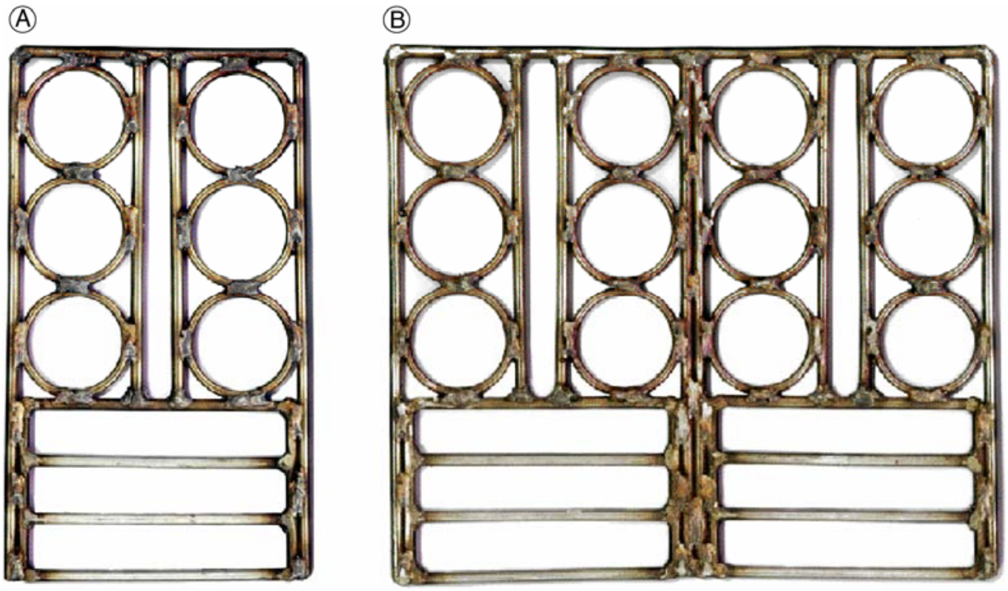

Figure 3. The panels tested in 1999 consisted of 1.875″ diameter rings and 5.125″x .875″ slots. Both were constructed of round stainless steel bars to reduce friction on released fishes. Ring and slot sizes were based on the performance of and refinement of panel openings tested in 1998.

Panels were constructed of round stainless steel bars, and ring and slot dimensions were based on those that had proven effective at size selection in the 1998 pilot study. Panels were also designed to be sewn directly into the pocket's corners without weakening the gear's construction. Panels were also placed at right angles to one another (Figure 5) in order to maximize passive release under varied tidal conditions and active release during brailing. Brailing is the procedure that reduces the head area slowly and pushes fish to one side of the net so that they may be bailed into the landing vessel. Brailing occurs in a variety of directions depending on tidal flow and wind conditions.

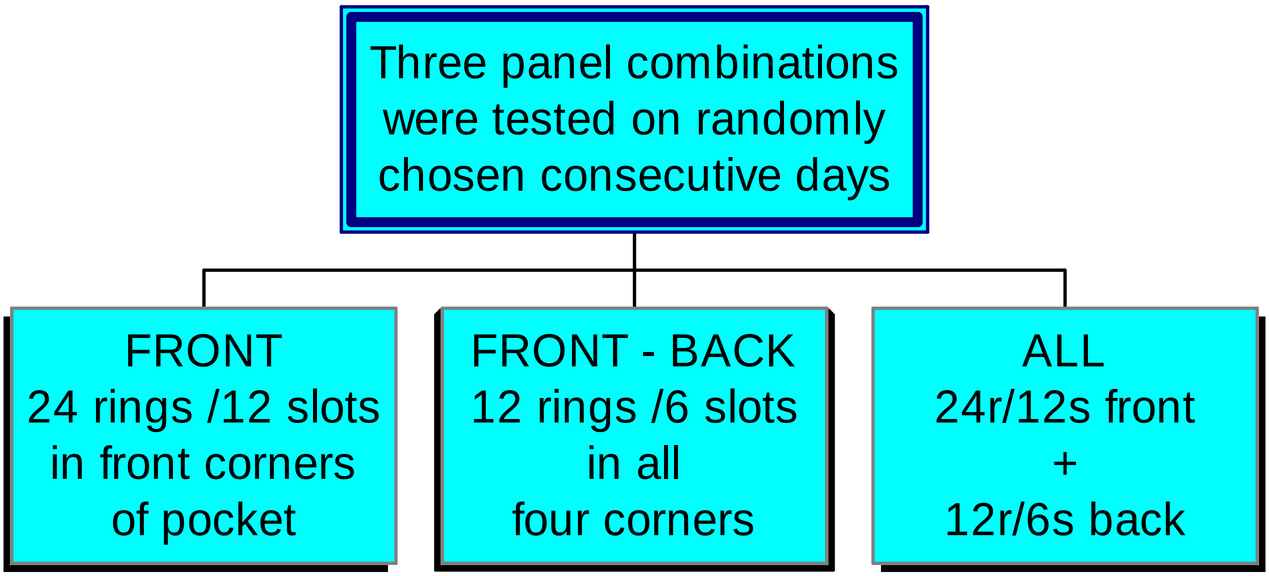

Figure 4. 1999's BRP designs varied in total ring and slot number as well as in panel location within pocket. Panels containing 48 rings and 24 slots in total where used in both design one and two (numbered from left to right in illustration above). Distribution and panel size varied. Design three consisted of 72 rings and 36 slots in total and panels were placed in all four corners. Ring and slot distribution was unequal, with the offshore/front side of pocket containing twice the number of ring and slots as the inshore/back side.

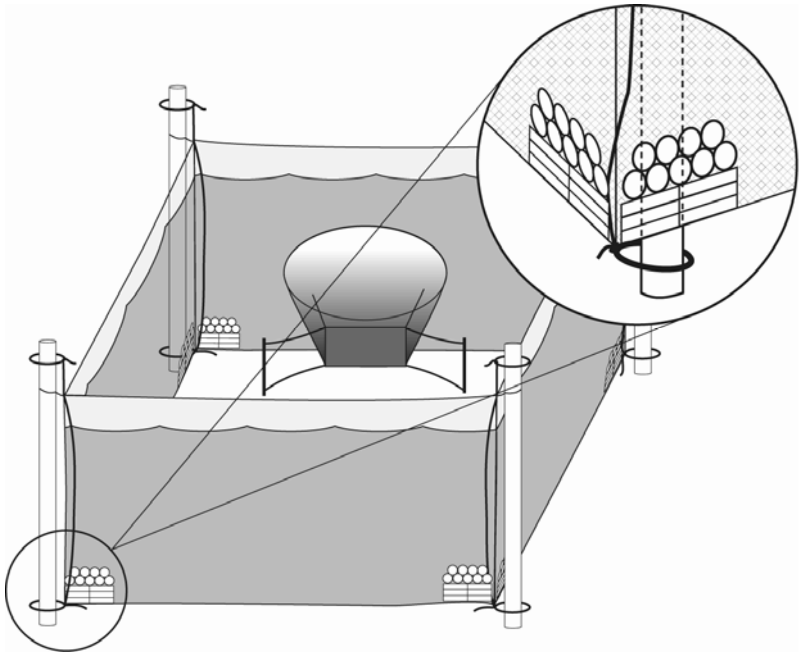

Figure 5: This illustration is an example of correct placement of BRPs so that they intersect corners and bottom of pocket.

Design three (see Figure 4) provided the highest release efficiency for all species examined, based on sublegal-to-legal fish ratios between test and control days. Simple regression comparisons showed a positive linear relationship between release efficiency and release-opening number with regard to weakfish (rings) and flatfish (slots) respectively, therefore, it is likely the third design provided greater release simply due to its increased number of potential escape routes. Use of the third BRP design reduced sublegal weakfish retention from 67% to 39%**.** The percent of retained summer flounder that were sublegal was reduced from 96% to 82%. Both improvements in proportion of legal fish retained were significant ($P < 0.05$) based on chi-square analysis of sublegal/legal ratios between days. If an equal ratio of sublegal to legal fish is assumed to have encountered the net and been retained in the pocket on trial and control days, 68% of sublegal weakfish and 84% of sublegal flounder were released. Size improvements were also noticed in species for which no minimum size limits existed. All croaker shorter that 9″ were released, 28% of the spot shorter than 6″ were released and 66% of the bluefish smaller than 10″ were released. Again these reduction percentages are based on an assumption of ratio equality between consecutive days. No fouling was witnessed in either the rings or slots. In fact, fish use of both kept the stainless steal clean from any sort of growth though out study.

2000-2001

In 2000, research focused on engineering a less expensive BRP and testing it to assure maximum release efficiency. A polymer that could withstand the rigors of fishing was chosen and the panel designed so that it could be sewn directly into the pocket walls. Ring number was increased to maximize release of fusiform fishes. The polymer construction replaced the expensive stainless steel but rings and slots were still made of round bars to minimize friction. The resin composition was varied once to improve resilience and the mix subsequently successfully tested for flexing and weight bearing under cold-water conditions.

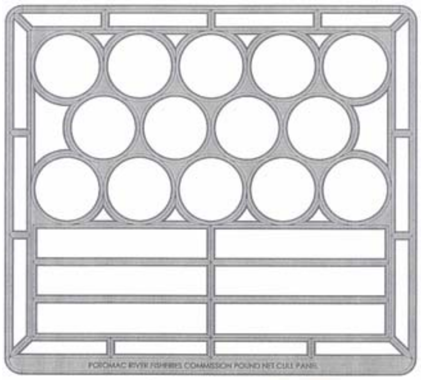

Figure 6: BRP version tested in 2000-2001

In 2000-2001 trials, eight matching panels (Figure 6) were sewn into all four corners of the pocket at ninety degree angles to one another. Total ring number in the pocket was increased to 112 and slot number to 48. Panels of equal ring and slot number were placed in the offshore and inshore sides of the pocket intersecting the bottom of the pocket (Figure 5).

Field testing started in the fall of 2000 and continued in the spring of 2001. A paired day open–day shut methodology with standardized twenty-hour set times was again used. Augmentation of the total number of escape openings was predicted to reduce pound-net catches of sublegal flounder by 19% and catches of illegal weakfish by 44% based on the linear relationships seen in 1999 between release efficiency and ring and slot number.

The 2000-2001 design reduced retention of sublegal weakfish by 83% and sublegal flounder by 77%, based on an assumption of equal sublegal-to-legal fish ratios on consecutive trial and control days. The percentage of weakfish and flounder retained that were sublegal decreased by 42% and 19%, respectively, if no such assumption is presumed. This reduction in sublegal weakfish retention of 42% far surpassed the Amendment 4 goal of 30%. Chi-square analyses of alteration in catch ratios were significant, $P < 0.001$ and 0.03 respectively.

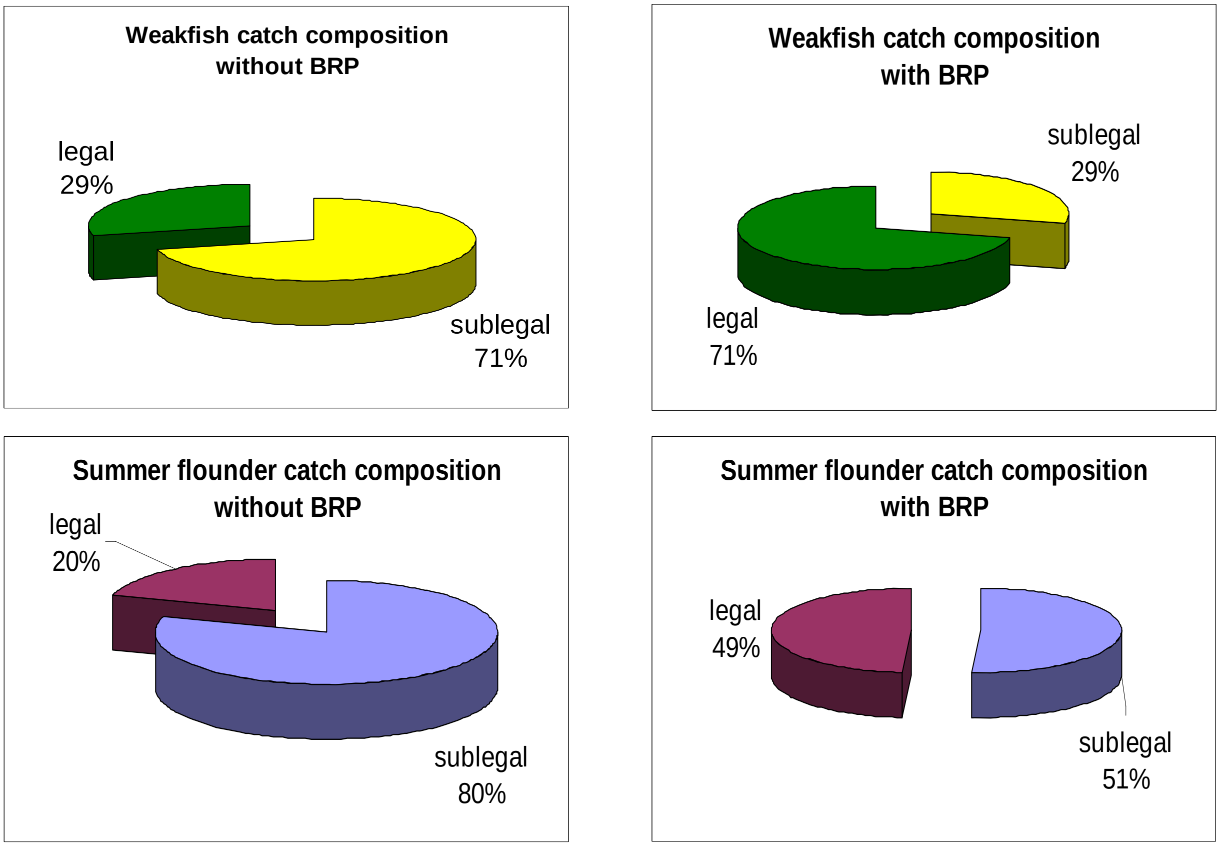

Figure 7: BRP use in 2000-2001 again substantially reduced the retention of sublegal weakfish and flounder.

The gear engineering and subsequent tests that occurred during this research demonstrate the power of cooperative research efforts. Pound nets provide an efficient means of harvesting large numbers of fishes but does not negatively affect habitat like mobile gears. In addition, research suggest that the protected species interactions that have discouraged expansion of this fishery can be eaily solved with leader alterations that do not significantly reduce harvest of targeted species (ASMFC, 2008). With the addition of BRPs the gear can be both highly effective and selective. Such gear characteristics are of growing importance to the sustainability of our marine resources and should be carefully considered by marine resource managers before fishers are encouraged to move into alternative gears with bycatch problems that are less easily resolved. .

Citations

ASMFC (Atlantic States Marine Fisheries Commission). 2008. Fishing Gear Technology Work Group, 2008 Report to the Management & Science Committee, ASMFC, Washington, D.C.

Austin, H., Hovel k., Connelly, W., and A. Goodnight 1998. Potomac River Pound-net Survey, Dept. Fisheries, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point, Virginia.

Boyd, D. 1997. Bycatch Reduction in the Pound net Weakfish Fishery Through the Use of Escape Panels., SK Narrative. Virginia Marine Resource Commission, Newport News, Virginia.

Gearhart, J., 1998. Selectivity of square mesh escape panels in the sciaenid pound net fishery of North Carolina., A final report presented to North Carolina Sea Grant, North Carolina Division of Marine Fisheries, Beaufort, N.C.,

Hager C. H. 2000. Efficiency of Pound-net Cull Panels: A Comparison of Size Selectivity and Relative Release for Weakfish and Summer Flounder, M.A. Thesis, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point Virginia.

Higgins, E. and J.C. Pearson 1928. Examination of the summer fisheries of Pamlico and Core Sounds, N.C., with special references to the destruction of undersized fish and the protection of gray trout, *Cynosion regalis*, Report U.S. Commission of Fisheries for 1927: 29-65.

Hildebrand, S. F. and Schroeder, W. C. 1929. *Fishes of the Chesapeake Bay*. Bulletin of the United States Bureau of Fisheries, Vol. 18, part1.

Houston, H.R. 1929. Biennial report to the Commission of Fisheries of Virginia for 30th and 31st years, July 1, 1927 to June 30, 1929. Division of Purchase and Printing, Richmond Va.

Lockhart, F., R. W. Laney and R. O' eilly. 1996. Amendment #3 to the Interstate Fishery Management Plan for Weakfish. Fishery Management Report No. 27 of the Atlantic States Marine Fisheries Commission.

Massman, W.H. 1963. Age and Size Composition of Weakfish, *Cynosion regalis*, from pound nets in the Chesapeake Bay, Virginia, 1954-58. Cont. No.128 of VIMS, Gloucester Point, Virginia.

Mc Hugh, J.L. 1960. The pound net fishery in Virginia. Part 2. Species composition of landings reported as menhaden. Comm. Fish Rev. 22(2): 1-16.

Meyers, H.L. 1876. Retention and escape characteristics of pound nets as a function of pound head mesh size. M.A. Thesis, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point Virginia.

Swihart, G.L., L.B. Daniel and M. Swihart 1995. Evaluation of release mortality from recreational hook-and-line fishery and a commercial pound-net fishery on Weakfish (*Cynosion regalis*). U.S. Fish and Wildlife Service, Gloucester, Va.