

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

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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. The 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, in 1996 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. In light of catch-size distributions documented by Austin et al. in 1996 and 1997 (1998) of both weakfish and flounder, 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.

Previous research that focused on reducing retention of small fishes by enlarging all of the head's stretched mesh size demonstrated that excessive gilling and mortality resulted, thus reducing the quality of landed fish. In addition, this alteration significantly increased total harvest time, thus greatly reducing CPUE by increasing effort to a level that was unacceptable to the fishing community (Houston 1929, Meyer 1976). Gear alteration experiments which placed panels of enlarged mesh sizes in the pocket's sides, did not achieve significant release of weakfish and resulted in no release of flounder (Gearhart 1998, Boyd 1996).

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 under ideal conditions, any effective gear engineering solution needs to be designed to release sublegal and undersized fish prior to harvest. The ideal strategy would be to release fish passively before harvest to reduce stress and then remove any remaining undersized fish actively during harvest in order to maximize release.

Experiments to determine the correct ring and slot sizes to cull sublegal weakfish and flounder and maximize release efficiency began in 1998 (for more details see Hager 2000). Experiments continued into 2001 to reduce the bulk and cost of the device and fully test minor alterations to panel design and 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. A location near the net's intersection with the bottom was selected because previous grids placed in mid-water locations resulted in poor weakfish release (Boyd 1997) and also because this BRD was designed to provide release of undersized flatfish known to stay near or on the bottom. This first BRD design was never intended to be applied to the fishery due to its bulk. 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.

The use of this BRD resulted in significant release of illegal weakfish (73%) and flounder (86%), based on jack knife simulations of odds of release ratios between days (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.

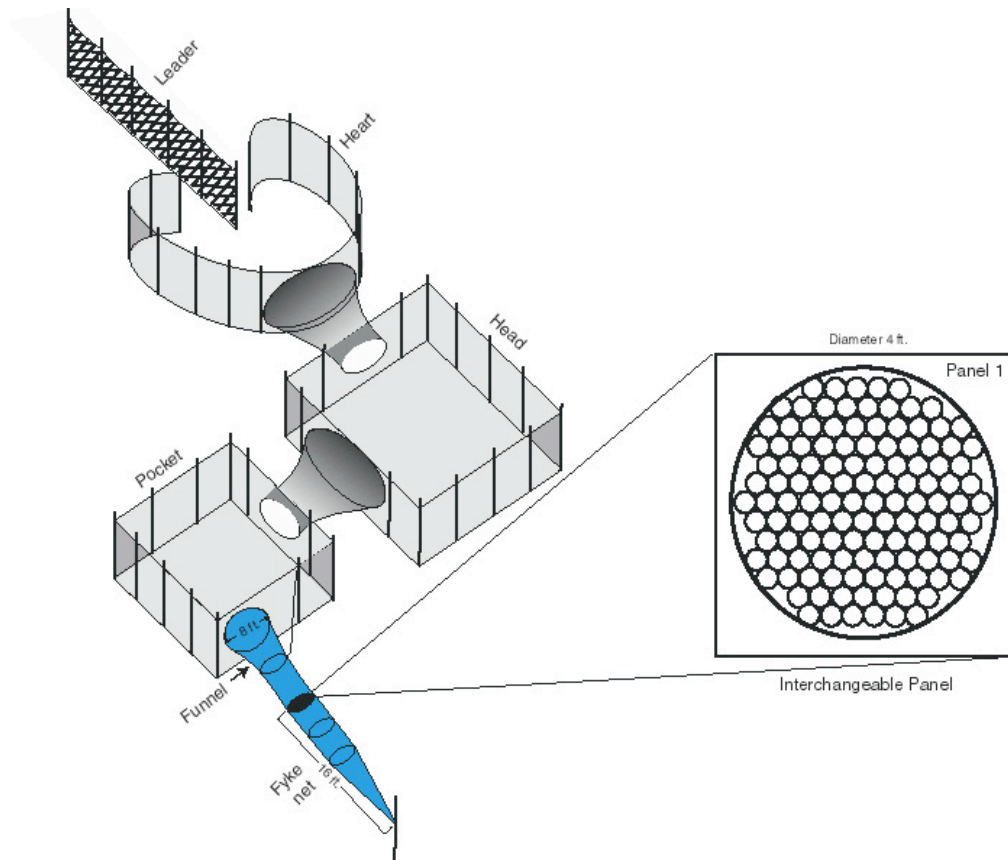


Figure 1. The shaded bycatch reduction device above was used to determine correct ring and slot sizes so that release of sublegal fish was maximized and legal fish minimized. Species-specific size distributions were easily determined because fish escaping the pocket were retained in the fyke net portion of the device. Although release efficiency was also determined, it was recognized from the start of this test that this device was far too bulky to be applied to the fishery in general. Recapture of the escaping fish also provided an easy means of demonstrating selectivity to cooperating fishers.

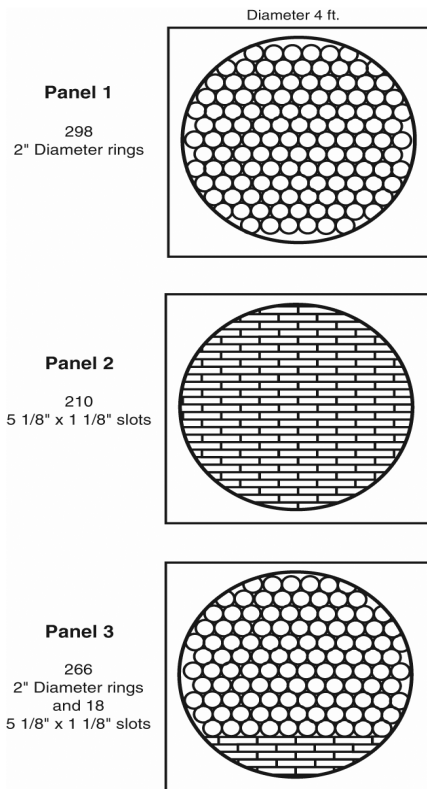


Figure 2. The three grid designs tested in 1998 provided a means of determining selectivity of rings, slots and a combination of both.

1999

In 1999, the bycatch reduction device was replaced with bycatch reduction panels (BRP) that were greatly reduced in size compared to the 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). 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. Ratios were then summed across like design trials to determine cumulative release efficiencies 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 difference in legal-to-sublegal fish ratios to ratios occurring during control trials using Chi square analysis. This day open-day closed methodology was selected because a paired gear analysis is not possible due to the fixed nature of the gear and the varied catches which often occur between gear sites.

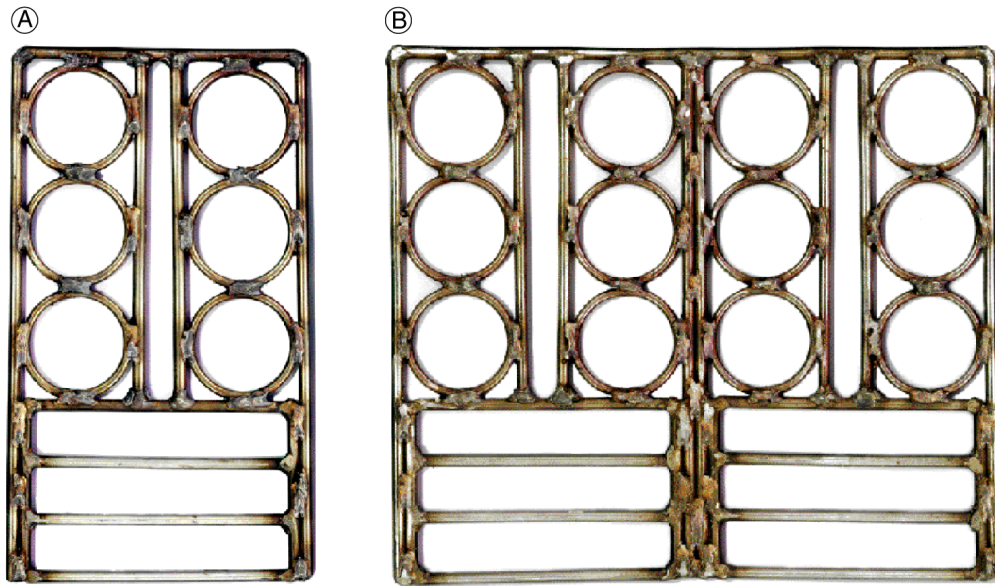


Figure 3. The panels tested in 1999 were constructed of stainless steel. Ring and slot sizes were based on the experimental panel tested at end of 1998 that restricted escape of the majority of legal fishes.

Panels were constructed of stainless steel, 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 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.

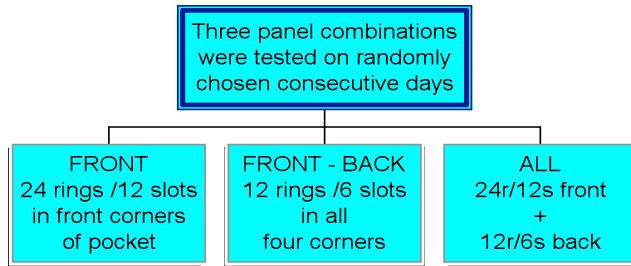


Figure 4. 1999's BRP designs varied in total ring and slot number as well as in panel location within pocket. Panels containing 48 rings and 24 slots in total were used in both design one and two (numbered from left to right in illustration above). Distribution and panel size varied. Design three consisted 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.

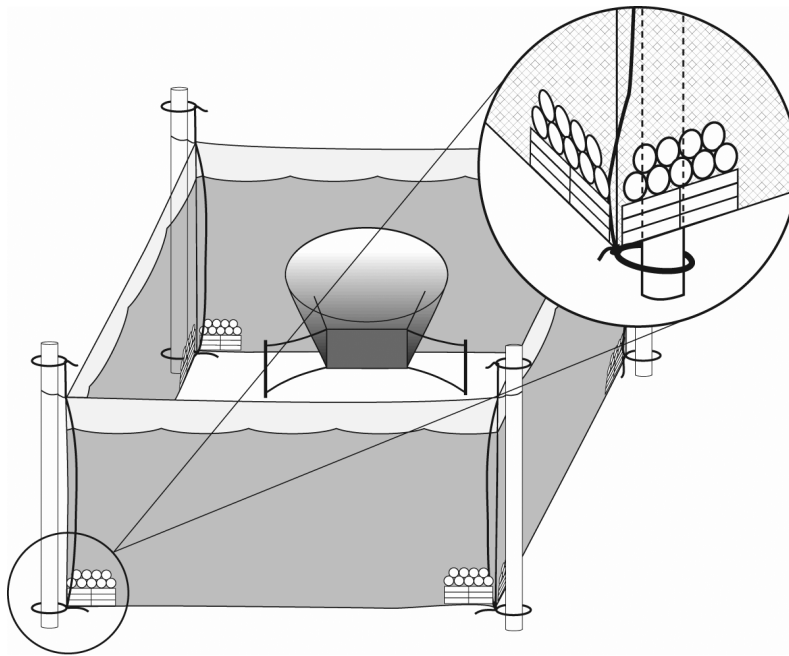


Figure 5: This illustration is an example of correct placement of BRPs so that they intersect corners and bottom of pocket.

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 simple 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 than 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.

2000-2001

In 2000, research focused on engineering inexpensive BRPs consisting of a polymer that can withstand the rigors of fishing and be sewn directly into the pocket walls. Ring number was also increased to improve release efficiencies for fusiform fish. Stainless steel was replaced by an inexpensive, mass-producible black panel made of high-density polyester resin. Different resin mixtures were tested for resilience under severe stress due to flexing and for weight bearing under cold-water conditions.

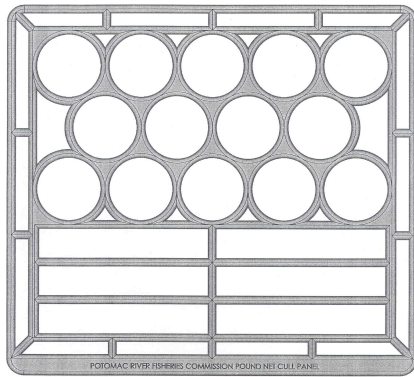


Figure 6: BRP version tested in 2000-2001

In 2000-2001 trials, eight matching panels (Figure 6) were sewn into all four corners of the pocket at ninety degrees. 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.

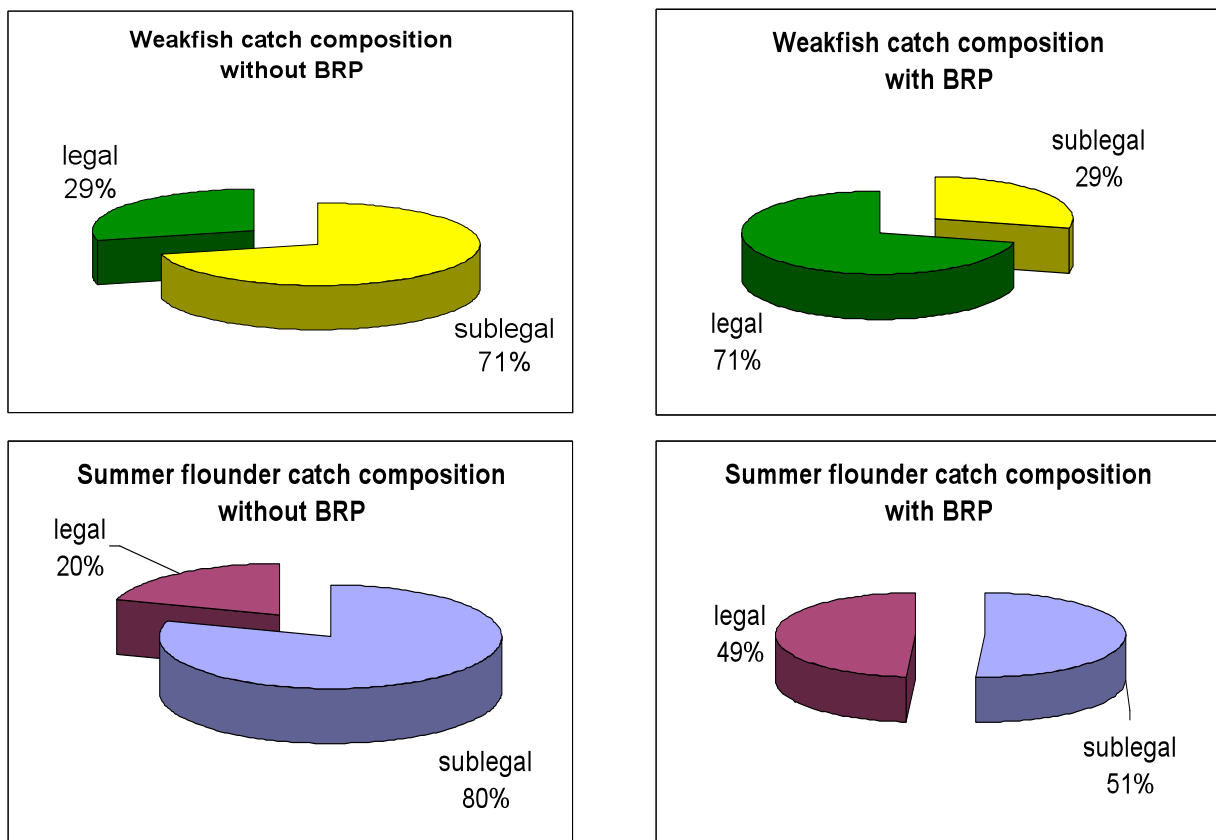


Figure 7: BRP use in 2000-2001 again substantially reduced the retention of sublegal weakfish and flounder.

The gear engineering and subsequent tests that occurred during this research demonstrate the power of cooperative research efforts. Use of this passive pound net gear minimizes habitat alterations and 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. .

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