Proposal Submission to

The Virginia Marine Resource Commission
Recreational Fishing Advisory Board

By

The Virginia Institute of Marine Science
College of William & Mary

Patterns in Prey Selectivity of Key Sportfishes in Chesapeake Bay

BUDGET PERIOD: 2014

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PRIORITY AREA ADDRESSED Research	**PROJECT LOCATION** VIMS

DESCRIPTIVE TITLE OF PROJECT

Patterns in Prey Selectivity of Key Sportfishes in Chesapeake Bay

PROJECT SUMMARY

Recreational fisheries for striped bass, summer flounder, and weakfish support multi-million dollar industries within the Chesapeake Bay. Despite their socio-economic importance along the Atlantic coast and the potential for these species to impact prey populations, no studies to date have quantified prey size selectivity or prey type selectivity within the Chesapeake Bay. One goal of the Chesapeake Bay Multispecies Monitoring and Assessment Program is to quantify major links in the Bay's food web for numerous recreationally important species. The objectives of our 2014 work are to build on previous years successes by completing the following: 1. continue diet composition analyses for priority species, 2. determine prey availability in the environment and calculate prey size and prey type selectivity patterns, 3. extend outreach efforts to educational groups, conservation groups (e.g. Coastal Conservation Association), and state management groups (e.g. VMRC) to assist in sustainable recreational fishing practices.

EXPECTED BENEFITS

Understanding patterns in prey selectivity of key sportfishes will provide increased understanding of the importance of specific prey groups/sizes within the Chesapeake Bay, thus aiding regional management strategies and recreational fishing practices. Additionally, prey availability patterns obtained from the proposed study can be used for similar analyses on other recreationally important fishes (e.g. Atlantic croaker, black sea bass, bluefish).

COSTS

January 1, 2014, through December 31, 2014
VMRC Funding: $38,446
VIMS Funding: $5,844
Total Cost: $44,289

detailed budget included with proposal

INTRODUCTION

Recreational fisheries for striped bass (*Morone saxatilis*), summer flounder (*Paralichthys dentatus*), and weakfish (*Cynoscion regalis*) support multi-million dollar industries within the Chesapeake Bay region. The distribution of these fishes overlap, typically ranging from Maine to Florida, and they are all seasonally abundant within the bay. The predatory effects of fishes are important in structuring prey communities (Rudershausen et al., 2005), and numerous studies have examined the dietary composition for striped bass, weakfish, and summer flounder (Latour et al., 2008; Walter and Austin, 2003; Hartman and Brandt, 1995). Moreover, research on predator diets is critical for understanding trophic interactions and thus successfully developing ecosystem-approaches to fisheries management (Livingston, 1985). Despite the importance and widespread distributions of striped bass, summer flounder, and weakfish along the Atlantic coast, no studies to date have investigated or quantified fish predator selectivity in relation to prey size or prey type, which constitutes a notable gap in our understanding of food web interactions in the bay.

Knowledge of trophic interaction patterns is essential to address many ecological and conservation issues of societal importance in marine ecosystems (Albaina et al., 2010). Evidence suggests that anthropogenic changes in marine habitats may alter trophic structures, production, and composition of fish and invertebrate communities (Kemp et al., 2005). However, our ability to detect changes in marine food webs is, in many instances, very limited. Information on the seasonal availability and abundance of prey groups within the bay is necessary to understand patterns in prey selectivity of key predatory fishes. This type of information significantly aids our ability to quantify effects of anthropogenic stressors on food web interactions.

Determining prey selectivity patterns requires long-term time-series monitoring programs that investigate the diets of predatory fishes as well as relative abundance estimates of prey groups. The Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP) has been conducting fishery-independent bottom trawl surveys on the geographic and seasonal distribution of priority species, as well as quantifying major links in the bay's food web through stomach content analyses. The ChesMMAP survey utilizes a random stratified sampling design to collect biological and ecological data on late juvenile and adult fishes in the bay mainstem (Fig. 1). The program has been ongoing since 2002 and research cruises are conducted bimonthly (March, May, July, September, and November annually) with approximately 80 sampling sites per cruise.

To determine the impact of prey selectivity on the diets of fishes collected on ChesMMAP research cruises, we propose to deploy benthic and pelagic prey sampling devices during regular surveys. A major goal of ChesMMAP is to understand factors that influence the diets of recreationally important fishes, such as striped bass, summer flounder, and weakfish, both spatially and temporally. Research on prey selectivity would aid our understanding of

overall ecosystem functioning within the Chesapeake Bay. Furthermore, prey selectivity analyses would further inform anglers about what these important recreational fish species are consuming, when and where they are doing so, and lend insight as to why they are feeding on specific prey types.

IMPORTANT FINDINGS TO DATE

Given that we propose to utilize the ChesMMAP sampling platform for this project, it is important to provide a brief summary of extant predator-prey information. Since 2002, a total of 2498 striped bass stomachs have been analyzed for diet composition (Fig. 2). Results of diet analyses from ChesMMAP differ markedly from previous dietary studies within the Chesapeake Bay. Fish represented the largest taxonomic group in the diet of striped bass by weight (42.9%), followed by crustaceans (29.1%) and worms (15.5%). Among fish species, ChesMMAP consistently found that bay anchovy contributed the highest proportion by weight (16.9%) with Atlantic menhaden ranking second (9.5%). In stark contrast to previous studies (Griffin and Margraf, 2003; Hartman and Brandt, 1995), mysids and amphipods combined represented 22.3% of striped bass diet by weight. The influence of prey selectivity or availability may explain these differences and warrants further investigation.

Over 2700 summer flounder stomachs have been processed for dietary information since 2002 (Fig. 3). Fish represented a slight majority (52.3%) of the diet by weight, with the primary prey being bay anchovy (17.7%), weakfish (9.6%), and spot (8.3%), and crustaceans represented 43.9% of the diet by weight. Crustaceans characterized 63.7% of the diet by number, with the main prey types being mysids (48.2%), sand shrimps (6.9%), and mantis shrimps (4.8%). The high prevalence of fish in summer flounder diets, especially for larger individuals, provides evidence for the consideration of this species as a top predator in the Chesapeake Bay along with striped bass, bluefish, and weakfish (Latour et al., 2008).

A total of 4784 weakfish stomachs have been analyzed for diet composition since 2002. Fish dominated the diet by weight (57.6%), with bay anchovy being the most common fish prey species (Fig. 4). Similar to summer flounder, crustaceans comprised nearly two-thirds (63.2%) of the diet of weakfish in Chesapeake Bay as measured by number, and were dominated by mysids (54.7%). The importance of menhaden was relatively low in the diet (2.9% by weight) when compared with previous dietary analyses (Hartman and Brandt, 1995). Similar to striped bass, the influence of prey selectivity is unknown for weakfish and may account for some of the discrepancies between studies.

The most notable success of the ChesMMAP survey is the long-term monitoring of biological and ecological patterns of numerous socio-economically important fish species, which have ultimately aided regional management strategies. Additionally, due to the large amounts of data generated by ChesMMAP, there is high potential for ancillary 'value added'

research that can further improve our knowledge of fish populations within the Chesapeake Bay.

PROJECT GOALS

1. Estimate prey availability and determine selectivity patterns of predatory fishes

We proposed to deploy a pelagic macroplankton trawl and an epibenthic sled (500 μm) at all locations sampled by ChesMMAP in 2014 to determine relative abundance of various prey groups throughout the sampling year, and to estimate prey selectivity patterns for striped bass, summer flounder, and weakfish.

2. Expand outreach efforts to educational, conservancy, and government groups working toward sustainable recreational fishing practices for striped bass, summer flounder, and weakfish

We intend to expand outreach efforts to disseminate ChesMMAP related data and information collected with this study to educational groups, and other bay state management groups (e.g., Maryland Department of Natural Resources) to enhance bay-wide understanding of feeding patterns in striped bass, summer flounder, and weakfish. Additionally, we intend to interact with conservation groups, such as the Coastal Conservation Association, to assist in the dissemination of findings from the proposed study.

METHODS

GOAL 1. Large-scale spatial and temporal sampling efforts for striped bass, summer flounder, weakfish, and their prey utilizing the ChesMMAP survey to determine dietary composition and prey selectivity patterns. To achieve this goal, the methodological steps will involve: 1. collection of predatory fishes; 2. collection of prey groups for abundance estimates; 3. identification of stomach contents of predatory fishes; 4. general diet description; and 5. quantitatively determine prey selectivity patterns.

1. Collection of predatory fishes

Sampling of striped bass, summer flounder, and weakfish will follow the ChesMMAP survey protocols that have proven successful for collecting these fishes (Latour et al., 2008). Specimens will be collected during regular surveys utilizing a 13.7 m 4-seam balloon otter trawl towed for 20 minutes at approximately 6.5 km h^{-1}. The catch from each tow will be sorted and individual fork lengths will be recorded. Stomachs will be removed at sea from a subsample of each species and preserved for subsequent identification of stomach contents at the VIMS Multispecies Research Laboratory.

2. Collection of prey groups

Two methods of prey collection will be incorporated into routine ChesMMAP sampling protocols to estimate the amount of prey available to predatory fishes. The first method will involve deploying a pelagic macroplankton net to sample a wide range of prey groups that reside in the upper water column. Initially, day/night tow comparisons will be performed to determine the influence of diel patterns on pelagic prey abundance. The second prey collection methodology will involve deploying an epibenthic sled (500 µm) to sample prey items that reside near the benthos and are important in the diets of the targeted predatory fishes (e.g. mysids, worms). All prey will be preserved at sea for further laboratory analysis where each will be identified, enumerated, and measured. Each sampling technique will involve towing the gear at a speed of 2 knots for a set duration of time in an effort to standardize prey abundance estimates.

3. Identification of stomach contents

The identification of predatory fish stomach contents will continue to follow standard ChesMMAP procedures. The contents of each stomach will be removed and identified to the lowest taxonomic resolution possible. Due to the lack of retention of prey in the large mesh of the otter trawl, prey encountered in the esophagus and buccal cavity will be included for identification and subsequent analyses. Conversely, prey encountered in the intestines will be ignored due to difficulty in identifying highly decomposed prey items. All prey items will then be sorted, measured, and a wet weight (0.001 g) of each will be documented.

4. General diet description

Several diet composition indices (% contribution by weight, % contribution by number, and % frequency of occurrence) will be calculated to identify primary prey in the diets of striped bass, summer flounder, and weakfish within the mainstem Chesapeake Bay. Since ChesMMAP trawl collections yield a cluster of fish at each sampling location, dietary indices will be calculated using a cluster sampling estimator (Latour et al., 2008; Buckel et al., 1999).

5. Quantitative prey selectivity determination

Prey type selectivity by striped bass, summer flounder, and weakfish will be determined by comparing the proportional contribution of each prey type in the predatory fish diets with the proportional abundance of that prey type in the environment. Prey taxa used for selectivity calculations will be determined by selecting the most important prey types for each predatory fish species. Chesson's (1978) index has been commonly used to measure preference in selective predation (Jacobs et al., 2013, Rudershausen et al., 2005) and will be utilized in the proposed study. One benefit of Chesson's index that is that it allows for temporal comparisons among selectivity values even if the relative abundance of prey types in the environment

changes (Chesson, 1983). Prey size selection will be determined by comparing monthly length-frequency distributions of prey types consumed by the targeted predatory fishes with the length-frequency distribution of the prey captured by the macroplankton trawl or the epibenthic sled.

GOAL 2. Expand outreach to include educational, conservancy, and bay state management groups

Many educational groups routinely visit the VIMS Multispecies Research Laboratory to learn about the major fisheries within the Chesapeake Bay. Implementation of sustainable fishing practices requires a unique partnership between scientists and current/future recreational fishers. One of our main efforts will be to expand outreach efforts to include local schools and the State Council for Higher Education to highlight trends in the feeding ecology of key sportfishes of the Chesapeake Bay.

The ChesMMAP survey regularly contributes fishery-independent data to state and federal groups to aid in the management of a variety of species. Results obtained from the proposed study will provide additional predator dietary patterns to more accurately account for population-level effects of predation. Our objective is to develop valuable partnerships between scientists, educators, and the general public to promote sustainable fishing practices.

EXPECTED BENEFITS

Results from the proposed research will provide valuable information to both fisheries managers and recreational anglers. Feeding behavior at the level of prey selection can have important implications at the individual, population, and community levels and thus can aid in the management of striped bass, summer flounder, and weakfish fisheries. Additionally, patterns in prey preference for these key Chesapeake Bay sportfishes can lend insight to recreational anglers about the appropriate bait selection for targeted species. Identifying sportfish preferred prey may benefit recreational fisheries by revealing important seasonal trends in food choice throughout the Chesapeake Bay, enhancing angler knowledge and providing information for fishing bait selection.

PRODUCTS

Quarterly reports will be submitted to VMRC detailing progress and results to date for the previous quarter as well as planned activities for the following quarter. Reports will be due as determined by VMRC. Instead of a final report, we will continue to analyze data and write manuscripts in a publishable format and submit these to peer-reviewed journals. We will also make presentations at scientific meetings as well as public meetings as requested.

TIMELINE

	2014											
TASK	J	F	M	A	M	J	J	A	S	O	N	D
Collection of predatory fishes			X		X		X		X		X	
Collect of prey groups			X		X		X		X		X	
Identification of stomach contents				X		X		X		X		X
General diet description				X		X		X		X		X
Prey selectivity quantification				X		X		X		X		X

LITERATURE CITED

Albaina A., Fox C.J., Taylor N., Hunter E., Maillard M., and Taylor M.I., 2010. A Taqman QPCR based assay targeting plaice (*Pleuronectes platessa* L.) DNA to detect predation by brown shrimp (*Crangon crangon* L.) – assay development and validation. J. Mar. Biol. Ecol. 391: 178-189.

ASMFC Weakfish Technical Committee, 2009. Weakfish Stock Assessment Report. Presented to the 48th Stock Assessment Workshop Stock Assessment Review Committee. Woods Hole, MA. 296 pp.

Bonzek C.F., Gartland J., Johnson R.A., and Latour R.J., 2011. Progress Report: The Chesapeake Bay Multispecies Monitoring and Assessment Program. Project Number F-130-R-5. Virginia Institute of Marine Science. Gloucester Point, VA. 160 pp.

Buckel J.A., Conover D.O., Steinberg N.D., and McKown K.A., 1999. Impact of age-0 bluefish (*Pomatomus saltatrix*) predation on age-0 fishes in the Hudson River estuary: evidence for density-dependent loss of juvenile striped bass (*Morone saxatilis*). Can. J. Fish. Aquat. Sci. 56: 275-287.

Chesson J., 1978. Measuring preference in selective predation. Ecology 59: 211-215.

Chesson J., 1983. The estimation and analysis of preference and its relationship to foraging models. Ecology 64: 1297-1304.

Griffin J.C., and Margraf F.J., 2003. The diet of Chesapeake Bay striped bass in the late 1950s. Fish. Manage. Ecol. 10: 323-328.

Hartman K.J. and Brandt S.B., 1995. Trophic resource partitioning, diets, and growth of sympatric estuarine predators. T. Am. Fish. Soc. 124(4): 520-537.

Kemp W.M., Boynton W.R., Adolf J.E., Boesch D.F., Boicourt W.C., Brush G., Cornwell J.C., Fisher T.R., Glibert P.M., Hagy J.D., Harding L.W., Houde E.D., Kimmel D.G., Miller W.D., Newell R.I.E., Roman M.R., Smith E.M. and Stevenson J.C., 2005. Eutrophication of Chesapeake Bay: historical trends and ecological interactions. Mar. Ecol. Prog. Ser. 303: 1-29.

Latour R.J., Gartland J., Bonzek C.F., and Johnson R.A., 2008. The trophic dynamics of summer flounder (*Paralichthys dentatus*) in Chesapeake Bay. Fish. Bull. 106(1): 47-57.

Livingston P.A., 1985. An ecosystem model evaluation: the importance of fish food habits data. Mar. Fish. Rev. 47: 9-12.

Rudershausen P.J., Tuomikoski J.E., and Buckel J.A., 2005. Prey selectivity and diet of striped bass in western Albemarle Sound, North Carolina. T. Am. Fish. Soc. 134: 1059-1074.

Terceiro M., 2011. Stock assessment of summer flounder for 2011. Northeast Fisheries Science Center Reference Document. Woods Hole, MA. 144 pp.

Walter J. F. and Austin H.M., 2003. Diet composition of large striped bass (*Morone saxatilis*) in Chesapeake Bay. Fish. Bull. 101(2): 414-423.

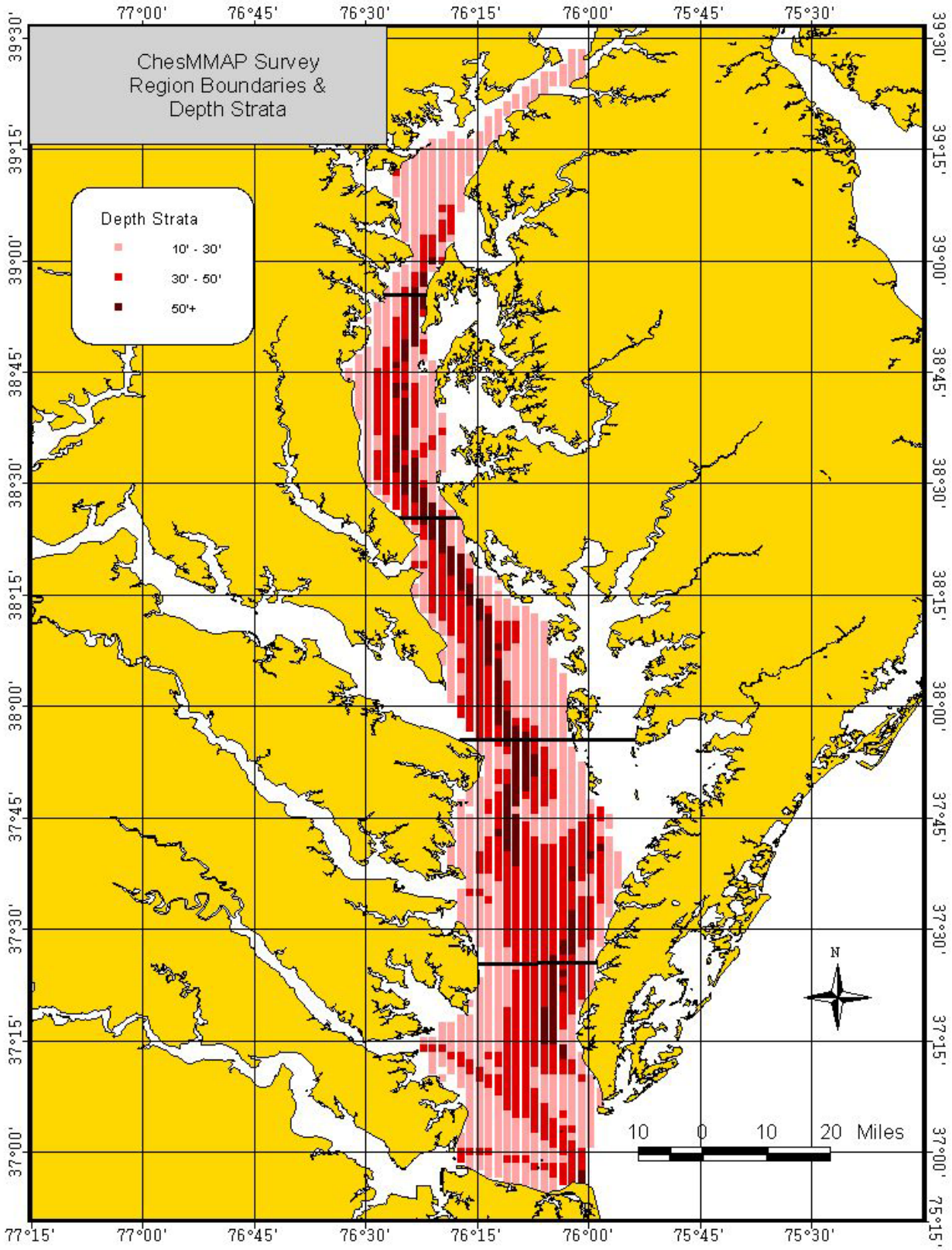

Figure 1. ChesMMAP sampling regions and depth strata.

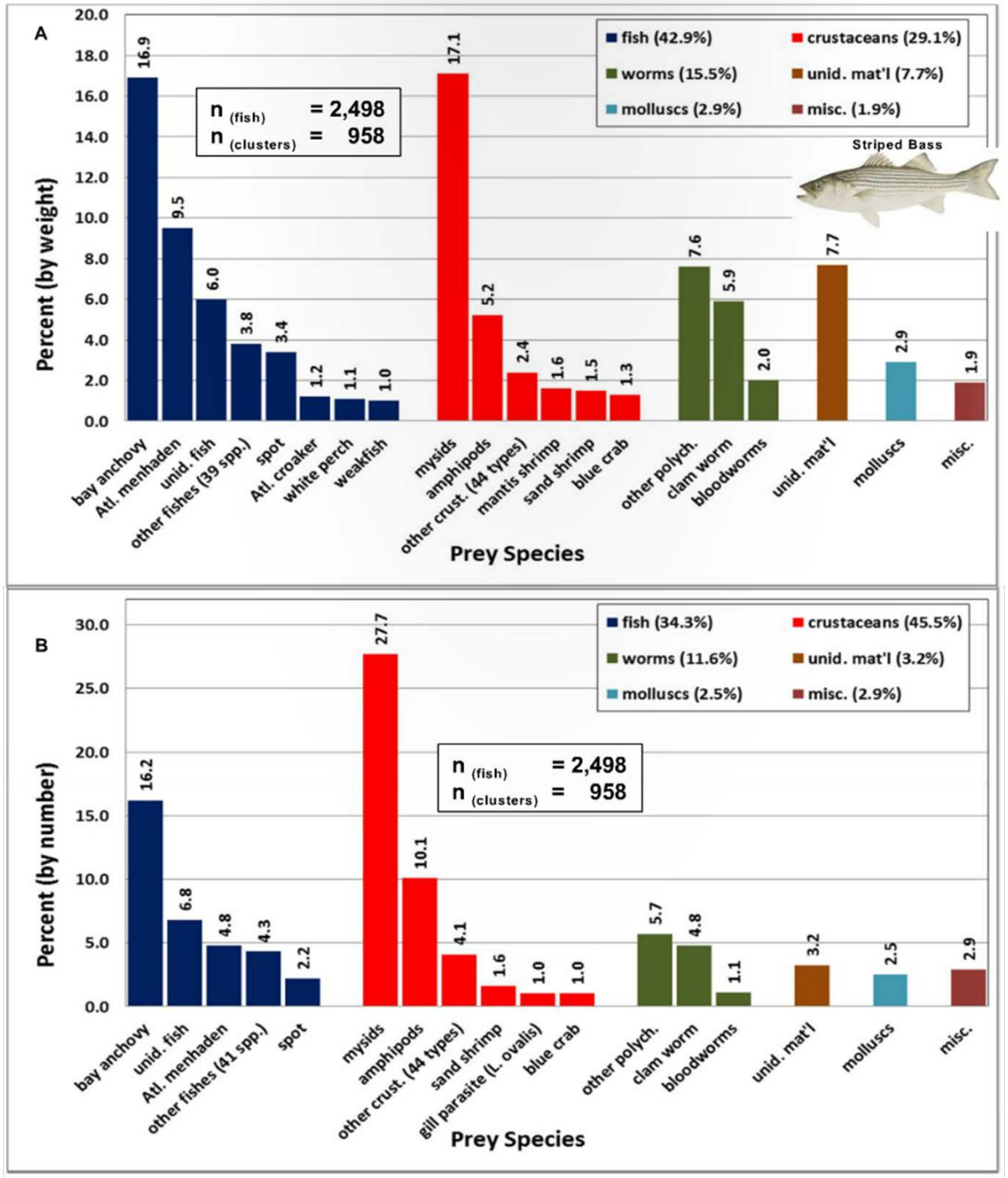

Figure 2. Diet composition expressed as percent by weight (A) and percent by number (B) of striped bass collected during ChesMMAP cruises in 2002-2010 combined (after Bonzek et al., 2011).

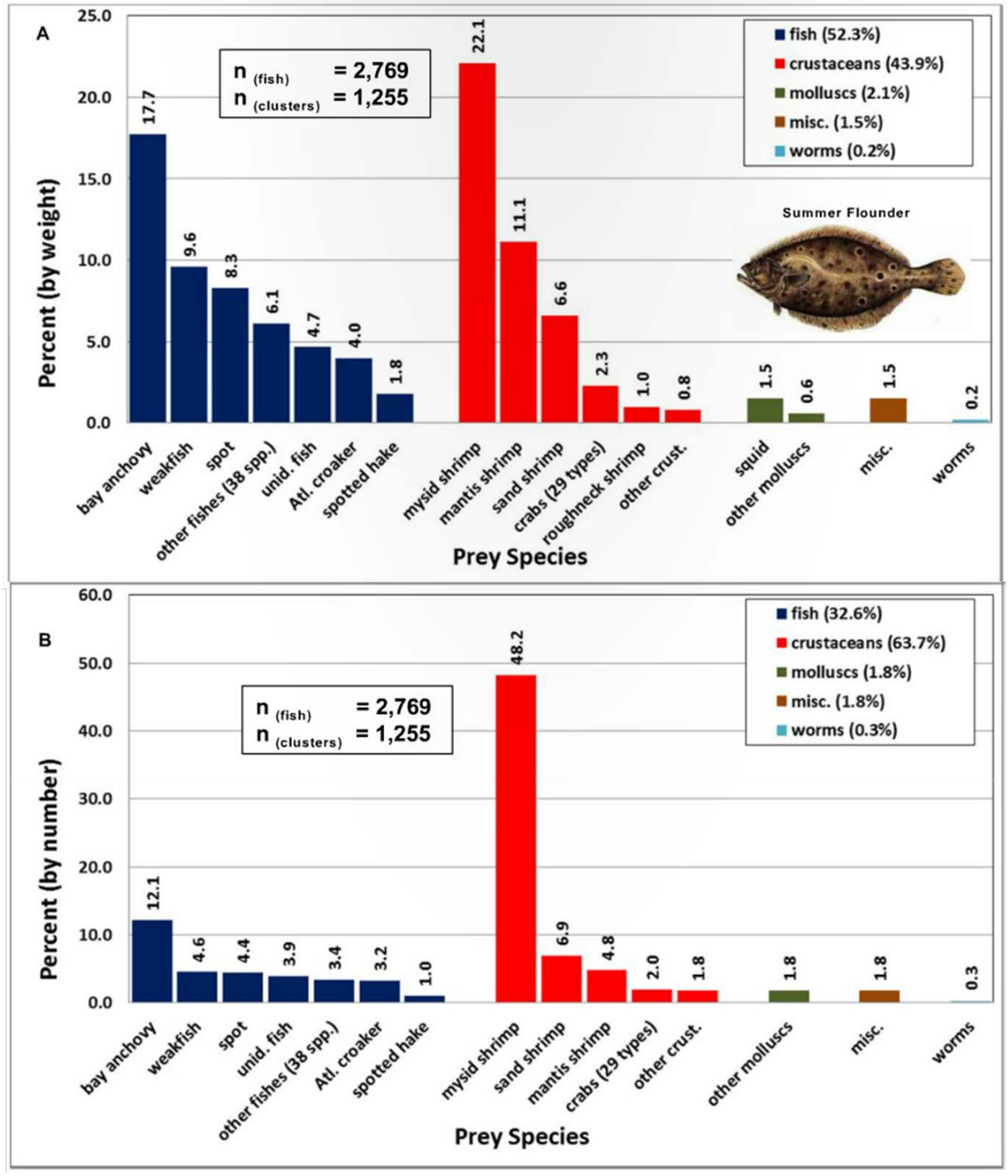

Figure 3. Diet composition expressed as percent by weight (A) and percent by number (B) of summer flounder collected during ChesMMAP cruises in 2002-2010 combined (after Bonzek et al., 2011).

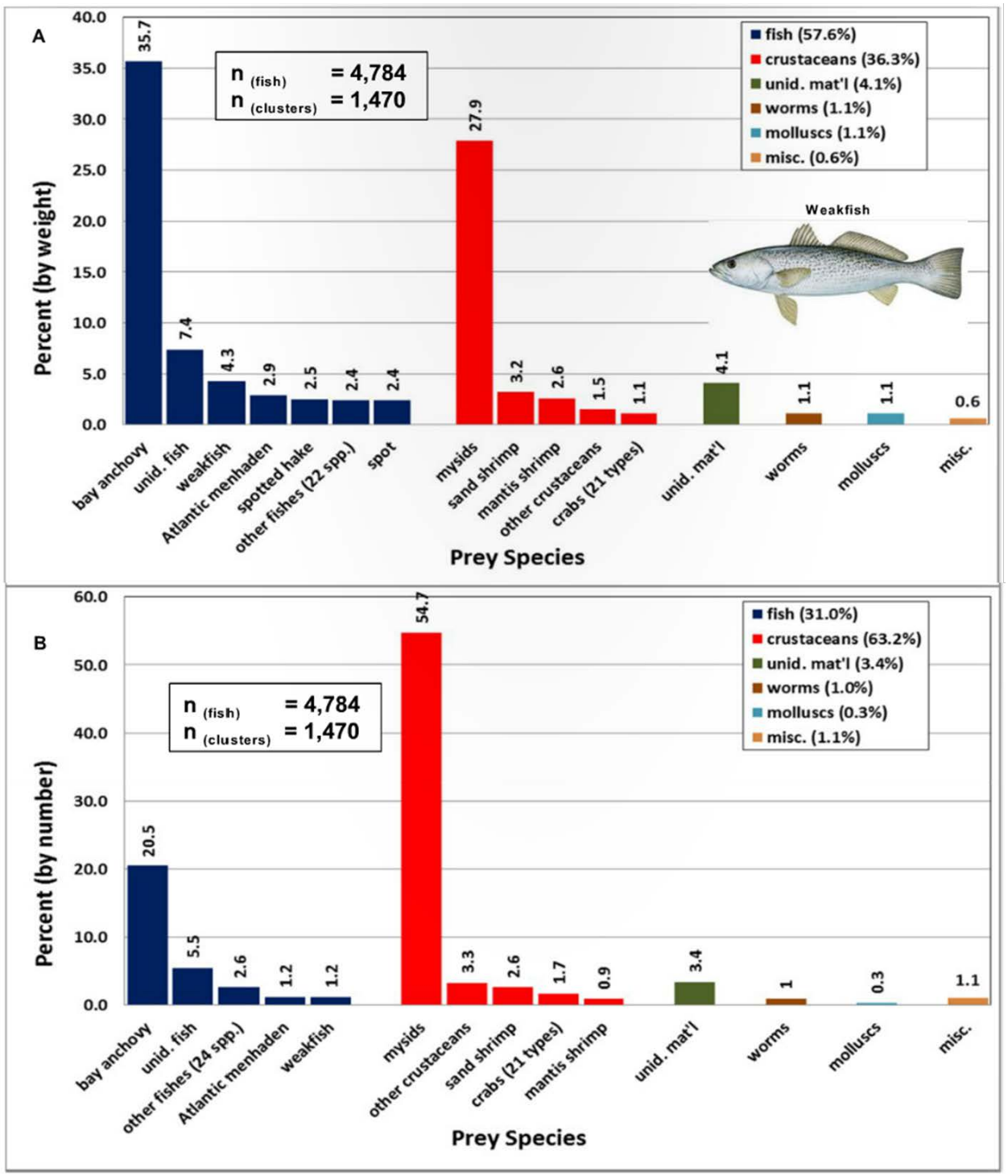

Figure 4. Diet composition expressed as percent by weight (A) and percent by number (B) of weakfish collected during ChesMMAP cruises in 2002-2010 combined (after Bonzek et al., 2011).

Title: Patterns in Prey Selectivity of Key Sportfishes in Chesapeake Bay

Personnel	**Time**	**Monthly**	**Agency**	**VIMS**	**Total**
Robert Latour (Principal investigator)	0.5 mos	$9,664	$4,832	$0	$4,832
Christopher Sweetman (Graduate Student)	12 mos	$1,774	$21,292	$0	$21,292
Fringe, 40% salaries;			$1,933	$0	$1,933
7.65% hourly			$0	$0	$0
Total Personnel			$28,057	$0	$28,057
Supplies (Plankton nets, epibenthic sled, sample preservation materials, etc)			$1,500	$0	$1,500
Travel (Outreach and presentations to fishing clubs, scientific conferences, public meetings)			$1,200	$0	$1,200
Contractual Services			$0	$0	$0
Tuition			$0	$0	$0
Vessels			$0	$0	$0
Publication Center			$0	$0	$0
Equipment			$0	$0	$0
SUBTOTAL: Direct Costs			$30,757	$0	$30,757
Facilities & Administrative Costs		**25%**	$7,689	$5,844	$13,533
TOTAL			$38,446	$5,844	$44,289