Abundance and Population Structure of Fishes in Cove Point Marsh 1999-2001

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Abstract

The fish community structure was surveyed over a two year period at Cove Point, a freshwater marsh immediately adjacent to the Chesapeake Bay. Buoyant pop nets were set in four locations, each with different substrates and levels of vegetation cover. The survey collected 1782 individuals representing 16 fish species. Fish abundance was very high, while diversity was low. The fish community is similar to that of a freshwater rather than estuarine marsh, although salinity reached 12 ppt. in the first year. *Gambusia holbrooki* were the most abundant species, reaching densities of 81 individuals per square meter. Other common species included *Cyprinodon variegatus*, *Lucania parva*, *Umbra pygmaea* and *Lepomis gibbosus*. Physical conditions in the marsh were highly variable. Severely decreased water volume and increased salinity in the first year paralleled decreased abundance for all fish species. In the second year, high rainfall and low salinity lead to freshwater species such as *Umbra pygmaea* becoming much more common. The Cove Point fish community seems adapted to the dynamic nature of the marsh, and its composition alters in response to these changes. If the marsh opens to the Chesapeake Bay in the future, there will likely be drastic changes in fish community composition.

Introduction

Marshes and wetlands, both tidal and freshwater, are characterized by high primary productivity (Odum, 1969; Turner, 1976). This is due in part to an influx of sediments and plant nutrients, particularly nitrogen and phosphorus compounds. In tidal estuaries, the interface of surface freshwater and incoming subsurface seawater acts to trap nutrients within the estuary. Freshwater marshlands and wetlands often receive nutrient-rich water, and remove those nutrients through plant uptake as the water slowly passes through the marsh. This results in the purification of water before it reaches larger basins, while the extracted nutrients promote bacterial and vascular plant growth and thus primary production.

High levels of available energy, trapped through plant primary production, allow heterotroph populations to grow abundantly. Both estuarine and tidal freshwater marshes can support large populations of resident, anadromous and catadromous fishes (Turner,

1979) and are often essential areas for spawning and the growth of juveniles. Estuarine marshes often exhibit higher fish diversity than freshwater tidal marshes (Dahlberg, 1972), apparently because many marine species can move into oligohaline water while freshwater fishes cannot. Freshwater fishes seem less able than marine fishes to adapt to salinity changes and are therefore excluded from estuarine marshes (Odum, 1988).

Atlantic coast marshes open to tidal influence thus contain fish species of both marine and freshwater origin. In oligohaline areas abundant species often are killifish (*Fundulus* sp.), silversides (*Menidia* sp.) and sheepshead minnows (*Cyprinodon variegatus*) (Varnell *et al*., 1995; Mitsch and Gosselink, 2000; personal observation). Tidal marshes also are important habitats for anadromous and catadromous fishes, such as striped bass (*Morone saxatilis*), white perch (*Morone americana*), and American eel (*Anguilla rostrata*). Freshwater fishes commonly found in tidal marshes include cyprinids (minnows, carps) centrarchids (sunfishes) and ictalurids (catfishes).

Cove Point marsh is located on the western shore of the Chesapeake Bay, in Calvert County, Maryland. It is bounded by Calvert Cliffs to the north, the Patuxent River to the south, an upland forest area to the west and the Chesapeake Bay to the east. The marsh has attributes of both freshwater and estuarine systems. It receives its water primarily from freshwater runoff, seeps and groundwater discharge. Storms and high tides bring saltwater incursions from the Chesapeake Bay, but there is no connection between the Bay and the marsh. Cove Point consists of a larger body of open water as well as several smaller, isolated ponds and freshwater drainage streams (Fig. 1). The open water areas are shallow, no more than 1.5 meters in depth, permitting the dense growth of submerged aquatic vegetation. The ponds are lined with emergents, such as cattail (*Typha* sp.) and common reed (*Phragmites australis*). The marsh has remained relatively free of human disturbance, which might benefit the fish community in two ways: as a refuge for rarer fishes and as a stable, non-degraded habitat for more common species. Abundant species are ecologically important, because they play roles as both predators and prey for other organisms. These fish populations can thus increase the abundance and diversity of many other organisms in the food web.

An early informal survey of fishes in Cove Point marsh was done in 1936 by members of the Natural History Society of Maryland (Yingling, 1936). The author

described the marsh as "the brackish waters of the tidepools," suggesting that the marsh was open to the Bay at that time. They reported the most abundant fish collected as the mummichog (*Fundulus heteroclitus*) and the sheepshead minnow. Rainwater killifish and mosquitofish were mentioned as being collected in vegetated areas, but were evidently in lower abundance.

A two year survey was initiated in the Spring of 1999 to determine the abundance, diversity and population structure of Cove Point marsh fishes. It was designed to provide these data: 1) the abundance and diversity of the fish community, 2) estimates of fish reproductive success, 3) estimates of major food types for fishes, 4) identification of common macroinvertebrates, and 5) measurements of water quality parameters and submerged aquatic vegetation. These data will help in evaluations of current fish community and the overall ecological health of Cove Point marsh.

Materials and Methods

Fishes were collected from April to November in 1999 (Year 1) and May to November in 2000 (Year 2). Sampling times were once per month in April and May, twice per month in June through October, and once in November. Sampling occurred during daylight hours, usually between 09:00 and 16:00.

Characterization of the fish community

Pop nets were the primary sampling technique (Serafy *et al.*, 1988; Dewey *et al*., 1989; Connolly, 1994). They consisted of two 1 m^2 squares formed from ¾ in. PVC. The PVC squares were joined by 1mm^2 netting, so that one PVC square formed the base and the other the top of a cube, with the netting along the sides. The bottom square was water-filled and remained on the bottom of the marsh. The top square was buoyant, and was held underwater just above the bottom square with two galvanized nails, each slid through two swivels. String was attached to the nails and led 3-4 m away from the net. When the strings were pulled, the nails slid out of the swivels and the top square floated to the surface. This acted to trap all organisms within the 1 m^2 area of the net. The pop nets were placed in the water in the morning, usually by 10:00. After at least two hours, the nets were then popped from a 3-4 m distance. Caught organisms were removed from

the popped net with three scoops of a 1 mm^2 mesh rectangular net, slightly smaller in length than the inside width of the pop net squares.

Figure 1. Aerial photograph of Cove Point marsh, showing the four sampling sites used in the survey: Small Pond, Front Marsh, Back Marsh, and South Marsh. Boardwalk Pond, Wilbur creek (not shown), and several sites in the deeper areas of the marsh were also occasionally sampled.

Pop nets were set in four areas: Small Pond, Front Marsh, Back Marsh, and South Marsh (Fig. 1). These areas were chosen to sample a variety of habitats. Small Pond was isolated from the main marsh, mud bottomed and densely vegetated. Front Marsh was adjacent to the Bay, sand bottomed and sparsely vegetated. Back Marsh was adjacent to woodland, soft mud bottomed and vegetated. South Marsh was adjacent to emergent vegetation, hard mud bottomed and vegetated. A total of 59 pop net sets were conducted over the two sampling seasons.

Other sampling methods were also used throughout the two year sampling period. Minnow pots were set to collect small fishes in the pond near the boardwalk (Boardwalk Pond) and mid-water areas of the marsh not sampled with pop nets. Minnow pots were baited with a mixture of algae-based and shrimp-based flake fish food wrapped in cheese

cloth. A small seine, 1.5 m in length, was used to collect fishes in Wilbur and Gray's creeks and larger seeps draining into the main marsh. A larger 50 ft seine was used once at Front Marsh and South Marsh.

For all fishes, identity, total counts and total length were recorded. Data from the pop nets were used to calculate abundance (# fishes/m^2) for the more common species. Data from all sampling methods were used to estimate the overall diversity of fishes in the marsh. Diversity was calculated using the Simpson's diversity index (Simpson, 1949). Sexual maturity, pregnancy, or damage, were also recorded as noted.

Estimates of major food types for fishes

The minnow pots were employed in two sampling efforts to collect fishes for analysis of gut contents. Minnow pots were set at Boardwalk Pond and Small Pond, and the caught fish were placed on ice for several hours. They were preserved in 10% formalin followed by 70% ethanol and stored until analysis. The gut contents of ten individuals of the most common species – mosquito fish, sheepshead minnows, and rainwater killifish – were examined for food type. In addition, one *Fundulus heteroclitus* and one *Fundulus diaphanus* were examined.

Identification of common macroinvertebrates

Invertebrates, such as crustaceans and aquatic juvenile insects, were commonly found in the pop nets. Insects caught in the pop nets were preserved in 70% ethanol and sent to Dr. Richard Orr for identification. Crustaceans were identified and noted when found.

Physical characteristics of the marsh and aquatic vegetation types

Water depth, temperature, pH, and salinity were recorded at each sampling site during each sampling period. Dissolved oxygen was also recorded in the Year 2 sampling season. General observations and water levels in the marsh were noted on each sampling day. The presence, type, and approximate distribution of aquatic vegetation at each sampling site were noted casually in Year 1. For Year 2, submerged aquatic vegetation cover was determined by placing a 1 m^2 floating PVC square to the immediate left and

right of a pop net. Percent cover within the 1 m^2 area was estimated by eye . On May 28 of Year 1, at the height of that year's aquatic vegetation density, all plant material was collected from two 0.25 m^2 areas. The material was weighed in the laboratory to estimate biomass/m^2 in areas of dense and patchy vegetation.

Results

Characterization of the fish community

The survey identified nine different families and 16 species of fish within the Cove Point marsh and freshwater tributaries (Table 1). Photographs and descriptions of the more common species are given in Appendix I. See Hildebrand and Schroeder (1928) and Murdy *et al.* (1997) for complete descriptions of these species. All species, except the eastern mudminnow, are salt-tolerant species and can be found in estuarine environments.

Table 1. Fish species collected at Cove Pont marsh. Collection numbers are summed for Year 1 and Year 2.

Family Name	Common name	Total #
Clupeidae		
Anchoa mitchilli	bay anchovy	21
Cyprinidae		
Cyprinus carpio	common carp	5 (est.)
Notemigonus crysoleucas	golden shiner	8
Ictaluridae		
Ameiurus nebulosus	brown bullhead	1
Umbridae		
Umbras pygmaea	eastern mudminnow	97
Esocidae		
Esox sp.	pickerel	1
Cyprinodontidae		
Cyprinodon variegatus	sheepshead minnow	171
Fundulus heteroclitus	mummichog	12
Fundulus diaphanus	banded killifish	10
Fundulus confluentus	marsh killifish	2
Lucania parva	rainwater killifish	482
Poeciliidae		
Gambusia holbrooki	mosquito fish	933
Atherinidae		
Membras martinica	rough silverside	12
Menidia beryllina	inland silverside	35
Centrarchidae		
Lepomis gibbosus	pumpkinseed	31
Lepomis macrochirus	bluegill	4

Simpson's Diversity Index = 2.92

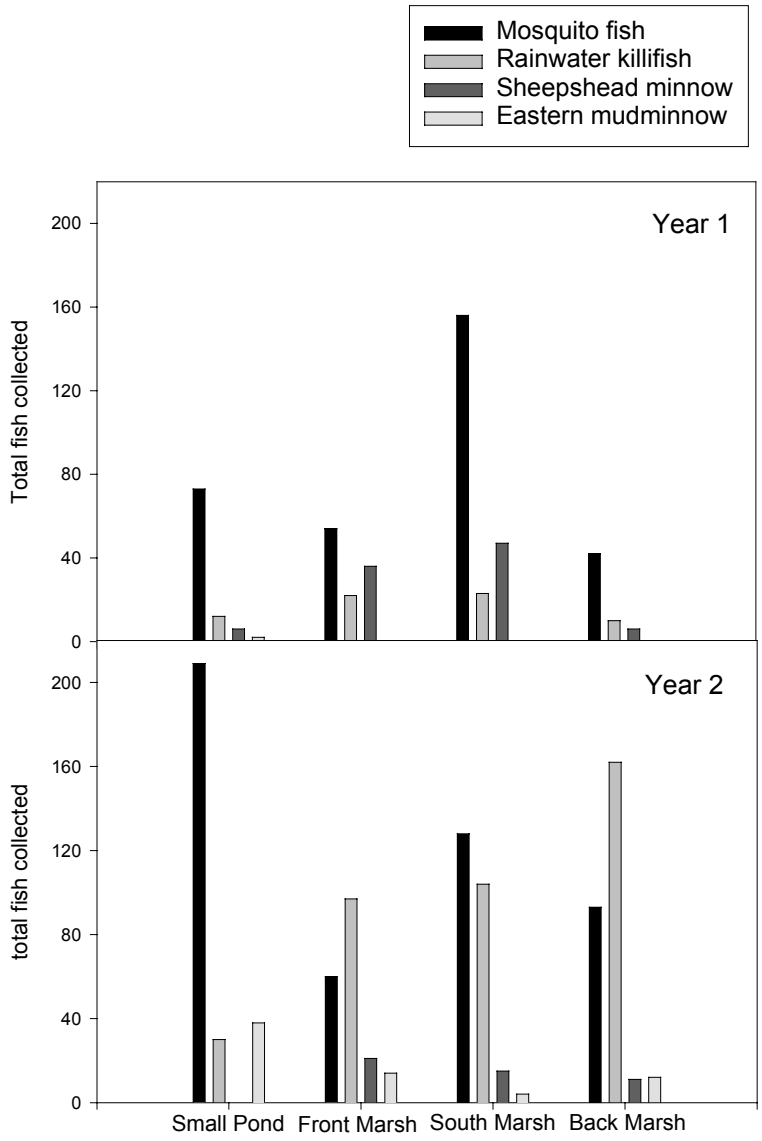

Figure 2. Total number of fish collected at each sampling site, for the four most common species, over the two year survey.

The most common species were *Gambusia holbrooki* (mosquitofish), *Cyprinodon variegatus* (sheepshead minnow), *Lucania parva* (rainwater killifish) and *Umbra pygmaea* (eastern mudminnow). These species were unevenly distributed in the marsh (Figure 2). Mosquitofish were most common and were found in all areas of the marsh, although highest densities occurred at South Marsh and Small Pond, associated with submerged aquatic vegetation. Rainwater killifish were more common at Back Marsh, where a soft mud substrate and dense vegetation were present. Sheepshead minnows

were common at Front Marsh, where they congregated in large schools on sand flats created from the moving beach, and the hard mud bottom areas of South Marsh. Eastern mudminnows were in very low abundance in Year 1 and were not found in the marsh except at Small Pond. They were found in both years in Wilbur creek, Gray's creek tributaries, and a seep draining into Purgatory creek at the south end of the marsh. They expanded their range in Year 2 and were found at all marsh pop net sampling sites. Eastern mudminnows were collected in greatest numbers at Small Pond.

Other fish species were encountered less frequently. *Membras martinica* (rough silverside) was found once (June of Year 1) at Front Marsh. *Menidia beryllina* (inland silverside), was found occasionally throughout the marsh during both sampling years. Three killifish species (*Fundulus* sp.) were found in low abundance throughout the marsh and at Small Pond. Although *Fundulus heteroclitus* is often the most abundant fish species in tidal marshes, its overall density in Cove Point marsh was low, with 12 individuals caught in a total of 59 pop net sets (0.2 individuals/m^2). Other *Fundulus* species – *F. diaphanus*, and *F. confluentus* - were less common. A species identified as *Fundulus majalis* was observed, but no individuals were collected. *Lepomis gibbosus* (pumpkinseed sunfish) was commonly found at Back Marsh and Boardwalk Pond. Individuals as large as 145 mm were collected. An adult pumpkinseed, guarding a nest, was observed at Boardwalk Pond on August 17 of Year 1. *Lepomis macrochirus* (bluegill sunfish) was uncommon. In the marsh, juveniles were found in only in Wilbur creek and Boardwalk Pond. However, it was very abundant in the small reservoir above the marsh. *Cyprinus carpio* (common carp) was observed at Back Marsh on May 28. They were adults (estimated +50 cm). Carp were not observed again anywhere in Cove Point marsh. One species of pickerel (*Esox* sp.) was observed at Boardwalk Pond. It represents the only strictly piscivorous fish found in the survey. Overall diversity of fish species was not high. A Simpson's diversity index of 2.92 was calculated from all fish collections of both sampling years (Table 1).

Total abundance, summed over all sampling sites, of the four most common species varied over the course of the sampling seasons and between years (Figure 3). In Year 1, abundance peaked in July. Mosquito fish densities reached 81 individuals/m^2 at South Marsh on July 16 of that year. Sheepshead minnow and rainwater killifish

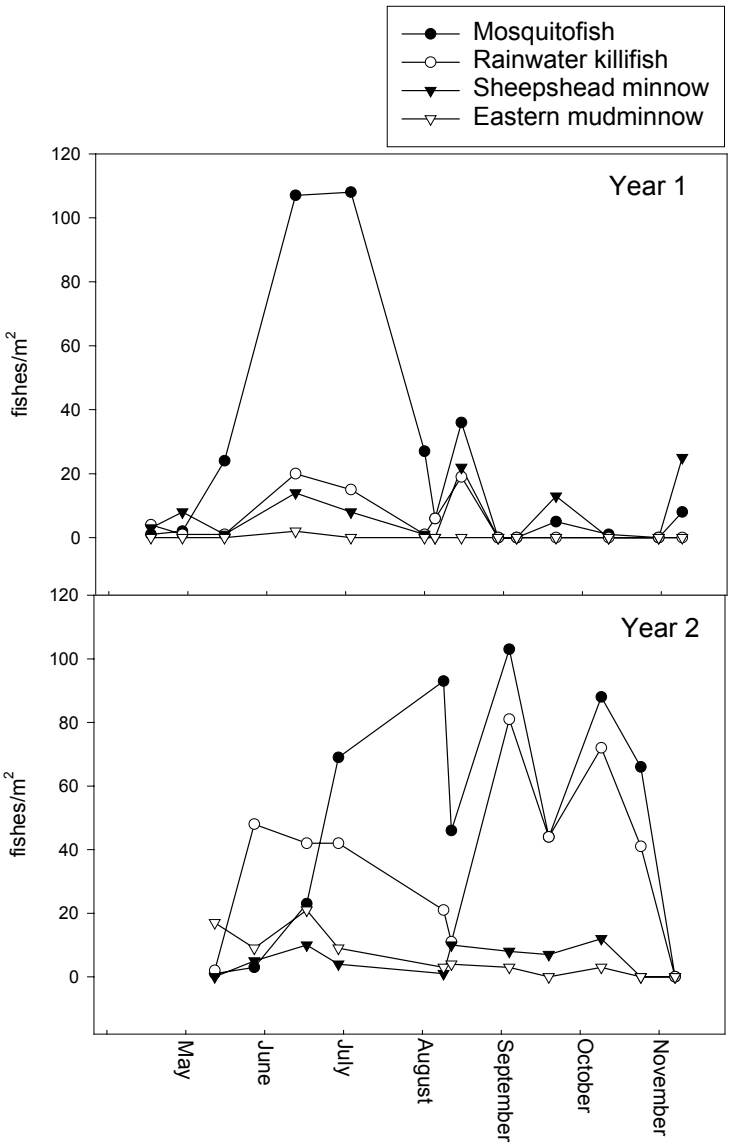

Figure 3. Monthly abundance for the four most common fish species over the two year survey.

densities were 8 and 9 individuals/m^2, respectively, on this sampling date. Abundance dropped considerably in subsequent sampling efforts. Calculated densities at the end of August, a low point, were 8.0, 0.5, and 0.24 individuals/m^2 for mosquito fish, sheepshead minnows and rainwater killifish, respectively. This decline in fishes paralleled declines in water levels and submerged aquatic vegetation. In Year 2, fish populations increased again, with mosquito fish again the most abundant species. The greatest numbers were

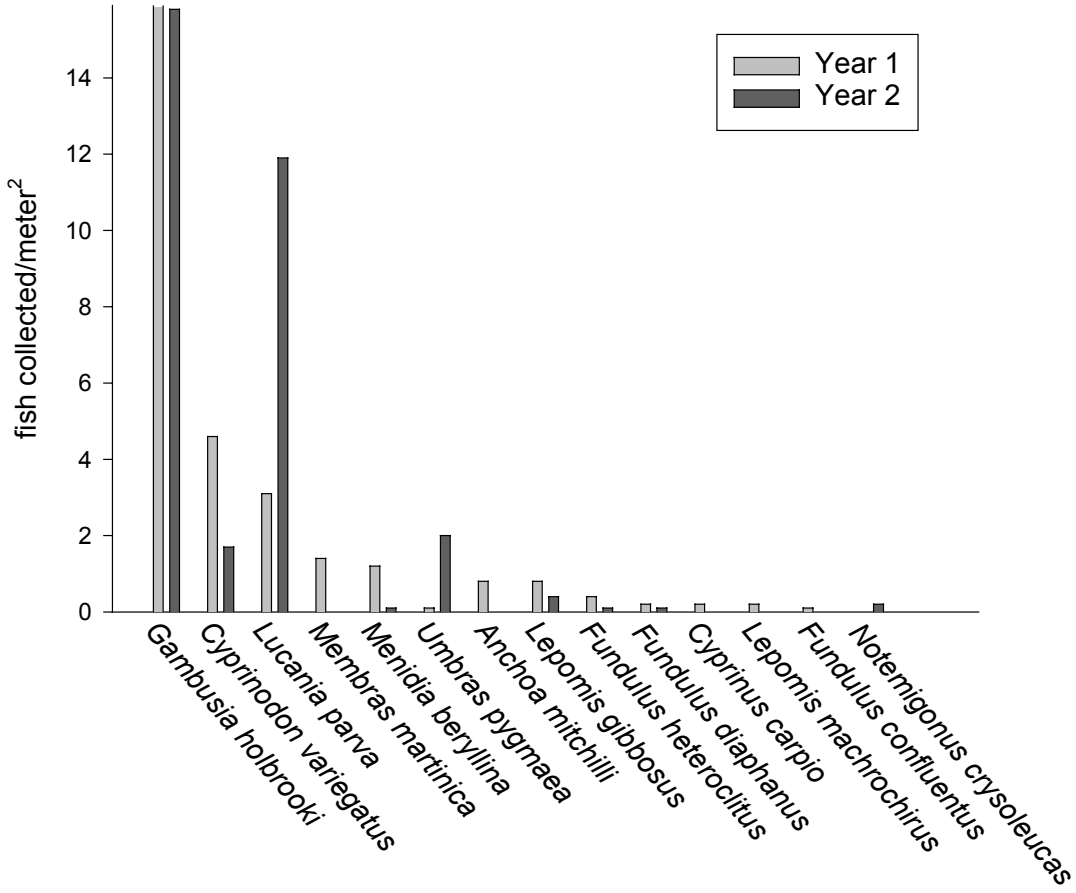

Figure 4. Abundance (fishes/m^2) of all fish species for Year 1 and Year 2 sampling seasons.

later in the Summer than Year 1, and collections did not decline. Although there was considerable variation, collections remained high until the end of sampling in November.

All fish populations declined in Year 1. Many populations did not appear to fully recover in Year 2, while a few species expanded their range and abundance (Fig. 4). Mosquitofish (*Gambusia holbrooki*) were most common both years and their abundance did not change between years. Rainwater killifish (*Lucania parva*) and eastern mudminnow (*Umbra pygmaea*) populations greatly increased in Year 2. Golden shiners (*Notemigonus crysoleucas*) were collected only in Year 2. All other species declined from Year 1 to Year 2, and several of the less common species were not found in Year 2.

Table 2. Earliest time and location of juvenile collection for those species where juveniles were collected.

Year 1

Species	Juveniles observed	Location
Umbras pygmaea	12-May	Wilbur creek
Gambusia holbrooki	28-May	Small Pond
Cyprinodon variegatus	25-Jun, 2-Oct	Front Marsh
Menidia beryllina	25-Jun	South Marsh
Lucania parva	16-Jul	South Marsh
Lepomis gibbosus	16-Jul	South Marsh

Year 2

Species	Juveniles observed	Location
Umbras pygmaea	26-May	Front Marsh
Gambusia holbrooki	12-Jul	Front, Back, South Marsh
Cyprinodon variegatus	9-Jun	Front Marsh
Menidia beryllina	30-Jun	South Marsh
Lucania parva	30-Jun	Front Marsh
Lepomis gibbosus	9-Jun	Back Marsh, Small Pond

The timing of reproduction was inferred for six species by the collection of juvenile individuals (Table 2). In Year 1, eastern mudminnow juveniles first appeared on May 12 in Wilbur creek and on May 26 at Front Marsh in Year 2. Adults collected during the breeding season had ragged fins, evidence of aggressive behavior during courtship. In Year 1, mosquito fish juveniles first appeared on May 28 throughout the marsh and small juveniles continued to be caught through July. Mosquitofish juveniles were not observed until mid-July in Year 2. In Year 1, sheepshead minnow juveniles were first caught on June 25 in front and South Marsh. Juveniles of this species were also caught in early October, after the marsh had refilled. In Year 2, sheepshead reproduction was first detected on June 9 at Front Marsh. In Year 1, rainwater killifish juveniles were first observed at South Marsh on July 16, and in Year 2 on June 30 at Front Marsh. In Year 1, inland silversides juveniles were found at South Marsh on July

16 and June 30 in Year 2. In Year 1, pumpkinseed and bluegill sunfish juveniles first appeared on July 16 at Back Marsh and Boardwalk Pond, respectively. Pumpkinseed juveniles were found on June 9 in Year 2. No bluegill sunfish were found in Year 2.

Estimates of major food types for fishes

Individuals of the three most common species – mosquito fish, sheepshead minnows and rainwater killifish – were dissected and gut contents examined to determine food types. The mosquito fish examined had eaten primarily water boatmen (Hemiptera: Corixidae), filamentous algae and what appeared to be mosquito larvae or a related species. The sheepshead minnows had fed primarily on vascular plant material and filamentous algae. In the guts of rainwater killifish were small amphipods, water boatmen, and a small amount of plant material. The gut contents of the single *Fundulus diaphanus* examined contained water boatmen and one caddisfly larvae. The gut of the *Fundulus heteroclitus* individual contained only filamentous algae.

Characterization of collected macroinvertebrates

The most abundant macroinvertebrates were grass shrimp (*Palaemonetes pugio*). and amphipods. These species were found in all areas of the marsh, and were present in most pop net and minnow pot catches. They were found throughout both sampling years, from May through November.

Blue crabs (*Callinectes sapidus*) were also observed and collected from all areas of the marsh. Both mature and juvenile males were observed in the main body of the marsh. Mature females were seen at Front Marsh and South Marsh, and prepubertal premolt females were collected at Front Marsh. A male courtship display towards a premolt female was observed at Front Marsh on May 28 of Year 1. The display lasted several minutes, after which the female moved away from the area. Blue crabs tended to congregate in the Front Marsh area, and were observed leaving the marsh, crossing the beach and entering the Chesapeake Bay.

The most common aquatic insects collected in the nets were water boatmen. They were found commonly throughout the marsh. Year 1 population peaks of high abundance were observed at Small Pond on June 25, and at South Marsh on October 2. Several

aquatic insect larvae were collected in the pop nets. These were fixed in 70% ethanol and given to Dr. Richard Orr for identification.

Observations of other wildlife

Casual observations were made of any animal life, or animal signs, observed at the marsh over the course of the two sampling seasons. These observations are listed in Appendix II.

Physical Parameters of the Marsh

The physical habitat varied considerably throughout the year and between years. Year 1 saw a severe drought followed by heavy rains and hurricane Floyd. The main marsh area showed the greatest drought impact. The marsh was fully flooded in April, but by June 25 the water had begun to recede. By July 16 it was no longer possible to sample the Front Marsh or Back Marsh sites. By the end of July there were only three areas of open water - Small Pond, South Marsh, and a narrow area near Back Marsh. By the end of August, after a night of heavy rain, the main marsh began to fill and the water again extended to the Front Marsh area. The marsh was completely refilled by storm Dennis and hurricane Floyd. Immediately after Floyd (9/17 of Year 1) excess water was observed flowing in three channels from the marsh into the Bay. The marsh remained filled until Year 2, which was considerable wetter and cooler, with consistent rainfall throughout the summer. Water levels did not recede in any section of the marsh from April to November of Year 2.

Three areas – Boardwalk Pond, Small Pond and South Marsh - showed little change in water volume during the Year 1 drought. Small Pond and South Marsh seemed to receive groundwater input. Small Pond did not greatly recede and remained fresh until Floyd washed Bay water into the area (Fig. 5). South Marsh was freshest near the beach, the probable site of groundwater discharge. There was water movement out of South Marsh into the main marsh. Boardwalk Pond appeared to receive water from Wilbur creek, which flowed throughout the Summer.

Salinity increased in all areas of the marsh over the course of Year 1, except at Small Pond (Fig. 5). Salinity climbed from zero in the Spring to 12 ppt by the end of

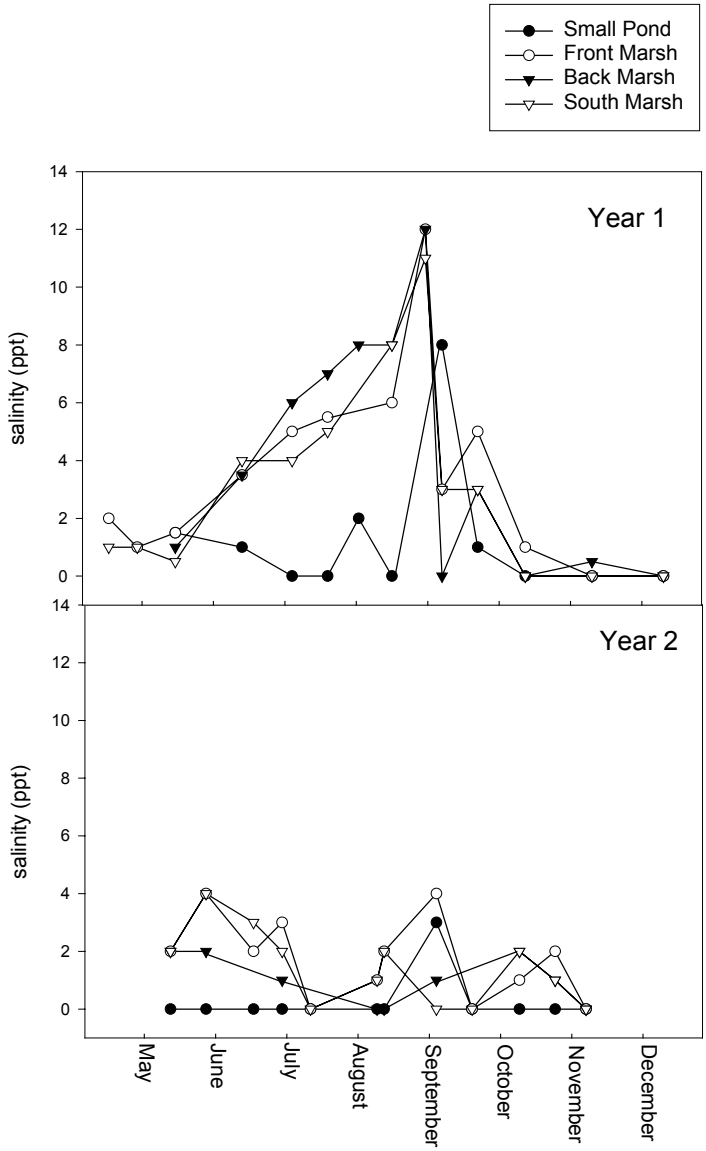

Figure 5. Salinity changes at the four sampling sites over the two year survey period.

August. With the hurricane, salinity dropped to zero in the main marsh, but rose briefly to 8 ppt at Small Pond. In Year 2, salinity remained low, never exceeding 4 ppt. in any area. Small Pond again possessed the lowest salinity, with 0 ppt except for one sample (3 ppt) taken on September 15 which appeared to follow an overwash from Chesapeake Bay.

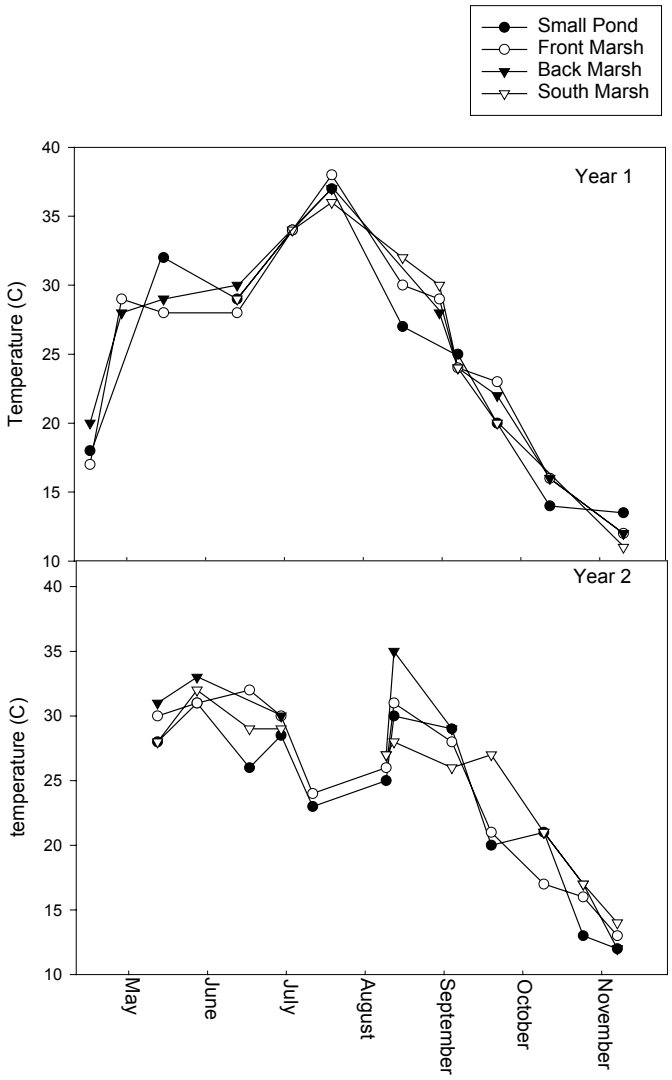

Figure 6. Temperature changes at the four sampling sites over they two year survey period.

Water temperature climbed throughout the Summer of Year 1, reaching 37° C at Small Pond in August (Fig. 6). Temperatures began falling in late August, and dropped quickly after the hurricane. Water temperatures generally remained lower in Year 2. Temperatures rose to 31-33° C by June 9, then fell to 23-24° C by July 23. Temperatures rose again to 30-35° C by August 24, then fell throughout the Fall.

pH readings were taken at each sampling site both years, and dissolved oxygen was measured in Year 2. Marsh water pH was generally consistent and slightly acid throughout the marsh both years, with readings of 6-7 pH units. Hypoxic conditions were

not observed in the marsh. Dissolved oxygen measurements were 6-10 mg/L throughout the Summer, a range adequate for aquatic animal respiration.

Submerged aquatic vegetation

By May of Year 1, submerged aquatic vegetation (SAV) grew densely in all shallow areas of the marsh. The most abundant species was *Ruppia maritima*, although water milfoil and bladderwort were also observed. On May 28, *R. maritima* biomass was up to 2 kilograms/meter wet weight in areas of dense growth. By July 16, water levels were dropping, and SAV was disappearing from the main marsh. What remained, mostly *R. maritima*, was heavily fouled. South Marsh and Small Pond, where water was not receding, showed similar SAV declines. In the main marsh, where standing water was gone, *R. maritima* was replaced by spike rush (*Eleocharis* sp.), and eventually in some areas by *Spartina patens*. By July 31, SAV was absent from the marsh in all areas except Boardwalk Pond. South Marsh and Small Pond, which maintained water levels, also lost all SAV by this date. Water in the marsh was generally turbid. Exposed areas throughout the marsh were covered by spike rush. *R. maritima* was observed growing in the re-flooded main marsh on December 17.

In Year 2, submerged aquatic vegetation grew densely in most areas of the marsh and remained abundant throughout the Summer. *R. maritima* and spike rush were the dominant species. SAV cover was quantified in areas immediately adjacent to the pop net sampling sites with 1 m^2 quadrats (Fig. 7). Back Marsh and South Marsh were heavily vegetated, with 100% cover through out the Summer. SAV coverage at Front Marsh was less dense, but the area remained vegetated at the end of sampling in November. Small Pond was heavily vegetated in Summer, but vegetation thinned considerably in the Fall.

Discussion

Cove Point marsh is a highly dynamic ecosystem exhibiting physical attributes of both freshwater and estuarine systems. These attributes appear to contribute to a very abundant fish community, while also placing restraints upon the types of fish that inhabit the marsh and thus reducing diversity.

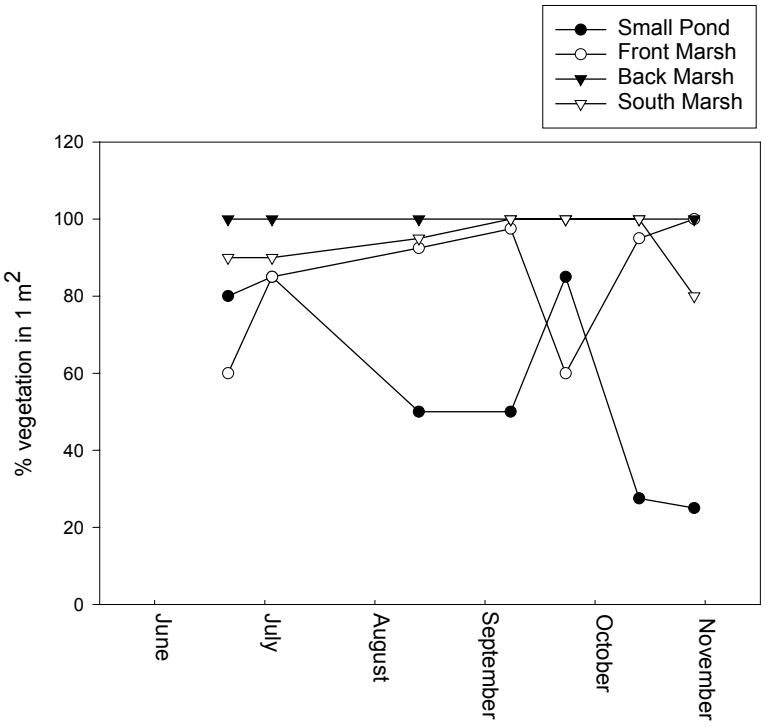

Figure 7. Mean estimated submerged aquatic vegetation cover within a 1m^2 area adjacent to each sampling site. Estimations were made only in Year 2.

The Front Marsh area, adjacent to the Bay, seems physically different from other areas, with a hard or sandy bottom and less submerged aquatic vegetation. This area supports a large population of sheepshead minnows and appears to be a congregating area for blue crabs. Back Marsh, South Marsh and Small Pond more closely resemble a freshwater marsh, with a soft mud substrate and dense submerged aquatic vegetation. In these areas rainwater killifish and eastern mudminnows are most common. Mosquitofish were found throughout the marsh. As topminnows, they may be less tied to any particular substrate.

The shallow, clear water of the marsh allows a dense growth of submerged aquatic vegetation. This in turn provides habitat and primary production to support an abundant fish community. In addition, fishes in Cove Point marsh are likely under less predation pressure than tidal marshes open to the Bay. Resident piscivorous fishes are rare or absent, although the abundant pumpkinseed sunfish will eat small fishes and juveniles. Anadromous piscivorous species, such as striped bass (*Morone saxatilis*) and white perch (*Morone americana*), are also excluded from the marsh. These conditions

likely contribute to the high abundance of fishes observed. The pop nets had a mean catch rate of 30 fishes/m^2 over the two year sampling period, with peak catches of more than 80 fishes/m^2.

The proximity of the marsh to the Chesapeake Bay may contribute to the low diversity of fish species. Although marsh waters are often fresh, salinity can rise in Summer and reached 12 ppt in Year 1 as rain and groundwater discharge slowed. The marsh must receive saline water from the Chesapeake Bay, perhaps as seepage through the beach. The rise in salinity acts to exclude many freshwater fishes from the marsh. Most resident fishes in Cove Pont marsh are salt tolerant. The exception is the eastern mudminnow. However, this species was absent from the marsh in Year 1, when salinity was high. In Year 2, when freshwater input kept salinity low, eastern mudminnows expanded their range and were found in all areas of the marsh.

Although oligohaline at times, there is no direct connection to the Chesapeake Bay and thus anadromous and marine fishes cannot enter the marsh. The exclusion of these fishes acts to further limit diversity. The list of resident fishes is therefore quite different from that of the adjacent estuary. The fish community is dominated by mosquitofish, sheepshead minnows and rainwater killifish. Fishes commonly resident in tidal estuarine marshes, such as *Fundulus* killifishes, anchovies, some silversides, naked gobies and flounder (Kneib and Wagner, 1994; Varnell *et al.*, 1995), are rare or absent from the marsh.

Cove Pont marsh is a dynamic system, with changes in salinity, temperature, water levels and vegetation. Resident fishes must be capable of adapting to those rapidly changing conditions. In Year 1 the marsh experienced a drought, with declining water levels and water quality and increasing salinity. Submerged aquatic vegetation disappeared in most areas and fish populations declined severely. The marsh then re-filled with freshwater in one day with the precipitation from hurricane Floyd. Year 2 was very different, with high water levels, cooler temperatures, low salinity and dense SAV throughout the season. Populations of the more common fishes recovered and remained high. The rarer fishes, however, seemed not to recover fully from the Year 1 declines and some were not found in Year 2. Some species may have been extirpated.

Within these constraints, the marsh may provide a refuge for rare fishes subject to disturbance in other areas. Two individuals collected by minnow pot in Year 1 were identified as marsh killifish (*Fundulus confluentus*). This species, although common in coastal marshes further south, has not been reported in Maryland and has been reported in the Chesapeake Bay only from one location in Lynnhaven Bay near Norfolk, Virginia (Hildebrand and Schroeder, 1928). Recent attempts to find this species in the Chesapeake Bay have been unsuccessful (Murdy *et al*., 1997). It is likely that *Fundulus confluentus* is a rare, permanent resident of the marsh. For Maryland species existing on the edge of their natural range, undisturbed areas such as Cove Point may be important for their continued survival.

Cove Point marsh is used extensively by blue crabs. With no opening to the Bay, crabs were observed crossing the beach to enter the marsh. Males and females, both juveniles and adults, were observed, as well as courtship behaviors. The marsh, with its extensive beds of *R. maritima*, represent a functional grass bed, and the only one of its size along the Western Shore from Rosehaven in the north south to the Patuxent River (Orth *et al*., 1998). As such, Cove Point marsh may represent an important habitat for blue crab growth and reproduction.

The submerged aquatic vegetation at Cove Point marsh is ecologically important as a grass bed and provides the basis for the abundant fish populations observed. In Year 1, however, the grasses disappeared, and with them many of the fishes. With no vegetation, the water became turbid, and water quality undoubtedly deteriorated. The reason for SAV disappearance is unknown. It can partly be attributed simply to receding waters, but the grasses also vanished at South Marsh and Small Pond, which retained water all Summer. Two non-indigenous species present in the marsh, mute swans and common carp, are capable of damaging grass beds and may have played a role in SAV disappearance. However, SAV was not reduced in Year 2. Without the added pressure of reduced open water areas, swans and carp do not appear capable of seriously impacting the grass beds in Cove Point marsh.

Recommendations

Long term monitoring of the marsh is important to track changes that may affect the abundance and diversity of life in the marsh. Cove Point currently is closed to the Bay, and functions primarily as a freshwater marsh. This may not have been true in the past, since Yingling (1936) describes the marsh as "brackish tidepools" and mummichogs (*Fundulus heteroclitus)* as a very common fish, while mosquitofish were evidently rare. This suggests that the marsh may have been open to the Bay at that time and that the fish community was quite different. Currently, the beach is receding in many areas and sea levels are rising. The marsh will likely experience more frequent saltwater incursions in the future and may eventually open to the Bay.

Conversion of the marsh from an essentially freshwater system to a tidal marsh will entail large changes, including increases in salinity, nutrients and possibly turbidity. The vegetation may change in species composition or in some areas be reduced or eliminated. These changes will likely lead to significant alterations in the fish community. Establishment of a marsh-Bay connection may lead to reduced abundance of the common species (Rey *et al*., 1990). Mosquitofish, as open water topminnows, may be particularly affected by the influx of estuarine predators. Further, increases in salinity have been shown to negatively impact sheepshead minnows (Rowe and Dunson, 1995), a common species in Cove Point marsh. The fish community would likely become dominated by estuarine species such as *Fundulus* sp., silversides and anchovies rather than mosquitofish. However, a marsh-Bay connection could lead to a large influx of transient and marine species (Rey *et al*, 1990). An tidal marsh would likely support a more diverse fish community that is quite different from the present community. Further, such a marsh also provides a spawning habitat for many marine and anadromous fishes that are currently excluded.

This report presents a picture of the current fish community in Cove Point marsh. This can serve as a baseline for future work. As conditions change, especially if the marsh opens to the Chesapeake Bay, surveys should be conducted to evaluate potential changes in the fish community and the ecological functioning of the marsh. These future surveys, when compared with current data, will lead to a better understanding of the

dynamic nature of Cove Pont marsh and the impacts of future changes to this ecosystem as a whole.

References

Connolly, R.M. 1994. Comparison of fish catches from a buoyant pop net and a beach seine net in a shallow seagrass habitat. *Mar. Ecol. Prog. Ser*. 109:305-309.

Dahlberg, M.D. 1872. An ecological study of Georgia coastal marshes. *Fish. Bull*. 70:323-353.

Dewey, M.R., L.E. Holland-Bartels and S.J. Zigler. 1989. Comparison of fish catches with buoyant pop nets and seines in vegetated and nonvegetated habitats. *N. Am. J. Fish. Manage.* 9:249-253.

Hildebrand, S.F. and W.C. Schroeder. 1928. *Fishes of Chesapeake Bay*. *Bulletin of the U.S. Bureau of Fisheries* 43(1):1-366.

Knieb, R.T. and S.L. Wagner. 1994. Nekton use of vegetated marsh habitats at different stages of tidal inundation. *Mar. Ecol. Prog. Ser*. 106:227-238.

Mitsch, W.J. and J.G. Gosselink. 2000. *Wetlands*. Van Reinhold:New York.

Murdy, E.O., R.S. Birdsong And J.A. Musick. 1997. *Fishes of Chesapeake Bay*. Smithsonian Institution Press, Washington.

Odum, E.P. 1969. The strategy of ecosystem development. *Science* 164:262-270.

Odum, W.E. 1988. Comparative ecology of tidal freshwater and salt marshes. *Ann Rev. Ecol. Syst*. 19:147-176.

Orth, R.J., J.F. Nowak, D.J. Wilcox, J.R. Whiting and L.S. Nagey. 1998. Distributions of submerged aquatic vegetation in the Chesapeake Bay and tributaries and the coastal bays-1997. *VIMS Special Scientific Report*, number 138.

Rey, J.R., J. Shaffer, D. Tremain, R.A. Crossman, and T. Kain. 1990. Effects of re-establishing tidal connections in two impounded subtropical marshes on fishes and physical conditions. *Wetlands* 10(1):27-45.

Rowe, C.L. and W.A. Dunson. 1995. Individual and interactive effects of salinity and initial fish density on a slat marsh assemblage. *Mar. Ecol. Prog. Ser*. 128:271-278.

Serafy, J.E., R.M. Harrell and J.C. Stevenson. 1988. Quantitative sampling of small fishes in dense vegetation: design and field testing of portable "pop nets." *J. Appl. Ichthyol*. 4:149-157.

Simpson, E.H. 1949. Measurement of diversity. *Nature*, 163:688.

Turner, R.E., 1976. Geographic variations in salt marsh macrophyte production. *Contrib. Mar. Sci*. 20:47-147.

Turner, R.E. 1979. A simple model of the seasonal growth of *Spartina alterniflora* and *Spartina patens*. *Contrib. Mar. Sci*. 22:137-147.

Varnell, L.M. and K.J. Havens. 1995. A comparison of dimension-adjusted catch data methods for assessment of fish and crab abundance in intertidal salt marshes. *Estuaries* 18(2):319-325.

Yingling, F. 1936. Fish observed at Cove Point, Maryland. *Bulletin of the Natural History Society of Maryland* 6(8): 47-52.