European Carp (*Cyprinus carpio*) and Native Fishes in Cove Point Marsh

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Abstract

A survey of European carp and native fishes in Cove Point marsh was conducted in 2003. Fishes were sampled using pop nets, minnow pots and two gill nets. Data were compared with those from two previous surveys in 1999 and 2000. Fish diversity had declined from previous years, with some rare species no longer present in the survey. Species that were abundant in the earlier surveys were present in low numbers, and regained abundance as the year progressed. European carp were present in the marsh in low abundance. There was no evidence of carp reproduction, and all fishes were of the same year class. They may represent recruitment from outside the marsh, possibly from adjacent freshwater reservoirs. The current carp population is unlikely to lead to major changes in the marsh. Physical conditions, such as drought and storms, are likely to be more important factors shaping the animal and plant communities present within the marsh.

Introduction

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 fresh water primarily from runoff, seeps and groundwater discharge. Storms and high tides bring saltwater incursions from the Chesapeake Bay, but there is usually no connection between the Bay and the marsh. The marsh is composed of a larger body of open water as well as several smaller, isolated ponds and freshwater drainage streams. The open water areas are shallow, no more than 1.5 meters in depth, permitting dense growth of submerged aquatic vegetation (SAV). The ponds are lined with emergents, such as cattail (*Typha* sp.) and common reed (*Phragmites australis*).

The marsh supports an abundant fish community. Common species include *Gambusia holbrooki* (mosquito fish), *Cyprinodon variegatus* (sheepshead minnow), *Lucania parva* (rainwater killifish) and *Lepomis gibbosus* (pumpkinseed sunfish). Abundance for these species can be as high as 80 fishes/m2 (Bushmann, 2000). Other species, such as inland silversides (*Menidia beryllina*), mummichogs (*Fundulus heteroclitus*) and eastern mudminnows (*Umbra pygmaea*), exist in small populations.

Biological abundance in the marsh depends upon primary production, which is in part due to dense beds of submerged aquatic vegetation (SAV). SAV beds are also important foraging areas for waterfowl (Michot and Chadwick, 1994). The dominant SAV at Cove Point is *Ruppia maritima* (widgeon grass). These beds can become quite dense (2 kg wet wt/m2), and grow throughout most of the open water areas of the marsh. Other submersed vegetation includes *Myriophyllum aquaticum* (milfoil), and *Chara* sp. (a multicellular algae). In 1999, *Eleocharis* sp. (spike rush) grew in areas uncovered during drought, and persisted as a submersed plant throughout the following wet year (personal observation). SAV loss can lead to oxygen loss, loss of habitat for small fishes and invertebrates, leading to a food loss for larger organisms, and increased turbidity in the water (Adams, 1976; Orth and Heck 1980, Terrados and Duarte, 2000).

Biological diversity in Cove Point marsh can be impacted by factors that reduce or extirpate animal or plant populations. Primary factors likely to have impact include variations in weather patterns and invasive species. The marsh is a highly dynamic system, with water levels fluctuating between flood and drought (Fig 1). Drought years, 1999 and 2002, produced increased turbidity, increased salinity and declines in fish and aquatic plant populations. In 2000, a wet year, SAV remained abundant throughout the

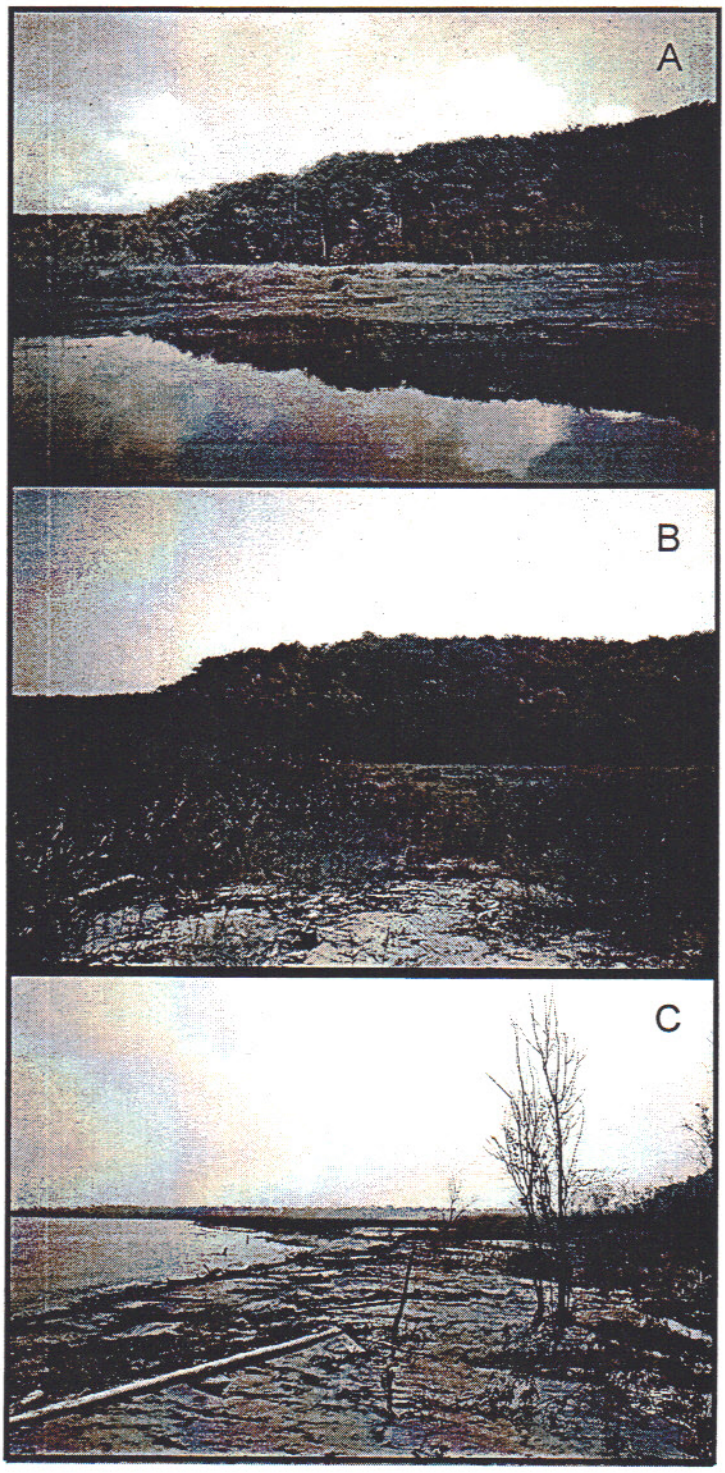

Figure 1. 1A: Main marsh in 2000, a wet year. 1B: Main marsh in August 1999, a drought year. 1C: Beach area in late 2003, after Isabel. Much of the front dune and vegetation between the marsh and the Chesapeake Bay has been removed.

Summer. In 2003, a very wet year, large freshwater inputs led to increased turbidity and little aquatic vegetation was observed. Further, two hurricanes occurred over the sampling period. Hurricane Floyd, in 1999, refilled the marsh and lowered salinity to zero in a single day. In 2003, hurricane Isabel caused saltwater to wash into the marsh and raised salinity from zero to 10 ppt in one day.

Cove Point marsh also contains non-indigenous species capable of impacting the ecosystem. European carp (*Cyprinus carpio*), mute swans (*Cygnus olor*) and nutria (*Myocastor coypus*) have all been observed within the marsh. The European carp, introduced in the United States in the 1800's, is considered a threat to submerged aquatic vegetation. Carp can damage SAV through direct consumption, root disturbance and increasing turbidity (King and Hunt, 1967; Crivelli, 1983; Dieter *et al.*, 1991). Carp are often common in shallow marshes because of their ability to withstand the large fluctuations in temperature and oxygen levels (Mitsch and Gosslink, 2000), but they are not considered desirable by many managers.

This study had two purposes. The first was to re-examine the native fish population, two years after the previous survey. These current data can be compared with that survey to evaluate how environmental changes, such as droughts and hurricanes, had impacted the abundance and diversity of native fishes in the marsh. The second purpose of a new survey was to determine the status of any European carp population present in the marsh. Carp were observed in previous years, but no specimens had been collected and a positive identification had not been made. An examination of the resident carp population may help in determining if this non-indigenous species poses a threat to the overall health of the marsh.

Materials and Methods

Collections occurred approximately every two weeks, from May 2003 to October 2003. Small fishes were sampled using buoyant pop nets and minnow traps (Serafy *et al.*, 1988; Dewey *et al.*, 1989; Connolly, 1994). Pop nets consisted of two squares formed from ¾ in. PVC, each square with an area of 1 m2. The PVC sections were joined by 1mm2 netting, so that one square formed the base and the other the top of a cube, with the netting on the sides. The bottom square was not buoyant, and remained on the bottom of the marsh. The top square was buoyant. It was held attached to 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 m2 area of the net.

Pop nets were set in areas established in previous surveys: small pond, front marsh, back marsh and south marsh (Fig. 2). A minnow pot was also set 5-6 meters from each pop net. A minnow pot was also set in boardwalk pond (Fig. 2). Each minnow pot was baited with a mixture of algae-based and shrimp-based flake fish food wrapped in cheese cloth.

All nets and pots were usually set by 10:00 am. At least two hours was allowed for disturbance to settle. The nets were then popped at a 3-4 m distance. Caught organisms were removed from the popped net with three scoops of a rectangular net slightly smaller than the inside width of the pop net. Fishes in the pop nets were identified, counted, and total length recorded for the first ten fish of each species. Fishes in the minnow pots were identified and counted.

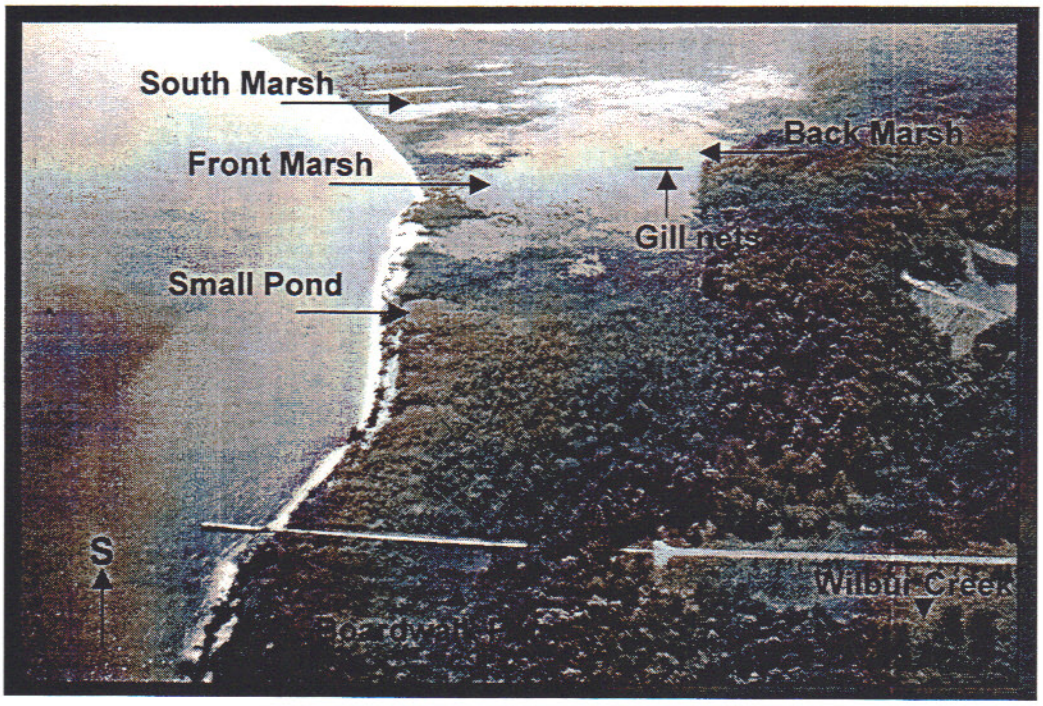

Figure 2. Aerial photograph of Cove Point marsh, showing the four sampling sites used in the survey: Small Pond, Front Marsh, Back Marsh, and South Marsh. Boardwalk Pond was also occasionally sampled. The location and orientation of the gill nets are shown.

Larger fishes and European carp were collected using two gill nets. Each gill net was approximately three meters in length and two meters in depth and composed monofilament netting with 5 cm openings. The two gill nets were set in series, stretching 6 meters perpendicular to the shoreline, through the deepest part of the marsh (Fig 2). Gill nets were set early in the sampling day and examined after 3-4 hours. All caught fish were identified and standard length determined. Any carp were put on ice and returned to the laboratory for measurement of standard length, weight, gonad weight, sex, and age. Age was determined by examination of scale circuli (Ambrose, 1989; Devries and Frie, 1996).

Results

Native Fishes

Table 1. Totals of all fishes collected over a three year sampling period.

	common name	1999	2000	2003
Clupeiformes				
Anchoa mitchilli	bay anchovy	21	0	0
Dorosoma cepedianum	gizzard shad	0	0	1
Cypriniformes				
Cyprinus carpio	European carp	5 (est.)	0	29
Notemigonus crysoleucas	golden shiner	0	8	0
Siluriformes				
Ameiurus nebulosus	bullhead catfish	0	1	2
Salmoniformes				
Umbras pygmaea	eastern mudminnow	28	69	0
Esox sp.	pickerel	1	0	0
Cyprinodontiformes				
Cyprinodon variegatus	sheepshead minnow	114	57	7
Fundulus heteroclitus	mummichog	10	2	90
Fundulus diaphanus	banded killifish	6	4	0
Fundulus confluentus	marsh killifish	2	0	0
Lucania parva	rainwater killifish	78	404	1
Gambusia holbrooki	mosquitofish	397	536	325
Atheriniformes				
Membras martinica	rough silversides	25	0	0
Menidia beryllina	inland silversides	30	5	13
Perciformes				
Morone americana	white perch	0	0	1
Lepomis gibbosus	pumpkinseed sunfish	19	12	218
Lepomis macrochirus	bluegill sunfish	4	0	0
Totals		**735**	**1098**	**687**
S-W Index		**1.61**	**1.19**	**1.29**

Ten species were collected in 2003 (Table 1). Ten species were also collected in 2000, while fourteen species were collected in 1999. Two new species were recorded in 2003, a filter feeder *Dorosoma cepedianum* (gizzard shad) and a fish predator *Morone americana* (white perch). Eight species, observed in previous years, were not recorded in

2003. A Shannon-Weiner diversity index of 1.29 was calculated for 2003. This index is well below that calculated for 1999 (1.61), but slightly higher than that for 2000 (1.19).

The fish community in 2003 was dominated by three abundant species: *G. holbrooki*, *L. gibbosus* and *F. heteroclitus* (Fig. 3). *G. holbrooki* was abundant in previous surveys and was the most common species in 2003. *L. gibbosus* and *F. heteroclitus* populations increased compared with previous years. All other species declined in number compared with previous surveys. *U. pygmaea* (eastern mudminnow), common in 2000, was not recorded at all in 2003.

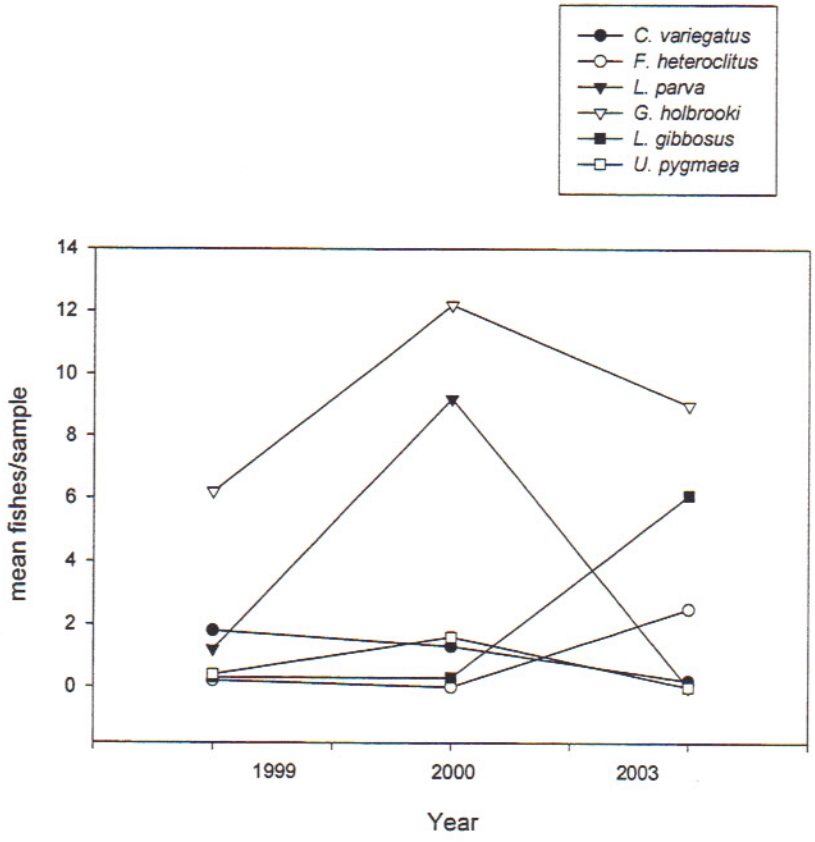

Figure 3. Mean fish collected per sample for common species over a three year sampling period.

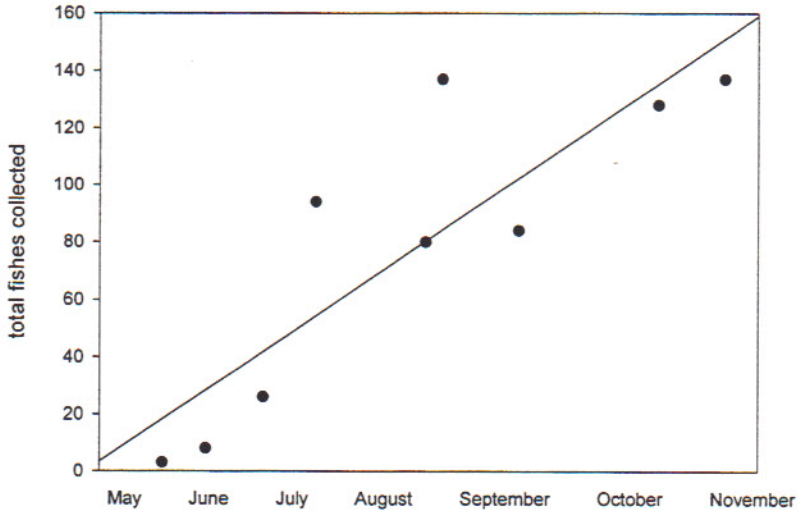

Figure 4. Total fishes collected for each sampling day over the 2003 sampling season.

Fish abundance was very low early in the 2003 sampling season but increased through November (Fig. 4). Few fishes were found in the first two sampling efforts in late May and early June. Pop nets during this period failed to collect any fish. The number of fishes collected during each sampling day rose throughout the Summer.

This rise in abundance was primarily due to increases in the three most common species (Fig. 5). *G. holbrooki*, *L. gibbosus* and *F. heteroclitus* all increased in number over the sampling season. Other species remained rare in 2003. Increases in *G. holbrooki* and *L. gibbosus* appeared to be due to reproduction within the marsh, rather than outside recruitment. Very small juveniles of both species were collected early in the season and throughout the Summer. These individuals likely represent that Summer's spawning effort. Increase in *F. heteroclitus* numbers was probably due largely to recruitment from the Chesapeake Bay. Few *F. heteroclitus* juveniles were collected and the greatest

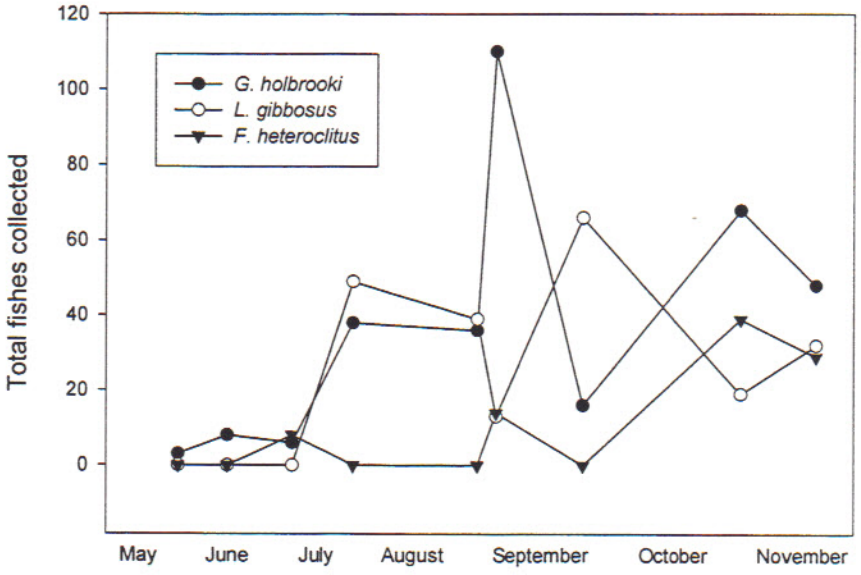

Figure 5. Numbers of the three common species collected over the 2003 sampling season.

increase in numbers occurred after hurricane Isabel opened the marsh to the Bay. Collections after this point often contained *F. heteroclitus* adults larger than those observed just prior to the hurricane.

European carp

Carp were observed in the marsh in 1999, but were not collected by pop net or minnow pot in the 1999, 2000 or 2003 surveys. Adult carp were collected in 2003 using gill nets. Although the gill nets were set during on all sampling dates, carp were collected only on two occasions. On September 15, two adult carp were collected in the gill nets. On October 16, 27 adult carp were collected. All carp were all of similar size and condition. Two individuals from the October 16 collection were "mirror" carp, a morphotype in which body scales are larger and irregularly scattered over the body (Fig. 6).

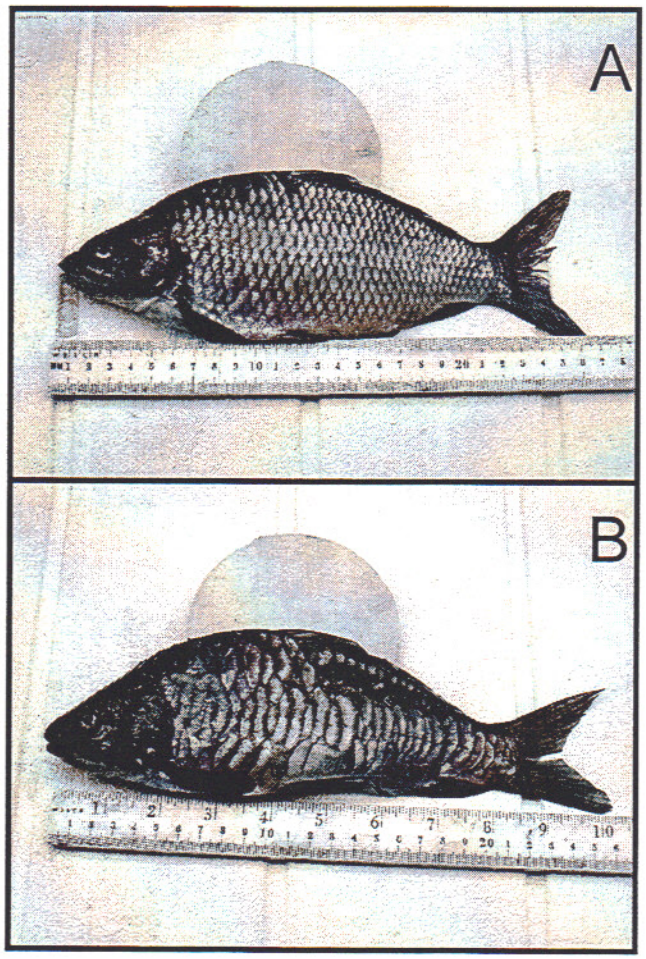

Figure 6. 6A: Typical size carp, collected on October 16, 2003.
6B: A "mirror" carp, collected on the same day.

Standard length and weight were recorded for all carp collected in 2003 (Table 2). In addition, gonad weight and age were determined for ten randomly selected individuals. Gonad weights and body weights were used to determine gonadosomatic indeces (GSI) for females. A GSI was determined using the formula GSI = (gonad wt/body wt)*100. All carp collected were of a similar size and length, with means of 235 mm and 279 g, respectively. Of the ten fish examined in more detail, eight were female and two were

male. Females had low gonadal weights with a mean GSI of 2.11. Examination of scale circuli showed that all ten fish were three years of age.

Table 2. Summary biological data for all carp collected in 2003.

	Std Length (mm)	Weight (g)	Female Gonad Wt. (g)	Female GSI	Age (yrs)
Range	217 - 345	220 - 325	1.60 - 8.71	0.57 - 3.96	3 - 3
Mean	234.69	279.02	5.27	2.11	3
SEM	7.77	6.17	1.03	0.45	0

Physical Conditions

Rainfall was plentiful in 2003. Water levels were high and salinity remained near zero in all areas of the marsh. The water was generally turbid throughout the season and SAV was not abundant. Many areas of the marsh, without standing water in the previous drought season, did not exhibit SAV re-growth in 2003. These conditions changed abruptly on September 19 when hurricane Isabel caused a large overwash of saltwater into the marsh (Fig.1). Observations on September 27 found salinity in the main marsh at 10 ppt. The marsh had opened to the Bay in two areas. By October 16th, the marsh beach had closed and there was again no open water connection to the Bay.

Conclusions

This study confirms the presence of European carp in Cove Point marsh. All individuals were approximately the same size and all appeared to be three years of age. Carp spawn in Spring and early Summer, suggesting that these fish were spawned in Summer 2001. These carp likely represent a single year class. Because no other size

carp have been collected in the marsh, these fish may not represent a reproductive population but rather a recruitment event from outside the marsh. Chesapeake Bay salinity at Cove Point can be within the upper range of tolerance for carp (Murdy *et al.*, 1997). It is thus possible for carp to enter the marsh in that way, possibly carried in the wash from large storms. Carp may also enter the marsh from the freshwater reservoirs above the marsh. Although the fish communities in these water bodies have not been examined, the reservoirs seem to represent good carp habitat, with soft bottoms and abundant aquatic vegetation.

Calculated GSI for females were low, 0.57 – 3.9g. This indicates that none of those females were in reproductive condition, as GSI for spawning females can reach 20% of body weight (Basavaraju *et al.*, 2002). This is expected for fish collected in Fall, when the reproductive period is over. However, many carp reach sexual maturity by three years of age. The fishes collected in Fall 2003 would likely have spawned the following Spring had they remained in the marsh.

Based upon the carp collected to date, it is unlikely that this species has had a significant impact upon the marsh. Population numbers do not appear large, and reproduction may not have occurred. The carp population may spawn and grow in the future, but currently other factors are likely more important. The effects of other non-indigenous species, such and nutria and mute swans, remains unexamined.

It is likely that changing physical conditions and major weather events are the primary controlling influences in the marsh. This conclusion is consistent with earlier observations and illustrates the dynamic nature of Cove Point marsh. Changes in environmental conditions, such as rainfall, marsh water level and salinity, can be abrupt

and severe. Major storms may push saltwater into the marsh or open the marsh to the Bay. Submerged aquatic vegetation can be extensive or absent. These changing conditions more than any other single factor shape the fish community.

Overall, fish diversity has decreased since the 1999 survey. The community at that time consisted of a 4-5 very common and 12-13 less common species. The common species have survived, although both their absolute and relative numbers have changed. Several less common species have not been collected since 1999. These species have either become too rare to reliably collect, or they are now absent from the marsh. It is likely that the two severe droughts that occurred in 1999 and 2002 led to the eradication of some species. Species that are exist in large numbers in the marsh are "survivors", capable of adapting to rapidly changing conditions.

A related factor that may influence the fish community is the opening of the marsh to the Bay In addition to the possibility of carp recruitment by this route, an adult white perch was caught by gill net in the marsh after hurricane Isabel. This individual represents movement of a fish predator into the marsh from the estuary. If this species arrived in any number and can survive in the marsh, it would likely exert top-down influences on the marsh community. Although the marsh closed again, a persistent opening would allow the introduction of many different species would greatly affect many populations within the marsh.

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