AN ANALYSIS OF FRESHWATER INFLOW EFFECTS ON THE EARLY STAGES OF FISH AND THEIR INVERTEBRATE PREY IN THE ALAFIA RIVER ESTUARY

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SUMMARY

Quantitative ecological criteria are needed to establish minimum flows and levels for rivers and streams within the Southwest Florida Water Management District (SWFWMD), as well as for the more general purpose of improving overall management of aquatic ecosystems. As part of the approach to obtaining these criteria, the impacts of managed freshwater inflows on downstream estuaries are being assessed. A 17-month study of freshwater inflow effects on habitat use by estuarine organisms in the tidal Alafia River was started in June 1998, using funds provided by SWFWMD. An additional 9 months of surveys were conducted at the start of Tampa Bay Water's ongoing Hydrobiological Monitoring Program (HBMP), and the data from these surveys were combined with the SWFWMD surveys to produce the first interpretive report for the Alafia River (Peebles 2002a). An additional 36 monthly surveys have been conducted since publication of the first report. The present report uses these newer data to update selected analyses for ichthyoplankton (fish eggs, larvae, and small juveniles) and invertebrates collected by plankton net. Updated analyses of seine and trawl data can be found in Matheson et al. (2004).

The general objective of these studies was to identify patterns of estuarine habitat use and organism abundance under variable freshwater inflow conditions. Systematic monitoring was performed to develop a predictive capability for evaluating potential impacts of proposed freshwater withdrawals and, in the process, to contribute to baseline data. The predictive aspect involves development of regressions that describe variation in organism distribution and abundance as a function of natural variation in inflows and salinity. These regressions can be applied to any proposed alterations of freshwater inflows or salinity that fall within the range of natural variation documented during the data collection period.

For sampling purposes, the lengthwise axis of the tidal Alafia River was divided into six zones, and two plankton samples were taken from each zone on a monthly basis. All plankton sampling was limited to nighttime flood tides. Salinity, water

temperature, dissolved oxygen and pH measurements were taken in association with each plankton-net deployment. Daily freshwater inflow estimates for the Alafia River estuary were derived from gauges positioned upstream of the tidal river and modeled flows from ungauged areas (Tara et al. 2001), which represent eighteen percent of the Alafia River watershed.

A large body of descriptive habitat-use information was generated and is presented in tabular form. In general, observed habitat-use patterns are consistent with findings from other tidal rivers on Florida's west coast. The plankton samples documented the distributions the egg, larval, and juvenile stages of estuarine-dependent, estuarine-resident, and freshwater fishes. *Estuarine-dependent* fishes are spawned at seaward locations and invade tidal rivers during the late larval or early juvenile stage, whereas *estuarine-resident* fishes are present within tidal rivers throughout their life cycles. Comparisons of life-stage-specific distributions demonstrated the ingress of certain estuarine-dependent fishes into the Alafia River. For example, the mean location of capture for the bay anchovy, measured as distance upstream from the river mouth, moved progressively upstream during development, starting at 0.5 km during the egg stage and increasing from 2.0 to 2.4 km during various larval stages and finally to 7.4 km as this species occupied its estuarine nursery habitat during the juvenile stage. Similar patterns of ingress were found for other estuarine-dependent species, including spotted seatrout, sand seatrout, hogchoker, and the daggerblade grass shrimp (*Palaemonetes pugio*). Other species such as red drum, snook, and striped mullet did not appear to move into the interior of the tidal river until the juvenile stage (Matheson et al. 2004).

In addition to collecting the early stages of coastal fishes, the plankton net collected large numbers of freshwater and estuarine invertebrate plankton and hyperbenthos, which consists of substrate-associated invertebrates that rise into the water column at night. These organisms are of particular interest because many serve as important prey for the juvenile estuarine-dependent fishes that seek out tidal rivers as nursery habitat.

The survey data were used to develop regressions that describe shifts in fish and invertebrate distributions as inflow rates and salinities change. It was found that the distributions of more than 70 types of fish and invertebrates shifted as freshwater inflows fluctuated, moving upstream during low-inflow periods and downstream during high-inflow periods. Some species appeared to be more reluctant to change position than others.

The abundances of 48 types of fish and invertebrates changed in response to inflow variation. During high-inflow periods, freshwater organisms increased in number as they were flushed into the survey area, and marine groups decreased in number as they moved seaward and out of the survey area. Eight taxa were estuarine or estuarine-dependent species that increased in number as inflows increased. This group included two species, a mysid shrimp (*Americamysis almyra*) and a grass shrimp (*Palaemonetes pugio*), that are known to be important prey for young estuarine-dependent fishes such as snook and red drum that use the upper parts of estuaries as their principal nursery habitat. The group of positive responders also included the early juvenile stages of two biomass-dominant estuarine-dependent fishes, the sand seatrout (*Cynoscion arenarius*) and the bay anchovy (*Anchoa mitchilli*). The bay anchovy is important forage for sportfishes and seabirds throughout the Tampa Bay estuary. Inflow-abundance regressions were used to calculate the abundances that would be expected under typical (median) inflow conditions. The regressions were also used to estimate inflow-related deviations away from typical abundances.

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1.0 INTRODUCTION

Rivers export nutrients, detritus and other productivity promoting materials to the estuary and sea. Freshwater inflows also strongly influence the stratification and circulation of coastal waters, which in itself may have profound effects on coastal ecosystems (Mann and Lazier 1996). Estuary-related fisheries constitute a very large portion of the total weight of the U.S. fisheries yield (66% of finfish and shellfish harvest, Day et al. 1989; 82% of finfish harvest, Imperial et al. 1992). The contribution of estuary-related fisheries is consistently high among U.S. states that border the Gulf of Mexico, where the estimates typically exceed 80% of the total weight of the catch (Day et al. 1989). Examples from around the world indicate that these high fisheries productivities are not guaranteed, however. In many locations, large amounts of fresh water have been diverted from estuaries to generate hydroelectric power or to provide water for agricultural and municipal use. Mann and Lazier (1996) reviewed cases where freshwater diversions were followed by the collapse of downstream fisheries in San Francisco Bay, the Nile River delta, James Bay, Canada, and at several inland seas in the former U.S.S.R. Sinha et al. (1996) documented a reversal of this trend where an increase in fisheries landings followed an increase in freshwater delivery to the coast.

Fishery yields around the world are often positively correlated with freshwater discharge at the coast (Drinkwater 1986). These correlations are often strongest when they are lagged by the age of the harvested animal. In south Florida, Browder (1985) correlated 14 years of pink shrimp landings with lagged water levels in the Everglades. Associations between river discharge and fisheries harvests have also been identified for various locations in the northern and western Gulf of Mexico (Day et al. 1989, Grimes 2001). Surprisingly, discharge-harvest correlations sometimes extend to non-estuarine species. Sutcliffe (1972, 1973) reported lagged correlations between discharge of the St. Lawrence River and the harvest of non-estuarine species such as American lobster and haddock. In recognition of the potential complexities behind these correlations, Drinkwater (1986) advised that the effect of freshwater inflows be considered on a species-by-species basis.

Fresh water's influence on coastal ecosystems extends beyond its immediate effects on fisheries. Because of the intricate nature of many food web interactions, changes in the abundance of even a single species may be propagated along numerous pathways, some anticipated and some not, eventually causing potentially large changes in the abundance of birds, marine mammals and other groups of special concern (Christensen 1998, Okey and Pauly 1999). Mann and Lazier (1996) concluded "one lesson is clear: a major change in the circulation pattern of an estuary brought about by damming the freshwater flows, a tidal dam, or other engineering projects may well have far reaching effects on the primary and secondary productivity of the system."

This project was conducted to support the establishment of minimum flows for the Alafia River estuarine system by the Southwest Florida Water Management District (SWFWMD). Minimum flows are defined in Florida Statutes (373.042) as the "limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." In the process of establishing minimum flows for an estuarine system, the SWFWMD evaluates the effects of the freshwater inflows on ecological resources and processes in the receiving estuary. The findings of this project will be used by the SWFWMD to evaluate the fish nursery function of the Alafia River estuary in relation to freshwater inflows. It is not the purpose of this project to determine the level of effect that constitutes significant harm, as that determination will be made by the Governing Board of the SWFWMD. This report includes data from an earlier SWFWMD-funded study (Peebles 2002a), and extends the analysis to include more recent plankton-net data collected through 2003.

1.1 Objectives

This project uses plankton-net surveys to document the abundance and distribution of the early life stages of fishes and invertebrates that use the tidal Alafia River as habitat. A coordinated seine and trawl survey (Matheson et al. 2004) addresses similar objectives for later stages of estuarine fishes and invertebrates.

There were several objectives for this project. One was to produce a descriptive database that could serve as a baseline for comparison with future ecological change. These baseline data also provide seasonality records that identify the times of year when the risk of adverse impacts would be greatest for specific organisms.

Another principal objective was to develop regressions to model the responses of estuarine organisms to variations in freshwater inflows. The resulting models would then be available for evaluating proposed minimum flows or the potential impacts of proposed freshwater management plans. These models were developed for both the early life stages of estuarine fishes and the invertebrate prey groups that sustain young fishes while they occupy estuarine nursery habitats.

1.2 Overview of Estuarine Dependence and the Importance of Tidal Rivers

The estuarine-dependent life history is characterized by habitat shifts that occur at predictable points in an organism's life cycle. These shifts involve an initial seaward-to-landward shift followed at some later point by a return seaward migration (Gunter 1961, 1967). In contrast, estuarine residents do not undergo predictable habitat shifts. Estuarine residents tend to be small species that do not contribute substantially to fisheries yields, yet they serve as important forage for wading birds and estuarine-dependent fishes. Estuarine-dependent fishes are of marine evolutionary origin and spawn either at sea or in relatively high salinity estuarine waters. In a typical estuarine-dependent life cycle, the young begin migrating landward at some point during the first few weeks of life, eventually congregating in estuarine nursery habitats (sensu Beck et al. 2001). After spending a few months in these low salinity habitats, the young animals gradually move back seaward. In some estuarine-dependent species, the ingression of the young animals into tidal rivers is detectable during the organisms' larval stages, which are often planktonic. Other species invade tidal rivers at larger juvenile sizes and make their first appearance in seine or trawl catches. The process of invading the tidal Little Manatee River is illustrated by Fig. 1.2.1.

While living at the seaward end of the estuary, fish larvae feed on small types of zooplankton such as the early stages of copepods (Houde and Lovdal 1984, Watson and Davis 1989, Peebles 1996, Flores-Coto 1998). Spawning in zooplankton-rich estuarine plume waters helps ensure that the larvae will encounter adequate prey densities (Govoni et al. 1983, Govoni and Chester 1990, Peebles et al. 1996, Peebles 2002d). Peebles et al. (1996) demonstrated that as the estuarine plume shifts seaward in response to increasing freshwater inflows, spawning locations may shift seaward with it. Likewise, variation in spawning location from one coastal area to another can sometimes be explained by differences in the relative position of estuarine gradients (Peebles 1987, Peebles and Tolley 1988). These differences in spawning location appear to have more to do with shifting prey distributions than shifting salinity, although salinity and prey distributions are often correlated (Peebles 2002d).

It is a general rule that fish diets change with age (Helfman 1978). In many species, the estuarine-dependent life cycle is driven by changes in prey requirements as the fishes grow larger (Marks and Conover 1993, Peebles 1996). Progressively larger prey organisms are included in the fishes' diets as the gapes of the fishes' mouths increase. Fish larvae living in the estuarine plume advance through various sizes of zooplankton prey and eventually undergo a dietary shift toward prey that is larger than that which is typically available in the coastal or estuarine plankton assemblage. For many species, this transition entails a diet shift from planktonic copepods to bottom dwelling organisms, notably mysids, amphipods and deposit feeding invertebrates in general. In order to maximize the availability of this new, larger prey, the young fishes move landward to begin a period of residence in areas where these prey types are most abundant. The onset of this landward migration can be predicted by predator models that are applied to observed prey distributions (Peebles 1996).

For some species, the landward migration coincides with their first use of structured habitats such as mangroves, marsh grasses, seagrasses, macroalgae and oyster reefs. The type of structure that is occupied is often highly variable, although a given species of fish may demonstrate a preference for a specific type of structure if two or more types are present in the same area (Rooker et al. 1998). As with other types of structure, estuarine macrophytes (mangroves, marsh grasses, seagrasses and macroalgae) provide refuge from predation (Boesch and Turner 1984), which is a role

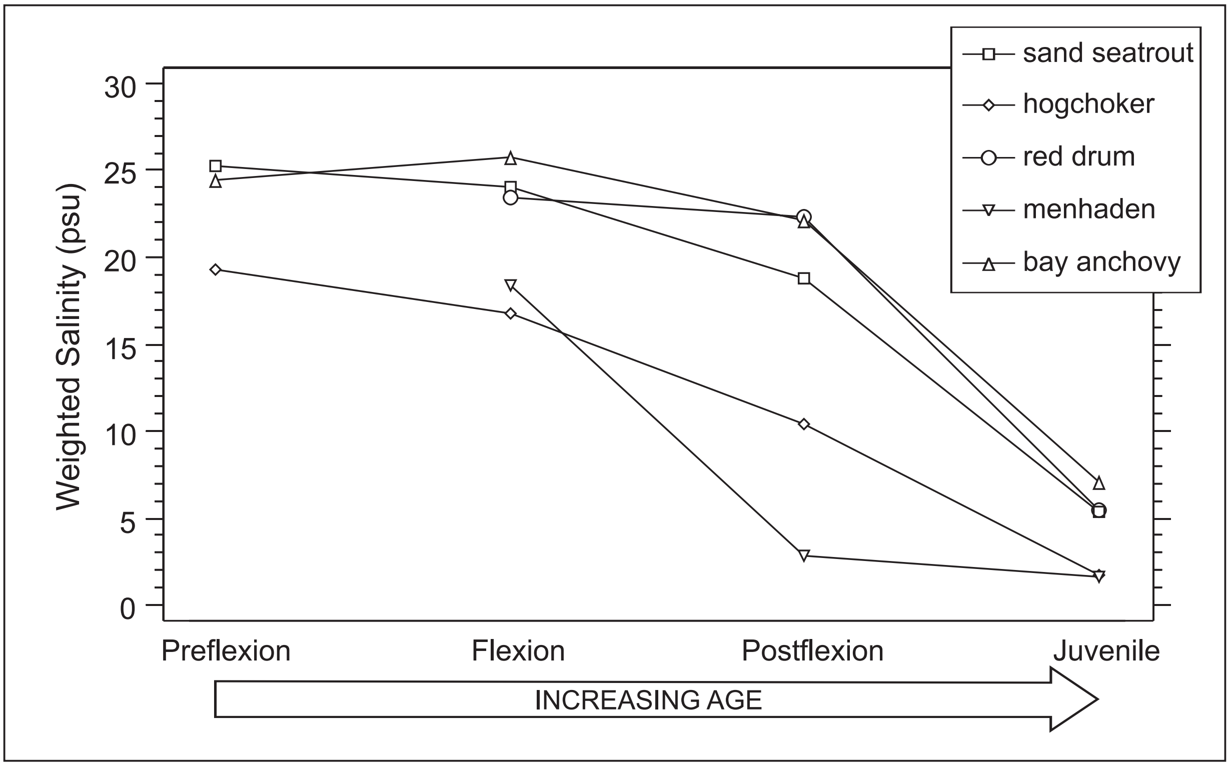

Fig. 1.2.1. Decreasing salinity at capture during fish development (redrawn from Peebles and Flannery, 1992).

that has been demonstrated experimentally on many occasions (Werner et al. 1983, Anderson 1984, Werner and Hall 1988).

The young of many biomass-dominant fish species aggregate over what is essentially featureless estuarine bottom in the upper parts of estuaries (Markle 1976, Chao and Musick 1977, Szedlmayer and Able 1996, Meng and Powell 1999), apparently taking advantage of "hot spots" in food availability (Barry et al. 1996). The unvegetated substrates of upper estuaries where the young fish and invertebrates congregate are characterized by sediments with small grain sizes (Weinstein 1979, Szedlmayaer and Able 1996, Meng and Powell 1999). These depositional areas tend to support large numbers of benthic, deposit-feeding and grazing invertebrates, provided benthic hypoxia is not also chronic there (Darnell 1961, McBee and Brehm 1982, Holland et al. 1987, Gaston and Nasci 1988). The tidal rivers along Florida's west coast include this type of depositional nursery habitat, a habitat that Meng and Powell (1999) describe as being "economically and ecologically undervalued."

Freshwater inflow delivers organic matter directly to tidal rivers and also stimulates local microalgal blooms. The pulsed delivery of fresh water causes alternation between local washout and bloom, to which the internal dynamics of estuarine trophic relationships are coupled with variable efficiency (Flint 1985, Ingram et al. 1985, Odum et al. 1995, Livingston 1997, Mallin et al. 1999, Peebles 2002d). Although large celled diatoms, which are prone to sedimentation, sometimes dominate in the upper estuary (WAR and SDI 1995, Lehman 2000), most types of smaller phytoplankton can also settle to the bottom, including blue-green algae (Darnell 1961). A large proportion of coastal phytoplankton production ends up as surface sediment deposits, providing an important energy source for deposit-feeding invertebrates and the fishes that prey upon them (Darnell 1961, Townsend and Cammen 1988). According to a straightforward argument presented by Mann (1988), more phytoplankton is processed through detrital pathways than through grazing pathways; if <80% of primary production is grazed and the grazers' assimilation is <50%, then >60% becomes detritus in the form of either sedimenting phytoplankton or fecal pellets.

Stable isotope studies tend to confirm the importance of phytoplankton (either suspended or deposited) and benthic microalgae to estuarine fish and invertebrate production (Haines 1976, Haines and Montague 1979, Hughes and Sherr 1983, Litvin and Weinstein 2003, Hollander and Peebles 2004). New deposits of microalgal biomass have a higher nutritional value than the refractory detritus produced by most macrophytes. In his review of the fate of detritus in aquatic ecosystems, Mann (1988) concluded that the bulk of macrophyte detritus is lost to microbial respiration. Despite this tendency for loss, macrophyte detritus can be a significant energy source for coastal fishes and invertebrates in the interiors of wetlands, in the freshwater reaches of rivers, and in oligotrophic coastal areas lacking substantial microalgal biomass (Mann 1988, Whitfield 1988, Litvin and Weinstein 2003). In all other parts of the estuary, phytoplankton and benthic microalgae are the primary producers that are most responsible for fish and shellfish production.

While in the estuary, fishes such as menhaden directly consume phytoplankton or phytoplankton enriched deposits (Hughes and Sherr 1983, Mann 1988). Postflexion stage menhaden larvae invade tidal rivers from the seaward direction and subsequently metmorphose into juveniles. Friedland et al. (1996) found a remarkably strong coincidence between the distributions of juvenile menhaden and chlorophyll *a* concentrations in two North Carolina tidal rivers. They stated:

> The Neuse and Pamlico estuaries exhibit predictable patterns of phytoplankton distribution, a feature that can be generalized to other estuaries providing menhaden nursery habitat and that in part explains menhaden estuarine dependence. . . . We suggest that these enhanced phytoplankton zones are critical to the survival of post-metamorphic juvenile menhaden, and may have played a role in the evolution of the species' estuarine dependence.

Friedland et al. (1996) found that the phytoplankton/menhaden maxima moved upstream and downstream as freshwater inflows varied. Other estuarine-dependent species, such as mullet, have isotope ratios consistent with consumption of benthic microalgae (Hughes and Sherr 1983, Mann 1988). Most fishes, however, are carnivorous, but reflect the isotope ratios of their deposit-feeding or grazing prey.

At various locations around the world, estuarine-dependent fishes and invertebrates use the depositional portions of estuaries as their principal nursery habitat.

In peninsular Florida, these depositional habitats often constitute remarkably small geographic areas within tidal rivers and streams (Flannery et al. 2002, Peebles 2005). Because these small, semi-confined locations are focal points for watershed runoff and are not protected from development, there would appear to be great potential for human impact on the natural nursery function of these areas. The SWFWMD recognizes the significance of this nursery function, and incorporates documented ecological relationships between inflow and nursery function into the process of developing minimum flows and levels for streams and rivers in west-central Florida.

2.0 METHODS

2.1 Study Area

The tidal portion of the Alafia River (Fig. 2.1.1) is a geographically small, microtidal, drowned-river-valley estuary that connects to the Gulf of Mexico via Hillsborough Bay and Tampa Bay. At the river mouth, the mixed, mainly semi-diurnal tide has a range of <1.2 m. The Alafia River watershed has an area of 1,092 km^2 (421 mi^2) bounded within Hillsborough and Polk counties. The main channel of the Alafia River begins at the confluence of the north and south prongs of the river at Alderman's Ford Park. From there, the river flows 38 km in a predominantly western direction to the river mouth at Hillsborough Bay. Limestone sills restrict saline water to the lowermost 17 km of the Alafia River channel during droughts. The upstream rocky substrate is replaced by fine grained sediments in the lowermost 10 km reach. The lowermost 1.4 km was diverted from its natural channel and dredged to a depth of 5-6 m in order to serve as a ship channel.

Mangrove shorelines, consisting primarily of black mangrove (*Avicennia germinans*) and red mangrove (*Rhizophora mangle*), are mostly restricted to shorelines within 2 km of the river mouth. Oyster reefs are largely restricted to the lowermost 4 km. Submerged aquatic vegetation appears to be absent from the tidal river. Between 2 and 6 km upstream, small intertidal areas (collectively <1.0 km^2) are vegetated by black rush (*Juncus roemarianus*). Leather fern (*Acrostichum danaeifolium*) is present in several intertidal locations in the 2-5 km reach. Hardwood trees dominate undeveloped shorelines upstream of 5 km.

Agricultural and urban/suburban land use comprise 27% and 17% of the river's watershed area (SWFWMD 2001). Lands for surface mining, located primarily in the basins of the north and south prongs, comprise about 28% of the watershed area. Spills of waste clays and acids from mining operations have historically occurred in the Alafia River basin. An acid spill on the north prong during December, 1997 had significant impacts on the biota of the river and its estuarine zone. Existing freshwater withdrawals for industrial use are limited to withdrawals from Lithia and Buckhorn Springs. Withdrawals from the river for public supply started in late summer, 2002. These withdrawals are limited to 10% of the daily flow at the intake site located at Bell Shoals Road (km 18).

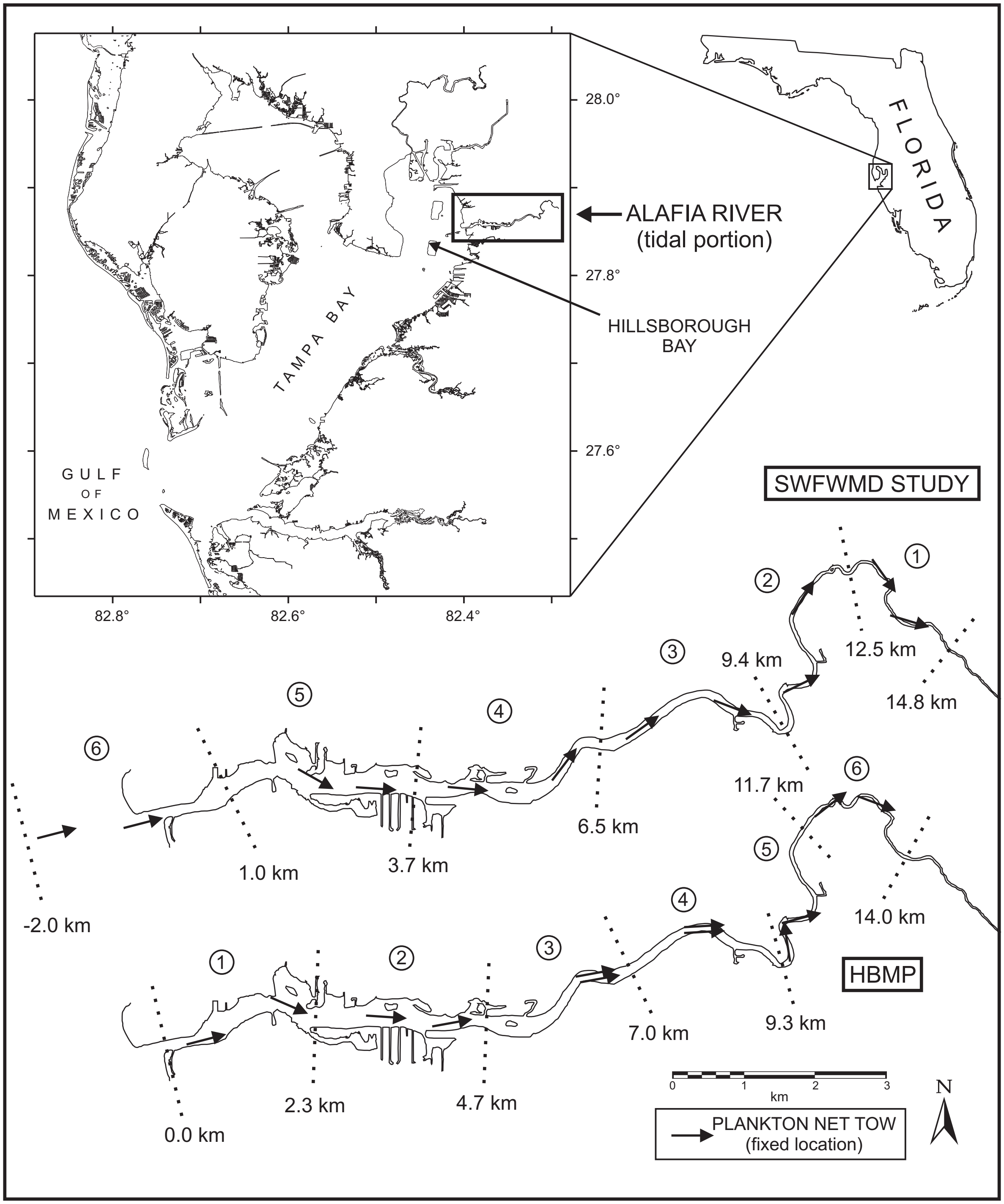

Fig. 2.1.1. Map of survey area. Sampling zones are numbered according to conventions used to label plankton samples.

2.2 Survey Design

The small organisms collected at night by the plankton net represent a combination of the zooplankton and hyperbenthos communities. The term *zooplankton* includes all weakly swimming animals that suspend in the water column during one or more life stages. The distribution of such animals is largely subject to the motion of the waters in which they live. The term *hyperbenthos* applies to animals that are associated with the bottom but tend to suspend above it, rising higher into the water column at night or during certain times of year (vertical migrators). The permanent hyperbenthos of estuaries (non-transient hyperbenthos) tends to be dominated by peracarid crustaceans, especially mysids and amphipods (Mees et al. 1993).

The faunal mixture that forms in the nighttime water column includes the planktonic eggs and larvae of fishes (ichthyoplankton), as well as juveniles and adults of smaller fish species. One of the most common reasons for using plankton nets to survey estuarine waters is to study ichthyoplankton. Although fish eggs and larvae are the intended focus of many plankton-net surveys, invertebrate plankton and hyperbenthos tend to numerically dominate estuarine plankton samples, particularly when the samples are collected at night. The invertebrate catch largely consists of organisms that serve as important food for juvenile estuarine-dependent and estuarine fishes. In an effort to characterize the invertebrate catch more completely, all water column animals collected by the plankton net were enumerated at a practical taxonomic level.

Data from two series of surveys will be analyzed here. The first series was conducted by the SWFWMD and the second was conducted by PBS&J, Inc. for Tampa Bay Water, Inc., a regional water supply utility. The latter project, known as the Hydro-Biological Monitoring Program (HBMP) for the Tampa Bypass Canal/Alafia Water Supply Projects, is ongoing. Analysis of HBMP data will be restricted to 45 months of data from the Alafia River taken prior to 2004. Monthly sampling for the SWFWMD study was conducted for 17 months beginning in June 1998. In both surveys, the tidal Alafia River was divided into six collection zones (Fig. 2.1.1), and two plankton samples were taken from each zone on a monthly basis. The SWFWMD plankton collections were made at fixed stations of a systematic design, whereas those of the HBMP were made at fixed locations selected through a one-time stratified randomization. The longitudinal position of each station was measured as the distance from the mouth of the tidal river, following the geometric centerline of the channel.

2.3 Plankton Net Specifications and Deployment

The plankton gear consisted of a 0.5 m mouth diameter, 500 μm mesh, conical (3:1) plankton net equipped with a three point nylon bridle, a flowmeter (General Oceanics model 2030R), a one liter plastic cod end jar and a 9 kg (20 lb.) weight. The net was deployed between low slack and high slack tide, with sampling beginning within two hours after sunset and typically ending less than four hours later. Tow duration was five minutes, with tow time being divided equally among bottom, mid-water and surface depths. The boat towed the net along a nearly constant depth contour that was estimated to be close to the average cross-sectional depth for the local river reach. There were two exceptions to this approach: (1) within the dredged reach that extends seaward from a point 1.4 km upstream, the net was towed along the transitional depth between the channel and adjacent shallows or shoreline, and (2) in the uppermost zone, the bottom contours were highly variable and numerous snags were present, so the net was deployed at the surface only. The fishing depth of the weighted net was controlled by adjusting the length of the tow line while using tachometer readings to maintain a constant line angle. The tow line was attached to a winch located on the gunnel near the transom. Placement of the winch in this location caused asymmetry in the steering of the boat, which caused propeller turbulence to be directed away from the towed net. Tow speed was approximately 1.3 m s^{-1}, resulting in a tow length of about 400 m over water and a typical filtration of 70-80 m^3. Each month's combined tow length was >30% of the total transect length. Upon retrieval of the net, the flowmeter reading was recorded and the contents of the net were rinsed into the cod end jar using an electric washdown pump and hose with an adjustable nozzle. The samples were preserved in 6-10% formalin in ambient saline.

When ctenophore (comb jelly) volumes exceeded the cod end jar's capacity, volume indicators on the net panel seams were used to estimate the total volume of ctenophores in the net. If the total volume was <3.0 liters, only the material in the cod end jar was preserved. If the total volume was >3.0 liters, a second cod end jar was filled and preserved by ladling material from inside the net. Abundances of all organisms in the sample were later adjusted to reflect this subsampling method. The net was cleaned between surveys using an enzyme solution that dissolves organic deposits. Salinity, temperature, pH and dissolved oxygen were measured at one meter intervals from surface to bottom after each plankton-net deployment.

2.4 Plankton Sample Processing

All aquatic taxa collected by the plankton net were identified and counted, except for invertebrate eggs and organisms that were attached to debris (sessile stages of barnacles, bryozoans, sponges, tunicates and sessile coelenterates). During sorting, the data were entered directly into an electronic database via a macro-driven spreadsheet. Photomicrographs of representative specimens were compiled into a reference atlas that was used for quality control purposes.

Most organisms collected by the plankton net fell within the size range of 0.5-50 mm. This size range spans three orders of magnitude, and includes mesozooplankton (0.2-20 mm) macrozooplankton/micronekton (>20 mm) and analogous sizes of hyperbenthos. To prevent larger objects from visually obscuring smaller ones during sample processing, all samples were separated into two size fractions using stacked sieves with mesh openings of 4 mm and 250 µm. The >4 mm fraction primarily consisted of juvenile and adult fishes, large macroinvertebrates and large particulate organic matter. In most cases, the fishes and macroinvertebrates in the >4 mm fraction could be identified and enumerated without the aid of microscopes. When bay anchovy juveniles were encountered in high numbers (>300), the number present was estimated using either a Motoda box (SWFWMD study) or by counting specimens in a weighed fraction (HBMP).

A microscope magnification of 7-12X was used to enumerate organisms in the

>250 μm fraction, with zoom magnifications as high as 90X being available for identifying individual specimens. The >250 μm fraction was usually sorted in two stages. In the first sorting stage, the entire sample was processed as 10-15 ml aliquots that were scanned in succession using a gridded petri dish. Only relatively uncommon taxa (n<50) were enumerated during this first stage. After the entire sample had been processed in this manner, the collective volume of the aliquots was recorded within a graduated mixing cylinder, the sample was inverted repeatedly, and then a single 30-60 ml aliquot was poured. The aliquot volume typically represented about 12-50% of the entire sample volume. The second sorting stage consisted of enumerating the relatively abundant taxa within this single aliquot. The second sorting stage was not required for all samples. The second stage was, however, sometimes extended to less abundant taxa (n<50) that were exceptionally small or were otherwise difficult to enumerate (e.g., some copepods, barnacle nauplii, and the larvacean *Oikopleura dioica*).

2.4.1 **Staging Conventions.** All fishes were classified according to developmental stage (Fig. 2.4.1), where

> **preflexion** larval stage = the period between hatching and notochord flexion; the tip of the straight notochord is the most distal osteological feature.
>
> **flexion** larval stage = the period during notochord flexion; the upturned notochord or urostyle is the most distal osteological feature.
>
> **postflexion** larval stage = the period between completion of flexion and the juvenile stage; the hypural bones are the most distal osteological feature.
>
> **metamorphic** stage (clupeid fishes) = the stage after postflexion stage during which body depth increases to adult proportions (ends at juvenile stage).
>
> **juvenile** stage = the period beginning with attainment of meristic characters and body shape comparable to adult fish and ending with sexual maturity.

Decapod larvae were classified as zoea, megalopa or mysis stages. These terms are used as terms of convenience and should not be interpreted as technical definitions. Planktonic larvae belonging to Anomura and Brachyura (crabs) were called zoea. Individuals from these groups displaying the planktonic to benthic transitional morphologies were classified as megalopae. All other decapod larvae (shrimps) were classified as mysis stages until the uropods differentiated into exopods and endopods (5 total elements in the telsonic fan), after which they were classified as postlarvae until they reached the juvenile stage. The juvenile stage was characterized by resemblance to small (immature) adults. Under this system, the juvenile shrimp stage (e.g., for *Palaemonetes*) is equivalent to the postlarval designation used by some authors.

In many fish species, the juvenile stage is difficult to distinguish from other stages. At its lower limit, the juvenile stage may lack a clear developmental juncture that distinguishes it from the postflexion or metamorphic stage. Likewise, at its upper limit, more than one length at maturity may be reported for a single species or the reported length at maturity may differ between males and females. To avoid inconsistency in the staging process, length based staging conventions were applied to the more common taxa. These staging conventions agree with stage designations used by the U.S. Fish and Wildlife Service (e.g., Jones et al. 1978). The list in Table 2.4.1 is comprehensive, representing the conventions that have been required to date by various surveys. Some of the species or stages in the list were not encountered during the surveys covered by this report.

Table 2.4.1. Length based staging conventions used to define developmental stage limits. Fish lengths are standard length (SL) and shrimp length is total length.

Postflexion-juvenile transition (mm):	
Lucania parva	10
Menidia spp.	10
Eucinostomus spp.	10
Lagodon rhomboides	10
Bairdiella chrysoura	10
Cynoscion arenarius	10
Cynoscion nebulosus	10
Sciaenops ocellatus	10
Menticirrhus spp.	10
Leiostomus xanthurus	15
Orthopristis chrysoptera	15
Achirus lineatus	5
Trinectes maculatus	5
Gobiesox strumosus	5
Diapterus plumieri	10
Prionotus spp.	10
Symphurus plagiusa	10
Anchoa mitchilli	15
Sphoeroides spp.	10
Chilomycterus shoepfi	10
Lepomis spp.	10
Micropterus salmoides	10
Membras martinica	10
Chloroscombrus chrysurus	10
Hemicaranx amblyrhynchus	10
Micropogonias undulatus	15
Chaetodipterus faber	5

Juvenile-adult transition (mm):	
Anchoa mitchilli	30
Lucania parva	15
Gambusia holbrooki	15
Heterandria formosa	10
Menidia spp.	35
Eucinostomus spp.	50
Gobiosoma bosc	20
Gobiosoma robustum	20
Microgobius gulosus	20
Microgobius thalassinus	20
Gobiesox strumosus	35
Trinectes maculatus	35
Palaemonetes pugio	20
Membras martinica	50
Syngnathus spp.	80
Poecilia latipinna	30
Anchoa hepsetus	75

Metamorph-juvenile transition (mm):	
Brevoortia spp.	30
Dorosoma petenense	30

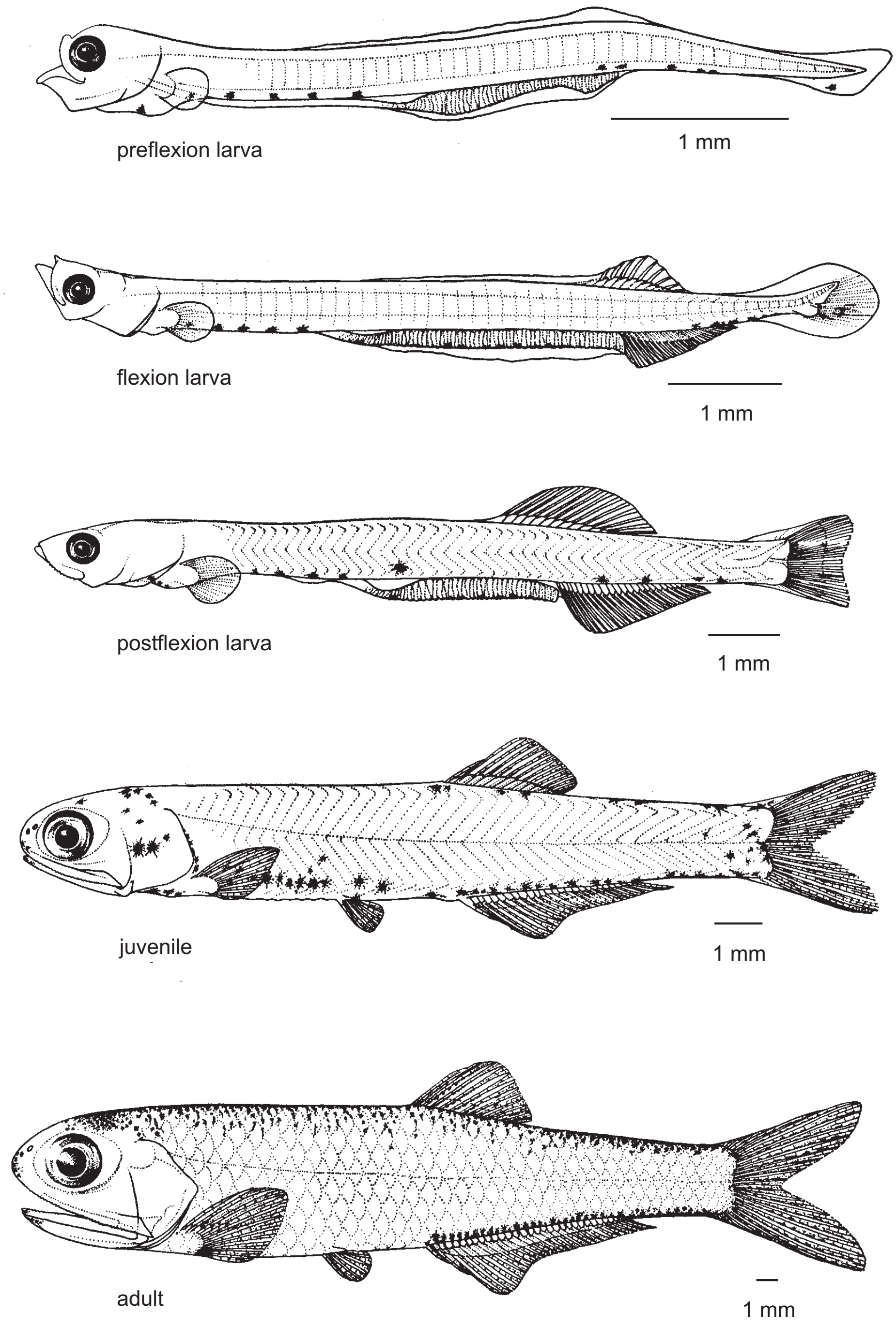

Fig. 2.4.1 Fish-stage designations, using the bay anchovy as an example. Specimens measured 4.6, 7.0, 10.5, 16 and 33 mm standard length.

2.5 Data Analysis

2.5.1 **Freshwater Inflow (*F*).** Freshwater inflow to the upper estuary, in cfs, was estimated by multiplying the gauged flow at Lithia (USGS gauge 02301500) by 1.117, a factor that accounts for ungauged watershed between the Lithia gauge and Bell Shoals (the upstream end of the tidal river), and then adding flows from Lithia and Buckhorn Springs. Daily records from the USGS database were complete, although some records were estimates provided by the USGS. When daily flows from Lithia and Buckhorn Springs were missing, these flows were represented by interpolation of periodic values or by regression during longer periods.

2.5.2 **Organism Weighted Salinity (S_U).** The central salinity tendency for catch-per-unit-effort (CPUE) was calculated as

$$S_U = \frac{\Sigma(S \cdot U)}{\Sigma U} ,$$

where U is CPUE (No. m^{-3}) and S is water column average salinity during deployment.

2.5.3 **Organism Total Number (*N*).** The total number of organisms in the tidal portion of the river was estimated by summing the products of mean organism density ($\overline{U}$, as No. m^{-3}) and tide corrected water volume (V) from six volume zones as

$$N = \Sigma(\overline{U} \cdot V) .$$

Volumes corresponding to a fixed vertical datum were calculated using recent bathymetric survey data, and these volumes were then adjusted to the actual water level at the time of collection using data from the USGS water level recorder near US highway 41. The volume zones were delineated in a manner that allowed comparison of the SWFWMD and HBMP plankton databases (Fig. 2.5.1).

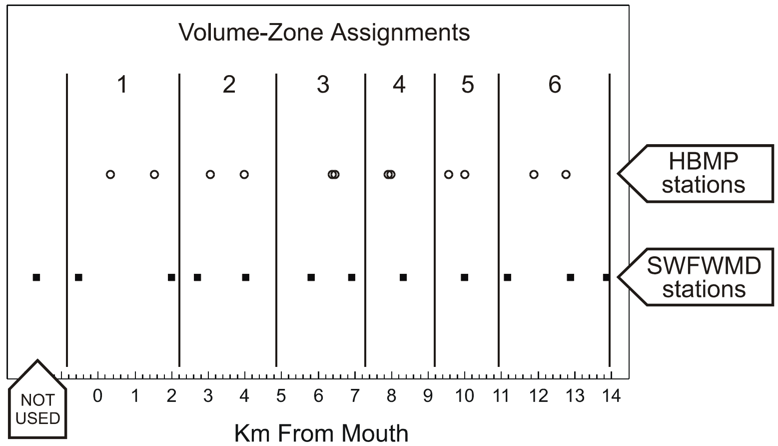

Fig. 2.5.1. Volume zone assignments used to calculate organism total number.

2.5.4 **Center of CPUE (km_U).** The central geographic tendency for CPUE was calculated as

$$km_U = \frac{\Sigma(km \cdot U)}{\Sigma U} ,$$

where *km* is distance from the river mouth. There was no effort to standardize the ranges of the SWFWMD and HBMP surveys. The longer length of the SWFWMD transects is likely to produce better estimates of km_U for organisms that were most abundant near the river mouth or in freshwater reaches. The two studies could have been standardized by not using data from the upper and lower SWFWMD stations, but the principal effect of this approach would have been to reduce the quality of some of the SWFWMD km_U estimates.

2.5.5 **Inflow Response Regressions.** Regressions were run for km_U on *F* and *N* on *F*. *N* and *F* were Ln transformed prior to regression, which greatly improved normality. All regressions were limited to taxa that were encountered during a minimum of 10 of the 62 monthly surveys. Twelve linear and nonlinear regression models were evaluated for each taxon. In these regressions, *F* was represented by same day inflow and by mean inflows extending as far back as 120 days prior to the sampling date. The combination of consecutive dates that produced the maximum regression fit was used to model the *N* and km_U responses to *F* for each taxon. This approach provided an indication of the temporal responsiveness of the various taxa to inflow variations. An organism was considered to be responsive if the regression slope was significantly different from zero at $p<0.05$.

2.5.6 **Data Limitations and Gear Biases.** All nets used to sample aquatic organisms are size selective. Small organisms pass through the meshes and large organisms evade the gear altogether. Intermediate sized organisms are either fully retained or partially retained. When retention is partial, abundance becomes relative. However, temporal or spatial comparisons can still be made because, for a given deployment method and size of organism, the selection process can usually be assumed to have constant characteristics over space and time. The 500 μm plankton gear retains a wide range of organism sizes completely, yet it should be kept in mind that many estimates of organism density and total number are relative rather than absolute. Organism measurements from Little Manatee River and Tampa Bay plankton samples (Peebles 1996) indicate that the following taxa will be collected selectively by 500 μm mesh: marine derived cyclopoid copepods, some cladocerans, some ostracods, harpacticoid copepods, cirriped nauplii and cypris larvae, the larvacean *Oikopleura dioica*, some decapod zoeae, and some adult calanoid copepods. Taxa that are more completely retained include: cumaceans, chaetognaths, insect larvae, fish eggs, most fish larvae and postlarvae, some juvenile fishes, gammaridean amphipods, decapod mysis larvae, most decapod megalopae, mysids, isopods, and the juveniles and adults of most shrimps. This partitioning represents a very general guide to the relative selectivities of commonly caught organisms.

The plankton nets were deployed during nighttime flood tides because larval fishes and invertebrates are generally more abundant in the water column at night (Colton et al. 1961, Temple and Fisher 1965, Williams and Bynum 1972, Wilkins and Lewis 1971, Fore and Baxter 1972, Hobson and Chess 1976, Alldredge and King 1985, Peebles 1987, Haney 1988, Lyczkowski-Shultz and Steen 1991, Olmi 1994) and during specific tide stages (Wilkins and Lewis 1971, King 1971, Peebles 1987, Olmi 1994, Morgan 1995a, 1995b). Organisms that selectively occupy the water column during flood tides tend to move upstream, and organisms that occupy the water column during all tidal stages tend to have little net horizontal movement other than that caused by net estuarine outflow (Cronin 1982, McCleave and Keckner 1982, Olmi 1994). The plankton catch was therefore biased toward organisms that were either invading the tidal rivers or were attempting to maintain position within the tidal rivers. This bias would tend to exclude the youngest larvae of some estuarine crabs, which are released at high tide to facilitate export downstream with the ebb tide (Morgan 1995a). However, as the young crabs undergo their return migrations at later larval stages, they become most available for collection during nighttime flood tides (Olmi 1994, Morgan 1995b). The sample sizes used in some regressions were limited by the increase in taxonomic resolution that took place for many groups of organisms at the inception of the HBMP; mysids, isopods, myodocopoid ostracods, crabs, and calanoid copepods were identified at higher taxonomic resolutions during the HBMP.

3.0 RESULTS AND DISCUSSION

3.1 Streamflow Status During Survey Years, 1998-2003

A series of exceptionally rainy, El Niño related cold fronts passed through the survey area prior to the start of the SWFWMD survey in 1998. The last of these are evident in Fig. 3.1.2. The SWFWMD survey started approximately one month after the end of strongly elevated El Niño inflows, but their cumulative effects persisted into the SWFWMD survey period. Average streamflows were at their lowest during the first year of the HBMP, which started in the spring of 2000, reflecting La Niña drought conditions. During this approximately two year period of drought, the summer rainy periods had streamflows that were well below the long term average. Inflow magnitude rose again during 2001 (summer), 2002 and 2003, attaining levels in 2003 that were comparable to the El Niño inflows. However, the 2003 inflows were not as biased toward winter as were the El Niño inflows. In summary, inflows started at high levels in 1998, decreased to a minimum in the middle of the study period in 2000, and then rose again to predominantly above average levels during the last 1.5 years of the study period.

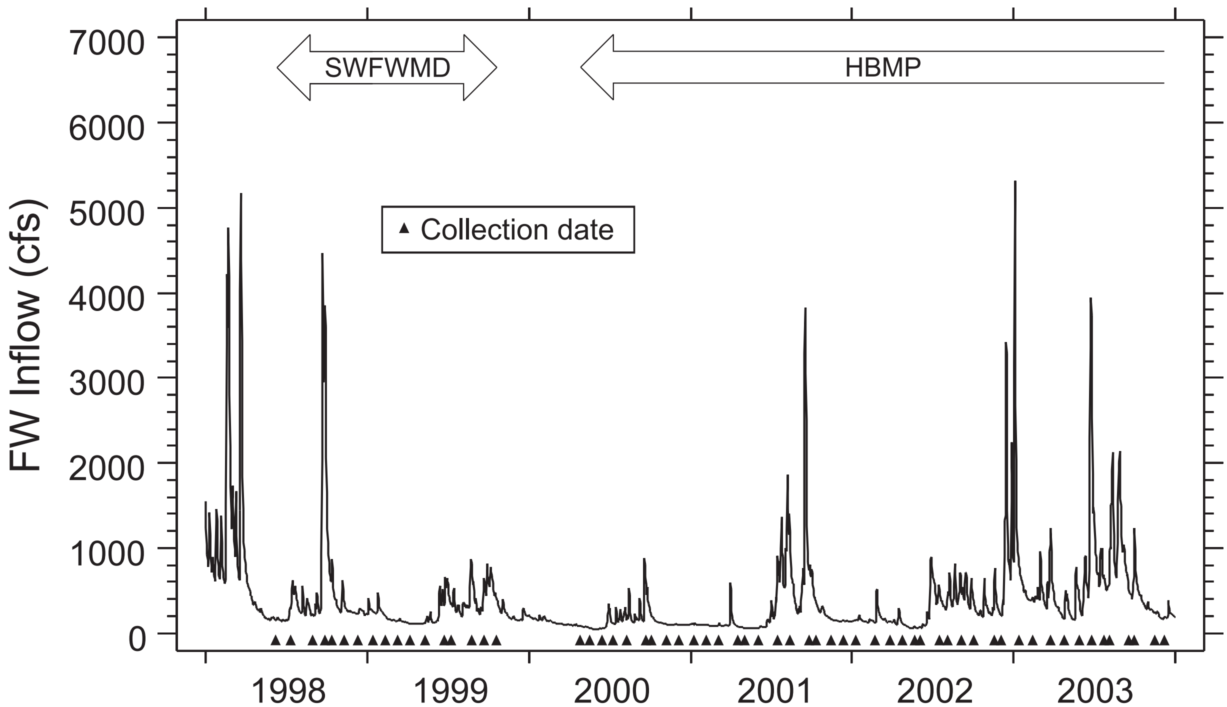

Fig. 3.1.2. Freshwater inflow.

3.2 Physico-chemical Conditions

Temperatures underwent seasonal variation within a typical range (Fig. 3.2.1), with the highest values recorded during the summer of 1998, which may have reflected climatic trends associated with the 1997-98 El Niño period. Winters were not cold enough to cause fish kills during any year of the survey period.

As the result of the residual effects of high winter and spring inflows, salinities remained reduced at the onset of the SWFWMD survey (June 1998, prior to the summer rainy season). All summer rainy seasons caused strong reductions in salinity, with the weakest reduction occurring during 2000. Salinities gradually decreased after 2000 as inflows increased through the end of the survey period, except during the prolonged dry period preceding the 2002 summer rainy season.

Dissolved oxygen often reached supersaturation levels in the lower Alafia River. Supersaturation was most common during winter and spring. Isolated cases of supersaturation were occasionally observed during the rainy season (especially during August). Supersaturation is caused by phytoplankton blooms that typically occur after nutrient loading events have ended, when residence times are long (low inflows) and water clarity is high (see Mallin et al. 1999). Deeper areas such as the dredged ship channel at the river mouth (lower 2 km) are particularly prone to hypoxia during warmer months.

pH also varied with inflow, being highest when salinities were high and lowest during periods of high inflow. At all times, however, pH remained within a range that is considered to be safe for estuarine organisms.

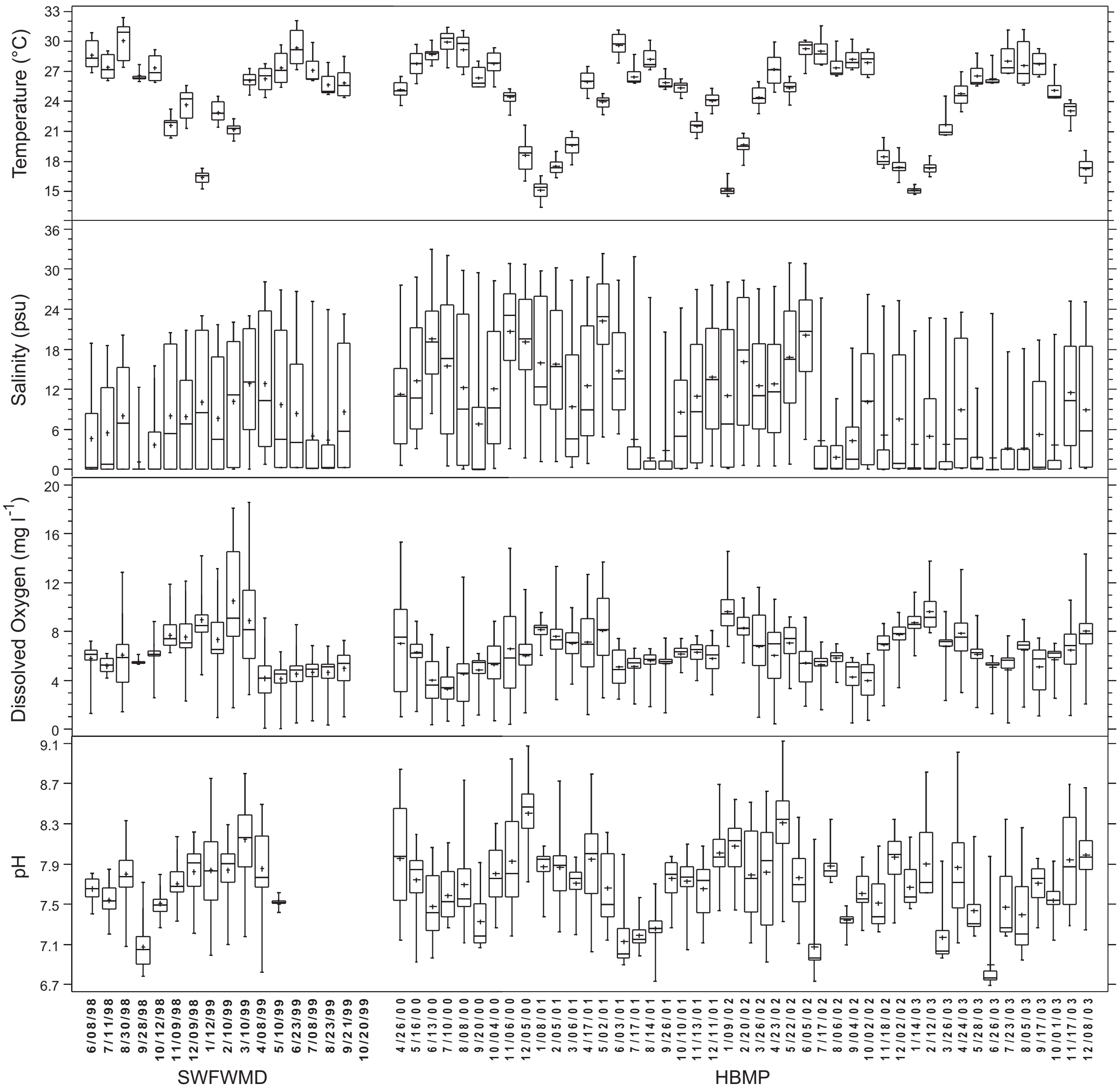

Fig. 3.2.1. Electronic meter data from the plankton-net surveys of the Alafia River, where the cross identifies the mean, the horizontal line identifies the median, the box delimits the interquartile range, and the whiskers delimit the total range.

Table 3.2.1. Electronic meter summary statistics from the HBMP surveys. Mean depth is mean depth at deployment.

Location (km from mouth)	Mean Depth (m)	Salinity (psu)					Water Temperature (°C)					Dissolved Oxygen (mg/l)					pH				
		n	mean	std. dev.	min.	max.	*n*	mean	std. dev.	min.	max.	*n*	mean	std. dev.	min.	max.	*n*	mean	std. dev.	min.	max.
0.4	2.8	183	22.2	8.1	0.2	32.6	183	25.3	5.0	13.4	31.3	183	5.8	2.4	0.5	12.5	181	7.9	0.3	6.8	8.7
1.5	2.1	152	19.3	9.1	0.3	31.2	152	24.9	5.1	13.4	31.6	152	6.4	2.3	0.9	13.0	149	7.9	0.4	6.7	8.9
3.0	1.6	133	16.1	9.3	0.1	29.7	133	24.7	4.9	13.8	31.5	133	6.7	2.5	1.0	13.8	130	7.9	0.4	6.8	9.0
4.0	2.0	145	14.9	9.1	0.1	30.1	145	24.8	4.9	13.8	31.2	145	6.5	2.8	0.5	13.1	142	7.8	0.5	6.8	8.9
6.4	1.4	130	8.6	8.2	0.1	29.0	130	24.4	4.5	14.8	30.8	130	7.1	2.8	0.8	15.4	127	7.8	0.5	6.8	8.9
6.4	1.6	134	8.5	8.2	0.1	27.3	134	24.4	4.6	14.8	31.2	134	7.1	2.6	1.2	15.0	131	7.7	0.5	6.8	9.1
7.9	1.8	142	7.0	7.5	0.1	26.3	142	24.2	4.2	15.2	30.9	142	6.7	2.5	0.4	13.4	139	7.6	0.5	6.7	9.1
8.0	1.8	144	7.3	7.7	0.1	26.1	144	24.2	4.3	14.5	30.9	144	6.5	2.5	0.8	13.7	141	7.6	0.4	6.7	9.0
9.5	2.3	163	5.3	6.9	0.1	25.2	163	23.9	4.1	14.8	30.7	163	6.0	2.3	0.6	13.1	160	7.5	0.4	6.7	9.1
10.0	2.5	173	5.0	6.6	0.1	25.0	173	24.1	4.0	14.9	30.5	173	5.7	2.2	0.3	12.3	169	7.5	0.3	6.7	8.7
11.9	2.9	186	3.4	5.4	0.1	22.9	186	23.3	4.0	14.8	29.4	186	5.7	2.0	0.4	10.8	182	7.4	0.3	6.7	8.3
12.7	2.9	188	2.3	4.3	0.1	21.4	188	23.2	4.1	14.3	29.0	188	6.1	1.9	0.3	11.1	184	7.4	0.3	6.7	8.3

3.3 Catch Composition

Different locations were sampled during the SWFWMD and HBMP surveys. Location-specific catch data for the SWFWMD survey were reported by Peebles (2002a). Location-specific catch data for the HBMP survey are presented in Appendix A, where mean densities are calculated as total catch divided by total volume filtered during the entire study (Table A1) and at each location (Table A3). Season of occurrence during the two surveys, on the other hand, could be analyzed as a collective database, and these results are presented in Table A2, where the mean is presented as the total monthly catch divided by total monthly volume filtered by both studies. Irregularity in monthly effort (Table A2 and Fig. 3.5.1) was caused by differences in the start and stop dates between the SWFWMD and HBMP surveys For taxa with encounter frequencies <272, which comprise 97% of the taxa in Table A-1, median densities are zero.

3.3.1 **Fishes.** All stages of the bay anchovy (*Anchoa mitchilli*) were dominant in the plankton-net fish catch; the vast majority of larvae identified as *Anchoa* spp. were probably *A. mitchilli* - other species of *Anchoa* were relatively uncommon at stages that could be identified to species level. Postflexion and metamorphic menhaden (*Brevoortia spp.*, primarily *B. smithi*) were also abundant, particularly during the relatively wet SWFWMD survey. Other abundant fishes were the sand seatrout (*Cynoscion arenarius*), hogchoker (*Trinectes maculatus*), silversides (*Menidia* spp.), skilletfish (*Gobiesox strumosus*) and gobies. As a group, gobies were second only to the bay anchovy in abundance. Adult gobies tend to be cryptic and can be difficult to sample effectively, but high larval densities reveal that gobies must be exceedingly abundant within tidal rivers. Members of the genera *Gobiosoma* and *Microgobius* were the dominant larval gobies in the Alafia River. Some of the larvae that were previously identified as darter goby (*Gobionellus boleosoma*) by Peebles and Flannery (1992) and WAR and SDI (1995) may actually be larvae of a tropical species, the emerald goby (*Gobionellus smaragdus*). Prior to the present surveys, *G. smaragdus* had not been recorded from the Tampa Bay area, but a single specimen was collected from the Alafia River by FMRI personnel during the HBMP seine survey, and several other specimens have been recently recorded from the

Tampa Bay area by FMRI's Fisheries Independent Monitoring Program (R.E. Matheson, pers. comm.). Because the larvae of *G. smaragdus* have not been described and are likely to resemble the larvae of *G. boleosoma*, the taxonomic resolution for these larvae has been generalized to *Gobionellus* spp.

3.3.2 **Invertebrates.** The plankton-net invertebrate catch was dominated by larval crabs (decapod zoeae), chaetognaths, calanoid copepods, gammaridean amphipods, mysids, isopods, cumaceans, and polychaete worms. The decapod zoeae were dominated by pinnotherid crabs (primarily *Pinnixa sayana*) at the seaward end of the transect and by xanthid crabs (primarily *Rhithropanopeus harrisii*) at upstream locations. The chaetognaths were *Sagitta tenuis* and *Ferosagitta hispida*, which appeared to be present in comparable proportions. These chaetognaths and calanoid copepods (primarily *Labidocera aestiva* and *Acartia tonsa*) invaded the interior of the tidal river during low inflow periods.

Gammaridean amphipods were abundant, but not to the extent observed in other tidal rivers on Florida's west coast (Peebles and Flannery 1992, Peebles 2002b,c). Gammarideans were noticeably less abundant in the upstream part of the survey transect, probably due to the lack of wetlands there (*Gammarus* nr. *tigrinus* was conspicuously absent). A single specimen of hyperiid amphipod, collected 1.5 km upstream of the river mouth (near the Cargill ship terminal), was identified as *Lestigonus bengalensis* by Stephen Grabe of the Environmental Protection Commission of Hillsborough County. This species is usually encountered in offshore continental shelf waters, and may have been introduced into the Alafia River during ballast water release. Within the interior of the tidal river, the mysid assemblage was strongly dominated by *Americamysis almyra*, whereas *A. stucki* was more prevalent in high salinity areas near the river mouth. The isopod catch was dominated by *Edotea triloba* (=*E. montosa*) and juvenile cymothoid isopods, which are believed to primarily consist of *Lironeca* sp. The juvenile cymothoids are ectoparasitic on schooling fishes, but are also active free swimmers that frequently occur in samples that do not contain suitable hosts. Relative to other tidal rivers, juvenile cymothoids appear to be very common in the Alafia River, possibly because of locally high densities of the bay anchovy, which serves as a potential host. Another isopod of note is the cirolanid *Anopsilana jonesi*. Until recently, *A. jonesi* was known to be associated with estuarine mangroves on the coasts of Central and South America, but was not thought to occur in the Gulf of Mexico (Kensley and Schotte 1989, W. Price, pers. comm.). Previous encounters outside of its expected tropical range have resulted in the misidentification of this species as *Cirolana parva*. The cumacean catch comprised a fairly even assemblage, which is somewhat atypical. In many tidal rivers and bays on Florida's west coast, the cumacean catch from plankton nets is typically dominated by *Cyclaspis varians*. This species was not as conspicuously dominant in the Alafia River, however. Polychaetes were present in small numbers in a large percentage of samples, but occasionally were the numerically dominant organism in individual samples. Whenever polychaetes dominated, the diversity and richness of other organisms was almost always very low.

Gerrid heteropterans (water striders) were not abundant relative to other taxa, but were far more abundant in the Alafia than in other tidal rivers that have been surveyed using similar methods. Water striders prey on non-aquatic insects that strand on the water's surface. The high degree of canopy coverage in the oligohaline and freshwater reaches may have enhanced prey availability for these predators.

3.4 Use of Area as Spawning Habitat

The eggs of the bay anchovy (*Anchoa mitchilli*), striped anchovy (*Anchoa hepsetus*) and unidentified sciaenid fishes were collected from the survey area. Bay anchovy eggs outnumbered striped anchovy eggs by a wide margin, and were encountered in 16 samples, whereas striped anchovy eggs were encountered only once. The bay anchovy probably spawns near or within the mouth of the Alafia River on occasion, but most of the juveniles that congregate within the river probably originate from eggs spawned in nearby Hillsborough Bay or upper Middle Tampa Bay (Peebles et al. 1996).

Many sciaenid eggs cannot be readily identified using visible characteristics. Those found in the lower tidal Alafia could have belonged to several species, as the early larvae of three sciaenid species were spatially and temporally coincident with the eggs. Likely identities include the silver perch (*Bairdiella chrysoura*), spotted seatrout (*Cynoscion nebulosus*) and sand seatrout (*Cynoscion arenarius*). Recent HBMP surveys have found eggs and yolk-sac larvae of the black drum (*Pogonias cromis*) within nearby McKay Bay, indicating that black drum may spawn close inshore and therefore could spawn within the tidal Alafia at times. Any of the fishes listed in Table 3.4.1 may spawn within the lower Alafia River, with the exception of menhaden (*Brevoortia* spp.). An abundance of small juveniles in FMRI seine and trawl collections from the Alafia River suggests that the taxon *Menticirrhus* spp. is dominated by the southern kingfish, *M. americanus*.

Some fishes have eggs that are either adhesive or have filaments that cause the eggs to become entangled with submerged vegetation or other substrates. For species with such non-planktonic eggs, preflexion stage larvae are usually the first developmental stage to be present in the water column. This is true for many of the estuarine-resident fishes, including silversides (*Menidia* spp.), gobies, blennies, and skilletfish (*Gobiesox strumosus*). The gobies that are likely to spawn within the river include the naked goby (*Gobiosoma bosc*), the code goby (*G. robustum*), the green goby (*Microgobius thalassinus*), the clown goby (*M. gulosus*), the frillfin goby (*Bathygobius soporator*) and the taxon *Gobionellus* spp., which consists of the darter goby (*G. boleosoma*) and the emerald goby (*G. smaragdus*) in unknown proportions. Many killifishes (*Fundulus* spp.) are also estuarine-resident species that spawn within tidal rivers. Their adhesive eggs are spawned in shallow waters and hatch at a relatively advanced stage, the postflexion stage. The presence of postflexion-stage killifishes is therefore evidence of spawning near or within the tidal Alafia River. Small juveniles of live-bearing species such as the eastern mosquitofish (*Gambusia holbrooki*), sailfin molly (*Poecilia latiipinna*), chain pipefish (*Syngnathus louisianae*) and gulf pipefish (*S. scovelli*) are also indications that the tidal river is serving as habitat for the earliest stages of these species. A review of trends in spawning habitat among coastal fishes is presented by Peebles and Flannery (1992).

Table 3.4.1. Relative abundance of larval stages for non-freshwater fishes with a collection frequency >10 for the larval stage aggregate, where *Pre* = preflexion (youngest larval stage), *Flex* = flexion stage (intermediate larval stage) and *Post* = postflexion (oldest larval stage). **X** identifies the most abundant stage and x indicates that the stage was present. Data from the SWFWMD and HBMP surveys are combined.

Taxon	Common Name	Pre	Flex	Post
Anchoa spp.	anchovies	**X**	x	x
Menidia spp.	silversides	**X**	x	x
Membras martinica	rough silverside	**X**	x	x
blenniids	blennies	**X**	x	x
gobiids	gobies	**X**	x	x
Bathygobius soporator	frillfin goby	**X**	x	x
Chloroscombrus chrysurus	Atlantic bumper	x	**X**	x
Oligoplites saurus	leatherjack	x	**X**	x
Bairdiella chrysoura	silver perch	x	**X**	x
Cynoscion nebulosus	spotted seatrout	x	**X**	x
Cynoscion arenarius	sand seatrout	x	x	**X**
Menticirrhus spp.	kingfishes	x	x	**X**
Gobiesox strumosus	skilletfish	x	x	**X**
Achirus lineatus	lined sole	x	x	**X**
Trinectes maculatus	hogchoker	x	x	**X**
Brevoortia spp.	menhaden			**X**

3.5 Seasonality

The number of taxa collected during an individual survey is not a true measure of species richness because many taxa could not be identified to species level, and taxonomic resolution increased for some invertebrate groups during the HBMP surveys (2000-2003). Furthermore, the plankton-net data are also segregated by developmental stage. Nevertheless, this index produces a clear seasonal pattern. Specifically, more taxa tend to be collected during the spring and summer months than at other times of year (Fig. 3.5.1). Lowest apparent richness was observed from October through February.

Species diversity tends to be highest near the mouths of tidal rivers due to an increased presence of marine derived species, and also tends to be relatively high at the upstream end due to the presence of freshwater species. This creates a low diversity zone in the middle reaches of the tidal river (Merriner et al. 1976). Freshwater inflow and the seasonal arrival of young animals can shift this pattern downstream or upstream. The small depression in apparent richness that took place in the May plankton data (Fig. 3.5.1) occurred because inflows were consistently low during May, and therefore fewer freshwater invertebrates were present in the survey area. The taxa in the plankton samples primarily consisted of short lived organisms or stages that underwent a strong decrease in apparent richness during the fall. Flemer et al. (1999) report that the richness and abundance of infaunal organisms in the northern Gulf of Mexico and southeastern Atlantic tends to decline during summer after a spring peak.

For a given species, the seasonal range of the spawning season tends to become shorter at the more northerly locations within a species' geographic range, but the time of year when spawning takes place is otherwise consistent for a given species. Among species with long or year-round spawning seasons, local conditions have been observed to have a strong influence on egg production within the spawning season (Peebles 2002d). Local influences include seasonally anomalous water temperature, seasonal variation in the abundance of prey, and seasonal variation in retention or transport of eggs and larvae after spawning. The latter processes (prey availability and retention and transport) are influenced by freshwater inflows to the coast.

Alteration of inflows would appear to have the lowest potential for estuarine impact during the period from October through February, which is the period when the fewest taxa are present. The highest potential for impact would appear to be from April to June, a time of year when naturally low inflows are coupled with increasing use of the estuary as nursery habitat. However, the potential for impact is species-specific (Table A2). Some species, such the bay anchovy, are present year-round. Others present a seasonal succession in their individual abundance peaks, specifically: menhaden, pinfish, spot and black drum (winter through early spring); sand seatrout, spotted seatrout, kingfishes, hogchoker, and crab and shrimp larvae (spring and summer); and red drum (fall). Red drum recruitment to the tidal Alafia River is primarily evident in the seine database (Matheson et al. 2004), as this species primarily arrives as juveniles rather than larvae. There is no time of year when freshwater inflow management is free from potential impact on estuarine nursery habitat.

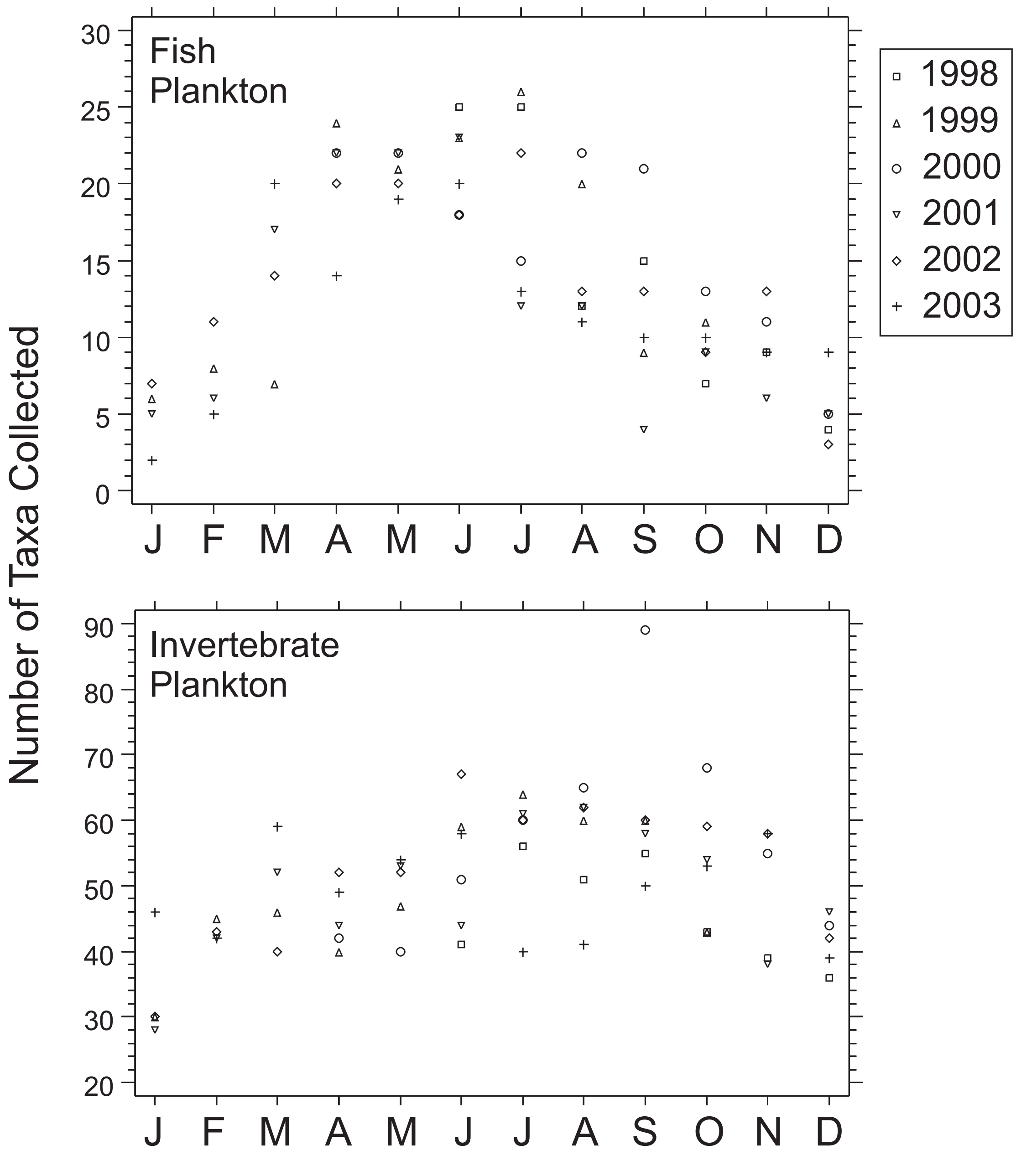

Fig. 3.5.1. Number of taxa collected per month.

3.6 Distribution (km_U) Responses to Freshwater Inflow

Many animals exhibit behaviors that allow them to regulate their position along the estuarine gradient. Regulation of position allows the animals to optimize the combination of food resources, physiological costs and predation risk. Young (1995) provided a review of the various dispersal and position control mechanisms used by small aquatic organisms. Truly planktonic animals appear to be less adept at controlling their position and are easily swept downstream. Others control position using tactic (directional) responses to vector cues (cues that contain directional information). These responses include vertical orientation to light (phototaxis) or gravity (geotaxis) and horizontal orientation to currents (rheotaxis). Kinetic (non-directional) responses are also used, including response to changing pressure (barokinesis) for precise detection of depth or changes in tidal height, which can be monitored if the organism remains stationary on the bottom for a period of time. A number of animals have demonstrated motile responses to changes in salinity (halokinesis). Estuarine organisms may use combinations of these signals to selectively occupy tidal streams that will result in their rapid transport to a preferred habitat or food source. On the other hand, larger fishes and crustaceans may simply swim toward preferred habitats.

Estuarine and estuarine-dependent organisms that use selective tidal stream transport or two layered circulation are capable of repositioning themselves within the tidal river in a matter of hours or days. The monthly sampling frequency for describing changes in organism position is therefore not likely to reflect serial correlation, which would be caused if the sampling frequency were shorter than the time required for an organism to change position in the tidal river. In regressions of organism position against freshwater inflow or isohaline position, the Durbin-Watson statistic sometimes indicated that serial correlation was possible (Tables 3.6.1 and 3.6.2). This was primarily a detection of intraseasonal consistency in an organism's position within the tidal river rather than an indication of actual serial correlation. Organisms tended to be upstream during dry seasons and downstream during wet seasons (see next two sections), and because several consecutive surveys were conducted within wet or dry seasons, this pattern sometimes simulated serial correlation.

3.6.1 ***km_U* Responses to Inflow (*F*).** A linear model using Ln transformed data produced the best general fit for this relationship (Table 3.6.1). Example plots of the regressions in Table 3.6.1 are provided in Fig. 3.6.1. All of the significant relationships had negative slopes, indicating that organisms move downstream as freshwater inflow increases. The strongest responses rank near the bottom of Table 3.6.1. Strong responses were evident among relatively strong swimmers, such as juvenile menhaden, and relatively weak swimmers, such as the isopod *Edotea triloba*. Plots of all significant regressions of km_U on *F* appear in Appendix B. Taxa with very high intercepts tend to be freshwater taxa, taxa with medium-to-high intercepts tend to be estuarine or estuarine-dependent, and taxa with low intercepts tend to be open bay species that invade the tidal river during low inflow periods.

The distributions of most taxa responded quickly to changes in inflow, with lags of <5 d being the most common (Table 3.6.1 and Fig. 3.6.2.A). After classifying the taxa in Table 3.6.1 according to the vertical position of their habitat, it was found that water column animals (plankton and nekton) and vertical migrators generally responded faster than benthos. Taxa classified as vertical migrators were: mysids, amphipods, cumaceans, the postflexion-stage larvae of some fishes, penaeid shrimp metamorphs, decapod megalopae, *E. triloba*, the copepod *Pseudodiaptomus coronatus*, and postlarval *Palaemonetes* shrimp. Taxa included as benthos were: polychaete worms, pinnotherid crab juveniles, insect larvae, podocopid ostracods, juvenile and adult *Palaemonetes*, leeches, the isopods *Cyathura polita* and *Erichsonella attenuata*, the tanaid *Hargeria rapax*, and juvenile sand seatrout and hogchokers. These classifications were based on literature reports describing vertical distribution, and also on whether a taxon was observed to swarm at night (e.g., *E. triloba* often swarms and was classified as a vertical migrator, whereas *C. polita* and *E. attenuata* have not been observed to swarm and were considered to be more benthic). The response speeds for the three groups are summarized in Fig. 3.6.2.B.

Fishes and invertebrates in the middle of the tidal river appeared to have much steeper response slopes than those near the river mouth (Fig. 3.6.2.C), which is expected to some extent because of differences in flushing characteristics between the upper and lower reaches of the tidal river. However, rapid flushing times in the upper and middle tidal river do not explain the shallow slopes observed for freshwater taxa. One explanation for these shallow slopes is that these taxa have evolved behaviors that encourage retention in fresh waters. Another explanation is that the shallow slopes are mathematical products of the sampling design; i.e., a sampling transect extending farther downstream and upstream might have produced different results. These artifacts would be apparent as nonlinearities in the plots in Appendix B, wherein point clusters at the transect limits would force shallower slopes at high flows (downstream) or low flows (upstream). This effect does appear to be influencing some of the slopes for downstream organisms (e.g., *Americamysis stucki*, *Acartia tonsa*), but most of the freshwater organisms appear to be largely independent of this effect. Examples of lag correlations are presented in Fig. 3.6.3.

There were instances of organisms tracking each other better than they tracked inflow (Fig. 3.6.4). Because the anchovies in Fig 3.6.4 were generally too small to eat adult mysids, this remarkably close association does not appear to reflect predators orienting to their prey. One explanation is that the two species orient to the same locally productive bottom areas, and that these productive areas shifted over time. Animals that orient to benthic food resources are likely to have their distributions deviate from their normally fast response time as these animals persist near food concentrations that are relatively slow to move (Fig. 3.6.2.B).

Table 3.6.1. Organism distribution (km_U) responses to mean freshwater inflow (Ln *F*), ranked by linear regression slope (*b*). Other regression statistics are sample size (*n*), intercept (*a*), slope probability (*p*) and fit (r^2, as %). *DW* identifies where serial correlation is possible (x indicates p<0.05 for Durbin-Watson statistic). *d* is the number of daily inflow values used to calculate mean freshwater inflow.

Description	Common Name	*n*	*a*	*b*	*p*	r^2	DW	*d*
chaetognaths, sagittid	arrow worms	62	2.164	-0.282	0.0190	9	x	1
Americamysis stucki	opossum shrimp, mysid	23	2.713	-0.352	0.0151	25		1
Acartia tonsa	copepod	37	3.234	-0.430	0.0049	20		1
Lucifer faxoni juveniles and adults	shrimp	50	3.309	-0.519	0.0022	18	x	1
Cynoscion arenarius flexion larvae	sand seatrout	22	3.688	-0.542	0.0145	26	x	9
hemipterans, gerrid adults	water striders	38	14.717	-0.545	0.0014	25		3
Periclimenes spp. postlarvae	shrimps	21	3.818	-0.578	0.0489	19		13
Anchoa spp. flexion larvae	anchovies	38	3.846	-0.582	0.0036	21		1
unidentified calanoids	copepods	21	2.625	-0.594	0.0010	44	x	120
Anchoa spp. preflexion larvae	anchovies	34	4.104	-0.655	0.0046	22		1
pinnotherid juveniles	pea crabs	26	5.352	-0.665	0.0381	17	x	1
Cynoscion arenarius postflexion larvae	sand seatrout	25	5.105	-0.672	0.0201	21		1
Parasterope pollex	ostracod, seed shrimp	40	5.413	-0.675	0.0017	23	x	1
gastropods, prosobranch	snails	62	10.846	-0.694	0.0126	10		38
ostracods, podocopid	ostracods, seed shrimps	41	12.253	-0.717	0.0306	11		46
ephemeropteran larvae	mayflies	49	15.579	-0.769	0.0044	16		13
Americamysis bahia	opossum shrimp, mysid	18	6.697	-0.818	0.0120	33		1
decapod mysis, unidentified	shrimp larvae	61	8.175	-0.822	0.0041	13		120
appendicularian, Oikopleura dioica	larvacean	26	4.853	-0.833	0.0115	24		120
siphonostomatids	parasitic copepods	52	7.137	-0.860	0.0149	11		1
Anchoa mitchilli postflexion larvae	bay anchovy	37	6.865	-0.881	0.0125	17		1
odonates, zygopteran larvae	damselflies	20	16.622	-0.889	0.0010	46		3
dipterans, ceratopogonid larvae	biting midges	24	13.550	-0.897	0.0183	23		5
Pseudodiaptomus coronatus	copepod	35	7.382	-0.919	0.0017	26	x	2
isopods, unidentified sphaeromatids	isopods	20	12.714	-0.924	0.0325	23		22
dipterans, chironomid larvae	midges	61	15.384	-0.948	0.0000	54		6
Erichsonella attenuata	isopod	25	6.148	-0.952	0.0010	38		1
dipteran, Chaoborus punctipennis larvae	phantom midge	35	15.432	-0.959	0.0021	25		38
cumaceans, unidentified	cumaceans	62	7.111	-0.979	0.0000	32	x	1
Anchoa mitchilli adults	bay anchovy	62	9.311	-0.981	0.0000	32	x	1
Mnemiopsis mccradyi	comb jelly, ctenophore	21	8.563	-1.024	0.0047	35	x	3
Mesocyclops edax	copepod	24	16.364	-1.031	0.0004	44		1
cladoceran, Simocephalus vetulus	water flea	17	16.885	-1.060	0.0088	38		1
amphipods, unidentified gammarideans	amphipods	62	10.295	-1.090	0.0005	18	x	54
trichopteran larvae	caddisflies	40	17.871	-1.103	0.0000	36	x	2
Palaemonetes spp. postlarvae	grass shrimp	55	8.498	-1.122	0.0001	24		2
decapod megalopae, unidentified	post-zoea crab larvae	54	8.636	-1.129	0.0079	13	x	17
gobiid preflexion larvae	gobies	39	10.973	-1.189	0.0020	23		1
cladocerans, daphniid	water fleas	11	18.409	-1.190	0.0054	60		1
Palaemonetes pugio adults	daggerblade grass shrimp	26	13.101	-1.197	0.0014	35		1
Anchoa mitchilli juveniles	bay anchovy	62	13.145	-1.250	0.0000	48	x	1
Palaemonetes pugio juveniles	daggerblade grass shrimp	43	12.671	-1.297	0.0018	21		13
Cyathura polita	isopod	22	14.536	-1.308	0.0001	52		105
penaeid metamorphs	penaeid shrimps	15	8.463	-1.308	0.0308	31	x	1
coleopterans, gyrinid larvae	whirligig beetles	21	19.271	-1.342	0.0315	22		103
dipterans, pupae	flies, mosquitoes	60	17.855	-1.357	0.0000	50		120
Ambidexter symmetricus juveniles	shrimp	12	9.238	-1.360	0.0441	35	x	34
Trinectes maculatus juveniles	hogchoker	42	14.441	-1.426	0.0005	26	x	15
polychaetes	sand worms, tube worms	62	13.531	-1.478	0.0000	37		47
unidentified Americamysis juveniles	opossum shrimps, mysids	60	11.692	-1.484	0.0000	28		5
decapod zoeae, unidentified	crab larvae	62	11.004	-1.503	0.0001	24	x	1
coleopterans, elmid larvae	riffle beetles	25	19.776	-1.585	0.0001	49		14

Americamysis almyra	opossum shrimp, mysid	45	14.843	-1.634	0.0000	43		3
Membras martinica juveniles	rough silverside	13	12.687	-1.710	0.0007	66		11
Edotea triloba	isopod	61	13.828	-1.710	0.0000	70		1
coleopterans, elmid adults	riffle beetles	29	20.402	-1.724	0.0004	37	x	1
Cynoscion arenarius juveniles	sand seatrout	28	13.194	-1.752	0.0000	62		1
acari	water mites	42	20.621	-1.759	0.0000	55		5
Diaptomus spp.	copepods	12	21.151	-1.847	0.0045	57		107
Trinectes maculatus postflexion larvae	hogchoker	38	14.109	-1.878	0.0000	64		1
branchiurans, Argulus spp.	fish lice	39	17.044	-1.880	0.0000	48		1
Brevoortia smithi juveniles	yellowfin menhaden	17	15.796	-1.946	0.0001	65		17
cymothoid sp. a (Lironeca) juveniles	isopod	62	15.442	-2.034	0.0000	72		1
Trinectes maculatus flexion larvae	hogchoker	19	13.803	-2.069	0.0102	33		1
Hargeria rapax	tanaid	12	19.656	-2.153	0.0118	49	x	6
Taphromysis bowmani	opossum shrimp, mysid	18	20.539	-2.164	0.0026	44		64
hirudinoideans	leeches	49	19.510	-2.221	0.0000	57	x	110
Gobiosoma spp. postflexion larvae	gobies	41	16.674	-2.474	0.0000	36	x	5
Menticirrhus spp. flexion larvae	kingfishes	11	17.085	-3.006	0.0269	44		51
Brevoortia spp. metamorphs	menhaden	12	23.877	-3.120	0.0017	64		75
collembolas, podurid	springtails	12	24.884	-3.164	0.0151	46		75
Brevoortia spp. postflexion larvae	menhaden	12	21.845	-3.189	0.0077	53		1
Syngnathus scovelli juveniles	gulf pipefish	12	21.149	-3.305	0.0281	40		117

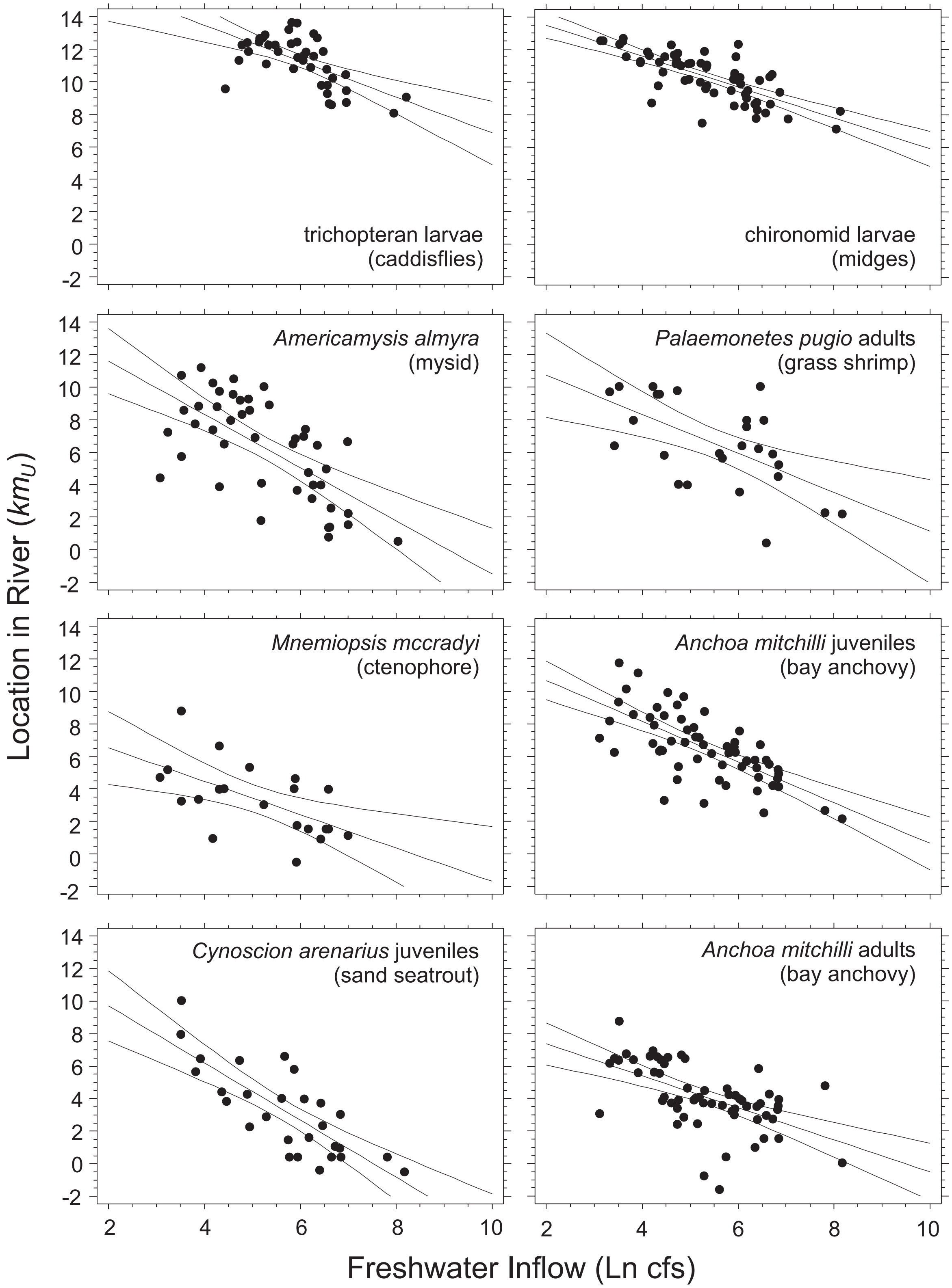

Fig. 3.6.1. Example regressions of organism location (km_U) on inflow (F), with 95% confidence limits for estimated means (see Table 3.6.1 and Appendix B).

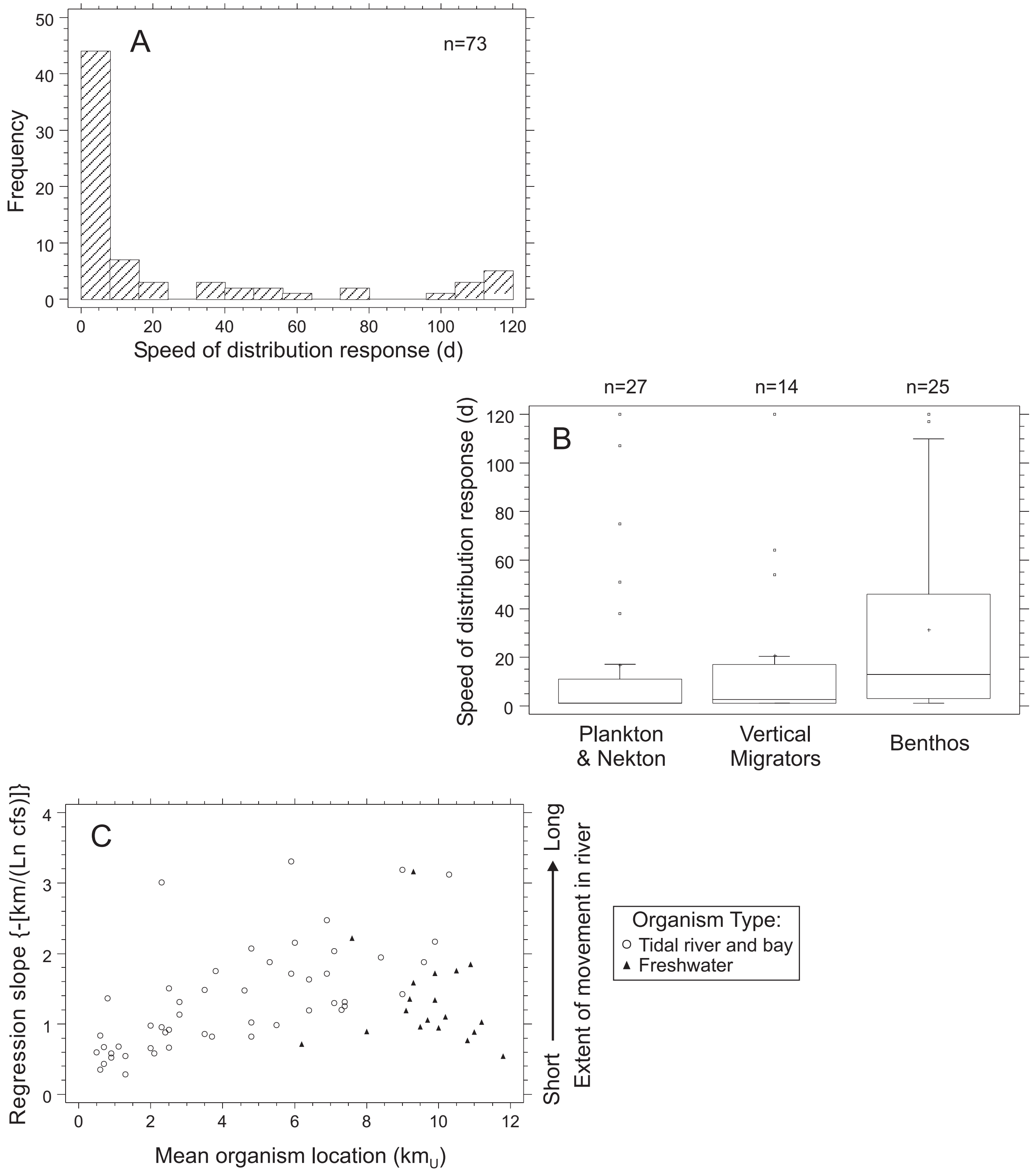

Fig. 3.6.2. Characteristics of the distribution response in Table 3.6.1., where (A) is the frequency distribution for *d*, (B) compares *d* by vertical location, and (C) compares *b* by organism type and horizontal location. In B, the box identifies the interquartile range, the whiskers extend to the smallest (bottom whisker) and largest (top whisker) points that are within 1.5 interquartile ranges from the interquartile range. Points beyond this distance are considered to be outliers. The median is indicated by a horizontal line and the mean is indicated by a cross.

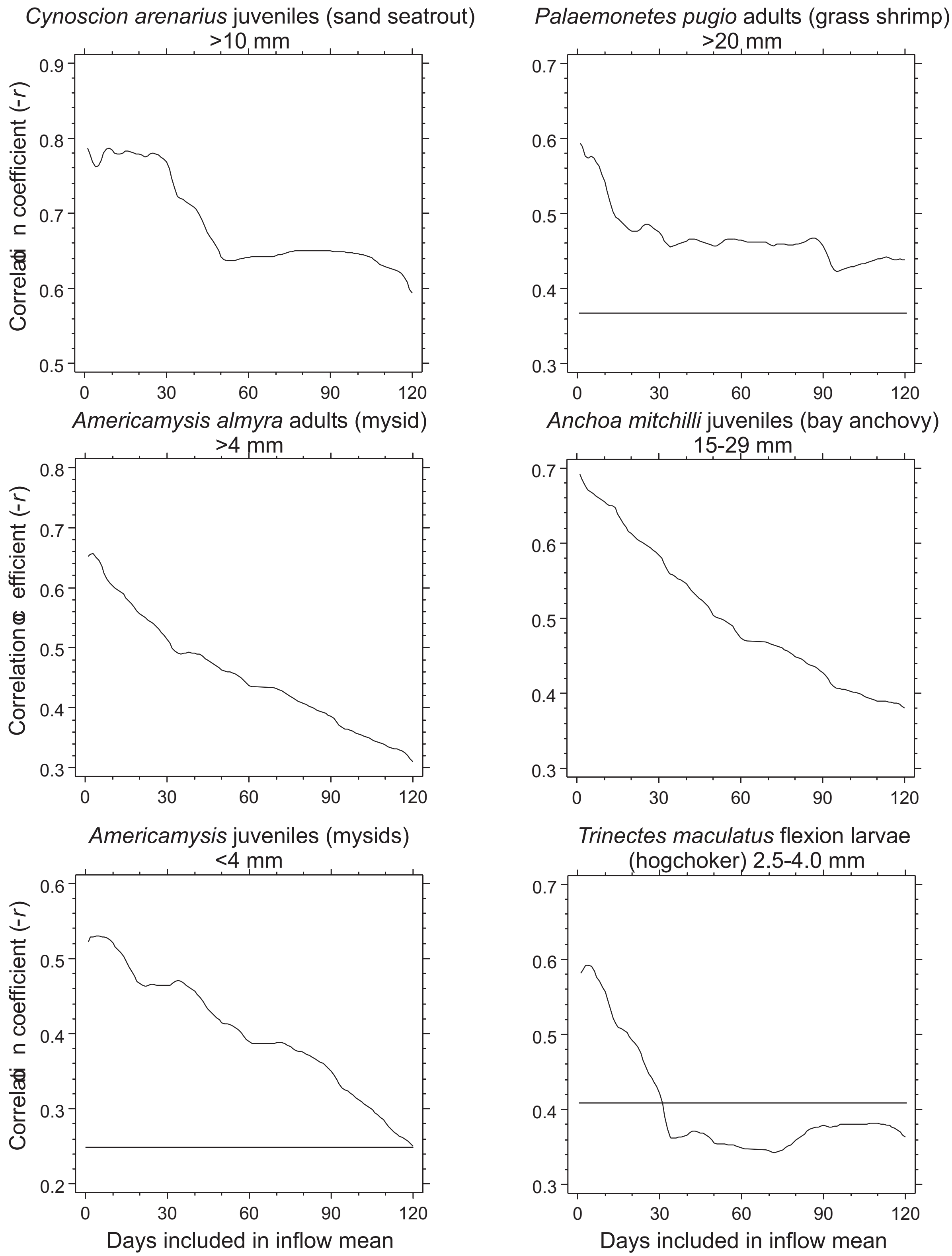

Fig. 3.6.3. Examples of organism distribution (km_U) responses to mean freshwater inflow (Ln F) over variable periods. The horizontal line identifies the 5% probability threshold for r. If this line is absent, all values are significant at p<0.05. The sign of the r values has been reversed for presentation purposes; all values are negative.

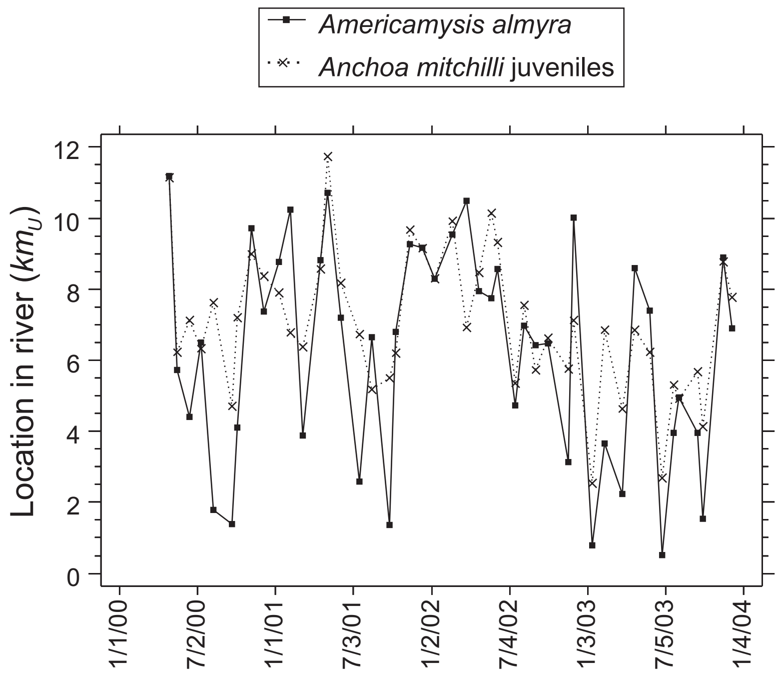

Fig. 3.6.4. Time series of location shifts by *Americamysis almyra* (mysid) and *Anchoa mitchilli* (bay anchovy) juveniles during the HBMP (r=0.77, n=45, p<0.0001).

3.7 Abundance (*N*) Responses to Freshwater Inflow

In the present study, a number of significant relationships were found between organism number and freshwater inflow. In cases where the Durbin-Watson statistic identified that serial correlation was possible, plots of residuals vs. order generally revealed no actual serial correlation. There would appear to be great potential for resampling the same organisms on consecutive monthly surveys, yet this potential is diminished by the short life spans of many organisms, the addition of new recruits to the river, the graduation of larger specimens from the size classes that are caught by the gear, and variation in survival within the recruited size classes. Instead, indications of serial correlation probably reflect successive months that have similar influences on abundance due to similar rates of inflow.

3.7.1 ***N* Responses to Inflow (*F*).** A linear model produced the best overall fit for this relationship when both terms were Ln transformed. Freshwater inflow tended to introduce freshwater animals into the tidal portion of the river from upstream freshwater reaches, increasing their numbers in the tidal river (Table 3.7.1). The introduction of freshwater organisms by inflow is characterized by small intercepts (Table 3.7.1) because numbers of these animals tend to go toward zero during low inflow periods. On the other hand, species that invade the tidal river from the seaward direction during low inflow periods (plume associated groups) have relatively large intercepts, as their numbers are typically at a maximum when inflows are reduced. Plume associated groups moved away from the mouth of the tidal river during high inflow periods, giving them a negative correlation with inflow. This pattern of downstream shift by plume organisms during high inflow periods was observed in the tidal Little Manatee River by Rast et al. (1991). Some river-dominant isopods, notably juvenile cymothoids (*Lironeca* sp.) and *Edotea triloba*, also left the river during high inflow periods.

From a management perspective, the shape of the abundance response curves can be used to identify inflow ranges that have proportionately large influences on abundance. The non-transformed data represented by the regression statistics in Table 3.7.1 are described by the power function $y=ax^b$, which is differentiated as $dy/dx=abx^{(b-1)}$.

The value of the slope determines the shape of the non-transformed abundance response to variations in inflow. Organisms with slopes <0 undergo proportionately large decreases in number as low-end inflows increase. This is characteristic of animals that often occupy the higher salinities near the river mouth. Members of the second group, which includes freshwater, estuarine-resident and estuarine-dependent taxa, have slopes between 0 and 1 and undergo proportionately large increases in number as low-end inflows increase, although the abundance increase becomes more constant for organisms with slopes near 1. Members of the third group, which is primarily composed of freshwater organisms, are characterized by slopes >1. Freshwater taxa may either wash into the tidal river at a fairly constant rate (e.g., dipteran pupae in Table 3.7.1) or, at even larger slopes, increase dramatically in number during floods (mayfly larvae, caddisfly larvae and the freshwater copepod *Mesocyclops edax*). Floods may also cause burrowing marine-derived animals (e.g., the pinnotherid crab *Pinnixa sayana*) to emerge from their burrows in large numbers, producing a very similar pattern. Because most estuarine-resident and estuarine-dependent taxa tend to have a group 2 response (proportionately large increases in number at the low end of the inflow range), protection of low inflows becomes important.

Among estuarine or estuarine-dependent organisms that congregate within the tidal river itself, there was a general increase in total number when inflows were elevated (Fig. 3.7.1). This effect was observed for a hydromedusa, pinnotherid crabs, sand seatrout juveniles, green goby juveniles, hogchoker larvae, daggerblade grass shrimp juveniles and adults, and the mysid *Americamysis almyra*. These increases did not appear to be caused by individuals entering the survey area from the upstream direction. Even under the rather extreme conditions represented by distribution response intercepts (zero inflow), the modeled distribution centers for most estuarine or estuarine-dependent organisms did not move any farther upstream than 2-4 km below the upstream limit of the survey area (Fig. 3.6.1, Table 3.6.1).

Most of the remaining positive inflow-abundance relationships involved freshwater organisms. The retreat of freshwater organisms above the upstream limit of the transect during low inflow periods caused their numbers to decline.

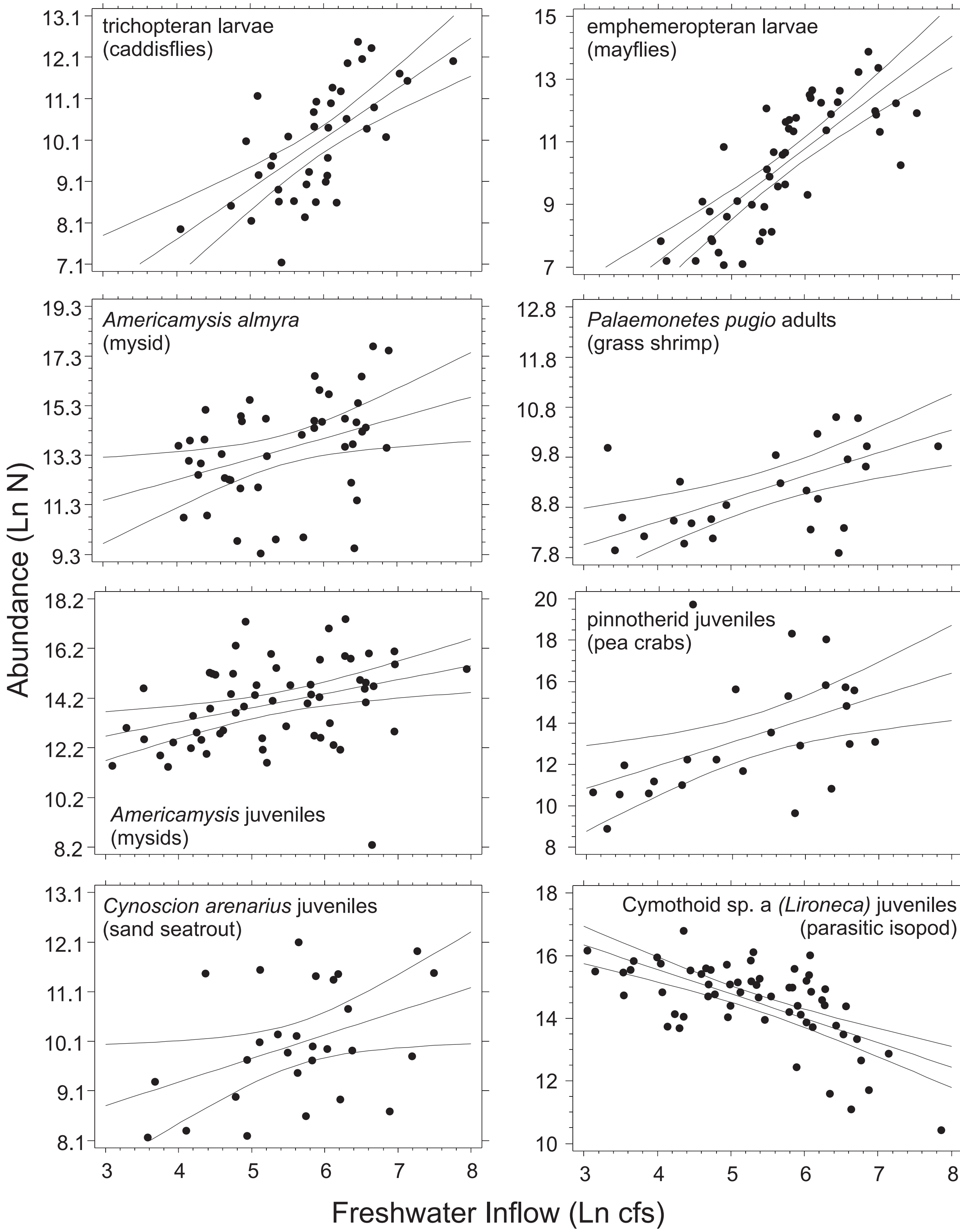

Fig. 3.7.1. Example regressions of organism abundance (*N*) on inflow (*F*), with 95% confidence limits for estimated means (see Table 3.7.1 and Appendix C).

Table 3.7.1. Abundance responses to mean freshwater inflow (Ln N vs. Ln *F*), ranked by linear regression slope (*b*). Other regression statistics are sample size (*n*), intercept (*a*), slope probability (*p*) and fit (r^2, as %). *DW* identifies where serial correlation is possible (x indicates p<0.05 for Durbin-Watson statistic). *d* is the number of daily inflow values used to calculate mean freshwater inflow.

Description	Common Name	*n*	*a*	*b*	*p*	r^2	*DW*	*d*
ephemeropteran larvae	mayflies	49	0.003	1.796	0.0000	61		26
Mesocyclops edax	copepod	24	4.253	1.212	0.0109	26		4
trichopteran larvae	caddisflies	40	2.860	1.211	0.0000	47	x	9
pinnotherid juveniles	pea crabs	26	7.497	1.114	0.0067	27		2
Liriope tetraphylla	hydromedusa	17	6.911	1.111	0.0446	24		8
Diaptomus spp.	copepods	12	2.446	1.100	0.0359	37		1
dipterans, pupae	flies, mosquitoes	60	5.242	1.064	0.0000	48	x	6
Hargeria rapax	tanaid	12	3.276	0.957	0.0285	40	x	106
Orthocyclops modestus	copepod	13	3.086	0.951	0.0208	40		91
coleopterans, elmid larvae	riffle beetles	25	3.923	0.841	0.0031	32	x	9
Americamysis almyra	opossum shrimp, mysid	45	8.975	0.834	0.0152	13	x	117
oligochaetes	freshwater worms	36	5.637	0.699	0.0424	12		120
coleopterans, elmid adults	riffle beetles	29	5.218	0.685	0.0140	20	x	120
ostracods, podocopid	ostracods, seed shrimps	41	6.750	0.605	0.0069	17		50
coleopterans, noterid adults	burrowing water beetles	24	5.430	0.580	0.0039	32		1
unidentified Americamysis juveniles	opossum shrimps, mysids	60	10.970	0.567	0.0038	14	x	2
neuropterans, Climacia spp. larvae	spongillaflies	14	4.744	0.488	0.0353	32		3
Cynoscion arenarius juveniles	sand seatrout	28	7.373	0.476	0.0351	16		19
Palaemonetes pugio adults	daggerblade grass shrimp	26	6.673	0.459	0.0011	36		1
gastropods, prosobranch	snails	62	9.891	0.374	0.0179	9	x	3
odonates, zygopteran larvae	damselflies	20	5.786	0.356	0.0319	23		1
lepidopterans, pyralid larvae	aquatic caterpillars	12	6.464	0.301	0.0323	38		34
hirudinoideans	leeches	49	8.505	0.197	0.0495	8	x	2
branchiurans, Argulus spp.	fish lice	39	12.050	-0.456	0.0258	13	x	120
siphonostomatids	parasitic copepods	51	13.534	-0.511	0.0133	12	x	1
Palaemonetes spp. postlarvae	grass shrimp	55	15.458	-0.582	0.0159	10	x	119
decapod mysis	shrimp larvae	61	18.471	-0.668	0.0273	8	x	93
amphipods, gammaridean	amphipods	62	18.317	-0.681	0.0060	12		79
cumaceans	cumaceans	61	19.052	-0.690	0.0436	7		65
Anchoa mitchilli postflexion larvae	bay anchovy	35	16.016	-0.726	0.0425	12		65
cymothoid sp. a (Lironeca) juveniles	isopod	62	18.678	-0.780	0.0000	44	x	8
gobiid flexion larvae	gobies	46	14.633	-0.785	0.0027	19		118
Limulus polyphemus larvae	horsehoe crab	23	14.674	-0.852	0.0379	19		34
Anchoa spp. flexion larvae	anchovies	34	17.326	-0.863	0.0025	25		49
Edotea triloba	isopod	61	18.767	-0.879	0.0043	13	x	117
Petrolisthes armatus juveniles	porcelain crab	31	17.089	-0.883	0.0215	17		60
chaetognaths, sagittid	arrow worms	62	21.190	-0.940	0.0058	12	x	120
alphaeid postlarvae	snapping shrimps	33	16.963	-0.940	0.0005	32		120
gobiid preflexion larvae	gobies	38	17.082	-1.090	0.0000	40		120
Lucifer faxoni juveniles and adults	shrimp	46	20.037	-1.104	0.0200	12	x	90
Pseudodiaptomus coronatus	copepod	35	17.719	-1.107	0.0001	39		104
decapod zoeae	crab larvae	62	24.333	-1.166	0.0001	24	x	80
Anchoa spp. preflexion larvae	anchovies	31	20.712	-1.394	0.0006	34		53
Microgobius spp. flexion larvae	gobies	31	17.494	-1.488	0.0000	50		70
amphipods, caprellid	skeleton shrimps	19	18.533	-1.526	0.0198	28		15
appendicularian, Oikopleura dioica	larvacean	22	21.961	-1.534	0.0315	21		44
Mnemiopsis mccradyi	comb jelly, ctenophore	21	22.187	-1.651	0.0009	45		16
brachiopod, Glottidia pyramidata larvae	lamp shell	16	29.671	-2.824	0.0028	48	x	75

3.8 Predictive Tools

3.8.1 **Identifying Inflow-Abundance Mechanisms.** An indicator organism used to measure inflow effects on estuaries should be a non-freshwater organism that has a positive abundance response to inflow. Furthermore, the positive abundance response should be evaluated to determine if it could be a sampling artifact rather than an abundance response. For example, animals evacuating adjacent wetlands during floods might cause numbers to increase in the river channel, and if sampling is limited to the channel, then this response might give a false indication of a positive abundance response. Ideally, the mechanism or mechanisms responsible for the response will be identified through hypothesis development and testing. In order to narrow the broad field of potential hypotheses, the framework in Fig. 3.8.1 was developed. It is an extension of concepts and terminology presented by Robins et al. (2005). This approach borrows terminology from the fisheries management field, but adjusts the meaning of the terms to fit the present need. There are myriad hypotheses pertaining to abundance-inflow relationships, and usually a shortage of data with which to address them. However, the researcher is usually equipped with catch and inflow time series data. The fisheries terms *catchability*, *recruitment*, and *stock* are therefore placed into a strongly temporal context in the present application. The first step in detecting the likely mechanisms behind positive inflow responses is identification of the time scale of the response. Responses to inflow such as the evacuation example above are faster than the lagged responses that are synchronous with reproduction, growth, and survival. Because of the risk of overanalyzing the data and generating spurious correlations, most of the results produced by the framework in Fig. 3.8.1 should be viewed as hypotheses rather than conclusions.

Response mechanisms can be divided into three general categories based on the length of the lag in the abundance correlation with inflow: catchability, recruitment, and stock. The lag ranking for these response categories is catchability<recruitment<stock, where catchability has a lag measured in days, recruitment has a lag similar to the age of the recruit stage, and stock has a lag similar to the age of reproducing adults. In its original usage, the term *recruit* was applied to young fish that had recently entered a fishery. Its usage has broadened over the years to let it apply to the addition of young

individuals to any population or geographic area.

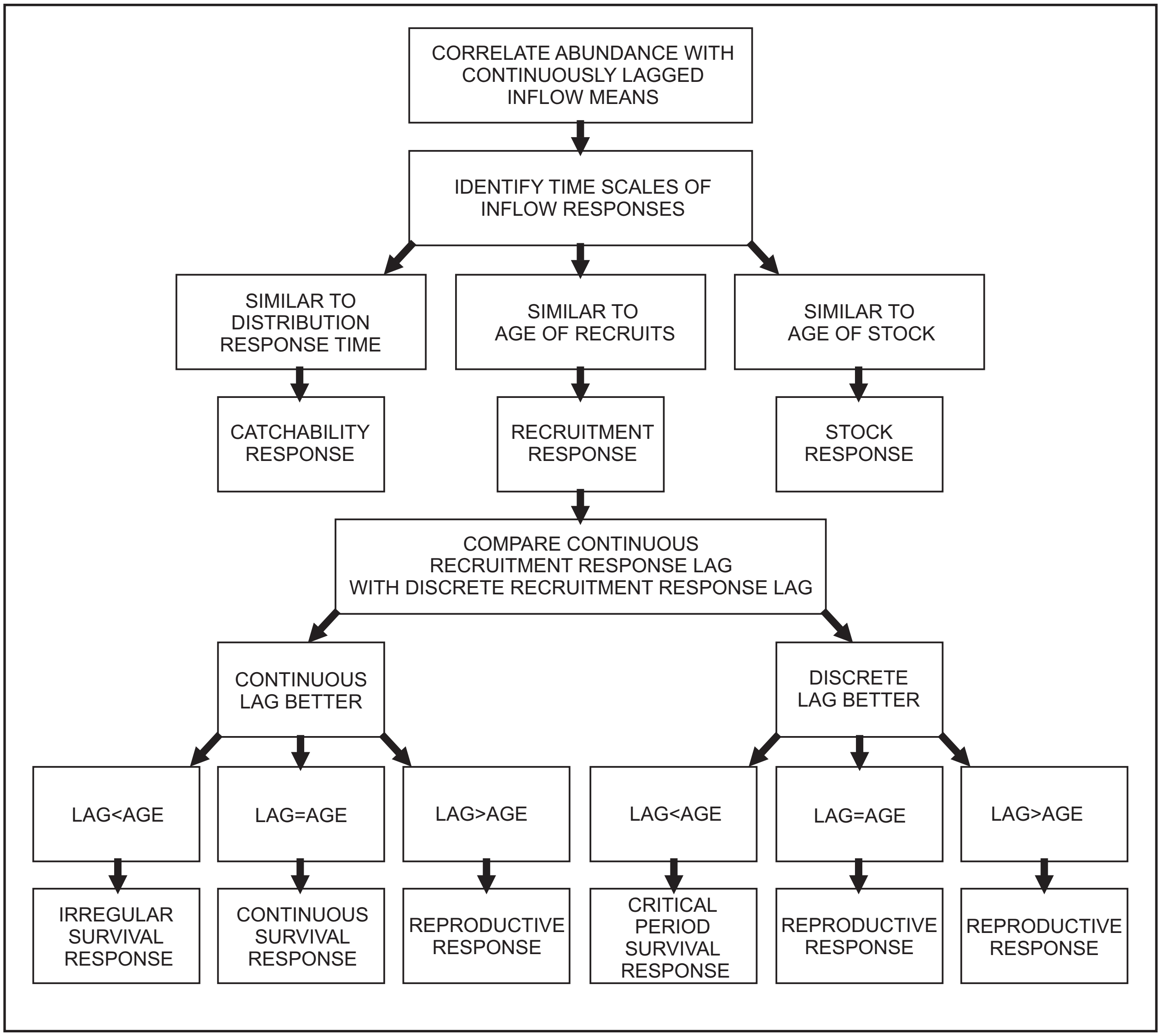

Fig. 3.8.1. Flow chart for developing hypotheses for causes of positive inflow-abundance relationships.

Catchability response to inflow. The fastest inflow-abundance mechanism involves distribution shifts, such as animals moving into the surveyed area from adjacent areas (i.e., from the direction of the shore, from channel substrate, or from areas seaward of the surveyed area). Such behavior could represent either involuntary flushing or an integral part of a mechanism for deliberately relocating in order to maintain associations with favorable salinities or prey concentrations. Animals may also redistribute themselves by moving into the tidal river from the seaward direction, either as larvae that are carried upstream by the vigorous two layered circulation that is often associated with high freshwater inflows, or as older stages that are actively following olfactory trails that are created or distributed by inflows (Kristensen 1964, Odum 1970, Benfield and Aldrich 1991). In all types of redistribution response, the result is likely to be a relatively fast change in catch rate. Numbers simply increase because the animals' redistribution caused them to be more likely to be collected. It is possible that redistributions could take longer than a few days, especially for benthic animals (section 3.6.1) or animals that take advantage of two layered estuarine circulation to move longer distances from seaward spawning grounds into the tidal river. Within the tidal river channel, Table 3.6.1 indicates that most redistributions are rapid (<3 d). The catchability responses of plankton are not likely to be of interest to resource managers, except when they involve the delivery of individuals to essential habitat such as nurseries.

Recruitment response to inflow. The second group of responses takes longer to become evident in the catch data. These are responses such as increased reproductive output by the parent generation and improved survival of the spawned progeny (fast growth is generally accepted as being an inherent part of high survival rates, Takasuka et al. 2004). Egg production is energetically expensive for most aquatic animals, and therefore egg production may vary as a function of energy intake. If adults spawn more intensively in the bay during high inflow periods as a response to better food supply, then the resulting increase in progeny will be evident at the point when these progeny move into the tidal river and congregate there, barring intervention by predation or other factors. Likewise, if inflow positively affects survival during an extended period of life, then the effect will require time before it becomes evident in the catch data. At various places around the world, correlations between fisheries catch and freshwater inflow have been shown to be lagged by the average age of the individuals in the catch. The ages of animals in the plankton net catch are highly variable, but the vast majority are less than four months old (~120 d). Recruitment responses can result from either increased reproductive output or increased survival, and are of interest to resource managers because they represent changes in population size. The hallmark of a recruitment response is a time lag in the correlation with inflow that is similar to the age of the catch.

Stock response to inflow. The dynamics of an adult stock have an obvious, but highly variable, impact on recruitment. If the abundance of recruits is tied to the dynamics of the parent stock, and the parent stock responds favorably to inflow, then an inflow response may result that is scaled to the age of the parent stock. Positive inflow effects may take a long time to accrue to the point of detection, and therefore it is possible to have a stock response in the absence of a recruitment response. In the present context, detecting a stock response involves the indirect measurement of the adult stock's response to inflow, using the abundance of its progeny as a proxy. In short lived species, stock response could be confused with lags that are associated with the time it takes for trophic cascades to develop in response to inflow.

Types of recruitment response. Given that growth rate is inherently coupled with survival (see discussion by Takasuka et al. 2004), the two principal types of positive recruitment response are increases in parental reproductive output and increases in the survival of progeny. The method of evaluating mean inflow effects by using progressively longer inflow periods will detect both reproductive and survival responses. If the response is reproductive, however, a lag representing a shorter period near spawning may produce a stronger correlation. Both approaches will tend to center on the age of the animals in question, provided survival responses are somewhat consistently distributed between hatching and collection. If, on the other hand, there are one or more critical survival periods between hatching and collection, then the correlation may be biased toward a period that is shorter than the average age. An example of this would be high variability in survival at the point when a larva settles from the plankton onto substrate. If freshwater inflow affects success during settlement (e.g., by providing a better food supply, fewer predators, reduced predator visibility, etc.), then the correlation may be strongest at a lag equivalent to the time between settlement and capture.

3.8.2 **Evaluating Potential Indicators.** The list of potential indicators includes all non-freshwater taxa that had positive slopes in Table 3.7.1. These are: pinnotherid juveniles (pea crabs), *Liriope tetraphylla* (hydromedusa), *Hargeria rapax* (tanaid), *Americamysis almyra* (mysid), *Americamysis* juveniles, *Cynoscion arenarius* juveniles (sand seatrout), and *Palaemonetes pugio* adults (daggerblade grass shrimp).

The distribution response of non-freshwater taxa is likely to interfere with the detection of abundance responses. As the animals move seaward in response to increased inflow, a part of their local population is likely to leave the survey area (washout), causing the false impression of a reduction in number. For this reason, and because the abundance relationships are more likely to be used to manage small inflows than large inflows, there is a need to refine the abundance-inflow relationships by reducing the distribution effect on abundance. A number of metrics could be used to detect washout conditions, which would then allow washout dates to be removed from the abundance regressions. Species-specific km_U responses could be used for this purpose, except that these values were often calculated from a few stray specimens that were caught upstream during washout events, and such numbers would fail to identify washout conditions. Inflow thresholds derived from the distribution response regressions are another potential measure of washout, except that washout events appear to be caused by unknown combinations of inflow and inflow duration. The cycle of washout and return ingression appears to be influenced by longer inflow periods than those which cause the relatively fast distribution shifts observed within the river channel itself. A low inflow occurring near the end of a washout cycle is associated with entirely different conditions than the same level of inflow observed near the start of a washout cycle. Despite the marked contextual difference between these two inflow observations, they would be otherwise indistinguishable. In the absence of a hydrodynamic model to solve this problem, the location of the 7 psu surface isohaline (I) was chosen as an indicator of integrated inflow history. Dates when the 7 psu isohaline was downstream of 2 km were excluded from the abundance regressions. This resulted in the removal 18 of the 62 dates (29%). The 2 km threshold generally coincided with what appeared to be likely washout events on the inflow hydrograph (Fig. 3.8.2).

The removal of washout dates had a profound effect on the response of *Americamysis almrya*, and also caused the response by bay anchovy juveniles to become significant (Fig 3.8.3). Washout removal appeared to emphasize the recruitment responses of daggerblade grass shrimp and sand seatrout relative to their catchability responses, but these recruitment responses were not significant due to reduced sample sizes.

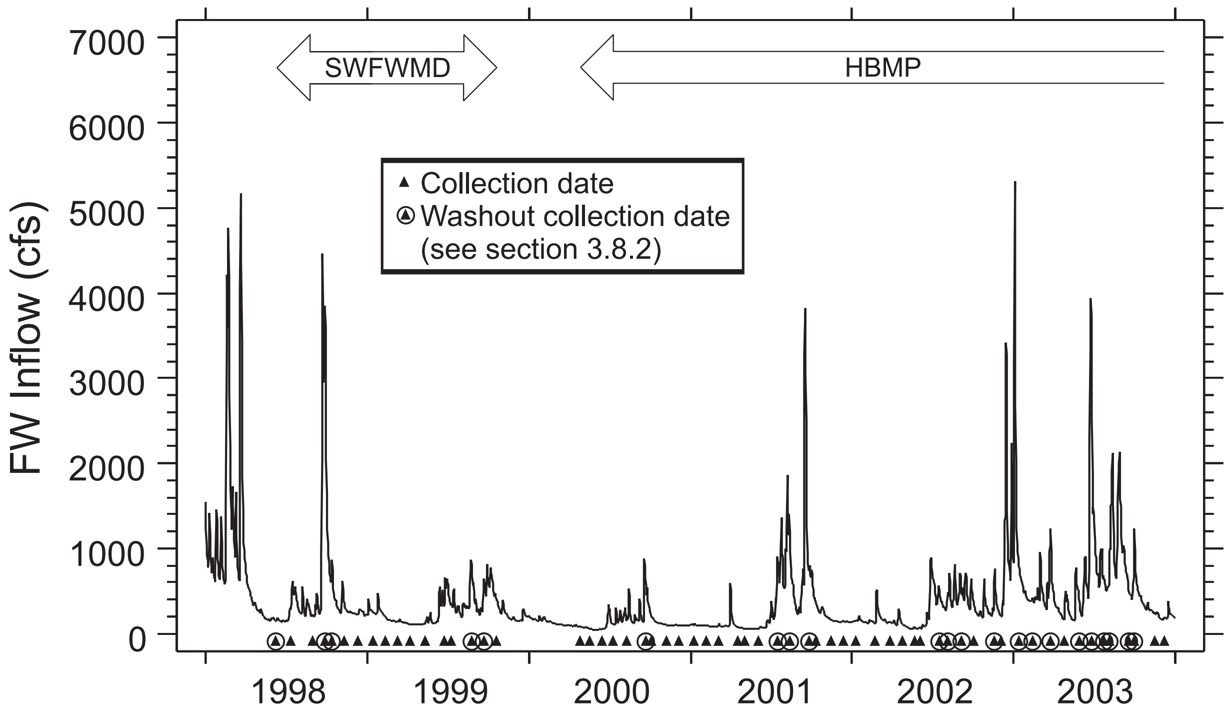

Fig. 3.8.2. Washout dates. Circled triangles are dates when the 7 psu surface isohaline was located downstream of river km 2.0.

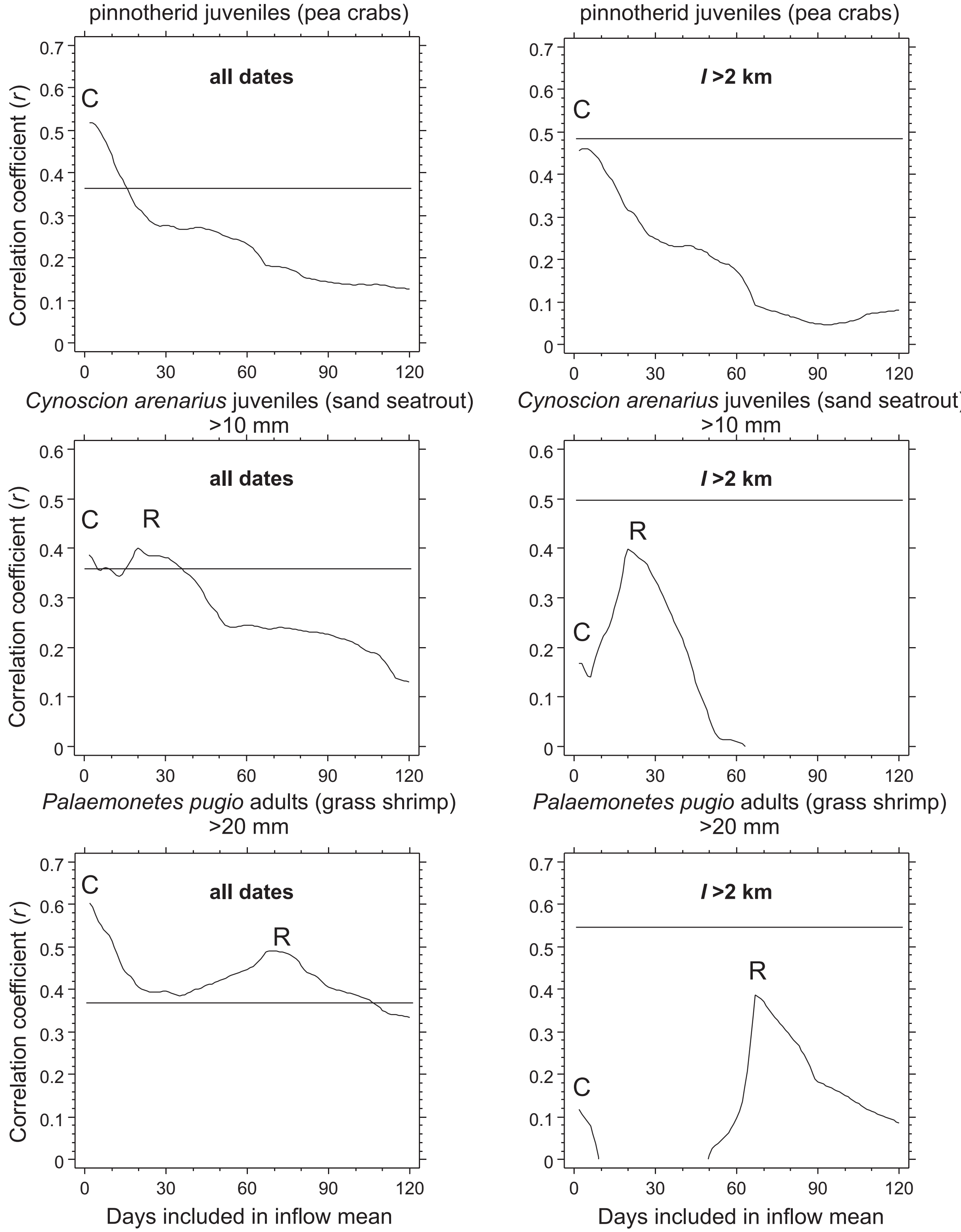

Fig. 3.8.3. Organism abundance (Ln *N*) responses to mean freshwater inflow (Ln *F*) over variable periods. *I*>2 km identifies data for which the location of the 7 psu isohaline was upstream of km 2. Horizontal lines identify the 5% probability threshold for *r*. *C* = catchability response, *R* = presumptive recruitment response and *S* = presumptive stock response.

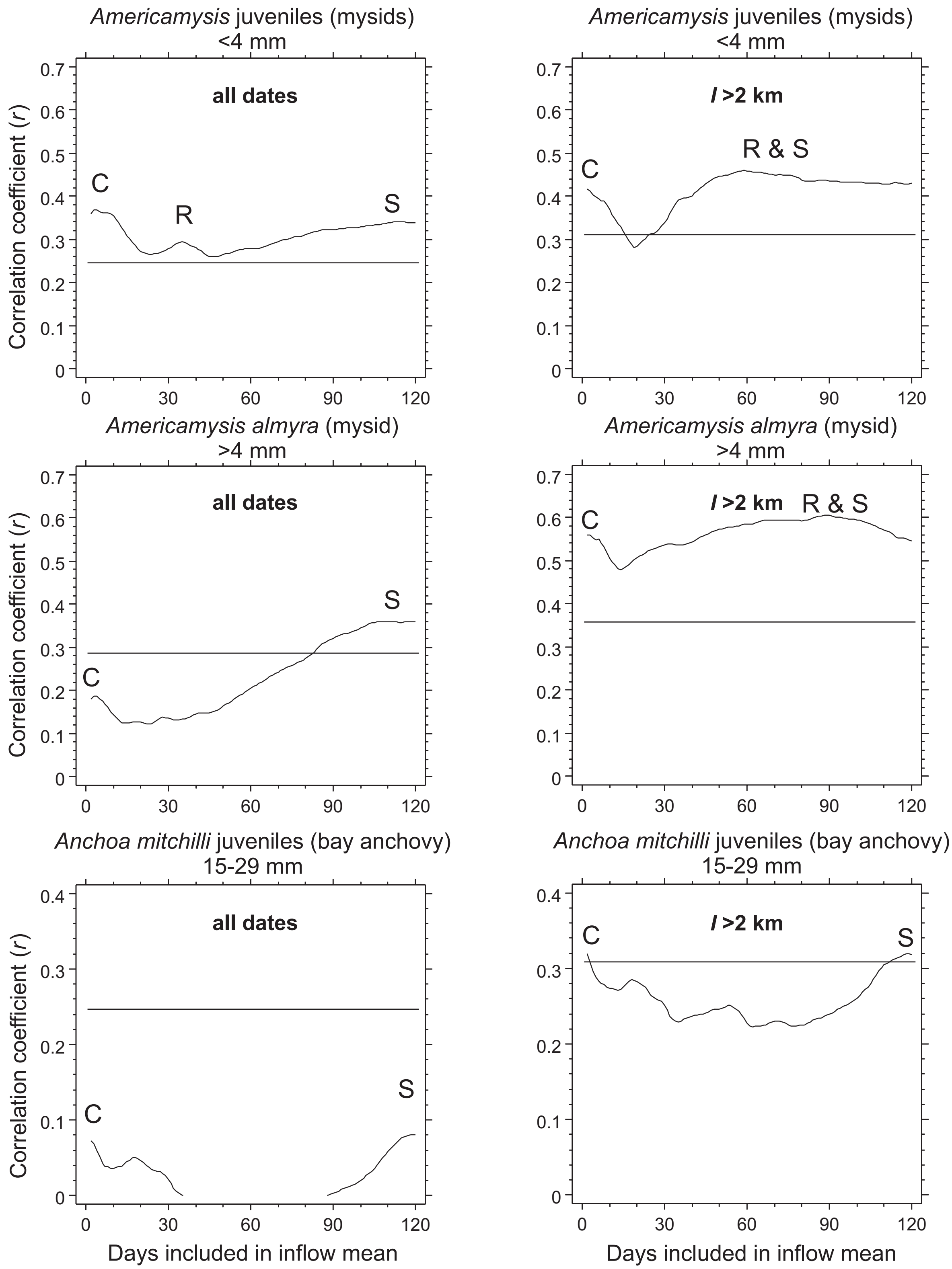

Fig. 3.8.3 (cont.). Organism abundance (Ln *N*) responses to mean freshwater inflow (Ln *F*) over variable periods. *I*>2 km identifies data for which the location of the 7 psu isohaline was upstream of km 2. Horizontal lines identify the 5% probability threshold for *r*. *C* = catchability response, *R* = presumptive recruitment response and *S* = presumptive stock response.

Pinnotherid juveniles (pea crabs). This rather broad taxonomic description appears to be almost entirely composed of a single species, *Pinnixa sayana*. The family level description was used because of uncertainty created by the small size of some specimens. Pea crabs are burrowers that are not usually susceptible to collection in the water column. The short time frame of the positive inflow response suggests that this is a catchability response (Fig. 3.8.3), probably caused by individuals relocating in response to changing inflow level. The catchability response of a species that primarily occupies the river mouth, rather than the interior of the tidal river, would not appear to be a meaningful representative of positive inflow response.

Liriope tetraphylla (hydromedusa). This hydromedusa appears to have a recruitment response to inflow with a time scale of about one month (Table 3.7.1). *L. tetraphylla* is an aggressive predator on plankton, and it is not known to be preyed upon by larger fishes or crustaceans. It is likely to be (1) a secondary productivity sink, (2) a competitor with planktivorous fishes, and (3) a predator on fish eggs and larvae, which are all characteristics that would make this species an indicator that represents a negative response to freshwater inflow from the management perspective. Its positive inflow response is largely influenced by three observations and may be spurious.

***Hargeria rapax* (tanaid).** This regression was based on only 12 observations and was heavily influenced by one data point (Appendix C). It is therefore likely to be spurious. Additional data from the continuing HBMP will determine if this species is useful as an indicator.

***Americamysis almyra* (mysid).** Mysids are critically important prey for estuarine-dependent fishes such as snook, red drum, spotted seatrout, sand seatrout and gulf flounder (Peters and McMichael 1987, McMichael and Peters 1989, McMichael et al. 1989, Peebles and Hopkins 1993, Peebles 2005). Mysids become important in the diets of these species as the fishes undergo a dietary transition from small plankters to fishes and decapod crustaceans. It would appear likely that the production of these fishes would decrease if mysid numbers were to decrease within the nursery habitat. Mysids were not identified to species level during the SWFWMD survey, and therefore the regression results for *A. almryra* are based entirely on HBMP data. *A. almyra* is the biomass dominant mysid in the Alafia River by a wide margin. Mysids may have multiple generations per year at low latitudes (Mees et al. 1993), which tends to blend the recruitment and stock responses together into a broad curve that encompasses the broad range of ages present. Maturity is reached in 17-25 d at 25˚C (Reitsema and Neff 1980). Juvenile *Americamysis* exhibited a very similar response that appeared to have a shorter lag than that of the adults, as would be expected (Fig. 3.8.3). The regression of adult number against the mean inflow of same day and 89 previous days (90 days total) is

$$\text{Ln } N=7.800+1.149(\text{Ln } F_{90}),$$

with n=28, slope p=0.001, r^2=36%. The Durbin-Watson statistic indicated serial correlation (Durbin-Watson p=0.03), but the plot of sequenced residuals did not have a strong serial pattern. This regression is based on non-washout dates. Positive inflow responses for mysids have also been detected in the Peace and Manatee Rivers (Peebles 2002b, 2002c).

The regression for *Americamysis* juveniles (60 days total) is

$$\text{Ln } N=9.636+0.793(\text{Ln } F_{60}),$$

with n=38, slope p=0.004, r^2=21%, and no indication of serial correlation (Durbin-Watson p=0.37). This regression is also based on non-washout dates.

***Cynoscion arenarius* juveniles (sand seatrout).** The sand seatrout and its Atlantic counterpart and ecological homolog, the weakfish (*Cynoscion regalis*), are biomass dominant fishes in estuaries throughout eastern North America. The weakfish is a major sportfish, whereas the smaller sand seatrout is a minor sportfish. The sand seatrout is often the most abundant piscivorous fish in tidal rivers, and it associates strongly with the bay anchovy on which it feeds. The adults favor open bay bottom and channels, and move into the Gulf of Mexico during winter. Spawning takes place within bays during spring and summer and will also occur within the lower parts of larger tidal rivers during the spring dry season. The larvae are common near the mouths of rivers. Early juveniles invade the interiors of tidal rivers. Once there, the juveniles tend to be more commonly collected by trawls deployed in the channel than by seines deployed at the shoreline. Given that the start of the juvenile stage was defined at a conservative 10 mm SL, the timing of the inflow response coincides very well with age, suggesting a recruitment response. The sand seatrout appears to have very good potential as an inflow indicator species. A positive inflow response was also detected in the Peace River (Peebles 2002b). Although the strongest correlation occurred at a continuous lag of 19 days (Table 3.7.1), Fig. 3.8.3 suggests that the response was centered closer to a lag of 30 days. The regression of juvenile number against the mean inflow of same day and 29 previous days (30 days total) is

$$\text{Ln } N = 7.317 + 0.490(\text{Ln } F_{30}),$$

with n=28, slope p=0.046, r^2=14%, and no indication of serial correlation (Durbin-Watson p=0.40). This regression is based on all dates.

Palaemonetes pugio **adults (daggerblade grass shrimp).** This grass shrimp may have a subtle estuarine-dependent life history in that the adults move seaward to release newly hatched larvae (McKenney 1979). Postlarvae, juveniles and adults are all very abundant in the interior of the tidal Alafia River. Shrimp of this genus are important prey for young estuarine-dependent fishes, including snook (McMichael et al. 1989). The short term responses for juveniles and adults (Table 3.7.1) appear to be catchability responses. However, analysis of both sets of dates (with and without washout) suggested the presence of an adult recruitment response that was centered near a 70 day lag. The time from hatching to maturity is highly variable, ranging from one to several months. The regression of adult number against the mean inflow of same day and 69 previous days (70 days total) is

$$\text{Ln } N = 6.182 + 0.566(\text{Ln } F_{70}),$$

with n=26, slope p=0.01, r^2=24%, and no indication of serial correlation (Durbin-Watson p=0.43). This regression is based on all dates. A positive inflow response for adult daggerblade grass shrimp was also detected in the Manatee River (Peebles 2002c).

Anchoa mitchilli juveniles (bay anchovy). The bay anchovy is the biomass dominant fish in estuaries throughout southeastern North America. Spawning is strongly oriented to zooplankton-rich areas. In Tampa Bay, spawning is known to be concentrated within Hillsborough Bay and in lower Tampa Bay near the mouth of the Manatee River (Peebles et al. 1996, Peebles 2002d). The early larvae generally remain associated with these spawning areas, which are primarily located in open waters. Postflexion stage larvae are migratory and move toward estuarine backwaters such as tidal rivers. The juvenile stage (15-29 mm SL) congregates within these locations for a period of time, but gradually returns seaward with continued growth and development. Fish >30 mm are mature or are in the process of maturing, and these are most common toward the mouth of the Alafia rather than within its interior. The juveniles often have km_U values in the 8-12 km range, whereas the adults (>30 mm SL) rarely had km_U values above 7 km. The regression of juvenile number against the mean inflow of same day and 119 previous days (120 days total) is

$$\text{Ln } N=13.174+0.458(\text{Ln } F_{120}),$$

with n=39, slope p=0.049, r^2=10%, and no indication of serial correlation (Durbin-Watson p=0.15). This regression is based on non-washout dates.

3.8.3 **Calculation of a Standard Reference Abundance.** The median inflow is the best representation of the inflow on a typical day during a specified period. The median also makes a good inflow reference for comparison with abundance regressions because it tends to fall near the middle range of the regression-based estimates rather than near end regions that have less certainty associated with them. The regressions developed in section 3.8.2 are plotted in Fig. 3.8.5. During the years 1998-2003, the median estimated total inflow into the Alafia River estuary was 245 cfs. The Ln transformed value is 5.5 cfs, which falls at the middle of these plots. These regressions were used to estimate abundances at median inflow and at all inflows between the median and 1 cfs. The results were then standardized as a percentage of the abundance at median flow. Once this has been done, the resource manager can decide on the percentage of typical abundance that should be preserved. An example is shown in Fig. 3.8.6, where maintenance of 50% of typical abundance would require 84 cfs. This number is less than half of the median inflow because most of the inflow relationships with non-transformed abundance data are nonlinear.

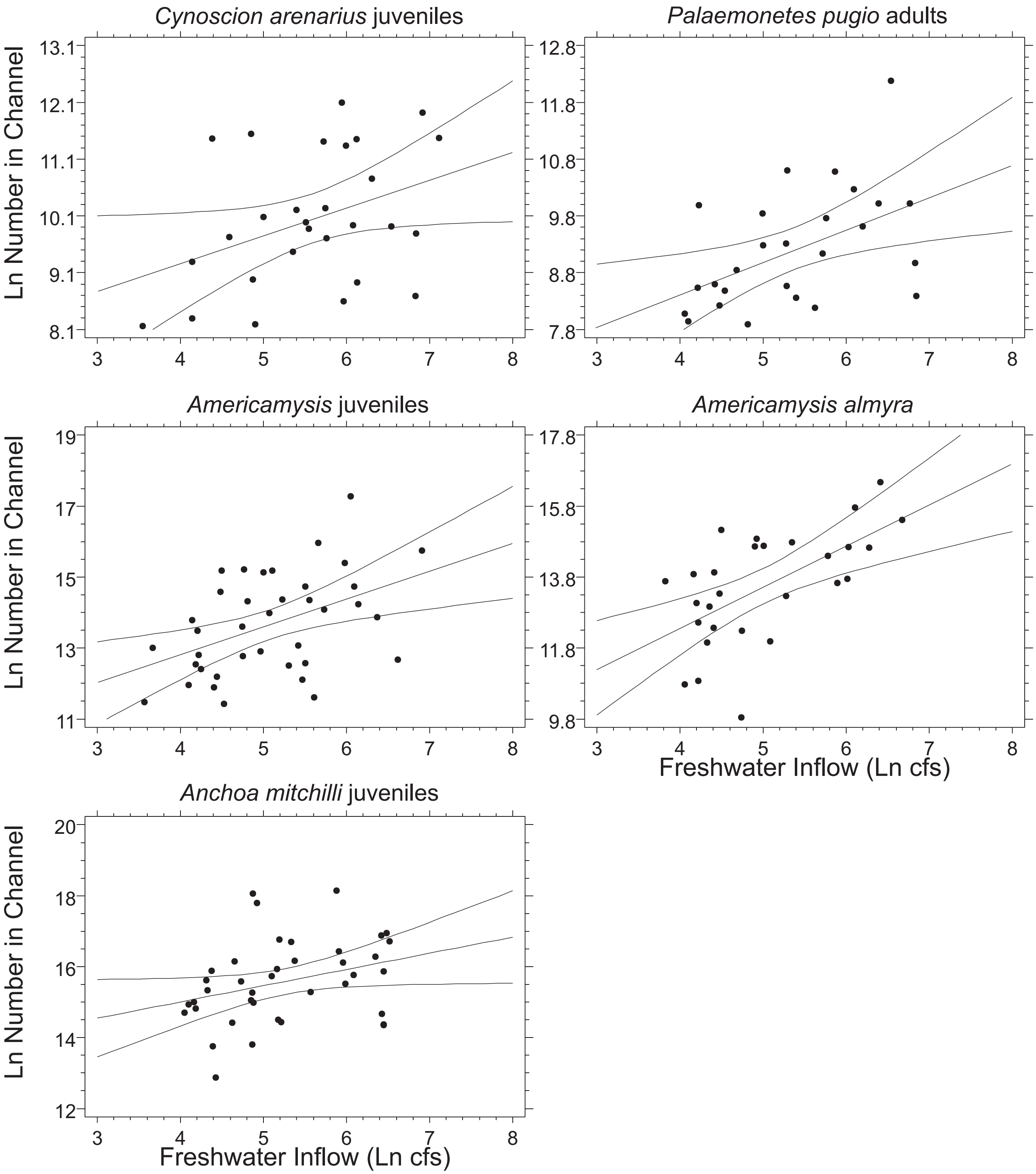

Fig. 3.8.4. Regressions (section 3.8.2) used to generate Fig. 3.8.5., with 95% confidence limits for estimated means.

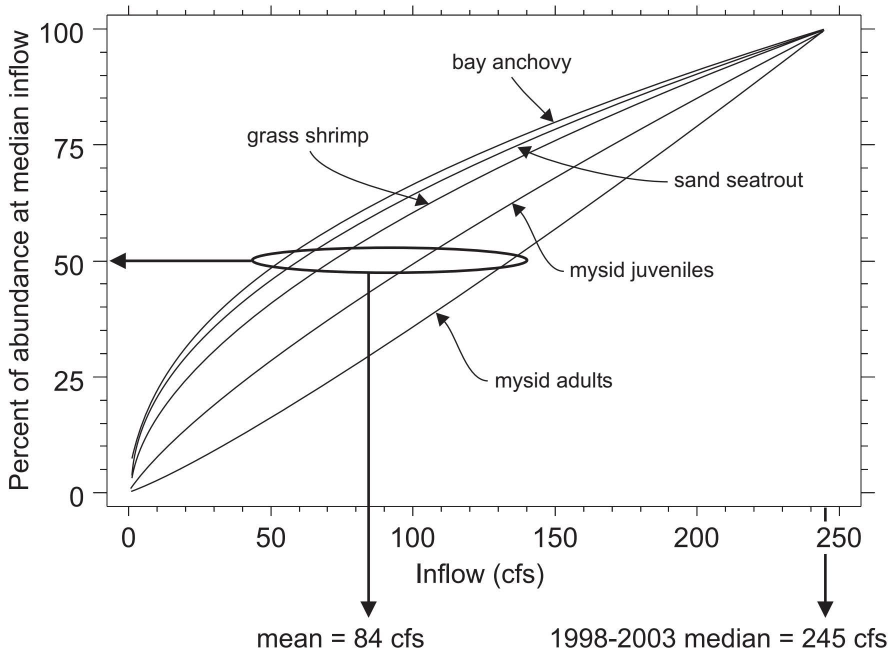

Fig. 3.8.5. Method for estimating the percentage of a standard reference abundance. The standard reference abundance is the abundance at median inflow, to which the abundances from regressions in section 3.8.2 (Fig. 3.8.4) can be standardized. In this example, 84 cfs would be the average inflow required to maintain 50% of typical abundance.

4.0 CONCLUSIONS

4.1 Descriptive Observations

1). **Dominant Catch.** The fish assemblage collected by the plankton net was dominated by the bay anchovy, gobies (primarily *Gobiosoma* spp. and *Microgobius* spp.), menhaden, sand seatrout, hogchoker, silversides (*Menidia* spp.) and skilletfish, and its invertebrate catch was dominated by larval crabs, arrow worms, copepods, mysids, amphipods, isopods, cumaceans, and polychaete worms.

2.) **Use of Area as Spawning Habitat.** Fishes that spawned very near or within the tidal Alafia River, as indicated by the presence of eggs or early stage larvae, were the bay anchovy, silversides (*Menidia* spp. and *Membras martinica*), blennies (primarily *Chasmodes saburrae*), several species of goby (primarily *Gobiosoma* spp. and *Microgobius* spp., but also *Bathygobius soporator*), Atlantic bumper, leatherjack, silver perch, spotted seatrout, sand seatrout, southern kingfish, skilletfish, lined sole and hogchoker. Live-bearing species that released their young into this area include the eastern mosquitofish, sailfin molly, chain pipefish, and gulf pipefish.

4.) **Seasonality.** The number of taxa present in the plankton-net catch increased during spring and decreased during fall, being generally highest from March through September. This pattern was observed for both fishes and invertebrates, except the trends in the invertebrate data were not as pronounced as those in the fish data. The potential for impact is species-specific (Table A2). Some species, such the bay anchovy, are present year-round. Others present a seasonal succession in their individual abundance peaks, specifically: menhaden, pinfish, spot and black drum (winter through early spring); sand seatrout, spotted seatrout, kingfishes, hogchoker, and crab and shrimp larvae (spring and summer); and red drum (fall). Red drum recruitment to the tidal Alafia River is primarily evident in the seine database (Matheson et al. 2004), as this species primarily arrives as juveniles rather than larvae. There is no time of year when freshwater inflow management is free from potential impact on estuarine nursery habitat.

4.2 Responses to Freshwater Inflow

1.) **Distribution Shifts.** Distribution responses to freshwater inflow were found for >70 taxa of fishes and invertebrates. All taxa moved downstream with increasing inflow. Although all of the responses had the same direction, the distributions of different organisms were staggered within the tidal river relative to each other, such that some were generally farther upstream than others. An investigation of the the scale of the distribution response indicated that most responses took place within 5 d of a change in inflow. Planktonic and vertically migrating animals responded faster (median = 1-3 d) than animals that spend most of the time at or near the bottom (benthos, median = 13 d). Freshwater organisms appeared to be relatively resistant to downstream displacement. The locations of the mysid *Americamysis almyra* and bay anchovy juveniles tracked each other better than either one tracked freshwater inflow, suggesting that other processes modified the distribution relationship with inflow.

2.) **Abundance Responses.** Positive and negative abundance responses to freshwater inflow were documented for 48 taxa of fishes and invertebrates. Most of these responses were expected; positive responses to high inflow were found for freshwater organisms that shifted downstream during high inflow periods, increasing their total numbers within the tidal river, and negative responses were found for high salinity organisms that moved from the tidal river into Hillsborough Bay, causing a decrease in their numbers during high inflow periods. The remaining relationships were positive responses by organisms that have been observed to congregate within the middle reaches of the tidal river as a characteristic part of their life histories. Notable among these were sand seatrout juveniles, daggerblade grass shrimp adults, juvenile *Americamysis* spp. mysids and adult *Americamysis almyra*. Bay anchovy juveniles also exhibited a positive response when washout dates were excluded. Numbers of these organisms were highest during or after high inflow periods. An investigation into the time scale of these responses separated catchability responses from responses that were related to increased reproductive output and increased survival. The regressions for these organisms were refined accordingly, and were then used to estimate standard reference abundances. It was estimated that 84 cfs would be required to maintain the mean abundances of this assemblage at levels near 50% of typical abundance, where typical abundance is the abundance at median inflow for a specified period.

Mysids, grass shrimp, and the bay anchovy are important prey for many of the juvenile estuarine-dependent fishes that use tidal rivers as nursery habitat (Peebles 2005). Reduction in prey numbers during low inflow periods is very likely to reduce the carrying capacities of the Alafia River for snook, red drum, sand seatrout, spotted seatrout and other economically important species. The observed reduction in juvenile sand seatrout numbers during low prey (low inflow) periods supports this concept of a prey related reduction in carrying capacity. Reductions in bay anchovy number are likely to have far reaching effects because the bay anchovy is important forage for seabirds and fishes throughout its extensive coastal range.

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6.0 LIST OF ACRONYMS

cfs	cubic feet per second
CPUE	Catch-per-unit-effort, where catch is the number of individuals collected during a specified effort, which is the volume filtered by a plankton net or the effort associated with a standard seine or trawl deployment. In the case of the plankton net, *CPUE* and *density* (individuals per volume filtered) are identical. *CPUE* is alternately represented by the symbol *U*.
F	Freshwater inflow, in cubic feet per second (cfs), estimated from both gauged and ungauged flows.
I	The location of a reference isohaline, in km from the river's mouth. A numeric subscript identifies the value of the reference isohaline, in psu.
km_U	The central geographic tendency in *CPUE*, in km from the river's mouth. km_U is calculated as a *CPUE*-weighted mean location of capture, in km.
N	The estimated total number of individuals of a given taxon within the study area during a given survey, calculated by multiplying taxon density by the volume of water represented by the collections.
NL	Notochord length, the distance from the tip of the snout to the tip of the notochord.
S	Salinity, in practical salinity units (psu).
SL	Standard length, the distance from the tip of the snout to the posterior edge of the hypural bones.
S_U	The central tendency in a taxon's salinity distribution, calculated as the *CPUE*-weighted mean salinity at capture, in psu.
U	Alternate designation for *CPUE*.
V	The volume of water (m^3) in a sampling zone, corrected for water level at the time of sampling.

7.0 ACKNOWLEDGMENTS

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Appendix A:

Data summary tables

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

Organisms are listed in phylogenetic order.

Taxon	Common Name	Number Collected	Collection Frequency	*Kmu* (km)	*Su* (psu)	Mean CPUE (No./10^3 m^3)	Max CPUE (No./10^3 m^3)
foraminiferans	foraminiferans	3	3	3.7	16.2	0.1	13.0
Craspedacusta sowberii	hydromedusa	2	1	11.9	10.0	0.0	25.5
Liriope tetraphylla	hydromedusa	2,548	45	1.4	20.1	60.7	8346.9
Nemopsis sp.	hydromedusa	6,163	65	1.5	12.4	157.1	37474.9
scyphozoan ephyrae	jellyfish larvae	1	1	4.0	26.0	0.0	18.5
Chrysaora quinquecirrha	sea nettle	20	6	4.3	21.3	0.7	223.5
Mnemiopsis mccradyi	comb jelly, ctenophore	35,946	58	4.8	18.2	1147.9	94449.9
Beroe ovata	sea walnut, ctenophore	3	2	0.8	21.4	0.1	27.7
turbellarians	flatworms	7	3	4.0	11.0	0.2	59.8
nemerteans	ribbon worms	1	1	6.4	10.0	0.0	12.1
nematodes	roundworms, threadworms	4	2	7.2	0.0	0.1	34.9
polychaetes	sand worms, tube worms	48,952	372	4.6	17.1	1620.1	307448.3
oligochaetes	freshwater worms	389	78	9.2	0.7	8.9	547.1
hirudinoideans	leeches	175	92	7.6	7.6	4.0	81.7
cladocerans, Daphnia spp.	water fleas	16,558	37	9.1	0.0	378.3	39613.1
cladoceran, Bosmina sp.	water flea	1	1	6.4	0.0	0.0	11.3
cladoceran, Scaphroleberis kingi	water flea	4	4	10.5	0.2	0.1	12.8
cladoceran, Simocephalus vetulus	water flea	182	60	9.7	0.3	4.1	224.6
cladoceran, Ceridodaphnia sp.	water flea	2	2	5.8	0.0	0.0	12.3
cladoceran, Bunops sp.	water flea	5	5	8.2	0.0	0.1	14.9
cladoceran, Ilyocryptus sp.	water flea	33	23	9.3	0.1	0.8	88.6
cladoceran, Diaphanosoma brachyurum	water flea	7	3	12.2	0.0	0.2	65.0
cladoceran, Sida crystallina	water flea	5	4	9.5	2.0	0.1	25.8
cladoceran, Latona setifera	water flea	20	9	7.4	0.0	0.5	121.7
cladoceran, Penilia avirostris	water flea	1,004	11	0.5	27.0	25.7	12437.6
cladoceran, Alona monacantha	water flea	1	1	7.9	0.0	0.0	13.3
cladoceran, Euryalona occidentalis	water flea	1	1	12.7	0.0	0.0	12.5
cladoceran, Kurzia longirostris	water flea	1	1	9.5	0.0	0.0	12.3
cladoceran, Leydigia sp.	water flea	10	9	9.1	0.0	0.2	23.3
cladoceran, Moinadaphnia macleayii	water flea	1	1	9.5	0.0	0.0	12.3
cladoceran, Evadne tergestina	water flea	59	9	0.6	25.7	1.5	568.5
leptostracan, Nebalia sp.	nebaliid	1	1	0.4	29.0	0.0	10.2
stomatopod, Squilla empusa larvae	mantis shrimp	69	18	2.3	22.6	1.6	409.2
stomatopod, Squilla empusa juveniles	mantis shrimp	1	1	0.4	11.0	0.0	11.8
decapod zoeae, unidentified	crab larvae	1,089,665	387	2.5	22.5	28007.1	7439849.4
decapod mysis, unidentified	shrimp larvae	39,083	343	4.8	11.3	916.1	34321.2
decapod megalopae, unidentified	post-zoea crab larvae	6,674	174	2.8	18.2	159.1	7144.4
shrimps, unidentified postlarvae	shrimps	13	8	1.1	20.3	0.3	40.9
shrimps, unidentified juveniles	shrimps	6	3	0.4	13.6	0.1	27.7
penaeid metamorphs	penaeid shrimps	56	19	2.8	19.4	1.4	118.1
Farfantepenaeus duorarum juveniles	pink shrimp	6	6	5.1	16.7	0.1	13.5
Rimapenaeus spp. postlarvae	shrimps	1	1	0.4	10.0	0.0	12.1
Rimapenaeus spp. juveniles	shrimps	10	7	0.9	14.2	0.2	37.8
Trachypenaeopsis mobilispinus juveniles	shrimps	1	1	1.5	26.0	0.0	12.3
Sicyonia laevigata juveniles	rock shrimp	1	1	0.4	24.0	0.0	13.5
Lucifer faxoni juveniles and adults	shrimp	19,792	118	0.9	24.9	489.8	39101.5
Leptochela serratorbita postlarvae	combclaw shrimp	9	2	0.7	29.2	0.2	111.5
Leptochela serratorbita juveniles	combclaw shrimp	155	18	0.7	23.7	4.0	1079.9
Palaemonetes spp. postlarvae	grass shrimp	1,499	179	4.4	18.2	37.8	1202.7
Palaemonetes pugio juveniles	daggerblade grass shrimp	289	97	7.1	7.1	7.0	279.2
Palaemonetes pugio adults	daggerblade grass shrimp	51	36	7.3	6.1	1.2	68.2
Periclimenes spp. postlarvae	shrimps	120	16	0.9	15.2	2.9	554.6
Periclimenes spp. juveniles	shrimps	22	9	0.8	17.0	0.5	61.1
Periclimenes spp. adults	shrimps	5	3	0.4	14.7	0.1	27.7
alphaeid postlarvae	snapping shrimps	716	48	0.7	26.4	18.1	3466.4
alphaeid juveniles	snapping shrimps	22	8	1.2	16.9	0.5	99.0
Alpheus viridari juveniles	snapping shrimp	1	1	0.4	11.0	0.0	11.8
Leptalpheus forceps juveniles	snapping shrimp	2	1	0.4	13.0	0.0	26.9
Hippolyte zostericola postlarvae	zostera shrimp	5	3	1.4	21.2	0.1	23.0
Hippolyte zostericola juveniles	zostera shrimp	8	5	0.7	21.7	0.2	36.0

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

Organisms are listed in phylogenetic order.

Taxon	Common Name	Number Collected	Collection Frequency	*Kmu* (km)	*Su* (psu)	Mean CPUE (No./10^3 m^3)	Max CPUE (No./10^3 m^3)
Hippolyte zostericola adults	zostera shrimp	1	1	0.4	20.0	0.0	12.0
Latreutes parvulus postlarvae	sargassum shrimp	19	1	0.4	24.0	0.5	266.0
Latreutes parvulus juveniles	sargassum shrimp	17	4	1.7	14.8	0.4	83.8
Tozeuma carolinense postlarvae	arrow shrimp	14	9	1.1	22.5	0.3	54.8
Tozeuma carolinense juveniles	arrow shrimp	11	6	1.3	17.5	0.3	56.0
Ogyrides alphaerostris juveniles and adults	estuarine longeye shrimp	11	2	0.5	9.1	0.3	125.9
processid postlarvae	night shrimps	38	4	0.8	23.5	0.8	282.2
processid juveniles	night shrimps	42	7	0.7	14.7	1.0	239.3
Ambidexter symmetricus juveniles	shrimp	80	13	0.8	18.3	1.9	221.6
Ambidexter symmetricus adults	shrimp	3	1	6.4	21.0	0.1	39.6
astacidean juveniles	crayfish	1	1	3.0	0.0	0.0	11.4
callianassid juveniles	ghost shrimps	3	2	0.4	17.9	0.1	26.0
Upogebia spp. postlarvae	mud shrimps	4,024	33	0.5	25.8	101.2	46713.8
Upogebia spp. juveniles	mud shrimps	18	3	0.4	9.8	0.4	194.0
Upogebia affinis juveniles	coastal mud shrimp	1	1	6.4	0.0	0.0	11.4
paguroid postlarvae	hermit crabs	3	3	1.2	19.9	0.1	13.1
paguroid juveniles	hermit crabs	10	5	0.9	22.3	0.3	41.5
porcellanid (not P. armatus) juveniles	porcelain crabs	3	3	4.3	14.5	0.1	14.0
Euceramus praelongus juveniles	olivepit porcelain crab	25	10	1.1	25.4	0.6	117.6
Petrolisthes armatus juveniles	porcelain crab	1,677	53	0.7	19.8	41.3	9698.4
Callinectes sapidus juveniles	blue crab	5	4	3.6	16.6	0.1	23.9
xanthid juveniles	mud crabs	1	1	10.0	0.0	0.0	11.3
Rhithropanopeus harrisii juveniles	Harris mud crab	3	3	9.2	8.9	0.1	13.8
Rhithropanopeus harrisii adults	Harris mud crab	1	1	9.5	15.0	0.0	13.9
Aratus pisonii juveniles	mangrove tree crab	1	1	11.9	6.0	0.0	12.3
Aratus pisonii adults	mangrove tree crab	1	1	0.4	28.0	0.0	11.1
pinnotherid juveniles	pea crabs	1,746	50	2.5	12.5	41.3	3702.3
Pinnixa sayana juveniles	pea crab	2,652	53	0.9	17.7	64.8	6793.3
Pinnixa sayana adults	pea crab	4	3	2.3	18.0	0.1	26.7
Uca spp. juveniles	fiddler crabs	1	1	0.4	28.0	0.0	11.6
unidentified Americamysis juveniles	opossum shrimps, mysids	10,583	249	3.5	12.4	246.1	19506.4
Americamysis almyra	opossum shrimp, mysid	24,019	324	6.4	8.7	553.7	20074.4
Americamysis bahia	opossum shrimp, mysid	879	40	3.7	17.4	21.7	7041.9
Americamysis stucki	opossum shrimp, mysid	1,123	39	0.6	22.8	26.6	5315.4
Bowmaniella brasiliensis	opossum shrimp, mysid	141	29	1.6	24.0	3.2	512.9
Brasilomysis castroi	opossum shrimp, mysid	15	3	0.4	24.1	0.4	154.0
Taphromysis bowmani	opossum shrimp, mysid	147	43	9.9	3.7	3.3	429.9
cumaceans, unidentified	cumaceans	88,040	294	2.0	19.5	2110.6	132530.1
Sinelobus stanfordi	tanaid	16	11	7.4	7.4	0.4	37.1
Hargeria rapax	tanaid	22	14	6.0	8.0	0.5	121.1
isopod sp. a	isopod	3	2	7.0	10.5	0.1	21.5
Cyathura polita	isopod	103	39	7.4	11.9	2.3	372.1
Munna reynoldsi	isopod	90	38	4.1	18.6	2.2	153.1
epicaridean larvae	isopods	8	3	3.5	20.3	0.2	55.7
Probopyrus sp. (attached)	isopod	4	4	7.0	7.9	0.1	18.2
Anopsilana jonesi	isopod	52	13	10.2	2.6	1.2	154.7
Olencira praegustator (in mouth)	isopod	1	1	1.5	11.0	0.0	11.3
cymothoid sp. a (Lironeca) juveniles	isopod	22,424	378	7.1	12.7	542.2	6900.7
cymothoid sp. b juveniles	isopod	14	8	1.3	22.1	0.3	41.6
cymothoid sp. c juveniles	isopod	3	2	3.7	20.7	0.1	25.0
cymothoid sp. d juveniles	isopod	1	1	1.5	17.0	0.0	13.4
isopods, unidentified sphaeromatids	isopods	19	13	7.8	12.8	0.5	43.7
Cassidinidea ovalis	isopod	297	125	8.6	5.0	6.7	148.8
Harrieta faxoni	isopod	39	14	1.2	25.4	0.9	105.7
Sphaeroma quadridentata	isopod	38	18	1.9	20.8	0.8	76.6
Sphaeroma terebrans	isopod	200	56	9.2	8.4	4.5	267.7
Edotea triloba	isopod	94,304	318	6.9	15.0	2192.1	223060.3
Erichsonella attenuata	isopod	169	44	2.3	22.1	4.0	253.5
Erichsonella filiforme	isopod	7	5	2.7	20.1	0.2	24.0
amphipods, unidentified gammarideans	amphipods	75,206	419	5.2	12.0	1839.6	356321.6

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

Organisms are listed in phylogenetic order.

Taxon	Common Name	Number Collected	Collection Frequency	*Kmu* (km)	*Su* (psu)	Mean CPUE (No./10^3 m^3)	Max CPUE (No./10^3 m^3)
Lestrigonus bengalensis	hyperiid amphipod	3	2	0.8	29.0	0.1	20.5
amphipods, caprellid	skeleton shrimps	8,372	40	3.4	23.5	195.6	39295.1
cirriped nauplius stage	barnacles	1,303	16	0.5	26.8	32.9	16124.9
cirriped cypris stage	barnacles	122	34	4.2	9.7	2.9	414.4
branchiurans, Argulus spp.	fish lice	269	91	9.6	9.0	6.3	229.7
unidentified calanoids	copepods	34,014	23	0.5	28.1	955.7	194952.1
paracalanids	copepods	20	6	0.9	25.6	0.5	124.8
Acartia tonsa	copepod	28,102	112	0.7	22.0	663.9	47949.0
Calanopia americana	copepod	22	6	1.2	22.2	0.5	72.6
Centropages hamatus	copepod	9	4	1.1	25.5	0.2	43.8
Centropages velificatus	copepod	1,515	24	0.8	23.2	35.5	11346.0
Diaptomus spp.	copepods	244	28	10.9	0.1	5.7	1095.4
Eucalanus sp.	copepod	2	2	2.3	18.8	0.0	12.4
Eurytemora affinis	copepod	18	10	10.8	2.1	0.4	69.4
Labidocera aestiva	copepod	44,464	99	0.7	24.4	1120.1	119292.8
Pseudodiaptomus coronatus	copepod	1,024	102	2.5	21.9	22.9	1602.8
Tortanus setacaudatus	copepod	1	1	12.7	8.0	0.0	12.2
Temora turbinata	copepod	7	1	0.4	27.0	0.2	97.1
Cyclops spp.	copepods	47	17	9.8	4.5	1.1	92.4
Oithona spp.	copepods	35	9	1.2	24.2	0.8	208.0
Saphirella spp.	copepods	30	13	1.5	24.9	0.6	63.4
Halicyclops sp.	copepod	1	1	7.9	12.0	0.0	12.3
Macrocyclops albidus	copepods	6	6	10.3	2.4	0.1	13.4
Mesocyclops edax	copepod	11,054	123	11.2	0.1	238.0	57224.6
Mesocyclops leuckarti	copepod	1	1	11.9	5.0	0.0	13.0
Orthocyclops modestus	copepod	66	26	10.4	0.6	1.6	149.1
Osphranticum labronectum	copepod	5	5	7.1	0.0	0.1	12.6
harpacticoids	copepods	102	33	6.0	16.9	2.7	279.2
Monstrilla sp.	copepod	19	9	1.4	26.5	0.4	82.6
Ergasilus sp.	copepod	1	1	9.5	12.0	0.0	11.0
siphonostomatids	parasitic copepods	355	113	3.5	20.6	8.6	205.7
Euconchoecia chierchiae	ostracod, seed shrimp	3	1	0.4	29.0	0.1	30.7
Eusarsiella zostericola	ostracod, seed shrimp	25	12	2.8	21.8	0.6	105.2
Parasterope pollex	ostracod, seed shrimp	14,424	118	1.1	19.8	337.8	23390.1
ostracods, podocopid	ostracods, seed shrimps	599	137	6.2	5.8	14.2	1898.3
collembolas, podurid	springtails	8	6	9.3	7.9	0.2	36.2
ephemeropterans	mayflies	2,146	137	10.8	0.1	47.8	2208.2
odonates, anisopteran larvae	dragonflies	9	7	8.1	0.0	0.2	22.8
odonates, zygopteran larvae	damselflies	18	15	11.0	0.2	0.4	24.7
hemipterans, belostomatid adults	giant water bugs	2	2	11.4	3.9	0.0	12.1
hemipterans, corixid juveniles	water boatmen	3	3	5.6	6.2	0.1	13.4
hemipterans, corixid adults	water boatmen	5	5	10.4	3.4	0.1	13.1
hemipterans, gerrid adults	water striders	1,023	54	11.8	0.7	21.5	2774.9
hemipterans, naucorid adults	creeoing water bugs	2	2	9.1	0.0	0.0	11.7
hemipterans, nepid adults	water scorpions	1	1	3.0	16.0	0.0	12.4
hemipterans, pleid adults	pygmy backswimmers	4	4	10.4	2.8	0.1	11.7
megalopterans, corydalid larvae	fishflies	2	2	10.6	0.5	0.0	11.1
neuropterans, Climacia spp, larvae	spongillaflies	9	9	9.2	0.0	0.2	13.4
coleopterans, chrysomelid larvae	beetles	429	3	10.0	9.0	9.0	4829.5
coleopterans, curculionid adults	beetles	23	17	9.9	0.5	0.5	71.3
coleopterans, dytiscid larvae	predaceous diving beetles	7	7	10.1	0.0	0.2	13.0
coleopterans, noterid adults	burrowing water beetles	75	28	11.0	0.6	1.6	175.4
coleopterans, dryopid larvae	long-toed water beetles	3	2	12.1	0.0	0.1	20.1
coleopterans, elmid larvae	riffle beetles	132	49	9.3	0.1	2.9	182.7
coleopterans, elmid adults	riffle beetles	88	39	9.9	0.6	1.9	133.9
coleopterans, gyrinid larvae	whirligig beetles	53	30	9.9	0.0	1.2	120.8
coleopterans, haliplid larvae	crawling water beetles	1	1	9.5	0.0	0.0	11.7
coleopterans, haliplid adults	crawling water beetles	3	3	10.8	0.0	0.1	13.0
coleopterans, dytiscid adults	predaceous diving beetles	2	1	9.5	0.0	0.0	22.3
coleopterans, scirtid larvae	marsh beetles	20	14	10.5	0.9	0.4	40.2

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

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Taxon	Common Name	Number Collected	Collection Frequency	*Kmu* (km)	*Su* (psu)	Mean CPUE (No./10^3 m^3)	Max CPUE (No./10^3 m^3)
dipterans, pupae	flies, mosquitoes	2,519	237	9.2	1.2	56.9	1689.2
dipterans, ceratopogonid larvae	biting midges	78	37	8.0	1.5	1.8	151.4
dipteran, Chaoborus punctipennis larvae	phantom midge	8,064	143	9.5	1.0	183.4	11179.8
dipterans, chironomid larvae	midges	2,913	252	10.0	2.4	66.2	1798.1
dipterans, muscid larvae	muscid flies	44	2	10.2	8.8	0.9	465.9
dipterans, simuliid larvae	black flies	19	12	11.2	0.4	0.4	49.2
dipterans, stratiomyid larvae	soldier flies	1	1	11.9	0.0	0.0	12.0
dipterans, sciomyzid larvae	marsh flies	4	4	10.3	5.7	0.1	11.6
trichopteran larvae	caddisflies	637	109	10.2	0.1	14.1	517.0
lepidopterans, pyralid larvae	aquatic caterpillars	14	11	9.9	3.8	0.3	48.2
pycnogonids	sea spiders	1	1	0.4	24.0	0.0	14.0
Limulus polyphemus larvae	horsehoe crab	207	40	1.8	24.5	5.0	918.5
acari	water mites	182	57	10.5	0.8	4.1	324.8
gastropods, prosobranch	snails	3,608	266	7.5	6.9	83.9	4166.6
gastropods, opisthobranch	sea slugs	14	9	4.1	20.8	0.4	69.0
pelecypods	clams, mussels, oysters	5,007	206	3.2	18.5	117.3	20603.1
ophiuroidean juveniles	brittlestars	9	5	1.7	26.1	0.2	43.0
Lolliguncula brevis juveniles	bay squid	35	19	2.3	23.3	0.9	97.4
brachiopod, Glottidia pyramidata larvae	lamp shell	27,423	28	1.6	28.3	700.4	104848.4
chaetognaths, sagittid	arrow worms	106,497	192	1.3	23.4	2602.5	133777.0
appendicularian, Oikopleura dioica	larvacean	13,126	27	0.6	26.9	360.7	45342.9
Branchiostoma floridae	lancelet	2	2	0.4	22.2	0.0	14.0
Lepisosteus platyrhincus postflexion larvae	Florida gar	1	1	12.7	2.0	0.0	14.1
Elops saurus postflexion larvae	ladyfish	24	18	7.5	8.8	0.5	34.4
Brevoortia spp. postflexion larvae	menhaden	177	32	9.0	8.2	3.7	369.2
Brevoortia spp. metamorphs	menhaden	719	31	10.3	5.5	15.7	2284.7
Brevoortia patronus juveniles	gulf menhaden	13	6	8.5	8.5	0.3	70.9
Brevoortia smithi juveniles	yellowfin menhaden	111	33	8.4	10.0	2.8	160.1
Dorosoma spp. preflexion larvae	shads	1	1	10.0	0.0	0.0	12.2
Dorosoma spp. postflexion larvae	shads	2	2	8.2	0.0	0.0	12.2
Dorosoma petenense juveniles	threadfin shad	1	1	0.4	11.0	0.0	11.8
Anchoa spp. preflexion larvae	anchovies	4,537	92	2.0	21.4	111.9	7486.7
Anchoa spp. flexion larvae	anchovies	1,580	94	2.1	22.4	39.8	2852.3
Anchoa hepsetus postflexion larvae	striped anchovy	79	9	0.7	28.4	2.1	798.9
Anchoa hepsetus juveniles	striped anchovy	123	27	4.7	16.3	3.1	386.5
Anchoa hepsetus adults	striped anchovy	2	1	12.7	5.0	0.0	24.3
Anchoa mitchilli eggs	bay anchovy	2,206	15	0.5	13.5	58.6	29343.9
Anchoa mitchilli postflexion larvae	bay anchovy	803	90	2.4	19.5	20.6	2177.4
Anchoa mitchilli juveniles	bay anchovy	103,395	479	7.4	7.1	2527.6	115301.8
Anchoa mitchilli adults	bay anchovy	5,111	271	5.5	11.4	122.9	14371.7
Anchoa cubana juveniles	Cuban anchovy	8	3	2.0	28.8	0.2	78.4
Anchoa cubana adults	Cuban anchovy	1	1	3.0	4.0	0.0	11.9
Notemigonus crysoleucas preflexion larvae	golden shiner	1	1	11.9	0.0	0.0	12.0
Notropis spp. postflexion larvae	minnows	1	1	12.7	0.0	0.0	11.7
Notropis spp. juveniles	minnows	1	1	9.5	0.0	0.0	13.1
Misgurnus anguillicaudatus juveniles	oriental weatherfish	1	1	7.9	0.0	0.0	11.7
Ameiurus catus juveniles	white catfish	38	21	9.5	0.0	0.9	51.2
Ameiurus natalis juveniles	yellow bullhead	17	10	9.4	0.0	0.4	65.3
Ameiurus nebulosus juveniles	brown bullhead	6	2	12.0	0.0	0.1	60.4
Noturus gyrinus juveniles	tadpole madtom	2	2	12.2	0.0	0.0	11.5
Ictalurus punctatus juveniles	channel catfish	21	12	10.3	0.0	0.5	36.9
Liposarcus spp. juveniles	suckermouth catfish	22	18	9.8	0.0	0.5	35.9
loricariid sp. B	suckermouth catfish	1	1	11.9	0.0	0.0	11.5
Hoplosternum littorale flexion larvae	brown hoplo catfish	8	5	6.8	0.0	0.2	24.6
Hoplosternum littorale juveniles	brown hoplo catfish	4	4	9.3	0.0	0.1	12.3
Synodus foetens postflexion larvae	inshore lizardfish	1	1	4.0	21.0	0.0	13.5
Opsanus beta juveniles	gulf toadfish	1	1	1.5	7.0	0.0	11.3
Gobiesox strumosus preflexion larvae	skilletfish	34	15	3.2	19.2	0.8	75.1
Gobiesox strumosus flexion larvae	skilletfish	74	25	4.3	16.8	1.9	131.3
Gobiesox strumosus postflexion larvae	skilletfish	85	27	4.2	17.3	2.1	137.7

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

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Taxon	Common Name	Number Collected	Collection Frequency	*Kmu* (km)	*Su* (psu)	Mean CPUE (No./10^3 m^3)	Max CPUE (No./10^3 m^3)
Gobiesox strumosus juveniles	skilletfish	152	39	4.3	16.8	4.0	292.5
Strongylura spp. postflexion larvae	needlefishes	6	6	11.2	1.1	0.1	13.0
Strongylura spp. juveniles	needlefishes	1	1	8.0	4.0	0.0	11.1
Fundulus spp. postflexion larvae	killifishes	1	1	8.0	12.0	0.0	14.7
Fundulus seminolis postflexion larvae	Seminole killifish	3	3	10.2	2.9	0.1	12.9
Fundulus seminolis juveniles	Seminole killifish	1	1	9.5	15.0	0.0	13.9
Fundulus grandis postflexion larvae	gulf killifish	1	1	9.5	9.0	0.0	11.8
Lucania goodei juveniles	bluefin killifish	1	1	11.9	0.0	0.0	12.4
Lucania parva postflexion larvae	rainwater killifish	2	2	8.7	8.0	0.0	12.5
Lucania parva juveniles	rainwater killifish	2	2	6.3	3.7	0.0	11.3
Lucania parva adults	rainwater killifish	5	5	7.3	6.6	0.1	13.7
Gambusia holbrooki juveniles	eastern mosquitofish	15	9	10.1	0.0	0.3	47.3
Gambusia holbrooki adults	eastern mosquitofish	4	4	8.8	0.0	0.1	13.0
Heterandria formosa juveniles	least killifish	2	2	11.9	0.0	0.0	13.9
Heterandria formosa adults	least killifish	3	3	9.5	0.0	0.1	13.0
Poecilia latipinna juveniles	sailfin molly	5	5	9.4	0.0	0.1	12.4
Menidia spp. eggs	silversides	9	3	5.6	11.4	0.2	51.3
Menidia spp. preflexion larvae	silversides	326	84	10.1	4.9	7.6	1118.0
Menidia spp. flexion larvae	silversides	21	6	9.7	9.8	0.5	100.7
Menidia spp. postflexion larvae	silversides	11	8	9.0	6.0	0.2	25.7
Menidia spp. juveniles	silversides	6	6	8.1	4.4	0.1	13.5
Menidia spp. adults	silversides	1	1	4.0	21.0	0.0	11.0
Menidia beryllina juveniles	inland silverside	5	4	12.0	3.4	0.1	23.7
Membras martinica preflexion larvae	rough silverside	29	11	2.7	17.2	0.7	127.3
Membras martinica flexion larvae	rough silverside	10	3	1.5	25.1	0.2	76.6
Membras martinica postflexion larvae	rough silverside	2	1	0.4	16.0	0.1	28.3
Membras martinica juveniles	rough silverside	64	25	5.9	12.1	1.6	125.9
Labidesthes sicculus preflexion larvae	brook silverside	3	3	11.5	0.0	0.1	12.7
Labidesthes sicculus flexion larvae	brook silverside	1	1	8.0	12.0	0.0	14.7
fish eggs, percomorph	sciaenid eggs (primarily)	3,469	33	0.5	26.9	88.0	31253.5
Hippocampus erectus juveniles	lined seahorse	1	1	0.4	28.0	0.0	14.8
Syngnathus louisianae juveniles	chain pipefish	45	26	4.1	20.1	1.1	79.3
Syngnathus scovelli juveniles	gulf pipefish	21	17	5.9	17.0	0.5	43.9
Syngnathus scovelli adults	gulf pipefish	1	1	8.0	3.0	0.0	12.7
Prionotus spp. flexion larvae	searobins	2	1	0.4	24.0	0.0	24.3
Prionotus spp. postflexion larvae	searobins	1	1	0.4	20.0	0.0	12.0
Prionotus tribulus postflexion larvae	bighead searobin	1	1	1.5	30.0	0.0	13.1
Prionotus tribulus juveniles	bighead searobin	1	1	1.5	13.0	0.0	12.4
Lepomis spp. preflexion larvae	sunfishes	3	2	10.7	0.0	0.1	22.3
Lepomis spp. flexion larvae	sunfishes	5	3	10.7	0.6	0.1	36.6
Lepomis spp. postflexion larvae	sunfishes	3	3	10.8	4.4	0.1	13.5
Lepomis spp. juveniles	sunfishes	18	7	8.2	0.0	0.4	73.7
Lepomis macrochirus postflexion larvae	bluegill	5	4	4.6	2.2	0.1	24.5
Lepomis macrochirus juveniles	bluegill	10	6	10.6	0.0	0.2	34.5
Lepomis auritus flexion larvae	redbreast sunfish	6	5	12.1	1.9	0.1	28.3
Lepomis auritus postflexion larvae	redbreast sunfish	4	2	12.0	3.8	0.1	40.2
Micropterus salmoides postflexion larvae	largemouth bass	2	2	9.8	0.0	0.0	13.3
centrarchid preflexion larvae	sunfishes	1	1	6.4	0.0	0.0	11.9
Chloroscombrus chrysurus preflexion larvae	Atlantic bumper	4	2	0.7	21.3	0.1	42.0
Chloroscombrus chrysurus flexion larvae	Atlantic bumper	14	4	1.5	18.1	0.4	84.0
Chloroscombrus chrysurus postflexion larvae	Atlantic bumper	5	4	1.6	17.9	0.1	27.9
Chloroscombrus chrysurus juveniles	Atlantic bumper	1	1	0.4	20.0	0.0	12.0
Oligoplites saurus preflexion larvae	leatherjack	5	1	0.4	27.0	0.1	69.3
Oligoplites saurus flexion larvae	leatherjack	6	4	2.7	25.3	0.1	26.3
Oligoplites saurus postflexion larvae	leatherjack	4	3	1.7	25.5	0.1	34.2
Oligoplites saurus juveniles	leatherjack	6	3	9.6	8.0	0.1	45.5
gerreid postflexion larvae	mojjaras	2	1	8.0	12.0	0.1	27.2
Diapterus plumieri postflexion larvae	striped mojarra	7	5	6.2	12.6	0.2	28.3
Eucinostomus spp. juveniles	mojarras	1	1	6.4	21.0	0.0	11.1
Eucinostomus harengulus juveniles	tidewater mojarra	1	1	3.0	8.0	0.0	13.0

Plankton-net catch statistics for the tidal Alafia River (April 2000 through December 2003, n=540)

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Orthopristis chrysoptera postflexion larvae	pigfish	1	1	0.4	14.0	0.0	12.6
Archosargus probatocephalus postflexion larva	sheepshead	3	3	9.1	5.9	0.1	12.9
Archosargus probatocephalus juveniles	sheepshead	2	2	4.1	15.6	0.0	11.9
Lagodon rhomboides juveniles	pinfish	28	10	4.0	19.3	0.6	99.5
Bairdiella chrysoura preflexion larvae	silver perch	2	2	1.0	17.1	0.0	13.5
Bairdiella chrysoura flexion larvae	silver perch	14	9	2.7	23.6	0.3	78.4
Bairdiella chrysoura juveniles	silver perch	1	1	0.4	11.0	0.0	11.8
Cynoscion arenarius preflexion larvae	sand seatrout	33	12	1.0	26.1	0.8	109.7
Cynoscion arenarius flexion larvae	sand seatrout	75	25	1.3	22.2	1.9	281.1
Cynoscion arenarius postflexion larvae	sand seatrout	141	20	0.7	17.8	3.4	546.0
Cynoscion arenarius juveniles	sand seatrout	58	29	3.8	12.5	1.4	106.3
Cynoscion nebulosus flexion larvae	spotted seatrout	4	4	4.1	15.7	0.1	18.5
Cynoscion nebulosus postflexion larvae	spotted seatrout	3	2	7.9	10.6	0.1	27.0
Cynoscion nebulosus juveniles	spotted seatrout	2	2	10.9	12.5	0.1	13.7
Leiostomus xanthurus juveniles	spot	3	2	5.5	4.2	0.1	26.7
Menticirrhus spp. preflexion larvae	kingfishes	5	3	0.4	25.8	0.1	34.2
Menticirrhus spp. flexion larvae	kingfishes	14	9	2.3	21.6	0.3	42.0
Menticirrhus spp. postflexion larvae	kingfishes	10	9	1.1	17.6	0.2	23.5
Pogonias cromis preflexion larvae	black drum	1	1	0.4	23.0	0.0	11.3
Pogonias cromis postflexion larvae	black drum	1	1	0.4	23.0	0.0	11.3
Sciaenops ocellatus postflexion larvae	red drum	3	2	1.2	16.7	0.1	27.9
Chaetodipterus faber flexion larvae	Atlantic spadefish	6	2	0.4	13.5	0.1	41.6
Tilapia spp. juveniles	tilapias	1	1	10.0	0.0	0.0	12.2
Mugil cephalus juveniles	striped mullet	1	1	6.4	14.0	0.0	12.3
blenniid preflexion larvae	blennies	62	21	1.9	23.9	1.5	184.4
Chasmodes saburrae flexion larvae	Florida blenny	1	1	1.5	24.0	0.0	12.2
Chasmodes saburrae postflexion larvae	Florida blenny	4	4	1.6	22.8	0.1	15.1
Lupinoblennius nicholsi flexion larvae	highfin blenny	2	2	5.3	18.4	0.0	13.6
Lupinoblennius nicholsi postflexion larvae	highfin blenny	1	1	0.4	24.0	0.0	12.1
gobiid preflexion larvae	gobies	790	143	6.4	14.4	19.0	982.0
gobiid flexion larvae	gobies	570	121	6.3	14.5	13.9	1190.5
gobiid postflexion larvae	gobies	4	2	10.0	12.1	0.1	36.0
Bathygobius soporator preflexion larvae	frillfin goby	27	11	1.3	23.6	0.7	97.4
Bathygobius soporator flexion larvae	frillfin goby	3	1	1.5	26.0	0.1	35.4
Bathygobius soporator postflexion larvae	frillfin goby	2	2	1.0	16.4	0.0	12.4
Gobionellus spp. postflexion larvae	gobies	1	1	0.4	20.0	0.0	12.0
Gobiosoma spp. postflexion larvae	gobies	1,158	103	6.9	11.5	28.5	2472.3
Gobiosoma bosc juveniles	naked goby	19	13	8.5	6.2	0.4	34.1
Gobiosoma bosc adults	naked goby	4	4	8.9	5.0	0.1	12.9
Gobiosoma robustum juveniles	code goby	8	5	8.8	5.2	0.2	26.8
Gobiosoma robustum adults	code goby	1	1	6.4	0.0	0.0	12.2
Microgobius spp. flexion larvae	gobies	130	54	4.5	19.0	3.2	250.9
Microgobius spp. postflexion larvae	gobies	110	34	2.1	23.4	2.8	236.7
Microgobius gulosus juveniles	clown goby	5	5	6.4	10.1	0.1	14.0
Microgobius thalassinus juveniles	green goby	12	8	1.5	16.0	0.3	37.2
Achirus lineatus preflexion larvae	lined sole	1	1	0.4	26.0	0.0	13.0
Achirus lineatus flexion larvae	lined sole	2	1	0.4	26.0	0.0	26.0
Achirus lineatus postflexion larvae	lined sole	3	3	3.8	18.1	0.1	13.7
Achirus lineatus juveniles	lined sole	12	6	2.1	18.7	0.3	34.0
Trinectes maculatus eggs	hogchoker	2	1	0.4	23.0	0.1	27.1
Trinectes maculatus preflexion larvae	hogchoker	26	13	3.8	16.3	0.6	81.4
Trinectes maculatus flexion larvae	hogchoker	45	21	4.8	17.8	1.1	116.3
Trinectes maculatus postflexion larvae	hogchoker	307	86	5.3	12.9	7.5	467.8
Trinectes maculatus juveniles	hogchoker	287	77	9.0	6.4	6.5	565.0
Trinectes maculatus adults	hogchoker	21	12	7.2	12.2	0.6	125.9
Symphurus plagiusa postflexion larvae	blackcheek tonguefish	7	6	1.3	22.6	0.2	27.7
Symphurus plagiusa juveniles	blackcheek tonguefish	7	7	2.8	14.5	0.2	15.5
anuran larvae	tadpoles	26	14	9.8	0.6	0.6	75.2

Table A2, page 1 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
foraminiferans	foraminiferans	1			1								1
Craspedacusta sowberii	hydromedusa						2						
Liriope tetraphylla	hydromedusa				17	1	52	85	17	293	1,257	825	1
Nemopsis sp.	hydromedusa				29	384	1,138	7,152	6,734	418	365	5	5
scyphozoan ephyrae	jellyfish larvae					1							
Chrysaora quinquecirrha	sea nettle					1	17	2	3				
Aurelia aurita	moon jellyfish							2					
Mnemiopsis mccradyi	comb jelly, ctenophore	1	2	14	8,880	6,147	25,878	46	4	1	7	283	186
Beroe ovata	sea walnut, ctenophore				3			1					
turbellarians	flatworms			6			1	16	4	3		1	
nemerteans	ribbon worms			1			2		6				
nematodes	roundworms, threadworms					1	702	3			3		
polychaetes	sand worms, tube worms	2,119	904	2,231	1,402	6,040	2,310	987	8,713	14,320	1,401	1,704	10,624
oligochaetes	freshwater worms	6	104	82	3	10	30	50	53	27	73	51	5
hirudinoideans	leeches	4	4	8	18	14	40	25	38	28	16	24	16
cladocerans, daphniid	water fleas			4	4		28	27	30	27	2	5	
cladocerans, Daphnia spp.	water fleas	8		2,201			2,191	1		5		12,152	
cladoceran, Bosmina sp.	water flea								1				
cladoceran, Scaphroleberis kingi	water flea		1	3									
cladoceran, Simocephalus vetulus	water flea	65	2	49		1	19	18	10	15	1	2	
cladoceran, Ceridodaphnia sp.	water flea						1					1	
cladoceran, Bunops sp.	water flea	2		3									
cladoceran, Ilyocryptus sp.	water flea	2	4	2	1	1		10	9	10	3		
cladoceran, Diaphanosoma brachyurum	water flea			2	34		17	7	2	4	5		
cladoceran, Sida crystallina	water flea			1	4								
cladoceran, Latona setifera	water flea	1		4		1			3	10		1	
cladoceran, Penilia avirostris	water flea		3,245	1,246	15,963	31	2,314					1	1
cladoceran, Alona monacantha	water flea		1										
cladoceran, Euryalona occidentalis	water flea									1			
cladoceran, Kurzia longirostris	water flea			1									
cladoceran, Leydigia sp.	water flea							2	5	2		1	2
cladoceran, Moinadaphnia macleayii	water flea			1									
cladoceran, Evadne tergestina	water flea		411	1	4,988	2	3,602	2		6		3	
leptostracan, Nebalia sp.	nebaliid		1										
stomatopod, Squilla empusa larvae	mantis shrimp		1	3	52	4	5	4	2	4		1	
stomatopod, Squilla empusa juveniles	mantis shrimp						1						
decapod zoeae, unidentified	crab larvae	10,107	15,503	36,049	724,321	282,742	126,118	188,397	146,434	71,499	20,959	57,482	26,132

Table A2, page 2 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
decapod mysis, unidentified	shrimp larvae	167	1,072	1,266	9,610	9,054	16,688	60,321	13,326	4,205	1,422	243	136
decapod megalopae, unidentified	post-zoea crab larvae	366	21	40	282	584	1,229	9,683	1,556	763	1,547	600	447
shrimps, unidentified postlarvae	shrimps		5	1			1	3	1	2		6	
shrimps, unidentified juveniles	shrimps				2	2	1			29			
penaeid postlarvae	penaeid shrimps									1		6	
penaeid metamorphs	penaeid shrimps					2	12	49	59	18	32		1
Farfantepenaeus duorarum juveniles	pink shrimp						4	2	3	18		1	
Rimapenaeus spp. postlarvae	shrimps								1				
Rimapenaeus spp. juveniles	shrimps					2		4	1	4			
Trachypenaeopsis mobilispinus juveniles	shrimps						1						
sicyoniid postlarvae	rock shrimps									2			
Sicyonia laevigata juveniles	rock shrimp										1		
Lucifer faxoni juveniles and adults	shrimp	14	11	69	1,006	67,510	6,252	20,314	805	1,050	710	5,163	982
Leptochela serratorbita postlarvae	combclaw shrimp							8			3		
Leptochela serratorbita juveniles	combclaw shrimp						73		8	83	30	7	1
Palaemonetes spp. postlarvae	grass shrimp	14	90	93	116	249	656	581	285	81	137	60	12
Palaemonetes pugio juveniles	daggerblade grass shrimp	1	6	1		14	67	95	179	166	44	16	6
Palaemonetes pugio adults	daggerblade grass shrimp	1	2		1	3	15	9	21	28		4	2
Periclimenes spp. postlarvae	shrimps	2	2	7	48	40	5	20	1	4	26	20	2
Periclimenes spp. juveniles	shrimps					4		2	4	9	4	7	
Periclimenes spp. adults	shrimps				2	2						1	
alphaeid postlarvae	snapping shrimps		38	11	107	99	303	143	66	20	16	14	
alphaeid juveniles	snapping shrimps					14	4	22	13	59	10	3	
Alpheus viridari juveniles	snapping shrimp						1						
Leptalpheus forceps juveniles	snapping shrimp								2				
Hippolyte zostericola postlarvae	zostera shrimp												5
Hippolyte zostericola juveniles	zostera shrimp						1				2	5	
Hippolyte zostericola adults	zostera shrimp											1	
Latreutes parvulus postlarvae	sargassum shrimp									19			
Latreutes parvulus juveniles	sargassum shrimp									11	6		
Tozeuma carolinense postlarvae	arrow shrimp		1	2	5			7	2		1	4	
Tozeuma carolinense juveniles	arrow shrimp			1				2		8	2	1	
Ogyrides alphaerostris juveniles and adults	estuarine longeye shrimp							2		81			
processid postlarvae	night shrimps					2	4		32				
processid juveniles	night shrimps								1	27	10	4	
Ambidexter symmetricus juveniles	shrimp				10	33	8	8	9	7	3	2	
Ambidexter symmetricus adults	shrimp											3	

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Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
astacidean juveniles	crayfish						1						
callianassid juveniles	ghost shrimps						1	2					
Upogebia spp. postlarvae	mud shrimps			1		9	3,533	123	370	43	5		
Upogebia spp. juveniles	mud shrimps							1	17	4			
Upogebia affinis juveniles	coastal mud shrimp							2		1			
paguroid postlarvae	hermit crabs			1	1							1	
paguroid juveniles	hermit crabs				2	6		3	2		3		
porcellanid (not P. armatus) juveniles	porcelain crabs				1					1	1		
Euceramus praelongus juveniles	olivepit porcelain crab					12	1	2	1	4	5		
Petrolisthes armatus juveniles	porcelain crab				163	2,464	249	962	64	86	37	14	
Callinectes sapidus juveniles	blue crab		1					1	1			2	3
xanthid juveniles	mud crabs	1					3						
xanthid adults	mud crabs										1		
Rhithropanopeus harrisii juveniles	Harris mud crab						1	2			1		
Rhithropanopeus harrisii adults	Harris mud crab						1						
Aratus pisonii juveniles	mangrove tree crab						1						
Aratus pisonii adults	mangrove tree crab	1											
pinnotherid postlarvae	pea crabs			2	10			48	4		179	2	
pinnotherid juveniles	pea crabs				10	18,564	261	7,284	721	7,066	56	4	
Pinnixa sayana juveniles	pea crab				496	1,011	52	548	33	136	165	199	14
Pinnixa sayana adults	pea crab										3		1
Pinnotheres maculatus juveniles	squatter pea crab					1							
Uca spp. juveniles	fiddler crabs											1	
unidentified Americamysis juveniles	opossum shrimps, mysids	552	179	1,241	2,389	2,617	1,729	656	1,049	6,521	1,433	1,716	2,034
Americamysis almyra	opossum shrimp, mysid	944	339	4,578	1,426	2,041	417	29	268	652	4,297	5,506	3,522
Americamysis bahia	opossum shrimp, mysid		68	46	13	54	1	5	17		517	145	13
Americamysis stucki	opossum shrimp, mysid		11	15	12	61	92	72	494	186	109	70	1
Bowmaniella brasiliensis	opossum shrimp, mysid	21	32	2						12	51	18	5
Brasilomysis castroi	opossum shrimp, mysid								3	11	1		
Taphromysis bowmani	opossum shrimp, mysid	2	6	10	30	4	11	9	14	48	4	1	8
cumaceans, unidentified	cumaceans	3,365	6,592	16,438	13,727	69,653	2,996	5,308	2,603	46,926	4,638	13,882	2,372
tanaids, unidentified	tanaids					1	5	8	3	1	7		
Sinelobus stanfordi	tanaid	1			1			5		3		1	5
Hargeria rapax	tanaid	1		10	1	2	1		2	1	2		2
isopod sp. a	isopod											3	
Cyathura polita	isopod			3	9	1	42	10	7	11	10	16	
Munna reynoldsi	isopod		1	6	32	11	17	7	1	6	1	5	8

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Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
epicaridean larvae	isopods		3		4	3						1	
Probopyrus sp. (attached)	isopod						1	1	1	2	1		1
Anopsilana jonesi	isopod	1						4	14	10	11	13	
Olencira praegustator (in mouth)	isopod							1					
cymothoid sp. a (Lironeca) juveniles	isopod	1,113	2,309	2,204	5,590	6,834	7,206	2,588	1,669	701	1,527	1,508	2,668
cymothoid sp. b juveniles	isopod			1	2			2			3	2	4
cymothoid sp. c juveniles	isopod				3								
cymothoid sp. d juveniles	isopod										1		
isopods, unidentified sphaeromatids	isopods		1	3	1	8	11	8	17	3	13	4	1
Cassidinidea ovalis	isopod		4	2	9	18	27	68	28	63	27	44	7
Harrieta faxoni	isopod	4	3	11	7	7	2	1				4	
Sphaeroma quadridentata	isopod		2	12	1			4	4	4		9	2
Sphaeroma terebrans	isopod	1		2	3	14	63	20	8	2	32	45	10
Edotea triloba	isopod	189	399	7,224	18,229	12,210	48,542	3,370	672	662	472	3,234	1,849
Erichsonella attenuata	isopod		1	36	47	99	19	6	4	2	4	5	1
Erichsonella filiforme	isopod				1	4						2	
amphipods, unidentified gammarideans	amphipods	589	1,803	7,233	43,737	9,733	7,104	3,935	2,284	1,466	741	5,238	466
Lestrigonus bengalensis	hyperiid amphipod		2										1
amphipods, caprellid	skeleton shrimps		34	12	909	1,875	5,563	3	1	1		2	2
cirriped nauplius stage	barnacles		185		1,758	265	16		1		8	50	
cirriped cypris stage	barnacles	2	130	54		13		7	14	50	42		4
branchiurans, Argulus spp.	fish lice	5	1	4	53	104	54	19	12	22	13	10	12
unidentified calanoids	copepods	2,317	13,597	16,503	29,526	54,208	16,757	25,423	3,667	4,598	5,499	5,075	6,705
paracalanids	copepods		1			5	9			2		2	1
Acartia tonsa	copepod	4,081	793	4,776	886	6,474	1,867		271	869	1,369	4,946	1,770
Calanopia americana	copepod										1	11	10
Centropages hamatus	copepod			4					2	1			2
Centropages velificatus	copepod						58		4	11	331	1,110	1
Diaptomus spp.	copepods	1	2	10	3		9	85		2	1	130	1
Eucalanus sp.	copepod												2
Eurytemora affinis	copepod	1	4	10	1	1							1
Labidocera aestiva	copepod	21	14	1,456	138	9,673	6,754	9,865	1,563	4,072	5,993	4,738	177
Pseudodiaptomus coronatus	copepod	61	274	138	10	32	18	114	135	14	34	35	159
Tortanus setacaudatus	copepod												1
Temora turbinata	copepod						7						
unidentified freshwater cyclopoids	copepods	4	12	6	4		25	29	270	141	42	13	
Cyclops spp.	copepods	12	6		2	12	2		4	4	5		

Table A2, page 5 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

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Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Oithona spp.	copepods		2			6	15	2		6		9	1
Saphirella spp.	copepods	8	3	7		3	1		1	1	2		4
Halicyclops sp.	copepod							1					
Macrocyclops albidus	copepods		1	1				1	1		1	1	
Mesocyclops edax	copepod	43	15	310	69		194	3,770	5,881	352	36	374	10
Mesocyclops leuckarti	copepod							1					
Orthocyclops modestus	copepod	34	6	15	1		1	1	2	2	3		1
Osphranticum labronectum	copepod	3		1			1						
harpacticoids	copepods	5	10		1	878	18	5	11	6		23	16
Monstrilla sp.	copepod		3	2	2	7	2					1	2
Ergasilus sp.	copepod		1										
siphonostomatids	parasitic copepods	14	42	23	82	120	83	39	9	6	35	47	102
ostracods, unidentified	ostracods, seed shrimps	1	5	4	3	116	301	360	310	508	14	2	1
Euconchoecia chierchiae	ostracod, seed shrimp		3										
Eusarsiella zostericola	ostracod, seed shrimp		5		1		12	4	1	1		1	
Parasterope pollex	ostracod, seed shrimp	216	2,521	902	553	2,589	1,130	1,533	565	1,583	2,059	754	19
ostracods, podocopid	ostracods, seed shrimps	20	46	22	14	20	32	37	214	60	58	47	29
collembolas, podurid	springtails	8	6	4			1	3	4	1	1		6
ephemeropterans	mayflies	14	10	63	7	13	33	509	665	761	551	86	32
ephemeropterans, potamanthid	mayflies										3		
odonates, anisopteran larvae	dragonflies						4	3	8	5	2	1	
odonates, zygopteran larvae	damselflies		1	1	2	3	2	8	7	9	2	1	2
hemipterans, belostomatid adults	giant water bugs							2		2			
hemipterans, corixid juveniles	water boatmen						1	3	4	6	1	1	
hemipterans, corixid adults	water boatmen			1	1	1	3	1		1		1	1
hemipterans, gerrid adults	water striders		2	11	13	564	227	219	252	68	111		13
hemipterans, naucorid adults	creeoing water bugs						1	1					
hemipterans, nepid adults	water scorpions										1		
hemipterans, pleid adults	pygmy backswimmers	1								5			6
megalopterans, corydalid larvae	fishflies									1	1		
neuropterans, Climacia spp, larvae	spongillaflies		1				2	3	2	7	2	1	
coleopterans, chrysomelid larvae	beetles						429						
coleopterans, curculionid adults	beetles			5	3	1	9	12	16	8	9	4	2
coleopterans, dytiscid larvae	predaceous diving beetles		1	1		1	10	28	1	4	1		
coleopterans, noterid adults	burrowing water beetles		3	4	1		18	3	13	88	14	3	4
coleopterans, dryopid larvae	long-toed water beetles									3			
coleopterans, elmid larvae	riffle beetles	2	4	7	8	25	46	15	49	14	8	2	

Table A2, page 6 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
coleopterans, elmid adults	riffle beetles	2	4	3	4	5	35	67	21	24	25	15	2
coleopterans, gyrinid larvae	whirligig beetles	2	1			2	26	25	22	26	4		
coleopterans, gyrinid adults	whirligig beetles						3			1			
coleopterans, haliplid larvae	crawling water beetles									1			
coleopterans, haliplid adults	crawling water beetles							1		3			
coleopterans, dytiscid adults	predaceous diving beetles						2	2		7	2		
coleopterans, scirtid larvae	marsh beetles			1			1	3	5	13	1		
coleopterans, scirtid adults	marsh beetles							1			1		
dipterans, pupae	flies, mosquitoes	26	265	150	279	441	676	612	433	618	254	60	34
dipterans, ceratopogonid larvae	biting midges	1	1	4	8	4	4	20	37	2	3	2	
dipteran, Chaoborus punctipennis larvae	phantom midge	6	2	101	65	1	425	1,341	891	1,838	217	3,965	33
dipterans, chironomid larvae	midges	73	383	685	312	160	267	582	485	220	228	278	271
dipterans, muscid larvae	muscid flies						44						
dipterans, simuliid larvae	black flies			10			1	4	2	3	1		1
dipterans, stratiomyid larvae	soldier flies								1				
dipterans, sciomyzid larvae	marsh flies									1			3
dipterans, tabanid larvae	deer flies						1	2	3			1	1
dipterans, tipulid larvae	crane flies									1			
trichopteran larvae	caddisflies	12	11	23	6	27	103	168	93	281	150	37	12
lepidopterans, pyralid larvae	aquatic caterpillars			1	1			3	5	2	2	1	1
pycnogonids	sea spiders									1			
Limulus polyphemus larvae	horsehoe crab	1	18	30	93	22	48	20		1		8	3
acari	water mites	18	42	97	61	5	40	46	18	56	56	31	8
gastropods, prosobranch	snails	125	406	308	96	141	1,123	1,420	360	448	333	198	57
gastropods, opisthobranch	sea slugs	5	2			4	2	1				4	
pelecypods	clams, mussels, oysters	165	287	23	206	756	1,883	1,665	2,113	78	667	222	195
ophiuroidean juveniles	brittlestars		1	2		3	3			1			
Lolliguncula brevis juveniles	bay squid	4	1	1	8	12	7		2	2	3	9	2
brachiopod, Glottidia pyramidata larvae	lamp shell				8	23,334	2,874	138	688	12	264	107	
chaetognaths, sagittid	arrow worms	582	408	720	3,359	33,067	24,602	70,647	120,806	4,711	5,811	16,405	1,392
appendicularian, Oikopleura dioica	larvacean		461	833	1,438	6,236	3,666	1,499	2	12	9,720	31	6,308
Branchiostoma floridae	lancelet							1		5		1	
Lepisosteus platyrhincus postflexion larvae	Florida gar				1								
Elops saurus postflexion larvae	ladyfish			15	10								
Myrophis punctatus juveniles	speckled worm eel	1											
Brevoortia spp. postflexion larvae	menhaden	1	105	2,556	115	8							
Brevoortia spp. metamorphs	menhaden		2	79	693	233		1					

Table A2, page 7 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Brevoortia patronus juveniles	gulf menhaden				2	10		7	1				
Brevoortia smithi juveniles	yellowfin menhaden			9	34	66	12	919					
Brevoortia smithi adults	yellowfin menhaden							2					
Dorosoma spp. preflexion larvae	shads			1	14								
Dorosoma spp. postflexion larvae	shads			1				1					
Dorosoma petenense juveniles	threadfin shad						1						
Harengula jaguana juveniles	scaled sardine	1											
Anchoa spp. preflexion larvae	anchovies		27	785	3,403	760	2,034	1,010	151	16	9		
Anchoa spp. flexion larvae	anchovies			81	454	459	884	774	255	36	27	1	
Anchoa hepsetus eggs	striped anchovy				6								
Anchoa hepsetus postflexion larvae	striped anchovy				8	1	57	3	14				
Anchoa hepsetus juveniles	striped anchovy				91	26	1	5		1			
Anchoa hepsetus adults	striped anchovy					2							
Anchoa mitchilli eggs	bay anchovy		1,272	9,408	301	3				43	1		
Anchoa mitchilli postflexion larvae	bay anchovy			691	190	385	271	336	175	33	19	7	
Anchoa mitchilli juveniles	bay anchovy	24,251	3,939	3,735	4,984	13,380	6,427	11,130	6,234	7,204	11,926	18,886	26,997
Anchoa mitchilli adults	bay anchovy	1,748	423	356	808	870	308	190	1,737	458	195	626	566
Anchoa cubana juveniles	Cuban anchovy					8							
Anchoa cubana adults	Cuban anchovy					1							
Notemigonus crysoleucas preflexion larvae	golden shiner								1				
Notropis spp. flexion larvae	minnows									1			
Notropis spp. postflexion larvae	minnows							1					
Notropis spp. juveniles	minnows										1		
Notropis maculatus juveniles	taillight shiner											2	
Misgurnus anguillicaudatus juveniles	oriental weatherfish							1					
Ameiurus catus juveniles	white catfish			1			3	3	32	4	1		
Ameiurus natalis juveniles	yellow bullhead						4	13	1				
Ameiurus nebulosus juveniles	brown bullhead							5	1				
Noturus gyrinus juveniles	tadpole madtom						1		1				
Ictalurus punctatus juveniles	channel catfish						12	2	5		2		
loricariid juveniles	suckermouth catfishes									1			
Liposarcus spp. juveniles	suckermouth catfish						8	4	13	2			
loricariid sp. B	suckermouth catfish					1							
Hoplosternum littorale flexion larvae	brown hoplo catfish						8						
Hoplosternum littorale juveniles	brown hoplo catfish						3	1					
Synodus foetens postflexion larvae	inshore lizardfish			1									
Opsanus beta juveniles	gulf toadfish					1							

Table A2, page 8 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Gobiesox strumosus preflexion larvae	skilletfish		9	6	17	2							1
Gobiesox strumosus flexion larvae	skilletfish			6	41	20	15						
Gobiesox strumosus postflexion larvae	skilletfish				69	19	12						1
Gobiesox strumosus juveniles	skilletfish			5	103	29	23					1	
Strongylura spp. postflexion larvae	needlefishes						1	4	1	2			
Strongylura spp. juveniles	needlefishes			1									
Fundulus spp. postflexion larvae	killifishes							1			1		
Fundulus seminolis postflexion larvae	Seminole killifish				2		1						
Fundulus seminolis juveniles	Seminole killifish						1						
Fundulus grandis postflexion larvae	gulf killifish						1						
Lucania goodei juveniles	bluefin killifish									1			
Lucania parva postflexion larvae	rainwater killifish				1		1						
Lucania parva juveniles	rainwater killifish					1		1		2			
Lucania parva adults	rainwater killifish						1	6	1				
Gambusia holbrooki juveniles	eastern mosquitofish		1				1	8	7	2	1		
Gambusia holbrooki adults	eastern mosquitofish							3	1	1			
Heterandria formosa juveniles	least killifish							1		1			
Heterandria formosa adults	least killifish			1			1	3	2				
Poecilia latipinna juveniles	sailfin molly								2	3			
Menidia spp. eggs	silversides		5		4								
Menidia spp. preflexion larvae	silversides	2	77	26	133	31	32	19	8	9	4	1	3
Menidia spp. flexion larvae	silversides			8	13			4					
Menidia spp. postflexion larvae	silversides			4	1	2	7			3			
Menidia spp. juveniles	silversides			2	1	2			1				
Menidia spp. adults	silversides					1							
Menidia beryllina juveniles	inland silverside	1		1	1	10	24	8			1		
Menidia beryllina adults	inland silverside							4					
Membras martinica preflexion larvae	rough silverside		1	18			1	10					
Membras martinica flexion larvae	rough silverside			10	1		1						
Membras martinica postflexion larvae	rough silverside							2					
Membras martinica juveniles	rough silverside				5	19	24	16	2				
Labidesthes sicculus preflexion larvae	brook silverside			3									
Labidesthes sicculus flexion larvae	brook silverside							1					
fish eggs, percomorph	sciaenid eggs (primarily)		45	147	937	186	4,427	107	1	1	6	32	1
Hippocampus erectus juveniles	lined seahorse				1								
Syngnathus louisianae juveniles	chain pipefish			4	6	19	3	1	2	1	2	8	4
Syngnathus scovelli juveniles	gulf pipefish	1	1	2	1	9	2	4		1		2	

Table A2, page 9 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Syngnathus scovelli adults	gulf pipefish				1								
Prionotus spp. preflexion larvae	searobins							2					
Prionotus spp. flexion larvae	searobins				2							2	
Prionotus spp. postflexion larvae	searobins							1				1	
Prionotus tribulus postflexion larvae	bighead searobin					1							
Prionotus tribulus juveniles	bighead searobin											1	
Lepomis spp. preflexion larvae	sunfishes						2	3					
Lepomis spp. flexion larvae	sunfishes					1			5				
Lepomis spp. postflexion larvae	sunfishes						3						
Lepomis spp. juveniles	sunfishes						18						
Lepomis macrochirus postflexion larvae	bluegill						4	1					
Lepomis macrochirus juveniles	bluegill						8	2	1				
Lepomis auritus flexion larvae	redbreast sunfish		1		2		1	2					
Lepomis auritus postflexion larvae	redbreast sunfish						4				1		
Micropterus salmoides flexion larvae	largemouth bass					2							
Micropterus salmoides postflexion larvae	largemouth bass					3							
centrarchid preflexion larvae	sunfishes						1						
Chloroscombrus chrysurus preflexion larvae	Atlantic bumper						1			4			
Chloroscombrus chrysurus flexion larvae	Atlantic bumper								1	12	1		
Chloroscombrus chrysurus postflexion larvae	Atlantic bumper							5	1	2	2		
Chloroscombrus chrysurus juveniles	Atlantic bumper							1	1			1	
Oligoplites saurus preflexion larvae	leatherjack						6	1					
Oligoplites saurus flexion larvae	leatherjack				1	1	4	2					
Oligoplites saurus postflexion larvae	leatherjack					1	4						
Oligoplites saurus juveniles	leatherjack						6	3			1		
gerreid postflexion larvae	mojjaras						8						
Diapterus plumieri postflexion larvae	striped mojarra					6		1					
Eucinostomus spp. postflexion larvae	mojarras									1			
Eucinostomus spp. juveniles	mojarras												1
Eucinostomus harengulus juveniles	tidewater mojarra											1	
Orthopristis chrysoptera postflexion larvae	pigfish	1											
Archosargus probatocephalus postflexion larvae	sheepshead				3								
Archosargus probatocephalus juveniles	sheepshead			2									
Lagodon rhomboides postflexion larvae	pinfish						1						
Lagodon rhomboides juveniles	pinfish	14	9	4	1								
Bairdiella chrysoura preflexion larvae	silver perch			1	1		5		1				
Bairdiella chrysoura flexion larvae	silver perch			1	5	10	27		2			1	

Table A2, page 10 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Bairdiella chrysoura postflexion larvae	silver perch		1		2		2	2					
Bairdiella chrysoura juveniles	silver perch					1	3						
Cynoscion arenarius preflexion larvae	sand seatrout	1	1		9	18	44	10	4	2			
Cynoscion arenarius flexion larvae	sand seatrout			3	8	11	98	15	7	16	1		
Cynoscion arenarius postflexion larvae	sand seatrout			5	14	15	66	82	25	91	2		
Cynoscion arenarius juveniles	sand seatrout			4	23	11	14	12	12	27	2	1	
Cynoscion nebulosus preflexion larvae	spotted seatrout						2						
Cynoscion nebulosus flexion larvae	spotted seatrout			1		2	11		1		1		
Cynoscion nebulosus postflexion larvae	spotted seatrout					1	5	4	1				
Cynoscion nebulosus juveniles	spotted seatrout						2						
Leiostomus xanthurus juveniles	spot		3										
Menticirrhus spp. preflexion larvae	kingfishes				1		2	1	2	1			
Menticirrhus spp. flexion larvae	kingfishes				1	3	12	2	5	5	1		
Menticirrhus spp. postflexion larvae	kingfishes				1		7	9	6	6	2		
Menticirrhus americanus juveniles	southern kingfish								1	2			
Pogonias cromis preflexion larvae	black drum												1
Pogonias cromis postflexion larvae	black drum												1
Sciaenops ocellatus postflexion larvae	red drum									3			
Chaetodipterus faber flexion larvae	Atlantic spadefish				3	3							
Tilapia spp. juveniles	tilapias			1					1				
Mugil cephalus juveniles	striped mullet	1											
blenniid preflexion larvae	blennies	1	1	26	20	9	4	9	1	1	6	4	5
Chasmodes saburrae flexion larvae	Florida blenny			1									
Chasmodes saburrae postflexion larvae	Florida blenny			1	2	2	1	4					
Hypsoblennius spp. postflexion larvae	blennies					1							
Hypsoblennius spp. juveniles	blennies							1					
Lupinoblennius nicholsi flexion larvae	highfin blenny		2		1								
Lupinoblennius nicholsi postflexion larvae	highfin blenny											1	
gobiid preflexion larvae	gobies		16	137	348	169	32	48	42	17	28	25	4
gobiid flexion larvae	gobies	1	6	172	104	111	28	44	29	8	10	86	23
gobiid postflexion larvae	gobies				2	2							
Bathygobius soporator preflexion larvae	frillfin goby			2	17	18	5		1		2		
Bathygobius soporator flexion larvae	frillfin goby					3							
Bathygobius soporator postflexion larvae	frillfin goby							1				2	
Gobionellus spp. postflexion larvae	gobies											1	
Gobionellus boleosoma flexion larvae	darter goby				1			1				1	
Gobionellus boleosoma postflexion larvae	darter goby							1				1	

Table A2, page 11 of 11.

Plankton-net catch by month (June 1998 to October 1999 and April 2000 to December 2003).

Number of monthly samples is indicated in parentheses.

Taxon	Common Name	Jan (48)	Feb (48)	Mar (48)	Apr (60)	May (60)	Jun (72)	Jul (72)	Aug (72)	Sep (72)	Oct (72)	Nov (60)	Dec (60)
Gobiosoma spp. postflexion larvae	gobies	2	9	42	426	183	249	33	6	8	14	226	56
Gobiosoma bosc juveniles	naked goby					7	8	3	1	2			
Gobiosoma bosc adults	naked goby					1			2	1			
Gobiosoma robustum juveniles	code goby					4	2	2	1				
Gobiosoma robustum adults	code goby								1				
Microgobius spp. flexion larvae	gobies		1	12	24	54	21	24	19	9	5	2	
Microgobius spp. postflexion larvae	gobies			2	5	60	63	19	17	40	16	4	
Microgobius gulosus juveniles	clown goby				3				2	1		1	
Microgobius thalassinus juveniles	green goby							2		38	5	2	1
Dormitator maculatus juveniles	fat sleeper						1	1					
Microdesmus longipinnis preflexion larvae	pink wormfish				2								
Achirus lineatus preflexion larvae	lined sole				1		3						
Achirus lineatus flexion larvae	lined sole				2	1	2						
Achirus lineatus postflexion larvae	lined sole					1	6	2	1				
Achirus lineatus juveniles	lined sole					3	5		4	1	3	2	
Trinectes maculatus eggs	hogchoker										2		
Trinectes maculatus preflexion larvae	hogchoker				4	6	17	15	3	2	1	1	
Trinectes maculatus flexion larvae	hogchoker				3	15	23	18	3	6	4		
Trinectes maculatus postflexion larvae	hogchoker				27	88	148	72	24	40	12	4	
Trinectes maculatus juveniles	hogchoker	3	4	7	1	11	91	44	47	118	13	16	1
Trinectes maculatus adults	hogchoker					2	11	1	3	1	3	1	
Symphurus plagiusa postflexion larvae	blackcheek tonguefish						3		2		3		
Symphurus plagiusa juveniles	blackcheek tonguefish						5	5	4	1	1		
anuran larvae	tadpoles						6	9	4	23			

Table A3, page 1 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
foraminiferans	foraminiferans	0.00	0.26	0.29	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Craspedacusta sowberii	hydromedusa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00
Liriope tetraphylla	hydromedusa	409.09	120.41	182.28	8.78	3.05	0.00	1.67	0.27	0.54	1.64	0.29	0.00
Nemopsis sp.	hydromedusa	1145.54	351.48	190.71	71.62	3.38	30.43	56.81	29.20	1.16	4.51	0.28	0.54
scyphozoan ephyrae	jellyfish larvae	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chrysaora quinquecirrha	sea nettle	0.59	0.00	4.97	0.00	1.73	0.00	0.92	0.00	0.00	0.26	0.00	0.00
Mnemiopsis mccradyi	comb jelly, ctenophore	506.10	413.56	3375.30	3197.62	2281.20	2519.08	933.07	442.17	95.10	12.20	0.00	0.00
Beroe ovata	sea walnut, ctenophore	0.62	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
turbellarians	flatworms	0.00	0.00	1.33	0.00	0.27	0.24	0.00	0.00	0.00	0.00	0.00	0.00
nemerteans	ribbon worms	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
nematodes	roundworms, threadworms	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.24	0.00	0.00	0.00
polychaetes	sand worms, tube worms	6133.49	150.95	86.95	140.47	8698.94	2320.51	930.03	615.41	124.55	110.42	71.12	58.60
oligochaetes	freshwater worms	0.00	0.49	1.14	1.97	4.11	20.81	7.83	14.21	11.22	13.39	11.22	19.88
hirudinoideans	leeches	0.00	2.36	3.04	3.75	5.76	5.47	4.13	6.74	4.48	5.54	2.47	4.17
cladocerans, Daphnia spp.	water fleas	6.56	18.50	37.64	95.76	291.97	250.75	939.70	824.07	500.60	376.18	555.86	642.11
cladoceran, Bosmina sp.	water flea	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
cladoceran, Scaphroleberis kingi	water flea	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.27	0.00	0.55
cladoceran, Simocephalus vetulus	water flea	0.52	0.00	0.25	0.78	4.04	4.34	4.33	3.87	4.59	5.37	11.78	9.50
cladoceran, Ceridodaphnia sp.	water flea	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00
cladoceran, Bunops sp.	water flea	0.00	0.00	0.00	0.00	0.27	0.27	0.00	0.30	0.00	0.60	0.00	0.00
cladoceran, Ilyocryptus sp.	water flea	0.00	0.00	0.00	0.00	0.00	0.26	1.07	2.73	0.80	2.83	1.04	0.28
cladoceran, Diaphanosoma brachyurum	water flea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.27	1.44
cladoceran, Sida crystallina	water flea	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.57	0.29	0.28	0.00
cladoceran, Latona setifera	water flea	0.00	0.00	0.00	0.00	2.98	1.08	0.28	0.52	0.00	0.00	0.53	0.28
cladoceran, Penilia avirostris	water flea	301.58	5.14	0.27	1.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cladoceran, Alona monacantha	water flea	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00
cladoceran, Euryalona occidentalis	water flea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28
cladoceran, Kurzia longirostris	water flea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
cladoceran, Leydigia sp.	water flea	0.00	0.00	0.00	0.00	0.00	0.25	0.53	0.80	0.27	0.29	0.00	0.53
cladoceran, Moinadaphnia macleayii	water flea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00
cladoceran, Evadne tergestina	water flea	16.59	0.58	0.27	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
leptostracan, Nebalia sp.	nebaliid	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
stomatopod, Squilla empusa larvae	mantis shrimp	4.42	4.24	9.62	1.08	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.00
stomatopod, Squilla empusa juveniles	mantis shrimp	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
decapod zoeae, unidentified	crab larvae	215129.25	32052.10	19531.21	10269.08	1891.10	1973.43	4865.22	6977.79	12846.63	7493.20	12324.00	10731.61
decapod mysis, unidentified	shrimp larvae	723.56	2874.03	1094.29	473.15	1709.89	1569.92	641.11	1033.04	519.06	297.38	49.55	8.80
decapod megalopae, unidentified	post-zoea crab larvae	811.36	474.99	180.52	93.29	5.39	9.54	56.05	41.09	81.62	68.33	27.91	59.12
shrimps, unidentified postlarvae	shrimps	1.66	1.76	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
shrimps, unidentified juveniles	shrimps	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
penaeid metamorphs	penaeid shrimps	5.01	3.16	2.09	3.64	1.52	1.65	0.00	0.00	0.00	0.00	0.00	0.00
Farfantepenaeus duorarum juveniles	pink shrimp	0.00	0.56	0.55	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.30
Rimapenaeus spp. postlarvae	shrimps	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A3, page 2 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Rimapenaeus spp. juveniles	shrimps	1.72	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trachypenaeopsis mobilispinus juveniles	shrimps	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sicyonia laevigata juveniles	rock shrimp	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lucifer faxoni juveniles and adults	shrimp	4412.15	909.12	413.83	112.85	6.84	10.80	4.28	0.53	2.59	4.17	0.29	0.00
Leptochela serratorbita postlarvae	combclaw shrimp	2.48	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptochela serratorbita juveniles	combclaw shrimp	37.63	8.61	0.81	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palaemonetes spp. postlarvae	grass shrimp	161.70	42.28	23.55	31.82	21.05	26.82	32.35	36.25	22.29	40.43	7.93	7.43
Palaemonetes pugio juveniles	daggerblade grass shrimp	6.60	3.74	1.59	2.42	7.64	15.79	10.02	17.40	7.26	5.13	1.73	5.07
Palaemonetes pugio adults	daggerblade grass shrimp	0.27	0.58	0.76	1.37	1.41	1.07	1.89	1.62	1.80	3.04	0.27	0.00
Periclimenes spp. postlarvae	shrimps	30.14	2.39	0.00	0.25	0.62	1.58	0.00	0.00	0.00	0.00	0.00	0.00
Periclimenes spp. juveniles	shrimps	4.29	1.63	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Periclimenes spp. adults	shrimps	1.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
alphaeid postlarvae	snapping shrimps	173.18	35.02	4.73	2.47	0.86	0.00	0.65	0.00	0.00	0.00	0.00	0.00
alphaeid juveniles	snapping shrimps	3.52	1.41	1.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alpheus viridari juveniles	snapping shrimp	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leptalpheus forceps juveniles	snapping shrimp	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hippolyte zostericola postlarvae	zostera shrimp	0.50	0.51	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hippolyte zostericola juveniles	zostera shrimp	1.63	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hippolyte zostericola adults	zostera shrimp	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Latreutes parvulus postlarvae	sargassum shrimp	5.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Latreutes parvulus juveniles	sargassum shrimp	1.23	2.52	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tozeuma carolinense postlarvae	arrow shrimp	2.92	0.54	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tozeuma carolinense juveniles	arrow shrimp	1.82	0.62	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ogyrides alphaerostris juveniles and adults	estuarine longeye shrimp	2.80	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
processid postlarvae	night shrimps	6.88	3.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
processid juveniles	night shrimps	9.52	2.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ambidexter symmetricus juveniles	shrimp	17.29	5.31	0.00	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ambidexter symmetricus adults	shrimp	0.00	0.00	0.00	0.00	0.00	0.88	0.00	0.00	0.00	0.00	0.00	0.00
astacidean juveniles	crayfish	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
callianassid juveniles	ghost shrimps	0.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upogebia spp. postlarvae	mud shrimps	1168.28	31.29	7.20	6.41	0.25	0.28	0.75	0.00	0.00	0.00	0.00	0.00
Upogebia spp. juveniles	mud shrimps	4.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Upogebia affinis juveniles	coastal mud shrimp	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
paguroid postlarvae	hermit crabs	0.23	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
paguroid juveniles	hermit crabs	2.62	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
porcellanid (not P. armatus) juveniles	porcelain crabs	0.31	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00
Euceramus praelongus juveniles	olivepit porcelain crab	3.02	4.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petrolisthes armatus juveniles	porcelain crab	412.98	68.53	11.37	2.47	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00
Callinectes sapidus juveniles	blue crab	0.00	0.31	0.30	0.53	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
xanthid juveniles	mud crabs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00
Rhithropanopeus harrisii juveniles	Harris mud crab	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.31	0.29	0.00	0.00
Rhithropanopeus harrisii adults	Harris mud crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00

Table A3, page 3 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Aratus pisonii juveniles	mangrove tree crab	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00
Aratus pisonii adults	mangrove tree crab	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pinnotherid juveniles	pea crabs	157.60	157.87	58.34	20.64	64.58	29.02	3.81	3.28	0.21	0.23	0.24	0.00
Pinnixa sayana juveniles	pea crab	523.09	208.04	22.46	22.55	0.27	0.27	0.00	0.53	0.00	0.00	0.00	0.00
Pinnixa sayana adults	pea crab	0.30	0.59	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uca spp. juveniles	fiddler crabs	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
unidentified Americamysis juveniles	opossum shrimps, mysids	1429.63	271.32	178.15	120.52	177.02	215.69	62.03	83.28	100.91	133.14	60.48	121.23
Americamysis almyra	opossum shrimp, mysid	761.77	822.28	625.12	444.49	545.63	473.22	334.49	321.21	628.73	543.15	659.78	483.99
Americamysis bahia	opossum shrimp, mysid	4.10	10.93	192.03	14.37	14.97	4.12	0.81	3.72	15.51	0.23	0.00	0.00
Americamysis stucki	opossum shrimp, mysid	283.34	28.32	4.25	2.45	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00
Bowmaniella brasiliensis	opossum shrimp, mysid	19.66	10.33	4.90	1.06	2.18	0.51	0.00	0.00	0.27	0.00	0.00	0.00
Brasilomysis castroi	opossum shrimp, mysid	4.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taphromysis bowmani	opossum shrimp, mysid	0.83	0.24	0.00	0.00	0.00	0.00	0.79	1.34	17.93	9.92	5.91	2.81
cumaceans, unidentified	cumaceans	7939.29	6850.37	6883.72	2994.63	336.63	63.62	28.80	104.78	45.19	69.86	8.22	2.53
Sinelobus stanfordi	tanaid	0.00	0.00	0.52	0.29	0.74	0.57	0.00	0.26	1.10	0.84	0.00	0.00
Hargeria rapax	tanaid	0.00	2.69	0.26	0.00	0.00	0.00	0.55	0.26	0.98	0.29	0.82	0.27
isopod sp. a	isopod	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.27	0.00	0.00	0.00	0.00
Cyathura polita	isopod	0.00	0.00	0.56	1.63	2.44	8.78	1.63	6.49	4.38	1.96	0.00	0.00
Munna reynoldsi	isopod	4.14	10.56	1.77	2.31	0.51	0.24	0.00	0.79	0.52	3.28	0.60	1.47
epicaridean larvae	isopods	0.00	1.24	0.28	0.00	0.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00
Probopyrus sp. (attached)	isopod	0.00	0.00	0.00	0.40	0.30	0.00	0.00	0.00	0.27	0.25	0.00	0.00
Anopsilana jonesi	isopod	0.00	0.00	0.00	0.00	0.00	1.12	0.00	0.27	4.40	3.62	4.80	0.00
Olencira praegustator (in mouth)	isopod	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
cymothoid sp. a (Lironeca) juveniles	isopod	356.35	440.07	431.21	443.14	878.36	638.38	618.82	488.18	541.68	682.51	559.31	428.19
cymothoid sp. b juveniles	isopod	2.77	0.84	0.25	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
cymothoid sp. c juveniles	isopod	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00
cymothoid sp. d juveniles	isopod	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
isopods, unidentified sphaeromatids	isopods	0.00	0.26	0.28	0.40	0.00	0.00	0.57	2.13	1.03	0.51	0.30	0.00
Cassidinidea ovalis	isopod	0.71	0.86	2.95	4.88	9.14	7.31	6.20	6.92	12.68	8.63	10.78	9.46
Harrieta faxoni	isopod	6.56	2.03	1.10	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sphaeroma quadridentata	isopod	3.66	3.67	1.07	1.36	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00
Sphaeroma terebrans	isopod	0.00	0.30	0.53	2.28	1.64	3.66	5.69	7.61	8.69	11.32	11.27	1.47
Edotea triloba	isopod	155.01	364.62	1490.23	1680.19	7036.80	5716.60	2651.23	2676.44	1738.43	2153.72	492.59	149.88
Erichsonella attenuata	isopod	17.54	11.40	5.46	6.98	1.80	2.45	1.10	0.33	0.38	0.00	0.00	0.00
Erichsonella filiforme	isopod	0.56	0.00	0.53	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
amphipods, unidentified gammarideans	amphipods	1409.09	2997.80	1178.40	2012.82	9239.04	3460.50	223.95	354.45	316.01	421.11	292.62	169.41
Lestrigonus bengalensis	hyperiid amphipod	0.45	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
amphipods, caprellid	skeleton shrimps	3.67	96.49	1123.52	1115.90	3.97	1.68	0.58	0.59	0.00	0.27	0.00	0.30
cirriped nauplius stage	barnacles	384.01	5.95	3.33	0.29	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00
cirriped cypris stage	barnacles	1.80	3.54	3.37	17.95	1.65	2.22	0.25	2.02	0.80	0.81	0.00	0.00
branchiurans, Argulus spp.	fish lice	0.00	2.42	1.02	0.87	3.69	3.44	6.78	7.76	9.48	13.91	11.67	14.48
unidentified calanoids	copepods	11021.76	381.27	45.53	14.64	2.32	0.29	0.92	1.29	0.00	0.29	0.58	0.00

Table A3, page 4 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
paracalanids	copepods	3.94	1.57	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acartia tonsa	copepod	6063.23	1787.25	57.80	35.50	2.52	4.23	2.25	9.19	0.49	0.00	4.34	0.00
Calanopia americana	copepod	3.19	1.61	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Centropages hamatus	copepod	0.83	1.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Centropages velificatus	copepod	347.86	35.18	33.63	1.86	3.15	2.39	0.27	1.09	0.00	0.33	0.00	0.28
Diaptomus spp.	copepods	0.00	0.00	0.00	0.52	1.89	0.53	7.00	2.38	7.14	10.16	6.55	31.99
Eucalanus sp.	copepod	0.25	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eurytemora affinis	copepod	0.00	0.00	0.00	0.00	0.25	0.00	0.30	0.88	0.00	0.54	0.50	2.39
Labidocera aestiva	copepod	10991.85	2175.40	215.95	47.12	4.39	2.66	3.01	0.00	0.52	0.00	0.00	0.00
Pseudodiaptomus coronatus	copepod	53.65	91.64	76.87	32.32	5.78	4.99	1.61	3.22	1.27	1.72	1.07	0.62
Tortanus setacaudatus	copepod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27
Temora turbinata	copepod	2.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cyclops spp.	copepods	0.00	0.00	0.51	0.00	0.79	0.26	0.00	3.44	0.73	1.67	3.35	2.00
Oithona spp.	copepods	6.78	1.87	0.61	0.53	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00
Saphirella spp.	copepods	3.96	1.23	1.86	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Halicyclops sp.	copepod	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00
Macrocyclops albidus	copepods	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.29	0.00	0.23	0.58	0.26
Mesocyclops edax	copepod	0.26	1.71	6.31	2.62	24.13	22.04	250.89	299.98	185.38	151.92	355.09	1555.81
Mesocyclops leuckarti	copepod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00
Orthocyclops modestus	copepod	0.00	0.00	0.00	0.56	0.53	0.76	1.14	0.57	1.87	4.69	4.39	4.21
Osphranticum labronectum	copepod	0.00	0.27	0.00	0.00	0.00	0.24	0.28	0.00	0.28	0.27	0.00	0.00
harpacticoids	copepods	0.76	0.84	7.54	4.47	1.42	3.89	1.55	7.36	0.24	3.57	0.00	0.77
Monstrilla sp.	copepod	0.73	4.03	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ergasilus sp.	copepod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00
siphonostomatids	parasitic copepods	29.64	22.36	12.14	6.67	6.97	9.63	5.09	2.48	1.53	3.77	2.05	0.86
Euconchoecia chierchiae	ostracod, seed shrimp	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eusarsiella zostericola	ostracod, seed shrimp	1.75	0.84	1.06	2.90	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00
Parasterope pollex	ostracod, seed shrimp	2381.23	1141.65	356.60	162.59	4.28	1.13	3.15	1.74	0.21	0.77	0.55	0.00
ostracods, podocopid	ostracods, seed shrimps	2.09	43.24	2.96	7.27	20.21	27.26	14.30	15.91	11.21	8.88	10.02	6.82
collembolas, podurid	springtails	0.00	0.00	0.00	0.27	0.25	0.26	0.00	0.00	0.26	0.00	1.08	0.00
ephemeropterans	mayflies	0.00	0.00	1.51	0.53	6.94	13.13	48.20	51.05	56.89	71.85	104.21	218.70
odonates, anisopteran larvae	dragonflies	0.00	0.00	0.50	0.26	0.00	0.00	0.51	0.00	0.00	0.25	0.27	0.47
odonates, zygopteran larvae	damselflies	0.00	0.00	0.25	0.00	0.00	0.00	0.25	0.27	0.00	0.75	1.06	2.08
hemipterans, belostomatid adults	giant water bugs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.27
hemipterans, corixid juveniles	water boatmen	0.00	0.30	0.00	0.00	0.00	0.00	0.25	0.27	0.00	0.00	0.00	0.00
hemipterans, corixid adults	water boatmen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.25	0.28	0.26	0.29
hemipterans, gerrid adults	water striders	0.00	0.00	0.00	0.00	0.00	0.25	0.51	0.00	9.22	50.48	62.12	135.63
hemipterans, naucorid adults	creeoing water bugs	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.26	0.00
hemipterans, nepid adults	water scorpions	0.00	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
hemipterans, pleid adults	pygmy backswimmers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.24	0.00	0.24
megalopterans, corydalid larvae	fishflies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.22	0.00
neuropterans, Climacia spp, larvae	spongillaflies	0.00	0.00	0.00	0.00	0.25	0.00	0.30	0.78	0.25	0.27	0.29	0.26

Table A3, page 5 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
coleopterans, chrysomelid larvae	beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	107.32	0.82	0.30
coleopterans, curculionid adults	beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.84	2.11	1.04	1.34	0.28
coleopterans, dytiscid larvae	predaceous diving beetles	0.00	0.00	0.00	0.00	0.25	0.28	0.00	0.28	0.00	0.00	0.22	0.83
coleopterans, noterid adults	burrowing water beetles	0.00	0.00	0.00	0.00	0.00	0.80	0.53	0.57	4.30	1.52	4.96	6.50
coleopterans, dryopid larvae	long-toed water beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.45	0.24
coleopterans, elmid larvae	riffle beetles	0.00	0.82	2.52	1.05	1.63	0.80	2.17	4.09	5.17	3.37	6.55	6.63
coleopterans, elmid adults	riffle beetles	0.34	0.00	0.27	0.29	1.05	0.27	3.40	3.33	0.75	4.31	3.01	6.28
coleopterans, gyrinid larvae	whirligig beetles	0.00	0.00	0.00	0.26	1.36	0.51	1.90	0.54	3.18	0.58	2.73	3.03
coleopterans, haliplid larvae	crawling water beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00
coleopterans, haliplid adults	crawling water beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.24	0.00	0.28
coleopterans, dytiscid adults	predaceous diving beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00
coleopterans, scirtid larvae	marsh beetles	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.27	0.86	0.74	1.37	1.01
dipterans, pupae	flies, mosquitoes	1.07	4.75	17.55	16.18	47.21	80.12	45.80	74.04	72.23	127.39	85.57	110.67
dipterans, ceratopogonid larvae	biting midges	0.26	0.00	0.50	0.85	2.93	0.75	2.49	6.97	4.01	1.23	0.27	0.77
dipteran, Chaoborus punctipennis larvae	phantom midge	3.41	13.99	80.79	47.84	64.05	54.28	355.57	352.60	240.65	209.21	334.43	444.44
dipterans, chironomid larvae	midges	0.95	4.04	2.72	5.92	59.68	31.52	43.75	48.41	160.28	114.33	176.37	146.73
dipterans, muscid larvae	muscid flies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.35	0.82	0.00
dipterans, simuliid larvae	black flies	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	1.59	1.11	1.89
dipterans, stratiomyid larvae	soldier flies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00
dipterans, sciomyzid larvae	marsh flies	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25	0.26	0.00
trichopteran larvae	caddisflies	0.00	0.27	2.27	1.31	2.17	6.08	19.79	21.88	16.48	22.66	32.90	43.94
lepidopterans, pyralid larvae	aquatic caterpillars	0.00	0.00	0.28	0.00	0.00	0.26	0.30	0.30	0.56	0.28	1.37	0.54
pycnogonids	sea spiders	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Limulus polyphemus larvae	horsehoe crab	14.32	33.32	5.46	4.57	0.58	0.30	0.28	0.23	0.26	0.30	0.00	0.00
acari	water mites	0.00	0.27	0.00	0.00	3.11	2.78	3.08	2.21	6.61	6.36	8.05	16.82
gastropods, prosobranch	snails	31.05	25.51	34.82	45.04	162.37	113.24	91.48	185.54	158.30	77.79	33.38	48.19
gastropods, opisthobranch	sea slugs	0.00	2.39	0.23	0.00	1.53	0.54	0.00	0.00	0.26	0.00	0.00	0.00
pelecypods	clams, mussels, oysters	664.06	201.03	33.67	105.40	85.89	84.44	48.37	36.35	39.53	64.82	17.65	26.00
ophiuroidean juveniles	brittlestars	0.98	0.55	0.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lolliguncula brevis juveniles	bay squid	2.36	4.24	2.59	0.00	0.55	0.88	0.00	0.00	0.00	0.00	0.00	0.00
brachiopod, Glottidia pyramidata larvae	lamp shell	3470.43	2740.66	1483.07	649.53	61.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
chaetognaths, sagittid	arrow worms	21096.12	4912.58	2208.91	2117.36	48.93	151.08	47.63	6.44	149.63	165.44	247.32	78.76
appendicularian, Oikopleura dioica	larvacean	3861.07	274.64	27.86	164.38	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00
Branchiostoma floridae	lancelet	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepisosteus platyrhincus postflexion larvae	Florida gar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Elops saurus postflexion larvae	ladyfish	0.23	0.73	0.29	0.58	0.27	0.27	0.73	0.57	1.03	0.27	0.58	0.83
Brevoortia spp. postflexion larvae	menhaden	2.22	0.50	2.58	0.82	1.34	0.52	2.81	4.98	6.15	9.78	5.59	7.54
Brevoortia spp. metamorphs	menhaden	0.00	0.00	0.53	3.39	5.13	7.54	2.22	7.26	47.92	38.03	55.75	21.22
Brevoortia patronus juveniles	gulf menhaden	0.00	0.00	0.00	0.29	0.00	0.00	0.30	1.57	0.26	1.43	0.00	0.00
Brevoortia smithi juveniles	yellowfin menhaden	0.00	1.10	0.00	0.97	1.51	1.68	7.49	5.12	7.75	7.24	0.26	0.31
Dorosoma spp. preflexion larvae	shads	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00
Dorosoma spp. postflexion larvae	shads	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.27	0.00	0.00

Table A3, page 6 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Dorosoma petenense juveniles	threadfin shad	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anchoa spp. preflexion larvae	anchovies	518.46	371.19	293.56	39.02	28.97	31.24	18.21	25.21	14.59	2.13	0.00	0.00
Anchoa spp. flexion larvae	anchovies	223.58	104.56	57.93	27.81	8.81	19.74	6.04	20.98	4.38	2.57	0.74	0.88
Anchoa hepsetus postflexion larvae	striped anchovy	19.73	4.49	0.00	0.29	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anchoa hepsetus juveniles	striped anchovy	1.54	2.01	4.83	15.33	4.10	4.91	0.80	0.81	1.90	0.49	0.00	0.00
Anchoa hepsetus adults	striped anchovy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54
Anchoa mitchilli eggs	bay anchovy	675.37	25.72	1.35	0.28	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00
Anchoa mitchilli postflexion larvae	bay anchovy	143.37	26.74	13.80	11.62	9.04	17.84	4.35	9.94	4.83	0.87	3.62	0.81
Anchoa mitchilli juveniles	bay anchovy	205.15	691.68	1064.25	1156.94	6209.36	3481.83	6158.50	5657.31	2385.65	1283.25	1140.39	897.08
Anchoa mitchilli adults	bay anchovy	31.62	59.20	158.32	479.40	267.81	175.14	74.67	57.56	60.51	106.58	2.80	1.39
Anchoa cubana juveniles	Cuban anchovy	0.00	1.74	0.32	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Anchoa cubana adults	Cuban anchovy	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Notemigonus crysoleucas preflexion larvae	golden shiner	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00
Notropis spp. postflexion larvae	minnows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26
Notropis spp. juveniles	minnows	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.00	0.00	0.00
Misgurnus anguillicaudatus juveniles	oriental weatherfish	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00
Ameiurus catus juveniles	white catfish	0.00	0.00	0.00	0.26	0.54	0.81	1.27	1.89	0.50	1.82	0.28	2.93
Ameiurus natalis juveniles	yellow bullhead	0.00	0.00	0.00	0.26	0.00	0.00	0.25	0.87	1.07	1.45	0.52	0.26
Ameiurus nebulosus juveniles	brown bullhead	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.28
Noturus gyrinus juveniles	tadpole madtom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.21
Ictalurus punctatus juveniles	channel catfish	0.00	0.00	0.00	0.00	0.00	0.00	1.06	0.54	0.74	1.16	0.78	1.35
Liposarcus spp. juveniles	suckermouth catfish	0.00	0.00	0.25	0.00	0.26	0.00	1.03	0.80	0.52	0.76	0.55	1.60
loricariid sp. B	suckermouth catfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00
Hoplosternum littorale flexion larvae	brown hoplo catfish	0.00	0.00	0.50	0.26	0.00	0.00	0.28	0.54	0.00	0.55	0.00	0.00
Hoplosternum littorale juveniles	brown hoplo catfish	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.52	0.00
Synodus foetens postflexion larvae	inshore lizardfish	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Opsanus beta juveniles	gulf toadfish	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gobiesox strumosus preflexion larvae	skilletfish	0.29	4.57	2.08	0.56	1.33	0.27	0.00	0.33	0.00	0.29	0.00	0.00
Gobiesox strumosus flexion larvae	skilletfish	0.55	4.37	2.23	7.70	2.70	2.83	0.94	0.59	0.25	0.29	0.00	0.00
Gobiesox strumosus postflexion larvae	skilletfish	0.91	7.51	1.68	4.82	4.77	2.62	0.94	1.97	0.00	0.00	0.00	0.00
Gobiesox strumosus juveniles	skilletfish	4.17	6.58	5.15	13.81	7.69	6.77	2.06	0.97	1.14	0.00	0.00	0.00
Strongylura spp. postflexion larvae	needlefishes	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	1.30	0.00
Strongylura spp. juveniles	needlefishes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00
Fundulus spp. postflexion larvae	killifishes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
Fundulus seminolis postflexion larvae	Seminole killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.27	0.00	0.29
Fundulus seminolis juveniles	Seminole killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00
Fundulus grandis postflexion larvae	gulf killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00
Lucania goodei juveniles	bluefin killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00
Lucania parva postflexion larvae	rainwater killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.26	0.00	0.00	0.00
Lucania parva juveniles	rainwater killifish	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00
Lucania parva adults	rainwater killifish	0.00	0.00	0.30	0.29	0.00	0.00	0.28	0.00	0.00	0.28	0.00	0.24
Gambusia holbrooki juveniles	eastern mosquitofish	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	1.59	1.40	0.80	0.00

Table A3, page 7 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Gambusia holbrooki adults	eastern mosquitofish	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.28	0.56	0.00	0.00	0.00
Heterandria formosa juveniles	least killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.00
Heterandria formosa adults	least killifish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.84	0.00	0.00	0.00
Poecilia latipinna juveniles	sailfin molly	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.27	0.26	0.27	0.22	0.00
Menidia spp. eggs	silversides	0.81	0.00	0.00	0.00	0.00	1.14	0.00	0.00	0.00	0.00	0.54	0.00
Menidia spp. preflexion larvae	silversides	3.98	1.85	0.82	1.19	0.59	1.40	7.64	7.20	4.78	6.35	39.62	16.19
Menidia spp. flexion larvae	silversides	0.00	1.11	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	3.24	0.77
Menidia spp. postflexion larvae	silversides	0.00	0.31	0.00	0.00	0.00	0.00	0.51	0.27	0.53	0.85	0.00	0.52
Menidia spp. juveniles	silversides	0.00	0.30	0.00	0.26	0.00	0.00	0.00	0.00	0.25	0.29	0.26	0.26
Menidia spp. adults	silversides	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Menidia beryllina juveniles	inland silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.10	0.31
Membras martinica preflexion larvae	rough silverside	3.09	1.01	2.41	0.25	0.00	0.00	0.48	0.25	0.53	0.00	0.00	0.00
Membras martinica flexion larvae	rough silverside	0.47	1.70	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membras martinica postflexion larvae	rough silverside	0.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Membras martinica juveniles	rough silverside	0.62	0.56	3.00	2.77	2.80	4.00	2.02	1.18	2.08	0.61	0.00	0.00
Labidesthes sicculus preflexion larvae	brook silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.28	0.27
Labidesthes sicculus flexion larvae	brook silverside	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00
fish eggs, percomorph	sciaenid eggs (primarily)	964.35	89.31	0.00	0.96	0.83	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Hippocampus erectus juveniles	lined seahorse	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Syngnathus louisianae juveniles	chain pipefish	2.85	1.72	2.79	0.79	0.57	2.03	0.22	0.26	0.64	1.03	0.00	0.00
Syngnathus scovelli juveniles	gulf pipefish	0.63	0.52	0.54	1.29	0.29	0.29	1.02	0.00	0.50	1.27	0.00	0.00
Syngnathus scovelli adults	gulf pipefish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	0.00	0.00
Prionotus spp. flexion larvae	searobins	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prionotus spp. postflexion larvae	searobins	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prionotus tribulus postflexion larvae	bighead searobin	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prionotus tribulus juveniles	bighead searobin	0.00	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lepomis spp. preflexion larvae	sunfishes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.27	0.00
Lepomis spp. flexion larvae	sunfishes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.53	0.00
Lepomis spp. postflexion larvae	sunfishes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.27	0.00	0.30
Lepomis spp. juveniles	sunfishes	0.00	0.27	0.50	0.00	0.00	0.26	0.28	0.27	1.49	1.64	0.00	0.00
Lepomis macrochirus postflexion larvae	bluegill	0.26	0.54	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.26	0.00
Lepomis macrochirus juveniles	bluegill	0.00	0.00	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	1.34	0.83
Lepomis auritus flexion larvae	redbreast sunfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.27	1.23
Lepomis auritus postflexion larvae	redbreast sunfish	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.89
Micropterus salmoides postflexion larvae	largemouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.25	0.00
centrarchid preflexion larvae	sunfishes	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloroscombrus chrysurus preflexion larvae	Atlantic bumper	0.93	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloroscombrus chrysurus flexion larvae	Atlantic bumper	2.13	1.86	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00
Chloroscombrus chrysurus postflexion larvae	Atlantic bumper	0.26	0.95	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chloroscombrus chrysurus juveniles	Atlantic bumper	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oligoplites saurus preflexion larvae	leatherjack	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oligoplites saurus flexion larvae	leatherjack	0.29	0.26	0.56	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A3, page 8 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Oligoplites saurus postflexion larvae	leatherjack	0.76	0.00	0.27	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oligoplites saurus juveniles	leatherjack	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.26	1.01	0.00	0.00
gerreid postflexion larvae	mojjaras	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.00	0.00
Diapterus plumieri postflexion larvae	striped mojarra	0.00	0.00	0.53	0.00	0.57	0.00	0.30	0.63	0.00	0.00	0.00	0.00
Eucinostomus spp. juveniles	mojarras	0.00	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eucinostomus harengulus juveniles	tidewater mojarra	0.00	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Orthopristis chrysoptera postflexion larvae	pigfish	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Archosargus probatocephalus postflexion larvae	sheepshead	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.56	0.00	0.00	0.00
Archosargus probatocephalus juveniles	sheepshead	0.00	0.24	0.00	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lagodon rhomboides juveniles	pinfish	2.44	1.17	0.24	0.00	0.00	0.52	0.49	1.85	0.00	0.25	0.00	0.00
Bairdiella chrysoura preflexion larvae	silver perch	0.26	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bairdiella chrysoura flexion larvae	silver perch	0.58	2.60	0.00	0.24	0.00	0.00	0.00	0.41	0.00	0.26	0.00	0.00
Bairdiella chrysoura juveniles	silver perch	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cynoscion arenarius preflexion larvae	sand seatrout	5.87	2.75	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cynoscion arenarius flexion larvae	sand seatrout	14.64	3.92	2.14	1.12	0.00	0.28	0.00	0.00	0.38	0.00	0.00	0.00
Cynoscion arenarius postflexion larvae	sand seatrout	35.65	2.43	1.22	0.29	0.00	0.86	0.00	0.00	0.00	0.00	0.00	0.00
Cynoscion arenarius juveniles	sand seatrout	5.25	1.39	1.10	2.92	2.69	0.27	0.00	1.66	0.00	0.98	0.00	0.00
Cynoscion nebulosus flexion larvae	spotted seatrout	0.32	0.00	0.00	0.68	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00
Cynoscion nebulosus postflexion larvae	spotted seatrout	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.31	0.00	0.00	0.00	0.00
Cynoscion nebulosus juveniles	spotted seatrout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.30	0.00
Leiostomus xanthurus juveniles	spot	0.00	0.00	0.00	0.33	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Menticirrhus spp. preflexion larvae	kingfishes	1.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Menticirrhus spp. flexion larvae	kingfishes	1.19	2.03	0.00	0.29	0.00	0.27	0.00	0.00	0.00	0.30	0.00	0.00
Menticirrhus spp. postflexion larvae	kingfishes	1.18	1.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pogonias cromis preflexion larvae	black drum	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pogonias cromis postflexion larvae	black drum	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sciaenops ocellatus postflexion larvae	red drum	0.31	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chaetodipterus faber flexion larvae	Atlantic spadefish	1.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tilapia spp. juveniles	tilapias	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00
Mugil cephalus juveniles	striped mullet	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
blenniid preflexion larvae	blennies	6.02	7.69	2.53	0.41	0.79	0.00	0.00	0.00	0.00	0.00	0.37	0.00
Chasmodes saburrae flexion larvae	Florida blenny	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chasmodes saburrae postflexion larvae	Florida blenny	0.30	0.61	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lupinoblennius nicholsi flexion larvae	highfin blenny	0.00	0.00	0.00	0.28	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Lupinoblennius nicholsi postflexion larvae	highfin blenny	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
gobiid preflexion larvae	gobies	27.10	52.06	8.19	13.97	5.07	14.05	10.71	10.53	15.61	6.04	28.51	35.97
gobiid flexion larvae	gobies	15.90	12.70	6.51	30.83	16.71	13.21	17.78	9.90	14.32	9.85	7.74	10.95
gobiid postflexion larvae	gobies	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	0.00	0.00	0.63
Bathygobius soporator preflexion larvae	frillfin goby	3.33	4.51	0.28	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Bathygobius soporator flexion larvae	frillfin goby	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bathygobius soporator postflexion larvae	frillfin goby	0.27	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gobionellus spp. postflexion larvae	gobies	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A3, page 9 of 9. Location-specific plankton-net catch (April 2000 to December 2003).

Data are presented as mean number per 1,000 cubic meters.

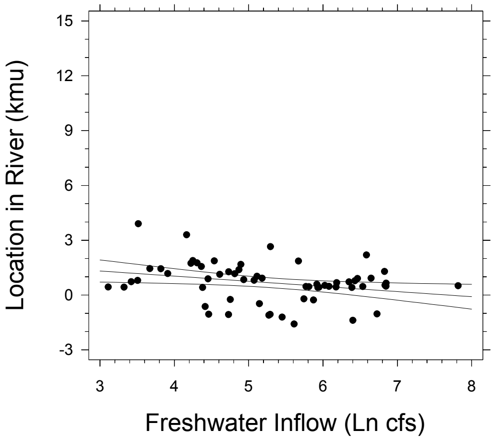
Organisms are listed in phylogenetic order.

		Location (km from mouth)											
Description	Common Name	0.4	1.5	3.0	4.0	6.4	6.4	7.9	8.0	9.5	10.0	11.9	12.7
Gobiosoma spp. postflexion larvae	gobies	58.80	7.71	15.42	21.90	31.73	56.75	22.68	14.56	20.55	9.20	20.32	61.94
Gobiosoma bosc juveniles	naked goby	0.00	0.25	0.27	0.24	0.25	0.59	0.00	0.80	0.24	1.26	0.54	0.60
Gobiosoma bosc adults	naked goby	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.49	0.00	0.29	0.00
Gobiosoma robustum juveniles	code goby	0.00	0.00	0.26	0.00	0.26	0.00	0.00	0.53	0.48	0.00	0.00	0.60
Gobiosoma robustum adults	code goby	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00
Microgobius spp. flexion larvae	gobies	14.12	7.18	0.54	0.29	2.00	0.58	1.11	0.88	3.94	2.93	3.18	1.14
Microgobius spp. postflexion larvae	gobies	17.11	7.69	2.96	0.67	0.27	0.84	0.30	2.33	0.00	0.00	0.58	0.27
Microgobius gulosus juveniles	clown goby	0.00	0.59	0.00	0.00	0.00	0.00	0.00	0.28	0.30	0.00	0.28	0.00
Microgobius thalassinus juveniles	green goby	1.70	0.62	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achirus lineatus preflexion larvae	lined sole	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achirus lineatus flexion larvae	lined sole	0.58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achirus lineatus postflexion larvae	lined sole	0.00	0.26	0.28	0.00	0.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00
Achirus lineatus juveniles	lined sole	0.28	1.82	0.56	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trinectes maculatus eggs	hogchoker	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Trinectes maculatus preflexion larvae	hogchoker	1.20	2.09	0.85	0.29	0.00	2.05	0.32	0.63	0.00	0.00	0.00	0.00
Trinectes maculatus flexion larvae	hogchoker	3.38	1.49	0.28	1.86	0.00	2.89	0.00	1.23	0.55	0.26	1.25	0.00
Trinectes maculatus postflexion larvae	hogchoker	11.24	13.28	6.99	9.70	9.61	6.86	6.23	16.14	3.17	2.44	2.37	1.75
Trinectes maculatus juveniles	hogchoker	0.34	0.86	2.22	2.19	1.49	7.69	4.92	11.60	18.48	13.24	5.95	9.41
Trinectes maculatus adults	hogchoker	0.00	0.00	0.27	0.29	4.33	0.85	0.00	0.00	0.27	1.47	0.30	0.00
Symphurus plagiusa postflexion larvae	blackcheek tonguefish	0.88	0.92	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Symphurus plagiusa juveniles	blackcheek tonguefish	0.61	0.26	0.27	0.58	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.00
anuran larvae	tadpoles	0.00	0.31	0.25	0.00	0.00	0.00	0.54	0.82	1.88	0.28	1.22	1.67

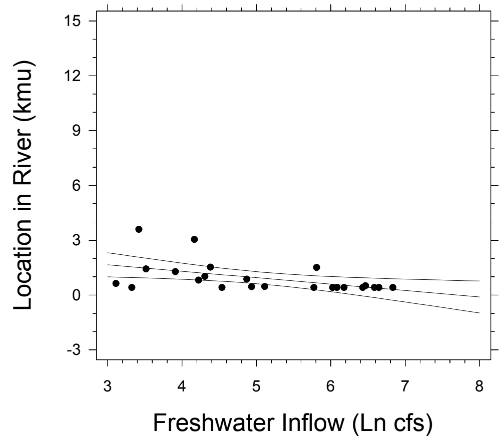
Appendix B:

Plots of the regressions in Table 3.6.1

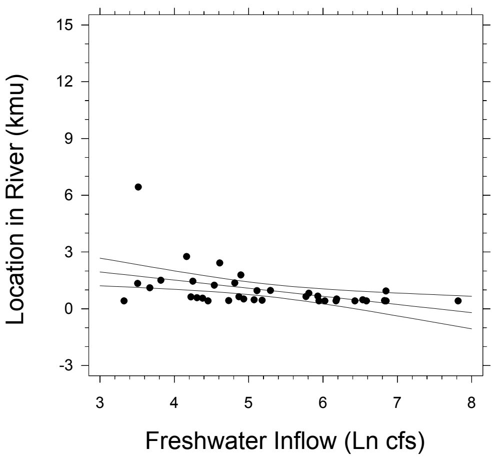
chaetognaths, sagittid



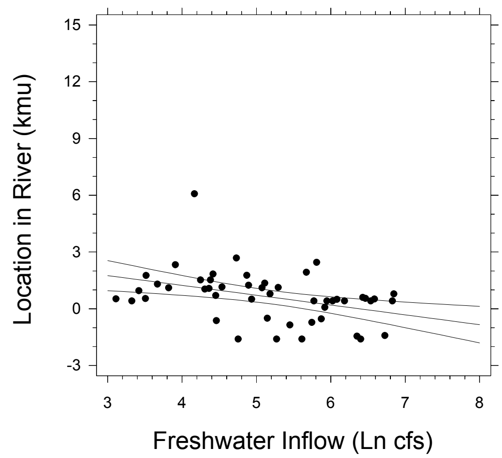
Americamysis stucki



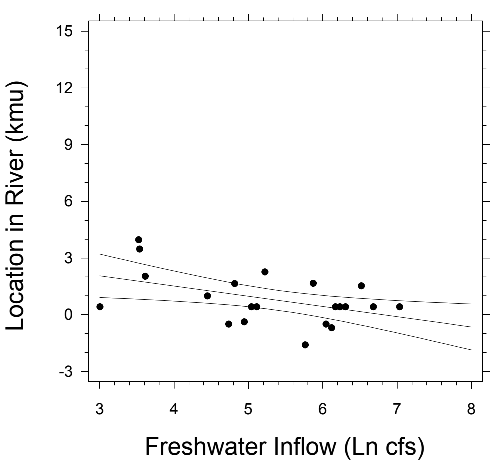
Acartia tonsa



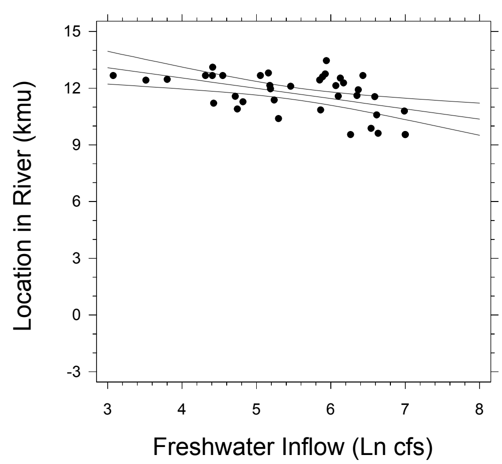
Lucifer faxoni



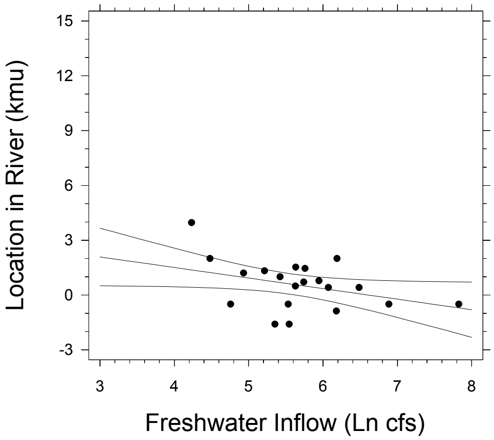
Cynoscion arenarius flexion larvae



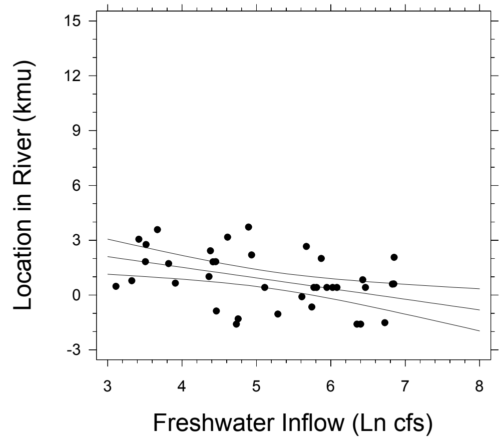
hemipterans, gerrid adults



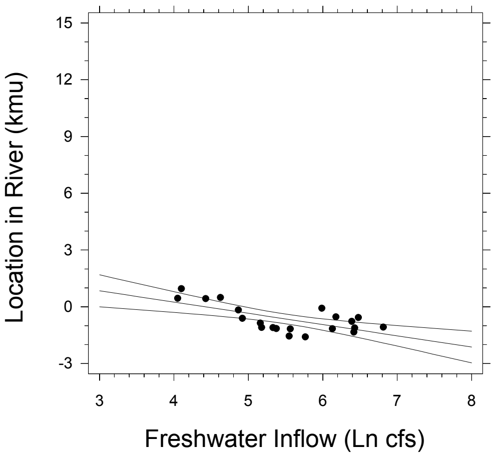
Periclimenes spp. postlarvae



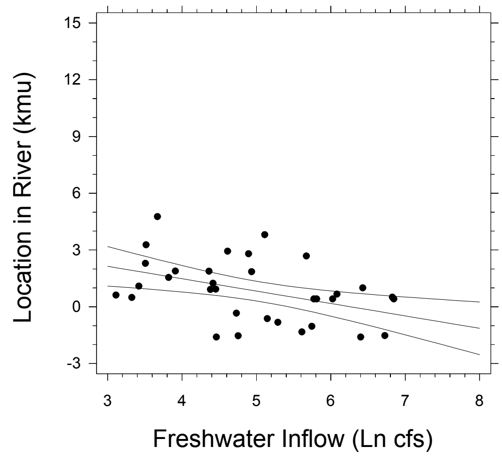
Anchoa spp. flexion larvae



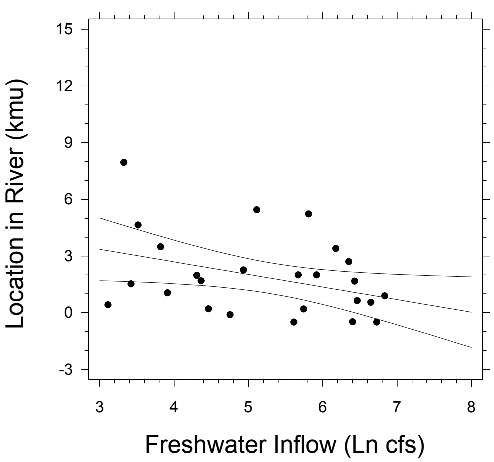
unidentified calanoids



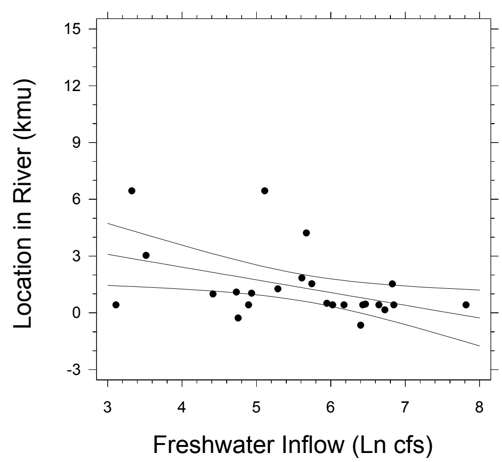
Anchoa spp. preflexion larvae



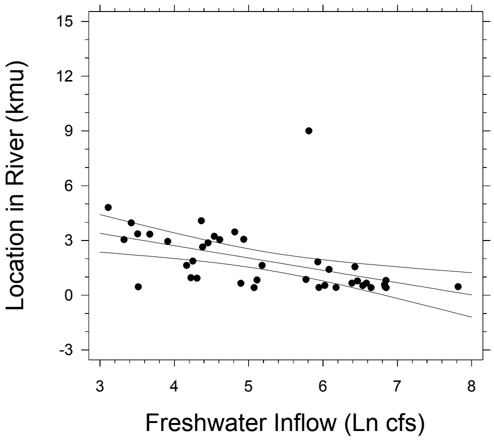
pinnotherid juveniles



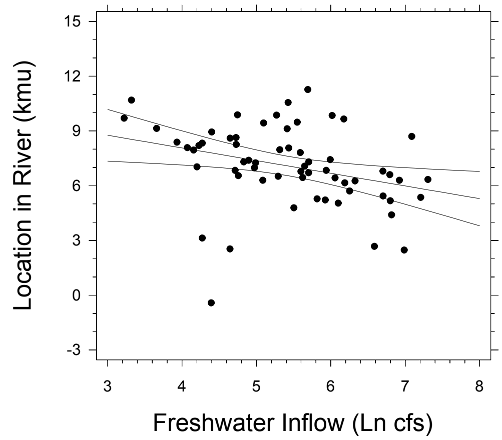
Cynoscion arenarius postflexion larvae



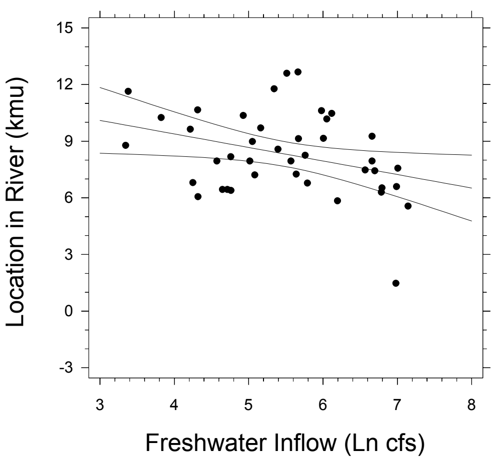
Parasterope pollex



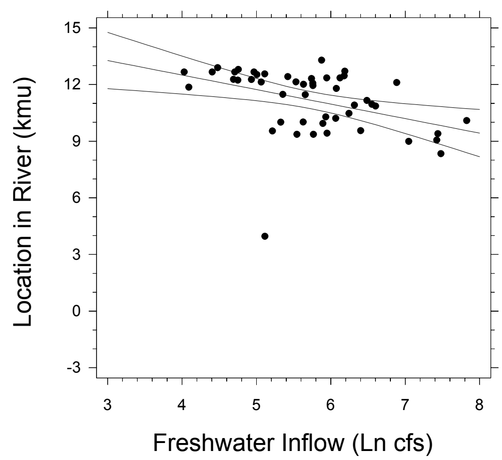
gastropods, prosobranch



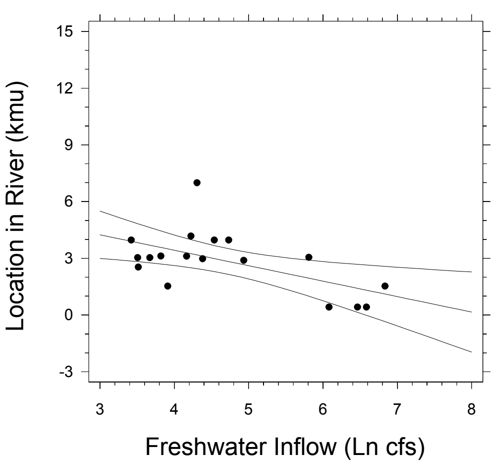
ostracods, podocopid



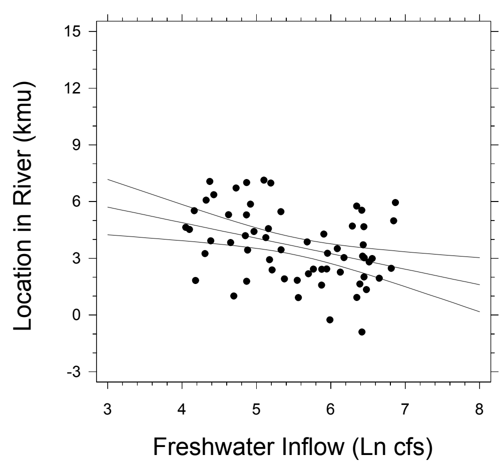
ephemeropteran larvae



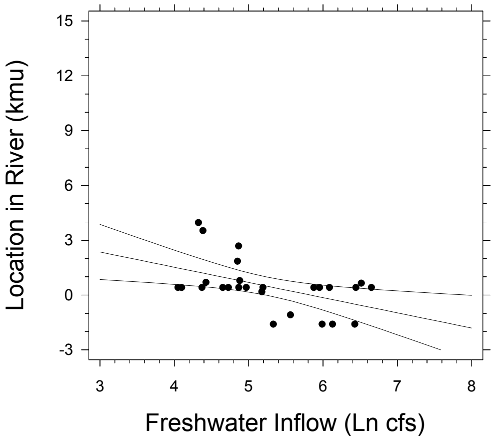
Americamysis bahia



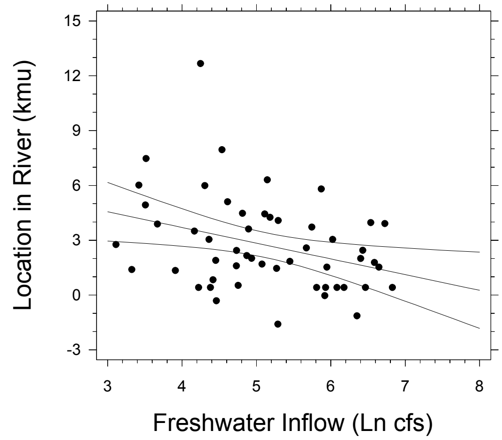
decapod mysis, unidentified



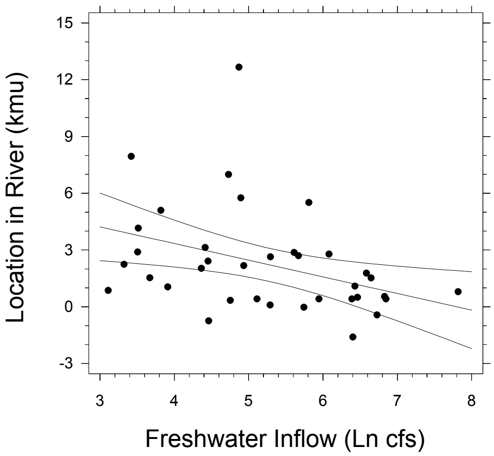
appendicularian, Oikopleura dioica



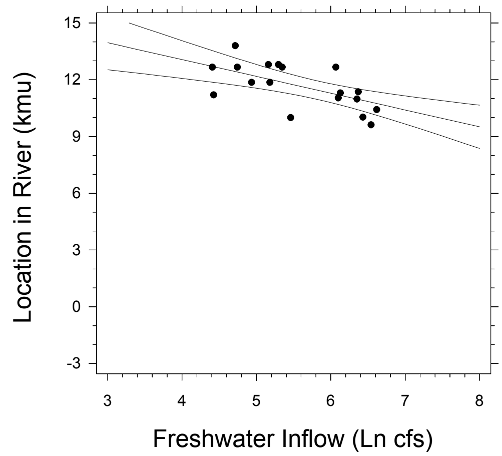
siphonostomatids



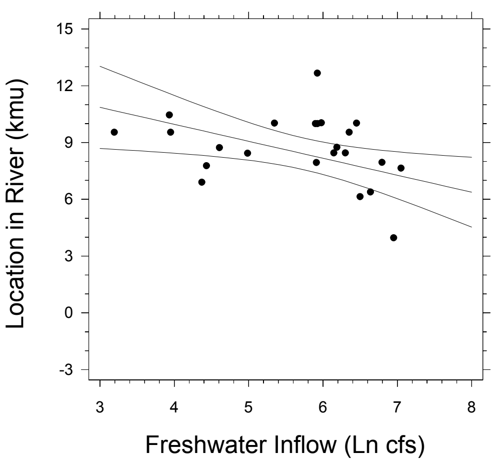
Anchoa mitchilli postflexion larvae



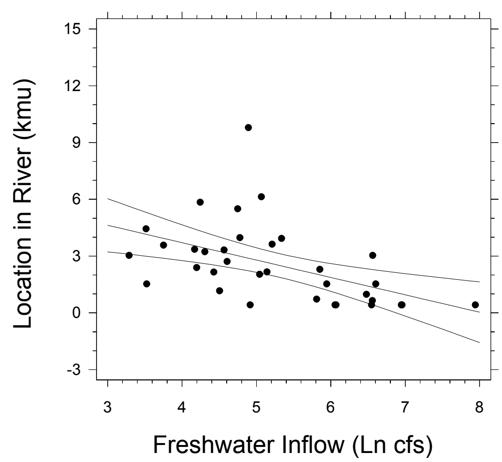
odonates, zygopteran larvae



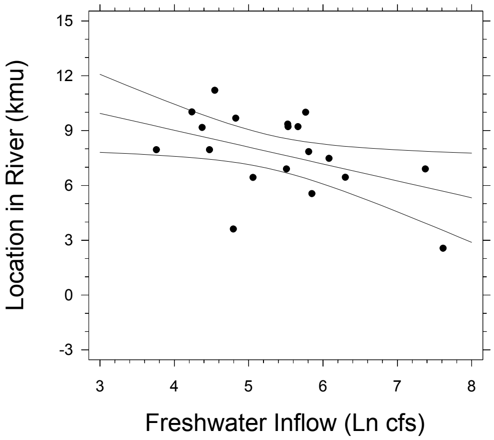
dipterans, ceratopogonid larvae



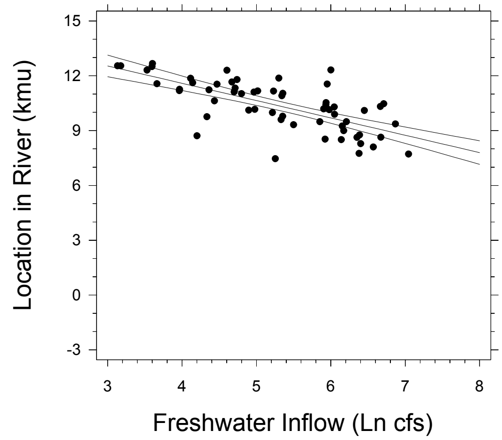
Pseudodiaptomus coronatus



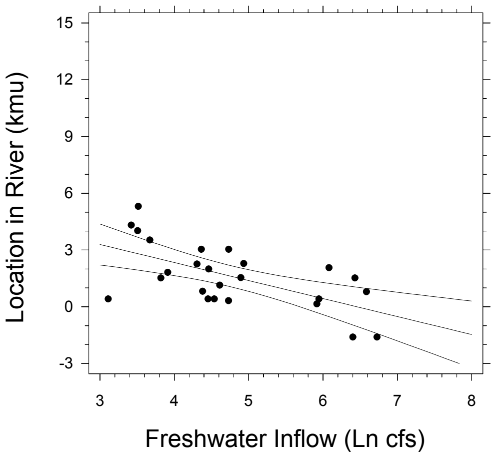
isopods, unidentified sphaeromatids



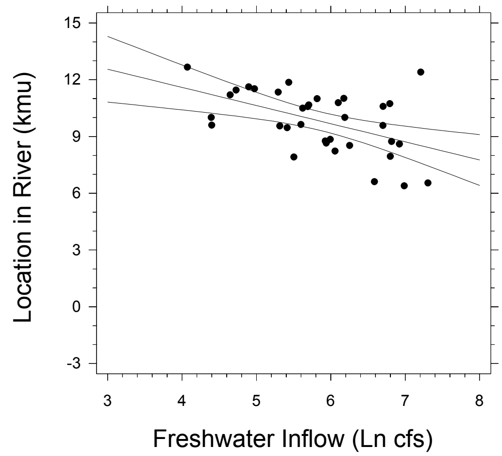
dipterans, chironomid larvae



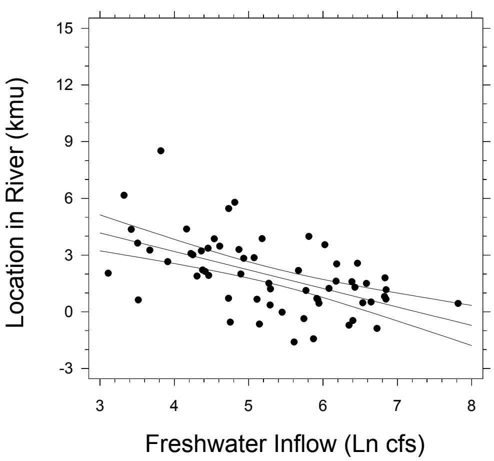
Erichsonella attenuata



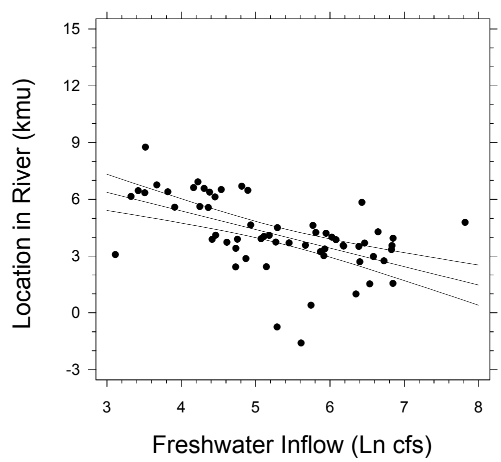
dipteran, Chaoborus punctipennis larvae



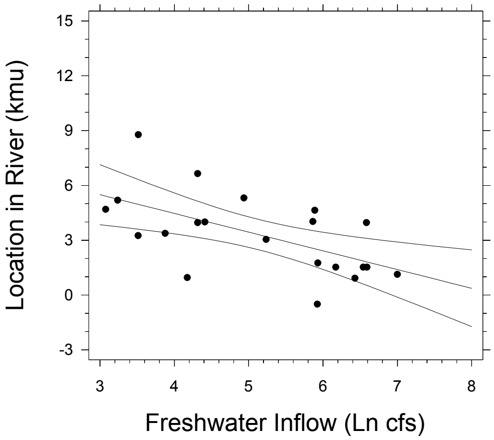
cumaceans, unidentified



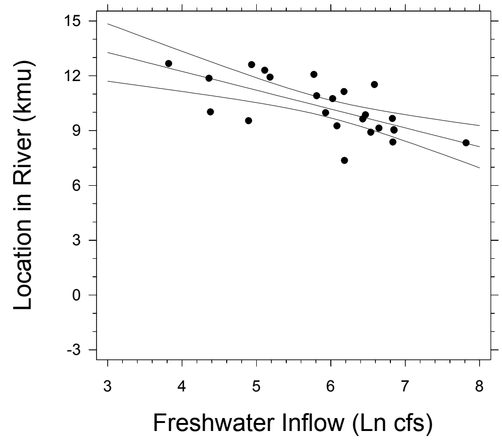
Anchoa mitchilli adults



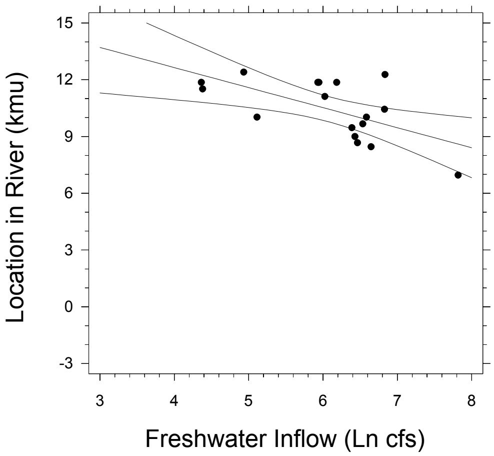
Mnemiopsis mccradyi



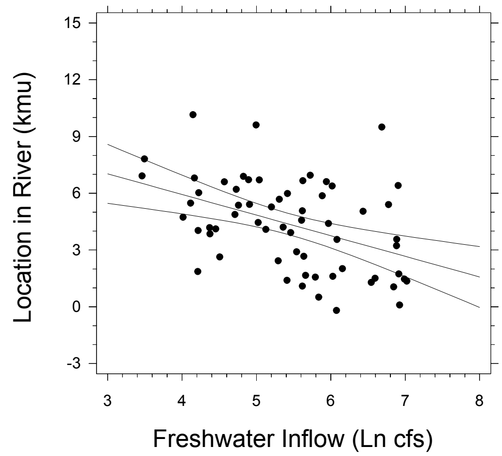
Mesocyclops edax



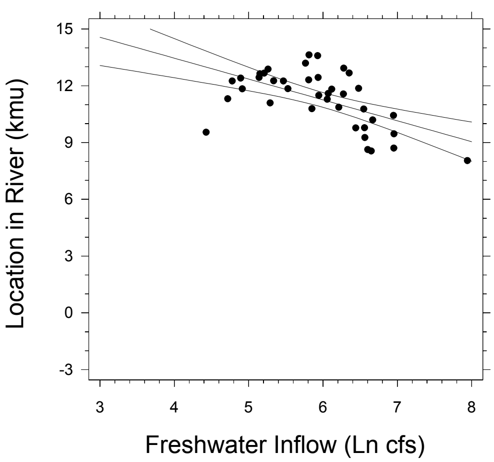
cladoceran, Simocephalus vetulus



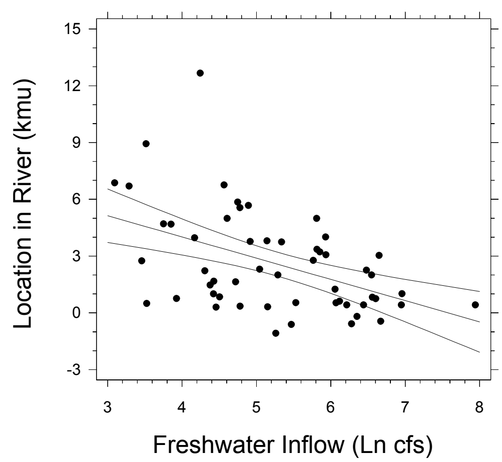
amphipods, unidentified gammarideans



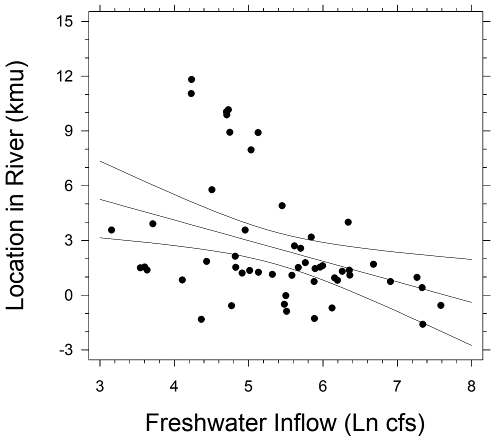
trichopteran larvae



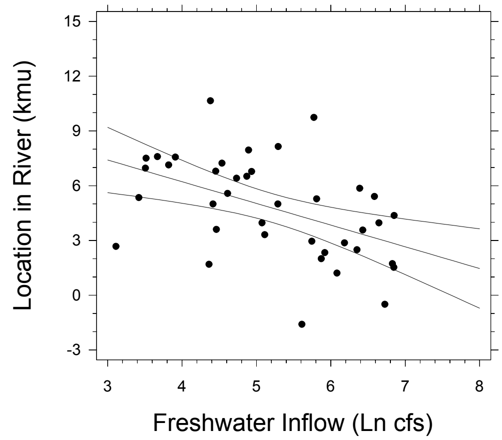
Palaemonetes spp. postlarvae



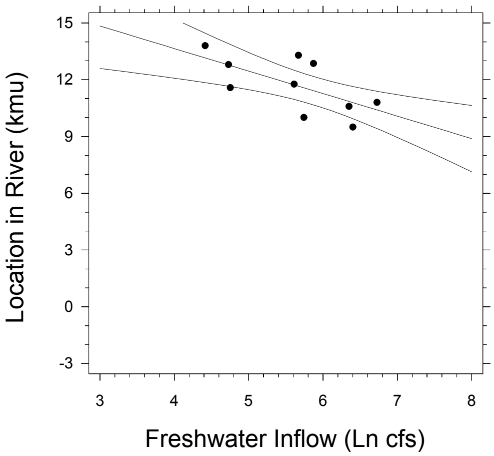
decapod megalopae, unidentified



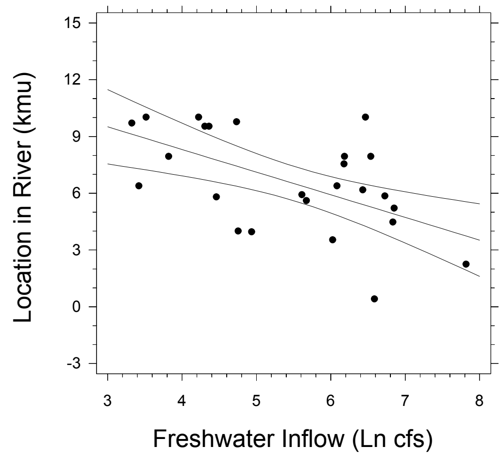
gobiid preflexion larvae



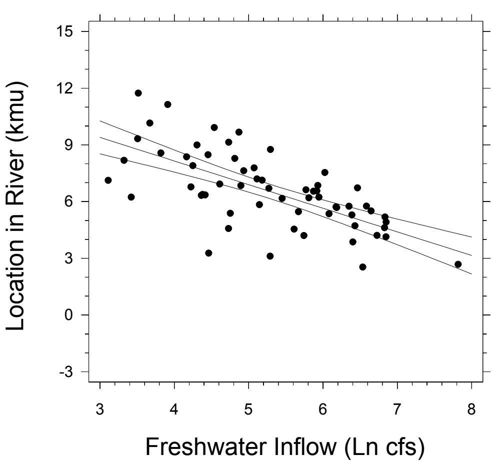
cladocerans, daphniid



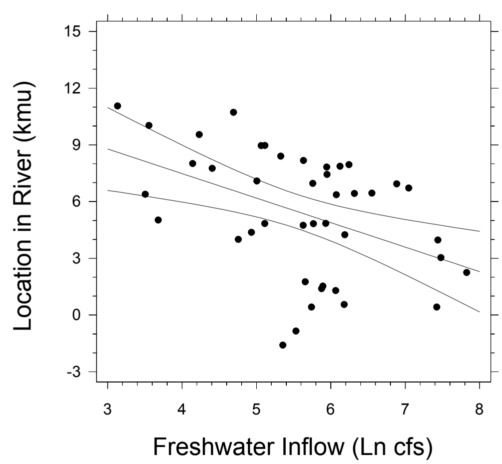
Palaemonetes pugio adults



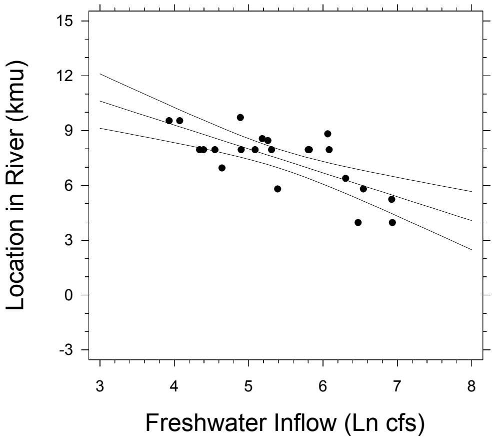
Anchoa mitchilli juveniles



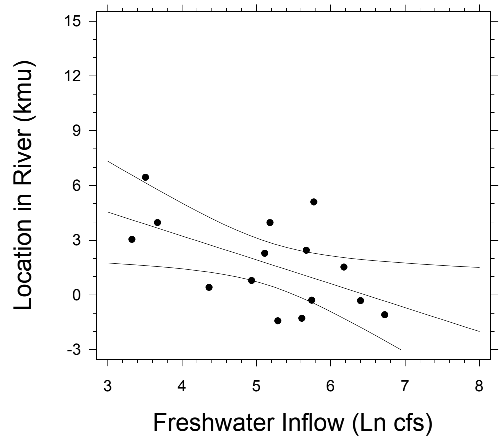
Palaemonetes pugio juveniles



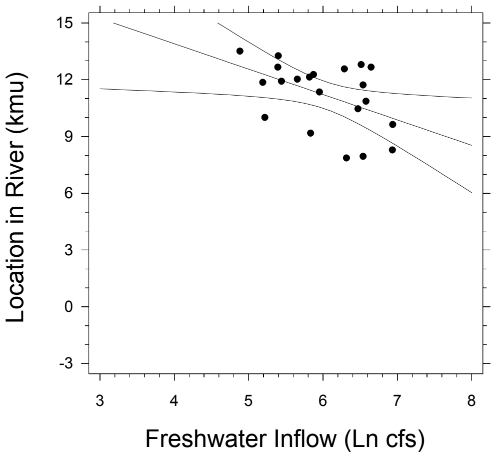
Cyathura polita



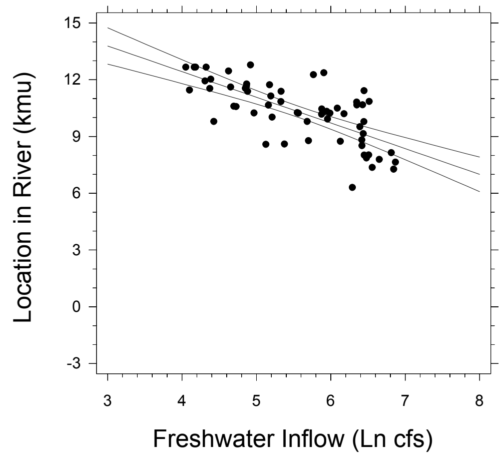
penaeid metamorphs



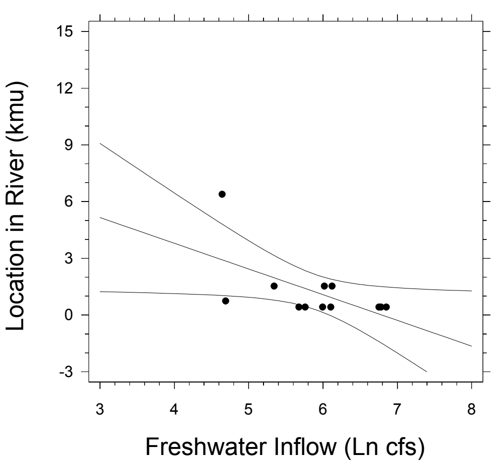
coleopterans, gyrinid larvae



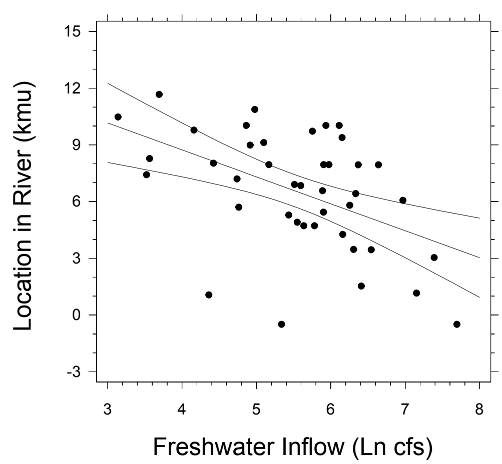
dipterans, pupae



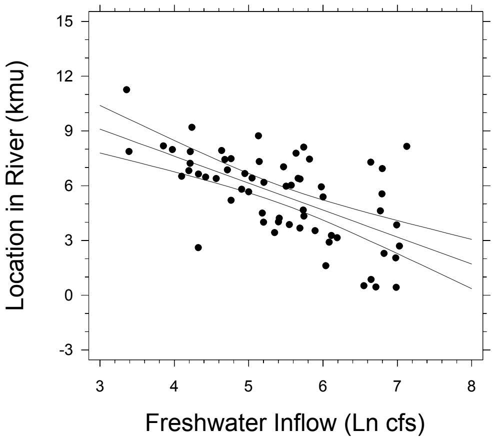
Ambidexter symmetricus juveniles



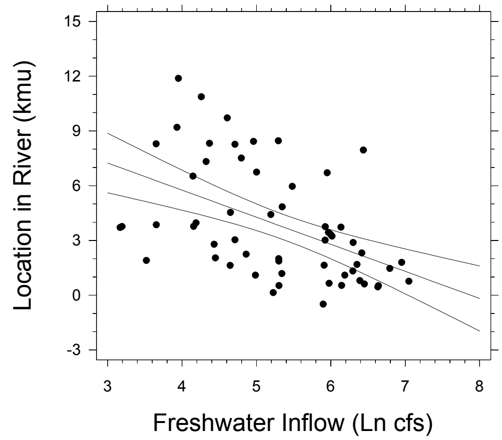
Trinectes maculatus juveniles



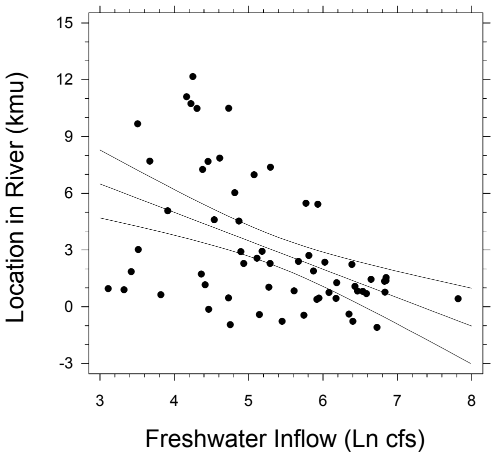
polychaetes



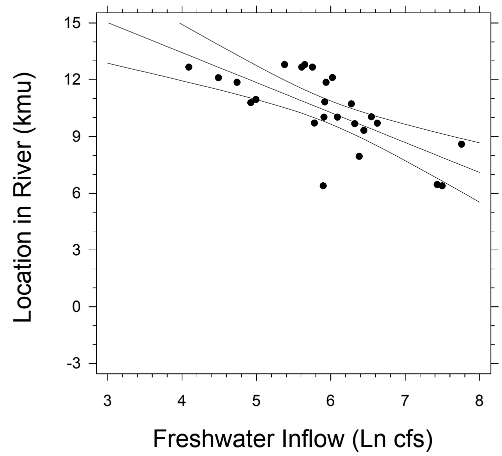
Americamysis juveniles



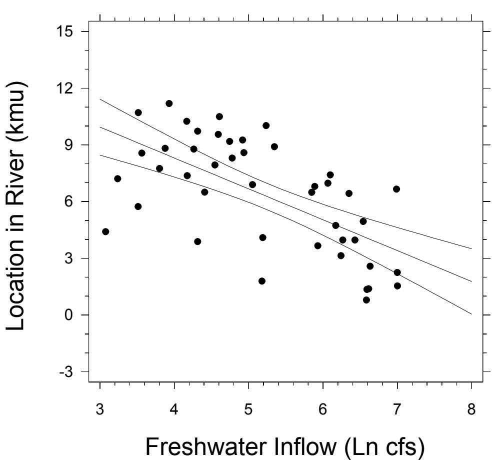
decapod zoeae, unidentified



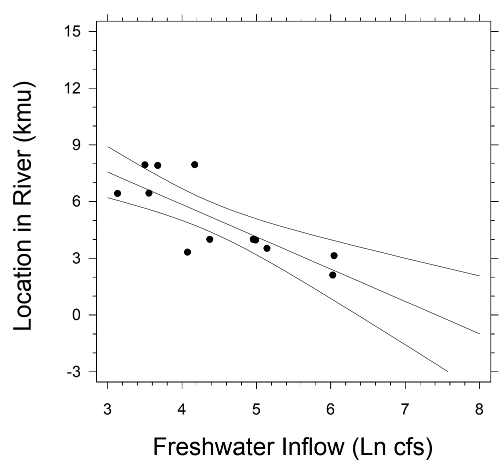
coleopterans, elmid larvae



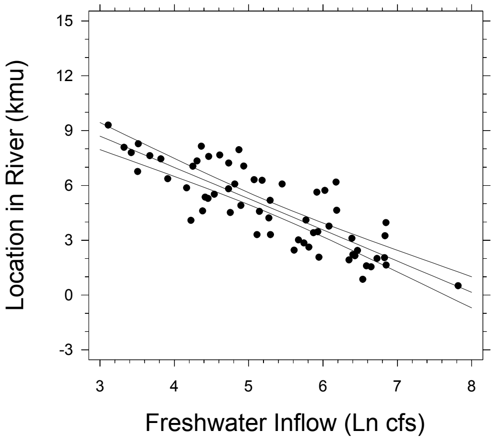
Americamysis almyra



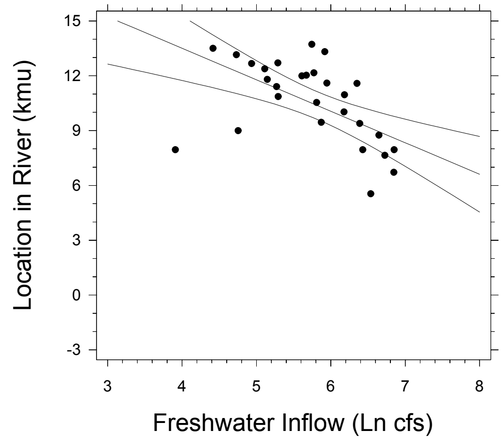
Membras martinica juveniles



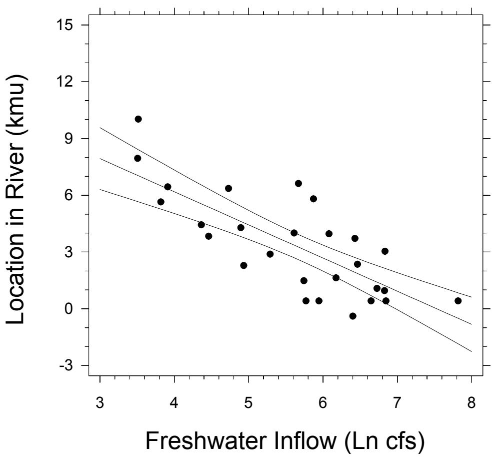
Edotea triloba



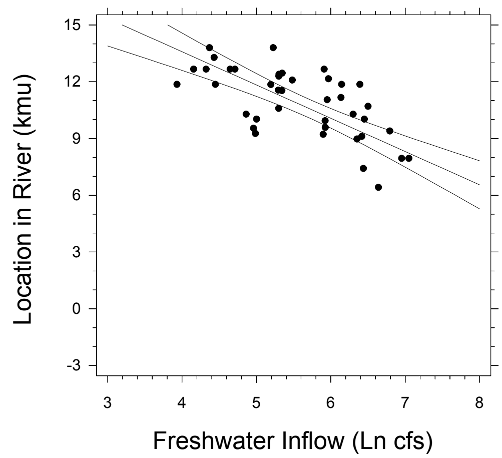
coleopterans, elmid adults



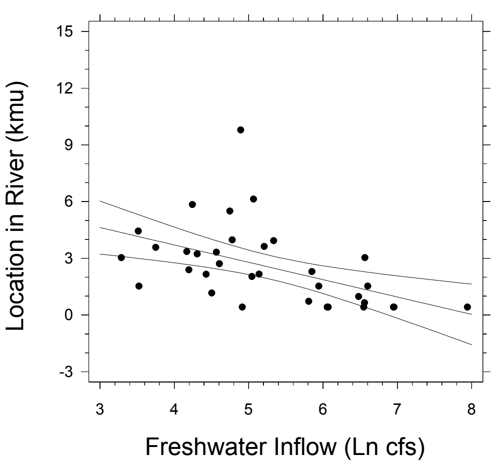
Cynoscion arenarius juveniles



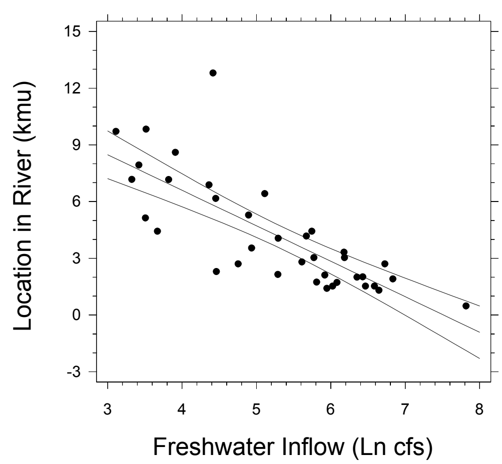
acari



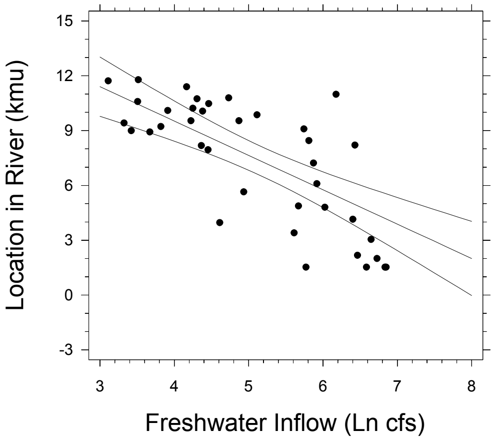
Pseudodiaptomus coronatus



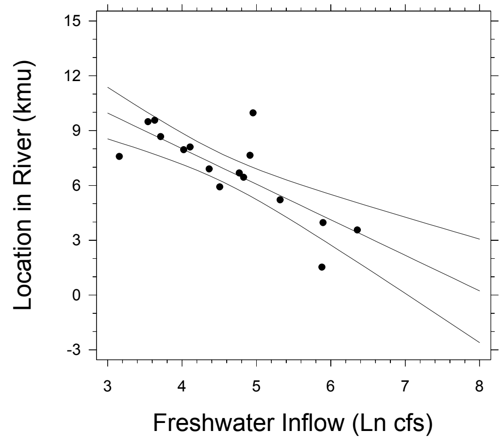
Trinectes maculatus postflexion larvae



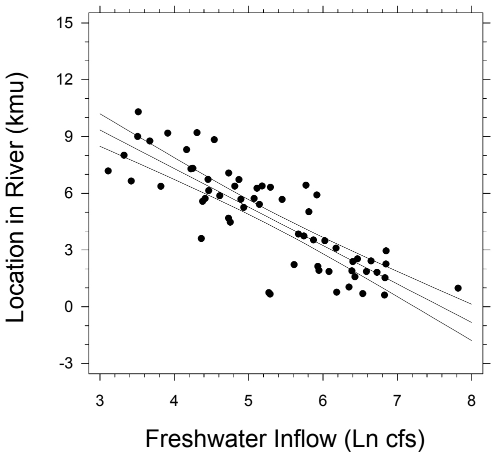
branchiurans, Argulus spp.



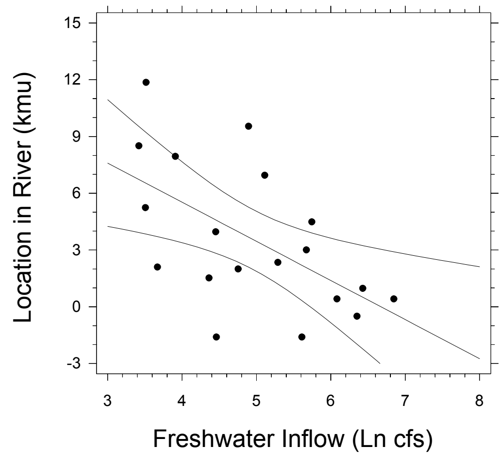
Brevoortia smithi juveniles



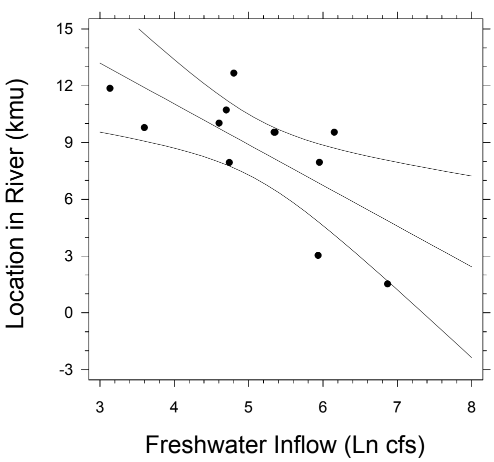
cymothoid sp. a (Lironeca) juveniles



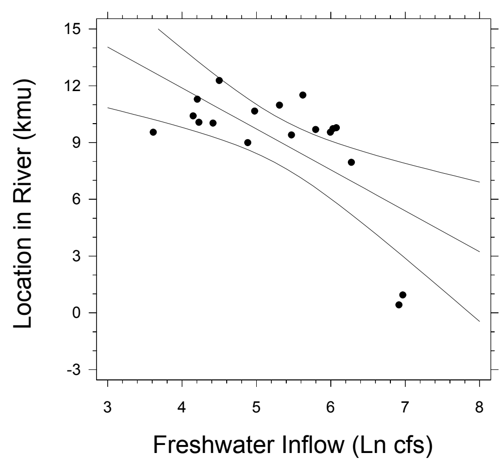
Trinectes maculatus flexion larvae



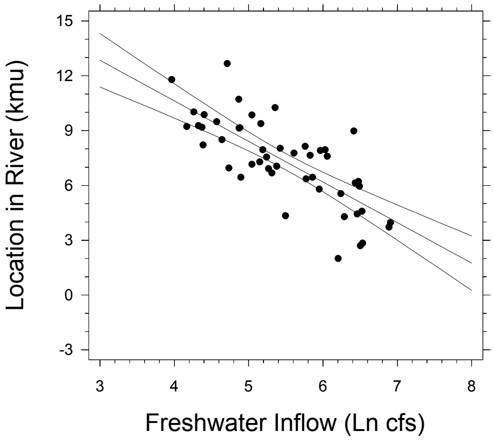
Hargeria rapax



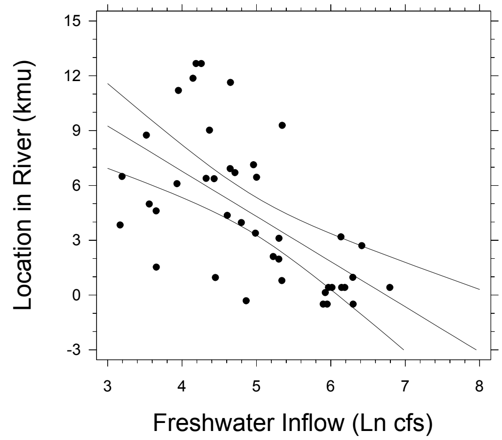
Taphromysis bowmani



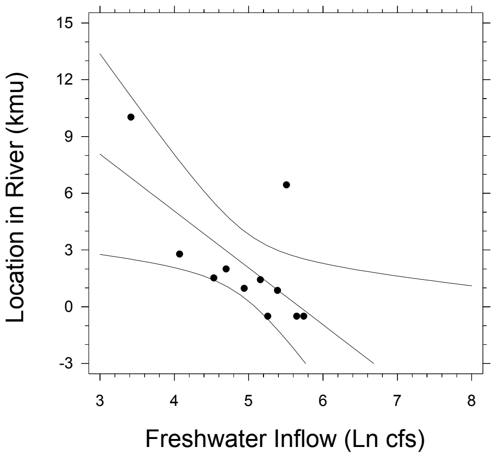
hirudinoideans



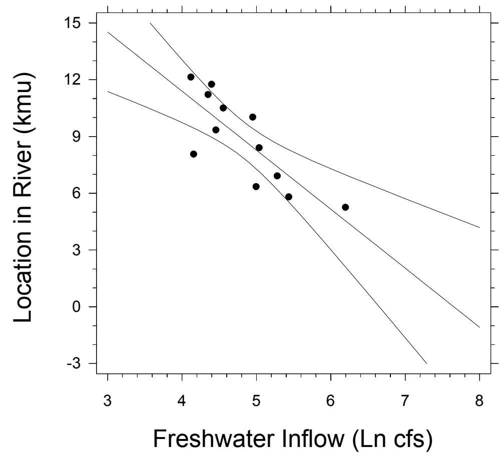
Gobiosoma spp. postflexion larvae



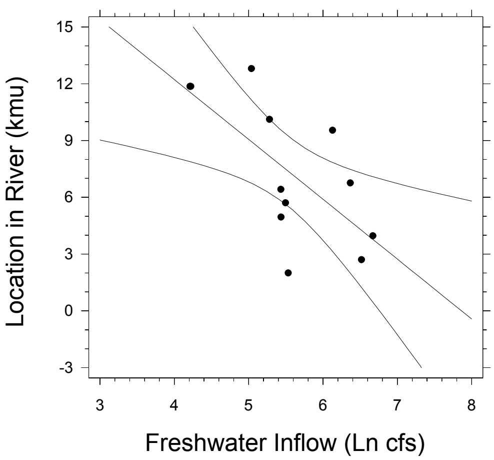
Menticirrhus spp. flexion larvae



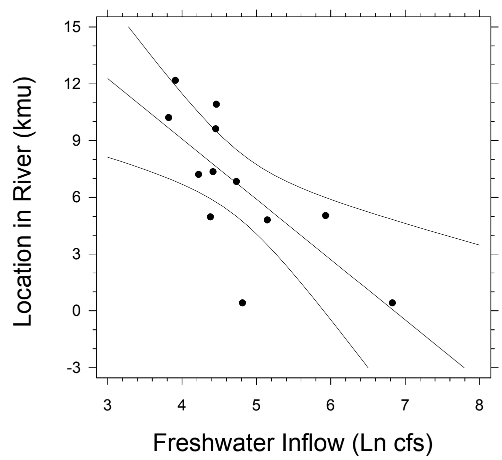
Brevoortia spp. metamorphs



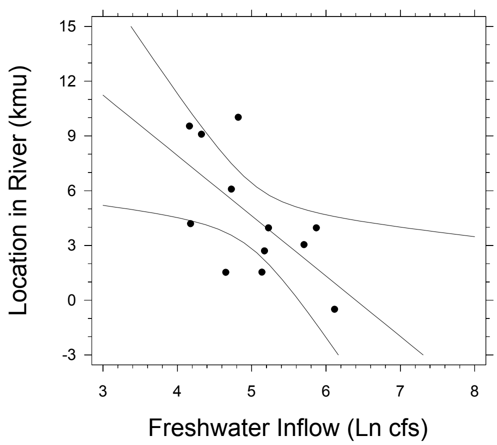
collembolas, podurid



Brevoortia spp. postflexion larvae

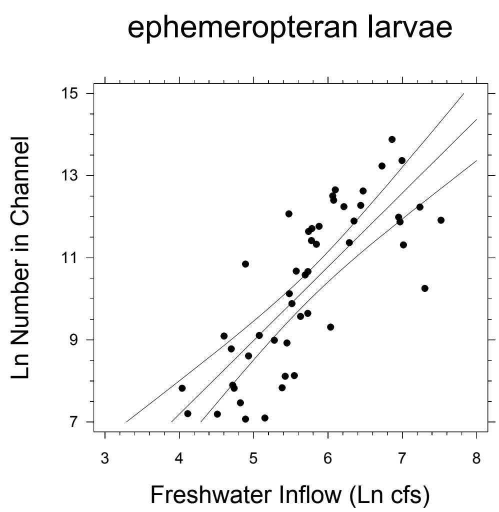


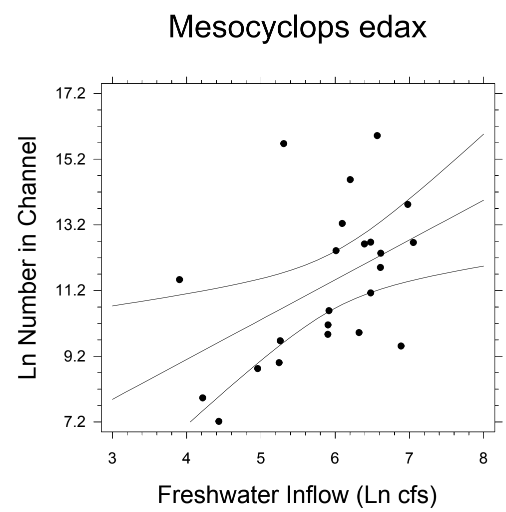
Syngnathus scovelli juveniles

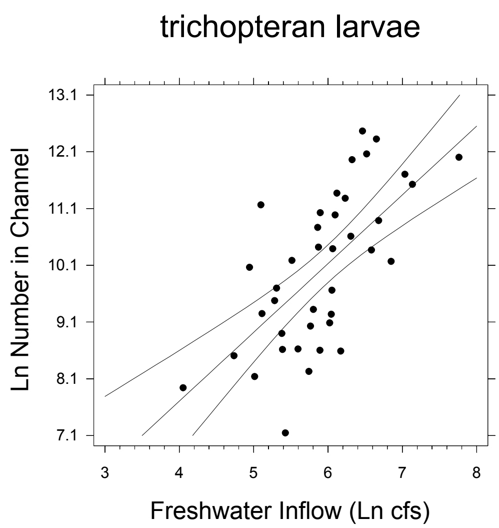


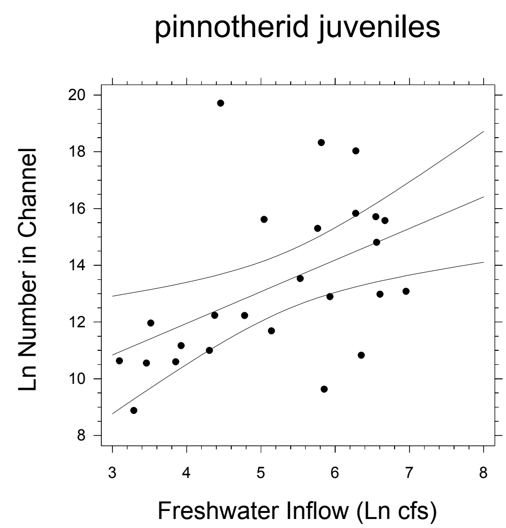
Appendix C:

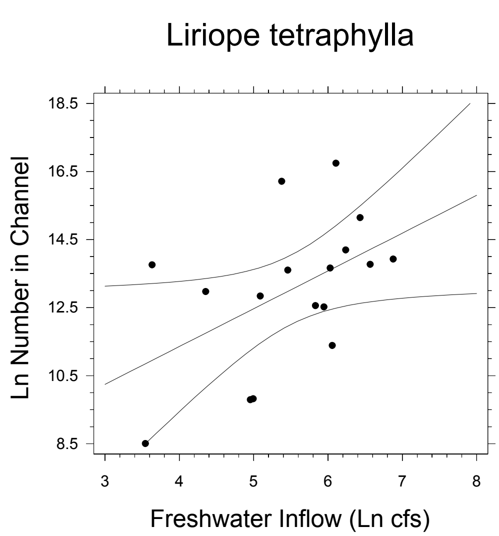
Plots of the regressions in Table 3.7.1

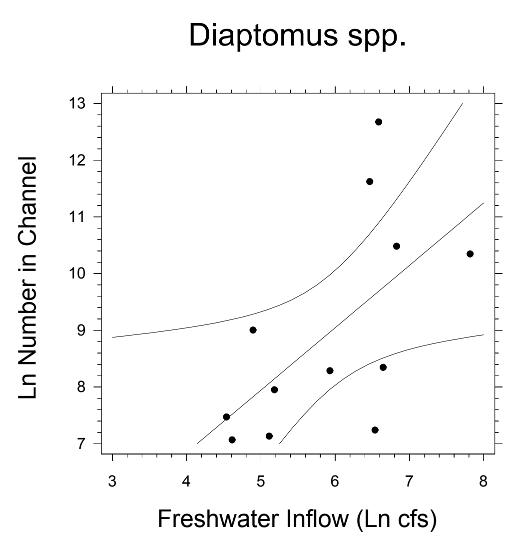

ephemeropteran larvae
Ln Number in Channel
Freshwater Inflow (Ln cfs)
15
13
11
9
7
3 4 5 6 7 8

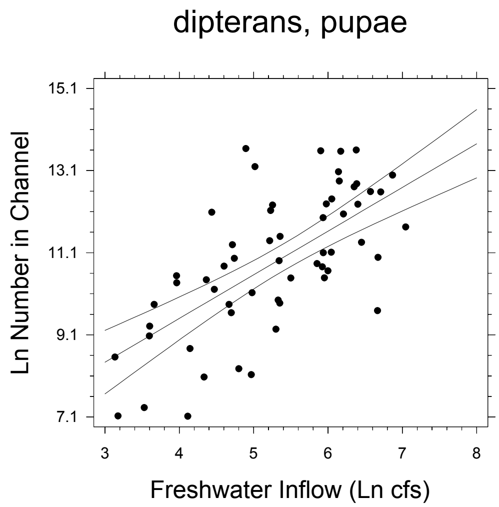

Mesocyclops edax
Ln Number in Channel
Freshwater Inflow (Ln cfs)
17.2
15.2
13.2
11.2
9.2
7.2
3 4 5 6 7 8

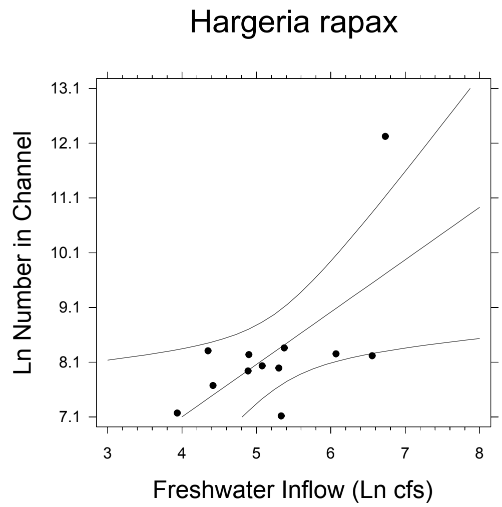

trichopteran larvae
Ln Number in Channel
Freshwater Inflow (Ln cfs)
13.1
12.1
11.1
10.1
9.1
8.1
7.1
3 4 5 6 7 8

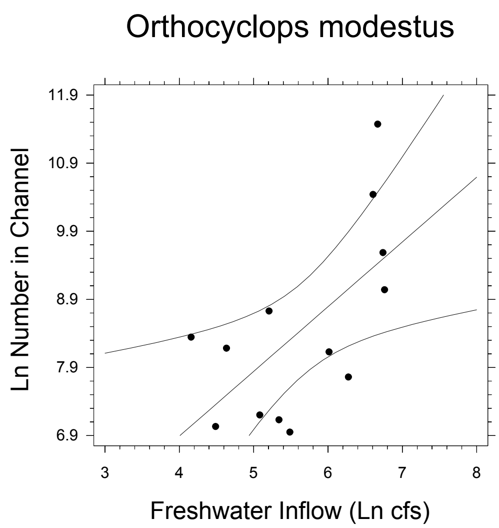

pinnotherid juveniles
Ln Number in Channel
Freshwater Inflow (Ln cfs)
20
18
16
14
12
10
8
3 4 5 6 7 8

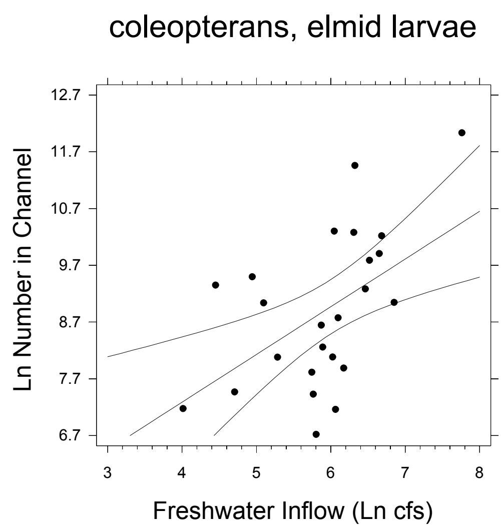

Liriope tetraphylla
Ln Number in Channel
Freshwater Inflow (Ln cfs)
18.5
16.5
14.5
12.5
10.5
8.5
3 4 5 6 7 8

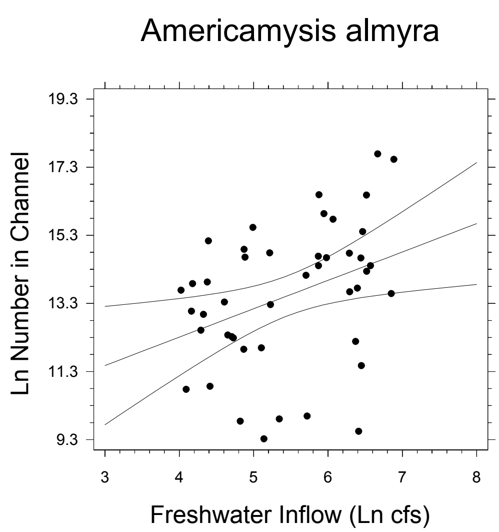

Diaptomus spp.
Ln Number in Channel
Freshwater Inflow (Ln cfs)
13
12
11
10
9
8
7
3 4 5 6 7 8

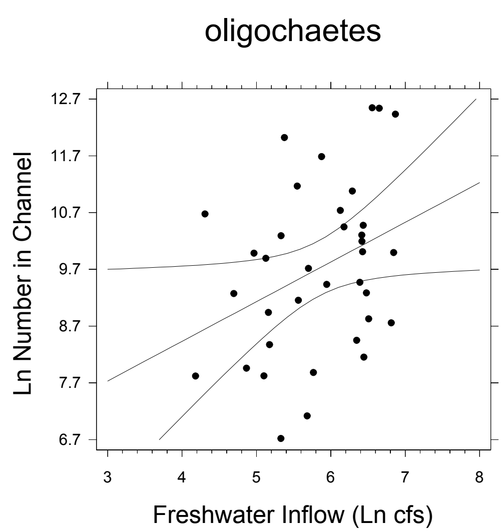

dipterans, pupae
Ln Number in Channel
15.1
13.1
11.1
9.1
7.1
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)

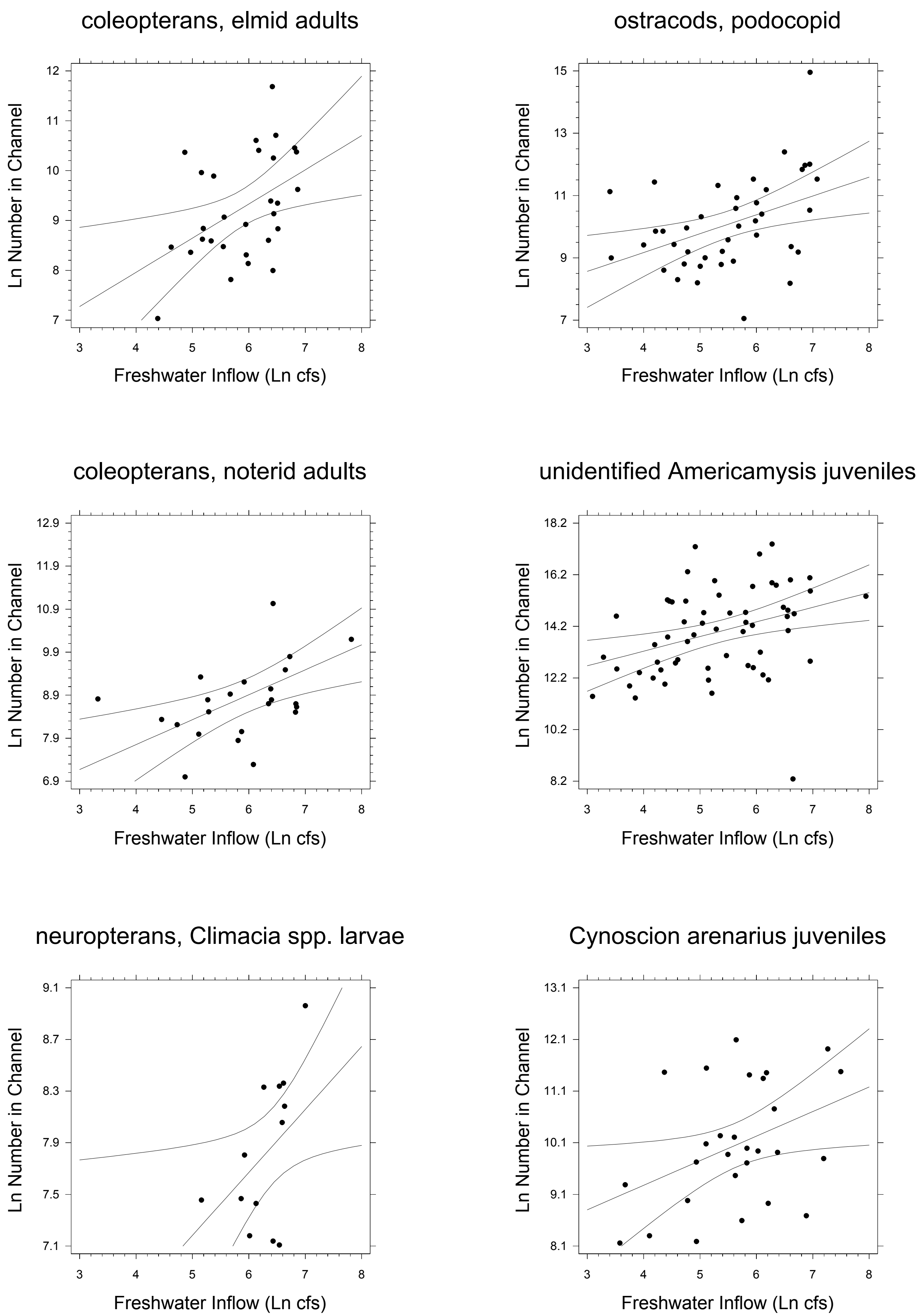

Hargeria rapax
Ln Number in Channel
13.1
12.1
11.1
10.1
9.1
8.1
7.1
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)


Orthocyclops modestus
Ln Number in Channel
11.9
10.9
9.9
8.9
7.9
6.9
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)


coleopterans, elmid larvae
Ln Number in Channel
12.7
11.7
10.7
9.7
8.7
7.7
6.7
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)

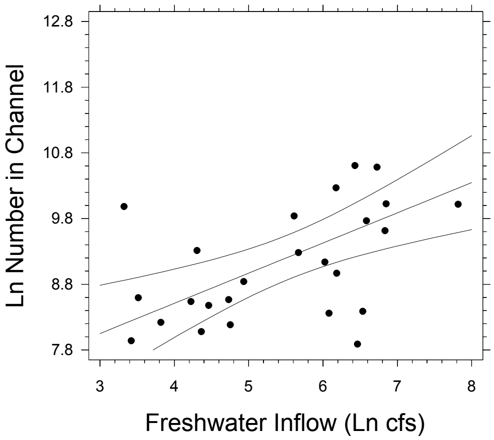

Americamysis almyra
Ln Number in Channel
19.3
17.3
15.3
13.3
11.3
9.3
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)


oligochaetes
Ln Number in Channel
12.7
11.7
10.7
9.7
8.7
7.7
6.7
3
4
5
6
7
8
Freshwater Inflow (Ln cfs)

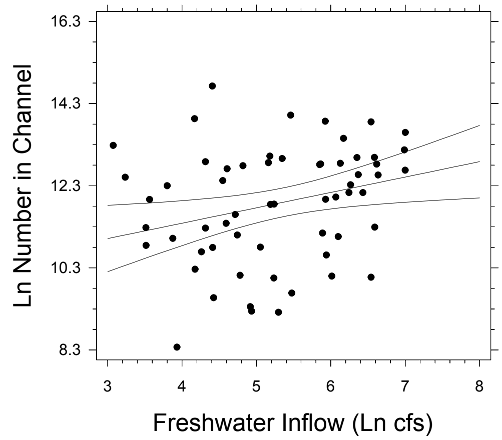


coleopterans, elmid adults
ostracods, podocopid
coleopterans, noterid adults
unidentified Americamysis juveniles
neuropterans, Climacia spp. larvae
Cynoscion arenarius juveniles
Ln Number in Channel
Freshwater Inflow (Ln cfs)

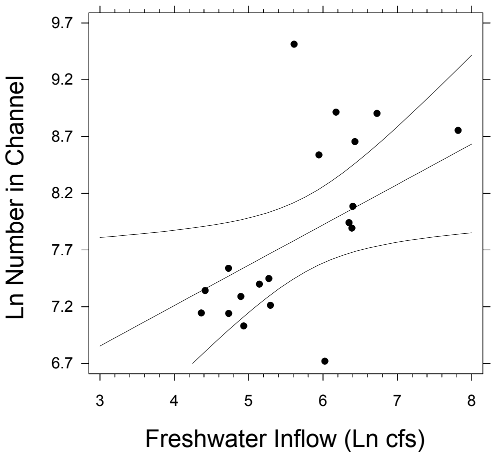
Palaemonetes pugio adults



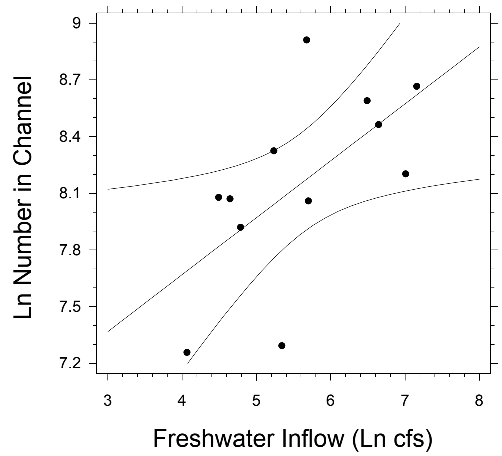
gastropods, prosobranch



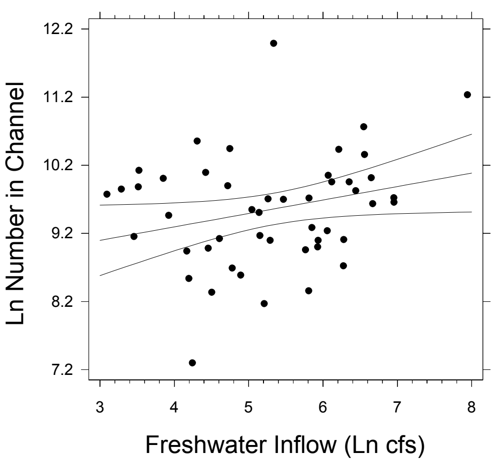
odonates, zygopteran larvae



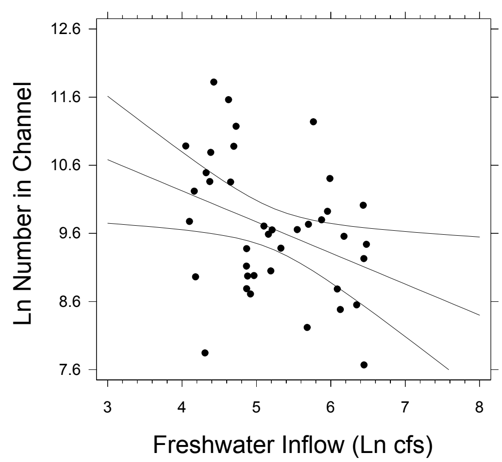
lepidopterans, pyralid larvae



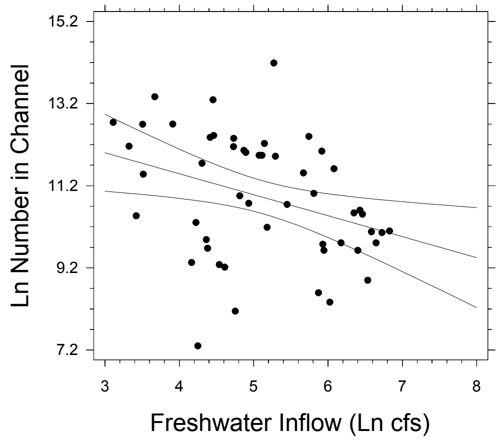
hirudinoideans



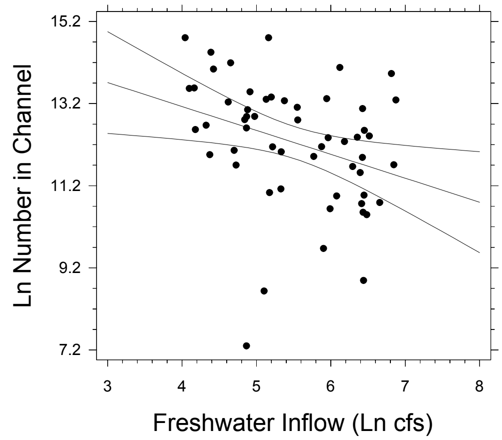
branchiurans, Argulus spp.



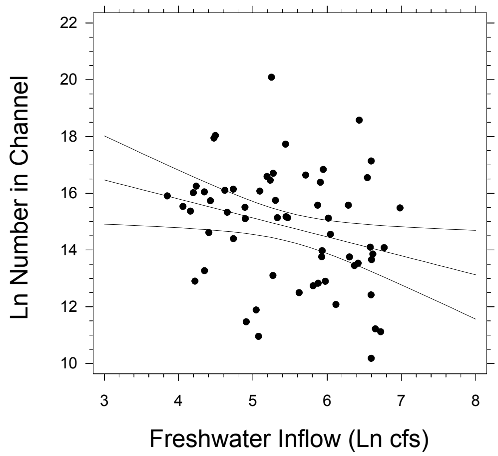
siphonostomatids



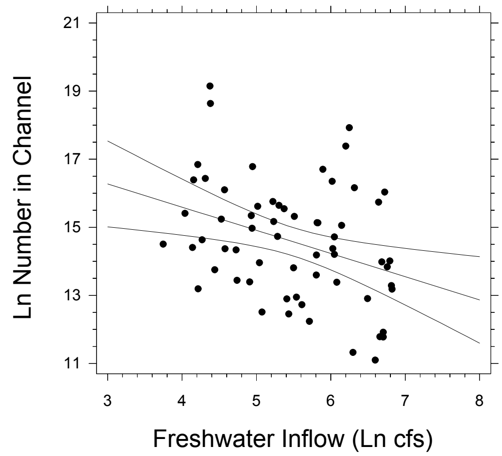
Palaemonetes spp. postlarvae



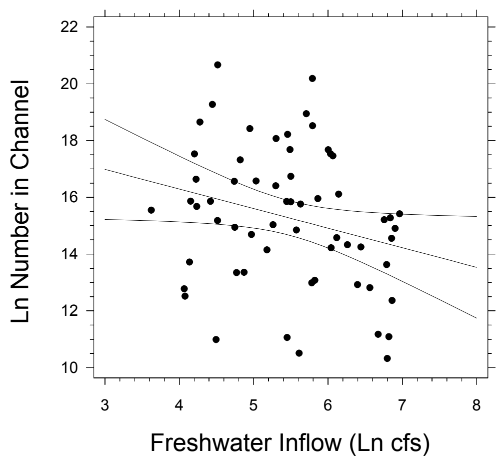
decapod mysis



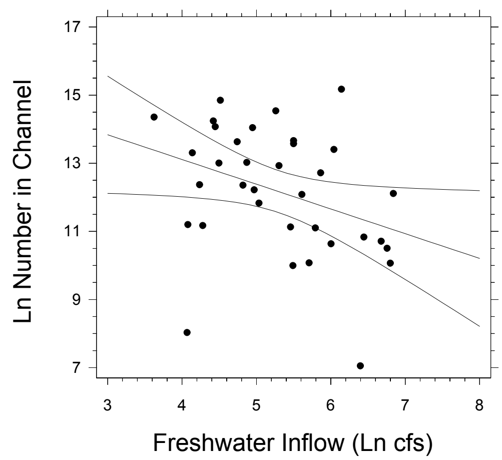
amphipods, gammaridean



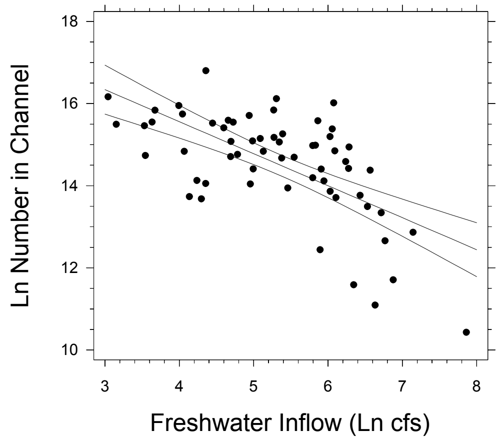
cumaceans



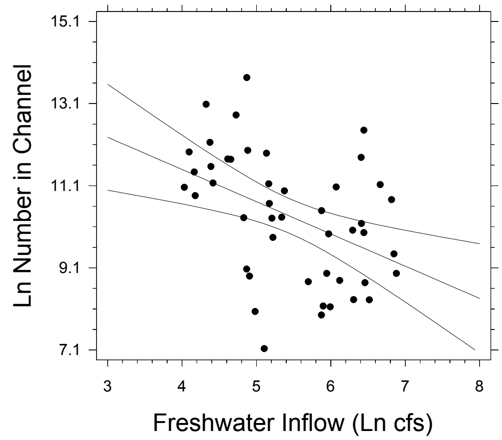
Anchoa mitchilli postflexion larvae



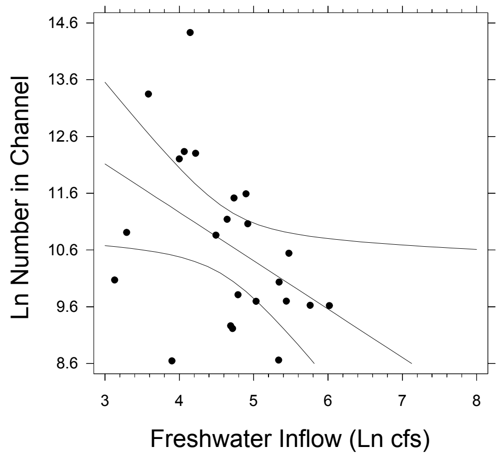
cymothoid sp. a (Lironeca) juveniles



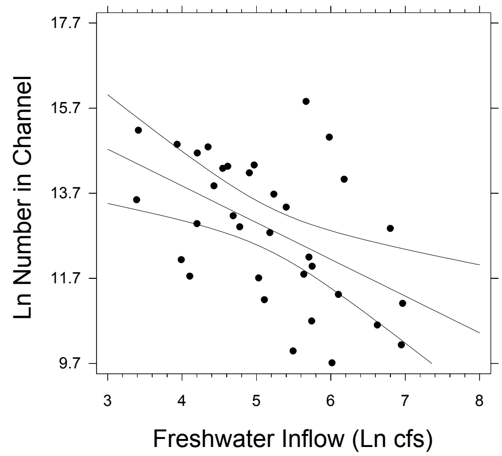
gobiid flexion larvae



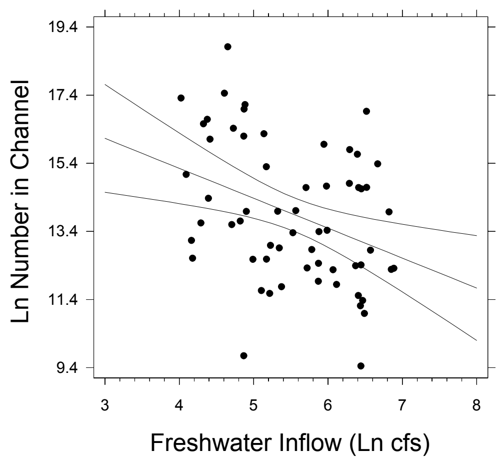
Limulus polyphemus larvae



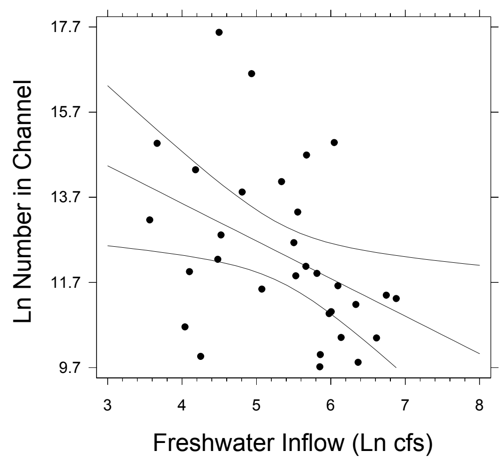
Anchoa spp. flexion larvae



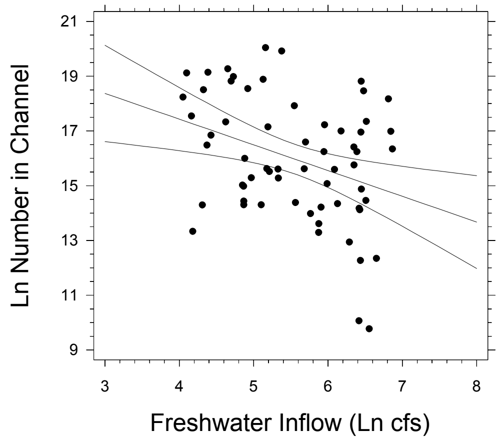
Edotea triloba



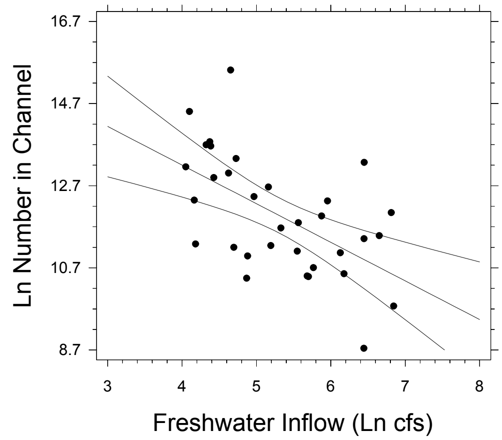
Petrolisthes armatus juveniles



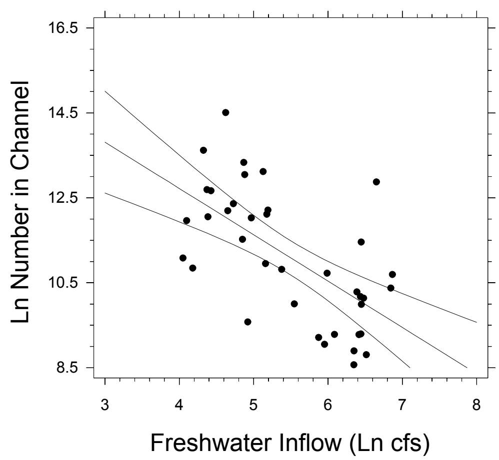
chaetognaths, sagittid



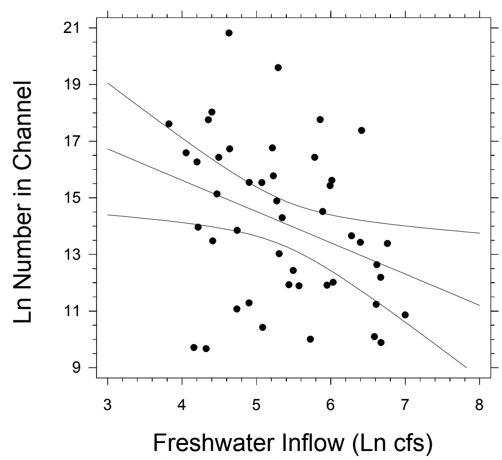
alphaeid postlarvae



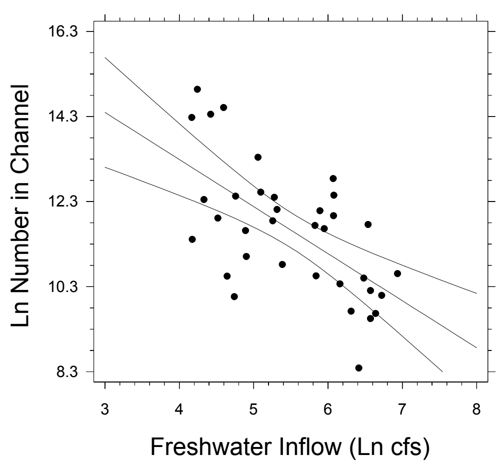
gobiid preflexion larvae



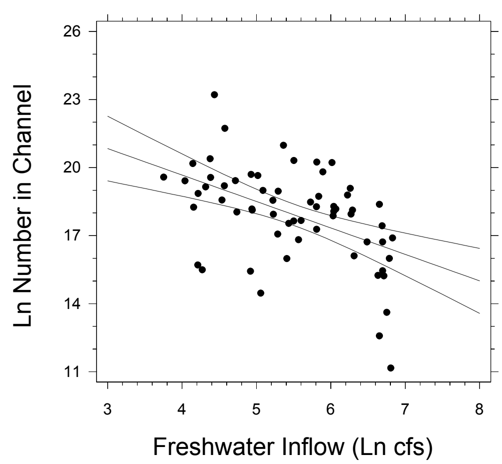
Lucifer faxoni juveniles & adults



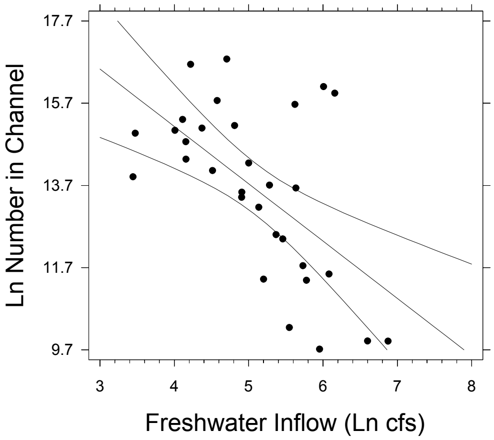
Pseudodiaptomus coronatus



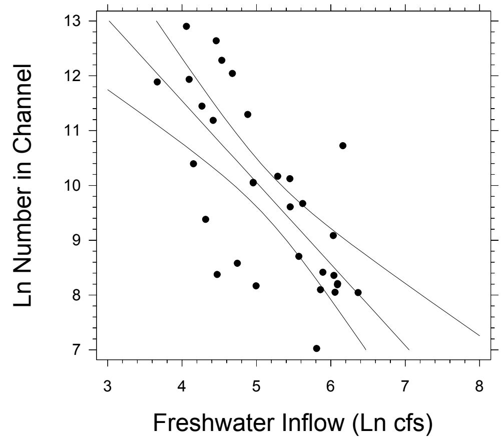
decapod zoeae



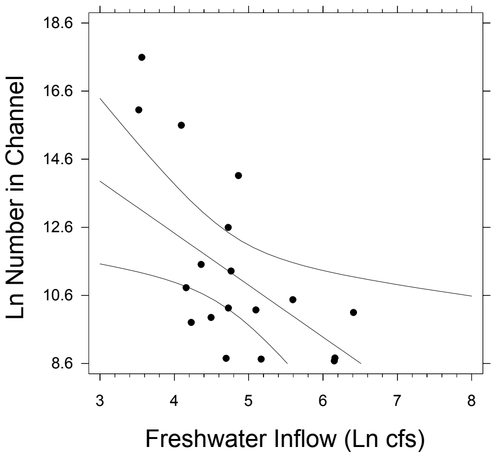
Anchoa spp. preflexion larvae



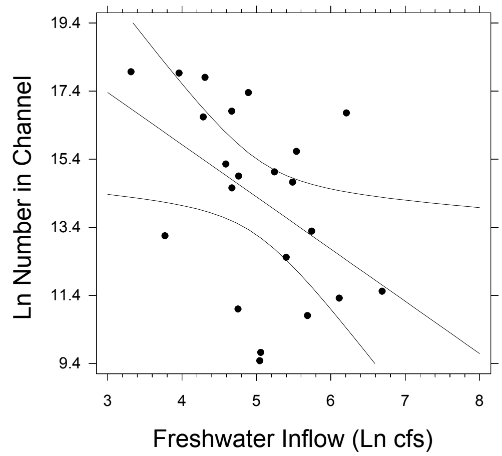
Microgobius spp. flexion larvae



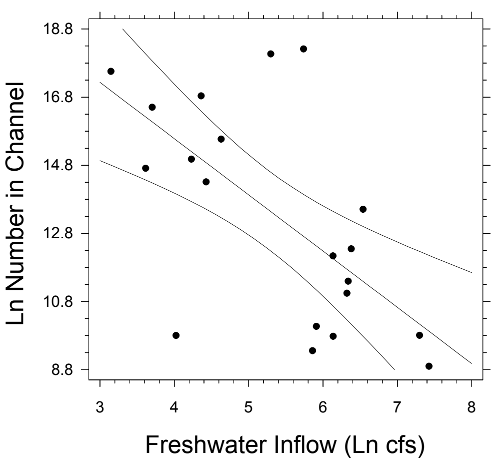
amphipods, caprellid



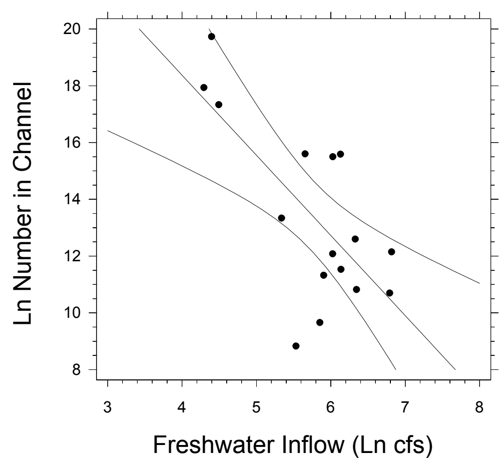
appendicularian, Oikopleura dioica



Mnemiopsis mccradyi



brachiopod, Glottidia pyramidata

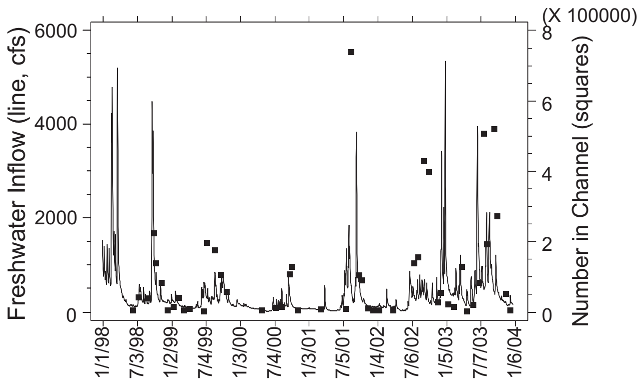


Appendix D:

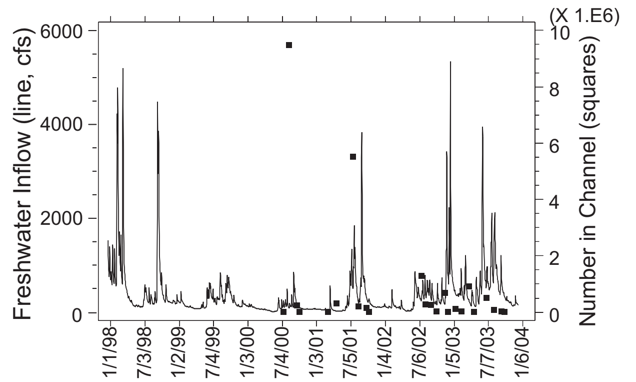
Time-series plots of abundance and freshwater inflow

* indicates that a higher taxonomic resolution was used during the HBMP surveys

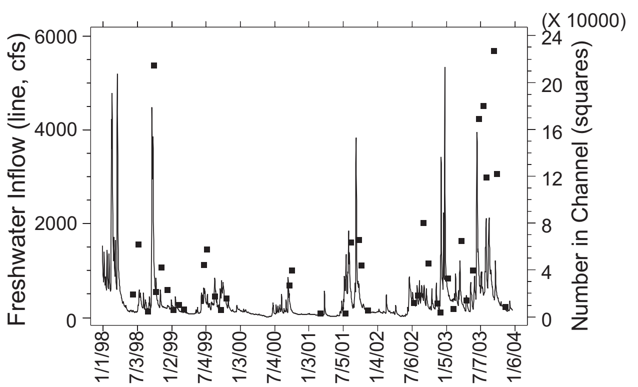
ephemeropteran larvae



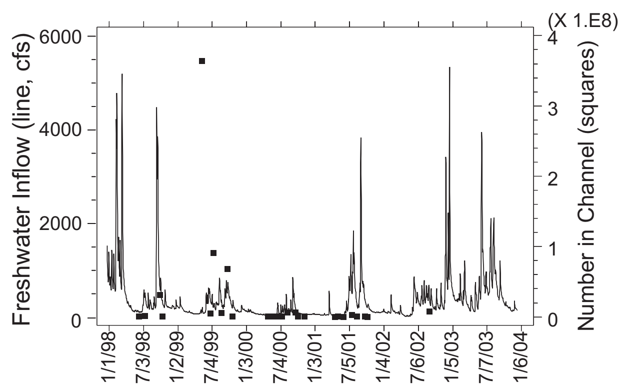
Mesocyclops edax*



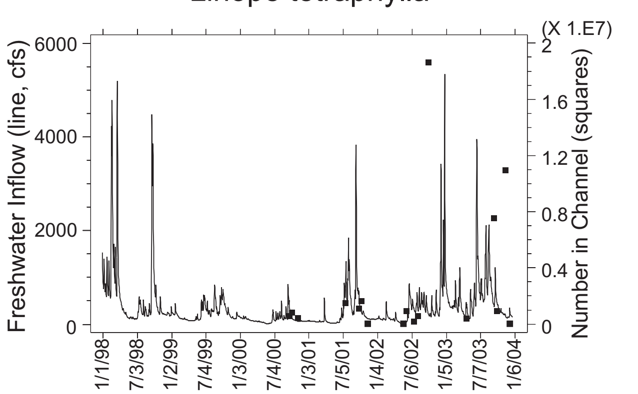
trichopteran larvae



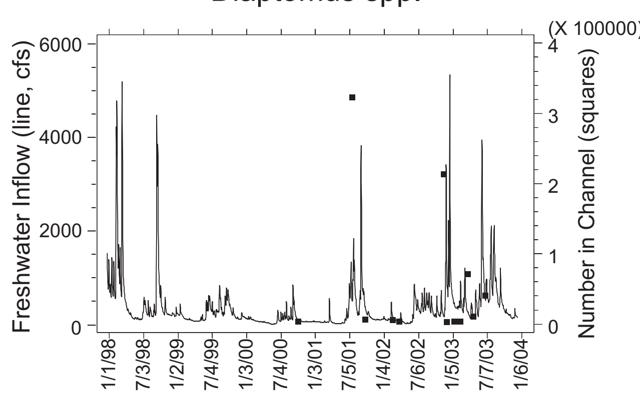
pinnotherid juveniles



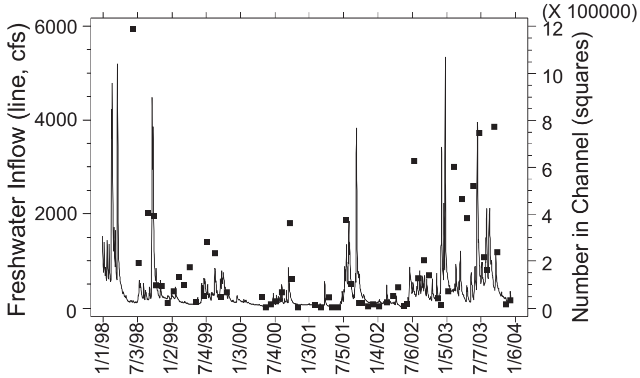
Liriope tetraphylla*



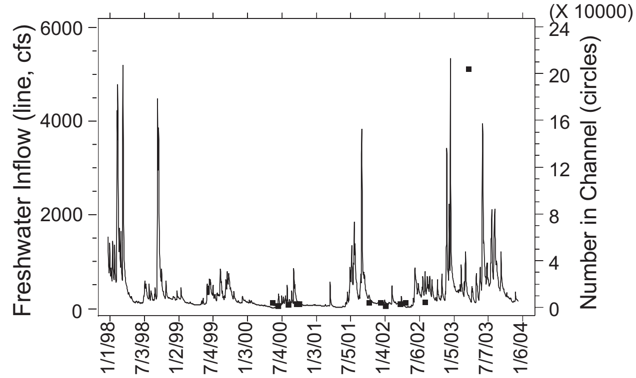
Diaptomus spp.*



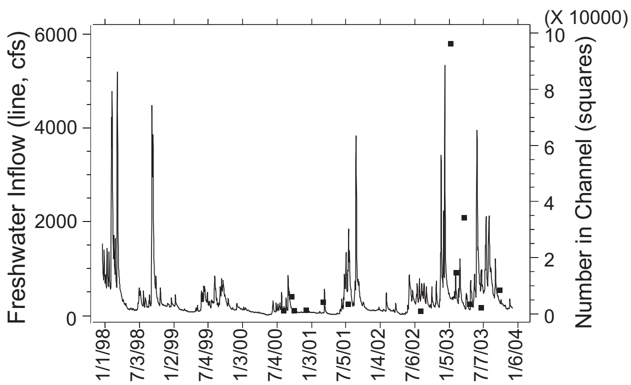
dipterans, pupae



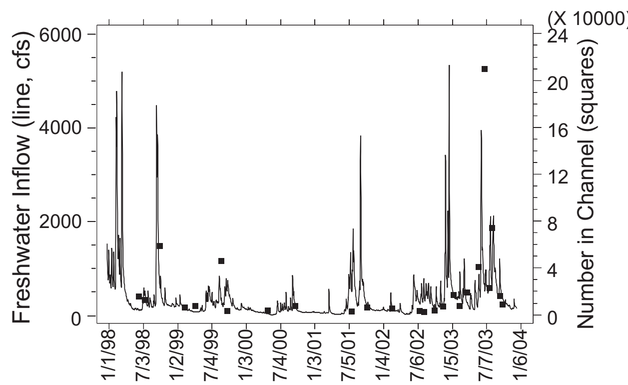
Hargeria rapax



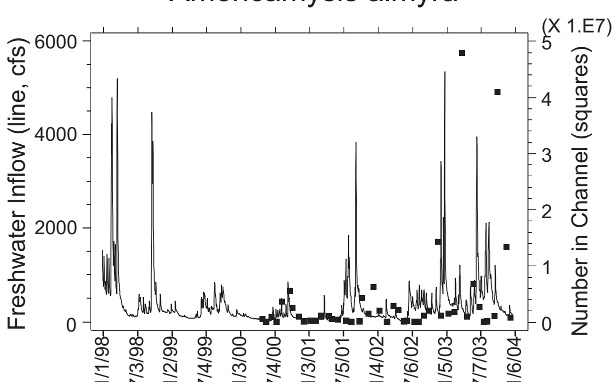
Orthocyclops modestus



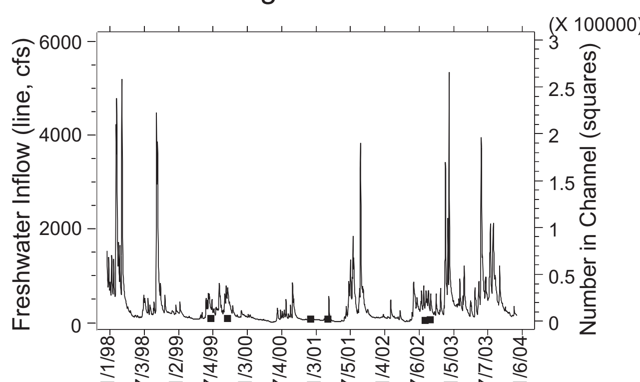
coleopterans, elmid larvae



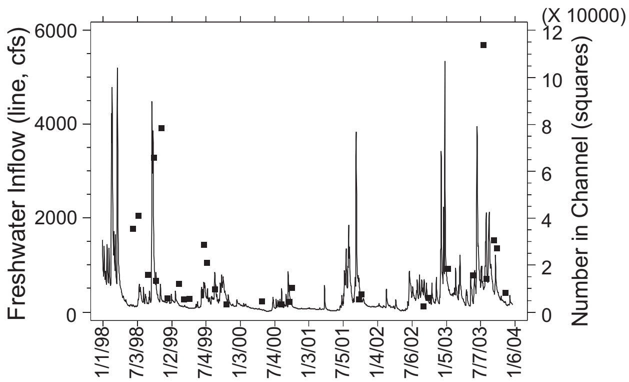
Americamysis almyra*



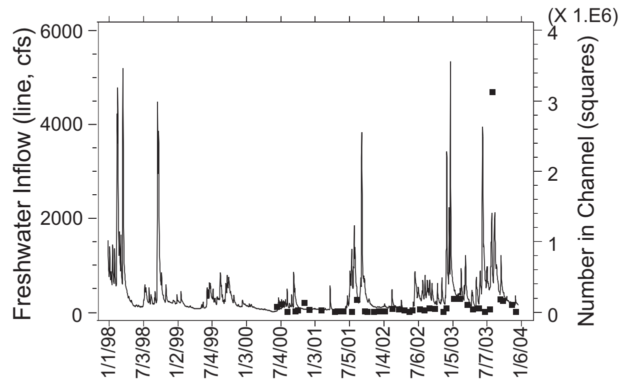
oligochaetes



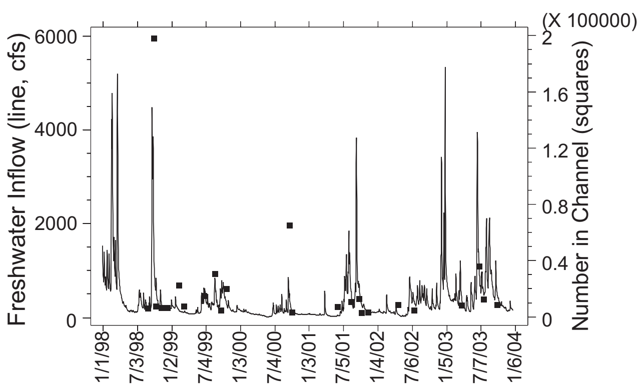
coleopterans, elmid adults



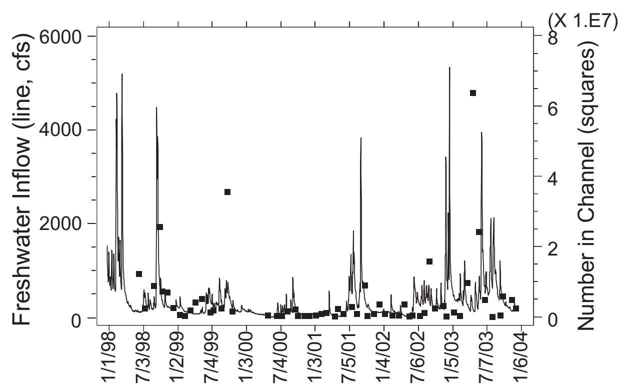
ostracods, podocopid*



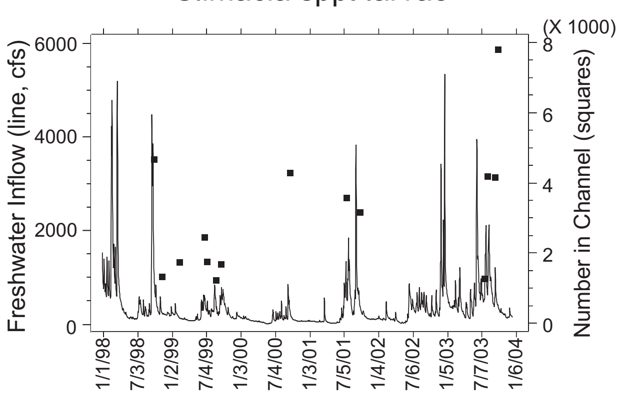
coleopterans, noterid adults



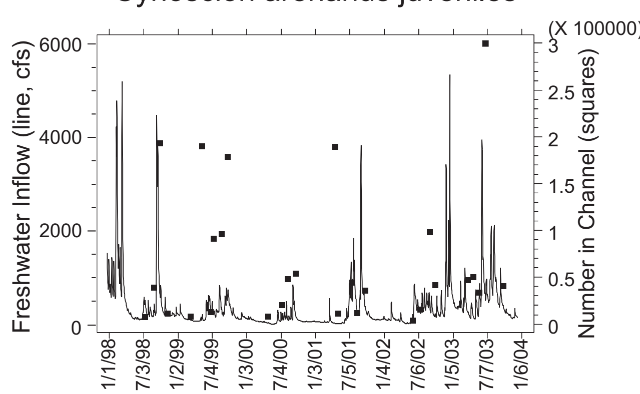
Americamysis juveniles



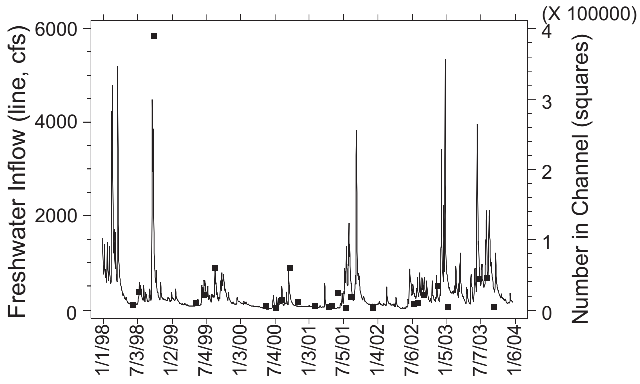
Climacia spp. larvae



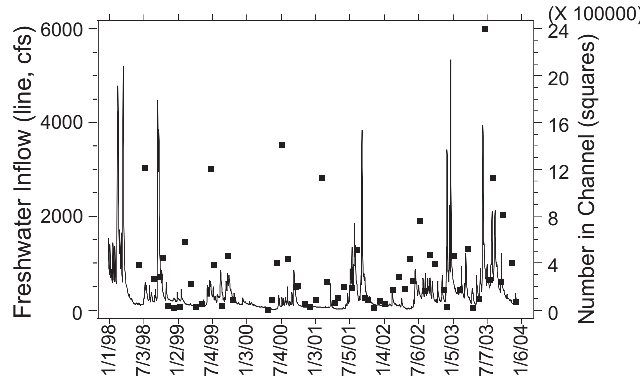
Cynoscion arenarius juveniles



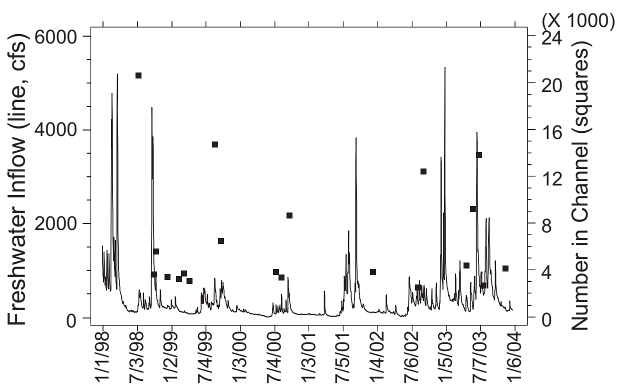
Palaemonetes pugio adults



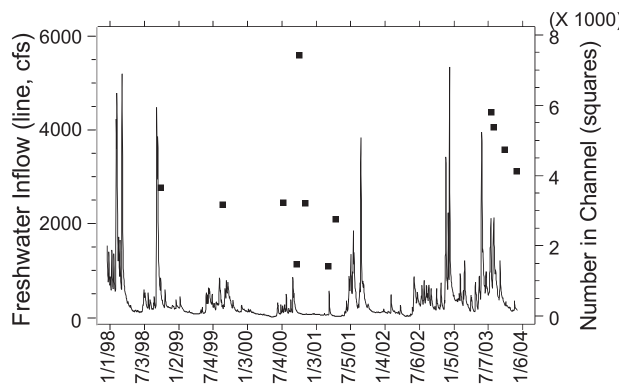
gastropods, prosobranch



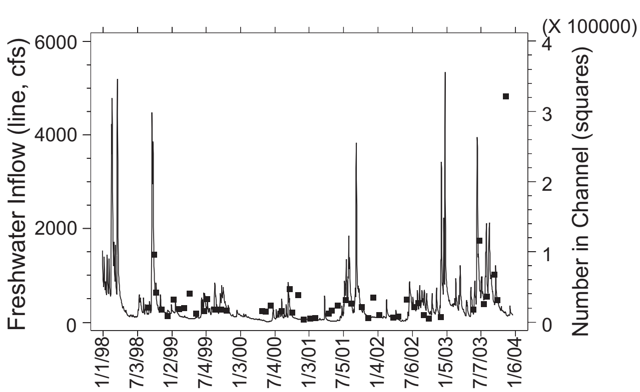
odonates, zygopteran larvae



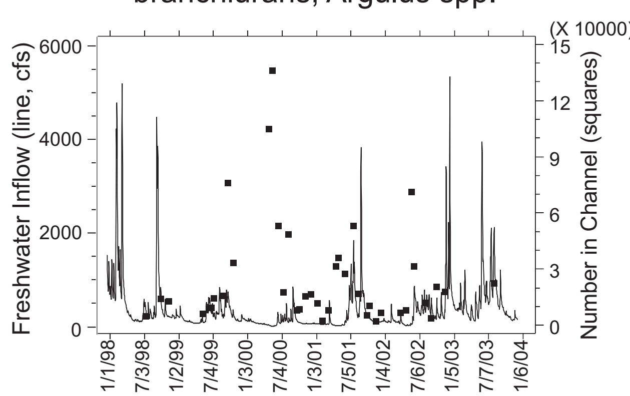
Lepidopterans, pyralid larvae



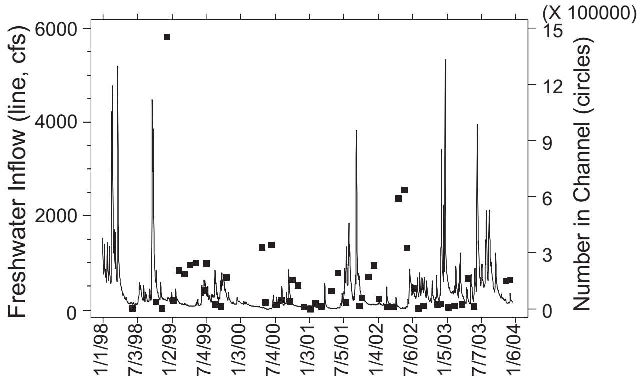
hirudinoideans



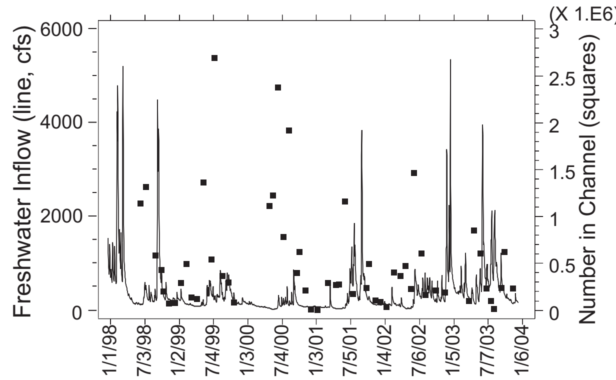
branchiurans, Argulus spp.



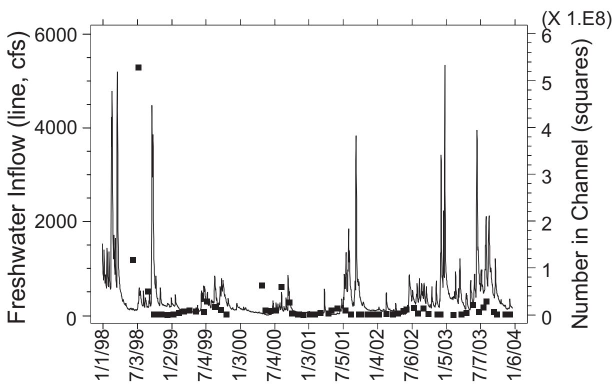
siphonostomatids



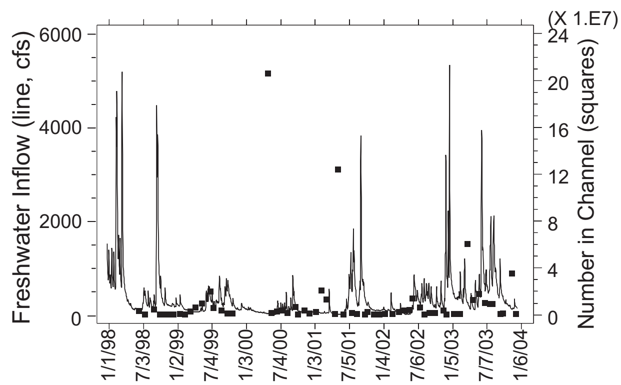
Palaemonetes spp. postlarvae



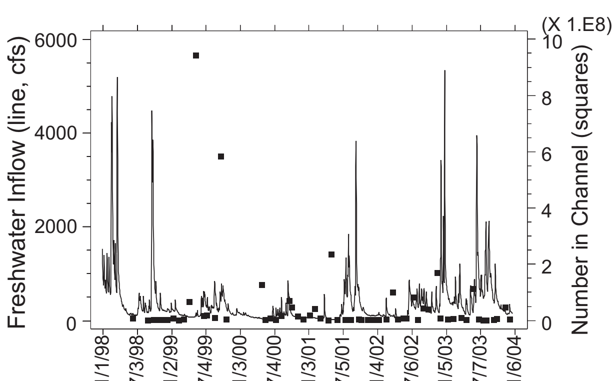
decapod mysis larvae



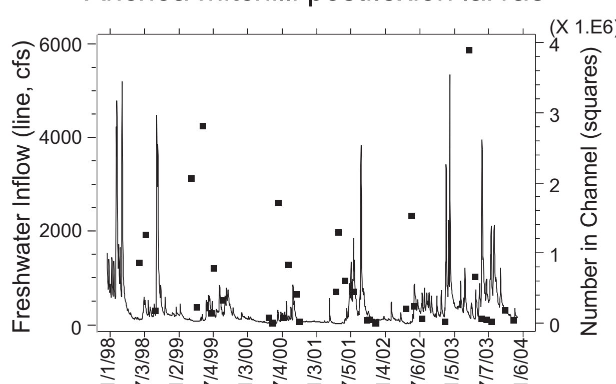
amphipods, gammaridean



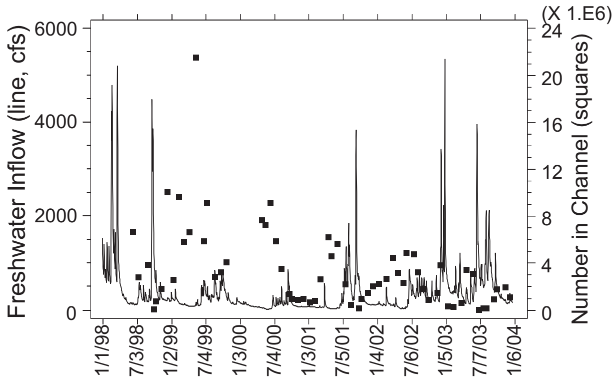
cumaceans



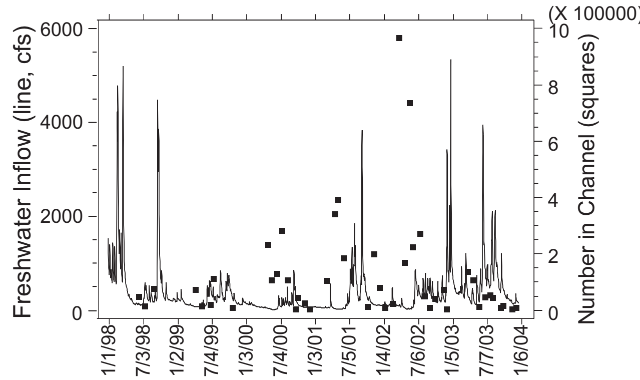
Anchoa mitchilli postflexion larvae



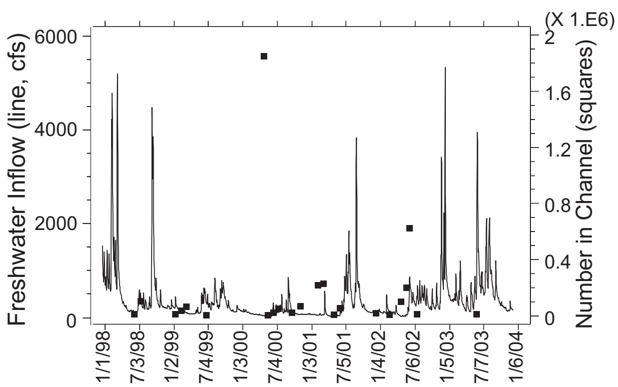
cymothoid (Lironeca sp.)



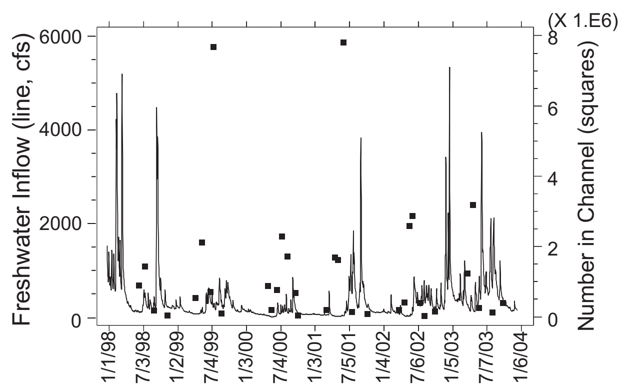
gobiid flexion larvae



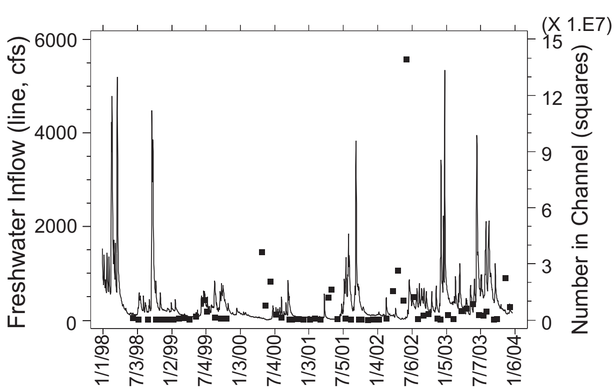
Limulus polyphemus larvae



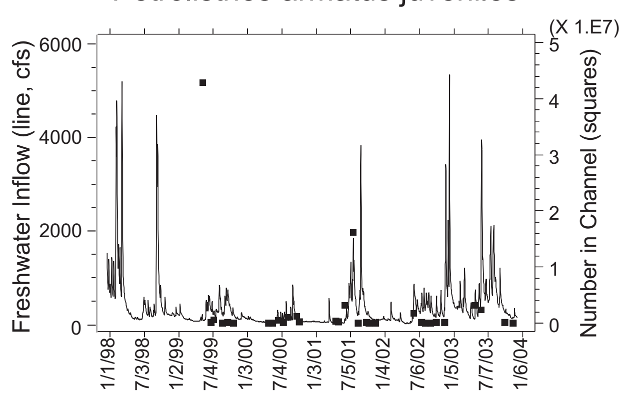
Anchoa spp. flexion larvae



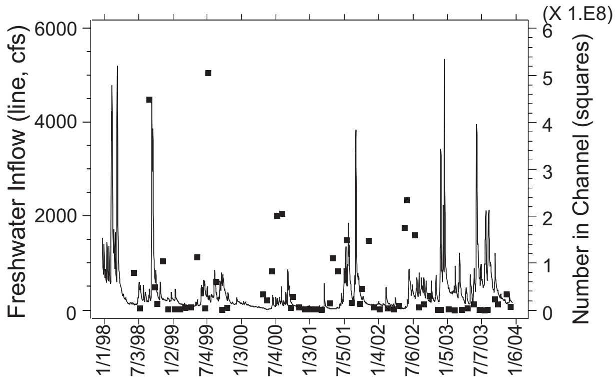
Edotea triloba



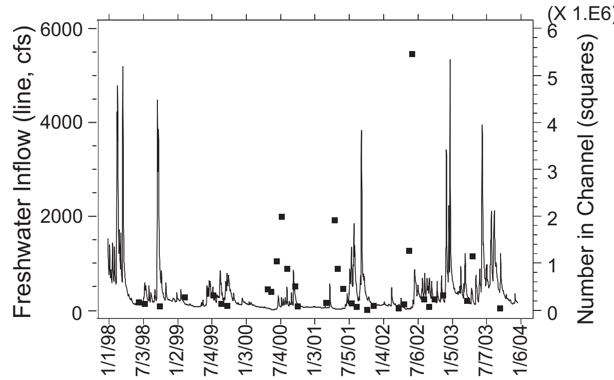
Petrolisthes armatus juveniles



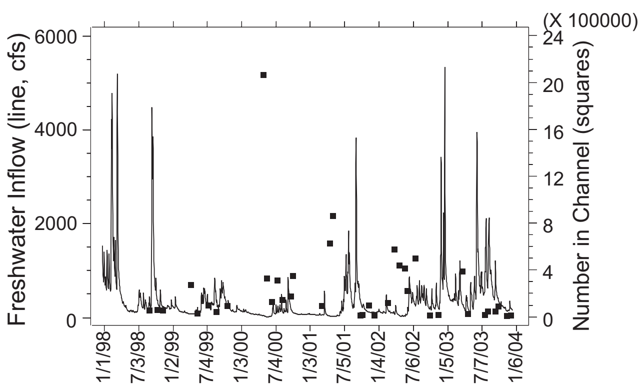
chaetognaths, sagittid



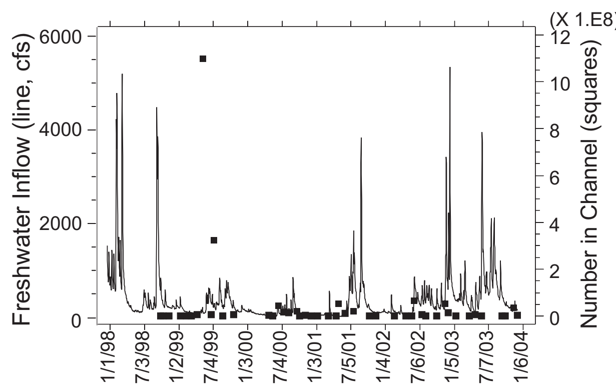
alphaeid postlarvae



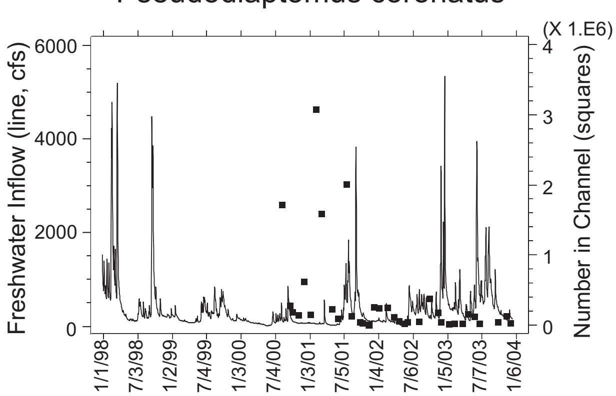
gobiid preflexion larvae



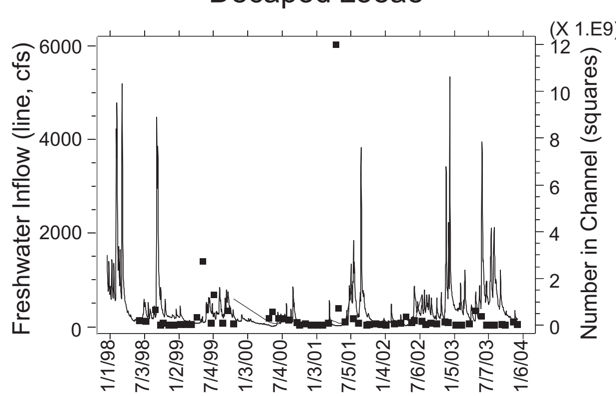
Lucifer faxoni

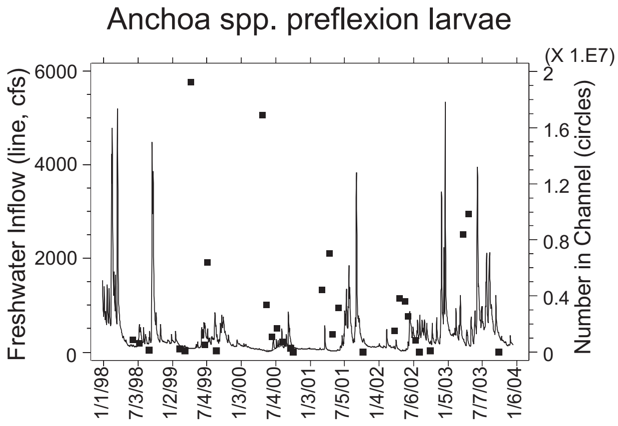


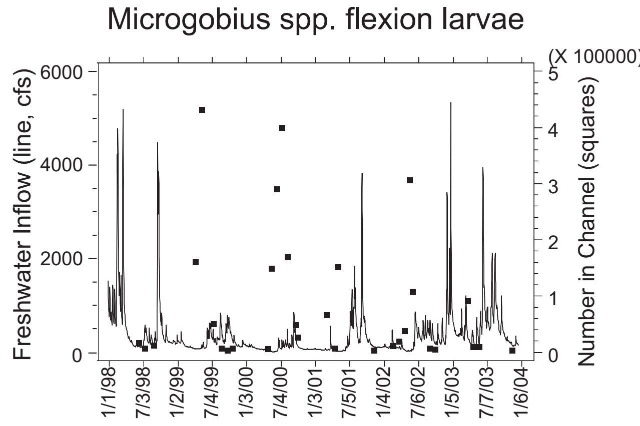
Pseudodiaptomus coronatus*

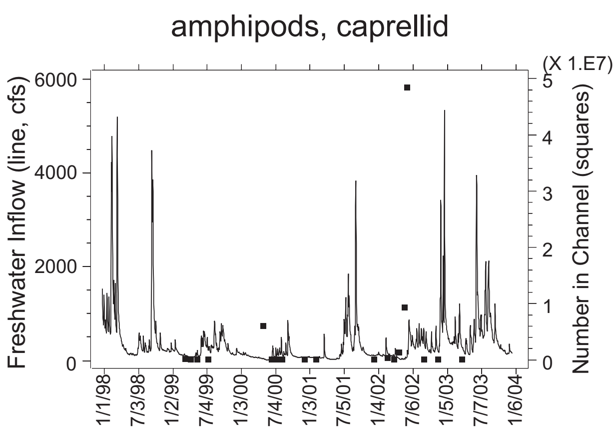


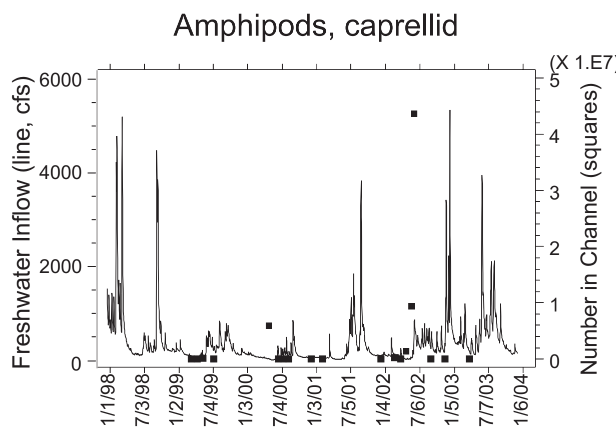
Decapod zoeae

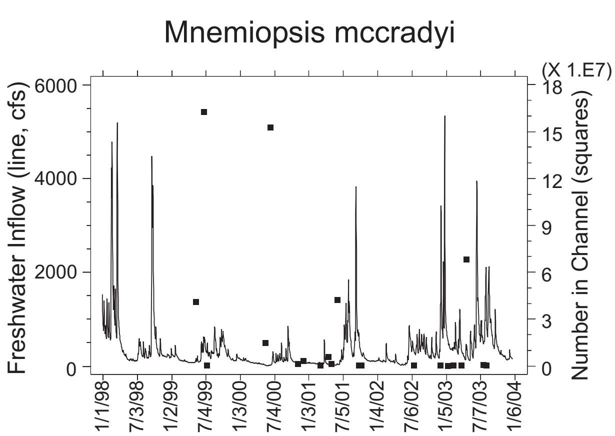


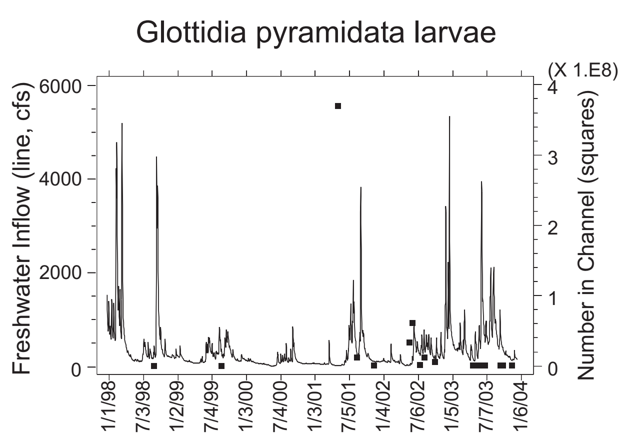

Anchoa spp. preflexion larvae
Freshwater Inflow (line, cfs)
Number in Channel (circles)
(X 1.E7)
0
2000
4000
6000
0
0.4
0.8
1.2
1.6
2
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04


Microgobius spp. flexion larvae
Freshwater Inflow (line, cfs)
Number in Channel (squares)
(X 100000)
0
2000
4000
6000
0
1
2
3
4
5
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04


amphipods, caprellid
Freshwater Inflow (line, cfs)
Number in Channel (squares)
(X 1.E7)
0
2000
4000
6000
0
1
2
3
4
5
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04


Amphipods, caprellid
Freshwater Inflow (line, cfs)
Number in Channel (squares)
(X 1.E7)
0
2000
4000
6000
0
1
2
3
4
5
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04


Mnemiopsis mccradyi
Freshwater Inflow (line, cfs)
Number in Channel (squares)
(X 1.E7)
0
2000
4000
6000
0
3
6
9
12
15
18
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04


Glottidia pyramidata larvae
Freshwater Inflow (line, cfs)
Number in Channel (squares)
(X 1.E8)
0
2000
4000
6000
0
1
2
3
4
1/1/98
7/3/98
1/2/99
7/4/99
1/3/00
7/4/00
1/3/01
7/5/01
1/4/02
7/6/02
1/5/03
7/7/03
1/6/04

Anchoa mitchilli juveniles