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Long-term Feeding Ecology of Early-stage Striped Bass (Morone saxatilis) and American Shad (Alosa sapidissima) in the Hudson River Estuary

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TABLE OF CONTENTS

PREFACE

Feeding ecology of fishes

Studying the feeding ecology of fishes is particularly interesting because fish show a wide variety of body forms, morphology, habitats usage, and predatory strategies. There has long been an interest in what, where, when, and how fish are feeding in nature. Furthermore, fish are represented on practically every trophic level and are present in the majority of aquatic and marine habitats. In addition to basic diet characterization, diet analyses also provide insight towards broader subjects such as population dynamics (Braga et al. 2012), habitat use (Feitosa & Ferreira 2015), evolution (Collar et al. 2009), energy flow between ecosystems (Baxter et al. 2005), and conservation (Alcaraz et al. 2015; Donadelli et al. 2015).

Early feeding ecology studies mainly focused on basic characterization of food habits (Braga et al. 2012). As our understanding of ecosystems advanced, diet studies shifted towards a more community-based approach. Study trends have transitioned towards using feeding ecology studies to understand community structure (Alfaro et al. 2006), intra- and interspecies interactions (Platell & Potter 2001), niche breadth and overlap (Llopiz & Cowen 2009), and overall food web structure (Vander Zanden & Vadeboncoeur 2002). Additionally, the proportion of studies investigating the feeding ecology of larval fishes have increased since the 1950s (Fig 1). Larval fish feeding has not been studied as much as that of adults because of their size and associated difficulties in working with fragile fish (Gerking 1994).

Studying larval fish diet is particularly important because their diet is often vastly different that the adult stage. In terms of feeding, larval fish have been depicted as essentially "separate species" when compared to their adult forms (Gerking 1994). Besides feeding on different food types, young fishes must rely on different feeding strategies to search, find, and

ingest food. Nutrition for larval fishes starts with endogenous food (yolk) and transitions to exogenous foods (e.g. plankton). Larval fish must rely on smaller exogenous sources, such as algae or diatoms, since their mouth sizes are relatively small. Larvae feed upon larger sized prey items as they increase in length and weight (Gerking 1994). Larval feeding success can depend on a multitude of factors including light intensity (Batty 1987), temperature (Blaxter 1991), location (Llopiz & Cowen 2009; Llopiz 2013), and prey density (Parra & Yúfera 2000).

Although larval fish feeding ecology has been studied in detail over the last 20 some years, several areas require more research. As anthropogenic impacts continue to increase throughout the planet, factors such as climate change, habitat loss, water pollution, and invasive species present potential impacts to larval feeding and survival. More research is also necessary to understand how fish feeding ecology changes long-term in response to different factors. Given the variable nature of aquatic and marine systems, long-term feeding ecology studies can provide numerous values and benefits. Long-term data is critical for quantifying ecological response to environmental changes, understanding expression of key ecological trends, providing core data for parameterizing models, influencing management of species or ecosystems, and acting as the basis of collaborative studies (Lindenmayer et al. 2012).Continually studying fish feeding ecology in a long-term sense will provide researches and managers opportunities to make more informed management decisions as well as aid in conservation efforts.

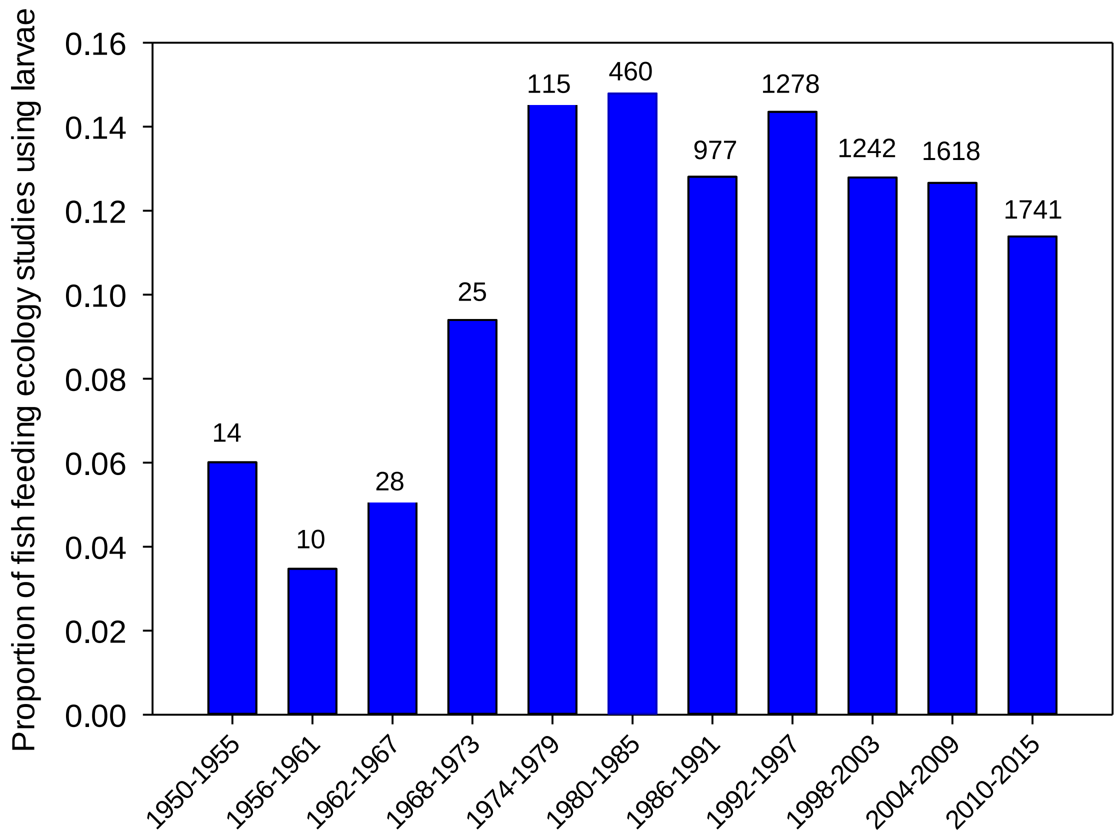

Fig 1 Proportion of fish feeding ecology studies investigating larval fish feeding . The number of publications was determined using Web of Science search engine. Search criteria used included "fish feeding ecology", which was then subsetted with a "larvae OR larval" search. The proportion was calculated as the number of search hits for "larvae OR larval" divided by the number of fish feeding ecology studies. The number of publications is represented above each bar.

Invasive species impacts on fish feeding ecology

Marine and aquatic species invasions are increasing at unprecedented rates as anthropogenic impacts increase around the planet (Bax et al. 2001; Ruiz et al. 1997; Ruiz et al. 2000; Strayer 2010). The International Union for Conservation of Nature (IUCN) defines invasive species as species that have been introduced to an environment where it is non-native, or alien, and whose introduction causes environmental or economic damage or harm to human health. Invasive species can reduce biological diversity (Hejda et al. 2009), change habitat structure (Didham et al. 2007), introduce new diseases (Crowl et al. 2008), and alter food webs (Strayer 2009). IUCN considers invasive species introductions second to habitat loss and degradation on a list of main threats to biodiversity. Some researchers have even described invasive species as the leading cause of animal extinctions worldwide (Clavero et al. 2005). The economic impacts of invasions are also astonishing, with nearly $120 billion per year in the United States attributed to major environmental damages and lose (Pimentel et al. 2005). Invasive species are a threat to nearly all bodies of water and understanding potential effects and outcomes are a major research priority.

Estuary systems are particularly susceptible to species invasions because they are typically areas of congruence for major vectors, such as shipping and boating (Williams & Grosholz 2008). Estuaries are coastal areas that represent a transition zone between the marine and river environments, and a critical nursery habitat for larval fishes (MacLusky & Elliott 2004). The dynamics behind estuaries, larval fishes, and invasive species are complex and often understudied. Estuaries harbor larval fish, which grow to the economically important adult stage. Negative effects on larval stages can impact year-class strength and untimely the overall

health of economically important fish stocks. One area of study that needs more attention is the impacts of invasive species on early stage fish feeding ecology.

Interestingly, relatively few studies have investigated the effects of invasive species on the feeding ecology of larval fishes. Paolucci et al. (2015) found that invasive bivalve veligers replaced the original prey of native fish larvae in the Paraguay and Parana Rivers. A similar result was found in the Hudson River, where larval American Shad fed heavily on invasive zebra mussel veligers (Nack et al. 2015b). In the case of larval threadfin shad in Lake Mead, Nevada, the quagga mussel invasion has yet to reveal significant effects on shad diet (Loomis et al. 2011). Studies investigating the impacts of invasive species on adult fish feeding ecology are more common and have produced mixed results. Zebra mussels in the Great Lakes caused Lake Whitefish and Alewives to shift their prey use away from native *Diporeia* (Pothoven et al. 2001; Pothoven & Madenjian 2008). In Long Island Sound, several species of fish have incorporated the Asian shore crab (*Hemigrapsus sanguineus*) into their diet (Heinonen & Auster 2012). Introduction of invasive smallmouth and rock bass in Canadian lakes lowered the overall trophic feeding position of native lake trout (Vander Zanden et al. 1999). It is clear that the effects of invaders on fish species are highly specific to the local ecosystem or native species. Through various processes, such as shifts in species composition, the effects of an invasive species can change over time. In order to best assess acute and chronic effects, researchers must adopt a long-term perspective (Strayer et al. 2006). Conducting long-term early stage fish feeding ecology studies in relation to invasive species will help future conservation and management of native species as well as a better understanding of long-term invasion dynamics.

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CHAPTER 1:Long-term feeding ecology of early-stage Striped Bass (*Morone saxatilis*) in the Hudson River estuary[1]

ABSTRACT

Estuaries are dynamic systems that act as nursery habitat for fishes that is critical to their survival and early development. Studying the feeding ecology of fish at this stage within estuaries provides insight towards a broad variety of fundamental aspects of larval fish diet including long-term feeding dynamics. We studied 14 years of early stage Striped Bass diet extending over a 25-year time span in the Hudson River estuary, including years of invasive zebra mussel impact which markedly altered energy flow within the estuary. We found copepods, amphipods, mysids, and *Leptodora* to constitute the highest prey-specific index of relative importance throughout the estuary. While feeding success varied significantly year to year, we did not find effects of zebra mussel invasion on the diet composition or feeding success of bass. We investigated what ecological variables most influenced long-term feeding success and found temperature, dissolved oxygen, chlorophyll *a* concentration, and copepod density to be most important in the estuary. We used the most inclusive of the top ‘best’ models in upriver and downriver sections of the estuary to estimate effect size on Striped Bass condition and found that in upriver samples, high levels of temperature, chlorophyll *a*, and copepod density resulted in a 26% increase in condition, whereas in downriver samples low levels of dissolved oxygen, high levels of copepod density and chlorophyll *a* led to a 11% increase in condition. This long-term study demonstrates the resilience of early-stage fish feeding ecology to a dramatic estuarine species invasion.

[1] Portions of this chapter have been submitted to Environmental Biology of Fishes.

INTRODUCTION

Estuaries are dynamic, variable systems with fluctuating biotic and abiotic factors. They are a transition zone between the marine and river environments and a critical nursery habitat for larval fishes (MacLusky & Elliott 2004). These systems are complex productive areas, in which fish aggregate to enhance growth and find favorable feeding conditions (Blaber & Blaber 1980; Friedland et al. 1996). Many early-stage coastal fish spend most of their time developing and feeding within estuaries. Food abundance as well as abiotic conditions can fluctuate greatly over space and time. Given the variable nature of estuary systems, long-term ecological studies can provide numerous values and benefits. Long-term data is critical for quantifying ecological response to environmental changes, understanding expression of key ecological trends, providing core data for parameterizing models, influencing management of species or ecosystems, and acting as the basis of collaborative studies (Lindenmayer et al. 2012). The goal of this study is to document the long-term feeding ecology of early-stage estuary-dependent Striped Bass (*Morone saxatilis*, Walbaum1792).

Studying fish feeding ecology addresses fundamental questions including what prey was consumed and when it was consumed. Diet analyses also provide insight towards broader subjects such as population dynamics (Braga et al. 2012), habitat use (Feitosa & Ferreira 2015), evolution (Collar et al. 2009), energy flow between ecosystems (Baxter et al. 2005), and conservation (Alcaraz et al. 2015; Donadelli et al. 2015). Characterizing the diet of early-stage fishes is particularly important because this life stage is when fish grow most rapidly and undergo ontogenetic shifts that are critical to survival. Generally the feeding of young fishes has not been studied as much as that of adults due to additional difficulties associated with collecting

and working with smaller fish (Gerking 1994). Additionally, knowledge of patterns in feeding ecologies of estuarine larvae relative to other habitats remains limited (Llopiz 2013).

The Hudson River estuary is a body of water that hosts many early stage fish species, including nearly a dozen diadromous fish species (Waldman 2006). The estuary is a complex, well-studied system with several long-term environmental data collection programs in place for multiple decades (see Levinton and Waldman 2006). The estuary has undergone major ecological changes throughout its recent history, including the invasion of zebra mussels (*Dreissena polymorpha*, Pallas 1771). Zebra mussels first appeared in the Hudson River in 1991, and have been abundant throughout the freshwater portion of the estuary since then (Strayer et al. 2011). The mussels sharply reduced phytoplankton biomass and markedly altered estuarine energy flow (Pace et al. 1998; Pace et al. 2010; Strayer et al. 2014b). Within the first two years of mussel establishment, total phytoplankton biomass declined 85% (Caraco et al. 1997), zooplankton biomass declined by more than 70%, (Pace et al. 1998), and zoobenthos biomass declined by 40% (Strayer & Smith 2001). Strayer et al. (2004) found multiple effects of zebra mussels on pelagic fish species, including a decrease in the growth rate of Striped Bass. After 2005, many mussel-induced ecological impacts within the river diminished towards pre-invasion levels (Strayer et al. 2014a). The effects of these changes on feeding success and diet composition of larval fish has not yet been studied.

The Hudson River Utilities Longitudinal River Survey, an ichthyoplankton plankton study begun in 1973, samples larval fishes to document the distribution and abundances of early life stages of fish species throughout the length of the estuary (ASA Analysis & Communication 2012). These larval fish samples have been archived and made available for research purposes through Normandeau Associates and the New York State Museum. One early-stage fish species

made available through the archived samples are Striped Bass. Striped Bass once represented a commercial fishery in the Hudson until it was closed in the mid-1970's because of PCB contamination (Waldman 2006). Today they are perhaps the most popular sport fish in the river. Striped Bass are anadromous, spending most of their adult life in marine waters and entering the estuary in the spring to spawn in the fresh waters of the middle and upper estuary (O'Connor et al. 2012). Bass are typically described as feeding opportunists (Hurst & Conover 2001), but at least one study documented selective feeding (Howe et al. 2008). Prior studies of larval bass diet showed that bass consumed mainly copepods, *Bosmina,* and amphipods (Brett & Groves 1979; Hurst & Conover 2001; Jordan et al. 2003; K. E. Limburg et al. 1997; Morgan et al. 1981).

The purpose of this study is to characterize Striped Bass diet composition and feeding success over a 25-year period in the Hudson River Estuary. We focus on three main goals: 1) to describe diet composition and evaluate feeding success over a multi-decade time span; 2) to test for effects of zebra mussels on the feeding ecology of bass; and, 3) determine what ecological factors most influence bass long-term feeding success. We predict reduced bass feeding success (i.e. reduced condition) and a change in diet composition during years of mussel impact. Given the variable nature of estuaries, we expect that changes in additional environmental factors could also affect feeding success.

METHODS

Early-stage Striped Bass samples were collected and archived as part of the Hudson River Utilities Longitudinal River Survey. The trawl survey, deployed in a stratified random design, encompasses the entire length of the estuary weekly from early April through June and then biweekly until September. All samples are collected at night, ranging from 2000h to 0500h. Samples were made available through Normandeau Associates and the New York State

Museum. The years analyzed for this study included: 1988, 1991-'93, 1997, 1999, 2003, 2005-07, 2009-12. Years were selected based on sample availability within our study time frame. For analysis of zebra mussel effects, we grouped these years into three periods (Pace et al. 2010): "pre-invasion" (1988-1992), "invasion impact" (1993-2004), and "recovery" (2005-present).

Bass were selected for analysis based on size, time of year, and river km. Sixty bass per year between 6-60 mm total length were selected from dates during the growing season (early June until mid-September). In total, 840 specimens were used for this study. Specimens from each year were partitioned into upriver (above river km= 96) and downriver (below river km=96), with 30 fish per location when possible. Upriver specimens are from areas of high zebra mussel abundance, whereas downriver areas contain few or no zebra mussels due to high salinities that they cannot tolerate.

We used condition as a measure of long-term feeding success and settled gut content volume for our measure of short-term feeding success. All specimens were photographed and digitally measured to the nearest 0.01 mm using SigmaScan® Pro 5.0 (Systat Software Inc, San Jose, CA). Specimens were placed into a drying oven for 48 h at 60°C for determination of dry mass. Condition was expressed as the dry mass at length in an Analysis of Covariance (ANCOVA), similar to residual condition analysis as suggested by Jakob (1996). Settled gut content volume was recorded by measuring the gut contents of individual fish in 1.5 mL vials. Settled gut content height was measured to the nearest 0.01 mm using digital calipers. We converted the distance measure to volume using a fitted equation based on known volumes.

For analysis of diet, prey items from each stomach were identified to the lowest taxonomic level possible. In some cases we aggregated prey categories into higher taxonomic levels in order to increase the frequency of occurrence. The frequency of occurrence (FO), the

average percentage abundance ($\%A_i = \%N_i$; $\%W_i$) and the prey-specific abundance ($\%PA_i =$ $\%PN_i$; $\%PW_i$) were calculated with the following equations according to Brown et al. (2012):

Frequency of occurrence (FO):

$$FO_i = \frac{n_i}{n} \quad (1)$$

Average percentage abundance ($\%N_i$, $\%W_i$):

$$\%A_i = \sum_{j=1}^{n} \%A_{ij}/n \quad (2)$$

Prey-specific abundance ($\%PN_i$, $\%PW_i$):

$$\%PA_i = \sum_{j=1}^{n} \%A_{ij}/n_i \quad (3)$$

where $\%A_{ij}$ is the abundance (by number or mass) of prey category i in stomach sample j, n_i is the number of stomachs containing prey i, and n is the total number of stomachs. To determine prey importance in the diet of striped bass, the prey-specific index of relative importance (%PSIRI) was calculated according to Brown et al. (2012):

$$\%PSIRI_i = \frac{\%FO_i * (\%PN_i + \%PW_i)}{2} \quad (4)$$

To evaluate differences in feeding success between periods of zebra mussel invasion, we ran an ANCOVA model in which $\log_{10}$(dry mass) or $\log_{10}$(gut volume) was the response variable and the predictors were $\log_{10}$length, river position, zebra mussel period, year nested within period, and interactions among main effects. Year nested within period was treated as a random effect. Due to significant interactions involving the river position effect, we then conducted separate analyses by position (upriver and downriver). We constructed a hypothesis test based on the expected means square expressions of fixed and random variables in the model. To visually display any interannual differences in condition and gut volume, we plotted the difference (upriver – downriver) in mean untransformed dry mass or gut content volume per year.

We tested seven environmental factors (Table 1) in mixed effects models to identify what factors most influence long-term feeding success. Abiotic data was acquired from the Hudson River Utilities year class reports and biotic data from the Cary Institute of Ecosystem Studies. Abiotic data was collected at the same time and location as the ichthyoplankton samples. Annual averages were used for biotic data because samples were not taken on the same time scale or in same locations as icthyoplankton samples. Due to no prior expectations that the response in long-term feeding success to abiotic variables would be linear, we included quadratic terms in our models. These variables were centered to a mean of 0 before squaring to minimize collinearity between first-order and second-order terms. Upriver and downriver samples were treated separately in our analyses. The seven environmental factors were treated as fixed effects and we used sample tow nested within year as a random effect in the design. Because the abiotic and biotic data were selected at different scales, we modeled them separately and then we tested whether a combined model was best. The best models for upriver and downriver samples were selected by minimizing the Akaike Information Criterion (AIC) (Akaike 1974) (Table 2a). In order to quantify the effect of environmental variability on long-term feeding success, we chose the most inclusive models out of the top models with similar AIC values. We estimated the regression model upriver and downriver and used the equation from the respective selected model to predict condition. To assess the effect size on a mean bass length, we used the 5^{th} and 95^{th} percentile values of each environmental variable in the model equations to predict condition at relatively "low" and "high" levels of the environmental variables.

To explore differences in diet composition between years and periods, we performed a multivariate two-way analysis of similarity (ANOSIM) on a Bray-Curtis dissimilarity matrix constructed from the average $\log_{10}+1$ transformed numerical percentages of prey types. A

Similarity percentage analysis (SIMPER) was performed to determine which prey items accounted for the most dissimilarity between years. SIMPER tables for upriver and downriver bass are presented in Appendix A and B respectively. For visual representation of mean dietary differences between years, we used non-metric multi-dimensional scaling ordination (NMDS). This approach employed a dissimilarity matrix produced by the ANOSIM analysis. Kruskal's stress statistic 1 was used to determine the best spatial representation of the different years and a stress of <0.2 was considered an acceptable fit (Clarke 1993). All dietary comparisons were made with PRIMER Version 6 software (Clarke & Gorley 2006).

RESULTS

Long and short-term measures of feeding success displayed year-to-year differences. Condition did not differ among zebra mussel invasion periods in either position, but there was a significant effect of year on bass condition upriver ($F_{11, 374}$=5.0; p=<0.0001) and downriver ($F_{11, 425}$=3.91; p=<0.0001). In 9 out of the 14 years sampled, downriver fishes had higher mean condition than upriver fishes (Fig. 1a). Similarly, settled gut volume did not differ between periods in both river positions, but differed among years upriver ($F_{11, 328}$=4.52; p=<0.0001) and downriver ($F_{11, 290}$=7.26; p=<0.001). Difference in gut volume showed no evidence of a river position effect over the years studied (Fig. 1b). Our measures of feeding success were not correlated. Prey was found in the stomachs of 74% of upriver fish and 67% of downriver samples.

Several models in both sections of the river were selected as top models to predict condition based on AIC weights (Table 2a). In upriver samples, temperature, temperature^2, chlorophyll *a* and copepod density were used to explain year-to-year variability in condition, whereas in downriver samples, dissolved oxygen, dissolved oxygen^2, copepod density, and

chlorophyll *a* were utilized to explain condition. Estimates for each variable within the respective models are presented in table 2b. In upriver models copepod density, temperature, and chlorophyll *a* were positively correlated with condition. Dissolved oxygen and one instance of chlorophyll *a* (model 4) were negatively correlated in downriver samples. Our effect size estimation procedure indicated that in upriver samples, condition increased 26% (0.017 vs 0.013 g dry mass) when the model was run using 95th percentile versus 5th percentile values. In downriver samples, condition increased 11% (0.036 vs 0.033 g dry mass) using low levels of dissolved oxygen and high levels of copepod density and chlorophyll *a*.

Copepods and amphipods made up the highest %PSIRI in the diet of bass in both river sections over the 14 years sampled (Table 3). Mysids (%PSIRI=10%) and *Leptodora* (4.6%) were the only other prey items with %PSIRI values greater than 2%. Upriver, amphipods (40%) and copepods (39%) represented the dominant prey items whereas downriver, amphipods (41%), copepods (37%), and mysids (19%) constituted the majority of the diet (Table 3, Fig 2). The %N of mysids in downriver samples was over five times that of upriver. *Leptodora* %N upriver was over ten times that found in downriver samples. Diet composition did not differ among zebra mussel periods in both sections of the river; however diet composition differed among years upriver (ANOSIM, global R=0.27, p=0.001) and downriver (ANOSIM, global R=0.13, p=0.001). Although no clear patterns exist in the NMDS plots (Fig 3) for upriver or downriver samples, particular years stand out from the general groupings. Upriver, 2009 diverged from other years, largely because of the high consumption of *Leptodora*. In general, differences in copepod consumption drove differences between years upriver. Downriver, low copepod abundance in 1991, 1993, and 2010 accounted for as high as 50% average dissimilarity within

pairwise comparisons of years. 2010 also featured high average abundance of mysids, which contributed to dissimilarity between years.

DISCUSSION

We found copepods, amphipods, mysids, and *Leptodora* to be the most important prey items overall throughout the estuary over a 25-year period. While feeding success and diet composition varied significantly year to year, we did not find effects of zebra mussel invasion on the overall feeding ecology of bass. In general, copepod consumption drove differences in diet composition between years upriver and downriver. In upriver larval bass populations, we found that high levels of temperature, chlorophyll *a*, and copepod density resulted in a 26% increase in long-term feeding success, whereas in downriver samples using low levels of dissolved oxygen, high levels of copepod density and chlorophyll *a* resulted in an 11% increase.

We found a general agreement in bass prey consumption with earlier studies. The prevalence of copepods, amphipods, mysids, and *Leptodora* within the bass diet is comparable to previous work on early stage bass diet (Hurst & Conover 2001; Jordan et al. 2003; K. E. Limburg et al. 1997), however *Bosmina* was not well represented in the diets of bass we observed. The scarcity of *Bosmina* within the diet is likely a result of their high seasonal variation in abundance, which displays a pattern of dramatic increase and decline in May through June (K. E. Limburg et al. 1997; Strayer et al. 1999). Most of our samples were taken after the major *Bosmina* bloom would be expected. In terms of overall %PSIRI, copepods were the most important prey item upriver and second-most important downriver. The importance of copepods in the diet of young-of-the-year (YOY) bass has been highlighted in other studies (Gardinier & Hoff 1982; K. E. Limburg et al. 1997; Markle & Grant 1970). The high frequency of occurrence of copepods in the bass diet may be explained by the relatively stable abundance of copepods

over our study period. Even during years of zebra mussel impacts, which devastated certain types of zooplankton, copepod abundances remained stable (Pace et al. 1998). The prevalence of amphipods in the diet across years, particularly downriver, was similar to Jordan et al. (2003) and Gardinier and Hoff (1982), where amphipods were found to be the most common prey item by both frequency of occurrence and percent weight. Diet composition was similar upriver and downriver. The main differences in diet between river positions were the importance of mysids downriver and *Leptodora* upriver. The high importance of mysids in downriver samples is not surprising, given that most mysids are found in marine and brackish waters (Smith 2001). On the contrary, *Leptodora* are freshwater cladocerans (Browman et al. 1989) which explains the low %FO in downriver samples.

We used two indices of feeding success in this study. Ferron and Leggett (1994) state that morphometric indices of condition can accurately assess long-term feeding effects, such as that of starvation, over a period of several days. Contrary to condition, gut content volume in young fishes represents short and variable passage times that can change within hours (Govoni et al. 1986). Consequently, we determined condition as an appropriate measure of long-term feeding success and gut content volume as short-term feeding success. Overall we found a strong effect of year on feeding success. Although not statistically significant, measures of long-term feeding success tended to be higher downriver. This result could be due to differing prey densities; however, prey density data available in downriver sections of the estuary is limited.

We investigated how environmental variables affected long-term feeding success and found four variables to be most important in the estuary. Upriver, high values of temperature, chlorophyll *a*, and copepods result in higher condition. Prior studies have identified temperature as important factors in survival of Striped Bass larvae (Dey 1981; Morgan et al. 1981; Secor &

Houde 1995). Cook et al. (2010) found that juvenile Striped Bass mean growth rate was highest between 26-30°C. Similarly, Secor et al. (2000) found growth rate to be highest at 28°C. The same study reported a 54% increase in feeding rate at 28°C versus 20°C. Our model indicates that bass in the upper estuary at higher temperatures are likely consuming more prey. Downriver, condition was highest during low dissolved oxygen levels. This result is surprising, given that decreasing dissolved oxygen generally results in decreased growth and food intake in fish (Brett & Groves 1979; Jobling 1993). It is well known that dissolved oxygen levels in estuaries can influence complex pathways of energy flow (Breitburg et al. 1997; Wu 2002). It is likely that at these levels dissolved oxygen doesn't affect condition per se, but instead it reflects the influence of some other factor that we have not accounted for in our modeling. In both sections of the estuary, copepod densities and chlorophyll *a* levels were positively correlated with higher condition. High levels of chlorophyll *a* suggest a greater food source for planktonic grazers, such as copepods, which young bass readily feed on. An increase in available prey forage likely improves bass feeding opportunities and success. The appearance of copepod density in our models complements their high importance found within in the stomachs of bass.

We emphasized information theoretic criteria for model selection in our analyses. We favored this approach over selection of variables according to p-values, because we sought the set of variables that best fit the data, rather than selecting variables that were least likely to have had no effect. Lively discussion continues on the relative merits of information-theoretic criteria versus significance testing (Murtaugh 2014), but there is general agreement that either should be supplemented by estimates of effect size. We have done so by showing that an individual in a good environment, according to the selected model, would be 11% to 26% heavier at length than

an individual in a poor environment. We regard these as relatively dramatic differences in condition.

We found little evidence that the invasion of zebra mussels in the Hudson River affected the feeding ecology of early stage bass. While high year-to-year variability in feeding success and diet composition existed, this variability was not related to zebra mussel invasion periods or zebra mussel filtration rates. If zebra mussels had affected diet composition, we would expect to see years of high impact grouped closely together in Fig. 3, which was not the case. Given the mussel's dramatic impacts (Strayer et al. 1999, 2014a), it was plausible to expect a decrease in feeding success during years of high impact, particularly upriver, where zebra mussels are abundant. Instead, we received no signal of an influence on zebra mussels on the feeding success and diet composition of bass. The lack of response of bass to zebra mussels has been observed in the Hudson River estuary before. Strayer et al. (2004) found that Striped Bass did not decline in abundance nor did they change their distribution, however apparent growth rates of juveniles declined.

Interestingly, our results are contrary to other studies that investigated impacts of zebra mussel on fish feeding ecology. In the Great Lakes, the appearance of zebra mussel led to the collapse of the amphipod *Diporeia*, which forced Lake Whitefish and Alewives to shift their prey use and consume less, grow more slowly, and suffer reduced condition (Pothoven et al. 2001; Pothoven & Madenjian 2008). Some fishes also incorporated zebra mussels into their diets (French III & Bur 1996; Pothoven et al. 2001; Ruetz III et al. 2012; Watzin et al. 2008). We found no evidence of early stage bass feeding on zebra mussel veligers, but it is possible juvenile and adult bass may incorporate adult mussels into their diet. The reliance of early stage bass on copepods and amphipods could explain their resilience to zebra mussel impacts within the river.

Copepod populations were relatively unaffected by zebra mussels (Pace et al. 1998) and amphipods among vegetated sites and zebra mussel beds increased (Strayer & Smith 2001), thus bass did not have to deal with major depletions in critical prey.

We found a high frequency of empty guts in this study, possibly due to some combination of nonvisual feeding and low prey density. Specimens collected for this study were all taken at night, whereas most dietary studies that report sampling time occurred during daylight hours. Although bass larvae do feed at night (Chesney Jr 1989; McHugh & Heidinger 1977), Duston & Astakie (2012) found that the prey capture rate of larval striped bass at night depends on prey densities; visual feeding was up to four-fold more effective than nonvisual feeding at low prey densities but similar at the highest densities. Interestingly, our analysis indicated no effect of tow time on gut fullness (results not shown). We acknowledge that this does not ensure that nighttime tows provide a complete picture of feeding ecology. Future studies in the Hudson might incorporate daytime samples to compliment the data we have shown.

This research brings forth the value of studying long-term ecological data by demonstrating how bass feeding ecology has responded to complex phenomena that occurred over a prolonged period within an estuary. If we had taken a cross-sectional approach, we might have drawn different conclusions based on surprise events or fluctuations in environmental factors that wouldn’t have been accounted for. This study also sheds light to the importance of long-term environmental sampling programs. Thanks to these long-term programs, we were able to utilize bass samples to characterize 14 years of bass diet composition. Additionally, the availability of archived larval fishes has made it possible to demonstrate the resilience in trophic ecology of early stage Striped Bass to zebra mussels within the Hudson River estuary.

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TABLES & FIGURES

Table 1. Summary of environmental variables used in mixed modeling. Mean, 5^{th} percentile, and 95^{th} percentiles are provided for each variable.

Environmental variable	Mean	5^{th} Percentile	95^{th} Percentile
Temperature[ac] (°C)	23	21	26
DO[ac] (mg l^{-1})	6.6	5.6	7.9
Salinity[ac] (ppt)	3.1	0.10	7.0
Chlorophyll *a*[b] (μg l^{-1})	11	4.8	28
Copepods[b] (no. l^{-1})	6.8	3.4	17
ZM filtration rate[b] ($m^3m^{-2}d^{-1}$)	3.4	0.063	8.3
Amphipods[b] (no. m^{-2})	1300	380	3300

[a] – Hudson River Utilities data; data collected during tows when ichthyoplankton samples were collected throughout the estuary

[b] – Cary Institute of Ecosystem Studies data; data represents a year average collected at the Kingston long-term monitoring station

[c] – Squared values also used in modeling to test for a quadratic response

Table 2. Summary of AIC 'best models' to predict condition in upriver and down river samples (a) and summary of variable estimates from respective models (b). AIC, Akaike's Information Criterion; ΔAIC, change in AIC between models; AICWt, AIC weight; LL, maximized log-likelihood function; Chl, chlorophyll *a* (μg l^{-1}) ; Temp, temperature (°C); Cop, copepod density (no. l^{-1}), DO, dissolved oxygen (mg l^{-1}).

a)

Upriver					Downriver				
Model	Predictors	AIC	ΔAIC	AICWt	Model	Predictors	AIC	ΔAIC	AICWt
1	Chl	-710.5	0	0.133	1	Cop	-1055.1	0	0.359
2	Temp, $Temp^2$, Cop	-710.4	0.1	0.126	2	DO, DO^2, Cop	-1053.9	1.2	0.198
3	$Temp^2$, Chl	-710.3	0.2	0.12	3	DO, Cop	-1053.3	1.8	0.146
4	Chl, Cop	-709.9	0.6	0.098	4	Cop, Chl	-1053.2	1.9	0.139
5	Temp, $Temp^2$, Cop, Chl	-709.9	0.6	0.098	5	DO, DO^2, Cop,Chl	-1052.2	2.9	0.0844

Table 2 cont'd

b)

Upriver					Downriver				
Model	Cop	Temp	$Temp^2$	Chl	Model	Cop	DO	DO^2	Chl
1	--	--	--	0.00124	1	0.00286	--	--	--
2	0.00342	--	0.00123	0.00174	2	0.0026	-0.0321	0.0123	--
3	--	--	0.00101	0.00141	3	0.00244	-0.0243	--	--
4	0.00285	--	--	0.00149	4	0.00282	--	--	-1.00×10^{-4}
5	0.00392	0.00744	0.0021	0.00184	5	0.00262	-0.0321	0.0124	3.63×10^{-5}

Table 3. Prey of striped bass from upriver and downriver locations in the Hudson River estuary, quantified by mean percent number (%N), percent weight (%W), percent prey-specific number (PN), percent prey specific weight (%PW), percent frequency of occurrence (%FO), and percent prey specific index of relative importance (%PSIRI). Each value represents a 14-year average.

	Upriver						Downriver					
Prey Taxon	%N	%PN	%W	%PW	%FO	%PSIRI	%N	%PN	%W	%PW	%FO	%PSIRI
Copepoda	44	73	35	57	60	39	42	79	34	64	52	37
Amphipoda:												
Gammaridae	19	53	24	68	35	21	18	55	20	61	33	19
Corophiidae	1.4	5.6	1.2	4.9	1.8	1.3	2.8	14	4.6	19	6.6	3.7
Unidentified	16	57	19	69	28	18	18	59	19	62	30	18
Mysida	2.6	74	3.4	97	3.5	3.0	17	71	22	92	24	19
Leptodora	7.8	79	8.0	82	9.8	7.9	0.77	54	0.54	38	1.4	0.65
Bosmina	2.3	39	2.8	47	5.9	2.5	0.46	14	0.63	19	3.3	0.54
Sididae	2.0	47	2.5	58	4.3	2.3	0.77	55	0.79	56	1.4	0.78
Podocopa	1.7	21	0.34	4.2	8.2	1.0	0.33	17	0.043	2.2	1.9	0.18
Chydoridae	0.98	50	0.56	28	1.9	0.77	0.17	18	0.001	0.11	0.94	0.086
Daphnia	0.31	39	0.043	5.4	0.78	0.17	0.11	23	0.001	0.60	0.47	0.056
Cumacea	0.46	8.3	0.41	7.6	1.4	0.44	1.82	4	0.22	0.52	4.1	1
Bivalvia	0.62	33	0.39	25	1.6	0.45	0.31	67	0.25	54	0.47	0.28

Table 3 (cont'd)

Chironomidae	0.80	23	1.6	45	3.5	1.2	0.74	39	0.69	36	1.9	0.71
Clupeidae	0.72	61	1.1	94	1.2	0.91	0.41	44	0.86	92	0.94	0.64

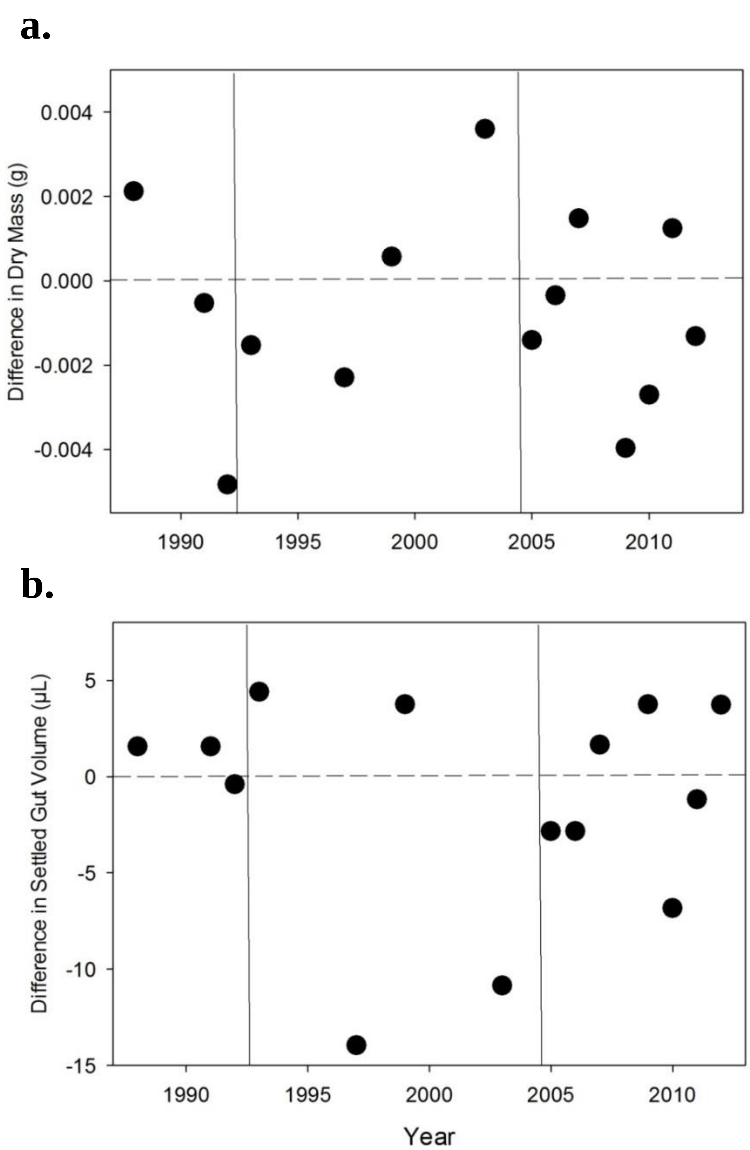

Fig. 1 Difference in mean condition (a) and settled gut volume (b) between up- and downriver samples. Each point represents 60 fish combined between up- and downriver fish. Points above the dotted horizontal line indicate years of higher condition or gut volume in upriver fish. The figure is split into thirds by vertical lines to mark the zebra mussel invasion periods. The periods from left to right are pre-invasion, invasion, and recovery.

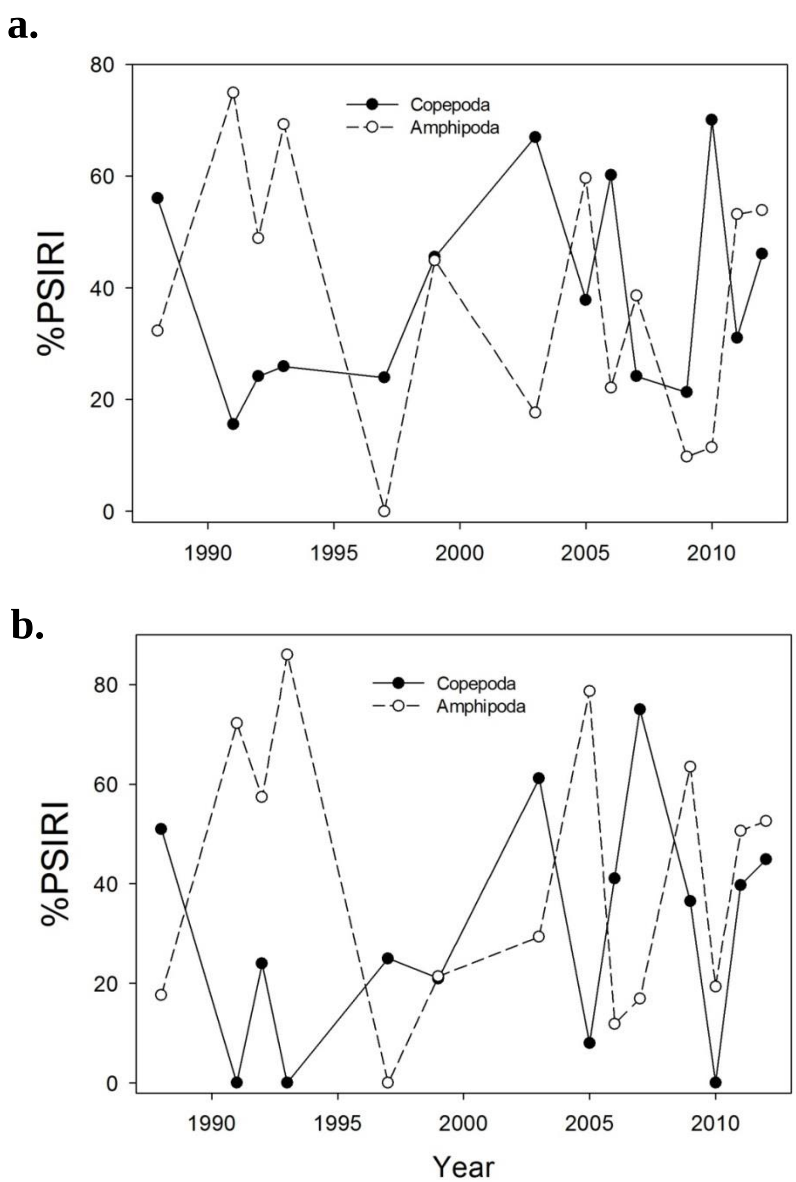

Fig. 2 Annual mean %PSIRI of copepods and amphipods (all families combined) for (a) upriver and (b) downriver samples.

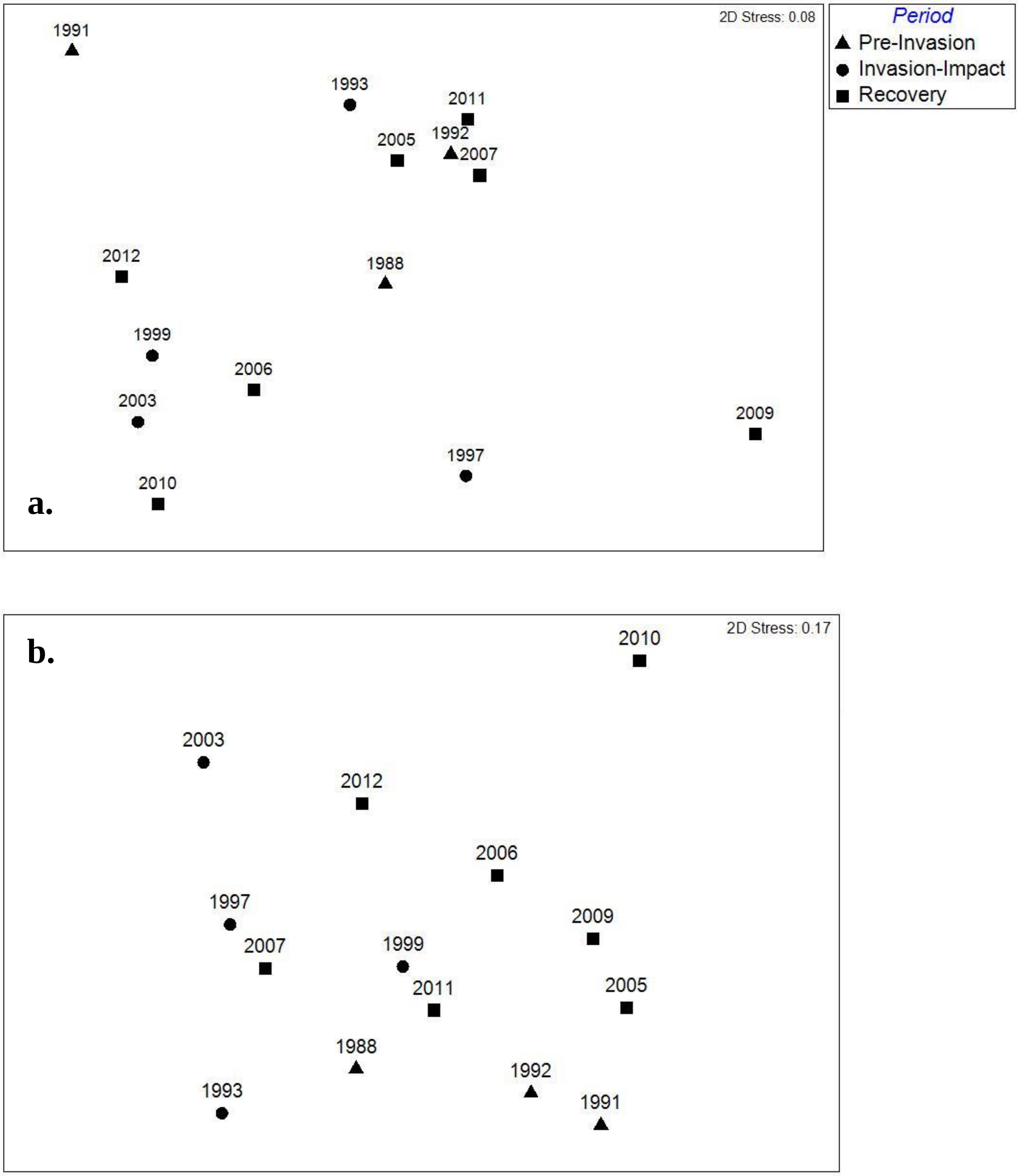

Fig. 3 Non-metric multidimensional scaling plot of (a) upriver and (b) downriver diet composition. Distance between points indicates dissimilarity.

CHAPTER 2:Long-term feeding ecology of early-stage American Shad (*Alosa sapidissima*) in the Hudson River estuary

ABSTRACT

Estuaries are dynamic systems that act as nursery habitat for fishes that is critical to their survival and early development. Studying the feeding ecology of fish at this stage within estuaries provides insight towards a broad variety of fundamental aspects of larval fish diet including long-term feeding dynamics. We studied 15 years of early stage American Shad diet extending over a 25-year time span in the Hudson River estuary, including years of invasive zebra mussel impact which markedly altered energy flow within the estuary. We found copepods, *Bosmina*, insects, and amphipods to be of the highest prey-specific index of relative importance in the estuary. Niche breadth was greater in juvenile versus larval shad. While feeding success and diet composition varied significantly year to year, we did not find effects of zebra mussel invasion on the overall feeding ecology of shad. We investigated what ecological factors most influenced long-term feeding success and found temperature, dissolved oxygen, chlorophyll *a* concentration, and copepod density to be most important in the estuary. We used the best models in separate analyses of larval and juvenile shad to estimate effect size on condition and found that in larval shad, high levels of temperature, chlorophyll *a*, and copepod density resulted in a 220% increase in condition, whereas in juveniles using high levels of dissolved oxygen, copepod density, and chlorophyll *a* resulted in a 10% increase. This long-term study demonstrates the resilience of early-stage fish feeding ecology to a dramatic estuarine species invasion.

INTRODUCTION

Estuaries are dynamic, variable systems with fluctuating biotic and abiotic factors. They are a transition zone between the marine and river environments and a critical nursery habitat for larval fishes (MacLusky & Elliott 2004). These systems are complex productive areas, in which fish aggregate to enhance growth and find favorable feeding conditions (Blaber & Blaber 1980; Friedland et al. 1996). Many early-stage coastal fish spend most of their time developing and feeding within estuaries. Food abundance as well as abiotic conditions can fluctuate greatly over space and time. Given the variable nature of estuary systems, long-term ecological studies can provide numerous values and benefits. Long-term data is critical for quantifying ecological response to environmental changes, understanding expression of key ecological trends, providing core data for parameterizing models, influencing management of species or ecosystems, and acting as the basis of collaborative studies (Lindenmayer et al. 2012). The goal of this study is to document the long-term feeding ecology of early-stage estuary-dependent American Shad (*Alosa sapidissima*, Wilson 1818).

Studying fish feeding ecology addresses fundamental questions including what prey was consumed and when it was consumed. Diet analyses also provide insight towards broader subjects such as population dynamics (Braga et al. 2012), habitat use (Feitosa & Ferreira 2015), evolution (Collar et al. 2009), energy flow between ecosystems (Baxter et al. 2005), and conservation (Alcaraz et al. 2015; Donadelli et al. 2015). Characterizing the diet of early-stage fishes is particularly important because this life stage is when fish grow most rapidly and undergo ontogenetic shifts that are critical to survival. Generally the feeding of young fishes has not been studied as much as that of adults due to additional difficulties associated with collecting

and working with smaller fish (Gerking 1994). Additionally, knowledge of patterns in feeding ecologies of estuarine larvae relative to other habitats remains limited (Llopiz 2013).

The Hudson River estuary is a body of water that hosts many early stage fish species, including nearly a dozen diadromous fish species (Waldman 2006). The estuary is a complex, well studied system with several long-term environmental data collection programs in place for multiple decades (see The Hudson River Estuary 2006). The estuary has undergone major ecological changes throughout its recent history, including the invasion of zebra mussels (*Dreissena polymorpha*, Pallas 1771). Zebra mussels first appeared in the Hudson River in 1991, and have been abundant throughout the freshwater portion of the estuary since then (Strayer et al. 2011). The mussels sharply reduced phytoplankton biomass and markedly altered estuarine energy flow (Pace et al. 1998; Pace et al. 2010; Strayer et al. 2014b). Within the first two years of mussel establishment, total phytoplankton biomass declined 85% (Caraco et al. 1997), zooplankton biomass declined by more than 70%, (Pace et al. 1998), and zoobenthos biomass declined by 40% (Strayer & Smith 2001). Strayer et al. (2004) found multiple effects of zebra mussels on pelagic fish species, including a decrease in the abundance of American Shad. After 2005, many mussel-induced ecological impacts within the river diminished towards pre-invasion levels (Strayer et al. 2014a). Chapter 1 describes no effects of zebra mussels on young Striped Bass feeding ecology; however, the effects on early-stage American Shad have yet to be fully studied.

Studying long-term feeding ecology is made possible through a multi-decade monitoring program. The Hudson River Utilities Longitudinal River Survey, an ichthyoplankton plankton study begun in 1973, samples larval fishes to document the distribution and abundances of early life stages of fish species throughout the length of the estuary (ASA Analysis & Communication

2012). These larval fish samples have been archived and made available for research purposes through Normandeau Associates and the New York State Museum. One early-stage fish species made available through the archived samples are American Shad. American Shad of the Hudson River estuary are anadromous clupeids that spawn in spring within the river, but spend most of their lives in the Atlantic Ocean from Virginia to Maine. Shad were one of the Hudson River estuary's most economically important fish, providing seemingly unlimited harvest to Native Americans and early European settlers. By the 1900s, shad became the second highest harvested fish on the east coast. Shad populations in the Hudson dramatically declined since the 1950s, and a 2007 stock assessment summarized the stock as historically low (ASMFC 2007), which has ultimately lead to fishing moratorium in 2010. The principal known cause of shad decline in the Hudson is overharvest, however several other factors have been detrimental to shad stock health including habitat loss due to dredging and channelization of the river, water pollution, and the introduction of zebra mussels (Kahnle & Hattala 2010;Strayer et al. 2004). The 2010 Hudson River American Shad recovery plan describes the mussel's effects within the river and the reduced forage base available to young shad; however any potential changes in young shad feeding ecology have yet to be studied (Kahnle & Hattala 2010). Conservation and restoration of this signature species is a key goal of this plan.

The purpose of this study is to characterize early-stage American Shad diet composition and feeding success over a 25-year period in the Hudson River Estuary. We focus on four main goals: 1) to describe diet composition and niche breadth; 2) evaluate feeding success over a multi-decade time span; 3) to test for effects of zebra mussels on the feeding ecology of shad; and, 4) determine what ecological factors most influence shad long-term feeding success. We predict reduced shad feeding success, increased niche breadth, and a change in diet composition

during years of mussel impact. Given the variable nature of estuaries, we expect that changes in additional environmental factors could also affect feeding success. Results from this study provide valuable information to fisheries managers in regards to the long-term feeding ecology of young shad within the Hudson, as well as shad response to invasive zebra mussels.

METHODS

Methods for this study follow those similar to Chapter 1. Early-stage American Shad samples were collected and archived as part of the Hudson River Utilities Longitudinal River Survey. The trawl survey, deployed in a stratified random design, encompasses the entire length of the estuary weekly from early April through June and then biweekly until September. All samples are collected at night, ranging from 2100h to 0500h. Samples were made available through Normandeau Associates and the New York State Museum. Fifteen years, ranging over a 25 year time span, were analyzed. The years analyzed for this study included: 1988, 1991-1994, 1997, 1999, 2003, 2005-06, 2009-2012. Years were selected based on sample availability within our study time frame. Certain desirable years could not be analyzed due to insufficient sample sizes. For analysis of zebra mussel effects, we grouped these years into three periods (Pace et al. 2010): “pre-invasion” (1988-1992), “invasion impact” (1993-2004), and “recovery” (2005-present).

Shad were selected for analysis based on size, time of year, and river km. Thirty shad per year (mean SL=30 mm ±11.5 SE) were selected from dates during the growing season (late June until mid-September). In total, 450 specimens were used for this study. Shad were separated into two size groups based on length (<26 mm and ≥26 mm), and 15 fish per size group were analyzed per year when possible (larvae n=210; juvenile n=240). These sizes categories roughly correspond to the onset of metamorphosis from larval to juvenile shad (Maxfield 1953; Walburg

& Nichols 1967). All samples were taken above river km 96, which features freshwater habitat with high zebra mussel abundance.

We used condition as a measure of long-term feeding success and settled gut content volume for our measure of short term feeding success. All specimens were photographed and digitally measured to the nearest 0.01 mm using SigmaScan® Pro 5.0 (Systat Software Inc, San Jose, CA). Specimens were placed into a drying oven for 48 h at 60°C for determination of dry mass. Condition was expressed as the dry mass at length in an Analysis of Covariance (ANCOVA), similar to residual condition analysis as suggested by Jakob (1996). Settled gut content volume was recorded by measuring the height of gut contents of individual fish in 1.5 mL vials. Settled gut content height was measured to the nearest 0.01 mm using digital calipers. We converted the distance measure to volume using a fitted equation based on known volumes. Empty guts were enumerated and we used a binomial logistic regression model to ascertain the effects of sampling hour on the likelihood of shad having gut contents present.

For analysis of diet, prey items from each stomach were identified to the lowest taxonomic level possible. Due to digestion and difficulty associated with accurate identification, adult insects were grouped into one category. The frequency of occurrence (FO), the average percentage abundance ($\%A_i = \%N_i$; $\%W_i$) and the prey-specific abundance ($\%PA_i = \%PN_i$; $\%PW_i$) were calculated with the following equations according to Brown et al. (2012):

Frequency of occurrence (FO):

$$FO_i = \frac{n_i}{n} \quad (1)$$

Average percentage abundance ($\%N_i$, $\%W_i$):

$$\%A_i = \sum_{j=1}^{n} \%A_{ij}/n \quad (2)$$

Prey-specific abundance ($\%PN_i$, $\%PW_i$):

$$\%PA_i = \sum_{j=1}^{n} \%A_{ij}/n_i \quad (3)$$

where $\%A_{ij}$ is the abundance (by number or mass) of prey category i in stomach sample j, n_i is the number of stomachs containing prey i, and n is the total number of stomachs. To determine prey importance in the diet of American Shad, the prey-specific index of relative importance (%PSIRI) was calculated according to Brown et al. (2012):

$$\%PSIRI_i = \frac{\%FO_i*(\%PN_i+\%PW_i)}{2} \quad (4)$$

We calculated Levin's measure (B) and standardized measure (B_A) of niche breadth for each life stage per year and period using the equations:

$$B = \frac{1}{\sum p_j^2} \quad (5)$$

$$B_A = \frac{(B-1)}{(n-1)} \quad (6)$$

where p_j is the proportion of diet composed of prey species j and n is the total number of prey species found in the gut (Levins 1968; Marshall & Elliott 1997). Levin's B measures the complexity of the diet and is used to determine if diet is considered diverse or specialized. The standardized measure B_A (scale of 0 to 1) indicates a reliance on a limited prey group in the diet if the value is close to zero (i.e. maximum specialization) (Marshall & Elliott 1997). To test for differences between overall larval and juvenile shad niche breadth, we performed a Mann-Whitney U test. Lastly, a Kruskal-Wallis test was used to test for differences in niche breadth between zebra mussel periods.

To evaluate differences in feeding success among periods of zebra mussel invasion, we ran an ANCOVA model in which $\log_{10}$dry mass or $\log_{10}$gut volume was the response variable and the predictors were $\log_{10}$length, zebra mussel period, year nested within period, and interactions among main effects. Year nested within period was treated as a random effect. We

constructed a hypothesis test based on the expected means square expressions of fixed and random variables in the model. We plotted the mean untransformed dry mass or gut content volume per year to display condition and gut content volume for larval and juvenile shad. Annual abundance indices reported by the Utilities year-class reports for young of year and post-yolk sac larvae shad were plotted with condition to visualize potential trends.

We tested eight environmental factors (Table 1) in mixed-effects models to identify what factors most influence long-term feeding success. Larval and juvenile shad were treated separately in our analyses. Abiotic data was acquired from the Hudson River Utilities year class reports and biotic data from the Cary Institute of Ecosystem Studies. Abiotic data was collected at the same time and location as the ichthyoplankton samples. In contrast, annual averages were used for biotic data because samples were not taken on the same time scale or in same locations as icthyoplankton samples. Abiotic factors were tested in quadratic form, due to no prior expectations that the response in long-term feeding success to these factors would be linear, after centering to a mean of 0 before squaring to minimize collinearity between first-order and second-order terms. Response to biotic factors was expected to be linear and thus only first-order expression biotic variables were incorporated in the model. The seven environmental factors were treated as fixed effects and we used sample tow nested within year as a random effect in the design. Because the abiotic and biotic data were selected at different scales, we modeled them separately and then we tested whether a combined model was best. The best models for larval and juvenile shad were selected by Akaike Information Criterion (AIC) model selection using Akaike weights (Akaike 1974) (Table 2a). To assess the effect size on a mean shad length, we used the 5^{th} and 95^{th} percentile values of each environmental variable in the model equations to predict condition at relatively "low" and "high" levels of the environmental variables.

To explore differences in diet composition between years and periods, we performed a multivariate two-way analysis of similarity (ANOSIM) on a Bray-Curtis dissimilarity matrix constructed from the average square root-transformed numerical percentages of prey types. Due to the high proportion of empty guts found in larval shad, and thus low sample size, 1992, 1995, 1997, and 1999 were removed from this analysis. All years were included for juvenile shad. A similarity percentage analysis (SIMPER) was performed to determine which prey items accounted for the most dissimilarity between years. SIMPER tables for larval and juvenile shad are presented in Appendix C and D respectively. For visual representation of mean dietary differences between years and periods, we used non-metric multi-dimensional scaling ordination (NMDS). This approach employed a dissimilarity matrix used by the ANOSIM analysis. Kruskal's stress statistic 1 was used to determine the best spatial representation of the different years and a stress of <0.2 was considered an acceptable fit (Clarke 1993). All dietary comparisons were made with PRIMER Version 6 software (Clarke & Gorley 2006).

RESULTS

Long and short-term measures of feeding success displayed year-to-year discordance. Condition did not differ among zebra mussel invasion periods in either size class, but there was a significant effect of year in larval ($F_{17, 192}$=17; p=<0.0001) and juvenile ($F_{17, 222}$=5; p=<0.0001) shad (Fig 1). Similarly, settled gut volume did not differ between periods, but differed among years in larval ($F_{17, 328}$=4.52; p=<0.03) and juvenile ($F_{17, 290}$=7.26; p=<0.001) shad (Fig 2). Our measures of feeding success were not correlated. Additionally, shad condition was not correlated with year class abundance in either life stage (larvae, r=0.2 p>0.05; juvenile, r=0.06 p>0.05). Of all shad sampled, 36% had empty guts. Larval shad (64% empty guts) were more likely to have

an empty gut than juveniles (10%). The frequency of guts containing prey items decreased as sampling hour increased ($\chi 2=41$, $p < 0.001$) (Fig 3)

Several models in both life stages were selected as top models to predict condition based on AIC weights (Table 2a). In larval shad samples, temperature, chlorophyll *a* and copepod density explained year-to-year variability in condition, whereas in juvenile samples, dissolved oxygen, dissolved oxygen^2, chlorophyll *a*, and copepod density were utilized to explain condition. Estimates for each variable within the respective models are presented in table 2b. In larval stage models all factors positively correlated with condition. In juvenile models, only dissolved oxygen squared was negatively correlated with condition. Our effect size estimation procedure indicated that in larval shad samples, condition increased ~220% (0.0052 vs 0.016 g dry mass) when the model was run using 95th percentile versus 5th percentile values of temperature, copepod density, and chlorophyll *a*. In juvenile samples, condition increased ~10% (0.089 vs 0.098 g dry mass) using high levels dissolved oxygen, dissolved oxygen squared, copepod density, and chlorophyll *a*.

Cyclopoid copepods, *Bosmina*, insects, amphipods, and chironomid larvae made up the highest %PSIRI in the diet of both shad life stages in 15 years sampled (Table 3). In larval shad, copepods, insects, and *Bosmina* comprised ~80% PSIRI of the overall diet, whereas in juvenile shad the same three prey items accounted for ~55%. The importance of gammarid and other amphipods was greater for juvenile shad. (20% vs. 6% respectively). Chironomid larvae importance was similar between shad life stages (9% juvenile; 5% larval). Adult insects were an important part of the juvenile diet (%19).The mean standardized niche breadth over the 15 years sampled was significantly greater in juvenile (0.45 ± 0.02) than larvae (0.23 ± 0.04) shad (Mann-Whitney, z= -4.7, p<0.001). Standardized niche breadth did not differ between invasion periods

in both shad life stages (Table 4). Total diet composition did not differ among zebra mussel periods in both life stages; however diet composition differed among years in larval shad (Fig 4a; ANOSIM, global R=0.17, p=0.004) and juvenile shad (Fig 4b; ANOSIM, global R=0.20, p=0.001). In larval shad, SIMPER analysis attributed dissimilarity in diet between years primarily to differences in copepod and *Bosmina* consumption. Juvenile shad dissimilarity was mainly due to differences copepod, *Bosmina* and amphipods consumption.

DISCUSSION

We found niche breadth to be greater in juvenile versus larval shad, yet niche breadth in both life stages did not change as a result of zebra mussel presence in the estuary. While feeding success and diet composition varied significantly year to year, we did not find effects of zebra mussel invasion on the overall feeding ecology of shad. In general, copepod and *Bosmina* consumption drove differences in diet composition between years in larval shad, whereas amphipod consumption in addition to copepod and *Bosmina* consumption were responsible for dissimilarity in juveniles. For larval shad, we found that high levels of temperature, chlorophyll *a*, and copepod density resulted in a ~220% increase in long-term feeding success, whereas in juveniles using high levels of dissolved oxygen, copepod density, and chlorophyll *a* resulted in a 10% increase.

This study's diet composition data is in general agreement with American Shad prey consumption in earlier studies. Larval shad diet was primarily composed of copepods (%PSIRI=40) and *Bosmina* (34%), similar to other larval American Shad feeding studies (Crecco & Blake 1983; Johnson & Dropkin 1996; Nack et al. 2015b). Although copepods and *Bosmina* were important in juvenile diets (21% and 14% respectively), juveniles relied on a broader variety of prey taxa, thus representing a wider niche breadth. Limburg et al. (2003) describes

juvenile shad as opportunistic visual feeders with prey size increasing as the fish grow. This notion can be viewed in our own data, where the %N of smaller zooplankton prey (e.g. copepods and *Bosmina*) decreases nearly half between larval and juvenile shad. Inversely, larger prey items (e.g. amphipods and insects) increased in juvenile diets. In this study, juvenile shad fed heavily on terrestrial insects. Juvenile shad have been known to include littoral-associated invertebrates and even flying insects into their diet as they grow (K. Limburg et al. 2003). The high importance of adult insects in the juvenile diet has been documented in other studies (Domermuth & Reed 1980; Grabe 1996; Levesque & Reed 1972; Maxfield 1953). Larval and juvenile shad variations in copepod, *Bosmina*, and amphipods consumption lead to the most dissimilarity between years. Some of this variation is likely explained by seasonal pulsation of certain zooplankton, such as *Bosmina*, that are capable of displaying dramatic increase and declines in only a few weeks in the Hudson June (K. E. Limburg et al. 1997; Strayer et al. 1999). The seasonal pulsation could lead to certain years of shad feeding more readily on what is most available in that particular time frame that they were collected in, while in other years that prey item may bloom early or later than when our samples were collected.

A similar American Shad diet study conducted in the Hudson River estuary by Nack et al. (2015) found that zebra mussel veligers accounted for over 26% biomass of early-stage shad diet. Interestingly, no zebra mussel veligers were found in the guts of any shad in our study. The difference in sampling timing as well as the sample preservation methods are likely responsible for the discrepancy. Nack et al. (2015) shad samples were collected between late May and Mid-June whereas the vast majority of our samples were taken starting in late June through August. Zebra mussels exhibit sequential spawning behavior, producing free-swimming veligers that appear in the plankton for anywhere from five days to five weeks depending on water

temperatures (Ludyanskiy et al. 1993; Nichols 1996). It's likely that our sampling period in all years was later than the major planktonic veliger blooms, thus the shad fed on more preferred prey items in equal or greater abundances. Additionally, all fish samples were preserved in formalin which would dissolve veliger shells, making them difficult to detect.

This study found little evidence of zebra mussels affecting the feeding ecology of early-stage shad in the Hudson River estuary. While high year-to-year variability in feeding success and diet composition existed, this variability was not related to zebra mussel invasion periods or zebra mussel filtration rates. Additionally, there was no difference in the niche breadth of shad over the mussel invasion periods. Given the mussel's dramatic impacts within the estuary (Strayer et al. 1999, 2014a), along with the documented decrease in shad abundance and growth in relation to zebra mussel presence (Strayer et al. 2004), it was plausible to expect changes in shad feeding ecology during years of high impact. Instead, we received no signal of an influence on zebra mussels on the feeding success, niche breadth, or diet composition of shad. This result mirrors that of Chapter 1, which used similar methods to study Striped Bass. Early-stage shad trophic resistance to the impacts of zebra mussels could be explained by their primary prey. During years of zebra mussel impact, which negatively influenced certain types of zooplankton, copepod abundances remained stable (Pace et al. 1998). On the contrary, many invertebrates, such as amphipods and chironomids, displayed positive changes in the littoral zones (Strayer & Smith 2001; Strayer et al. 1999) where early-stage American Shad are often feeding. Lastly, Nack et al. (2015) provides evidence that zebra mussel veligers could be acting as an additional important food source early in the summer months. Our results suggest that further research centered on American Shad restoration in the Hudson should focus on other factors attributed to stock declines.

We investigated how environmental factors influenced long-term feeding success and our models found four variables to be most important in the estuary. For larval shad, high levels of temperature, copepod density, and chlorophyll *a* resulted in a much greater predicted condition. Higher water temperatures have been associated with increased larval shad survival and growth (Crecco & Savoy 1985; Nack et al. 2015a), and year class strength (Crecco & Savoy 1984). Increasing temperatures would result in higher larval metabolism, which could result in higher feeding success, growth, and development rates during periods of optimal feeding conditions. However, even the low end of the temperatures range presented in this study (22°C), and used in our modeling, is well within the favorable range of larval shad. It is likely that at these levels temperature doesn't affect condition per se, but instead it reflects the influence of an accumulation of other factors that we have not accounted for in our modeling. For juvenile shad, high levels of dissolved oxygen resulted in greater predicted condition. Dissolved oxygen is generally positively correlated with growth and food intake in fish (Brett & Groves 1979). Higher dissolved oxygen levels are likely promoting better growing and feeding opportunities within the estuary. In both shad life stages, copepod densities and chlorophyll *a* levels were positively correlated with higher condition. High levels of chlorophyll *a* suggest a greater food source for planktonic grazers, such as copepods, on which young shad readily feed. An increase in available prey forage likely improves shad feeding opportunities and success. The appearance of copepod density in our models complements their high importance found within the stomachs of shad.

We found that shad feeding success can vary substantially according to their environment. By analyzing the effect size of factors in our model, we have shown that an individual in a good environment, according to the selected model, would be 10% to ~220%

heavier at length than an individual in a poor environment. We regard these as relatively dramatic differences in condition. The large difference in predicted condition over the model for larval shad further displays the sensitivity of larval fishes to biotic and abiotic influences in their environment. Crecco and Savoy (1985) indicate that American Shad year-class strength in the Connecticut River is established before the juvenile stage. The results of our modeling suggest that variable conditions within a river system can dramatically reduce, or increase, larval shad long-term feeding success. Changes in feeding success may consequently affect year-class strength; however we did not find a correlation between year-class abundance indices and feeding success for either life stage.

The high proportion of empty guts in larval shad is most likely a result of sampling hour. All samples analyzed in this study were collected past sunset. Feeding activity for American Shad peaks during the afternoon and evening, with minimal feeding at night (Grabe 1996; Johnson & Dropkin 1996). Given the low gut volume and high digestion rates of larval fish, most prey consumed before sunset was probably digested before sampling occurred. Results of our logistic regression model confirm that the time past sunset had a significant effect on the probability of containing gut contents. 23% of our samples were collected after the probability of containing gut contents was 0.50 (~400 minutes past sunset). Future long-term American Shad diet studies should focus their sampling efforts between daylight and dusk hours to maximize the number of shad samples containing prey items.

In this study we have presented 15 years of early-stage American Shad diet data over a 25 year period in the Hudson River Estuary. This study provides a valuable update to preexisting early-stage American Shad diet characterization. Through this long-term analysis we've displayed larval and juvenile shad resistance of feeding success, niche breadth, and diet

composition to the impacts of a notorious biological invasion. Thanks to long-term monitoring programs, we have provided valuable diet data that fisheries managers can use in their efforts to further understand reasons behind dwindling shad stocks in the Hudson River estuary.

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TABLES & FIGURES

Table 1. Summary of environmental variables used in mixed modeling. Mean, 5th percentile, and 95th percentiles are provided for each variable.

Environmental variable	Mean	5th Percentile	95th Percentile
Temperature[ac] (°C)	25	22	28
DO[ac] (mg l^{-1})	7.5	6.4	9.5
Salinity[ac] (ppt)	0.14	0.10	0.2
Freshwater flow[ac] ($m^3 sec^{-1} day^{-1}$)	210	96	500
Chlorophyll *a*[b] (μg l^{-1})	10	4.8	28
Copepods[b] (no. l^{-1})	6.5	3.4	17
ZM filtration rate[b] ($m^3 m^{-2} d^{-1}$)	4.0	0.44	8.3
Amphipods[b] (no. m^{-2})	1200	380	3300

[a] – Hudson River Utilities data; data collected during tows when ichthyoplankton samples were collected throughout the estuary. Freshwater flow data taken from Green Island, New York.

[b] – Cary Institute of Ecosystem Studies data; data represents a year average collected at the Kingston long-term monitoring station

[c] – Squared values also used in modeling to test for a quadratic response

Table 2. Summary of AIC 'best models' to predict condition in larvalr and juvenile shad samples (a) and summary of variable estimates from respective models (b). AIC, Akaike's Information Criterion; ΔAIC, change in AIC between models; AICWt, AIC weight; Chl, chlorophyll *a* (μg l^{-1}) ; Temp, temperature (°C); Cop, copepod density (no. l^{-1}), DO, dissolved oxygen (mg l^{-1}).

Larvae					Juveniles				
Model	Predictors	AIC	ΔAIC	AICWt	Model	Predictors	AIC	ΔAIC	AICWt
1	Temp, Cop, Chl	-447.7	0.0	0.72	1	DO, DO^2,Cop, Chl	-727.8	0	0.45
2	Temp,DO^2, Cop, Chl	-445.8	1.9	0.28	2	DO, DO^2, Cop	-727.2	0.60	0.33
3	Temp, Chl	-430.3	17	0.00	3	DO, DO^2	-725.1	2.7	0.11
4	Cop, Chl	-429.6	18	0.00	4	DO, DO^2,Chl	-724.5	3.3	0.088

Table 2 cont'd

b)

Larvae					Juvenile				
Model	Temp	DO^2	Cop	Chl	Model	DO	DO^2	Cop	Chl
1	0.0294	--	0.0107	0.00803	1	0.0358	-0.0236	0.00334	0.00132
2	0.0294	0.00308	0.00107	0.00788	2	0.0369	-0.0221	0.002889	--
3	0.0263	--	--	0.00672	3	0.00244	-0.0243	--	--
4	--	--	0.00988	0.00819	4	0.03701	-0.0227	--	--

Table 3. Prey of larval and juvenile American Shad in the Hudson River estuary, quantified by mean percent number (%N), percent weight (%W), percent prey-specific number (PN), percent prey specific weight (%PW), percent frequency of occurrence (%FO), and percent prey specific index of relative importance (%PSIRI). Each value represents a 14-year average.

	Larvae						Juvenile					
Prey taxon	%N	%PN	%W	%PW	%FO	%PSIRI	%N	%PN	%W	%PW	%FO	%PSIRI
Copepoda												
Cyclopoida	41	76	38	70	53	39	25	46	17	30	55	21
Nauplii	1.1	81	1.0	76	1.3	1.0	0.057	6.1	<0.01	0.99	0.92	0.033
Cladocera												
Bosmina	34	77	34	78	44	34	18	53	13	39	34	15
Chydoridae	2.2	83	1.7	62	2.7	1.94	0.64	17	0.086	2.3	3.7	0.37
Daphnia	0.75	28	0.14	5.2	2.7	0.44	2.2	43	0.86	17	5.1	1.5
Leptodora	0.52	20	0.71	27	2.7	0.62	1.5	20	1.3	16	7.8	1.4
Sididae	1.3	100	1.3	100	1.3	1.3	0.91	39	0.81	35	2.3	0.86
Unidentified	0.22	17	0.037	2.7	1.3	0.13	2.6	24	0.97	8.7	11	1.8
Amphipoda												
Gammaridae	4.8	61	6.0	75	8.0	5.4	14	45	13	42	30	13
Unidentified	0.33	25	0.65	48	1.3	0.49	6.7	31	7.6	35	22	7.1
Ostracoda												

Podocopa	1.5	56	1.3	50	2.7	1.4	4.0	25	1.3	8.4	16	2.6
Unidentified	1.3	100	1.3	100	1.3	1.3	1.4	31	0.93	20	4.6	1.2
Insecta												
Chironomidae (larvae)	4.1	38	4.9	46	11	4.5	8.2	30	9.4	34	28	8.8
Unidentified adult	6.5	70	8.1	86	9.3	7.3	10	27	28	74	38	19
Arachnida												
Hydrachnidiae	0.17	12	<0.01	0.56	1.3	0.087	0.45	14	0.24	7.5	3.2	0.35
Nematoda												
Unidentified	0.80	60	1.1	86	1.3	0.97	3.7	37	3.9	38	10	3.8
Isopoda												
Cyathura	0.0	0.0	0.0	0.0	0.0	0.0	0.34	9.2	0.57	16	3.7	0.46
Malacostraca												
Mysida	0.0	0.0	0.0	0.0	0.0	0.0	0.29	9.1	1.5	48	3.2	0.92

Table 4. American Shad sample size, % empty stomachs for size class, pre-invasion, invasion-impact, and recovery mean Levin's standardized measure B_A with Levin's unstandardized measure (B) represented in parentheses, ch-squared test statistic, and p-value from Kruskal-Wallis test.

Life stage	Number of shad	% empty stomachs	Pre-Invasion $B(B_A)$	Invasion-Impact $B(B_A)$	Recovery $B(B_A)$	Chi-Square(X^2)	P-value
Larvae	210	64	0.33 (1.5)	0.22 (1.3)	0.21 (1.3)	0.79	0.7
Juvenile	240	9.6	0.51 (2.4)	0.44 (2.1)	0.43 (1.7)	3.3	0.2

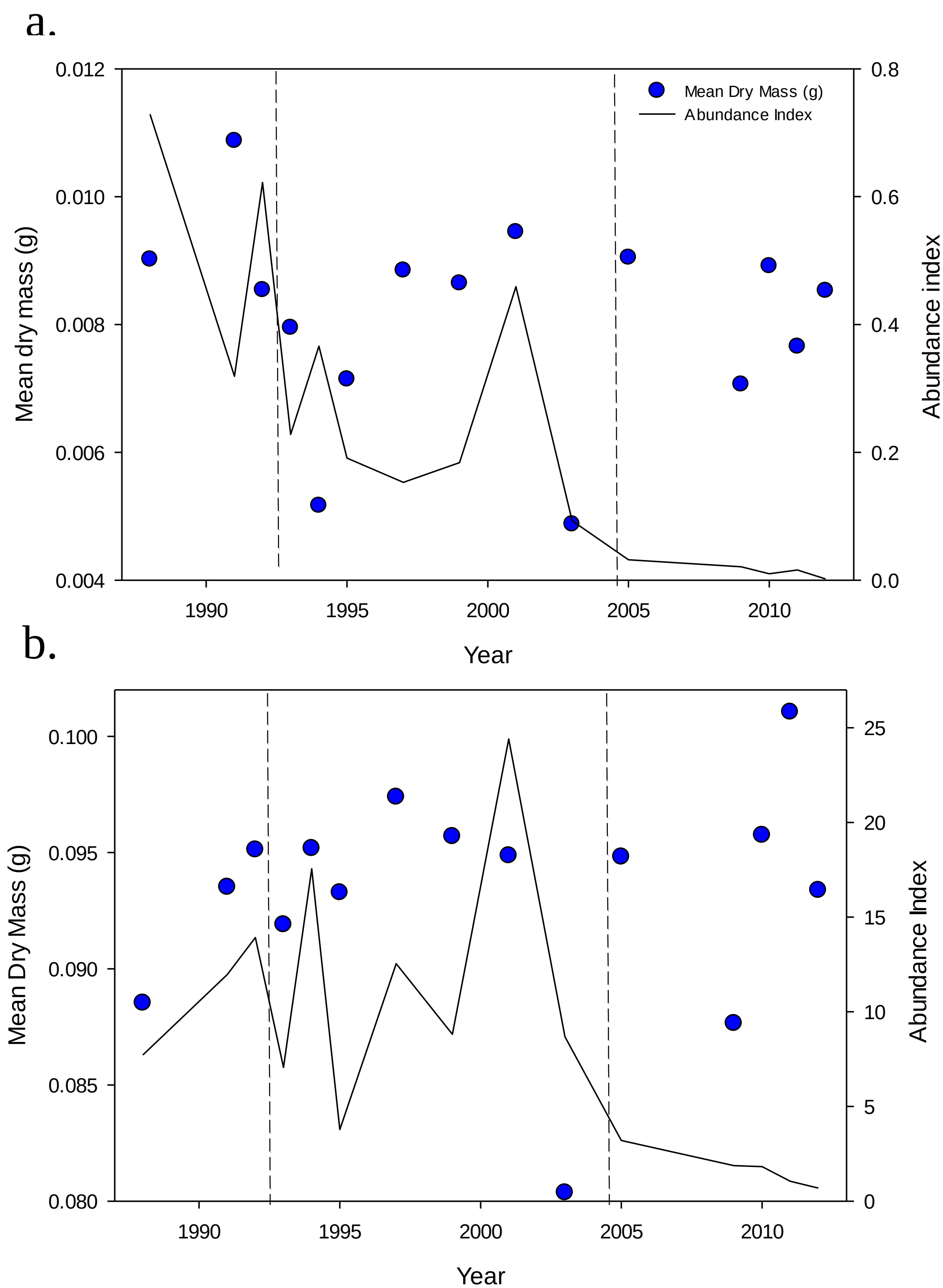

Fig. 1 Mean condition of larval (a) and juvenile (b) American Shad samples. The figure is split into thirds by vertical lines to mark the zebra mussel invasion periods. The periods from left to right are pre-invasion, invasion-impact, and recovery.

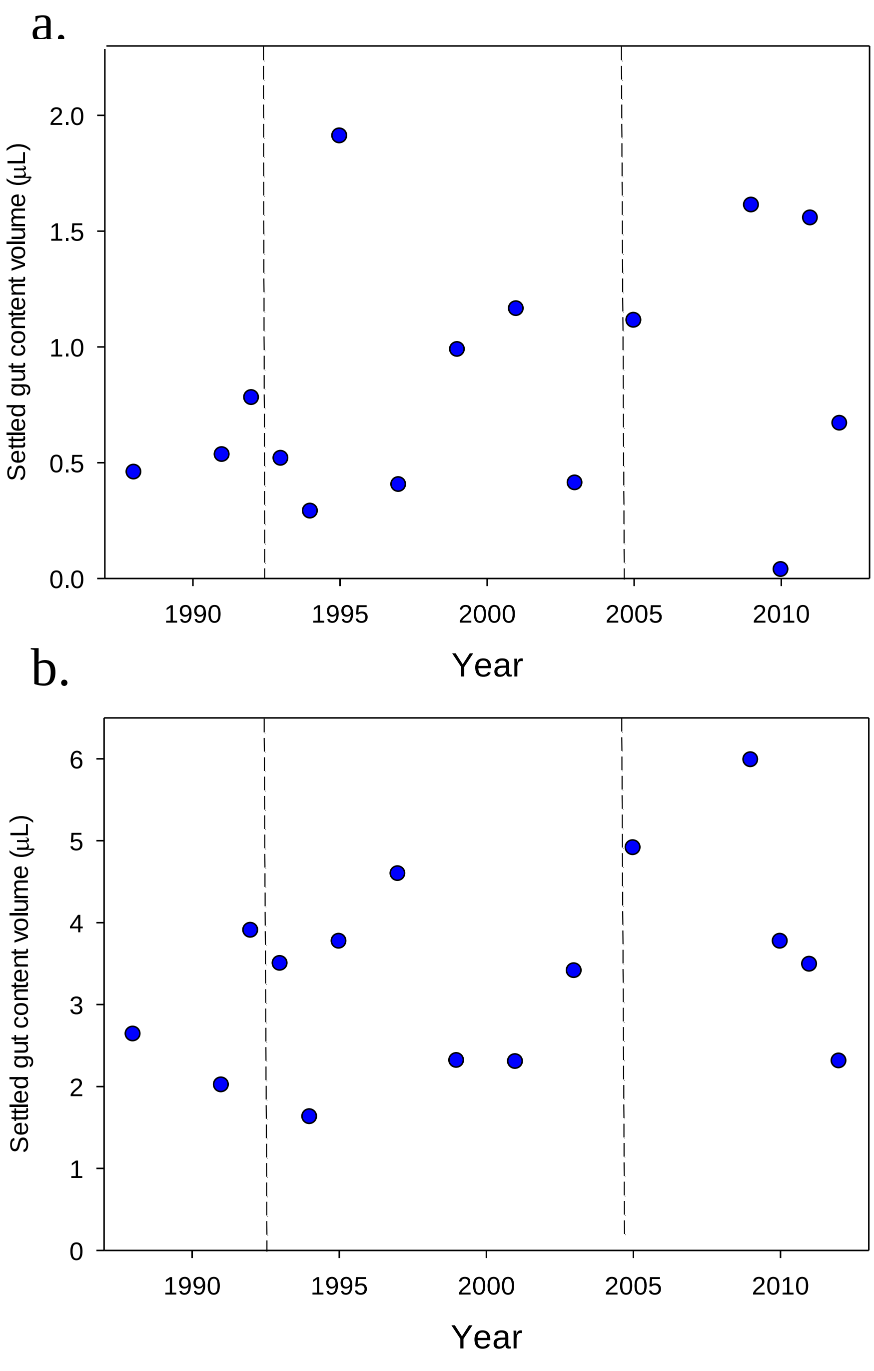

Fig. 2 Mean settled gut content volume of larval (a) and juvenile (b) American Shad samples. The figure is split into thirds by vertical lines to mark the zebra mussel invasion periods. The periods from left to right are pre-invasion, invasion-impact, and recovery.

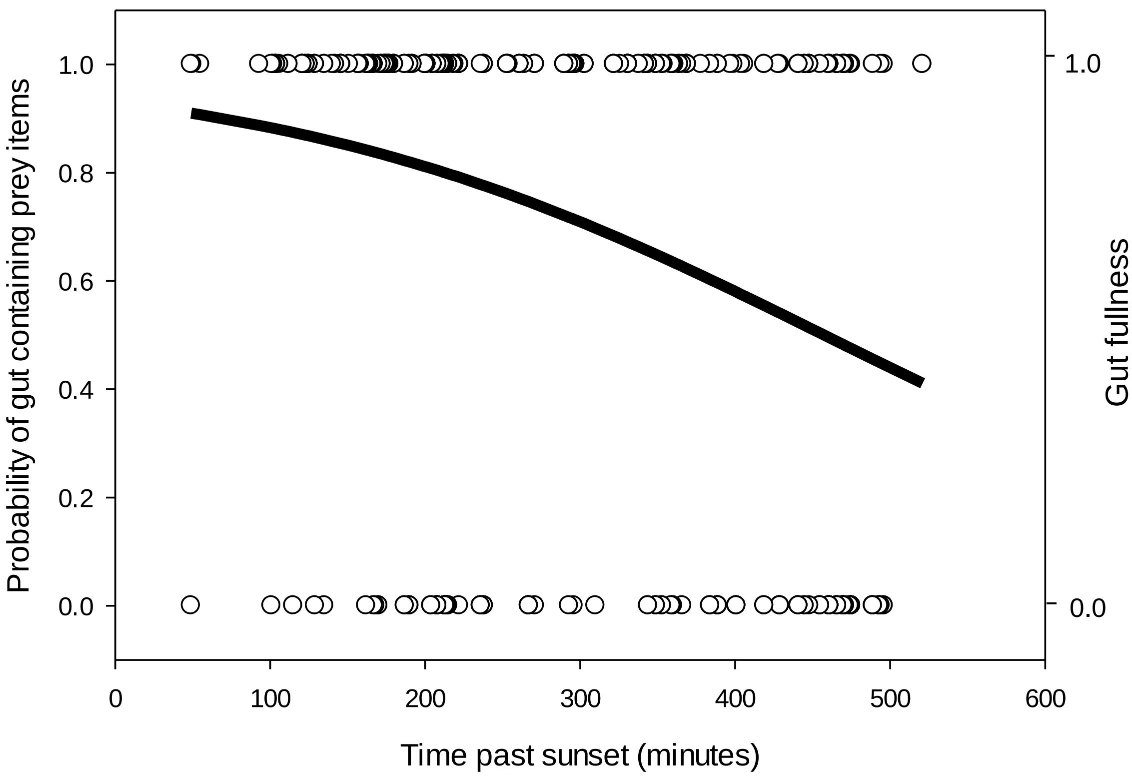

Fig. 3 Estimated probability (filled line) of a shad gut containing prey items in response to sampling time. Gut fullness was treated as a binary variable. For observed values (open circles), 1 indicates gut contents present, whereas 0 is an empty gut.

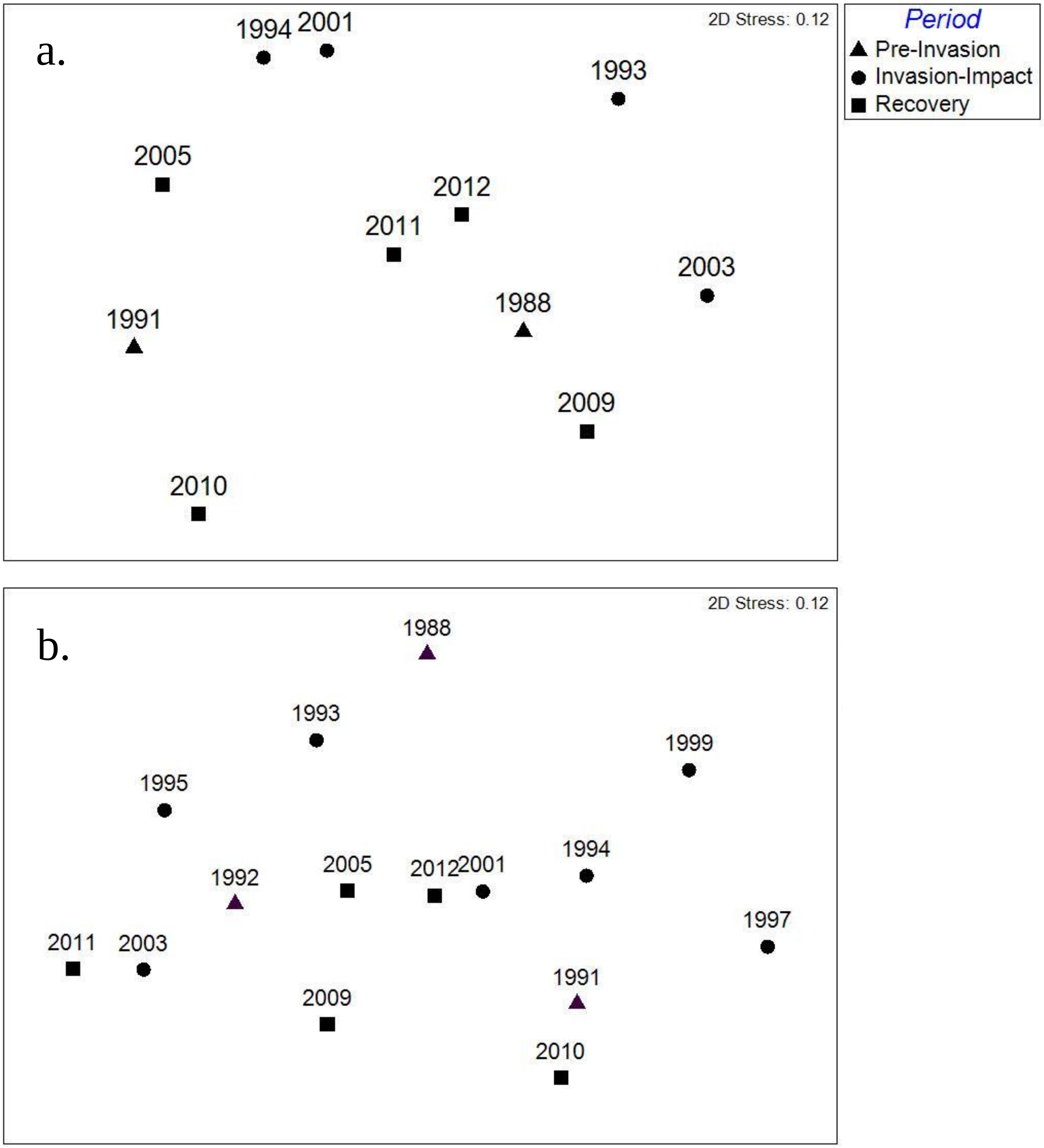

Fig. 4 Non-metric multidimensional scaling plot of larval (a) and juvenile (b) American Shad diet composition per year. Distance between points indicates dissimilarity.

APPENDIX A

Upriver Striped Bass SIMPER

Similarity Percentages - species contributions

Parameters

Resemblance: S17 Bray Curtis similarity

Cut off for low contributions: 90.00%

Group 1988

Average similarity: 23.26

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	39.64	14.76	0.48	63.48	63.48
Amphipoda	22.92	4.69	0.29	20.15	83.62
Gammaridae	18.89	2.86	0.22	12.28	95.91

Group 1991

Average similarity: 41.79

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gammaridae	46.27	27.17	1.06	65.01	65.01
Copepoda	21.04	7.13	0.51	17.07	82.07
Amphipoda	17.83	5.05	0.37	12.09	94.16

Group 1992

Average similarity: 21.56

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	40.95	14.56	0.49	67.53	67.53
Copepoda	22.45	4.22	0.30	19.59	87.12
Sididae	22.22	2.78	0.17	12.88	100.00

Group 1993

Average similarity: 32.62

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gammaridae	46.98	21.63	0.66	66.31	66.31
Amphipoda	29.94	8.85	0.43	27.14	93.45

Group 1997

Average similarity: 41.53

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	52.64	24.86	0.60	59.86	59.86
Leptodora_kindtii	44.44	16.67	0.44	40.14	100.00

Group 1999

Average similarity: 42.80

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	52.03	32.53	1.13	76.02	76.02
Amphipoda	25.41	6.88	0.37	16.08	92.09

Group 2003
Average similarity: 48.08

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	62.22	42.30	1.31	87.99	87.99
Gammaridae	21.16	5.48	0.42	11.40	99.39

Group 2005
Average similarity: 30.86

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	49.41	23.12	0.60	74.93	74.93
Copepoda	22.46	3.99	0.22	12.92	87.85
Gammaridae	21.88	3.75	0.22	12.15	100.00

Group 2006
Average similarity: 36.33

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	56.66	32.50	0.85	89.47	89.47
Gammaridae	13.04	1.76	0.23	4.83	94.30

Group 2007
Average similarity: 16.08

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	28.13	7.90	0.41	49.13	49.13
Sididae	14.63	2.38	0.24	14.82	63.95
Chydoridae	16.15	2.04	0.18	12.68	76.63
Copepoda	14.29	1.65	0.18	10.25	86.88
Gammaridae	15.41	1.44	0.13	8.98	95.87

Group 2009
Average similarity: 55.48

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Leptodora_kindtii	73.81	53.57	1.11	96.57	96.57

Group 2010
Average similarity: 56.75

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	70.93	53.13	1.66	93.62	93.62

Group 2011
Average similarity: 18.79

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	39.39	14.85	0.54	79.03	79.03
Corophiidae	18.18	1.82	0.13	9.68	88.71
Copepoda	13.64	0.91	0.13	4.84	93.55

Group 2012
Average similarity: 47.71

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	49.55	26.19	0.79	54.89	54.89
Gammaridae	44.57	21.52	0.76	45.11	100.00

Groups 1988 & 1991
Average dissimilarity = 74.89

	Group 1988	Group 1991				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	18.89	46.27	22.39	1.38	29.90	29.90
Copepoda	39.64	21.04	20.91	1.17	27.92	57.82
Amphipoda	22.92	17.83	15.14	0.92	20.22	78.03
Leptodora_kindtii	13.33	1.90	7.36	0.44	9.83	87.86
Podacopa	0.00	9.71	4.86	0.63	6.49	94.35

Groups 1988 & 1992
Average dissimilarity = 78.21

	Group 1988	Group 1992				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	22.92	40.95	21.93	1.06	28.03	28.03
Copepoda	39.64	22.45	21.36	1.06	27.32	55.35
Gammaridae	18.89	11.11	12.90	0.64	16.50	71.85
Sididae	0.00	22.22	11.11	0.53	14.21	86.05
Leptodora_kindtii	13.33	0.00	6.67	0.39	8.52	94.58

Groups 1991 & 1992
Average dissimilarity = 79.10

	Group 1991	Group 1992				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.27	11.11	23.55	1.42	29.77	29.77
Amphipoda	17.83	40.95	20.92	1.11	26.45	56.22
Copepoda	21.04	22.45	15.35	0.99	19.41	75.63
Sididae	0.00	22.22	11.11	0.53	14.05	89.68
Podacopa	9.71	3.27	5.59	0.72	7.07	96.75

Groups 1988 & 1993
Average dissimilarity = 75.34

	Group 1988	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	18.89	46.98	23.40	1.16	31.05	31.05

Copepoda	39.64	17.95	21.50	0.99	28.54	59.59
Amphipoda	22.92	29.94	18.61	0.99	24.70	84.29
Leptodora_kindtii	13.33	0.00	6.67	0.39	8.85	93.14

Groups 1991 & 1993
Average dissimilarity = 63.25

	Group 1991	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.27	46.98	21.96	1.40	34.72	34.72
Amphipoda	17.83	29.94	16.82	1.02	26.60	61.32
Copepoda	21.04	17.95	15.14	0.91	23.93	85.25
Podacopa	9.71	2.56	5.47	0.69	8.65	93.90

Groups 1992 & 1993
Average dissimilarity = 76.49

	Group 1992	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	11.11	46.98	23.83	1.11	31.15	31.15
Amphipoda	40.95	29.94	22.28	1.14	29.13	60.28
Copepoda	22.45	17.95	15.89	0.82	20.78	81.06
Sididae	22.22	2.56	11.82	0.58	15.46	96.52

Groups 1988 & 1997
Average dissimilarity = 72.83

	Group 1988	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	52.64	24.89	1.13	34.18	34.18
Leptodora_kindtii	13.33	44.44	22.96	0.92	31.53	65.71
Amphipoda	22.92	0.00	11.46	0.63	15.74	81.45
Gammaridae	18.89	0.00	9.44	0.54	12.97	94.42

Groups 1991 & 1997
Average dissimilarity = 87.55

	Group 1991	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	52.64	25.30	1.34	28.90	28.90
Gammaridae	46.27	0.00	23.14	1.40	26.43	55.33
Leptodora_kindtii	1.90	44.44	22.33	0.92	25.50	80.83
Amphipoda	17.83	0.00	8.92	0.69	10.18	91.02

Groups 1992 & 1997
Average dissimilarity = 87.85

	Group 1992	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	52.64	25.40	1.19	28.91	28.91
Leptodora_kindtii	0.00	44.44	22.22	0.89	25.30	54.20

Amphipoda	40.95	0.00	20.47	0.92	23.31	77.51
Sididae	22.22	0.00	11.11	0.53	12.65	90.16

Groups 1993 & 1997
Average dissimilarity = 90.48

	Group 1993	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	52.64	25.77	1.11	28.48	28.48
Gammaridae	46.98	0.00	23.49	1.10	25.96	54.45
Leptodora_kindtii	0.00	44.44	22.22	0.89	24.56	79.01
Amphipoda	29.94	0.00	14.97	0.79	16.55	95.55

Groups 1988 & 1999
Average dissimilarity = 67.46

	Group 1988	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	52.03	23.28	1.43	34.51	34.51
Amphipoda	22.92	25.41	17.55	0.93	26.02	60.53
Gammaridae	18.89	14.16	13.15	0.78	19.50	80.03
Leptodora_kindtii	13.33	0.00	6.67	0.39	9.88	89.91
Mysida	3.33	0.00	1.67	0.27	2.47	92.38

Groups 1991 & 1999
Average dissimilarity = 69.51

	Group 1991	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	52.03	21.75	1.44	31.29	31.29
Gammaridae	46.27	14.16	20.77	1.33	29.89	61.17
Amphipoda	17.83	25.41	15.53	0.94	22.34	83.51
Podacopa	9.71	0.00	4.86	0.63	6.99	90.50

Groups 1992 & 1999
Average dissimilarity = 72.68

	Group 1992	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	52.03	23.05	1.42	31.71	31.71
Amphipoda	40.95	25.41	21.95	1.09	30.20	61.91
Sididae	22.22	1.46	11.52	0.56	15.84	77.76
Gammaridae	11.11	14.16	11.06	0.67	15.22	92.98

Groups 1993 & 1999
Average dissimilarity = 73.07

	Group 1993	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	52.03	24.98	1.51	34.18	34.18
Gammaridae	46.98	14.16	22.58	1.19	30.90	65.08

Amphipoda	29.94	25.41	18.87	1.03	25.82	90.90

Groups 1997 & 1999
Average dissimilarity = 71.39

	Group 1997	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	52.03	24.01	1.45	33.63	33.63
Leptodora_kindtii	44.44	0.00	22.22	0.89	31.13	64.76
Amphipoda	0.00	25.41	12.70	0.69	17.80	82.56
Gammaridae	0.00	14.16	7.08	0.59	9.92	92.48

Groups 1988 & 2003
Average dissimilarity = 67.98

	Group 1988	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	62.22	24.56	1.41	36.12	36.12
Gammaridae	18.89	21.16	15.31	0.86	22.52	58.64
Amphipoda	22.92	1.22	11.66	0.65	17.16	75.80
Leptodora_kindtii	13.33	3.23	7.85	0.45	11.55	87.35
cumacea	1.88	5.26	3.47	0.31	5.11	92.46

Groups 1991 & 2003
Average dissimilarity = 69.46

	Group 1991	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	62.22	25.33	1.60	36.46	36.46
Gammaridae	46.27	21.16	20.94	1.36	30.14	66.61
Amphipoda	17.83	1.22	9.08	0.72	13.07	79.68
Podacopa	9.71	2.94	5.47	0.73	7.87	87.55
cumacea	0.00	5.26	2.63	0.24	3.79	91.34

Groups 1992 & 2003
Average dissimilarity = 80.20

	Group 1992	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	62.22	26.29	1.54	32.78	32.78
Amphipoda	40.95	1.22	20.43	0.93	25.48	58.26
Gammaridae	11.11	21.16	13.78	0.76	17.19	75.45
Sididae	22.22	1.96	11.65	0.57	14.53	89.98
Podacopa	3.27	2.94	2.78	0.53	3.47	93.45

Groups 1993 & 2003
Average dissimilarity = 76.07

	Group 1993	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	62.22	28.35	1.63	37.27	37.27

Gammaridae	46.98	21.16	22.79	1.23	29.96	67.23
Amphipoda	29.94	1.22	15.02	0.81	19.74	86.98
cumacea	0.00	5.26	2.63	0.24	3.46	90.44

Groups 1997 & 2003
Average dissimilarity = 64.93

	Group 1997	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	62.22	23.79	1.33	36.64	36.64
Leptodora_kindtii	44.44	3.23	22.40	0.92	34.50	71.14
Gammaridae	0.00	21.16	10.58	0.68	16.29	87.43
cumacea	0.00	5.26	2.63	0.24	4.05	91.49

Groups 1999 & 2003
Average dissimilarity = 57.41

	Group 1999	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	62.22	19.63	1.35	34.20	34.20
Gammaridae	14.16	21.16	13.15	0.87	22.90	57.11
Amphipoda	25.41	1.22	12.83	0.71	22.34	79.45
cumacea	0.00	5.26	2.63	0.24	4.58	84.03
Sididae	1.46	1.96	1.63	0.35	2.84	86.87
Leptodora_kindtii	0.00	3.23	1.61	0.24	2.81	89.68
Podacopa	0.00	2.94	1.47	0.39	2.56	92.25

Groups 1988 & 2005
Average dissimilarity = 74.80

	Group 1988	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	22.92	49.41	24.40	1.14	32.62	32.62
Copepoda	39.64	22.46	21.93	1.00	29.31	61.93
Gammaridae	18.89	21.88	16.08	0.77	21.49	83.42
Leptodora_kindtii	13.33	0.00	6.67	0.39	8.91	92.34

Groups 1991 & 2005
Average dissimilarity = 73.75

	Group 1991	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	17.83	49.41	23.95	1.21	32.48	32.48
Gammaridae	46.27	21.88	23.22	1.41	31.49	63.97
Copepoda	21.04	22.46	16.63	0.96	22.54	86.51
Podacopa	9.71	3.13	5.81	0.68	7.88	94.39

Groups 1992 & 2005
Average dissimilarity = 71.35

	Group 1992	Group 2005

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	40.95	49.41	24.49	1.14	34.33	34.33
Copepoda	22.45	22.46	17.13	0.85	24.01	58.33
Gammaridae	11.11	21.88	14.06	0.65	19.71	78.04
Sididae	22.22	0.00	11.11	0.53	15.57	93.62

Groups 1993 & 2005
Average dissimilarity = 69.71

	Group 1993	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	29.94	49.41	24.25	1.19	34.78	34.78
Gammaridae	46.98	21.88	23.83	1.15	34.18	68.96
Copepoda	17.95	22.46	16.11	0.74	23.11	92.07

Groups 1997 & 2005
Average dissimilarity = 88.07

	Group 1997	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	22.46	25.62	1.10	29.09	29.09
Amphipoda	0.00	49.41	24.71	1.05	28.05	57.14
Leptodora_kindtii	44.44	0.00	22.22	0.89	25.23	82.38
Gammaridae	0.00	21.88	10.94	0.55	12.42	94.79

Groups 1999 & 2005
Average dissimilarity = 71.00

	Group 1999	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	22.46	24.83	1.48	34.97	34.97
Amphipoda	25.41	49.41	24.24	1.16	34.14	69.12
Gammaridae	14.16	21.88	14.60	0.80	20.57	89.68
Podacopa	0.00	3.13	1.56	0.26	2.20	91.89

Groups 2003 & 2005
Average dissimilarity = 79.61

	Group 2003	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	22.46	27.78	1.57	34.90	34.90
Amphipoda	1.22	49.41	24.63	1.07	30.94	65.83
Gammaridae	21.16	21.88	16.56	0.87	20.80	86.63
Podacopa	2.94	3.13	2.85	0.44	3.58	90.21

Groups 1988 & 2006
Average dissimilarity = 70.71

	Group 1988	Group 2006				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	56.66	24.68	1.24	34.90	34.90

Amphipoda	22.92	9.37	13.60	0.75	19.24	54.13
Gammaridae	18.89	13.04	13.05	0.73	18.45	72.58
Leptodora_kindtii	13.33	0.00	6.67	0.39	9.43	82.01
Clupeidae	0.00	12.28	6.14	0.40	8.68	90.69

Groups 1991 & 2006
Average dissimilarity = 75.93

	Group 1991	Group 2006				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	56.66	25.18	1.44	33.16	33.16
Gammaridae	46.27	13.04	21.70	1.36	28.58	61.73
Amphipoda	17.83	9.37	11.16	0.80	14.70	76.43
Clupeidae	0.00	12.28	6.14	0.40	8.09	84.52
Podacopa	9.71	0.00	4.86	0.63	6.40	90.92

Groups 1992 & 2006
Average dissimilarity = 80.20

	Group 1992	Group 2006				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	56.66	25.66	1.33	31.99	31.99
Amphipoda	40.95	9.37	20.88	0.99	26.03	58.02
Sididae	22.22	0.75	11.32	0.55	14.12	72.14
Gammaridae	11.11	13.04	10.63	0.60	13.25	85.39
Clupeidae	0.00	12.28	6.14	0.40	7.66	93.04

Groups 1993 & 2006
Average dissimilarity = 78.99

	Group 1993	Group 2006				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	56.66	26.83	1.31	33.97	33.97
Gammaridae	46.98	13.04	22.97	1.16	29.08	63.05
Amphipoda	29.94	9.37	16.22	0.88	20.53	83.58
Clupeidae	0.00	12.28	6.14	0.40	7.77	91.35

Groups 1997 & 2006
Average dissimilarity = 69.64

	Group 1997	Group 2006				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	56.66	24.29	1.18	34.88	34.88
Leptodora_kindtii	44.44	0.00	22.22	0.89	31.91	66.79
Gammaridae	0.00	13.04	6.52	0.49	9.36	76.15
Clupeidae	0.00	12.28	6.14	0.40	8.82	84.97
Amphipoda	0.00	9.37	4.68	0.40	6.73	91.69

Groups 1999 & 2006
Average dissimilarity = 61.75

Species	Group 1999 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	56.66	21.91	1.40	35.49	35.49
Amphipoda	25.41	9.37	14.41	0.79	23.34	58.83
Gammaridae	14.16	13.04	10.81	0.76	17.51	76.34
Clupeidae	0.00	12.28	6.14	0.40	9.94	86.29
Mysida	0.00	7.89	3.95	0.32	6.39	92.68

Groups 2003 & 2006
Average dissimilarity = 58.00

Species	Group 2003 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	56.66	21.48	1.29	37.04	37.04
Gammaridae	21.16	13.04	13.33	0.83	22.98	60.02
Clupeidae	0.00	12.28	6.14	0.40	10.59	70.60
Amphipoda	1.22	9.37	5.06	0.43	8.73	79.33
Mysida	0.00	7.89	3.95	0.32	6.81	86.14
cumacea	5.26	0.00	2.63	0.24	4.54	90.67

Groups 2005 & 2006
Average dissimilarity = 78.97

Species	Group 2005 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.46	56.66	26.50	1.28	33.56	33.56
Amphipoda	49.41	9.37	24.48	1.11	31.00	64.56
Gammaridae	21.88	13.04	14.40	0.74	18.23	82.79
Clupeidae	0.00	12.28	6.14	0.40	7.78	90.57

Groups 1988 & 2007
Average dissimilarity = 83.46

Species	Group 1988 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	14.29	20.80	1.00	24.92	24.92
Amphipoda	22.92	28.13	18.15	0.97	21.75	46.67
Gammaridae	18.89	15.41	14.15	0.70	16.95	63.62
Chydoridae	0.00	16.15	8.07	0.50	9.67	73.30
Sididae	0.00	14.63	7.31	0.56	8.76	82.06
Leptodora_kindtii	13.33	0.00	6.67	0.39	7.99	90.05

Groups 1991 & 2007
Average dissimilarity = 81.39

Species	Group 1991 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.27	15.41	23.34	1.42	28.68	28.68
Amphipoda	17.83	28.13	16.22	0.99	19.93	48.61
Copepoda	21.04	14.29	13.56	0.91	16.67	65.27
Chydoridae	0.00	16.15	8.07	0.50	9.92	75.20

Sididae	0.00	14.63	7.31	0.56	8.99	84.18
Podacopa	9.71	0.00	4.86	0.63	5.97	90.15

Groups 1992 & 2007
Average dissimilarity = 78.62

	Group 1992	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	40.95	28.13	22.11	1.12	28.12	28.12
Sididae	22.22	14.63	15.17	0.77	19.30	47.42
Copepoda	22.45	14.29	14.38	0.80	18.30	65.71
Gammaridae	11.11	15.41	11.55	0.56	14.69	80.40
Chydoridae	0.00	16.15	8.07	0.50	10.27	90.67

Groups 1993 & 2007
Average dissimilarity = 79.35

	Group 1993	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.98	15.41	23.79	1.13	29.98	29.98
Amphipoda	29.94	28.13	19.22	1.06	24.22	54.20
Copepoda	17.95	14.29	13.37	0.70	16.85	71.05
Chydoridae	0.00	16.15	8.07	0.50	10.18	81.23
Sididae	2.56	14.63	7.91	0.62	9.97	91.20

Groups 1997 & 2007
Average dissimilarity = 91.86

	Group 1997	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	14.29	25.73	1.16	28.02	28.02
Leptodora_kindtii	44.44	0.00	22.22	0.89	24.19	52.21
Amphipoda	0.00	28.13	14.06	0.76	15.31	67.52
Chydoridae	0.00	16.15	8.07	0.50	8.79	76.31
Gammaridae	0.00	15.41	7.70	0.44	8.39	84.70
Sididae	0.00	14.63	7.31	0.56	7.96	92.66

Groups 1999 & 2007
Average dissimilarity = 79.32

	Group 1999	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	14.29	24.12	1.46	30.41	30.41
Amphipoda	25.41	28.13	18.38	1.00	23.17	53.58
Gammaridae	14.16	15.41	12.40	0.72	15.64	69.22
Chydoridae	0.00	16.15	8.07	0.50	10.18	79.40
Sididae	1.46	14.63	7.63	0.60	9.61	89.01
Chironomidae	2.94	3.80	3.00	0.54	3.78	92.79

Groups 2003 & 2007
Average dissimilarity = 84.88

	Group 2003	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	14.29	28.03	1.63	33.02	33.02
Gammaridae	21.16	15.41	14.73	0.80	17.36	50.38
Amphipoda	1.22	28.13	14.15	0.78	16.67	67.06
Chydoridae	1.32	16.15	8.45	0.54	9.96	77.01
Sididae	1.96	14.63	7.79	0.60	9.18	86.19
bivalve	0.00	5.61	2.80	0.40	3.30	89.50
cumacea	5.26	0.00	2.63	0.24	3.10	92.60

Groups 2005 & 2007
Average dissimilarity = 78.27

	Group 2005	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	49.41	28.13	24.19	1.18	30.90	30.90
Gammaridae	21.88	15.41	15.24	0.70	19.47	50.37
Copepoda	22.46	14.29	14.98	0.74	19.14	69.51
Chydoridae	0.00	16.15	8.07	0.50	10.32	79.83
Sididae	0.00	14.63	7.31	0.56	9.34	89.17
bivalve	3.13	5.61	4.02	0.48	5.13	94.30

Groups 2006 & 2007
Average dissimilarity = 85.54

	Group 2006	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	56.66	14.29	26.63	1.33	31.13	31.13
Amphipoda	9.37	28.13	15.51	0.86	18.13	49.26
Gammaridae	13.04	15.41	12.06	0.66	14.10	63.36
Chydoridae	0.00	16.15	8.07	0.50	9.44	72.80
Sididae	0.75	14.63	7.48	0.58	8.74	81.54
Clupeidae	12.28	0.00	6.14	0.40	7.18	88.72
Mysida	7.89	0.00	3.95	0.32	4.61	93.34

Groups 1988 & 2009
Average dissimilarity = 82.96

	Group 1988	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	13.33	73.81	33.73	1.48	40.66	40.66
Copepoda	39.64	9.52	20.81	0.93	25.08	65.74
Gammaridae	18.89	14.29	13.89	0.67	16.74	82.48
Amphipoda	22.92	2.38	11.93	0.66	14.38	96.86

Groups 1991 & 2009
Average dissimilarity = 89.18

	Group 1991	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Leptodora_kindtii	1.90	73.81	36.41	1.74	40.82	40.82
Gammaridae	46.27	14.29	23.67	1.43	26.54	67.36
Copepoda	21.04	9.52	13.28	0.84	14.89	82.25
Amphipoda	17.83	2.38	9.35	0.73	10.48	92.73

Groups 1992 & 2009
Average dissimilarity = 95.12

	Group 1992	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	38.80	38.80
Amphipoda	40.95	2.38	20.51	0.94	21.56	60.36
Copepoda	22.45	9.52	13.85	0.73	14.56	74.92
Gammaridae	11.11	14.29	11.11	0.53	11.68	86.60
Sididae	22.22	0.00	11.11	0.53	11.68	98.28

Groups 1993 & 2009
Average dissimilarity = 90.62

	Group 1993	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	40.72	40.72
Gammaridae	46.98	14.29	23.92	1.12	26.40	67.12
Amphipoda	29.94	2.38	15.20	0.82	16.78	83.90
Copepoda	17.95	9.52	12.03	0.59	13.27	97.17

Groups 1997 & 2009
Average dissimilarity = 62.18

	Group 1997	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	44.44	73.81	26.32	1.08	42.33	42.33
Copepoda	52.64	9.52	26.07	1.09	41.92	84.25
Gammaridae	0.00	14.29	7.14	0.41	11.49	95.74

Groups 1999 & 2009
Average dissimilarity = 92.19

	Group 1999	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	40.03	40.03
Copepoda	52.03	9.52	25.82	1.54	28.01	68.04
Amphipoda	25.41	2.38	13.07	0.73	14.17	82.21
Gammaridae	14.16	14.29	12.20	0.70	13.23	95.45

Groups 2003 & 2009
Average dissimilarity = 88.56

	Group 2003	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	3.23	73.81	36.09	1.71	40.75	40.75

Copepoda	62.22	9.52	29.95	1.72	33.81	74.56
Gammaridae	21.16	14.29	14.70	0.79	16.60	91.16

Groups 2005 & 2009
Average dissimilarity = 93.42

	Group 2005	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	39.50	39.50
Amphipoda	49.41	2.38	24.58	1.07	26.31	65.82
Gammaridae	21.88	14.29	14.96	0.68	16.01	81.83
Copepoda	22.46	9.52	13.85	0.64	14.83	96.66

Groups 2006 & 2009
Average dissimilarity = 92.42

	Group 2006	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	39.93	39.93
Copepoda	56.66	9.52	27.70	1.31	29.97	69.90
Gammaridae	13.04	14.29	11.80	0.64	12.77	82.67
Clupeidae	12.28	0.00	6.14	0.40	6.64	89.31
Amphipoda	9.37	2.38	5.55	0.45	6.01	95.32

Groups 2007 & 2009
Average dissimilarity = 95.51

	Group 2007	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	0.00	73.81	36.90	1.73	38.64	38.64
Amphipoda	28.13	2.38	14.32	0.79	15.00	53.64
Gammaridae	15.41	14.29	12.65	0.60	13.24	66.88
Copepoda	14.29	9.52	10.54	0.58	11.04	77.92
Chydoridae	16.15	0.00	8.07	0.50	8.45	86.37
Sididae	14.63	0.00	7.31	0.56	7.66	94.03

Groups 1988 & 2010
Average dissimilarity = 66.04

	Group 1988	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	70.93	25.65	1.41	38.84	38.84
Amphipoda	22.92	13.82	14.77	0.79	22.36	61.20
Gammaridae	18.89	2.38	10.00	0.60	15.14	76.34
Leptodora_kindtii	13.33	0.00	6.67	0.39	10.09	86.44
Bosmina	0.00	9.15	4.58	0.53	6.93	93.37

Groups 1991 & 2010
Average dissimilarity = 75.96

	Group 1991	Group 2010

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	70.93	28.15	1.74	37.06	37.06
Gammaridae	46.27	2.38	22.45	1.39	29.56	66.62
Amphipoda	17.83	13.82	12.55	0.83	16.52	83.14
Bosmina	2.50	9.15	5.28	0.60	6.95	90.09

Groups 1992 & 2010
Average dissimilarity = 75.50

	Group 1992	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	70.93	28.80	1.64	38.14	38.14
Amphipoda	40.95	13.82	21.21	1.00	28.10	66.24
Sididae	22.22	0.00	11.11	0.53	14.72	80.96
Gammaridae	11.11	2.38	6.48	0.42	8.58	89.54
Bosmina	0.00	9.15	4.58	0.53	6.06	95.60

Groups 1993 & 2010
Average dissimilarity = 80.36

	Group 1993	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	70.93	31.21	1.79	38.83	38.83
Gammaridae	46.98	2.38	23.22	1.13	28.89	67.72
Amphipoda	29.94	13.82	17.06	0.92	21.23	88.95
Bosmina	0.00	9.15	4.58	0.53	5.69	94.64

Groups 1997 & 2010
Average dissimilarity = 61.84

	Group 1997	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	70.93	23.71	1.28	38.33	38.33
Leptodora_kindtii	44.44	0.00	22.22	0.89	35.94	74.27
Amphipoda	0.00	13.82	6.91	0.47	11.17	85.44
Bosmina	0.00	9.15	4.58	0.53	7.40	92.84

Groups 1999 & 2010
Average dissimilarity = 53.13

	Group 1999	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	70.93	19.88	1.32	37.41	37.41
Amphipoda	25.41	13.82	15.48	0.83	29.13	66.54
Gammaridae	14.16	2.38	7.51	0.65	14.13	80.67
Bosmina	1.33	9.15	4.96	0.57	9.33	90.00
Chironomidae	2.94	0.76	1.76	0.40	3.32	93.32

Groups 2003 & 2010
Average dissimilarity = 49.97

	Group 2003	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	70.93	18.41	1.24	36.84	36.84
Gammaridae	21.16	2.38	10.67	0.71	21.35	58.19
Amphipoda	1.22	13.82	7.20	0.49	14.41	72.60
Bosmina	0.70	9.15	4.76	0.56	9.52	82.12
cumacea	5.26	1.38	3.25	0.29	6.50	88.62
Podacopa	2.94	1.59	2.06	0.51	4.11	92.74

Groups 2005 & 2010
Average dissimilarity = 75.71

	Group 2005	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.46	70.93	30.22	1.68	39.91	39.91
Amphipoda	49.41	13.82	24.49	1.11	32.35	72.26
Gammaridae	21.88	2.38	11.53	0.61	15.23	87.50
Bosmina	0.00	9.15	4.58	0.53	6.04	93.54

Groups 2006 & 2010
Average dissimilarity = 55.13

	Group 2006	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	56.66	70.93	21.25	1.24	38.55	38.55
Amphipoda	9.37	13.82	9.88	0.61	17.93	56.47
Gammaridae	13.04	2.38	7.09	0.56	12.87	69.34
Clupeidae	12.28	0.00	6.14	0.40	11.14	80.48
Bosmina	0.00	9.15	4.58	0.53	8.30	88.77
Mysida	7.89	0.00	3.95	0.32	7.16	95.93

Groups 2007 & 2010
Average dissimilarity = 83.03

	Group 2007	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	14.29	70.93	31.21	1.81	37.59	37.59
Amphipoda	28.13	13.82	16.45	0.89	19.82	57.41
Gammaridae	15.41	2.38	8.40	0.50	10.12	67.53
Chydoridae	16.15	0.00	8.07	0.50	9.73	77.25
Sididae	14.63	0.00	7.31	0.56	8.81	86.06
Bosmina	1.99	9.15	5.12	0.59	6.16	92.22

Groups 2009 & 2010
Average dissimilarity = 92.47

	Group 2009	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	73.81	0.00	36.90	1.73	39.91	39.91
Copepoda	9.52	70.93	33.47	1.97	36.19	76.10
Gammaridae	14.29	2.38	7.99	0.47	8.64	84.74

Amphipoda	2.38	13.82	7.67	0.52	8.29	93.04

Groups 1988 & 2011
Average dissimilarity = 81.27

	Group 1988	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	22.92	39.39	21.18	1.08	26.06	26.06
Copepoda	39.64	13.64	20.91	0.97	25.73	51.80
Gammaridae	18.89	12.12	12.98	0.68	15.97	67.77
Corophiidae	0.00	18.18	9.09	0.47	11.19	78.96
Leptodora_kindtii	13.33	0.00	6.67	0.39	8.20	87.16
Mysida	3.33	7.58	4.95	0.53	6.09	93.25

Groups 1991 & 2011
Average dissimilarity = 80.83

	Group 1991	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.27	12.12	22.67	1.39	28.05	28.05
Amphipoda	17.83	39.39	19.76	1.10	24.44	52.49
Copepoda	21.04	13.64	13.77	0.89	17.04	69.53
Corophiidae	0.00	18.18	9.09	0.47	11.25	80.78
Podacopa	9.71	0.00	4.86	0.63	6.01	86.79
Mysida	0.00	7.58	3.79	0.46	4.69	91.47

Groups 1992 & 2011
Average dissimilarity = 77.98

	Group 1992	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	40.95	39.39	23.05	1.15	29.56	29.56
Copepoda	22.45	13.64	14.49	0.78	18.58	48.14
Sididae	22.22	0.00	11.11	0.53	14.25	62.39
Gammaridae	11.11	12.12	10.27	0.54	13.17	75.56
Corophiidae	0.00	18.18	9.09	0.47	11.66	87.22
Mysida	0.00	7.58	3.79	0.46	4.86	92.08

Groups 1993 & 2011
Average dissimilarity = 78.12

	Group 1993	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	46.98	12.12	23.42	1.13	29.97	29.97
Amphipoda	29.94	39.39	21.49	1.15	27.51	57.48
Copepoda	17.95	13.64	13.23	0.67	16.93	74.41
Corophiidae	0.00	18.18	9.09	0.47	11.64	86.05
Mysida	0.00	7.58	3.79	0.46	4.85	90.90

Groups 1997 & 2011
Average dissimilarity = 92.69

Species	Group 1997 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	13.64	25.83	1.13	27.86	27.86
Leptodora_kindtii	44.44	0.00	22.22	0.89	23.97	51.84
Amphipoda	0.00	39.39	19.70	0.94	21.25	73.09
Corophiidae	0.00	18.18	9.09	0.47	9.81	82.90
Gammaridae	0.00	12.12	6.06	0.41	6.54	89.44
Mysida	0.00	7.58	3.79	0.46	4.09	93.52

Groups 1999 & 2011
Average dissimilarity = 78.26

Species	Group 1999 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.03	13.64	24.72	1.49	31.59	31.59
Amphipoda	25.41	39.39	21.10	1.10	26.96	58.55
Gammaridae	14.16	12.12	10.94	0.70	13.98	72.53
Corophiidae	0.00	18.18	9.09	0.47	11.62	84.14
Mysida	0.00	7.58	3.79	0.46	4.84	88.98
Bosmina	1.33	4.55	2.82	0.37	3.60	92.58

Groups 2003 & 2011
Average dissimilarity = 86.88

Species	Group 2003 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	13.64	28.60	1.65	32.91	32.91
Amphipoda	1.22	39.39	19.64	0.96	22.61	55.52
Gammaridae	21.16	12.12	13.58	0.79	15.63	71.15
Corophiidae	0.00	18.18	9.09	0.47	10.46	81.61
Mysida	0.00	7.58	3.79	0.46	4.36	85.97
cumacea	5.26	0.00	2.63	0.24	3.03	89.00
Bosmina	0.70	4.55	2.56	0.36	2.95	91.95

Groups 2005 & 2011
Average dissimilarity = 73.60

Species	Group 2005 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	49.41	39.39	24.22	1.18	32.90	32.90
Copepoda	22.46	13.64	14.87	0.71	20.21	53.10
Gammaridae	21.88	12.12	14.25	0.69	19.36	72.47
Corophiidae	0.00	18.18	9.09	0.47	12.35	84.82
Mysida	0.00	7.58	3.79	0.46	5.15	89.96
bivalve	3.13	4.55	3.55	0.41	4.82	94.79

Groups 2006 & 2011
Average dissimilarity = 84.78

Group 2006 Group 2011

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	56.66	13.64	26.94	1.32	31.78	31.78
Amphipoda	9.37	39.39	20.07	1.01	23.67	55.45
Gammaridae	13.04	12.12	10.68	0.64	12.59	68.04
Corophiidae	0.00	18.18	9.09	0.47	10.72	78.77
Mysida	7.89	7.58	6.94	0.53	8.18	86.95
Clupeidae	12.28	0.00	6.14	0.40	7.24	94.19

Groups 2007 & 2011
Average dissimilarity = 82.57

	Group 2007	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	28.13	39.39	21.23	1.12	25.72	25.72
Gammaridae	15.41	12.12	11.83	0.60	14.33	40.04
Copepoda	14.29	13.64	11.69	0.65	14.16	54.20
Corophiidae	0.00	18.18	9.09	0.47	11.01	65.21
Chydoridae	16.15	0.00	8.07	0.50	9.78	74.98
Sididae	14.63	0.00	7.31	0.56	8.86	83.84
bivalve	5.61	4.55	4.57	0.51	5.53	89.37
Mysida	0.00	7.58	3.79	0.46	4.59	93.96

Groups 2009 & 2011
Average dissimilarity = 95.74

	Group 2009	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	73.81	0.00	36.90	1.73	38.55	38.55
Amphipoda	2.38	39.39	19.66	0.96	20.54	59.08
Gammaridae	14.29	12.12	11.47	0.58	11.98	71.06
Copepoda	9.52	13.64	10.28	0.55	10.74	81.80
Corophiidae	0.00	18.18	9.09	0.47	9.50	91.30

Groups 2010 & 2011
Average dissimilarity = 82.17

	Group 2010	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	70.93	13.64	31.81	1.84	38.71	38.71
Amphipoda	13.82	39.39	20.51	1.03	24.96	63.67
Corophiidae	0.00	18.18	9.09	0.47	11.06	74.73
Gammaridae	2.38	12.12	6.82	0.48	8.30	83.03
Bosmina	9.15	4.55	6.02	0.62	7.33	90.36

Groups 1988 & 2012
Average dissimilarity = 68.19

	Group 1988	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	39.64	49.55	23.56	1.25	34.55	34.55
Gammaridae	18.89	44.57	22.30	1.17	32.71	67.26

Amphipoda	22.92	5.88	13.05	0.68	19.14	86.40
Leptodora_kindtii	13.33	0.00	6.67	0.39	9.78	96.18

Groups 1991 & 2012
Average dissimilarity = 61.36

	Group 1991	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	21.04	49.55	22.50	1.36	36.67	36.67
Gammaridae	46.27	44.57	20.62	1.34	33.61	70.28
Amphipoda	17.83	5.88	10.81	0.73	17.61	87.89
Podacopa	9.71	0.00	4.86	0.63	7.91	95.81

Groups 1992 & 2012
Average dissimilarity = 79.81

	Group 1992	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	22.45	49.55	23.17	1.25	29.03	29.03
Gammaridae	11.11	44.57	22.89	1.15	28.68	57.71
Amphipoda	40.95	5.88	21.01	0.94	26.32	84.03
Sididae	22.22	0.00	11.11	0.53	13.92	97.95

Groups 1993 & 2012
Average dissimilarity = 66.10

	Group 1993	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	17.95	49.55	24.47	1.27	37.01	37.01
Gammaridae	46.98	44.57	22.92	1.28	34.68	71.69
Amphipoda	29.94	5.88	16.15	0.83	24.43	96.12

Groups 1997 & 2012
Average dissimilarity = 73.21

	Group 1997	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	52.64	49.55	24.30	1.25	33.20	33.20
Gammaridae	0.00	44.57	22.28	1.13	30.44	63.64
Leptodora_kindtii	44.44	0.00	22.22	0.89	30.35	93.99

Groups 1999 & 2012
Average dissimilarity = 60.07

	Group 1999	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	14.16	44.57	20.94	1.16	34.86	34.86
Copepoda	52.03	49.55	20.78	1.33	34.60	69.45
Amphipoda	25.41	5.88	14.15	0.74	23.56	93.01

Groups 2003 & 2012

Average dissimilarity = 53.92

Species	Group 2003 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	62.22	49.55	21.48	1.32	39.84	39.84
Gammaridae	21.16	44.57	21.25	1.19	39.42	79.26
Amphipoda	1.22	5.88	3.48	0.30	6.45	85.71
cumacea	5.26	0.00	2.63	0.24	4.88	90.59

Groups 2005 & 2012
Average dissimilarity = 75.23

Species	Group 2005 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	49.41	5.88	24.74	1.05	32.88	32.88
Copepoda	22.46	49.55	24.37	1.24	32.39	65.28
Gammaridae	21.88	44.57	23.00	1.18	30.57	95.85

Groups 2006 & 2012
Average dissimilarity = 62.10

Species	Group 2006 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	56.66	49.55	22.91	1.27	36.90	36.90
Gammaridae	13.04	44.57	21.65	1.17	34.86	71.76
Amphipoda	9.37	5.88	7.07	0.47	11.39	83.15
Clupeidae	12.28	0.00	6.14	0.40	9.89	93.04

Groups 2007 & 2012
Average dissimilarity = 83.03

Species	Group 2007 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	14.29	49.55	23.76	1.25	28.61	28.61
Gammaridae	15.41	44.57	22.83	1.17	27.50	56.11
Amphipoda	28.13	5.88	15.35	0.80	18.49	74.60
Chydoridae	16.15	0.00	8.07	0.50	9.73	84.33
Sididae	14.63	0.00	7.31	0.56	8.81	93.13

Groups 2009 & 2012
Average dissimilarity = 88.77

Species	Group 2009 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Leptodora_kindtii	73.81	0.00	36.90	1.73	41.57	41.57
Copepoda	9.52	49.55	24.82	1.25	27.96	69.53
Gammaridae	14.29	44.57	23.06	1.16	25.98	95.50

Groups 2010 & 2012
Average dissimilarity = 59.12

Species	Group 2010 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	70.93	49.55	21.84	1.29	36.94	36.94
Gammaridae	2.38	44.57	21.80	1.14	36.88	73.82
Amphipoda	13.82	5.88	9.04	0.53	15.28	89.11
Bosmina	9.15	0.00	4.58	0.53	7.74	96.85

Groups 2011 & 2012
Average dissimilarity = 84.15

Species	Group 2011 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	13.64	49.55	24.15	1.25	28.70	28.70
Gammaridae	12.12	44.57	22.26	1.15	26.45	55.15
Amphipoda	39.39	5.88	20.32	0.97	24.15	79.29
Corophiidae	18.18	0.00	9.09	0.47	10.80	90.10

APPENDIX B

Downriver Striped Bass SIMPER

Similarity Percentages - species contributions

Parameters
Resemblance: S17 Bray Curtis similarity
Cut off for low contributions: 90.00%

Group 1988
Average similarity: 29.25

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	45.07	19.15	0.53	65.44	65.44
Mysida	23.62	5.07	0.29	17.34	82.78
Amphipoda	24.37	4.93	0.24	16.86	99.64

Group 1991
Average similarity: 57.36

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	70.73	54.57	3.21	95.14	95.14

Group 1992
Average similarity: 34.69

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	44.10	22.49	0.83	64.82	64.82
Copepoda	25.26	8.42	0.54	24.27	89.09
Mysida	16.87	2.89	0.27	8.32	97.42

Group 1993
All the similarities are zero

Group 1997
Average similarity: 100.00

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	100.00	100.00	#######	100.00	100.00

Group 1999
Average similarity: 22.21

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	37.15	12.44	0.43	56.01	56.01
Amphipoda	22.25	3.93	0.25	17.68	73.69
Mysida	23.08	3.85	0.20	17.32	91.01

Group 2003
Average similarity: 41.94

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%

Copepoda	48.60	27.07	0.88	64.55	64.55
Gammaridae	33.77	13.08	0.58	31.19	95.75

Group 2005
Average similarity: 36.62

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	51.81	25.52	0.63	69.70	69.70
Gammaridae	32.46	9.70	0.38	26.48	96.18

Group 2006
Average similarity: 19.44

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Mysida	33.07	10.02	0.36	51.57	51.57
Copepoda	23.17	4.72	0.25	24.31	75.87
Gammaridae	19.41	3.96	0.30	20.39	96.26

Group 2007
Average similarity: 32.40

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	53.52	26.95	0.69	83.17	83.17
Amphipoda	27.27	5.45	0.24	16.83	100.00

Group 2009
Average similarity: 34.56

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	43.87	18.74	0.63	54.24	54.24
Gammaridae	40.58	14.83	0.50	42.92	97.16

Group 2010
Average similarity: 59.45

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Mysida	75.13	56.40	1.53	94.87	94.87

Group 2011
Average similarity: 25.45

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Copepoda	35.20	11.78	0.41	46.29	46.29
Amphipoda	33.98	10.85	0.39	42.64	88.94
Gammaridae	15.62	2.37	0.21	9.33	98.27

Group 2012
Average similarity: 34.24

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gammaridae	43.82	18.85	0.55	55.04	55.04

Copepoda	38.27	14.39	0.47	42.03	97.07

Groups 1988 & 1991
Average dissimilarity = 76.62

	Group 1988	Group 1991				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	24.37	70.73	29.68	1.94	38.74	38.74
Copepoda	45.07	0.00	22.54	0.95	29.41	68.16
Mysida	23.62	15.58	14.71	0.91	19.20	87.36
Gammaridae	3.66	8.11	5.26	0.59	6.87	94.22

Groups 1988 & 1992
Average dissimilarity = 71.57

	Group 1988	Group 1992				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	25.26	23.06	1.23	32.22	32.22
Amphipoda	24.37	44.10	23.00	1.28	32.14	64.36
Mysida	23.62	16.87	15.74	0.82	21.99	86.35
Gammaridae	3.66	9.72	6.11	0.50	8.54	94.89

Groups 1991 & 1992
Average dissimilarity = 57.79

	Group 1991	Group 1992				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	44.10	20.79	1.40	35.97	35.97
Copepoda	0.00	25.26	12.63	0.82	21.86	57.83
Mysida	15.58	16.87	12.23	0.86	21.17	79.00
Gammaridae	8.11	9.72	7.63	0.62	13.21	92.21

Groups 1988 & 1993
Average dissimilarity = 76.85

	Group 1988	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	33.33	24.18	1.02	31.46	31.46
Amphipoda	24.37	33.33	20.73	0.86	26.97	58.43
Mysida	23.62	0.00	11.81	0.62	15.37	73.80
Corophiidae	0.00	16.67	8.33	0.70	10.84	84.65
cumacea	0.00	16.67	8.33	0.70	10.84	95.49

Groups 1991 & 1993
Average dissimilarity = 76.42

	Group 1991	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	33.33	28.45	1.76	37.23	37.23
Copepoda	0.00	33.33	16.67	0.68	21.81	59.04
Corophiidae	0.00	16.67	8.33	0.68	10.90	69.95

cumacea	0.00	16.67	8.33	0.68	10.90	80.85
Mysida	15.58	0.00	7.79	0.74	10.19	91.04

Groups 1992 & 1993
Average dissimilarity = 76.88

	Group 1992	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	33.33	24.02	1.31	31.24	31.24
Copepoda	25.26	33.33	20.88	1.07	27.16	58.40
Mysida	16.87	0.00	8.43	0.53	10.97	69.36
Corophiidae	0.00	16.67	8.33	0.70	10.84	80.20
cumacea	0.00	16.67	8.33	0.70	10.84	91.04

Groups 1988 & 1997
Average dissimilarity = 54.93

	Group 1988	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	100.00	27.46	1.15	50.00	50.00
Amphipoda	24.37	0.00	12.19	0.58	22.19	72.19
Mysida	23.62	0.00	11.81	0.62	21.50	93.69

Groups 1991 & 1997
Average dissimilarity = 100.00

	Group 1991	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	0.00	100.00	50.00	Undefined!	50.00	50.00
Amphipoda	70.73	0.00	35.36	2.75	35.36	85.36
Mysida	15.58	0.00	7.79	0.73	7.79	93.15

Groups 1992 & 1997
Average dissimilarity = 74.74

	Group 1992	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	25.26	100.00	37.37	2.41	50.00	50.00
Amphipoda	44.10	0.00	22.05	1.21	29.50	79.50
Mysida	16.87	0.00	8.43	0.53	11.28	90.79

Groups 1993 & 1997
Average dissimilarity = 66.67

	Group 1993	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	100.00	33.33	1.29	50.00	50.00
Amphipoda	33.33	0.00	16.67	0.65	25.00	75.00
Corophiidae	16.67	0.00	8.33	0.65	12.50	87.50
cumacea	16.67	0.00	8.33	0.65	12.50	100.00

Groups 1988 & 1999
Average dissimilarity = 71.18

Species	Group 1988 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	37.15	24.05	1.10	33.79	33.79
Mysida	23.62	23.08	17.90	0.82	25.14	58.93
Amphipoda	24.37	22.25	17.75	0.82	24.94	83.87
Gammaridae	3.66	17.53	9.85	0.56	13.83	97.70

Groups 1991 & 1999
Average dissimilarity = 77.45

Species	Group 1991 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	22.25	29.21	1.91	37.72	37.72
Copepoda	0.00	37.15	18.57	0.83	23.98	61.70
Mysida	15.58	23.08	15.73	0.88	20.31	82.01
Gammaridae	8.11	17.53	11.14	0.65	14.39	96.40

Groups 1992 & 1999
Average dissimilarity = 72.74

Species	Group 1992 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	22.25	22.17	1.28	30.48	30.48
Copepoda	25.26	37.15	20.75	1.14	28.53	59.01
Mysida	16.87	23.08	16.08	0.76	22.11	81.11
Gammaridae	9.72	17.53	11.71	0.63	16.11	97.22

Groups 1993 & 1999
Average dissimilarity = 80.20

Species	Group 1993 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	37.15	22.86	0.98	28.50	28.50
Amphipoda	33.33	22.25	20.37	0.88	25.40	53.90
Mysida	0.00	23.08	11.54	0.54	14.39	68.29
Gammaridae	0.00	17.53	8.77	0.48	10.93	79.22
Corophiidae	16.67	0.00	8.33	0.70	10.39	89.61
cumacea	16.67	0.00	8.33	0.70	10.39	100.00

Groups 1997 & 1999
Average dissimilarity = 62.85

Species	Group 1997 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	37.15	31.43	1.39	50.00	50.00
Mysida	0.00	23.08	11.54	0.54	18.36	68.36
Amphipoda	0.00	22.25	11.12	0.58	17.70	86.05
Gammaridae	0.00	17.53	8.77	0.48	13.95	100.00

Groups 1988 & 2003
Average dissimilarity = 73.14

	Group 1988	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	48.60	23.95	1.34	32.74	32.74
Gammaridae	3.66	33.77	16.88	0.93	23.08	55.82
Amphipoda	24.37	7.03	13.87	0.69	18.97	74.79
Mysida	23.62	0.93	11.97	0.64	16.36	91.15

Groups 1991 & 2003
Average dissimilarity = 89.66

	Group 1991	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	7.03	32.93	2.47	36.73	36.73
Copepoda	0.00	48.60	24.30	1.32	27.10	63.83
Gammaridae	8.11	33.77	16.97	0.99	18.93	82.76
Mysida	15.58	0.93	7.88	0.78	8.79	91.56

Groups 1992 & 2003
Average dissimilarity = 75.88

	Group 1992	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	7.03	21.60	1.25	28.46	28.46
Copepoda	25.26	48.60	21.58	1.38	28.44	56.90
Gammaridae	9.72	33.77	17.50	0.96	23.06	79.96
Mysida	16.87	0.93	8.61	0.55	11.34	91.30

Groups 1993 & 2003
Average dissimilarity = 80.92

	Group 1993	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	48.60	24.77	1.34	30.61	30.61
Amphipoda	33.33	7.03	17.84	0.79	22.04	52.65
Gammaridae	0.00	33.77	16.89	0.90	20.87	73.52
cumacea	16.67	1.60	8.60	0.75	10.63	84.14
Corophiidae	16.67	0.00	8.33	0.70	10.30	94.44

Groups 1997 & 2003
Average dissimilarity = 51.40

	Group 1997	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	48.60	25.70	1.39	50.00	50.00
Gammaridae	0.00	33.77	16.89	0.89	32.85	82.85
Amphipoda	0.00	7.03	3.52	0.35	6.84	89.69
Bosmina	0.00	6.37	3.18	0.52	6.20	95.89

Groups 1999 & 2003
Average dissimilarity = 72.22

Species	Group 1999 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	37.15	48.60	23.55	1.34	32.60	32.60
Gammaridae	17.53	33.77	19.26	1.00	26.67	59.27
Amphipoda	22.25	7.03	12.79	0.69	17.71	76.98
Mysida	23.08	0.93	11.79	0.57	16.32	93.31

Groups 1988 & 2005
Average dissimilarity = 79.93

Species	Group 1988 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	24.37	51.81	25.36	1.10	31.73	31.73
Copepoda	45.07	6.90	22.83	0.99	28.56	60.29
Gammaridae	3.66	32.46	16.64	0.81	20.81	81.10
Mysida	23.62	8.83	13.47	0.78	16.85	97.95

Groups 1991 & 2005
Average dissimilarity = 56.06

Species	Group 1991 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	51.81	23.44	1.48	41.81	41.81
Gammaridae	8.11	32.46	17.13	0.88	30.56	72.37
Mysida	15.58	8.83	9.25	0.91	16.50	88.87
Copepoda	0.00	6.90	3.45	0.29	6.15	95.02

Groups 1992 & 2005
Average dissimilarity = 68.50

Species	Group 1992 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	51.81	24.21	1.36	35.34	35.34
Gammaridae	9.72	32.46	17.60	0.86	25.70	61.04
Copepoda	25.26	6.90	14.03	0.87	20.49	81.53
Mysida	16.87	8.83	10.63	0.71	15.52	97.05

Groups 1993 & 2005
Average dissimilarity = 80.43

Species	Group 1993 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	33.33	51.81	25.30	1.06	31.46	31.46
Copepoda	33.33	6.90	17.82	0.75	22.15	53.61
Gammaridae	0.00	32.46	16.23	0.76	20.18	73.79
Corophiidae	16.67	0.00	8.33	0.70	10.36	84.15
cumacea	16.67	0.00	8.33	0.70	10.36	94.51

Groups 1997 & 2005
Average dissimilarity = 93.10

Species	Group 1997 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	6.90	46.55	3.88	50.00	50.00
Amphipoda	0.00	51.81	25.91	1.08	27.82	77.82
Gammaridae	0.00	32.46	16.23	0.75	17.43	95.26

Groups 1999 & 2005
Average dissimilarity = 77.64

Species	Group 1999 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	22.25	51.81	25.22	1.14	32.49	32.49
Copepoda	37.15	6.90	19.37	0.88	24.95	57.43
Gammaridae	17.53	32.46	19.13	0.89	24.64	82.08
Mysida	23.08	8.83	13.92	0.72	17.92	100.00

Groups 2003 & 2005
Average dissimilarity = 80.42

Species	Group 2003 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	7.03	51.81	25.55	1.13	31.77	31.77
Copepoda	48.60	6.90	24.18	1.33	30.06	61.84
Gammaridae	33.77	32.46	21.18	1.12	26.34	88.17
Mysida	0.93	8.83	4.68	0.55	5.82	93.99

Groups 1988 & 2006
Average dissimilarity = 78.05

Species	Group 1988 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	23.17	23.50	1.04	30.11	30.11
Mysida	23.62	33.07	20.31	0.93	26.02	56.13
Amphipoda	24.37	9.09	14.52	0.66	18.60	74.73
Gammaridae	3.66	19.41	10.46	0.66	13.40	88.13
Clupeidae	0.00	6.82	3.41	0.30	4.37	92.49

Groups 1991 & 2006
Average dissimilarity = 85.58

Species	Group 1991 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	9.09	33.48	2.46	39.12	39.12
Mysida	15.58	33.07	18.66	1.01	21.80	60.93
Copepoda	0.00	23.17	11.58	0.59	13.54	74.46
Gammaridae	8.11	19.41	11.43	0.76	13.36	87.82
Clupeidae	0.00	6.82	3.41	0.30	3.98	91.81

Groups 1992 & 2006
Average dissimilarity = 81.36

Species	Group 1992 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	9.09	22.59	1.25	27.76	27.76
Mysida	16.87	33.07	19.20	0.91	23.60	51.36
Copepoda	25.26	23.17	17.77	1.01	21.84	73.20
Gammaridae	9.72	19.41	12.15	0.73	14.93	88.13
Clupeidae	0.00	6.82	3.41	0.30	4.19	92.32

Groups 1993 & 2006
Average dissimilarity = 89.25

Species	Group 1993 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	23.17	20.53	0.87	23.00	23.00
Amphipoda	33.33	9.09	18.18	0.75	20.37	43.37
Mysida	0.00	33.07	16.54	0.73	18.53	61.90
Gammaridae	0.00	19.41	9.70	0.60	10.87	72.77
Corophiidae	16.67	0.00	8.33	0.70	9.34	82.11
cumacea	16.67	0.00	8.33	0.70	9.34	91.45

Groups 1997 & 2006
Average dissimilarity = 76.83

Species	Group 1997 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	23.17	38.42	1.93	50.00	50.00
Mysida	0.00	33.07	16.54	0.73	21.52	71.52
Gammaridae	0.00	19.41	9.70	0.59	12.63	84.15
Amphipoda	0.00	9.09	4.55	0.31	5.92	90.07

Groups 1999 & 2006
Average dissimilarity = 77.83

Species	Group 1999 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	37.15	23.17	21.30	0.98	27.37	27.37
Mysida	23.08	33.07	20.44	0.87	26.26	53.63
Gammaridae	17.53	19.41	14.81	0.77	19.03	72.66
Amphipoda	22.25	9.09	13.65	0.67	17.53	90.19

Groups 2003 & 2006
Average dissimilarity = 78.91

Species	Group 2003 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	48.60	23.17	23.79	1.32	30.15	30.15
Gammaridae	33.77	19.41	18.60	1.05	23.57	53.72

Mysida	0.93	33.07	16.66	0.75	21.11	74.83
Amphipoda	7.03	9.09	7.42	0.47	9.41	84.24
Clupeidae	0.00	6.82	3.41	0.30	4.32	88.56
Bosmina	6.37	0.00	3.18	0.53	4.04	92.60

Groups 2005 & 2006
Average dissimilarity = 83.51

Species	Group 2005 Av.Abund	Group 2006 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	51.81	9.09	25.74	1.09	30.82	30.82
Gammaridae	32.46	19.41	19.01	0.96	22.76	53.58
Mysida	8.83	33.07	17.74	0.88	21.24	74.83
Copepoda	6.90	23.17	13.39	0.66	16.04	90.86

Groups 1988 & 2007
Average dissimilarity = 68.25

Species	Group 1988 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	53.52	24.78	1.14	36.30	36.30
Amphipoda	24.37	27.27	19.18	0.81	28.10	64.40
Mysida	23.62	0.00	11.81	0.62	17.31	81.71
Gammaridae	3.66	9.09	6.04	0.41	8.85	90.56

Groups 1991 & 2007
Average dissimilarity = 79.97

Species	Group 1991 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	27.27	29.71	1.92	37.15	37.15
Copepoda	0.00	53.52	26.76	1.17	33.46	70.61
Gammaridae	8.11	9.09	7.86	0.54	9.83	80.45
Mysida	15.58	0.00	7.79	0.76	9.74	90.19

Groups 1992 & 2007
Average dissimilarity = 72.32

Species	Group 1992 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	25.26	53.52	24.62	1.33	34.04	34.04
Amphipoda	44.10	27.27	23.66	1.30	32.72	66.76
Gammaridae	9.72	9.09	8.52	0.51	11.79	78.54
Mysida	16.87	0.00	8.43	0.54	11.66	90.21

Groups 1993 & 2007
Average dissimilarity = 73.07

Species	Group 1993 Av.Abund	Group 2007 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	53.52	25.59	1.11	35.02	35.02

Amphipoda	33.33	27.27	21.21	0.85	29.03	64.05
Corophiidae	16.67	0.00	8.33	0.70	11.40	75.45
cumacea	16.67	0.00	8.33	0.70	11.40	86.85
Gammaridae	0.00	9.09	4.55	0.31	6.22	93.08

Groups 1997 & 2007
Average dissimilarity = 46.48

	Group 1997	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	53.52	23.24	1.00	50.00	50.00
Amphipoda	0.00	27.27	13.64	0.60	29.34	79.34
Gammaridae	0.00	9.09	4.55	0.31	9.78	89.11
bivalve	0.00	5.57	2.79	0.31	6.00	95.11

Groups 1999 & 2007
Average dissimilarity = 71.85

	Group 1999	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	37.15	53.52	24.85	1.17	34.58	34.58
Amphipoda	22.25	27.27	18.69	0.83	26.01	60.59
Gammaridae	17.53	9.09	11.72	0.58	16.31	76.90
Mysida	23.08	0.00	11.54	0.55	16.06	92.96

Groups 2003 & 2007
Average dissimilarity = 67.47

	Group 2003	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	48.60	53.52	23.51	1.35	34.85	34.85
Gammaridae	33.77	9.09	18.36	0.95	27.21	62.07
Amphipoda	7.03	27.27	15.23	0.71	22.58	84.65
Bosmina	6.37	0.00	3.18	0.53	4.72	89.37
bivalve	0.00	5.57	2.79	0.32	4.13	93.50

Groups 2005 & 2007
Average dissimilarity = 79.13

	Group 2005	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	6.90	53.52	26.41	1.18	33.38	33.38
Amphipoda	51.81	27.27	25.41	1.07	32.12	65.50
Gammaridae	32.46	9.09	17.83	0.81	22.53	88.03
Mysida	8.83	0.00	4.42	0.52	5.58	93.61

Groups 2006 & 2007
Average dissimilarity = 82.81

	Group 2006	Group 2007				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Copepoda	23.17	53.52	25.65	1.18	30.98	30.98
Mysida	33.07	0.00	16.54	0.73	19.97	50.94
Amphipoda	9.09	27.27	15.70	0.68	18.96	69.91
Gammaridae	19.41	9.09	12.48	0.68	15.07	84.98
bivalve	4.55	5.57	4.81	0.38	5.80	90.78

Groups 1988 & 2009
Average dissimilarity = 81.92

	Group 1988	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	24.37	43.87	23.08	1.12	28.18	28.18
Copepoda	45.07	10.55	22.60	1.06	27.59	55.76
Gammaridae	3.66	40.58	20.29	0.96	24.77	80.53
Mysida	23.62	0.00	11.81	0.62	14.42	94.95

Groups 1991 & 2009
Average dissimilarity = 61.09

	Group 1991	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	43.87	22.44	1.39	36.74	36.74
Gammaridae	8.11	40.58	20.29	1.01	33.21	69.95
Mysida	15.58	0.00	7.79	0.76	12.75	82.70
Copepoda	0.00	10.55	5.28	0.49	8.64	91.34

Groups 1992 & 2009
Average dissimilarity = 69.61

	Group 1992	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	43.87	21.93	1.32	31.50	31.50
Gammaridae	9.72	40.58	20.81	1.01	29.90	61.40
Copepoda	25.26	10.55	13.92	0.96	19.99	81.39
Mysida	16.87	0.00	8.43	0.54	12.11	93.50

Groups 1993 & 2009
Average dissimilarity = 80.19

	Group 1993	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	33.33	43.87	23.98	1.12	29.90	29.90
Gammaridae	0.00	40.58	20.29	0.91	25.30	55.20
Copepoda	33.33	10.55	18.43	0.84	22.98	78.18
Corophiidae	16.67	5.00	9.17	0.75	11.43	89.61
cumacea	16.67	0.00	8.33	0.70	10.39	100.00

Groups 1997 & 2009
Average dissimilarity = 89.45

	Group 1997	Group 2009

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	10.55	44.72	4.06	50.00	50.00
Amphipoda	0.00	43.87	21.93	1.03	24.52	74.52
Gammaridae	0.00	40.58	20.29	0.90	22.68	97.21

Groups 1999 & 2009
Average dissimilarity = 77.64

	Group 1999	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	22.25	43.87	22.54	1.14	29.03	29.03
Gammaridae	17.53	40.58	21.74	1.01	28.00	57.03
Copepoda	37.15	10.55	19.33	0.95	24.89	81.92
Mysida	23.08	0.00	11.54	0.55	14.86	96.78

Groups 2003 & 2009
Average dissimilarity = 74.61

	Group 2003	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	48.60	10.55	22.71	1.31	30.44	30.44
Gammaridae	33.77	40.58	22.27	1.20	29.85	60.29
Amphipoda	7.03	43.87	21.83	1.10	29.26	89.55
Bosmina	6.37	0.00	3.18	0.53	4.27	93.82

Groups 2005 & 2009
Average dissimilarity = 62.08

	Group 2005	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	51.81	43.87	24.51	1.21	39.48	39.48
Gammaridae	32.46	40.58	22.75	1.09	36.65	76.14
Copepoda	6.90	10.55	7.90	0.56	12.73	88.86
Mysida	8.83	0.00	4.42	0.52	7.11	95.97

Groups 2006 & 2009
Average dissimilarity = 84.57

	Group 2006	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	9.09	43.87	22.49	1.08	26.60	26.60
Gammaridae	19.41	40.58	21.31	1.07	25.20	51.80
Mysida	33.07	0.00	16.54	0.73	19.55	71.35
Copepoda	23.17	10.55	14.10	0.76	16.67	88.02
Clupeidae	6.82	0.00	3.41	0.30	4.03	92.05

Groups 2007 & 2009
Average dissimilarity = 77.99

	Group 2007	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Copepoda	53.52	10.55	25.68	1.24	32.92	32.92
Amphipoda	27.27	43.87	23.61	1.12	30.27	63.19
Gammaridae	9.09	40.58	21.15	0.95	27.11	90.31

Groups 1988 & 2010
Average dissimilarity = 78.97

	Group 1988	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	23.62	75.13	30.71	1.61	38.88	38.88
Copepoda	45.07	0.00	22.54	0.96	28.54	67.42
Amphipoda	24.37	5.00	13.36	0.67	16.92	84.34
Gammaridae	3.66	19.87	10.73	0.66	13.59	97.93

Groups 1991 & 2010
Average dissimilarity = 78.90

	Group 1991	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	5.00	32.98	2.32	41.80	41.80
Mysida	15.58	75.13	31.53	1.86	39.97	81.77
Gammaridae	8.11	19.87	11.59	0.73	14.70	96.46

Groups 1992 & 2010
Average dissimilarity = 80.99

	Group 1992	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	16.87	75.13	32.47	1.80	40.09	40.09
Amphipoda	44.10	5.00	21.43	1.23	26.46	66.55
Copepoda	25.26	0.00	12.63	0.82	15.59	82.14
Gammaridae	9.72	19.87	12.44	0.73	15.36	97.50

Groups 1993 & 2010
Average dissimilarity = 98.33

	Group 1993	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	0.00	75.13	37.57	2.19	38.20	38.20
Amphipoda	33.33	5.00	17.50	0.76	17.80	56.00
Copepoda	33.33	0.00	16.67	0.70	16.95	72.95
Gammaridae	0.00	19.87	9.93	0.59	10.10	83.05
Corophiidae	16.67	0.00	8.33	0.70	8.47	91.53

Groups 1997 & 2010
Average dissimilarity = 100.00

	Group 1997	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	0.00	50.00	Undefined!	50.00	50.00
Mysida	0.00	75.13	37.57	2.17	37.57	87.57

Gammaridae	0.00	19.87	9.93	0.58	9.93	97.50

Groups 1999 & 2010
Average dissimilarity = 77.59

	Group 1999	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	23.08	75.13	31.77	1.59	40.94	40.94
Copepoda	37.15	0.00	18.57	0.84	23.94	64.88
Gammaridae	17.53	19.87	15.00	0.77	19.33	84.21
Amphipoda	22.25	5.00	12.26	0.67	15.79	100.00

Groups 2003 & 2010
Average dissimilarity = 90.76

	Group 2003	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	0.93	75.13	37.20	2.20	40.98	40.98
Copepoda	48.60	0.00	24.30	1.32	26.77	67.76
Gammaridae	33.77	19.87	18.93	1.06	20.86	88.61
Amphipoda	7.03	5.00	5.50	0.49	6.06	94.67

Groups 2005 & 2010
Average dissimilarity = 82.32

	Group 2005	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	8.83	75.13	34.12	1.99	41.45	41.45
Amphipoda	51.81	5.00	25.61	1.13	31.11	72.56
Gammaridae	32.46	19.87	19.14	0.95	23.25	95.81

Groups 2006 & 2010
Average dissimilarity = 69.63

	Group 2006	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	33.07	75.13	28.81	1.43	41.37	41.37
Gammaridae	19.41	19.87	15.02	0.85	21.57	62.94
Copepoda	23.17	0.00	11.58	0.59	16.64	79.57
Amphipoda	9.09	5.00	6.59	0.44	9.47	89.04
Clupeidae	6.82	0.00	3.41	0.30	4.90	93.94

Groups 2007 & 2010
Average dissimilarity = 96.83

	Group 2007	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	0.00	75.13	37.57	2.21	38.80	38.80
Copepoda	53.52	0.00	26.76	1.18	27.63	66.43
Amphipoda	27.27	5.00	14.77	0.69	15.26	81.69
Gammaridae	9.09	19.87	12.67	0.67	13.09	94.77

Groups 2009 & 2010
Average dissimilarity = 88.26

Species	Group 2009 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	0.00	75.13	37.57	2.21	42.56	42.56
Amphipoda	43.87	5.00	21.55	1.07	24.41	66.97
Gammaridae	40.58	19.87	21.37	1.05	24.22	91.19

Groups 1988 & 2011
Average dissimilarity = 73.60

Species	Group 1988 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	35.20	23.98	1.08	32.58	32.58
Amphipoda	24.37	33.98	20.77	0.92	28.21	60.79
Mysida	23.62	4.17	12.91	0.66	17.54	78.33
Gammaridae	3.66	15.62	8.80	0.58	11.95	90.28

Groups 1991 & 2011
Average dissimilarity = 72.12

Species	Group 1991 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	33.98	26.96	1.70	37.39	37.39
Copepoda	0.00	35.20	17.60	0.79	24.41	61.80
Gammaridae	8.11	15.62	10.02	0.68	13.90	75.69
Mysida	15.58	4.17	9.22	0.75	12.79	88.48
Sididae	0.00	6.25	3.13	0.28	4.33	92.82

Groups 1992 & 2011
Average dissimilarity = 71.71

Species	Group 1992 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	33.98	23.05	1.31	32.15	32.15
Copepoda	25.26	35.20	20.50	1.12	28.58	60.73
Gammaridae	9.72	15.62	10.81	0.66	15.07	75.80
Mysida	16.87	4.17	9.81	0.58	13.69	89.49
Sididae	0.00	6.25	3.13	0.28	4.36	93.84

Groups 1993 & 2011
Average dissimilarity = 75.51

Species	Group 1993 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	35.20	22.53	0.96	29.84	29.84
Amphipoda	33.33	33.98	22.33	0.95	29.57	59.42
Corophiidae	16.67	4.29	9.05	0.78	11.98	71.40
cumacea	16.67	0.00	8.33	0.70	11.04	82.44

Gammaridae	0.00	15.62	7.81	0.50	10.34	92.78

Groups 1997 & 2011
Average dissimilarity = 64.80

	Group 1997	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	35.20	32.40	1.44	50.00	50.00
Amphipoda	0.00	33.98	16.99	0.76	26.22	76.22
Gammaridae	0.00	15.62	7.81	0.50	12.05	88.27
Sididae	0.00	6.25	3.13	0.28	4.82	93.09

Groups 1999 & 2011
Average dissimilarity = 74.79

	Group 1999	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	37.15	35.20	22.69	1.05	30.33	30.33
Amphipoda	22.25	33.98	20.26	0.94	27.09	57.43
Gammaridae	17.53	15.62	13.67	0.71	18.27	75.70
Mysida	23.08	4.17	12.66	0.58	16.93	92.63

Groups 2003 & 2011
Average dissimilarity = 72.87

	Group 2003	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	48.60	35.20	23.69	1.34	32.51	32.51
Gammaridae	33.77	15.62	18.45	1.02	25.32	57.83
Amphipoda	7.03	33.98	17.87	0.84	24.53	82.35
Bosmina	6.37	0.00	3.18	0.53	4.37	86.72
Sididae	0.00	6.25	3.13	0.28	4.29	91.01

Groups 2005 & 2011
Average dissimilarity = 73.80

	Group 2005	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	51.81	33.98	25.06	1.12	33.96	33.96
Copepoda	6.90	35.20	18.56	0.84	25.15	59.10
Gammaridae	32.46	15.62	18.54	0.91	25.12	84.22
Mysida	8.83	4.17	6.13	0.52	8.31	92.53

Groups 2006 & 2011
Average dissimilarity = 83.48

	Group 2006	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	23.17	35.20	20.83	0.95	24.95	24.95
Amphipoda	9.09	33.98	18.44	0.81	22.10	47.05
Mysida	33.07	4.17	17.24	0.76	20.65	67.70

Gammaridae	19.41	15.62	13.86	0.79	16.60	84.30
Clupeidae	6.82	0.00	3.41	0.30	4.08	88.39
Sididae	0.00	6.25	3.13	0.28	3.74	92.13

Groups 2007 & 2011
Average dissimilarity = 69.98

	Group 2007	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	53.52	35.20	25.02	1.16	35.76	35.76
Amphipoda	27.27	33.98	21.36	0.92	30.52	66.28
Gammaridae	9.09	15.62	10.94	0.60	15.63	81.91
Sididae	0.00	6.25	3.13	0.28	4.47	86.38
bivalve	5.57	0.00	2.79	0.32	3.98	90.36

Groups 2009 & 2011
Average dissimilarity = 72.73

	Group 2009	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	43.87	33.98	23.31	1.16	32.05	32.05
Gammaridae	40.58	15.62	21.10	1.02	29.02	61.07
Copepoda	10.55	35.20	18.65	0.92	25.64	86.70
Corophiidae	5.00	4.29	4.22	0.48	5.80	92.50

Groups 2010 & 2011
Average dissimilarity = 91.26

	Group 2010	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	75.13	4.17	36.52	2.07	40.02	40.02
Copepoda	0.00	35.20	17.60	0.79	19.29	59.31
Amphipoda	5.00	33.98	17.55	0.83	19.23	78.54
Gammaridae	19.87	15.62	14.07	0.78	15.42	93.96

Groups 1988 & 2012
Average dissimilarity = 77.54

	Group 1988	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	45.07	38.27	24.05	1.10	31.02	31.02
Gammaridae	3.66	43.82	21.87	1.00	28.20	59.22
Amphipoda	24.37	11.75	15.18	0.69	19.57	78.79
Mysida	23.62	0.00	11.81	0.63	15.23	94.02

Groups 1991 & 2012
Average dissimilarity = 87.09

	Group 1991	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	70.73	11.75	32.74	2.35	37.59	37.59

Gammaridae	8.11	43.82	21.76	1.05	24.98	62.58
Copepoda	0.00	38.27	19.14	0.86	21.97	84.55
Mysida	15.58	0.00	7.79	0.76	8.94	93.50

Groups 1992 & 2012
Average dissimilarity = 79.17

	Group 1992	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	44.10	11.75	22.57	1.26	28.51	28.51
Gammaridae	9.72	43.82	22.05	1.02	27.86	56.37
Copepoda	25.26	38.27	21.06	1.17	26.61	82.98
Mysida	16.87	0.00	8.43	0.54	10.65	93.63

Groups 1993 & 2012
Average dissimilarity = 83.32

	Group 1993	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	33.33	38.27	23.05	1.00	27.66	27.66
Gammaridae	0.00	43.82	21.91	0.96	26.29	53.95
Amphipoda	33.33	11.75	18.63	0.77	22.35	76.30
Corophiidae	16.67	0.00	8.33	0.70	10.00	86.30
cumacea	16.67	0.00	8.33	0.70	10.00	96.31

Groups 1997 & 2012
Average dissimilarity = 61.73

	Group 1997	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	100.00	38.27	30.86	1.38	50.00	50.00
Gammaridae	0.00	43.82	21.91	0.96	35.49	85.49
Amphipoda	0.00	11.75	5.88	0.37	9.52	95.01

Groups 1999 & 2012
Average dissimilarity = 74.79

	Group 1999	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	37.15	38.27	23.10	1.09	30.88	30.88
Gammaridae	17.53	43.82	22.74	1.02	30.41	61.30
Amphipoda	22.25	11.75	14.33	0.70	19.16	80.46
Mysida	23.08	0.00	11.54	0.55	15.43	95.88

Groups 2003 & 2012
Average dissimilarity = 63.04

	Group 2003	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	48.60	38.27	23.29	1.32	36.95	36.95
Gammaridae	33.77	43.82	22.89	1.19	36.30	73.26

Amphipoda	7.03	11.75	8.49	0.51	13.47	86.73
Bosmina	6.37	0.00	3.18	0.53	5.05	91.78

Groups 2005 & 2012
Average dissimilarity = 76.47

	Group 2005	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	51.81	11.75	25.65	1.09	33.54	33.54
Gammaridae	32.46	43.82	23.45	1.10	30.67	64.20
Copepoda	6.90	38.27	19.88	0.91	26.00	90.20

Groups 2006 & 2012
Average dissimilarity = 80.63

	Group 2006	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	19.41	43.82	22.46	1.09	27.85	27.85
Copepoda	23.17	38.27	21.57	0.99	26.75	54.61
Mysida	33.07	0.00	16.54	0.74	20.51	75.12
Amphipoda	9.09	11.75	9.35	0.49	11.60	86.72
Clupeidae	6.82	0.00	3.41	0.30	4.23	90.94

Groups 2007 & 2012
Average dissimilarity = 71.70

	Group 2007	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	53.52	38.27	24.91	1.19	34.75	34.75
Gammaridae	9.09	43.82	22.47	0.98	31.34	66.09
Amphipoda	27.27	11.75	16.31	0.70	22.74	88.83
Leptodora_kindtii	4.55	1.43	2.86	0.37	3.99	92.82

Groups 2009 & 2012
Average dissimilarity = 71.72

	Group 2009	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	40.58	43.82	23.84	1.15	33.24	33.24
Amphipoda	43.87	11.75	22.55	1.09	31.44	64.69
Copepoda	10.55	38.27	19.75	0.98	27.53	92.22

Groups 2010 & 2012
Average dissimilarity = 90.08

	Group 2010	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Mysida	75.13	0.00	37.57	2.22	41.70	41.70
Gammaridae	19.87	43.82	22.54	1.08	25.02	66.73
Copepoda	0.00	38.27	19.14	0.86	21.24	87.97
Amphipoda	5.00	11.75	7.76	0.49	8.61	96.58

Groups 2011 & 2012
Average dissimilarity = 74.58

Species	Group 2011 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Copepoda	35.20	38.27	22.89	1.07	30.69	30.69
Gammaridae	15.62	43.82	22.42	1.06	30.06	60.76
Amphipoda	33.98	11.75	18.82	0.84	25.24	85.99
Sididae	6.25	3.70	4.75	0.35	6.36	92.36

APPENDIX C

Larval American Shad SIMPER

Similarity Percentages - species contributions

Parameters
Resemblance: S17 Bray Curtis similarity
Cut off for low contributions: 90.00%

Group 1988
Average similarity: 24.18

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	39.54	19.40	0.87	80.23	80.23
Cyclopoida	21.43	2.38	0.22	9.85	90.07

Group 1991
Average similarity: 16.67

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gammaridae	37.50	8.33	0.41	50.00	50.00
Cyclopoida	37.50	8.33	0.41	50.00	100.00

Group 1993
Average similarity: 58.84

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	54.42	41.72	5.77	70.90	70.90
Cyclopoida	32.83	17.12	0.76	29.10	100.00

Group 1994
Average similarity: 66.67

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	83.33	66.67	1.37	100.00	100.00

Group 2001
Average similarity: 57.14

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	75.00	53.57	1.05	93.75	93.75

Group 2003
Average similarity: 64.33

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	80.39	62.55	1.44	97.24	97.24

Group 2005
Average similarity: 48.81

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%

Cyclopoida	72.54	48.81	1.09	100.00	100.00

Group 2009
Average similarity: 37.20

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	62.20	37.20	1.06	100.00	100.00

Group 2010
Average similarity: 15.00

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironomidae	35.61	10.61	0.59	70.73	70.73
insecta	18.78	4.39	0.32	29.27	100.00

Group 2011
Average similarity: 19.05

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	35.71	9.52	0.37	50.00	50.00
Bosmina	35.71	9.52	0.37	50.00	100.00

Group 2012
Average similarity: 22.77

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	37.82	12.60	0.46	55.36	55.36
Bosmina	31.14	7.95	0.35	34.93	90.28

Groups 1988 & 1991
Average dissimilarity = 91.07

	Group 1988	Group 1991				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	21.43	37.50	20.54	1.00	22.55	22.55
Bosmina	39.54	0.00	19.77	1.21	21.71	44.26
Gammaridae	0.00	37.50	18.75	0.89	20.59	64.84
Podocopa	0.00	25.00	12.50	0.57	13.73	78.57
insecta	14.29	0.00	7.14	0.40	7.84	86.41
Daphnia	10.74	0.00	5.37	0.58	5.90	92.31

Groups 1988 & 1993
Average dissimilarity = 59.51

	Group 1988	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	21.43	32.83	18.07	1.30	30.37	30.37
Bosmina	39.54	54.42	16.09	1.21	27.03	57.40
insecta	14.29	0.00	7.14	0.40	12.00	69.41
Daphnia	10.74	0.00	5.37	0.58	9.03	78.43
Chironomidae	3.26	5.56	3.87	0.60	6.50	84.93

Leptodora_kindtii	7.48	0.00	3.74	0.62	6.28	91.21

Groups 1991 & 1993
Average dissimilarity = 84.15

	Group 1991	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.00	54.42	27.21	2.47	32.33	32.33
Cyclopoida	37.50	32.83	19.32	1.30	22.96	55.29
Gammaridae	37.50	0.00	18.75	0.89	22.28	77.57
Podocopa	25.00	0.00	12.50	0.57	14.85	92.42

Groups 1988 & 1994
Average dissimilarity = 75.55

	Group 1988	Group 1994				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	21.43	83.33	34.52	1.62	45.69	45.69
Bosmina	39.54	16.67	21.51	1.28	28.47	74.17
insecta	14.29	0.00	7.14	0.40	9.45	83.62
Daphnia	10.74	0.00	5.37	0.58	7.11	90.73

Groups 1991 & 1994
Average dissimilarity = 68.75

	Group 1991	Group 1994				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	37.50	83.33	29.17	1.34	42.42	42.42
Gammaridae	37.50	0.00	18.75	0.89	27.27	69.70
Podocopa	25.00	0.00	12.50	0.57	18.18	87.88
Bosmina	0.00	16.67	8.33	0.44	12.12	100.00

Groups 1993 & 1994
Average dissimilarity = 63.57

	Group 1993	Group 1994				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	32.83	83.33	30.72	2.19	48.33	48.33
Bosmina	54.42	16.67	26.47	2.39	41.64	89.97
Amphipoda	7.20	0.00	3.60	0.44	5.66	95.63

Groups 1988 & 2001
Average dissimilarity = 74.04

	Group 1988	Group 2001				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	21.43	75.00	32.14	1.45	43.41	43.41
Bosmina	39.54	25.00	22.38	1.33	30.23	73.64
insecta	14.29	0.00	7.14	0.40	9.65	83.29
Daphnia	10.74	0.00	5.37	0.58	7.25	90.54

Groups 1991 & 2001
Average dissimilarity = 71.88

Species	Group 1991 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	37.50	75.00	28.13	1.29	39.13	39.13
Gammaridae	37.50	0.00	18.75	0.89	26.09	65.22
Podocopa	25.00	0.00	12.50	0.57	17.39	82.61
Bosmina	0.00	25.00	12.50	0.57	17.39	100.00

Groups 1993 & 2001
Average dissimilarity = 61.77

Species	Group 1993 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	32.83	75.00	29.29	2.02	47.42	47.42
Bosmina	54.42	25.00	26.10	2.35	42.26	89.68
Amphipoda	7.20	0.00	3.60	0.44	5.82	95.50

Groups 1994 & 2001
Average dissimilarity = 33.33

Species	Group 1994 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	75.00	16.67	0.70	50.00	50.00
Bosmina	16.67	25.00	16.67	0.70	50.00	100.00

Groups 1988 & 2003
Average dissimilarity = 62.29

Species	Group 1988 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	39.54	80.39	26.83	1.63	43.08	43.08
Cyclopoida	21.43	19.61	15.94	0.80	25.59	68.67
insecta	14.29	0.00	7.14	0.40	11.47	80.13
Daphnia	10.74	0.00	5.37	0.58	8.62	88.76
Leptodora_kindtii	7.48	0.00	3.74	0.63	6.00	94.76

Groups 1991 & 2003
Average dissimilarity = 91.98

Species	Group 1991 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.00	80.39	40.19	2.24	43.70	43.70
Cyclopoida	37.50	19.61	20.54	1.01	22.33	66.02
Gammaridae	37.50	0.00	18.75	0.89	20.39	86.41
Podocopa	25.00	0.00	12.50	0.57	13.59	100.00

Groups 1993 & 2003
Average dissimilarity = 46.10

	Group 1993	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	80.39	21.65	1.90	46.96	46.96
Cyclopoida	32.83	19.61	18.07	1.34	39.21	86.17
Amphipoda	7.20	0.00	3.60	0.44	7.81	93.97

Groups 1994 & 2003
Average dissimilarity = 70.26

	Group 1994	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	19.61	35.13	1.66	50.00	50.00
Bosmina	16.67	80.39	35.13	1.66	50.00	100.00

Groups 2001 & 2003
Average dissimilarity = 65.19

	Group 2001	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	19.61	32.60	1.47	50.00	50.00
Bosmina	25.00	80.39	32.60	1.47	50.00	100.00

Groups 1988 & 2005
Average dissimilarity = 81.07

	Group 1988	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	21.43	72.54	30.91	1.50	38.13	38.13
Bosmina	39.54	0.00	19.77	1.21	24.39	62.51
insecta	14.29	20.00	14.29	0.62	17.62	80.14
Daphnia	10.74	0.00	5.37	0.58	6.63	86.76
Leptodora_kindtii	7.48	0.00	3.74	0.62	4.61	91.38

Groups 1991 & 2005
Average dissimilarity = 70.00

	Group 1991	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	37.50	72.54	26.89	1.32	38.41	38.41
Gammaridae	37.50	0.00	18.75	0.88	26.79	65.19
Podocopa	25.00	7.46	14.36	0.70	20.52	85.71
insecta	0.00	20.00	10.00	0.49	14.29	100.00

Groups 1993 & 2005
Average dissimilarity = 73.74

	Group 1993	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	0.00	27.21	2.48	36.90	36.90
Cyclopoida	32.83	72.54	26.42	1.72	35.83	72.73
insecta	0.00	20.00	10.00	0.49	13.56	86.30

Podocopa	0.00	7.46	3.73	0.49	5.06	91.35

Groups 1994 & 2005
Average dissimilarity = 39.55

	Group 1994	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	72.54	17.49	0.81	44.21	44.21
insecta	0.00	20.00	10.00	0.49	25.29	69.50
Bosmina	16.67	0.00	8.33	0.44	21.07	90.57

Groups 2001 & 2005
Average dissimilarity = 45.59

	Group 2001	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	72.54	19.36	0.88	42.47	42.47
Bosmina	25.00	0.00	12.50	0.57	27.42	69.89
insecta	0.00	20.00	10.00	0.49	21.93	91.82

Groups 2003 & 2005
Average dissimilarity = 85.38

	Group 2003	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	80.39	0.00	40.19	2.25	47.08	47.08
Cyclopoida	19.61	72.54	31.45	1.54	36.84	83.92
insecta	0.00	20.00	10.00	0.49	11.71	95.63

Groups 1988 & 2009
Average dissimilarity = 68.69

	Group 1988	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	39.54	62.20	21.78	1.34	31.71	31.71
Cyclopoida	21.43	7.80	12.39	0.72	18.03	49.75
Ostracoda	0.00	20.00	10.00	0.49	14.56	64.30
insecta	14.29	0.00	7.14	0.40	10.40	74.70
Daphnia	10.74	0.00	5.37	0.58	7.82	82.52
Gammaridae	0.00	10.00	5.00	0.49	7.28	89.80
Leptodora_kindtii	7.48	0.00	3.74	0.62	5.45	95.25

Groups 1991 & 2009
Average dissimilarity = 91.10

	Group 1991	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.00	62.20	31.10	1.63	34.14	34.14
Gammaridae	37.50	10.00	18.75	0.95	20.58	54.72
Cyclopoida	37.50	7.80	18.75	0.96	20.58	75.30
Podocopa	25.00	0.00	12.50	0.56	13.72	89.02

Ostracoda	0.00	20.00	10.00	0.49	10.98	100.00

Groups 1993 & 2009
Average dissimilarity = 54.65

Species	Group 1993 Av.Abund	Group 2009 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	62.20	17.97	1.43	32.88	32.88
Cyclopoida	32.83	7.80	15.30	1.30	28.00	60.89
Ostracoda	0.00	20.00	10.00	0.49	18.30	79.18
Gammaridae	0.00	10.00	5.00	0.49	9.15	88.33
Amphipoda	7.20	0.00	3.60	0.44	6.58	94.92

Groups 1994 & 2009
Average dissimilarity = 83.14

Species	Group 1994 Av.Abund	Group 2009 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	7.80	39.07	2.19	46.99	46.99
Bosmina	16.67	62.20	29.07	1.50	34.96	81.96
Ostracoda	0.00	20.00	10.00	0.49	12.03	93.99

Groups 2001 & 2009
Average dissimilarity = 78.60

Species	Group 2001 Av.Abund	Group 2009 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	7.80	35.55	1.77	45.23	45.23
Bosmina	25.00	62.20	28.05	1.44	35.69	80.92
Ostracoda	0.00	20.00	10.00	0.49	12.72	93.64

Groups 2003 & 2009
Average dissimilarity = 46.63

Species	Group 2003 Av.Abund	Group 2009 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	80.39	62.20	20.11	1.09	43.12	43.12
Cyclopoida	19.61	7.80	11.53	0.69	24.71	67.84
Ostracoda	0.00	20.00	10.00	0.49	21.44	89.28
Gammaridae	0.00	10.00	5.00	0.49	10.72	100.00

Groups 2005 & 2009
Average dissimilarity = 93.76

Species	Group 2005 Av.Abund	Group 2009 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	72.54	7.80	33.93	1.81	36.19	36.19
Bosmina	0.00	62.20	31.10	1.64	33.17	69.36
Ostracoda	0.00	20.00	10.00	0.49	10.67	80.03
insecta	20.00	0.00	10.00	0.49	10.67	90.69

Groups 1988 & 2010
Average dissimilarity = 91.07

Species	Group 1988 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	39.54	0.00	19.77	1.21	21.71	21.71
Chironomidae	3.26	35.61	17.48	0.96	19.19	40.90
Cyclopoida	21.43	20.00	16.43	0.75	18.04	58.94
insecta	14.29	18.78	13.85	0.86	15.21	74.14
Gammaridae	0.00	20.00	10.00	0.49	10.98	85.12
Daphnia	10.74	0.00	5.37	0.58	5.90	91.02

Groups 1991 & 2010
Average dissimilarity = 85.00

Species	Group 1991 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	37.50	20.00	21.25	0.97	25.00	25.00
Cyclopoida	37.50	20.00	21.25	0.97	25.00	50.00
Chironomidae	0.00	35.61	17.80	0.93	20.95	70.95
Podocopa	25.00	0.00	12.50	0.56	14.71	85.65
insecta	0.00	18.78	9.39	0.79	11.05	96.70

Groups 1993 & 2010
Average dissimilarity = 90.28

Species	Group 1993 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	0.00	27.21	2.48	30.14	30.14
Cyclopoida	32.83	20.00	19.85	1.39	21.99	52.13
Chironomidae	5.56	35.61	17.43	0.98	19.30	71.43
Gammaridae	0.00	20.00	10.00	0.49	11.08	82.51
insecta	0.00	18.78	9.39	0.80	10.40	92.91

Groups 1994 & 2010
Average dissimilarity = 83.33

Species	Group 1994 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	20.00	35.00	1.50	42.00	42.00
Chironomidae	0.00	35.61	17.80	0.94	21.37	63.37
Gammaridae	0.00	20.00	10.00	0.49	12.00	75.37
insecta	0.00	18.78	9.39	0.80	11.27	86.63
Bosmina	16.67	0.00	8.33	0.44	10.00	96.63

Groups 2001 & 2010
Average dissimilarity = 85.00

Species	Group 2001 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	20.00	32.50	1.35	38.24	38.24

Chironomidae	0.00	35.61	17.80	0.94	20.95	59.18
Bosmina	25.00	0.00	12.50	0.57	14.71	73.89
Gammaridae	0.00	20.00	10.00	0.49	11.76	85.65
insecta	0.00	18.78	9.39	0.80	11.05	96.70

Groups 2003 & 2010
Average dissimilarity = 96.08

Species	Group 2003 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	80.39	0.00	40.19	2.25	41.83	41.83
Chironomidae	0.00	35.61	17.80	0.94	18.53	60.37
Cyclopoida	19.61	20.00	15.88	0.73	16.53	76.90
Gammaridae	0.00	20.00	10.00	0.49	10.41	87.31
insecta	0.00	18.78	9.39	0.80	9.77	97.08

Groups 2005 & 2010
Average dissimilarity = 81.74

Species	Group 2005 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	72.54	20.00	31.76	1.45	38.86	38.86
Chironomidae	0.00	35.61	17.80	0.94	21.78	60.64
insecta	20.00	18.78	15.63	0.90	19.13	79.77
Gammaridae	0.00	20.00	10.00	0.49	12.23	92.01

Groups 2009 & 2010
Average dissimilarity = 96.44

Species	Group 2009 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	62.20	0.00	31.10	1.64	32.25	32.25
Chironomidae	0.00	35.61	17.80	0.94	18.46	50.71
Gammaridae	10.00	20.00	13.00	0.68	13.48	64.19
Cyclopoida	7.80	20.00	12.34	0.65	12.79	76.99
Ostracoda	20.00	0.00	10.00	0.49	10.37	87.35
insecta	0.00	18.78	9.39	0.80	9.74	97.09

Groups 1988 & 2011
Average dissimilarity = 75.91

Species	Group 1988 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	39.54	35.71	21.70	1.29	28.59	28.59
Cyclopoida	21.43	35.71	20.41	0.95	26.88	55.47
Chydoridae	0.00	14.29	7.14	0.40	9.41	64.88
Sididae	0.00	14.29	7.14	0.40	9.41	74.29
insecta	14.29	0.00	7.14	0.40	9.41	83.70
Daphnia	10.74	0.00	5.37	0.58	7.08	90.78

Groups 1991 & 2011

Average dissimilarity = 85.71

	Group 1991	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	37.50	35.71	22.32	1.07	26.04	26.04
Gammaridae	37.50	0.00	18.75	0.89	21.88	47.92
Bosmina	0.00	35.71	17.86	0.80	20.83	68.75
Podocopa	25.00	0.00	12.50	0.57	14.58	83.33
Chydoridae	0.00	14.29	7.14	0.40	8.33	91.67

Groups 1993 & 2011
Average dissimilarity = 64.29

	Group 1993	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	35.71	23.10	1.83	35.93	35.93
Cyclopoida	32.83	35.71	20.53	1.38	31.93	67.86
Chydoridae	0.00	14.29	7.14	0.40	11.11	78.97
Sididae	0.00	14.29	7.14	0.40	11.11	90.08

Groups 1994 & 2011
Average dissimilarity = 64.29

	Group 1994	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	35.71	29.76	1.30	46.30	46.30
Bosmina	16.67	35.71	20.24	0.88	31.48	77.78
Chydoridae	0.00	14.29	7.14	0.40	11.11	88.89
Sididae	0.00	14.29	7.14	0.40	11.11	100.00

Groups 2001 & 2011
Average dissimilarity = 64.29

	Group 2001	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	35.71	28.57	1.24	44.44	44.44
Bosmina	25.00	35.71	21.43	0.93	33.33	77.78
Chydoridae	0.00	14.29	7.14	0.40	11.11	88.89
Sididae	0.00	14.29	7.14	0.40	11.11	100.00

Groups 2003 & 2011
Average dissimilarity = 63.52

	Group 2003	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	80.39	35.71	28.96	1.34	45.59	45.59
Cyclopoida	19.61	35.71	20.28	0.95	31.92	77.51
Chydoridae	0.00	14.29	7.14	0.40	11.24	88.76
Sididae	0.00	14.29	7.14	0.40	11.24	100.00

Groups 2005 & 2011

Average dissimilarity = 73.56

	Group 2005	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	72.54	35.71	27.69	1.30	37.64	37.64
Bosmina	0.00	35.71	17.86	0.80	24.28	61.92
insecta	20.00	0.00	10.00	0.49	13.59	75.51
Chydoridae	0.00	14.29	7.14	0.40	9.71	85.22
Sididae	0.00	14.29	7.14	0.40	9.71	94.93

Groups 2009 & 2011
Average dissimilarity = 73.17

	Group 2009	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	62.20	35.71	25.47	1.33	34.81	34.81
Cyclopoida	7.80	35.71	18.41	0.91	25.17	59.98
Ostracoda	20.00	0.00	10.00	0.49	13.67	73.64
Chydoridae	0.00	14.29	7.14	0.40	9.76	83.41
Sididae	0.00	14.29	7.14	0.40	9.76	93.17

Groups 2010 & 2011
Average dissimilarity = 92.86

	Group 2010	Group 2011				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	20.00	35.71	20.71	0.90	22.31	22.31
Bosmina	0.00	35.71	17.86	0.80	19.23	41.54
Chironomidae	35.61	0.00	17.80	0.94	19.17	60.71
Gammaridae	20.00	0.00	10.00	0.49	10.77	71.48
insecta	18.78	0.00	9.39	0.80	10.11	81.59
Chydoridae	0.00	14.29	7.14	0.40	7.69	89.29
Sididae	0.00	14.29	7.14	0.40	7.69	96.98

Groups 1988 & 2012
Average dissimilarity = 74.59

	Group 1988	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	39.54	31.14	21.43	1.34	28.73	28.73
Cyclopoida	21.43	37.82	20.96	1.00	28.10	56.84
insecta	14.29	17.60	13.43	0.68	18.01	74.84
Daphnia	10.74	0.00	5.37	0.58	7.20	82.04
Leptodora_kindtii	7.48	0.00	3.74	0.63	5.01	87.06
Chironomidae	3.26	4.75	3.68	0.50	4.93	91.99

Groups 1991 & 2012
Average dissimilarity = 83.21

	Group 1991	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Cyclopoida	37.50	37.82	22.50	1.12	27.04	27.04
Gammaridae	37.50	3.25	18.75	0.93	22.53	49.57
Bosmina	0.00	31.14	15.57	0.74	18.71	68.28
Podocopa	25.00	0.00	12.50	0.57	15.02	83.31
insecta	0.00	17.60	8.80	0.54	10.58	93.88

Groups 1993 & 2012
Average dissimilarity = 65.19

	Group 1993	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.42	31.14	23.38	1.96	35.87	35.87
Cyclopoida	32.83	37.82	20.47	1.41	31.40	67.27
insecta	0.00	17.60	8.80	0.55	13.50	80.77
Chironomidae	5.56	4.75	4.60	0.55	7.05	87.82
Amphipoda	7.20	0.00	3.60	0.44	5.52	93.34

Groups 1994 & 2012
Average dissimilarity = 63.29

	Group 1994	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	83.33	37.82	29.06	1.30	45.91	45.91
Bosmina	16.67	31.14	18.71	0.84	29.57	75.48
insecta	0.00	17.60	8.80	0.55	13.91	89.39
Chydoridae	0.00	5.43	2.72	0.33	4.29	93.68

Groups 2001 & 2012
Average dissimilarity = 63.85

	Group 2001	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	75.00	37.82	28.04	1.25	43.92	43.92
Bosmina	25.00	31.14	20.29	0.90	31.77	75.70
insecta	0.00	17.60	8.80	0.55	13.79	89.48
Chydoridae	0.00	5.43	2.72	0.33	4.25	93.74

Groups 2003 & 2012
Average dissimilarity = 66.57

	Group 2003	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	80.39	31.14	30.33	1.45	45.57	45.57
Cyclopoida	19.61	37.82	20.72	0.99	31.12	76.69
insecta	0.00	17.60	8.80	0.55	13.22	89.91
Chydoridae	0.00	5.43	2.72	0.33	4.08	93.99

Groups 2005 & 2012
Average dissimilarity = 68.46

	Group 2005	Group 2012

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	72.54	37.82	27.16	1.32	39.68	39.68
Bosmina	0.00	31.14	15.57	0.74	22.75	62.42
insecta	20.00	17.60	15.28	0.74	22.32	84.74
Podocopa	7.46	0.00	3.73	0.49	5.45	90.19

Groups 2009 & 2012
Average dissimilarity = 75.06

	Group 2009	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	62.20	31.14	26.16	1.41	34.85	34.85
Cyclopoida	7.80	37.82	19.04	0.95	25.36	60.21
Ostracoda	20.00	0.00	10.00	0.49	13.32	73.53
insecta	0.00	17.60	8.80	0.55	11.73	85.26
Gammaridae	10.00	3.25	5.98	0.59	7.96	93.22

Groups 2010 & 2012
Average dissimilarity = 84.63

	Group 2010	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	20.00	37.82	21.35	0.95	25.22	25.22
Chironomidae	35.61	4.75	17.72	0.98	20.94	46.16
Bosmina	0.00	31.14	15.57	0.74	18.40	64.56
insecta	18.78	17.60	13.50	0.93	15.95	80.51
Gammaridae	20.00	3.25	10.98	0.56	12.97	93.48

Groups 2011 & 2012
Average dissimilarity = 73.62

	Group 2011	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	35.71	37.82	22.70	1.07	30.84	30.84
Bosmina	35.71	31.14	21.89	1.03	29.73	60.57
Chydoridae	14.29	5.43	9.08	0.51	12.34	72.91
insecta	0.00	17.60	8.80	0.55	11.96	84.86
Sididae	14.29	0.00	7.14	0.41	9.70	94.57

APPENDIX D

Juvenile American Shad SIMPER

Similarity Percentages - species contributions

Group 1988

Average similarity: 34.04

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	43.30	24.14	1.04	70.90	70.90
Podocopa	11.00	3.11	0.42	9.14	80.05
Chironomidae	11.01	3.07	0.43	9.02	89.06
Cladocera	7.50	1.73	0.30	5.09	94.15

Group 1991

Average similarity: 31.80

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	31.86	11.82	0.60	37.17	37.17
Gammaridae	24.35	9.57	0.67	30.10	67.27
insecta	18.80	6.96	0.57	21.90	89.17
Chironomidae	12.01	2.94	0.37	9.24	98.40

Group 1992

Average similarity: 26.79

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	27.64	10.48	0.65	39.12	39.12
insecta	14.48	5.94	0.66	22.18	61.30
Cyclopoida	14.80	4.89	0.51	18.25	79.55
Podocopa	11.15	2.86	0.38	10.68	90.23

Group 1993

Average similarity: 28.32

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	29.69	11.15	0.63	39.38	39.38
Cladocera	16.91	6.99	0.59	24.66	64.04
Bosmina	16.95	5.09	0.44	17.96	82.01
insecta	9.50	2.23	0.31	7.87	89.88
Amphipoda	11.22	1.24	0.20	4.37	94.26

Group 1994

Average similarity: 28.15

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	34.76	13.31	0.61	47.28	47.28
Gammaridae	33.28	11.91	0.54	42.31	89.59
Amphipoda	14.69	1.98	0.24	7.04	96.63

Group 1995
Average similarity: 34.78

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	27.94	17.40	1.32	50.02	50.02
Cyclopoida	22.82	5.95	0.45	17.11	67.13
insecta	12.32	4.59	0.51	13.20	80.33
Cladocera	9.55	2.96	0.41	8.50	88.83
Chironomidae	9.02	2.28	0.41	6.56	95.39

Group 1997
Average similarity: 45.05

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Gammaridae	32.16	21.87	1.72	48.54	48.54
Cyclopoida	18.42	13.32	1.41	29.56	78.11
Mysida	8.13	3.33	0.57	7.38	85.49
Amphipoda	8.94	2.71	0.43	6.02	91.51

Group 1999
Average similarity: 29.99

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Amphipoda	33.94	14.02	0.70	46.76	46.76
Cyclopoida	22.90	9.73	0.89	32.44	79.20
Gammaridae	11.82	3.13	0.39	10.45	89.65
insecta	5.46	1.25	0.32	4.17	93.81

Group 2001
Average similarity: 17.73

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	29.28	8.28	0.37	46.68	46.68
Gammaridae	23.54	5.08	0.33	28.62	75.30
Nematoda	16.23	1.56	0.14	8.82	84.12
Amphipoda	8.51	1.28	0.25	7.19	91.31

Group 2003
Average similarity: 36.42

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	44.62	23.03	0.88	63.23	63.23
insecta	14.89	6.39	0.65	17.54	80.77
Cyclopoida	22.40	4.90	0.34	13.46	94.23

Group 2005
Average similarity: 17.66

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	29.49	8.97	0.45	50.78	50.78
Bosmina	26.92	5.77	0.27	32.67	83.45

Nematoda	15.38	1.81	0.20	10.27	93.71

Group 2009
Average similarity: 17.23

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	24.63	6.57	0.42	38.16	38.16
Ostracoda	19.70	3.03	0.24	17.59	55.75
Bosmina	18.48	2.90	0.28	16.81	72.56
Nematoda	10.40	2.63	0.40	15.26	87.82
Chironomidae	15.56	2.10	0.29	12.18	100.00

Group 2010
Average similarity: 28.88

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Chironomidae	28.10	8.69	0.47	30.09	30.09
insecta	19.72	8.41	0.66	29.13	59.21
Gammaridae	23.84	6.20	0.39	21.48	80.70
Cyclopoida	13.06	4.12	0.42	14.28	94.97

Group 2011
Average similarity: 39.27

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bosmina	54.71	30.89	0.86	78.66	78.66
insecta	21.20	6.51	0.56	16.57	95.23

Group 2012
Average similarity: 14.37

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cyclopoida	24.56	7.06	0.49	49.15	49.15
Amphipoda	9.06	1.86	0.31	12.97	62.12
Chironomidae	10.38	1.72	0.21	11.97	74.09
Bosmina	11.59	1.26	0.19	8.75	82.84
Gammaridae	11.03	1.16	0.18	8.06	90.90

Groups 1988 & 1991
Average dissimilarity = 74.61

	Group 1988	Group 1991				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	31.86	19.82	1.35	26.56	26.56
Gammaridae	0.49	24.35	12.11	0.92	16.24	42.80
insecta	9.75	18.80	11.34	0.92	15.20	57.99
Chironomidae	11.01	12.01	8.09	0.96	10.84	68.83
Podocopa	11.00	2.05	5.69	0.82	7.62	76.46
Nematoda	0.00	8.17	4.08	0.33	5.47	81.93
Cladocera	7.50	0.00	3.75	0.65	5.03	86.96
Daphnia	6.23	0.00	3.12	0.48	4.18	91.13

Groups 1988 & 1992
Average dissimilarity = 78.14

Species	Group 1988 Av.Abund	Group 1992 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	14.80	18.40	1.32	23.54	23.54
Bosmina	3.73	27.64	13.71	0.93	17.54	41.08
insecta	9.75	14.48	9.49	0.85	12.14	53.23
Podocopa	11.00	11.15	7.64	1.01	9.78	63.01
Daphnia	6.23	8.32	6.57	0.53	8.41	71.42
Chironomidae	11.01	4.11	6.04	0.86	7.73	79.15
Cladocera	7.50	0.94	3.93	0.70	5.02	84.17
Gammaridae	0.49	5.30	2.78	0.58	3.56	87.73
Amphipoda	2.85	3.01	2.60	0.57	3.32	91.05

Groups 1991 & 1992
Average dissimilarity = 79.66

Species	Group 1991 Av.Abund	Group 1992 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	14.80	15.58	1.02	19.56	19.56
Bosmina	0.00	27.64	13.82	0.90	17.35	36.91
Gammaridae	24.35	5.30	11.79	0.95	14.81	51.72
insecta	18.80	14.48	9.89	1.19	12.41	64.13
Chironomidae	12.01	4.11	6.62	0.79	8.31	72.44
Nematoda	8.17	4.98	5.99	0.49	7.52	79.97
Podocopa	2.05	11.15	5.81	0.77	7.30	87.27
Daphnia	0.00	8.32	4.16	0.33	5.22	92.49

Groups 1988 & 1993
Average dissimilarity = 72.67

Species	Group 1988 Av.Abund	Group 1993 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	29.69	19.64	1.35	27.02	27.02
Bosmina	3.73	16.95	8.87	0.84	12.21	39.23
Cladocera	7.50	16.91	8.45	1.12	11.63	50.86
insecta	9.75	9.50	7.96	0.67	10.96	61.82
Chironomidae	11.01	5.87	6.48	0.89	8.92	70.75
Amphipoda	2.85	11.22	6.40	0.53	8.81	79.55
Daphnia	6.23	8.01	6.15	0.64	8.46	88.01
Podocopa	11.00	0.00	5.50	0.75	7.57	95.58

Groups 1991 & 1993
Average dissimilarity = 80.26

Species	Group 1991 Av.Abund	Group 1993 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	29.69	18.29	1.07	22.78	22.78
Gammaridae	24.35	1.85	12.14	0.93	15.13	37.92

insecta	18.80	9.50	9.77	1.07	12.17	50.09
Bosmina	0.00	16.95	8.47	0.77	10.56	60.65
Cladocera	0.00	16.91	8.46	0.99	10.54	71.19
Chironomidae	12.01	5.87	7.02	0.82	8.75	79.94
Amphipoda	0.00	11.22	5.61	0.45	6.99	86.93
Nematoda	8.17	0.00	4.08	0.33	5.09	92.02

Groups 1992 & 1993
Average dissimilarity = 77.32

	Group 1992	Group 1993				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	14.80	29.69	14.63	0.98	18.92	18.92
Bosmina	27.64	16.95	14.43	1.08	18.66	37.58
Cladocera	0.94	16.91	8.41	1.00	10.87	48.45
insecta	14.48	9.50	7.98	1.12	10.32	58.77
Daphnia	8.32	8.01	7.29	0.53	9.43	68.20
Amphipoda	3.01	11.22	6.45	0.53	8.34	76.54
Podocopa	11.15	0.00	5.58	0.71	7.21	83.76
Chironomidae	4.11	5.87	4.16	0.71	5.38	89.14
Gammaridae	5.30	1.85	3.28	0.59	4.24	93.38

Groups 1988 & 1994
Average dissimilarity = 77.07

	Group 1988	Group 1994				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	34.76	20.08	1.36	26.06	26.06
Gammaridae	0.49	33.28	16.61	0.91	21.55	47.60
Amphipoda	2.85	14.69	7.97	0.59	10.34	57.94
insecta	9.75	6.68	7.13	0.57	9.25	67.19
Chironomidae	11.01	3.57	6.51	0.79	8.44	75.63
Podocopa	11.00	1.19	5.61	0.79	7.28	82.91
Bosmina	3.73	4.99	3.87	0.54	5.03	87.94
Cladocera	7.50	0.00	3.75	0.65	4.87	92.80

Groups 1991 & 1994
Average dissimilarity = 71.12

	Group 1991	Group 1994				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	34.76	19.43	1.12	27.32	27.32
Gammaridae	24.35	33.28	17.70	1.18	24.88	52.20
insecta	18.80	6.68	9.90	1.01	13.92	66.13
Amphipoda	0.00	14.69	7.35	0.52	10.33	76.45
Chironomidae	12.01	3.57	6.99	0.73	9.83	86.29
Nematoda	8.17	0.00	4.08	0.33	5.74	92.03

Groups 1992 & 1994
Average dissimilarity = 82.38

Species	Group 1992 Av.Abund	Group 1994 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	14.80	34.76	16.68	1.05	20.25	20.25
Gammaridae	5.30	33.28	16.37	0.96	19.87	40.12
Bosmina	27.64	4.99	13.85	0.95	16.81	56.93
Amphipoda	3.01	14.69	8.05	0.59	9.77	66.69
insecta	14.48	6.68	8.00	1.04	9.72	76.41
Podocopa	11.15	1.19	5.71	0.74	6.94	83.35
Daphnia	8.32	0.00	4.16	0.33	5.05	88.40
Chironomidae	4.11	3.57	3.55	0.52	4.31	92.70

Groups 1993 & 1994
Average dissimilarity = 79.68

Species	Group 1993 Av.Abund	Group 1994 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	34.76	18.98	1.09	23.81	23.81
Gammaridae	1.85	33.28	16.62	0.92	20.86	44.67
Amphipoda	11.22	14.69	10.72	0.68	13.45	58.12
Bosmina	16.95	4.99	9.14	0.86	11.47	69.59
Cladocera	16.91	0.00	8.46	0.99	10.61	80.21
insecta	9.50	6.68	6.45	0.81	8.10	88.31
Chironomidae	5.87	3.57	4.30	0.57	5.40	93.71

Groups 1988 & 1995
Average dissimilarity = 74.65

Species	Group 1988 Av.Abund	Group 1995 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	22.82	20.30	1.36	27.20	27.20
Bosmina	3.73	27.94	13.19	1.53	17.67	44.87
insecta	9.75	12.32	8.73	0.79	11.69	56.56
Chironomidae	11.01	9.02	6.94	0.98	9.29	65.85
Cladocera	7.50	9.55	5.90	1.01	7.90	73.76
Podocopa	11.00	2.74	5.79	0.83	7.75	81.51
Daphnia	6.23	0.00	3.12	0.48	4.17	85.69
Leptodora_kindtii	0.98	5.52	2.98	0.66	3.99	89.68
Amphipoda	2.85	3.88	2.91	0.62	3.89	93.57

Groups 1991 & 1995
Average dissimilarity = 79.54

Species	Group 1991 Av.Abund	Group 1995 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	22.82	17.84	1.02	22.43	22.43
Bosmina	0.00	27.94	13.97	1.60	17.57	39.99
Gammaridae	24.35	1.96	12.07	0.93	15.18	55.18
insecta	18.80	12.32	9.60	1.16	12.07	67.24
Chironomidae	12.01	9.02	7.60	0.93	9.55	76.79
Cladocera	0.00	9.55	4.78	0.80	6.01	82.80
Nematoda	8.17	0.81	4.39	0.36	5.52	88.32

Leptodora_kindtii	2.76	5.52	3.53	0.71	4.44	92.76

Groups 1992 & 1995
Average dissimilarity = 70.79

	Group 1992	Group 1995				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	27.94	13.92	1.28	19.66	19.66
Cyclopoida	14.80	22.82	13.02	0.91	18.40	38.06
insecta	14.48	12.32	7.78	1.21	11.00	49.05
Podocopa	11.15	2.74	5.92	0.79	8.36	57.41
Chironomidae	4.11	9.02	5.20	0.83	7.35	64.76
Cladocera	0.94	9.55	4.86	0.84	6.87	71.63
Daphnia	8.32	0.00	4.16	0.33	5.88	77.51
Gammaridae	5.30	1.96	3.25	0.61	4.60	82.11
Amphipoda	3.01	3.88	3.05	0.57	4.32	86.42
Leptodora_kindtii	0.00	5.52	2.76	0.61	3.90	90.32

Groups 1993 & 1995
Average dissimilarity = 69.71

	Group 1993	Group 1995				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	22.82	17.03	0.98	24.43	24.43
Bosmina	16.95	27.94	12.41	1.46	17.80	42.23
Cladocera	16.91	9.55	8.44	1.18	12.10	54.33
insecta	9.50	12.32	7.30	1.09	10.48	64.81
Amphipoda	11.22	3.88	6.71	0.56	9.63	74.44
Chironomidae	5.87	9.02	5.77	0.87	8.27	82.71
Daphnia	8.01	0.00	4.00	0.43	5.74	88.45
Leptodora_kindtii	0.00	5.52	2.76	0.61	3.96	92.41

Groups 1994 & 1995
Average dissimilarity = 81.26

	Group 1994	Group 1995				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	34.76	22.82	18.73	1.05	23.05	23.05
Gammaridae	33.28	1.96	16.56	0.92	20.38	43.43
Bosmina	4.99	27.94	13.20	1.54	16.25	59.67
Amphipoda	14.69	3.88	8.25	0.61	10.15	69.83
insecta	6.68	12.32	7.24	1.01	8.91	78.73
Chironomidae	3.57	9.02	5.65	0.73	6.95	85.69
Cladocera	0.00	9.55	4.78	0.80	5.88	91.56

Groups 1988 & 1997
Average dissimilarity = 79.38

	Group 1988	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	18.42	16.48	1.33	20.76	20.76

Gammaridae	0.49	32.16	15.87	1.86	19.99	40.75
insecta	9.75	5.62	6.49	0.56	8.17	48.93
Chironomidae	11.01	3.04	5.77	0.84	7.26	56.19
Podocopa	11.00	1.47	5.59	0.81	7.05	63.24
Cladocera	7.50	3.85	5.10	0.69	6.42	69.66
Amphipoda	2.85	8.94	4.77	0.91	6.01	75.67
Mysida	0.00	8.13	4.06	1.00	5.12	80.78
Bosmina	3.73	3.41	3.14	0.61	3.96	84.74
Daphnia	6.23	0.00	3.12	0.48	3.93	88.67
Chydoridae	1.18	4.51	2.71	0.40	3.42	92.09

Groups 1991 & 1997
Average dissimilarity = 69.12

	Group 1991	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	18.42	14.09	1.01	20.39	20.39
Gammaridae	24.35	32.16	13.02	1.33	18.84	39.23
insecta	18.80	5.62	9.27	1.03	13.41	52.65
Chironomidae	12.01	3.04	6.39	0.77	9.24	61.89
Amphipoda	0.00	8.94	4.47	0.81	6.46	68.35
Nematoda	8.17	0.62	4.32	0.35	6.24	74.60
Mysida	0.00	8.13	4.06	1.00	5.88	80.47
Cyathura	0.00	4.62	2.31	0.75	3.34	83.82
Chydoridae	0.00	4.51	2.26	0.34	3.26	87.08
Leptodora_kindtii	2.76	2.13	2.18	0.53	3.15	90.23

Groups 1992 & 1997
Average dissimilarity = 78.91

	Group 1992	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	5.30	32.16	14.12	1.60	17.89	17.89
Bosmina	27.64	3.41	13.37	0.91	16.94	34.83
Cyclopoida	14.80	18.42	8.41	1.46	10.65	45.48
insecta	14.48	5.62	7.10	1.07	9.00	54.48
Podocopa	11.15	1.47	5.71	0.76	7.24	61.73
Amphipoda	3.01	8.94	4.98	0.88	6.31	68.04
Daphnia	8.32	0.00	4.16	0.33	5.27	73.31
Mysida	0.00	8.13	4.06	1.00	5.15	78.46
Chironomidae	4.11	3.04	2.96	0.69	3.75	82.21
Chydoridae	1.59	4.51	2.85	0.43	3.61	85.82
Nematoda	4.98	0.62	2.66	0.50	3.37	89.19
Cyathura	1.50	4.62	2.63	0.82	3.33	92.52

Groups 1993 & 1997
Average dissimilarity = 80.09

	Group 1993	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	1.85	32.16	15.56	1.80	19.43	19.43

Cyclopoida	29.69	18.42	12.80	0.93	15.98	35.41
Cladocera	16.91	3.85	9.08	1.03	11.34	46.75
Bosmina	16.95	3.41	8.69	0.86	10.85	57.59
Amphipoda	11.22	8.94	8.10	0.73	10.12	67.71
insecta	9.50	5.62	5.79	0.91	7.23	74.94
Mysida	0.00	8.13	4.06	1.00	5.07	80.01
Daphnia	8.01	0.00	4.00	0.43	5.00	85.01
Chironomidae	5.87	3.04	3.78	0.70	4.72	89.73
Cyathura	0.00	4.62	2.31	0.75	2.88	92.62

Groups 1994 & 1997
Average dissimilarity = 68.32

	Group 1994	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	33.28	32.16	16.92	1.50	24.77	24.77
Cyclopoida	34.76	18.42	15.21	1.05	22.26	47.03
Amphipoda	14.69	8.94	9.38	0.76	13.72	60.76
insecta	6.68	5.62	5.02	0.75	7.35	68.11
Mysida	0.00	8.13	4.06	0.99	5.95	74.06
Bosmina	4.99	3.41	3.71	0.60	5.44	79.49
Chironomidae	3.57	3.04	3.09	0.48	4.52	84.01
Cyathura	0.00	4.62	2.31	0.75	3.38	87.39
Chydoridae	0.00	4.51	2.26	0.34	3.30	90.69

Groups 1995 & 1997
Average dissimilarity = 80.08

	Group 1995	Group 1997				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	1.96	32.16	15.41	1.77	19.24	19.24
Bosmina	27.94	3.41	12.80	1.49	15.98	35.22
Cyclopoida	22.82	18.42	12.15	0.97	15.17	50.39
insecta	12.32	5.62	6.39	1.11	7.98	58.36
Cladocera	9.55	3.85	5.96	0.82	7.45	65.81
Amphipoda	3.88	8.94	5.11	0.92	6.38	72.19
Chironomidae	9.02	3.04	4.85	0.81	6.06	78.25
Mysida	0.00	8.13	4.06	0.99	5.07	83.32
Leptodora_kindtii	5.52	2.13	3.22	0.73	4.02	87.34
Chydoridae	1.40	4.51	2.80	0.41	3.50	90.84

Groups 1988 & 1999
Average dissimilarity = 77.87

	Group 1988	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	22.90	18.22	1.33	23.40	23.40
Amphipoda	2.85	33.94	16.48	1.00	21.17	44.57
Podocopa	11.00	7.87	7.45	0.85	9.57	54.14
insecta	9.75	5.46	6.44	0.56	8.28	62.42
Chironomidae	11.01	4.52	6.43	0.85	8.26	70.68

Gammaridae	0.49	11.82	5.96	0.74	7.66	78.34
Cladocera	7.50	0.00	3.75	0.65	4.82	83.15
Daphnia	6.23	1.44	3.54	0.54	4.55	87.70
Leptodora_kindtii	0.98	5.32	2.94	0.57	3.78	91.48

Groups 1991 & 1999
Average dissimilarity = 77.49

	Group 1991	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	0.00	33.94	16.97	0.99	21.90	21.90
Cyclopoida	31.86	22.90	16.31	1.04	21.05	42.95
Gammaridae	24.35	11.82	12.07	1.03	15.58	58.53
insecta	18.80	5.46	9.22	1.02	11.90	70.43
Chironomidae	12.01	4.52	6.91	0.77	8.92	79.35
Nematoda	8.17	1.57	4.67	0.38	6.03	85.38
Podocopa	2.05	7.87	4.51	0.53	5.82	91.20

Groups 1992 & 1999
Average dissimilarity = 82.47

	Group 1992	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	3.01	33.94	16.61	1.01	20.14	20.14
Bosmina	27.64	0.32	13.77	0.90	16.70	36.84
Cyclopoida	14.80	22.90	11.42	1.00	13.85	50.70
Podocopa	11.15	7.87	7.58	0.82	9.19	59.88
insecta	14.48	5.46	7.01	1.05	8.50	68.38
Gammaridae	5.30	11.82	6.60	0.87	8.01	76.39
Daphnia	8.32	1.44	4.71	0.38	5.71	82.10
Chironomidae	4.11	4.52	3.77	0.62	4.57	86.67
Nematoda	4.98	1.57	3.02	0.53	3.66	90.33

Groups 1993 & 1999
Average dissimilarity = 80.39

	Group 1993	Group 1999				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	11.22	33.94	17.47	1.06	21.73	21.73
Cyclopoida	29.69	22.90	15.28	0.98	19.00	40.73
Bosmina	16.95	0.32	8.49	0.78	10.56	51.30
Cladocera	16.91	0.00	8.46	0.99	10.52	61.82
Gammaridae	1.85	11.82	6.27	0.76	7.79	69.61
insecta	9.50	5.46	5.72	0.91	7.11	76.72
Daphnia	8.01	1.44	4.48	0.49	5.58	82.30
Chironomidae	5.87	4.52	4.44	0.65	5.52	87.82
Podocopa	0.00	7.87	3.93	0.45	4.89	92.71

Groups 1994 & 1999
Average dissimilarity = 73.83

Species	Group 1994 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	14.69	33.94	17.76	1.08	24.06	24.06
Cyclopoida	34.76	22.90	17.22	1.07	23.33	47.38
Gammaridae	33.28	11.82	16.49	1.04	22.34	69.72
insecta	6.68	5.46	4.95	0.74	6.70	76.42
Podocopa	1.19	7.87	4.27	0.49	5.78	82.20
Chironomidae	3.57	4.52	3.72	0.48	5.04	87.25
Leptodora_kindtii	0.84	5.32	2.88	0.56	3.90	91.14

Groups 1995 & 1999
Average dissimilarity = 82.60

Species	Group 1995 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	3.88	33.94	16.44	1.00	19.90	19.90
Cyclopoida	22.82	22.90	14.51	0.95	17.57	37.47
Bosmina	27.94	0.32	13.86	1.60	16.78	54.24
insecta	12.32	5.46	6.31	1.09	7.64	61.88
Gammaridae	1.96	11.82	6.21	0.77	7.52	69.40
Chironomidae	9.02	4.52	5.67	0.82	6.87	76.27
Cladocera	9.55	0.00	4.78	0.80	5.78	82.05
Podocopa	2.74	7.87	4.74	0.56	5.73	87.79
Leptodora_kindtii	5.52	5.32	4.33	0.80	5.24	93.02

Groups 1997 & 1999
Average dissimilarity = 70.58

Species	Group 1997 Av.Abund	Group 1999 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	8.94	33.94	15.70	1.03	22.24	22.24
Gammaridae	32.16	11.82	12.98	1.50	18.39	40.63
Cyclopoida	18.42	22.90	9.15	0.88	12.96	53.59
Podocopa	1.47	7.87	4.30	0.51	6.10	59.69
Mysida	8.13	0.00	4.06	1.00	5.76	65.45
insecta	5.62	5.46	4.05	0.93	5.74	71.18
Chironomidae	3.04	4.52	3.37	0.60	4.78	75.97
Leptodora_kindtii	2.13	5.32	3.25	0.64	4.60	80.57
Chydoridae	4.51	1.74	2.95	0.42	4.18	84.74
Cyathura	4.62	0.00	2.31	0.75	3.27	88.02
Cladocera	3.85	0.00	1.92	0.29	2.72	90.74

Groups 1988 & 2001
Average dissimilarity = 79.44

Species	Group 1988 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	29.28	21.08	1.40	26.53	26.53
Gammaridae	0.49	23.54	11.79	0.66	14.84	41.37
Nematoda	0.00	16.23	8.11	0.45	10.21	51.58
insecta	9.75	8.34	7.76	0.60	9.77	61.35

Chironomidae	11.01	5.42	6.69	0.86	8.42	69.77
Podocopa	11.00	2.25	5.90	0.81	7.43	77.20
Amphipoda	2.85	8.51	4.90	0.68	6.17	83.37
Bosmina	3.73	5.44	4.10	0.53	5.16	88.53
Cladocera	7.50	0.99	3.93	0.71	4.95	93.48

Groups 1991 & 2001
Average dissimilarity = 75.36

	Group 1991	Group 2001				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	29.28	20.04	1.16	26.59	26.59
Gammaridae	24.35	23.54	16.24	1.05	21.55	48.14
Nematoda	8.17	16.23	10.84	0.56	14.38	62.52
insecta	18.80	8.34	10.25	1.02	13.60	76.12
Chironomidae	12.01	5.42	7.16	0.79	9.50	85.61
Amphipoda	0.00	8.51	4.26	0.56	5.65	91.26

Groups 1992 & 2001
Average dissimilarity = 83.76

	Group 1992	Group 2001				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	14.80	29.28	16.37	1.07	19.55	19.55
Bosmina	27.64	5.44	13.92	0.95	16.62	36.17
Gammaridae	5.30	23.54	12.44	0.75	14.85	51.02
Nematoda	4.98	16.23	9.66	0.57	11.53	62.55
insecta	14.48	8.34	8.50	1.04	10.14	72.70
Podocopa	11.15	2.25	6.00	0.76	7.16	79.86
Amphipoda	3.01	8.51	5.03	0.66	6.00	85.86
Daphnia	8.32	0.00	4.16	0.33	4.97	90.83

Groups 1993 & 2001
Average dissimilarity = 82.64

	Group 1993	Group 2001				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	29.28	19.62	1.16	23.74	23.74
Gammaridae	1.85	23.54	12.04	0.68	14.57	38.31
Bosmina	16.95	5.44	9.31	0.86	11.27	49.58
Cladocera	16.91	0.99	8.40	1.01	10.17	59.75
Amphipoda	11.22	8.51	8.20	0.67	9.92	69.66
Nematoda	0.00	16.23	8.11	0.45	9.82	79.48
insecta	9.50	8.34	7.05	0.81	8.53	88.01
Chironomidae	5.87	5.42	4.78	0.66	5.78	93.79

Groups 1994 & 2001
Average dissimilarity = 75.02

	Group 1994	Group 2001				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%

Cyclopoida	34.76	29.28	20.62	1.18	27.48	27.48
Gammaridae	33.28	23.54	19.27	1.08	25.68	53.16
Amphipoda	14.69	8.51	9.49	0.71	12.65	65.81
Nematoda	0.00	16.23	8.11	0.45	10.82	76.63
insecta	6.68	8.34	6.28	0.68	8.37	85.00
Bosmina	4.99	5.44	4.61	0.56	6.14	91.13

Groups 1995 & 2001
Average dissimilarity = 82.79

Species	Group 1995 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	22.82	29.28	18.58	1.05	22.45	22.45
Bosmina	27.94	5.44	13.29	1.53	16.06	38.50
Gammaridae	1.96	23.54	12.04	0.68	14.54	53.05
Nematoda	0.81	16.23	8.33	0.47	10.07	63.11
insecta	12.32	8.34	7.75	0.98	9.36	72.47
Chironomidae	9.02	5.42	5.94	0.82	7.17	79.64
Amphipoda	3.88	8.51	5.24	0.70	6.32	85.97
Cladocera	9.55	0.99	4.86	0.85	5.86	91.83

Groups 1997 & 2001
Average dissimilarity = 77.29

Species	Group 1997 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	32.16	23.54	17.09	1.54	22.11	22.11
Cyclopoida	18.42	29.28	16.76	1.42	21.69	43.80
Nematoda	0.62	16.23	8.28	0.47	10.71	54.51
Amphipoda	8.94	8.51	6.44	0.93	8.33	62.84
insecta	5.62	8.34	5.73	0.73	7.41	70.25
Mysida	8.13	0.00	4.06	0.99	5.26	75.51
Bosmina	3.41	5.44	3.90	0.58	5.04	80.55
Chironomidae	3.04	5.42	3.76	0.61	4.87	85.42
Cladocera	3.85	0.99	2.34	0.35	3.03	88.45
Cyathura	4.62	0.00	2.31	0.75	2.99	91.44

Groups 1999 & 2001
Average dissimilarity = 80.22

Species	Group 1999 Av.Abund	Group 2001 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	22.90	29.28	17.94	1.20	22.36	22.36
Amphipoda	33.94	8.51	16.36	1.05	20.40	42.76
Gammaridae	11.82	23.54	13.55	0.87	16.89	59.65
Nematoda	1.57	16.23	8.60	0.49	10.72	70.38
insecta	5.46	8.34	5.66	0.73	7.06	77.44
Podocopa	7.87	2.25	4.65	0.52	5.80	83.23
Chironomidae	4.52	5.42	4.33	0.57	5.39	88.63
Bosmina	0.32	5.44	2.83	0.41	3.53	92.16

Groups 1988 & 2003
Average dissimilarity = 79.94

	Group 1988	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	3.73	44.62	21.53	1.25	26.93	26.93
Cyclopoida	43.30	22.40	20.65	1.36	25.83	52.76
insecta	9.75	14.89	9.61	0.88	12.02	64.78
Chironomidae	11.01	9.55	7.87	0.84	9.85	74.63
Podocopa	11.00	0.00	5.50	0.75	6.88	81.52
Cladocera	7.50	0.00	3.75	0.65	4.69	86.21
Daphnia	6.23	0.00	3.12	0.48	3.90	90.10

Groups 1991 & 2003
Average dissimilarity = 78.82

	Group 1991	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.00	44.62	22.31	1.25	28.31	28.31
Cyclopoida	31.86	22.40	18.29	1.04	23.20	51.51
Gammaridae	24.35	5.43	11.93	0.95	15.14	66.65
insecta	18.80	14.89	9.83	1.22	12.48	79.13
Chironomidae	12.01	9.55	8.40	0.81	10.66	89.79
Nematoda	8.17	0.00	4.08	0.33	5.18	94.97

Groups 1992 & 2003
Average dissimilarity = 69.81

	Group 1992	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	44.62	19.96	1.33	28.59	28.59
Cyclopoida	14.80	22.40	13.48	0.93	19.31	47.90
insecta	14.48	14.89	8.12	1.24	11.64	59.53
Chironomidae	4.11	9.55	5.78	0.62	8.27	67.81
Podocopa	11.15	0.00	5.58	0.71	7.99	75.80
Gammaridae	5.30	5.43	4.36	0.73	6.25	82.05
Daphnia	8.32	0.00	4.16	0.33	5.96	88.01
Nematoda	4.98	0.00	2.49	0.46	3.57	91.57

Groups 1993 & 2003
Average dissimilarity = 74.76

	Group 1993	Group 2003				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	16.95	44.62	19.76	1.28	26.44	26.44
Cyclopoida	29.69	22.40	17.62	1.01	23.57	50.01
Cladocera	16.91	0.00	8.46	0.99	11.31	61.32
insecta	9.50	14.89	8.01	1.17	10.71	72.03
Chironomidae	5.87	9.55	6.41	0.67	8.57	80.59
Amphipoda	11.22	0.00	5.61	0.45	7.50	88.10
Daphnia	8.01	0.00	4.00	0.43	5.35	93.45

Groups 1994 & 2003
Average dissimilarity = 81.01

Species	Group 1994 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	4.99	44.62	21.39	1.25	26.40	26.40
Cyclopoida	34.76	22.40	19.13	1.06	23.62	50.02
Gammaridae	33.28	5.43	16.47	0.96	20.33	70.35
insecta	6.68	14.89	8.11	1.10	10.01	80.36
Amphipoda	14.69	0.00	7.35	0.52	9.07	89.43
Chironomidae	3.57	9.55	5.99	0.57	7.39	96.83

Groups 1995 & 2003
Average dissimilarity = 66.30

Species	Group 1995 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.94	44.62	17.48	1.40	26.36	26.36
Cyclopoida	22.82	22.40	16.21	0.91	24.44	50.81
insecta	12.32	14.89	7.67	1.22	11.58	62.39
Chironomidae	9.02	9.55	7.18	0.78	10.84	73.22
Cladocera	9.55	0.00	4.78	0.80	7.20	80.42
Gammaridae	1.96	5.43	3.34	0.56	5.04	85.47
Leptodora_kindtii	5.52	0.00	2.76	0.61	4.17	89.63
Amphipoda	3.88	0.00	1.94	0.43	2.93	92.56

Groups 1997 & 2003
Average dissimilarity = 81.92

Species	Group 1997 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	3.41	44.62	21.51	1.26	26.26	26.26
Gammaridae	32.16	5.43	14.32	1.62	17.48	43.75
Cyclopoida	18.42	22.40	13.34	1.11	16.29	60.03
insecta	5.62	14.89	7.22	1.14	8.82	68.85
Chironomidae	3.04	9.55	5.42	0.59	6.61	75.46
Amphipoda	8.94	0.00	4.47	0.81	5.45	80.91
Mysida	8.13	0.00	4.06	1.00	4.96	85.87
Cyathura	4.62	0.00	2.31	0.75	2.82	88.69
Chydoridae	4.51	0.00	2.26	0.34	2.75	91.45

Groups 1999 & 2003
Average dissimilarity = 86.57

Species	Group 1999 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.32	44.62	22.23	1.25	25.68	25.68
Amphipoda	33.94	0.00	16.97	0.99	19.60	45.28
Cyclopoida	22.90	22.40	15.33	1.01	17.70	62.99
insecta	5.46	14.89	7.16	1.13	8.27	71.26

Gammaridae	11.82	5.43	6.80	0.86	7.85	79.11
Chironomidae	4.52	9.55	6.12	0.62	7.07	86.18
Podocopa	7.87	0.00	3.93	0.45	4.54	90.72

Groups 2001 & 2003
Average dissimilarity = 82.99

Species	Group 2001 Av.Abund	Group 2003 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	5.44	44.62	21.44	1.26	25.84	25.84
Cyclopoida	29.28	22.40	18.46	1.00	22.24	48.08
Gammaridae	23.54	5.43	12.52	0.75	15.08	63.16
insecta	8.34	14.89	8.59	1.09	10.35	73.51
Nematoda	16.23	0.00	8.11	0.45	9.78	83.29
Chironomidae	5.42	9.55	6.43	0.64	7.75	91.04

Groups 1988 & 2005
Average dissimilarity = 81.03

Species	Group 1988 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	29.49	20.25	1.35	24.99	24.99
Bosmina	3.73	26.92	14.18	0.70	17.50	42.49
Nematoda	0.00	15.38	7.69	0.50	9.49	51.98
Podocopa	11.00	4.88	7.09	0.77	8.75	60.73
Sididae	0.70	11.54	6.01	0.42	7.42	68.15
insecta	9.75	2.56	5.73	0.46	7.07	75.22
Chironomidae	11.01	0.00	5.51	0.74	6.80	82.02
Cladocera	7.50	0.00	3.75	0.65	4.63	86.64
Gammaridae	0.49	6.66	3.50	0.45	4.32	90.96

Groups 1991 & 2005
Average dissimilarity = 82.82

Species	Group 1991 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	29.49	19.24	1.12	23.23	23.23
Bosmina	0.00	26.92	13.46	0.64	16.25	39.48
Gammaridae	24.35	6.66	12.47	0.97	15.06	54.54
Nematoda	8.17	15.38	10.37	0.61	12.52	67.06
insecta	18.80	2.56	9.53	0.95	11.51	78.58
Chironomidae	12.01	0.00	6.01	0.67	7.25	85.83
Sididae	0.00	11.54	5.77	0.40	6.97	92.79

Groups 1992 & 2005
Average dissimilarity = 81.40

Species	Group 1992 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	26.92	19.26	1.09	23.66	23.66
Cyclopoida	14.80	29.49	15.62	1.04	19.19	42.85

Nematoda	4.98	15.38	9.03	0.63	11.10	53.95
insecta	14.48	2.56	7.52	1.01	9.24	63.19
Podocopa	11.15	4.88	7.16	0.74	8.79	71.98
Sididae	0.00	11.54	5.77	0.40	7.09	79.07
Gammaridae	5.30	6.66	5.17	0.66	6.35	85.41
Daphnia	8.32	0.00	4.16	0.33	5.11	90.52

Groups 1993 & 2005
Average dissimilarity = 82.66

	Group 1993	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	29.49	18.88	1.13	22.84	22.84
Bosmina	16.95	26.92	16.82	0.96	20.35	43.19
Cladocera	16.91	0.00	8.46	0.99	10.23	53.42
Nematoda	0.00	15.38	7.69	0.50	9.31	62.73
Amphipoda	11.22	2.56	6.35	0.51	7.68	70.41
Sididae	0.00	11.54	5.77	0.40	6.98	77.39
insecta	9.50	2.56	5.34	0.72	6.47	83.85
Daphnia	8.01	0.00	4.00	0.43	4.84	88.69
Gammaridae	1.85	6.66	3.97	0.48	4.80	93.50

Groups 1994 & 2005
Average dissimilarity = 81.86

	Group 1994	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	34.76	29.49	19.87	1.14	24.27	24.27
Gammaridae	33.28	6.66	16.80	0.97	20.52	44.79
Bosmina	4.99	26.92	14.42	0.72	17.62	62.40
Amphipoda	14.69	2.56	7.97	0.57	9.74	72.14
Nematoda	0.00	15.38	7.69	0.50	9.40	81.54
Sididae	0.00	11.54	5.77	0.40	7.05	88.59
insecta	6.68	2.56	4.20	0.55	5.13	93.71

Groups 1995 & 2005
Average dissimilarity = 81.38

	Group 1995	Group 2005				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.94	26.92	18.90	1.48	23.23	23.23
Cyclopoida	22.82	29.49	18.00	1.03	22.12	45.35
Nematoda	0.81	15.38	7.91	0.53	9.72	55.07
insecta	12.32	2.56	6.49	0.96	7.98	63.05
Sididae	0.00	11.54	5.77	0.40	7.09	70.14
Cladocera	9.55	0.00	4.78	0.80	5.87	76.01
Chironomidae	9.02	0.00	4.51	0.69	5.54	81.55
Gammaridae	1.96	6.66	4.01	0.50	4.93	86.48
Podocopa	2.74	4.88	3.60	0.43	4.42	90.90

Groups 1997 & 2005

Average dissimilarity = 84.63

Species	Group 1997 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	18.42	29.49	15.45	1.27	18.26	18.26
Gammaridae	32.16	6.66	14.96	1.74	17.68	35.94
Bosmina	3.41	26.92	14.12	0.71	16.68	52.62
Nematoda	0.62	15.38	7.86	0.52	9.29	61.91
Sididae	0.00	11.54	5.77	0.40	6.82	68.72
Amphipoda	8.94	2.56	5.06	0.86	5.98	74.70
Mysida	8.13	0.00	4.06	0.99	4.80	79.51
insecta	5.62	2.56	3.66	0.70	4.33	83.83
Podocopa	1.47	4.88	3.06	0.37	3.62	87.45
Cyathura	4.62	0.00	2.31	0.75	2.73	90.18

Groups 1999 & 2005
Average dissimilarity = 86.00

Species	Group 1999 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	22.90	29.49	17.05	1.15	19.83	19.83
Amphipoda	33.94	2.56	16.77	1.01	19.50	39.32
Bosmina	0.32	26.92	13.52	0.64	15.73	55.05
Nematoda	1.57	15.38	8.12	0.54	9.44	64.49
Gammaridae	11.82	6.66	7.52	0.84	8.75	73.23
Sididae	1.16	11.54	6.17	0.43	7.17	80.41
Podocopa	7.87	4.88	5.78	0.53	6.72	87.13
insecta	5.46	2.56	3.59	0.70	4.18	91.30

Groups 2001 & 2005
Average dissimilarity = 82.45

Species	Group 2001 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.28	29.49	19.49	1.08	23.64	23.64
Bosmina	5.44	26.92	14.51	0.73	17.59	41.23
Nematoda	16.23	15.38	13.25	0.68	16.06	57.30
Gammaridae	23.54	6.66	12.90	0.75	15.65	72.94
Sididae	0.00	11.54	5.77	0.40	7.00	79.94
Amphipoda	8.51	2.56	4.98	0.63	6.04	85.98
insecta	8.34	2.56	4.96	0.56	6.02	92.00

Groups 2003 & 2005
Average dissimilarity = 77.47

Species	Group 2003 Av.Abund	Group 2005 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	44.62	26.92	23.06	1.31	29.76	29.76
Cyclopoida	22.40	29.49	18.05	1.01	23.30	53.06
Nematoda	0.00	15.38	7.69	0.50	9.93	62.99
insecta	14.89	2.56	7.64	1.06	9.86	72.85

Sididae	0.00	11.54	5.77	0.40	7.45	80.30
Gammaridae	5.43	6.66	5.21	0.63	6.72	87.02
Chironomidae	9.55	0.00	4.77	0.49	6.16	93.19

Groups 1988 & 2009
Average dissimilarity = 80.63

	Group 1988	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	24.63	19.76	1.37	24.51	24.51
Chironomidae	11.01	15.56	10.22	0.78	12.68	37.19
Bosmina	3.73	18.48	9.97	0.66	12.37	49.56
Ostracoda	0.00	19.70	9.85	0.58	12.21	61.78
insecta	9.75	2.52	5.67	0.46	7.03	68.81
Podocopa	11.00	0.75	5.55	0.78	6.88	75.69
Nematoda	0.00	10.40	5.20	0.74	6.45	82.14
Cladocera	7.50	0.00	3.75	0.65	4.65	86.79
Daphnia	6.23	0.00	3.12	0.48	3.87	90.66

Groups 1991 & 2009
Average dissimilarity = 82.29

	Group 1991	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	24.63	18.16	1.11	22.07	22.07
Gammaridae	24.35	4.55	12.52	0.96	15.21	37.28
Chironomidae	12.01	15.56	10.63	0.78	12.92	50.20
Ostracoda	0.00	19.70	9.85	0.58	11.97	62.17
insecta	18.80	2.52	9.46	0.95	11.49	73.66
Bosmina	0.00	18.48	9.24	0.58	11.23	84.89
Nematoda	8.17	10.40	8.05	0.68	9.78	94.66

Groups 1992 & 2009
Average dissimilarity = 81.76

	Group 1992	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	18.48	16.25	1.04	19.87	19.87
Cyclopoida	14.80	24.63	13.73	1.03	16.79	36.66
Ostracoda	2.17	19.70	10.34	0.63	12.65	49.31
Chironomidae	4.11	15.56	8.57	0.62	10.48	59.80
insecta	14.48	2.52	7.38	1.01	9.03	68.83
Nematoda	4.98	10.40	6.11	0.87	7.47	76.29
Podocopa	11.15	0.75	5.64	0.73	6.90	83.20
Gammaridae	5.30	4.55	4.44	0.59	5.43	88.63
Daphnia	8.32	0.00	4.16	0.33	5.09	93.72

Groups 1993 & 2009
Average dissimilarity = 83.07

	Group 1993	Group 2009

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	24.63	17.64	1.10	21.24	21.24
Bosmina	16.95	18.48	13.06	0.93	15.72	36.96
Ostracoda	0.00	19.70	9.85	0.58	11.86	48.82
Chironomidae	5.87	15.56	9.02	0.65	10.86	59.68
Cladocera	16.91	0.00	8.46	0.99	10.18	69.86
Amphipoda	11.22	0.75	5.82	0.47	7.00	76.86
insecta	9.50	2.52	5.28	0.73	6.36	83.22
Nematoda	0.00	10.40	5.20	0.74	6.26	89.48
Daphnia	8.01	0.00	4.00	0.43	4.82	94.30

Groups 1994 & 2009
Average dissimilarity = 84.22

	Group 1994	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	34.76	24.63	18.97	1.13	22.52	22.52
Gammaridae	33.28	4.55	16.82	0.95	19.97	42.49
Bosmina	4.99	18.48	10.29	0.68	12.22	54.71
Ostracoda	0.00	19.70	9.85	0.58	11.69	66.41
Chironomidae	3.57	15.56	8.78	0.60	10.43	76.83
Amphipoda	14.69	0.75	7.51	0.54	8.91	85.75
Nematoda	0.00	10.40	5.20	0.74	6.18	91.92

Groups 1995 & 2009
Average dissimilarity = 79.97

	Group 1995	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	22.82	24.63	16.50	1.00	20.63	20.63
Bosmina	27.94	18.48	15.16	1.40	18.96	39.59
Ostracoda	0.89	19.70	10.05	0.60	12.57	52.16
Chironomidae	9.02	15.56	9.72	0.74	12.16	64.31
insecta	12.32	2.52	6.38	0.96	7.97	72.28
Nematoda	0.81	10.40	5.26	0.77	6.57	78.86
Cladocera	9.55	0.00	4.78	0.80	5.97	84.83
Gammaridae	1.96	4.55	3.08	0.41	3.85	88.68
Leptodora_kindtii	5.52	0.00	2.76	0.61	3.45	92.13

Groups 1997 & 2009
Average dissimilarity = 85.38

	Group 1997	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	32.16	4.55	15.57	1.82	18.23	18.23
Cyclopoida	18.42	24.63	13.39	1.26	15.68	33.91
Ostracoda	1.01	19.70	10.08	0.60	11.80	45.72
Bosmina	3.41	18.48	9.79	0.66	11.47	57.18
Chironomidae	3.04	15.56	8.32	0.60	9.75	66.93
Nematoda	0.62	10.40	5.23	0.76	6.12	73.05
Amphipoda	8.94	0.75	4.50	0.84	5.27	78.32

Mysida	8.13	0.00	4.06	0.99	4.76	83.08
insecta	5.62	2.52	3.56	0.73	4.17	87.25
Cyathura	4.62	0.00	2.31	0.75	2.71	89.96
Chydoridae	4.51	0.00	2.26	0.34	2.64	92.60

Groups 1999 & 2009
Average dissimilarity = 87.07

	Group 1999	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	33.94	0.75	16.79	0.99	19.29	19.29
Cyclopoida	22.90	24.63	15.39	1.12	17.67	36.96
Ostracoda	0.82	19.70	10.03	0.60	11.53	48.49
Bosmina	0.32	18.48	9.28	0.59	10.66	59.15
Chironomidae	4.52	15.56	8.77	0.62	10.08	69.22
Gammaridae	11.82	4.55	7.13	0.79	8.19	77.41
Nematoda	1.57	10.40	5.44	0.79	6.25	83.66
Podocopa	7.87	0.75	4.12	0.48	4.73	88.39
insecta	5.46	2.52	3.49	0.73	4.01	92.40

Groups 2001 & 2009
Average dissimilarity = 84.21

	Group 2001	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.28	24.63	18.36	1.06	21.80	21.80
Gammaridae	23.54	4.55	12.60	0.72	14.97	36.77
Nematoda	16.23	10.40	11.35	0.72	13.48	50.25
Bosmina	5.44	18.48	10.43	0.68	12.39	62.64
Ostracoda	0.00	19.70	9.85	0.58	11.70	74.33
Chironomidae	5.42	15.56	9.05	0.64	10.74	85.07
insecta	8.34	2.52	4.90	0.57	5.82	90.89

Groups 2003 & 2009
Average dissimilarity = 78.12

	Group 2003	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	44.62	18.48	21.40	1.28	27.40	27.40
Cyclopoida	22.40	24.63	16.63	0.99	21.29	48.69
Ostracoda	3.12	19.70	10.56	0.65	13.51	62.20
Chironomidae	9.55	15.56	10.26	0.70	13.14	75.34
insecta	14.89	2.52	7.49	1.05	9.59	84.93
Nematoda	0.00	10.40	5.20	0.74	6.66	91.58

Groups 2005 & 2009
Average dissimilarity = 82.30

	Group 2005	Group 2009				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.49	24.63	17.95	1.07	21.81	21.81

Bosmina	26.92	18.48	17.42	0.86	21.17	42.98
Nematoda	15.38	10.40	10.49	0.79	12.75	55.73
Ostracoda	0.00	19.70	9.85	0.58	11.97	67.70
Chironomidae	0.00	15.56	7.78	0.53	9.46	77.15
Sididae	11.54	0.00	5.77	0.40	7.01	84.16
Gammaridae	6.66	4.55	5.00	0.52	6.07	90.24

Groups 1988 & 2010
Average dissimilarity = 79.56

Species	Group 1988 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	13.06	18.57	1.31	23.34	23.34
Chironomidae	11.01	28.10	14.38	0.91	18.08	41.42
Gammaridae	0.49	23.84	11.96	0.71	15.04	56.46
insecta	9.75	19.72	11.57	0.98	14.54	71.00
Podocopa	11.00	3.65	5.92	0.86	7.44	78.44
Amphipoda	2.85	7.01	4.28	0.67	5.39	83.83
Cladocera	7.50	0.00	3.75	0.65	4.71	88.54
Daphnia	6.23	0.00	3.12	0.48	3.92	92.46

Groups 1991 & 2010
Average dissimilarity = 70.53

Species	Group 1991 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	24.35	23.84	15.75	1.07	22.32	22.32
Cyclopoida	31.86	13.06	15.42	0.99	21.86	44.18
Chironomidae	12.01	28.10	14.74	0.92	20.90	65.09
insecta	18.80	19.72	10.97	1.23	15.55	80.64
Nematoda	8.17	0.00	4.08	0.33	5.79	86.43
Amphipoda	0.00	7.01	3.51	0.52	4.97	91.40

Groups 1992 & 2010
Average dissimilarity = 80.79

Species	Group 1992 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironomidae	4.11	28.10	14.04	0.82	17.38	17.38
Bosmina	27.64	1.14	13.68	0.90	16.93	34.30
Gammaridae	5.30	23.84	12.39	0.79	15.33	49.64
insecta	14.48	19.72	9.76	1.23	12.08	61.71
Cyclopoida	14.80	13.06	9.00	1.10	11.14	72.85
Podocopa	11.15	3.65	6.07	0.82	7.52	80.37
Amphipoda	3.01	7.01	4.37	0.64	5.41	85.78
Daphnia	8.32	0.00	4.16	0.33	5.15	90.92

Groups 1993 & 2010
Average dissimilarity = 82.86

	Group 1993	Group 2010

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	13.06	14.57	0.97	17.58	17.58
Chironomidae	5.87	28.10	14.15	0.83	17.07	34.66
Gammaridae	1.85	23.84	12.10	0.73	14.60	49.26
insecta	9.50	19.72	9.82	1.13	11.85	61.11
Bosmina	16.95	1.14	8.55	0.80	10.32	71.42
Cladocera	16.91	0.00	8.46	0.99	10.21	81.63
Amphipoda	11.22	7.01	7.65	0.63	9.24	90.87

Groups 1994 & 2010
Average dissimilarity = 76.32

	Group 1994	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	33.28	23.84	18.86	1.10	24.71	24.71
Cyclopoida	34.76	13.06	16.61	1.03	21.76	46.47
Chironomidae	3.57	28.10	14.46	0.82	18.95	65.42
insecta	6.68	19.72	10.11	1.09	13.24	78.66
Amphipoda	14.69	7.01	9.06	0.68	11.87	90.53

Groups 1995 & 2010
Average dissimilarity = 80.50

	Group 1995	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironomidae	9.02	28.10	14.21	0.88	17.65	17.65
Bosmina	27.94	1.14	13.58	1.55	16.88	34.52
Cyclopoida	22.82	13.06	12.77	0.89	15.86	50.38
Gammaridae	1.96	23.84	12.09	0.73	15.02	65.41
insecta	12.32	19.72	9.43	1.18	11.71	77.12
Cladocera	9.55	0.00	4.78	0.80	5.93	83.05
Amphipoda	3.88	7.01	4.63	0.68	5.75	88.80
Leptodora_kindtii	5.52	0.92	2.96	0.66	3.68	92.48

Groups 1997 & 2010
Average dissimilarity = 73.36

	Group 1997	Group 2010				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	32.16	23.84	16.10	1.48	21.95	21.95
Chironomidae	3.04	28.10	13.96	0.80	19.03	40.98
insecta	5.62	19.72	9.48	1.11	12.93	53.91
Cyclopoida	18.42	13.06	8.34	1.66	11.37	65.28
Amphipoda	8.94	7.01	6.03	0.95	8.22	73.50
Mysida	8.13	0.00	4.06	1.00	5.54	79.04
Cyathura	4.62	0.00	2.31	0.75	3.15	82.19
Podocopa	1.47	3.65	2.30	0.60	3.13	85.32
Chydoridae	4.51	0.00	2.26	0.34	3.08	88.40
Bosmina	3.41	1.14	2.08	0.57	2.83	91.23

Groups 1999 & 2010

Average dissimilarity = 78.45

Species	Group 1999 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	33.94	7.01	16.39	1.04	20.89	20.89
Chironomidae	4.52	28.10	14.24	0.82	18.16	39.05
Gammaridae	11.82	23.84	13.28	0.91	16.93	55.98
Cyclopoida	22.90	13.06	11.36	1.01	14.49	70.47
insecta	5.46	19.72	9.44	1.10	12.03	82.50
Podocopa	7.87	3.65	5.02	0.59	6.40	88.90
Leptodora_kindtii	5.32	0.92	2.92	0.56	3.72	92.62

Groups 2001 & 2010
Average dissimilarity = 80.25

Species	Group 2001 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	23.54	23.84	16.98	0.94	21.16	21.16
Cyclopoida	29.28	13.06	16.15	1.04	20.12	41.28
Chironomidae	5.42	28.10	14.35	0.83	17.88	59.17
insecta	8.34	19.72	10.42	1.09	12.98	72.15
Nematoda	16.23	0.00	8.11	0.45	10.11	82.26
Amphipoda	8.51	7.01	6.22	0.77	7.75	90.01

Groups 2003 & 2010
Average dissimilarity = 80.73

Species	Group 2003 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	44.62	1.14	22.04	1.25	27.31	27.31
Chironomidae	9.55	28.10	14.97	0.88	18.54	45.84
Cyclopoida	22.40	13.06	13.10	0.89	16.23	62.07
Gammaridae	5.43	23.84	12.42	0.79	15.38	77.45
insecta	14.89	19.72	9.57	1.23	11.86	89.31
Amphipoda	0.00	7.01	3.51	0.52	4.34	93.65

Groups 2005 & 2010
Average dissimilarity = 89.04

Species	Group 2005 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.49	13.06	15.34	1.00	17.23	17.23
Chironomidae	0.00	28.10	14.05	0.77	15.78	33.01
Bosmina	26.92	1.14	13.68	0.66	15.37	48.38
Gammaridae	6.66	23.84	12.82	0.79	14.40	62.78
insecta	2.56	19.72	9.88	1.04	11.09	73.87
Nematoda	15.38	0.00	7.69	0.50	8.64	82.51
Sididae	11.54	1.32	6.23	0.44	6.99	89.50
Amphipoda	2.56	7.01	4.28	0.60	4.81	94.32

Groups 2009 & 2010

Average dissimilarity = 85.23

Species	Group 2009 Av.Abund	Group 2010 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironomidae	15.56	28.10	16.22	0.90	19.03	19.03
Cyclopoida	24.63	13.06	13.40	0.99	15.72	34.75
Gammaridae	4.55	23.84	12.64	0.76	14.83	49.58
Ostracoda	19.70	0.00	9.85	0.58	11.55	61.13
insecta	2.52	19.72	9.76	1.03	11.45	72.58
Bosmina	18.48	1.14	9.44	0.61	11.07	83.66
Nematoda	10.40	0.00	5.20	0.74	6.10	89.76
Amphipoda	0.75	7.01	3.70	0.57	4.35	94.10

Groups 1988 & 2011
Average dissimilarity = 85.38

Species	Group 1988 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	3.73	54.71	26.64	1.39	31.20	31.20
Cyclopoida	43.30	8.97	20.61	1.35	24.14	55.35
insecta	9.75	21.20	12.41	0.83	14.54	69.88
Podocopa	11.00	9.54	8.76	0.70	10.26	80.14
Chironomidae	11.01	4.69	5.95	0.89	6.97	87.11
Cladocera	7.50	0.00	3.75	0.65	4.39	91.50

Groups 1991 & 2011
Average dissimilarity = 86.24

Species	Group 1991 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.00	54.71	27.36	1.37	31.72	31.72
Cyclopoida	31.86	8.97	16.72	0.98	19.38	51.11
insecta	18.80	21.20	12.51	1.04	14.51	65.62
Gammaridae	24.35	0.88	12.07	0.92	13.99	79.61
Chironomidae	12.01	4.69	6.64	0.82	7.70	87.31
Podocopa	2.05	9.54	5.48	0.42	6.35	93.66

Groups 1992 & 2011
Average dissimilarity = 70.88

Species	Group 1992 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	54.71	23.56	1.45	33.24	33.24
insecta	14.48	21.20	11.17	0.95	15.76	49.01
Cyclopoida	14.80	8.97	9.65	0.92	13.61	62.62
Podocopa	11.15	9.54	8.86	0.69	12.49	75.12
Daphnia	8.32	0.00	4.16	0.33	5.87	80.98
Chironomidae	4.11	4.69	3.50	0.78	4.94	85.92
Gammaridae	5.30	0.88	2.88	0.60	4.07	89.99
Nematoda	4.98	0.00	2.49	0.46	3.51	93.50

Groups 1993 & 2011
Average dissimilarity = 79.68

Species	Group 1993 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	16.95	54.71	24.34	1.45	30.55	30.55
Cyclopoida	29.69	8.97	15.87	0.97	19.92	50.46
insecta	9.50	21.20	11.05	0.88	13.87	64.33
Cladocera	16.91	0.00	8.46	0.99	10.61	74.94
Amphipoda	11.22	0.00	5.61	0.45	7.04	81.98
Podocopa	0.00	9.54	4.77	0.35	5.99	87.97
Chironomidae	5.87	4.69	4.27	0.79	5.35	93.32

Groups 1994 & 2011
Average dissimilarity = 88.77

Species	Group 1994 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	4.99	54.71	26.41	1.39	29.75	29.75
Cyclopoida	34.76	8.97	17.89	1.01	20.16	49.90
Gammaridae	33.28	0.88	16.58	0.91	18.68	68.58
insecta	6.68	21.20	11.15	0.85	12.56	81.14
Amphipoda	14.69	0.00	7.35	0.52	8.27	89.42
Podocopa	1.19	9.54	5.18	0.39	5.84	95.25

Groups 1995 & 2011
Average dissimilarity = 70.19

Species	Group 1995 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.94	54.71	22.19	1.75	31.61	31.61
Cyclopoida	22.82	8.97	13.30	0.82	18.95	50.56
insecta	12.32	21.20	10.89	0.92	15.51	66.08
Podocopa	2.74	9.54	5.72	0.44	8.15	74.22
Chironomidae	9.02	4.69	5.13	0.87	7.31	81.54
Cladocera	9.55	0.00	4.78	0.80	6.80	88.34
Leptodora_kindtii	5.52	0.00	2.76	0.61	3.93	92.28

Groups 1997 & 2011
Average dissimilarity = 90.08

Species	Group 1997 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	3.41	54.71	26.70	1.42	29.64	29.64
Gammaridae	32.16	0.88	15.71	1.84	17.44	47.08
Cyclopoida	18.42	8.97	10.86	1.75	12.06	59.14
insecta	5.62	21.20	10.54	0.83	11.70	70.83
Podocopa	1.47	9.54	5.28	0.40	5.86	76.70
Amphipoda	8.94	0.00	4.47	0.81	4.96	81.66
Mysida	8.13	0.00	4.06	0.99	4.51	86.17
Chironomidae	3.04	4.69	3.05	0.80	3.39	89.55

Cyathura	4.62	0.00	2.31	0.75	2.56	92.12

Groups 1999 & 2011
Average dissimilarity = 91.95

Species	Group 1999 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	0.32	54.71	27.30	1.37	29.69	29.69
Amphipoda	33.94	0.00	16.97	0.99	18.45	48.14
Cyclopoida	22.90	8.97	12.90	1.02	14.03	62.17
insecta	5.46	21.20	10.48	0.82	11.40	73.56
Podocopa	7.87	9.54	7.74	0.55	8.42	81.99
Gammaridae	11.82	0.88	6.00	0.75	6.53	88.51
Chironomidae	4.52	4.69	3.98	0.70	4.33	92.84

Groups 2001 & 2011
Average dissimilarity = 88.24

Species	Group 2001 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	5.44	54.71	26.36	1.39	29.87	29.87
Cyclopoida	29.28	8.97	15.76	0.85	17.86	47.73
Gammaridae	23.54	0.88	11.82	0.66	13.40	61.13
insecta	8.34	21.20	11.52	0.87	13.05	74.18
Nematoda	16.23	0.00	8.11	0.45	9.20	83.38
Podocopa	2.25	9.54	5.58	0.42	6.33	89.71
Chironomidae	5.42	4.69	4.33	0.70	4.91	94.62

Groups 2003 & 2011
Average dissimilarity = 61.53

Species	Group 2003 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	44.62	54.71	22.08	1.39	35.90	35.90
Cyclopoida	22.40	8.97	13.12	0.78	21.33	57.22
insecta	14.89	21.20	11.18	0.98	18.17	75.39
Chironomidae	9.55	4.69	5.83	0.65	9.48	84.87
Podocopa	0.00	9.54	4.77	0.35	7.75	92.63

Groups 2005 & 2011
Average dissimilarity = 79.47

Species	Group 2005 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	26.92	54.71	25.58	1.31	32.18	32.18
Cyclopoida	29.49	8.97	15.73	0.90	19.79	51.98
insecta	2.56	21.20	10.75	0.79	13.53	65.51
Nematoda	15.38	0.00	7.69	0.50	9.68	75.18
Podocopa	4.88	9.54	6.69	0.46	8.42	83.60
Sididae	11.54	0.00	5.77	0.40	7.26	90.86

Groups 2009 & 2011
Average dissimilarity = 82.73

Species	Group 2009 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	18.48	54.71	25.25	1.37	30.52	30.52
Cyclopoida	24.63	8.97	13.73	0.87	16.60	47.12
insecta	2.52	21.20	10.68	0.79	12.91	60.03
Ostracoda	19.70	0.00	9.85	0.58	11.90	71.93
Chironomidae	15.56	4.69	8.65	0.64	10.45	82.39
Nematoda	10.40	0.00	5.20	0.74	6.29	88.67
Podocopa	0.75	9.54	5.03	0.38	6.08	94.75

Groups 2010 & 2011
Average dissimilarity = 85.74

Species	Group 2010 Av.Abund	Group 2011 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	1.14	54.71	27.14	1.38	31.65	31.65
Chironomidae	28.10	4.69	13.96	0.82	16.28	47.93
insecta	19.72	21.20	12.36	1.06	14.42	62.35
Gammaridae	23.84	0.88	12.00	0.72	13.99	76.34
Cyclopoida	13.06	8.97	9.01	0.88	10.50	86.85
Podocopa	3.65	9.54	6.03	0.46	7.04	93.88

Groups 1988 & 2012
Average dissimilarity = 78.47

Species	Group 1988 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	43.30	24.56	19.46	1.34	24.81	24.81
Chironomidae	11.01	10.38	8.07	0.95	10.29	35.09
insecta	9.75	7.22	7.49	0.55	9.55	44.65
Bosmina	3.73	11.59	6.86	0.61	8.75	53.39
Podocopa	11.00	2.78	6.06	0.82	7.73	61.12
Gammaridae	0.49	11.03	5.64	0.51	7.18	68.30
Amphipoda	2.85	9.06	5.03	0.77	6.41	74.72
Daphnia	6.23	4.17	4.68	0.56	5.96	80.68
Leptodora_kindtii	0.98	7.66	4.16	0.47	5.30	85.98
Cladocera	7.50	0.00	3.75	0.65	4.78	90.76

Groups 1991 & 2012
Average dissimilarity = 78.74

Species	Group 1991 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	31.86	24.56	17.77	1.08	22.57	22.57
Gammaridae	24.35	11.03	13.37	1.03	16.99	39.55
insecta	18.80	7.22	10.54	0.99	13.39	52.94
Chironomidae	12.01	10.38	8.53	0.89	10.84	63.78
Nematoda	8.17	6.84	6.76	0.52	8.58	72.36

Bosmina	0.00	11.59	5.79	0.50	7.36	79.72
Leptodora_kindtii	2.76	7.66	4.75	0.54	6.03	85.75
Amphipoda	0.00	9.06	4.53	0.65	5.75	91.51

Groups 1992 & 2012
Average dissimilarity = 81.49

	Group 1992	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	27.64	11.59	14.83	1.01	18.20	18.20
Cyclopoida	14.80	24.56	13.30	1.00	16.32	34.52
insecta	14.48	7.22	8.73	0.98	10.72	45.24
Gammaridae	5.30	11.03	7.02	0.68	8.62	53.85
Chironomidae	4.11	10.38	6.22	0.73	7.63	61.48
Podocopa	11.15	2.78	6.15	0.77	7.55	69.03
Daphnia	8.32	4.17	5.79	0.44	7.11	76.14
Amphipoda	3.01	9.06	5.16	0.74	6.33	82.47
Nematoda	4.98	6.84	5.13	0.63	6.29	88.76
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.70	93.46

Groups 1993 & 2012
Average dissimilarity = 81.02

	Group 1993	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.69	24.56	17.15	1.06	21.17	21.17
Bosmina	16.95	11.59	10.94	0.92	13.51	34.68
Cladocera	16.91	0.00	8.46	0.99	10.44	45.12
Amphipoda	11.22	9.06	8.23	0.70	10.16	55.28
insecta	9.50	7.22	7.01	0.74	8.66	63.94
Chironomidae	5.87	10.38	6.67	0.76	8.23	72.17
Gammaridae	1.85	11.03	6.07	0.54	7.49	79.66
Daphnia	8.01	4.17	5.48	0.53	6.77	86.43
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.73	91.15

Groups 1994 & 2012
Average dissimilarity = 78.74

	Group 1994	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	34.76	24.56	18.59	1.10	23.61	23.61
Gammaridae	33.28	11.03	17.23	1.01	21.89	45.49
Amphipoda	14.69	9.06	9.52	0.74	12.10	57.59
Bosmina	4.99	11.59	7.26	0.63	9.22	66.81
Chironomidae	3.57	10.38	6.23	0.63	7.92	74.73
insecta	6.68	7.22	6.04	0.60	7.68	82.40
Leptodora_kindtii	0.84	7.66	4.11	0.47	5.22	87.62
Nematoda	0.00	6.84	3.42	0.43	4.34	91.96

Groups 1995 & 2012
Average dissimilarity = 79.66

Species	Group 1995 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	22.82	24.56	16.12	0.98	20.24	20.24
Bosmina	27.94	11.59	14.01	1.56	17.59	37.83
insecta	12.32	7.22	7.94	0.92	9.97	47.80
Chironomidae	9.02	10.38	7.51	0.91	9.42	57.22
Gammaridae	1.96	11.03	6.09	0.55	7.64	64.87
Leptodora_kindtii	5.52	7.66	5.67	0.68	7.12	71.98
Amphipoda	3.88	9.06	5.37	0.79	6.75	78.73
Cladocera	9.55	0.00	4.78	0.80	6.00	84.73
Nematoda	0.81	6.84	3.69	0.48	4.63	89.35
Podocopa	2.74	2.78	2.53	0.49	3.18	92.53

Groups 1997 & 2012
Average dissimilarity = 78.72

Species	Group 1997 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Gammaridae	32.16	11.03	15.34	1.78	19.49	19.49
Cyclopoida	18.42	24.56	12.46	1.12	15.83	35.32
Bosmina	3.41	11.59	6.67	0.61	8.47	43.79
Amphipoda	8.94	9.06	6.30	1.01	8.01	51.80
Chironomidae	3.04	10.38	5.95	0.71	7.55	59.36
insecta	5.62	7.22	5.53	0.64	7.02	66.38
Leptodora_kindtii	2.13	7.66	4.54	0.53	5.77	72.15
Mysida	8.13	0.00	4.06	0.99	5.16	77.31
Nematoda	0.62	6.84	3.62	0.47	4.60	81.91
Chydoridae	4.51	1.94	3.02	0.44	3.84	85.75
Cyathura	4.62	0.00	2.31	0.75	2.93	88.69
Daphnia	0.00	4.17	2.08	0.30	2.65	91.33

Groups 1999 & 2012
Average dissimilarity = 79.20

Species	Group 1999 Av.Abund	Group 2012 Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Amphipoda	33.94	9.06	16.10	1.05	20.33	20.33
Cyclopoida	22.90	24.56	14.79	1.05	18.67	39.00
Gammaridae	11.82	11.03	9.03	0.86	11.40	50.41
Chironomidae	4.52	10.38	6.32	0.69	7.98	58.38
Bosmina	0.32	11.59	5.88	0.51	7.42	65.80
Leptodora_kindtii	5.32	7.66	5.60	0.64	7.07	72.88
insecta	5.46	7.22	5.45	0.63	6.88	79.76
Podocopa	7.87	2.78	4.85	0.54	6.12	85.88
Nematoda	1.57	6.84	3.94	0.50	4.98	90.86

Groups 2001 & 2012
Average dissimilarity = 81.16

Group 2001 Group 2012

Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.28	24.56	18.40	1.08	22.67	22.67
Gammaridae	23.54	11.03	13.94	0.81	17.17	39.84
Nematoda	16.23	6.84	10.34	0.60	12.74	52.58
Bosmina	5.44	11.59	7.40	0.63	9.11	61.69
Amphipoda	8.51	9.06	6.72	0.86	8.29	69.98
insecta	8.34	7.22	6.68	0.62	8.24	78.21
Chironomidae	5.42	10.38	6.59	0.70	8.12	86.33
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.72	91.05

Groups 2003 & 2012
Average dissimilarity = 80.88

	Group 2003	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	44.62	11.59	21.18	1.28	26.19	26.19
Cyclopoida	22.40	24.56	16.42	0.98	20.30	46.49
insecta	14.89	7.22	8.89	1.03	11.00	57.48
Chironomidae	9.55	10.38	8.11	0.77	10.03	67.52
Gammaridae	5.43	11.03	7.10	0.66	8.78	76.30
Amphipoda	0.00	9.06	4.53	0.65	5.60	81.90
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.73	86.63
Nematoda	0.00	6.84	3.42	0.43	4.23	90.86

Groups 2005 & 2012
Average dissimilarity = 83.37

	Group 2005	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	29.49	24.56	17.82	1.07	21.38	21.38
Bosmina	26.92	11.59	15.83	0.80	18.99	40.37
Nematoda	15.38	6.84	9.59	0.64	11.50	51.87
Gammaridae	6.66	11.03	7.56	0.65	9.07	60.95
Sididae	11.54	0.00	5.77	0.40	6.92	67.87
Chironomidae	0.00	10.38	5.19	0.57	6.22	74.09
Amphipoda	2.56	9.06	5.17	0.72	6.20	80.29
insecta	2.56	7.22	4.54	0.48	5.45	85.74
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.59	90.33

Groups 2009 & 2012
Average dissimilarity = 82.92

	Group 2009	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cyclopoida	24.63	24.56	16.39	1.05	19.76	19.76
Bosmina	18.48	11.59	12.14	0.77	14.65	34.41
Chironomidae	15.56	10.38	10.41	0.74	12.55	46.96
Ostracoda	19.70	0.00	9.85	0.58	11.88	58.84
Nematoda	10.40	6.84	6.96	0.85	8.39	67.23
Gammaridae	4.55	11.03	6.93	0.59	8.36	75.59
Amphipoda	0.75	9.06	4.66	0.69	5.62	81.20

insecta	2.52	7.22	4.50	0.48	5.43	86.63
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.62	91.25

Groups 2010 & 2012
Average dissimilarity = 80.99

	Group 2010	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Chironomidae	28.10	10.38	14.90	0.91	18.39	18.39
Gammaridae	23.84	11.03	13.87	0.86	17.13	35.52
Cyclopoida	13.06	24.56	12.98	0.96	16.03	51.55
insecta	19.72	7.22	10.82	1.07	13.37	64.92
Amphipoda	7.01	9.06	6.23	0.84	7.70	72.61
Bosmina	1.14	11.59	6.09	0.53	7.53	80.14
Leptodora_kindtii	0.92	7.66	4.14	0.47	5.11	85.24
Nematoda	0.00	6.84	3.42	0.43	4.22	89.46
Podocopa	3.65	2.78	2.91	0.54	3.59	93.06

Groups 2011 & 2012
Average dissimilarity = 85.06

	Group 2011	Group 2012				
Species	Av.Abund	Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Bosmina	54.71	11.59	25.50	1.37	29.98	29.98
Cyclopoida	8.97	24.56	13.70	0.89	16.10	46.08
insecta	21.20	7.22	11.75	0.85	13.82	59.90
Chironomidae	4.69	10.38	6.36	0.79	7.48	67.38
Podocopa	9.54	2.78	5.79	0.43	6.81	74.19
Gammaridae	0.88	11.03	5.73	0.52	6.74	80.93
Amphipoda	0.00	9.06	4.53	0.65	5.33	86.25
Leptodora_kindtii	0.00	7.66	3.83	0.43	4.50	90.7