BENTHOS

Benthic macroinvertebrates, or benthos, are widely used in assessing the biological integrity of aquatic systems. The Florida Stream Condition Index (SCI) and Lake Condition Index (LCI) both rely heavily on benthic community structure. These indices employ a variety of benthos metrics based on community diversity, number of pollution-intolerant taxa, and related factors. Because conditions in wetlands are very different from those in streams and lakes, many of the methods and metrics used in the SCI and LCI may not be applicable to wetlands. In particular, many pollution-intolerant taxa found in streams and lakes do not occur in even the highest quality wetlands. Due to the difficulty of applying stream- and lake-based metrics to wetlands, the only metrics explicitly addressed in the following discussion are species richness and density. Specific taxa are, however, discussed in detail, and it is hoped that observations made in this study will be of use in the development of a wetland condition index.

The dip net collection methodology favored for stream and lake sampling is not always possible in wetlands with extremely low water levels and periodic lack of standing water. For this reason, both dip net and core sampling were employed for benthic macroinvertebrates in this study.

Benthos have been widely researched in wetlands (Bataille and Baldassarre 1993; Brown et al. 1997; Corti et al. 1997; Jeffries 1994; Murkin and Kadlec 1986; Rader 1994). Much of the research on cypress wetlands has focused on cypress-tupelo swamps (Beck 1977; Sklar 1985; Sklar and Day 1985; Thorp et al. 1985), although some analyses of cypress domes have been performed as well (Brightman 1984; Leslie 1996; Leslie et al. 1997).

Species Richness and Density

Over the course of the study, 111 benthic taxa were collected from Tates Hell Swamp. This richness is similar to the 104 taxa that were collected in a cypress dome in North Central Florida (Prenger *et al.* in prep.). The taxonomic richness in these two studies is within the range reported for other types of wetlands (Figure 5-1). In both these studies, however, taxa were identified to the lowest practical taxonomic level, which typically was to genus, where possible. The richness would have been higher in both studies had taxa been identified to the species level. In other studies where taxa were identified to the species level such as those of Moorhead (1998) and Leeper (1998b), the taxon richness was higher than other macroinvertebrate studies performed in wetlands. Leslie (1997) found 85 taxa of benthic macroinvertebrates in cores from a north central Florida cypress dome. Duffy (1994), working in forested wetlands, collected 48 taxa in cores in the winter and spring; and Golladay (1997), working in forested Georgia lime sink wetlands collected only 33 taxa from cores and woody debris. At the opposite end of the spectrum, Leeper (1998b) collected 115 taxa from a forested Carolina Bay. Riparian swamps are variable, ranging from 72 taxa collected from substrate samplers (White 1985) to 98 taxa collected from cores (Corti *et al.* 1997). Marshes also fit this pattern, with taxa richness ranging from 40 taxa and 43 taxa in cores and sweep nets, respectively (Evans 1996) to 107 taxa from sweep nets and cores combined (Moorhead *et al.* 1998).

Due to the limited number of pre-restoration monitoring events and strong seasonality of the data, pre-/post-restoration comparisons will not be presented for biological parameters. Taxon richness and density data for the demonstration, control, and reference wetlands are presented on an individual sampling event basis in Figures 5-2 through 5-5.

Taxon richness for core samples averaged 8.9 taxa per sample (Figure 5-2). Little difference was observed between demonstration, control, and reference wetlands. Seasonal declines in richness during summer 1998 and winter/spring 1999 reflect dry conditions at those times.

Sweep net richness values (Figure 5-3) were slightly higher than those for cores, averaging 10.2 taxa per sample. Seasonal trends were similar to those observed in the core data, but somewhat more extreme. Lack of water in the control and reference wetlands precluded sweep net sampling on several sampling dates. For this reason, meaningful comparisons among demonstration, control and reference wetlands cannot be made.

The mean density of macroinvertebrates collected from cores in this study was 2,757 individuals/m^2, varying from a maximum of 8,081 individuals/m^2 in April 1998 to a minimum of 303 individuals/m^2 in July 1998 (Figure 5-4). These data are in the range of those reported from other cypress wetlands, but below that of marshes (Figure 5-6). Marshes typically possess high cover and diversity of submersed, floating, and emergent vegetation, which can provide structure and food for macroinvertebrate communities (Mitsch and Gosselink 1993). Many cypress wetlands and other swamps have limited understory vegetation, and this may limit the density of macroinvertebrates present.

Sweep nets yielded significantly lower invertebrate densities (Figure 5-5) than core sampling, mostly because sweep net sampling is not efficient at collecting sediment infauna, and the most common invertebrates (amphipods, isopods, chironomids, and ceratopogonids) are fauna associated with sediments. The mean density of macroinvertebrates collected from sweep nets in this study was 289 individuals/m^2, varying from a maximum of 1,632 individuals/m^2 in January 1999 to a minimum of 16 individuals/m^2 in November 1998.

Comparison of core and sweep net data illustrates the utility of corers for benthic work in intermittently flooded wetlands. Coring was possible on many occasions when insufficient water was present for use of sweep nets. Even when both methods could be employed, coring yielded much more consistent data than sweep nets. Taxa richness was only slightly lower for cores, while densities were much higher.

Coleopterans and dipterans (Table 5-1) dominate the benthos of Tates Hell Swamp. Within these two orders, the coleopteran family Dytiscidae accounted for 20% of the taxon richness, and the dipteran family chironomidae accounted for 37% of the taxon richness. These groups are often the dominant taxa in many drought-prone wetlands and other temporary waters (Leeper and Taylor 1998a; Leslie *et al.* 1999; Taylor *et al.* 1999; Williams 1987). The dipteran families Ceratopogonidae (10%) and Chironomidae (37%), the amphipod *Crangonyx* (20%), and the isopod *Caecidotea* (21%) were the dominant invertebrate groups in cores, contributing 88% of total density over the course of the study.

Coleopterans have limited ability to withstand drought conditions *in situ*, but they are very mobile and can simply fly or crawl to an area with standing water (Fernando and Calbraith 1972). This trait also allows them to reestablish populations quickly in cypress strands when water levels rise. No one coleopteran genus was dominant during the course of the study, with the total coleopteran density accounted for by many genera occurring at low densities.

Most dipterans can survive drought conditions in cypress wetlands (Leslie *et al.* 1997; Prenger *et al.* in prep.) and are presumed to go into diapause (Williams 1997). This is especially true of the ceratopogonids and the chironomids *Polypedilum* spp. and *Polypedilum tritum*, which contributed considerably to total dipteran densities in cores. Adults can also recolonize areas that were flooded and, after laying eggs, would be able to repopulate an area. *Polypedilum* spp., *Procladius*, and *Ablabesmyia* were the most commonly collected chironomids, though *Paratendipes* spp., *Parachironomus* spp., *Chironomus*, and *Georhthocladius* were also temporally important constituents of the dipteran fauna.

Densities of the insect orders Odonata, Ephemeroptera, Hemiptera, Lepidoptera, and Trichoptera were low in Tates Hell Swamp. Ephemeropterans, lepidopterans, and trichopterans have few taxa adapted to conditions in southeastern U.S. wetlands (see Merritt and Cummins 1996), and nowhere are they very rich. Ephemeroptera can be found in large numbers in other Florida wetlands but have not contributed much to the total invertebrate density in a series of north central Florida cypress domes (Leslie *et al.* 1999). Neither Lepidoptera nor Trichoptera have contributed significantly to the invertebrate densities in other southern wetlands (Leeper and Taylor 1998a; Leslie *et al.* 1999; Prenger *et al.* in prep.). The presence of ditches in Tates Hell Swamp does not appear to provide suitable habitat for these taxa either, as they do not occur in high densities.

Odonates are often ubiquitous members of the invertebrate fauna in wetlands. In Tates Hell Swamp, the periodic drying of wetlands may be a factor in the low odonate taxon richness and densities. Other wetlands prone to periodic drying also have low odonate taxon richness (Taylor *et al.* 1999).

Hemipterans also were neither a very rich nor abundant fauna in Tates Hell Swamp, despite the fact that many families are found in wetlands (see Merritt and Cummins

1996). Hemipterans are highly motile, even more so than odonates, and this could have presented a problem in adequately sampling them, even with dip nets. For example, the belostomatid *Lethocerus* was rarely collected in either cores or dip nets, yet a number of them were collected in fish traps.

Non-insect invertebrates were also collected in Tates Hell Swamp, but none showed high taxa richness, though amphipods and isopods were present in high densities. The orders Hydracarina, Amphipoda, Isopoda, and Decapoda were the most frequently encountered non-insect taxa. However, Hydracarina were enumerated only as Hydracarina, so this does not show up in the richness. Hydracarina are very difficult to identify, especially since they become fragile when preserved in ethanol (Smith and Cook 1991), so identification only to order was performed.

Amphipods, isopods, and decapods have poor richness at the genus level, though isopods do have high richness at the species level. Since isopods were identified only to the generic level, it is possible that they would have experienced greater species richness had they been identified to species. However, amphipods and isopods were, along with dipterans, the most commonly collected macroinvertebrates.

Amphipods and isopods are among the most numerous macroinvertebrates collected in several southern, forested wetlands (Duffy and LaBar 1994; Leslie *et al.* 1999; Porter *et al.* 1999; Prenger *et al.* in prep.; Sklar 1985). Both orders feed predominantly on periphyton and particulate organic matter, which are abundant in Tates Hell Swamp. One possible reason for their high densities is their ability to persist in moist soils, even if standing water is absent (Taylor *et al.* 1999). They are also known to migrate overland to standing water under drought conditions (Williams 1997).

Copepods were also collected in large numbers in the cores and often were the numerically dominant group. Since copepods were also collected in zooplankton tows (Chapter 5) and enumerated to lower taxonomic levels than simply copepods, copepod data collected in sweeps and cores were not included in the total invertebrate density calculations.

Benthic macroinvertebrates are important transformers of organic matter to usable energy for higher trophic levels. Amphipods, isopods and chironomids, the most abundant benthic invertebrates in Tates Hell Swamp, feed on the bacteria, fungi, and algae coating organic matter (Coffman and Ferrington 1996; Covich and Thorp 1991; Pennak 1989; Smock and Stoneburner 1980; Thorp and Covich 1991). Amphipods, isopods, and many chironomid dipterans serve as important food sources for other macroinvertebrates including odonates and dytiscid coleopterans as well as fish (Pennak 1989; Westfall 1996; White and Brigham 1996). A number of fish species found in Tates Hell Swamp, including pirate perch (*Aphredoderus sayanus*), swamp darter (*Etheostoma fusiforme*), topminnows (*Fundulus* spp.), bullheads (*Ameiurus* spp.), and warmouth (*Lepomis gulosus*) consume benthic macroinvertebrates as a major component of their diet (Hoyer and Canfield 1994; Lee *et al.* 1981).

Feeding Guilds

Tates Hell Swamp appears to be a periphyton-dominated system, although this is likely less the case in wetlands than in ditches and low water crossings. However, since nutrients are limited and other food sources such as microbe-rich particulate organic matter, dissolved organic matter, woody debris, and some phytoplankton are present, the majority of the benthic fauna should be generalists, as is the case in many cypress wetlands (Brightman 1984; Leslie *et al.* 1997; Porter *et al.* 1999; Prenger *et al.* in prep.). The amphipod *Crangonyx*, isopod *Caecidotea* and the chironomid *Polypedilum* are all generalists and together account for 89% of the total benthic macroinvertebrates collected in Tates Hell Swamp. These groups were also observed to be dominant taxa in a titi wetland in the Florida panhandle near Tates Hell Swamp (Haack 1984; Pezeshki 1987). Generalists have been found to predominate in highly colored, wooded sites (Haack 1984) as is the case in Tates Hell Swamp.

Cypress swamps often depend on allochthonous materials such as leaves, cypress needles, and macrophytes to provide coarse particulate organic matter (CPOM) as a food source for microbes, which are the base of the food web (Cummins and Merritt 1996). Generalists are often shredders (either detritivorous or herbivorous), though taxa feeding across several functional groups also are considered generalists. Since CPOM is always present in the cypress strands, regardless of water level and season, the dominance of generalists suggests that they may be better able to survive periods of drought or low primary production. Periodic drying and reflooding also can increase detrital protein levels as a result of microbial colonization (Barlocher *et al.* 1978).

Predators are also an important part of the Tates Hell Swamp benthic community (Table 5-1). As is the case with most aquatic systems, they do not form the dominant functional group (Merritt and Cummins 1996), although some chironomids can temporally contribute a considerable amount to total invertebrate density. Collector-gatherers are also a very rich fauna, but their contribution to the total benthic invertebrate density is minor.

Seasonality of Dominant Taxa

The following discussion deals primarily with corer data, since lack of standing water prohibited sweep net sampling during much of the study, especially in the control and reference wetlands. Total macroinvertebrate densities in Tates Hell Swamp followed the trend established by the four dominant taxa, *Crangonyx*, *Caecidotea*, ceratopogonids, and chironomids. Densities were low during the summer 1998 drought but rebounded relatively soon after the wetlands were filled with water. This was the case in both the demonstration wetland cores (Figure 5-4A) and reference cores (Figure 5-4C) and to a lesser extent in the demonstration wetland sweep nets (Figure 5-5A). Control wetland cores remained at near the same levels during the summer 1998 drought as afterwards (Figure 5-4B).

The amphipod *Crangonyx* occurred in fairly large numbers in the cores throughout the study (Figure 5-7). Abundances in the wetlands decreased during summer 1998 and shortly thereafter, probably due to the severe drought which dried the surface layers of the sediments. This summer 1998 decrease was not different from the summer 1999 decrease, suggesting the summer 1998 drought was not a limiting factor ($t = 0.416$; $P = 0.686$). Sweep nets showed a similar trend (Figure 5-8), though this is more likely due to the fact that sweep nets were not used in most sites during summer 1998 because of the lack of standing water. In cores, the highest densities of *Crangonyx* were collected from the control wetland prior to the drought. The reference wetland had variable densities and multiple peaks occurred throughout the year.

The isopod *Caecidotea* followed the same general trend as *Crangonyx*, although a more noticeable peak occurred prior to the drought/restoration with *Caecidotea*. As with *Crangonyx*, *Caecidotea* also experienced a summer 1998 decrease in density in both core (Figure 5-9) and sweep net samples (Figure 5-10), though this was only noticeable in demonstration wetlands. It is likely that the drought played a role in limiting *Caecidotea* during this time, although the difference in densities between summer 1998 and summer 1999 were not significant ($t = 1.70$; $P = 0.12$). Both the control and reference wetlands followed the same trend with larger densities prior to the drought restoration, though the highest density in the reference wetland occurred in March 1999.

Coleoptera were collected in moderate numbers in cores throughout the study (Figure 5-11). Coleopteran taxon richness was high in this study, but no one taxon dominated. Most coleoptera are very mobile, and cores are not the most efficient manner to collect them. However, the same trend also occurs for sweep nets, with low densities throughout the sampling period (Figure 5-12), although densities were higher in sweeps than cores. The same trend is seen in both the control and reference cores.

Diptera follow the same trend as *Crangonyx* and *Caecidotea*, with the densities in demonstration cores decreasing during the drought and rebounding thereafter (Figure 5-13). This is also evident with the control wetland cores. Reference wetland cores exhibited summer decreases, but without the rebound shown by demonstration and control wetlands. The reference wetland was dry for much longer than any of the other wetlands, and dipterans appear to have been unable to survive these conditions. Demonstration wetland sweep nets exhibited the same trend as did the demonstration and control cores (Figure 5-14).

Ceratopogonid densities were commonly collected throughout the study period. As with some other groups, ceratopogonid densities in demonstration wetland cores decreased during summer 1998 (Figure 5-15), although the summer 1998 densities were not lower than those of summer 1999 ($t = -1.05$; $P = 0.32$). An increase during the winter/early spring in the demonstration wetland cores could represent a repopulation of the wetlands after drought conditions subsided. Sweep net samples from demonstration wetlands showed a very similar trend, with the summer 1998 decrease, though densities remained low after the first three months of sampling (Figure 5-16). Cores from the control wetland resembled those from the demonstration wetlands, with more individuals collected prior to the drought, and few during and afterwards. Reference wetlands did not, however, exhibit the same rebound as the other wetlands.

Chironomids followed the same general trends as other dipterans and cores (Figure 5-17) and sweep net (Figure 5-18), patterns were nearly identical. Chironomids make up the majority of the dipterans sampled in Tates Hell Swamp, and their densities influenced total dipteran densities considerably.

Three species of the genus *Polypedilum* were collected from Tates Hell Swamp. *P. fallax* was only collected in substantial numbers in demonstration wetland sweep nets during January 1999 (Figure 5-19). *P. trigonus* was collected in demonstration wetlands in sweep nets (Figure 5-20) and cores (Figure 5-21) only after the summer 1998 drought. *P. tritum* was the most common of the three species and, along with *Procladius*, the two most common chironomids in Tates Hell Swamp. As with most other taxa, the densities of *P. tritum* were lowest during the summer 1998 drought, though they were uncommon during the warmer months of 1999 as well. This was the case in both cores (Figure 5-22) and sweep nets (Figure 5-23). It is possible that *P. tritum* prefers cooler periods, although literature on environmental tolerances of most aquatic macroinvertebrates is sparse.

The chironomids *Chironomus* (Figure 5-24), and *Tanypus* (Figure 5-26) were collected in low densities throughout the study in demonstration wetland cores, but did show a trend towards decreased densities during summer and winter 1998. This likely represents the effect of the severe summer 1998 drought and its effects may finally have abated as late as early 1999. A similar trend was seen with these genera [*Chironomus* (Figure 5-25) and *Tanypus* (Figure 5-26) in control and reference cores. Demonstration wetland sweep net samples exhibited a similar trend of decreased densities during and immediately after the drought with the exception of *Tanypus*, which exhibited peak density in late fall-winter 1998.

Procladius was much like the preceding chironomids, but densities were generally much higher. Again, cores had low densities during summer 1999 (Figure 5-28). *Procladius* collected from sweep nets were more abundant during the first three months prior to drought/restoration (Figure 5-29).

Hemipterans (Figure 5-30) and odonates (Figure 5-32) were similar to coleopterans in that they were present in low densities in demonstration wetland sweep nets throughout the study. Hemiptera (Figure 5-31) and odonates (Figure 5-33) were also present throughout the study in demonstration wetland cores. The control wetland had very few hemipterans present, and only in the beginning of the study, while the reference site had low densities throughout the study. Odonates were not found in the control wetland cores and were rare in reference wetland cores.

Low odonate densities are not unexpected as, unlike forms which can survive drawdown *in situ* such as chironomids, *Crangonyx*, and *Caecidotea*, or those which can move to areas with standing water such as Coleoptera and Hemiptera, odonates in general do not possess any special adaptations to survive drawdown (Wiggins *et al.* 1980; Williams

1987). The fluctuating hydroperiod of Tates Hell Swamp would make the wetlands fairly inhospitable habitats for many odonates.

Other organisms were encountered infrequently in Tates Hell Swamp. The chironomid *Tanytarsus* was found in sweep nets at times in large numbers, but rarely occurred in cores. Dipterans of the family Tipulidae were collected at all sites, primarily in cores. They were collected throughout the study, but rarely were abundant.

Polypedilum halterale, another chironomid, was encountered in substantial numbers in the reference wetland and rarely elsewhere. The fact that this wetland has its natural hydroperiod and a general lack of large numbers of vertebrate predators could explain why this species was abundant.

Georthocladius, another chironomid, was rarely found at any site, with the exception of Site 2 downstream from November 1998 to March 1999. Site 2 downstream differed from all other stations in that it was heavily wooded, primarily with slash pine, *Pinus elliottii*, and the sediment was very moist, poorly decomposed organic matter. It is possible this could explain its presence at this station but not elsewhere.

Unlike zooplankton, benthic macroinvertebrate communities in southern U.S. wetlands do not appear to be influenced much by seasonality and this may be a reflection of mild winters (Leslie *et al.* 1999; Porter *et al.* 1999; Prenger *et al.* in prep.). Instead, any temporal population changes may be as a result of hydrological influences.

Water level did not appear to be correlated with invertebrate taxon richness or density. This is not surprising, as the dominant numerical taxa in Tates Hell Swamp (*Caecidotea*, *Crangonyx*, *Culicoides*, *Polypedilum* spp., *Procladius*, and *Ablabesmia*) are all capable of remaining *in situ* to survive drought periods (Wiggins *et al.* 1980; Williams 1997) (Taylor *et al.* 1999). A lack of correlation between density and water level was also noted by Leslie (1997), who found that the major taxa in her study of cypress domes in north central Florida were all capable of surviving *in situ* under drought conditions.

Despite the lack of correlation between water level and richness, there is a very obvious trend of decreased densities of invertebrates in cores during the severe drought of summer 1998. The environmental conditions present in the wetlands at this time appeared to have very significant effects on the densities of most taxa. This differs from the lack of water level vs. density correlation discussed above in that the previous measure addressed small changes in water level (0-20 cm) and may not have been sensitive enough to show changes on the order of wet vs. extreme drought.

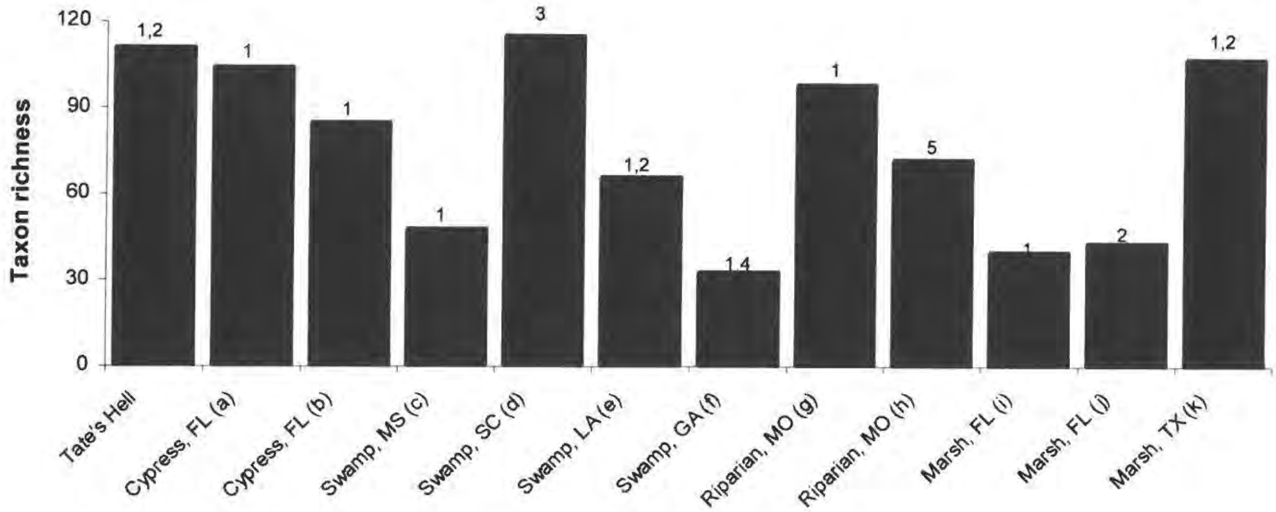

Figure 5-1. Benthic macroinvertebrate taxon richness from wetlands in the United States. Numbers indicate method of capture (1, core; 2, sweep net; 3, emergence trap; 4 wood; 5, substrate). a (Prenger *et al*., in prep), b (Leslie *et al*. 1997), c (Duffy and LaBar 1994), d (Leeper and Taylor 1998), e (Sklar 1985), f (Golladay *al*. 1997), g (Corti *et al*. 1997), h (White 1985), i (Evans 1996), j (Evans 1996), k (Moorhead *et al*. 1998).

Table 5-1. Benthic macroinvertebrates collected from wetlands in Tates Hell Swamp using cores and sweep nets.

Taxonomic Group	**Method of Collection** Core	Sweep	**Trophic Guild**
Class Oligochaeta	x		Collectors-gatherers
Class Arachnida			
Order Hydracarina	x	x	Predators
Class Crustacea			
Order Amphipoda			
Family Gammaridae			
Crangonyx	x	x	Shredders-herbivores
Order Isopoda			
Family Assellidae			
Caecidotea	x	x	Shredders-herbivores
Order Copepoda	x	x	Collectors-filterers
Order Decapoda			
Family Cambaridae	x	x	Collectors-predators
Class Insecta			
Order Collembola			
Family Entomobryidae	x	x	Collectors-gatherers
Family Isotomidae	x		Collectors-gatherers
Family Sminthuridae	x	x	Collectors-gatherers
Order Coleoptera			
Family Chrysomelidae	x	x	
Family Dytiscidae			
Agabetes (larvae)		x	Predators
Agabus (larvae)	x	x	Predators
Agaporomorphus (adult)	x		Predators
Bidessonotus (adult)		x	Predators
Copelatus (adult)	x	x	Predators
Coptotomus (larvae)	x	x	Predators
Coptotomus (adult)		x	Predators
Celina (larvae)	x	x	Predators
Celina (adult)	x	x	Predators
Cybister (larvae)	x	x	Predators
Desmopachria (adult)	x	x	Predators
Derovatellus (adult)	x	x	Predators
Eretes (adult)	x		Predators
Hydaticus (larvae)		x	Predators
Hydroporus(larvae)	x	x	Predators
Laccodytes (adult)	x		Predators
Laccornis (larvae)	x	x	Predators
Liodessus (larvae)	x	x	Predators
Liodessus (adult)		x	Predators
Matus (larvae)	x	x	Predators
Matus(adult)		x	
Neoporus (larvae)	x		Predators

Table 5-1 (continued)

Taxonomic Group	Method of Collection Core	Sweep	Trophic Guild
Pachydrus (adult)		x	Predators
Pachydrus (larvae)	x	x	Predators
Thermonectus (adult)		x	Predators
Uvarus (larvae)	x		Predators
Family Elmidae			
Dubiraphia (adult)	x		Collectors-gatherers
Dubiraphia (larvae)	x		Collectors-gatherers
Family Hydraenidae			
Hydraena (larvae)	x	x	Predators
Hydraena (adult)	x	x	Collectors-gatherers
Family Hydrophilidae			
Anacaena (adult)		x	Collectors-gatherers
Berosus (larvae)	x	x	Collectors-gatherers
Berosus(adult)		x	Collectors-gatherers
Derallus (adult)		x	Collectors-gatherers
Enochrus (adult)	x	x	Herbivores
Helocombus (larvae)	x		Predators
Helocombus (adult)	x		Collectors-gatherers
Hydrobiomorpha (larvae)		x	Predators
Hydrobius (larvae)	x		Collectors-gatherers
Hydrobius (adult)	x		Collectors-gatherers
Hydrochus (larvae)	x	x	Shredders-herbivores
Hydrochus (adult)	x	x	Shredders-herbivores
Hydrophilus (larvae)	x		Predators
Family Noteridae			
Hydrocanthus (adult)		x	Predators
Notomicrus (adult)	x		Predators
Family Scirtidae		x	Collectors-gatherers
Order Diptera			
Family Ceratopogonidae	x	x	
Family Chaoboridae			
Chaoborus	x	x	Predators
Family Chironomidae			
Ablabesmyia	x	x	Predators, collectors-gatherers
Chironomini genus III	x	x	
Chironomus	x	x	Collectors-gatherers
Cladopelma	x	x	Collectors-gatherers
Cladotanytarsus		x	Collectors-gatherers
Clinotanypus	x	x	Predators
Corynoneura	x		Collectors-gatherers
Cryptochironomus	x	x	Predators
Cryptotendipes	x	x	Collectors-gatherers
Dicrotendipes cf. *modestus*	x	x	Collectors-gatherers
Endochironomus cf. *subtendens*		x	Collectors-gatherers
Fittkauimyia	x	x	
Goeldichironomus holoprasinus	x	x	Collectors-gatherers
Guttipelopia	x	x	Predators
Kiefferulus	x	x	Collectors-gatherers
Labrundinia virescens	x	x	Predators

Table 5-1 (continued)

Taxonomic Group	Method of Collection		Trophic Guild
	Core	Sweep	
Limnophyes	x		Collectors-gatherers
Monopelopia boliekae	x	x	Predators
Natarsia	x		Predators
Nilothalma	x		Collectors-gatherers
Orthocladius	x	x	Collectors-gatherers
Parachironomus carinatus		x	Predators, collectors-gatherers
Parachironomus alatus	x	x	Predators, collectors-gatherers
Parachironomus hirtalatus	x	x	Predators, collectors-gatherers
Paratendipes subaequalis	x	x	Collectors-gatherers
Polypedilum laetum	x	x	Collectors-gatherers
Polypedilum fallax	x	x	Collectors-gatherers
Polypedilum trigonus	x	x	Collectors-gatherers
Polypedilum tritum	x	x	Collectors-gatherers
Procladius	x	x	Predators
Psectrocladius	x	x	Collectors-gatherers
Pseudochironomus	x		Collectors-gatherers
Smittia	x		Collectors-gatherers
Tanypus cf. *carinatus*	x	x	Predators
Tanytarsus	x	x	Collectors-gatherers
Zavreliella marmorata		x	Collectors-gatherers
Family Tabanidae	x	x	
Family Tipulidae	x	x	
Order Ephemeroptera			
Family Baetidae			
Baetis		x	Collectors-gatherers
Family Caenidae			
Caenis	x	x	Collectors-gatherers
Order Hemiptera			
Family Belostomatidae			
Belastoma		x	Predators
Lethocerus		x	Predators
Family Corixidae			
Hesperocorixa		x	Piercers-herbivores
Trichcorixa		x	Predators
Family Mesoveliidae			
Mesovelia	x		Predators
Family Naucoridae			
Pelocoris		x	
Order Lepidoptera			
Family Noctuidae	x		Shredders-herbivores
Family Pyralidae	x	x	Shredders-herbivores
Order Megaloptera			
Family Sialidae			
Sialis	x		Predators
Order Odonata			
Family Coenagrionidae	x	x	Predators
Family Corduliidae			
Didymops		x	Predators
Epitheca		x	Predators

Table 5-1 (continued)

Taxonomic Group	Method of Collection Core	Sweep	Trophic Guild
Family Gomphidae			
Aphylla		x	Predators
Arigomphus		x	Predators
Family Lestidae		x	Predators
Family Libellulidae			
Celithemis		x	Predators
Idiataphe	x	x	Predators
Libellula	x	x	Predators
Epitheca	x		Predators
Pachydiplax	x	x	Predators
Plathemis		x	Predators
Order Trichoptera	x	x	

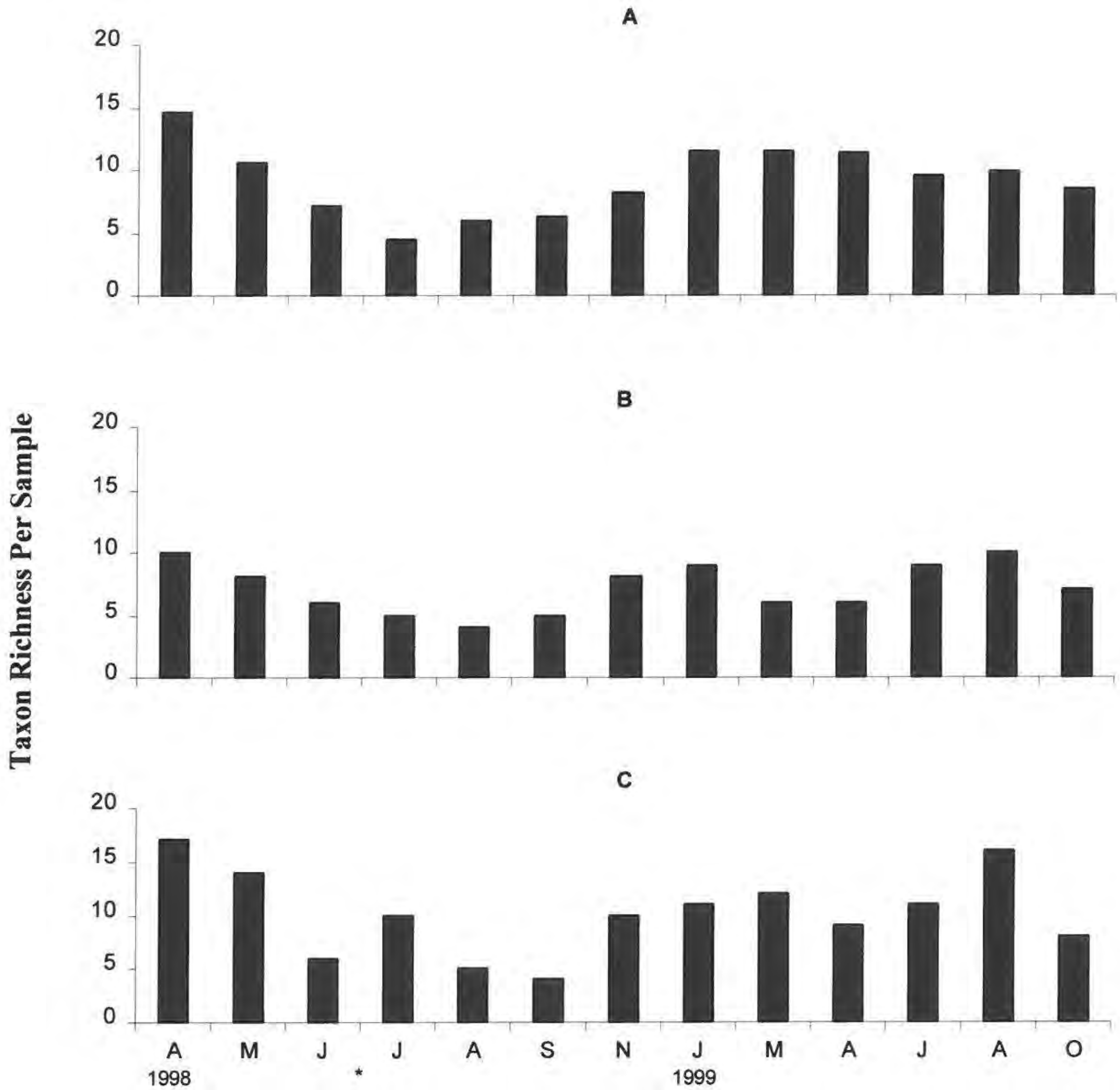

Figure 5-2. Mean taxon richness of total benthic macroinvertebrates collected from three habitats in Tates Hell Swamp using cores. A- demonstration wetlands, B- control wetland and C- reference wetland. *indicates initiation of restoration.

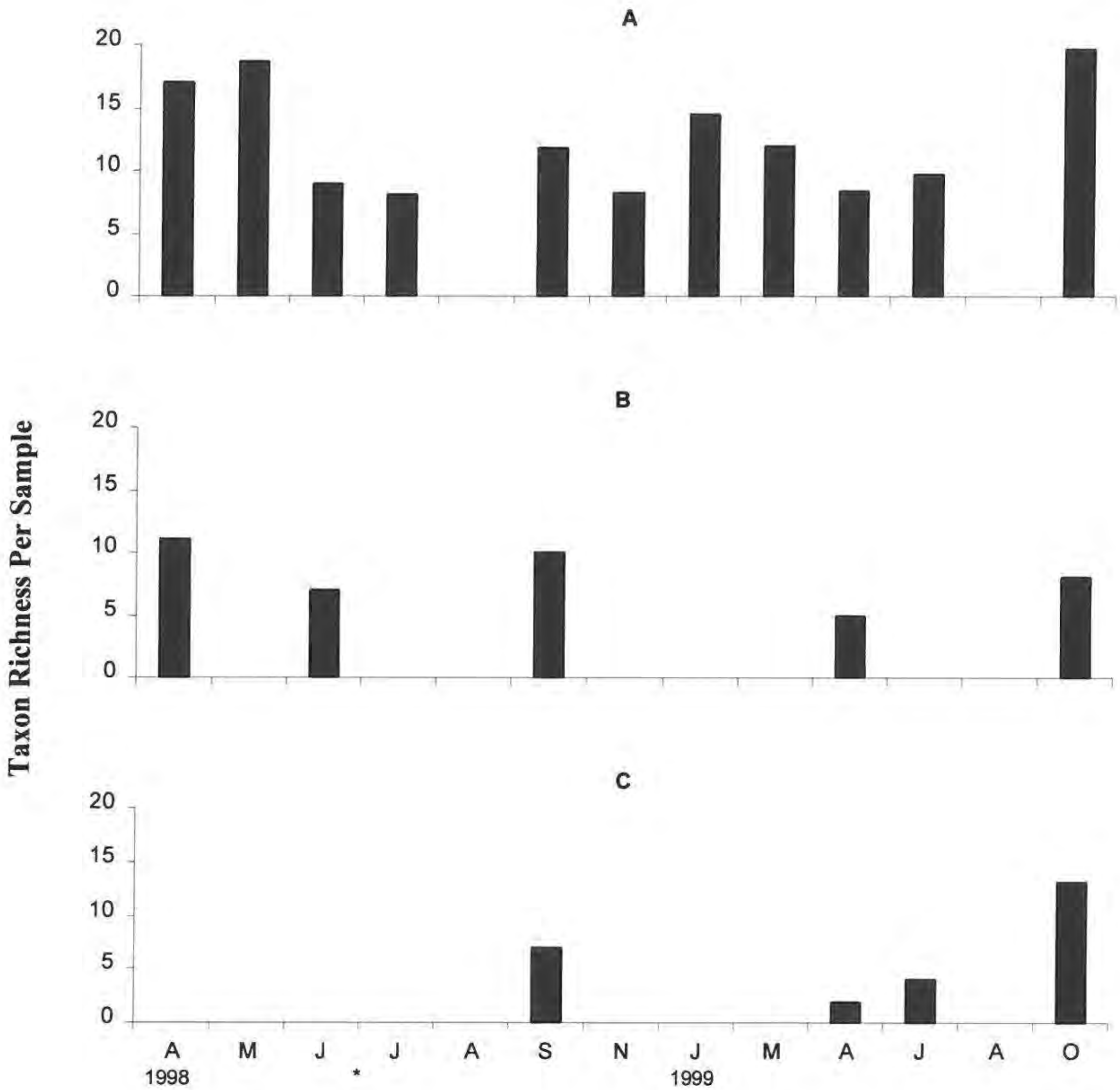

Figure 5-3. Mean taxon richness of total benthic macroinvertebrates collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. *indicates initiation of restoration.

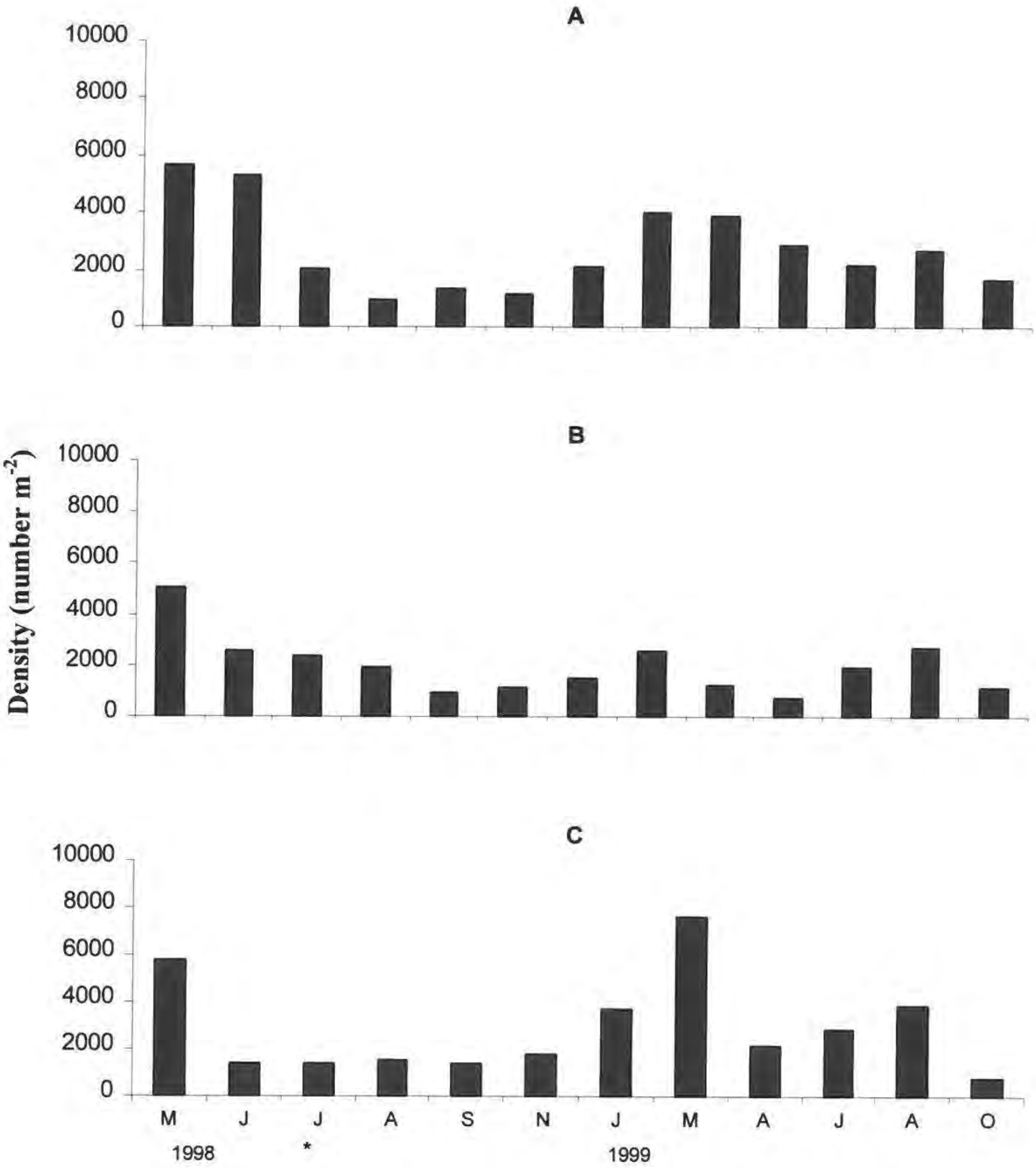

Figure 5-4. Mean density of total benthic macroinvertebrates collected from three habitats in Tates Hell Swamp using cores. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

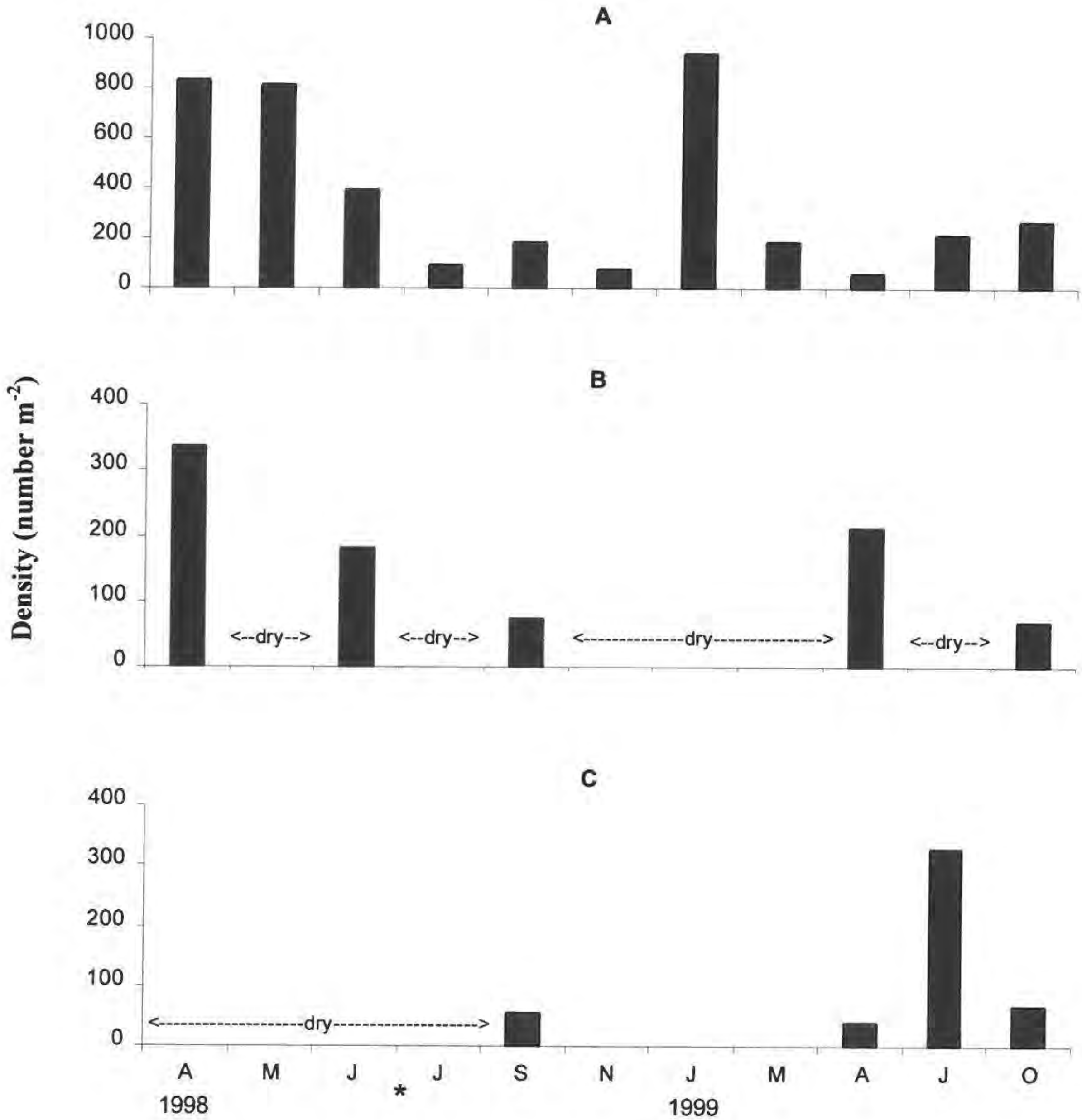

Figure 5-5. Mean density of total benthic macroinvertebrates collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

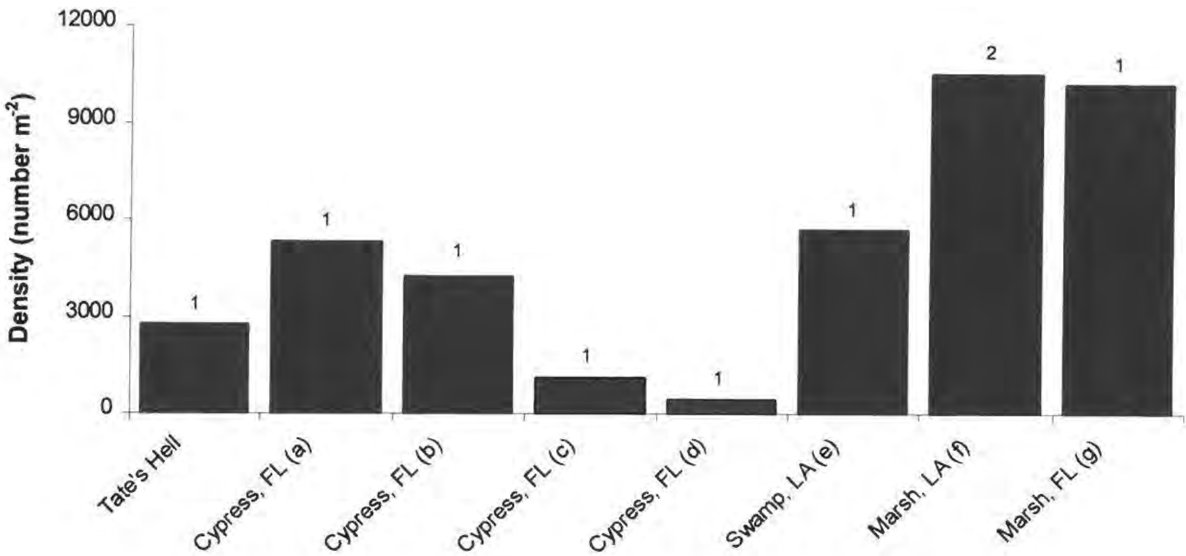

Figure 5-6. Benthic macroinvertebrate density collected from wetlands in the southeastern United States. Numbers indicate method of capture (1, core; 2, sweep net). a (Prenger *et al.* in prep), b (Leslie *et al.* 1997), c (Brightman 1984), d (Haack 1984), e (Sklar 1985), f (Sklar 1985), g (Evans 1996).

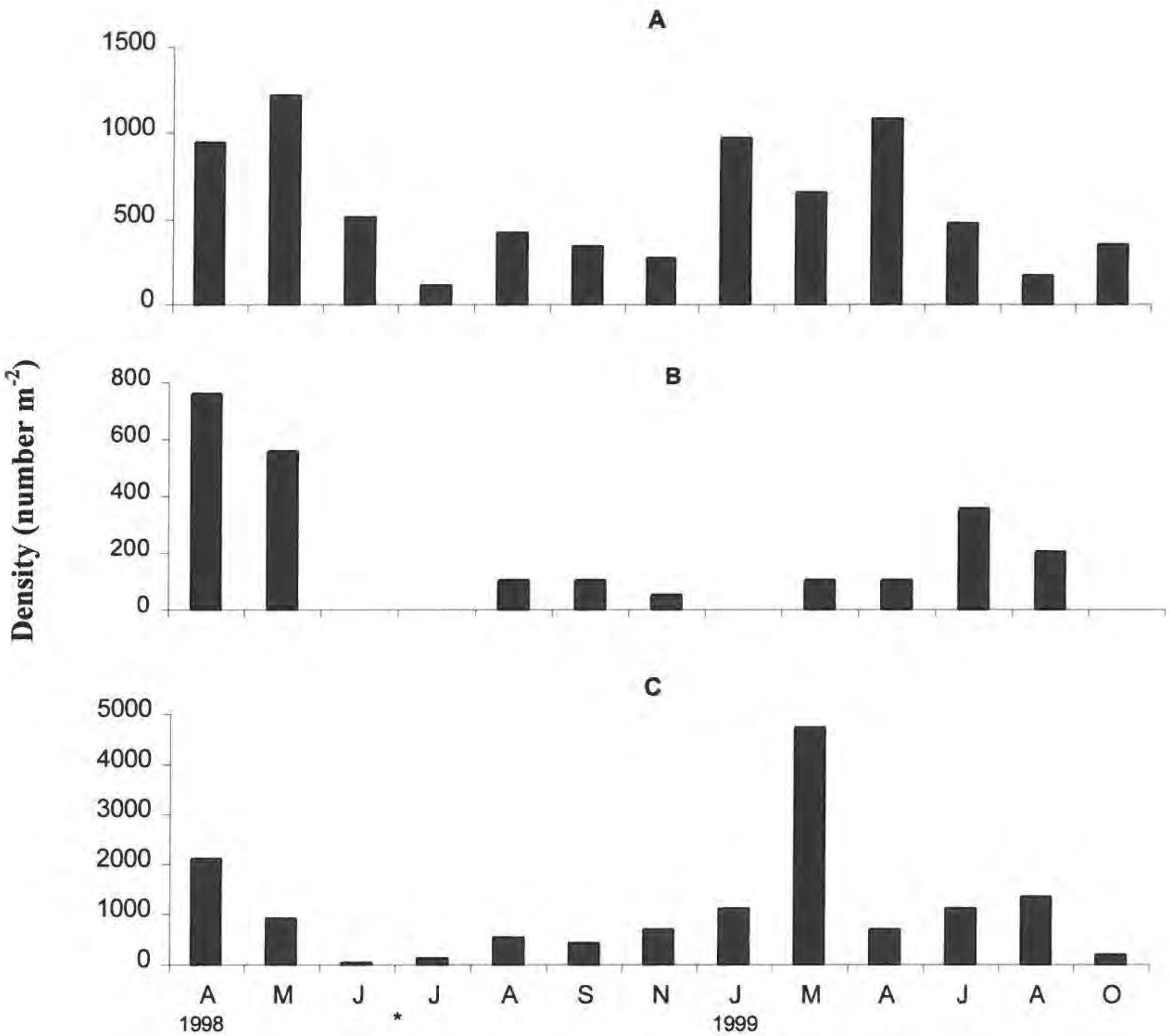

Figure 5-7. Mean density of *Crangonyx* collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

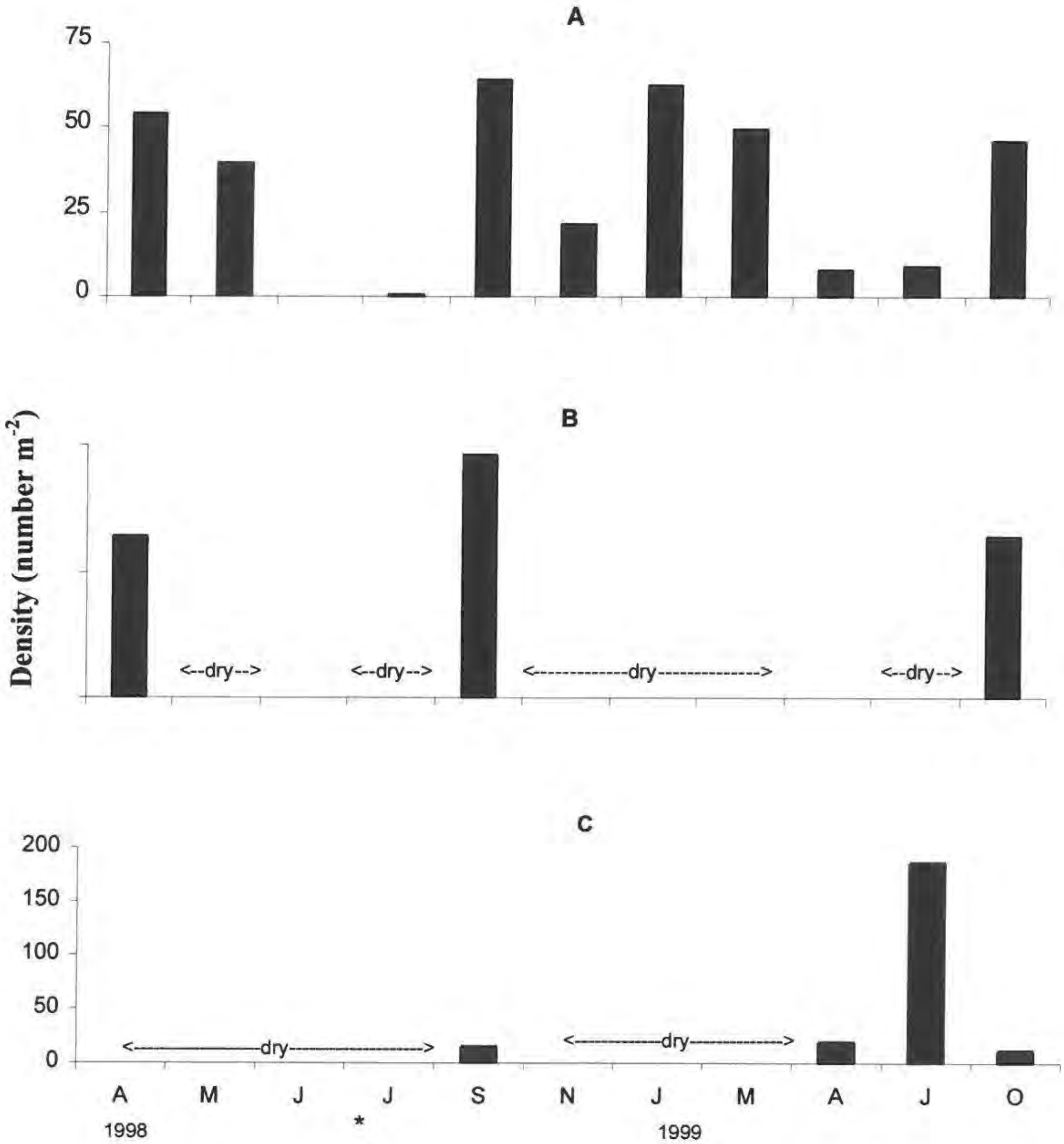

Figure 5-8. Mean density of *Crangonyx* collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

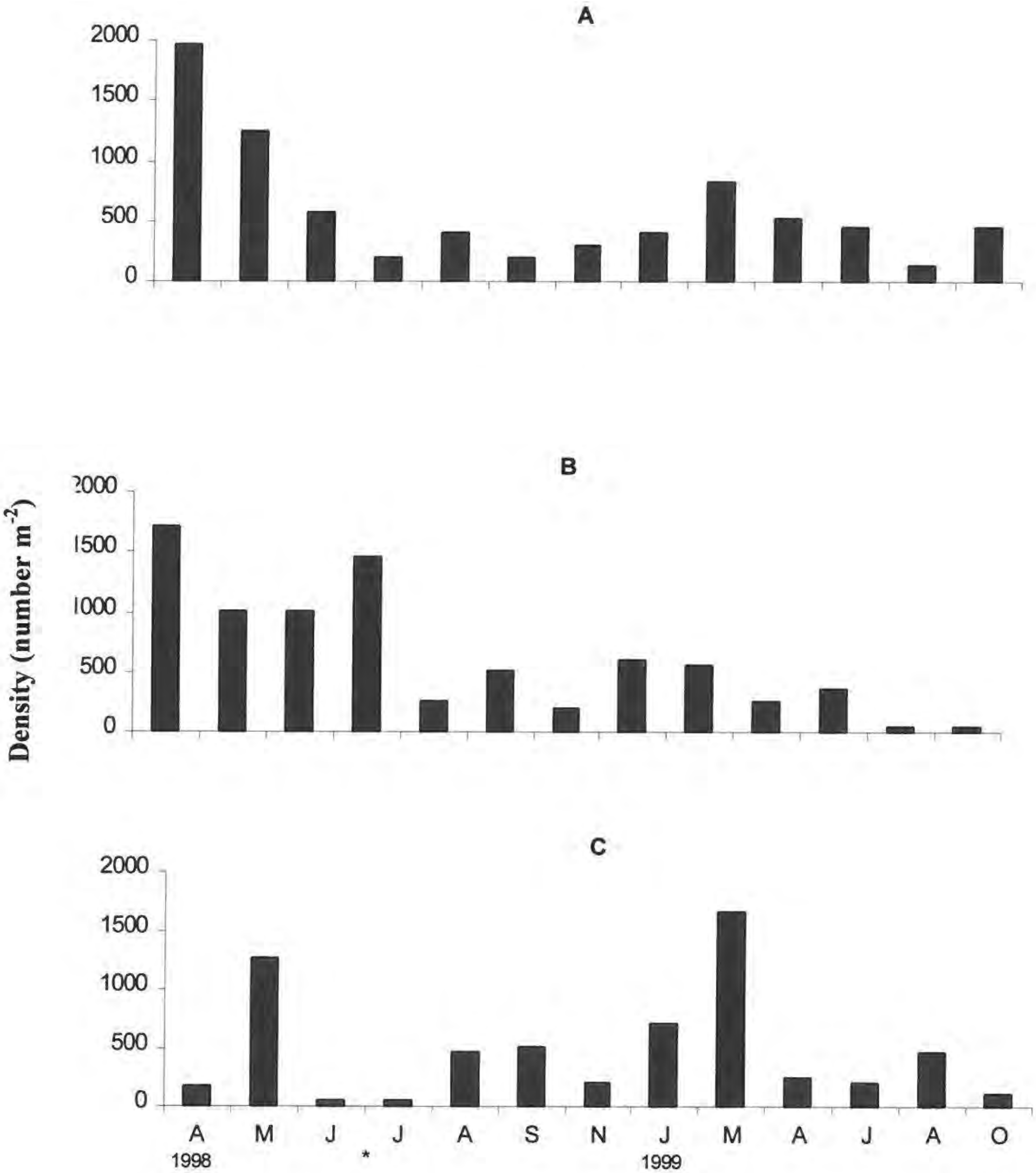

Figure 5-9. Mean density of *Caecidotea* collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration

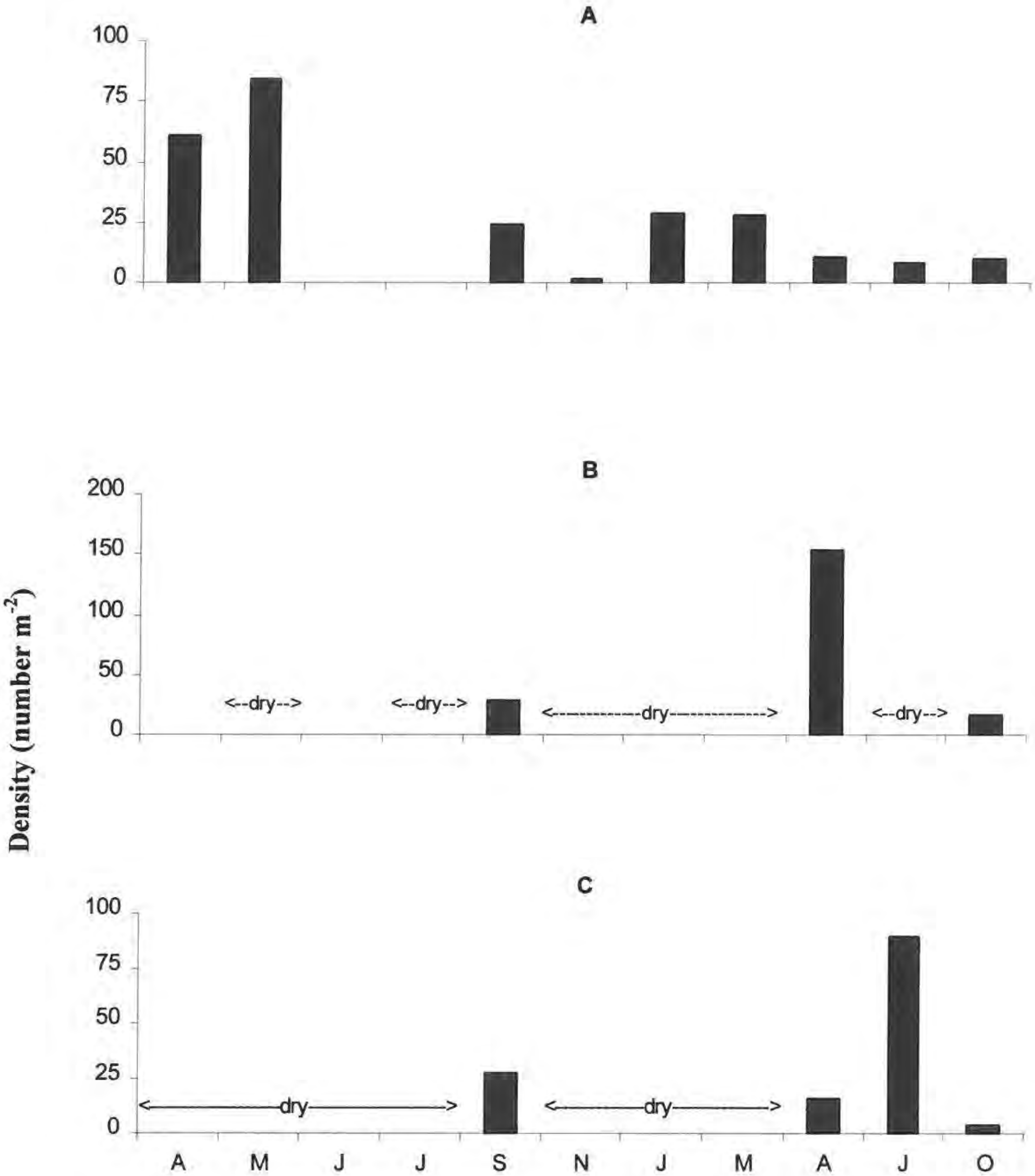

Figure 5-10. Mean density of *Caecidotea* collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

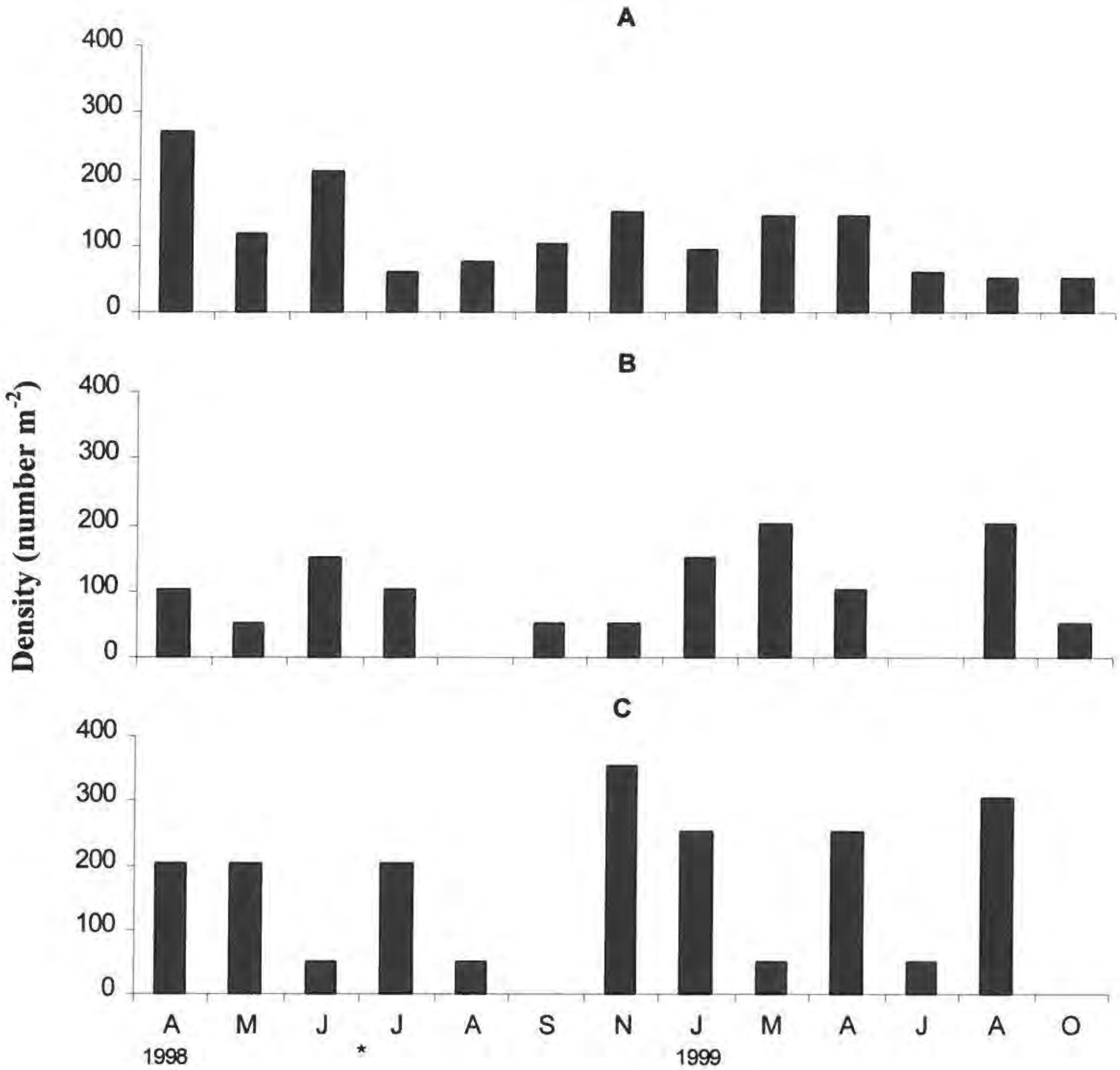

Figure 5-11. Mean density of Coleoptera collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

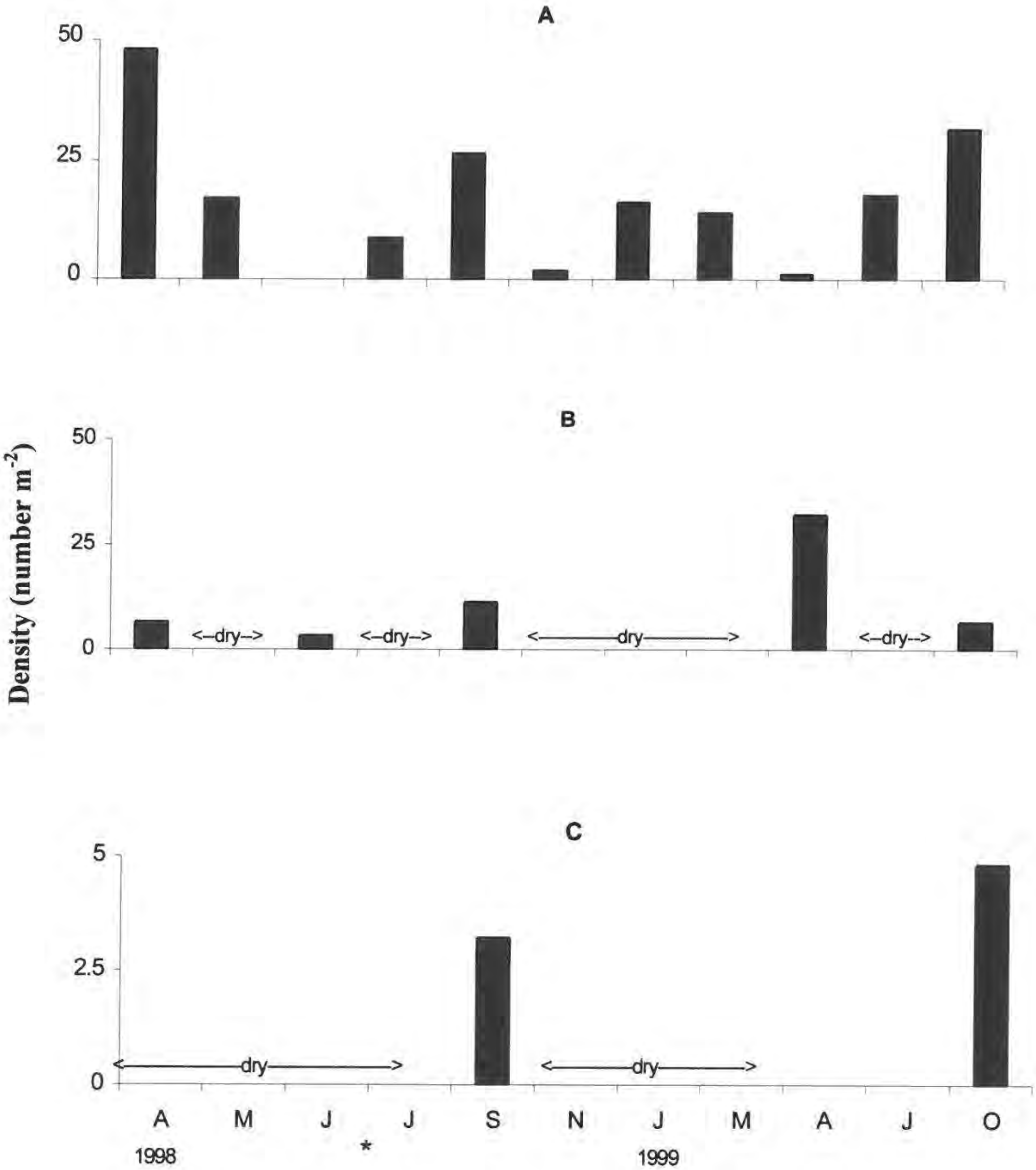

Figure 5-12. Mean density of Coleoptera collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

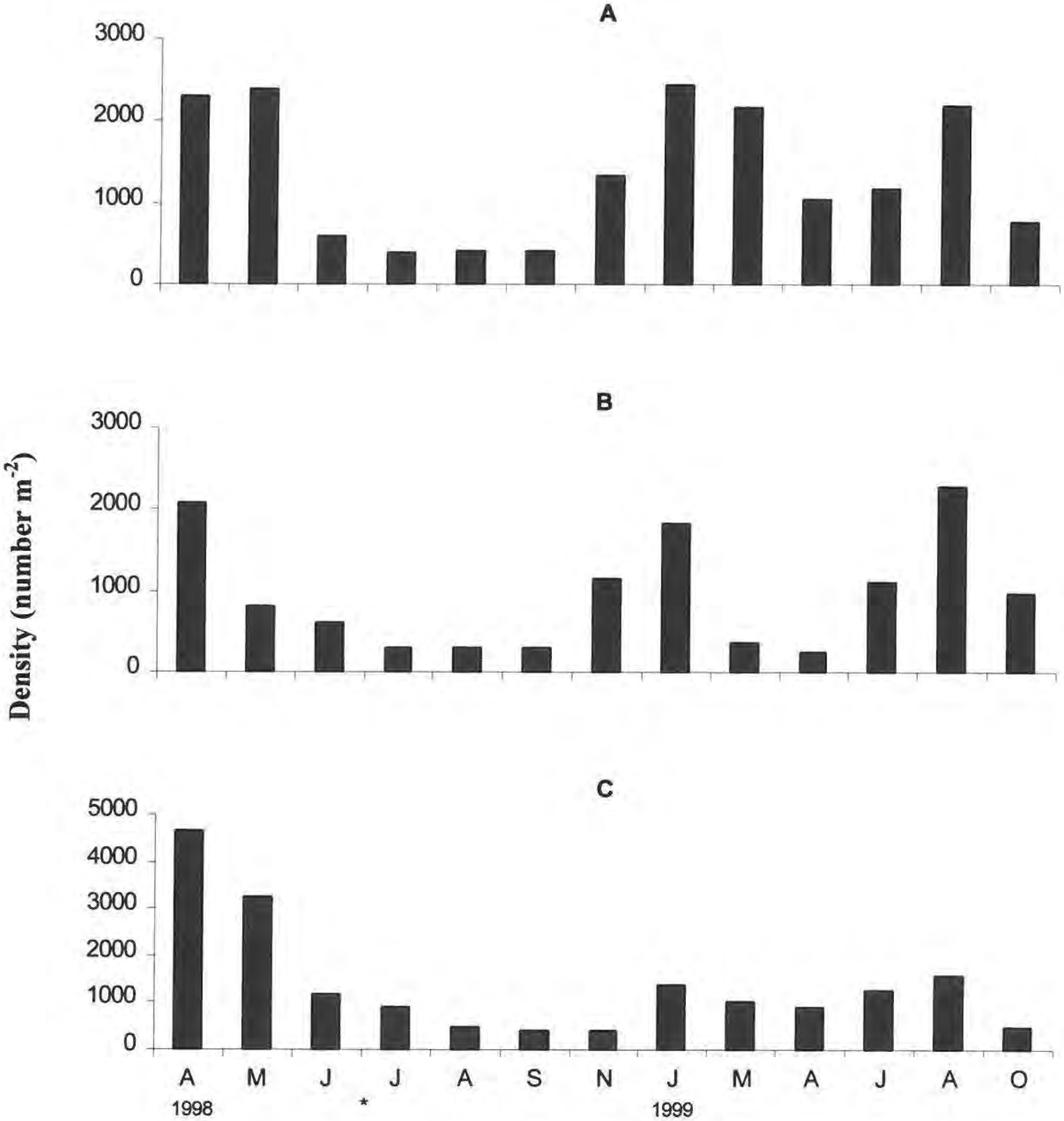

Figure 5-13. Mean density of Diptera collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

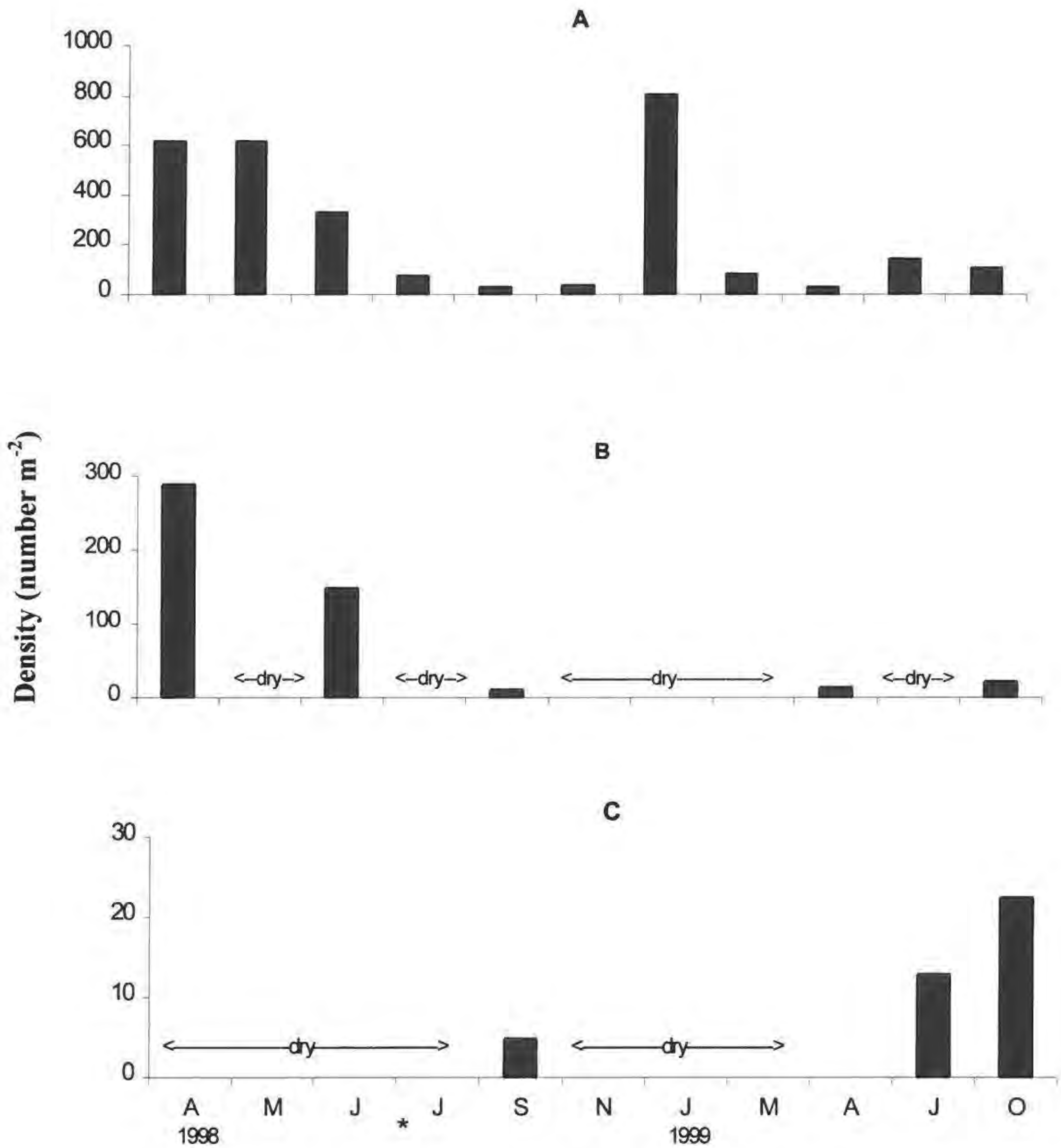

Figure 5-14. Mean density of Diptera collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

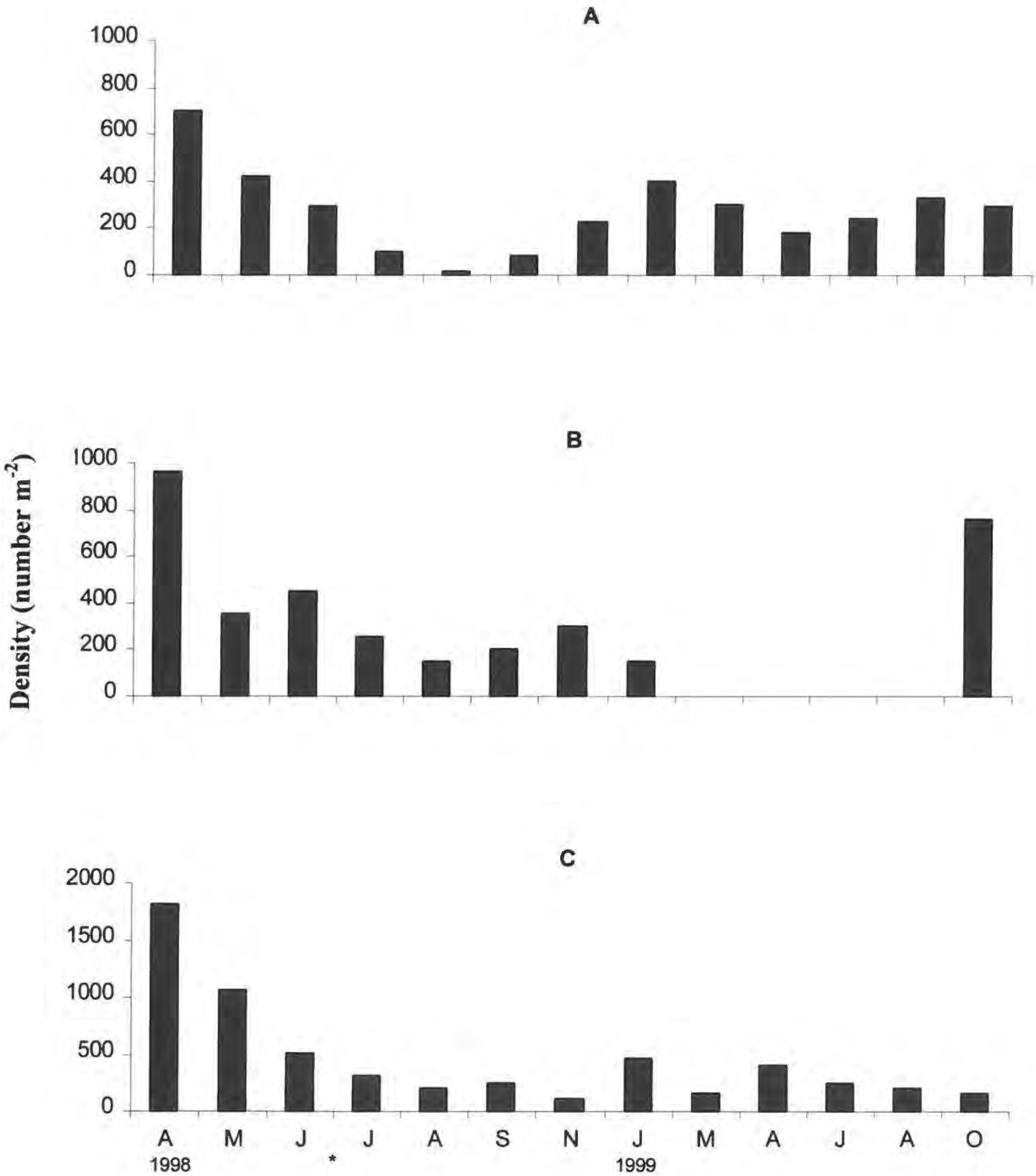

Figure 5-15. Mean density of Ceratopogonidae collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

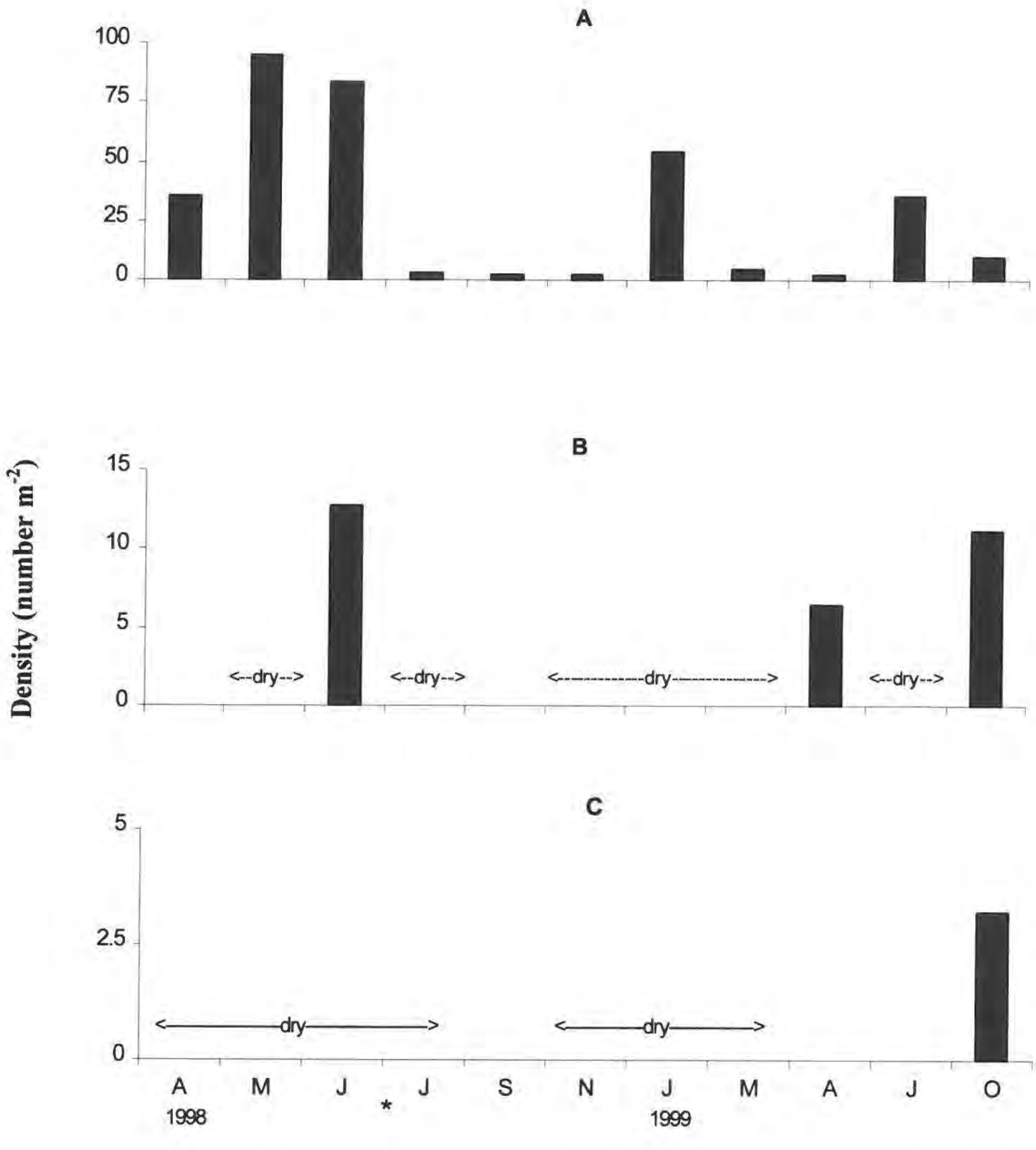

Figure 5-16. Mean density of Ceratopogonidae collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

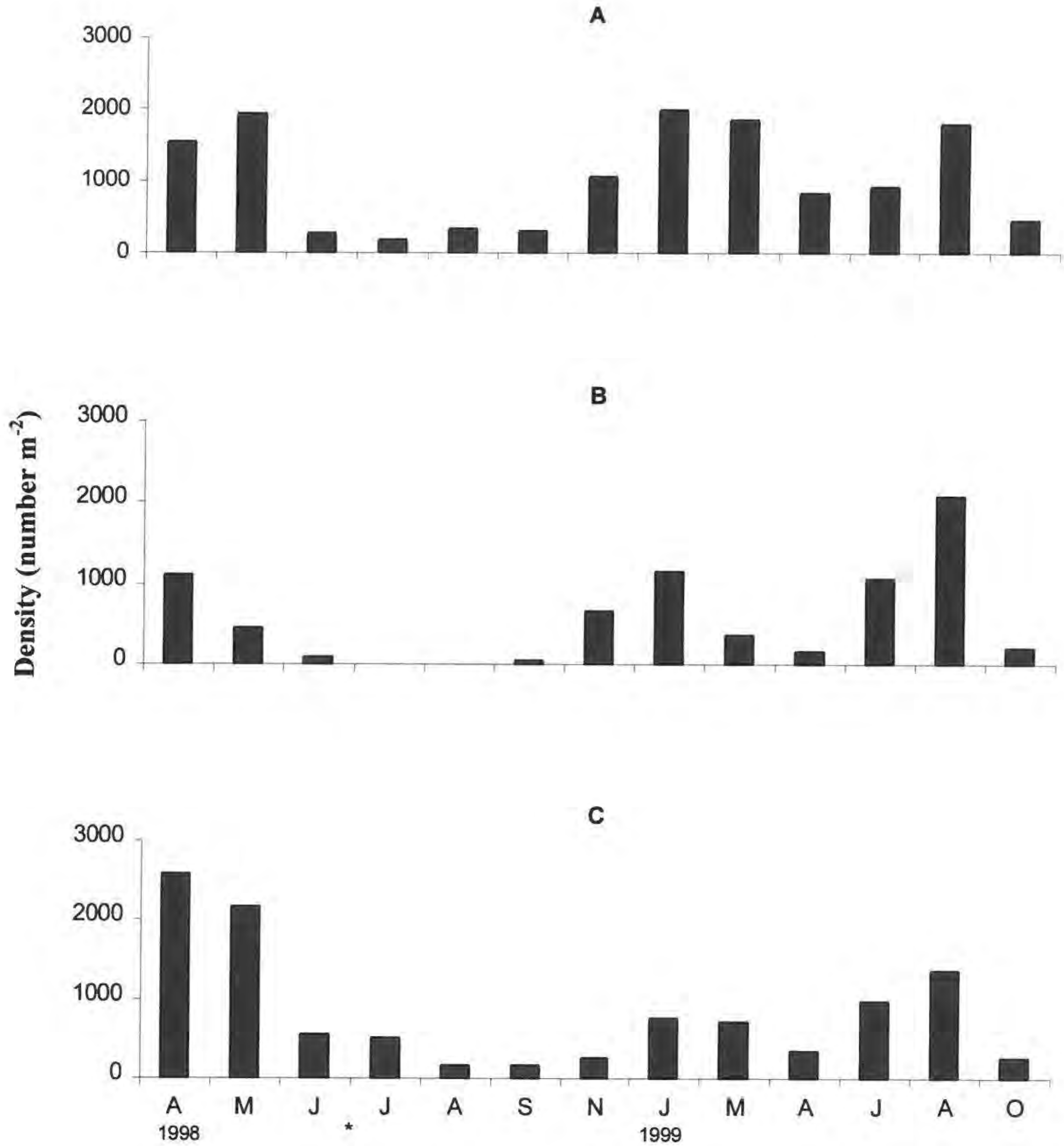

Figure 5-17. Mean density of Chironomidae collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

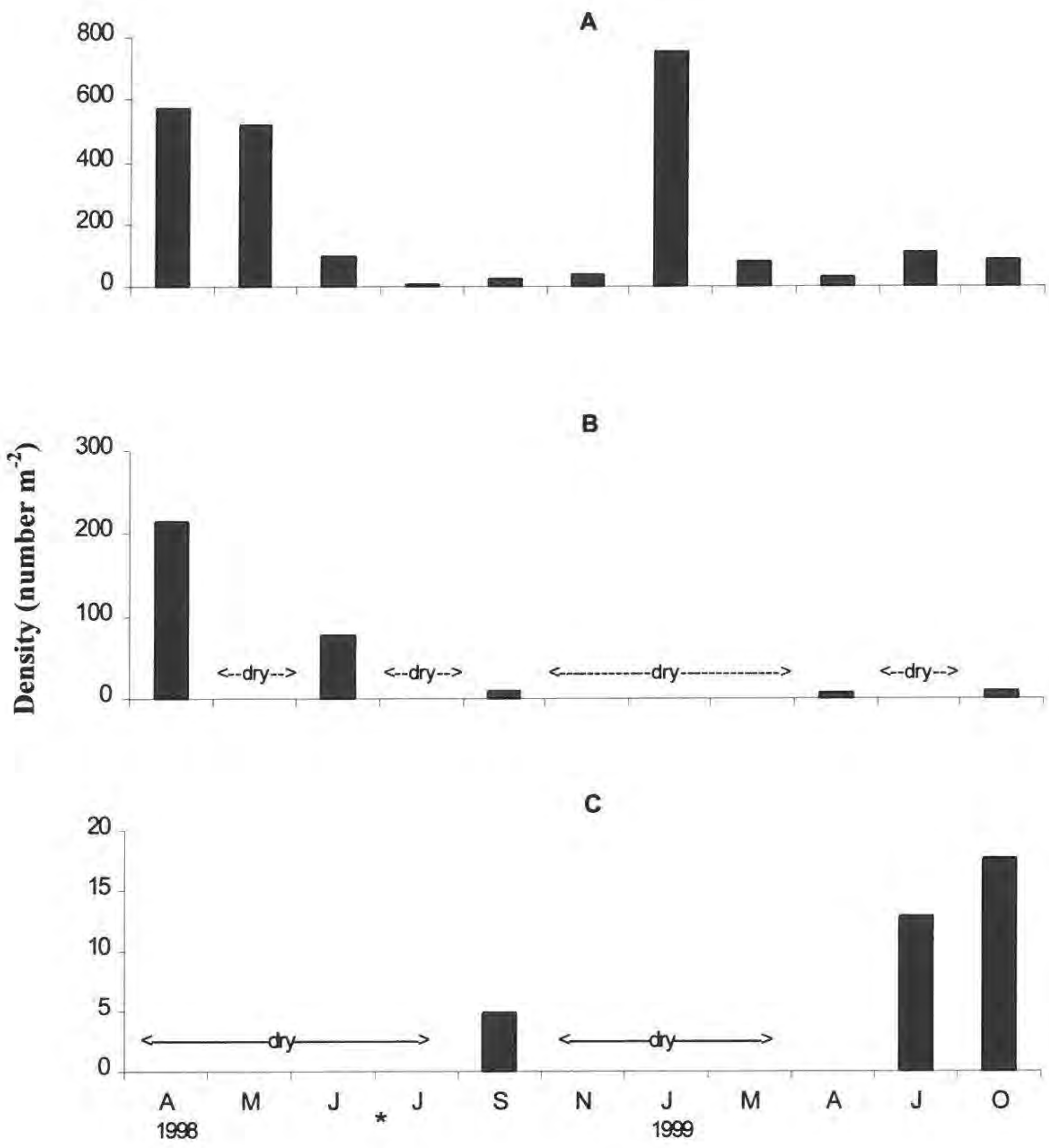

Figure 5-18. Mean density of Chironomidae collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

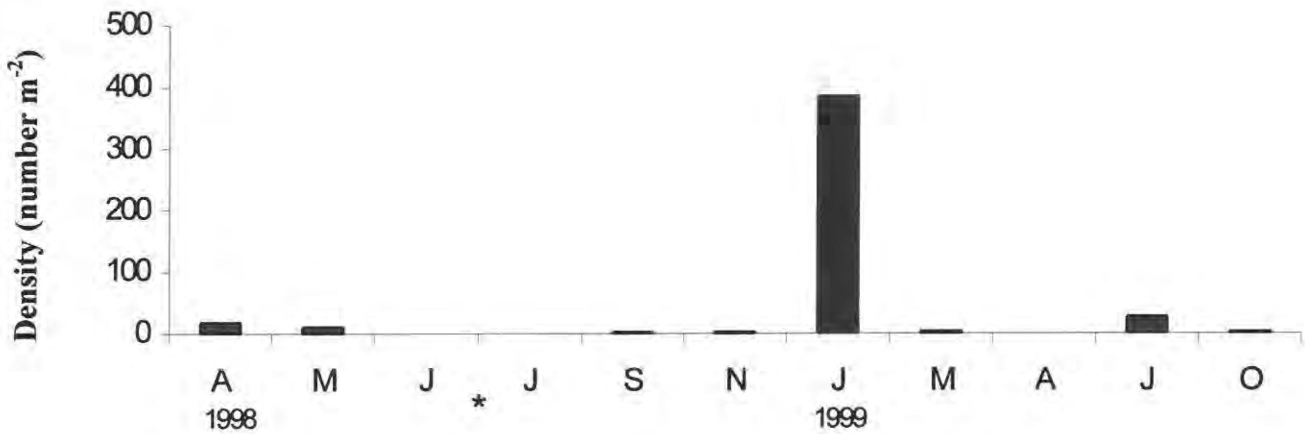

Figure 5-19. Mean density of *Polypedilum fallax* collected from demonstration wetlands in Tates Hell Swamp using sweep nets. No specimens were collected from control wetland or reference wetland. * indicates initiation of restoration.

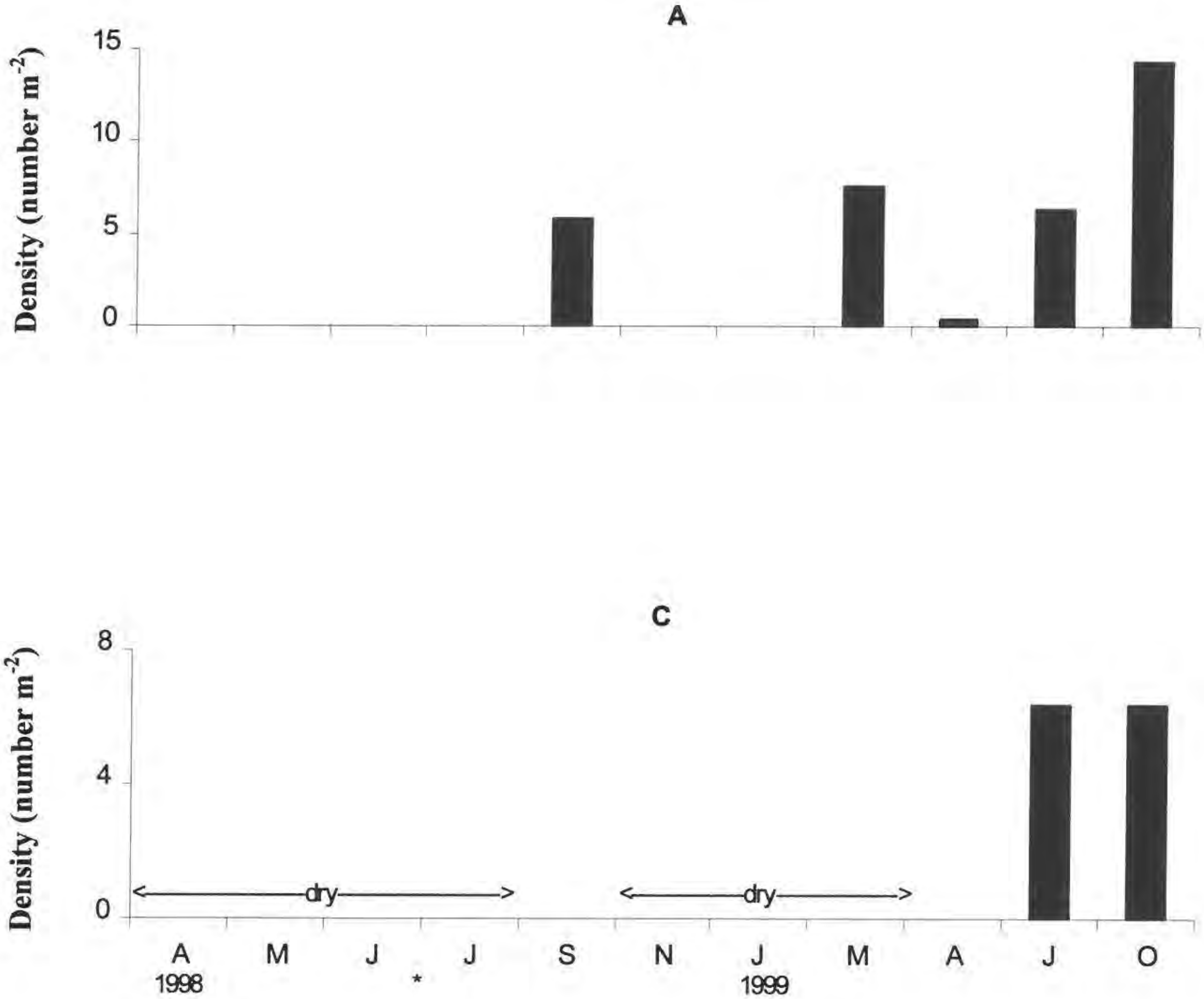

Figure 5-20. Mean density of *Polypedilum trigonus* collected from two habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands and C- reference wetland. No specimens were collected from control wetland. * indicates initiation of restoration.

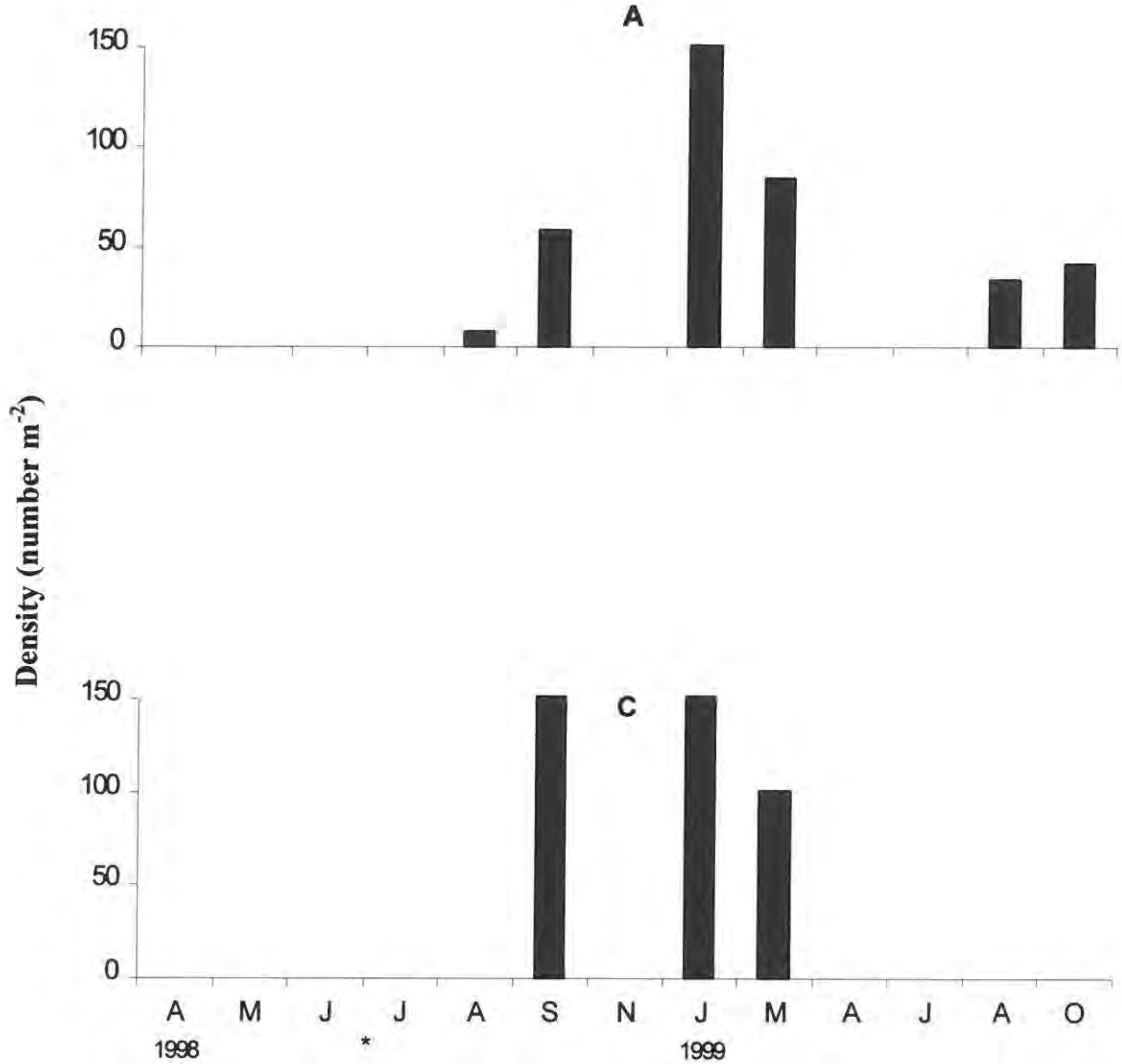

Figure 5-21. Mean density of *Polypedilum trigonus* collected from two habitats in Tates Hell Swamp using corers. A- demonstration wetlands and C- reference wetland. No specimens were collected from control wetland. * indicates initiation of restoration.

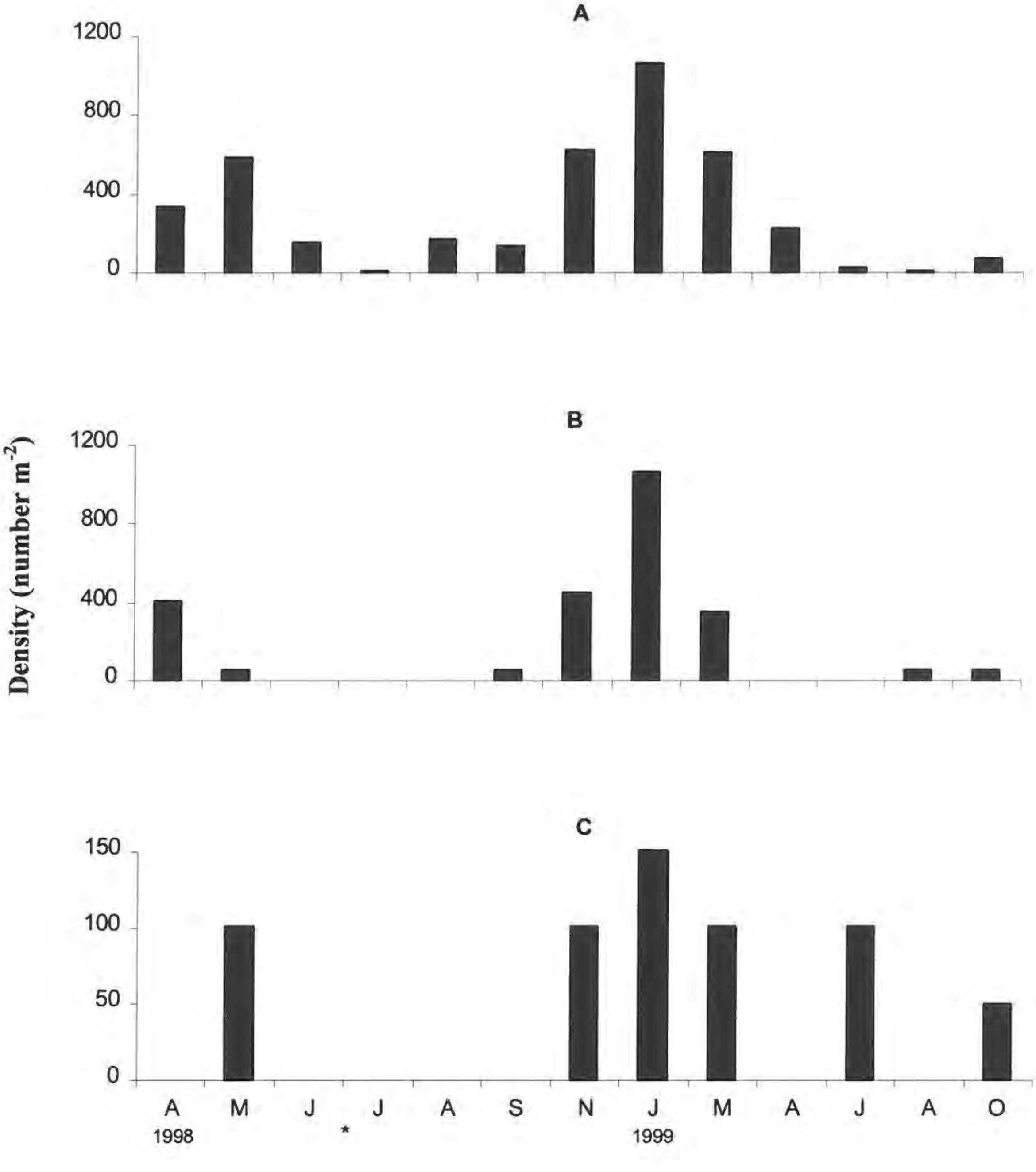

Figure 5-22. Mean density of *Polypedilum tritum* collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

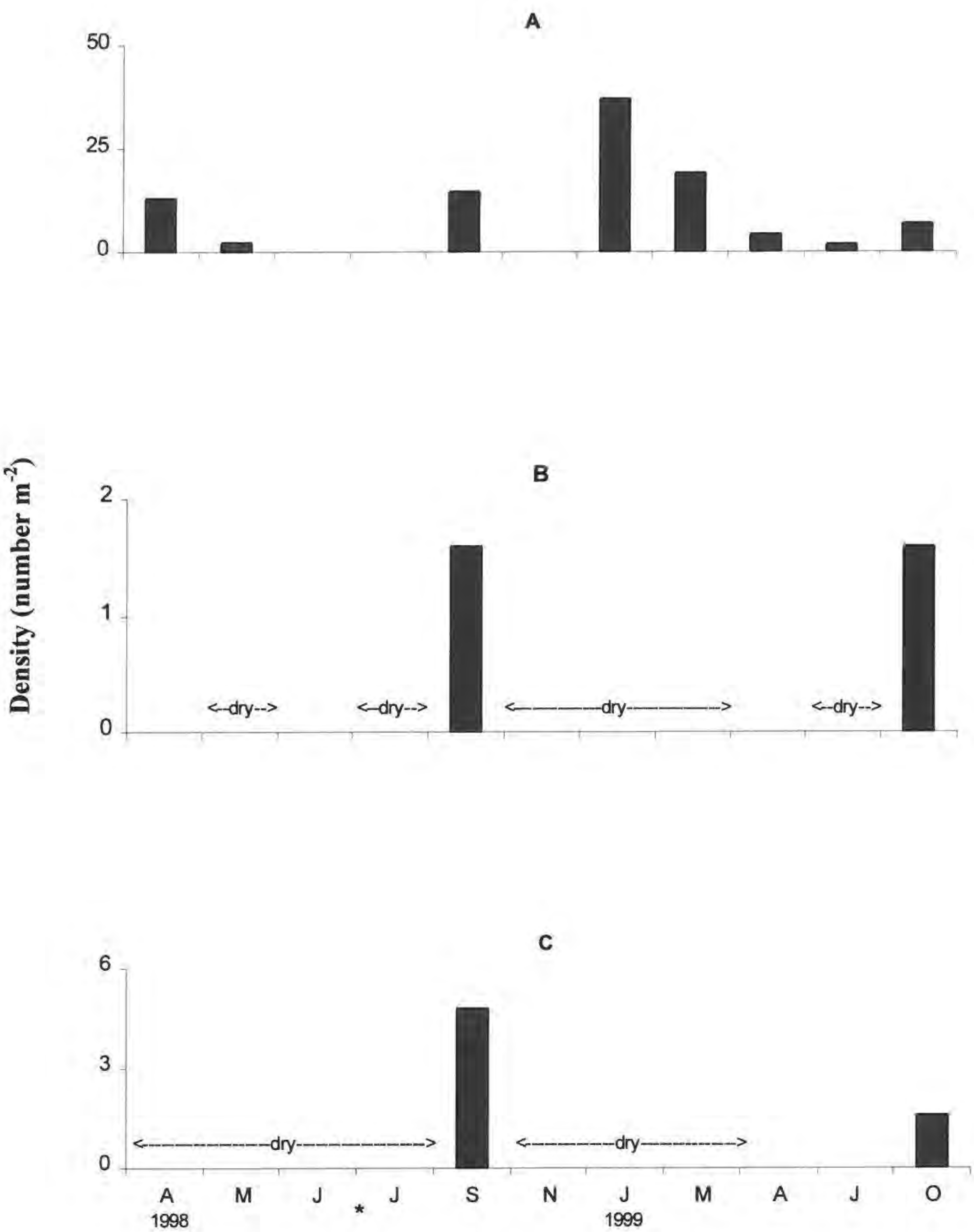

Figure 5-23. Mean density of *Polypedilum tritum* collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

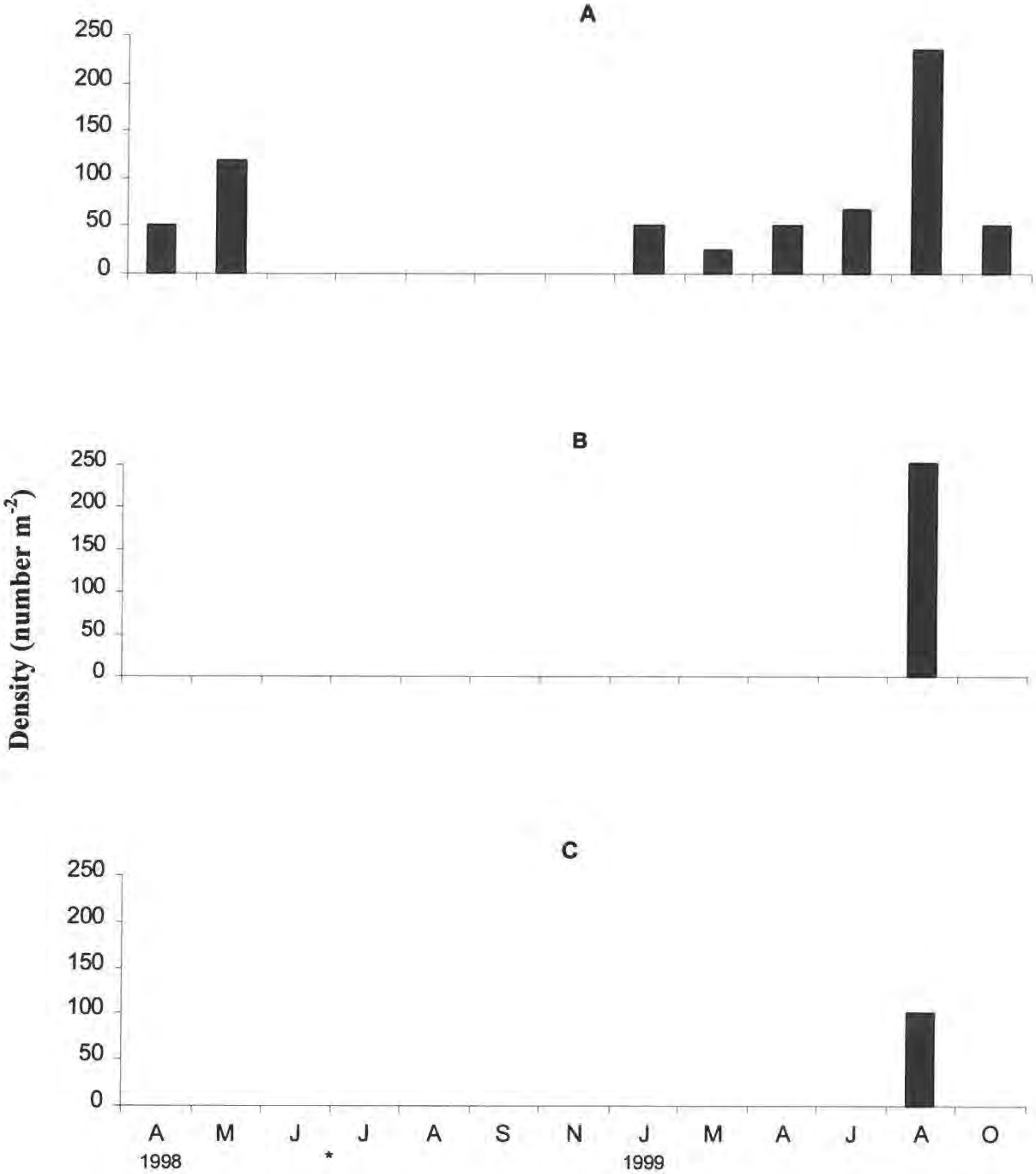

Figure 5-24. Mean density of *Chironomus* collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

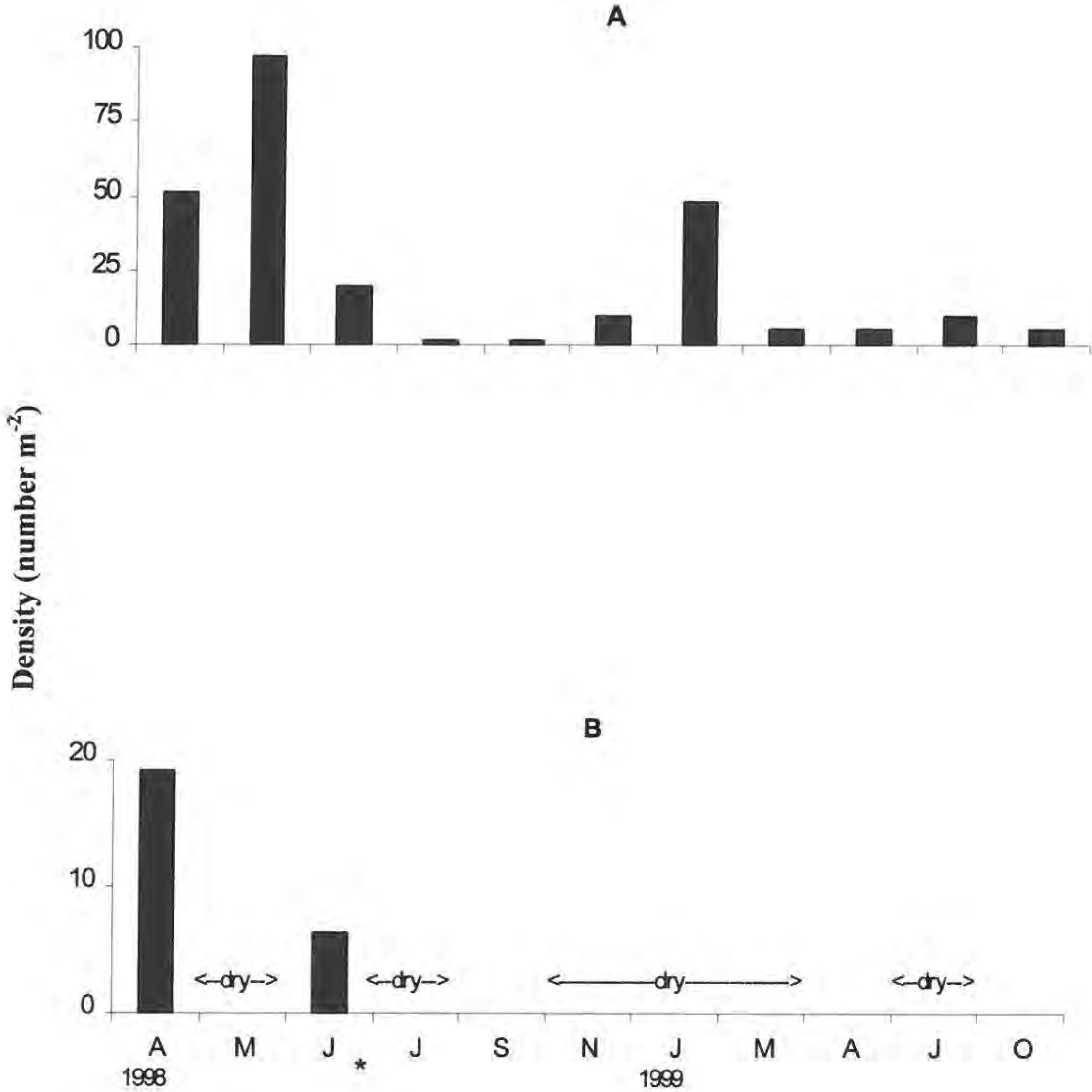

Figure 5-25. Mean density of *Chironomus* collected from two habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands and B- control wetland. No specimens were collected from the reference wetland. * indicates initiation of restoration.

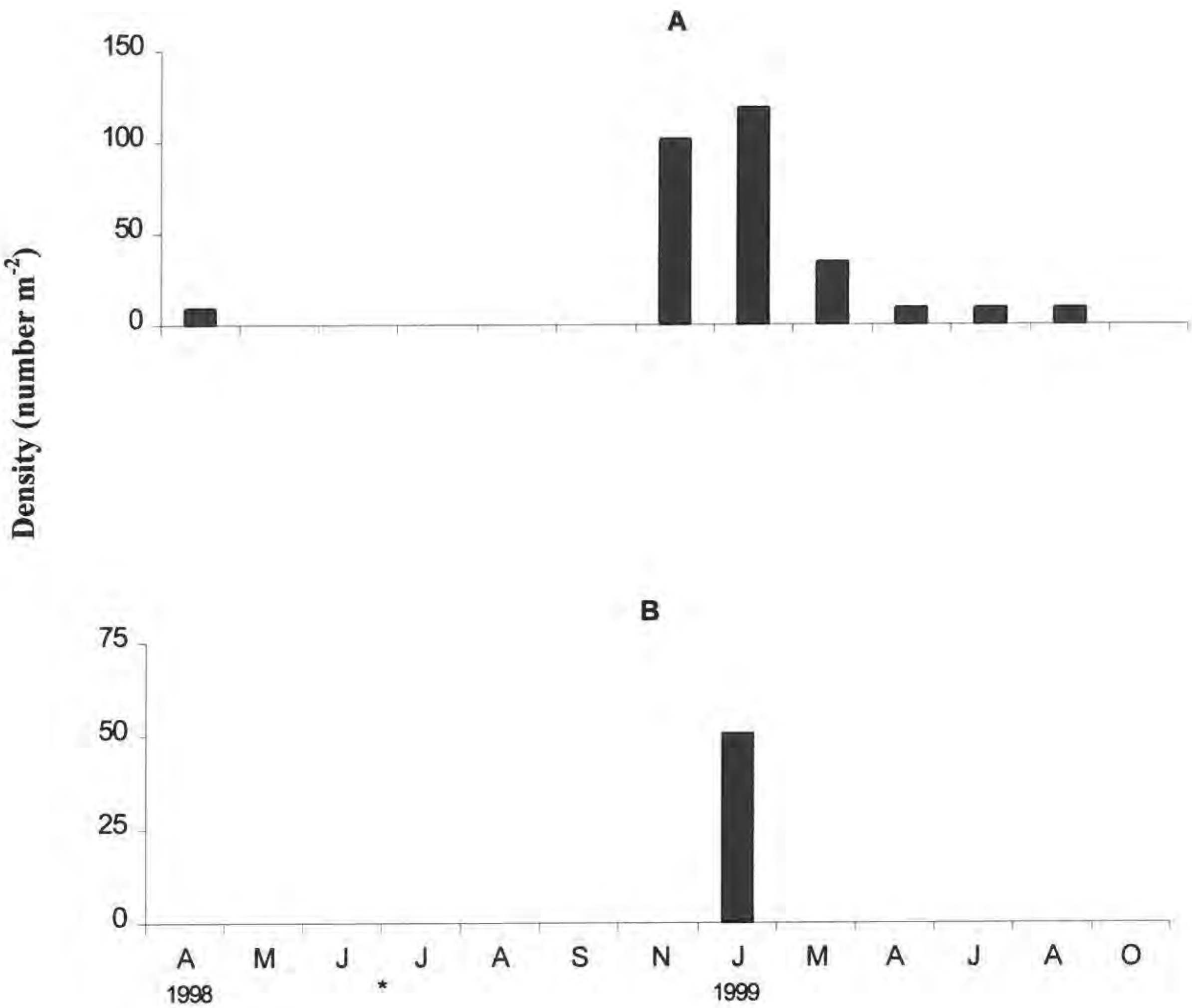

Figure 5-26. Mean density of *Tanypus* collected from two habitats in Tates Hell Swamp using corers. A- demonstration wetlands and C- control wetland. No specimens were collected from reference wetland. * indicates initiation of restoration.

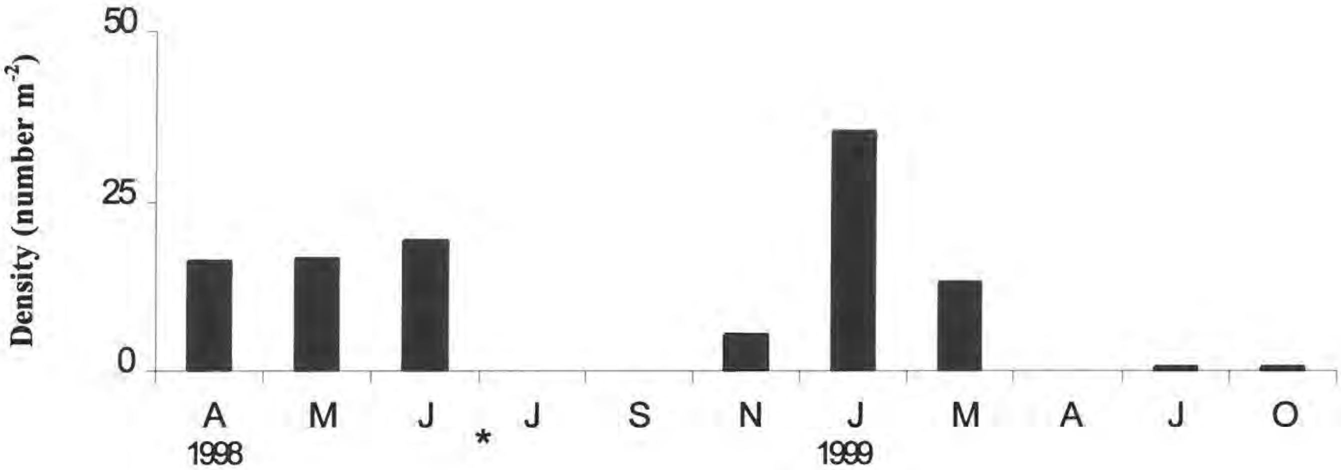

Figure 5-27. Mean density of *Tanypus* collected from demonstration wetlands in Tates Hell Swamp using sweep nets. No specimens were collected from control wetland or reference wetland. * indicates initiation of restoration..

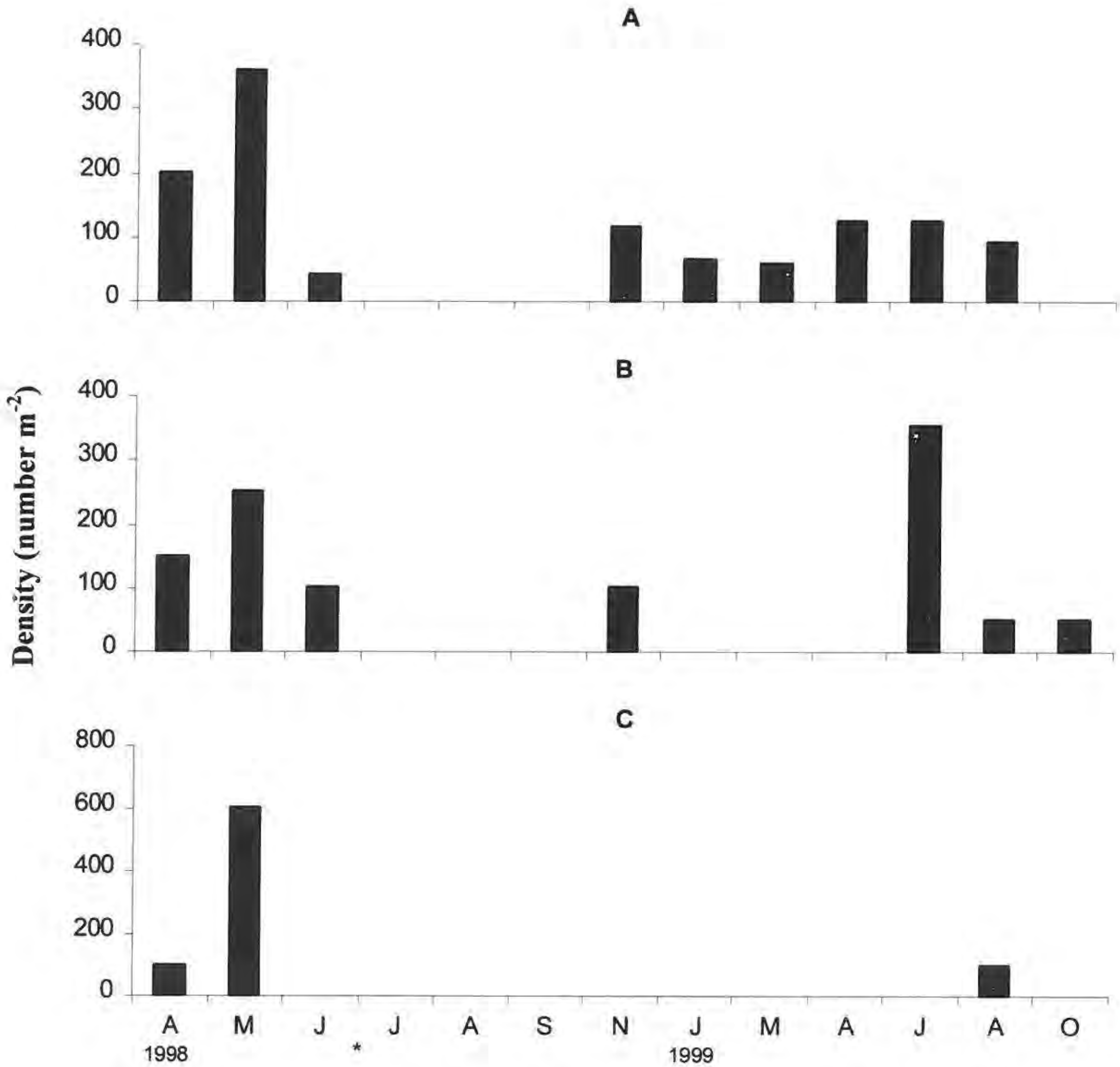

Figure 5-28. Mean density of *Procladius* collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands and B- control wetland. No specimens were collected from reference wetland. * indicates initiation of restoration.

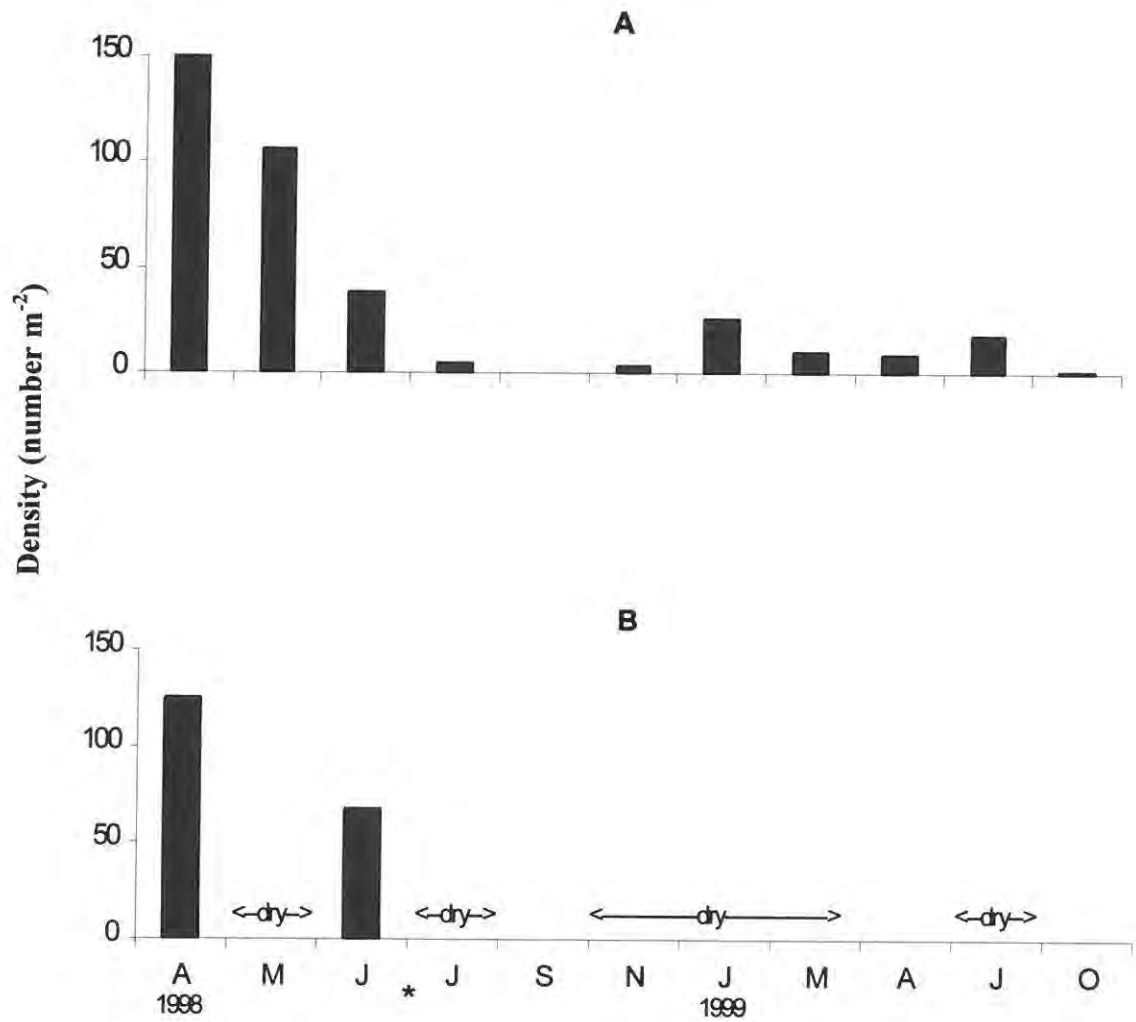

Figure 5-29. Mean density of *Procladius* collected from two habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands and B- control wetland. No specimens were collected from reference wetland. * indicates initiation of restoration.

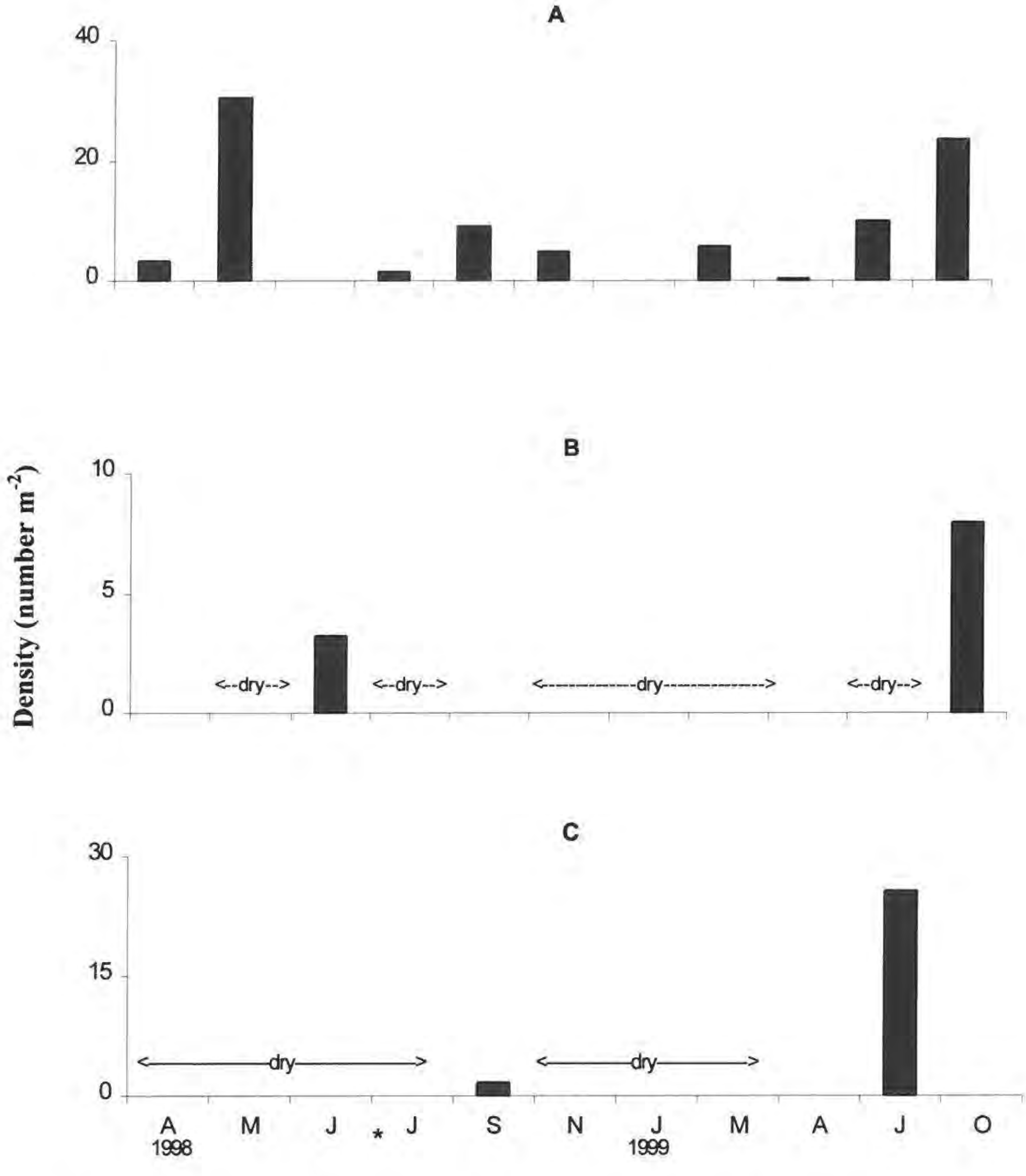

Figure 5-30. Mean density of Hemiptera collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

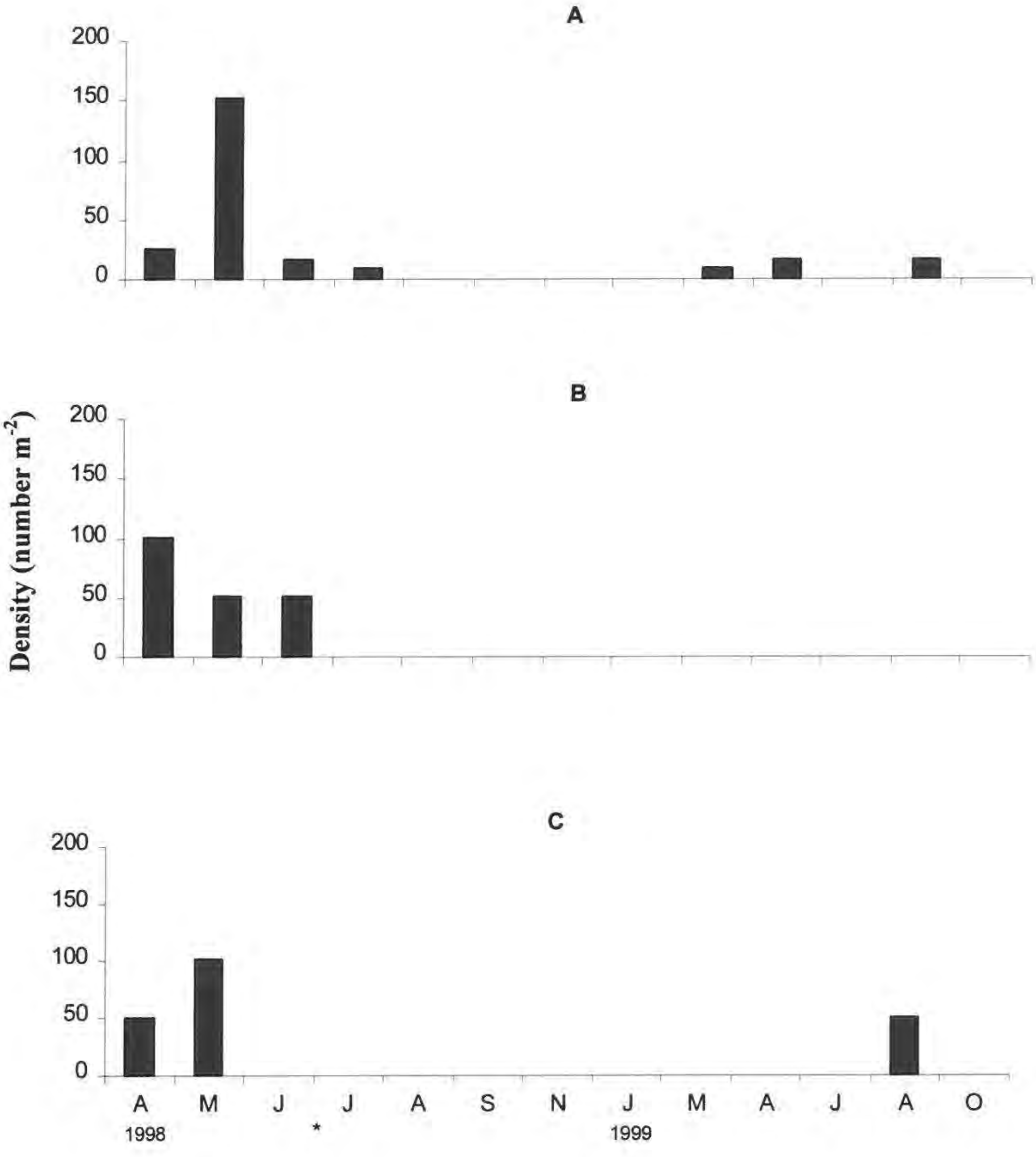

Figure 5-31. Mean density of Hemiptera collected from three habitats in Tates Hell Swamp using corers. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration.

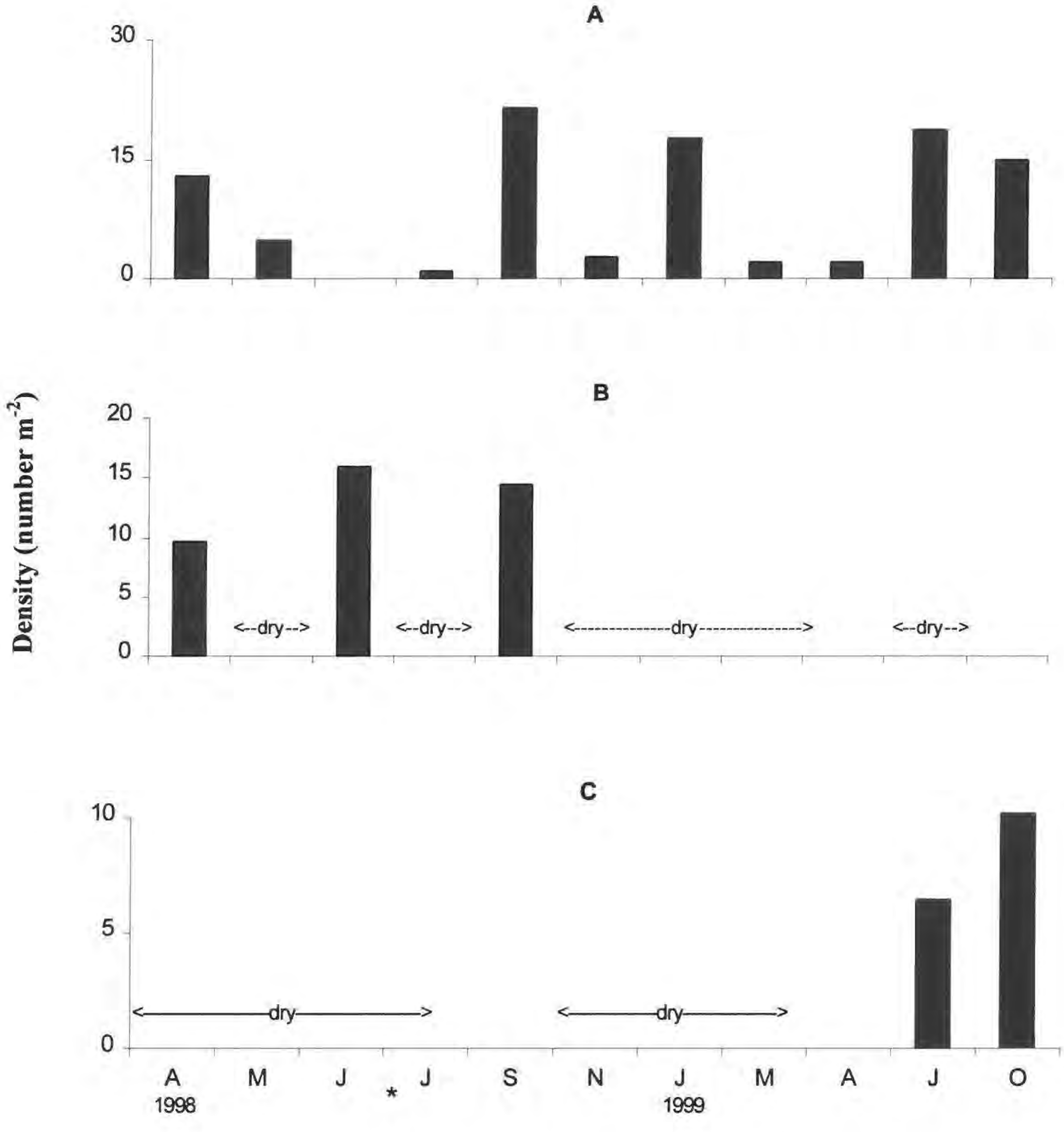

Figure 5-32. Mean density of Odonata collected from three habitats in Tates Hell Swamp using sweep nets. A- demonstration wetlands, B- control wetland and C- reference wetland. * indicates initiation of restoration

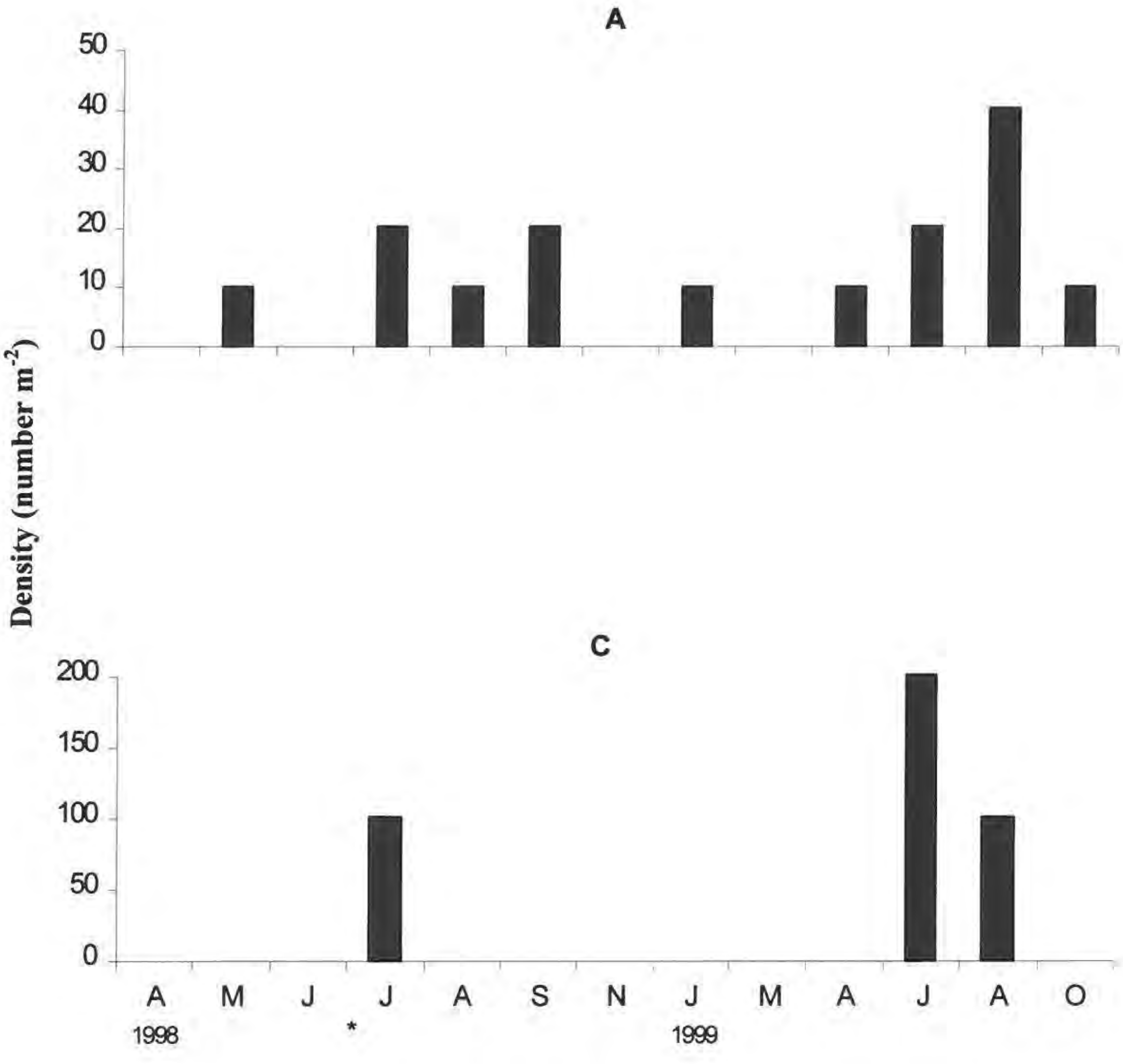

Figure 5-33. Mean density of Odonata collected from two habitats in Tates Hell Swamp using corers. A- demonstration wetlands and C- reference wetland. No specimens were collected from control wetland. * indicates initiation of restoration.