Grant Title: Identifying temporal variation in fish assemblages across water corridor units in the Big Thicket National Preserve

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Background

Effective conservation requires a thorough understanding of the processes affecting species abundance, richness and stability of communities (Sheldon 1988; Melvin 1994; Angermeier & Winston 1999). In fishes, these community properties can be regulated by a combination of both spatial and temporal forces (Ricklefs 1987; Matthews et al. 1988; Jackson et al. 2001). Thus, understanding the relative contribution of these structuring forces is critical for implementing conservation strategies (Allendorf 1988). For example, regional processes such as variation in drainage size, land use practices, and stream connectedness can drive uniqueness of communities and the number of species in a region (Weaver 1994; Lyons 1996; Ambrosio et al. 2009). At smaller spatial scales, availability of local microhabitat also can play an important role in regulating the number of species in a system (Gorman & Karr 1978; Schlosser 1982; Fisher & Paukert 2008). Thus, the processes driving richness at local scales also can influence overall richness within a region. Fish communities often vary over time because of natural seasonal dynamics and associated transient taxa. Because of the temporal dynamics in fish communities (Adams et al. 2004; Phillips & Johnston 2004; Taylor et al 2006), understanding variation in community structure over time also can have important implications for conservation. Therefore, a holistic approach to species conservation requires a comprehensive understanding of community properties across regional, local and temporal scales.

In summer 2008, we surveyed fishes from six water corridors (Big Sandy Ck, Turkey Ck, Menard Ck, Village Ck, Neches River, and Little Pine Island Bayou) in the Big Thicket National Preserve (BITH) to document local and regional variation in fish assemblages within this system (TWIG GRANT - *Influence of Local Microhabitat Structure on Ichthyofauna in the Big Thicket National Preserve*, PI: Chad Hargrave). We collected a total of 44 species in this study, and, although all streams shared a core of common species, we identified 4 assmblage types that were unique among the water corridor units. This indicated that regional differences in fish communities across water corridors were important for regulating overall fish richness within the BITH. In addition to important regional variation in fish assemblage structure across water corridors, local factors also regulated fish species richness in the BITH. For example, there was substantial variation in species composition across microhabitat types within each stream, indicating that local habitat structure was an important force contributing to fish richness within each water corridor unit. Thus, local microhabitat variation was indirectly contributing to richness in the BITH as a whole by directly promoting richness within each water corridor unit.

Objectives

The objectives of this study was to extend our sampling effort in the BITH by incorporating a temporal component to the overall monitoring program supported by the ATBI. By adding a temporal component, our goal was to (1) increasing the total number of samples (and sampling hours) taken from the BITH and thus increasing the likelihood of collecting rare species, (2) targeting transient species that might vary with season, and (3) identifying temporal patterns in community structure that are critical for detecting unnatural community change that could result from anthropogenic disturbances.

Methods

We took monthly fish collections from two locations for six stream corridors in the Big Thicket National Preserve (Fig. 1). Collections were made at road crossing within a ~100m stream reach. We collected fishes by seining (4.6 long X 1.8 tall, 30mm-mesh) all available habitat in each reach. Fishes were either identified and counted in the field (when appropriate) or preserved in 10% formalin (if identification was questionable) and returned to the laboratory for identification. Fishes that were returned to the laboratory were identified and place in 70% ethanol for long-term archival storage in the Sam Houston State University Vertebrate Museum.

We compared the number of families, number of species, assemblage composition and degree of temporal (month to month) variation in assemblages for each stream corridor. Assemblage composition and degree of temporal variation was determined with correspondence analysis using the PCOrd multivariate ordination software.

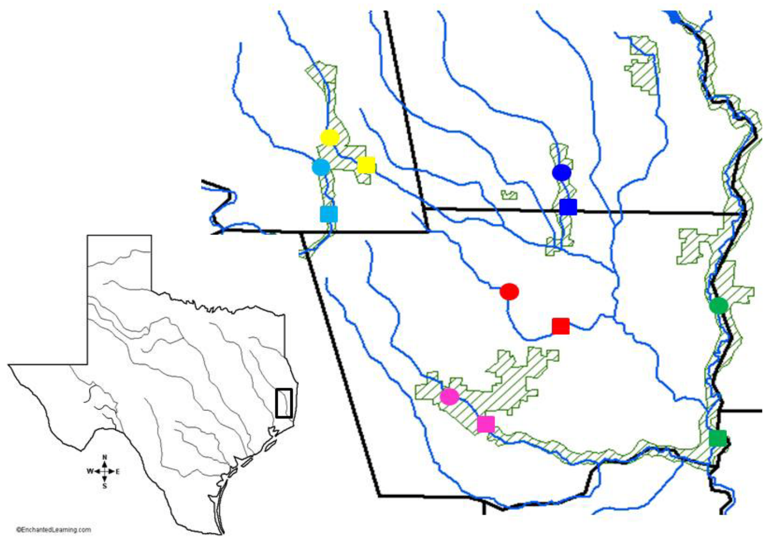

Figure 1. Sample location for the six river corridores sampled in the BITH. Colors correspond to sample localities in Fig. 2.

Results

We collected 62 species representing 18 fish families from six river corridors sampled monthly throughout the Big Thicket National Preserve (BITH; Table 1). Fish assemblages in the BITH were distinguished by three unique assemblage types specific to different water corridors (Fig. 2). I classified these assemblage types and their representative streams as (1) small stream assemblages (common in Menard Creek, Big Sandy Creek, Turkey Creek), (2) large river assemblages (Village Creek and Neches River), and (3) a swamp assemblage (Little Pine Island Bayou).
Below I describe the composition, richness and degree of temporal variation for each of these assemblage types.

Small Stream Assemblages

Menard Creek, Big Sandy Creek, and Turkey Creek had unique assemblages that I classified as a small stream assemblage type. These assemblages had the lowest species richness (22 to 29 species) and the fewest families (6 to 10; Table 1). Most species in these assemblages were represented by the minnow (Cyprinidae), sunfish (Centrarchidae) and darter (Percidae) families. A few unique representatives of these families, which were found only in these small streams, separated these assemblage types from the others (Fig. 2). In general, these assemblages were more temporally variable than assemblages in the other corridor units as indicated by the spread of points in multivariate space (Fig. 2).

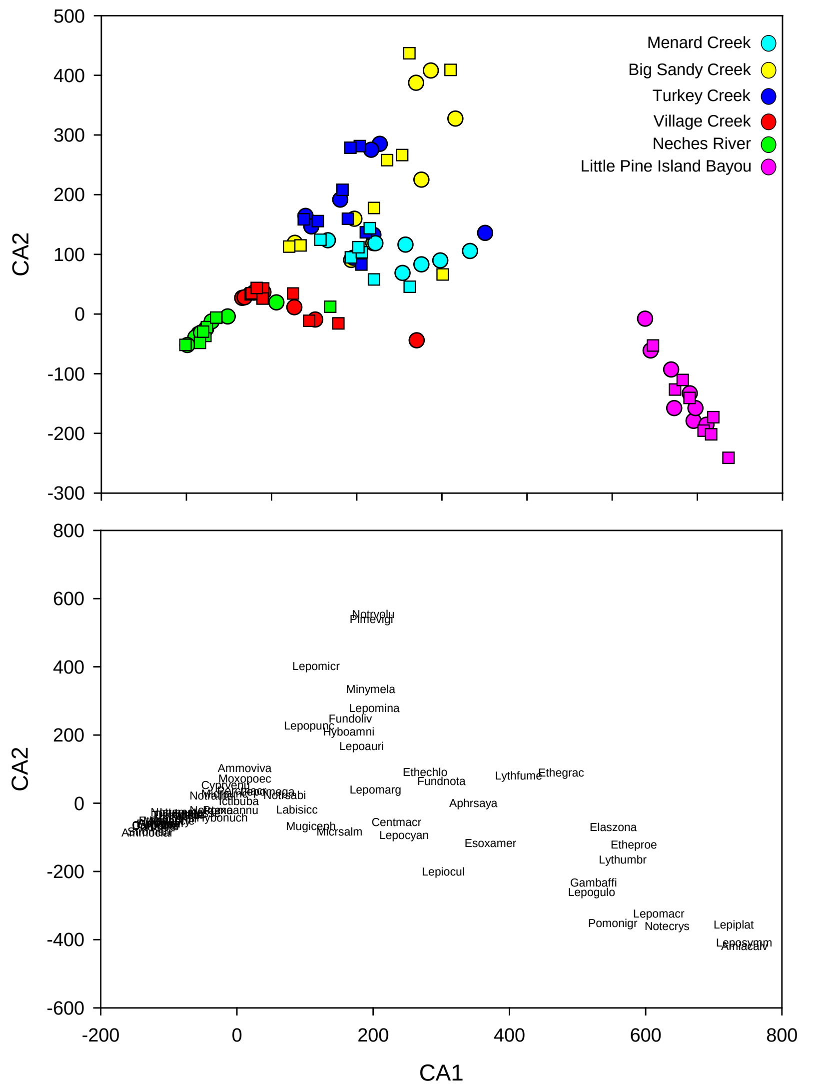

Figure 2. Ordination plot of locality scores (top panel) and species scores (bottom panel) from a correspondence analysis based on proportional abundance of all taxa. stream corridores are indicated by color and upstream (circles) and downstream (squares) locations within each river corridore are indicated by shape.

Large River Assemblages

Village Creek and the Neches River had unique assemblages that I classified as the Large River assemblage type. Although Village Creek had similar number of families and species found in small streams (10 families and ca. 30 species), the composition of the assemblage and the degree of temporal variation was similar to the Neches River (Fig. 2). The Neches River had the most specious fish assemblage, which included 16 fish families and 47 species (Table 1). The unique species that defined these large river assemblages included a gar, two shads, several minnow species, and two large-bodied suckers. We collected some estuary species in both of these rivers (Striped mullet, Hog choker and Atlantic needlefish). These species were not present in any of the other river systems. In general, Neches River had less temporal variation than the small stream assemblages

Swamp Assemblage.

Little Pine Island Bayou had the most unique fish assemblage, which I classified as a swamp assemblage (Fig. 2). This assemblage had the second greatest number of family and species (Table 1). Several low-land species that are often common to swamp-like habitats defined this assemblage. This included the bow fin, a gar, and a species of pygmy sunfish. In general the temporal variation in the fish assemblages of Little Pine Island Bayou was less than the small stream assemblages and similar to the large river assemblages.

Conclusions

Objective 1 - To increase total number of samples (and sampling hours) taken from the BITH and thus increasing the species count.

The previous ATBI funded research (Summer 2008) produced a species list of 44 taxa. Our extended temporal sampling expanded this list by 18 additional species. The new list for the BITH currently includes 62 species and 18 families. Therefore, this additional study significantly enhanced the number of species documented from this preserve, providing a more representative list of taxa in the BITH. I feel that there are additional species that could eventually be added to this list, but these species are likely extremely rare taxa (e.g., Alligator gar; lamprey species; American eel, large sucker species). Additional sampling methodology in specific habitats aimed at collecting these specific taxa is likely needed to add these taxa to the total ATBI inventory.

Objective 2- *To target transient species that might vary with season.*

Several of the species added to the list were transient taxa that migrated upstream from estuary ecosystems. These included the striped mullet, hog choker, and Atlantic needlefish. These taxa are not rare species, but rather just transient taxa that we happened to collect during our monthly sample intervals. These taxa are likely present in the stream corridors throughout the BITH but only during times when they are moving upstream for spawning .

Objective 3- To identify temporal patterns in community structure that are critical for detecting unnatural community change that could result from anthropogenic disturbances.

I analyzed monthly variation in assemblage structure for each river corridor in the BITH. Some general patterns emerge from this analysis. First, the small stream assemblages are the most temporally variable assemblages in the BITH river corridors. Therefore, relative to other streams these will be most difficult for identifying human stressors by monitoring fish assemblages. These assemblages were likely the least stable because local habitat variation across space is probably an important driver of assemblage structure than community-level interaction. Therefore, these assemblages likely mirror temporal variation in habitat across space. The most stable assemblages where the large rivers and the swamp communities. Therefore, these assemblages may be ideally suited for identifying human impacts in the BITH via monitoring biota. These data suggest that biotic interaction may play an important role in structuring large river and swamp assemblages in the BITH.

Overall, the data summer 2008, and 2009-2010 indicated that fish species richness in the BITH is regulated by a combination of both regional, local forces and temporal forces (e.g., Hoeinghaus et al. 2006). Thus, loss of a single water corridor unit or connectivity among units would negatively affect overall fish richness in the BITH as a whole. Moreover, our data also indicate that the loss of important in-stream structure that contributes to local microhabitat availability within each river also is critical for overall species richness within the BITH. Much of this local structure within water corridors comes from fallen trees, undercut banks, and scour pools. Thus, it is evident that a dynamic and healthy riparian zone contributes to this in-stream structure (e.g., Jones & Helfman 1999; Horwitz et al. 2008), and, therefore, riparian protection is critical for conserving overall fish richness in the BITH (see Pusey & Arthington 2003).

Progress towards deliverables

Below is a list of progress toward the projected deliverables as stated in the original proposal:

1. A more complete list of fish taxa occurring within the BITH – it is plausible that we will add 15 to 20 more fish taxa to our current species list via increased sampling effort;

Progress- deliverable90% met; August and September 2010 samples will be processed.

2. Identification of rare and transient fishes occurring within the BITH;

Progress- deliverable met.

3. An understanding of the seasonal community types across water corridor units;

Progress- deliverable met.

4. A general understanding of the intra-annual variation (i.e., stability) of fish community structure across water corridors;

Progress- deliverable met.

5. A comprehensive model describing predictability of fish richness in the BITH across space and time;

Progress- this will require further analysis, which will be included in the final publication.

6. A peer reviewed publication in a regional journal and several presentations at scientific conferences describing temporal variation in fishes of the BITH.

Progress- A publication over this work will be submitted in Spring 2011.

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Table 1. Relative abundance of all species by family for six stream corridores sampled monthly in the Big Thicket National Preserve

Family	*Genus*	*Species*	*Menard Creek*	*Big Sandy Creek*	*Turkey Creek*	*Village Creek*	*Neches River*	*Little Pine Island Bayou*
Lepisostidae								
	Lepisosteus	***oculatus***					5	4
	Lepisosteus	***osseus***					4	
	Lepisosteus	***platostomus***						1
Amiidae								
	Amia	***calva***						2
Clupeidae								
	Dorosoma	***cepedianum***					149	
	Dorosoma	***petenense***					439	
Cyprindae								
	Cyprinella	***lutrensis***	2	1143			31023	
	Cyprinella	***venusta***	1529		2282	6637	17174	11
	Hybognathus	***nuchalis***					2	
	Hybopsis	***amnis***	29	110	23	11	238	
	Lythrurus	***fumeus***	693	316	45	6	79	810
	Lythrurus	***umbratilis***	86	18	4	3		199
	Notemigonus	***crysoleucas***				11	8	14
	Notropis	***atherinoides***					2	
	Notropis	***emiliae***		50		24	14	16
	Notropis	***sabinae***		1		688	5010	
	Notropis	***texanus***	5	4	4	102	183	
	Notropis	***volucellus***	257	1141	616	166	393	9
	Pimephales	***vigilax***		765	361	537	7022	1
Catastomidae								
	Carpoides	***carpio***					8	
	Ictiobus	***bubalus***					2	

	Minytrema	***melanops***		5	7			
	Moxostoma	***poecilurum***	4	1				
Ictaluridae								
	Ictalurus	***furcatus***					5	
	Ictalurus	***punctatus***					7	
	Noturus	***nocturnus***		1		3		
Esocidae								
	Esox	***americanus***		2		4	4	12
Aphredoderidae								
	Aphredoderus	***sayanus***		1	10	15	2	12
Mugilidae								
	Mugil	***cephalus***				1	11	
Atherinopsidae								
	Labidesthes	***sicculus***		15	6	66	89	16
	Menidia	***beryllina***					228	
Belonidae								
	Strongylura	***marina***					2	
Fundulidae								
	Fundulus	***blairae***					3	
	Fundulus	***notatus***	174	103	81	124	112	192
	Fundulus	***olivaceus***	81	69	108	106	18	1
Poeciliidae								
	Gambusia	***affinis***	50	193	103	1034	371	2796
Centrarchidae								
	Centrarchus	***macropterus***		1		23		1
	Lepomis	***auritus***	7					1
	Lepomis	***cyanellus***				8		
	Lepomis	***gulosus***		2	2	1	5	20
	Lepomis	***macrochirus***	16	23	13	5	91	543

	Lepomis	***marginatus***	9	15	3	21	22	3
	Lepomis	***megalotis***	14		6	42	64	9
	Lepomis	***microlophus***			1			
	Lepomis	***minatus***	3		8	2		
	Lepomis	***punctatus***			5	3	3	1
	Lepomis	***symmetricus***						5
	Micropterus	***punctulatus***	3	13	15	14	142	
	Micropterus	***salmoides***	3	1	1	1	21	7
	Pomoxis	***annularis***					13	
	Pomoxis	***nigromaculatus***					4	7
Percidae								
	Ammocrypta	***clara***					3	
	Ammocrypta	***vivax***	36	122	128	90	568	
	Etheostoma	***asprigene***					1	
	Etheostoma	***chlorosomum***	22	26	32	23	14	33
	Etheostoma	***gracile***		9	3	1		16
	Etheostoma	***proeliare***	13	15	6	6		93
	Percina	***macrolepida***					52	
	Percina	***sciera***	22	24	43	116	30	
Sciaenidae								
	Aplodinotus	***grunneins***					6	
Ellasomatidae								
	Elassoma	***zonatum***			4			14
Achiridae								
	Trinectes	***maculates***					16	

	Menard Creek	*Big Sandy Creek*	*Turkey Creek*	*Village Creek*	*Neches River*	*Little Pine Island Bayou*
Families per site	6	10	9	10	16	12
Species per site	22	29	28	33	47	30
Individuals per site	3058	4189	3920	9894	63662	4849
Total Families	18					
Total Species	62					
Total Individuals	89572					