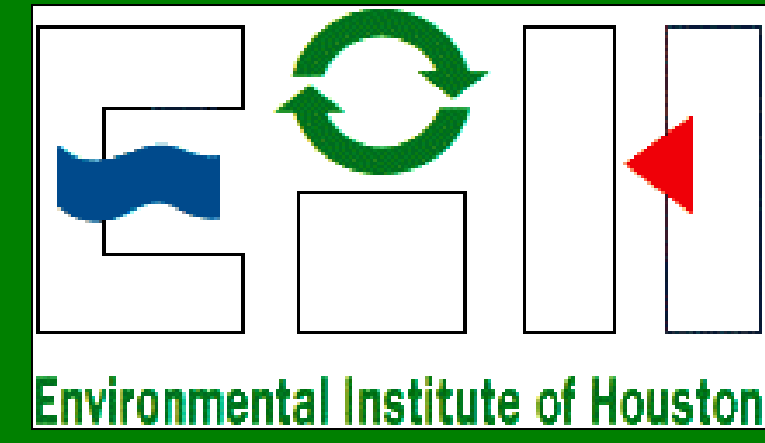


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Construction of River Fish Community Guilds Using Life History Characteristics and Multivariate Classification Methods: Case Study Trinity River, Texas



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Introduction

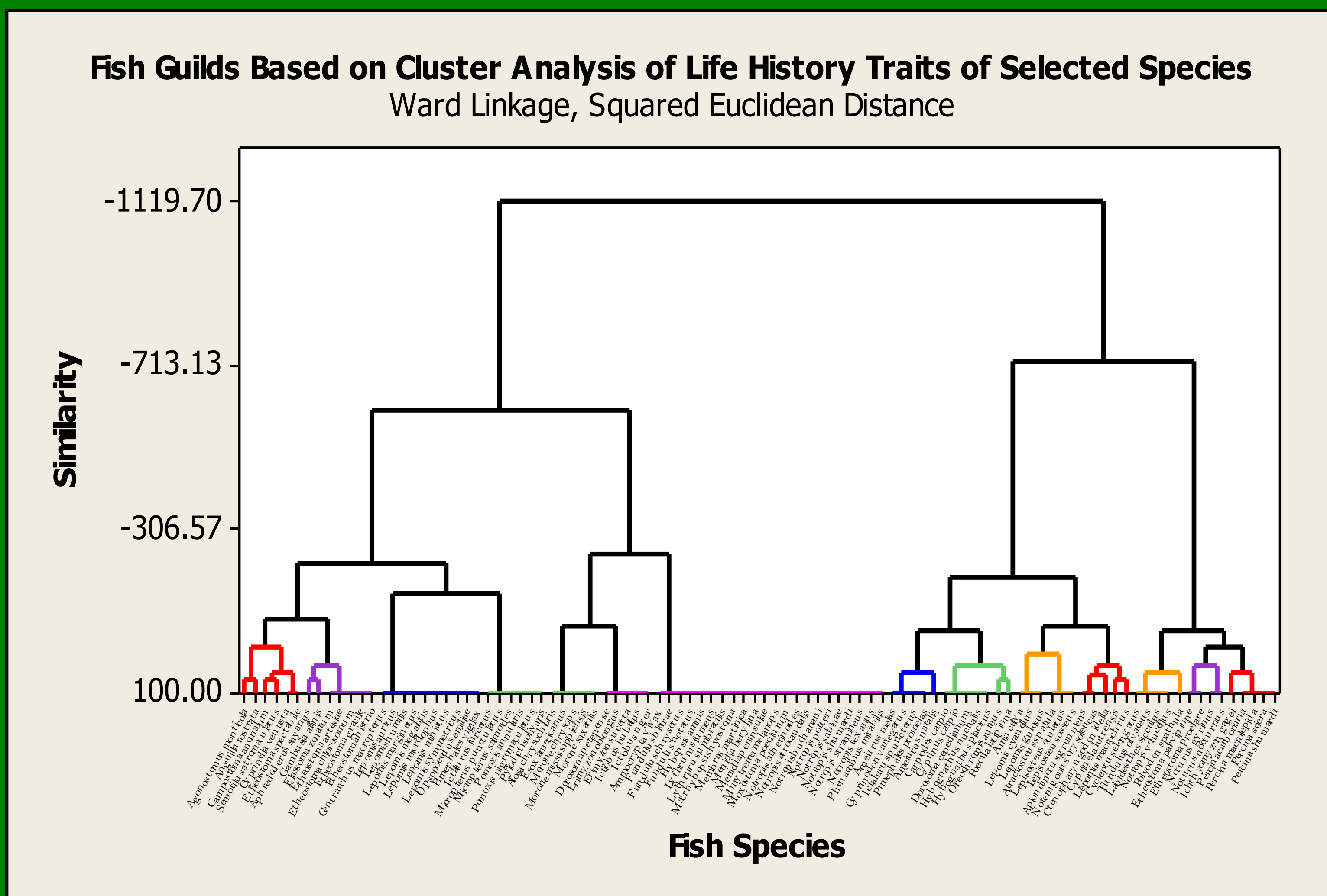
During 2009 we conducted a project funded by the Trinity River Authority (TRA) and others to evaluate spatial and temporal trends in Trinity River fish populations and communities. A comprehensive database and accompanying analysis was used to support recent ecological instream flow analyses of the Trinity River conducted by the Trinity-San Jacinto River and Galveston Bay, Basin and Bay expert Science Team (BBEST) in support of SB3 initiatives associated with the Galveston Bay watershed (Guillen et al. 2009). A total of 134 species were identified. However, to evaluate potential flow ecology relationships, it was necessary to reduce and focus the analysis on target "focal" species of concern. These species represented sensitive species and/or important game fish. To address potential impacts on the entire community we also attempted to reduce the original species matrix into a smaller group of ecologically similar "guilds" based on habitat preferences, environmental tolerances, trophic levels, reproductive traits and biological processes. We utilized cluster analysis techniques to construct guilds based on the similarity of these traits. These guilds represent species assemblages with analogous life history characteristics which should exhibit similar responses to environmental stressors. In addition previously identified candidate "focal" species were examined to determine if they were present in most guilds. Membership in a guild would suggest that the focal species exhibits life history characteristics similar to other members of the group. Management of flow regimes for protection of this focal species could be used to protect associated guilds.

Methods

To facilitate construction of meaningful species guilds we classified species based on published literature into their respective trophic levels, water quality tolerance, reproductive behavior, and early life history classifications (Balon 1975; Balon 1981; Linam and Kleinsasser 1998; Simon 1999). If data were lacking for a species we would utilize information from taxonomically related species that share similar life history traits. After compiling the list of fish species and their associated attributes, a multivariate cluster analysis technique (Wards algorithm, squared Euclidean distance) was used to classify species (observations) based on shared characteristics (Romesburg 1990). Cluster analysis was run using the Minitab software package supplemented by the Clustan software package using the "Best Cut" procedure to identify the appropriate number of groups (Wishart 2006). This process produced a multivariate dendrogram which depicts the similarity of species and species groups based on shared life history attributes. After examination of the output we then classified fish species with highest group affinities into community guilds.

Results

Fish species with similar traits were placed into one of 14 community guilds (Figure 1 and Table 1). We then checked to see if at least one candidate "focal" species (from both San Jacinto and Trinity River lists) occurred in each of the community guilds and could therefore theoretically serve as indicator species for that guild as well. Focal species were associated with many of the specific clusters or guilds.



Conclusions:

Trinity and San Jacinto River focal species are found in 7 of the 14 cluster groupings. These clusters or guilds represent a wide range of spawning habitats and life history requirements. Cluster analysis and other multivariate analyses when combined with species life history traits should provide a method for organizing and defining coherent guilds based on life history similarities and habitat use. This tool and approach should facilitate future analyses of fish community responses to changes in hydrological regime, habitat and water quality. Improvements and future analyses will include refining and expanding life history attribute data including growth, longevity and more refined habitat and conducting additional similarity analysis. This should yield even more definitive groupings and facilitate analyses of environmental impacts on freshwater fish communities.

Figure 1: Fish guilds identified from cluster analysis based on life history characteristics including trophic level, water quality tolerance and reproductive behavior. (Balon level 1). Species list based on abbreviated list using recommendations of TPWD and BBEST.

CLUSTER/GUILD	SPECIES	COMMON NAME	FAMILY	TROPHIC	TOLERANCE	BALON LEVEL 1	FOCAL SPECIES
Cluster 1: Mix Brood Hider and Catadromous Fish	<i>Agonostomus monticola</i>	mountain mullet	Mugilidae	O	N	CAT	no
	<i>Anguilla rostrata</i>	American eel	Anguillidae	P	N	CAT	no
	<i>Campostoma anomalum</i>	central stoneroller	Cyprinidae	H	N	A2	no
	<i>Cyprinella venusta</i>	blacktail shiner	Cyprinidae	IF	N	A2	no
	<i>Etheostoma spectabile</i>	orangefthroat darter	Percidae	IF	N	A2	no
Cluster 2: Predator, Open Substratum Riverate Spawner	<i>Semotilus atromaculatus</i>	creek chub	Cyprinidae	P	N	A2	no
	<i>Alosa chrysochloris</i>	skipjack herring	Clupeidae	P	N	A1	no
	<i>Esox americanus</i>	redfin pickerel	Esocidae	P	N	A1	no
	<i>Morone chrysops</i>	white bass	Moronidae	P	N	A1	Trinity River
	<i>Morone mississippiensis</i>	yellow bass	Moronidae	P	N	A1	no
Cluster 3: Omnivore, Tolerant, Nest Spawner	<i>Morone saxatilis</i>	striped bass	Moronidae	P	N	A1	no
	<i>Ameiurus melas</i>	black bullhead	Ictaluridae	O	T	B2	no
	<i>Ameiurus natalis</i>	yellow bullhead	Ictaluridae	O	N	B2	no
	<i>Cyprinodon variegatus</i>	sheepshead minnow	Cyprinodontidae	O	T	B2	no
	<i>Ictalurus punctatus</i>	channel catfish	Ictaluridae	O	T	B2	no
Cluster 4: Predator, Tolerant, Open and Nest Spawners	<i>Pimephales promelas</i>	fathead minnow	Cyprinidae	O	T	B2	no
	<i>Amia calva</i>	bowfin	Amiidae	P	T	B2	no
	<i>Atractosteus spatula</i>	alligator gar	Leptisosteidae	P	T	A1	Trinity River
	<i>Lepisosteus oculatus</i>	spotted gar	Leptisosteidae	P	T	A1	no
	<i>Lepisosteus osseus</i>	longnose gar	Leptisosteidae	P	T	A1	San Jacinto River
Cluster 5: Invertivore, Open Substratum Riverate Spawner	<i>Lepomis cyanellus</i>	green sunfish	Centrarchidae	P	T	B2	no
	<i>Lepomis gibbosus</i>	warmouth	Centrarchidae	P	T	B2	no
	<i>Ammocrypta vivax</i>	scaly sand darter	Percidae	IF	N	A1	no
	<i>Fundulus blairae</i>	western starhead topminnow	Fundulidae	IF	N	A1	no
	<i>Fundulus chrysotus</i>	golden topminnow	Fundulidae	IF	N	A1	no
	<i>Fundulus notatus</i>	blackstripe topminnow	Fundulidae	IF	N	A1	no
	<i>Hybopsis amnis</i>	pallid shiner	Cyprinidae	IF	N	A1	San Jacinto River
	<i>Lythrurus fumeus</i>	ribbon shiner	Cyprinidae	IF	N	A1	San Jacinto River
	<i>Lythrurus umbratilis</i>	redfin shiner	Cyprinidae	IF	N	A1	no
	<i>Macrhybopsis hyostoma</i>	shoal chub	Cyprinidae	IF	N	A1	no
	<i>Membras martinica</i>	rough silverside	Atherinopsidae	IF	N	A1	no
	<i>Menidia beryllina</i>	inland silverside	Atherinopsidae	IF	N	A1	no
	<i>Menidia peninsulae</i>	tidewater silverside	Atherinopsidae	IF	N	A1	no
	<i>Minytrema melanops</i>	spotted sucker	Catostomidae	IF	N	A1	no
	<i>Moxostoma poeciliurum</i>	blacktail redbhorse	Catostomidae	IF	N	A1	San Jacinto River
Cluster 6: Invertivore, Substratum Riverate Choosers & Others	<i>Notropis atherinoides</i>	emerald shiner	Cyprinidae	IF	N	A1	no
	<i>Notropis atrocaudalis</i>	blackspot shiner	Cyprinidae	IF	N	A1	Trinity & San Jacinto Rivers
	<i>Notropis buchanani</i>	ghost shiner	Cyprinidae	IF	N	A1	no
	<i>Notropis potteri</i>	chub shiner	Cyprinidae	IF	N	A1	no
	<i>Notropis sabiniae</i>	Sabine shiner	Cyprinidae	IF	N	A1	no
	<i>Notropis shumardi</i>	silverband shiner	Cyprinidae	IF	N	A1	Trinity River
	<i>Notropis stramineus</i>	sand shiner	Cyprinidae	IF	N	A1	no
	<i>Notropis texanus</i>	weed shiner	Cyprinidae	IF	N	A1	no
	<i>Phenacobius mirabilis</i>	suckermouth minnow	Cyprinidae	IF	N	A1	no
	<i>Aphredoderus sayanus</i>	pirate perch	Aphredoderidae	IF	N	C1	no
Cluster 7: Mainly Invertivore, Tolerant, Open and Nest Spawners	<i>Elassoma zonatum</i>	banded pygmy sunfish	Elassomatidae	IF	N	B1	no
	<i>Etheostoma artesiae</i>	redspot darter	Percidae	IF	N	B1	no
	<i>Etheostoma chlorosomum</i>	bluntnose darter	Percidae	IF	N	B1	no
	<i>Etheostoma gracile</i>	slough darter	Percidae	IF	N	B1	no
	<i>Etheostoma histrio</i>	harlequin darter	Percidae	IF	N	B1	no
	<i>Gambusia affinis</i>	western mosquitofish	Poeciliidae	IF	N	C2	no
Cluster 8: Omnivore, Tolerant, Mainly Open Spawners	<i>Aplodinotus grunniens</i>	freshwater drum	Sciaenidae	IF	T	A1	Trinity River
	<i>Ctenopharyngodon idella</i>	grass carp	Cyprinidae	H	T	A1	no
	<i>Cyprinella lutrensis</i>	red shiner	Cyprinidae	IF	T	A2	no
	<i>Lepomis macrochirus</i>	bluegill	Centrarchidae	IF	T	B2	no
	<i>Notemigonus crysoleucas</i>	golden shiner	Cyprinidae	IF	T	A1	no
Cluster 9: Invertivore, Nest Spawners	<i>Carpodacus carpio</i>	river carpsucker	Catostomidae	O	T	A1	no
	<i>Cyprinus carpio</i>	common carp	Cyprinidae	O	T	A1	no
	<i>Dorosoma cepedianum</i>	gizzard shad	Clupeidae	O	T	A1	no
	<i>Hybognathus nuchalis</i>	Mississippi silvery minnow	Cyprinidae	O	T	A1	no
	<i>Hybognathus placitus</i>	plains minnow	Cyprinidae	O	T	A1	no
Cluster 10: Mainly Invertivore, Intolerant, Open Water Spawners	<i>Oreochromis aureus</i>	blue tilapia	Cichlidae	O	T	B1	no
	<i>Poecilia latipinna</i>	saillin molly	Poeciliidae	O	T	C2	no
	<i>Centrarchus macropterus</i>	flier	Centrarchidae	IF	N	B2	no
	<i>Lepomis auritus</i>	redbreast sunfish	Centrarchidae	IF	N	B2	no
	<i>Lepomis humilis</i>	orangespotted sunfish	Centrarchidae	IF	N	B2	no
	<i>Lepomis marginatus</i>	dollar sunfish	Centrarchidae	IF	N	B2	no
	<i>Lepomis megalotis</i>	longear sunfish	Centrarchidae	IF	N	B2	Trinity River
	<i>Lepomis microlophus</i>	reardear sunfish	Centrarchidae	IF	N	B2	no
	<i>Lepomis miniatulus</i>	redspotted sunfish	Centrarchidae	IF	N	B2	no
	<i>Lepomis symmetricus</i>	bantam sunfish	Centrarchidae	IF	N	B2	no
Cluster 11: Omnivore, Open Water Spawners	<i>Opsopoeodus emiliae</i>	pugnose minnow	Cyprinidae	IF	N	B2	no
	<i>Pimephales vigilax</i>	bullhead minnow	Cyprinidae	IF	N	B2	no
	<i>Cypleptus elongatus</i>	blue sucker	Catostomidae	IF	I	A1	no
	<i>Fundulus olivaceus</i>	blackspotted topminnow	Fundulidae	IF	I	A1	no
	<i>Labidesthes sicculus</i>	brook silverside	Atherinopsidae	IF	I	A1	no
Cluster 12: Invertivore, Intolerant	<i>Notropis volucellus</i>	mimic shiner	Cyprinidae	IF	I	A1	no
	<i>Polyodon spathula</i>	padlefish	Polyodontidae	O	I	A1	Trinity River
	<i>Dorosoma petenense</i>	threadfin shad	Clupeidae	O	N	A1	no
	<i>Erimyzon oblongus</i>	creek chubsucker	Catostomidae	O	N	A1	San Jacinto River
	<i>Erimyzon sucetta</i>	lake chubsucker	Catostomidae	O	N	A1	no
Cluster 13: Invertivore, Intolerant, Brood Hiders	<i>Ictiobus bubalus</i>	smallmouth buffalo	Catostomidae	O	N	A1	no
	<i>Ictiobus niger</i>	black buffalo	Catostomidae	O	N	A1	no
	<i>Etheostoma parvipinne</i>	goldstripe darter	Percidae	IF	I	B1	no
	<i>Etheostoma proelare</i>	cypress darter	Percidae	IF	I	B1	no
	<i>Noturus gyrinus</i>	tadpole madtom	Ictaluridae	IF	I	B2	no
Cluster 14: Predator, Nest Spawners	<i>Noturus nocturnus</i>	freckled madtom	Ictaluridae	IF	I	B2	San Jacinto River
	<i>Ichthyomyzon gagei</i>	southern brook lamprey	Petromyzontidae	None	I	A2	no
	<i>Percina carbonaria</i>	Texas logperch	Percidae	IF	I	A2	no
	<i>Percina macrolepidia</i>	bigscale logperch	Percidae	IF	I	A2	no
	<i>Percina sciera</i>	dusky darter	Percidae	IF	I	A2	Trinity River
Cluster 14: Predator, Nest Spawners	<i>Percina shumardi</i>	river darter	Percidae	IF	I	A2	no
	<i>Ictalurus furcatus</i>	blue catfish	Ictaluridae	P	N	B2	Trinity River
	<i>Micropterus punctulatus</i>	spotted bass	Centrarchidae	P	N	B2	no
	<i>Micropterus salmoides</i>	largemouth bass	Centrarchidae	P	N	B2	Trinity River
	<i>Pomoxis annularis</i>	white crappie	Centrarchidae	P	N	B2	no
Cluster 14: Predator, Nest Spawners	<i>Pomoxis nigromaculatus</i>	black crappie	Centrarchidae	P	N	B2	no
	<i>Pylodictis olivaris</i>	flathead catfish	Ictaluridae	P	N	B2	San Jacinto River

Table 1: Fish guilds identified from cluster analysis based on life history characteristics including trophic level, water quality tolerance and reproductive behavior (Balon level 1). O = Omnivore, IF = Invertivore, Feeder, H = Herbivore, P = Picivore, N = Neutral, T = Tolerant, I = Intolerant, A1 = Open Substratum Spawner, A2 = Brood Hiders, B1 = Substratum Choosers, B2 = Nest Spawners, C1 = External Bearers, C2 = Internal Bearers, CAT = Catadromous

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