You may use the information and images contained in this document for non-commercial, personal, or educational purposes only, provided that you (1) do not modify such information and (2) include proper citation. If material is used for other purposes, you must obtain written permission from the author(s) to use the copyrighted material prior to its use.

Construction of River Fish Community Guilds Using Life History Characteristics and Multivariate Classification Methods: Case Study Trinity River, Texas
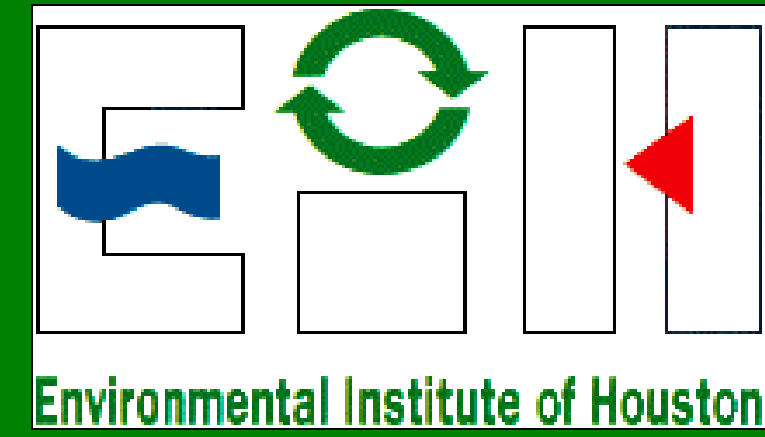
Dr. George Guillen, Jenny Wrast, & Dianna Ramirez

Environmental Institute of Houston, University of Houston Clear Lake
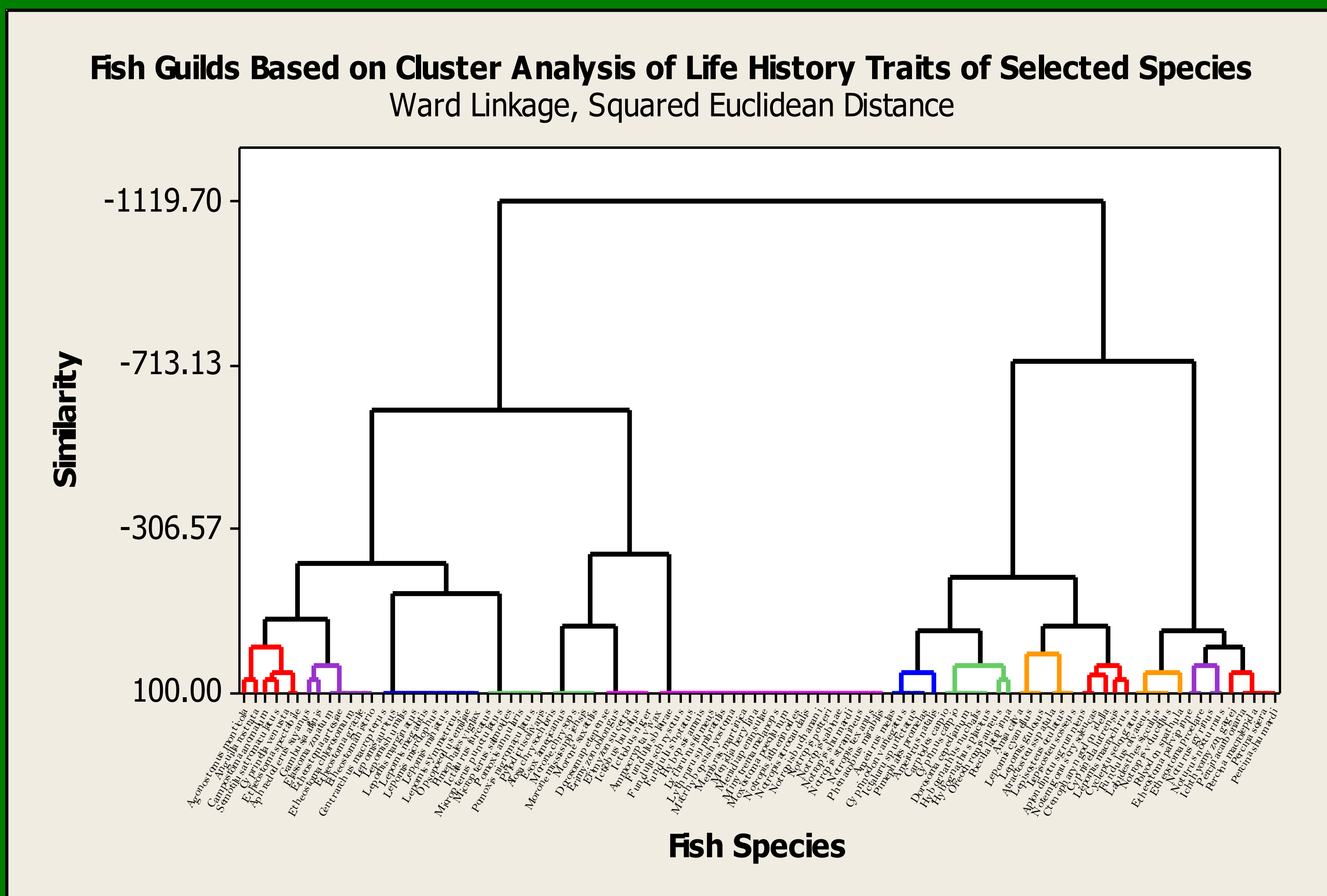
Introduction

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.

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.

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.

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

Funding Provided By: