2010

A Comparison of Traditional and Shoreline Sampling Methods for Fish Communities in Large Wadeable River Segments

Connecticut Department of Energy and Environmental Protection
Bureau of Water Protection and Land Reuse
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Project Summary Report:
A Comparison of Traditional and Shoreline Sampling Methods for Fish Communities in Large Wadeable River Segments

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Executive summary:

The Connecticut Department of Energy and Environmental Protection (DEEP) Bureau of Water Protection and Land Reuse (WPLR) routinely collects ambient fish community data in order to complement macroinvertebrate community data in support of Federal Clean Water Act (FCWA) aquatic life use support assessments (ALUS). Since fish are highly mobile and can readily avoid capture, sampling effort including both specialized gear and additional personnel increases with increasing stream width. The purpose of this project was to evaluate an alternative shoreline sampling method against the traditional whole channel effort in large wadeable river segments.

Forty-seven fish community samples (21 each method) and 5 samples (stream margin only) were collected during the 2008-2010 summer low-flow index periods. These samples were collected from 20 stream segments covering 9 different waterbodies.

Comparison of the traditional and shoreline collection methods indicate comparable findings at the majority of locations. Both methods adequately capture the resident fish community structure, but differ slightly on the length-frequency distribution generated. The shoreline method tends to capture more individuals in the juvenile or young-of-year class while the traditional method tends to capture more adult individuals.

The shoreline method is an adequate replacement for the traditional method when the intended use of fish community data is for FCWA ALUS assessments. As the shoreline method is much less labor and resource intensive, implementation will enable WPLR to increase the number of paired fish and macroinvertebrate data from large wadeable stream segments. The traditional method can be implemented to provide a second opinion or when additional information to augment water quality management decisions, especially when the assessment is ambiguous.

Background:

Beginning in 1999 US EPA Region 1 provided funding to WPLR to facilitate acquisition of fish community data with the intent to augment traditional macroinvertebrate-based water quality assessments. Since fish and macroinvertebrate communities often respond differently to the same anthropogenic stressors, the combination of 2 communities are thought to make ALUS assessments more robust. In recent years WPLR has provided funding to DEEP Inland Fisheries for 1 seasonal resource assistant position in exchange for 24 electrofishing crew days. Fish community samples collected during these 24 crew days are prioritized based on WPLR annual work plan so to maximize the number of streams with both macroinvertebrate and fish community data for ALUS assessments.

Fish community sampling involves obtaining a representative set of organisms from the populations present within a given stream reach and the sampling effort varies greatly by stream width (Table 1). As stream width increase so does the amount of gear and personnel. Traditional large river sampling involves the use of multiple sampling crews working side-by-side throughout the sample reach. Multiple crew sites reduce the total number of crew days and as a result can reduce the total amount of fish community data collected. Sites with stream width greater than 15 meters require multiple crews. This level of effort is double the typical effort and causes a significant reduction in total sites sampled within the 24 crew day budget.

Table 1. Equipment and personnel resources required for established fish community sampling effort in wadeable streams of Connecticut.

Stream Width (m)	Number of Crew	Gear Required	Crew day factor
< 4	3	1 backpack	1
4-8	6	2 backpacks	1
6-12	8	1 tote barge	1
>15	12 or more	2 tote barges or more	2 or more

An alternative method for large river segments was suggested to reduce personnel demands and ultimately increase the number of sites with paired community data. The proposed shoreline method replaces the multiple tote barges and large crews with a smaller field crew of 3-4 personnel and a single backpack electrofishing unit.

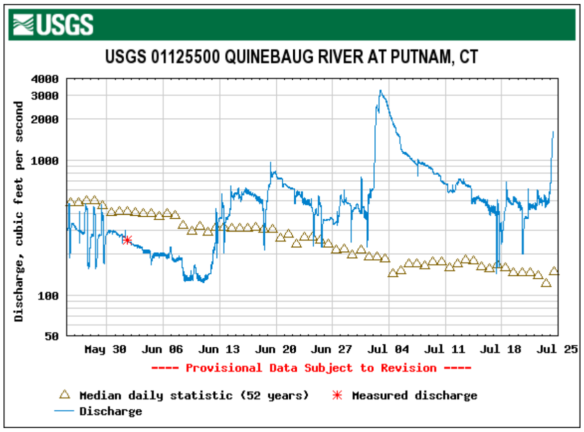
Furthermore, the traditional method usually focuses on the deeper habitat in the central portion of the channel. While this design works well to sample large game species like trout and black bass, it may not represent small negatively buoyant species and young of year individuals. Since the primary use of the fish community data is for aquatic life use support assessments it was thought the shoreline method may meet this goal more efficiently.

The primary question of this study was to determine: Are ALUS assessments based upon fish community data similar between the stream margin approach and the traditional approach? This study answered the research question by evaluating fish species length frequency data collected using the 2 methods at 20 wadeable stream segments on 9 large waterbodies within Connecticut during summer 2008-2010.

Approach:

Data acquisition consisted of collecting 2 sets of fish community data (one shoreline method and the second the traditional method) from each of the 20 selected segments (Figure 1 and Table 2). Candidate segments were selected to have wadeable riffle/run habitat throughout the entire reach, may have had prior traditional fish community samples collected at the same location, were existing macroinvertebrate sampling location, represent various degrees of macroinvertebrate community condition, and is on the WPLR annual work plan.

Sampling occurred during consecutive summer index periods (2008-2009). Unfortunately after 6/12/2009, immediately following collection of all shoreline method samples, the wettest summer on record began. No large river segments were wadeable until spring of 2010. To complete the project the second set of sites were sampled during summer 2010. The hydrograph to the right represents a typical hydrograph for a large wadeable stream segment. From mid-June on these stream segments were not wadeable.



Shoreline method: A WPLR crew of 3-4 personnel used a single Smith-Root Model L-24 backpack electrofishing unit to collect all fish within 5 meters of each stream bank throughout the sample reach (yellow lines in right side photo). After collection each fish was identified to species, measured to the nearest centimeter and recorded on a length-frequency data sheet, and released to the river.

Traditional method: Second after sufficient time for fish to re-distribute in the sample area (at least 3 weeks), inland fisheries crews of 10-15 personnel would revisit the site using 2 or more Colfelt tote-barges simultaneously side-by-side (yellow lines in right side photo). All fish were collected throughout the sample reach. After collection each fish was identified to species, measured to the nearest centimeter, and recorded on a length-frequency data sheet, and released to the river.

Data evaluation:

Samples collected using both methods were evaluated using a variety of tools. First since the overall question was to compare MW MMI scores between methods, the respective length frequency data were used to calculate the MW MMI. Various statistics including paired t-test and relative percent differences as well as various plots were made using Minitab Statistical software.

A more specific and detailed look at the each sample data was reviewed for number and type of unique species and common species, relative abundance, and quantity of each centimeter class by method.

Summary:

Fish community sampling of large wadeable stream segments is a logistical challenge. Traditional effort is very equipment and staff intensive and has limited the amount of segments where WPLR has been able pair with macroinvertebrate community data. The shoreline method is much less resource intensive and has proven to produce similar end product. WPLR will begin to use the shoreline method as our primary means of fish community data collection beginning in summer 2011. In the case of ambiguous or other assessment concern, WPLR may elect to have a second sample from the segment collected using the traditional approach. It is recommended that a future work focus upon the development of a multi-metric index for the shore-line method or similar assessment tool be developed and calibrated once an adequate number of samples using the shoreline method have been collected.

Citation:

Kanno, Y., J.C. Vokoun, and M. Beauchene. **2010**. Development of dual fish multi-metric indices of biological condition for streams with characteristic thermal gradients and low species richness. Ecological Indicators 10:565-571.

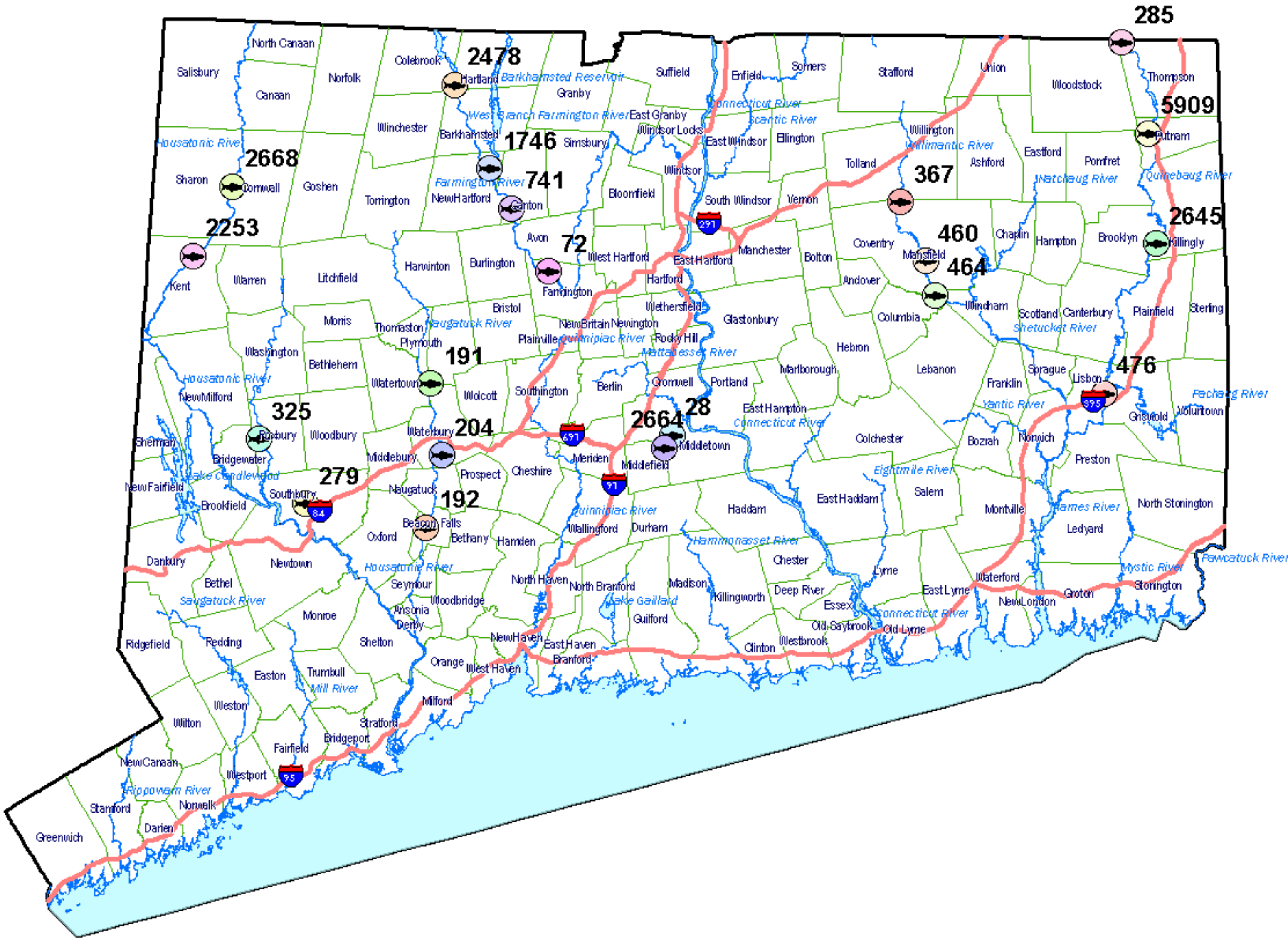


Figure 1. The location with station id for each of the 20 segments sampled for the large river method comparison project. The station id next to each symbol can be cross referenced with the descriptive information in table 1.

Table 2. Descriptive location information for each of the 20 segments sampled for the large river method comparison project.

Station ID	Stream Name	proximity	Landmark	Mean Stream Width (M)	Latitude (DD)	Longitude (DD)	Basin	Municipality
28	Coginchaug River	downstream	Route 66	12	41.55466	-72.6737	4607	Middletown
2664	Coginchaug River	DS	Rte 157 at #740 Wadsworth Street	10	41.5394	-72.6858	4607	Middletown
72	Farmington River	adjacent	Route 4 at Apricots Restaurant	35	41.75077	-72.8717	4300	Farmington
741	Farmington River	100 meters upstream	Steele bridge on Town Bridge Road	35	41.82569	-72.9295	4300	Canton
464	Hop River	upstream	Flanders River Road	25	41.72117	-72.2548	3108	Coventry
2253	Housatonic River	upstream	old bridge abutments end of North Kent Road	60	41.76732	-73.4379	6000	Kent
2668	Housatonic River	adjacent	Rte 7 at first trib upstream of Carse Bk	50	41.8508	-73.3758	6000	Cornwall
191	Naugatuck River	upstream	Frost Bridge Echo Lake Rd and Route 262	25	41.61593	-73.0579	6900	Watertown
192	Naugatuck River	behind	Fire Station	40	41.44348	-73.0642	6900	Beacon Falls
204	Naugatuck River	upstream	South Leonard Street	30	41.53043	-73.0402	6900	Waterbury
279	Pomperaug River	upstream	Transylvania Brook	15	41.47171	-73.256	6800	Southbury
285	Quinebaug River	upstream	Route 197	30	42.02198	-71.9528	3700	Thompson
476	Quinebaug River	downstream	Route 12 and upstream Patchaug River Confluence	58	41.60216	-71.9868	3700	Griswold
2645	Quinebaug River	at end of	Edwardson Street	47	41.7809	-71.901	3700	Killingly
5909	Quinebaug River	between	confluence with Little River and Rte 101 dam	35	41.91287	-71.9121	3700	Putnam
325	Shepaug River	downstream 100 meters	Wellers Bridge Road (Route 67)	25	41.54887	-73.3308	6700	Roxbury
1746	West Branch Farmington River	Adjacent to	Rte 44 between Upcountry Sports and dry cleaners	22	41.87319	-72.9648	4300	New Hartford
2478	West Branch Farmington River	adjacent	# 500 Hogback Road	20	41.9735	-73.0209	4300	Hartland
367	Willimantic River	upstream old bridge	Jones Crossing Road	25	41.83261	-72.3079	3100	Mansfield
460	Willimantic River	upstream	Depot Road Coventry Road	30	41.76226	-72.2691	3100	Mansfield

Key Findings:

Thirty fish species and stocked individuals of brook, brown, rainbow trout and atlantic salmon (Appendix A) were collected in the 21 samples from 9 waterbodies (Appendix B).

Mixed Water Muti-Metric Index (Kanno and others 2010):

Mixed Water Multi-Metric Index score does not significantly differ (p=0.590) between the 2 methods (Figure 2 and Figure 3)

MW MMI scores were nearly evenly split with 11 higher for shoreline method than traditional and 10 higher for traditional than shoreline. (Figure 4 and Appendix C).

Relative percent difference (RPD) between methods ranged from a low of 2.8% to a high of 40.0% with 12 samples < 20% and 9 samples with > 20% RPD (Table 2).

When RPD was > 20% for 6 of the 9 occurrences the shoreline method scored higher than the traditional method.

Component metrics of the MWMMI were consistent between the 2 methods. The one exception may be metric #1; "percent of the sample as white sucker" as samples varied greatly with the shoreline method scoring higher than traditional method (Figure 5 and Figure 6).

Other data review:

The traditional method tends to collect a greater number of total individuals, as expected with the greater number of netters and larger electro-fishing field (Figure 7).

The traditional method tends to collect 1-3 additional species as compared the shoreline method (Figure 8).

Largemouth bass and salmonid species were most likely to be found in the traditional samples versus shoreline samples (Table 3).

Species composition collected at each site varied even when total species collected by each method was not substantially different (Table 4). This is most likely due to the selective sampling of 2 different habitat and the use of these habitats by different species and or different life stages of the same species.

Single individuals of a species represent 20-40% of species found in the traditional method vs. shoreline and vica versa (Table 4). This indicates that large wadeable river habitat can support transient species and these are likely to be encountered when collecting fish with either method. These species represented by a single individual tend not to influence the overall scoring of the MW MMI.

Relative abundance of species by method:

Cyprinid relative abundance by method varied, blacknose dace (BL) had much greater relative abundance in shoreline samples. Conversely, common shiner (CS) had greater abundances in traditional methods. Fallfish and longnose dace were split between sites and methods (Figure 9).

Other commonly collected species varied by site and method (Figure 10, Figure 11, Figure 12).

Length Frequency Distribution of select species by method:

In general the traditional method would capture more individuals of species with life stages in large centimeter size classes (>20 cm total length) (Figures 13-20).

In general the shoreline method would capture the same relative distribution of small to medium life stages (5-20 cm total length) (Figures 13-20).

Of the most commonly collected species the traditional method captured larger individuals in white sucker (Figure 13), redbreast sunfish (Figure 17), smallmouth bass (Figure 18), common shiner (Figure 19) and Fallfish (Figure 20). While the shoreline method capture equal number or greater in American eel (Figure 14), longnose dace (Figure 15), blacknose dace (Figure 16).

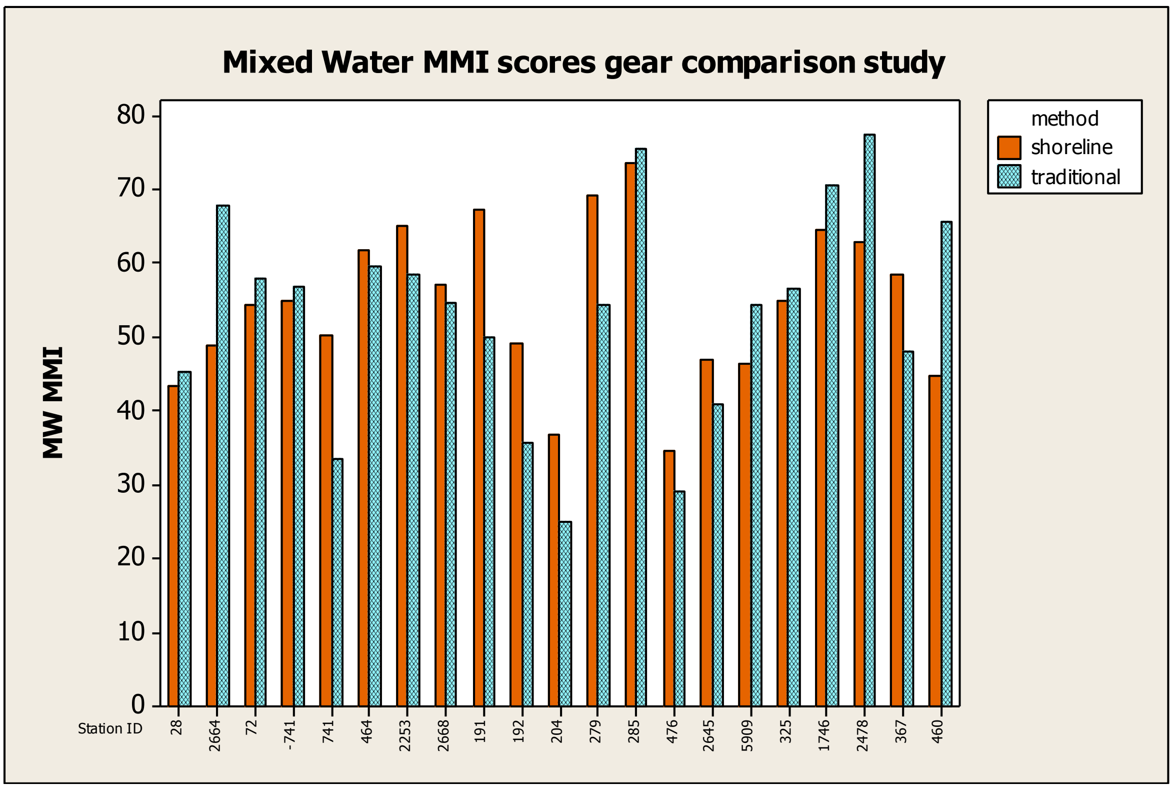


Figure 2. A bar chart representing Mixed Water Multimetric Index Scores (Kanno and others 2010) for paired fish community data collected using a shoreline sampling method and the traditional stream shocking method.

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Paired T for shoreline - traditional

               N   Mean  StDev  SE Mean
shoreline     21  54.49  10.56     2.31
traditional   21  53.17  14.48     3.16
Difference    21   1.32  11.06     2.41


95% CI for mean difference: (-3.72, 6.36)
T-Test of mean difference = 0 (vs not = 0): T-Value = 0.55  P-Value = 0.590
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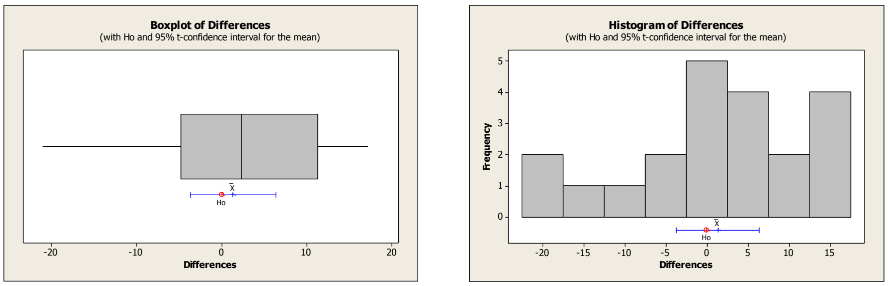


Figure 3. Paired T-test statistics, box plot, and histogram for paired MW MMI scores for fish community data collected using a shoreline sampling method and the traditional stream shocking method.

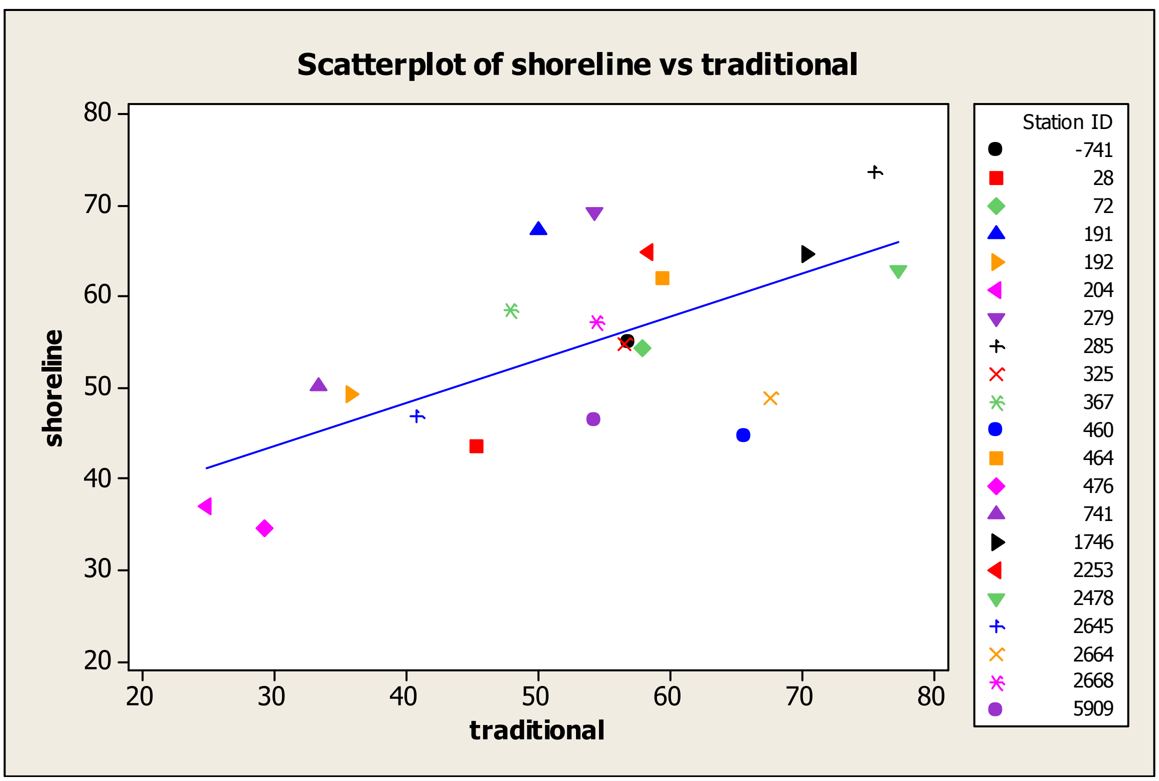


Figure 4. Scatter plot of MW MMI scores for paired fish community data collected using a shoreline sampling method and the traditional tote-barge method.

Table 2. Mixed water multi-metric index scores and the relative percent difference for each of the paired samples. Bold font indicates the higher MWMMI score in the pair of samples.

Station ID	MW MMI score shoreline	MW MMI score traditional	Relative Percent Difference %
28	43.4	**45.3**	4.2
72	54.3	**57.9**	6.6
191	**64.6**	48.1	29.3
192	**49.2**	35.7	31.6
204	**36.9**	24.9	38.8
279	**66.0**	54.2	19.6
285	73.5	**75.6**	2.8
325	54.8	**56.6**	3.1
367	**58.6**	48.0	19.9
460	44.7	**65.7**	38.1
464	**61.9**	59.5	3.9
476	**34.4**	29.2	16.4
-741	55.0	**56.9**	3.4
741	**50.1**	33.4	40.0
1746	64.6	**70.4**	8.6
2253	**64.9**	58.4	10.5
2478	62.8	**77.4**	20.8
2645	**46.8**	40.8	13.8
2664	48.7	**67.7**	32.5
2668	**57.1**	54.5	4.7
5909	46.3	54.3	15.9

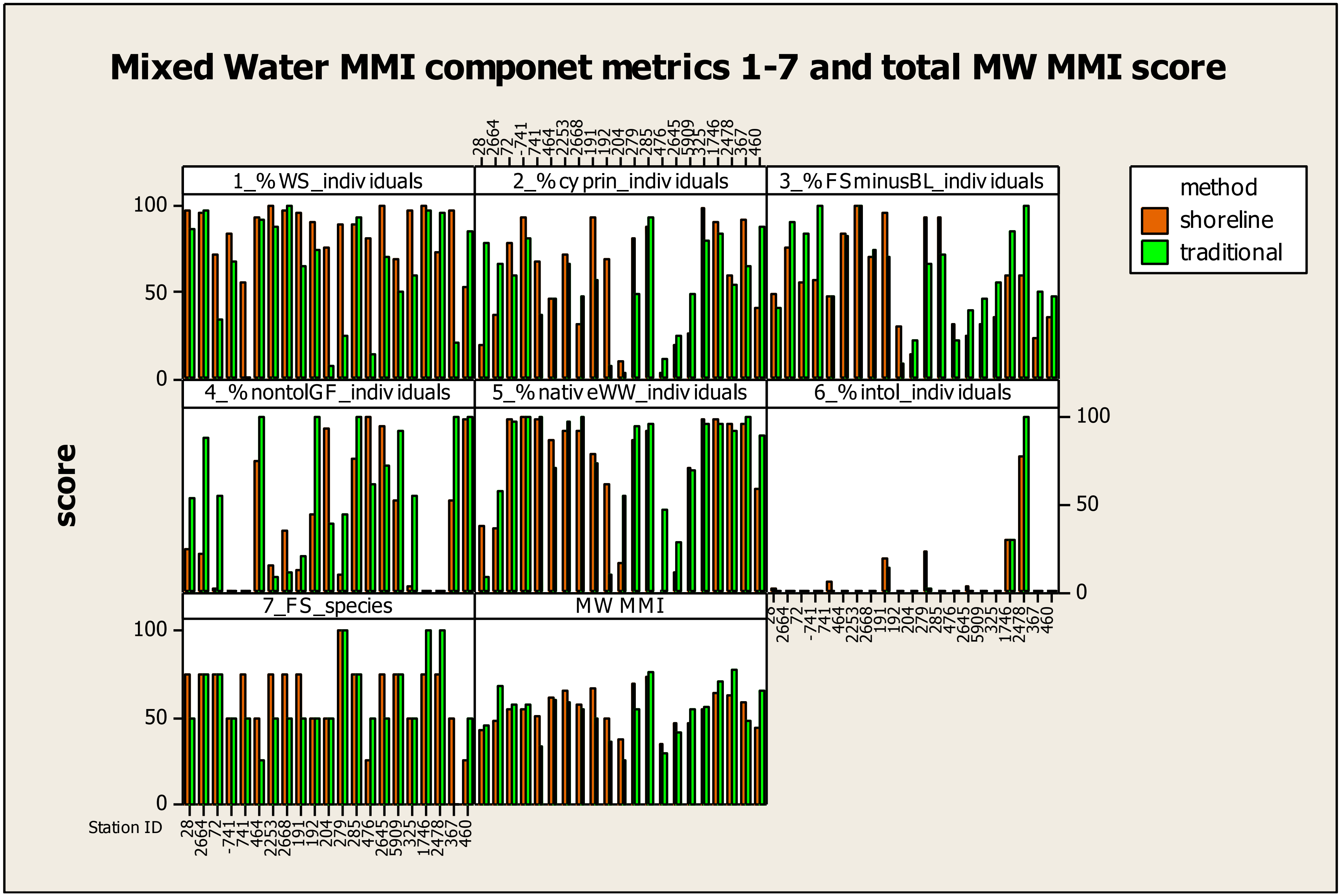


Figure 5. Bar plots of each of the 7 component metrics for the MW MMI. Metric titles are 1 = % of sample as white sucker individuals, 2= % of sample as family cyprinidae individuals, 3= % individuals in fluvial specialist guild without Eastern Black nose dace individuals, 4= % of sample as non tolerant generalist feeders, 5= % of sample as native warm water species, 6= % intolerant individuals, and 7= % of species in sample as fluvial specialist guild.

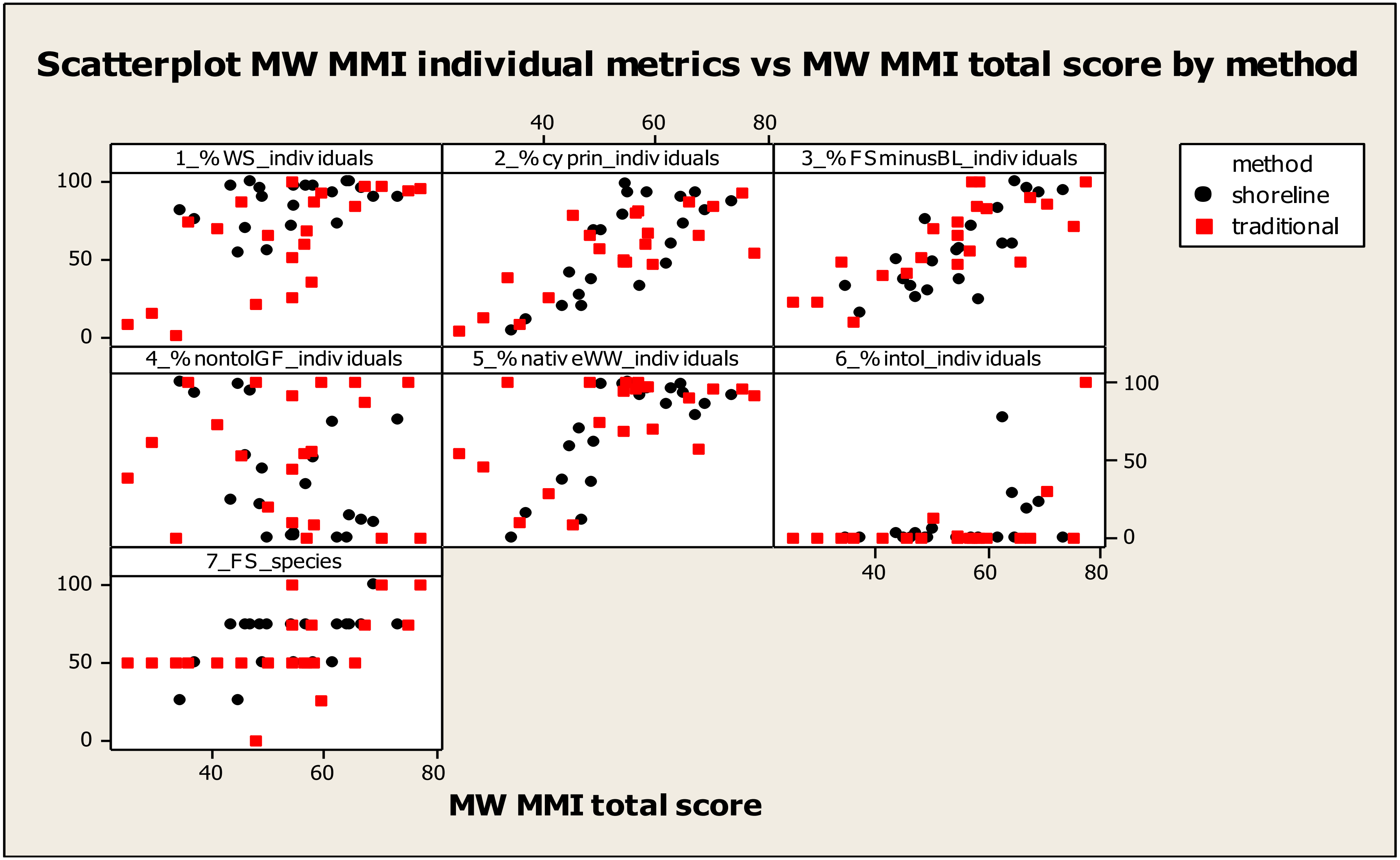


Figure 6. Scatter plots of each of the 7 component metrics for the MW MMI. Metric titles are 1 = % of sample as white sucker individuals, 2= % of sample as family cyprinidae individuals, 3= % individuals in fluvial specialist guild without Eastern Black nose dace individuals, 4= % of sample as non tolerant generalist feeders, 5= % of sample as native warm water species, 6= % intolerant individuals, and 7= % of species in sample as fluvial specialist guild.

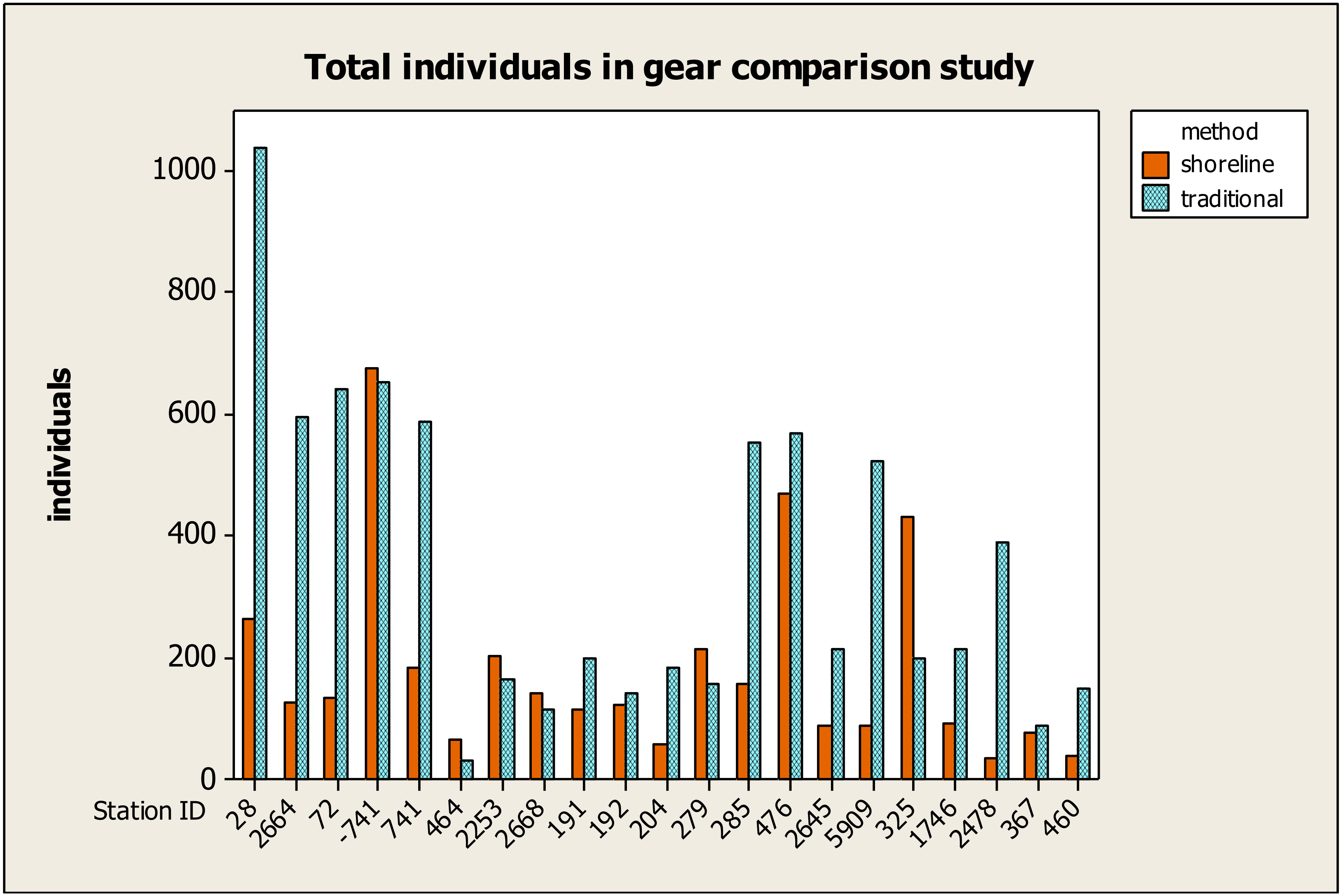


Figure 7. The total number of individual fish captured in each sample for each of the 2 methods. In 15/21 samples the traditional method captured more individuals. The large difference is related to the number of netters on the traditional crew versus the few netters on the shoreline crew.

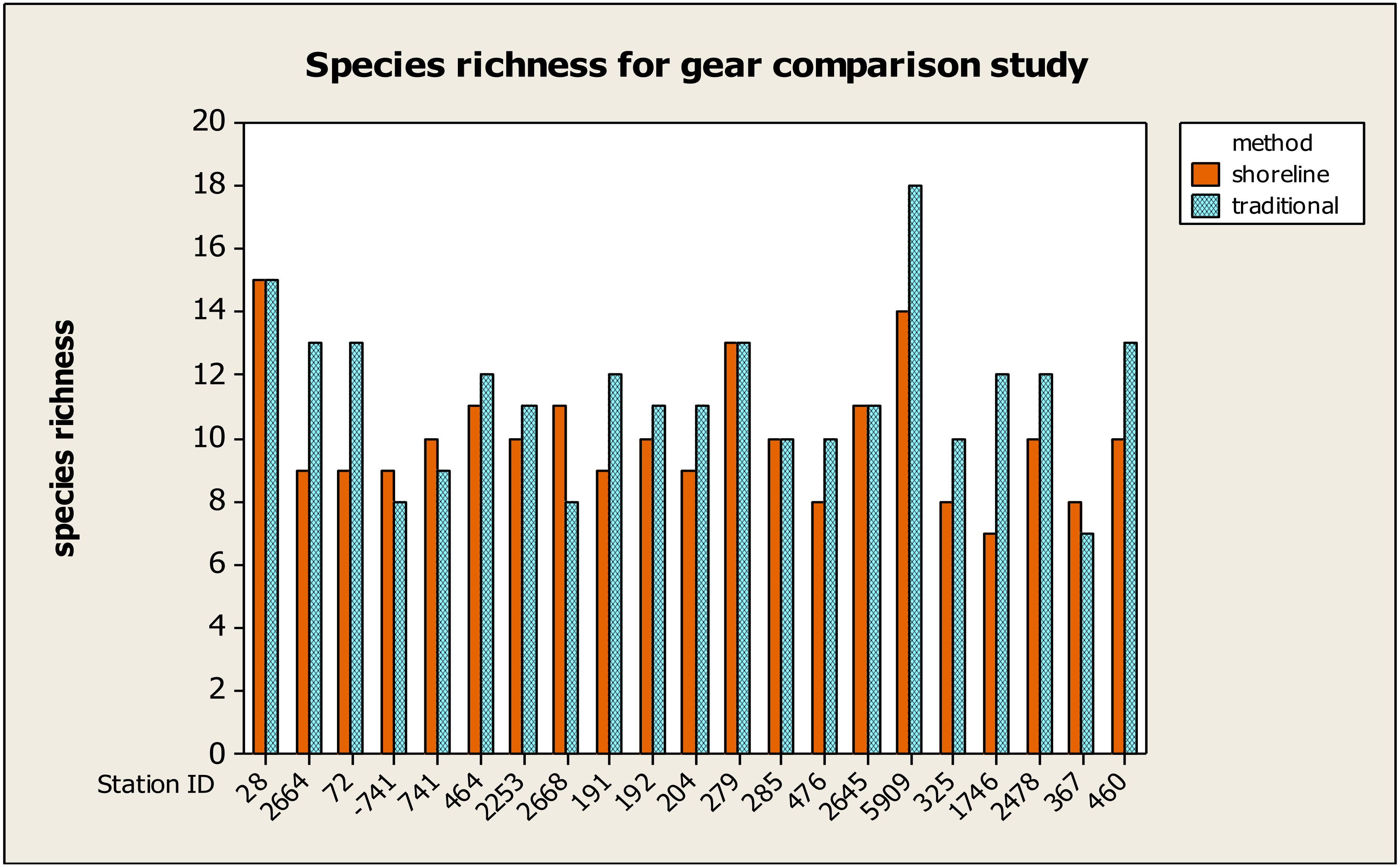


Figure 8. The total number of fish species captured in each sample for each of the 2 methods. In 13/21 samples the traditional method captured more individuals, 4/21 had the same number, and 4/21 the shoreline method had more species.

Table 3. The number of times a fish species was collected in only one of the 2 methods. In the case of Largemouth Bass (LM) it was found in the shoreline method but not traditional method 1 time and in the traditional method but not shoreline method 12 times.

species	shoreline	traditional
LM	**1**	**12**
BN-St	**2**	**9**
RW-St	0	5
WBN	0	5
SM	0	4
YP	0	4
CR	4	0
CP	1	4
BL	4	1
CS	1	3
SS	0	2
WS	0	2
BK-St	2	0
BM	2	0
GR	3	1
GS	4	2
RB	3	1
WBK	3	1
AE	0	1
BG	3	4
PS	2	3
SL	1	2
RP	1	0
RS	2	1
SC	1	0
TD	2	1
YB	2	1

Table 4. Table showing taxa common to each method at each station with taxa found in only the shoreline sample or traditional sample. Bold indicates the species is represented by a single individual (singleton).

station id	# species common to each method	SHORELINE had included	TRADITIONAL had included
28	**11**	**+4 (GR**,RP,**SL**,WBK)	**+4 (GS**,LM,SM,YP)
72	9	+0	+4 (BN-St,**LM**,SL,YP)
191	**7**	**+2 (BG,TD)**	+5 (BN-St,RW-st,SM,**WBN,YB)**
192	7	+2 (GS,**YB)**	+3 (BG,**RB,SL**)
204	9	+0	+2 (BG,**LM**)
279	10	+2 (RB,**SC**)	+3 (CS,**LM,SM**)
285	8	+1 (**BN-St**)	+2 (PS,SM)
325	8	+0	+2 (**RS**,WBN)
367	5	+3 (BL,RS,TD)	+2 (**BN-St**,YP)
460	7	+3 (**GR**,GS,PS)	+6 (**BG**,BL,**BN-St,**CP,**LM,WBN**)
464	8	+3 (BL,**LM,RB**)	+3 (**BN-St**,CP,CS)
476	6	+2 (**BG,BN-St**)	+3 (**CP**,LM,SS)
-741	5	+4 (BK-St,CR,CS,**RB**)	+3 (**BN-St**,RW,WBN)
741	6	+4 (**BG**,CR,**GS**,WBK)	+3 (**AE,BN-St**,LM)
1746	7	+0	+5 (BN-St,RW-St,WBK,WS,YP)
2253	6	+4 (BL,BM,**CR**,GR)	+6 (**PS**,RW-St,WBK,**WBN**,WS,**YB**)
2478	9	+1 (**BK-St**)	+3 (**LM**,RW-St,TD)
2645	7	+3 (GS,**WBK,YB**)	+4 (**GR**,LM,**PS**,WS)
2664	8	+0	+4 (**BN-St,CS**,LM,**WBN**)
2668	5	+6 (**BL**,BM,CR,PS,RS,WS)	+3 (**BG**,BN-St,**RW-St**)
5909	12	+1 (**CP**)	+5 (GS,**LM**,PS,SS,YP)

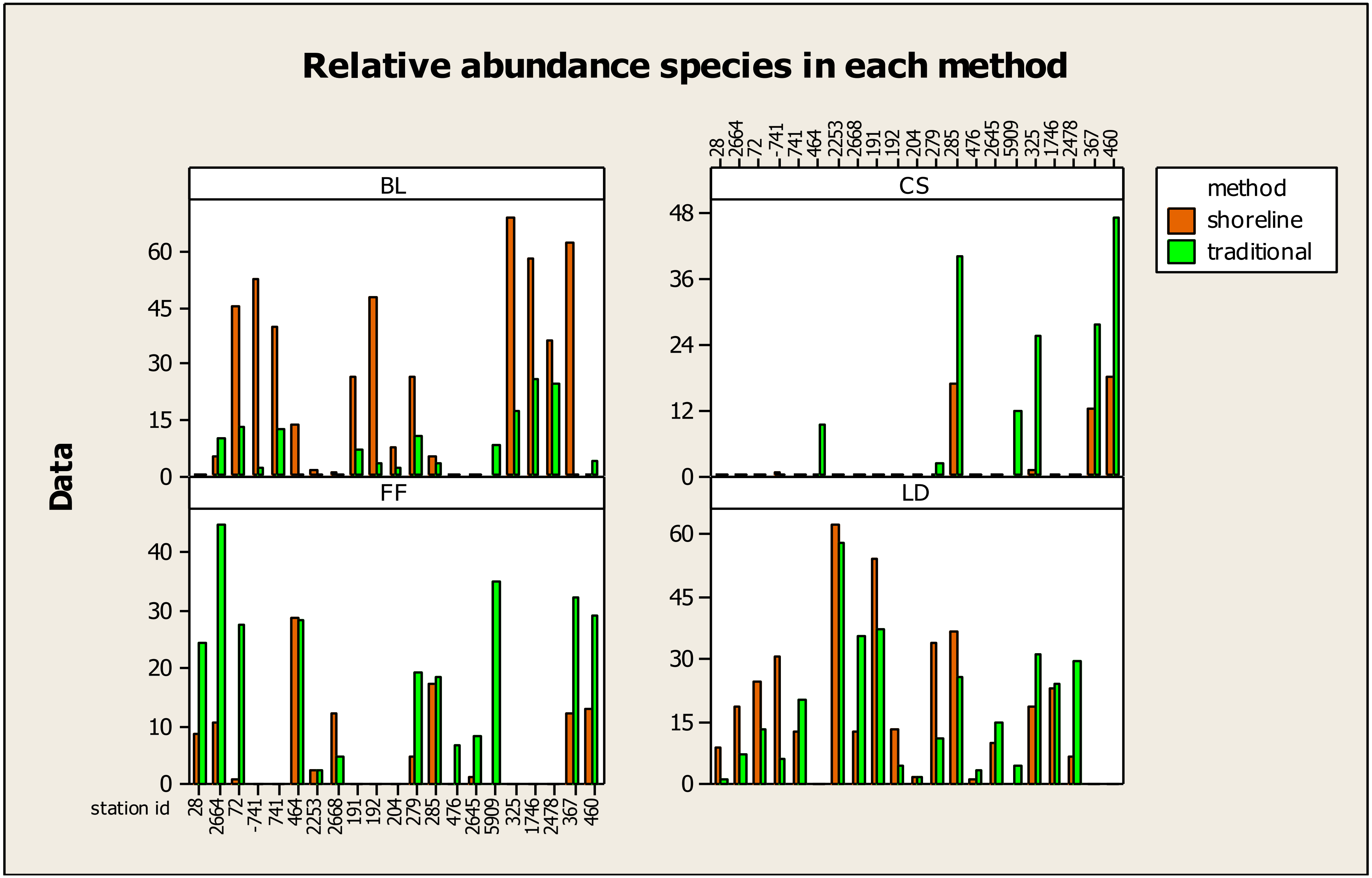


Figure 9. Bar chart plots of the relative abundance for selected cyprinid fish species collected using the shoreline method and the traditional stream shocker method. Abbreviations are; BL= blacknose dace, CS= common shiner, FF=Fallfish, and LD= longnose dace.

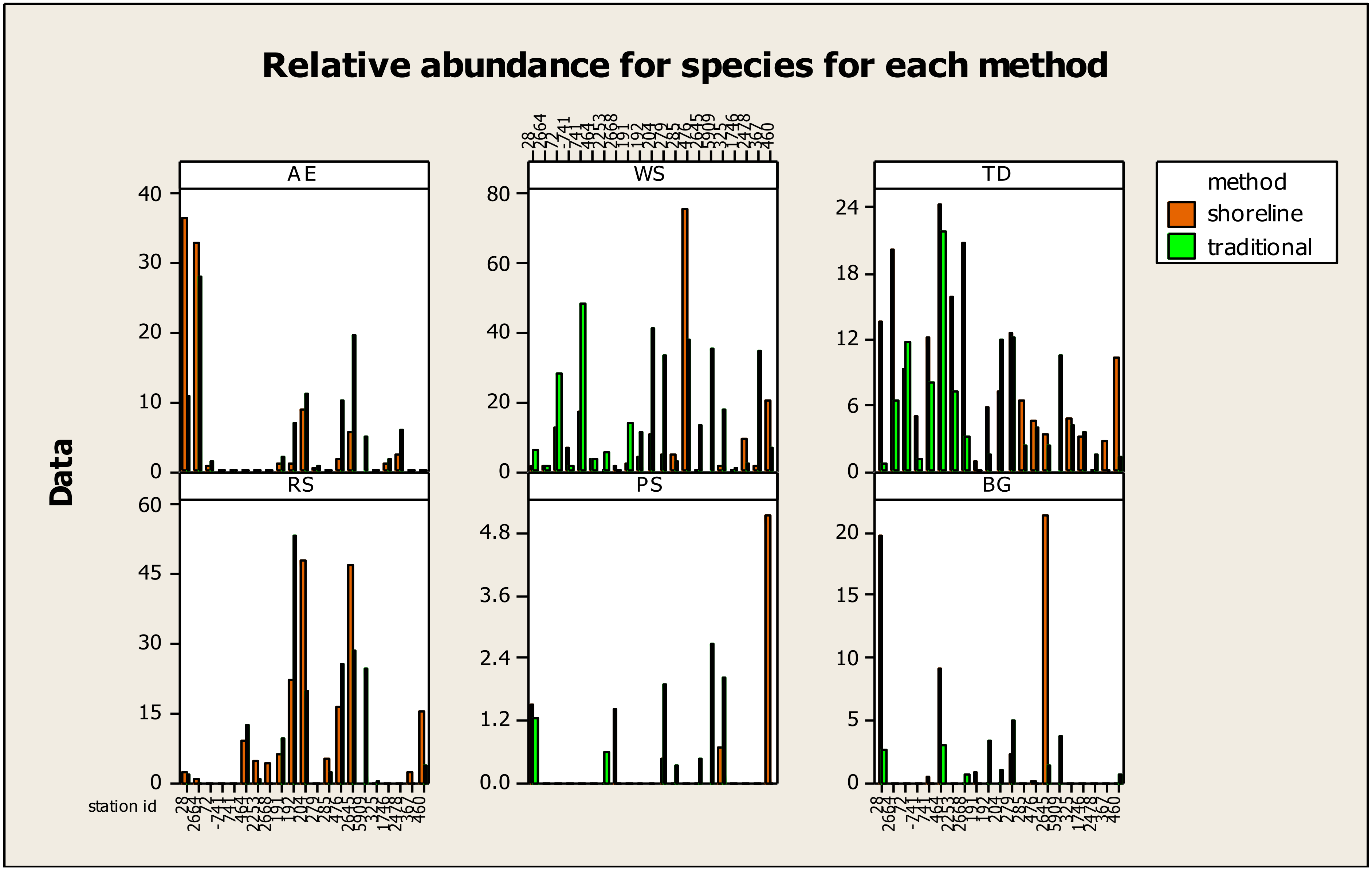


Figure 10. Bar chart plots of the relative abundance for selected fish species collected using the shoreline method and the traditional stream shocker method. Abbreviations are; AE= American Eel, WS= White sucker, TD= tessellated darter, RS= Redbreast sunfish, PS=pumpkinseed sunfish, and BG=bluegill sunfish.

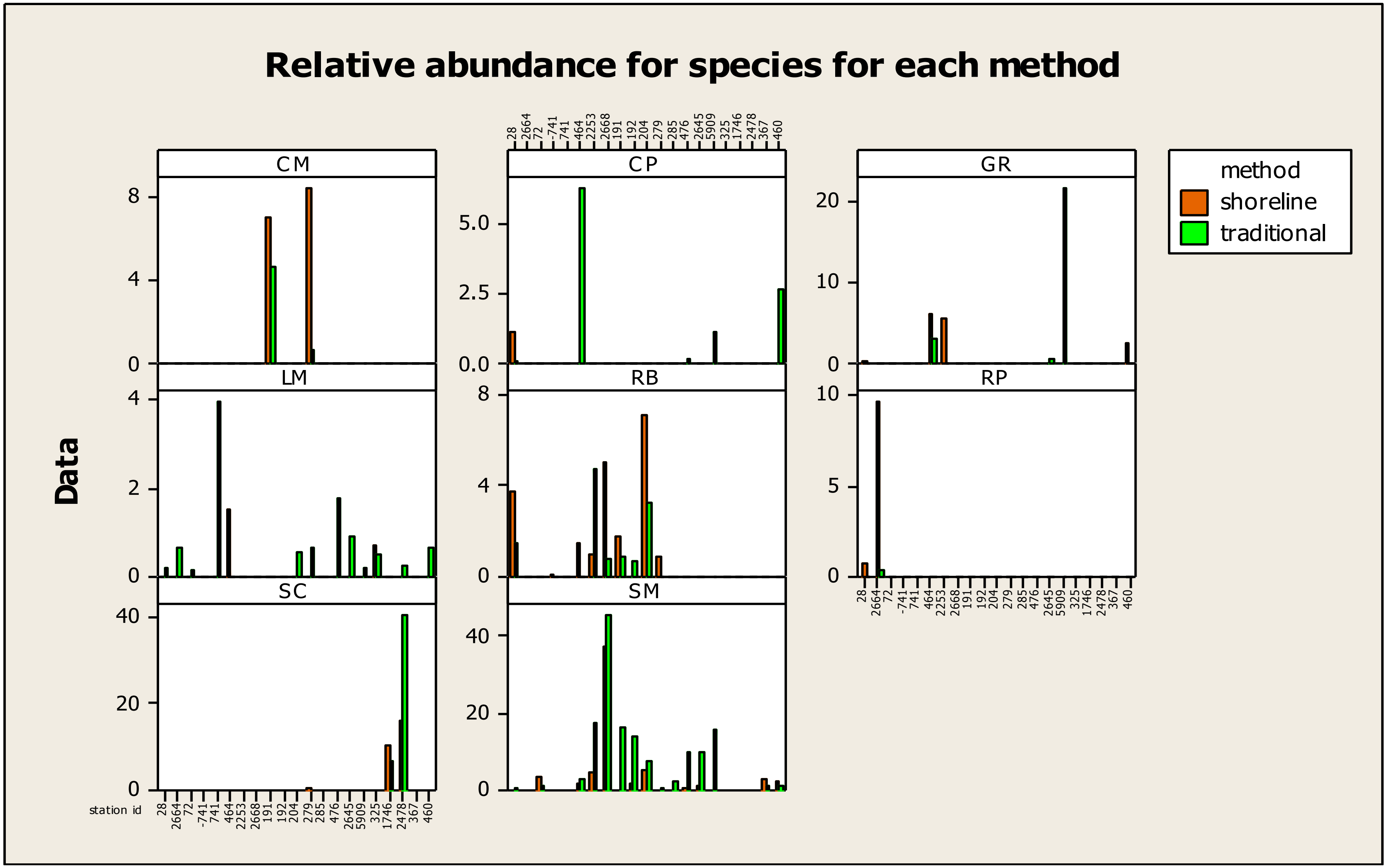


Figure 11. Bar chart plots of the relative abundance for selected fish species collected using the shoreline method and the traditional stream shocker method. Abbreviations are; CM=cutlips minnow, CP=chain pickerel, GR=green sunfish, LM=largemouth bass, RB=rock bass, RP=redfin pickerel, SC=slimy sculpin, and SM=smallmouth bass.

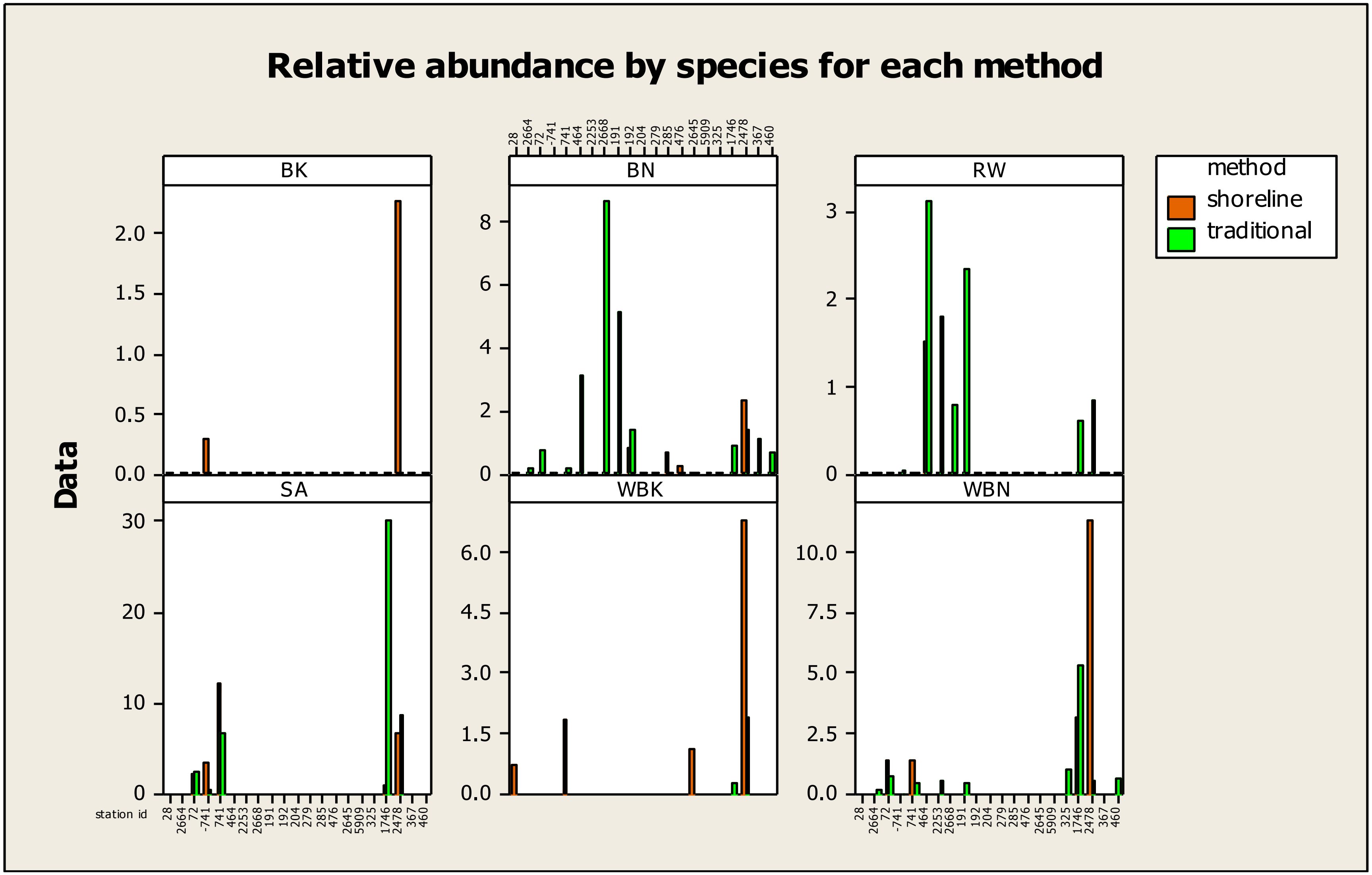
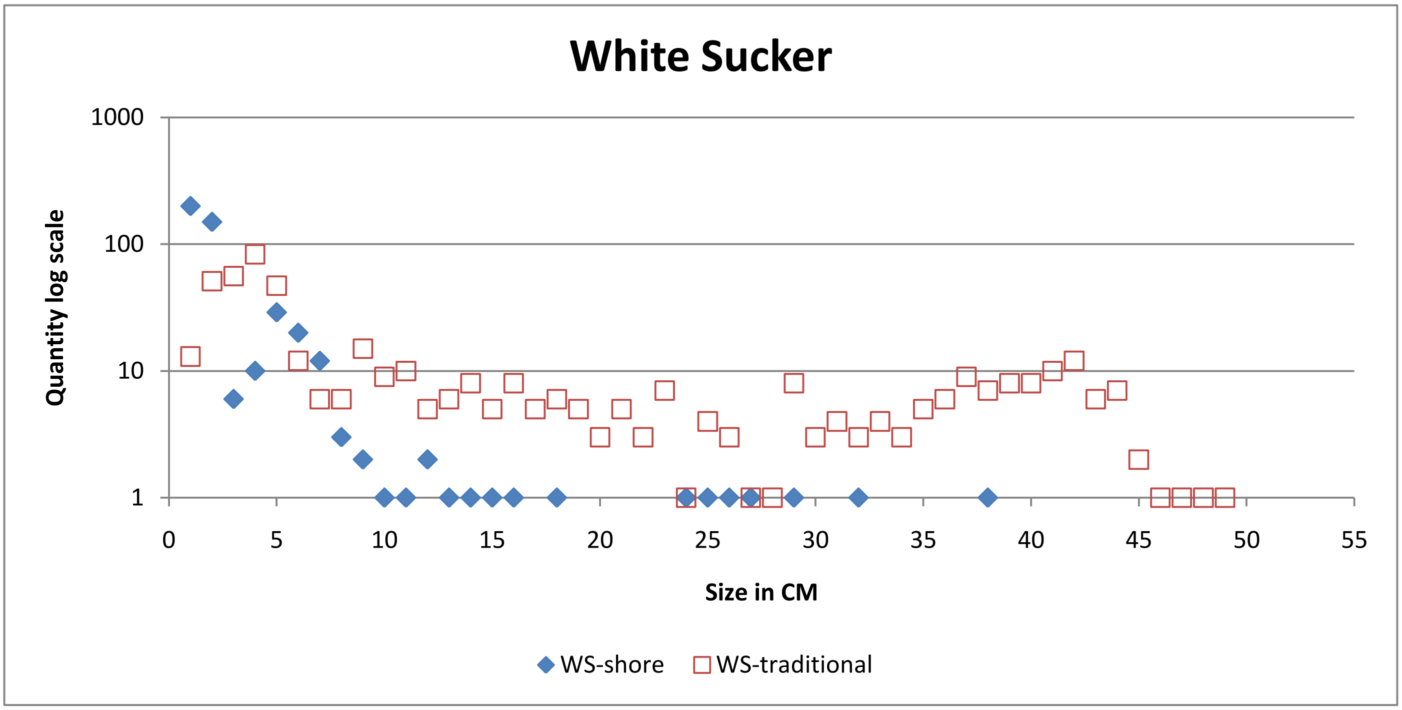


Figure 12. Bar chart plots of the relative abundance for selected fish species collected using the shoreline method and the traditional stream shocker method. Abbreviations are; BK= Brook trout (stocked), BN=Brown trout (stocked), RW=Rainbow trout (stocked), SA=Atlantic salmon (stocked), WBK=Brook trout (wild), and WBN=Brown trout (wild).



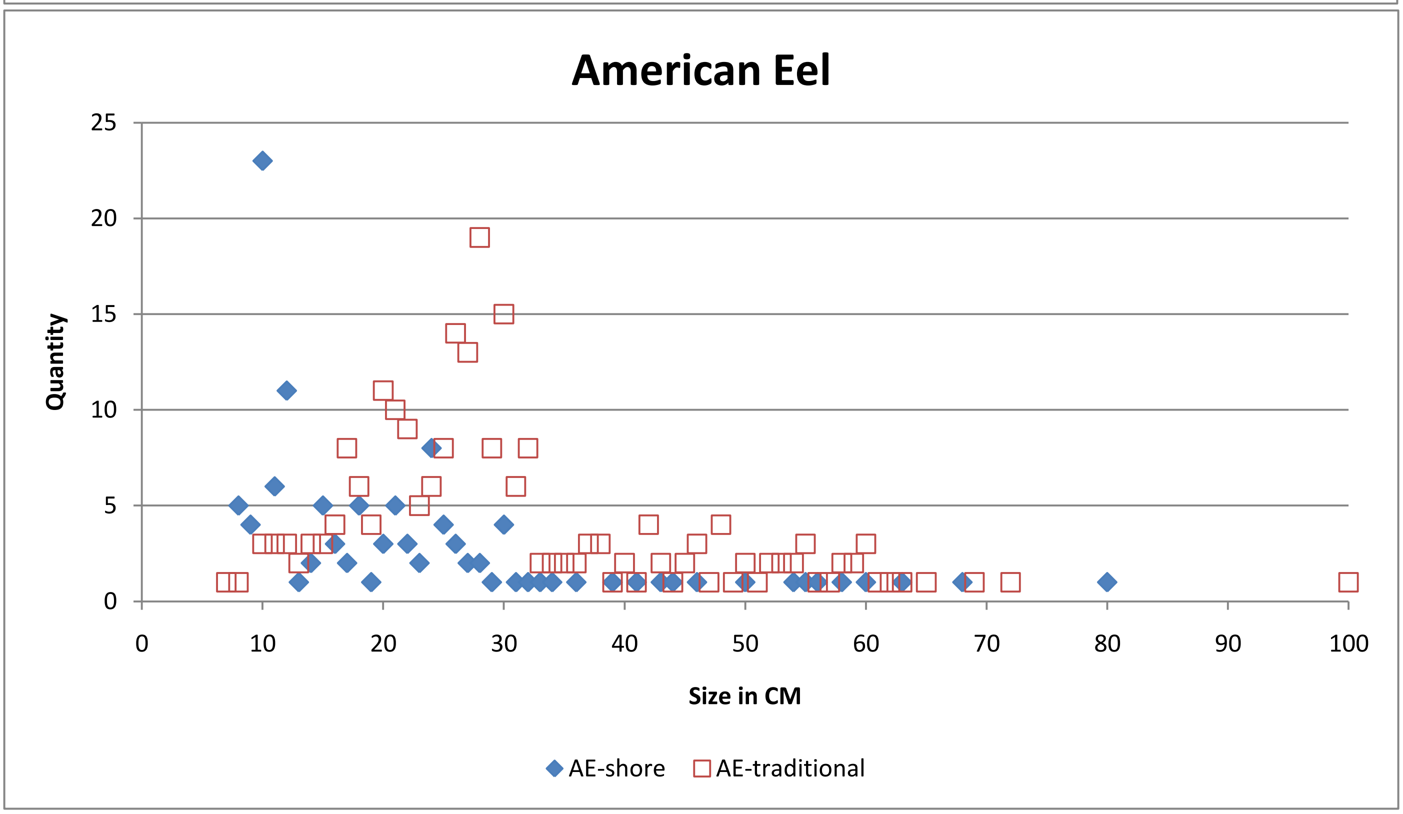
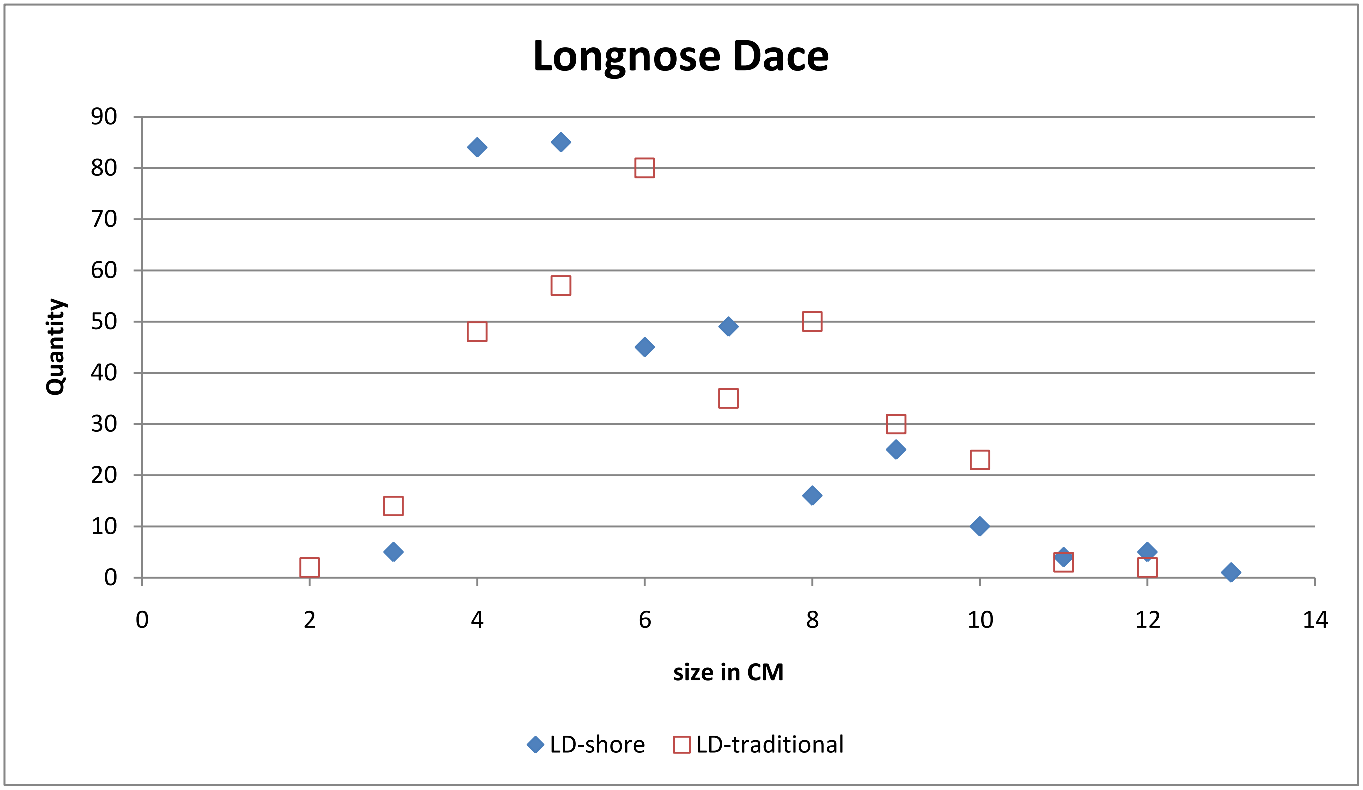


Figure 13 top and 14 bottom. Plot of total quantity of fish by centimeter size class for samples collected using the shoreline method and the traditional method.



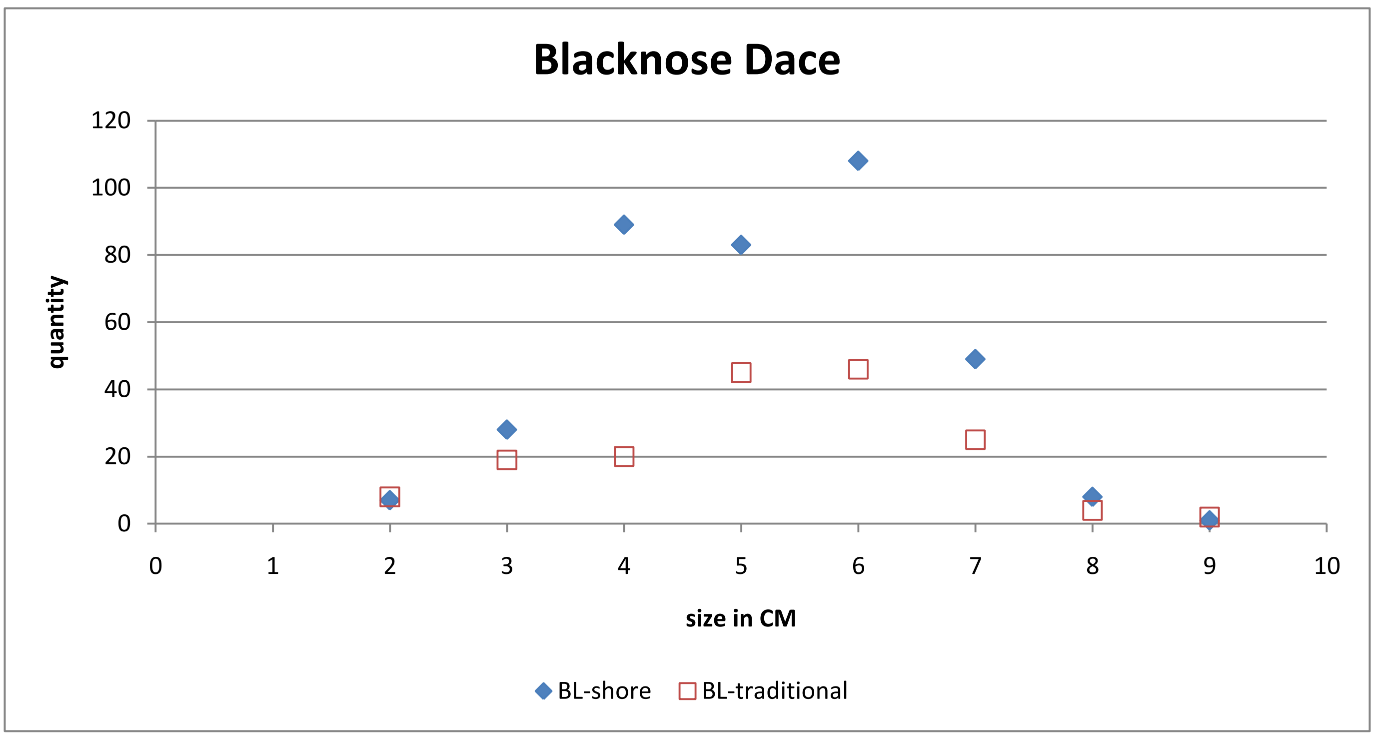
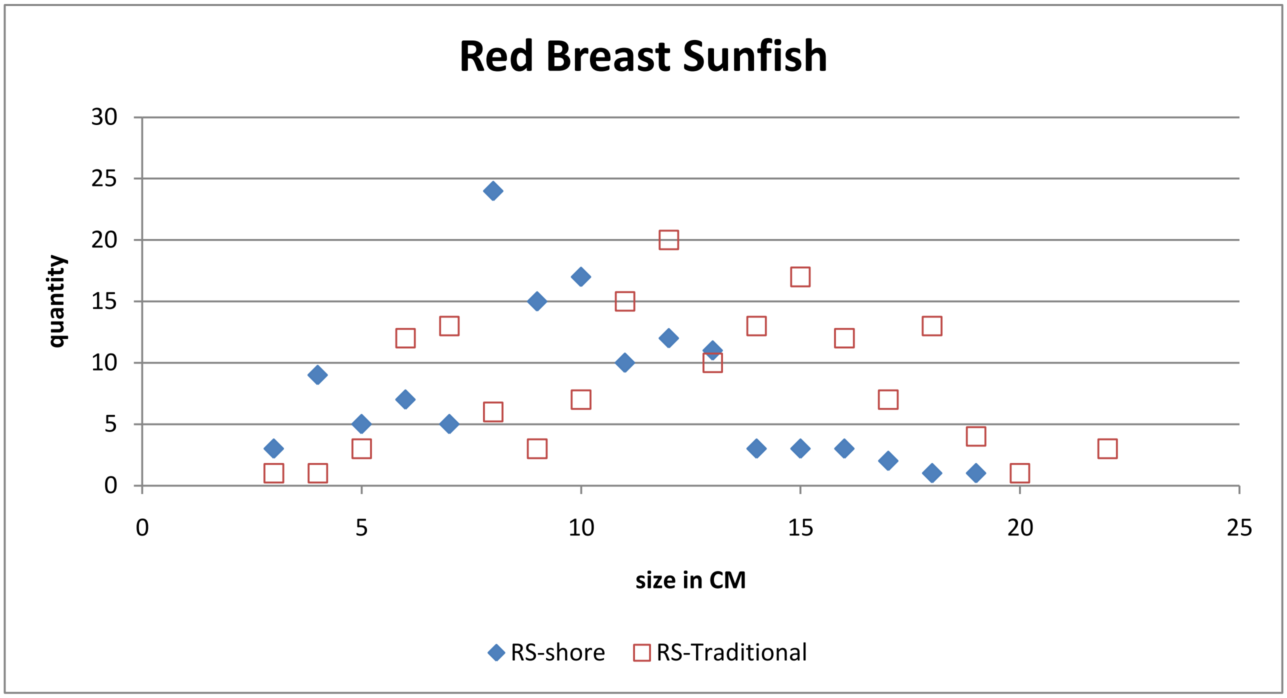


Figure 15 top and 16 bottom. Plot of total quantity of fish by centimeter size class for samples collected using the shoreline method and the traditional method.



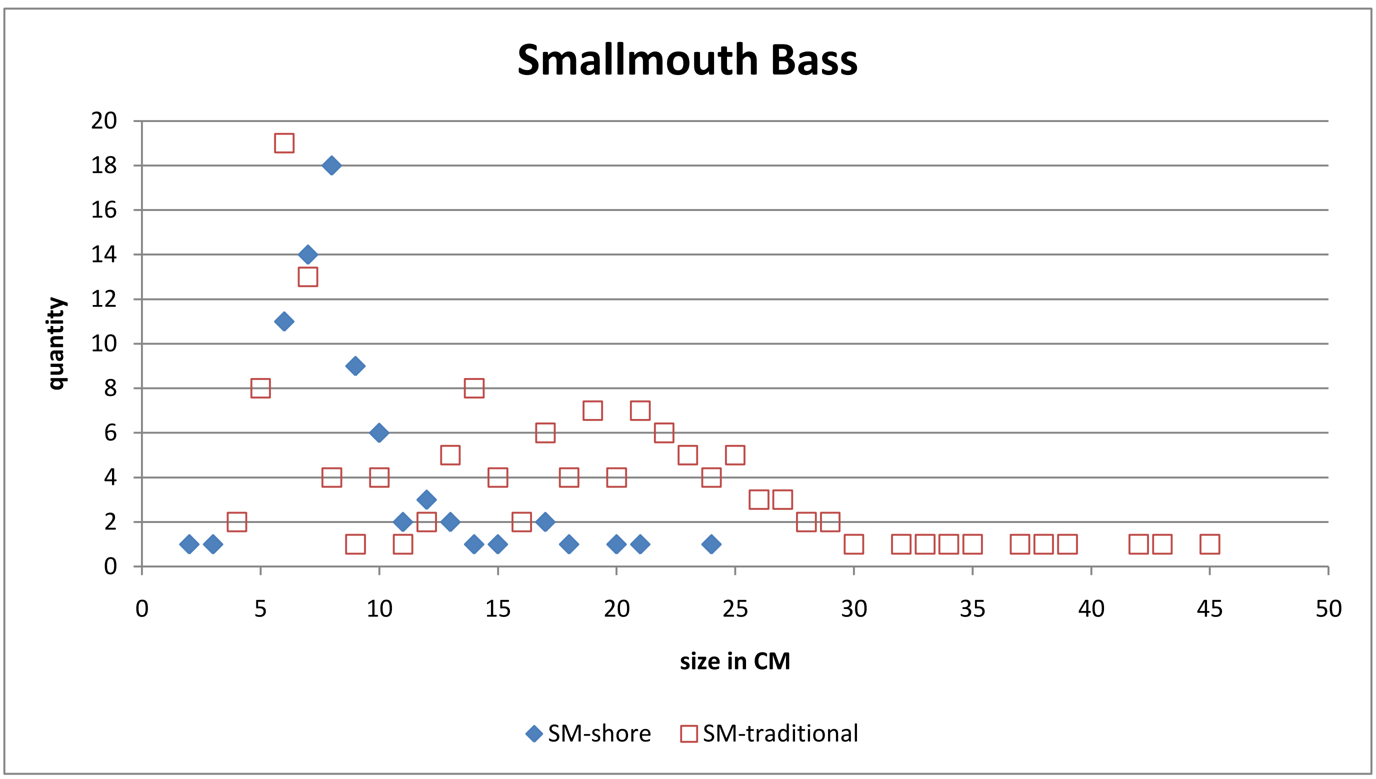
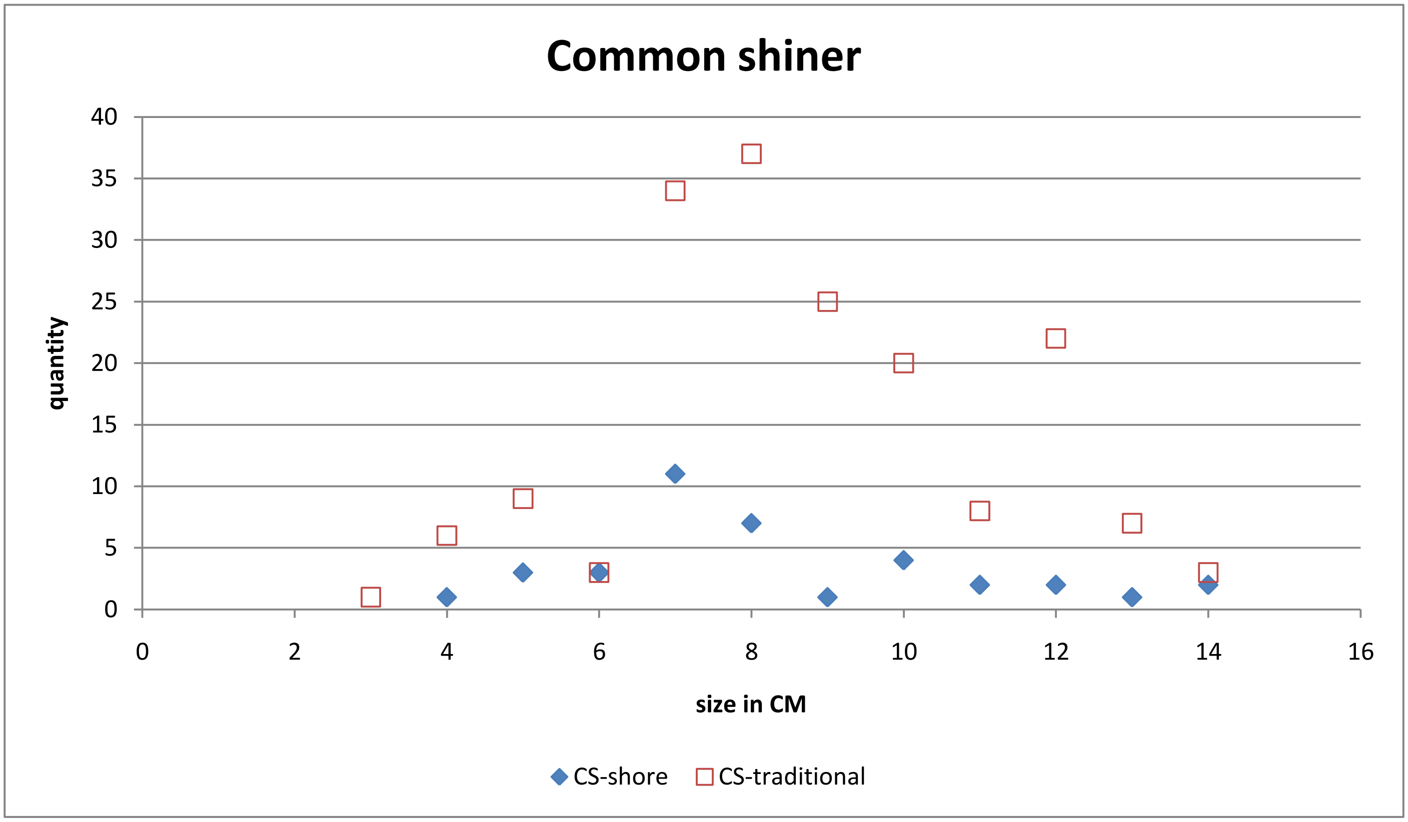


Figure 17 top and 18 bottom. Plot of total quantity of fish by centimeter size class for samples collected using the shoreline method and the traditional method.



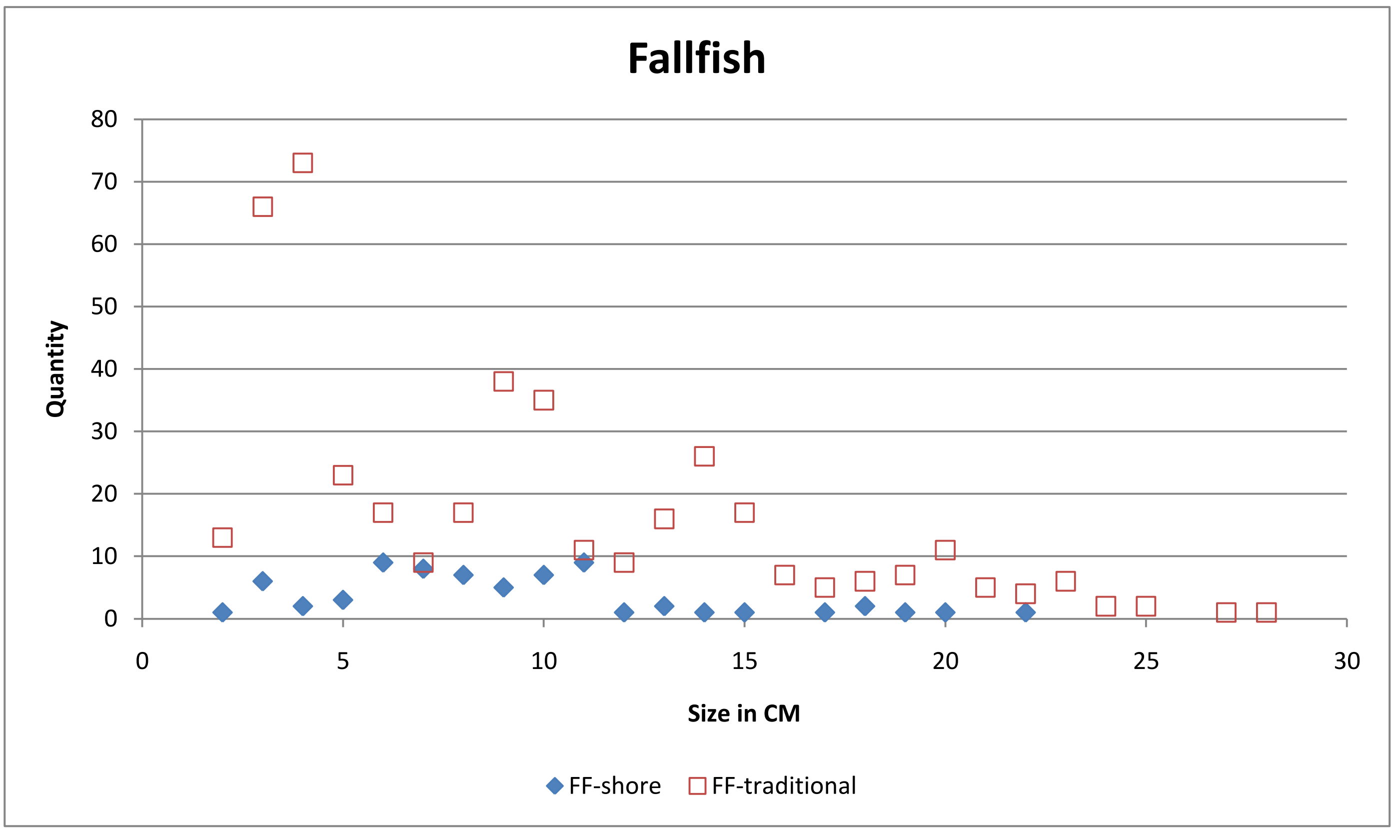


Figure 19 top and 20 bottom. Plot of total quantity of fish by centimeter size class for samples collected using the shoreline method and the traditional method.

Appendix A. Ecological characteristics of fish species from regional references (Whitworth, 1996; Halliwell et al., 1999; Armstrong et al., 2001) listed by common name. Abbreviations are: C = coldwater, C-W = coolwater, W = warmwater; GF = general feeder, TC = top carnivore, BI = benthic invertivore, WC = water column insectivore, NF = nonparasitic filterer, PF = parasitic filterer; I = intolerant, M = intermediate, T = tolerant; FS = fluvial specialist, FD = fluvial dependent, MG = macrohabitat generalist; A = non-native, N = native.

Species name	**Abbrev.**	**Temp**	**Trophic class**	**Tolerance**	**Stream flow**	**Origin**
American eel *Anguilla rostrata*	AE	W	TC	T	FD	N
Atlantic salmon *Salmo salar*	SA	C-W	TC	I	FS	N
black crappie *Pomoxis nigromaculatus*	BC	W	TC	M	MG	A
blacknose dace *Rhinichthys atratulus*	BL	C-W	GF	T	FS	N
bluegill *Lepomis macrochirus*	BG	W	GF	T	MG	A
bluntnose minnow *Pimephales notatus*	BM	W	GF	T		A
brook trout *Salvelinus fontinalis*	WBK/BK-ST	C	TC	I	FS	N
brown bullhead *Ameiurus nebulosus*	BB	W	GF	T	MG	N
brown trout *Salmo trutta*	WBN/BN-ST	C-W	TC	I	FD	A
chain pickerel *Esox niger*	CP	W	TC	M	MG	N
common shiner *Luxilus cornutus*	CS	C-W	GF	M	FD	N
creek chub *Semotilus atromaculatus*	CR	C-W	GF	T	MG	N
cutlips minnow *Exoglossum maxillingua*	CM	W	BI	M	FS	N
fallfish *Semotilus corporalis*	FF	C-W	GF	M	FS	N
fathead minnow *Pimephales promelas*	FM	W	GF	T	MG	A
golden shiner *Notemigonus crysoleucas*	GS	W	GF	T	MG	N
green sunfish *Lepomis cyanellus*	GR	W	GF	T	FD	A
largemouth bass *Micropterus salmoides*	LM	W	TC	M	MG	A
longnose dace *Rhinichthys cataractae*	LD	C-W	BI	M	FS	N
pumpkinseed *Lepomis gibbosus*	PS	W	GF	M	MG	N
rainbow trout *Oncorhynchus mykiss*	WRW/RW-ST	C-W	TC	I	FD	A
redbreast sunfish *Lepomis auritus*	RS	W	GF	M	MG	N
redfin pickerel *Esox americanus americanus*	RP	W-B	TC	M	MG	N
rock bass *Ambloplites rupestris*	RB	C-W	TC	M	MG	A
slimy sculpin *Cottus cognatus*	SC	C	BI	I	FS	N
smallmouth bass *Micropterus dolomieu*	SM	C-W	TC	M	MG	A
spottail shiner *Notropis hudsonius*	SS	W	WC	M	MG	N
tessellated darter *Etheostoma olmstedi*	TD	C-W	BI	M	FS	N
white sucker *Catostomus commersonii*	WS	C-W	GF	T	FD	N
yellow bullhead *Ameiurus natalis*	YB	W-B	GF	T	MG	A
yellow perch *Perca flavescens*	YP	C-W	TC	M	MG	N

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Halliwell, D.B., Langdon, R.W., Daniels, R.A., Kurtenbach, J.P., Jacobson, R.A., 1999. Classification of freshwater fish species of the northeastern United States for use in the development of indices of biological integrity, with regional applications. In: Simon, T.P. (Ed.), Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. CRC Press, Boca Raton, FL, pp.301–337.

Whitworth, W.R., 1996. Freshwater Fishes of Connecticut. Second edition. Bulletin 114. State Geological and Natural History Survey of Connecticut, and Connecticut Department of Environmental Protection, Hartford, CT, pp. 243.

Appendix B. Count of each species collected in each sample at each station for the large river gear comparison project. Abbreviations used in the table are: Method- S= Shoreline and T= Traditional. Brown Bullhead (Quinebaug River -5909 Traditional), Black Crappie (Pomperaug River-279 Shoreline), and Wild Rainbow (Quinebaug River-2645 Shoreline) are excluded as they were only found the single sample in parenthesis

Stream	Method	AE	BG	BK	BL	BM	BN	CM	CP	CR	CS	FF	GR	GS	LD	LM	PS	RB	RP	RS	RW	SA	SC	SL	SM	SS	TD	WBK	WBN	WS	YB	YP
Coginchaug River-28	S	96	52						3			23	1		23		4	10	2	6				1		2	36	2		3		
	T	112	27						1			138		1	14	2	13	15		20					9	122	7			60		5
Farmington River-72	S	1			63							1			34							3			5		13		2	17		
	T	8			86		5					183			86	1						17		2	8		78		5	185		3
Naugatuck River-191	S	1	1		30			8							62			2		7							1			2		
	T	4			15		11	10							80			2		21	5				35				1	30	1	
Naugatuck River-192	S	1			58		1							3	16					27					2		7			5	1	
	T	10	5		4		2								6			1		77				1	20		2			16		
Naugatuck River-204	S	5			4										1			4		27					3		4			6	2	
	T	20	2		3										3	1		6		36					14		22			75	1	
Pomperaug River-279	S	1	5		56			18		7		10			73		1	2					1				27			10		
	T	1	8		16			1		5	3	30			17	1	3								1		19			52		
Quinebaug River-285	S				8		1				26	27			57					8							10			7	3	
	T				16						116	102			141		2			14					12		12			15	16	
Shepaug River-325	S				225					18	3				79	3	3										20			5		
	T				34					1	51				62	1	4			1							8		2	35		
Willimantic River-367	S				47						9	9								2					2		2			1	3	
	T						1				25	29													1					31	1	2
Willimantic River-460	S										7	5	1	3			2			6					1		4			8	2	
	T		1		6		1		4		72	44				1				6					2		2		1	10	1	
Hop River-464	S		6		9							19	4			1		1		6	1				1		16			2		
	T		1				1		2		3	9	1							4	1				1		7			1		
Quinebaug River-476	S	8	1				1								4					78					2		21			355		

	T	57							1			37			19	10				145					58	4	22			215		
Farmington River--741	S			2	164					8	2				193			1				24					35			48		
	T				113		1								242						2	65					65		2	93		
Farminton River-741	S		1		85					4				1	27							26					26	4	3	36		
	T	1			76		1								128	25						42					51		3	163		
West Branch Farmington River-1746	S	1			55										22							1	10				3		3			
	T	5			86		3								82						2	102	23				12	1	18	3		1
Housatonic River-2253	S				2	2				1		5	11		126			2		10					10		32					
	T											4			97		1	8		2	3				29		12		1	9	1	
West Branch Farmington River-2478	S	1		1	16		1								3							3	7					3	5	4		
	T	21			89		5								109	1					3	67	148				5	7	2	8		
Quinebaug River-2645	S	5	19									1		6	9					42					1		3	1			1	
	T	42	3									18	1		32	2	1			61					21		5			28		
Coginchaug River-2664	S	41			6							13			23				12	1							25			2		1
	T	167			57		1				1	152			41	4			2	1							38		1	8		7
Housatonic River-2668	S				1	2				3		17			18		2	7		6					53		29			2		
	T		1				11					6			45			1			1				58		4					
Quinebaug River-5909	S	3	2		7				1		1	9	19		2					14					3		7			12	6	
	T	8	8		1						56	130	1	2	10	1	14			47					64	36	14			114	12	2

Appendix C. Sample information including Mixed Water MMI total score and individual metric scores for each of the 42 samples collected as part of the method comparison project. Metric titles are 1 = % of sample as white sucker individuals, 2= % of sample as family cyprinidae individuals, 3= % individuals in fluvial specialist guild without Eastern Black nose dace individuals, 4= % of sample as non tolerant generalist feeders, 5= % of sample as native warm water species, 6= % intolerant individuals, and 7= % of species in sample as fluvial specialist guild .

Trip ID	Date	Sample ID	Station ID	Stream	landmark	Method	Species Richness	Individuals	MW MMI	1	2	3	4	5	6	7
2711	6/5/2008	12569	28	Coginchaug River	Route 66	S	15	264	43.4	97.4	19.2	49.2	24.2	37.0	2.0	75
2805	8/1/2008	13311	28	Coginchaug River	Route 66	T	15	1035	45.3	86.8	78.7	40.5	53.0	8.1	0.0	50
2711	6/5/2008	12570	2664	Coginchaug River	DS rte 157 at #740 Wadsworth Street	S	9	124	48.7	96.3	36.0	76.0	21.9	35.9	0.0	75
2805	8/1/2008	13312	2664	Coginchaug River	DS rte 157 at #740 Wadsworth Street	T	13	593	67.7	96.9	65.8	90.2	87.9	57.8	0.0	75
3984	6/7/2010	20367	72	Farmington River	Route 4 at Apricots Restaurant	S	9	134	54.3	71.1	78.0	55.4	1.4	98.9	0.0	75
4073	7/19/2010	21304	72	Farmington River	Route 4 at Apricots Restaurant	T	13	640	57.9	34.2	59.1	83.8	55.4	98.2	0.0	75
2707	6/3/2008	12537	-741	Farmington River	Steele bridge on Town Bridge Road	S	9	675	55.0	83.8	93.4	57.0	0.6	100.0	0.0	50
2874	9/23/2008	13876	-741	Farmington River	Steele bridge on Town Bridge Road	T	8	652	56.9	67.5	80.8	100.0	0.0	100.0	0.0	50
3984	6/7/2010	20368	741	Farmington River	Steele bridge on Town Bridge Road	S	10	184	50.1	55.4	67.8	47.9	0.0	99.2	5.7	75
4073	7/19/2010	21305	741	Farmington River	Steele bridge on Town Bridge Road	T	9	586	33.4	0.0	37.0	47.2	0.0	99.7	0.0	50
2972	6/8/2009	14466	464	Hop River	Flanders River Road	S	11	65	61.9	93.0	45.9	83.2	74.5	86.4	0.0	50
3040	7/23/2009	14986	464	Hop River	Flanders River Road	T	12	30	59.5	92.4	46.1	82.4	100.0	70.5	0.0	25
2879	9/25/2008	13891	2253	Housatonic River	old bridge abutments end of North Kent Road	S	10	201	64.9	100.0	72.2	100.0	14.5	92.7	0.0	75
2862	9/4/2008	13766	2253	Housatonic River	old bridge abutments end of North Kent Road	T	11	163	58.4	87.4	66.1	100.0	8.3	97.3	0.0	50

2879	9/25/2008	13890	2668	Housatonic River	Adjacent to Rte 7 at First NNT upstream of Carse Bk	S	11	140	57.1	96.7	31.1	70.7	34.6	91.6	0.0	75
2862	9/4/2008	13765	2668	Housatonic River	Adjacent to Rte 7 at First NNT upstream of Carse Bk	T	8	115	54.5	100.0	47.2	73.9	10.1	100.0	0.0	50
2706	6/2/2008	12536	191	Naugatuck River	Frost Bridge Echo Lake Rd and Route 262	S	9	114	64.6	96.0	93.6	96.3	11.9	79.3	0.0	75
2782	7/16/2008	13154	191	Naugatuck River	Frost Bridge Echo Lake Rd and Route 262	T	12	198	48.1	65.5	56.5	70.3	20.6	74.0	0.0	50
2706	6/2/2008	12534	192	Naugatuck River	Fire Station	S	10	120	49.2	90.5	68.4	29.6	43.6	62.0	0.0	50
2782	7/16/2008	13152	192	Naugatuck River	Fire Station	T	11	142	35.7	74.3	7.3	8.7	100.0	9.8	0.0	50
2706	6/2/2008	12535	204	Naugatuck River	South Leonard Street	S	9	56	36.9	75.6	9.3	13.8	93.4	15.8	0.0	50
2782	7/16/2008	13153	204	Naugatuck River	South Leonard Street	T	11	183	24.9	6.6	3.3	21.1	38.1	54.9	0.0	50
2761	7/2/2008	12992	279	Pomperaug River	Transylvania Brook	S	13	214	66.0	89.4	81.7	93.2	10.0	86.2	1.2	100
2804	7/31/2008	13310	279	Pomperaug River	Transylvania Brook	T	13	157	54.2	24.6	48.8	66.0	44.4	95.3	0.0	100
4013	6/18/2010	20654	285	Quinebaug River	Route 197	S	10	155	73.5	89.7	87.4	93.7	76.3	92.4	0.0	75
4061	7/14/2010	21198	285	Quinebaug River	Route 197	T	10	552	75.6	93.8	93.0	71.4	100.0	95.7	0.0	75
3986	6/8/2010	20383	476	Quinebaug River	Route 12 and upstream Patchaug River Confluence	S	8	469	34.4	81.6	3.2	31.2	100.0	0.0	0.0	25
4060	7/13/2010	21195	476	Quinebaug River	Route 12 and upstream Patchaug River Confluence	T	10	568	29.2	13.8	11.1	21.2	62.1	46.3	0.0	50
2967	6/3/2009	14436	2645	Quinebaug River	Edwardson Street	S	11	88	46.8	100.0	19.2	24.6	94.7	11.3	3.0	75
4060	7/13/2010	21196	2645	Quinebaug River	Edwardson Street	T	11	214	40.8	70.2	24.8	39.7	72.4	28.4	0.0	50

4013	6/18/2010	20655	5909	Quinebaug River	confluence with Little River and Rte 101 dam	S	14	89	46.3	69.3	26.2	31.3	52.3	70.2	0.0	75
4060	7/13/2010	21197	5909	Quinebaug River	confluence with Little River and Rte 101 dam	T	18	521	54.3	50.2	48.0	45.7	91.9	69.5	0.0	75
2761	7/2/2008	12991	325	Shepaug River	Wellers Bridge Road (Route 67)	S	8	429	54.8	97.3	99.0	35.7	2.7	99.0	0.0	50
2804	7/31/2008	13309	325	Shepaug River	Wellers Bridge Road (Route 67)	T	10	197	56.6	59.5	80.1	54.9	55.1	96.3	0.0	50
3984	6/7/2010	20369	1746	West Branch Farmington River	at Upcountry Sports	S	7	91	64.6	100.0	90.3	59.4	0.0	98.4	28.8	75
4073	7/19/2010	21306	1746	West Branch Farmington River	at Upcountry Sports	T	12	213	70.4	96.8	84.1	85.6	0.0	96.5	29.6	100
2707	6/3/2008	12538	2478	West Branch Farmington River	# 500 Hogback Road	S	10	34	62.8	73.2	59.6	59.1	0.0	95.7	77.2	75
2874	9/23/2008	13877	2478	West Branch Farmington River	# 500 Hogback Road	T	12	388	77.4	95.3	54.4	100.0	0.0	92.0	100.0	100
2972	6/8/2009	14468	367	Willimantic River	Jones Crossing Road	S	8	75	58.6	97.0	92.5	22.7	51.7	96.1	0.0	50
3149	8/13/2009	15740	367	Willimantic River	Jones Crossing Road	T	7	89	48.0	20.7	64.7	50.4	100.0	100.0	0.0	0
2972	6/8/2009	14467	460	Willimantic River	Depot Road Coventry Road	S	10	39	44.7	53.3	40.9	35.7	99.4	58.5	0.0	25
3149	8/13/2009	15741	460	Willimantic River	Depot Road Coventry Road	T	13	149	65.7	84.7	87.4	47.7	100.0	90.1	0.0	50