

**Population characteristics of Bluegill and Redear Sunfish in Kansas impoundments**

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## **Introduction**

Bluegill are an important component of many aquatic ecosystems in Kansas and contribute to recreational fisheries both as a sport fish and as a baitfish (Steffen 2015). Although Bluegill are an abundant and ubiquitous resource throughout Kansas, anglers only ranked them as the 10<sup>th</sup> favorite species to catch in the 2013 Kansas Licensed Angler Survey. Additionally, they represent the 7<sup>th</sup> most fished for species in the same survey (Steffen 2015). Redear Sunfish are likely not differentiated from Bluegill by many Kansas anglers and probably represent a key component of catch and harvest by “sunfish” anglers. Reasons for the relative indifference toward sunfish by Kansas anglers are unknown, but a survey indicated that in general, Kansas Bluegill populations are not producing “trophy” Bluegill (i.e., 257 mm; Steffen, unpublished information) that are sought by anglers. Similarly, standardized sampling results suggest that relative abundance of Bluegill exceeding minimum size for sport harvest (174 mm; Steffen, unpublished information) has decreased since the mid-2000s. Although Kansas reservoir Bluegill and Redear Sunfish populations are routinely monitored with annual standard sampling via fall trap netting (Martenev 2010), a comprehensive evaluation of age and growth of Bluegill and Redear Sunfish was lacking. Additionally, there is interest in using restrictive regulations to improve Bluegill and Redear Sunfish populations. As such, the objective of this study was to estimate Bluegill and Redear Sunfish population parameters (e.g., growth and mortality) from 34 impoundments throughout Kansas. These data are summarized herein and will be used to further Bluegill and Redear Sunfish management in Kansas.

## **Methods**

Bluegill and Redear Sunfish were sampled from June to September 2017 using daytime boat electrofishing as catch rates of Bluegill and Redear Sunfish in fall trap nets are often low and variable (Koch et al. 2014). Fish were sampled from 34 impoundments varying in surface area from 3 to 121 ha (7 to 300 acres) using daytime pulsed-DC electrofishing (Figure 1). Study impoundments were chosen by district biologists who had an interest in Bluegill populations in the study lakes. Twelve of the study impoundments were sampled by Kansas State University as part of a project examining food webs in small Kansas impoundments. Sample sites were randomly chosen and the electrofishing boat was navigated in littoral habitat with two dippers who captured as many Bluegill and Redear Sunfish as possible. Collected fish were measured (TL) and weighed to the nearest gram. Saggital otoliths were removed from up to five individuals per centimeter group from each study species at each

impoundment. The smallest fish that were considered recruited to the gear and were collected for this project were 50 mm.

Otoliths were mounted in epoxy (Koch and Quist 2007) and sectioned with a low-speed saw. Resulting sections were aged using a microscope linked to a computer monitor. Sectioned otoliths were aged by two readers. When individual age estimates did not agree, a consensus age was assigned to the structure. If a consensus age could not be agreed upon, the structure was discarded from further analyses. Upon reaching a consensus age estimate, presumed annuli were enumerated and measured in Image J software (Rueden et al. 2017, Neely et al. in press).

Data were analyzed using the FSA package in R (Ogle 2015; R Core Team 2016). Back-calculated lengths were computed using the Fraser-Lee method with a project-specific calculated  $y$ -intercept of 30 mm (Shoup and Michaletz 2017). Mortality was estimated using a weighted catch curve (Ogle 2015) obtained from age structure data calculated using impoundment-specific age-length keys (Ogle 2015).

## **Results**

### *Bluegill*

A total of 7,054 Bluegill was collected from the study lakes. Of those, 1,685 were aged. The majority of sampled Bluegill (99.8%) were less than 203 mm (8 in; Figure 2). Of the 697 Redear Sunfish sampled, 493 were aged and 13.3% were greater than 203 mm (Figure 3). Growth of Bluegill and Redear Sunfish varied within and among populations (Figure 4; Figure 5). In general, male Bluegill and Redear Sunfish grew similarly compared to females, but males reached larger ultimate sizes (Figure 4; Figure 5). Age structures of Bluegill and Redear Sunfish populations were largely composed of fish less than less than age 4. Catch curves indicated that total annual mortality rate of all Bluegill populations combined was 64% and varied from 25.1% to 88.3% (Figure 6; Figure 7). Redear Sunfish total annual mortality rates were generally lower than those estimated for Bluegill and varied from 23.3% to 57.3% (Figure 8). Impoundment-specific age-length keys for Bluegill and Redear Sunfish are shown in Appendices 1 and 2. Additional growth data are presented in Appendices 3 and 4.

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Figure 1. Location of study impoundments.

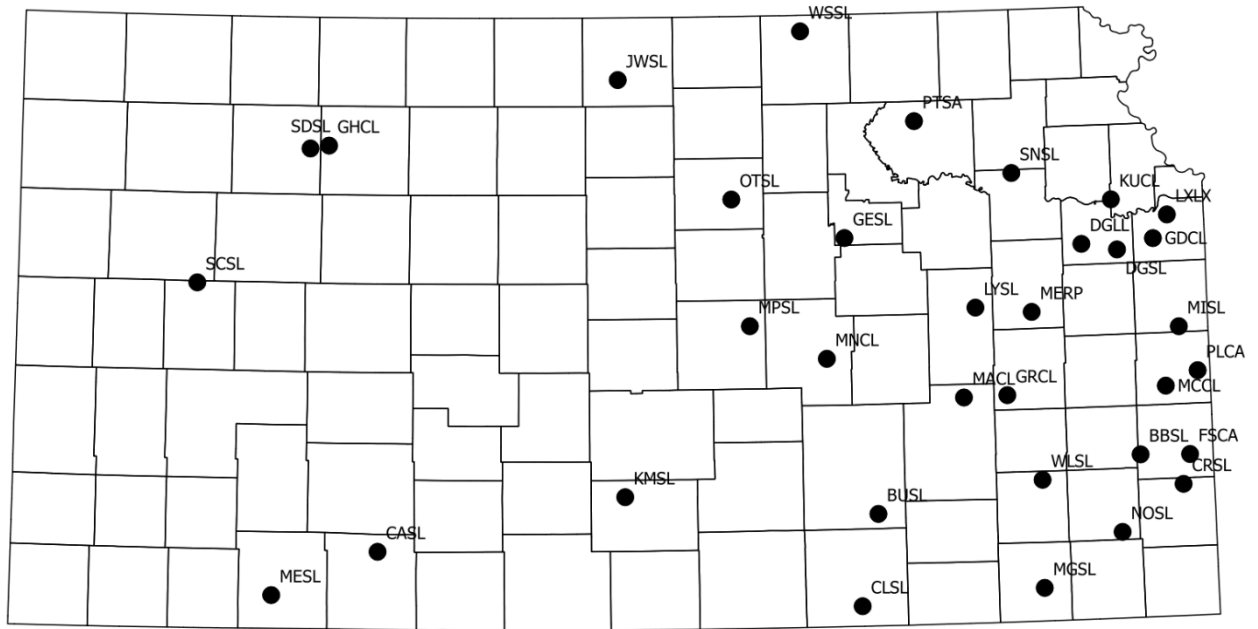
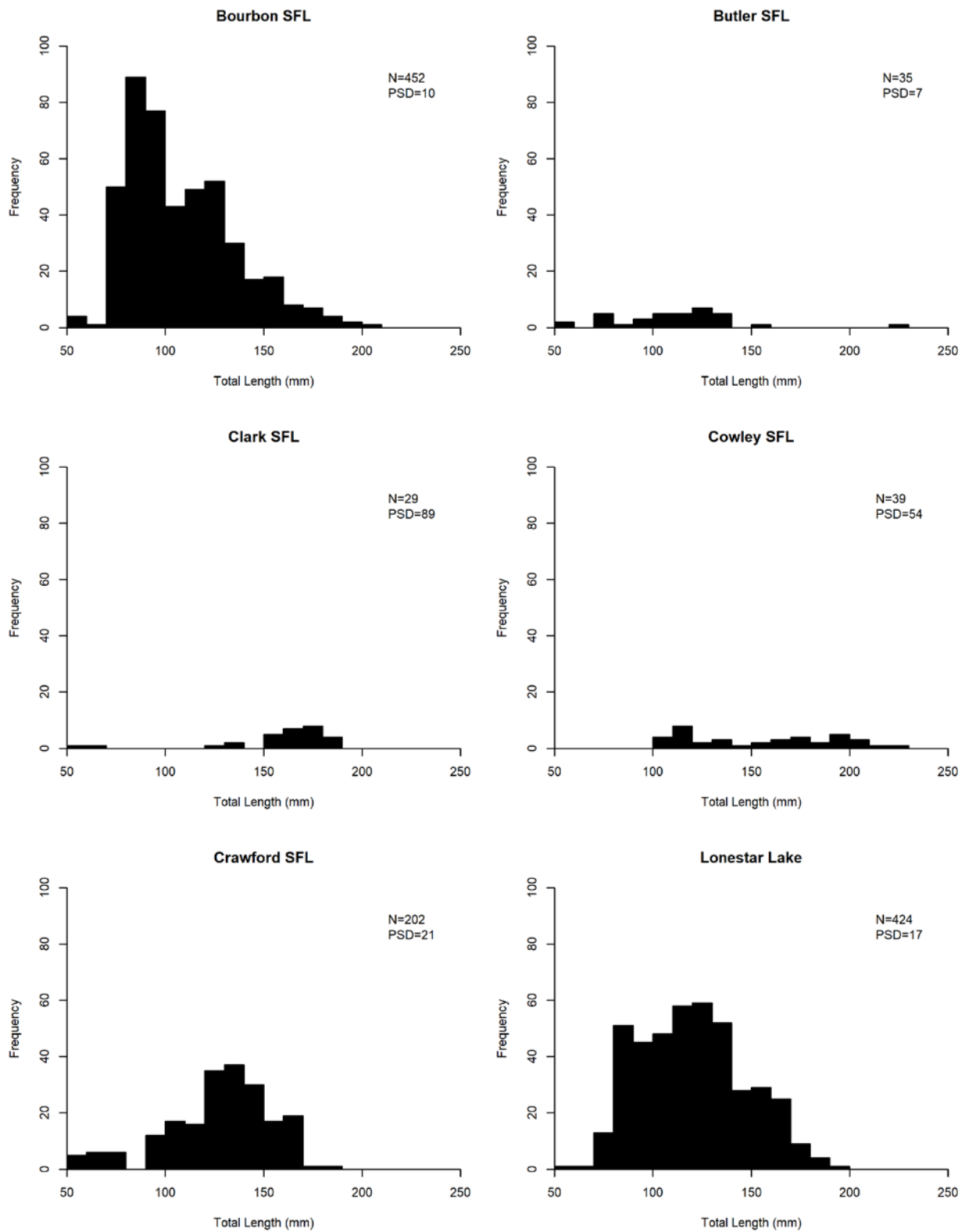
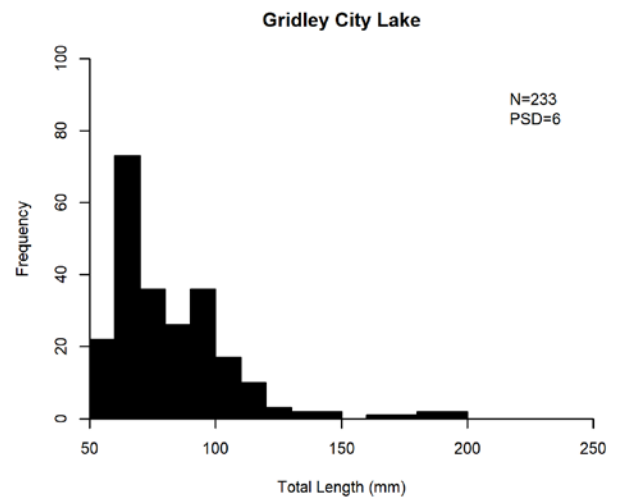
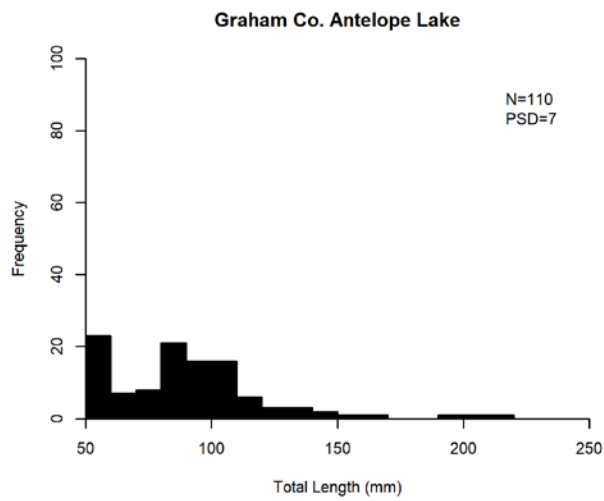
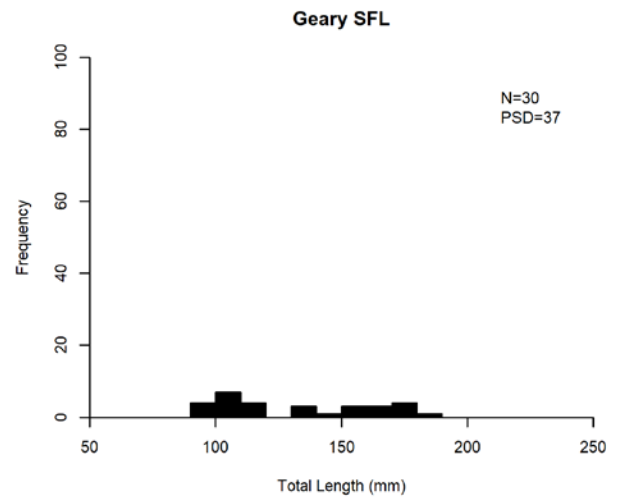
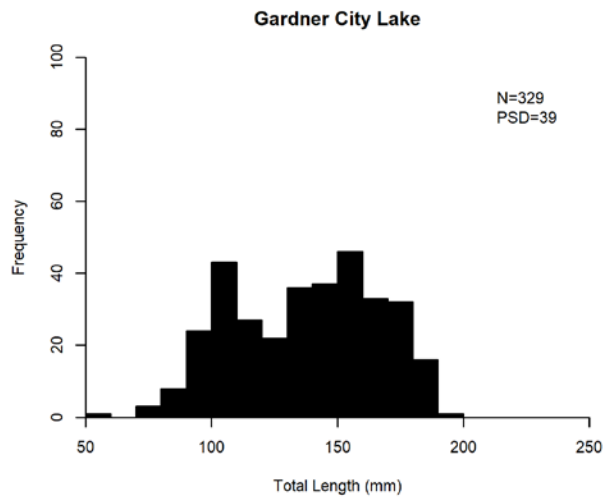
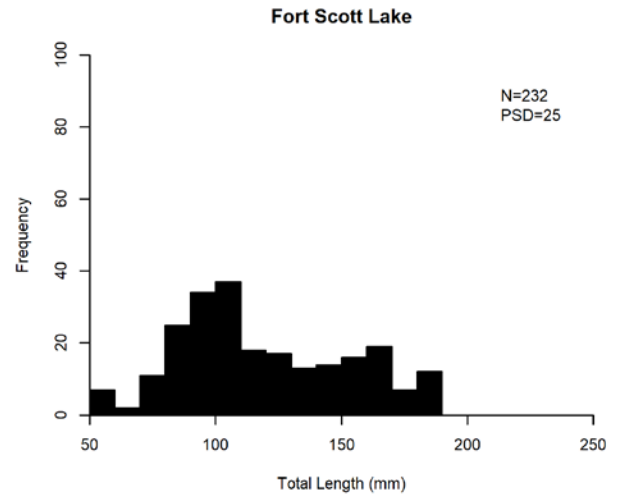
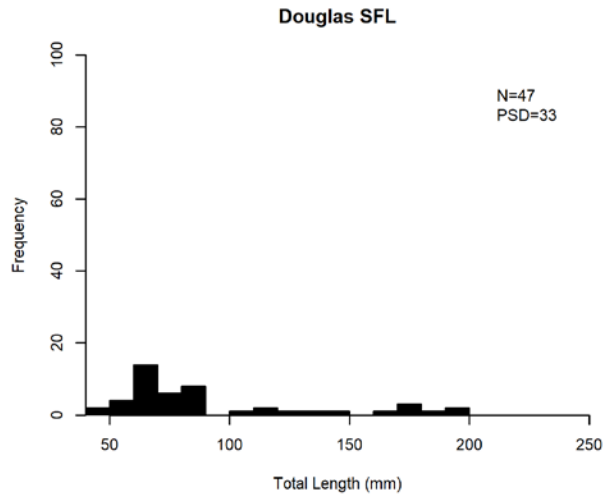
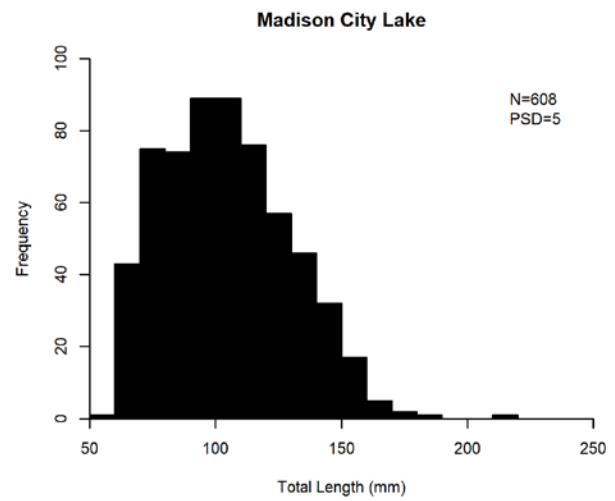
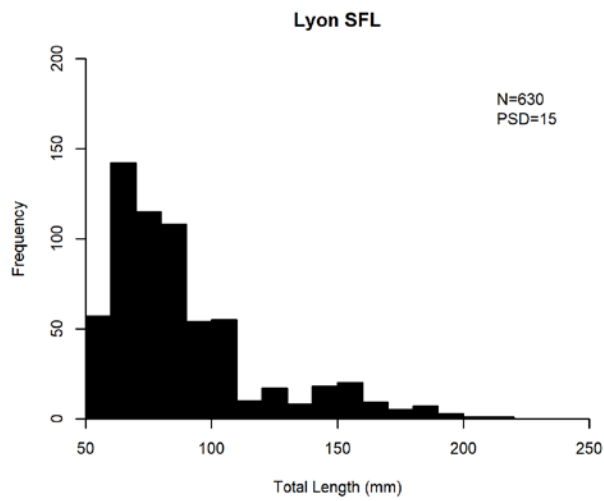
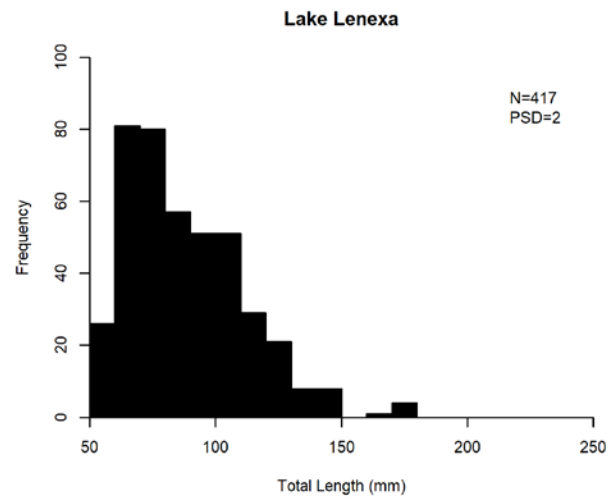
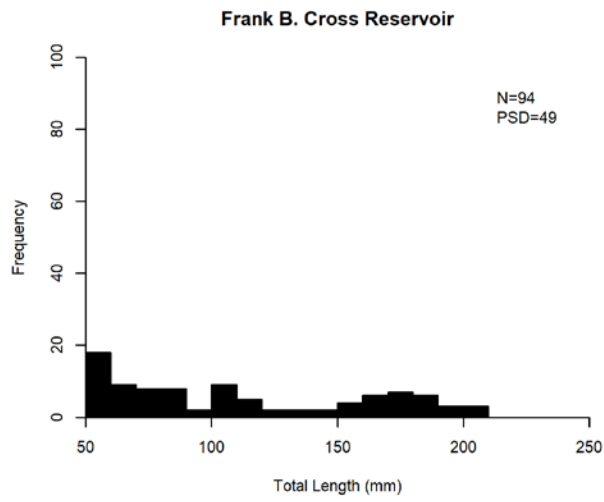
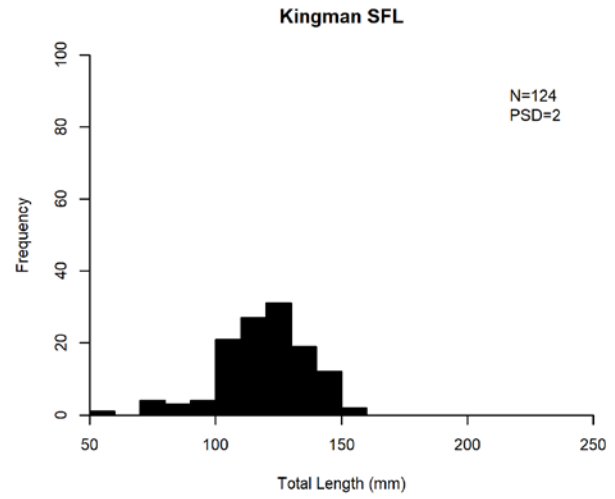
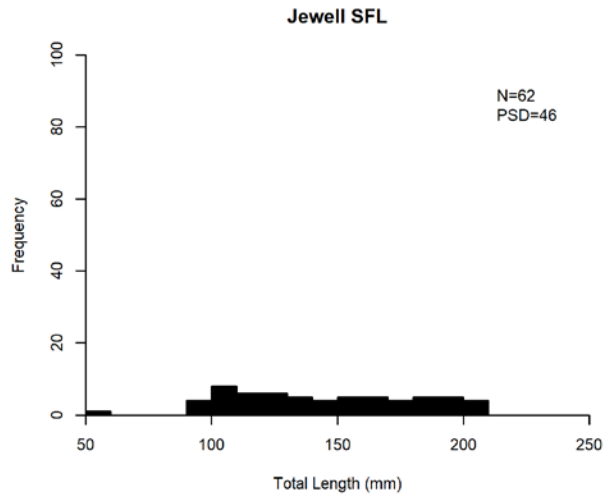


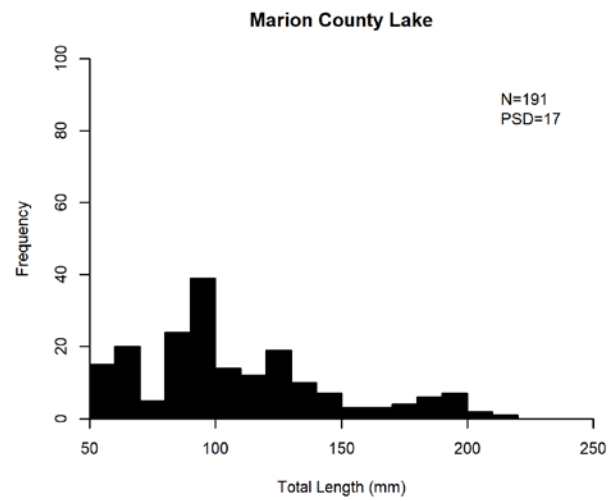
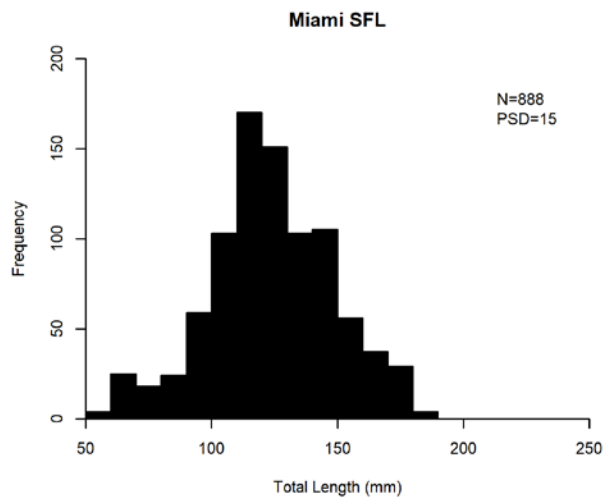
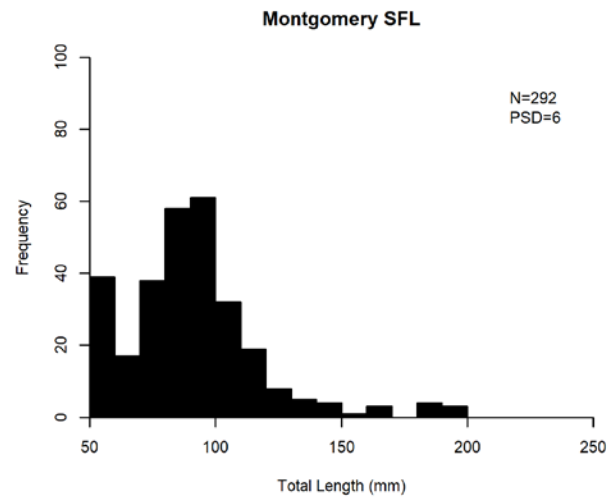
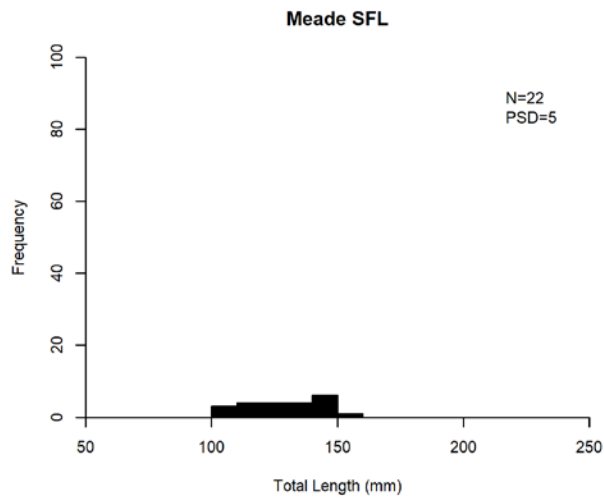
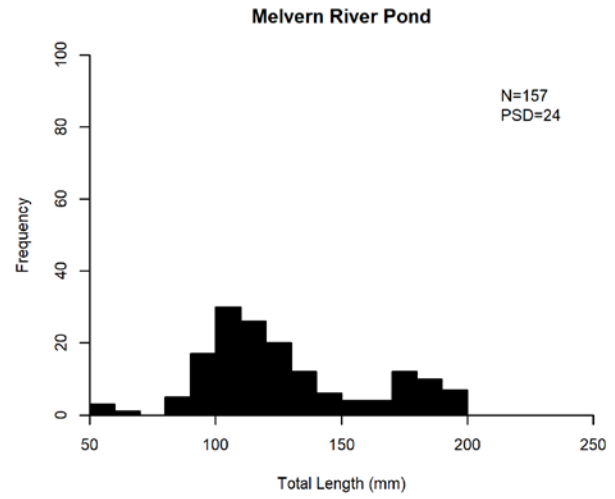
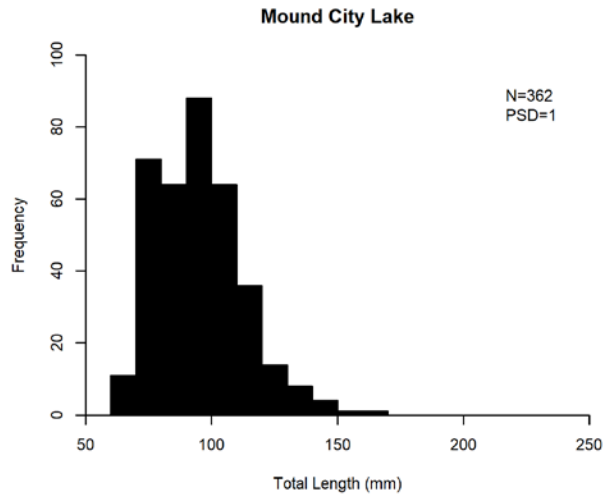
Figure 2. Length frequency histograms for Bluegill sampled with electrofishing in 2017. Sample size and PSD are shown.

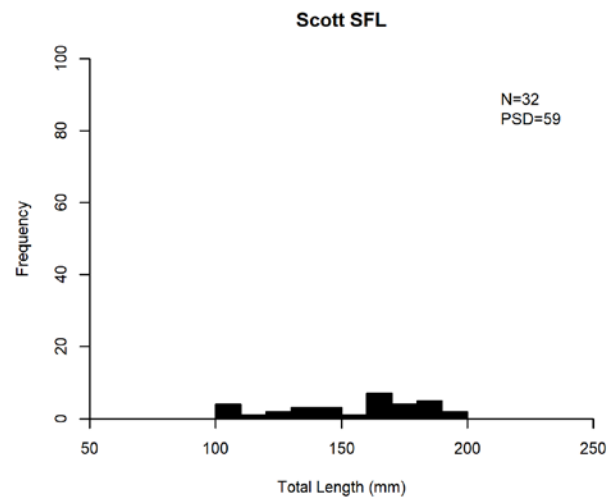
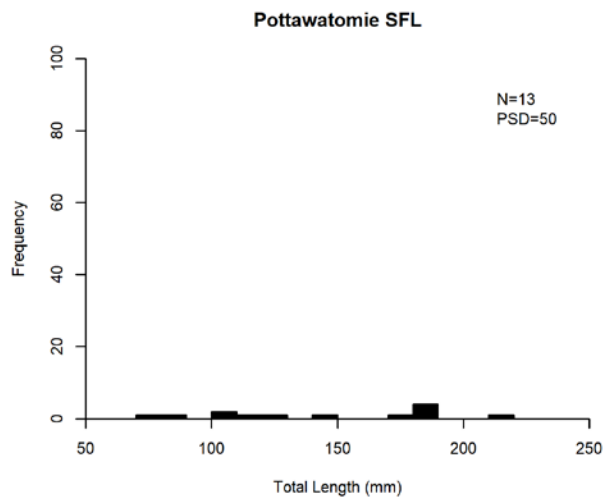
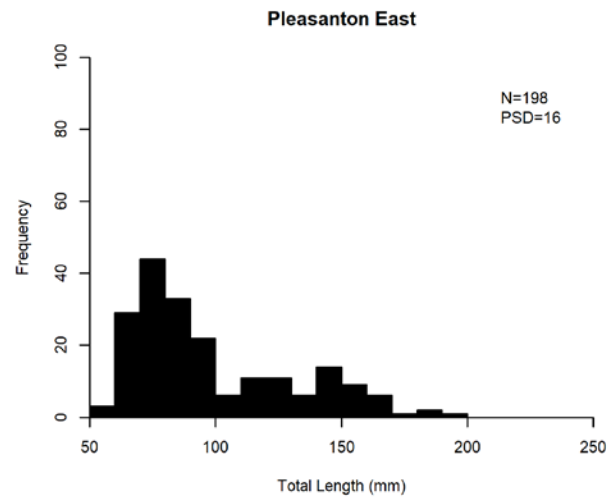
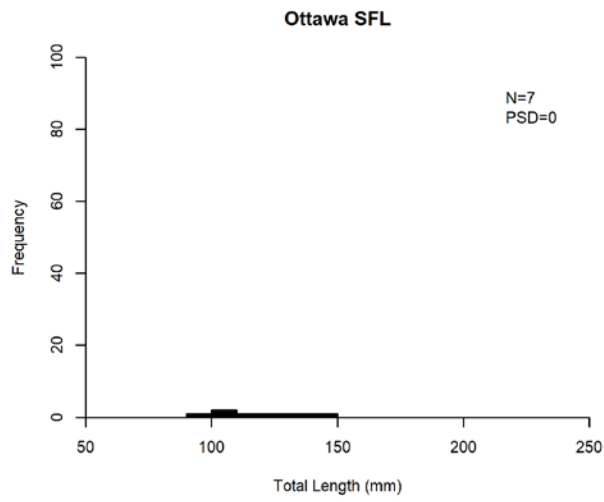
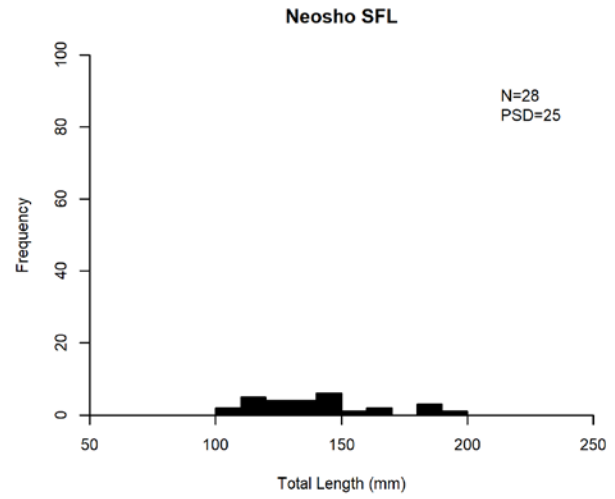
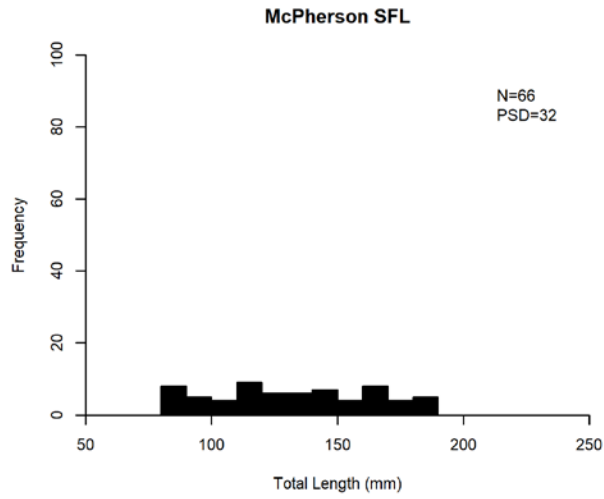




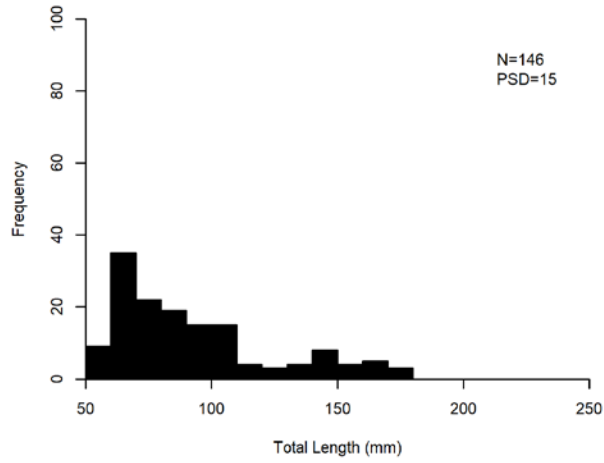




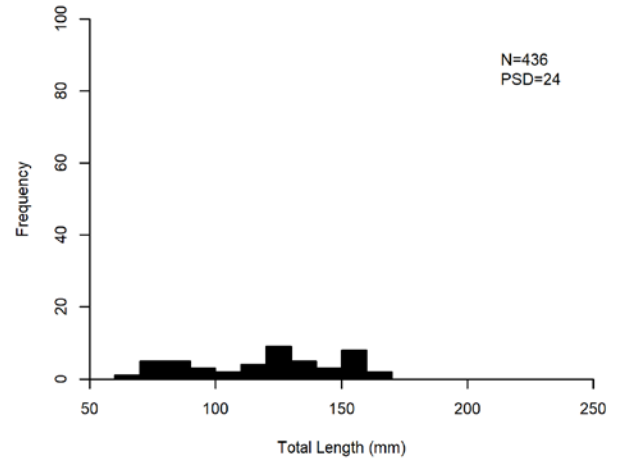




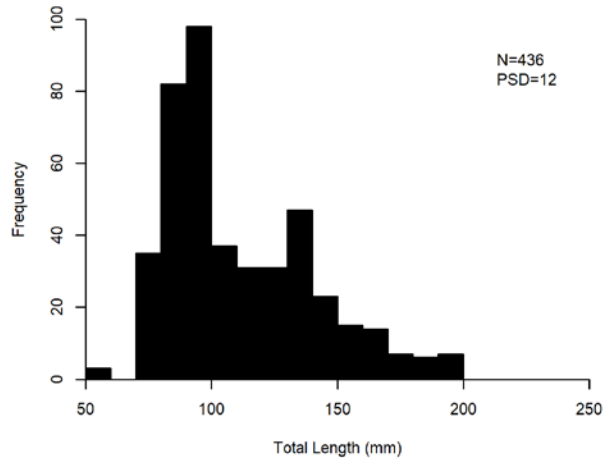
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**Shawnee SFL**



**Wilson SFL**



**Washington SFL**

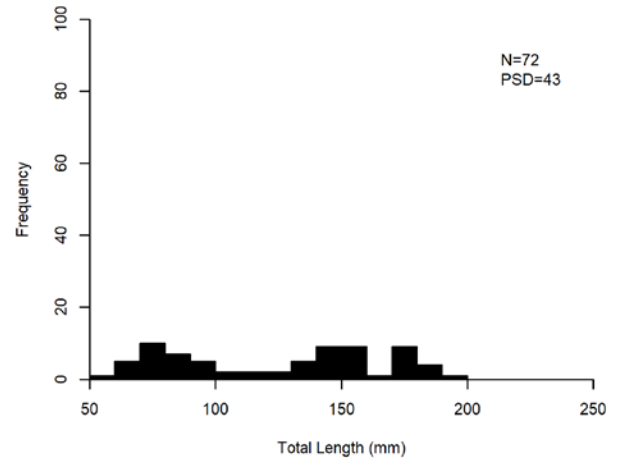
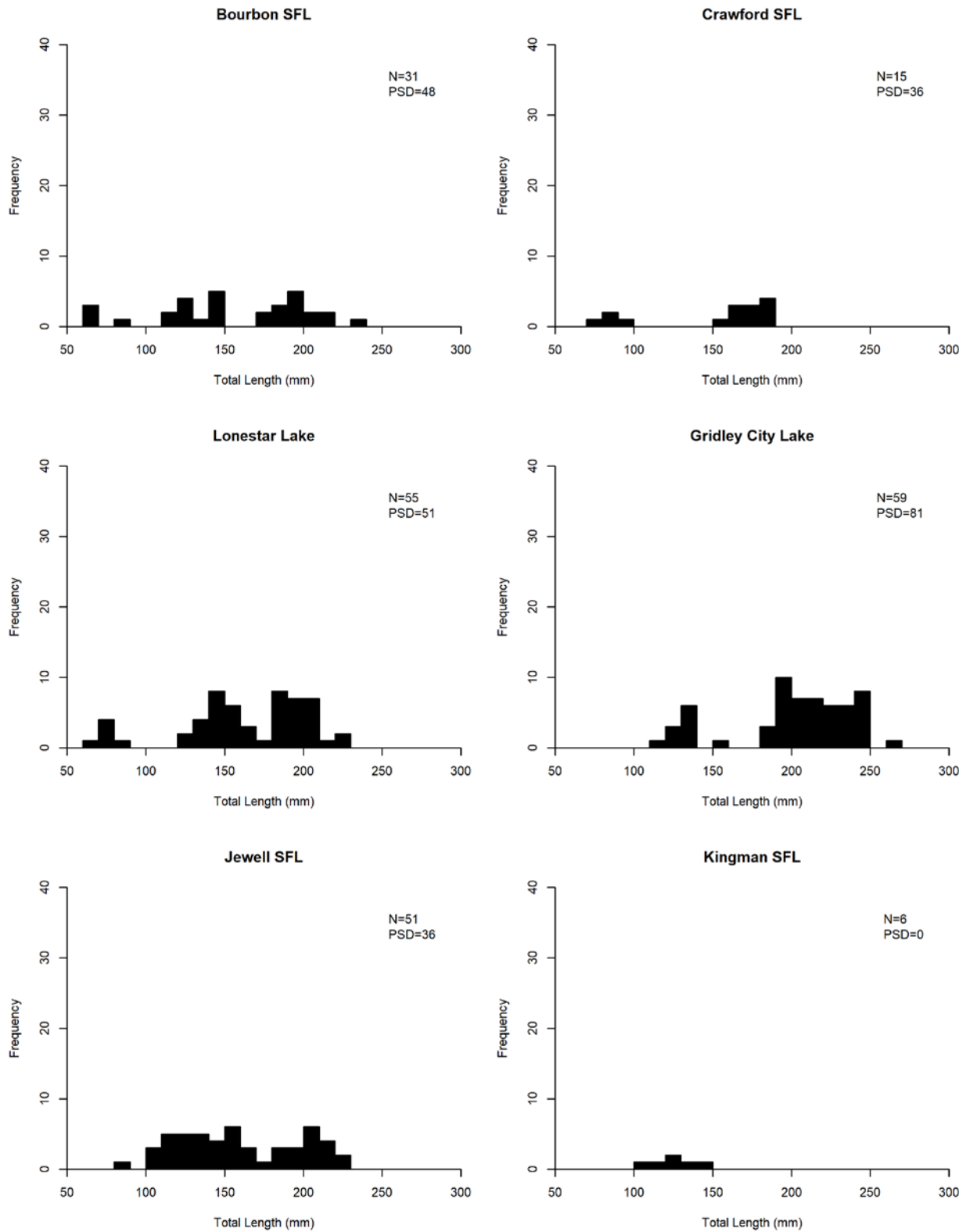
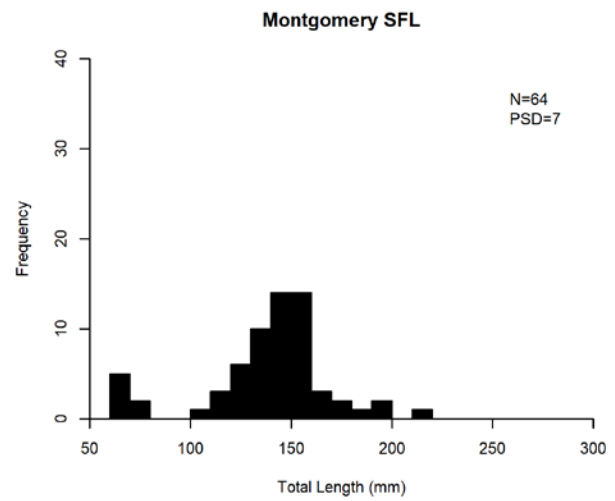
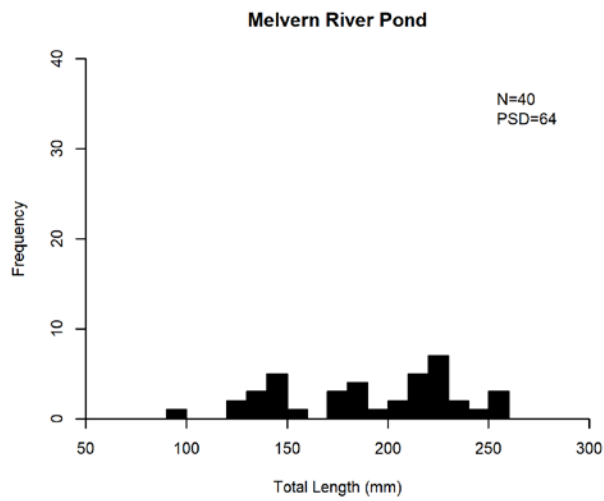
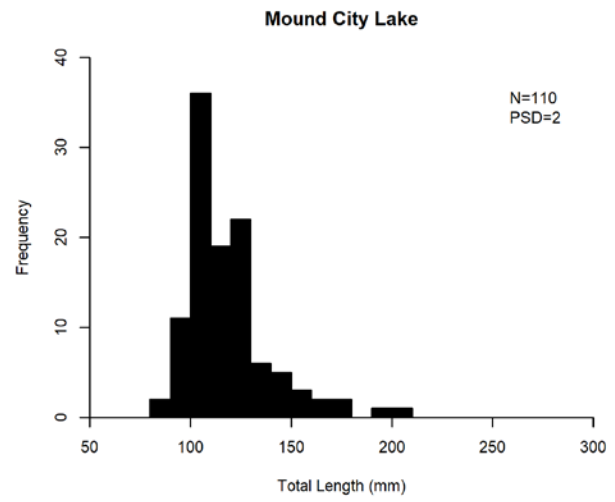
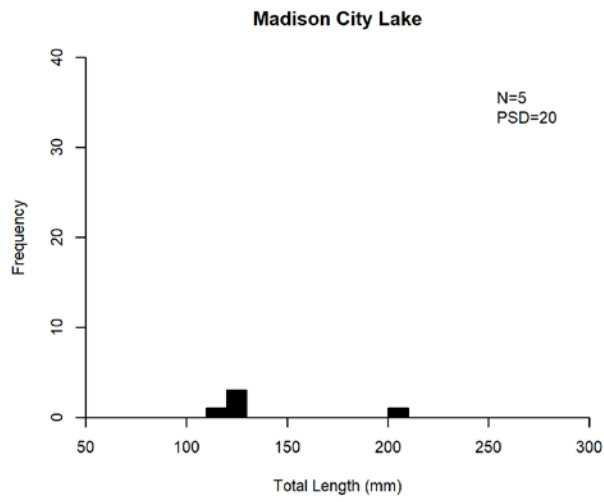
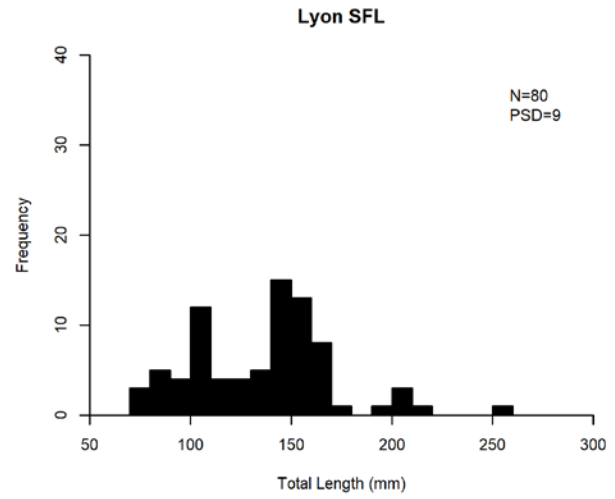
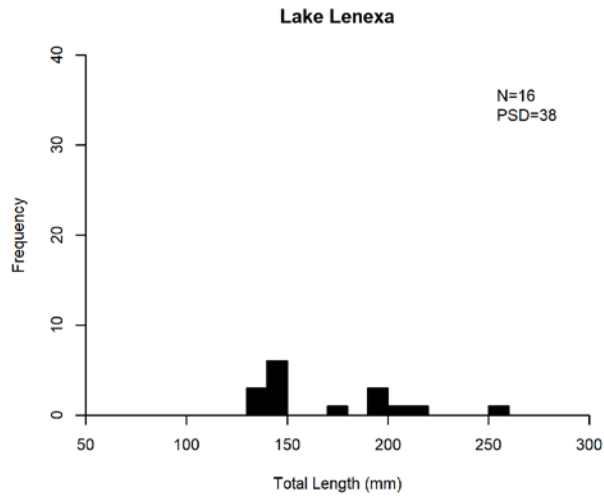


Figure 3. Length frequency histograms for Redear Sunfish sampled with electrofishing in 2017. Sample size and PSD are shown.





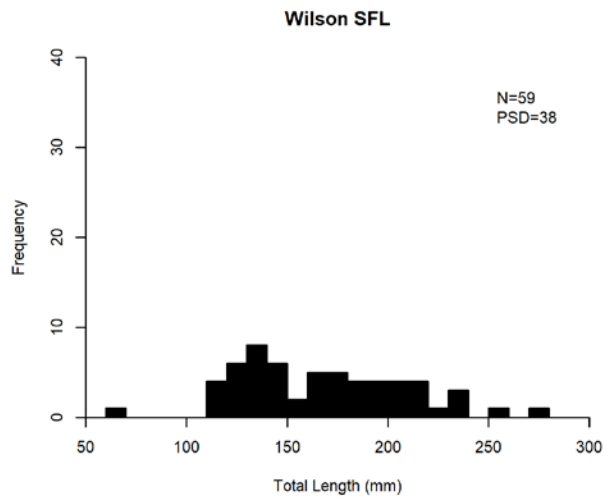
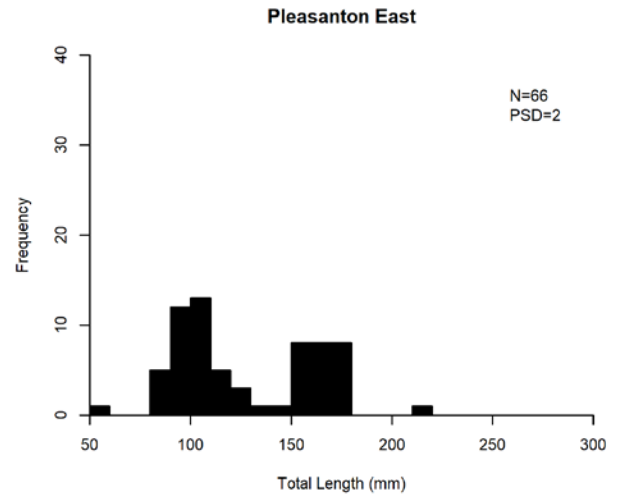
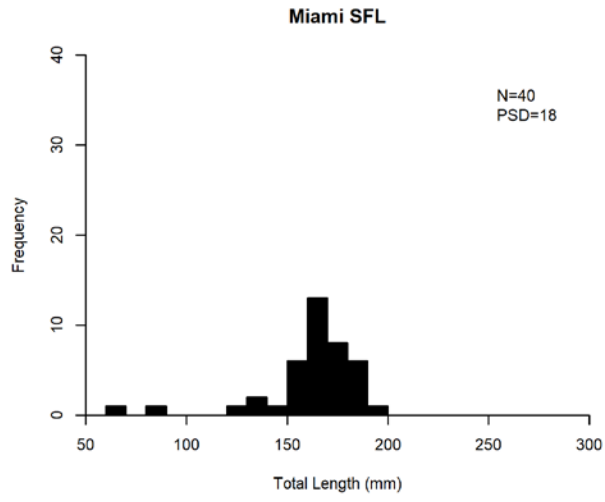
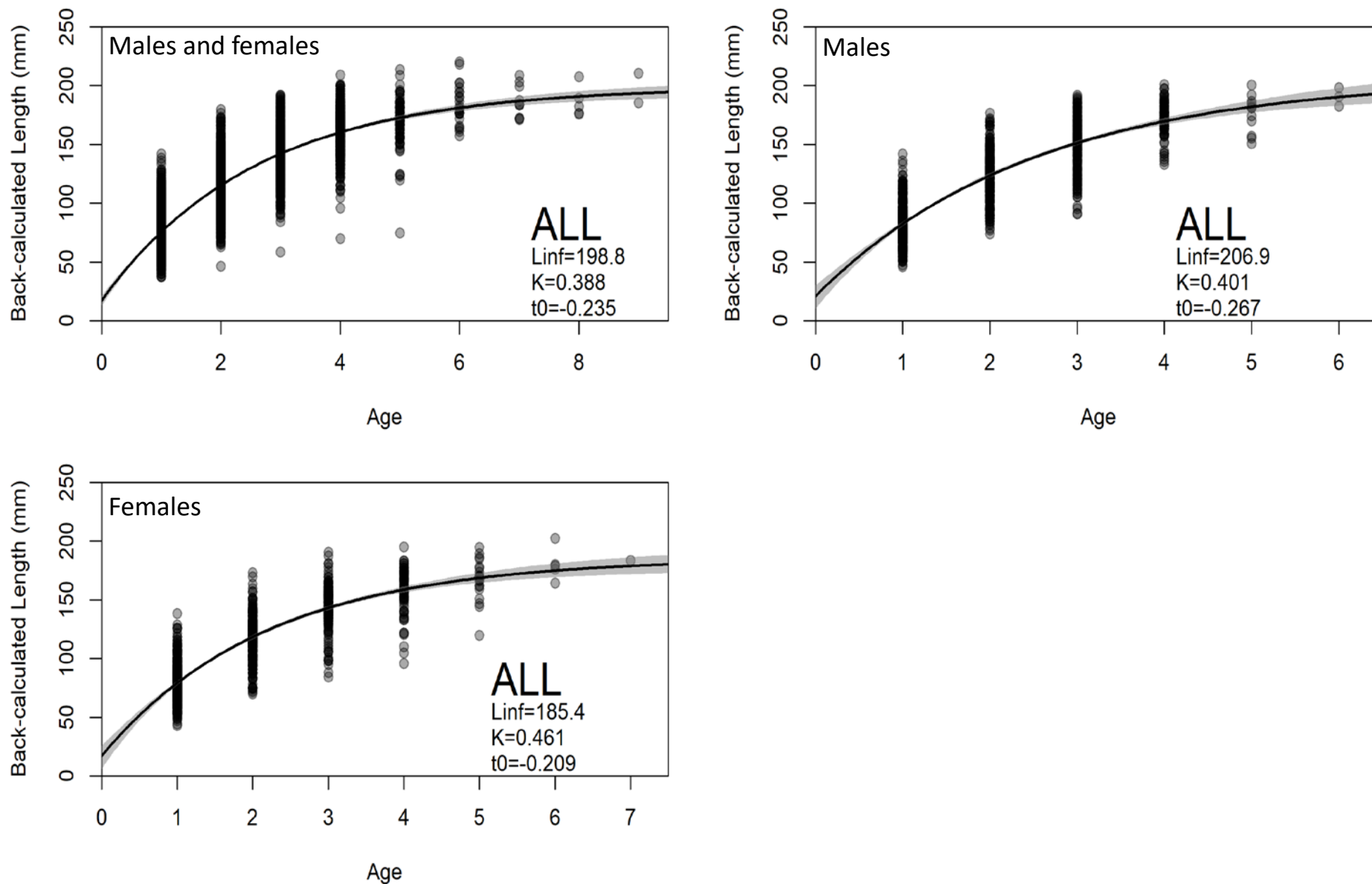
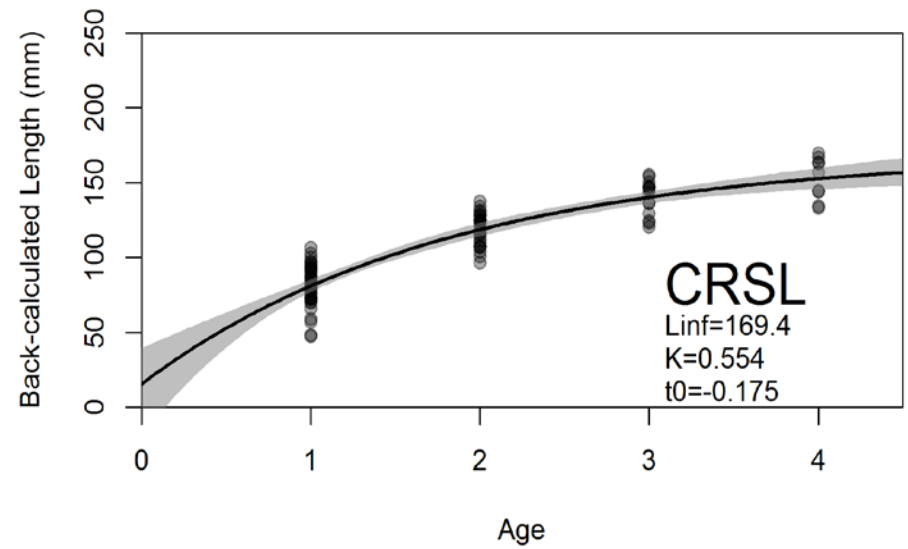
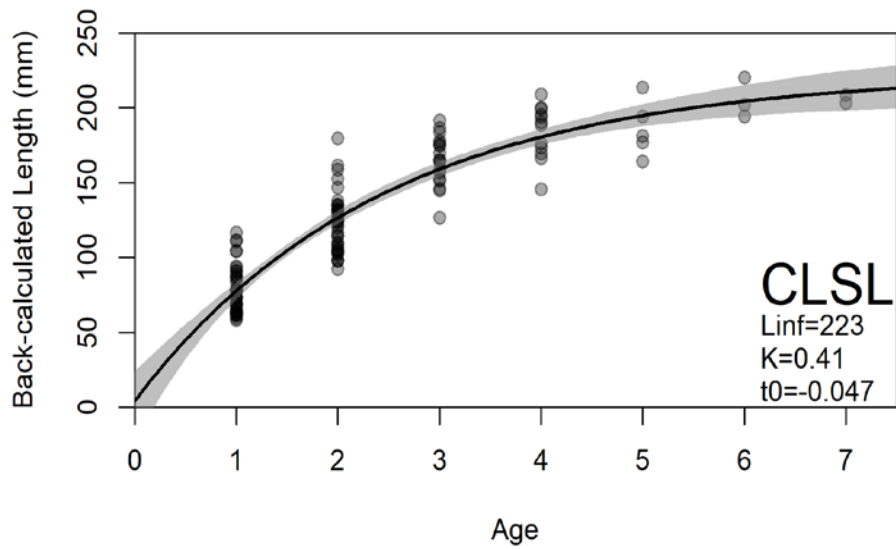
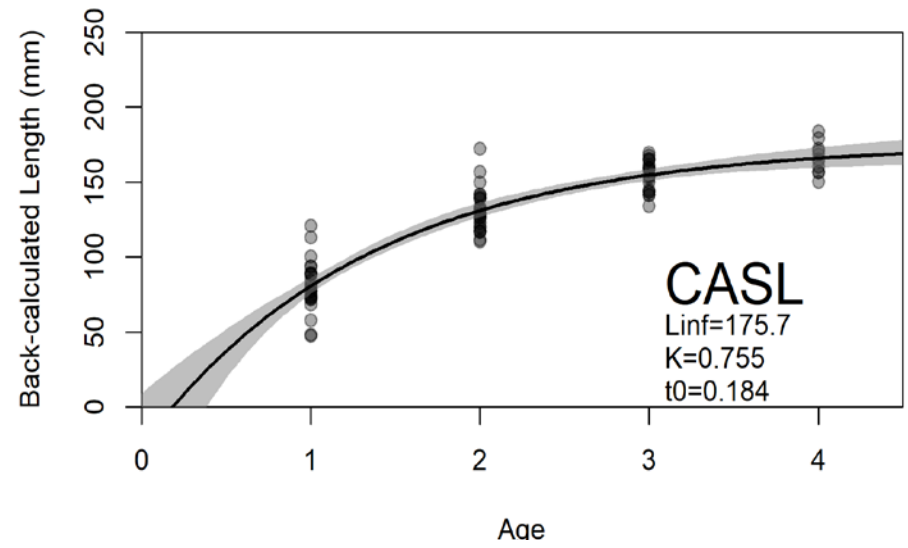
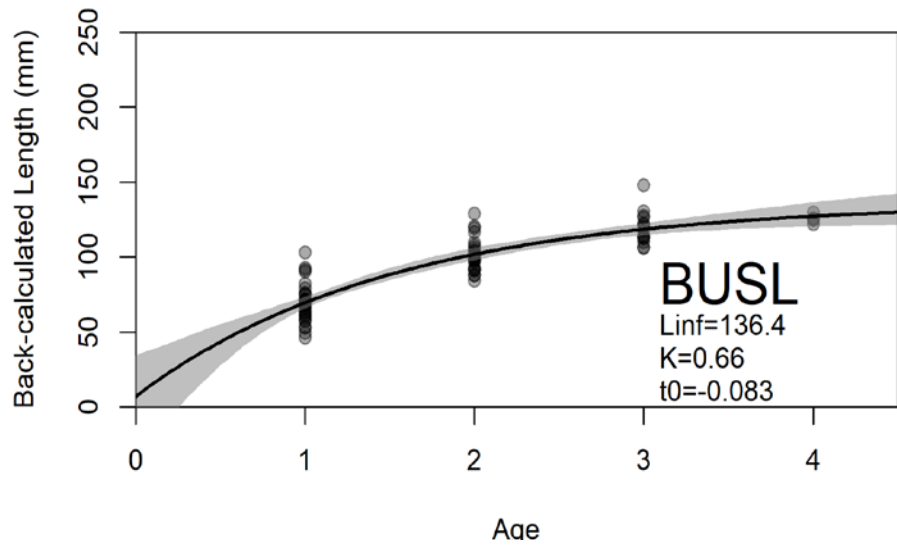
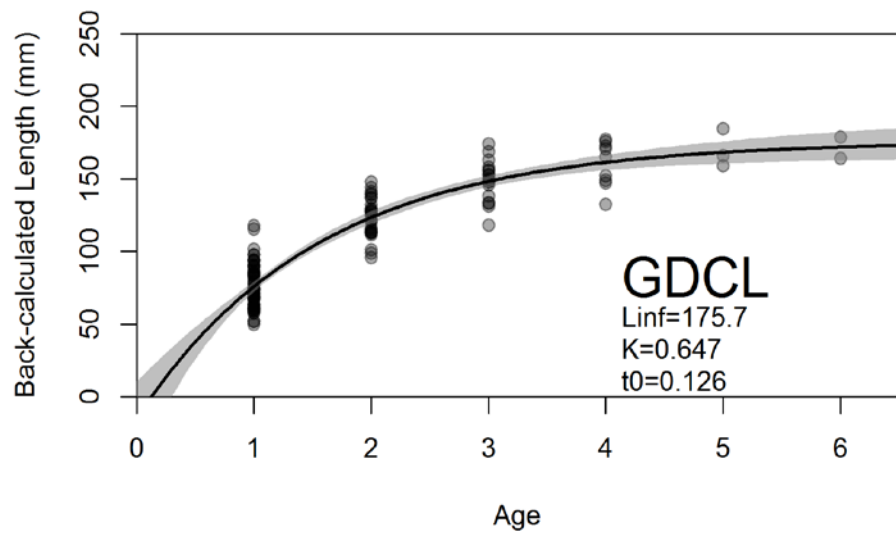
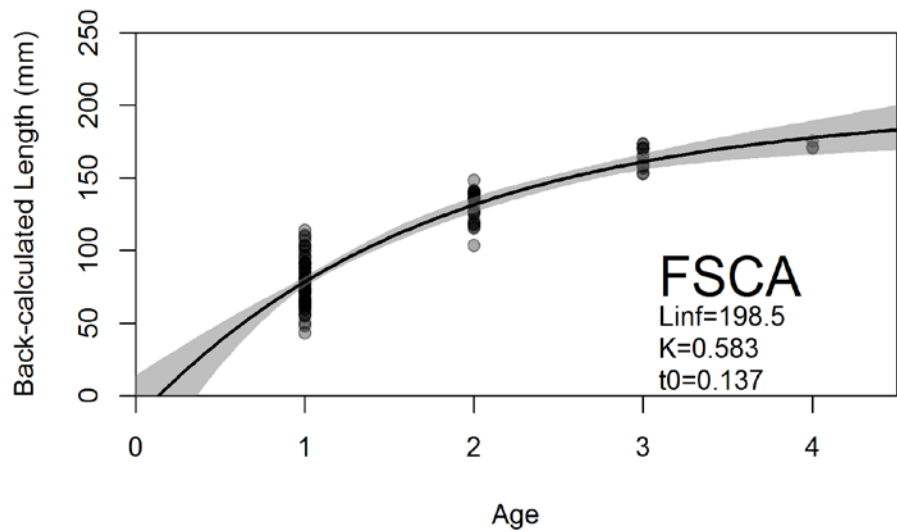
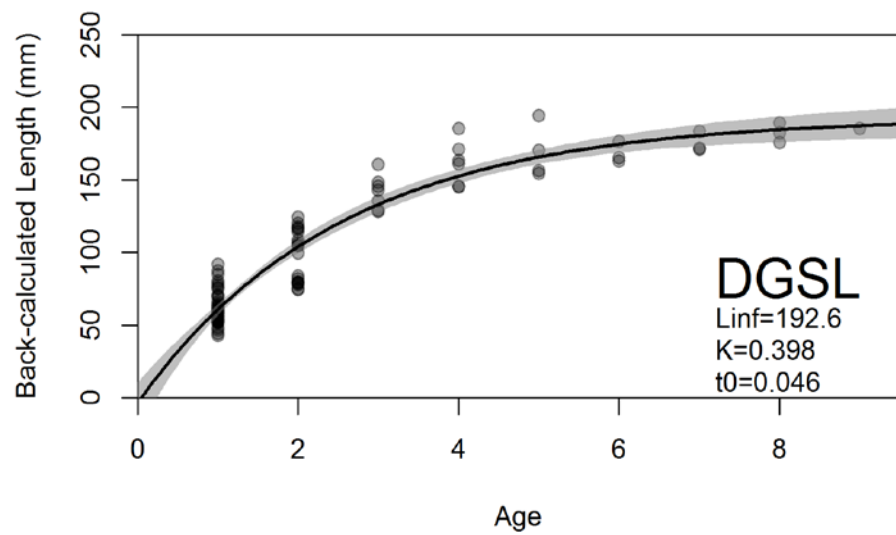
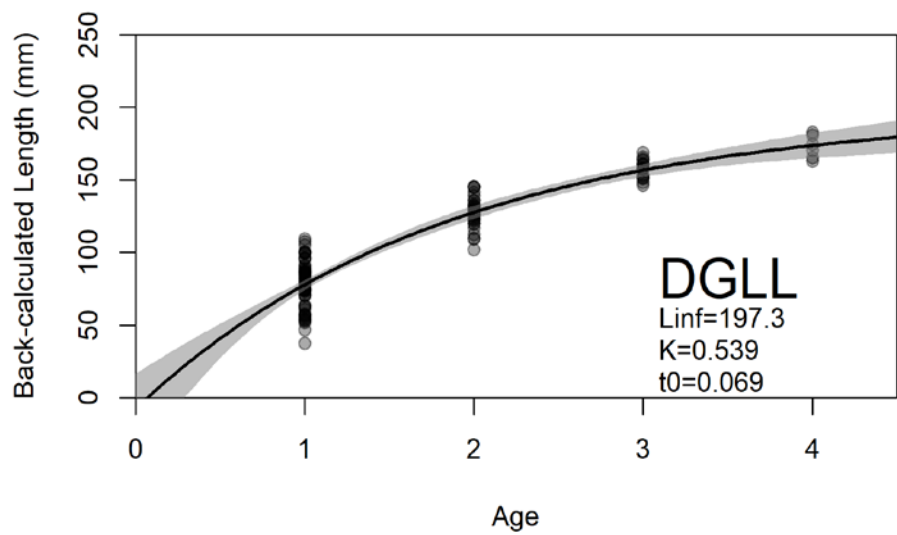


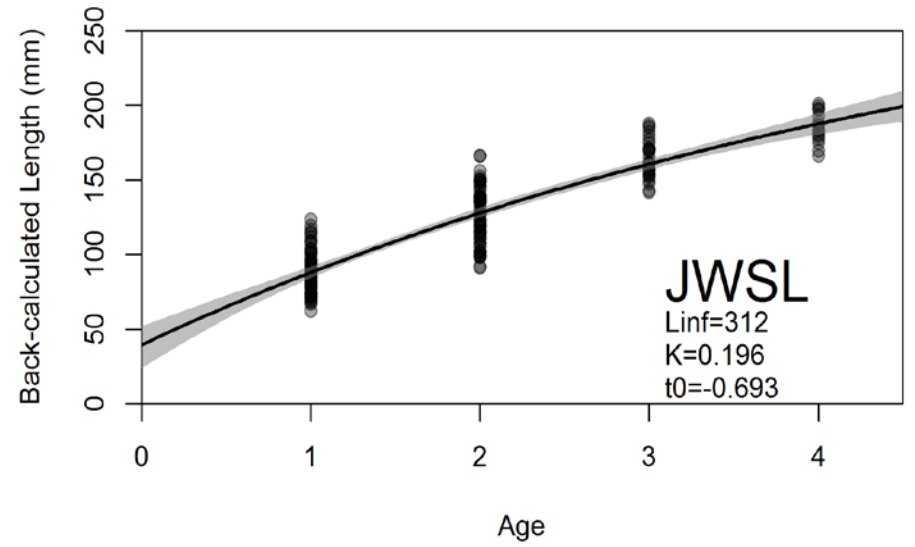
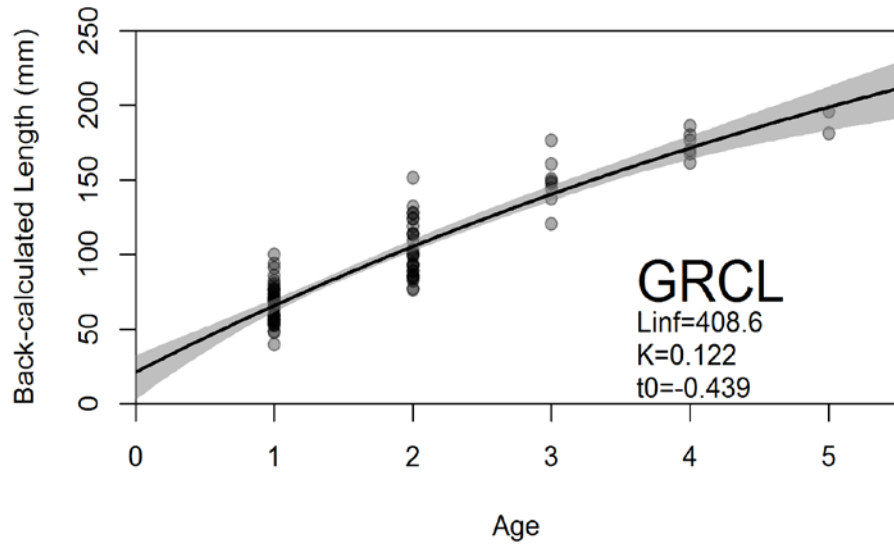
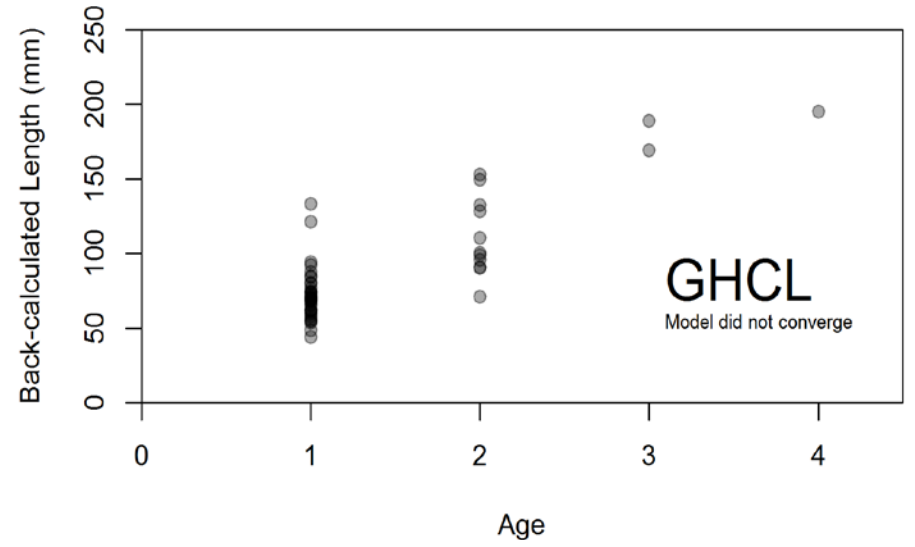
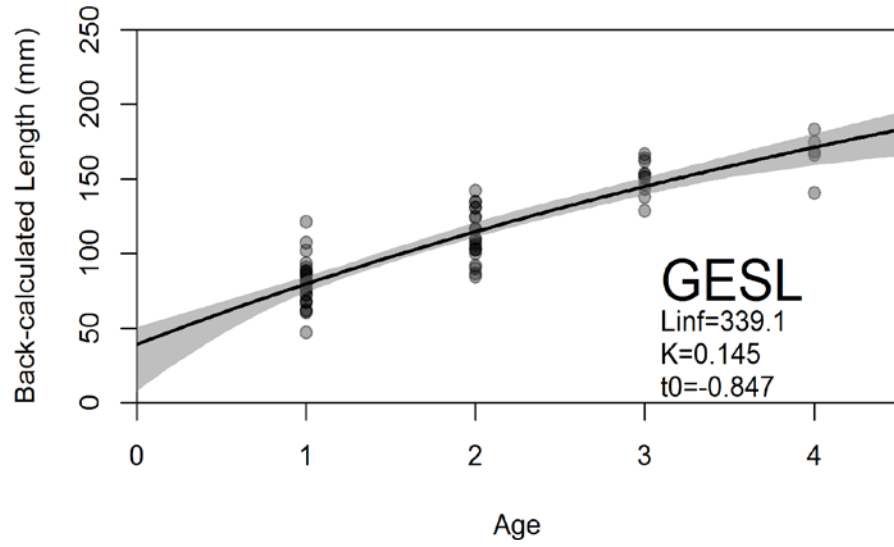
Figure 4. Back-calculated lengths, von Bertalanffy models, and equation coefficients for Bluegill sampled from Kansas impoundments in 2017. Points on the graphs are individual back-calculation estimates, the solid line is the predicted von Bertalanffy model, and the shaded area is the 95% confidence interval around the model. Models from some populations did not converge.

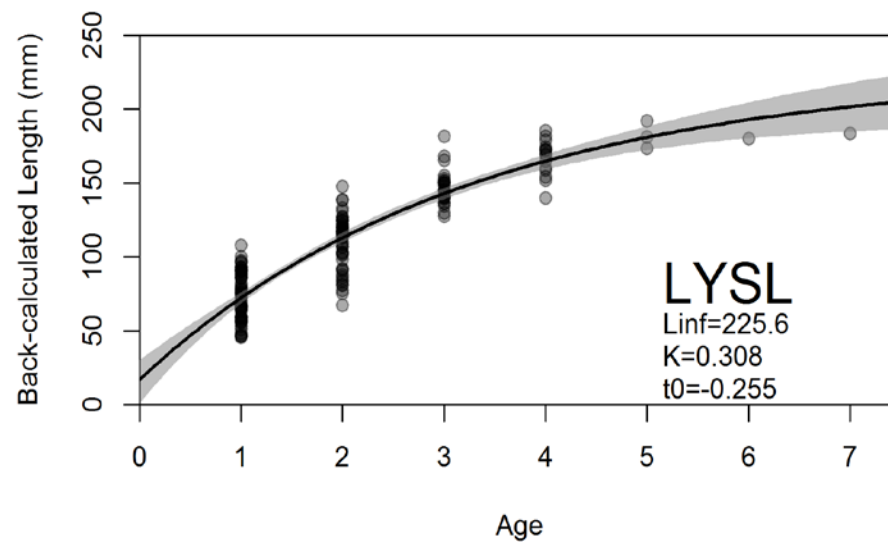
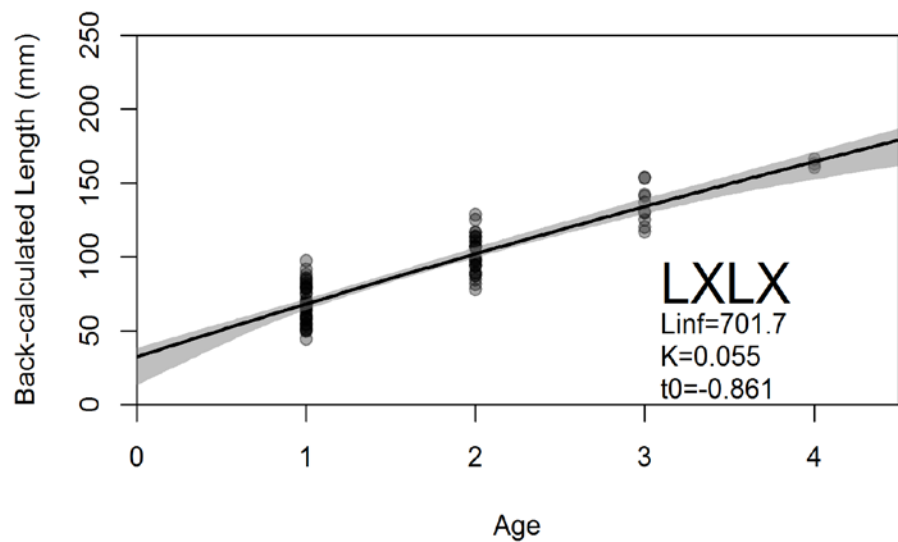
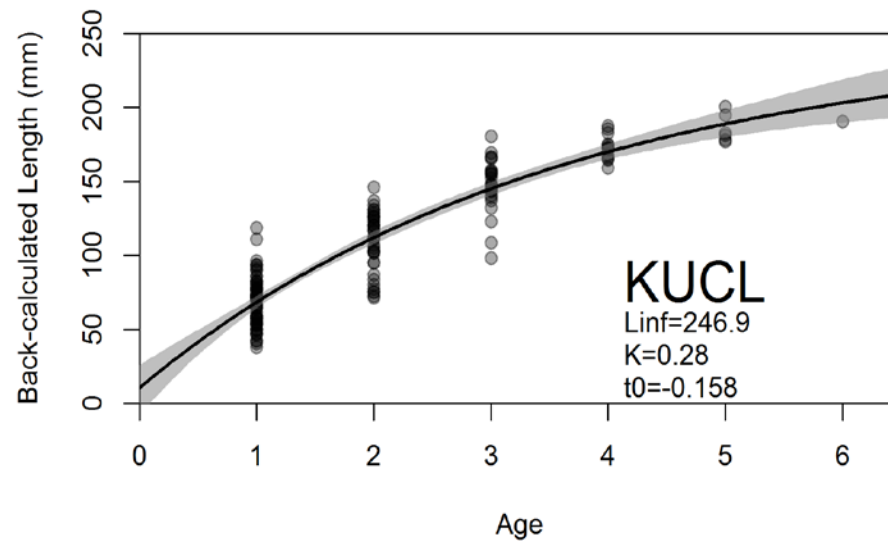
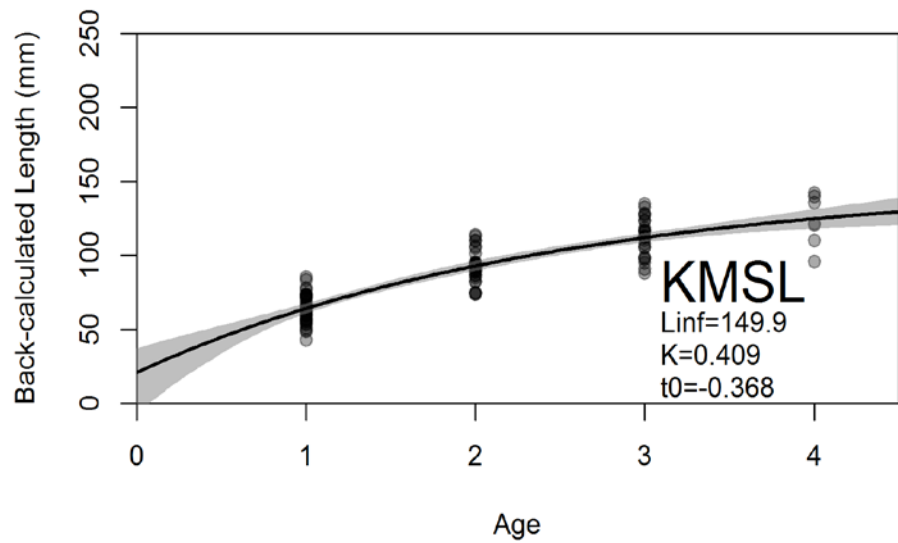


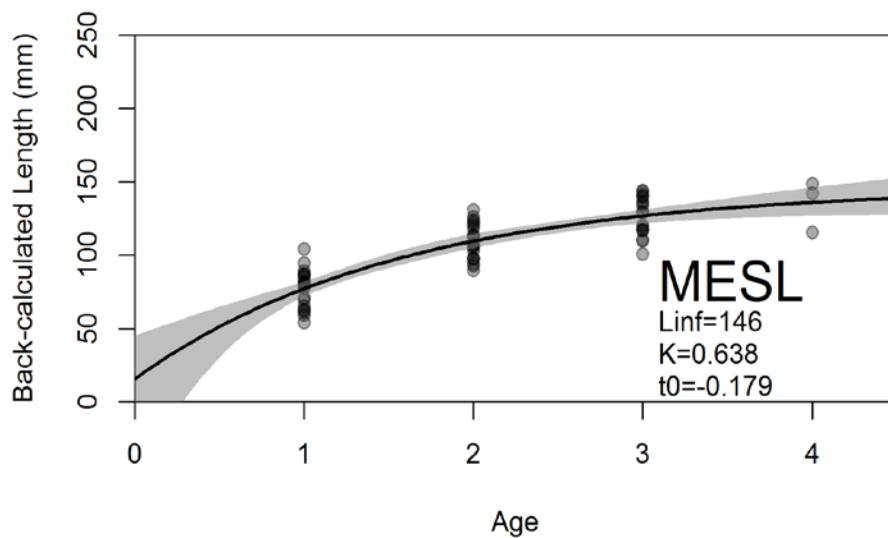
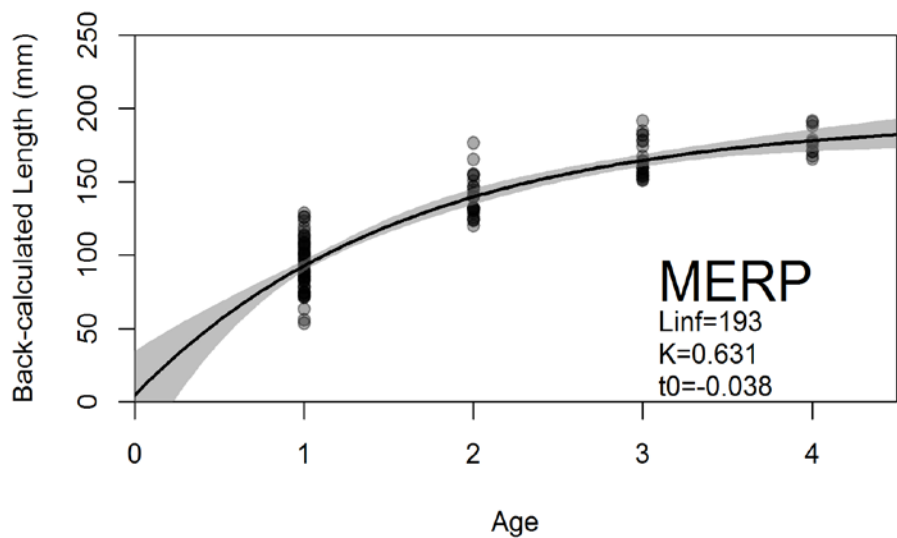
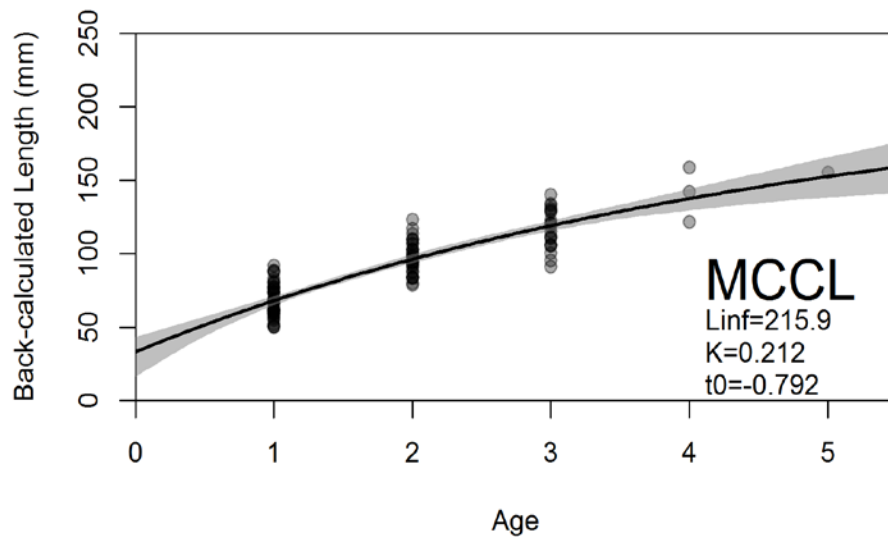
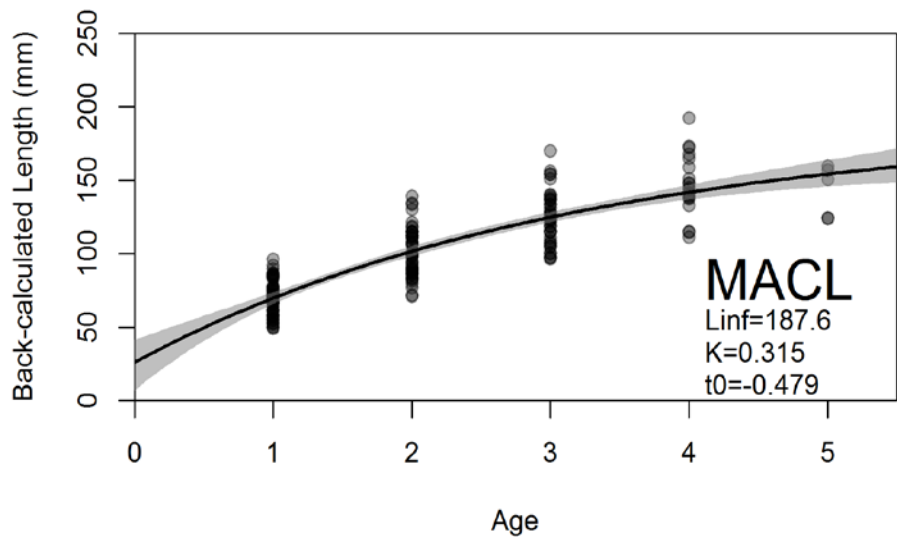


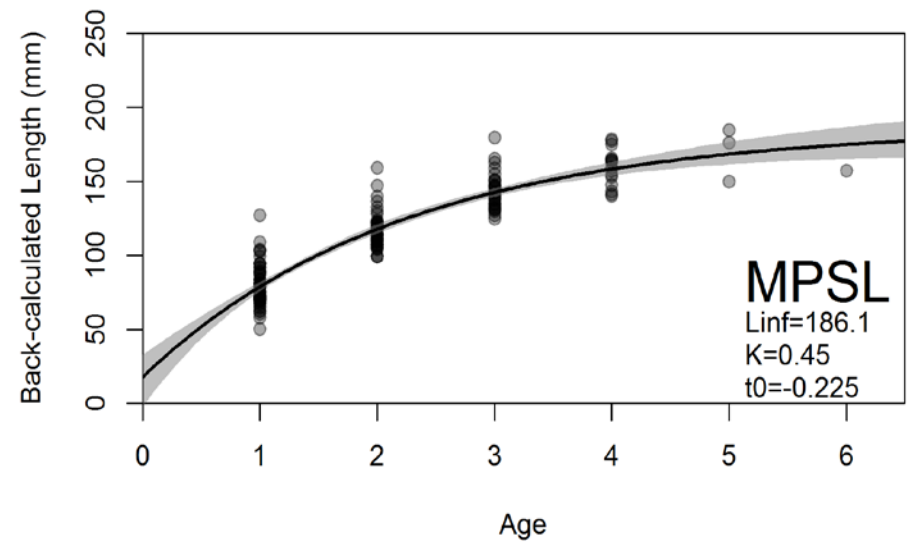
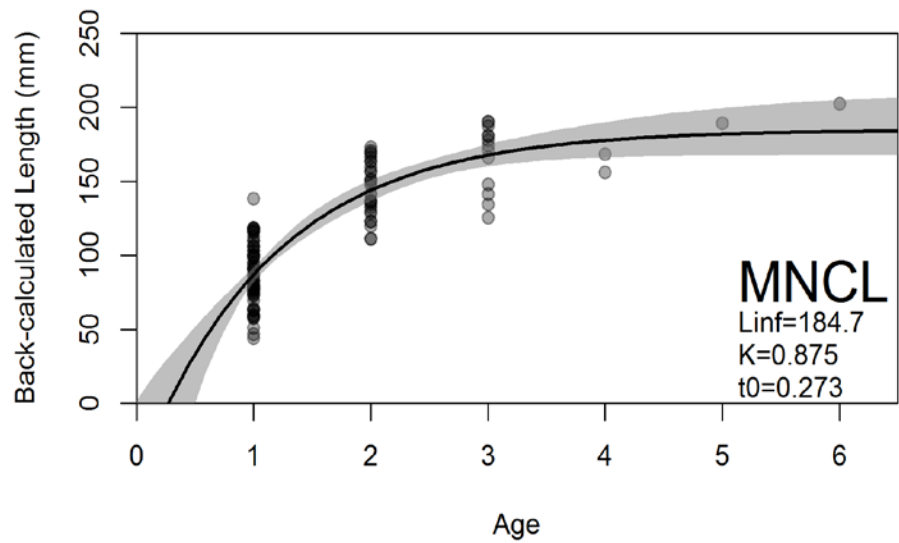
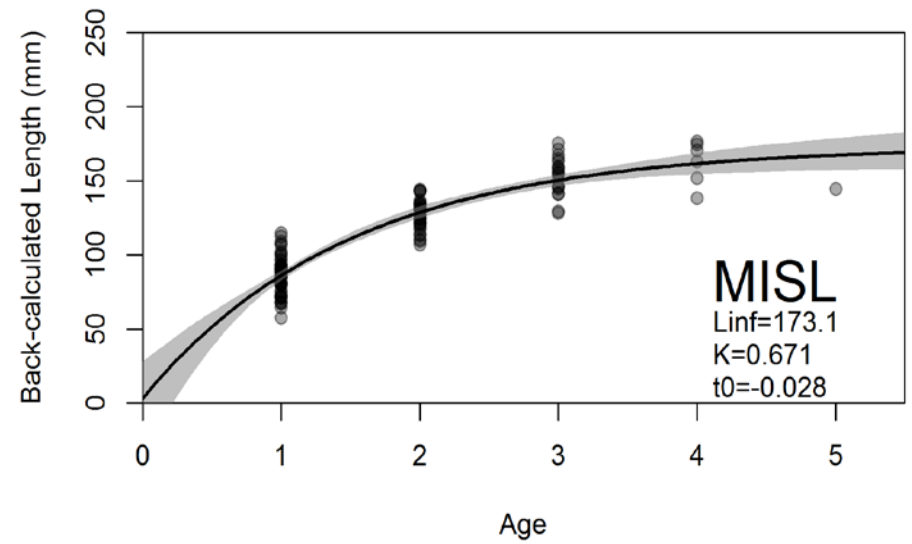
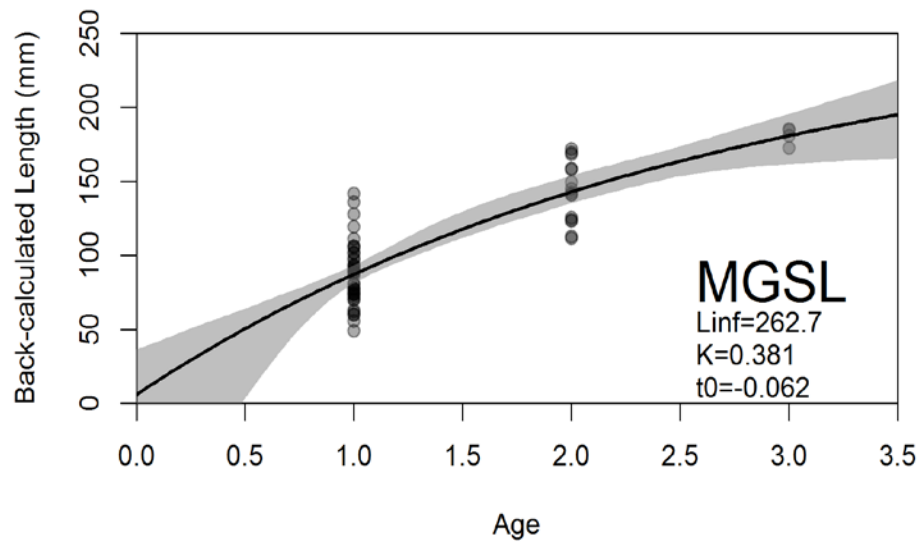


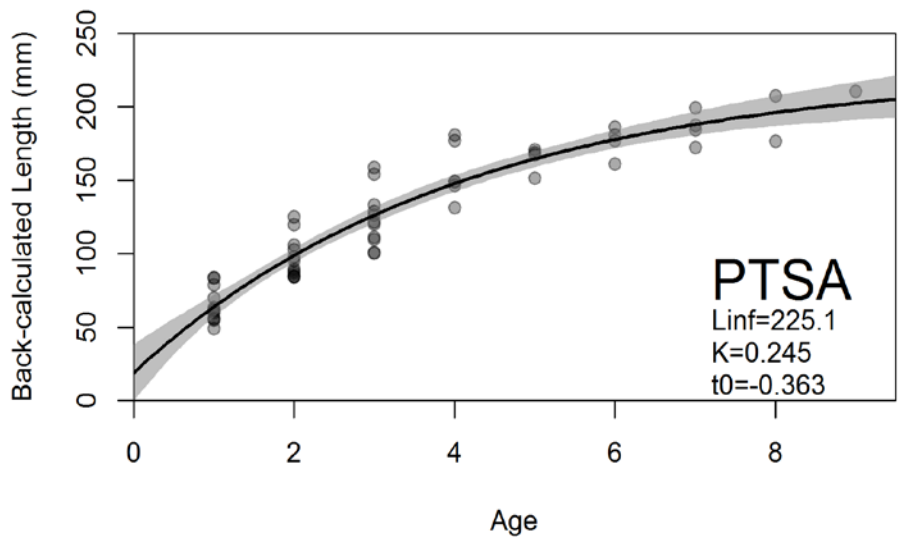
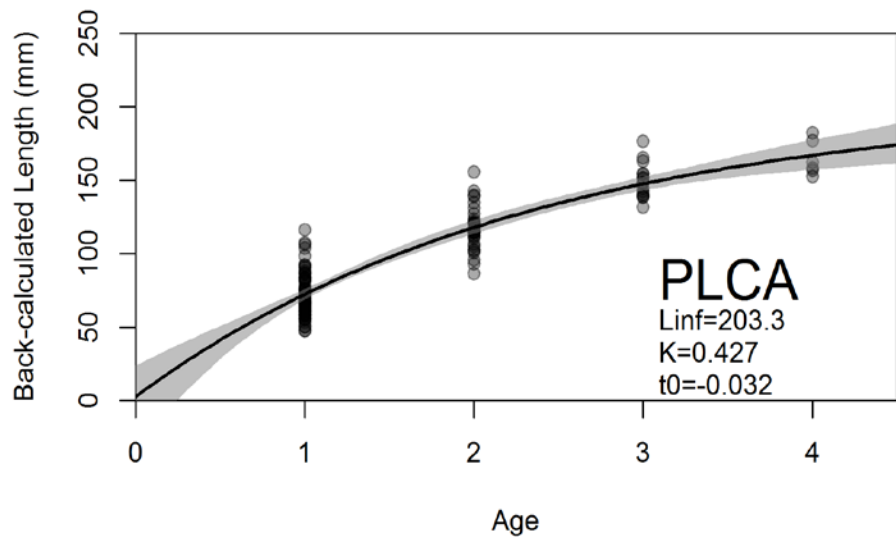
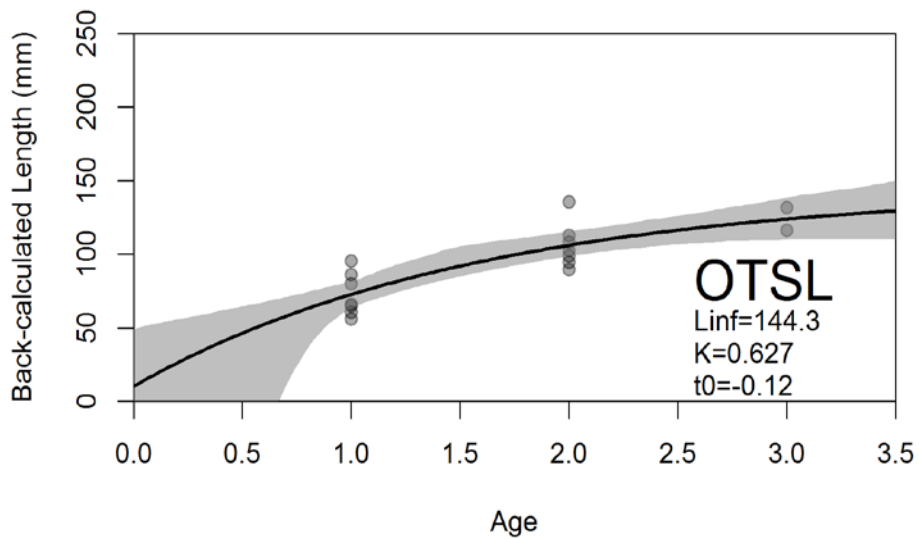
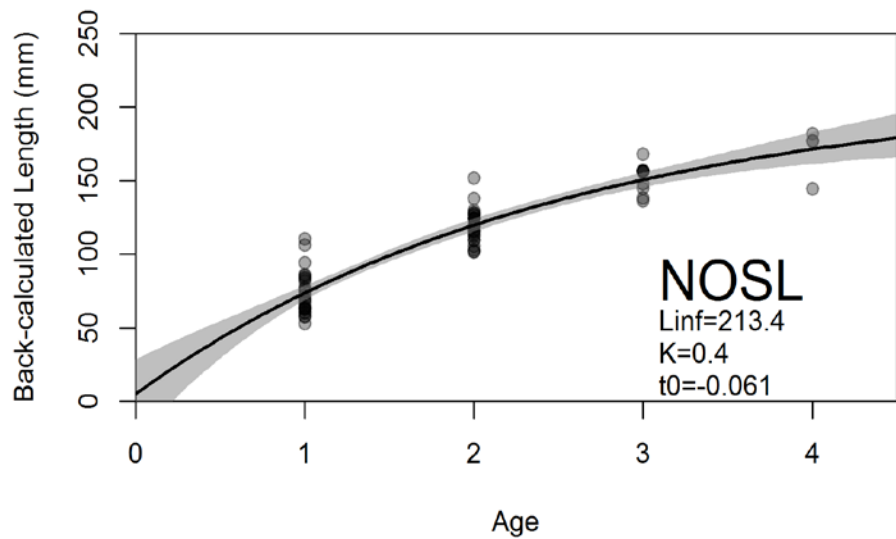


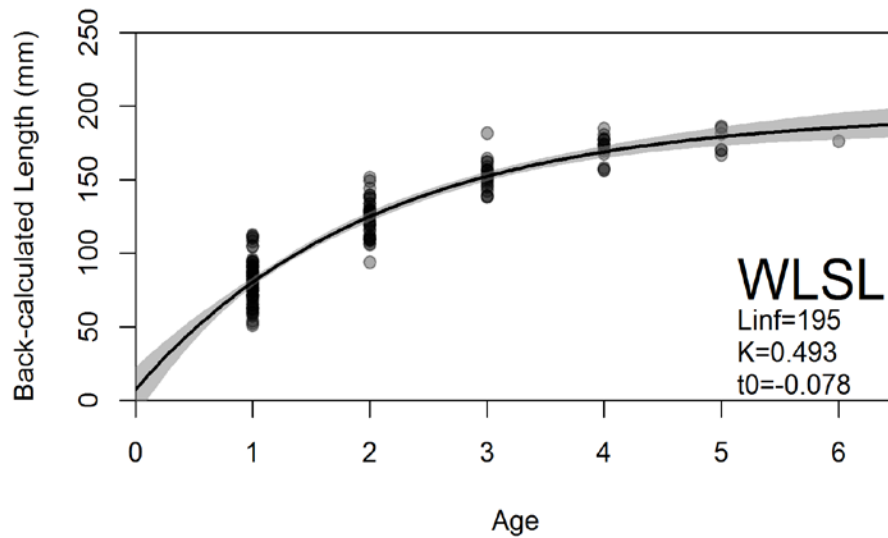
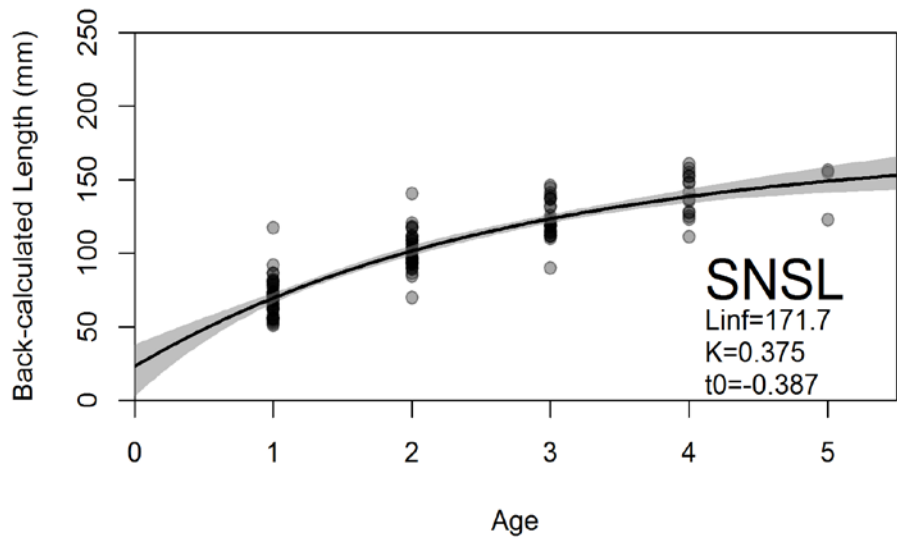
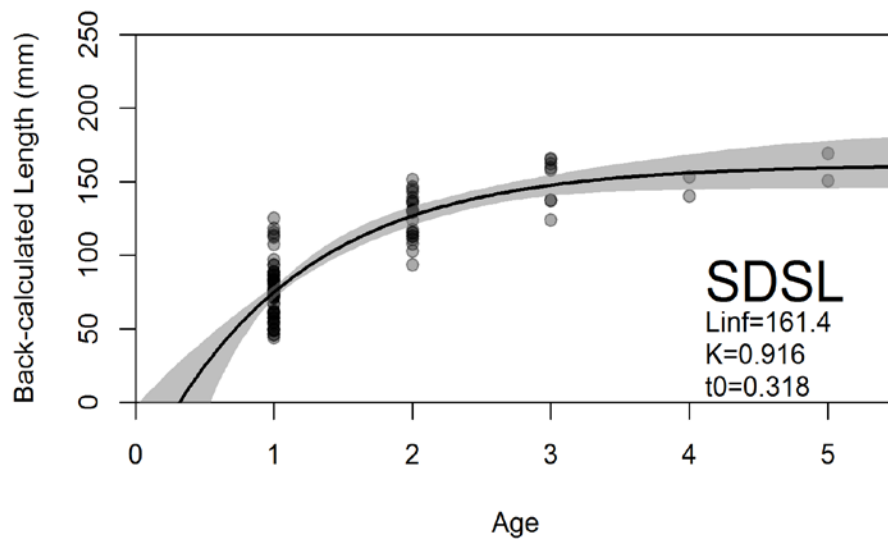
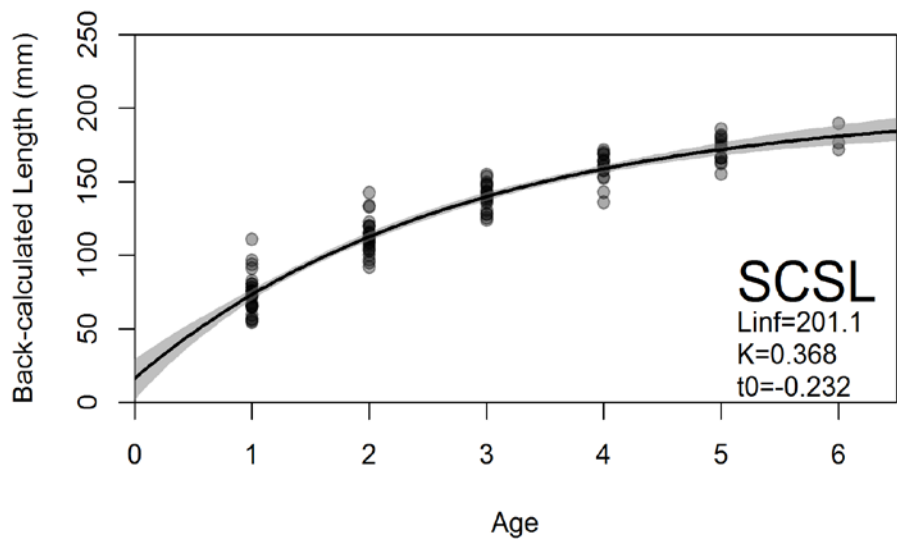












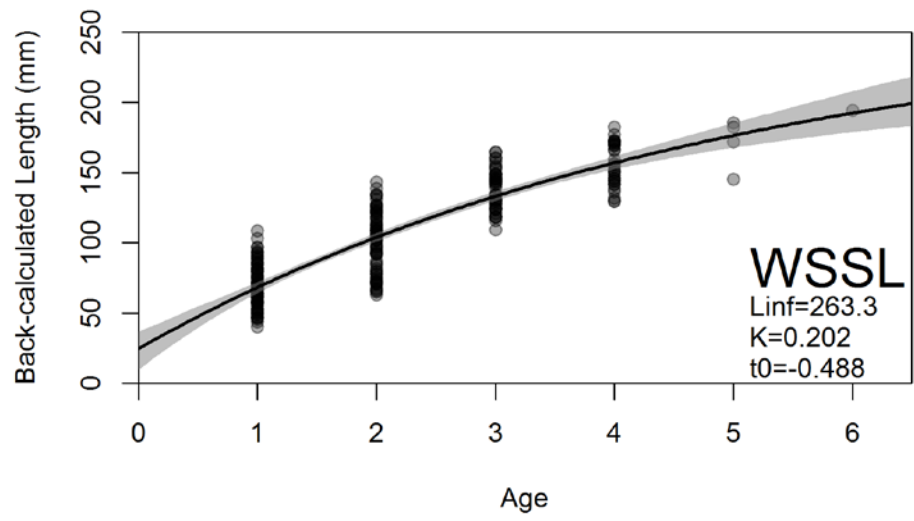
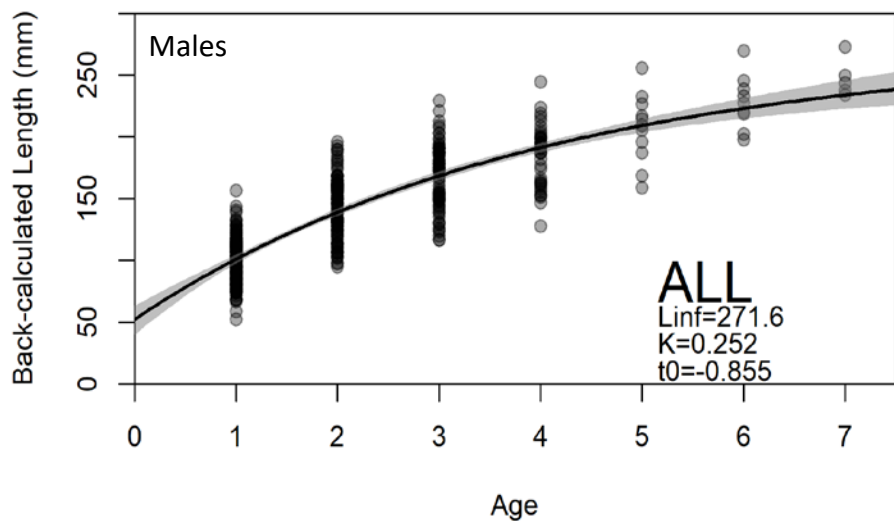
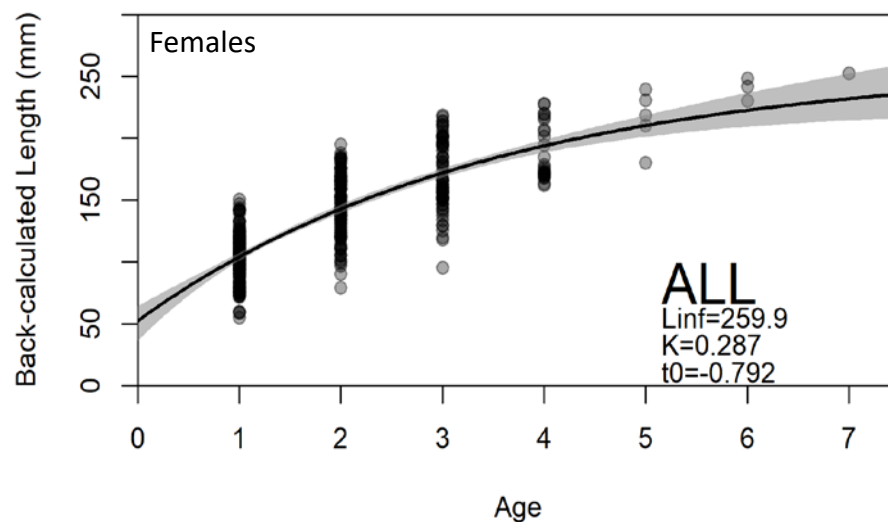
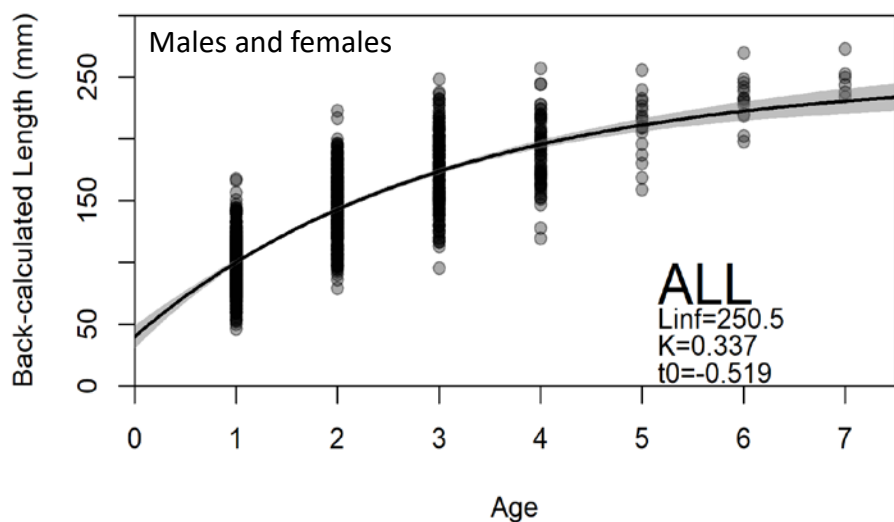
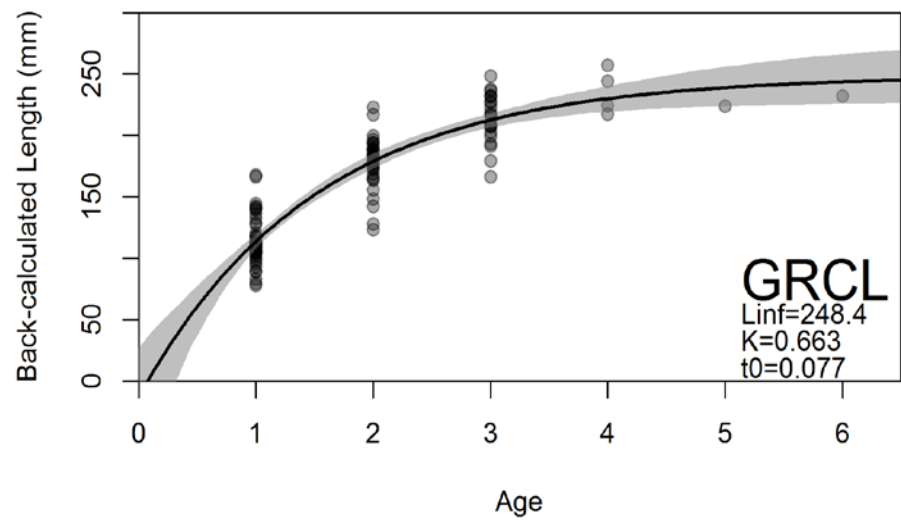
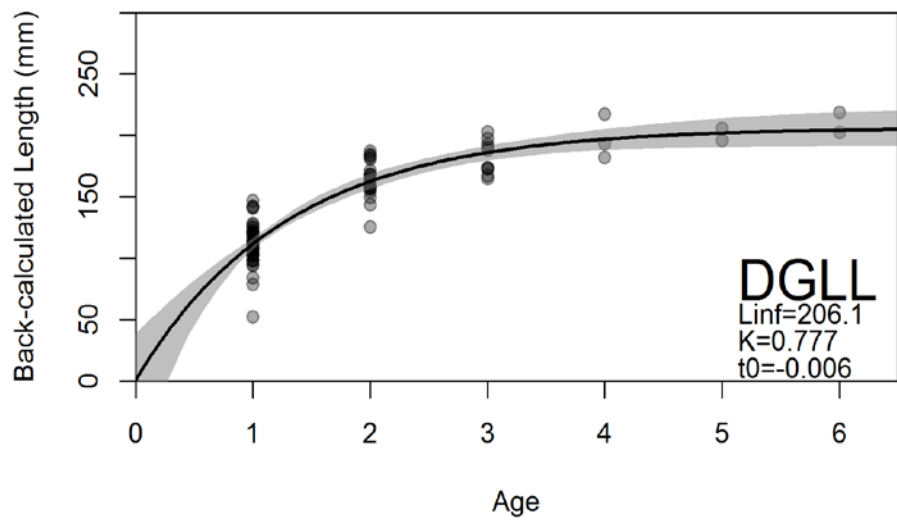
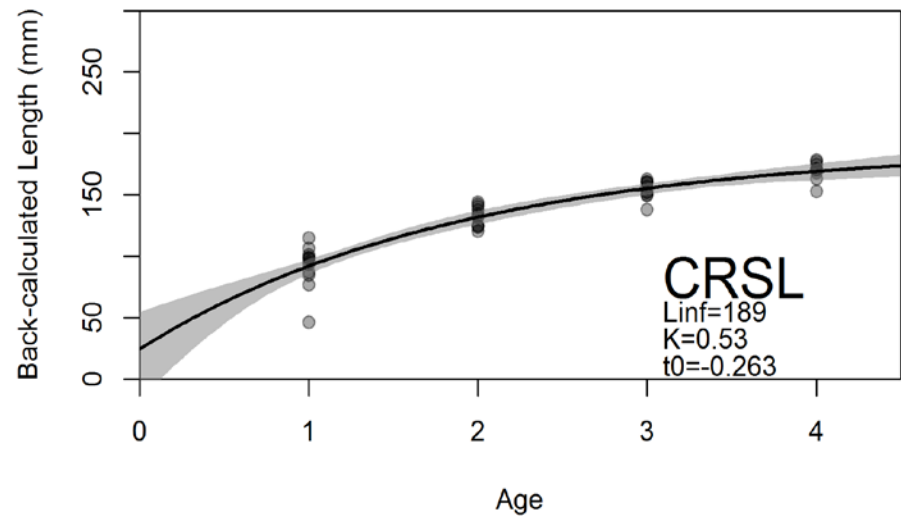
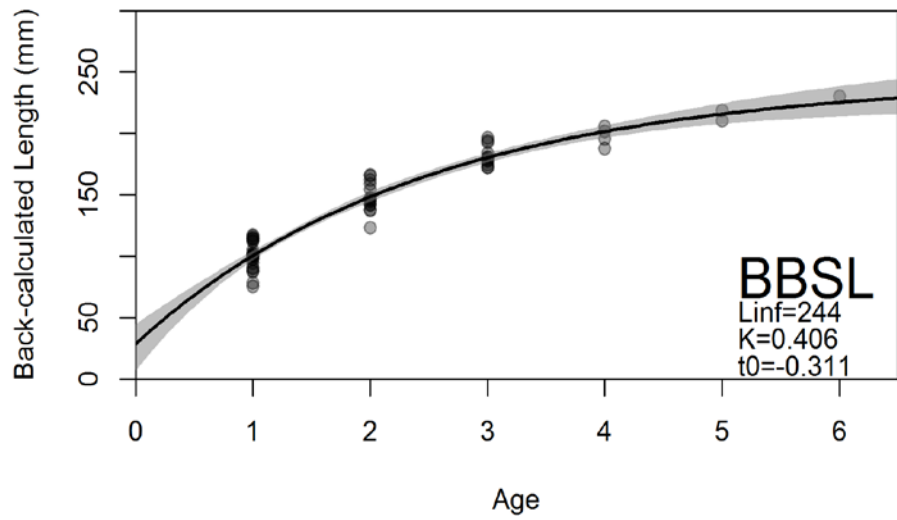
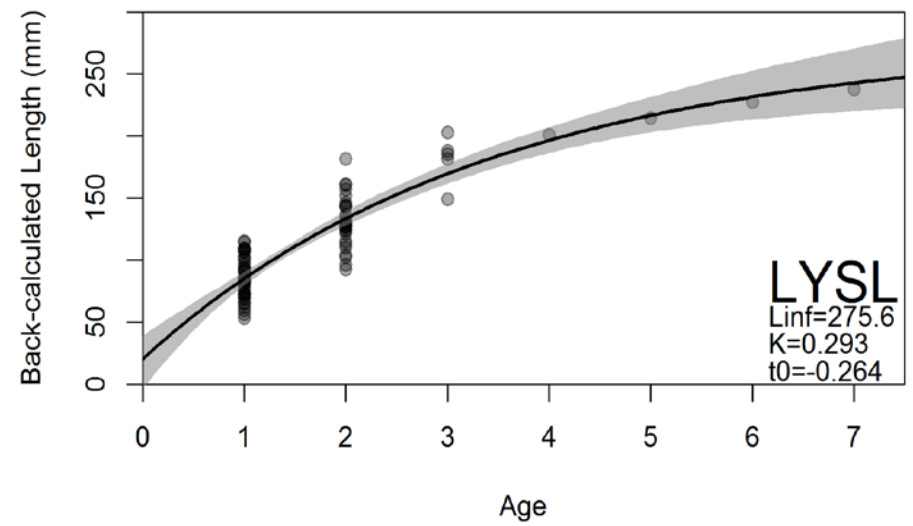
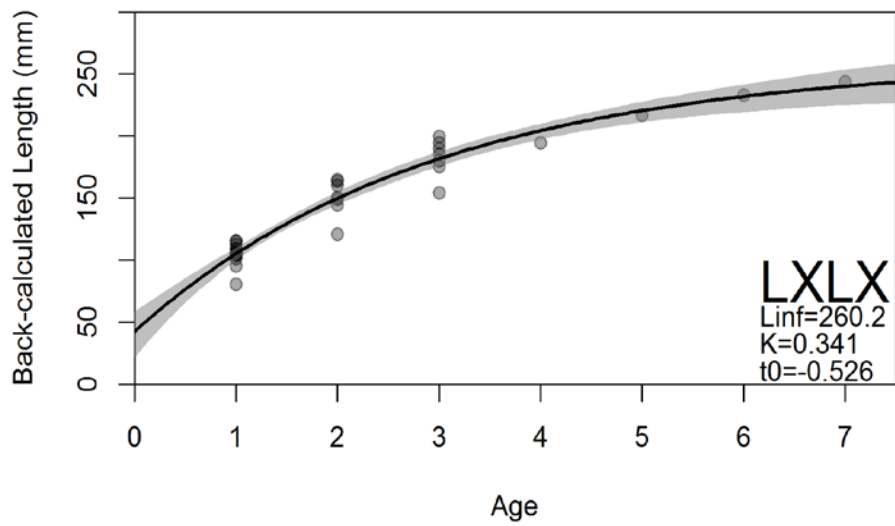
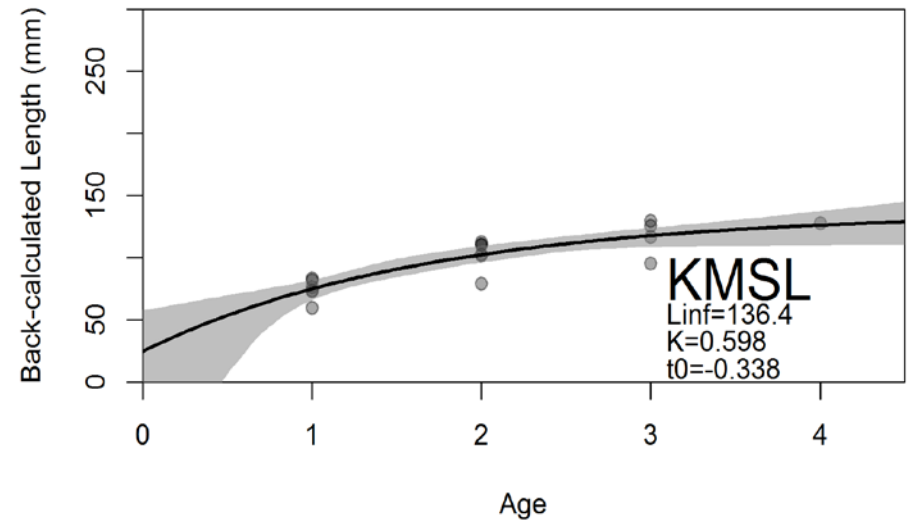
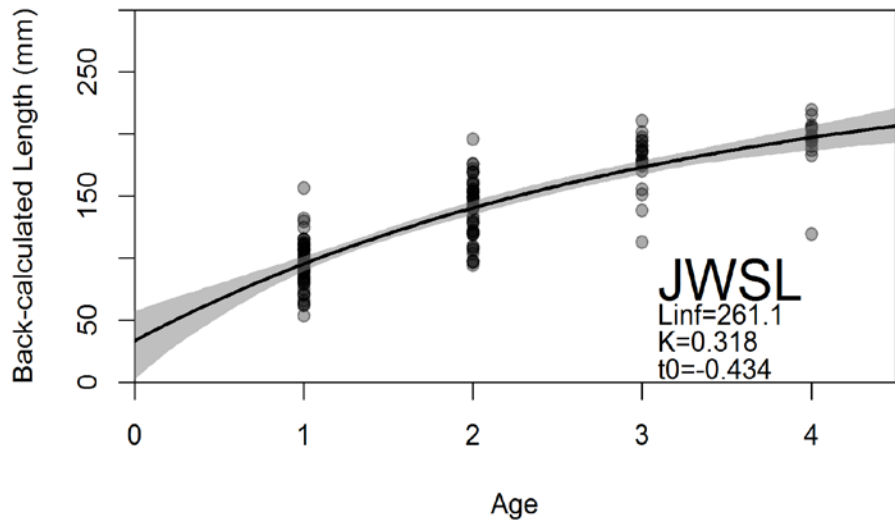




Figure 5. Back-calculated lengths, von Bertalanffy models, and equation coefficients for Redear Sunfish sampled from Kansas impoundments in 2017. Points on the graphs are individual back-calculation estimates, the solid line is the predicted von Bertalanffy model, and the shaded area is the 95% confidence interval around the model. Models from some populations did not converge.







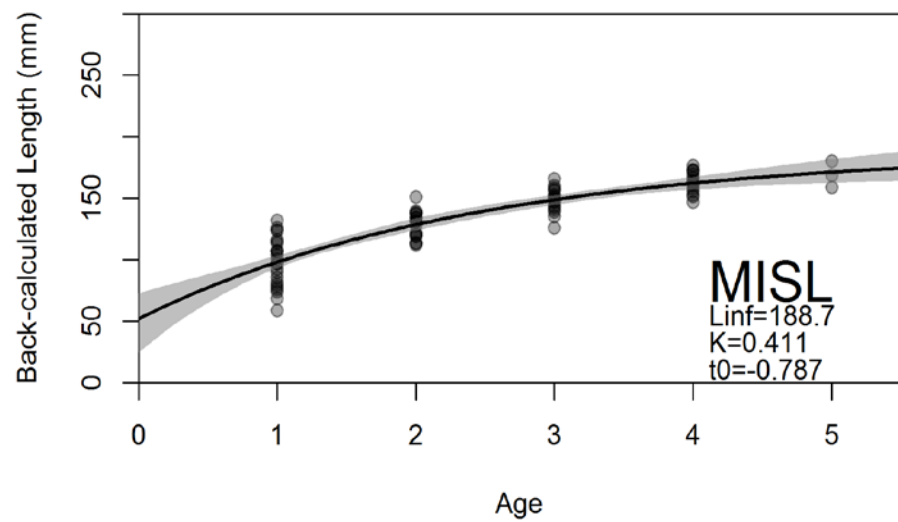
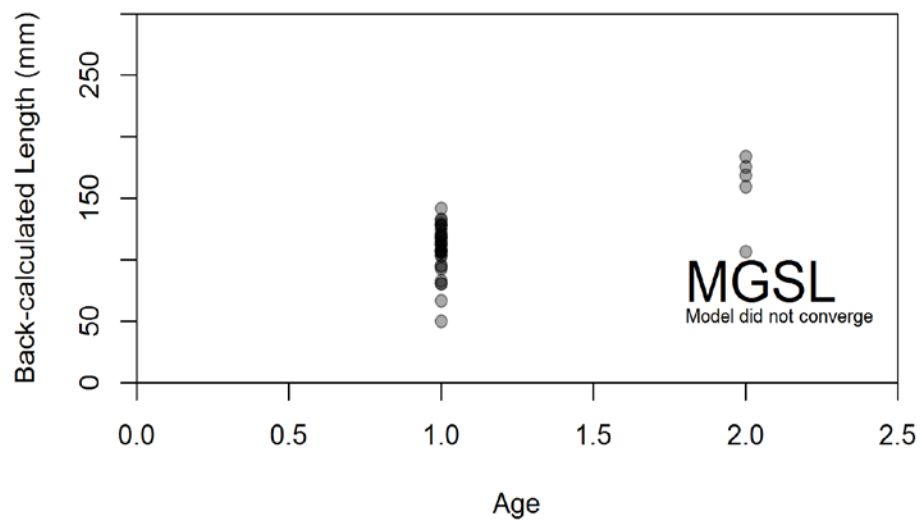
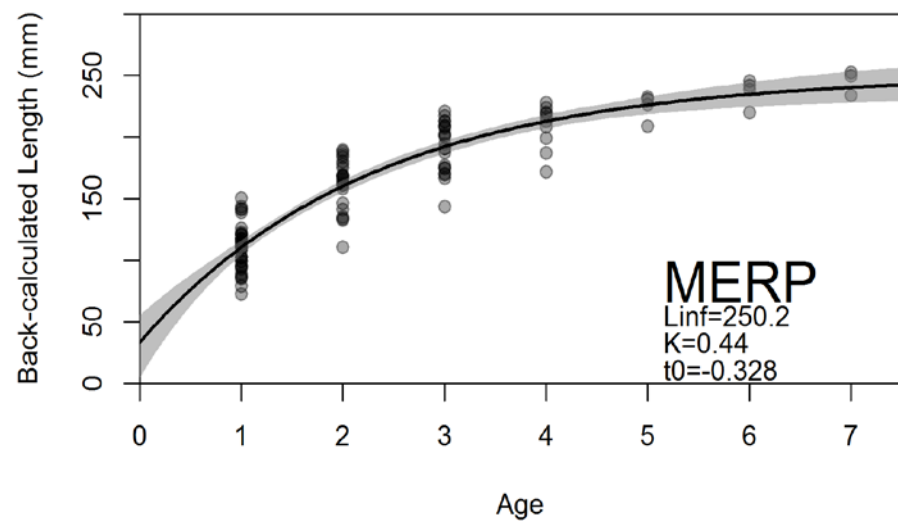
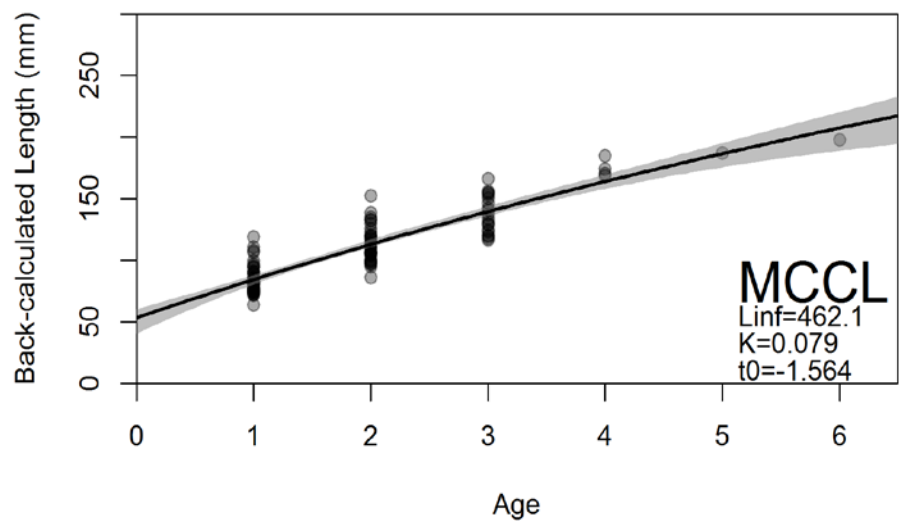
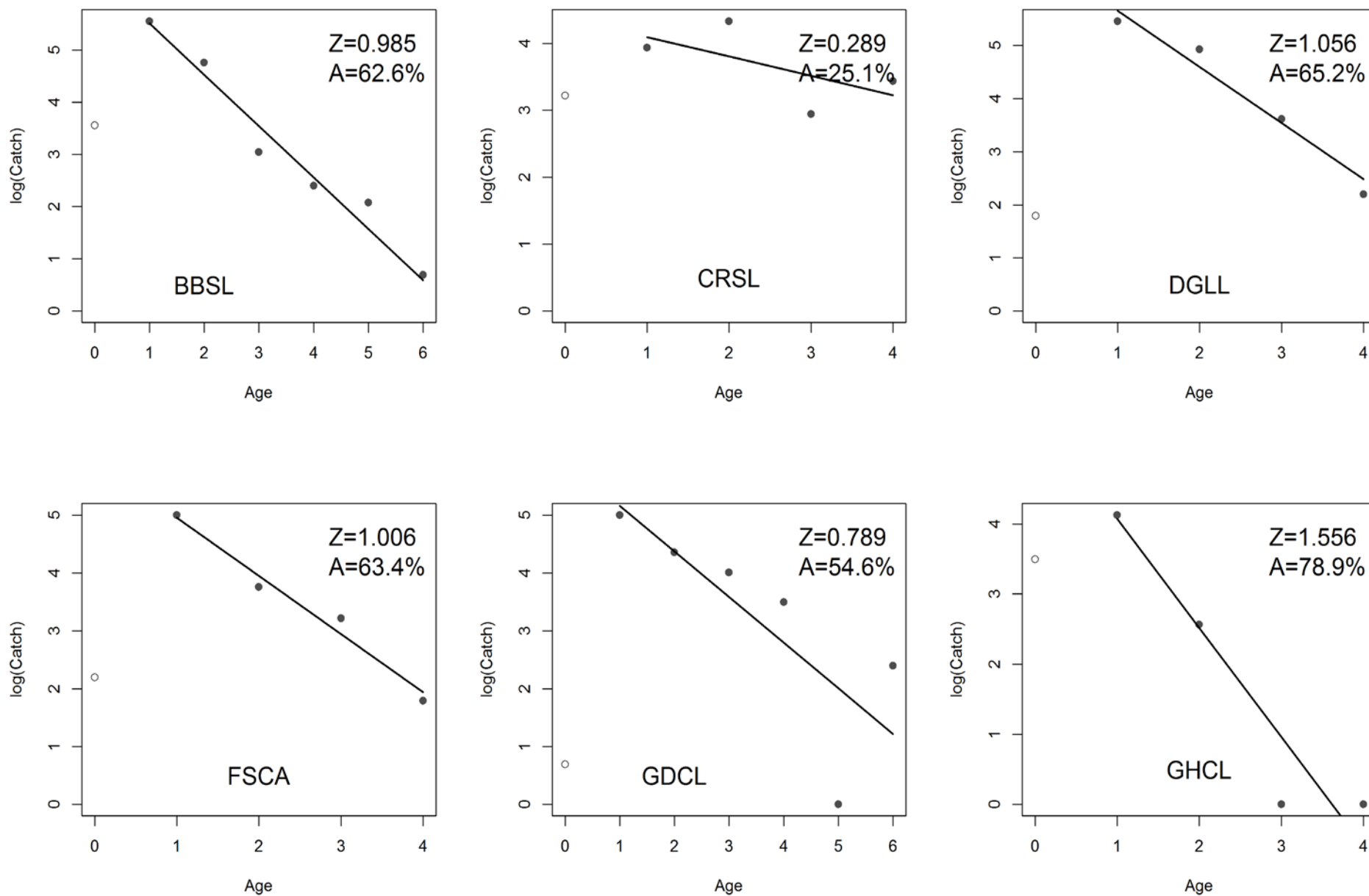
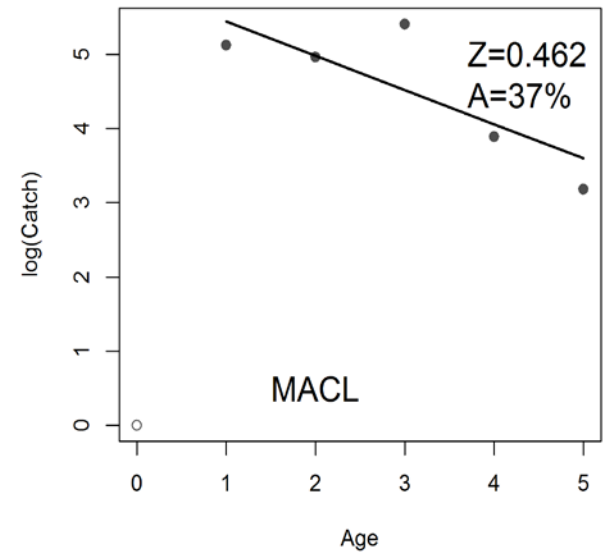
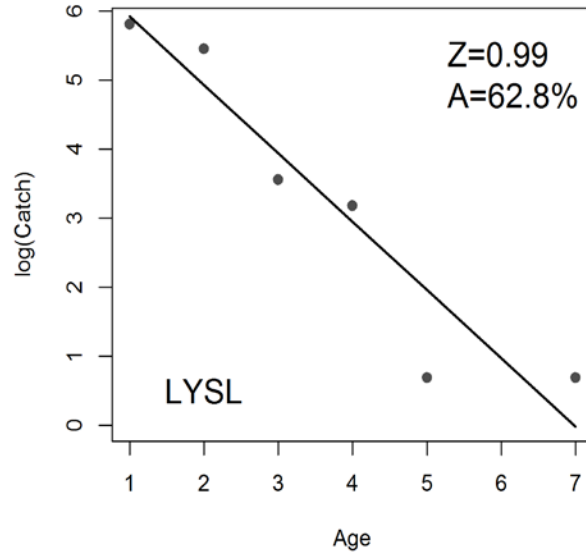
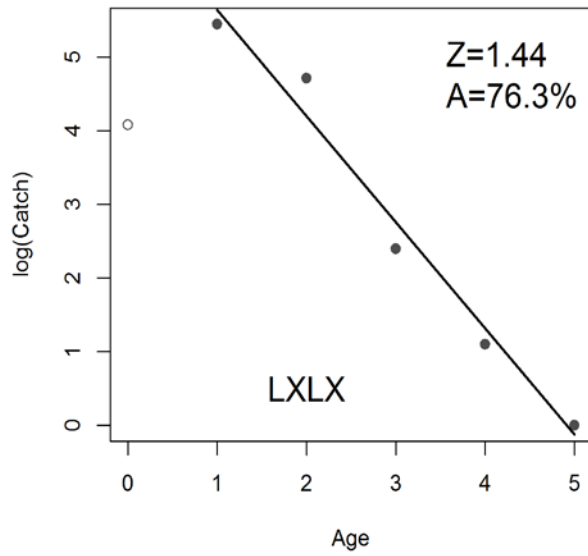
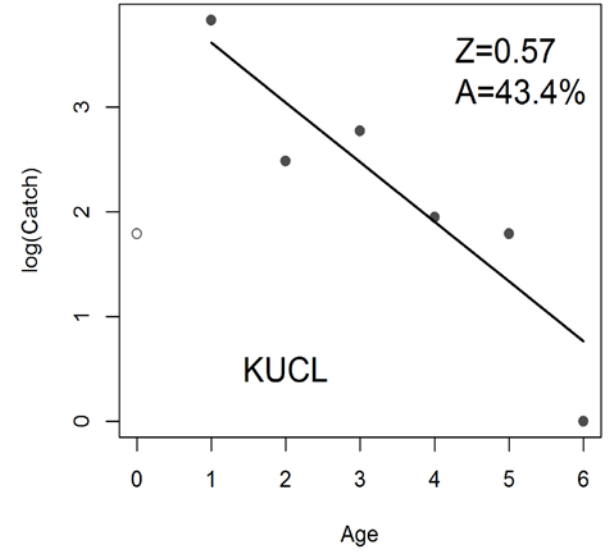
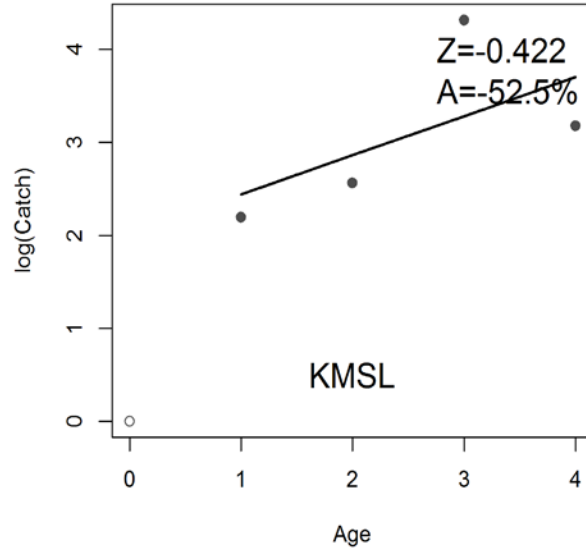
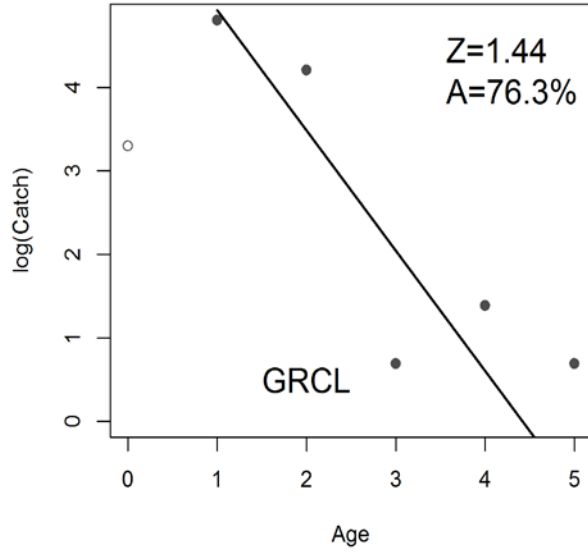
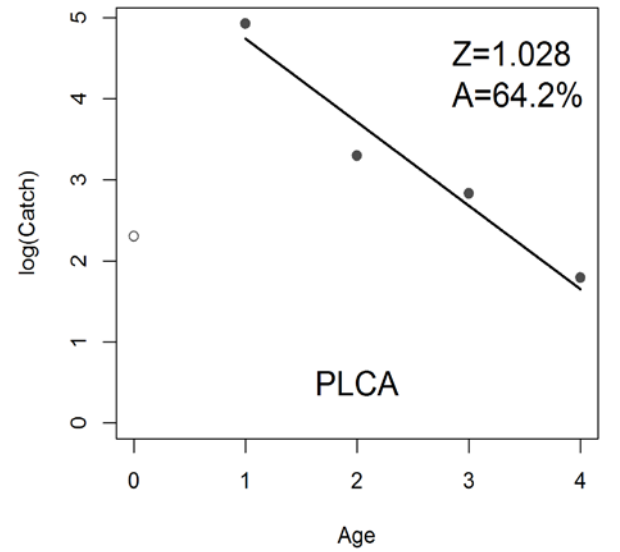
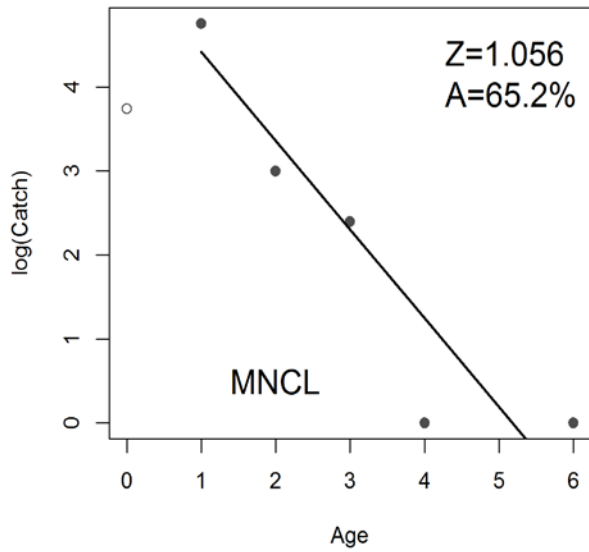
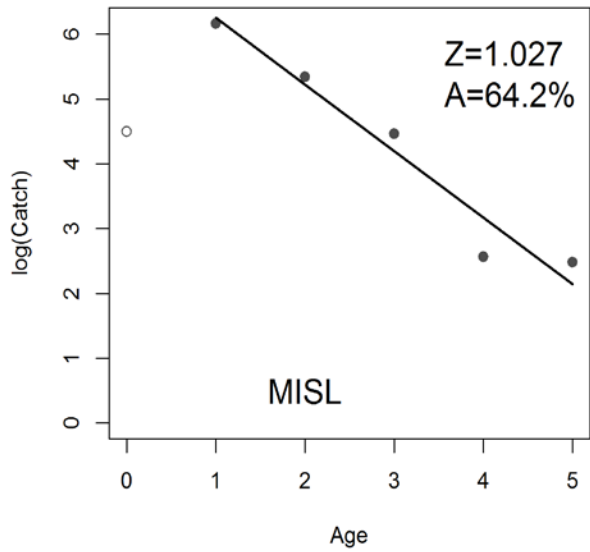
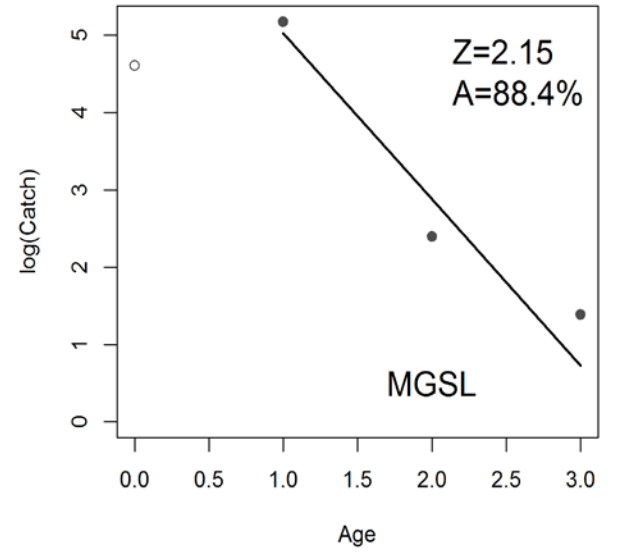
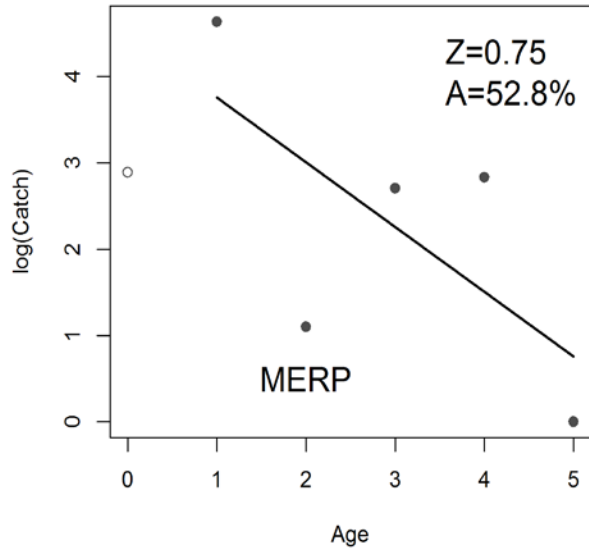
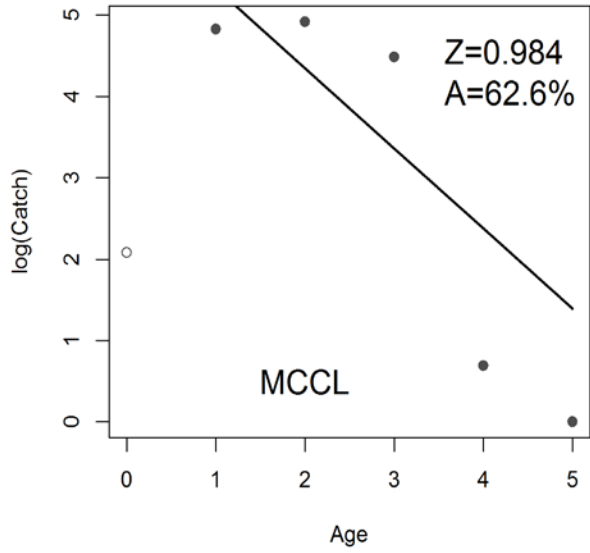


Figure 6. Catch curves, instantaneous mortality ( $Z$ ), and total annual mortality ( $A$ ) of Bluegill populations sampled with electrofishing from 20 Kansas impoundments, 2017. Catch curves were not calculated for impoundments that lacked appropriate data. Mortality rates were estimated using ages considered recruited to the gear (i.e., closed circles). Open circles represent ages not used in catch curve regressions.







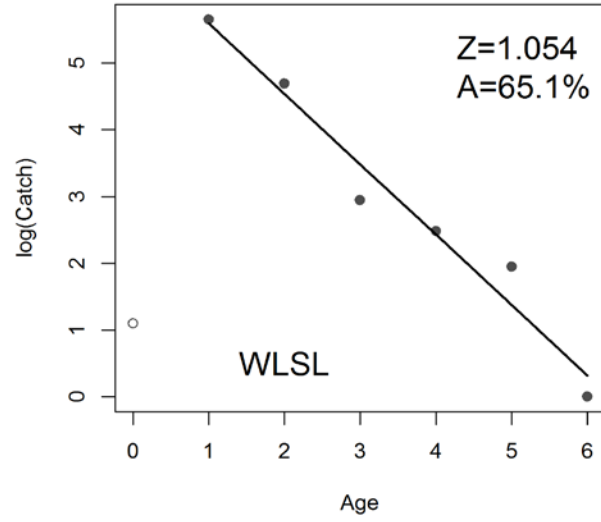
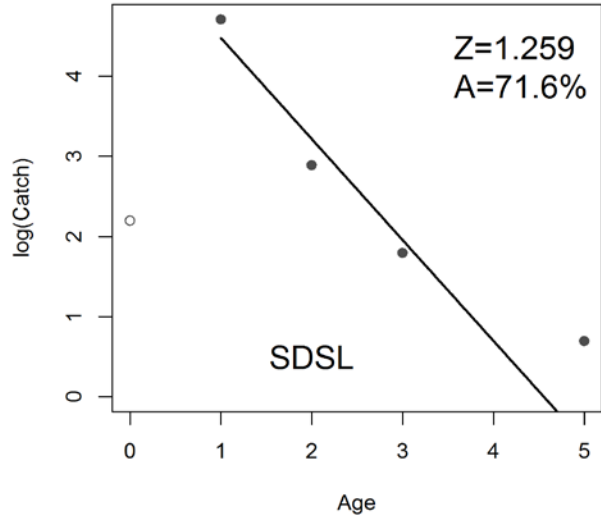




Figure 7. Total annual mortality (A) estimates for 20 Kansas impoundments sampled with electrofishing in 2017. Mortality estimates are represented by closed circles and error bars denote 95% confidence intervals around the estimate. No error bars are provided if confidence intervals overlapped zero. The solid horizontal line represents the mortality estimate of all populations combined. Horizontal dashed lines are upper and lower 95% confidence intervals for all populations combined. Study reservoirs with no mortality estimates are due to insufficient data needed to calculate estimates.

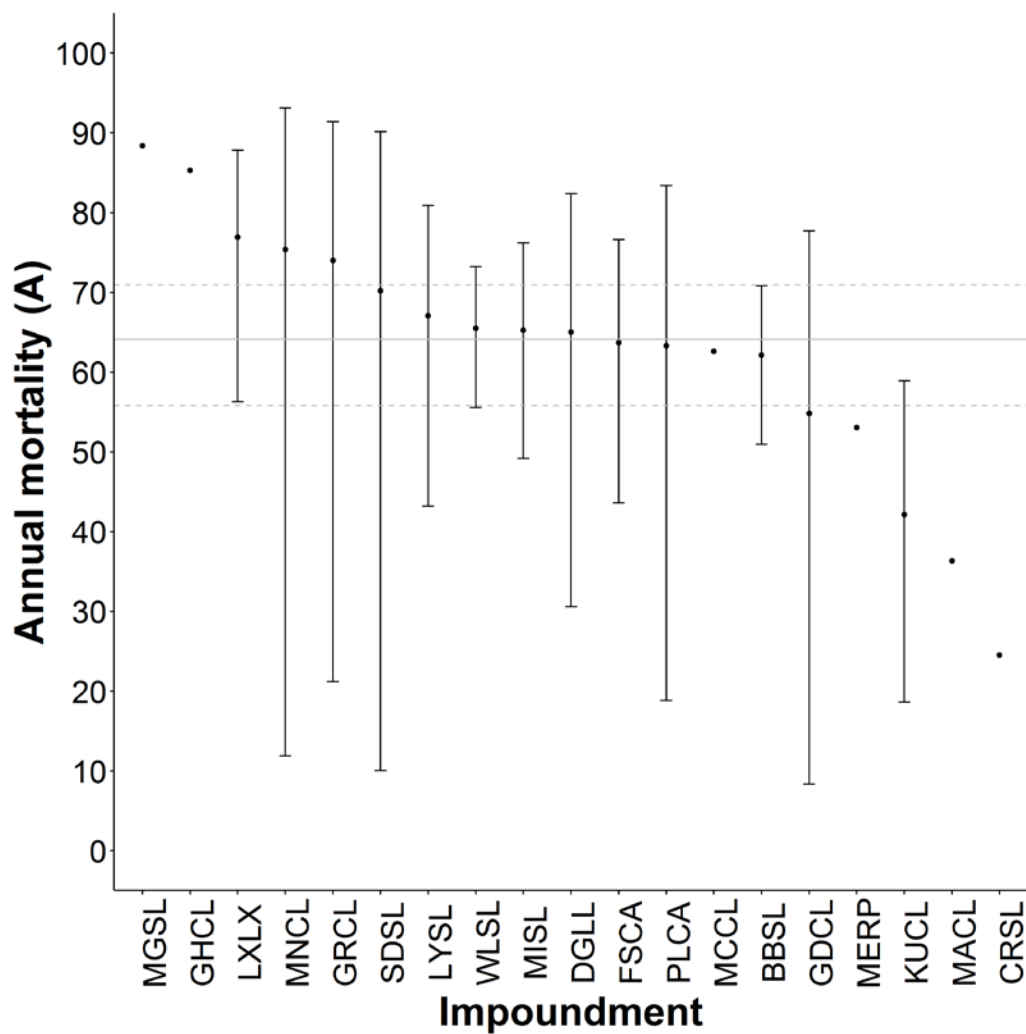
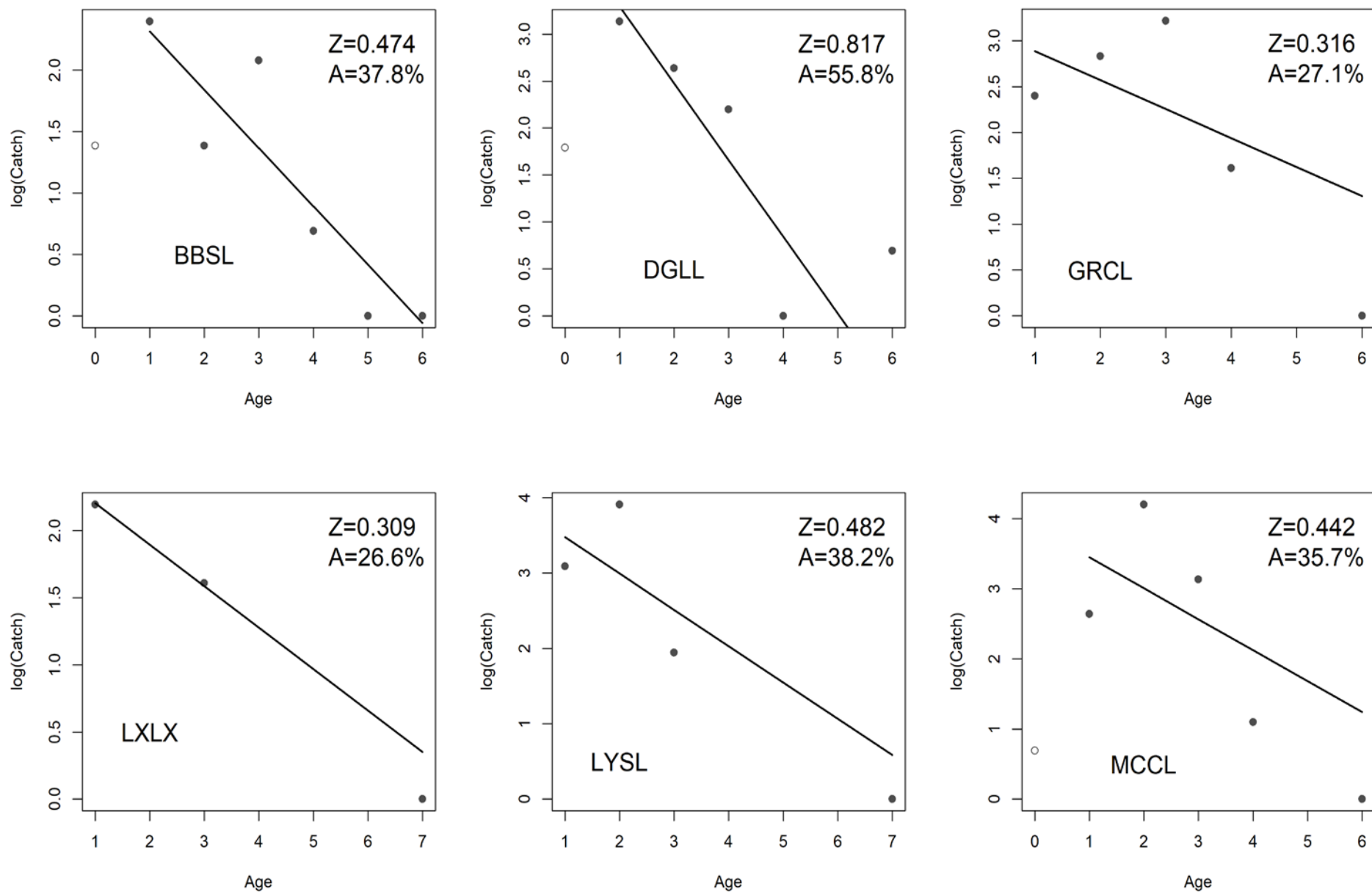
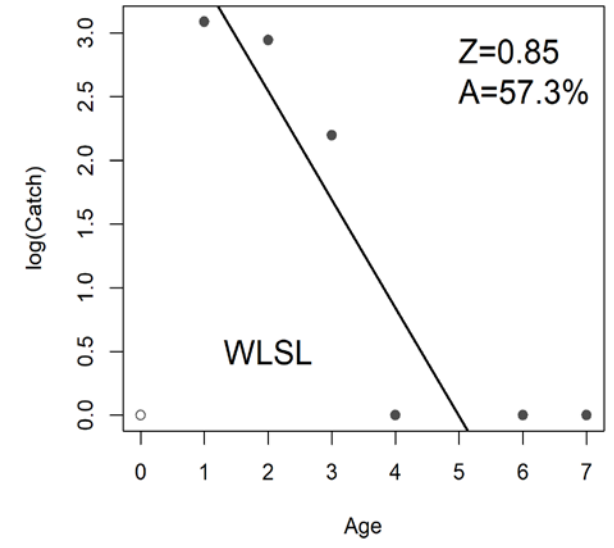
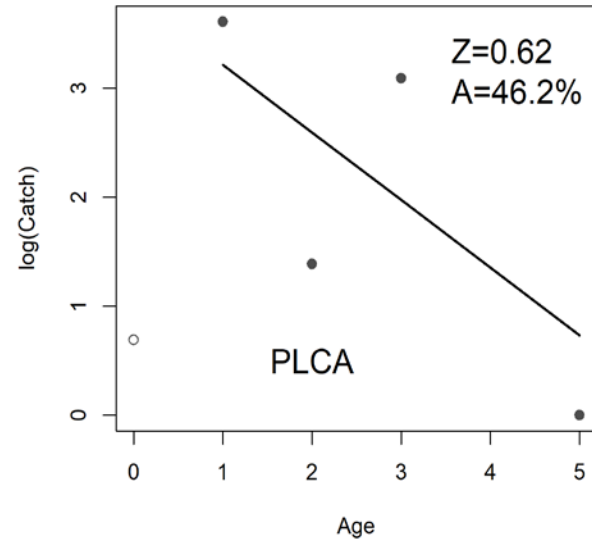
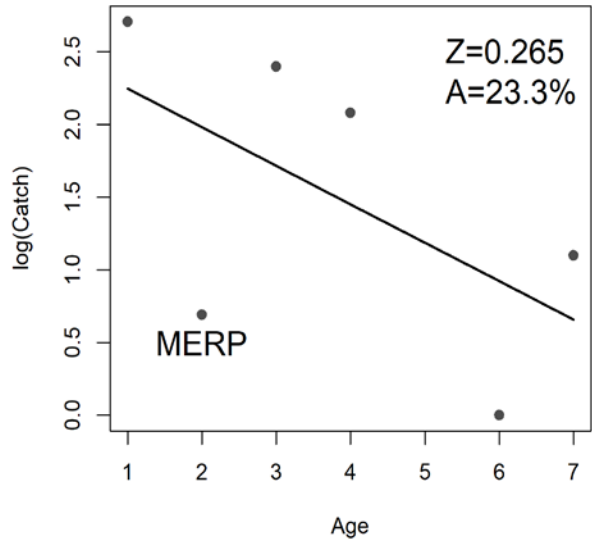


Figure 8. Catch curves, instantaneous mortality ( $Z$ ), and total annual mortality ( $A$ ) of Redear Sunfish populations sampled with electrofishing from 9 Kansas impoundments, 2017. Mortality rates were estimated using ages considered recruited to the gear (i.e., closed circles). Open circles represent ages not used in catch curve regressions.





Appendix 1. Predicted age length keys for Bluegill sampled with electrofishing from Kansas impoundments in 2017. These keys can be interpreted as approximating the probability that a bluegill within a given centimeter length group is a particular age. For example, a 130-mm bluegill from a random impoundment in Kansas has a 15.6% chance of being age-1, 45.8% chance of being age-2, 28.6% chance of being age-3, 8.3% chance of being age-4, and a 1.7% chance of being age-5. Some study impoundments did not have age-length keys developed due to insufficient data.

ALL mm group	Age									
	0	1	2	3	4	5	6	7	8	9
0	0.992	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.982	0.018	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.958	0.042	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.906	0.092	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40	0.802	0.191	0.008	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.628	0.350	0.022	0.000	0.000	0.000	0.000	0.000	0.000	0.000
60	0.410	0.534	0.055	0.002	0.000	0.000	0.000	0.000	0.000	0.000
70	0.218	0.666	0.111	0.005	0.000	0.000	0.000	0.000	0.000	0.000
80	0.098	0.700	0.188	0.013	0.001	0.000	0.000	0.000	0.000	0.000
90	0.039	0.648	0.280	0.031	0.002	0.000	0.000	0.000	0.000	0.000
100	0.014	0.539	0.376	0.064	0.007	0.001	0.000	0.000	0.000	0.000
110	0.004	0.403	0.453	0.119	0.017	0.003	0.000	0.000	0.000	0.000
120	0.001	0.268	0.486	0.197	0.041	0.008	0.000	0.000	0.000	0.000
130	0.000	0.156	0.458	0.286	0.083	0.017	0.000	0.000	0.000	0.000
140	0.000	0.080	0.376	0.362	0.149	0.032	0.001	0.000	0.000	0.000
150	0.000	0.036	0.271	0.403	0.234	0.053	0.002	0.001	0.001	0.000
160	0.000	0.014	0.173	0.398	0.327	0.077	0.006	0.002	0.003	0.000
170	0.000	0.005	0.100	0.355	0.412	0.102	0.015	0.005	0.005	0.001
180	0.000	0.002	0.053	0.289	0.474	0.123	0.036	0.012	0.009	0.004
190	0.000	0.000	0.025	0.214	0.497	0.135	0.076	0.027	0.014	0.010
200	0.000	0.000	0.011	0.142	0.466	0.133	0.145	0.057	0.020	0.027
210	0.000	0.000	0.004	0.081	0.378	0.113	0.239	0.102	0.024	0.058
220	0.000	0.000	0.001	0.039	0.258	0.081	0.332	0.154	0.026	0.109

BBSL mm group	Age						
	0	1	2	3	4	5	6
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.999	0.001	0.000	0.000	0.000	0.000	0.000
30	0.994	0.006	0.000	0.000	0.000	0.000	0.000
40	0.977	0.023	0.000	0.000	0.000	0.000	0.000
50	0.909	0.091	0.000	0.000	0.000	0.000	0.000
60	0.706	0.294	0.000	0.000	0.000	0.000	0.000
70	0.366	0.634	0.000	0.000	0.000	0.000	0.000
80	0.122	0.878	0.000	0.000	0.000	0.000	0.000
90	0.032	0.968	0.000	0.000	0.000	0.000	0.000
100	0.008	0.985	0.007	0.000	0.000	0.000	0.000
110	0.001	0.590	0.409	0.000	0.000	0.000	0.000
120	0.000	0.014	0.986	0.000	0.000	0.000	0.000
130	0.000	0.000	0.997	0.003	0.000	0.000	0.000
140	0.000	0.000	0.775	0.219	0.002	0.004	0.000
150	0.000	0.000	0.025	0.792	0.076	0.107	0.000
160	0.000	0.000	0.000	0.331	0.351	0.314	0.003
170	0.000	0.000	0.000	0.050	0.591	0.335	0.024
180	0.000	0.000	0.000	0.005	0.652	0.234	0.109
190	0.000	0.000	0.000	0.000	0.522	0.119	0.359
200	0.000	0.000	0.000	0.000	0.251	0.036	0.712

CRSL mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	0.999	0.001	0.000	0.000	0.000
20	0.997	0.003	0.000	0.000	0.000
30	0.994	0.006	0.000	0.000	0.000
40	0.985	0.015	0.000	0.000	0.000
50	0.964	0.036	0.000	0.000	0.000
60	0.915	0.085	0.000	0.000	0.000
70	0.814	0.186	0.000	0.000	0.000
80	0.641	0.359	0.000	0.000	0.000
90	0.421	0.579	0.000	0.000	0.000
100	0.228	0.771	0.001	0.000	0.000
110	0.104	0.865	0.031	0.000	0.000
120	0.019	0.384	0.573	0.011	0.014
130	0.000	0.013	0.834	0.062	0.090
140	0.000	0.000	0.566	0.167	0.266
150	0.000	0.000	0.236	0.280	0.484
160	0.000	0.000	0.068	0.323	0.609
170	0.000	0.000	0.017	0.322	0.661
180	0.000	0.000	0.004	0.308	0.688

DGLL mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	0.999	0.001	0.000	0.000	0.000
30	0.996	0.004	0.000	0.000	0.000
40	0.980	0.020	0.000	0.000	0.000
50	0.900	0.100	0.000	0.000	0.000
60	0.618	0.382	0.000	0.000	0.000
70	0.225	0.775	0.000	0.000	0.000
80	0.050	0.950	0.000	0.000	0.000
90	0.009	0.991	0.000	0.000	0.000
100	0.002	0.998	0.000	0.000	0.000
110	0.000	0.995	0.005	0.000	0.000
120	0.000	0.402	0.598	0.000	0.000
130	0.000	0.002	0.994	0.004	0.000
140	0.000	0.000	0.958	0.042	0.000
150	0.000	0.000	0.671	0.318	0.010
160	0.000	0.000	0.146	0.752	0.101
170	0.000	0.000	0.011	0.636	0.352
180	0.000	0.000	0.001	0.305	0.694
190	0.000	0.000	0.000	0.097	0.903

FSCA mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	0.999	0.001	0.000	0.000	0.000
60	0.830	0.170	0.000	0.000	0.000
70	0.030	0.970	0.000	0.000	0.000
80	0.000	1.000	0.000	0.000	0.000
90	0.000	1.000	0.000	0.000	0.000
100	0.000	0.999	0.001	0.000	0.000
110	0.000	0.992	0.008	0.000	0.000
120	0.000	0.928	0.072	0.000	0.000
130	0.000	0.558	0.442	0.000	0.000
140	0.000	0.110	0.890	0.001	0.000
150	0.000	0.012	0.959	0.025	0.004
160	0.000	0.000	0.414	0.480	0.105
170	0.000	0.000	0.015	0.769	0.216
180	0.000	0.000	0.000	0.735	0.264



GDCL mm group	Age						
	0	1	2	3	4	5	6
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.997	0.003	0.000	0.000	0.000	0.000	0.000
60	0.925	0.075	0.000	0.000	0.000	0.000	0.000
70	0.304	0.696	0.000	0.000	0.000	0.000	0.000
80	0.015	0.985	0.000	0.000	0.000	0.000	0.000
90	0.001	0.999	0.000	0.000	0.000	0.000	0.000
100	0.000	0.999	0.001	0.000	0.000	0.000	0.000
110	0.000	0.991	0.009	0.000	0.000	0.000	0.000
120	0.000	0.923	0.075	0.002	0.001	0.000	0.000
130	0.000	0.552	0.408	0.028	0.010	0.000	0.001
140	0.000	0.103	0.689	0.139	0.061	0.000	0.009
150	0.000	0.008	0.509	0.297	0.154	0.000	0.031
160	0.000	0.000	0.249	0.422	0.260	0.000	0.069
170	0.000	0.000	0.093	0.457	0.334	0.000	0.116
180	0.000	0.000	0.029	0.417	0.361	0.027	0.166
190	0.000	0.000	0.001	0.049	0.050	0.870	0.030

GHCL mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	0.999	0.001	0.000	0.000	0.000
40	0.994	0.006	0.000	0.000	0.000
50	0.964	0.035	0.001	0.000	0.000
60	0.815	0.179	0.006	0.000	0.000
70	0.417	0.554	0.029	0.000	0.000
80	0.103	0.828	0.069	0.000	0.000
90	0.018	0.869	0.113	0.000	0.000
100	0.003	0.828	0.170	0.000	0.000
110	0.000	0.757	0.243	0.000	0.000
120	0.000	0.665	0.335	0.000	0.000
130	0.000	0.559	0.441	0.000	0.000
140	0.000	0.447	0.553	0.000	0.000
150	0.000	0.340	0.660	0.000	0.000
160	0.000	0.247	0.753	0.000	0.000
170	0.000	0.173	0.827	0.000	0.000
180	0.000	0.118	0.882	0.000	0.000
190	0.000	0.075	0.885	0.040	0.000
200	0.000	0.002	0.036	0.935	0.028
210	0.000	0.000	0.000	0.026	0.974

GRCL mm group	Age					
	0	1	2	3	4	5
0	0.986	0.014	0.000	0.000	0.000	0.000
10	0.965	0.035	0.000	0.000	0.000	0.000
20	0.916	0.084	0.000	0.000	0.000	0.000
30	0.813	0.187	0.000	0.000	0.000	0.000
40	0.634	0.366	0.000	0.000	0.000	0.000
50	0.408	0.591	0.001	0.000	0.000	0.000
60	0.213	0.775	0.011	0.000	0.000	0.000
70	0.091	0.826	0.084	0.000	0.000	0.000
80	0.025	0.573	0.402	0.000	0.000	0.000
90	0.003	0.170	0.827	0.000	0.000	0.000
100	0.000	0.029	0.971	0.000	0.000	0.000
110	0.000	0.004	0.996	0.000	0.000	0.000
120	0.000	0.001	0.986	0.014	0.000	0.000
130	0.000	0.000	0.513	0.487	0.000	0.000
140	0.000	0.000	0.015	0.958	0.027	0.000
150	0.000	0.000	0.000	0.485	0.507	0.008
160	0.000	0.000	0.000	0.024	0.930	0.045
170	0.000	0.000	0.000	0.001	0.868	0.132
180	0.000	0.000	0.000	0.000	0.680	0.320
190	0.000	0.000	0.000	0.000	0.406	0.594

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KMSL mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	0.993	0.007	0.000	0.000	0.000
60	0.355	0.625	0.020	0.000	0.000
70	0.002	0.898	0.100	0.000	0.000
80	0.000	0.720	0.274	0.005	0.001
90	0.000	0.397	0.516	0.075	0.012
100	0.000	0.087	0.387	0.438	0.089
110	0.000	0.005	0.083	0.724	0.187
120	0.000	0.000	0.011	0.743	0.246
130	0.000	0.000	0.001	0.702	0.297
140	0.000	0.000	0.000	0.649	0.351
150	0.000	0.000	0.000	0.591	0.409

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KUCL mm group	Age						
	0	1	2	3	4	5	6
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.997	0.003	0.000	0.000	0.000	0.000	0.000
30	0.976	0.024	0.000	0.000	0.000	0.000	0.000
40	0.819	0.179	0.002	0.000	0.000	0.000	0.000
50	0.331	0.656	0.013	0.000	0.000	0.000	0.000
60	0.051	0.913	0.036	0.000	0.000	0.000	0.000
70	0.006	0.923	0.070	0.001	0.000	0.000	0.000
80	0.001	0.866	0.130	0.004	0.000	0.000	0.000
90	0.000	0.764	0.224	0.012	0.000	0.000	0.000
100	0.000	0.611	0.353	0.036	0.000	0.000	0.000
110	0.000	0.425	0.481	0.095	0.000	0.000	0.000
120	0.000	0.246	0.546	0.207	0.001	0.000	0.000
130	0.000	0.116	0.507	0.372	0.004	0.000	0.000
140	0.000	0.045	0.387	0.549	0.018	0.001	0.000
150	0.000	0.015	0.246	0.672	0.060	0.005	0.002
160	0.000	0.004	0.127	0.671	0.164	0.028	0.007
170	0.000	0.001	0.048	0.493	0.329	0.104	0.025
180	0.000	0.000	0.012	0.239	0.435	0.258	0.055
190	0.000	0.000	0.002	0.079	0.394	0.438	0.086
200	0.000	0.000	0.000	0.021	0.283	0.590	0.106

LXLX mm group	Age					
	0	1	2	3	4	5
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	0.998	0.002	0.000	0.000	0.000	0.000
60	0.400	0.593	0.006	0.000	0.000	0.000
70	0.001	0.963	0.036	0.000	0.000	0.000
80	0.000	0.880	0.120	0.000	0.000	0.000
90	0.000	0.668	0.331	0.000	0.000	0.001
100	0.000	0.354	0.641	0.001	0.000	0.004
110	0.000	0.129	0.851	0.007	0.000	0.014
120	0.000	0.036	0.879	0.048	0.000	0.036
130	0.000	0.008	0.664	0.258	0.000	0.070
140	0.000	0.001	0.249	0.683	0.000	0.067
150	0.000	0.000	0.047	0.920	0.000	0.033
160	0.000	0.000	0.007	0.967	0.013	0.013
170	0.000	0.000	0.000	0.252	0.747	0.001

LYSL mm group	Age					
	1	2	3	4	5	7
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	0.998	0.002	0.000	0.000	0.000	0.000
50	0.991	0.009	0.000	0.000	0.000	0.000
60	0.952	0.048	0.000	0.000	0.000	0.000
70	0.791	0.209	0.000	0.000	0.000	0.000
80	0.417	0.583	0.000	0.000	0.000	0.000
90	0.119	0.881	0.000	0.000	0.000	0.000
100	0.025	0.975	0.000	0.000	0.000	0.000
110	0.005	0.993	0.002	0.000	0.000	0.000
120	0.001	0.974	0.023	0.002	0.000	0.000
130	0.000	0.738	0.221	0.040	0.000	0.001
140	0.000	0.166	0.630	0.196	0.002	0.006
150	0.000	0.013	0.631	0.335	0.006	0.014
160	0.000	0.001	0.502	0.455	0.018	0.025
170	0.000	0.000	0.360	0.557	0.043	0.040
180	0.000	0.000	0.233	0.615	0.094	0.058
190	0.000	0.000	0.135	0.606	0.184	0.075
200	0.000	0.000	0.069	0.528	0.317	0.086
210	0.000	0.000	0.031	0.402	0.481	0.087

MACL mm group	Age					
	0	1	2	3	4	5
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	0.935	0.065	0.000	0.000	0.000	0.000
60	0.013	0.987	0.000	0.000	0.000	0.000
70	0.000	0.996	0.004	0.000	0.000	0.000
80	0.000	0.660	0.310	0.030	0.000	0.000
90	0.000	0.013	0.734	0.248	0.002	0.003
100	0.000	0.000	0.445	0.531	0.011	0.013
110	0.000	0.000	0.177	0.744	0.041	0.038
120	0.000	0.000	0.051	0.758	0.112	0.080
130	0.000	0.000	0.012	0.613	0.242	0.133
140	0.000	0.000	0.002	0.398	0.421	0.178
150	0.000	0.000	0.000	0.210	0.596	0.194
160	0.000	0.000	0.000	0.095	0.724	0.181
170	0.000	0.000	0.000	0.039	0.805	0.155
180	0.000	0.000	0.000	0.016	0.857	0.127
190	0.000	0.000	0.000	0.006	0.892	0.102
200	0.000	0.000	0.000	0.002	0.917	0.080
210	0.000	0.000	0.000	0.001	0.936	0.063



MCCL mm group	Age					
	0	1	2	3	4	5
0	0.012	0.988	0.000	0.000	0.000	0.000
10	0.015	0.985	0.000	0.000	0.000	0.000
20	0.019	0.981	0.000	0.000	0.000	0.000
30	0.025	0.975	0.000	0.000	0.000	0.000
40	0.031	0.969	0.000	0.000	0.000	0.000
50	0.040	0.960	0.000	0.000	0.000	0.000
60	0.050	0.950	0.000	0.000	0.000	0.000
70	0.063	0.937	0.000	0.000	0.000	0.000
80	0.063	0.733	0.197	0.007	0.000	0.000
90	0.000	0.003	0.862	0.134	0.000	0.000
100	0.000	0.000	0.597	0.400	0.002	0.000
110	0.000	0.000	0.253	0.735	0.011	0.001
120	0.000	0.000	0.071	0.893	0.033	0.003
130	0.000	0.000	0.016	0.885	0.083	0.015
140	0.000	0.000	0.003	0.754	0.180	0.063
150	0.000	0.000	0.000	0.496	0.298	0.206
160	0.000	0.000	0.000	0.219	0.334	0.447

MERP mm group	Age					
	0	1	2	3	4	5
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000
60	0.999	0.001	0.000	0.000	0.000	0.000
70	0.987	0.013	0.000	0.000	0.000	0.000
80	0.886	0.114	0.000	0.000	0.000	0.000
90	0.435	0.565	0.000	0.000	0.000	0.000
100	0.071	0.928	0.000	0.000	0.000	0.001
110	0.008	0.990	0.001	0.000	0.000	0.002
120	0.001	0.989	0.004	0.000	0.000	0.006
130	0.000	0.959	0.017	0.004	0.003	0.018
140	0.000	0.825	0.070	0.032	0.026	0.047
150	0.000	0.428	0.174	0.173	0.151	0.073
160	0.000	0.086	0.168	0.365	0.336	0.045
170	0.000	0.010	0.094	0.446	0.434	0.016
180	0.000	0.001	0.045	0.469	0.480	0.005
190	0.000	0.000	0.021	0.470	0.508	0.001

MGSL mm group	Age			
	0	1	2	3
0	1.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000
50	0.999	0.001	0.000	0.000
60	0.990	0.010	0.000	0.000
70	0.832	0.168	0.000	0.000
80	0.204	0.795	0.001	0.000
90	0.013	0.982	0.005	0.000
100	0.001	0.984	0.015	0.000
110	0.000	0.955	0.045	0.000
120	0.000	0.873	0.127	0.000
130	0.000	0.688	0.312	0.000
140	0.000	0.414	0.586	0.000
150	0.000	0.185	0.815	0.000
160	0.000	0.068	0.932	0.000
170	0.000	0.023	0.976	0.001
180	0.000	0.006	0.739	0.256
190	0.000	0.000	0.007	0.993

MISL mm group	Age					
	0	1	2	3	4	5
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000
60	0.999	0.001	0.000	0.000	0.000	0.000
70	0.989	0.011	0.000	0.000	0.000	0.000
80	0.863	0.137	0.000	0.000	0.000	0.000
90	0.315	0.685	0.000	0.000	0.000	0.000
100	0.032	0.967	0.001	0.000	0.000	0.000
110	0.002	0.986	0.011	0.000	0.000	0.000
120	0.000	0.862	0.136	0.000	0.000	0.001
130	0.000	0.309	0.668	0.009	0.000	0.013
140	0.000	0.028	0.834	0.093	0.000	0.044
150	0.000	0.001	0.489	0.434	0.008	0.067
160	0.000	0.000	0.111	0.780	0.069	0.040
170	0.000	0.000	0.012	0.692	0.284	0.012
180	0.000	0.000	0.001	0.344	0.653	0.002

MNCL mm group	Age					
	0	1	2	3	4	6
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	0.999	0.001	0.000	0.000	0.000	0.000
30	0.995	0.005	0.000	0.000	0.000	0.000
40	0.982	0.018	0.000	0.000	0.000	0.000
50	0.936	0.064	0.000	0.000	0.000	0.000
60	0.801	0.199	0.000	0.000	0.000	0.000
70	0.525	0.475	0.000	0.000	0.000	0.000
80	0.232	0.766	0.002	0.000	0.000	0.000
90	0.076	0.918	0.005	0.000	0.000	0.000
100	0.022	0.961	0.015	0.001	0.001	0.000
110	0.006	0.946	0.041	0.004	0.003	0.000
120	0.001	0.873	0.103	0.015	0.007	0.000
130	0.000	0.709	0.229	0.045	0.016	0.000
140	0.000	0.455	0.405	0.111	0.028	0.000
150	0.000	0.220	0.538	0.205	0.037	0.000
160	0.000	0.085	0.574	0.303	0.038	0.000
170	0.000	0.029	0.540	0.396	0.035	0.000
180	0.000	0.009	0.475	0.483	0.030	0.002
190	0.000	0.003	0.396	0.559	0.025	0.017
200	0.000	0.001	0.282	0.553	0.017	0.146
210	0.000	0.000	0.101	0.274	0.006	0.619

PLCA mm group	Age				
	0	1	2	3	4
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	0.963	0.037	0.000	0.000	0.000
60	0.215	0.784	0.001	0.000	0.000
70	0.003	0.994	0.003	0.000	0.000
80	0.000	0.988	0.011	0.000	0.000
90	0.000	0.960	0.040	0.000	0.000
100	0.000	0.871	0.129	0.000	0.000
110	0.000	0.655	0.345	0.000	0.000
120	0.000	0.347	0.651	0.002	0.000
130	0.000	0.126	0.841	0.032	0.001
140	0.000	0.029	0.680	0.269	0.022
150	0.000	0.002	0.168	0.685	0.145
160	0.000	0.000	0.015	0.639	0.346
170	0.000	0.000	0.001	0.420	0.579
180	0.000	0.000	0.000	0.222	0.778
190	0.000	0.000	0.000	0.101	0.899

SDSL mm group	Age				
	0	1	2	3	5
0	0.849	0.151	0.000	0.000	0.000
10	0.759	0.241	0.000	0.000	0.000
20	0.639	0.361	0.000	0.000	0.000
30	0.499	0.501	0.000	0.000	0.000
40	0.359	0.641	0.000	0.000	0.000
50	0.239	0.761	0.000	0.000	0.000
60	0.150	0.850	0.000	0.000	0.000
70	0.090	0.910	0.000	0.000	0.000
80	0.053	0.947	0.000	0.000	0.000
90	0.030	0.970	0.000	0.000	0.000
100	0.017	0.983	0.000	0.000	0.000
110	0.010	0.981	0.010	0.000	0.000
120	0.002	0.340	0.658	0.001	0.000
130	0.000	0.003	0.990	0.007	0.000
140	0.000	0.000	0.951	0.047	0.002
150	0.000	0.000	0.729	0.243	0.028
160	0.000	0.000	0.260	0.584	0.156
170	0.000	0.000	0.039	0.595	0.366

WLSL mm group	Age						
	0	1	2	3	4	5	6
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.994	0.006	0.000	0.000	0.000	0.000	0.000
60	0.404	0.596	0.000	0.000	0.000	0.000	0.000
70	0.003	0.997	0.000	0.000	0.000	0.000	0.000
80	0.000	1.000	0.000	0.000	0.000	0.000	0.000
90	0.000	1.000	0.000	0.000	0.000	0.000	0.000
100	0.000	0.992	0.008	0.000	0.000	0.000	0.000
110	0.000	0.844	0.156	0.000	0.000	0.000	0.000
120	0.000	0.183	0.817	0.000	0.000	0.000	0.000
130	0.000	0.009	0.991	0.000	0.000	0.000	0.000
140	0.000	0.000	0.996	0.004	0.000	0.000	0.000
150	0.000	0.000	0.596	0.382	0.014	0.006	0.001
160	0.000	0.000	0.007	0.751	0.151	0.075	0.015
170	0.000	0.000	0.000	0.356	0.385	0.215	0.044
180	0.000	0.000	0.000	0.090	0.518	0.327	0.065
190	0.000	0.000	0.000	0.017	0.531	0.377	0.075



Appendix 2. Predicted age length keys for redear sunfish sampled with electrofishing from Kansas impoundments in 2017. Some study impoundments did not have age-length keys developed due to sampling considerations.

ALL mm group	Age							
	0	1	2	3	4	5	6	7
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.999	0.001	0.000	0.000	0.000	0.000	0.000	0.000
30	0.998	0.002	0.000	0.000	0.000	0.000	0.000	0.000
40	0.992	0.008	0.000	0.000	0.000	0.000	0.000	0.000
50	0.970	0.029	0.001	0.000	0.000	0.000	0.000	0.000
60	0.898	0.096	0.006	0.000	0.000	0.000	0.000	0.000
70	0.701	0.275	0.023	0.001	0.000	0.000	0.000	0.000
80	0.383	0.550	0.062	0.004	0.001	0.000	0.000	0.000
90	0.139	0.732	0.115	0.010	0.003	0.000	0.000	0.000
100	0.040	0.767	0.166	0.020	0.006	0.001	0.000	0.000
110	0.010	0.725	0.218	0.035	0.011	0.001	0.000	0.000
120	0.003	0.648	0.270	0.058	0.020	0.002	0.000	0.000
130	0.001	0.553	0.318	0.091	0.034	0.003	0.000	0.000
140	0.000	0.448	0.357	0.136	0.054	0.005	0.000	0.000
150	0.000	0.342	0.377	0.192	0.081	0.007	0.000	0.000
160	0.000	0.245	0.374	0.254	0.115	0.010	0.001	0.000
170	0.000	0.165	0.349	0.317	0.154	0.014	0.001	0.000
180	0.000	0.105	0.308	0.373	0.194	0.017	0.003	0.000
190	0.000	0.064	0.258	0.418	0.232	0.021	0.007	0.000
200	0.000	0.037	0.208	0.448	0.267	0.024	0.017	0.000
210	0.000	0.021	0.161	0.462	0.294	0.026	0.035	0.001
220	0.000	0.011	0.119	0.456	0.311	0.027	0.072	0.004
230	0.000	0.005	0.082	0.418	0.305	0.027	0.136	0.027
240	0.000	0.002	0.047	0.319	0.249	0.022	0.214	0.148
250	0.000	0.001	0.016	0.149	0.124	0.011	0.207	0.493

BBSL mm group	Age						
	0	1	2	3	4	5	6
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000	0.000	0.000
70	1.000	0.000	0.000	0.000	0.000	0.000	0.000
80	1.000	0.000	0.000	0.000	0.000	0.000	0.000
90	0.988	0.012	0.000	0.000	0.000	0.000	0.000
100	0.100	0.894	0.006	0.000	0.000	0.000	0.000
110	0.000	0.985	0.015	0.000	0.000	0.000	0.000
120	0.000	0.967	0.033	0.000	0.000	0.000	0.000
130	0.000	0.927	0.073	0.000	0.000	0.000	0.000
140	0.000	0.848	0.152	0.000	0.000	0.000	0.000
150	0.000	0.711	0.289	0.000	0.000	0.000	0.000
160	0.000	0.520	0.480	0.000	0.000	0.000	0.000
170	0.000	0.317	0.666	0.016	0.001	0.000	0.000
180	0.000	0.058	0.278	0.594	0.070	0.000	0.000
190	0.000	0.000	0.004	0.822	0.169	0.004	0.000
200	0.000	0.000	0.000	0.694	0.250	0.055	0.000
210	0.000	0.000	0.000	0.345	0.218	0.409	0.028
220	0.000	0.000	0.000	0.025	0.028	0.445	0.502
230	0.000	0.000	0.000	0.000	0.000	0.051	0.948

CRSL mm group	Age				
	0	1	2	3	4
0	0.000	1.000	0.000	0.000	0.000
10	0.000	1.000	0.000	0.000	0.000
20	0.000	1.000	0.000	0.000	0.000
30	0.000	1.000	0.000	0.000	0.000
40	0.000	1.000	0.000	0.000	0.000
50	0.000	1.000	0.000	0.000	0.000
60	0.000	1.000	0.000	0.000	0.000
70	0.002	0.998	0.000	0.000	0.000
80	0.999	0.001	0.000	0.000	0.000
90	1.000	0.000	0.000	0.000	0.000
100	0.994	0.000	0.006	0.000	0.000
110	0.917	0.000	0.083	0.000	0.000
120	0.415	0.000	0.585	0.000	0.000
130	0.044	0.000	0.956	0.000	0.000
140	0.003	0.000	0.997	0.000	0.000
150	0.000	0.000	0.993	0.007	0.000
160	0.000	0.000	0.002	0.330	0.668
170	0.000	0.000	0.000	0.001	0.999
180	0.000	0.000	0.000	0.000	1.000

DGLL mm group	Age					
	0	1	2	3	4	6
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000	0.000
70	0.999	0.001	0.000	0.000	0.000	0.000
80	0.991	0.009	0.000	0.000	0.000	0.000
90	0.892	0.108	0.000	0.000	0.000	0.000
100	0.377	0.623	0.000	0.000	0.000	0.000
110	0.043	0.957	0.000	0.000	0.000	0.000
120	0.003	0.996	0.000	0.000	0.000	0.000
130	0.000	0.998	0.001	0.001	0.000	0.000
140	0.000	0.990	0.005	0.005	0.000	0.000
150	0.000	0.949	0.026	0.024	0.000	0.000
160	0.000	0.770	0.125	0.105	0.000	0.000
170	0.000	0.375	0.355	0.270	0.000	0.000
180	0.000	0.097	0.535	0.368	0.000	0.000
190	0.000	0.019	0.605	0.377	0.000	0.000
200	0.000	0.003	0.628	0.355	0.000	0.014
210	0.000	0.000	0.052	0.027	0.053	0.868
220	0.000	0.000	0.000	0.000	0.474	0.525

GRCL mm group	Age				
	1	2	3	4	6
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000
70	1.000	0.000	0.000	0.000	0.000
80	1.000	0.000	0.000	0.000	0.000
90	1.000	0.000	0.000	0.000	0.000
100	1.000	0.000	0.000	0.000	0.000
110	1.000	0.000	0.000	0.000	0.000
120	1.000	0.000	0.000	0.000	0.000
130	1.000	0.000	0.000	0.000	0.000
140	0.997	0.002	0.000	0.000	0.000
150	0.966	0.034	0.000	0.000	0.000
160	0.663	0.328	0.009	0.000	0.000
170	0.119	0.826	0.055	0.000	0.000
180	0.009	0.858	0.132	0.000	0.001
190	0.001	0.734	0.261	0.001	0.003
200	0.000	0.542	0.445	0.004	0.009
210	0.000	0.332	0.633	0.016	0.019
220	0.000	0.169	0.748	0.048	0.035
230	0.000	0.073	0.750	0.123	0.053
240	0.000	0.027	0.635	0.270	0.069
250	0.000	0.008	0.439	0.481	0.073
260	0.000	0.002	0.244	0.692	0.062

LYSL mm group	Age			
	1	2	3	7
0	1.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000
70	1.000	0.000	0.000	0.000
80	1.000	0.000	0.000	0.000
90	1.000	0.000	0.000	0.000
100	0.797	0.203	0.000	0.000
110	0.007	0.993	0.000	0.000
120	0.000	1.000	0.000	0.000
130	0.000	0.999	0.001	0.000
140	0.000	0.994	0.006	0.000
150	0.000	0.973	0.027	0.000
160	0.000	0.890	0.110	0.000
170	0.000	0.646	0.354	0.000
180	0.000	0.293	0.707	0.000
190	0.000	0.086	0.914	0.000
200	0.000	0.021	0.979	0.000
210	0.000	0.005	0.991	0.004
220	0.000	0.001	0.937	0.062
230	0.000	0.000	0.492	0.508
240	0.000	0.000	0.059	0.941
250	0.000	0.000	0.004	0.996

MCCL mm group	Age					
	1	2	3	7	4	6
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000	0.000
70	1.000	0.000	0.000	0.000	0.000	0.000
80	1.000	0.000	0.000	0.000	0.000	0.000
90	1.000	0.000	0.000	0.000	0.000	0.000
100	0.797	0.203	0.000	0.000	0.000	0.000
110	0.007	0.993	0.000	0.000	0.000	0.000
120	0.000	1.000	0.000	0.000	0.000	0.000
130	0.000	0.999	0.001	0.000	0.000	0.000
140	0.000	0.994	0.006	0.000	0.000	0.000
150	0.000	0.973	0.027	0.000	0.000	0.000
160	0.000	0.890	0.110	0.000	0.022	0.000
170	0.000	0.646	0.354	0.000	0.979	0.000
180	0.000	0.293	0.707	0.000	1.000	0.000
190	0.000	0.086	0.914	0.000	0.965	0.035
200	0.000	0.021	0.979	0.000	0.033	0.967

MERP mm group	Age					
	1	2	3	4	6	7
0	1.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000	0.000
70	1.000	0.000	0.000	0.000	0.000	0.000
80	1.000	0.000	0.000	0.000	0.000	0.000
90	1.000	0.000	0.000	0.000	0.000	0.000
100	1.000	0.000	0.000	0.000	0.000	0.000
110	1.000	0.000	0.000	0.000	0.000	0.000
120	0.998	0.000	0.001	0.000	0.000	0.000
130	0.995	0.001	0.004	0.000	0.000	0.000
140	0.982	0.003	0.014	0.001	0.000	0.000
150	0.943	0.009	0.045	0.003	0.000	0.000
160	0.830	0.026	0.133	0.012	0.000	0.000
170	0.587	0.060	0.312	0.040	0.000	0.000
180	0.291	0.097	0.514	0.097	0.000	0.000
190	0.104	0.114	0.613	0.169	0.000	0.000
200	0.031	0.111	0.611	0.247	0.000	0.000
210	0.009	0.099	0.561	0.331	0.000	0.000
220	0.002	0.085	0.488	0.421	0.000	0.004
230	0.001	0.062	0.363	0.458	0.015	0.101
240	0.000	0.012	0.071	0.130	0.153	0.634
250	0.000	0.000	0.002	0.007	0.274	0.716



MGSL mm group	Age		
	0	1	2
0	0.999	0.001	0.000
10	0.997	0.003	0.000
20	0.993	0.007	0.000
30	0.986	0.014	0.000
40	0.969	0.031	0.000
50	0.935	0.065	0.000
60	0.869	0.131	0.000
70	0.752	0.248	0.000
80	0.582	0.418	0.001
90	0.389	0.609	0.002
100	0.226	0.770	0.004
110	0.117	0.874	0.009
120	0.057	0.925	0.018
130	0.027	0.940	0.034
140	0.012	0.925	0.063
150	0.005	0.883	0.112
160	0.002	0.806	0.191
170	0.001	0.692	0.307
180	0.000	0.545	0.454
190	0.000	0.391	0.609
200	0.000	0.255	0.745
210	0.000	0.154	0.845

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MISL	Age				
mm group	0	1	3	4	5
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	1.000	0.000	0.000	0.000	0.000
60	1.000	0.000	0.000	0.000	0.000
70	0.999	0.001	0.000	0.000	0.000
80	0.988	0.012	0.000	0.000	0.000
90	0.889	0.111	0.000	0.000	0.000
100	0.444	0.556	0.000	0.000	0.000
110	0.074	0.926	0.000	0.000	0.000
120	0.008	0.992	0.000	0.000	0.000
130	0.001	0.995	0.004	0.000	0.000
140	0.000	0.966	0.034	0.000	0.000
150	0.000	0.755	0.232	0.011	0.002
160	0.000	0.003	0.007	0.846	0.144
170	0.000	0.000	0.000	0.828	0.172
180	0.000	0.000	0.000	0.797	0.203
190	0.000	0.000	0.000	0.763	0.237

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PLCA mm group	Age				
	0	1	2	3	5
0	1.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000
50	0.999	0.001	0.000	0.000	0.000
60	0.988	0.012	0.000	0.000	0.000
70	0.815	0.185	0.000	0.000	0.000
80	0.188	0.811	0.001	0.000	0.000
90	0.012	0.983	0.005	0.000	0.000
100	0.001	0.982	0.017	0.000	0.000
110	0.000	0.942	0.057	0.000	0.000
120	0.000	0.820	0.175	0.005	0.000
130	0.000	0.543	0.405	0.053	0.000
140	0.000	0.196	0.511	0.293	0.000
150	0.000	0.030	0.275	0.695	0.000
160	0.000	0.003	0.082	0.915	0.000
170	0.000	0.000	0.020	0.977	0.003
180	0.000	0.000	0.004	0.960	0.036
190	0.000	0.000	0.001	0.674	0.325
200	0.000	0.000	0.000	0.139	0.861
210	0.000	0.000	0.000	0.012	0.988

WLSL mm group	Age						
	0	1	2	3	4	6	7
0	1.000	0.000	0.000	0.000	0.000	0.000	0.000
10	1.000	0.000	0.000	0.000	0.000	0.000	0.000
20	1.000	0.000	0.000	0.000	0.000	0.000	0.000
30	1.000	0.000	0.000	0.000	0.000	0.000	0.000
40	1.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.999	0.001	0.000	0.000	0.000	0.000	0.000
60	0.989	0.011	0.000	0.000	0.000	0.000	0.000
70	0.898	0.102	0.000	0.000	0.000	0.000	0.000
80	0.468	0.532	0.000	0.000	0.000	0.000	0.000
90	0.081	0.919	0.000	0.000	0.000	0.000	0.000
100	0.009	0.991	0.000	0.000	0.000	0.000	0.000
110	0.001	0.999	0.000	0.000	0.000	0.000	0.000
120	0.000	1.000	0.000	0.000	0.000	0.000	0.000
130	0.000	1.000	0.000	0.000	0.000	0.000	0.000
140	0.000	1.000	0.000	0.000	0.000	0.000	0.000
150	0.000	0.973	0.027	0.000	0.000	0.000	0.000
160	0.000	0.208	0.775	0.010	0.007	0.000	0.000
170	0.000	0.002	0.948	0.035	0.015	0.000	0.000
180	0.000	0.000	0.886	0.088	0.026	0.000	0.000
190	0.000	0.000	0.755	0.204	0.041	0.000	0.000
200	0.000	0.000	0.544	0.401	0.055	0.000	0.000
210	0.000	0.000	0.313	0.628	0.058	0.000	0.000
220	0.000	0.000	0.147	0.802	0.051	0.000	0.000
230	0.000	0.000	0.060	0.890	0.038	0.012	0.000
240	0.000	0.000	0.015	0.597	0.017	0.370	0.000
250	0.000	0.000	0.000	0.032	0.001	0.944	0.023
260	0.000	0.000	0.000	0.000	0.000	0.485	0.514
270	0.000	0.000	0.000	0.000	0.000	0.022	0.978

Appendix 3. Mean back-calculated lengths at age for Bluegill sampled with electrofishing from Kansas impoundments in 2017. Sample size, mean length, standard deviation, and standard error are shown for each age and impoundment. Percentile calculations indicate relative percentile of mean back-calculated length at a particular age for the populations sampled.

Impoundment	Age	n	Mean length (mm)	SD	SE	Percentile
BBSL	1	60	72.31523	10.54777	1.361711	37%
BBSL	2	39	114.4778	8.220923	1.316401	53%
BBSL	3	23	142.0744	8.505645	1.77355	41%
BBSL	4	16	163.7478	11.13698	2.784245	56%
BBSL	5	7	170.1609	8.47846	3.204557	52%
BBSL	6	2	190.2207	11.33315	8.013749	62%
BUSL	1	33	70.41263	13.15067	2.289238	31%
BUSL	2	27	103.6781	15.04833	2.896052	29%
BUSL	3	16	123.3898	19.07331	4.768328	15%
BUSL	4	5	140.4363	33.12736	14.81501	13%
BUSL	5	1	208.6791			100%
BUSL	6	1	218.3146			100%
CASL	1	26	80.74341	16.54611	3.244959	80%
CASL	2	26	131.2171	14.09429	2.764118	91%
CASL	3	20	154.4121	10.20545	2.282009	76%
CASL	4	11	166.128	10.07664	3.03822	63%
CLSL	1	38	78.89522	15.978	2.591973	69%
CLSL	2	37	122.9219	19.83128	3.260242	68%
CLSL	3	18	164.8037	16.71714	3.940269	91%
CLSL	4	12	183.9478	17.95204	5.182306	94%
CLSL	5	5	186.0499	18.72433	8.373776	86%
CLSL	6	3	205.4062	13.23964	7.643911	92%
CLSL	7	2	205.863	3.834213	2.711198	100%
CRSL	1	1	80.95428			83%
CRSL	1	36	81.10053	14.36068	2.393446	86%
CRSL	2	25	118.8033	10.95385	2.190771	62%
CRSL	3	14	140.0189	11.65263	3.114295	35%
CRSL	4	9	152.8888	14.00231	4.667436	31%
DGLL	1	58	77.91763	16.61901	2.182183	63%
DGLL	2	31	127.4322	10.53002	1.891247	85%
DGLL	3	16	157.447	6.537945	1.634486	79%
DGLL	4	6	172.7735	8.026741	3.276903	88%
DGSL	1	45	61.87084	11.23075	1.674181	3%
DGSL	2	20	97.3408	17.94635	4.012926	9%
DGSL	3	7	141.5993	11.56827	4.372394	38%
DGSL	4	6	161.869	15.38791	6.282086	47%
DGSL	5	4	168.925	18.36386	9.181929	43%
DGSL	6	3	168.2933	7.170554	4.139921	15%
DGSL	7	3	175.5044	7.017115	4.051333	25%

DGSL	8	3	182.3894	6.887923	3.976744	50%
DGSL	9	1	185.4392			50%
FSCA	1	61	78.56628	16.92079	2.166486	66%
FSCA	2	27	130.6842	10.63356	2.046429	88%
FSCA	3	13	163.6485	7.309904	2.027402	85%
FSCA	4	3	172.4315	2.636621	1.522254	81%
GDCL	1	59	75.92838	15.03559	1.957467	57%
GDCL	2	29	123.407	13.465	2.500387	71%
GDCL	3	18	148.7377	13.87288	3.269869	56%
GDCL	4	9	160.2949	15.58796	5.195988	44%
GDCL	5	3	169.9926	13.24625	7.647724	48%
GDCL	6	2	171.5129	10.50709	7.429632	23%
GESL	1	26	80.30234	15.73962	3.086793	74%
GESL	2	22	112.0643	16.53211	3.524657	47%
GESL	3	11	150.6139	11.31961	3.412992	62%
GESL	4	5	166.5382	15.81544	7.072882	66%
GHCL	1	37	72.17517	17.6439	2.90064	34%
GHCL	2	11	111.0154	26.30287	7.930613	44%
GHCL	3	2	179.1438	13.84415	9.789292	97%
GHCL	4	1	195.0124			100%
GRCL	1	43	66.7291	12.99135	1.981163	11%
GRCL	2	30	102.3717	18.74095	3.421614	26%
GRCL	3	8	148.4534	16.30736	5.765522	53%
GRCL	4	6	173.6294	8.951215	3.654318	91%
GRCL	5	2	188.3988	10.26778	7.260415	90%
JWSL	1	61	88.44321	14.76518	1.890487	97%
JWSL	2	59	126.3609	18.98774	2.471994	79%
JWSL	3	28	164.1477	13.08594	2.47301	88%
JWSL	4	16	185.1468	10.50414	2.626034	97%
KMSL	1	39	64.27229	9.661186	1.547028	9%
KMSL	2	32	92.55413	10.78547	1.906619	3%
KMSL	3	26	112.6931	12.68646	2.48802	3%
KMSL	4	7	123.7474	16.95028	6.406605	3%
KUCL	1	62	69.03983	16.92581	2.14958	20%
KUCL	2	37	109.2408	20.33362	3.342827	35%
KUCL	3	26	147.4892	18.01333	3.532705	50%
KUCL	4	13	172.6857	8.423839	2.336353	84%
KUCL	5	6	185.6252	9.668198	3.947025	81%
KUCL	6	1	190.4779			69%
LXLX	1	44	67.90821	12.81037	1.931237	17%
LXLX	2	29	100.5794	14.12008	2.622033	15%
LXLX	3	11	130.4389	19.50695	5.881565	26%
LXLX	4	4	148.6412	29.31095	14.65547	28%
LXLX	5	1	119.6963			5%
LYSL	1	58	73.35984	16.22679	2.130682	46%

LYSL	2	47	109.3478	18.63192	2.717745	38%
LYSL	3	26	146.7714	11.72336	2.29914	47%
LYSL	4	15	166.9809	12.15882	3.139395	69%
LYSL	5	3	182.1521	9.224826	5.325956	76%
LYSL	6	1	179.8037			54%
LYSL	7	1	183.5831			50%
MACL	1	60	70.18663	11.59636	1.497083	29%
MACL	2	47	100.6589	16.68816	2.434218	18%
MACL	3	39	124.4758	18.1295	2.903043	21%
MACL	4	20	146.736	20.65963	4.619633	22%
MACL	5	5	143.1085	17.51724	7.833948	10%
MCCL	1	47	67.88686	10.72733	1.564742	14%
MCCL	2	32	97.46134	11.0536	1.954019	12%
MCCL	3	22	117.3497	13.2395	2.822671	6%
MCCL	4	3	140.8883	18.57493	10.72424	16%
MCCL	5	1	155.2056			33%
MERP	1	57	92.05999	18.18682	2.408903	100%
MERP	2	28	136.1973	17.91051	3.384769	94%
MERP	3	25	161.225	18.23928	3.647855	82%
MERP	4	13	170.7221	18.2598	5.064358	75%
MERP	5	1	146.7896			29%
MESL	1	21	77.19777	12.94361	2.824528	60%
MESL	2	21	109.5759	12.07966	2.635998	41%
MESL	3	18	126.9424	13.20582	3.112642	24%
MESL	4	3	135.4838	17.41742	10.05595	6%
MGSL	1	41	87.38584	20.95263	3.272251	94%
MGSL	2	15	142.8943	20.07215	5.182606	97%
MGSL	3	4	180.823	5.868078	2.934039	100%
MISL	1	52	86.42417	12.63036	1.751516	89%
MISL	2	32	127.2529	10.13681	1.791951	82%
MISL	3	19	153.1374	12.86965	2.9525	74%
MISL	4	6	162.4065	14.88287	6.075905	53%
MISL	5	1	144.5369			14%
MNCL	1	61	86.81078	20.88813	2.674451	91%
MNCL	2	28	144.6669	18.48387	3.493123	100%
MNCL	3	13	166.7703	22.03171	6.110496	94%
MNCL	4	2	162.2199	8.566088	6.057139	50%
MNCL	5	1	189.4278			95%
MNCL	6	1	202.5094			85%
MPSL	1	57	79.12351	13.96691	1.849962	71%
MPSL	2	45	116.8257	12.2194	1.82156	56%
MPSL	3	30	143.3415	12.34579	2.254023	44%
MPSL	4	16	159.2549	12.13347	3.033367	38%
MPSL	5	3	170.2291	18.06531	10.43001	57%
MPSL	6	1	157.3854			8%

NOSL	1	25	73.86088	14.91818	2.983635	51%
NOSL	2	25	119.4613	11.6043	2.32086	65%
NOSL	3	10	151.7537	9.720238	3.073809	68%
NOSL	4	4	170.1434	17.25684	8.628421	72%
OTSL	1	7	72.82692	14.55461	5.501127	43%
OTSL	2	7	106.1306	15.15959	5.729788	32%
OTSL	3	2	123.9156	10.84008	7.665097	18%
PLCA	1	62	72.52127	15.5852	1.979322	40%
PLCA	2	32	117.2518	14.87046	2.628751	59%
PLCA	3	16	149.2888	11.57808	2.894519	59%
PLCA	4	6	164.9267	11.96162	4.883312	59%
PTSA	1	13	62.80337	13.47251	3.736601	6%
PTSA	2	13	93.21454	19.35955	5.369374	6%
PTSA	3	12	118.6609	26.3604	7.609591	9%
PTSA	4	7	143.3586	36.81413	13.91444	19%
PTSA	5	5	146.4926	40.98164	18.32754	24%
PTSA	6	4	176.1792	10.81231	5.406157	38%
PTSA	7	4	185.7585	11.01128	5.505639	75%
PTSA	8	2	192.0951	21.86556	15.46128	100%
PTSA	9	1	210.4563			100%
SCSL	1	29	73.4162	13.07343	2.427675	49%
SCSL	2	26	112.37	11.78348	2.31093	50%
SCSL	3	20	139.7314	9.08364	2.031164	32%
SCSL	4	15	159.5276	10.03726	2.59161	41%
SCSL	5	14	171.6776	8.681172	2.320141	67%
SCSL	6	3	179.3672	9.288632	5.362794	46%
SDSL	1	59	74.99322	19.40233	2.525968	54%
SDSL	2	24	126.1765	14.85701	3.032674	76%
SDSL	3	8	151.1343	15.91313	5.626142	65%
SDSL	4	2	146.8191	9.408471	6.652794	25%
SDSL	5	2	159.9755	13.24623	9.366501	38%
SNSL	1	46	69.70573	12.28055	1.810669	26%
SNSL	2	36	101.3906	12.66398	2.110663	24%
SNSL	3	27	123.1767	12.88838	2.480371	12%
SNSL	4	15	140.1878	14.77257	3.81426	9%
SNSL	5	3	144.6039	18.91806	10.92235	19%
WLSL	1	64	80.5448	15.27157	1.908946	77%
WLSL	2	40	124.1184	12.61419	1.994479	74%
WLSL	3	22	152.8191	9.940997	2.119428	71%
WLSL	4	14	171.2187	8.772946	2.344668	78%
WLSL	5	6	176.6655	8.481512	3.462563	71%
WLSL	6	1	175.9847			31%
WSSL	1	71	69.27316	15.69142	1.862229	23%
WSSL	2	68	100.9239	21.4898	2.606022	21%
WSSL	3	41	138.4438	14.46962	2.259774	29%



WSSL	4	31	155.344	15.18767	2.727787	34%
WSSL	5	4	171.2131	18.36864	9.184322	62%
WSSL	6	1	194.3156			77%

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Appendix 4. Mean back-calculated lengths at age for Redear Sunfish sampled with electrofishing from Kansas impoundments in 2017. Sample size, mean length, standard deviation, and standard error are shown for each age and impoundment. Percentile calculations indicate relative percentile of mean back-calculated length at a particular age for the populations sampled.

Impoundment	Age	n	Mean length (mm)	SD	SE	Percentile
BBSL	1	25	100.7327	11.41931	2.283862	60%
BBSL	2	15	148.0622	11.74871	3.033503	53%
BBSL	3	12	181.9503	8.378163	2.418567	57%
BBSL	4	4	197.6606	7.796579	3.89829	62%
BBSL	5	2	214.6706	5.710002	4.037581	60%
BBSL	6	1	230.5229			50%
CRSL	1	12	92.0406	17.47485	5.044555	33%
CRSL	2	11	132.5944	8.226662	2.480432	40%
CRSL	3	10	154.4097	7.383733	2.334941	29%
CRSL	4	9	169.7014	7.82833	2.609443	23%
DGLL	1	40	111.6297	17.76893	2.809515	93%
DGLL	2	21	164.1917	14.94535	3.261342	87%
DGLL	3	10	182.4585	13.36294	4.225732	64%
DGLL	4	3	197.5345	18.02269	10.40541	54%
DGLL	5	2	200.7594	6.912701	4.888018	30%
DGLL	6	2	210.7898	11.36583	8.036853	25%
GDCL	1	44	113.9373	20.17024	3.040779	100%
GDCL	2	34	177.7256	21.03459	3.607403	100%
GDCL	3	22	214.1981	20.22438	4.311852	100%
GDCL	4	4	235.6038	18.27892	9.13946	100%
GDCL	5	1	224.0131			80%
GDCL	6	1	231.951			63%
JWSL	1	51	95.98742	20.1846	2.826409	40%
JWSL	2	49	138.9318	24.35369	3.479098	47%
JWSL	3	22	178.0826	22.00875	4.692282	43%
JWSL	4	16	194.6845	22.17562	5.543906	38%
KMSL	1	6	75.05546	8.560415	3.494775	7%
KMSL	2	6	103.1608	12.47477	5.092803	7%
KMSL	3	4	116.9384	15.39946	7.699728	7%
KMSL	4	1	128.0806			8%
LXLX	1	15	105.2413	8.46168	2.184796	67%
LXLX	2	7	150.7097	15.25994	5.767714	60%
LXLX	3	7	182.889	14.98541	5.663952	71%
LXLX	4	1	194.8931			46%
LXLX	5	1	216.9585			70%
LXLX	6	1	232.8959			75%
LXLX	7	1	243.945			50%

LYSL	1	40	86.02726	16.99802	2.687624	27%
LYSL	2	28	130.9627	20.8255	3.935649	33%
LYSL	3	5	181.473	19.7078	8.813597	50%
LYSL	4	1	201.0935			77%
LYSL	5	1	214.598			50%
LYSL	6	1	227.699			38%
LYSL	7	1	237.8152			25%
MACL	1	5	99.81987	8.072764	3.61025	53%
MACL	2	1	173.8917			93%
MACL	3	1	198.9147			86%
MCCL	1	40	84.75944	12.02062	1.900627	13%
MCCL	2	34	113.2265	14.47767	2.4829	13%
MCCL	3	20	137.5927	15.01441	3.357325	14%
MCCL	4	4	174.7254	7.366659	3.683329	31%
MCCL	5	1	187.2681			20%
MCCL	6	1	197.8843			13%
MERP	1	37	110.2309	18.58241	3.05493	87%
MERP	2	23	162.2252	20.30567	4.234024	73%
MERP	3	21	192.2644	20.35749	4.442369	79%
MERP	4	10	208.8207	17.6827	5.59176	85%
MERP	5	4	224.8223	10.86217	5.431087	90%
MERP	6	4	236.5523	11.2239	5.611948	88%
MERP	7	3	245.3351	10.03047	5.791094	75%
MGSL	1	35	109.218	19.4768	3.29218	80%
MGSL	2	5	158.9415	30.47335	13.6281	67%
MISL	1	24	98.28495	19.9339	4.068989	47%
MISL	2	18	128.6986	10.68693	2.518933	20%
MISL	3	18	148.6688	9.641975	2.272635	21%
MISL	4	17	163.1066	8.353463	2.026012	15%
MISL	5	3	169.2337	10.66662	6.158374	10%
PLCA	1	40	84.91635	13.95615	2.20666	20%
PLCA	2	19	129.4434	15.3686	3.525799	27%
PLCA	3	15	156.1664	11.88251	3.068051	36%
PLCA	4	1	199.8461			69%
PLCA	5	1	209.7815			40%
WLSL	1	53	105.7121	17.50543	2.404556	73%
WLSL	2	31	163.0936	16.75685	3.009619	80%
WLSL	3	12	200.3327	17.59923	5.08046	93%
WLSL	4	3	221.1846	27.21442	15.71225	92%
WLSL	5	2	247.6752	11.31794	8.00299	100%
WLSL	6	2	259.042	14.94739	10.5694	100%
WLSL	7	1	273.0215			100%