3.0 RESULTS

3.1 ANGLER FISHING EFFORT

3.1.1 Daytime Fishing Effort

The estimate of daytime (7 AM to 9 PM) fishing effort was based on the aerial angler counts, in conjunction with the daily effort distribution estimated from the access survey. The number of interviews completed in the access point survey by spatio-temporal strata is in Table 3-1, and details on the aerial sampling effort (primary sampling units) by spatio-temporal strata are Table 3-2. Nearly 70% of the daytime interviews were from intercepts of anglers that completed their trips after 1 PM (Table 3-1). Overall, the aerial angler counts were evenly conducted between mornings (AM) and afternoons (PM) (Table 3-2).

The daily distribution of angler effort in the non-tidal and tidal portion of the river during weekday and weekends (based on interview data), for two periods (original temporal strata 1-3, and 4-7), is in Figures 3-1 to 3-4. Based on the original temporal stratification, the mean length of a fishing trip for boat anglers was 4.3 hours across geographic and temporal strata, while shore angler trips averaged 2.1 hours in length (Tables 3-3a and 3-4a). Tables 3-3b and 3-4b provide similar estimates based on the monthly post-strata.

We derived the expansion factors for estimating angler effort from the aerial daily counts from the effort distributions estimated from interview data. Based on this model-approach, the total effort across fishing modes (boat and shore) for daytime fishing (7 AM to 9 PM) was estimated to be 260,849 angler hours (79,854 trips) in the non-tidal section of the river, and 139,621 hours (40,192 trips) in the tidal section (Table 3-5a) based on the original temporal stratification. The total effort for the entire survey period was estimated at 400,470 hours (120,046 trips). The respective effort estimates based on monthly post-stratification were slightly higher (Table 3-5b). The above total estimates for the non-tidal portion of the river includes non-tidal stratum 3 with the East Branch. For the total sample period, the afternoon fishing (1 PM to 9 PM) accounted for 59% of the overall effort in the non-tidal as well as in the tidal portions of the river. Based on the aerial survey, we estimated that boat anglers accounted for 80% of the total effort (angler hours) in the non-tidal section, and 90% in the tidal (Figures 3-5 and 3-6; Tables 3-3 and 3-4). The comparable estimates based on the access survey showed a lower proportion of boat anglers, with boats accounting for 71% of the effort in the non-tidal river and 61% in the tidal portion of the river (Figures 3-5 and 3-6).

Separate estimates of fishing effort for river strata 2 and 3 based on the aerial surveys are in Tables 3-6a and 3-6b. The total effort across fishing modes for non-tidal stratum 2 was estimated at 49,887 hours (14,071) trips based on the original temporal stratification. The total effort across fishing modes for non-tidal stratum 3 (including the East Branch) using the original temporal stratification was 48,403 hours (13,889 trips), with the hourly effort distributed

approximately evenly among shore and boat anglers (Table 3-6b). The comparable estimates based on the access survey showed similar proportion of boat anglers overall, but exhibited more variation in the boat and shore effort ratio over time (Figure 3-7). This variation is likely due to sampling variability. Only 130 anglers were interviewed in non-tidal stratum 3 for the total sample period (35 boat anglers and 95 shore anglers), with less than 10 boat anglers interviewed in some temporal strata. Based on the original post stratification, the mean length of a fishing trip for boat anglers was 6.6 hours for the total sample period, while shore angler trips averaged 2.6 hours in length (Table 3-6a). Based on four separate aerial counts, we estimated that fishing effort in the East Branch accounted for 8% of the effort by boat anglers and 43% of the effort by shore anglers in stratum 3. Boat anglers in the East Branch fished an estimated 1,793 angler hours (299 trips), while shore anglers fished an estimated 9,976 hours (3,325 trips), totaling 11,769 angler hours (3624 trips). The aerial counts indicated that most of the fishing trips on the East Branch occurred during spring. Only about 5% of anglers counted in stratum 3 during the August and September flights were fishing in the East Branch.

Table 3-1. Number of interviews completed within and across spatial and temporal strata. Stratum 3 includes the East Branch.

Temporal Strata	Sampled Shift	Geographic Strata						
		Tidal	Stratum 1	Stratum 2	Stratum 3	East Branch	All Non-Tidal	All
Monthly - 1	AM	98	76	15	7	7	98	189
	PM	113	201	59	13		273	386
	Night		1	1			2	2
Original - 1	AM	54	22	2	7	7	31	78
	PM	41	67	28	5		100	141
	Night						0	0
Monthly - 2	AM	25	65	13	1		79	104
	PM	117	126	47	6		179	296
	Night	4	7				7	11
Original - 2	AM	69	146	37	1		184	253
	PM	210	274	78	14		366	576
	Night	4	13	1			14	18
Monthly - 3	AM	30	81	19			100	130
	PM	58	52	54	8		114	172
	Night		5	8	7		20	20
Original - 3	AM	31	79	23			102	133
	PM	44	50	84	9		143	187
	Night			16	7		23	23
Monthly - 4	AM	29	51	29	8		88	117
	PM	113	95	72	29		196	309
	Night	12	5	13	6		24	36

Table 3-1. Continued

Temporal Strata	Sampled Shift	Geographic Strata						
		Tidal	Stratum 1	Stratum 2	Stratum 3	East Branch	All Non-Tidal	All
Original - 4	AM	28	26	14	8		48	76
	PM	106	83	42	28		153	259
	Night	12	5	5	6		16	28
Monthly - 5	AM	21	22	32	5		59	80
	PM	52	80	57	16		153	205
	Night	8	1	2			3	11
Original - 5	AM	21	22	32	5		59	80
	PM	52	80	57	16		153	205
	Night	8	1	2			3	11
Monthly - 6	AM	23	9	17	2		28	51
	PM	36	40	20	10		70	106
	Night	2	1		1		2	4
Original - 6	AM	23	9	17	2		28	51
	PM	36	40	20	10		70	106
	Night	2	1		1		2	4
Monthly - 7	AM	3	12	4	4		20	23
	PM	34	24	33	7		64	98
	Night	3					0	3
Original - 7	AM	3	12	4	4		20	23
	PM	34	24	33	7		64	98
	Night	3					0	3
Total Period	AM	229	316	129	27	7	472	694
	PM	523	618	342	89	0	1049	1572
	AM+PM	752	934	471	116	7	1521	2266
	Night	29	20	24	14	0	58	87

Table 3-2. Aerial sampling effort (number of primary sampling units) by spatio-temporal strata. An instantaneous count was obtained for each PSU. Stratum 3 includes the East Branch.

Temporal Strata	Sampled Shift	Geographic Strata					
		Tidal	Stratum 1	Stratum 2	Stratum 3	All Non-Tidal	All Spatial Strata
Monthly - 1	AM	3	6	1	1	8	11
	PM	3	4	2	2	8	11
Original - 1	AM	2	4			4	6
	PM	3	3	1	1	5	8
Monthly - 2	AM	1	3		1	4	5
	PM	2	6	3	2	11	13
Original - 2	AM	3	7	2	2	11	14
	PM	2	8	4	4	16	18
Monthly - 3	AM	2	4	1		5	7
	PM	2	2	3	4	9	11
Original - 3	AM	2	3	1		4	6
	PM	2	1	3	4	8	10
Monthly - 4	AM	3	2	3	2	7	10
	PM	1	2	1	2	5	6
Original - 4	AM	2	1	2	2	5	7
	PM	1	2	1	1	4	5
Monthly - 5	AM	3	2	3	2	7	10
	PM	1	2	1	2	5	6
Original - 5	AM	3	2	3	2	7	10
	PM	1	2	1	2	5	6
Monthly - 6	AM	3	4	2	2	8	11
	PM	1		2	2	4	5
Original - 6	AM	3	4	2	2	8	11
	PM	1		2	2	4	5
Monthly - 7	AM	1	2	1	1	4	5
	PM	2	1	3	3	7	9
Original - 7	AM	1	2	1	1	4	5
	PM	2	1	3	3	7	9
Total Period	AM	16	23	11	9	43	59
	PM	12	17	15	17	49	61

Table 3-3a. Total daytime fishing effort for boat anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on original temporal stratification.

Strata		# PSU Aerial	Effort (Hours)	RSE	Mean Hours/rip	# Trips	# Interviews	# PSU Access
Geographic	Time							
Non-Tidal 2+3	1	2	3750	0.11	4.14	906	18	9
	2	12	16861	0.18	4.55	3708	59	28
	3	8	6196	0.13	5.09	1217	101	18
	4	6	3285	0.20	4.95	663	27	15
	5	8	5598	0.18	4.46	1256	66	27
	6	8	6339	0.34	4.38	1446	34	24
	7	8	2445	0.29	4.14	590	17	28
Non-Tidal 1	1	7	51027	0.43	4.15	12302	45	14
	2	15	51285	0.19	4.96	10340	243	37
	3	4	9282	0.14	3.47	2675	77	16
	4	3	15561	0.14	4.05	3844	71	11
	5	4	17558	0.10	3.56	4938	64	18
	6	4	13789	0.11	4.28	3225	32	15
	7	3	8466	0.58	3.71	2283	24	18
Pooled Non-Tidal	1	9	54777	0.40	4.15	13209	63	23
	2	27	68146	0.15	4.85	14049	302	65
	3	12	15478	0.10	3.98	3892	178	34
	4	9	18846	0.12	4.18	4507	98	26
	5	12	23156	0.09	3.74	6194	130	45
	6	12	20128	0.13	4.31	4671	66	39
	7	11	10911	0.46	3.80	2873	41	46
Tidal	1	5	21433	0.63	4.39	4877	41	16
	2	5	48767	0.16	4.54	10732	165	27
	3	4	10324	0.47	3.72	2778	35	14
	4	3	16574	0.17	4.32	3837	73	17
	5	4	10896	0.24	3.76	2895	31	15
	6	4	10952	0.12	3.25	3370	21	13
	7	3	7404	0.42	8.83	838	6	16
Non-Tidal	1-7	92	211442	0.12	4.28	49395	878	278
Tidal	1-7	28	126350	0.14	4.31	29327	371	118
All	1-7	120	337792	0.09	4.29	78722	1249	396

Table 3-3b. Total daytime fishing effort for boat anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on monthly temporal post-stratification.

Strata		# PSU Aerial	Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU Access
Geographic	**Month**							
Non-Tidal 2+3	Mar/Apr	6	14394	0.20	3.90	3691	24	17
	May	6	10335	0.29	4.69	2205	51	15
	Jun	8	7049	0.18	5.56	1269	69	18
	Jul	8	4745	0.20	4.50	1054	61	20
	Aug	8	5598	0.18	4.46	1256	66	27
	Sep	8	6339	0.34	4.38	1446	34	24
	Oct	8	2445	0.29	4.14	590	17	28
Non-Tidal 1	Mar/Apr	10	76109	0.30	4.72	16130	158	26
	May	9	27674	0.22	5.09	5433	118	20
	Jun	6	11152	0.15	3.35	3330	73	17
	Jul	4	21327	0.10	4.09	5213	87	15
	Aug	4	17558	0.10	3.56	4938	64	18
	Sep	4	13789	0.11	4.28	3225	32	15
	Oct	3	8466	0.69	3.71	2283	24	18
Pooled Non-Tidal	Mar/Apr	16	90503	0.26	4.57	19822	182	43
	May	15	38009	0.18	4.98	7638	169	35
	Jun	14	18201	0.12	3.96	4598	142	35
	Jul	12	26072	0.09	4.16	6267	148	35
	Aug	12	23156	0.09	3.74	6194	130	45
	Sep	12	20128	0.13	4.31	4671	66	39
	Oct	11	10911	0.54	3.80	2873	41	46
Tidal	Mar/Apr	6	36933	0.55	4.25	8689	138	26
	May	3	34800	0.31	5.28	6597	50	14
	Jun	4	12689	0.59	3.99	3178	49	14
	Jul	4	21713	0.15	4.27	5080	76	20
	Aug	4	10896	0.24	3.76	2895	31	15
	Sep	4	10952	0.12	3.25	3370	21	13
	Oct	3	7404	0.34	8.83	838	6	16
Non-Tidal	Mar-Oct	92	226980	0.11	4.36	52063	878	278
Tidal	Mar-Oct	28	135386	0.18	4.42	30647	371	118
All	Mar-Oct	120	362366	0.10	4.38	82710	1249	396

Table 3-4a. Total daytime fishing effort for shore anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on original temporal stratification.

Strata		# PSU Aerial	Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU Access
Geographic	Time							
Non-Tidal 2+3	1	2	0		1.64	0	24	9
	2	12	9532	0.31	2.11	4517	72	28
	3	8	5090	0.19	2.78	1831	38	18
	4	6	3169	0.26	2.20	1440	76	15
	5	8	2882	0.14	1.57	1836	46	27
	6	8	3086	0.47	3.01	1027	16	24
	7	8	411	0.36	4.01	102	31	28
Non-Tidal 1	1	7	3945	0.42	1.78	2214	44	14
	2	15	8388	0.20	2.31	3639	190	37
	3	4	1129	0.36	1.48	764	52	16
	4	3	2582	0.23	1.90	1362	43	11
	5	4	4189	0.13	1.85	2265	39	18
	6	4	2506	0.40	1.66	1514	18	15
	7	3	2497	0.40	1.46	1712	12	18
Pooled Non-Tidal	1	9	3945	0.42	1.78	2214	68	23
	2	27	17920	0.19	2.20	8156	262	65
	3	12	6220	0.17	2.40	2594	90	34
	4	9	5752	0.18	2.05	2801	119	26
	5	12	7071	0.10	1.72	4101	85	45
	6	12	5593	0.32	2.20	2541	34	39
	7	11	2908	0.35	1.60	1814	43	46
Tidal	1	5	4711	0.34	2.47	1904	54	16
	2	5	2440	0.73	3.01	810	119	27
	3	4	217	0.49	2.37	91	40	14
	4	3	462	1.03	3.58	129	73	17
	5	4	2215	0.05	2.20	1005	50	15
	6	4	831	0.89	2.57	323	40	13
	7	3	2396	0.31	3.18	754	34	16
Non-tidal	1-7	92	49407	0.09	2.04	24223	701	278
Tidal	1-7	28	13271	0.20	2.65	5017	410	118
All	1-7	120	62678	0.08	2.14	29240	1111	396

Table 3-4b. Total daytime fishing effort for shore anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on monthly temporal post-stratification.

Strata		# PSU Aerial	Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU Access
Geographic	**Month**							
Non-Tidal 2+3	Mar/Apr	6	5419	0.50	1.90	2853	71	17
	May	6	6213	0.41	2.24	2768	16	15
	Jun	8	6131	0.25	2.50	2456	27	18
	Jul	8	4767	0.21	2.36	2024	96	20
	Aug	8	2882	0.14	1.57	1836	46	27
	Sep	8	3086	0.47	3.01	1027	16	24
	Oct	8	411	0.36	4.01	102	31	28
Non-Tidal 1	Mar/Apr	10	7931	0.26	2.36	3367	120	26
	May	9	4423	0.19	2.04	2164	80	20
	Jun	6	1543	0.24	2.10	735	65	17
	Jul	4	3559	0.16	1.44	2475	64	15
	Aug	4	4189	0.13	1.85	2265	39	18
	Sep	4	2506	0.40	1.66	1514	18	15
	Oct	3	2497	1.59	1.46	1712	12	18
Pooled Non-Tidal	Mar/Apr	16	13350	0.25	2.15	6219	191	43
	May	15	10636	0.25	2.16	4932	96	35
	Jun	14	7675	0.20	2.41	3191	92	35
	Jul	12	8326	0.14	1.85	4499	160	35
	Aug	12	7071	0.10	1.72	4101	85	45
	Sep	12	5593	0.32	2.20	2541	34	39
	Oct	11	2908	1.36	1.60	1814	43	46
Tidal	Mar/Apr	6	5441	0.36	2.64	2063	73	26
	May	3	2794	1.00	3.05	917	96	14
	Jun	4	289	0.49	2.35	123	39	14
	Jul	4	369	1.06	3.48	106	78	20
	Aug	4	2215	0.05	2.20	1005	50	15
	Sep	4	831	0.89	2.57	323	40	13
	Oct	3	2396	0.31	3.18	754	34	16
Non-tidal	Mar-Oct	92	55558	0.12	2.04	27297	701	278
Tidal	Mar-Oct	28	14335	0.25	2.71	5292	410	118
All	Mar-Oct	120	69893	0.11	2.14	32589	1111	396

Table 3-5a. Total daytime fishing effort for boat and shore anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on original temporal stratification.

Strata		# PSU Aerial	Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU Access
Geographic	Time							
Non-Tidal 2+3	1	2	3750	0.11	2.71	1382	42	9
	2	12	26393	0.16	3.21	8229	131	28
	3	8	11286	0.11	4.46	2531	139	18
	4	6	6454	0.17	2.92	2208	103	15
	5	8	8480	0.13	3.27	2592	112	27
	6	8	9425	0.28	3.94	2390	50	24
	7	8	2856	0.26	4.06	704	48	28
Non-Tidal 1	1	7	54972	0.40	2.96	18543	89	14
	2	15	59673	0.16	3.80	15696	433	37
	3	4	10412	0.13	2.67	3904	129	16
	4	3	18144	0.12	3.24	5606	114	11
	5	4	21747	0.09	2.91	7474	103	18
	6	4	16296	0.12	3.33	4890	50	15
	7	3	10963	0.46	2.96	3706	36	18
Pooled Non-Tidal	1	9	58722	0.38	2.95	19925	131	23
	2	27	86066	0.12	3.60	23924	564	65
	3	12	21697	0.09	3.37	6435	268	34
	4	9	24598	0.10	3.15	7814	217	26
	5	12	30227	0.07	3.00	10066	215	45
	6	12	25720	0.12	3.53	7280	100	39
	7	11	13819	0.37	3.13	4410	84	46
Tidal	1	5	26143	0.52	3.30	7916	95	16
	2	5	51207	0.16	3.90	13127	284	27
	3	4	10541	0.46	3.00	3515	75	14
	4	3	17036	0.16	3.95	4314	146	17
	5	4	13111	0.20	2.80	4682	81	15
	6	4	11783	0.12	2.80	4203	61	13
	7	3	9800	0.32	4.02	2435	40	16
Non-Tidal	1-7	92	260849	0.10	3.27	79854	1579	278
Tidal	1-7	28	139621	0.12	3.47	40192	782	118
All	1-7	120	400470	0.08	3.34	120046	2361	396

Table 3-5b. Total daytime fishing effort for boat and shore anglers for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on monthly temporal post-stratification.

Strata		# PSU Aerial	Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU Access
Geographic	**Month**							
Non-Tidal 2+3	Mar/Apr	6	19813	0.25	2.40	8239	95	17
	May	6	16548	0.32	4.10	4033	67	15
	Jun	8	13180	0.19	4.70	2807	96	18
	Jul	8	9513	0.12	3.14	3030	157	20
	Aug	8	8480	0.13	3.27	2592	112	27
	Sep	8	9425	0.27	3.94	2390	50	24
	Oct	8	2856	0.29	4.06	704	48	28
Non-Tidal 1	Mar/Apr	10	84040	0.29	3.70	22715	278	26
	May	9	32097	0.21	3.87	8292	198	20
	Jun	6	12695	0.15	2.76	4600	138	17
	Jul	4	24885	0.10	2.97	8389	151	15
	Aug	4	21747	0.11	2.91	7474	103	18
	Sep	4	16296	0.14	3.33	4890	50	15
	Oct	3	10963	0.76	2.96	3706	36	18
Pooled Non-Tidal	Mar/Apr	16	103853	0.24	3.36	30954	373	43
	May	15	48646	0.18	3.95	12325	265	35
	Jun	14	25876	0.12	3.49	7407	234	35
	Jul	12	34398	0.08	3.01	11419	308	35
	Aug	12	30227	0.09	3.00	10066	215	45
	Sep	12	25720	0.13	3.53	7280	100	39
	Oct	11	13819	0.60	3.13	4410	84	46
Tidal	Mar/Apr	6	42374	0.48	3.69	11475	211	26
	May	3	37594	0.28	3.81	9868	147	14
	Jun	4	12978	0.59	3.26	3976	88	14
	Jul	4	22082	0.14	3.87	5700	154	20
	Aug	4	13111	0.20	2.80	4682	81	15
	Sep	4	11783	0.15	2.80	4203	61	13
	Oct	3	9800	0.33	4.02	2435	40	16
Non-Tidal	Mar-Oct	92	282538	0.10	3.37	83861	1579	278
Tidal	Mar-Oct	28	149721	0.16	3.54	42340	782	118
All	Mar-Oct	120	432260	0.09	3.43	126200	2361	396

Table 3-6a. Total daytime fishing effort by fishing mode in the non-tidal stratum 2 estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Based on original temporal stratification. Mode legend B= boat anglers, S= shore anglers, All = boat and shore anglers combined.

Strata		Total						
Temporal	Mode	# PSU from Aerial Data	Total Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU from Interview Data
Original Temporal Stratification								
1-2	B	7	17557	0.31	4.29	4095	74	12
3	B	4	6629	1.07	4.89	1355	89	9
4-5	B	7	6634	0.22	4.38	1516	78	23
6-7	B	8	6014	0.34	4.41	1365	46	11
All	B	26	36834	0.25	4.42	8331	287	55
1-2	S	7	5646	0.66	2.02	2796	72	12
3	S	4	2929	1.80	2.46	1193	34	9
4-5	S	7	2911	0.30	2.58	1129	74	23
6-7	S	8	1568	0.73	3.41	459	28	11
All	S	26	13053	0.51	2.34	5577	208	55
1-2	All	7	23202	0.28	3.17	7323	146	12
3	All	4	9558	0.93	4.37	2186	123	9
4-5	All	7	9545	0.18	3.56	2680	152	23
6-7	All	8	7582	0.31	4.03	1881	74	11
All	All	26	49887	0.23	3.55	14071	495	55
Monthly Stratification								
1-2	B	6	11963	0.33	4.27	2805	72	12
3	B	4	6049	0.35	4.90	1234	57	9
4-5	B	8	9357	0.23	4.38	2138	112	23
6-7	B	8	6014	0.34	4.41	1365	46	11
All	B	26	33384	0.16	4.43	7542	287	55
1-2	S	6	4513	0.68	1.98	2279	63	12
3	S	4	2738	0.36	2.39	1144	24	9
4-5	S	8	4076	0.25	2.58	1580	93	23
6-7	S	8	1568	0.73	3.41	459	28	11
All	S	26	12895	0.28	2.36	5463	208	55
1-2	All	6	16477	0.31	3.20	5151	135	12
3	All	4	8787	0.27	4.16	2113	81	9
4-5	All	8	13433	0.18	3.56	3772	205	23
6-7	All	8	7582	0.31	4.03	1881	74	11
All	All	26	46278	0.14	3.58	12917	495	55

Table 3-6b. Total daytime fishing effort by fishing mode in the non-tidal stratum 3 estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Based on original temporal stratification. Mode legend B= boat anglers, S= shore anglers, All = boat and shore anglers combined.

Strata	Total							
Temporal	Mode	# PSU from Aerial Data	Total Effort (hours)	RSE	Mean hours/trip	# Trips	# Interviews	# PSU from Interview Data
Original Temporal Stratification								
1-2	B	7	12722	0.24	8.50	1497	3	1
3	B	4	5762	0.53	8.67	665	12	1
4-5	B	7	3091	0.13	5.25	589	15	7
6-7	B	8	3629	0.46	3.37	1078	5	3
All	B	26	25205	0.19	6.58	3828	35	12
1-2	S	7	9926	0.34	1.92	5179	24	3
3	S	4	7251	0.20	3.00	2417	4	2
4-5	S	7	3498	0.22	2.76	1267	48	12
6-7	S	8	2522	0.60	4.04	624	19	12
All	S	26	23198	0.18	2.45	9487	95	28
1-2	All	7	22648	0.20	2.65	8552	27	5
3	All	4	13014	0.26	7.25	1795	16	2
4-5	All	7	6589	0.13	3.35	1965	63	19
6-7	All	8	6152	0.37	3.90	1576	24	14
All	All	26	48403	0.13	3.49	13889	130	40
Monthly Stratification								
1-2	B	6	7959	0.26	8.50	936	3	1
3	B	4	8049	0.13	8.67	929	12	1
4-5	B	8	4029	0.12	5.25	767	15	7
6-7	B	8	3629	0.46	3.37	1078	5	3
All	B	26	23666	0.12	6.38	3710	35	12
1-2	S	6	5572	0.35	1.92	2907	24	4
3	S	4	9525	0.05	3.33	2858	3	1
4-5	S	8	5491	0.23	2.74	2000	49	12
6-7	S	8	2522	0.60	4.04	624	19	11
All	S	26	23110	0.12	2.75	8389	95	28
1-2	All	6	13531	0.21	2.65	5110	27	5
3	All	4	17574	0.07	7.60	2312	15	2
4-5	All	8	9519	0.14	3.33	2857	64	19
6-7	All	8	6152	0.37	3.90	1576	24	14
All	All	26	46776	0.09	3.95	11855	130	40

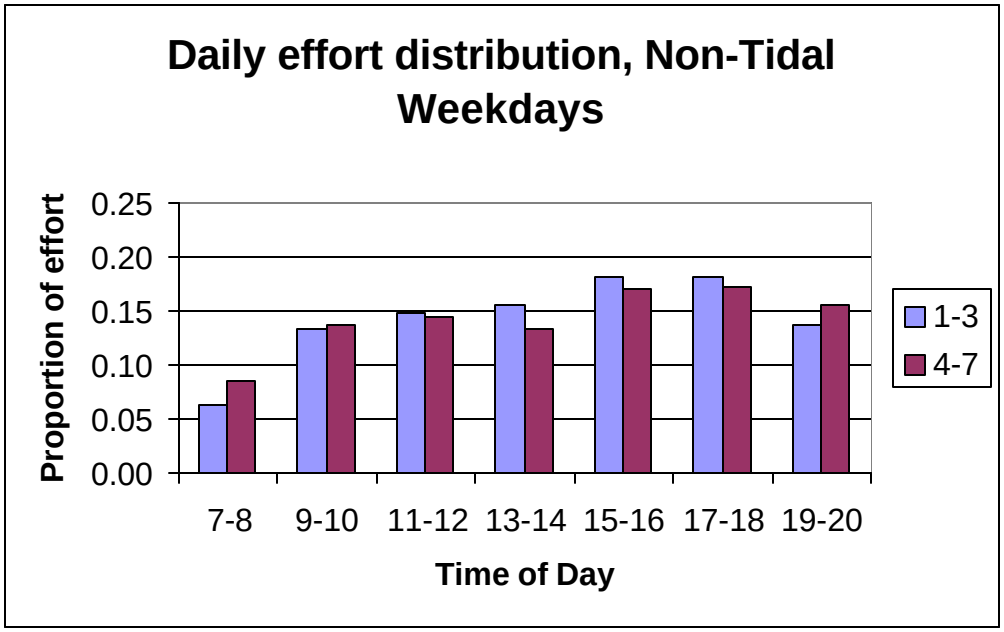

Figure 3-1. Proportion of total daily fishing effort (angler hours) by 2-hour time intervals (military time) in the non-tidal portion of the river during weekdays for the original temporal strata 1-3, and 4-7.

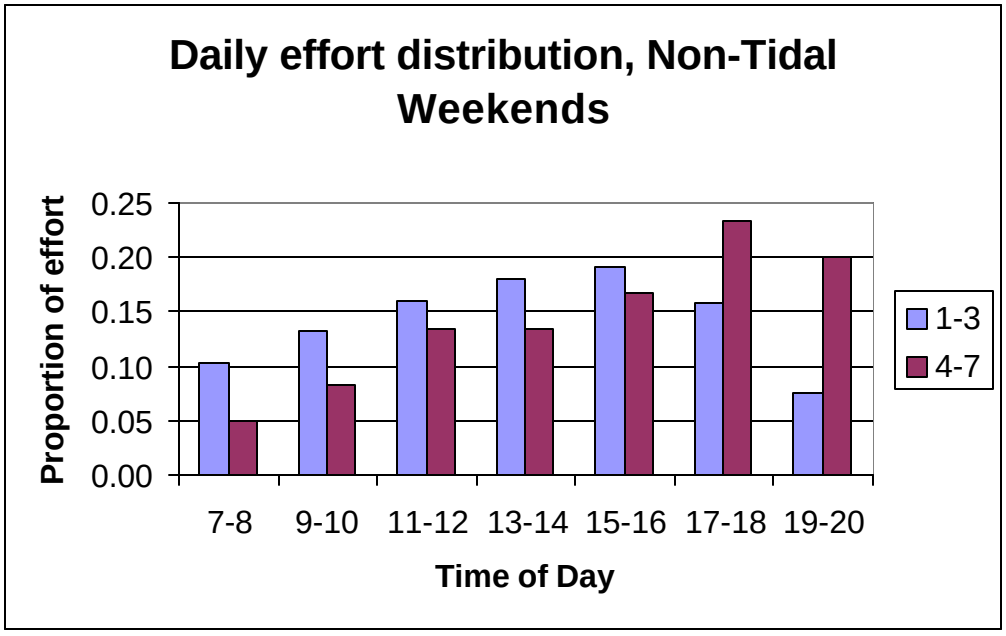

Figure 3-2. Proportion of total daily fishing effort (angler hours) by 2-hour time intervals (military time) in the non-tidal portion of the river during weekends for original temporal strata 1-3, and 4-7.

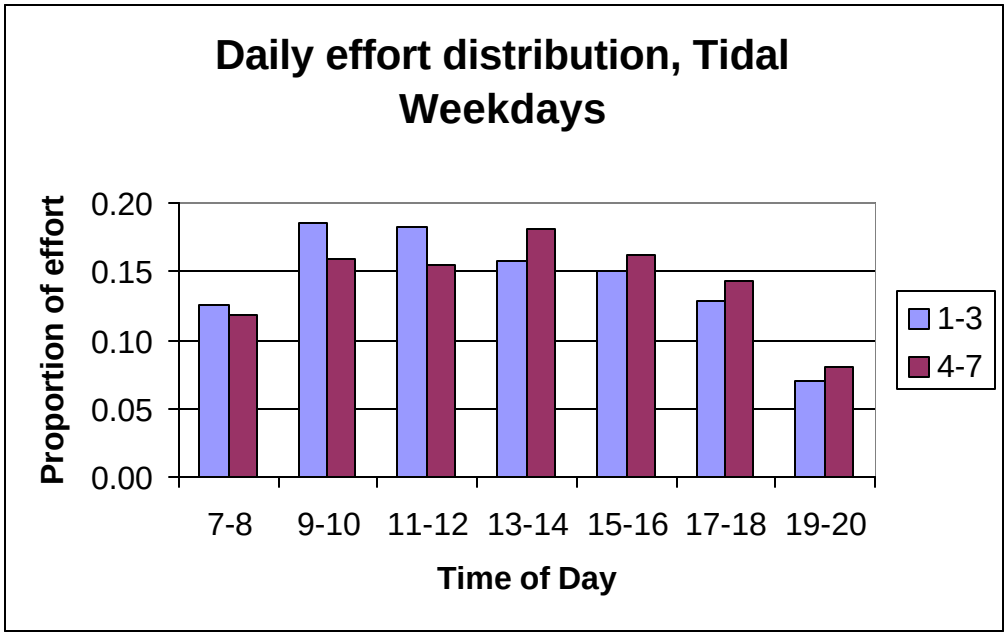

Figure 3-3. Proportion of total daily fishing effort (angler hours) by 2-hour time intervals (military time) in the tidal portion of the river during weekdays for original temporal strata 1-3, and 4-7.

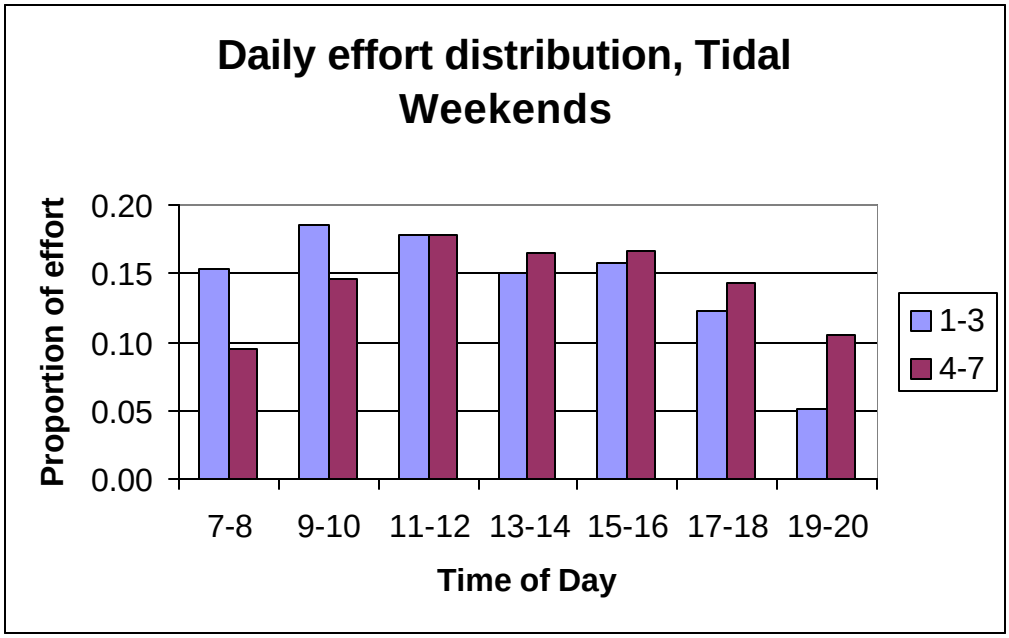

Figure 3-4. Distribution of total daily fishing effort (angler hours) by 2-hour time intervals (military time) in the tidal portion of the river during weekends and holidays for original temporal strata 1-3, and 4-7.

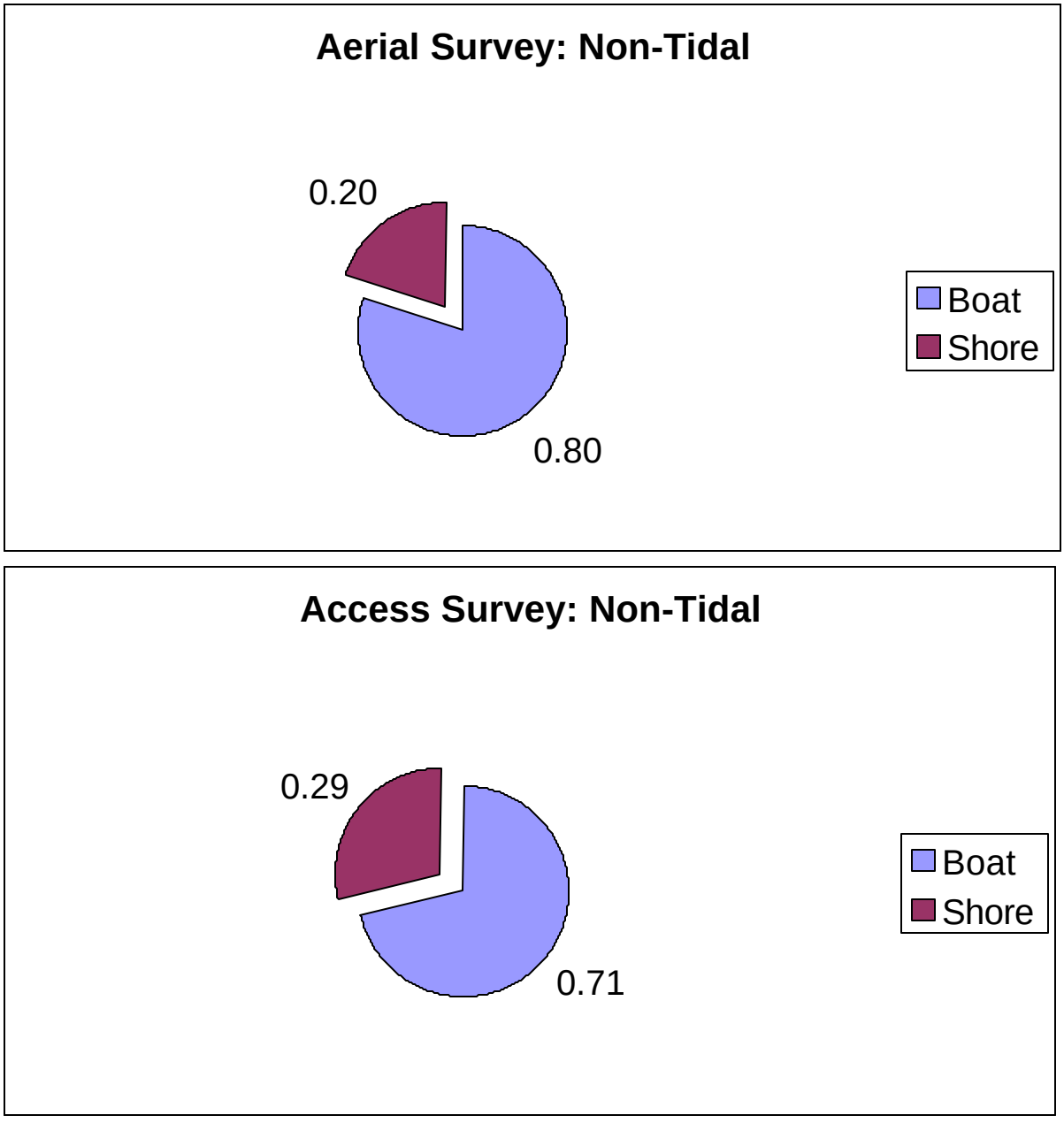

Figure 3-5. Proportion of total fishing effort (angler hours) in the non-tidal portion of the river by fishing mode, based on the aerial survey and the access survey.

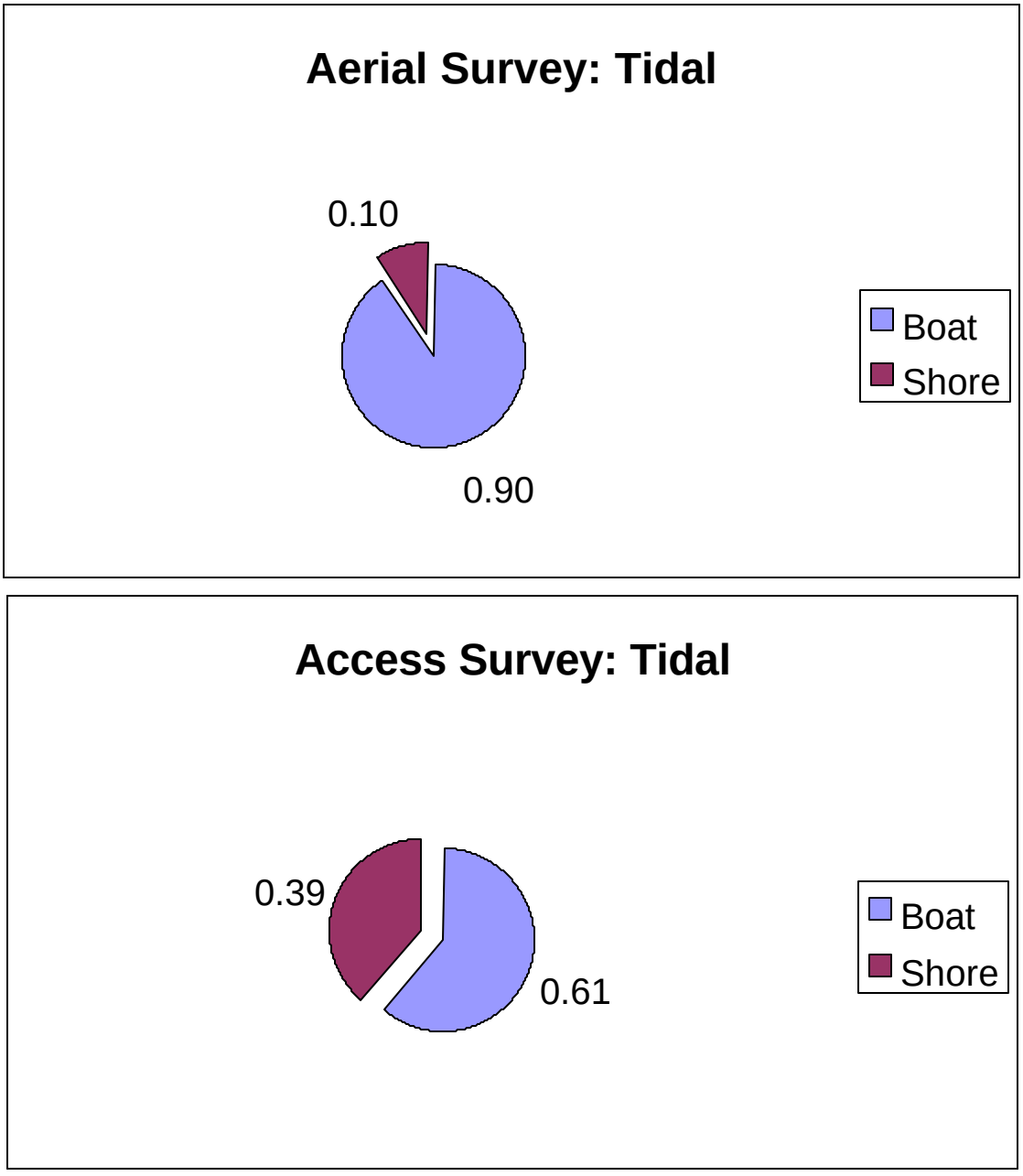

Figure 3-6. Proportion of total effort fishing (angler hours) in the tidal portion of the river by fishing mode, based on the aerial survey and the access survey.

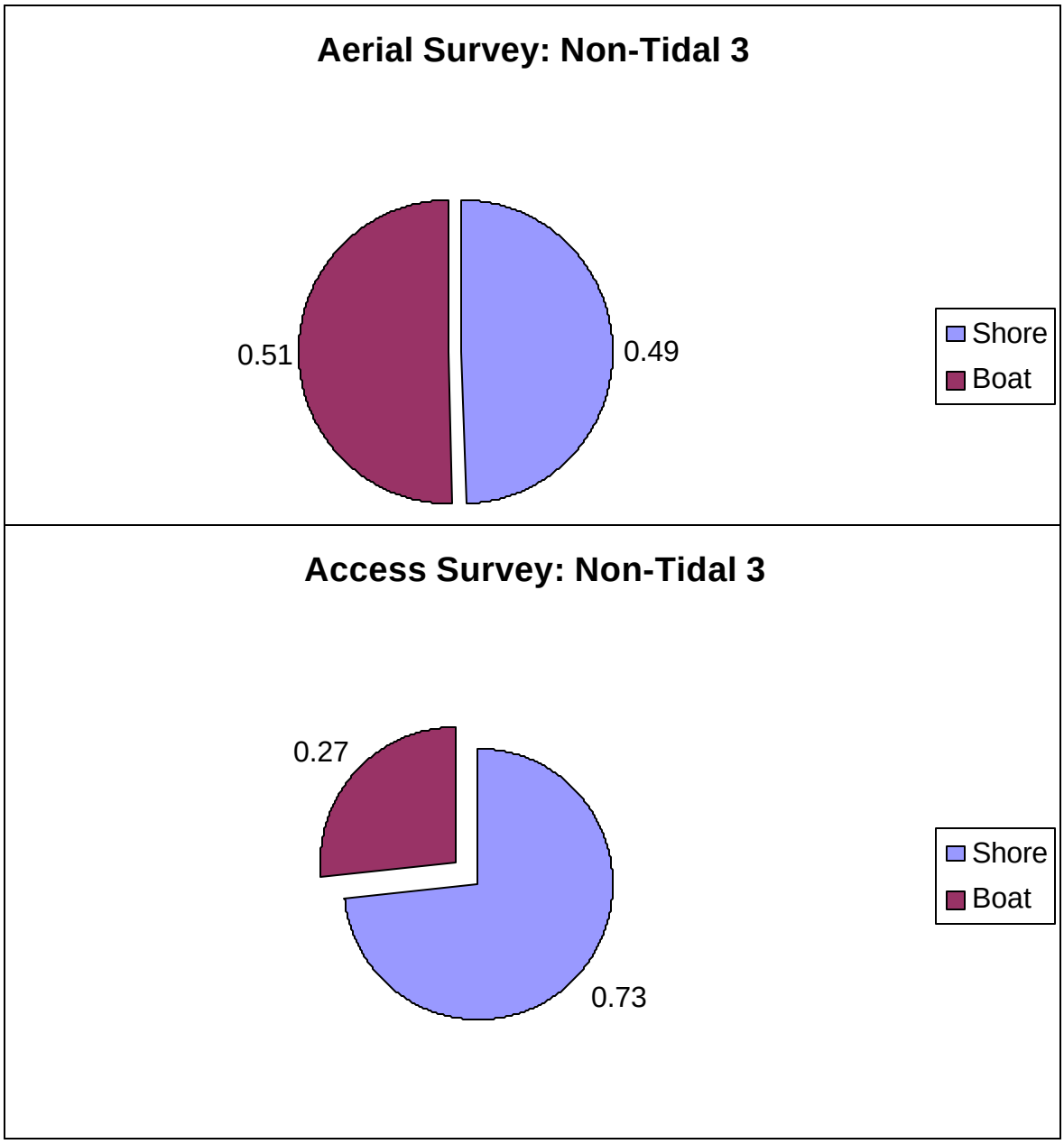

Figure 3-7. Proportion of total effort fishing (angler hours) accounted for by boat anglers in the non-tidal stratum 3, based on the aerial survey and the access survey.

3.1.2 Night Fishing Effort

Based on equations 1.15-1.20 we estimated that the total angler effort at night (9 PM to midnight) for the total sample period was 25,689 hours (RSE=35%) for boat and shore anglers combined (19,595 trips). The total night effort was evenly distributed between the non-tidal river (12,891 hours) and the tidal river (12,798 hours). The fishing effort at night accounts for 4% of the total effort (7 AM to midnight) in the non-tidal River, and 8% in the tidal portion of the river (Figures 3-8 and 3-9; Table 3-7). The ratio of night effort versus PM effort was estimated from interviews collected from 55 primary sampling units (sites/days) with paired PM and nightshifts. The sample sizes precluded a finer geographic or temporal stratification. The pooled monthly strata (March-June; July-October) closely overlap the original strata 1-3, and 4-7.

Table 3-7. Total night (9 PM to midnight) fishing effort (angler hours) for the non-tidal and tidal portions of the river estimated from the aerial survey, along with estimates of precision (relative standard error, RSE). Estimates based on monthly temporal stratification. Boat and shore anglers combined.

Stratum		Night			Fraction of all effort	
Geographic	**Temporal**	**Effort**	**RSE**	**# of Trips**	**Daytime**	**Night**
Non-Tidal	Mar-Jun	6815	0.44	4638	0.96	0.04
	Jul-Oct	6076	0.77	4563	0.94	0.06
	Mar-Oct	12891	0.43	9256	0.96	0.04
Tidal	Mar-Jun	8346	0.88	23112	0.92	0.08
	Jul-Oct	4452	0.20	3263	0.93	0.07
	Mar-Oct	12798	0.58	10996	0.92	0.08
All	Mar-Oct	25689	0.36	19595	0.94	0.06

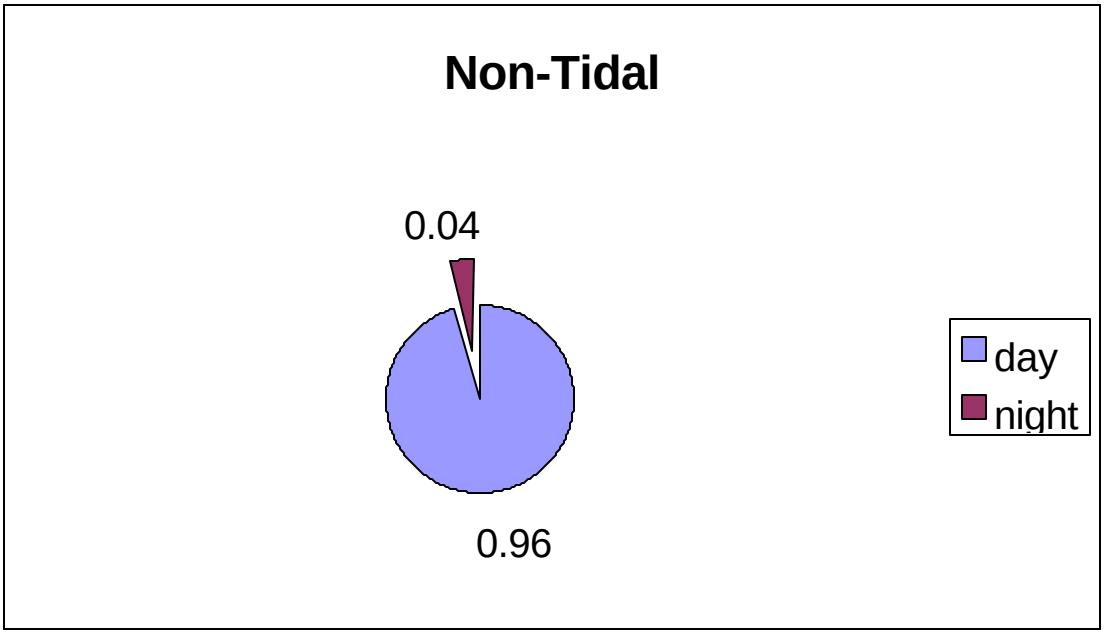

Figure 3-8. The proportion of total angler effort by daytime (7 AM to 9 PM) and night (9 PM to midnight) for the total sample period in the non-tidal portion of the River.

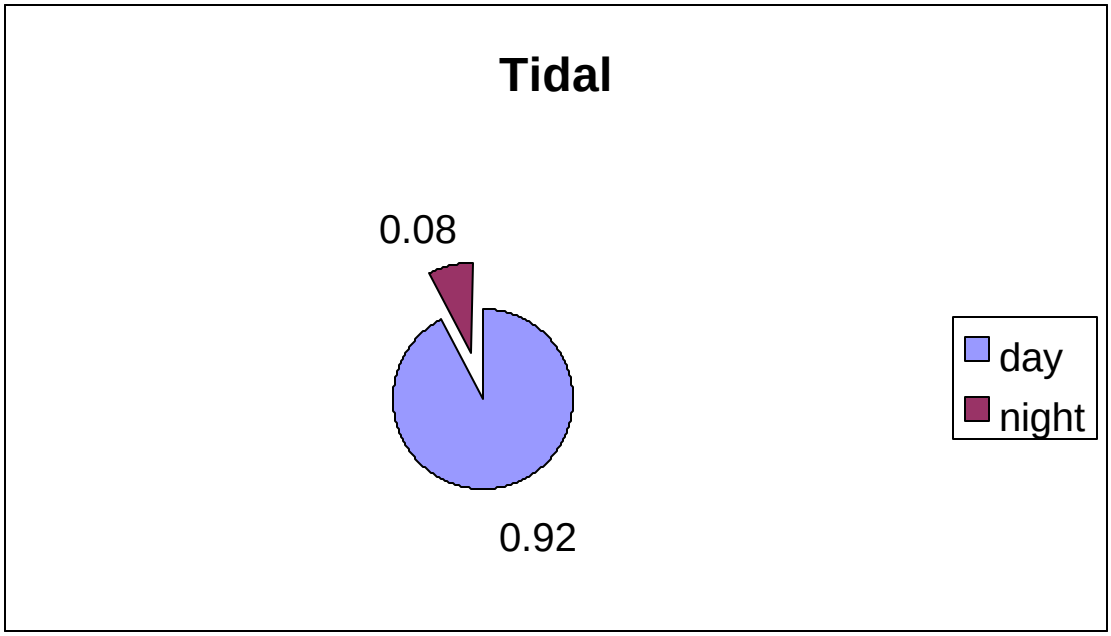

Figure 3-9. The proportion of total angler effort by daytime (7 AM to 9 PM) and night (9 PM to midnight) for the total sample period in the tidal portion of the River.

3.2 ANGLER CATCH AND HARVEST STATISTICS

A total number of 396 daytime PSUs were completed in the access point survey between March 17 and October 31. Data on catch and harvest were collected from 2,357 completed angler trips, averaging 6 interviews per site/day. The species composition of reported catches (by stratum) for all anglers interviewed during daytime (7 AM and 9 PM) are presented in Figures 3-10 to 3-12. The composition of catches reported by anglers interviewed at night (9 PM to midnight) for the tidal and non-tidal portions of the river are presented in Figures 3-13 and 3-14. These catch distributions are not weighted according to the temporal stratification and fishing modes, and thus may not accurately reflect the overall catch composition throughout the study period.

Table 3-8 provides the estimated total angler catch and harvest for the total sample period (March 17 through October) based on the original temporal stratification for the four key species as well as for the two species with highest catches. Table 3-9 provides the same catch and harvest statistics based on the monthly post-strata. These estimates represent boat and shore fishing combined. Estimates of catch and harvest for the total sample period are provided for the non-tidal and tidal portions of the Delaware River, and for the total study area.

No meaningful separate estimate for the East Branch could be provided because only seven anglers were interviewed in this section throughout the study period, and they reported zero catches. Only two striped bass were recorded from interviews in the entire non-tidal stratum 3, and no catches of American shad or river herring were reported by anglers interviewed in this portion of the river.

Based on the original stratification, the total catch of American shad was estimated at 35,281 fish (Table 3-8), with a relative standard error of (RSE) of 22%. The monthly post-stratification resulted in a slightly higher (but not significantly) estimate of total catch (38,363 fish), with the same precision (RSE= 22%) (Table 3-9). Estimates of catch and harvest for American shad and striped bass by temporal strata (original and monthly) are in tables 3-10 and 3-11. On average, the anglers caught 0.25 shad per hour in the non-tidal River from March through May. The catch in June was negligible, and none were caught after June (Table 3-10). In the Estuary, the catch rate was 0.02 shad per hour during March/April, while none were caught after April. Overall, only 19% of the American shad caught were kept (harvested). An estimated 49% of the harvested shad were females. In all, over 97% of American shad were caught in the non-tidal River. Catches by boat anglers represented 85% of the total catch of American shad in the non-tidal portion, and 97% in the tidal (Figures 3-15 and 16).

Based on the original stratification, an estimated 36,328 striped bass (RSE=22%) were caught during the survey period, with anglers fishing in the non-tidal portion of the river accounting for 45% of the total catch (Table 3-8). The monthly post-stratification resulted in a similar (but not significantly different) total catch estimate of 37,315 fish, with RSE = 20% (Table 3-9). The catch rate for striped bass was 0.06 fish/hour in the non-tidal River, and 0.17 in

the Estuary. Boat anglers accounted for 80% of the catch in the non-tidal river, and 83% in the tidal (Figures 3-17 and 3-18). In all, about 1% of the striped bass caught were harvested (Table 3-8).

An estimated 7,553 river herrings were caught during the entire survey period (RSE=52%), and 4,916 fish (65%) were kept (harvested). This survey indicates marginal catches of hickory shad (43 fish) and zero harvest (Table 3-8).

Smallmouth bass was the most frequently caught species, with an estimated total catch of 98,393 fish (RSE=12%) during daytime (Table 3-8). As expected, most of this catch (99%) was from the non-tidal river, and the fishery was almost exclusively catch-and-release (~1% were harvested). This species was regularly caught by angler throughout the survey period, and thus the total catch was precisely estimated. The fishery for channel catfish also was significant, with and estimated total catch of 58,703 fish (RSE=15%) throughout the river during the survey period, with 79% of the fish being caught in the Tidal River (Table 3-8). The harvest rate for this species was about 16%. Again, the total catch was precisely estimated because the catches were widely distributed both in time and space.

Table 3-12 provides separate catch and harvest estimates for selected species in non-tidal stratum 2. Smallmouth bass was the most frequently caught species in this section of the river, with an estimated total catch of 14,162 fish (RSE=32%). An estimated total number of 9,365 (RSE=39%) American shad were caught in stratum 2. Table 3-13 provides separate estimates of catch and harvest for non-tidal stratum 3 (including the East Branch) for the six most frequently caught species. Each of these species represented > 5% of the total number fish caught by the anglers interviewed in this stratum. Smallmouth bass represented the most significant catch, with an estimated 7,708 fish caught throughout the study period (RSE=18%). This fishery was almost exclusively catch and release (1% were kept). An estimated 2,230 rainbow trout (RSE=20%) were caught, and 10% were harvested. A large portion of walleyes was harvested (74%), out of a total catch of 1,813 fish (RSE=69%). No catch was recorded for the seven anglers interviewed in the East Branch.

Table 3-14 provides estimates of catch and harvest for the most frequently caught species at night, for the non-tidal and tidal portion of the river. Overall, the night catch of striped bass was 12% of the daytime catch. No American shad or river herring were caught by anglers interviewed after 9 PM.

Comprehensive results within and across spatial and temporal strata for these and other species targeted by anglers are provided in the appendices (Volume II). A list of all species recorded in the survey is in Appendix C, along with total catch by species reported by all the anglers intercepted during the total study period. Estimates of catch, harvest, catch-rates, and harvest-rates for American shad, striped bass, river herring, hickory shad and other species with significant catches are provided by spatial and temporal strata (original and monthly), and by fishing modes in Appendix D. Separate estimates of catch and harvest for strata 2 and 3 are also

provided in Appendix D. The estimates for strata 2 and 3 were provided for pooled temporal strata (usually 8-week periods) because the limited number of interviews for these small sections of the river precluded estimates for shorter time intervals.

Of all of anglers interviewed, 69% targeted specific species. The composition of target species varied with temporal and geographic stratum. For the non-tidal portion of the river, American shad was most frequently targeted from March to June (48% of targeted trips), followed by smallmouth bass (17%) (Figure 3-19). From July to October, the majority of anglers in the non-tidal portion of the river (63%) targeted smallmouth bass (Figure 3-20). In the tidal section of the river, striped bass (38%) followed by river herring (22%) were the most frequently targeted species from March to June (Figure 3-21). From July to October, channel catfish (43%) and striped bass (25%) were the most frequently targeted species in the Tidal portion of the river (Figure 3-22). The size frequency of all American shad (by sex) and striped bass measured by creel clerks throughout the study period are in Figures 3-23 and 3-24.

A majority of the anglers interviewed in this study were residents of Pennsylvania, but some anglers came from as far away as California and England. In the non-tidal section of the river, 64% of the anglers came from Pennsylvania, 28% from New Jersey, and 8% from New York (Figure 3-25). In the tidal section of the river, 71% of the anglers were from Pennsylvania, 29% from New Jersey, and 4% from Delaware (Figure 3-26). Within the state of Pennsylvania, the majority of anglers were from the following counties: Bucks (25%), Philadelphia (23%), and Northampton (18%) (Figure 3-27). A majority of all anglers interviewed were males (92%) (Figure 3-28). The largest part of anglers were adult (79%), while young and senior anglers accounted for only 13% and 8%, respectively (Figure 3-29). Volume II contains estimates of targeted effort and catch and harvest within and across spatial and temporal strata for these and other species (Appendix D). The questionnaire used in the access survey, and the field data collection from for the aerial survey is in Appendix E.

Table 3-8. Total angler catch and harvest (daytime fishing) for the four key species and two species most frequently caught throughout the study period from March 17 to October 31, based on the original temporal strata. Boat and shore fishing modes are combined. [1] 49 % were females

Species	Stratum	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
American shad	Non-Tidal	34091	0.23	6312	0.44	0.19
	Tidal	1190	0.69	315	0.64	0.26
	All	35281	0.22	6627[1]	0.42	0.19
Striped bass	Non-Tidal	16182	0.26	294	0.66	0.02
	Tidal	20146	0.33	244	1.05	0.01
	All	36328	0.22	538	0.60	0.01
River herring	Non-Tidal	5142	0.72	3452	0.84	0.67
	Tidal	2411	0.56	1465	0.89	0.61
	All	7553	0.52	4916	0.65	0.65
Hickory shad	Non-Tidal	43	1.08	0		0
	Tidal	0		0		
	All	43	1.08	0		0
Smallmouth bass	Non-Tidal	93936	0.13	1428	0.41	0.02
	Tidal	4457	0.59	0		0.00
	All	98393	0.12	1428	0.41	0.01
Channel catfish	Non-Tidal	10151	0.22	1739	0.51	0.17
	Tidal	48552	0.18	7444	0.43	0.15
	All	58703	0.15	9183	0.36	0.16

Table 3-9. Total angler catch and harvest (daytime fishing) for the four key species and two species most frequently caught throughout the study period from March 17 to October 31, based on the monthly post- strata. Boat and shore fishing modes are combined. [1] 49% were females

Species	Stratum	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
American shad	Non-Tidal	37517	0.23	4820	0.31	0.13
	Tidal	846	0.76	280	0.84	0.33
	All	38363	0.22	5100[1]	0.29	0.13
Striped bass	Non-Tidal	18907	0.24	307	1.16	0.02
	Tidal	18408	0.31	244	1.05	0.01
	All	37315	0.20	551	0.79	0.01
River herring	Non-Tidal	6391	0.61	3688	0.74	0.58
	Tidal	2328	0.71	1336	1.13	0.57
	All	8719	0.48	5025	0.62	0.58
Hickory shad	Non-Tidal	103	1.13	0		0
	Tidal	0		0		
	All	103	1.13	0		0
Smallmouth bass	Non-Tidal	100564	0.12	1392	0.44	0.01
	Tidal	5236	0.55	0		0.00
	All	105800	0.12	1392	0.44	0.01
Channel catfish	Non-Tidal	11848	0.24	2337	0.61	0.20
	Tidal	53907	0.21	7377	0.43	0.14
	All	65756	0.18	9714	0.36	0.15

Table 3-10a. Total angler catch and harvest (daytime fishing) of American shad by original temporal strata. Boat and shore fishing modes are combined. [1]50% were females; [2] 49% were females

Species	Temporal Strata	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
American shad	1	19324	0.37	4581[1]	0.59	0.24
	2	15884	0.23	2046[2]	0.31	0.13
	3	73	0.82	0		0.00
	4	0		0		
	5	0		0		
	6	0		0		
	7	0		0		

Table 3-10b. Total angler catch and harvest (daytime fishing) of American shad by monthly post-strata. Boat and shore fishing modes are combined. [1]50% were females; [2] 49% were females

Species	Month	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
American shad	Mar/Apr	26576	0.27	4100[1]	0.34	0.15
	May	11675	0.40	1000[2]	0.53	0.09
	Jun	113	0.72	0		0.00
	Jul	0		0		
	Aug	0		0		
	Sept	0		0		
	Oct	0		0		

Table 3-11a. Total angler catch and harvest (daytime fishing) of striped bass by original temporal strata. Boat and shore fishing modes are combined.

Species	Temporal Strata	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
Striped bass	1	7715	0.70	0		0.00
	2	8766	0.38	63	0.12	0.01
	3	7905	0.38	0		0.00
	4	4629	0.45	0		0.00
	5	5045	0.56	0		0.00
	6	1385	0.29	88	0.16	0.06
	7	882	0.40	387	0.72	0.44

Table 3-11b. Total angler catch and harvest (daytime fishing) of striped bass by monthly post-strata. Boat and shore fishing modes are combined.

Species	Month	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
Striped bass	Mar/Apr	5630	0.65	0		0.00
	May	6079	0.50	76	0.61	0.01
	Jun	10731	0.35	0		0.00
	Jul	7562	0.39	0		0.00
	Aug	5045	0.56	0		0.00
	Sept	1385	0.29	88	1.25	0.06
	Oct	882	0.53	387	1.09	0.44

Table 3-12. Total angler catch and harvest (daytime fishing) for the non-tidal stratum 2 for selected species throughout the study period from March 17 to October 31, based on the original temporal stratification.

Species	Mode	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
American shad	Boat	8211	0.43	719	0.55	0.09
	Shore	1154	0.82	159	0.84	0.14
	All	9365	0.39	879	0.47	0.09
Striped bass	Boat	189	0.75	0		0.00
	Shore	56	0.80	0		0.00
	All	245	0.61	0		0.00
Smallmouth bass	Boat	11629	0.29	169	0.46	0.01
	Shore	2533	1.17	242	0.37	0.10
	All	14162	0.32	411	0.29	0.03
Rock bass	Boat	2241	0.84	120	0.93	0.05
	Shore	347	0.37	208	0.39	0.60
	All	2589	0.73	328	0.42	0.13

Table 3-13. Total angler catch and harvest (daytime fishing) for the non-tidal stratum 3 for the six species with highest catch throughout the study period from March 17 to October 31, based on the original temporal stratification. No catches of any species were reported in the East Branch, from Hancock, NY, to Downsville, NY.

Species	Mode	Catch		Harvest		Ratio
		# Fish	RSE	# Fish	RSE	Harvest/Catch
Smallmouth bass	Boat	2324	0.43	51	1.20	0.02
	Shore	5384	0.26	0		0
	All	7708	0.18	51	1.20	0.01
Rainbow trout	Boat	1503	0.21	216	1.26	0.14
	Shore	726	0.42	0		0
	All	2230	0.20	216	1.26	0.10
Walleye	Boat	1752	0.73	1294	0.56	0.75
	Shore	88	1.14	44	1.14	0.50
	All	1813	0.69	1337	0.54	0.74
Fallfish	Boat	1074	0.76	0		0
	Shore	263	0.71	0		0
	All	1337	0.63	0		0
Brown trout	Boat	51	0.65	0		0
	Shore	430	0.55	0		0
	All	481	0.55	0		0

Table 3-14. Total angler catch and harvest during night (9 PM to midnight) for the four species with highest catch throughout the study period from March 17 to October 31. Boat and shore anglers combined.

Species	Stratum	Catch			Harvest			Ratio Harvest/Catch
		# Fish	RSE	Rate	# Fish	RSE	Rate	
Striped bass	Non-Tidal	0		0.3480	0		0.0000	
	Tidal	4454	0.69	0.0000	0		0.0000	0.00
	All	4454	0.69	0.1734	0		0.0000	0.00
Channel catfish	Non-Tidal	1605	0.56	0.1810	344	0.83	0.0557	0.21
	Tidal	2316	0.98	0.1245	713	1.31	0.0267	0.31
	All	3921	0.62	0.1526	1057	0.92	0.0411	0.27
Eel	Non-Tidal	2522	0.72	0.0278	1376	1.12	0.0000	0.55
	Tidal	356	1.07	0.1957	0		0.1067	0.00
	All	2879	0.64	0.1121	1376	1.12	0.0536	0.48
Small-mouth bass	Non-Tidal	1147	0.74	0.0000	0		0.0000	0.00
	Tidal	0		0.0889	0		0.0000	
	All	1147	0.74	0.0446	0		0.0000	0.00

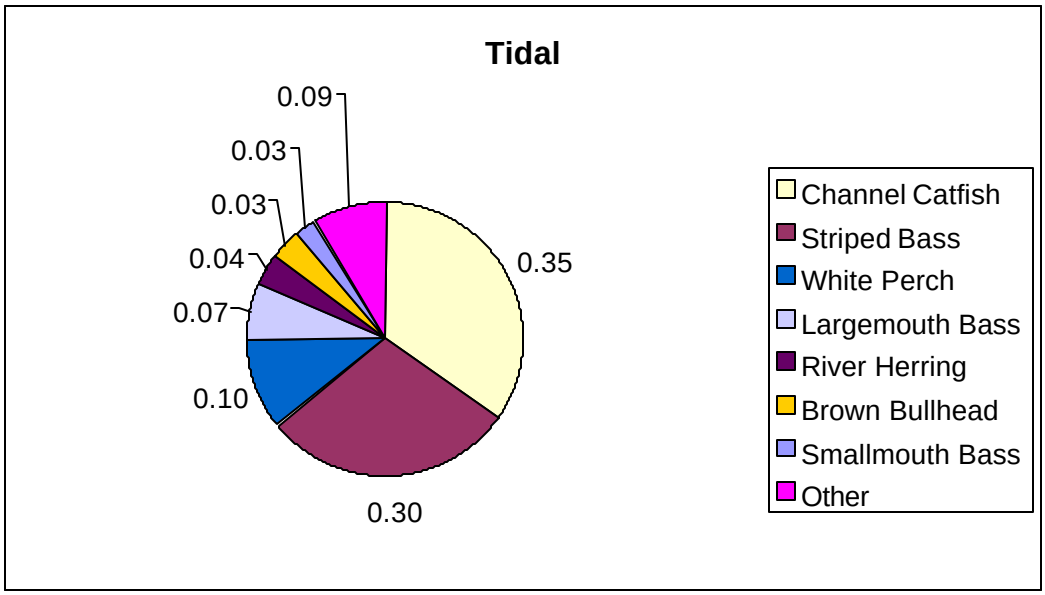

Figure 3-10. The species composition of catches (proportions) reported by anglers interviewed in the tidal portion of the river throughout the study period. Boat and shore anglers combined.

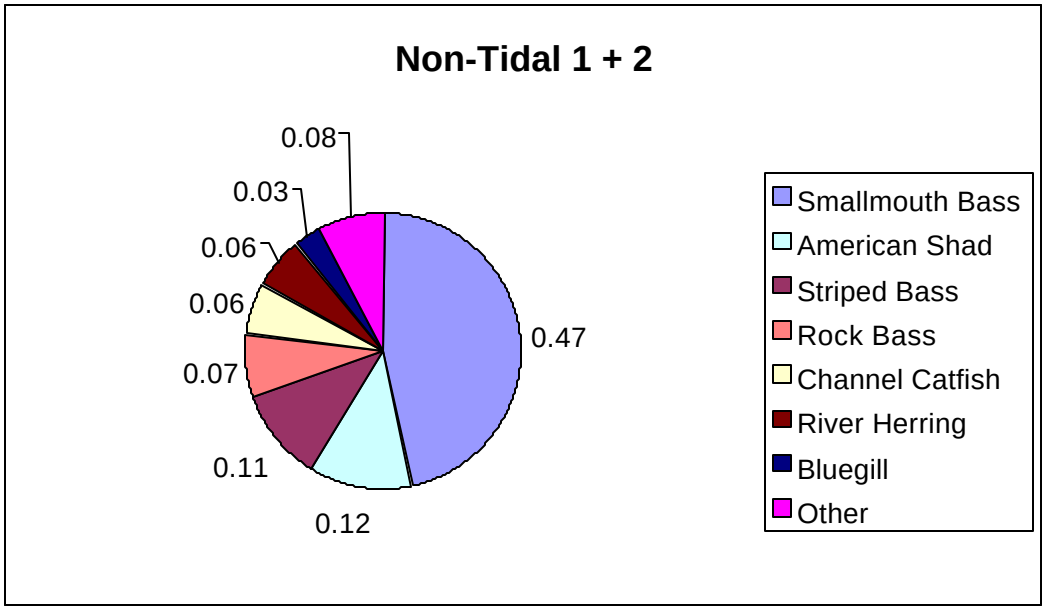

Figure 3-11. The species composition of catches (proportions) reported by anglers interviewed in the non-tidal portion of the river (Strata 1 and 2) throughout the study period. Boat and shore anglers combined. It is likely that some bluegill was misidentified by anglers, and a large portion of the reported catch may represent redbreast sunfish.

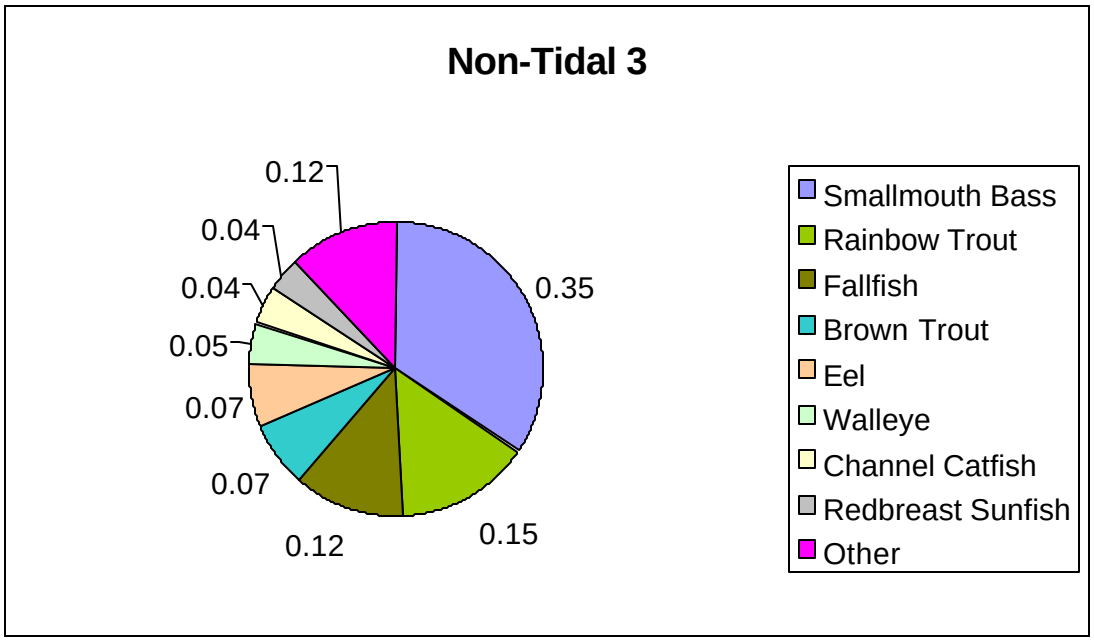

Figure 3-12. The species composition of catches (proportions) reported by anglers interviewed in the non-tidal stratum 3 throughout the study period. Boat and shore anglers combined.

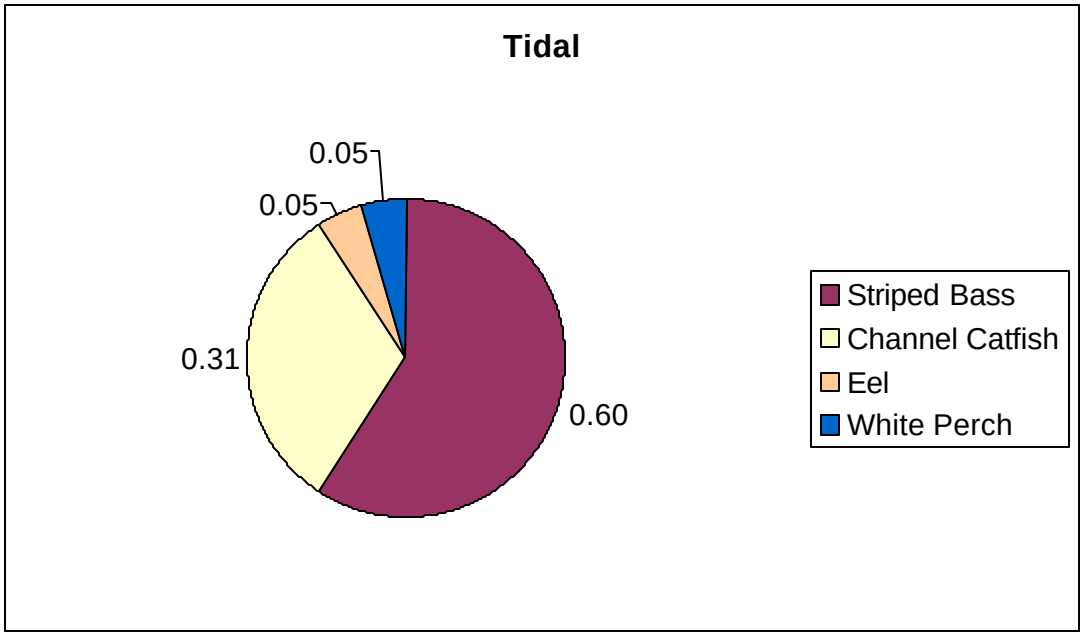

Figure 3-13. The species composition of catches (proportions) reported by anglers interviewed at night (9 PM to midnight) in the tidal portion of the river throughout the study period. Boat and shore anglers combined.

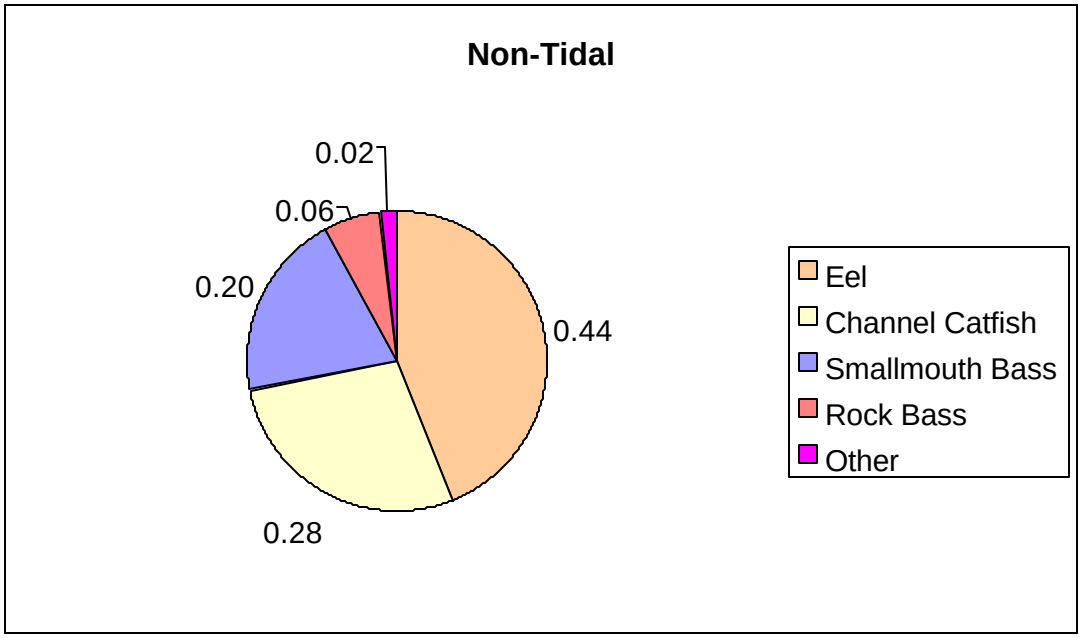

Figure 3-14. The species composition of catches (proportions) reported by anglers interviewed at night (9 PM to midnight) in the non-tidal portion of the river throughout the study period. Boat and shore anglers combined.

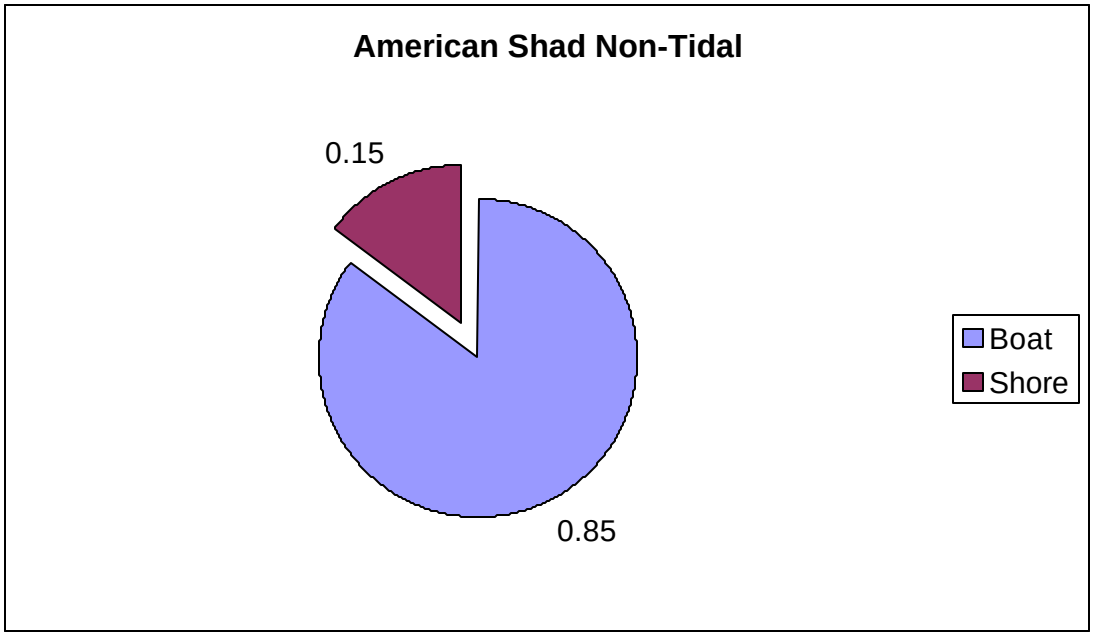

Figure 3-15. Proportion of the total catch of American shad by fishing mode in the non-tidal portion of the river

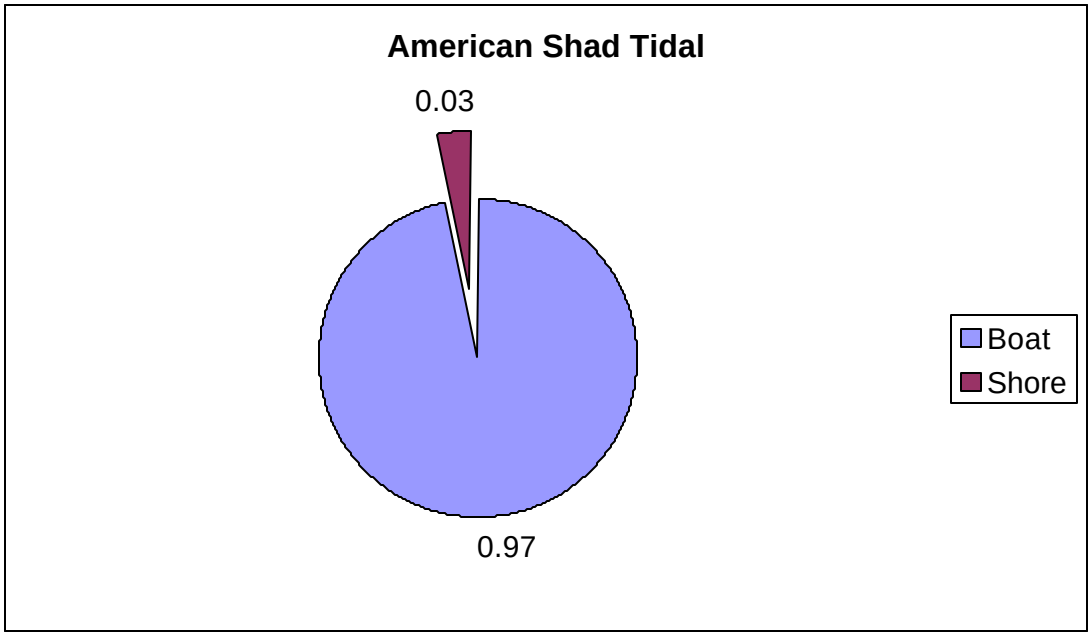

Figure 3-16. Proportion of the total catch of American shad by fishing mode in the tidal portion of the river

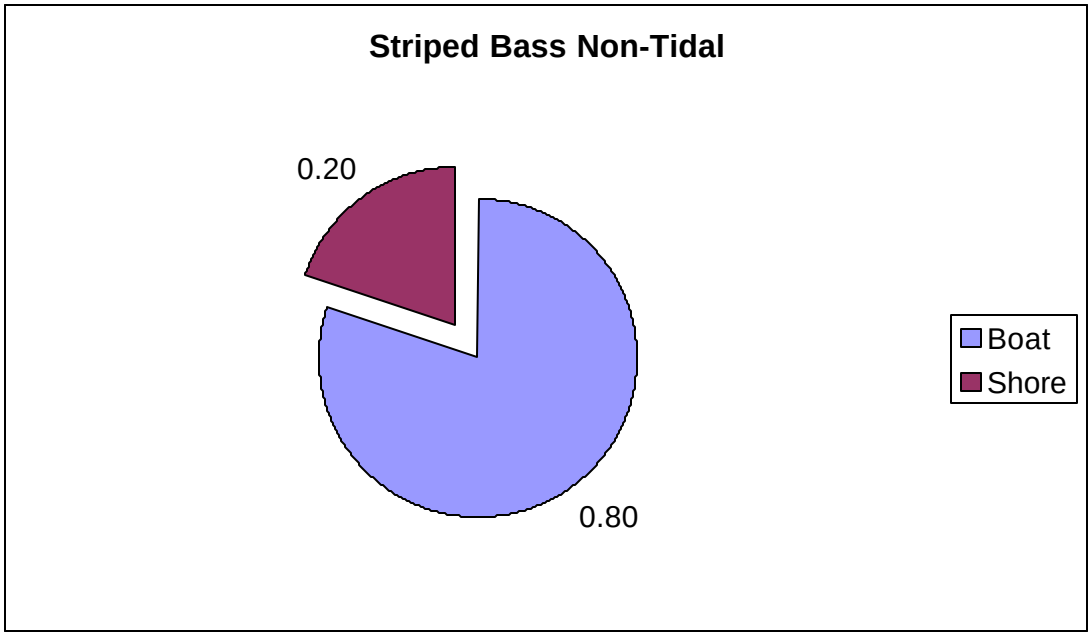

Figure 3-17. Proportion of the total catch of striped bass by fishing mode in the non-tidal portion of the river

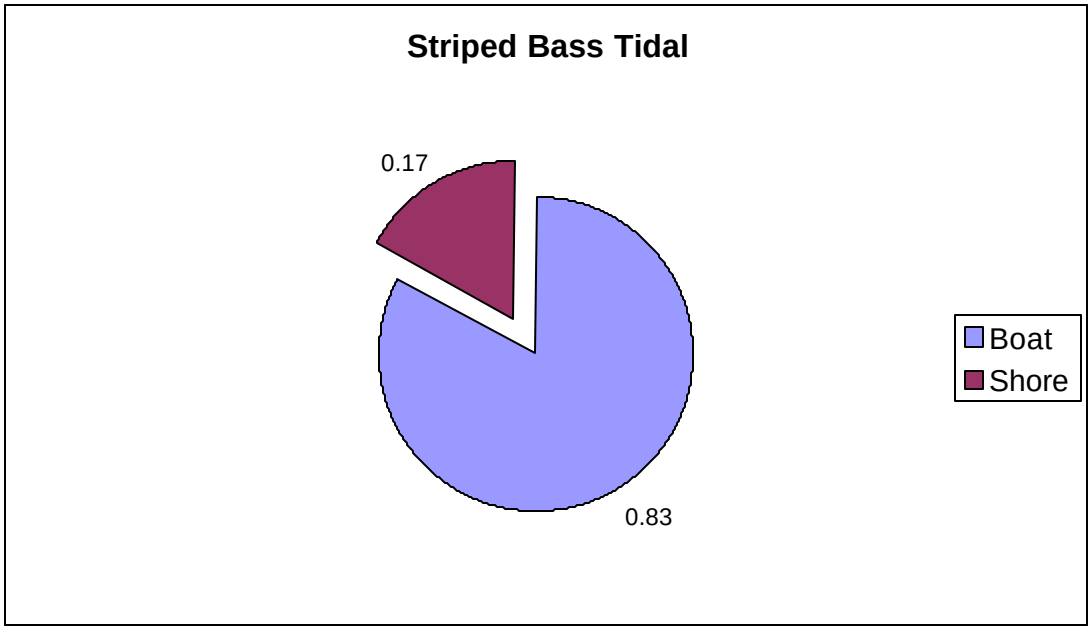

Figure 3-18. Proportion of the total catch of striped bass by fishing mode in the tidal portion of the river

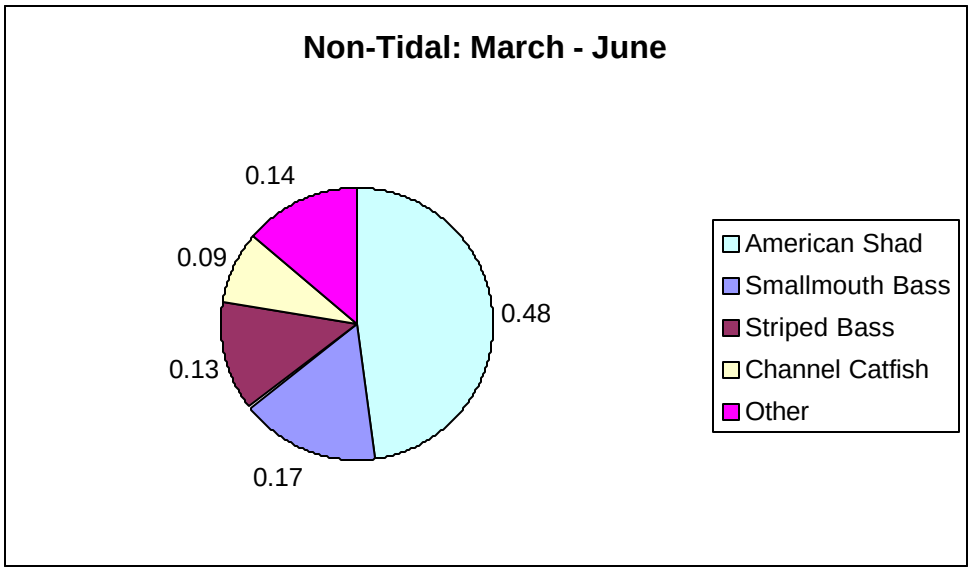

Figure 3-19. Proportion of targeted species within anglers that target specific species for the non-tidal portion of the river from March to June.

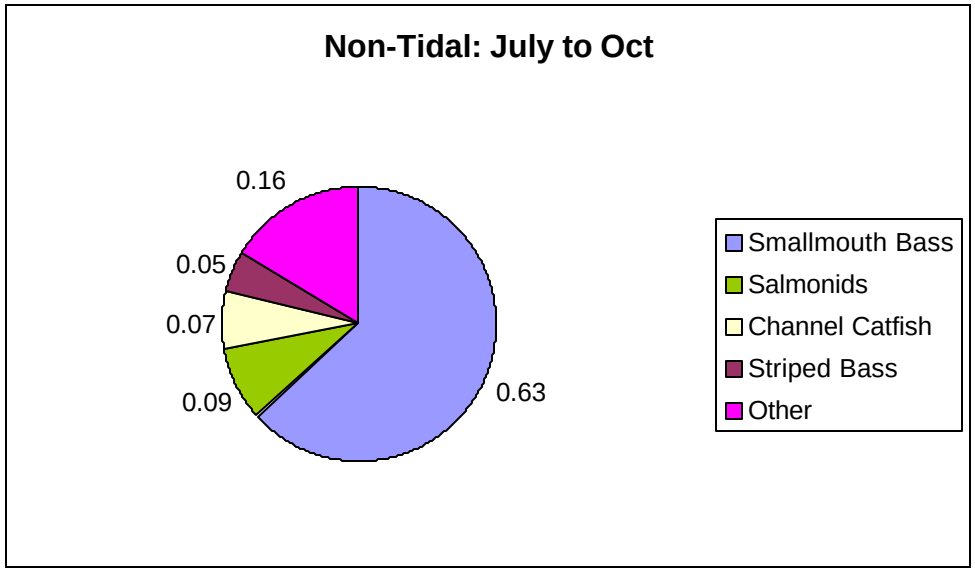

Figure 3-20. Proportion of targeted species within anglers that target specific species for the non-tidal portion of the river from July to October.

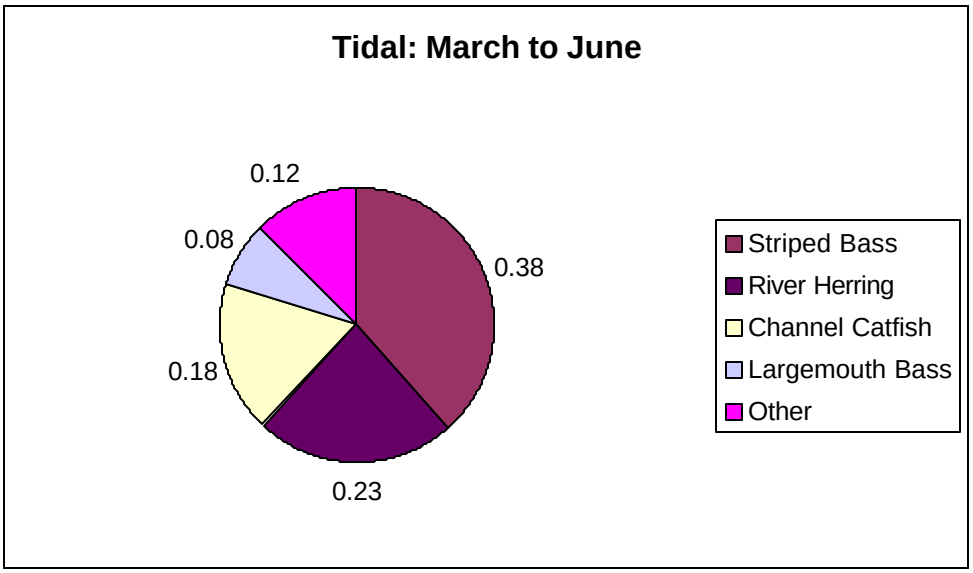

Figure 3-21. Proportion of targeted species within anglers that target specific species for the tidal portion of the river from March to June.

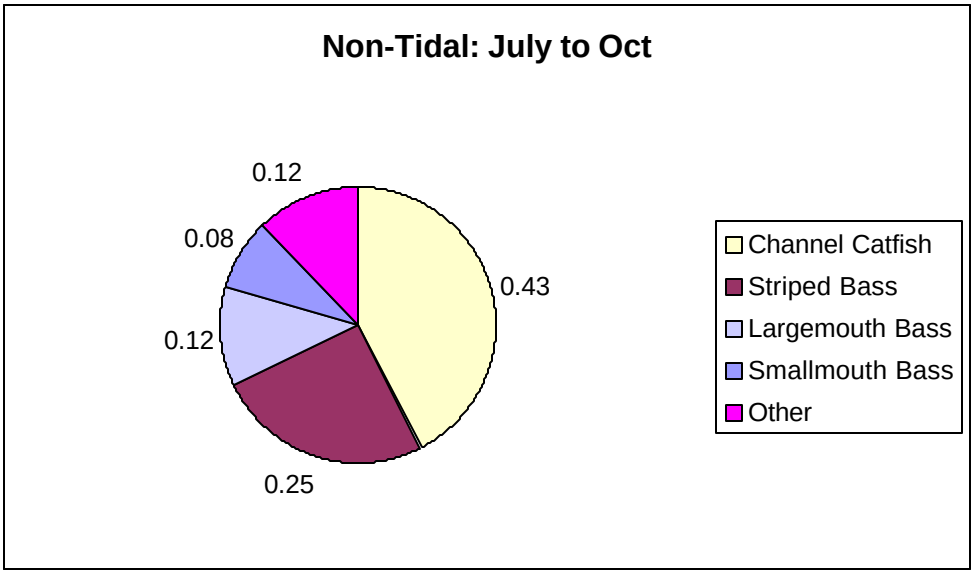

Figure 3-22. Proportion of targeted species within anglers that target specific species for the tidal portion of the river from July to October.

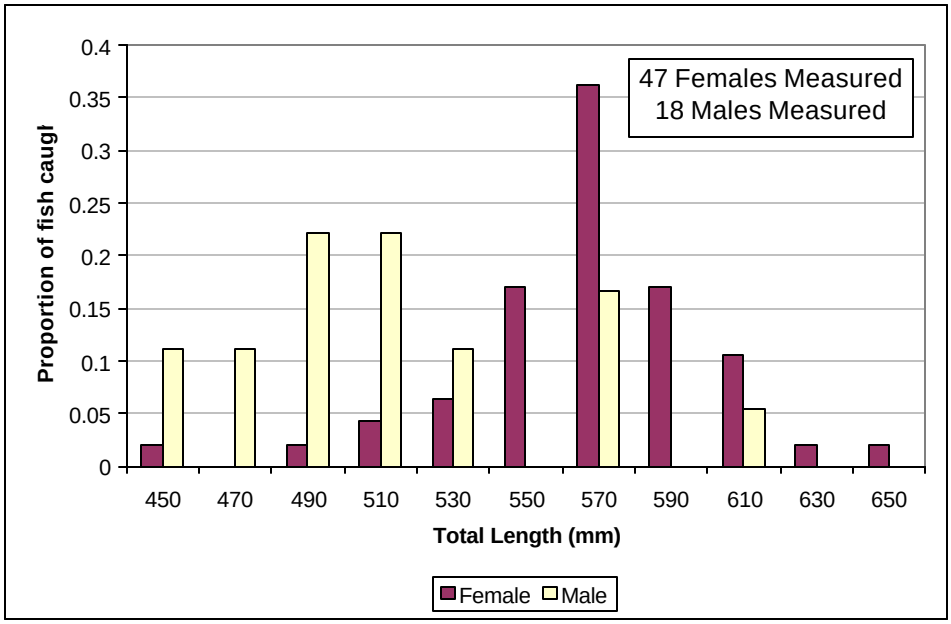

Figure 3-23. Size distribution (total length by sex) of all harvested American shad measured by creel clerks throughout the study period.

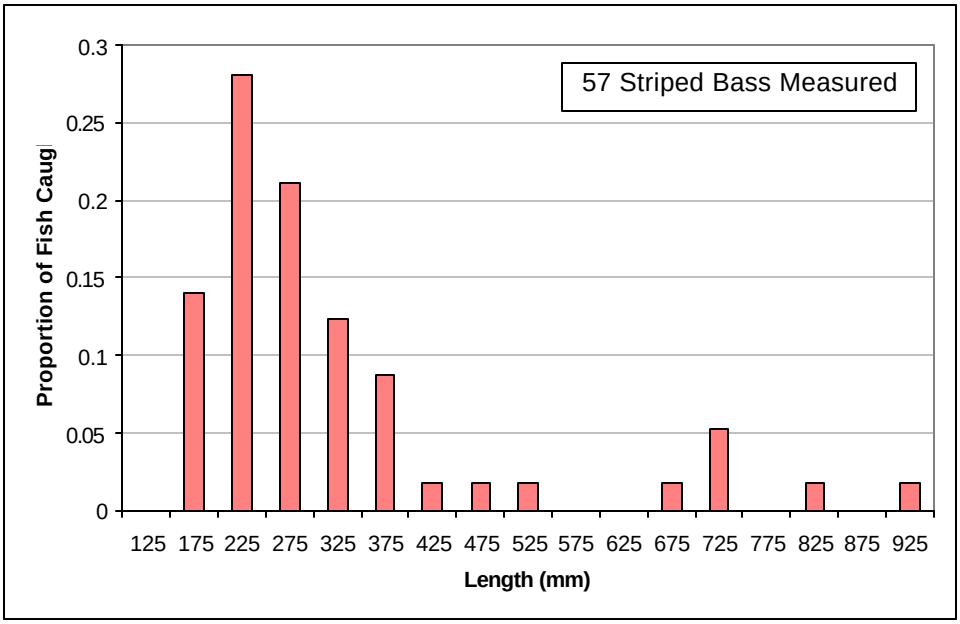

Figure 3-24. Size distribution of all striped bass measured by creel clerks throughout the study period. Specimens below minimum size limits were generally released.

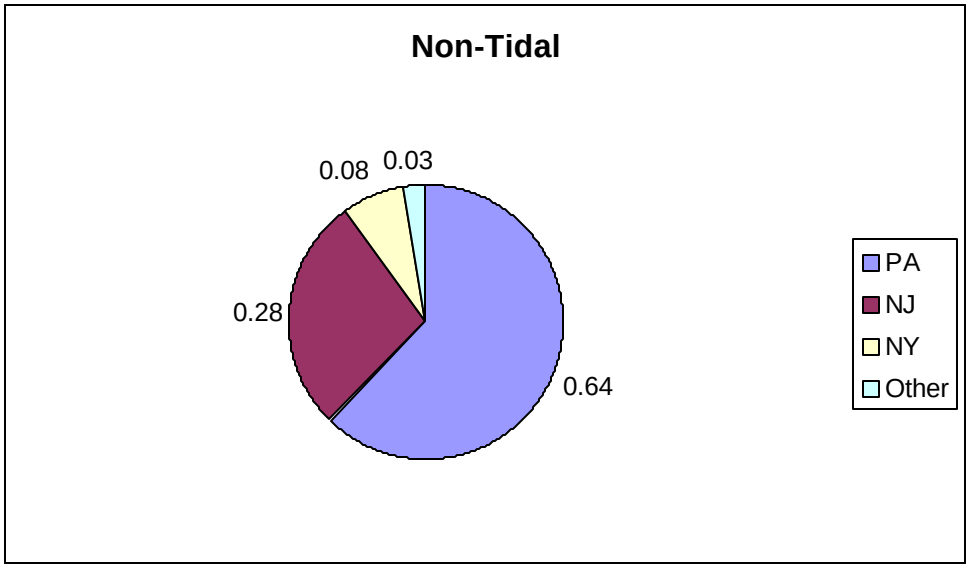

Figure 3-25. Demographic composition of state residency for anglers interviewed in the non-tidal portion of the river.

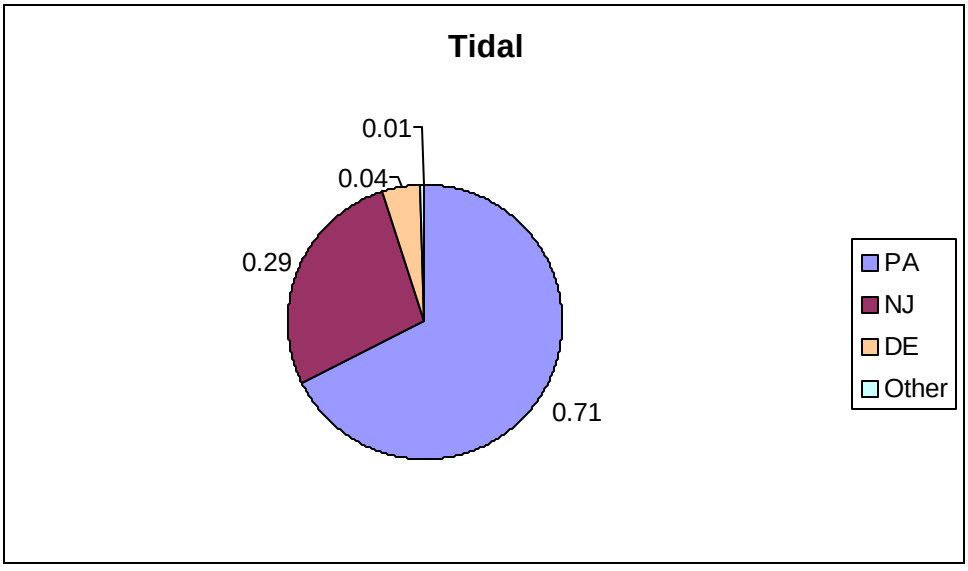

Figure 3-26. Demographic composition of state residency for anglers interviewed in the tidal portion of the river.

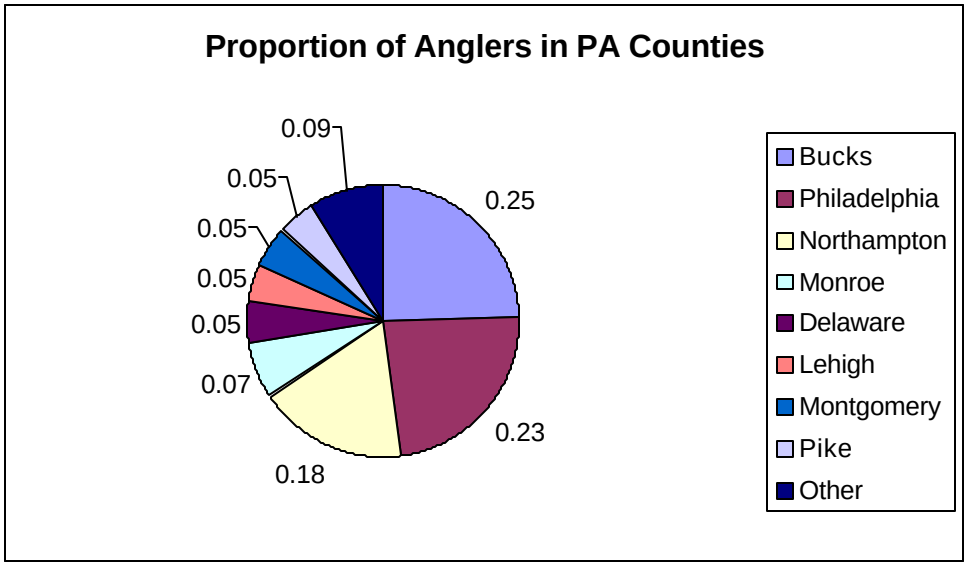

Figure 3-27. Demographic composition of Pennsylvania county residency for all anglers interviewed.

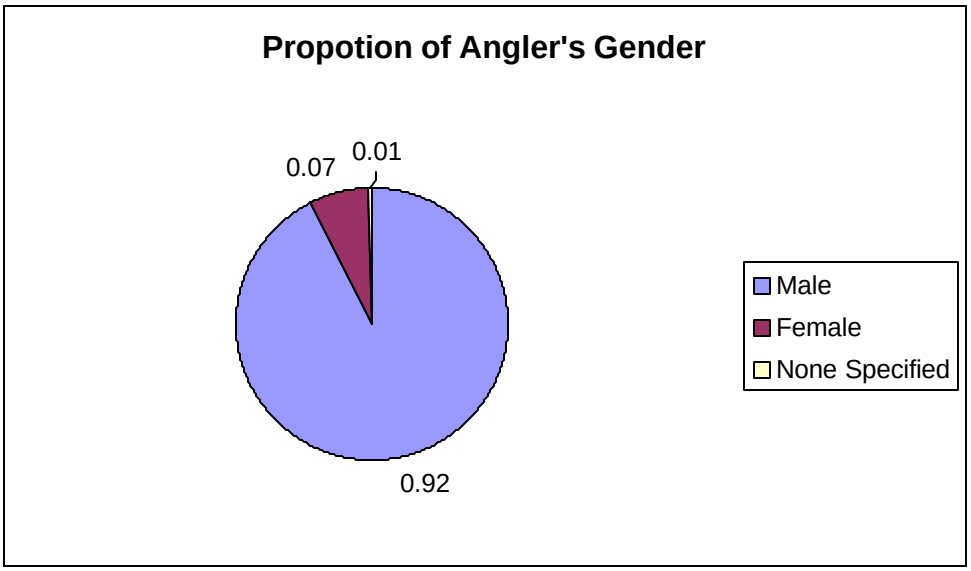

Figure 3-28. Demographic composition of gender for all anglers interviewed.

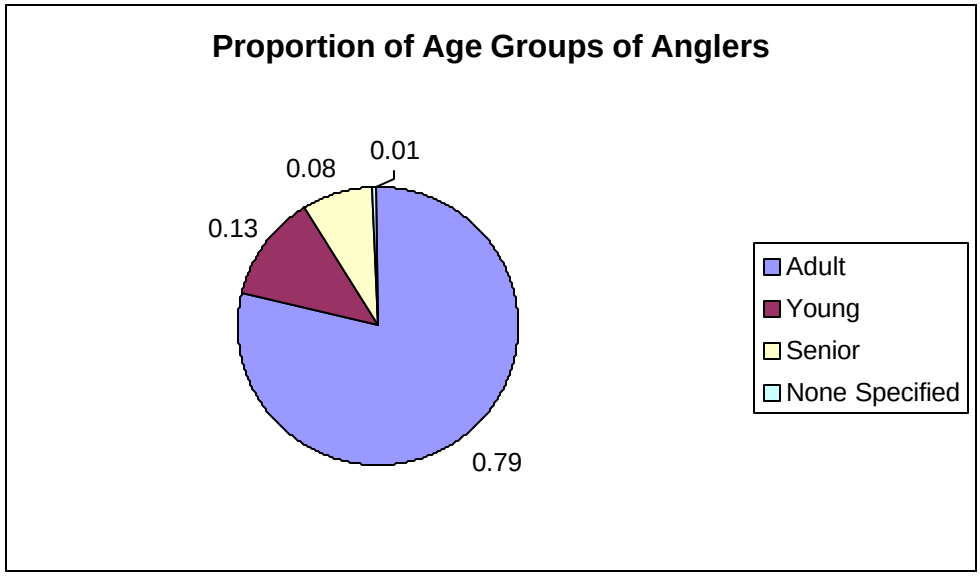

Figure 3-29. Demographic composition of age groups for all anglers interviewed.