STUDY PERFORMANCE REPORT

State: Michigan

Study No.: 689

Project No.: F-53-R-15

Title: Projecting piscivore predation in Lake Huron

Period Covered: April 1, 1998 - September 30, 1999

Study Objective: Work with other investigators to refine and expand stock assessment models for major predators in Lake Huron. Package the results of these models into an integrated and easy to update projection model for evaluating consequences of stocking levels and changes in mortality rates from sea lamprey or harvest controls.

Job 1. Title: Literature Review.

Findings: The purpose of this task was for the Graduate Student Research Assistant to become familiar with background literature and to develop a comprehensive understanding of past work directly related to this project. To this end she has reviewed literature on bioenergetics, predator-prey dynamics, Great Lakes fishes and fisheries, and the Lake Huron system. Using Cambridge Scientific Abstracts, ISI (Institute for Scientific Information) Citation Database, and JSTOR the student has amassed 345 references into a database, with over 200 of the most pertinent references copied and cataloged in the lab.

Job 2. Title: Develop projection model.

Findings: Population models already exist for lake trout (separate models for three areas), burbot, walleye (2 areas), and chinook salmon. These models are currently in the form of spreadsheets. The Graduate Student Research Assistant (Norine Dobiesz) working on this project has reviewed the structure and assumptions of these models. Based on this review we determined that these spreadsheet models should be ported into a more structured programming and database environment such as Visual Basic, linked to an Access database. Based upon bioenergetics models we have updated information on Gross Conversion Efficiencies (GCEs) used in calculations of consumption in the population models. Table 1 contains the age-specific GCEs currently being used.

Job 3. Title: Bioenergetics models.

Findings: The Wisconsin model (Hewett & Johnson 1995) was used to generate estimates on GCE for the key predators – lake trout, chinook, walleye, and burbot. This model requires significant amounts of data including files containing diet composition, energy density of predators and prey, predator growth, and species-specific physiological parameters. Information for many of these data existed in various places but needed summarization or further analysis in preparation for input into the Wisconsin model. The following tasks were undertaken to obtain the data needed for the model:

1. Growth information in the form of weight-at-age was used obtained from Bence and Meehan (1996) and entered into the Wisconsin model. Default physiological parameters were used for all predators except burbot. Burbot physiological parameters were not available in the model so appropriate values were obtained from Rudstram et al. (1995) and Bence and Meehan (1996) to create a new physiological parameters file.

2. Diet composition information was previously collected from BRD, COTFMA, and MIDNR and encompassed various timeframes (approximately from 1990 to 1997) depending on the predator. In most cases, prey counts were multiplied by mean prey weight to determine proportion by weight of each prey item for each data source. When data were missing, prey item counts and weights were pooled over the data time periods to provide a large enough sample size to estimate diet proportions. Table 2 contains diet composition data used to code input files for the Wisconsin model.

3. Energy content analyses were previously completed for 200 predator and prey specimens. These data were analyzed by the Graduate Research Assistant to determine if spatial and/or temporal differences existed. Linear regression was used to model the relationship between energy density and percent wet weight and apply to 500 other specimens collected. Preliminary analyses suggest that some spatial and temporal differences exist but additional analysis is needed. Table 3 contains general estimates of energy density used in the current version of the bioenergetics model described below.

4. Once these pertinent data files were built, the Wisconsin model was run to fit P-values (average proportion of maximum consumption) for specific ages of each predator. These values along with consumption estimates by predator are shown in Table 1.

Job 4. Title: <u>Publish results and prepare annual reports.</u>

Findings: This progress report was prepared.

References:

Bence, J.R. and R.A.M. Meehan. 1996. SIMPLE model development for Lake Huron. Project Progress Report to Great Lakes Fisheries Commission, Ann Arbor, Michigan.

Hewett. S.W. and B.L. Johnson. 1995 Fish Bioenergetics Model 3. University of Wisconsin Sea Grant Institute, Report WIS-SG-91-250.

Rudstram, L.G., P.E. Peppard, T.W. Fratt, R.E. Bruesewitz, D.W. Coble, F.A. Copes and J.F. Kitchell. 1995. Prey consumption by the burbot (*Lota lota*) population in Green Bay, Lake Michigan, based on a bioenergetics model. Canadian Journal of Fisheries and Aquatic Sciences, 52: 1074-1082.

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Table 1.–Gross Conversion Efficiency

	Age	P-value	Consumption (g)	GCE
Burbot	1	0.190	467	14.13
	2	0.197	635	14.80
	3	0.203	865	15.38
	4	0.128	595	9.41
	5	0.139	728	12.50
	6	0.153	930	15.48
	7	0.166	1224	17.89
	8	0.100	813	1.11
	9	0.112	939	6.50
	10	0.112	991	6.66
	11	0.113	1044	6.70
	12	0.113	1102	6.81
Chinook	0	1.242	6986	9.67
	1	0.203	3377	41.75
	2	0.277	10357	41.13
	3+	0.254	9300	36.56
Lake trout *	1-3	0.206	1006	40.67
(North)	4-5	0.145	2045	40.55
	6	0.109	2262	30.51
Lake trout *	1-3	0.208	1029	39.00
(Central)	4-5	0.150	2110	39.29
	6	0.112	2332	29.59
Lake trout *	1-3	0.191	1021	39.31
(South)	4-5	0.148	2087	39.74
	6	0.111	2313	29.83
Walleye	2	0.175	829	38.24
(South)	3	0.137	855	32.06
	4	0.179	1427	35.04
	5	0.148	1483	30.35
Walleye	2	0.294	1391	22.78
(Saginaw Bay)	3	0.229	1434	19.11
	4	0.298	2377	21.03
	5	0.247	2469	18.22

* These values represent averages over the specified age range

Table 2.–Diet Composition

	Age	Alewife	Bloater	Invertebrate	Sculpin	Rainbow Smelt	Stickleback	Other
Burbot	1-3	0.23	0.00	0.28	0.34	0.14	0.00	0.01
	4-7	0.38	0.04	0.10	0.22	0.24	0.01	0.01
	8+	0.38	0.04	0.03	0.12	0.41	0.00	0.02
Chinook	0	0.13				0.35	0.00	0.52
	1	0.27				0.70	0.00	0.03
	2+	0.87				0.08	0.04	0.01
Lake trout	1-3	0.31	0.00		0.14	0.51	0.04	0.00
(MH1)	4-6	0.18	0.00		0.02	0.77	0.02	0.01
	7+	0.45	0.04		0.04	0.45	0.00	0.02
Lake trout	1-3	0.52	0.00		0.01	0.46	0.01	
(MH2)	4-6	0.60	0.00		0.00	0.4	0.00	
	7+	0.85	0.01		0.00	0.14	0.00	
Lake trout	1-3	0.57			0.01	0.42		
(MH3)	4-6	0.61			0.00	0.39		
	7+	0.94			0.00	0.06		
Walleye	2-3	0.68				0.32		0.00
(South)	4+	0.78				0.18		0.04
Walleye	2-3	0.34				0.16		0.50
(Saginaw Bay)	4+	0.39				0.09		0.52

Table 3.–Energy Density

Spp	N	Mean %Wet weight	Mean Kcal/g	Std dev Kcal/g	Min Kcal/g	Max Kcal/g
Alewife	26	81.94	4.909	0.424	3.863	5.694
Bloater	24	75.86	5.611	0.575	4.262	6.478
Burbot	25	75.16	5.718	0.580	4.688	7.087
Chinook	49	73.13	5.517	0.503	4.449	6.848
Lake trout	25	67.84	6.332	0.443	5.332	7.003
North	9	70.76	6.346	0.491	5.714	7.003
Central	9	68.09	6.382	0.542	5.332	6.888
South	7	63.78	6.252	0.243	5.862	6.542
Rainbow smelt	25	78.93	5.394	0.306	4.779	6.034
Stickleback	3	77.23	5.153	0.822	4.289	5.925
Walleye	25	71.32	5.466	0.292	4.921	5.944

Sculpin and invertebrates are also represented in the diet composition but energy density for these species was not obtained from bomb calorimetry. The following values were obtained from the literature:

Sculpin	4.909 cal/g
Invertebrates	0.972 cal/g