LENGTH -WEIGHT RELATIONSHIP AND CONDITION FACTOR OF 26 FISH SPECIES CAUGHT BY CAST NET IN NEW CALABAR RIVER, NIGERIA

Abstract

The length -weight relationship and condition factor (K) of fish species caught by cast net were studied from three stations in the New Calabar River, Rivers State, Nigeria. A total of 1541 specimens of 26 fish species and representing 11 families were randomly collected using cast net with mesh sizes of 1.5 and 2.5cm. Total length (TL) was measured to 0.1 cm, while whole body weight (W) was taken to the nearest 0.1 g for each individual. Sample sizes of the species examined in this study ranged from 8.79±0.25 (*Caranx hippos*) to 31.48±4.93cm (*Sphyraena barracuda*) in total length and 15.45±0.40 (*Elops lacerta*) to 156.00±39.30g (*Pelmatolapia mariae*) in weight. The entire length-weight data in all the three stations were pooled together and the calculated correlation coefficient showed a high positive correlation between length and weight of all the fish species except in *Caranx hippos* (0.18) with low positive correlation. The b value obtained ranged from 0.61 for *Caranx hippos to3.53 for Pelmatolapia mariae.* The mean condition factor ranged from 0.41±0.03 to 4.23±0.49. The results of the present study will provide an effective tool for further studies of population dynamics and stock assessment studies.

Keywords: Cast net, Length-weight, Condition factor, New Calabar River.

Introduction

All fishing gears are species and size selective particularly in multispecies fisheries. The area of operation of a gear, the inconstant behavior of the fish relative to the gear, and size of the fish determine the part of a stock that can be caught by a gear. A generally important technical measure for fishing gears is the size selectivity which is defined as the probability of fish being retained in a fishing gear as a function of the length of the fish (Misund et al., 2001). In fisheries management, it is often desired that commercial fishing gear be highly selective for larger fish to minimize impact of fishing on the fish population and maximized yield (Gulland, 1983; Maclennan 1992).

Cast net is a falling gear, conical in shape with lead sunken or weights attracted at regular intervals on the lead rope forming the circumference of the cone. The cheapness and transportability make cast nets one of the most common gears in inland water fisheries (Jawad, 200) This type of fishing gear is usually used in shallow waters and cast from the shore or from a boat to catch fish by falling and closing in on them. Cast nets are selective for lower size ranges, and larger, faster-moving fish can escape the falling net but may become entangled in the process (Welcome, 2001).

Knowing selectivity of the gear is very important since it affect population parameters such as length- weight relationship, gender ratio, estimate of population size through marking trails and growth and death ratios (Hamley, 1975).These relationships provide additional information about condition of fish in its habitat and also are vital in the biology of fisheries, assessing the fish's average weight in a given length using mathematical equations (Oscoz *et al.* 2005).The parameters like general well-being of any fish species either in its natural habitat or cultivable environment, comparison of growth pattern, onset of maturity spawning, fecundity etc., can be assessed with the help of length –weight relation and condition factor (LeCren,1951). Condition factor is important in understanding the life cycle of fish species and it contributes to adequate management of these species, hence, maintaining the equilibrium in the ecosystem (Imam et al., 2010).The study was designed to provide basic scientific information on the length-weight relationship of some fish species in the New Calabar River, Niger Delta Nigeria.

Materials and Methods

The Study Area

The study area is the section of the New Calabar River as shown in Figure 1. The New Calabar River lies between longitude 006º53 53086'E and latitude 04º53' 19.020'N in Choba, Rivers

State, Nigeria. The entire river course is situated between longitude 7º60'E and latitude 5º45'N in the coastal area of the Niger Delta and empties into the Atlantic Ocean.

Three sampling stations (S1 –Aluu, S2 – Choba, and S3 – Iwofe) were established along the main course of the river. Fish species were collected monthly for 4 consecutive months (March to August, 2017) from the three sampling stations with the assistance of local artisanal fishers using different cast nets (1.5 and 2.5cm mesh sizes).

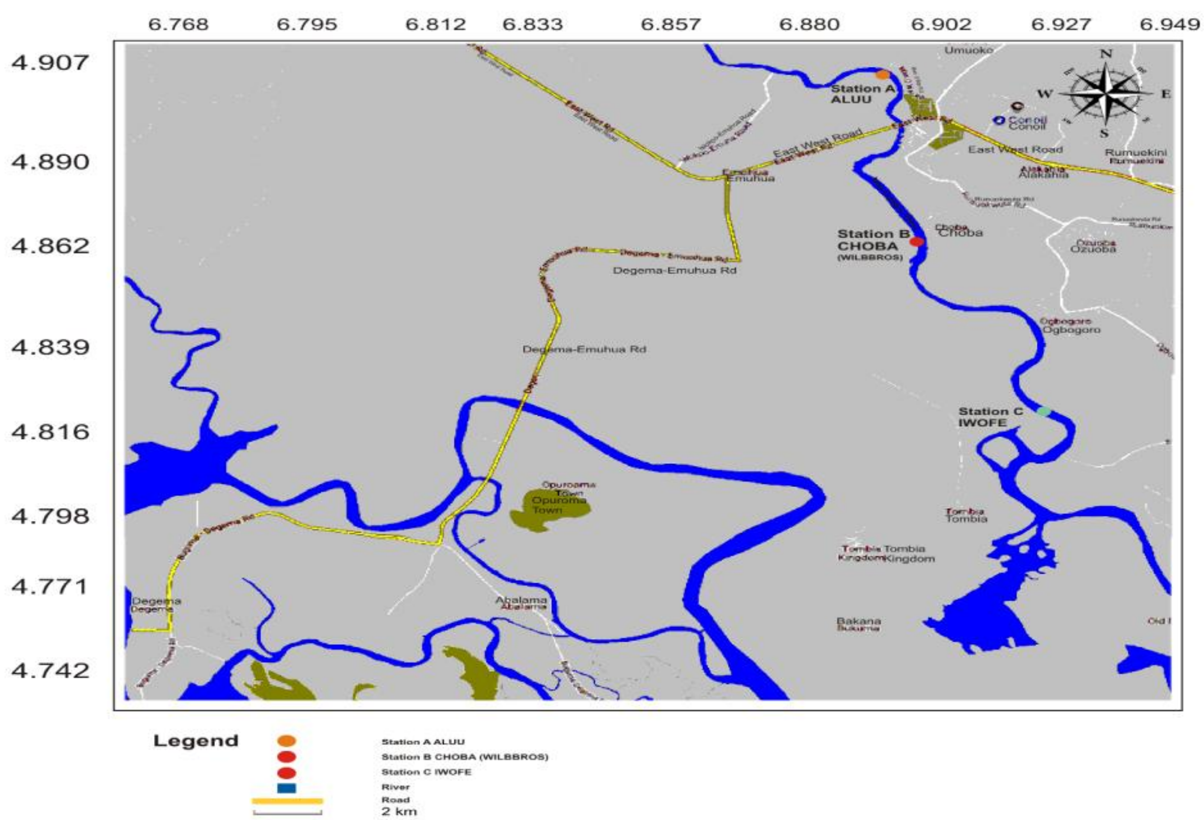


Figure 1: Map showing the sampling Stations

Fish Sampling

The fish were sampled on a monthly basis between the months of March to August 2017, from all with the assistance of local artisanal fishermen using cast nets of varying mesh sizes (1.5cm net area = 16.6 m2 and 2.5cm).The local canoes used by the fishers were manned by an average of two men per boat.The specimens were immediately preserved in iced packed cooler and transferred to the Fisheries Laboratory, Faculty of Agriculture, University of Port Harcourt, Choba where the identification were done, it was preserved in formalin in the laboratory, and immediately after, appropriate labelling and identification was made with the aid of relevant texts, Adesulu and Sydenham, (2007). Catch composition of cast nets were recorded by physical examination of the total catch, the Total Length (TL) and Standard Length (SL) were measured in centimeter (cm), and the Body Weights (BW) were measured in grams (g). The Total Length (TL) of each fish was taken from the tip of the snout (mouth closed) to the extended tip of the caudal fin using a meter rule.

The length–weight relationship is expressed by the equation W = aLb, where W = body weight (g), and L = total length (cm), (Ricker, 1973). Parameters a and b were estimated by the logarithmic expression: log W = log a + b log L (Froese, 2006).

The condition factor which shows the degree of wellbeing of the fish in their habitat was determined by using the equation, K = 100W/ Lb (Gomiero and Braga, 2005). Where by K = condition factor W = the weight of the fish in gram (g) L = the total length of the fish in centimeters (cm) b = the value obtained from the length-weight equation.

Statistical evaluations of the variations observed in the different species were assessed using the SPSS (1999).

Results

A total of 1541 specimens of 26 fish species and representing 11 families. Sample sizes of the species examined in this study ranged from 8.79±0.25 (*Caranx hippos*) to 31.48±4.93cm (*Sphyraena barracuda*) in total length and 15.45±0.40 (*Elops lacerta*) to 156.00±39.30g (*Pelmatolapia mariae*) in weight (Table 1).

Results of the LWR regressions are shown in Tables 2, 3 and 4. In station 1, apart from *Sardinella maderensis* with isometry growth pattern the remaining fish species showed negative allometry. The exponent b ranged from 0.33 (*Sphyraena barracuda*) to 3.35 (*Sardinella maderensis*). The coefficients of determination (r^2) of the LWR regressions ranged between 0.45 and 1.00. The mean condition factor ranged from 0.36±0.03 recorded for *Sphyraena barracuda* to 3.80±0.95 recorded for *Caranx hippos.*

As far as the length weight relationship of station 2 was concerned, the growth pattern revealed allometry with the value of parameter b ranged from0.99 for *Caranx hippos* to 4.23 for *Pelmatolapia mariae*. The coefficients of determination (r^2) of the LWR regressions ranged 0.32 to 0.98. The mean condition factor ranged between 0.95±0.10 (*Mugil cephalus*) and 5.53±0.85 *(Caranx hippos*).

In station 3, only *Coptodon zillii* revealed isometry growth pattern the remaining fish species showed allometry pattern. The exponent b ranged from 0.51 (*Caranx hippos*) to 3.12 (*Sardinella maderensis*). The coefficients of determination (r^2) of the LWR regressions ranged between 0.15 and 1.00. The mean condition factor ranged from 0.45±0.05 to 3.08±0.33.

The entire length-weight data in all the three stations were pooled together and the calculated correlation coefficient showed a high positive correlation between length and weight of all the fish species except in *Caranx hippos* (0.18) with low positive correlation. The b value obtained in this study ranged from 0.61 for *Caranx hippos to3.53 for Pelmatolapia mariae.* The condition factor has been calculated for each species, the mean condition factor ranged from 0.41±0.03 to 4.23±0.49.

Discussion

In this study most of the samples consisted mainly juvenile with the sizes of fish species ranged from 8.79±0.25 to 31.48±4.93cm in length and 15.45±0.40 to 156.00±39.30g in weight. This can be ascribed to selectivity of the cast nets used in the study area and anthropogenic impacts, especially the fishing pressure and habitat destruction. The second most common indicator of unsustainable fishing is the observation of a decrease of large-sized fish, or a decrease in the mean size of the fish in the catch (e.g. Worm et al., 2009).

Length–weight relationships in fishes can be a ected by multiple of factors including the number and length range of the sampled specimens (often a ected by the type of fishing gear used), seasonality, habitat, gonad ripeness, sex, diet, stomach fullness, and growth phase (Froese, 2006; Karachle and Stergiou, 2008; Mir et al., 2013); however, these factors were not considered in the present study.

Hile (1936) and Martin (1949) opined that the value of ‘b’ may range between 2.5 and 4.0. In the literature, b values outside of this range are generally considered to be erroneous (Ricker 1975 Oscoz, 2005). LeCren (1951) pointed out that the variation in ‘b’ value is due to environmental factors, season, food availability, sex, life stage and other physiological factors. The b value obtained in this study ranged from 0.61 to 3.53 revealed that the studied species did not followed the cube law as all the species studied had allometric growth pattern.

According to LeCren (1951) and George et al. (1985) the relative condition factor (Kn) is an indicator of general well-being of the fish. (Kn) greater than one (1) is indicative of the general well-being of fish, whereas its value less than one (1) indicates that fish is not in a good condition. It was noticed that fish species in station 2 had highest condition factor values (0.95-5.53). This could be due to a difference in environmental conditions such as salinity.

The present work revealed that the pooled mean condition values factor ranged from 0.41±0.03 to 4.23±0.49 with only *Sphyraena barracuda* had less than one. This implies that the fish species are in good condition. However, the variations in the condition factor (K) observed in different fish species may be attributed to different factors, such as environmental condition, food availability and the gonadal maturity, as suggested by many workers (Le Cren, 1951).

Conclusion

The study has provided baseline information to understand the length-weight relation and condition factor of different fish species caught using cast net in the New Calabar River. The study revealed that the catches are made up of relatively small sizes and allometric growth pattern in all the studied fish species. The condition factor indicated that almost all the species were thriving very well in the river. It is hoped that the results of the present study will provide an effective tool for further studies of population dynamics and stock assessment studies.

Table 1: ***Sizes Range*** **of** ***Fish Species Caught With Cast net***

SPECIES	TOTAL LENGTH (Cm) Mean±SE	Range (Cm)	TOTAL WEIGHT (g) Mean±SE	Range (g)
CICHLIDAE				
Coptodon guineensis	16.35±0.25	8.7 - 33.7	121.80±6.73	13 - 697
Coptodon zillii	15.69±0.23	9.3 - 30.1	101.96±5.88	16 - 645
Coptodon dageti	16.16±0.52	9.5 - 26.3	96.15±9.04	20 - 311
Sarotherodon galilaeus	13.56±0.54	7.8 - 22.8	59.96±6.81	12 - 259
Sarotherodon melanotheron	16.19±0.38	8.3 - 23.5	86.06±5.29	15 - 213
Pelmatolapia mariae	18.25±1.67	13.2 - 22	156.00±39.30	41 - 242
Pelvicachromis taeniatus	15.07±0.36	14.1 - 16.5	57.33±3.23	49 - 70
Chromidotilapia guntheri	14.25±0.39	13.2 - 15	55.75±2.78	48 - 61
Hemichromis fasciatus	14.33±0.45	13 - 14.9	57.25±3.57	47 - 63
MUGILIDAE				
Liza falcipinnis	20.96±0.41	9.1 - 37.1	97.39±5.86	13 - 370
Liza grandisquamis	9.80±0.70	9.1 - 10.5	13.50±1.50	12 - 15
Mugil cephalus	19.27±0.68	14.7 - 27.1	73.88±7.78	39 - 185
CLUPEIDAE				
Ethmalosa fimbriata	15.76±0.26	13.6 - 17.3	57.06±2.02	39 - 69
Sardinella maderensis	11.04±0.23	9.2 - 13.5	30.26±1.99	12 - 49
ALESTIDAE				
Brycinus macrolepidotus	15.23±0.67	9.6 - 22.5	51.78±4.65	16 - 94
Brycinus nurse	17.04±0.49	12.9 - 23.3	65.57±3.18	34 - 103
CLAROTEIDAE				
Chrysicthys aluuensis	13.45±1.47	9.9 - 22.4	39.50±4.32	27 - 69
Chrysicthys nigrodigitatus	15.11±1.62	9.8 - 22.3	50.90±16.84	16 - 195
LUTJANIDAE				
Lutjanus agennes	16.36±0.56	11.7 - 20.8	65.14±5.41	25 - 123
Lutjanus dentatus	16.24±0.42	12.8 - 20.6	64.09±4.25	32 - 120
CARANGIDAE				
Caranx hippos	8.79±0.25	7.3 - 10.5	25.72±1.04	19 - 33
Trachinotus teraia	10.83±0.92	7.5 - 14.1	27.10±2.27	19 - 38
ELOPIDEA				
Elops lacerta	12.76±0.30	7.6 - 15.7	15.45±0.40	9 - 22
HAEMULIDAE				
Pomadasys jubelini	10.89±0.30	8.8 - 14.3	21.78±2.43	11 - 69
MONODACTYLIDAE				
Monodactylus sebae	9.63±0.16	8.8 - 10.7	31.09±1.52	23 - 45
SPHYRAENIDAE				
Sphyraena barracuda	31.48±4.93	19.3 - 45	155.83±52.01	30 - 278

Table 2: *Growth Pattern* and *Conditional Factor* for *Station 1*

Species	Condition factor (K) Mean±SE	Range	A	b	r^2	Growth pattern
Brycinus macrolepidotus	1.44±0.05	0.83 - 1.94	-2.12	2.21	0.95	Negative allometry
Brycinus nurse	1.35±0.06	0.80 - 1.67	-0.72	1.72	0.92	Negative allometry
Caranx hippos	3.80±0.95	2.25 - 7.52	4.70	0.69	0.45	Negative allometry
Chromidotilapia guntheri	1.93±0.06	1.81 - 2.09	-0.95	1.87	0.99	Negative allometry
Chrysicthys nigrodigitatus	0.86±0.00	0.86 - 0.86	1.85	1.05	1.00	Negative allometry
Coptodon dageti	2.12±0.04	1.11 - 2.46	-3.33	2.81	0.94	Negative allometry
Coptodon guineensis	2.24±0.03	0.20 - 4.61	-3.15	2.76	0.91	Negative allometry
Coptodon zilli	2.22±0.02	1.48 - 2.98	-3.68	2.95	0.97	Negative allometry
Elops lacerta	0.86±0.08	0.49 - 2.05	0.28	0.96	0.85	Negative allometry
Ethmalosa fimbriata	1.46±0.03	1.29 - 1.62	-1.83	2.13	0.90	Negative allometry
Hemichromis fasciatus	1.95±0.07	1.84 - 2.14	-1.33	2.02	0.99	Negative allometry
Liza falcipinnis	0.88±0.02	0.44 - 1.73	-4.07	2.78	0.95	Negative allometry
Lutjanus dentatus	1.36±0.06	1.03 - 2.00	-2.21	2.24	0.84	Negative allometry
Monodactylus sebae	3.41±0.07	3.20 - 3.83	-2.61	2.66	0.94	Negative allometry
Mugil cephalus	1.08±0.09	0.75 - 1.24	-1.81	2.05	0.82	Negative allometry
Pelmatolapia mariae	2.33±0.03	2.27 - 2.37	1.87	1.17	0.96	Negative allometry
Pomadasys jubelini	1.64±0.00	1.64 - 1.64	1.84	0.44	1.00	Negative allometry
Sardinella maderensis	2.13±0.06	1.54 - 2.59	-4.70	3.35	0.88	Positive allometry
Sarotherodon galilaeus	2.16±0.24	1.06 - 3.49	-1.70	2.22	0.88	Negative allometry
Sphyraena barracuda	0.36±0.03	0.31 - 0.42	4.38	0.33	0.95	Negative allometry
Trachinotus teraia	2.63±0.44	1.32 - 4.50	1.02	0.96	0.96	Negative allometry

Table 3: ***Growth Pattern*** **and** ***Conditional Factor*** **for** ***Station 2***

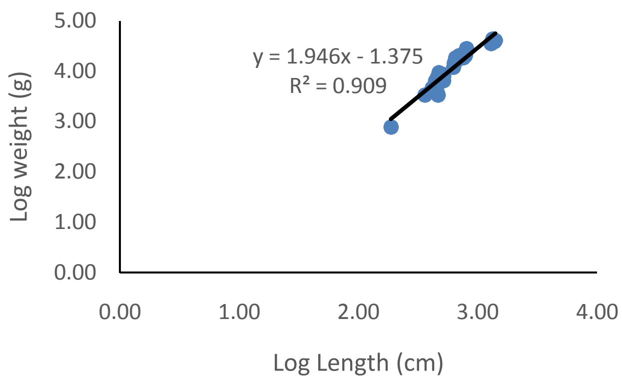
Species	Condition factor (K) Mean±SE	Range	A	b	r^2	Growth pattern
Brycinus nurse	1.37±0.07	0.83 - 1.58	-1.30	1.92	0.94	Negative allometry
Caranx hippos	5.53±0.85	2.17 - 7.45	5.38	0.99	0.40	Negative allometry
Chrysicthys aluuensis	2.15±0.31	0.60 - 3.11	1.23	0.94	0.84	Negative allometry
Coptodon dageti	1.17±0.04	1.08 - 1.24	0.16	1.32	0.98	Negative allometry
Coptodon guineensis	2.12±0.03	1.57 - 2.66	-3.61	2.91	0.98	Negative allometry
Coptodon zillii	2.18±0.02	1.49 - 2.54	-3.55	2.90	0.98	Negative allometry
Liza falcipinnis	1.00±0.08	0.83 - 1.20	-3.89	2.75	0.85	Negative allometry
Monodactylus sebae	3.37±0.09	3.20 - 3.48	-3.08	2.86	0.96	Negative allometry
Mugil cephalus	0.95±0.10	0.81 - 1.14	2.11	0.60	0.32	Negative allometry
Pelmatolapia mariae	2.02±0.26	1.63 - 2.51	-7.23	4.23	0.98	Positive allometry
Sarotherodon galilaeus	2.04±0.10	1.89 - 2.24	-1.47	2.08	0.84	Negative allometry
Sarotherodon melanotheron	2.38±0.26	1.87 - 2.72	0.89	1.26	1.00	Negative allometry

Table 4: ***Growth Pattern*** **and** ***Conditional Factor*** **for** ***Station 3***

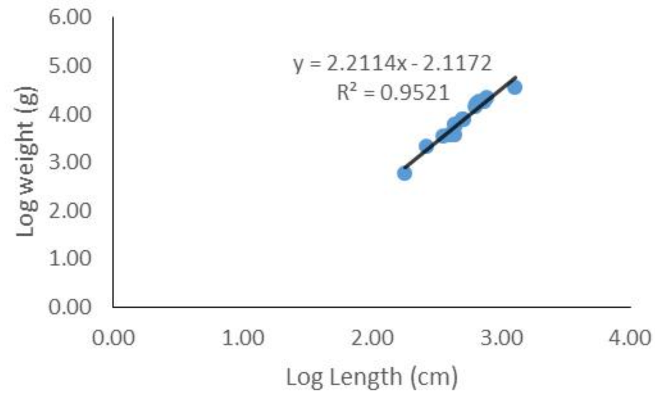
Species	Condition factor (K) Mean±SE	Range	a	b	r^2	Growth pattern
Brycinus nurse	1.34±0.12	0.79 - 1.74	-0.13	1.53	0.93	Negative allometry
Caranx hippos	3.08±0.33	2.17 - 4.33	2.05	0.51	0.15	Negative allometry
Chrysicthys nigrodigitatus	1.53±0.30	0.60 - 3.02	-1.42	1.90	0.68	Negative allometry
Coptodon dageti	2.45±0.32	1.15 - 4.55	-1.41	2.12	0.88	Negative allometry
Coptodon guineensis	2.21±0.03	1.15 - 4.61	-3.53	2.89	0.97	Negative allometry
Coptodon zillii	2.20±0.03	1.50 - 4.79	-3.77	2.98	0.97	Isometric
Elops lacerta	0.89±0.08	0.48 - 2.19	0.29	0.97	0.78	Negative allometry
Liza falcipinnis	1.08±0.05	0.72 - 2.70	-1.39	1.92	0.80	Negative allometry
Liza grandisquamis	1.45±0.15	1.30 - 1.59	0.38	0.78	1.00	Negative allometry
Lutjanus agennes	1.46±0.06	1.03 - 1.91	-2.36	2.32	0.84	Negative allometry
Lutjanus dentatus	1.66±0.08	1.33 - 2.22	-2.52	2.42	0.86	Negative allometry
Monodactylus sebae	3.47±0.06	2.94 - 3.69	-3.16	2.91	0.94	Negative allometry
Mugil cephalus	0.99±0.07	0.77 - 1.95	-2.19	2.18	0.79	Negative allometry
Pelvicachromis taeniatus	1.67±0.03	1.56 - 1.78	-2.08	2.26	0.96	Negative allometry
Fantapenaeus) notialis	1.04±0.03	0.55 - 2.16	-1.04	1.66	0.79	Negative allometry
Pomadasys jubelini	1.66±0.14	1.21 - 4.26	-2.26	2.21	0.53	Negative allometry
Sardinella maderensis	2.20±0.09	1.81 - 2.52	-4.12	3.12	0.89	Positive allometry
Sarotherodon galilaeus	2.04±0.07	1.05 - 4.64	-3.14	2.69	0.95	Negative allometry
Sarotherodon melanotheron	1.90±0.06	1.34 - 5.42	-2.90	2.61	0.92	Negative allometry
Sphyraena barracuda	0.45±0.05	0.39 - 0.55	-2.38	2.00	0.46	Negative allometry

Table 5: ***Pooled Growth Pattern*** **and** ***Conditional Factor***

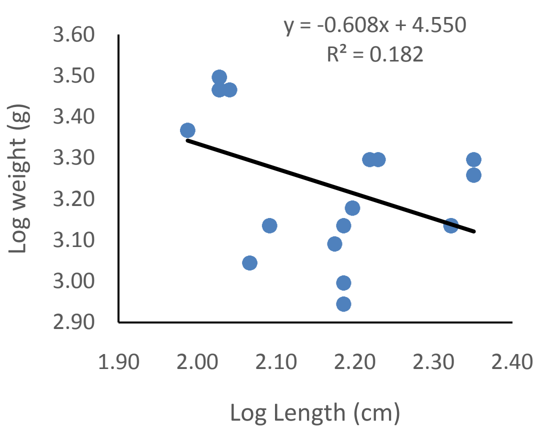
Species	Condition factor (K) Mean±SE	Range	a	b	r^2	Growth pattern
Brycinus macrolepidotus	1.44±0.05	0.83±1.94	-2.12	2.21	0.95	Negative allometry
Brycinus nurse	1.35±0.04	0.79±1.74	-1.38	1.95	0.91	Negative allometry
Caranx hippos	4.23±0.49	2.17±7.52	4.55	0.61	0.18	Negative allometry
Chromidotilapia guntheri	1.93±0.06	1.81±2.09	-0.95	1.87	0.99	Negative allometry
Chrysicthys aluuensis	2.15±0.31	0.60±3.11	1.23	0.94	0.84	Negative allometry
Chrysicthys nigrodigitatus	1.47±0.28	0.60±3.02	-1.23	1.82	0.83	Negative allometry
Coptodon dageti	2.12±0.09	1.08±4.55	-2.43	2.47	0.83	Negative allometry
Coptodon guineensis	2.20±0.02	0.20±4.61	-3.42	2.85	0.95	Negative allometry
Coptodon zilli	2.20±0.02	1.48±4.79	-3.71	2.96	0.97	Negative allometry
Elops lacerta	0.87±0.06	0.48±2.19	0.28	0.96	0.81	Negative allometry
Ethmalosa fimbriata	1.46±0.03	1.29±1.62	-1.83	2.13	0.90	Negative allometry
Hemichromis fasciatus	1.95±0.07	1.84±2.14	-4.79	3.36	0.95	Positive allometry
Liza falcipinnis	0.98±0.03	0.44±2.70	-2.81	2.38	0.89	Negative allometry
Liza grandisquamis	1.45±0.15	1.30±1.59	0.38	0.78	1.00	Negative allometry
Lutjanus agennes	1.46±0.06	1.03±1.91	-2.36	2.32	0.84	Negative allometry
Lutjanus dentatus	1.47±0.05	1.03±2.22	-3.00	2.55	0.90	Negative allometry
Monodactylus sebae	3.43±0.04	2.94±3.83	-4.20	3.36	0.93	Positive allometry
Mugil cephalus	1.01±0.05	0.75±1.95	-2.34	2.22	0.81	Negative allometry
Pelmatolapia mariae	2.17±0.14	1.63±2.51	-5.33	3.53	0.98	Positive allometry
Pelvicachromis taeniatus	1.67±0.03	1.56±1.78	-2.08	2.26	0.96	Negative allometry
Penaeus nitialis	1.04±0.03	0.55±2.16	-1.08	1.68	0.80	Negative allometry
Pomadasys jubelini	1.66±0.13	1.21±4.26	-3.80	2.86	0.86	Negative allometry
Sardinella maderensis	2.16±0.05	1.54±2.59	-4.52	3.28	0.88	Positive allometry
Sarotherodon galilaeus	2.06±0.07	1.05±4.64	-3.07	2.68	0.94	Negative allometry
Sarotherodon melanotheron	1.92±0.06	1.34±5.42	-2.87	2.60	0.93	Negative allometry
Sphyraena barracuda	0.41±0.03	0.31±0.55	-4.37	2.66	0.98	Negative allometry
Trachinotus teraia	2.63±0.44	1.32±4.50	1.02	0.96	0.96	Negative allometry



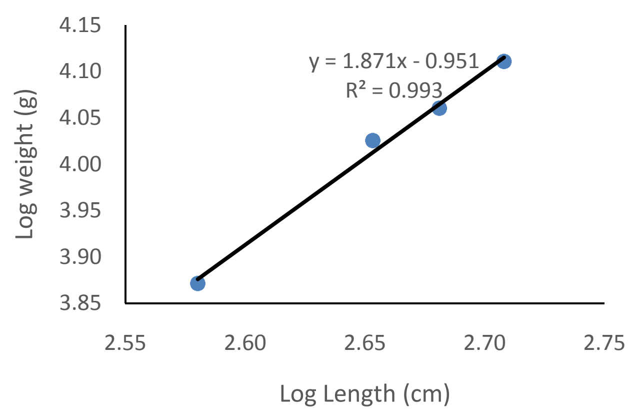
Brycinus macrolepidotus



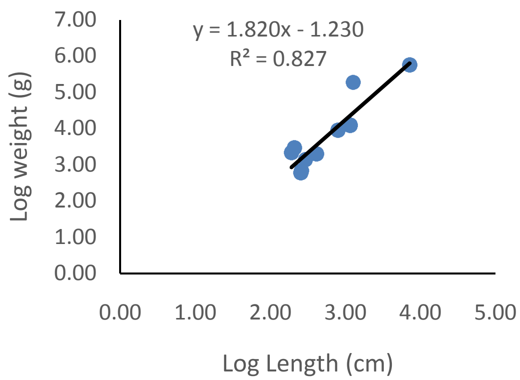
Brycinus nurse



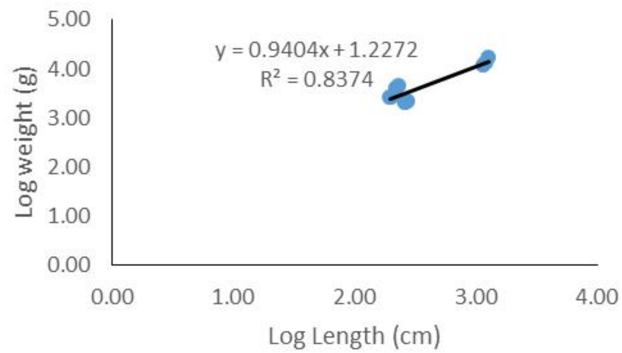
Caranx hippos



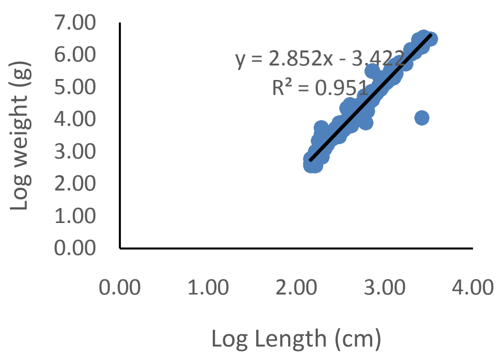
Chromidotilapia guntheri



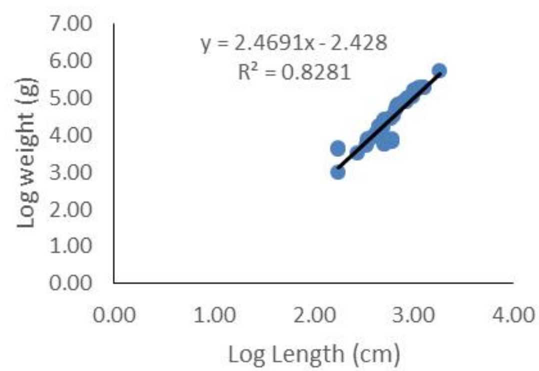
Chrysicthys aluuensis



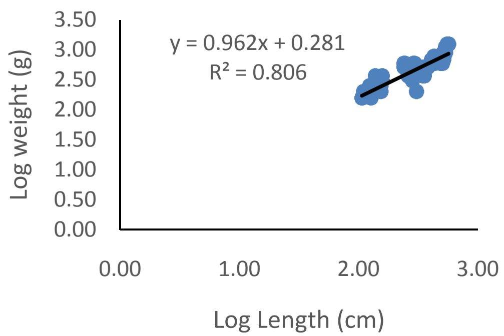
Chrysicthys nigrodigatatus



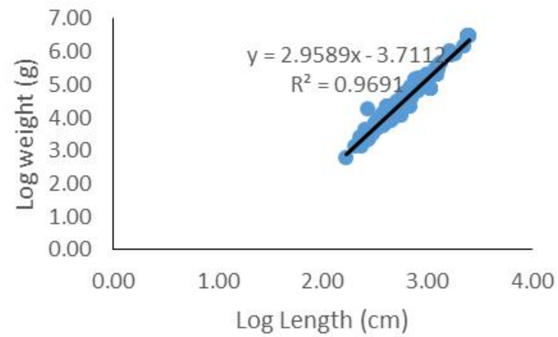
Coptodon dageti



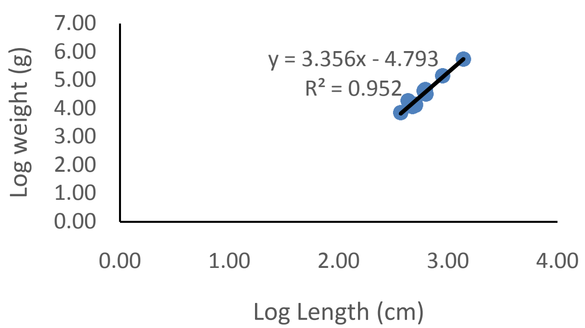
Coptodon guineensis



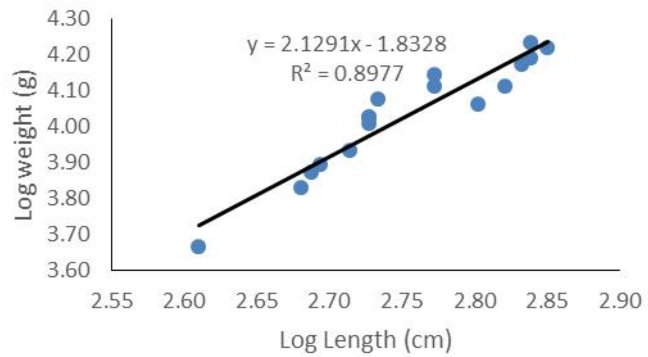
Coptodon zilli



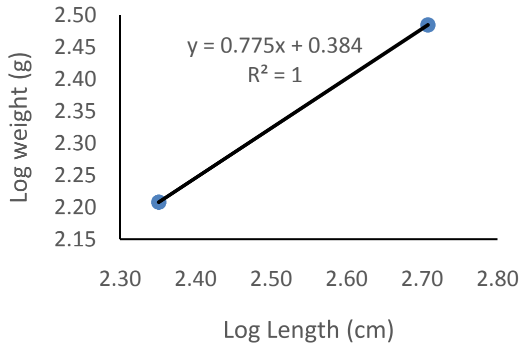
Elops lacerta



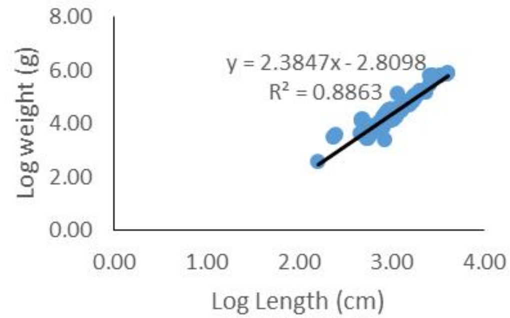
Ethimlosa fimbroata



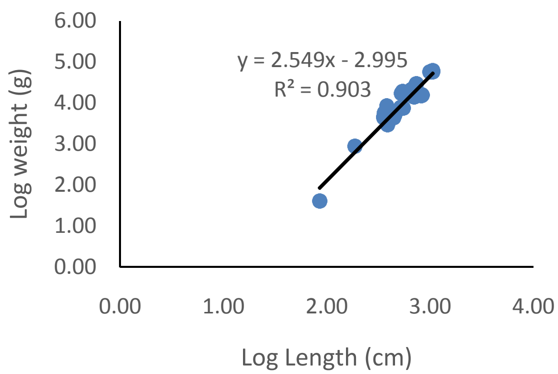
Hemischromis fasciatus



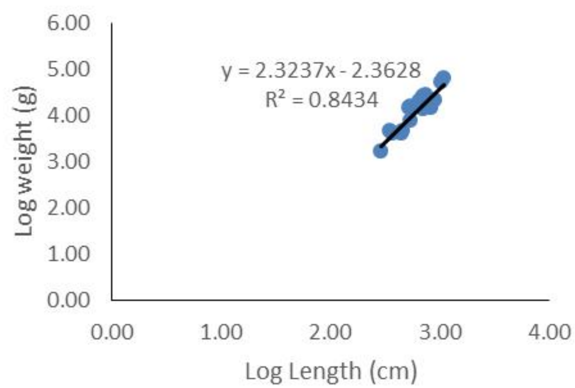
Liza falcipinnis



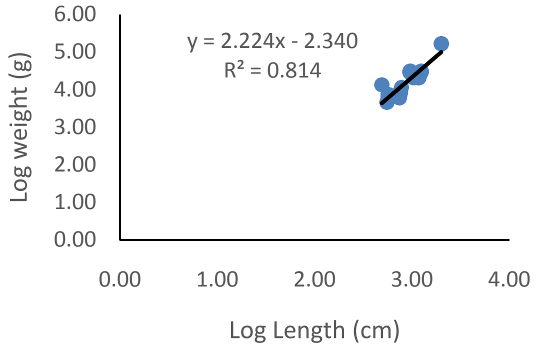
Liza grandisquamis



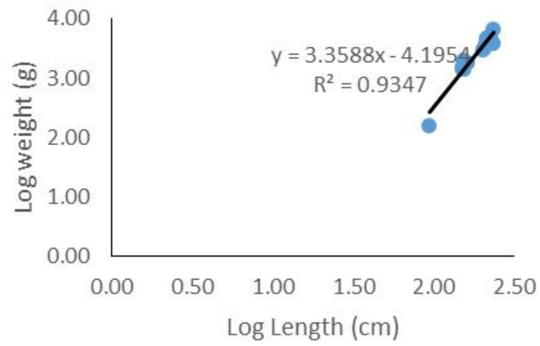
Lutjanus agennes



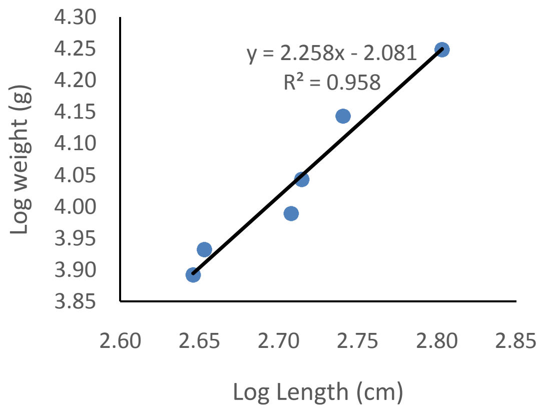
Lutjanus dentatus



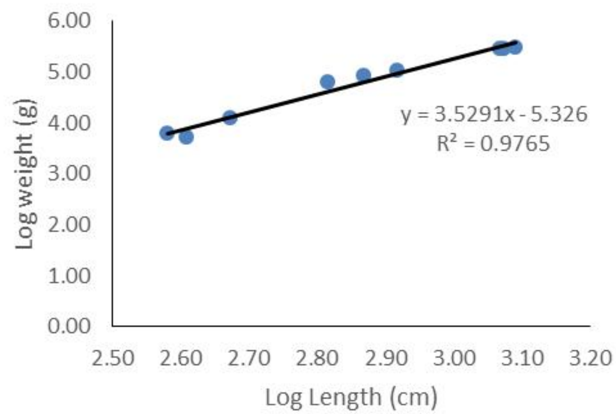
Monodactylus sebae



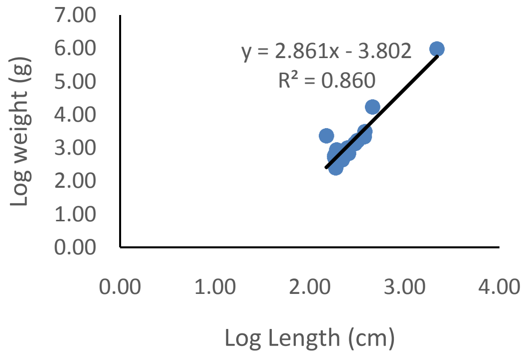
Mugil cephalus



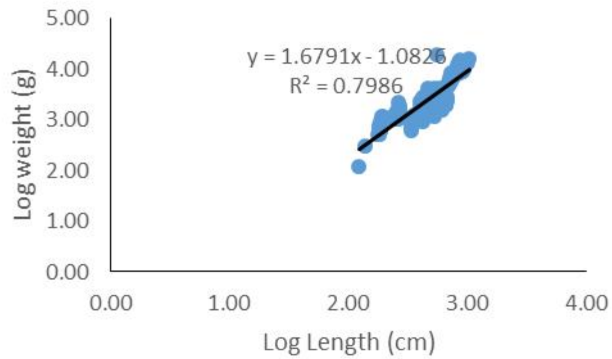
Pelmatolapia mariae



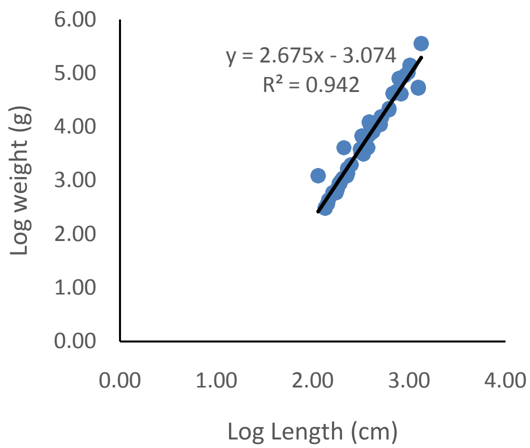
Pelvicachromis taeniatus



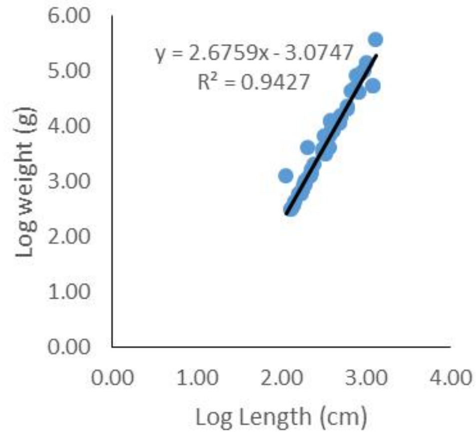
Penaeus nitialis



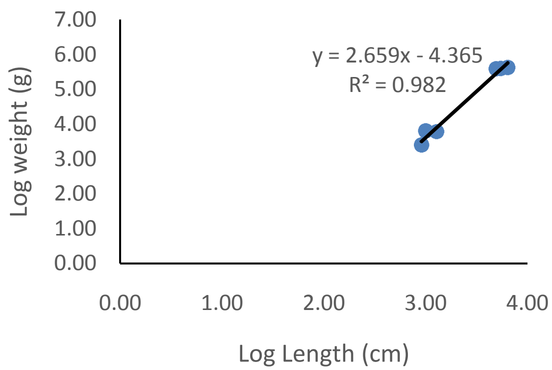
Pomadasys jubelini



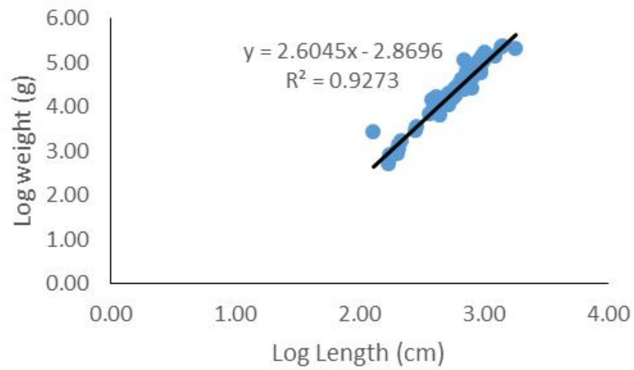
Sardinella maderensis



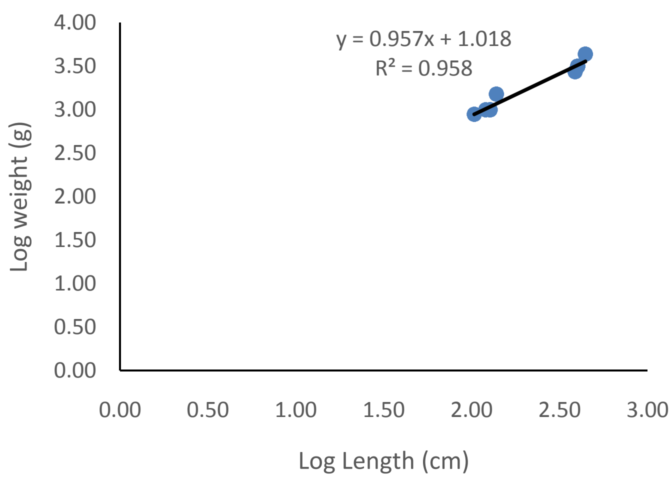
Sarotherodon galilaeus



Sarotherodon melanotheron



Sphyraena barracuda



Trachinotus teraia

Figure 2: Length-weight of fish species from New Calabar River

References

Adesulu EA and Sydenham DHJ. 2007. The fresh water and fisheries of Nigeria. *Macmillan Nigeria Publishers, Lagos. 397 pp.*

Froese, R. 2006. Cube law, condition factor and Length-Weight relationships: history, meta-analysis and recommendations. *Appl. Ichthyol., 22, 241–253*.

George, J. P.; Sharma, A. K.; Venkatshvaran ,K.; Sinha,P. S. R. K.;Venogopal, G. and Birader R. S. 1985. Length –weight relationship and relative condition factor in Cirrhina mirgala and Labeo rohita from a sewage-fed tank. *The Annals of Zoology XXIII (2): 79-90*

Gulland, J.A. 1983. Fish stock assessment: A manual of basic methods- New York: Wiley.

Gomiero, L. M., Braga, F. M. S. 2005. The condition factor of fishes from two river basins in Sao Paulo state, Southeast of Brazil. *Acta Scientiarum. 27:73-78*

Hamley J.M.1975 Review of Gillnet Selectivity. *Journal Fish Res., BD. Can 32:1943-1969*

Hile, R. 1936. Age and growth of the Cisco, Amloplites rupestris (Refineseque) in Nebish Lake, Wisconsin. Trans. Wis. *Acad. Sci. Arts. Lett. 33: 189-337*

Imam, T.S.; Bala, U.; Balarabe, M.L. & Oyeyi, T.I. 2010. Length-weight relationship and condition factor of four fish species from Wasai Reservoir in Kano, Nigeria. *African Journal of General Agriculture 6(3):1595-6984.*

Jawad, L.A. 2006. fishing gear and methods of the Lower Mesopotamian Plain with reference to fishing management. *Marina Mesoptamica 1:1:1-37*

Karachle, P. K.; Stergiou, K. I. 2008. Length-length and length weight relationships of several fish species from the North Aegean Sea (Greece). *J. Biol. Res. (Thessalon) 10:149–157.*

Le Cren, E.D. 1951. The length–weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). *J. Anim. Ecol., 20, 201–219*

MacLenna, D.N. 1992. Fishing gear selectivity. *Fish Res., 13:201-204.*

Martin, W. R. 1949. The mechanism of environmental control of body form in fishes. Univ. Toronto. Stu. Biol. 58: Ont. *Fish. Res. Lab. 70: 1-91*

Mir, J. I.; Gusain, O.; Gusain, M. P.; Mir, F. A.; Sarkar, U. K.; Pandey, A. 2013. Length–weight and length–length relationships of the vulnerable dark mahseer, *Puntius chelynoides* (McClelland, 1839) from Garhwal Himalaya, India. *J. Appl. Ichthyol. 30, 225–226*.

Misund, O.A., Kolding, J. and Fréon, P. 2002. Fish capture devices in industrial and artisanal fisheriesand their influence on management. In: *Handbook of Fish Biology and Fisheries, vol. II (eds. P.J.B.Hart and J.D. Reynolds). pp. 13-36. Blackwell Science, London*

Pillay, T. V. R. 1954. The biology of grey mullet, Mugil tade Forsskal with notes on its fishery in Bengal. Proc. *Nat. Inst. Sci. India, 17: 187-217*.

Oscoz, J., Campos. F., Escala M.C. 2005. Weight–length relationships of some fish species of the Iberian Peninsula. *Journal of Applied Ichthyology. 21:73-74.*

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191:1-382.

Welcomme, R. L. 2001. Inland fisheries: ecology and management. *Fishing News Books, Blackwell Science, Oxford, U.K., 358 pp.*