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Preliminary Study on Fishery Status during Initial Filling of Didhesa Reservoir

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Abstract

Scientific studies on water quality and productivity can contribute to the assessment of the suitability of water for particular uses such as domestic, irrigation, sanitation, fish production. The primary productivity of different water bodies has been widely investigated to assess the fish production capacity of a water body to formulate fishery management policies. This study aimed at the identifying the retained fish species during initial impoundment of Didesa reservoir and studying the fish establishment feature of the newly built reservoir for estimating their fisheries production potential. Three fish species of two families were recorded in Didesa reservoir. In the present study, *Labeobarbus intermedius* dominated the catch, Followed by *Oreochromis niloticus* and *Labeo cylindricus*. Length-weight relationships were highly significant with high coefficients of determination ranging from 0.97 for *Oreochromis niloticus* up to 0.990 for *Labeobarbus intermedius*. The length at first sexual maturity (L_{50}) was 32.9 cm TL while it was 25.4 for *Oreochromis niloticus* at Dhidhesa reservoir.

Keywords: Limnological parameters; Fish biodiversity; Reservoir fishery

Introduction

Reservoir development creates an invaluable option for the production of fisheries, in areas where there is a shortage of fish products. Reservoirs create a habitat for the maintenance of critically important fisheries worldwide [1], with potential to increase food security and rural livelihoods in tropical regions [2].

The negative impacts of impoundments have been well documented, predicting changes in fish assemblage structure and consequences for fisheries is challenging because of the high diversity and complexity of tropical rivers [3]. Impacts from hydrologic alteration are unevenly distributed within fish assemblages, with certain species being severely impacted while others thrive in reservoirs created by dams. Shifts in species abundances affect ecological processes and important ecosystem services, such as nutrient cycling and fisheries production [4].

Reservoir's impact spatio-temporal patterns of fish community structure and fisheries production by obstructing migration routes, altering sediment transport and water quality, promoting invasions by exotic species and biotic homogenization, and favoring generalist over specialist species [5].

Studies on the responses of fish stocks to environmental changes caused by dams is critical for mitigating socioeconomic and ecological impacts of these projects, particularly in tropical regions which are faced with food insecurity and malnutrition.

Materials and Methods

Study area: Didessa reservoir is located along Didessa river, one of the largest tributaries of the Blue Nile River. The major tributaries of to Didessa River among others include Rivers of Wama from the East, Dabana from the West and Angar from the East. The catchment area at the Dam site is 5,280 km^2, and it extends to area 8 districts of the two zones (Jima-Arjo and Bedele) of the National Regional State of Oromia. When completed the Dam will be 40.6 m high earth and rock-fill dam.

Fish sampling: The fish communities were sampled by multifilament gill net having (60, 80, 100 and 120 mm) stretched mesh size. Immediately after capture fish species were identified, and the Total (TL) and Total Weight (TW) were measured and weighted to the nearest 1 mm and 0.1 g respectively.

Data analysis: Length-weight relationships parameters were estimated by a linear model fitted to log transformed data using the following formula:

$$\log10\,W\,(g) = \log10\,a + b * \log10\,TL\,(cm)$$

Where W is the fish weight, TL is the total fish length and a and b are LWR parameters.

Length at which 50% of both sexes reach maturity (L_{50}) was determined from the percentages of mature fish that were grouped in 1 cm length classes and fitted to logistic equation described by Echeverria 1987.

$$PL= (\exp(\alpha + \beta L)) / (1+\exp(\alpha + \beta L))$$

Where PL is proportion of mature fish at Length (L) and L, is total length (cm), and α (the intercept) and β (the slope) of least-squares estimates.

The length frequency from gillnet fleets was corrected to provide an unbiased estimate of the length structure by determining the gillnet selectivity by using SELECT (Share Each Length's Catch Total) method. The SELECT method applies maximum likelihood, which estimates selectivity parameters from a general log-linear model.

Catch data were pooled by mesh size into 1 cm length classes, and the midpoint of each size class was used to estimate a selectivity curve for each mesh size. The four gillnet selectivity models (normal location, normal scale, gamma and log-normal) were fitted to the data by using the "gillnet functions" package in R statistical software [6]. For each model, the data were fitted under the assumptions of equal effort and proportional effort to the size of the mesh. Goodness of fit statistics in the form of model deviance was used to choose the best model.

Fish production estimation

Several predictive models, based on a variety of morphological physicochemical and biological parameters, have been developed to provide a general indication of potential fish yields from lakes and reservoirs [7]. From a number of models developed by MARG, 1995 the three models were selected due to their documented positive relationships between catchment area, reservoir area and maximum with fish species richness and production.

Model 1: Area (km^2), catchment area (km^2) and rainfall (mm), (based on 32 lakes and reservoirs, r^2=0.844)

ln (Catch)=-10.502+0.484 * ln (Area)+0.45* ln (Catchment) +1.57 * ln (Rainfall)

Model 2: Area (km^2), altitude (m a.s.l.), (based on 132 lakes and reservoirs, r^2=0.711)

ln (Catch)=3.844+0.891 * ln (Area)+-0.342 * ln (Altitude)

Model 3: Area (km^2), maximum depth (M), (based on 83 reservoirs, r^2=0.820)

ln (Catch)=2.625+0.879 * ln (Area)+ -0.121 * ln (Zmax)

Results and Discussion

Three fish species of two families were recorded in Didesa reservoir (Table 1). In the present study, *Labeobarbus intermedius* dominated the catch, Followed by *Oreochromis niloticus* and *Labeo cylindricus*.

Table 1: Fish species composition of Didessa reservoir.

Family/species	
Cichlidae	**Cyprinidae**
Oreochromis niloticus	*Labeobarbus intermedius*
	Labeo cylindricus

Length-weight relationships: LWRs were highly significant with high coefficients of determination ranging from 0.97 for *Oreochromis niloticus* up to 0.990 for *Labeobarbus intermedius* (Table 2). The exponent b is near to 3.00 for both species, with central value of 2.9 for *Oreochromis niloticus* and 3.14 for *Labeobarbus intermedius* in Dhidesa reservoir.

Table 2: Length weight relationship of fishes in Dhidesa reservoir.

Species	TL (cm)		Regression parameters				
	Min	Max	a	b	b CI 95%	p	R^2
Oreochromis niloticus	19.5	33	0.0256	2.9184	2.691-3.145	<0.001	0.976
Labeobarbus intermedius	20.5	54	0.006	3.1471	2.90-3.38	<0.001	0.99

Sexual maturity: The smallest fully ripe female captured during the sampling period was 27.5 cm for *Labeobarbus intermedius*, the length at first sexual maturity (L_{50}) was 32.9 cm TL while it was 25.4 for *Oreochromis niloticus* at Dhidhesa reservoir.

Gear selectively: The results of the SELECT method fitted for *L. intermedius*, the dominant fish species in Dhidhesa reservoir are given in Table 3. The Log-normal model provided the best fit as it had the lowest deviance value, indicating that both models can describe the gillnet catches proportionally for this species. The normal location (fixed spread) model was the worst fit model.

Table 3: Gear selectivity parameters of Dhidhesa reservoir.

Model	**Fishing power relative to mesh size**		**dof**
	Model deviance	**Null deviance**	
Normal	62.48	62.01	92
Normal_sca	53.61	71.38	92
Gamma	47.61	51.25	92
Lognormal	42.62	47.64	92

Fish production estimation: Based on the morphometric characteristics of the reservoirs, an average fish production of 183 t/year was estimated for Dhidhesa reservoir (Table 4).

Table 4: Estimated annual fish production potential of Dhidhesa reservoir.

Model	**Total yield (t/year)**
1	123
2	143
3	285
Average	**183**

This study represents the first published assessment of length-weight relationships for several species and contributes to the knowledge base of these species for which data were limited. Analysis of length and weight data can be used to mathematically describe this relationship so that one can be converted to another, or to measure variation in expected weight, providing a measure of overall well-being [8].

The range of the exponent b of the LWRs was consistent with the expected range of except *Labeo cylindricus* which has shown unexpected b value, this could be due to the narrow range of fish caught during the study for the species [9]. Further, LWR parameters determined for populations with those published in Fish Base were compared [10]. Parameters a and b were within 95% of observed parameter values based on Bayesian LWR estimates calculated in Fish Base Froese et al. records for *Labeobarbus intermedius*, *Bagrus docmak* and *Mormyrus kannume*.

Length-Weight Relationships (LWRs) are useful for estimating the biomass of stocks when number of specimens by length class are obtained and the parameters a and b of LWRs are useful in stock assessment [11].

Conclusion

Potential species and yield from reservoirs have been related to the trophic status of the water body.

Estimation of potential fish yield has to be estimated for each reservoir to determine the appropriate stocking management regime, which will avoid problems due to over and under-stocking of fish seed. Therefore, this study generated a baseline database on ecology, morpho-edaphic parameters, natural fish diversity patterns and potential fish yield for sustainable utilization and enhancement of fish production in the reservoirs.

In conclusion, results show a clear adaptation and fish colonization pattern for some riverine fisheries in the reservoir during initial impoundment. This helps in establishment of successful fisheries in Reservoir. The results also highlight the importance of considering stocking of *Oreochromis niloticus* as successional patterns of fish colonization in order to improve the fisheries in the future.

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