International Journal of Agriculture, Forestry and Fisheries
2020; 8(2): 72-78
http://www.openscienceonline.com/journal/ijaff
ISSN: 2381-4365 (Print); ISSN: 2381-4373 (Online)

Open Science

Fishers' Perspective on Abundance and Economic Value of *Cherax Quadricarinatus* in Lake Kariba, Zambia

Situmbeko Maurice[1], Nyimbili Bright[1, *], Haambiya Llyod[2], Kanja Kennedy[1], Musuka Confred[1]

[1]Department of Agriculture and Aquatic Sciences, Kapasa Makasa Campus, The Copperbelt University, Chinsali, Zambia

[2]Lake Tanganyika Fisheries Research Unit, Mpulungu, Zambia

Email address

brightnyimbili1974@gmail.com (N. Bright)

[*]Corresponding author

To cite this article

Situmbeko Maurice, Nyimbili Bright, Haambiya Llyod, Kanja Kennedy, Musuka Confred. Fishers' Perspective on Abundance and Economic Value of *Cherax Quadricarinatus* in Lake Kariba, Zambia. *International Journal of Agriculture, Forestry and Fisheries.* Vol. 8, No. 2, 2019, pp. 72-78.

Received: February 19, 2019; **Accepted**: April 7, 2019; **Published**: April 24, 2019

Abstract

A myriad of reports have indicated presence of the invasive red claw crayfish *Cherax quadricarinatus* in Lake Kariba Fishery. It was being harvested as bycatch by artisanal fishers. This study endeavored to measure abundance and economic value of *Cherax quadricarinatus* as perceived by artisanal fishers in Sinazongwe (stratum II) area of Lake Kariba. Interviews employing semi-structured questionnaires were held with artisanal fishers in Sinazongwe (stratum II), fisheries research officers from Department of Fisheries (DoF) at Sinazongwe Fisheries Training Centre and two crayfish traders based in Lusaka who were encountered in one of the five sampled fishing villages. The data were analyzed using SPSS version 16.0 and Microsoft Excel. The inference from this study was that crayfish had increased in abundance in Sinazongwe (stratum II) in Lake Kariba Fishery. This could be due to a combination of factors viz-a-viz: its behavioural traits that enabled it to adapt and thrive in non-native habitats, lack of native predators and the fact that it was not being commercially exploited. The increase in abundance of crayfish had impacted fishers negatively in economic terms by possibly increasing their operational costs as they mended/replaced damaged fishing nets and lessening the value of fish that was caught in their nets but ended up being disfigured via predation by the cray fish. However, studies conducted elsewhere, indicated that crayfish was a source of substantial economical benefits. The same could be achieved by artisanal fishers in Sinazongwe at Lake Kariba Fishery. Nevertheless, for this to materialise, there was need to fully comprehend and address underlying bottlenecks.

Keywords

Fishers' Perspective, Abundance and Economic Value, *Cherax quadricarinatus*, Lake Kariba, Zambia

1. Introduction

Though native to northern Australia and Papua New Guinea, the invasive red claw crayfish *Cherax quadricarinatus* has been widely translocated around the world due to aquaculture and aquarium trade [1-2]. Mostly as a result of escape from aquaculture facilities, this species has established wild populations in Europe, Asia, Central America and Africa [2]. It is highly invasive and causes adverse ecological impacts [3]. No wonder some countries do not promote its introduction and culturing.

The initial introduction in Zambia of *C. quadricarinatus* was in 1992 as an aquaculture species [4]. It has since formed some wild populations in some fisheries within the country. For instance, *C. quadricarinatus* had established feral populations in Siavonga area in the Lake Kariba, but there were no traces of the same in Sinazongwe (stratum II) [5]. Lately though, it had increased its range westwards from Siavonga towards Sinazongwe and it was being harvested as bycatch by artisanal fishers [6].

Lake Kariba (16^0 28'-18^0 06' S; 26^0 40' - 29^0 03'E) is a

man-made reservoir, bordered and almost equally shared by the two riparian countries Zambia and Zimbabwe with 45 percent and 55 percent respectively [7]. The lake stretches for 320 km with an average width of 19.4 km although the widest portion is 40 km. At maximum height, the lake holds 157 million cubic metres of water with an average depth of 29m [7].

It was created in 1950's as a result of damming the Zambezi River for purposes of hydroelectricity production [6]. However, later on a conducive lacustrine niche evolved which currently supports a multispecies fishery with about fifty (50) recorded fish species [6]. Some of these fish species (e.g. *Limnothrissa miodon*) were introduced into Lake Kariba about five decades ago and have since assumed commercial importance. The average annual total fish production fluctuates within 11,500 to 18,500 metric tonnes [6].

The Zambian side of the lake had a fisher population of 27,067 fishers [8]. In 1994, the fishers were re-grouped with the support of Zambia/Zimbabwe SADC Fisheries Project followed by introduction of collaborative fisheries resources management initiative that was meant to manage fishing effort and overall fishing practices on the Lake [7, 9]. Unlike most of the fisheries in Zambia, Lake Kariba, does not close during the national-wide annual fishing ban that runs from December to February the following year. As a result, it attracts a multitude of fishers/traders during this period from all over the country [6].

Basically, there are two types of fishery zones at Lake Kariba. Namely the artisanal fishery (which is based on the native species and is operated mostly by the local people with little capitalisation and the yields are usually low) and the pelagic fishery, which is based on *Limnothrissa miodon* (Kapenta) [8].

Though reports indicated presence of the invasive red claw crayfish *C. quadricarinatus* in Lake Kariba, there have been no studies done to measure its abundance and economic value in Sinazongwe (stratum II) area of the Lake [5, 6, 10]. This study was therefore an attempt to investigate abundance of C. *quadricarinatus* and its economic importance from artisanal fishers' point of view and thus ultimately contribute to informing policy on invasive species and enhancing management strategies.

2. Methods and Materials

In accordance with the principles of Bazigos, Lake Kariba is segmented into four strata namely Mweemba (stratum I), Sinazongwe (stratum II), Chipepo (stratum III) and Siavonga (stratum IV) [11]. These strata are geographical units and form the basis of statistical data collection, reflecting the differences in fish species composition.

This study was conducted in Sinazongwe (stratum II) (Figure 1) in July, 2018. According to the frame survey conducted in 2011 there were 14 fishing villages (of varying sizes) and 4943 fishers in stratum II [8].

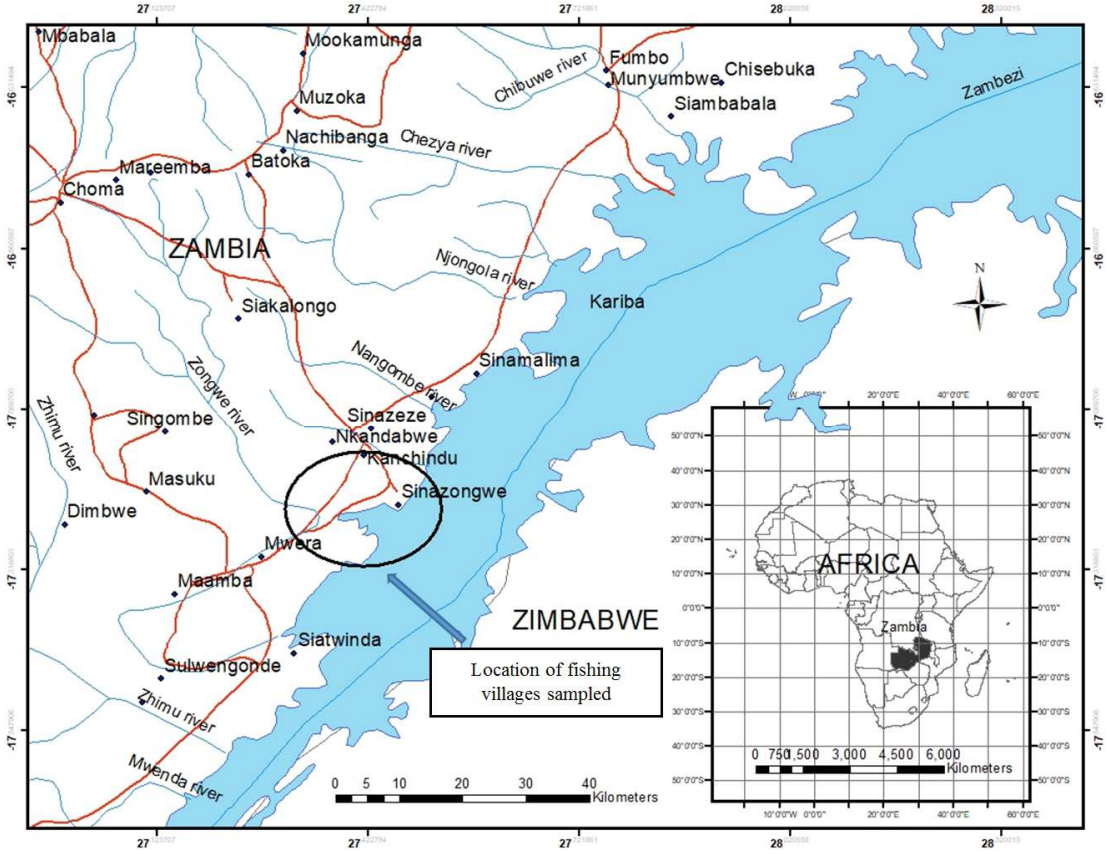

Figure 1. *Sampled fishing villages in Sinazongwe (stratum II) at Lake Kariba.*

Employing simple random sampling technique, 5 fishing villages were selected (Table 1). A quick probe and consultations with village heads in the selected fishing villages, revealed that there were 1026 fishers; out of which 220 respondents were randomly selected and semi-structured questionnaires administered to each one of them. Photos of crayfish *C. quadricarinatus*, which was being investigated, were shown to respondents during the interviews. Through these interviews data on demographics, general fishing operations, abundance of crayfish and its economic significance were gathered.

Structured interviews were also held with 3 fisheries research officers working for the Department of Fisheries (DoF) at Sinazongwe Fisheries Training Centre. They provided information with regards to socio-economic significance of crayfish to the riparian communities in Sinazongwe.

The last group interviewed were the 2 crayfish traders who were encountered in one of the fishing villages named Sinatandabale. They came all the way from Lusaka (capital city of Zambia) to purchase cray fish. The traders provided data on a number of issues pertaining to market niches, prices at which they bought cray fish from fishers. Suffice to mention that during this study, no local crayfish trader was ever encountered.

All these data were analysed using SPSS (version 16.0) and Microsoft Excel.

Table 1. *Distribution of respondents according to location.*

No.	Name of village	Settlement status	No. of respondents
1	Kaduku	Fishing Village	42
2	Ngoma	Fishing Village	39
3	Nzenga	Fishing Village	15
4	Simuzila	Fishing Village	66
5	Sinatandabale	Fishing Village	58
Total			220

3. Results and Discussion

3.1. Gender of Respondents

Gender is defined as social construct that ascribes different qualities and rights to women and men regardless of individual competence or desires [12]. All the respondents (220) interviewed for this study were male. Based on this study, it can be inferred that fishing is male dominated. Besides, traditional and culture in Zambia favours the notion that females should not engage in fishing activities [12]. These findings are in tandem with similar studies done elsewhere [13-14].

3.2. The Number of Years Respondents Had Spent Fishing at Sinazongwe (Stratum II)

Cumulatively, 88% of respondents had been fishing for between 6 and 16 years or more whilst 12% for five years or less (Figure 2). In essence this means that most of the fishers interviewed were not novices per se but had been fishing at Lake Kariba for a considerable period of time, thus rendering credence to their responses with regard to abundance and economic value of *C. quadricarinatus* in Lake Kariba. Furthermore, the long period of time they had been fishing demonstrated importance of the fishery to their livelihoods. It is therefore imperative to prudently safeguard the fishery against potential impacts of the invasive species *C. quadricarinatus*. Otherwise the consequences of inaction are too ghastly to contemplate.

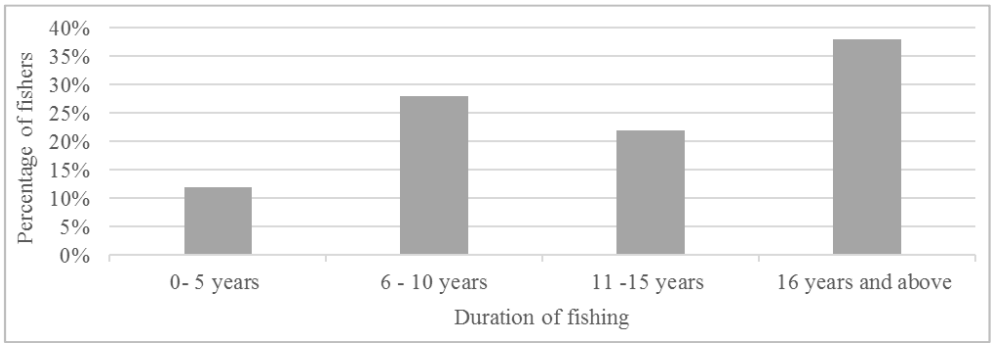

Figure 2. *Years spent fishing at Lake Kariba.*

3.3. Encountering Crayfish in the Catches of Artisanal Fishers

Of those sampled, 4% started noticing crayfish in their catches about 6-10 years ago whilst 96% (Figure 3) indicated that their first encounter with crayfish in their catches was less than 5 years ago. The fact that in the recent past, so many fishers were encountering crayfish could be indicative of the fish having been well established in the new niche and possibly increasing in density. The chances of an invasive species becoming established in a new environment increased if the prevailing conditions are similar to those of its native environment [15]. Crayfish grow best at temperatures of 20–33 °C in their natural range [16]. On average, lake Kariba has a similar temperature range [17]. This without doubt could have promoted growth and establishment of *C. quadricarinatus*. Furthermore, the absence of native freshwater crayfish species and other possible crustacean competitors such as crabs in Lake Kariba created a potential ecological niche for crayfish, thus facilitating their establishment [15].

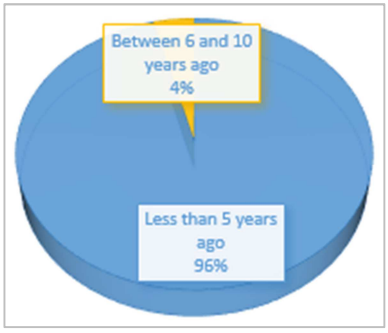

Figure 3. *The first time respondents encountered crayfish in their catches at Lake Kariba.*

3.4. Set Type of Nets Versus Crayfish By-catch

Bottom set gillnet caught highest numbers of crayfish by-catch (almost 68%), followed by top set at 20% and mid set 12.5% respectively (Figure 4). Crayfish are benthic dwelling organisms. However, from time to time, they used the mid and surface waters for feeding purposes [18]. This explains the differences in trends of the amounts of by-catch of *C. quadricarinatus* with respect to the set-type of net.

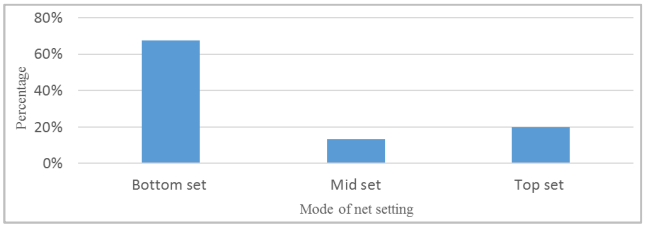

Figure 4. *Bycatch of crayfish according to the mode of net setting.*

3.5. Seasonal Variations in Crayfish Catches

The rainy season which spans from November to April, recorded the highest number of crayfish whist cold season the least (Figure 5). Studies done in some lakes within Southern Africa indicated a positive correlation between water levels and amount of fish catches [19]. At Lake Kariba, the rainy season corresponds with a period of high water levels. This could explain heightened bycatches of *C. quadricarinatus.* Further, water level fluctuations (low-high-low) experienced in any system attributed to seasons, play a significant role in the lake nutrient dynamics, and consequently may have a strong influence on the biological communities and productivity [20]. A study conducted at Kafue River in Zambia, showed that the season with highest bycatch of crayfish was hot season and not rainy season [18]. The differences at the two fisheries regarding season with highest bycatch could be largely due to the two fisheries being different ecosystems. Kariba is a lentic ecosystem whilst the Kafue River is lotic. Hence there was a high likelihood that the behaviour of crayfish differed with prevailing season subject to its habitat and thus the time of the year during which it was very vulnerable to capture as bycatch differed too from fishery to fishery.

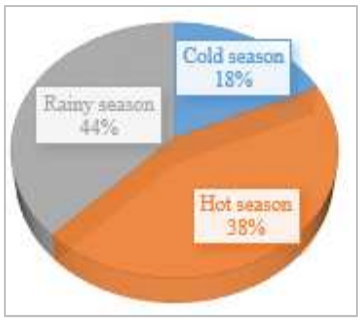

Figure 5. *Variations in the bycatches of C. quadricarinatus with season at Lake Kariba.*

3.6. The Abundance of Crayfish

Most of the respondents (Figure 3) first encountered *C. quadricarinatus* less than five years ago. And when they were queried on its abundance, all of them reported that it was increasing with time based upon the amounts caught as bycatch in their nets. The fact that artisanal fishers in Sinazongwe (stratum II) were experiencing an increase in the bycatch of *C. quadricarinatus* especially that they were not even targeting it, was a clear indication of its heightened levels of biomass. Its increase could be attributed to a myriad of factors: It had high fecundity, tolerated wide environmental conditions, availability of abundant food items along Kariba's shoreline, absence of native predators and the fact that it was not commercially exploited [21-23]. This booming in the population of the invasive *C. quadricarinatus* was very disconcerting for a number of reasons. There was possibility of littoral habitat changes caused by the feeding characteristics of *C. quadricarinatus* leading to competition with, and eventual displacement of, some native littoral fishes in this lake [24]. Invasive aquatic species could threaten biodiversity through predation, competition and possible introduction of new diseases [25]. Interaction between native and introduced species could also lead to structural and functional changes in ecosystems due to changes in trophic structure [26-28].

3.7. Economic Value of Crayfish

Upon harvesting *C. quadricarinatus* as bycatch, a majority of the respondents discarded it (Figure 6) whilst some disposed of it for cash at approximately K5 (about $ 0.40) per kg. This could possibly be due to limited/ no market locally or taboos/beliefs respondents associated this product with [10]. Furthermore, crayfish are not considered important food items for humans by some African countries' standards [29-30]. However, in America and Europe crayfish are considered as important food items and contribute millions of dollars to their economies [31-32].

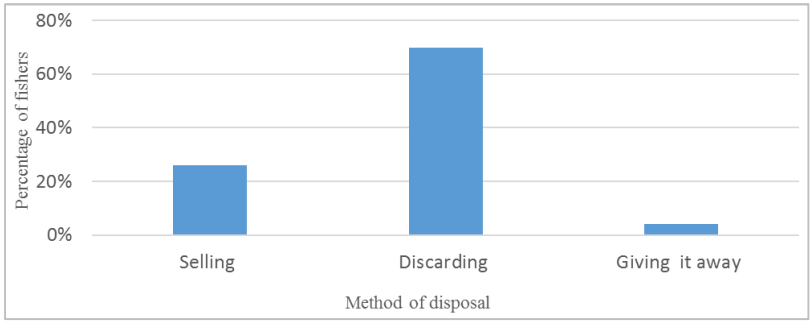

Figure 6. *Disposal methods for crayfish practised by artisanal fishers at Lake Kariba.*

The two buyers from Lusaka encountered during the study, had procured 70 kg of crayfish for supply to Asian, European and American communities located in Lusaka. This was positive news regarding market for the crayfish. Instead of continuing with this wasteful trend of discarding it or giving it away, fishers could sell it to such entrepreneurs. Further, a number of Chinese owned restaurants and hotels in Lusaka had crayfish on their menu [10]. This too was another potential market niche for artisanal fishers in Sinazongwe.

The fishers bemoaned crayfish' devastating abilities on their nets and catch (Figure 7). Crayfish predated and disfigured fish caught in their nets hence possibly lowered the sale price due to compromised quality of the saleable product. Furthermore, it damaged fishing nets and thus likely increased operational costs for the fishers since obviously time and again they had to either replace them with new ones or mend them in order to retain efficacy.

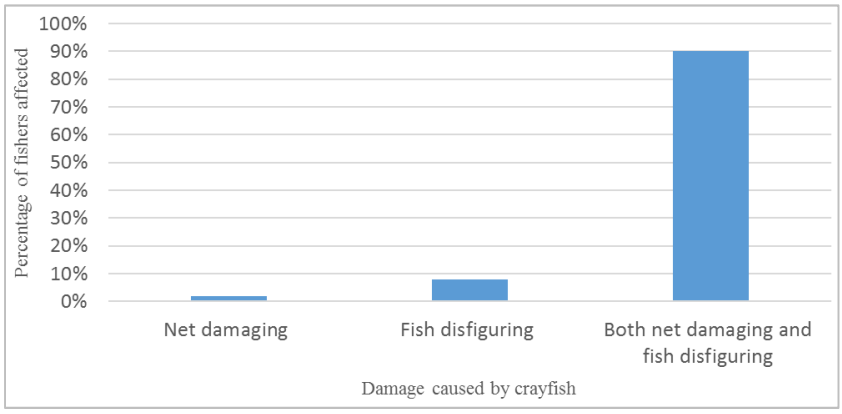

Figure 7. *Effects of cray fish on the nets and fish captured by artisanal fishers.*

Despite concerns raised by the artisanal fishers, the fisheries research officers from DoF were rather upbeat about presence of crayfish in the lake. From a socio-economic point of view, they urged that aside from being a potential source of proteins at household level, fishers could earn substantial revenues by selling it as long as they identified viable market niches. They alluded to presence of two crayfish traders from Lusaka as testimony of available market niche especially along the line of rail. However, it remained to be seen whether fishers would heed such counsel considering the taboos/beliefs associated with crayfish [10]. Such beliefs/taboos need serious addressing prior to persuading fishers to use it as food or locate market niches.

4. Conclusion

Based on this study, crayfish had increased in abundance in Sinazongwe (stratum II) in Lake Kariba. This could be on account of its behavioural traits that had enabled it to adapt and thrive in non-native habitats, lack of native predators and the fact that it was not being commercially exploited. As far as the majority of artisanal fishers were concerned, the economic value of crayfish was in negative terms especially considering that there was limited/no market for it locally in Sinazongwe and furthermore, it unleashed havoc on their fishing nets and disfigured the fish that was caught in same nets thus diminishing its market value. However, studies in Europe and America indicated that crayfish was economically valuable. The same could be achieved in Sinazongwe (stratum II) at Lake Kariba. Nevertheless, for this to materialise, overarching issues such as the manner in which fishers perceived *C. quadricarinatus* needed addressing. Moreover, if numbers are increasing, this invasive species could better be commercially exploited so as to avert/minimize potential negative effects on the native species and the environment.

Acknowledgements

We are grateful to the Higher Education Loans and Scholarships Board for providing funding for this study. We thank staff at Sinazongwe Fisheries Training Centre for the assistance during field work. Lastly, to all the fishers and

traders interviewed during this study, we say a big thank you for your cooperation.

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