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Global trends on inland fishery

Natal,
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Ao meu pai, principal motivo pelo
qual esse trabalho teve continuidade

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Apresentação

Este trabalho teve como objetivo coletar informações globais sobre a pesca de água doce, um serviço ecossistêmico de provisão de grande importância econômica ao redor do mundo. Para isso, foi feita uma ampla coleta de dados na literatura sobre a pesca de água doce ou estuarina para fazer um compilado das informações.

O trabalho é composto por uma revisão bibliográfica, que nos dá uma visão geral de como esses dados estão dispostos. São apresentados os países onde a pesca é estudada, quais as categorias de pesca reportadas, em que ecossistemas ela ocorre, a quantidade de estudos foram gerados a cada ano, o valor gerado pelo pescado desembarcado e quais as espécies mais reportadas nos trabalhos sobre pesca continental no mundo. Para buscar indicativos de produção destas pescarias de água doce, alguns fatores socioeconômicos foram correlacionados com os valores encontrados.

Em geral, os resultados indicam quatro tipos de pescarias de água doce e a captura de mais de 82 espécies, embora a grande maioria dos trabalhos não relate as espécies capturadas. A maior geração de renda deve-se a apenas 33% das espécies. Além disso, há uma profusão de maneiras de reportar os valores econômicos, embora em alguns casos apenas a captura seja descrita sem informações sobre qualquer valor comercial. Assim, este trabalho sintetizou uma ampla heterogeneidade de dados e permitiu algumas sugestões para padronizar a informação para facilitar a determinação da importância social e econômica real das pescarias de água doce, bem como as ameaças a essa pescaria.

Global trends on inland fishing areas and economic values

Silva C.A.C., Carneiro L.C., Carvalho A.R.

Resumo

Além do benefício para segurança alimentar, a pesca de água doce gera uma importante contribuição para a economia tanto em esfera local, regional e internacional. Desta forma, este trabalho teve o objetivo de investigar as quantidades pescadas e os valores gerados por diferentes modalidades de pesca de água doce no mundo e testar a hipótese de que a contribuição econômica da pesca continental de pequena escala é maior em países em desenvolvimento do que das outras modalidades de pesca de água doce em países desenvolvidos. Para tanto, foi feita uma revisão sistemática da literatura e síntese de informações. Assim, pôde-se observar que no período de 2004 a 2015, a produção de pesca de água doce acumulou perda de 775 milhões de toneladas. A produção da pesca de água doce diminuiu acentuadamente a partir de 2010. A pesca de subsistência foi registrada principalmente em África e a pesca em pequena escala prevaleceu na Ásia. A maior produção de pesca foi registrada nos EUA (principalmente recreativa) e no Mali, na África Ocidental. O desenvolvimento da pesca de água doce ainda é encorajado nessas áreas onde corpos d'água estão mal gerenciados, mas os dados aqui reunidos sugeriram o contrário; os ambientes de água doce devem ser monitorados e conservados com o objetivo de conduzir um melhor gerenciamento, uma vez que globalmente a pesca tem sido intensamente praticada nessas áreas.

Palavras-chave: pescas interiores, valor desembarcado, pesca de água doce, pesca continental, valor desembarcado pela pesca interior

Abstract

The benefits of small-scale freshwater fisheries In addition to consumption for food security, they make an important contribution to an economy both locally and regionally, as well as on an international scale, in this way, with the objective of investigating how the Quantities, hake and the values generated by different modes of freshwater fishing in the world and test a hypothesis of an economic contribution of small-scale continental fisheries is higher in developing countries than other forms of freshwater fishing in developed countries. For this, a systematic review of the literature and synthesis of information was made. Thus, it could be observed that in the period 2004-2015 the freshwater fisheries production, accumulated a loss of 775 millions of ton. Freshwater fishery production abruptly decreased markedly from 2010 onwards. Subsistence fishery was chiefly recorded in Africa and the small-scale fishery was prevalent in Asia. The highest fishing production was recorded in USA (mostly recreational) and in Mali, in western Africa. The development of FWF is still encouraged in those areas were inland water bodies are under-utilized and poor managed, but data gathered here suggested otherwise; freshwater environments should be indeed monitored and conserved aiming management since fishery has been intensively performed in these areas through the world.

Keywords: inland fisheries; landed value; freshwater fishery; continental fishery; inland fisheries' value

Introduction

In recent years the world fisheries have been in the bulk of scientific debate in reason of the different evidences about the decline in catches. This debate has often focused in ecological changes and in fishing pressure that cause resource depletion. There are two mainstream points leading this discussion; the first, advocated by Pauly (1998), was based on estimates of the trophic level of 220 fish species and on official landing statistics from FAO (Food and Agricultural Organization) to show that trophic level of global fish landings is decreasing by approximately 0.1 per decade and that this trend would bring 70 percent of current fish stocks into imminent collapse, making urgent implementation of fisheries management and of protected areas closed for fisheries. On the other hand Hilborn (2010) using abundance data indicated that fishing pressure would have been reduced in most of the ecosystems for which data were available and that only 17% of stocks could collapse if overfishing persisted. Even though marine industrial fishing is the main focus of these concerns, freshwater fishing is also important worldwide and has undergone the same process of adaptation to environmental changes and fishing pressure that lead to the decreasing in catches (WELCOME, 2010; ALLAN *et al*., 2005).

Freshwater fishing occurs worldwide and prevails in developing tropical countries as a small-scale, low-cost fishery performed by small vessels with few technology and large family involvement. The global production of these fisheries reached 11.6 million tonnes in 2012 and in 2014 was approximately 11.9 million tonnes (FAO, 2014; FAO, 2016).

Recent estimates indicate that about half of world catches for human consumption come from freshwater fishery, which employs about 90% of all workers involved in the capture of wild organisms and uses almost all the fish caught for human consumption (FAO 2016). These numbers indicate that this fishery plays key role to the survival, well-being and food security for workers in this sector(TEH *etal*. 2011).

However, the benefits of small-scale freshwater fisheries go beyond consumption for food security. The amounts paid for the volume of fish landed or for the work of the people involved in this sector generate an important contribution to the economy at both local and regional levels, as well as on an international scale(BÉNÉ, 2003). However, due to the characteristics of the activity such as part-time dedication, mixed and dynamic involvement through the time (seasonal, occasional or partial) and operations in dispersed and remote places (SMITH, KHOA& LORENZEN, 2005), the quantification of fishers and fishery numbers are still imprecise. This quantification also leads to a lack of information from illegal, unreported or unregulated fisheries (IUU fishing; GALIC & COX, 2005) or of post-harvest losses in reason of the amount of fish discarded or sold at low value due to deterioration or market dynamics (DIEI-OUADI&MGAWE 2011).In addition, in freshwater fishery, boats and fleets are usually small, operate at inland areas, through many environments and in dispersed communities of various sizes. Together, these factors hamper the register and quantification on the volume of fish and economic values generated by this fishery.

The recent paper of GRANTHAM E RUDD (2015) partially provided a useful synthesis on freshwater fisheries studies. However, the study dealt with the methods used for fisheries assessment and valuation, and reported markedly the recreational fisheries in freshwater environments. As a result, the extent of freshwater fisheries in volume landed, fish and environments exploited as well as the economic values generated by species harvested remains underestimated. Despite being less reported, some authors argue that small-scale fisheries in freshwater environments represents the last resource activity for many poor and/or, illiterate people who has insufficient capabilities for assuming other formal job positions and that the activity play an important role in the economies of developing countries(BÉNÉ et al., 2007;BÉNÉ, 2003; SMITH *et al*., 2005; WELCOME, 2010; LYNCH *et al*., 2016).As a result, freshwater fishers would be deeply dependent and affected by socioeconomic features and resource depletion (CARVALHO & BARROS, 2008) and their activity may be expected to have higher socioeconomic importance in underdeveloped and developing countries, which have lower macroeconomic standards. Not surprisingly, freshwater fisheries in these countries are deeply threatened by changes in the continental aquatic environments resulting from the developmental modifications (AGOSTINHO *et al*., 1992; AGOSTINHO *et al*., 2008).

Due to this context, this work aimed to investigate the amount of fish landed and the value generated by different fish species at each modalities of freshwater fishing in the world and to test the hypothesis that the economic contribution of small-scale continental fishing is greater in developing countries than in developed countries. To accomplish it, the available literature was systematically reviewed (*sensu* BOLAND *et al*., 2013) and actively searched to synthetize information on species and quantities caught, fishing sites, landed values, among others. The expectation is to collect global information that may reflects the economic values generated by the species harvested, aiming to underline gaps and provide suggestions to likely standardize few but key information in the reports on freshwater fisheries.

Data Collection

The main theme focused here was the search for economic value of freshwater fisheries. As such, the gathering for studies was made by systematic searching and by active searching. Active search was to extend the information gatheredon this topic and used scientific platforms (such as Scientific Electronic Library Online - SciELO and the Google Scholar.) and the platform Lattes, which is the Curriculum Vitae Database of the National Council for Scientific and Technological Development – CNPq in Brazil. In the CNPq database we used the author's knowledge to search for the publishing of Brazilian researchers who work on freshwater topics but had eventually published in Portuguese language or simply were not found on the databases used. Beyond we carried out a reference tracking identified by "snowballing" (GREENHALGH&PEACOCK, 2005) by scanning the reference lists of full papers and using title or abstract to decide whether to glimpse these further.

The scientific platforms used to the systematic searching were the Thomson Reuters Web of Knowledge (ISI)and The Economics of Ecosystems and Biodiversity database (TEEB). Specifically TEEB database (http://www.teebweb.org/) was included to access technical reports focusing on the values of biodiversity and ecosystem services and for searching those targeting on freshwater or inland fisheries.

The matching of terms used for searching in scientific platforms were (*"Economic* Valu*" OR "Economic* Asess*" OR "economic* viabilit*" OR "Economic* Significance" OR "economic* Indicator*" OR "economic* feasibili*" OR "economic* analysis*" AND "inland fish*" OR "Fresh*water" OR "resource* dependency*" OR "small-scale* fish*" OR "subsistence* fish*" OR "Specie* composition"* specifically excluding the following 38 categories: *genetics heredity, public environmental occupational health, medicine research experimental, mycology, molecular biology, entomology, biotechnology, applied microbiology, microbiology, agronomy, veterinary sciences, horticulture, plant sciences, dairy animal science, agriculture, agricultural economics policy*, *multidisciplinary agriculture, agricultural engineering, civil engineering, construction building technology, mechanics, mechanical engineering, nuclear physics, thermodynamics, energy fuels, coatings films, materials science, chemical engineering, applied chemistry, geochemistry, geophysics, physical geography, interdisciplinary mathematics applications, applied mathematics biochemistry, multidisciplinary geosciences, computer science information systems, interdisciplinary computer science applications, anthropology.*

Study selection and data analysis

During the inspection to verify whether the papers met our goals, we first read title and abstract. If findings indicated the economic estimates of freshwater fisheries the full text was read for seeking the economic and other additional information needed. The paper was assembled mainly if provided any economic value for fisheries regardless the biome, ecosystem (lakes, rivers, floodplains, wetlands, marshes, swamps, mangroves or estuaries) or the period of time assessed. Regarding the period of time of the publication, articles published from 1974 to 2016 were selected. All studies found were divided in technical report or scientific paper. From each paper were collected information on the coordinates of the area addressed, the origin of the researchers, the country and the year of the publication, the type and surface area (in ha) of the ecosystem assessed and its protected status, the type of fishery reported, the total Fish Productivity (t/year), the revenue converted (gross economic value in USD/yr after deflation), profit (net economic value in USD) and valuation method as well as the original currency used.

Regarding to species, information on productivity per species (t/year) and landed value per species (in original currency presented) were recorded when available.

Economic data were standardized by time period (year) and were presented in US dollars. Economic estimates of fisheries were deflated using the inflation rate for the period of the valuation, regardless the values were presented in original currency or directly in US dollars. Rates were applied according to the recorded in https://tradingeconomics.com. Values presented in original currency were converted to values of USD referent to 2016 (through the site http://www.x-rates.com/calculator/?from=INR&to=USD&amount=1) after being deflated. If an economic estimate (i) could not be deflated since reliable inflation rate was not found; (ii) could not be converted to USD/year or (iii) could not be converted to 2016 USD values, the papers presenting such values were excluded form the economic analysis. (Appendix1). When economic values of multiple fisheries were presented in the same paper each fishery was counted separated but referring to the same paper.

To verify the correlation between ecosystem's size and the productivity (to the 20 studies that reported both information) the Spearman coefficient was applied. The difference in freshwater fishing production among ecosystems of higher productivity was tested using the Kruskal-Wallis test. To ecosystems of lower productivity a variance analysis - Anova was performed. To verify whether fresh water fishery landed values are distinct by fishing ecosystem an Anova and à posteriori test were used (Mann Whitney). All the studies included for the analysis are listed in Appendix 2.

Results

A total of 245 were found by the first search. After inspection, 147 studies were selected and 13 were excluded because they did not present the total economic value or the means to calculate it. At the end, 110 scientific papers and 24 technical reports (N = 134) were used. Of the 134 studies, 19% (N=25) were located by systematic searching in the Thomson Reuters Web of Knowledge (ISI), 25% (N=33) were collected in the TEEB dataset, 8% (N=12) were collected by searching for the Lattes Platform and 47% (N=64) were gathered by active searching in the Scielo or Google Scholar (or using the snowballing method.).

Annual global fish production (ton/year) ranged from 189.43 (ton×1000)/year to 779,568.10 (ton×1000)/year. At the beginning of the 21st century the production of freshwater fishery in the world seemed stable (Figure 1), but indicated a marked decrease in the last 5 years (from 2010 to 2015; Table 1).

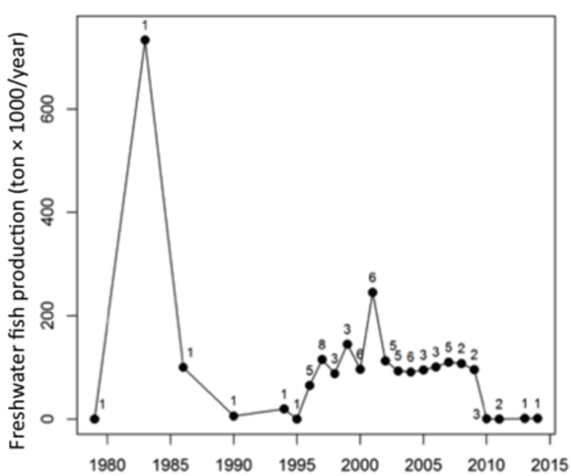


Figure1. Freshwater fishery production in the world reported in selected studies from 1974 to 2016. For each year, it is indicated how many studies provided the information. For the years that there is more than one study, the values were summed (the value of 14000000 t of the work of Postel & Carpenter 1997 was removed because it is a global productivity).

Table 1 -Variation of freshwater fisheries production in the world (in tons per decade; NE = not estimated for this period since only one work was found).

Period	Fishery production (ton x 1000)	Change / 5 years (ton x 1000)	Standard deviation (ton x 1000)

1974-1979	189,43	---	NE
1980-1985	733.468,05	+ 733.278,62	NE
1986-1991	106.264,00	- 627.204,05	2.096.000,67
1992-1997	199.922,90	+ 93.658,85	1.618.985,90
1998-2003	779.568,10	+579.645,20	1.894.476,84
2004-2009	599.436,96	- 180.131,14	237.974,83
2010-2015	3.785,70	- 595.651,26	18.840,49

Most of the scientific papers (57%) are concentrated from the decade 2001 to 2010, coinciding with the publication of most of the technical documents (71%), which were drafted between 2001 and 2008 (Figure 2).

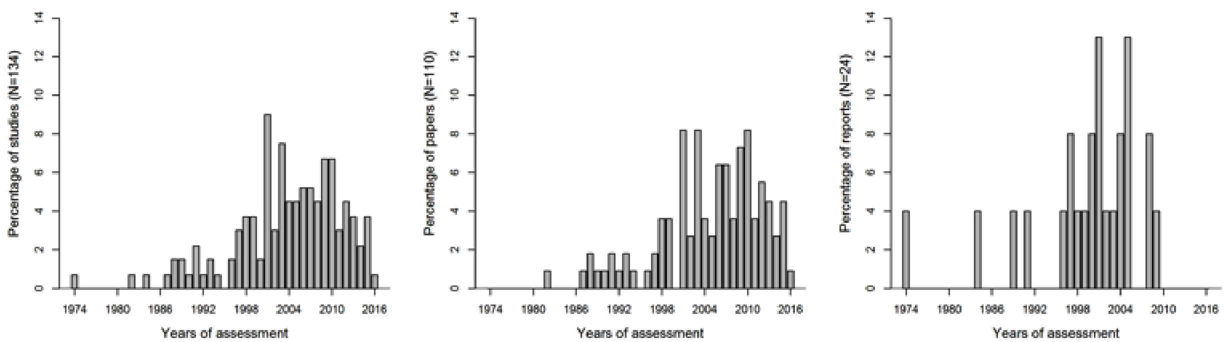


Figure 2. Distribution of selected studies (A), publications (B) and papers (C) reporting the world's freshwater fishery from 1974 to 2016. The scale of the percentage axis reaches the maximum of 14%, to allow better visualization of the data.

The papers come mainly from the North American continent (26.4%), markedly from the United States of America (89.6%). The technical documents come predominantly from the Asian (45.3%) and African (41.6%) continents. This is reflected in the nationality of the researchers who originated the information on freshwater fisheries, since ¼ of them were from the United States of America (25.4%). The second highest percentage of studies comes from Brazil (11.9%), followed by the United Kingdom (8.2%). The others (54.5%) are from 33 other countries on six continents (an average of 1.8 studies per country).

The great majority of the selected studies (61.5%) did not report if there were any protection instruments implemented in the area caught. A few papers (6.4% of N = 110) report fisheries in inland areas where there is some regulated protection instrument, while reports focused more on protected areas (24% N = 24). A small part of the studies was done in partially protected areas (17.8%), in areas where there were regulation instruments (9.6%) or in areas with no regulated protection instrument (11.1%).

Although 56% of the studies consulted reported the size of the study area, only few ones (37.3%) reported the size of the fishing area (Median = 34,830 ha, min = 0.0691, max = 47.752.882,88). The correlation between the size of the ecosystems and the productivity reported (for the 20 works which provided both information) was ρ = 0.72 (p = 0.0003, Figure 3).

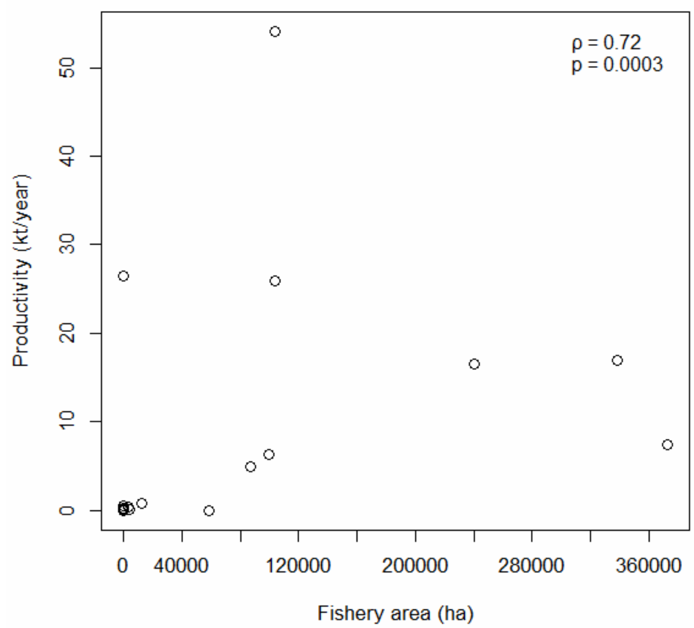


Figure 3. Analysis Spearman correlation reported between productivity and the size of the area fished (20 papers were used to the analysis).

Regarding the delay period between the collection of data of each work and its actual publication, it is observed that is half a year up to seven and a half years. However in the vast majority it was published 3 to 4 years and a half after the data collection (Table2).

Table 2. Average annual time spent between the collection of the data of each work and its publication.

Year of publication	Average delay in publication time (years)
1974	5

1982	3
1984	6.5
1987	1
1988	1.5
1989	5.5
1990	2
1991	2.7
1992	3
1993	5
1994	3
1996	2
1997	3
1998	4.4
1999	3
2000	0.5
2001	1.8
2002	5.8
2003	4.7
2004	4
2005	4
2006	6
2007	6.3
2008	4.2
2009	4.5
2010	5.3
2011	7.5
2012	4.8
2013	6
2014	2.7
2015	4.8
2016	3

Types of fisheries assessed

In total, four types of freshwater fisheries have been identified: small-scale commercial fishing (here referred to as small-scale fishery or SSF), recreational fisheries, subsistence fisheries and aquaculture. Most studies (62.6%) refer to more than one type of fishery occurring in the area (generally two types). However, considering the number of citations, small-scale fishing was the most reported (46.4%), followed by recreational fishing (22.5%), subsistence fishing (21.6%) and fishing of aquaculture (8.6%). Two papers did not clearly state what types of fisheries they were dealing with.

Over time, there has been an upward trend in the number of small-scale and subsistence freshwater fisheries. There was a greater volume of studies on recreational freshwater fisheries in the early 2000s, while the number of studies on aquaculture fisheries in freshwater remained constant (Figure 4).

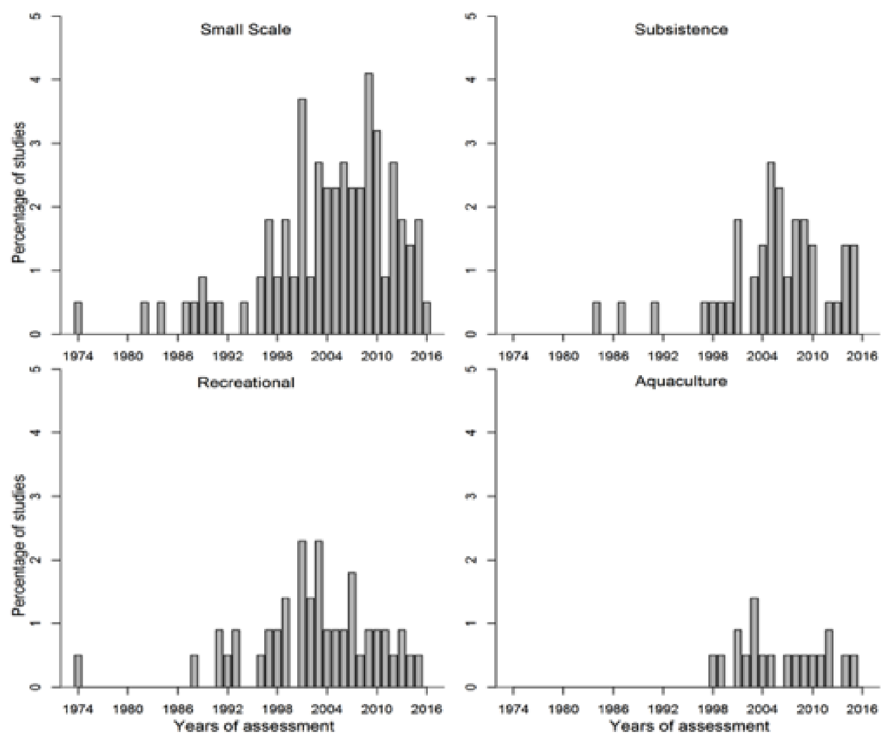


Figure 4. Distribution of studies on different freshwater fisheries from 1974 to 2016.

The proportion of these fisheries varies by continent. The largest proportion of small-scale, subsistence and aquaculture fisheries is practiced on the Asian continent, South America (which stands out in SSF production) and on the African continent (which stands out in subsistence fisheries). Recreation predominates in North America and Europe. Central America and Oceania have low production in all freshwater fisheries. Small-scale fisheries predominate as the most commonly practiced freshwater fishing activity on the African continent and South America (Figure 5).

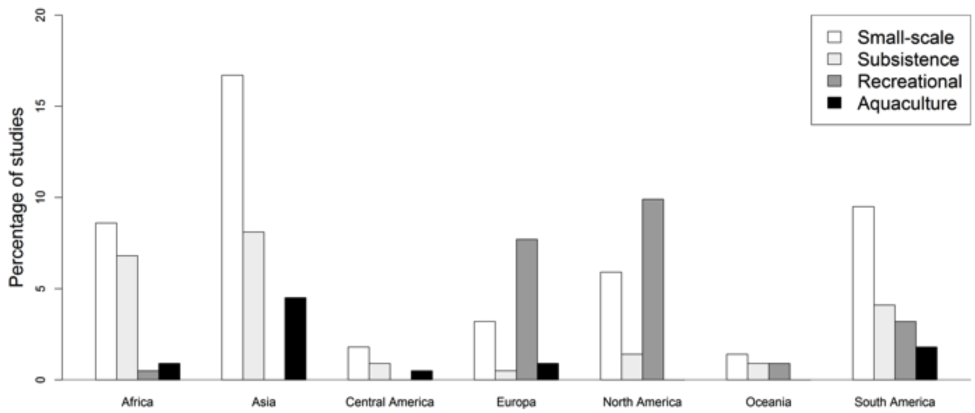


Figure 5. Percentage of works reporting the different freshwater fisheries practiced by the continents in the period 1974 to 2016. The percentage scale of the maximum axis of 20% to allow a better visualization of the data.

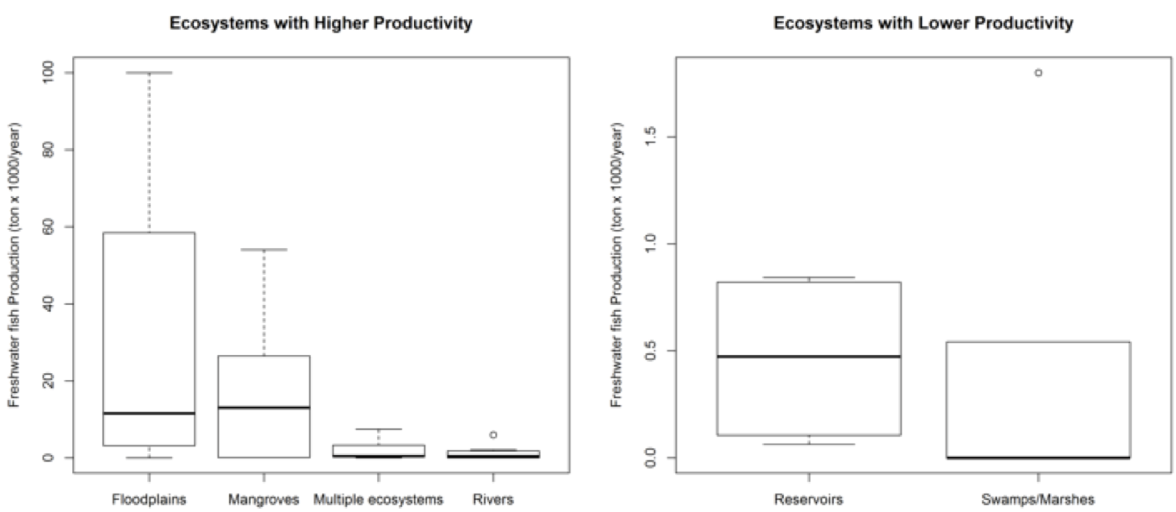
In general, the proportion of ecosystems explored per continent varied, but there was concentration of fishing in rivers (27%) and 23% of studies referred to multiple ecosystems (Table 3).

Table 3 - Relative percentage of each type of ecosystem exploited by freshwater fishing per continent from 1974 to 2016. The number of countries for which the information for each fishing environment was found is given in parentheses.

Ecosystem (Nº of countries)	Africa	Asia	Central America	Europa	North America	Oceania	South America	Percentual
Artificial ponds(2)	0	0.7	0	0	0	0	0.7	1.4
Basin(1)	0	0.7	0	0	0	0	0	0.7
Coastal (1)	0	0	0	0.7	0	0	0	0.7
Estuary(3)	0.7	0	0	0	0.7	0.7	0	2.1
Floodplains(5)	3.6	0	0	0	0	0	0	3.6
Lakes(16)	0.7	3.6	0	2.2	4.3	0	0.7	11.5
Lakes/Reservoir(1)	0	0.7	0	0	0	0	0	0.7
Mangrove(18)	0	8.6	2.2	0	0	1.4	0.7	12.9
Multiple ecosystem(32)	5.8	3.6	0	5.8	4.3	0	3.6	23.1
Reservoirs(7)	0.7	0	0	0.7	0.7	0.7	2.2	5.0
Rivers(38)	0.7	1.4	0	6.5	8.6	0.7	9.4	27.3
Swamps/Marshes(4)	0,.7	1.4	0	0	0	0	0.7	2.8
Tidal Marsh(4)	0	0.7	0	0	2.2	0	0	2.8
Wetlands(7)	2.9	0.7	0	0	1.4	0	0	5.0

% Total (N=139)	15.8	22.3	2.2	15.8	22.3	3.6	18	100.0

The highest freshwater fishery production was reported for the Tidal Marsh environment (733,928.26 t / year), however this information was taken from only two studies in the United States and Sri Lanka (Costanza et al., 1989 and Emerton & Kekulandala, 2003). The second ecosystem with the highest fish production was floodplain (Figure 6). Only studies in four countries reported the fishery production specifically for floodplain areas (Tanzania, Nigeria, Mali and Cameroon).There was no significant difference in fish yield between the most productive ecosystems (Kruskal-Wallis, H = 0.62356, p-value = 0.891) and among low productivity ecosystems (Anova, F = 0.0001405, p-value: 0.9909). If evaluated conjointly the ecosystems, differences are smoothed due to large variation in in production (kruskal-wallis. H = 5.9849; df = 5; p = 0.3077; Figure 6).



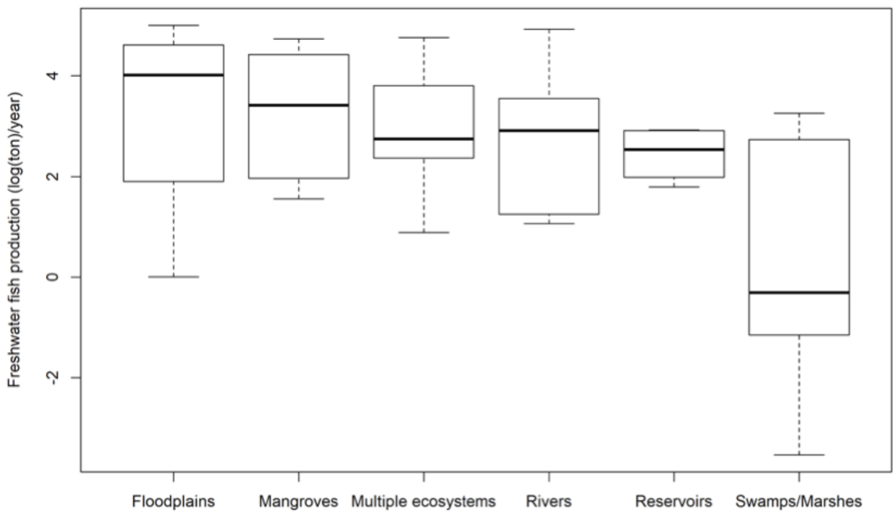


Figure 6. Median global fish production (ton×1000/yr) by freshwater ecosystems from 1974 to 2016(1st quartile = 25%, 2nd quartile = 75%, intervals = decile).Figures have different scales and the below figure is in logarithm scale. Six ecosystems were reported in a few works and are not represented (Artificial ponds: N = 1, 5,097.6 t/year; Lakes: N = 1,4900 t/year; Lakes and Artificial Reservoirs: N = 2; 88,172.85 t/year; Tidal Marsh: N = 2,733,928.26 t/year; and Wetlands: N = 2.16600.6 t/year). The economic values refer to the total gross value generated by the freshwater fishery in these environments globally in the period from 1974 to 2016.

An overview on gross economic value produced by the ecosystems exploited indicated difference in landed values generated by ecosystems in the 42-year period. Income generate by floodplains was significantly different productive ecosystems, like rivers. The lowest values were from reservoirs, swamps / marshes and lakes / artificial reservoirs (Table 4).

Table 4 – Values of Mann-Whitney test between economic value generated at each ecosystem exploited. The values presented at the bottom of the triangular matrix refer to the test result (U) for each pair wise comparison. In the upper part, are set the respective values of significance (p). Bold values indicate significant ($p < 0,05$).The arrows show the most productive ( ) or the lowest productive ( ) ecosystem (EST = Estuary; FLO = Floodplains; LAK = Lakes; MAN = Mangroves; MUL = Multiple Ecosystems; RES = Reservoir; RIV = River; SWA = Swamps e Marshes; TID = Tidal Marsh; WET = Wetland).

Ecosystems	EST	↑FLO	LAK	↑MAN	MUL	↓RES	↑RIV	↓SWA	↓TID	WET
EST	**-**	0.8571	0.1558	0.7757	0.4415	0.0571	**0.0407**	0.0571	0.6666	0.6285
FLO	7	-	0.0614	0.5696	0.2719	**0.0285**	**0.0274**	**0.0285**	0.6484	0.3428
LAK	33	46	-	0.1653	0.2700	0.8784	0.3440	0.5738	**0.0460**	0.9588
MAN	14	20	35	-	0.6741	0.0727	0.0667	0.0727	0.3356	0.8080
MUL	45	63	125	102	-	0.2158	**0.0303**	0.1909	0.2661	0.6216

RES	**12**	**16**	30	27	65	-	1	0.6857	**0.0424**	0.8857
RIV	**60**	**18**	192	133	**363**	46	-	0.7176	**0.0099**	0.7176
SWA	**12**	**16**	34	27	66	10	52	-	**0.0424**	0.6857
TID	8	11	**22**	19	57	**3**	**29**	**3**	-	0.1090
WET	8	12	29	18	54	7	40	6	23	**-**

The species exploited by the freshwater fishery

The capture of 82 species was reported in 77 studies (62% of the papers, N = 110, 37% of the reports, N = 24). Of this total, only 22 studies reported the value per species (29%).

In general, the most fished freshwater species in the world from 1995 to 2011 were Lungfish (*Protopterus annectens*) (41%) and *Oreochromis mossambicus* (15%). The most fished species in the Americas were Tambaqui (*Colossoma macropomum*, 20%, South America) and Tilapia-de-Moçambique (*Oreochromismos sambicus*, 49%, North America). In other continents predominate lungfish (West African lungfish, 91%; Africa), sardines (Clupeidae, 34%; Asia), gray mullet (*Mugil cephalus*; 39%; Oceania) and the barb (*Barbus*spp .; 51%; Europe) .

Eleven species generated very high annual landings ranging from USD 1.3 to USD7.5 million, including *Oreochromis mossambicus* (USD 7.5 million), *Centropomus parallelus* and *Melicertus plebejus* (USD 6.2 and 6.7 million, respectively) . The landed value was high (from 3 million to USD 7.5 million) to 21% of the species caught (17 species) and medium (from 45 thousand to 90 thousand) to 31% of the species (11 species). Most species (52%, 43 species) generated a landed value of whimsy (from USD 1.00 to USD 500.00 / year; n = 21) to very low (USD1000 to USD10,000; n = 10) or low (USD12,000) To 40,000, n = 12, Table 5).

Table 5. The list of species reported in the studies and the value generated by each (USD/year). [1]Only the name of the group is provided, species not reported.

Species	Common name English/Portuguese	Generated value (USD/year)	Classification
Moolgarda seheli	Blue spot mullet	1.23	Negligible annual value landed
Chanos chanos	Milkfish/Peixe-leite	1.43	
Ostorhinchus hartzfeldii	Cardinal fish/Cardinal	3.91	
Gobies (4 spp.)[1]	Gobies/Gobídeo	10.30	
Esox lucius	Northern pike	15.06	
Salmo trutta	Sea trout/Truta	19.79	

Shrimps (4 spp.)[1]	Shrimp/Camarão	33.32	
Rhamdia sp.	Not specified	40.82	
Hoplias malabaricus	Trahira/Traíra	95.80	
Slipmouths (3 spp.)[1]	Slipmouths	148.67	
Crabs NI	Caranguejo	199.26	
Cyphocarax modestus	Saguirú	222.38	
Scombero morustritor	West African mackerel/Peixe-serra	553.38	
Mudcrabs[1]	crab/caranguejo	1,315.89	Very low annual value landed
Parachela oxygastroides/Parambassissiamensis	Glass fishes	1359.14	
Geophagus brasiliensis	Pearl eartheater/Acará	1545.10	
Dasyatis margarita	Daisy stingray	1655.73	
Caranx crysos	Yellowmackerel/Xaréu	1947.92	
Cyprinus carpio	Common carp/Carpa	2090.31	
Astyanax eugenmanniorum	Lambari	2364.64	
Arapaima gigas	Giantarapaima/Pirarucu	9166.32	
Galeoides decadactylus	Guineanthreadfin/Barbudo	10,802.12	
Selenoto camultifasciatus	Southern butterfish	12218.40	Low annual value landed
Hyporhamphus regularisardelio	River garfish	13091.16	
Oreochromis niloticus	Nile tilapia/Tilápia do Nilo	14743.40	
Liza argêntea	Flat-tailmullet	17454.84	
Protopterus annectens	West African lungfish	21056.85	
Auxist hazard	Frigate tuna/Atum	23975.69	
Siluriformes sp.	Not specified	24436.56	
Brachydeuterus auritus	Big eye grunt	26397.32	
Pagellus bellottii	Red Pandora	31237.61	
Pseudotolithus senegalensis	Cassava croaker	34767.49	
Gerres subfasciatus	Common silverbelly	34909.32	
Lutjanus goreensis	Gorean snapper	35317.928	
Dentex congoensis	Congo dentex	47406.862	Moderate annual landed value
Uroteuthis spp.	Not specified	48000.36	
Hyperlophus vittatus	Sandy sprat	48,866.16	
Elegatis bipinnulata	Rainbow runner/Enxova	49,855.04	
Sillago maculata	Trumpeter sillago	51483.96	
Catosto muscatostomus	Longnose sucker	57450.00	
Girella tricuspidata	Parore	58464.48	
Trachurus novaezelandiae	Yellowtail horse mackerel	61082.28	
Trichiurus lepturus	Largeheadhairtail/Espada	69810.12	
Pomato mussaltatrix	Bluefish/Albacora	73300.68	
Platycephalus fuscus	Dusky flathead	89,007.96	

Sardino psneopilchardus	South American pilchard	103,841.06	High annual value landed
Sepia officinalis	Common Cuttlefish	108295.72	
Anguilla sp.	American eel	109949.28	
Sparus caeruleostictus	Blue spotted seabream	110540.25	
Portunus pelagicus	Flower crab	117800.56	
Carcharhinus spp.	Not specified	130016.88	
Sardinella aurita	Round sardinella/Sardinha	151901.17	
Epinephelus aeneus	White grouper/Garoupa	174436.59	
Dentex angolensis	Angolan dentex	174958.99	
Myxus elongatus	Sand grey mullet	190250.40	
Argyrosomus japonicus	Japanese meager	215558.88	
Platycephalus caeruleopunctatus	Blue-spotted flathead	223413.12	
Pseudocaranx georgianus	White trevally/Xaréu	297593.40	
Scylla serrata	Giantmudcrab	303669.36	
Sillago ciliata	Sand sillago	376968.84	
Tilápia	Tilápia	512894.86	
Acanth opagrusaustralis	Surf bream	781,040.40	
Callinectes rathbunae	Sharp tooth swimmin gcrab/xxx	1,359,960.00	Very high annual value landed
Callinectes sapidus	Blue crab/xxx	1,359,960.00	
Macrobrachium acanthurus	Cinnamon river shrimp/Camarão canela	1,554,240.00	
Mugil cephalus	Flathead grey mullet/Tainha	1,733,124.24	
Pimephales promelas	Fathead minnow	1,857,550.00	
Osmerus mordax	Rainbow smelt	2,594,825.00	
Metapenaeus macleayi	School prawn	2,610,901.20	
Centropomu sundecimalis	Common snook/Robalo	4,274,160.00	
Melicertus plebejus	Eastern king prawn	6,254,305.68	
Centropomus parallelus	Fat snook/Cambriaçu	6,702,660.00	
Oreochromis mossambicus	Mozambique tilapia/Tilápia	7,576,920.00	

Discussion

Through a systematic literature review this paper searched for an updating figure on global capture freshwater fisheries and an overview on economic values generated from 1968 to 2016. Most papers and reports were produced in the 2000's when data on freshwater capture fisheries showed an even catch worldwide. In the period 2004-2015 the freshwater fisheries production, accumulated a loss of 775 millions of ton. Freshwater fishery production abruptly decreased markedly from 2010 onwards. At first the lower fishery production could be attributed to the fewer recording. However, the lower production produces an increase in the price/kg and the total income produced (EMERTON, 2005; WAKAMATSY& MUYATA, 2015). Thus the checking in time series of prices per species and total landed value would indicate if production really dropped or just scientific records decreased. This assumption sheds light on the first suggestion emerging from the data gathered here; the clear need for recording economic values of each species harvested by the freshwater fishery and the total landed value, regardless the country.

Papers reporting freshwater fishery - FWF were published mainly in the Americas but markedly the USA while in Asia and Africa data on FWF were recorded mostly by technical reports. Overall mostly studies did not informed if FWF was practiced in areas under whichever measures for fish or habitat protection. Importantly, half of them informed the fish species exploited while only few informed the price per kg.

The size of the precise area fished was informed in only 15% of the studies, but indicated a strong correlation to the fishing production. The FWF production seems to be supported mainly by small-scale fishery, which represented nearly half of all studies. Recreational fishery and subsistence fishery were similarly reported but FWF for recreational purposes was predominantly recorded in USA and Europe. As matter of fact, in the USA recreational fishing is an economically and culturally important activity that involves an estimated 33 million anglers (HUGHES, 2015)

Subsistence fishery was chiefly recorded in Africa and the small-scale fishery was prevalent in Asian and South America. One could argue that these results indicated the bulk of scientific and academic focus on small-scale freshwater fishery. However the greater recording of papers about small-scale fishery worldwide seems to reflect the role of the small-scale fishing communities at supplying freshwater fish and fishing products to local and domestic markets and also for household consumption (FAO, 2003).

The highest fishing production was recorded in USA (mostly recreational) and in Mali, in western Africa. After Asia, Africa is considered the second largest producer of fish from inland waters (≈2.6 millions tonnes/year). Recent data suggests an African production from inland fisheries around 20 millions tonnes being 1 million ton produced by Lake Victoria alone (KOLDING *et al*., 2014b; KOLDING *et al*., 2016). Even though the inland fishery production is less significant than the catches in coastal countries, the production in landlocked countries such as Mali, Niger and Burkina Faso has grown as a result of production from Niger and Senegal rivers (NDIAYE, 2013). Even though the artisanal freshwater fisheries along rivers has becoming increasingly important in the multi-activity livelihoods of poor households (BÉNÉ, 2009; COOMES *et al*., 2009), specifically in Mali, the higher production was likely enabled by the inner Niger River delta and it's highly productive floodplain (FAO, 2016).

Indeed despite our literature review indicated that rivers and multiple environments were the most exploited freshwater environment, floodplains and mangroves were the most productive fishing environments and the former accumulated the higher gross economic returns during the entire period. The inland fishery in Mali had utmost importance for subsistence purpose and, as such, very small fish is likely to lead that fishery. In African countries, most productive fisheries target tiny fish that are consumed locally, turning the importance of catches, economic returns and nourishment into hidden information to catch statistics (KOLDING *et al*., 2016). As these small fish are preserved simply sundried they are available to most African markets at very low cost (BRUMMETT, 2000; FAO, 2016). It would explain why the greatest gross returns in terms of FWF were found in Brazil and South Africa instead of being combined to the highest FWF production.

The development of FWF is still encouraged in those areas were inland water bodies are under-utilized and poor managed (WEYL, 2007), but data gathered here suggested otherwise; freshwater environments should be indeed monitored and conserved aiming management since fishery has been intensively performed in these areas through the world. Fishing statistics however has been scantily taken (GARIBALDI, 2012; KOLDING *et al*., 2016), producing a knowledge-based bias on regards to the use of freshwater environments for fishery and its role for all levels of the economy. Influenced by this under-valuation, decision-makers scientists, and other stakeholders attribute little value to the use of freshwater habitats and few economic benefits associated to its conservation. As a result, freshwater ecosystems have been rapidly modified, over-exploited and converted or degraded in the interests of other uses which appear to yield much higher and more immediate profits (EMERTON, 2005).

Understanding the economics of fisheries is an important tool for management and a valuable framework for prioritizing management activity and expenditures (CHIZINSKI et al., 2005).In industrialized countries the economic importance of fisheries tends to be low but they can still be significant at the regional level (VIRTANEN, 2001). Hence, in developing countries, small-scale fisheries primarily dominate but typically lack landing monitoring programs (BERKES *et al.,*2001;PHILIPPSEN*et al.,* 2016).

In FWF, data limitation seems to preclude not only the account on catches but also the conservation efforts to safeguard the freshwater ecosystems and the economic benefits of freshwater capture fisheries. It is worth to mention that notwithstanding the macroeconomic variables did not significantly influenced productivity or the economic benefits generated by FWF, the socioeconomic situation of each country actually determines priorities and budget availability to fishery statistics, and its continuity. By missing fishery statistics we miss the whole information on FWF contribution for market supply, economies through the world, and nourishment of many people living at various inland ecosystems. Consideration must to be given to the fact that mostly records on FWF result from individual research efforts and despite all the information assembled here from literature, the real numbers on FWF remain unveiled.

Taken as example Brazil, which had the highest gross returns, the fishery statistic for marine fishing is lacking for many parts of the country beyond being quite irregular and imprecise where it exists. For freshwater fishery these statistics were never sampled. There are some statistics such as the 20-year time series dataset for Brazilian Amazon (see PETRERE, 1978a; PETRERE, 1978b; GONÇALVES & BATISTA, 2008), but again it resulted from personal initiatives and not lasted. The lack of data clearly hampers our understanding on FWF real numbers. Thus, the socio-economic role of freshwater fishing, mainly in developing countries is often underestimated (LOPES *et al.,* 2016).

Beyond limitation in data, there is also constrains in those studies available. The economic value produced by FWF is unreported in many cases, either gross or net income. As dataset for price of freshwater fish species does not exists, the values produced for those cases cannot be estimated. Also, the majority of studies do not record the taxonomic identification of fish species exploited or in some case, provided only group of species or vernacular names. Such uncertainties highly restrain our knowledge on the subsistence role of the species harvested and on the importance of the economic flow produced by its fishery.

As our goal was mainly present the economic value produced by FWF, we only included studies reporting economic accounts and as such, we also unreported the entire global production. Even when economic values were provided, not always was clear if values were referring to net or gross values. While in fisheries net value may be considered approximately equal to the gross value (NAYLOR *et al.,* 1998), as a second suggestion, it would be valuable that the registers of FWF worldwide always include proper information on regard to landed value, price per kg/species and ideally, also the profits and cost of FWF. Despite it, *C.*

macropomum and *O. niloticus* showed remarkable economic returns in FWF. The former has been highly overfished since the 1980's and is currently been supplied to the market by aquaculture (MERONA & BITTENCOURT 1988; ISAAC & RUFFINO 1996; ARANTES & FREITAS 2016).

In studies reporting multiple ecosystems, it was impossible detaches all freshwater environments and its catches and economic benefits. For our purpose, these studies were not helpful to uncover the contribution of each freshwater environment fished and represented a loss of nearly ¼ of information. It is worth to mention as a third suggestion that even though the report of fishery in multiple ecosystem echoes the heterogeneity of environments exploited by the small scale fishery, FWF management and the conservation of inland environments would benefit from more precise information on the fishing areas harvested. At last, but not least, it is also worth noting that active searching in gray literature assembled a large proportion of data used here. While it may introduce a considerable bias in the data collected (mainly towards Brazil) it also implies that data on FWF form many other countries were not assessed and remained hidden to the science, managers and decision makers. It indicates that the number shown here are clearly underestimated.

After have considered these caveats, it is noteworthy that fishing scientists do not follow any standardization when reporting freshwater fisheries and routinely, fishing habitats, landed value, prices/kg/species and cost of fishery are missing. As FWF production is clearly underreported the global numbers currently know may be under representing FWF by far. Understanding the distribution of fisheries resource and its real picture in terms of catch and economic contribution by environment is a challenging task, but, as underlined here, highly warranted.

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Apêndices

Appendix 1. Studies that could not have their economic estimates used in the analyzes.

Studies that cannot be used in calculations and economic analyzes	Reason
Emerton, L., L. Iyango, P. Luwum and A. Malinga (1998)	Não foi possível fazer a conversão da moeda original pra dólar.
Hussain, S. A. and Badola, R. (2010)	Não foi possível padronizar a unidade para USD/ano
Tuan, T. H., Van Xuan, M., Nam, D. and Navrud, S. (2009)	Não foi possível fazer a conversão da moeda original pra dólar.
Wedekind, H., Hilge, V., & Steffens, W. (2001)	Não foi possível fazer a conversão da moeda original pra dólar.
Islam, M. S., &Ikejima, K. (2010)	Não foi possível padronizar a unidade para USD/ano
Barbier, E.B., W.M. Adams and K. Kimmage. (1991)	Não foi encontrado índice de deflação para o país/ano
Chong, J. (2005)	Não foi possível fazer a conversão da moeda original pra dólar.
Hamilton, L.S. and Snedaker, S.C. (1984)	Não foi possível padronizar a unidade para USD/ano
Kumari, K. (1996)	Não foi possível fazer a conversão da moeda original pra dólar.
Postel, S. and S. Carpenter (1997)	Não foi possível padronizar a unidade para USD/ano
Naylor, R. and M. Drew (1998)	Não foi encontrado índice de deflação para o país/ano
Emerton, L. (1999)	Não foi encontrado índice de deflação para o país/ano
Karanja, F., L. Emerton, J. Mafumbo and W. Kakuru (2001)	Não foi possível fazer a conversão da moeda original pra dólar.
Kasthala, G., A. Hepelwa, H. Hamiss, E. Kwayu, L. Emerton, O. Springate-Baginski, D. Allen, and W. Darwall (2008)	Não foi possível fazer a conversão da moeda original pra dólar.
Do, T.N. and J. Bennett (2005)	Não foi possível fazer a conversão da moeda original pra dólar.
Ahmed, N., Ahammed, F., &Brakel, M.V. (2008)	Não foi possível padronizar a unidade para USD/ano
Peirson, G., Tingley, D., Spurgeon, J., Radford, A. (2001)	Não foi possível fazer a conversão da moeda original pra dólar.
Tesfaye, A., Wolanios, N. &Brouwer, R. (2015)	Não foi possível fazer a conversão da moeda original pra dólar.
Garbe, J. ,Beevers, L., Pender, G. (2013)	Não foi possível fazer a conversão da moeda original pra dólar.
Acreman, M. C. (2011)	Não foi possível fazer a conversão da moeda original pra dólar.
Kakuru, W., Turyahabwe, N., Mugisha, J. (2013)	Não foi possível padronizar a unidade para USD/ano
Rana, M.P. (2009)	Não foi possível fazer a conversão da moeda original pra dólar.
Britton, J.R., Orsi, M.L. (2012)	Não foi possível padronizar a unidade para USD/ano
Connelly, N.A. & Brown, T.L. (1991)	Não foi possível padronizar a unidade para USD/ano
Chizinski, C.J. et al. (2005)	Não foi possível padronizar a unidade para USD/ano
Israel, D.C. et al. (2007)	Não foi possível fazer a conversão da moeda original pra dólar.
Adekola, O.; Mitchell, G.; Grainger, A. (2015)	Não foi possível padronizar a unidade para USD/ano
Almeida, O., et al. (2011)	Não foi possível padronizar a unidade para USD/ano
Butler, J. R., Radford, A., Riddington, G., & Laughton, R. (2009)	Não foi possível fazer a conversão da moeda original pra dólar.
Navy H &Bhattarai M (2009)	Não foi possível padronizar a unidade para USD/ano
Acuña, V., Diez, J. R., Flores, L., Meleason, M., Elosegi, A. (2013)	Não foi possível padronizar a unidade para USD/ano
Jhonson, N. S., Adams, R. M. (1988)	Não foi possível padronizar a unidade para USD/ano
Kennedy, G. J. A. & Crozier, W.W. (1997)	Não foi possível fazer a conversão da moeda original

	pra dólar.
Arlinghaus R. &Mehner T. (2003)	Não foi possível padronizar a unidade para USD/ano
Carvalho, A.R. (2008)	Não foi possível padronizar a unidade para USD/ano
Shafer, E.L;, Carline, R., Guldin, R.W. & Cordell. H.K. (1993)	Não foi possível padronizar a unidade para USD/ano
Oh, C.-O., Ditton, R.B., Anderson, D.K., Scott, D. & Stoll, J.R. (2005)	Não foi possível padronizar a unidade para USD/ano
Olaussen JO & Liu Y (2011)	Não foi possível padronizar a unidade para USD/ano
Perez-Bote & Roso (2014)	Não foi possível padronizar a unidade para USD/ano
Train KE (1998)	Não foi possível padronizar a unidade para USD/ano
Willis KG &Garrod G (1991)	Não foi encontrado índice de deflação para o país/ano
Willis KG &Garrod GD (1999)	Não foi possível fazer a conversão da moeda original pra dólar.

Appendix 2 – List of studies that matched to the selection criteria and were included for reviewing and analyses performed (Analyses done: 1 = correlation by Spearman coefficient, 2 = Kruskal-Wallis, 3= Mann-Whitney.

Citation	Search method	Reviews in which it was included	Full reference
Gosselink, J.G., Odum, E.P. & Pope, R.M. (1974)	TEEB	3	Gosselink, J.G., Odum, E.P. & Pope, R.M. (1974) The value of the tidal marsh. Center for Wetland Resources, Lousiana State University, Baton Rouge, Lousiana, USA.
Neilson, L. A. (1982)	Active Search	2, 3	Neilson, L. A. (1982) The Bait-Fish Industry in Ohio and West Virginia, with Special Reference to the Ohio River Sport Fishery. North American Journal of Fisheries
Hamilton, L.S. and Snedaker, S.C. (1984)	TEEB	3	Hamilton, L.S. and Snedaker, S.C. (1984) Handbook for mangrove area management. East-West Environment and Policy Institute (Honolulu), 123pp
Marchand, M. (1987)	Active Search	1, 2, 3	Marchand, M. (1987) The productivity of African floodplains. International Journal of Environmental Studies, 29:2-3, 201-211
Jhonson, N. S., Adams, R. M. (1988)	Active Search		Jhonson, N. S., Adams, R. M. (1988) Benefits of increased streamflow: the case of the Jhon Day River Steelhead fishery. Water resourses research. V.24, No. 11: 1839-1846.
Noel, L. E., and W. A. Hubert. (1988)	Active Search	3	Noel, L. E., and W. A. Hubert. (1988) Harvest and Sale of Baitfish in Wyoming, North American Journal of Fisheries Management, 8:4, 511-515

Bell, F.W. (1989)	TEEB	3	Bell, F.W. (1989) Application of wetland valuation theory to Florida fisheries. Sea Grant Publication. SGR-95. Florida Sea Grant Program No. 95. Florida State University, USA.
Costanza, R., S. C. Farber, and Maxwell, J. (1989)	TEEB	3	Costanza, R., S. C. Farber, and Maxwell, J. (1989) Valuation and management of wetlands ecosystems. Ecological Economics 1(4): 335-361.
Carlson, B. N., and C. R. Berry, Jr. (1990)	Active Search	3	Carlson, B. N., and C. R. Berry, Jr. (1990) Population Size and Economic Value of Aquatic Bait Species in Palustrine Wetlands of Eastern South Dakota. Prairie Nat. 22(2):119-128.
Barbier, E.B., W.M. Adams and K. Kimmage. (1991)	TEEB	1,2	Barbier, E.B., W.M. Adams and K. Kimmage. (1991) Economic valuation of wetland benefits: the Hadejia-Jama floodplain, Nigeria. IIED, London, UK.
Connelly, N.A. & Brown, T.L. (1991)	Systematic review		Connelly, N.A. & Brown, T.L. (1991) Net Economic Value of the Freshwater Recreational Fisheries of New York. Transactions of the American Fisheries Society, 120:6, 770-775.
Willis KG & Garrod G (1991)	Active Search		Willis KG & Garrod G (1991) Valuing Open Access Recreation on Inland Waterways: On-site Recreation Surveys and Selection Effects, Regional Studies, 25:6, 511-524
Creel, M. & Loomis, J. (1992).	Active Search	3	Creel, M. & Loomis, J. (1992). Recreation Value of Water to Wetlands in the San Joaquin Valley' Linked Multinomial Logitand Count Data Trip Frequency Model.Water Resources Research. 28 (10): 2597-2606
Shafer, E.L;, Carline, R., Guldin, R.W. & Cordell. H.K. (1993)	Active Search		Shafer, E.L;, Carline, R., Guldin, R.W. & Cordell. H.K. (1993) Economic Amenity Values of Wildlife" Six Case Studies in Pennsylvania. Environmental Management Vol. 17, No. 5,pp. 669-682
Morey ER, Rowe RD & Watson M (1993)	Active Search	3	Morey ER, Rowe RD & Watson M (1993) A repeated nested-logit model of Atlantic salmon

			fishing. American Journal of Agricultural Economics,75, 578-592.
Ruitenbeek, H.J. (1994)	TEEB	3	Ruitenbeek, H.J. (1994) Modelling economy-ecology linkages in mangroves: Economic evidence for promoting conservation in Bintuni Bay, Indonesia. Ecological Economics
Kumari, K. (1996)	TEEB		Kumari, K. (1996) Sustainable forest management: myth or reality? Exploring the prospects for Malaysia. Ambio 25(7): 459-467.
Layman, R. C., Boyce, J.R. & Criddle, K.R. (1996).	Active Search	3	Layman, R. C., Boyce, J.R. & Criddle, K.R. (1996). Economic Valuation of the Chinook Salmon Sport Fishery of the Gulkana River, Alaska, under Current and Alternate Management Plans. LandEconomics 72(1): 113-28
Bann, C. (1997)	TEEB	3	Bann, C. (1997) An economic analysis of alternative mangrove management strategies in Koh Kong Province, Cambodia. Economy and Environment Program for Southeast Asia (EEPSEA research report series), International Development Research Centre.
Postel, S. and S. Carpenter (1997)	TEEB	2	Postel, S. and S. Carpenter (1997) Freshwater ecosystem services. In: G. Daily (ed), "Ecosystem services: their nature and value." Island Press, Washington, D.C., USA.
Baker, D. L., & Pierce, B. E. (1997)	Active Search	3	Baker, D. L., & Pierce, B. E. (1997). Does fisheries management reflect societal values? Contingent valuation evidence for the River Murray. Fisheries Management and Ecology, 4(1), 1-15.
Kennedy, G. J. A. & Crozier, W.W. (1997)	Active Search		Kennedy, G. J. A. & Crozier, W.W. (1997) What is the value of a wild salmon smolt, Salmo salar L.?. Fisheries Management and Ecology. 4: 103 - 110.

Emerton, L., L. Iyango, P. Luwum and A. Malinga (1998)	TEEB		Emerton, L., L. Iyango, P. Luwum and A. Malinga (1998) The present economic value of Nakivubo Urban Wetland, Uganda. National Wetlands Conservation and Management Programme; IUCN: Biodiversity economics for Eastern Africa.
Naylor, R. and M. Drew (1998)	TEEB		Naylor, R. and M. Drew (1998) Valuing mangrove resources in Kosrae, Micronesia. Environment and Development Economics 3: 471-490
Kircheis F.W. (1998)	Active Search	3	Kircheis F.W. (1998) Species composition and economic value of Maine's winter baitfish industry. North American Journal of Fisheries Management,18, 175-180.
Pendleton LH & Mendelsohn R (1998)	Active Search	3	Pendleton LH & Mendelsohn R (1998) Estimating the Economic Impact of Climate Change on the Freshwater Sportsfisheries of the Northeastern U.S.
Train KE (1998)	Active Search		Train KE (1998) Recreation Demand Models with Taste Differences over People. Land Economics, Vol. 74, No. 2. pp. 230-239.
Emerton, L. (1999)	TEEB	2	Emerton, L. (1999) Balancing the opportunity costs of wildlife conservation for communities around Lake Mburo National Park, Uganda. Working paper, Institute for Development Policy and Management, University of Manchester, UK.
Janssen, R. and J.E. Padilla (1999)	TEEB	1, 2, 3	Janssen, R. and J.E. Padilla (1999) Preservation or Conversion? Valuation and evaluation of a mangrove forest in the Philippines. Environmental and Resource Economics 14(3): 297-331.
Kitamura, P.C. et al. (1999)	Active Search	3	Kitamura, P.C. et al. (1999) Avaliação ambiental e econômica dos lagos de pesca esportiva na bacia do Rio Piracicaba. Boletim de Indústria Animal, 56(1), 95-107.
Henderson, M. M., Criddle, K. R., & Lee, S. T. (1999)	Active Search	3	Henderson, M. M., Criddle, K. R., & Lee, S. T. (1999). The economic value of Alaska’s Copper River personal use and subsistence

			fisheries. Alaska Fishery Research Bulletin, 6(2), 63-69.
Willis KG & Garrod GD (1999)	Active Search		Willis KG & Garrod GD (1999) Angling and recreation values of low-flow alleviation in rivers. Journal of Environmental Management 57, 71–83
Turpie, J.K. (2000)	TEEB	2, 3	Turpie, J.K. (2000) The use and value of natural resources of the Rufiji Floodplain and Delta, Tanzania. Rufiji Environmental Managemet Project, Technical report No. 17.
White, A.T., M. Ross and M. Flores (2000)	TEEB	3	White, A.T., M. Ross and M. Flores (2000) Benefits and costs of coral reef and wetland management, Olango Island, Philippines. In: Cesar, H. (ed), "Collected essays on the economics of coral reefs". Kalmar, Sweden: CORDIO, Kalmar University: 215-227.
Verma, M. (2001)	TEEB	3	Verma, M. (2001) Economic valuation of Bhoj Wetland for sustainable use. Indian Institute of Forest Management, Bhopal, EERC Working Paper Series: WB-9.
Seyam, I.M., A.Y. Hoekstra, G.S. Ngabirano and H.H.G. Savenije (2001)	TEEB	3	Seyam, I.M., A.Y. Hoekstra, G.S. Ngabirano and H.H.G. Savenije (2001) The value of freshwater wetlands in the Zambezi basin. Value of Water Research Report Series No. 7, IHE Delft, The Netherlands.
Wedekind, H., Hilge, V., & Steffens, W. (2001)	Systematic review	2	Wedekind, H., Hilge, V., & Steffens, W. (2001). Present status, and social and economic significance of inland fisheries in Germany. Fisheries Management and Ecology 8(4-5): 405-414.
Virtanen, J., Ahvonen, A., & Honkanen, A. (2001).	Active Search	3	Virtanen, J., Ahvonen, A., & Honkanen, A. (2001). Regional socio-economic importance of fisheries in Finland. Fisheries Management and Ecology 8(4-5): 393–403
Karanja, F., L. Emerton, J. Mafumbo and W. Kakuru (2001)	TEEB		Karanja, F., L. Emerton, J. Mafumbo and W. Kakuru (2001) Assessment of the economic value of pallisa district wetlands, Uganda. Biodiversity Economics for Eastern Africa & Uganda's National Wetlands Programme,

			IUCN Eastern Africa Programme.
Peirson, G., Tingley, D., Spurgeon, J., Radford, A. (2001)	Systematic review		Peirson, G., Tingley, D., Spurgeon, J., Radford, A. (2001). Economic evaluation of inland fisheries in England and Wales. Fisheries Management and Ecology, 8, 415-424.
Marta, P., Bochechas, J., Collares-Pereira, M.J. (2001).	Systematic review	2, 3	Marta, P., Bochechas, J., Collares-Pereira, M.J. (2001). Importance of recreational fisheries in the Guadiana River Basin in Portugal. Fisheries Management and Ecology, 8, 345-354
Almeida, O. T., McGrath, D. G., Ruffino, M. L. (2001).	Active Search	2, 3	Almeida, O. T., McGrath, D. G., Ruffino, M. L. (2001). The commercial fisheries of the lower Amazon: na economic analysis.Fisheries Management and Ecology. 8: 253-269.
Changeux, T., Bonnieux, F., Armand, C. (2001)	Systematic review	3	Changeux, T., Bonnieux, F., Armand, C. (2001) Cost benefit analysis of fisheries management plans. Fisheries Management and Ecology. 8,42-434.
Kvist, L. P., Gram, S., Cácares C., A., Ore B., I. (2001).	Active Search	2, 3	Kvist, L. P., Gram, S., Cácares C., A., Ore B., I. (2001). Socio-economy of flood plain households in the Peruvian Amazon. Forest Ecology and Management 150: 175 - 186.
Takasaki, Y., Barham, B.L. & Coomes, O.T. (2001)	Active Search	3	Takasaki, Y., Barham, B.L. & Coomes, O.T. (2001). Amazonian Peasants, Rain Forest Use, and Income Generation: The Role of Wealth and Geographical Factors. Society & Natural Resources: An International Journal, 14:4, 291-308.
Schuijt, K. (2002)	TEEB	1, 3	Schuijt, K. (2002) Land and water use of wetlands in Africa: economic values of African Wetlands. Interim Reports. International Institute for Applied Systems

			Analysis, Laxenburg, Austria.
Shrestha, R.K., et al. (2002)	Active Search	2, 3	Shrestha, R.K., et al. (2002) Value of recreational fishing in the Brazilian Pantanal: a travel cost analysis using count data models. Ecological Economics. 42, 289–299.
Kerkvliet, J., Nowell, C. & Lowe, S.(2002).	Active Search	3	Kerkvliet, J., Nowell, C. & Lowe, S.(2002). The Economic Value of the Greater Yellowstone's Blue-Ribbon Fishery. North American Journal of Fisheries Management 22:418–424
Provencher B, Baerenklau KA & Bishop RC (2002)	Active Search	3	Provencher B, Baerenklau KA & Bishop RC (2002) A Finite Mixture Logit Model Of Recreational Angling With Serially Correlated Random Utility. Amer. J. Agr. Econ. 84(4): 1066–1075
Van Beukering, P.J.H., H.S.J. Cesar and M.A. Jansen (2003)	TEEB	3	Van Beukering, P.J.H., H.S.J. Cesar and M.A. Jansen (2003) Economic valuation of the Leuser National Park on Sumatra, Indonesia. Ecological Economics 44(1): 43-62.
Emerton, L. and L.D.C.B. Kekulandala (2003)	TEEB	1, 3	Emerton, L. and L.D.C.B. Kekulandala (2003) Assessment of the economic value of Muthurajawela Wetland. Working Paper. IUCN, Sir Lanka, 28pp.
Turner, R.K., J. Paavola, P. Cooper, S. Farber, V. Jessamy and S. Georgious. (2003)	TEEB	3	Turner, R.K., J. Paavola, P. Cooper, S. Farber, V. Jessamy and S. Georgious. (2003) Valuing nature: lessons learned and future research directions. Ecological Economics 46(3): 493-510.
Knowler, D.J. et al. (2003)	Systematic review	3	Knowler, D.J. et al. (2003). Valuing freshwater salmon habitat on the west coast of Canada. Journal of Environmental Management 69, 261–273.
Ronnback, P. et al. (2003)	Systematic review	3	Ronnback, P. et al. (2003) Mangroves dependence and socio-economic concerns in shrimp hatcheries of Andhra pradesh, India. Environmental Conservation 30(04):344 - 352.
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			river (brazil). Braz. J. Biol. 63(4): 673-682, 2003
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Henderson, J. E., Kirk, J. P., Lamprecht, S. D., Hayes, W. E. (2003)	Active Search	3	Henderson, J. E., Kirk, J. P., Lamprecht, S. D., Hayes, W. E. (2003) Economic Impacts of Aquatic Vegetation to Angling in Two South Carolina Reservoirs. J. Aquat. Plant Manage. 41: 53-56.
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Salonen, E. & Mutenia, A.	Active Search	3	Salonen, E. & Mutenia, A. (2004). The

(2004).			commercial coregonid fishery in northernmost Finland - A review. Annales Zoologici Fennici, 41, 351-355.
Paulrud A & Laitila T (2004)	Active Search	3	Paulrud A & Laitila T (2004) Valuation of management policies for sport-fishing on Sweden's Kaitum river, Journal of Environmental Planning and Management, 47:6, 863-879
Toivonen A, Roth E, Navrud S, Gudbergsson G, Appelblad H, Bengtsson B & Tuunainen P (2004)	Active Search	3	Toivonen A, Roth E, Navrud S, Gudbergsson G, Appelblad H, Bengtsson B & Tuunainen P (2004) The economic value of recreational fisheries in Nordic countries. Fisheries Management and Ecology, 11, 1–14
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Chong, J. (2005)	TEEB		Chong, J. (2005) Valuing the role of aquatic resources in Livelihoods: economic aspects of community wetland management in Stoeng Treng Ramsar Site, Cambodia. IUCN Water, Nature and Economics Technical Paper No. 3.
Do, T.N. and J. Bennett (2005)	TEEB	1, 2	Do, T.N. and J. Bennett (2005) An economic valuation of wetlands in Vietnam's Mekong Delta: a case study of direct use values in Camau Province. Occasional Paper No. 8. Environment Management and Development Program, APSEG, ANU.
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Chizinski, C.J. et al. (2005)	Systematic review		Chizinski, C.J. et al. (2005). Economic Value of Angling at a Reservoir with Low Visitation, North American Journal of Fisheries Management, 25:1, 98-104.

Oh, C.-O., Ditton, R.B., Anderson, D.K., Scott, D. & Stoll, J.R. (2005)	Active Search		Oh, C.-O., Ditton, R.B., Anderson, D.K., Scott, D. & Stoll, J.R. (2005) Understanding Differences in Nonmarket Valuation by Angler Specialization Level, Leisure Sciences: An Interdisciplinary Journal, 27:3, 263-277
Jones, J.P.G. et al. (2006).	Systematic review	3	Jones, J.P.G. et al. (2006). The economic importance of freshwater crayfish harvesting in Madagascar and the potential of community-based conservation to improve management. Oryx, Vol 40 (2): 168–175.
Rivera, E.S. & Guerrero, Y.C.(2006)	Systematic review	3	Rivera, E.S. & Guerrero, Y.C.(2006). Beneficios económicos de los flujos de agua en el delta del Río Colorado: consideraciones y recomendaciones iniciales. Gaceta Ecológica, núm. 80, pp. 51-62.
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Faria Júnior, C. H., & Batista, V. S. (2006).	Active Search	3	Faria Júnior, C. H., & Batista, V. S. (2006). Repartição da renda derivada da primeira comercialização do pescado na pesca comercial artesanal que abastece Manaus (Estado do Amazonas, Brasil). Maringá 28 (1):131-136
Petrere Jr. M., Walter, T. & Minte-Vera, C.V. (2006).	Active Search	1, 2, 3	Petrere Jr. M., Walter, T. & Minte-Vera, C.V. (2006). Income Evaluation of Small - Scale Fishers in Two Brazilian Urban Reservoirs: Represa Billings (SP) and Lago Paranoá (DF). Braz. J. Biol., 66(3): 817-828.
Ringler, C. & Cai, X. (2006).	Active Search	3	Ringler, C. & Cai, X. (2006). Valuing Fisheries and Wetlands Using Integrated Economic-Hydrologic Modeling—Mekong River Basin. J. Water Resour. Plann. Manage. 132:480-487.
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			Economic Effects of Fishery Improvements. North American Journal of Fisheries Management 26:301–307
Barbier, E.B. (2007)	TEEB	3	Barbier, E.B. (2007) Valuing ecosystem services as productive inputs. Economic Policy 22(1): 177-229.
Samonte-Tan, G.P.B., A. T. White, M. A. Tercero, J. Diviva, E. Tabara and C. Caballes (2007)	TEEB	3	Samonte-Tan, G.P.B., A. T. White, M. A. Tercero, J. Diviva, E. Tabara and C. Caballes (2007) Economic Valuation of Coastal and Marine Resources: Bohol Marine Triangle, Philippines. Costal Management 35(2): 319-338.
Israel, D.C. et al. (2007).	Active Search	2	Israel, D.C. et al. (2007). Economic Valuation of Aquatic Resources in Siem Reap Province, Cambodia, Journal of Sustainable Agriculture, 31:1, 111-135.
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Weyl, O.L.F., Potts, W., Rouhani, Q. & Britz, P. (2007)	Active Search	2, 3	Weyl, O.L.F., Potts, W., Rouhani, Q. & Britz, P. (2007). The need for an inland fisheries policy in South Africa: A case study of the North West Province. Province. Water SA,33, 497-504.
Rolfe J & Prayaga P (2007)	Active Search	3	Rolfe J & Prayaga P (2007) fishing Estimating values for recreational fishing at freshwater dams in Queensland. The Australian Journal of Agricultural and Resource Economics, 51, pp. 157–174
Walter, T. and Petrere Jr., M (2007)	Active Search	1, 2, 3	Walter, T. and Petrere Jr., M (2007) The small-scale urban reservoir fisheries of Lago Paranoá, Brasília, DF, Brazil. Braz. J. Biol., 67(1): 9-21
Adekola, O., S. Moradet, R. de Groot and F. Grelot (2008)	TEEB	1, 2, 3	Adekola, O., S. Moradet, R. de Groot and F. Grelot (2008) The economic and livelihood value of provisioning services of Ga-Mampa

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