FAO Fisheries and Aquaculture Circular No. 942, Rev. 2 **FIRF/C942, Rev. 2 (En)**

ISSN 2070-6065

REVIEW OF THE STATE OF THE WORLD FISHERY RESOURCES: INLAND FISHERIES

Copies of FAO publications can be requested from:
Office of Knowledge Exchange, Research and Extension
Food and Agriculture Organization
of the United Nations
E-mail: publications-sales@fao.org
Fax: +39 06 57053360
Web site: www.fao.org/icatalog/inter-e.htm

REVIEW OF THE STATE OF THE WORLD FISHERY RESOURCES: INLAND FISHERIES

Robin Welcomme
Imperial College, London
United Kingdom

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Rome, 2011

ISBN 978-92-5-107078-9

PREPARATION OF THIS DOCUMENT

This document represents the second revision of Fisheries Circular No. 942, and is a key document in the Food and Agriculture Organization of the United Nations (FAO) Fisheries and Aquaculture Department's efforts to provide accurate and timely information on fishery resources. It reviews global inland capture fisheries for food production. It also explores the increasingly important recreational fisheries sector (see Annex III), although there is no systematic reporting of this to the FAO or to any other organization with global scope. The objectives of this review are:

- to update and expand the scope of the 2003 Review of the State of World Fishery Resources: Inland Fisheries, Revision 1 (FAO, 2003);
- to place inland capture fisheries in the context of overall world fish production and other sources of animal protein;
- to review the status and trends of inland fisheries production at global, continental and subcontinental levels;
- to call attention to the importance of inland capture fisheries with respect to food security and human development; and
- to call attention to the main issues facing inland fisheries.

The present version differs from earlier versions of Circular No. 942, (Rev. 1) in the following ways:

- the continental analysis is refined to subcontinental regions;
- updating of FAO statistical information is through 2009;
- indicators of the importance of inland capture fisheries production have been added including:
  - per capita production;
  - production per unit area;
  - ten-year trends; and
  - comparisons with other animal protein sources.
- inclusion in the annex of an analysis of the effect of large changes in national reports of inland capture fisheries statistics on the global trend;
- inclusion of an annex on recreational fishing; and
- inclusion of boxes highlighting items of particular interest.

Welcomme, R.
Review of the State of the World Fishery Resources: Inland Fisheries.
FAO Fisheries and Aquaculture Circular No. 942, Rev. 2. Rome, FAO. 2011. 97 pp.

ABSTRACT

The fishery statistics reported to FAO by countries and maintained in the FishStat database are analysed for trends in quantity and composition of catches from 1950 to 2009. Catches have been increasing at a steady rate throughout the period. Fish from inland water capture fisheries are an important source of animal protein, especially in landlocked countries and for populations riparian to lakes and rivers. Finfish contribute about 90 percent of the catch together with some crustaceans and molluscs. The accuracy of reporting of catches by taxonomic group has improved with time and more groups are being reported in 2009 than in 1950. At the same time, the percentage of catches assigned to the generic "freshwater fishes NEI" category has declined. Trends in catches and taxonomic groups are analysed for subcontinental regions under a more general continental heading. The regions are divided mainly by geography, although in some cases economic and political considerations are used. Catches in the various regions of Africa, Asia and South and Central America have risen steadily over the period of the review, although there are local exceptions to the general trend. There is clear evidence that such increases are real in some individual fisheries, but generally the increases are attributed to improvements in reporting, whereby catches that were already there but previously ignored are now being incorporated into the reports. Catches in North America, and most of Europe, have declined in the same period, which is attributed to shifts in economic conditions that make fishing not longer financially viable, and a greater public demand for recreational fishing. Catches from eastern Europe and the Russian Federation declined from a maximum in the 1980s, but have shown some signs of recovery in the last decade. In general, the world's inland fisheries still appear viable although environmental pressures, such as damming, water abstraction and overexploitation, pose a potential threat to the maintenance of present levels of reproduction and recruitment, and hence, ultimately catch.

CONTENTS

ANNEXES

LIST OF FIGURES

LIST OF TABLES

LIST OF BOXES

1. INTRODUCTION

Current views on inland fisheries are contradictory. There is the "inland fisheries are doomed" view (see Friend *et al*., 2009), which assumes that the numerous threats to aquatic ecosystems posed by man's activities will inevitably lead to a decline of aquatic resources. This view is supported by many individual studies and reports from all continents, which allege that catches are falling, species disappearing, and that there are many of the symptoms of chronic overfishing at the level of individual species or whole communities (see, for example: Thorpe *et al*., 2009, for Kyrgyzstan and other countries of the former Union of Soviet Socialist Republics (USSR), and Aps, Sharp and Kutonova, 2004, for Central and Eastern Europe; other examples see footnote[1]). The foundation of this view is the large number of threats to inland aquatic systems, including:

- Bad or inexistent fishery management – including uncontrolled and excessive fishing, fishing with inappropriate or illegal mesh sizes, and introductions of exotic and invasive species.
- Water abstractions – there is a growing trend in Africa for river flow to be diverted for irrigation either directly or from reservoirs.
- Land drainage – there is an increasing trend to drain wetlands and separate floodplains from the river channel. This results in a loss of living area and threats to many guilds of fish.
- Dam construction – with the fuel crisis facing the world there has been an increase in proposals for construction of large dams. For example, there is a project for the construction of a major dam at Ayourou in the Niger and another for a main stem dam across the Congo River. The impacts of such dams on the fish fauna downstream have usually not been assessed as it is believed all too often that the creation of the reservoir upstream of the dam has a compensatory effect through the creation of new fisheries in this reservoir. However, this effect does not offset the negative effect of the damming.
- Pollution/eutrophication – pollution has important local effects in rivers and in lakes. In lakes, eutrophication is an increasing threat from the growing levels of human population around their shores and a lack of proper wastewater treatment systems in place in many areas.
- Climatic variability/change – climatic variation has always been a severe problem, especially in the drought-prone belts of the Sahel and southern African region. These effects are likely to become more severe as global warming progresses.

In contrast to this pessimistic view of the present status and future of inland fisheries resources, catches are still recorded as rising at an apparently linear rate of increase of about 3 percent per year globally. There is also widespread expert opinion that much of the catch from inland fisheries is unrecorded. As a result, inland fishery catches are generally underestimated, and in some of the most productive fisheries seriously so. This is mainly because of the diffuse and small-scale nature of individual fisheries where there are no definable landings and much of the catch goes directly into domestic consumption. Typical examples of such catches are the fisheries on the numerous low order rivers and streams, which together may contribute a considerable amount of fish. This was noted by Welcomme as early as 1976 (Welcomme, 1976) and has not generally been rectified, although it is admitted by several countries. Specific examples include the general omission of wild fish catches in rice fields. Studies such as that of Hortle, Troeung and Lieng (2008) show production levels for rice fields to be high and, given their total area, the accumulative fish production is very significant. Indeed, where rice fish yields have been incorporated into the statistics, such as in Bangladesh and Cambodia, reported catches have increased. Similarly, under-reporting may occur in the regular collection of statistics. For example, in Africa, Braimah (2000, 2001, 2003) estimated that the catches from Lake Volta are considerably underestimated. In Asia, Lymer *et al*. (2008a) review the inland and marine statistics reported by Thailand and note that considerable underestimation of inland waters may be occurring, and Van Zahlinge *et al.* (2004) and Hortle (2007) increased the estimates on production from the lower Mekong basin by a factor of about three. More recently, the Big Numbers Project estimated that inland fishery catches were about 14 million tonnes.

[1] See, for example: www.bowdoin.edu/news/archives/1academicnews/004631.shtml for Lake Mweru in Africa; and http://news.bbc.co.uk/1/hi/world/africa/6261447.stm for Lake Chad in Africa.

Inland fishery statistics are generally submitted to the Statistics and Information Service (FIPS) of the Fisheries and Aquaculture Department of FAO by national correspondents in the appropriate ministry of Member Countries. Data reported by countries are carefully checked, and when the figures are questionable the national correspondent is consulted for clarification. The statistics made available by the national authorities can be complemented or replaced if better data from other origins are available. If a country does not report its catches despite several reminders, or if those provided are considered not to be reliable, FAO estimates the missing data and marks them in the database with an "F". In 2009, FAO estimated catches in 38 percent of countries (see Table 1). However, the quality of the FAO statistics depends upon the accuracy and reliability of the data collected nationally and provided to FAO. The data compiled are stored in the FishStat database and are available for analysis. Catches for all countries reporting catches over the last ten years are listed in Annex 1.

Table 1: Number of countries for which the FAO had to estimate inland catches in 2009

Continent	Countries with inland fish catches	Countries for which catch was estimated (No.)	Countries for which catch was estimated (%)	Tonnage reported	Tonnage estimated	Total tonnage estimated (%)
Africa	43	22	51.16	2 502 570	1 134 880	45.35
Asia	31	9	29.03	6 740 366	58 014	0.86
Europe, including the Russian Federation	40	8	20.00	403 355	11 670	2.89
North America	2	0	0.00	55 644	0	0.00
Oceania	7	4	57.14	17 786	15 706	88.31
South and Central America	22	12	54.55	500 908	405 486	80.95
Total	145	55	37.93	10 220 629	1 625 756	15.91

The accuracy of inland fisheries statistics has long been questioned; see, for example, Coates (2002), in his discussion on the deficiencies of inland catch recording for Southeast Asia, as well as the comments in FAO Fisheries Circular No. 942, Rev. 1, and the annotations in the *The State of World Fisheries and Aquaculture* (SOFIA) sections on inland fisheries (FAO, 2002, 2004, 2007, 2009). Recent studies (World Bank, 2010; Mills *et al.*, 2011) conclude that world inland fish catch is between 11 and 14 million tonnes/year, and the FAO Big Numbers Project supported the larger of these estimates. Thus, some of the increases registered appear to be through better reporting of data and the inclusion of the so far unreported fisheries, such as floodplains and rice fields, in the statistics, consistent with this higher estimate.

These various factors make it difficult to determine whether there are actual increasing trends in the fisheries or whether the fisheries have been at a higher level of real production for some time and the trends are only a statistical artefact tending towards this higher estimate. Therefore, all discussions of trends in this document refer to the trends in the statistics appearing in FishStat and do not necessarily reflect actual increases or decreases in production.

In order to adjust for the effects of irregularities in reporting by individual countries on regional trends, the year-to-year changes in catch (per country) were analysed by looking at the percentage change since the previous year by Lymer & Funge-Smith (2009) for the Indo-Pacific countries and by Welcomme and Lymer (2009) for Africa. This used two criteria to detect large irregularities in reporting:

- criterion 1: any year-on-year change greater than 40 percent, which is considered a significant change from the previous year; and
- criterion 2: individual country changes of more than 30 percent when compared with the regional average change.

Catches for countries that were selected using criterion 2, together with those showing reports of large negative changes of more than 30 percent (absolute value) of the average regional increase, were adjusted to smooth out any individual large increases backwards across the data series. The adjusted trends at continental level are presented in the relevant section of this circular for comparison. An analysis of the effect of large changes in national reports of inland capture fisheries statistics on the global trends is presented in Annex 2.

In this fisheries circular, inland fisheries are taken to include finfish, molluscs and crustaceans, and exclude crocodiles,[2] other reptiles and mammals.

2. GLOBAL TRENDS IN INLAND CAPTURE FISHERIES

Global reported fish production from all sources (marine, aquaculture and inland) has been increasing at a linear rate of 3.78 percent per year from 1950 to the current (2009) level of 158 159 993 tonnes (Figure 1).

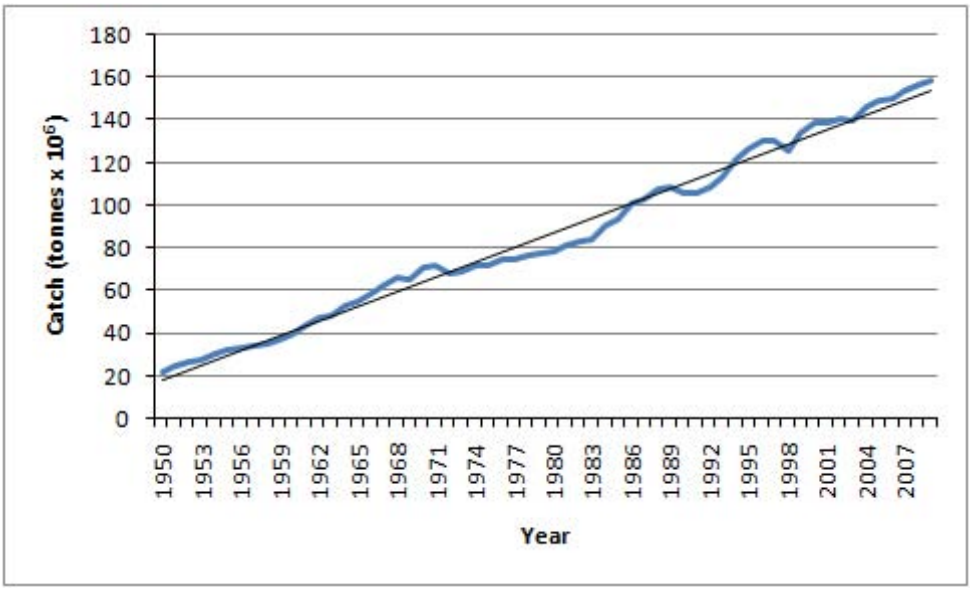


Figure 1: Global fish production from all sources (marine, aquaculture and inland) 1950–2009 with trend line y = 2E+06x + 2E+07

[2] Crocodile catches are the subject of a short note in Annex 4.

Table 2 shows the contribution of the various sources of animal protein to world consumption in 2009. This places fish from all sources as the major single source of animal protein worldwide, accounting for over one-third (37.42 percent) of global production in 2009. In reality, not all of this fish is directly eaten by humans, as much of the marine catch is transformed into fishmeal for use in agricultural and aquacultural feeds. The contribution of fish to overall animal production varies considerably by continent.

Table 2: Global production of animal protein by source in 2009 (aquatic plants are excluded from the aquaculture figures)

Protein source	Catch (tonnes)	%
Pig meat	106 069 157	23.68
Marine fish (capture fisheries)	88 942 948	19.86
Chicken meat	79 595,987	17.77
Aquaculture fish (all sources)	68 348 943	15.26
Cattle meat	61 837 770	13.80
Freshwater fish (capture fisheries)	10 323 905	2.30
Sheep meat	8 109 219	1.81
Turkey meat	5 319 748	1.19
Goat meat	4 938 655	1.10
Duck meat	3 845 443	0.86
Buffalo meat	3 307 818	0.74
10 other categories	7 301 670	1.63
Total	447 941 263	100.00

Source: FAOSTAT; FishStat.

2.1 Fish supply by origin

Figure 2 shows the trends in production classified by the origin of the fish produced for 1950–2009. This indicates clearly that marine catches have stabilized around their 1996 peak of about 87 million tonnes to the present (2009) value of just over 89 million tonnes. It also shows the rapid growth of aquaculture production since 1990 to its present level of about 36 percent of the total production (Table 3).

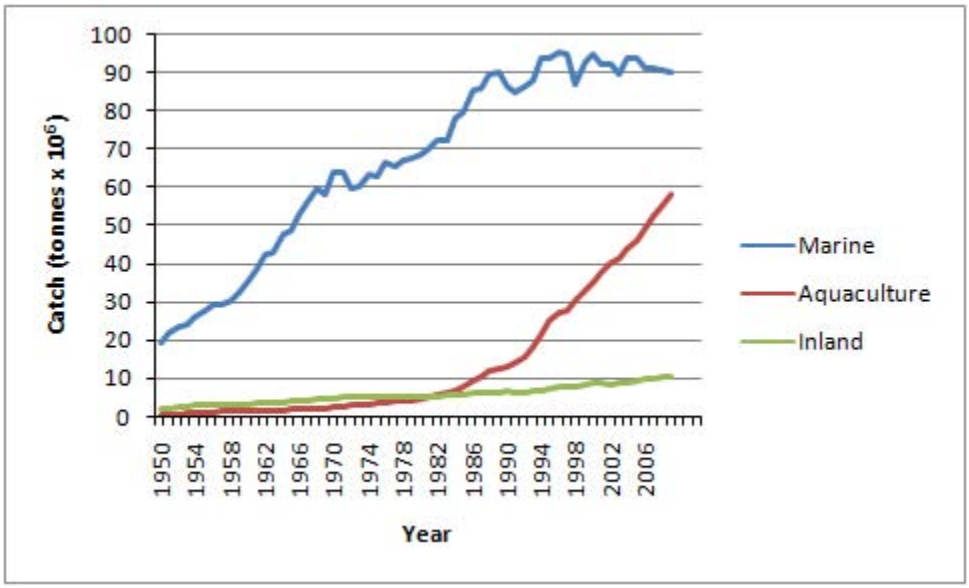


Figure 2: Trends in fish production from the major sources from 1950 to 2009
(aquatic plants are excluded from the aquaculture figures)

Table 3: Global fish production in 2009 by source

Sector	Catch (tonnes)	%
Marine capture	89 848 004	56.81
Freshwater aquaculture	33 833 863	21.39
Marine aquaculture	20 179 876	12.76
Inland capture	10 323 905	6.53
Brackish-water aquaculture	4 231843	2.68
Total	158 159 993	100.00

It is worth noting that fish from all inland sources (capture and aquaculture combined) make up about 28 percent of all fish produced as against the combined production of capture and culture from marine waters of 69 percent. The remaining 3 percent comes from brackish-water aquaculture. It is, perhaps, legitimate to combine the inland sources because of the many practices that are intermediate between capture and culture in inland waters, including various types of enhancement, gears such as fish parks, capture-based aquaculture, culture-based capture fisheries, and fisheries in rice fields and in small dams and reservoirs, that may be reported either as culture or capture dependent on local usage.

Inland capture fisheries currently contribute 6.5 percent to total fish production, which is only about 2.3 percent of the global protein production; they differ somewhat from other fisheries in that all produce is eaten either fresh as some form of salted or dried product or as a variety of fish sauces and pastes that are essential ingredients to many local cuisines. With few exceptions, such as the Amazonian large boat fishery, the Lake Victoria fisheries, the "sábalo" fishery of Argentina and the fishery concessions of the Mekong and Ayerwaddy, inland fisheries are small scale, involving large numbers of artisanal or subsistence fishers, and their products are usually marketed and consumed locally at the point of capture.

2.2 Global trends in inland fisheries

2.2.1 Trends in catches

Catches of fish and other organisms from inland water appear to have increased linearly by 2.93 percent per year since 1950 (Figure 3) to the present (2009) total of 10 323 905 tonnes.

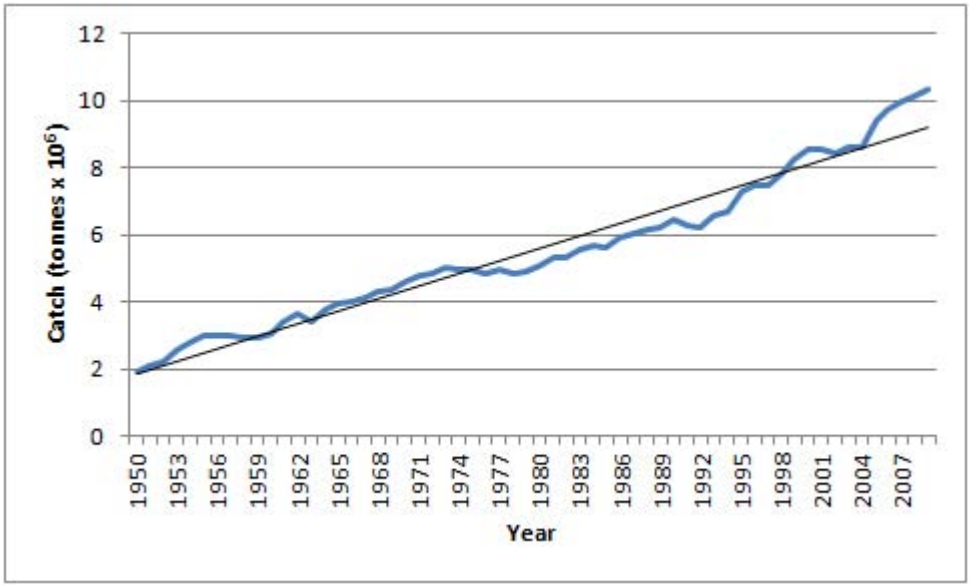


Figure 3: Global inland fish production 1950–2009 with trend line y = 12592x + 2E+06

2.2.2 Significance of inland fisheries in the human diet in 2007

Production of fish by capture from inland water remains relatively low compared with other sources of fish at 6.46 percent of the total. However, it is still the sixth major supplier of animal protein globally (Table 2). This global figure conceals considerable local variation, and in some countries fish caught

from inland water is the major source of animal protein available to the local population. For example, in Bangladesh, the inland catch of 1 006 761 tonnes in 2007 represents over 64 percent of all animal protein produced. Similar high figures apply to Uganda (66 percent), Cambodia (64 percent) and Malawi (44 percent). Slightly lower but still very important contributions are made in many other countries.

Nearly 38 percent of the inland fish captured comes from the 71 low-income food deficit countries (LIFDCs) as defined by FAO (see www.fao.org/countryprofiles/lifdc.asp for complete list).

While the unweighted mean level of production for all countries is equivalent to only 1.48 kg/ha globally, some countries depend heavily on inland fish for their protein needs.

Table 4 shows the consumption equivalents in kilograms per capita per year (2007) for all countries with over 3 kilograms per capita per year.

Table 4: Contribution of inland fish to diets for countries with over 3 kilograms per capita/year in 2007

Country	Annual consumption (kg/capita)
Cambodia	31.37
Uganda*	15.29
Myanmar	14.35
Republic of the Congo	8.18
Mali	7.69
Finland	6.78
United Republic of Tanzania	6.50
Gabon	6.44
Chad	6.25
Bangladesh	6.21
Zambia	5.03
Mauritania	4.56
Malawi	4.36
Lao People's Democratic Republic	4.26
Senegal	3.99
Cameroon	3.81
Thailand	3.53
Democratic Republic of the Congo	3.48
Central African Republic	3.39
Paraguay	3.15
Ghana	3.15
Egypt	3.14
Kenya	3.12

*Not all fish produced in some countries is consumed locally. For example, the Lake Victoria countries export a significant proportion of their Nile perch catch to Europe.
Source: FAOSTAT.

2.2.3 Inland fish supply by species

Of the 220 countries and political groupings reporting fish catches from all sources in 2009, 72 mostly arid or small-island countries did not report any inland catches; fairly complete lists of species are available for 52 (of which FAO estimated eight); restricted lists, including identification of important fish groups are available for 26 (of which FAO estimated six); and no breakdown at all were available for 34 (of which FAO estimated 21).

The main groups of species recorded as being caught by inland fisheries are listed in Table 5. This indicates that the majority of organisms caught (over 90 percent) were finfish throughout most of the 50+ year period. However, the relative proportions of the groups changed during the evolution of the fishery since 1950 with a slight decrease in the proportion of finfish and increases in the proportion of crustaceans and molluscs. There are indications from a range of detailed surveys and studies on consumption patterns (e.g. Hortle, 2007) that actual catches of crustaceans and molluscs have been considerably under-reported, at least in the Mekong basin and parts of China and Southeast Asia (Balzer *et al*., 2006; Halwart *et al*., 2006). This is probably driven by a tendency to focus on fish catches rather than on other species in official reporting systems. These other aquatic animals, therefore, probably comprise a far greater proportion of actual catches in other parts of the world where they form part of the informal, subsistence and artisanal fisheries that are frequently unreported.

Table 5: Main groups of organisms caught by inland fisheries from 1959 to 2009

Group	Year					
	1959	1969	1979	1989	1999	2009
	Catch (tonnes)					
Finfish	2 907 188	4 277 886	4 519 374	5 711 242	7 298 244	9 343 658
Crustaceans	19 618	59 885	95 088	160 118	471 450	556 912
Molluscs	33021	54492	275120	335531	501 910	373 275
Aquatic invertebrates	100	100	1075	3543	2665	47 477
Amphibians	1 050	1 435	7 427	4 739	1 823	2 488
Aquatic plants*	800	1 000	706	4817	83	190
Total	2 962 077	4 394 898	4 898 790	6 219 990	8 276 175	10 324 000
	Percentage					
Finfish	98.15	97.34	92.25	91.82	88.18	90.50
Crustaceans	0.66	1.36	1.94	2.57	5.70	5.39
Molluscs	1.11	1.24	5.62	5.39	6.06	3.62
Aquatic invertebrates	0.00	0.00	0.02	0.06	0.03	0.46
Amphibians	0.04	0.03	0.15	0.08	0.02	0.02
Aquatic plants	0.03	0.02	0.01	0.08	0.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

* The statistics for aquatic plants are reviewed in Annex 5.

Inland waters are among the most species-rich habitats on the planet, and some river basins such as the Amazon and Mekong have several thousand species (see Amarasinghe and Welcomme, 2002, for lakes and Oberdorff, Guegan and Hugueny, 1995, for rivers). Identifying and recording such diversity is clearly impractical in most fisheries, so in the FAO statistics species are generally reported either as individual species (in the case of the most significant) or under a series of taxonomic groups including by family. Many countries do not report their catches by grouping, preferring to use a general category such as "freshwater fishes NEI".[3] Fifty-five percent of the total tonnage caught in 2009 were not recorded by species category or assigned to the general category.

When the "freshwater fishes NEI" category is eliminated from the calculations, the remaining families together contribute about 95 percent of the catch; Table 6 lists the families.

[3] Freshwater fishes nei = freshwater fishes not elsewhere indicated.

Table 6: Families of fish and other organisms reported from inland fisheries in 2009 (excluding "freshwater fishes NEI")

Family	Catch (tonnes)	%
Cyprinidae	861 546	22.23
Cichlidae	789 989	20.38
Centropomidae	354 917	9.16
Palaemonidae	304 465	7.86
Clupeidae	217 315	5.61
Clariidae	174 648	4.51
Channidae	156 886	4.05
Salmonidae	113 545	2.93
Characidae	89 631	2.31
Curimatidae	82 241	2.12
Bagridae	61 920	1.60
Grapsidae	52 495	1.35
Pimelodidae	41 999	1.08
Belontiidae	41 152	1.06
Percidae	40 752	1.05
Mugilidae	39 500	1.02
Mormyridae	35 685	0.92
Coregonidae	32 950	0.85
Siluridae	30 389	0.78
Esocidae	28 329	0.73
Anabantidae	24 591	0.63
Mochokidae	20 905	0.54
Osteoglossidae	20 628	0.53
Protopteridae	20 247	0.52
Pangasiidae	19 760	0.51
Penaeidae	18 447	0.48
Citharinidae	17 155	0.44
Atherinidae	17 080	0.44
Osmeridae	13 981	0.36
Gymnarchidae	13 901	0.36
45 other families	138 697	3.21

Petersson (2009) identified a trend in the reporting by statistical grouping whereby the diversity index has increased over time, whereas the similarity index shows that the composition of the catch has changed progressively, indicating that catches in 2005 were very different from those in 1950.

This may be due to a greater number of taxonomic groups entering the catch with time, or to improvements in the identification and reporting of taxonomic groups. Figure 4 shows that there has been a steady increase in the number of taxonomic groups reporting each year since 1950. The accuracy of identification is indicated by the percentage of the catch that is assigned to the "freshwater species NEI" category. In Figure 4, this category fell slightly from 1965 to 1990 indicating improved identification of species in the reports but, globally, the trend has since reversed. The steady increase in the number of taxa reported is consistent with the fishing-down process, which predicts that increasing numbers of small species will enter the fishery as fishing pressure increases, although it could also be due to better reporting.

Figure 4: Global trends in the number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for 1950–2009

Of the 301 taxonomic categories of fish[4] and other aquatic organisms reported from inland water catches other than "freshwater fishes NEI", 76 groups contribute over 95 percent of world catches. Of these, two are particularly conspicuous: the cichlids, represented mainly by Nile tilapia (*Oreochromis niloticus*), at 20.38 percent, and the cyprinids, represented mainly by the common carp, Chinese carps and Indian major carps, at 22.23 percent. The significance of the tilapias in global inland fish catches is that tilapias are the major species used in freshwater aquaculture throughout the tropics and have been widely introduced across the tropical world to populate reservoirs where native riverine faunas have been unsuccessful in providing high production (Box 1) (see Database on Introductions of Aquatic Species [DIAS][5] for information on species introductions).

There is considerable variation between continents and regions, which will be explored in the following sections.

[4] Unless otherwise stated, "taxonomic group" is equivalent to the International Standard Statistical Classification of Aquatic Animals and Plants (ISSCAAP) group.
[5] www.fao.org/fishery/dias/en

BOX 1

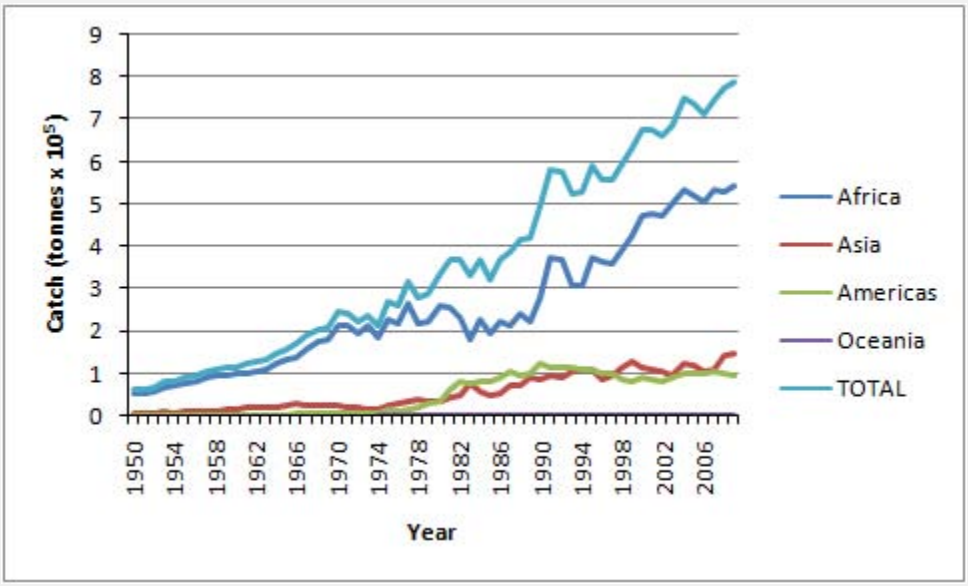
CICHLIDS AND CYPRINIDS – TWO IMPORTANT FAMILIES OF INLAND FISH

Cichlids

Ten categories of cichlids are reported, of which the tilapias make up 87 percent. Tilapias, mainly in the form of Nile tilapia (*Oreochromis niloticus*), have been introduced widely around the tropical world from their origins in Africa. Many introductions were originally made for aquaculture, but later escaped into the wild. Others were introduced for stocking of dams and reservoirs.

Since their introduction, tilapias have enjoyed great success in all tropical continents, and contribute significantly to the yields of most still waters and some rivers.

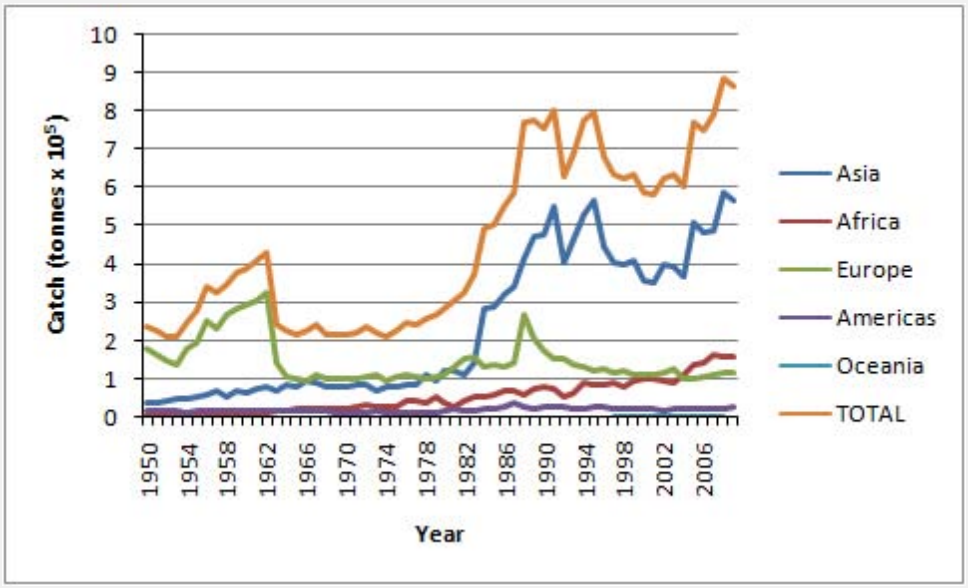
Growth in the tonnage of tilapias reported from the various continents, 1950–2009



Cyprinids

Fifty-three taxonomic categories of cyprinids are reported in the catches of various countries. Of these, the common carp, grass carp, and big head and silver carps have been widely distributed for aquaculture and have been introduced for stocking into reservoirs. They have been most successful in Asia and, to a lesser degree, in Europe. They are becoming more important in Africa but are largely absent from the Americas.

Growth in the tonnage of cyprinids reported from the various continents, 1950–2009



3. TRENDS BY CONTINENT

Within the general trend of about 3 percent annual growth in catches, there is considerable variation between continents (Figure 5).

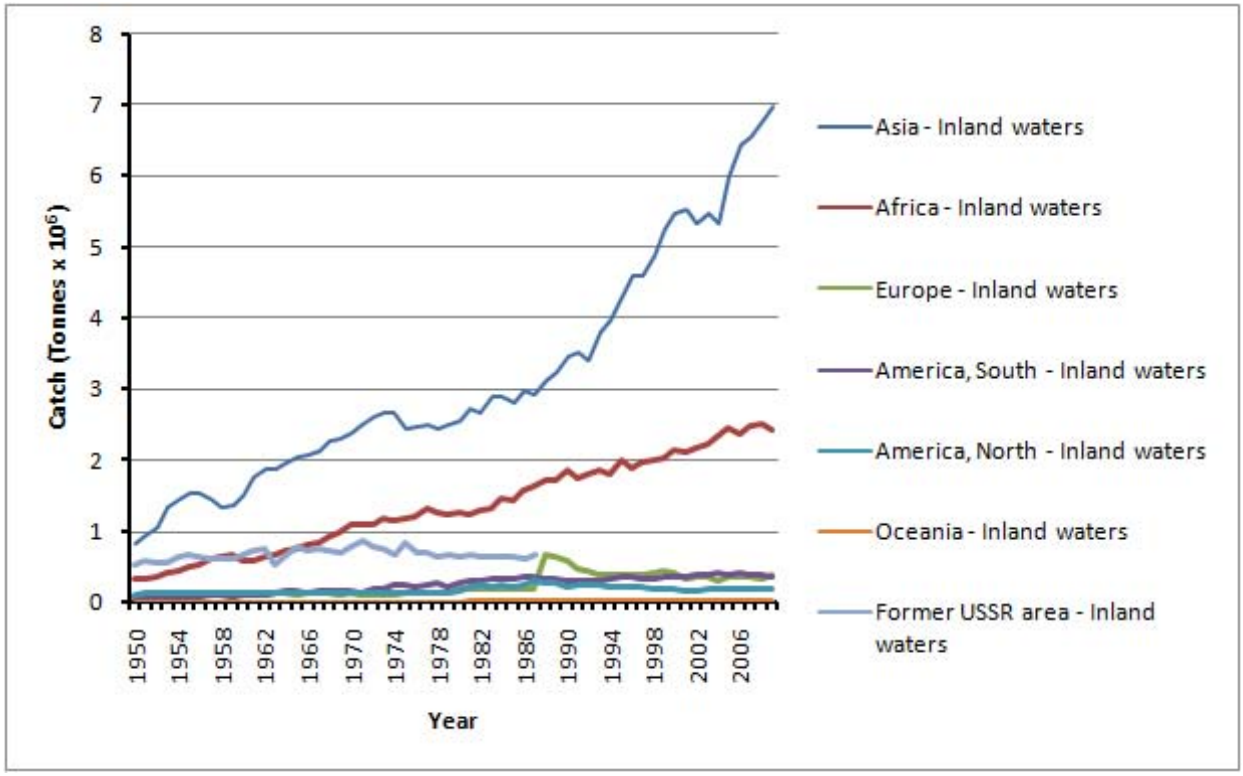


Figure 5: Trends in inland fish catches by continent, 1950–2009

Note that the FAO data set is discontinuous for catches in the former USSR area, which were reported in the group "Other" until 1987. Thereafter, the former USSR area provided individual reports. Here, the catches (including the former countries of Belarus, Moldova, Russia and Ukraine) were combined with those of Europe, causing the rise in European catches at that time. The remaining countries in "Other" were added to the Asian total.

In 2009, Asia contributed the greater part of the production at 67.4 percent, followed by Africa at 23.5 percent (Figure 6; Table 7). Note that the countries that formerly comprised the USSR only began reporting their data as individual States after 1987. The Russian Federation is included under Europe after 1988.

Table 7: Catch by continent in 2009

Continent	Catch (tonnes)	%
Asia – inland waters	6 962 672	67.44
Africa – inland waters	2 423 711	23.48
Europe – inland waters	379 958	3.68
America, South – inland waters	359 948	3.49
America, North – inland waters	179 532	1.74
Oceania – inland waters	18 084	0.18
Total	10 323 905	100.00

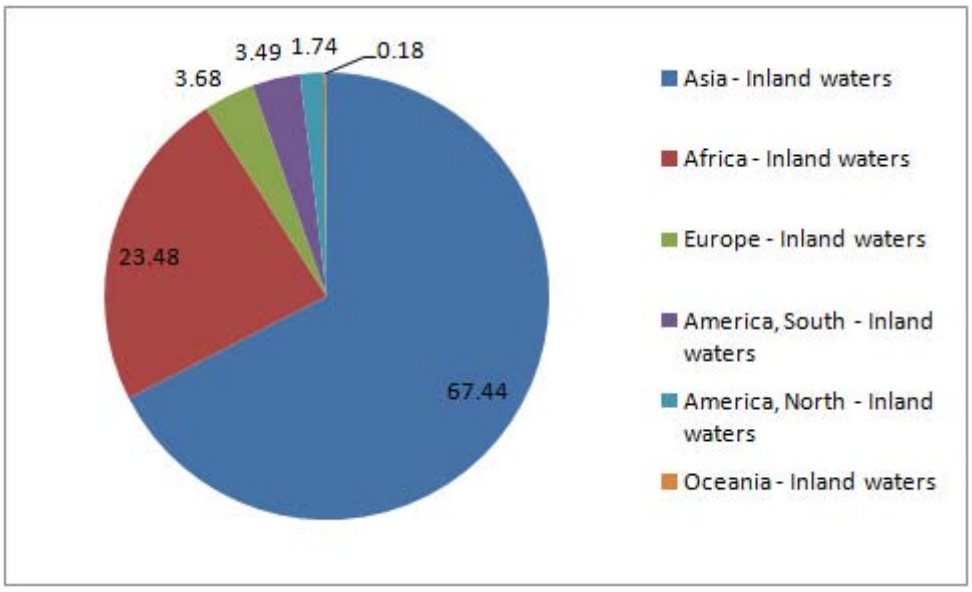


Figure 6: Percentage contribution of various continents to world inland fisheries production in 2009

The trends in production of the various continents are examined in more detail in the following sections. Because the various continents are not geographically or climatically homogeneous, they will be subdivided into subcontinental regions in this review. The regions are based mainly on geography, although in some cases economic or political considerations have been used.

Catches by country for the ten years from 2000 to 2009 are shown in Annex 1, and those for the top 26 countries (which together represent 90 percent of world inland fish catches) are shown in Figure 7.

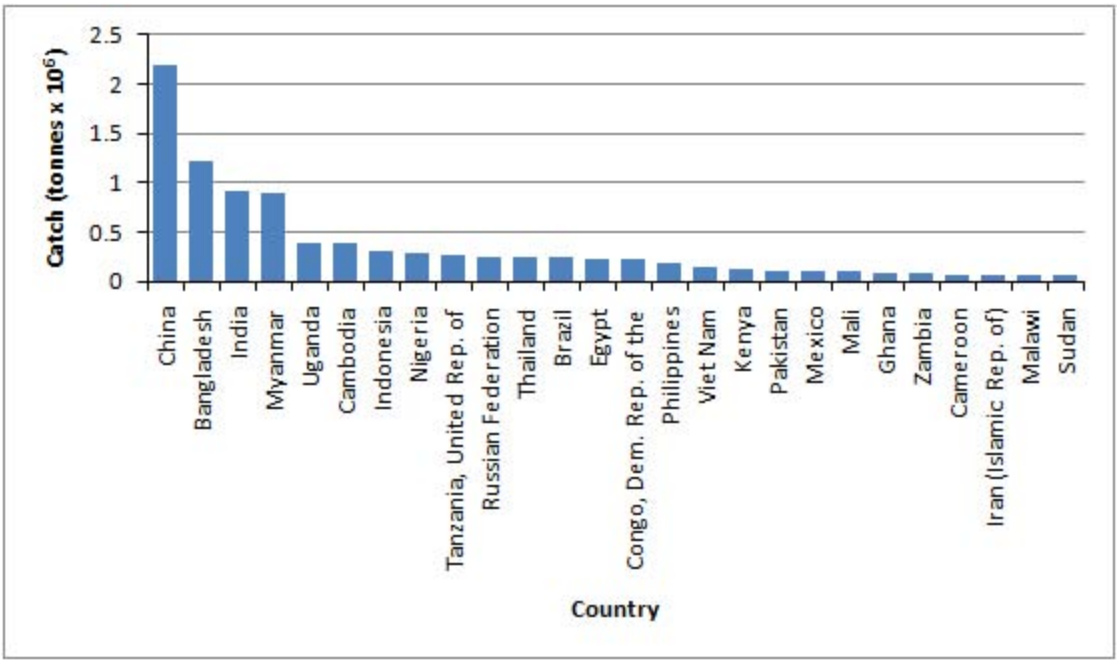


Figure 7: Catches for the top 26 countries, equivalent to 90 percent of world inland catch in 2009

3.1 Africa

African catches have risen steadily at about 3.5 percent per year, from 325 787 tonnes in 1950 to 2 423 711 in 2009 (Figure 8). The continental trend adjusted for irregularities of reporting are given in Box 2. The FAO FishStat catch statistics for Africa have been audited by Welcomme and Lymer (2009) to indicate the sort of clarifications that are needed for a better understanding of the statistics, and similar reviews will be carried out for the other continents.

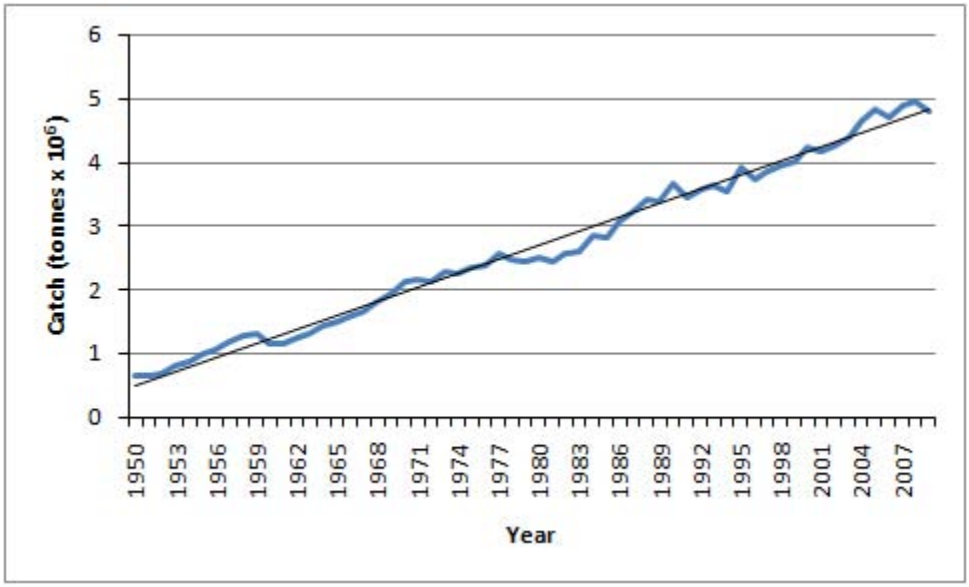


Figure 8: Trends in reported catch for Africa, 1950–2009

Africa is divided into nine regional groupings based on climate and geography, although some countries bridge two or more regions. For example, Ethiopia lies partly in the Nile, East African coastal and Great Lakes regions; the Central African Republic lies in both the Sahel and Congo regions; and Nigeria lies in the Sahel and West African coastal regions. The contribution of the different regions over time is illustrated in Figure 9 and quantified for 2009 in Table 8.

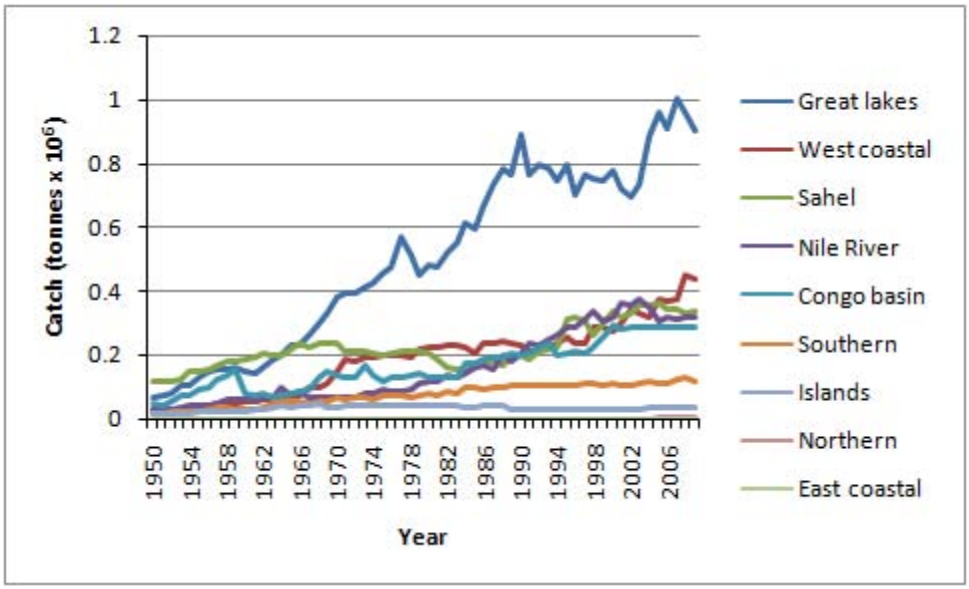
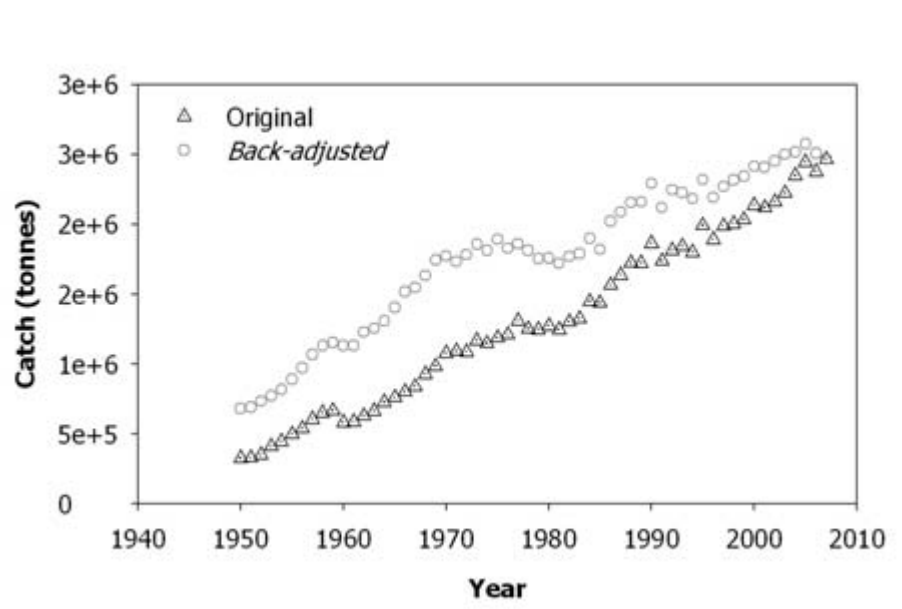


Figure 9: Trends in reported catch in the various African regions, 1950–2009

BOX 2

CATCH STATISTICS FOR AFRICA ADJUSTED FOR SUDDEN CHANGES IN MAGNITUDE



Historically modelled data of inland water capture fisheries catch in Africa (based on the changes identified from the original FishStat statistics by Welcomme and Lymer, 2009)

The reported statistics in this box, Box 5 and Annex 2 include many jumps in catch that are due to changes in reporting systems and in back calculation for non-reported catches, so these analyses attempt to rectify this situation by statistically smoothing the figures. Thus, the evolution of the back-adjusted catches over time described in the figure probably corresponds better to what is known of African inland fish catches than the original reported catch statistics. Catches from nearly all the major waterbodies appeared to be at their maximum potential as estimated by the then existing models by the time Van den Bossche and Bernacsek (1990) reviewed the literature, which were mostly drawn from surveys and reports for the 1970s and 1980s. This implied a period of relatively stable catches until the 1990s, when fish production from the continent was raised by the development of the Nile perch and dagaa fisheries in Lake Victoria, which, at 1 000 000 tonnes, now represent about 40 percent of the continental total. Furthermore, the increases in estimates from the Congo River fisheries since 1985 and improved reporting on subsistence fisheries from some countries would also contribute to the upward trend since 1990.

Table 8: Reported catches from the various African regions in 2009

Region	Catch (tonnes)	%
Great Lakes	898 763	37.08
West coastal	432 821	17.86
Sahel	333 945	13.78
Nile River	320 547	13.23
Congo basin	282 885	11.67
Southern	114 511	4.72
Islands	32 828	1.35
Northern	7 211	0.30
East coastal	200	0.01
Total	2 423 711	100.00

Fish from all sources is by far the most important animal protein source at 36 percent. Inland fisheries are particularly important for food security in Africa as they are the fourth most important source of animal protein after cattle, marine fish and chicken and contribute overall some 10.66 percent of the protein diet continent-wide (Table 9). In some riparian communities along the major rivers and lakes of the continent, fish is probably the major protein source. Although most inland fish is consumed locally, some such as the Nile perch from Lake Victoria is exported to Europe (approximately 52 800 tonnes of fillets of the 268 152 tonnes caught in 2005) and does not figure in the local dietary balance.

Table 9: Africa – Production of animal protein by source in 2009 (aquatic plants are excluded from the aquaculture figures)

Protein source	Catch (tonnes)	%
Cattle meat	5 013 482	22.04
Marine fish	4 800 579	21.10
Chicken meat	3 591 620	15.79
Inland fish	2 423 711	10.66
Sheep meat	1 260 474	5.54
Goat meat	1 200 805	5.28
Pig meat	1 168 138	5.14
Aquaculture	1 103 492	4.85
Game meat	1 012 893	4.45
10 other categories	1 171 895	5.15
Total	22 747 088	100.00

Source: FAOSTAT; FishStat.

Reporting by taxonomic group has improved considerably and progressively since 1950 as the percentage of the catch assigned to the "freshwater fishes NEI" category has declined steadily to 38 percent in 2009. At the same time, the number of taxonomic groups reported rose from 18 to 58 (Figure 10).

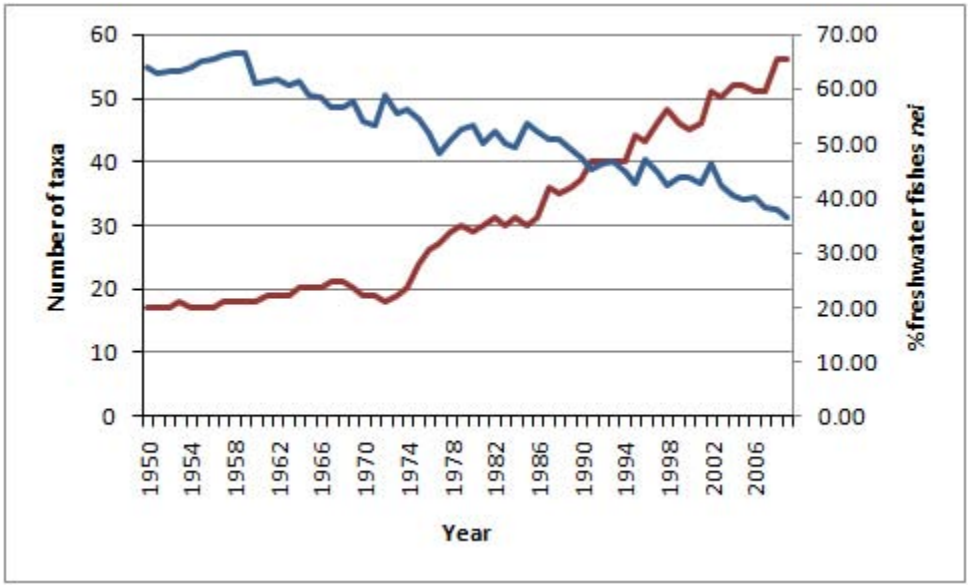


Figure 10: Trends in the number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for African countries, 1950–2009

Catches by main group in Africa are mostly finfish (Table 10) with very few crustaceans and molluscs recorded.

Table 10: Major taxonomic groupings of catches from Africa, 2009

Main group	Catch (tonnes)	%
Finfish	240 1823	99.10
Crustaceans	17 525	0.72
Molluscs	4 363	0.18
Total	2 423 711	100.00

3.1.1 North Africa

(Algeria, Libya, Morocco, Tunisia)

The North African region is extremely arid with few permanent rivers and freshwater lakes. There are, however, a number of reservoirs and coastal lagoons that support small fisheries in Morocco and Tunisia. Some intermittent catches were reported by Algeria before 1968.

Catches are reported to have risen in Tunisia, and in Morocco there has been an increase in the last five years after higher levels had been maintained through the 1990s with some decline in 2005 (Figure 11).

Catches consisted of cyprinids NEI 72 percent, freshwater species NEI 27 percent, with eels contributing the remaining 1 percent.

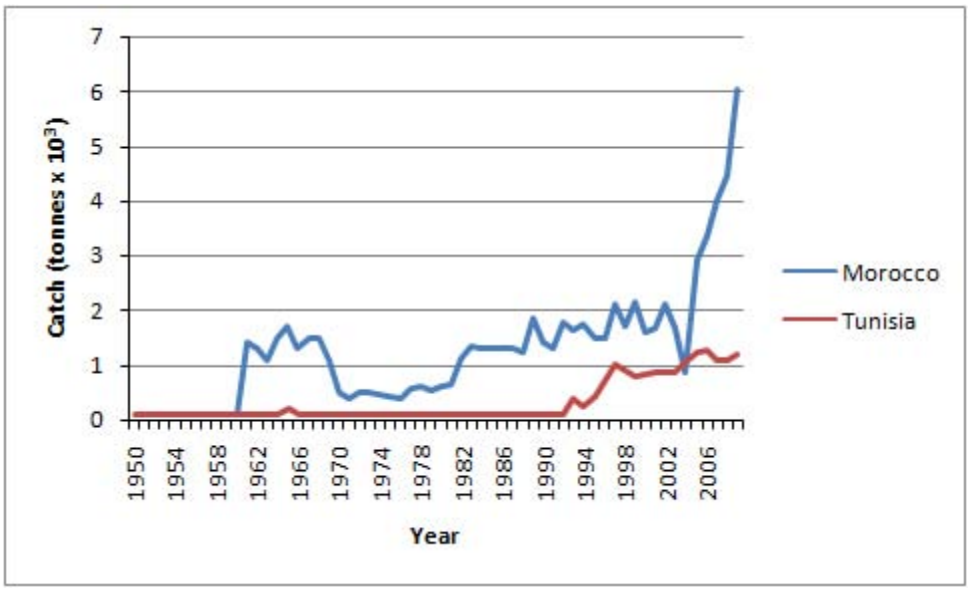


Figure 11: Trends in catches in the countries of the North African region, 1950–2009

3.1.2 Nile River

(Egypt, Ethiopia, the Sudan)

This region includes most of the Nile River and tributaries except for the headwaters in Uganda. It contains the Blue Nile, White Nile, Sudd, Lake Nasser/Lake Nubia, minor reservoirs, the Egyptian coastal lagoons, Lake Tana and the Ethiopian Rift Valley lakes.

Catches from this region are dominated by Egypt at 74 percent in 2009 (Figure 12). Catches from Ethiopia and the Sudan have generally increased steadily since 1950. However, Egyptian catches have declined since 2003 for reasons that are not yet understood.

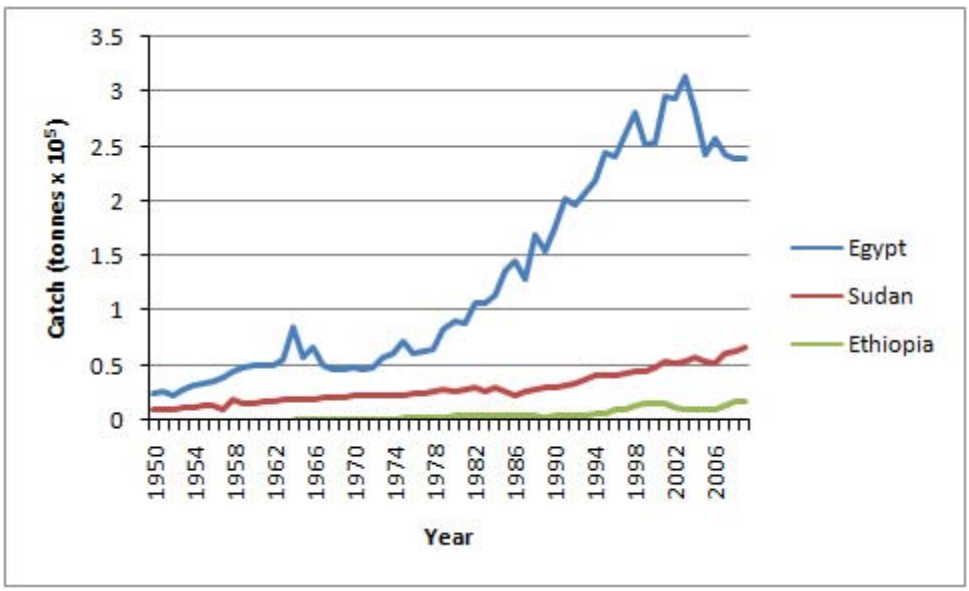


Figure 12: Trends in catches in the countries of Nile region, 1950–2009

Nile tilapia is the most important species in catches in Egypt and Ethiopia (Table 11). The high percentage of "freshwater fishes NEI" originates mainly from the Sudan, which does not report catch by taxonomic grouping. There is also a significant percentage of brackish-water species from the Egyptian coastal lagoons, although some species, particularly mullets, have been collected as fry for aquaculture (Saleh, 2008).

Table 11: Taxonomic groupings of catches for the Nile region, 2009

Taxonomic group	Catch (tonnes)	%
Nile tilapia	132 190	41.24
Freshwater fishes NEI*	66 771	20.83
Mudfish	32 350	10.09
Grass carp (= white amur)	21 180	6.61
Mullets NEI	18 770	5.86
Nile perch	7 770	2.42
Tilapias NEI	7 554	2.36
Silversides (= sand smelts) NEI	5 450	1.70
Freshwater prawns, shrimps NEI	5 400	1.68
Cyprinids NEI	4 466	1.39
Seabasses NEI	3 960	1.24
12 other taxa*	14 686	4.58
Total	320 547	100.00

**Note*: Fishes NEI are those fishes not reported by species to FAO: "other taxa" represents the sum of minor contributors to the catches reported by species but grouped here for economy of space.

3.1.3 Eastern coastal

(Djibouti, Eritrea, Somalia)

This is an arid zone with few rivers and lakes. The only major system is the Webe Shebelle that originates in Ethiopia and flows to the sea through the Sudan. This is a large but seasonal river that maintains a fishery. Its fisheries have not been studied and Somalia has not reported any catches. The present estimates have been made by FAO since 1986 (Figure 13).

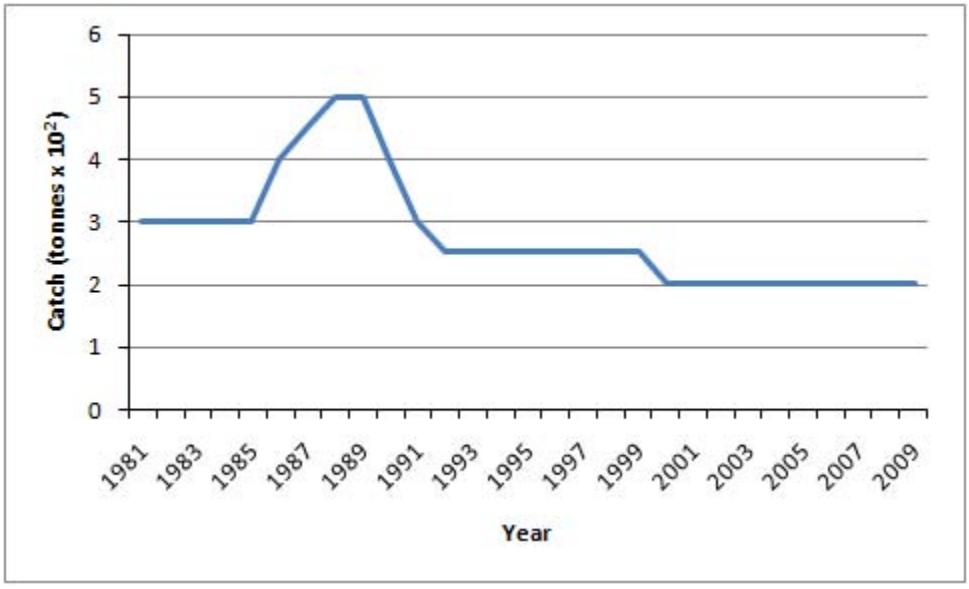


Figure 13: Trends in catches in the Eastern coastal region (Somalia), 1981–2009

3.1.4 Great Lakes

(Burundi, Kenya, Malawi, Rwanda, United Republic of Tanzania, Uganda)

The Great Lakes region includes some of the largest lakes in the world – Lake Turkana, Lake Victoria, Lake Kivu, Lake Tanganyika and Lake Malawi – and several lesser lakes.

Figure 14 shows that catches increased in all the region's countries until the 1990s and thereafter remained stable or declined slightly. There have been dramatic increases in "dagaa" (small pelagic cyprinid) catches in Lake Victoria over the last few years, possibly owing to increased productivity through eutrophication (Box 3), which have possibly not yet been incorporated into the Kenyan and Tanzanian statistics.

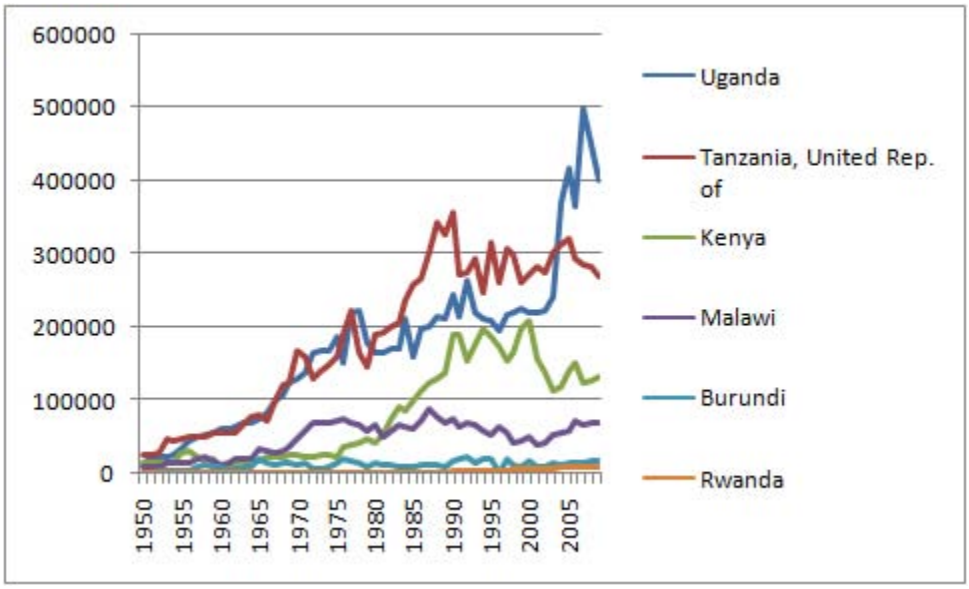


Figure 14: Trends in catches in the countries of the Great Lakes region, 1950–2009

Catches from the Great Lakes are heavily weighted towards Nile perch in 2009 at 35 percent of the catch (Table 12) because of the expansion of the Lake Victoria fishery. Cichlids form a second important group at 29.5 percent because of the complex haplochromine species flocks in Lake Malawi and Lake Victoria. Dagaa and silver cyprinids (*Rastrineobola*) together are very low at 11 percent as they are now the mainstay of the Lake Victoria and Lake Tanganyika fisheries. Box 3 indicates, for example, that 600 000 tonnes of dagaa were caught in Lake Victoria in 2007, but apparently these research-based figures have not yet reached the officially reported statistics.

The significance of these fisheries to local populations is shown by the fact that inland fish comprises 66 percent of the Ugandan animal protein production, despite the fact that a proportion of this is exported.

Table 12: Taxonomic groupings of catches for the Great Lakes region, 2009

Taxonomic group	Catch (tonnes)	%
Nile perch	318 008	35.38
Tilapias NEI	203 256	22.62
Freshwater fishes NEI	128 725	14.32
Silver cyprinid	75 547	8.41
Cyprinids NEI	26 862	2.99
Dagaa	23 410	2.60
Characins NEI	21 600	2.40
Nile tilapia	20 804	2.31
Cichlids NEI	20 187	2.25
African lungfishes	16 560	1.84
Mouthbrooding cichlids	14 401	1.60
Torpedo-shaped catfishes NEI	13 630	1.52
Naked catfishes	9 428	1.05
7 other taxa	63 45	0.71
Total	898 763	100.00

3.1.5 Southern Africa

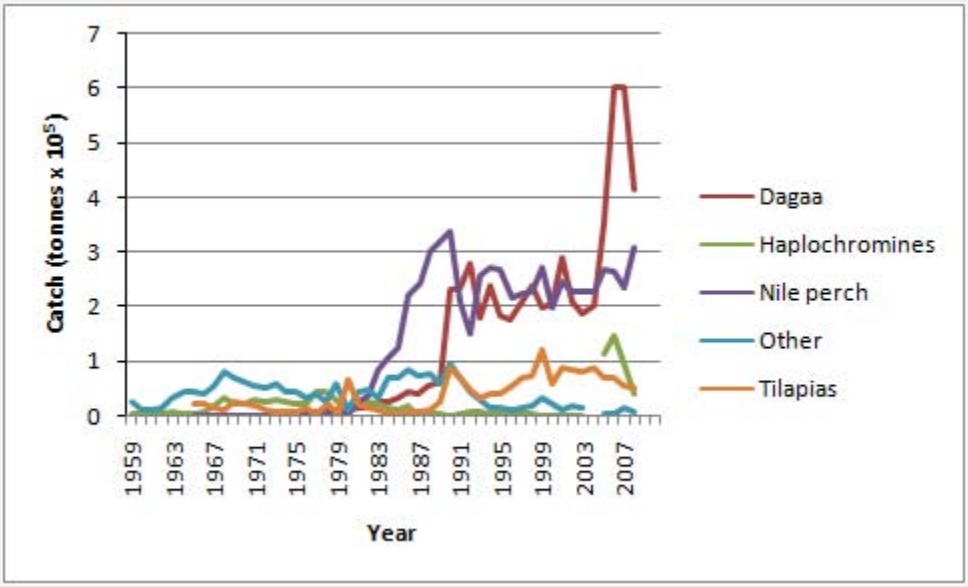
(Angola, Botswana, Mozambique, Namibia, South Africa, Lesotho, Swaziland, Zambia, Zimbabwe)

Southern Africa is rich in river and lake resources. It is centred on the Zambezi system with the Kariba and Cahora Bassa reservoirs, the Okavango and other river systems, and the major lakes of Mweru, Mweru wa Ntipa, and Bangweulu in Zambia. Catches for the region (Figure 15) are dominated by Zambia at (74 percent of the total), where catches have risen sharply since 2006. Catches in Angola and Mozambique rose, consistent with the magnitude of the aquatic resources of those countries and where civil unrest has made it difficult to document inland fisheries in the past. However, in 2009, Angola reported much lower figures than those that had been estimated for the previous two years. Catches from Mozambique had also declined to a third of their 2009 value. No explanation is yet available for these declines. Catches from Zimbabwe have fallen from a high in 1990 consistent with the breakdown of civil administration, although these have been estimated by FAO since 2001.

Catches from most of the Southern African countries are not reported by taxonomic grouping.

BOX 3

LAKE VICTORIA – CHANGING SPECIES COMPOSITION FOLLOWING THE INTRODUCTION OF NILE PERCH



Trends in Lake Victoria fisheries by species group, 1959–2008
Note: Dagaa = silver cyprinid in FISHSTAT classification.
Source: Lake Victoria Fisheries Organization.

Lake Victoria is now the single largest fishery on the African continent, having surpassed 1 million tonnes in 2006.

Until the end of the 1970s, the Lake Victoria fishery was based on a group of native species, which were subsequently supplanted by Nile perch and Nile tilapia that were introduced in the 1950s. The evolution of the fishery (see figure) from 1980 onwards has been characterized by the rapid growth of the Nile perch fishery, much of whose product is exported as fillets to Europe. The Nile perch fishery stabilized in the early 1990s, fluctuating around 250 000 tonnes. As the Nile perch were heavily fished, the native haplochromines have made a comeback and the introduced tilapias increased in the fishery. At the same time, changes to the ecology of the lake allowed a small native pelagic cyprinid species (dagaa) to expand its populations, which now support a major fishery for local consumption. This has encouraged an inflation in the riparian population of the lake and formed the basis for a thriving economy. Developments in the last few years show some reversal of these trends, with a decline in the catches of dagaa, tilapias and haplochromines and an apparent relative stability in Nile. Such oscillations will doubtless continue.

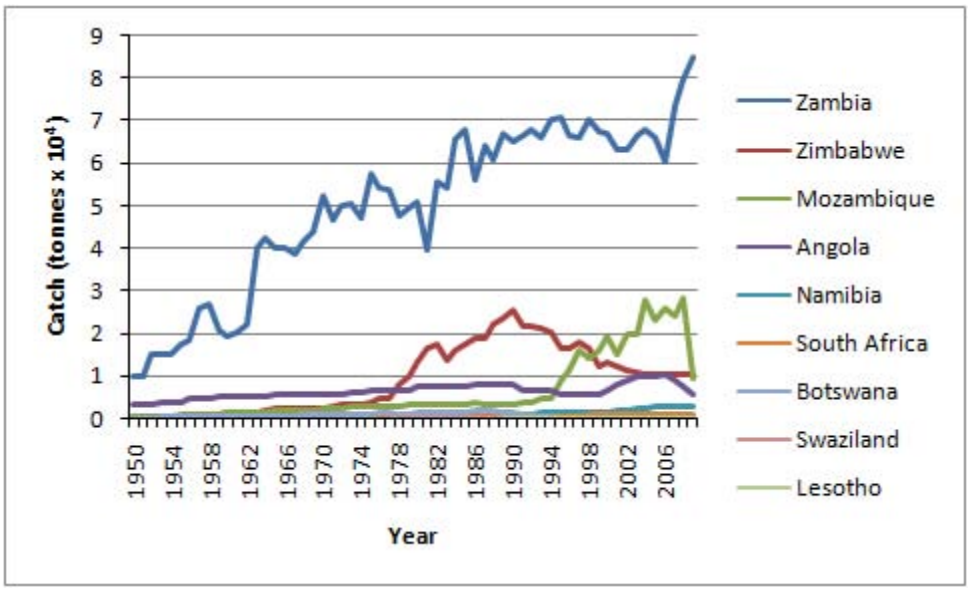


Figure 15: Trends in catches in the countries of the Southern African region, 1950–2009

3.1.6 Congo basin

(Central African Republic, the Congo, Democratic Republic of the Congo, Gabon)

The Congo basin consists of the central African rivers system consisting of the Congo and Ubangi Rivers and the associated tributary river basins. There are some reservoirs, and the region also borders the Great Lakes to the east and the Sahel region to the north, where rivers of part of the Central African Republic are tributaries of the Chari system.

Scientific knowledge of the Congo basin and its rivers is very poor, and FAO has estimated catches for the Central African Republic and the Democratic Republic of Congo for the last ten years. At 81 percent of the total, catches from the Democratic Republic of the Congo, which controls the major part of the basin, dominate the catches from the Congo River system. FAO has estimated catches from this basin for the last 11 years at a stable level. The general rising trend as described (Figure 16) for the period up to 2000 is probably consistent with the extensive nature of the Congo River resources and with what is known of the productivity of large rivers systems in general. However, the relatively low population density, isolation of communities, poor security and infrastructure make it extremely difficult to verify the true situation of this region. Catches from most of the Congo basin countries are not reported by taxonomic grouping.

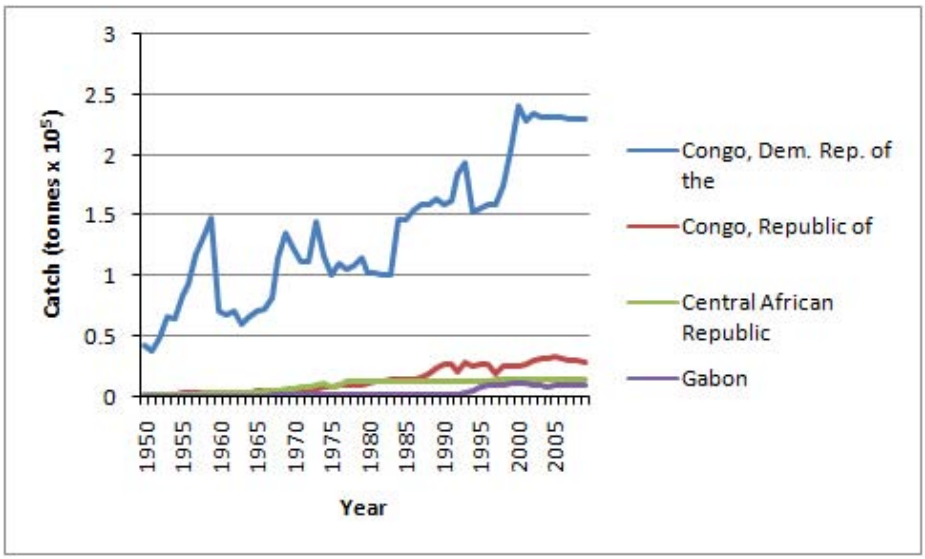


Figure 16: Trends in catches in the countries of the Congo basin region, 1950–2009

3.1.7 The Sahel

(Burkina Faso, Cameroon, Chad, the Gambia, Mali, Mauritania, the Niger, Senegal)

The Sahel is a climatically unstable region (see Box 4) that includes some of the richest fishery resources of the continent, including the Niger, Senegal, Chari and Logone River systems as well as Lake Chad.

Catches from individual countries of the region (Figure 17) show the variable trends characteristic for fisheries based mainly on rivers where year-to-year variations in rainfall and flooding produce similar variations in the catches of fish in following years. However, the recent history of this critical region is somewhat obscure as FAO has had to estimate catches for several of the major producers – Chad (9 years), the Gambia and Senegal (10 years), Mauritania (18 years), although in 2009 some of these countries reported catches. Furthermore, Mali reported a steady, but unlikely, 100 000 tonnes (30 percent of 2009 regional total) for the last eight years.

Catches from the Sahel are not reported by taxonomic grouping in the majority of countries.

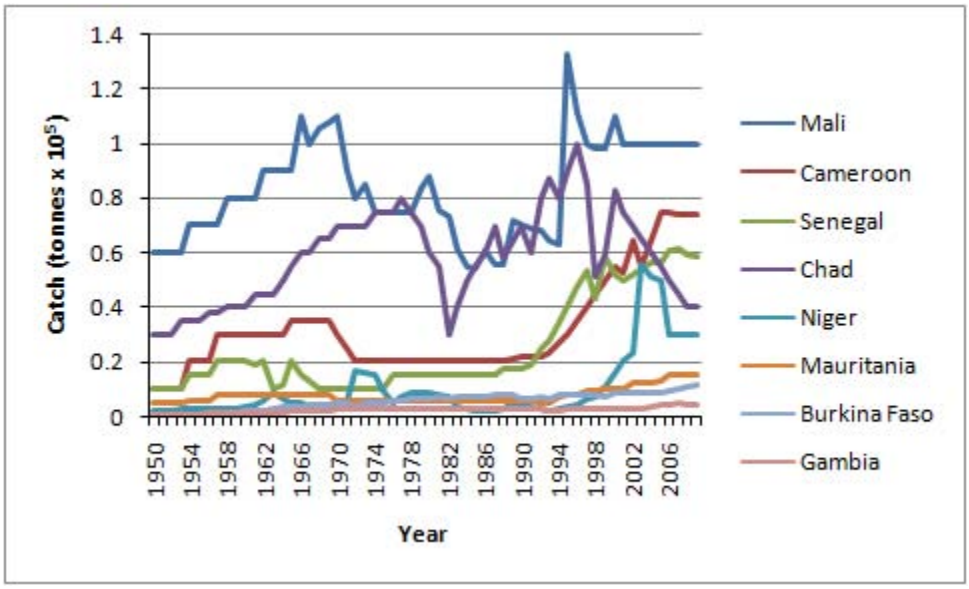
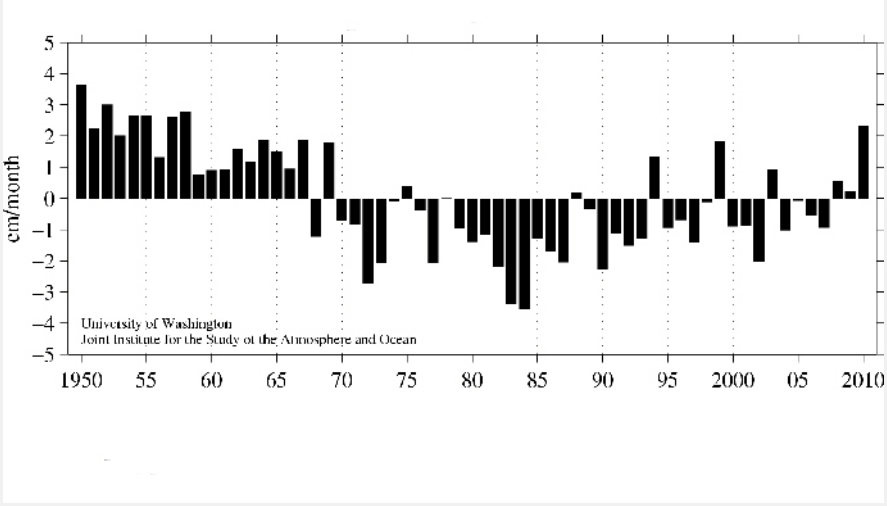


Figure 17: Trends in catches in the countries of the Sahel region, 1950–2009

BOX 4

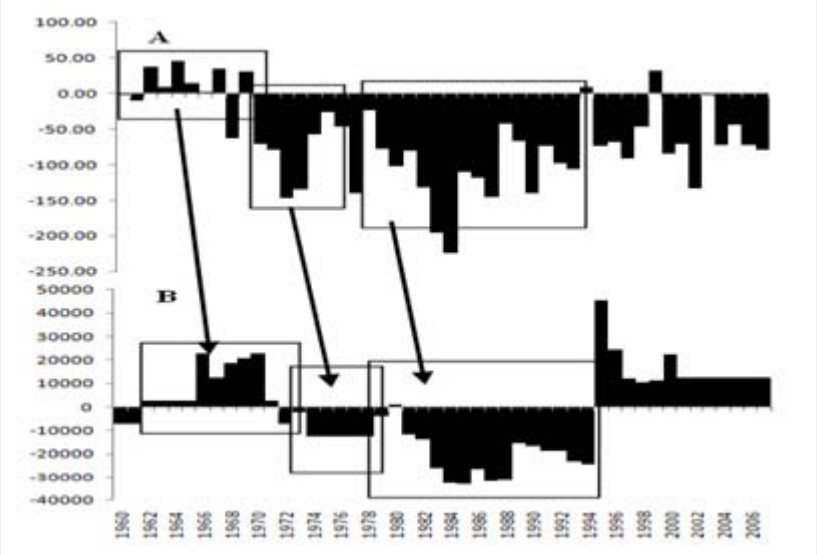
SAHELIAN CLIMATE – AN INDICATOR OF THE EFFECTS OF CLIMATE CHANGE

The Sahelian zone runs across Africa from Senegal to Ethiopia and is defined by the rainfall limits of 200 mm (north) and 600 mm (south) mean twentieth century annual rainfall. The area is climatically unstable with episodes of drought and more copious precipitation. The figure below shows these in terms of the deviation for the 1950–2008 mean rainfall. The area passed through a period of good rainfall in the 1960s only to suffer a severe drought from 1968 to 1974. The below average precipitation has continued to 2007, resulting in the desiccation of much of the Central Delta floodplain and the drying out of Lake Chad from an area of 26 000 km^2 in the 1960s to 1 500 km^2 in 2000 and 1 425 km^2 in 2003.



Years of above and below average rainfall in the Sahel region based on deviations from 1950–2010 mean
Source: http://jisao.washington.edu/data/sahel/

Changes in flow and the resulting area of flooding produce changes in the abundance and composition of the fish fauna of the region (see, for example, Lae, 1995; and the figure below), although the relationship has broken down since 1995, possibly owing to reporting errors (FAO has estimated catches for seven out of the last ten years).



Comparison of fish catch and rainfall between 1960 and 2007. A: Years of above and below average rainfall in the Sahel region (relative to 1950–2009 mean). B: Years of above and below average catch (relative to the 1960–2007 mean).

3.1.8 West African coastal

(Benin, Côte d'Ivoire, Equatorial Guinea, Ghana, Guinea, Guinea-Bissau, Liberia, Nigeria, Sierra Leone, Togo)

The West African coastal region groups those countries lying along the West African coast, which include a large number of relatively short rivers with the exception of the Niger River, that flow southwards into the Atlantic Ocean. Many of these rivers have been impounded, and the Volta system includes the largest reservoir in the world by area. Many rivers also terminate in coastal lagoon complexes.

Many countries in the West African coastal region are heavily influenced by the Sahelian climate as they extend northwards into the arid zone; this is especially the case with Ghana, Guinea and Nigeria.

Catches from the West African coastal region are dominated by those of Nigeria, which accounted for 66 percent of reported catches in 2009 (Figure 18). Ghana provided 20 percentof catches, although estimates have had to be made for this county by FAO for the last four years. Braimah (2000) considered that catches from Ghana are underestimated as the actual yield of the Volta reservoir (Lake Akosombo) (about 250 000 tonnes) is likely to far exceed existing estimates. Benin provided 7 percent and Sierra Leone about 3 percent. Other countries in the region reported relatively small catches, although in some, such as Guinea, actual catches are probably much larger.

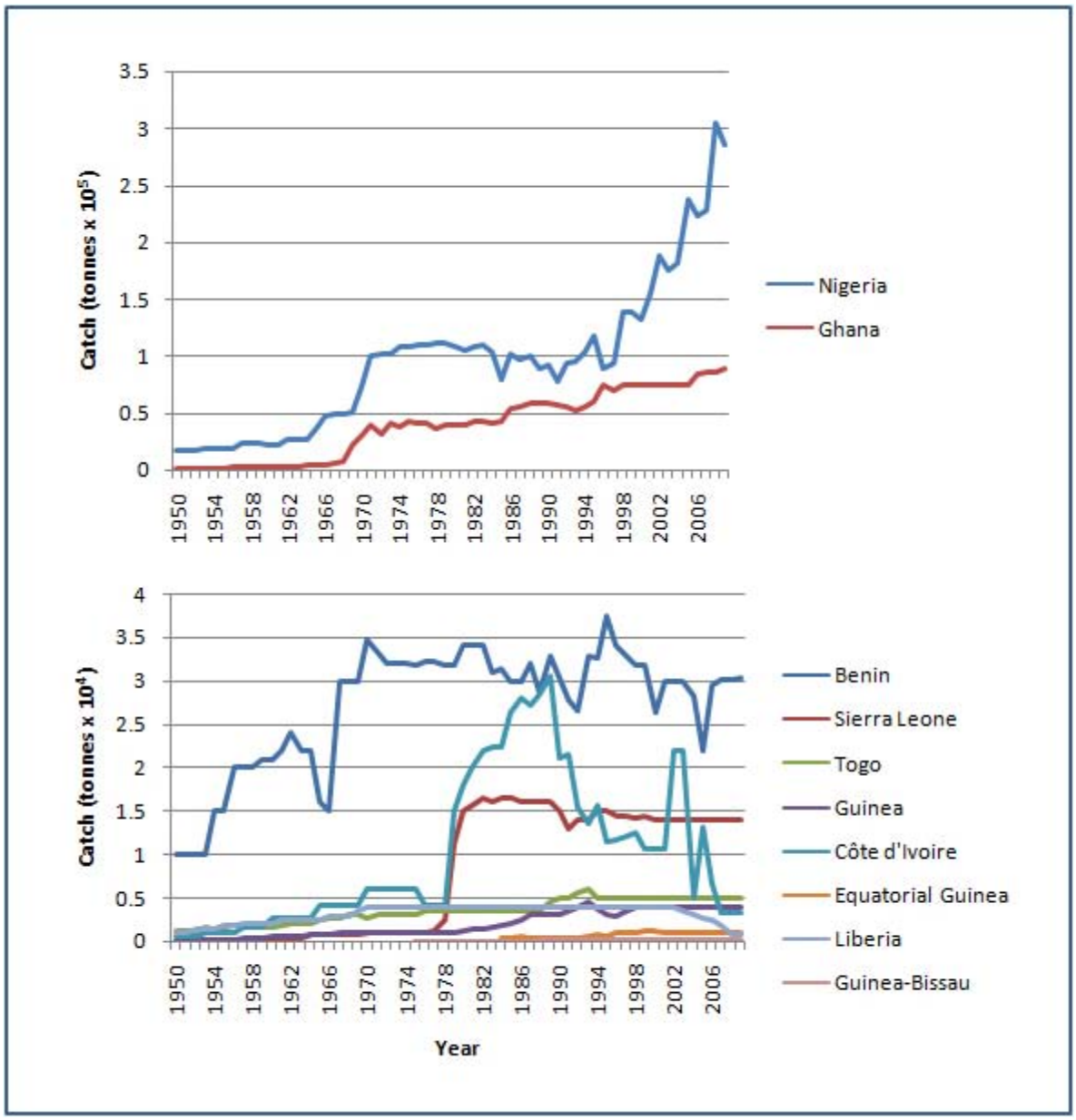


Figure 18: Trends in catches in the countries of the West African coastal region, 1950–2009

The catches from the region consist of a large number of species (Table 13), partly because of the high degree of endemism in the various rivers and partly because of the large contribution of brackish-water coastal systems to the catch.

Table 13: Taxonomic groupings of catches for the west African coastal region, 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	129 127	29.83
Tilapias NEI	68 671	15.87
Torpedo-shaped catfishes NEI	36 672	8.47
North African catfish	23 146	5.35
Elephant snout fishes NEI	22 564	5.21
Bagrid catfish	17 541	4.05
Characins NEI	15 987	3.69
African bony tongue	15 439	3.57
Cyprinids NEI	14 261	3.29
Aba	13 363	3.09
Upside-down catfishes	13 329	3.08
Nile perch	11 542	2.67
Citharinus NEI	11 395	2.63
Naked catfishes	7 788	1.80
Grass-eaters NEI	5 760	1.33
Snakeheads (= murrels) NEI	5 515	1.27
Freshwater crustaceans NEI	4 610	1.07
12 other taxa	16 111	3.72
Total	432 821	100.00

3.1.9 Islands

(Cape Verde, the Comoros, Madagascar, Mauritius, Réunion, Saint Helena, Ascension and Tristan da Cunha, Sao Tome and Principe, Seychelles)

Many islands fall within the African area, but of these only Madagascar reports any fisheries.

As Madagascar is an island, the fisheries are quite different from those of the mainland. It has several systems of coastal lagoons, rivers, and natural and man-made lakes. There is considerable population pressure leading to overfishing and environmental degradation.

Figure 19: Trends in catches in Madagascar, 1950–2009

Catches from Madagascar are reported to have risen to a peak production of around 40 000 tonnes/year but have declined more recently to a stable level of around 30 000 tonnes/year (Figure 19). However, Madagascar has not reported catches for the last twelve years, so FAO estimated the values.

3.2 Asia

Asia is a large and varied continent, which can be divided into seven regions. Of these, three are among the most productive in the world, whereas the other groupings are of somewhat lesser importance mainly because of their arid nature and relatively poor aquatic resources.

The total production for all regions (Figure 20) increased steadily throughout the period at a mean rate of 3.8 percent per year, from 808 011 tonnes in 1950 to 6 962 482 tonnes in 2009.

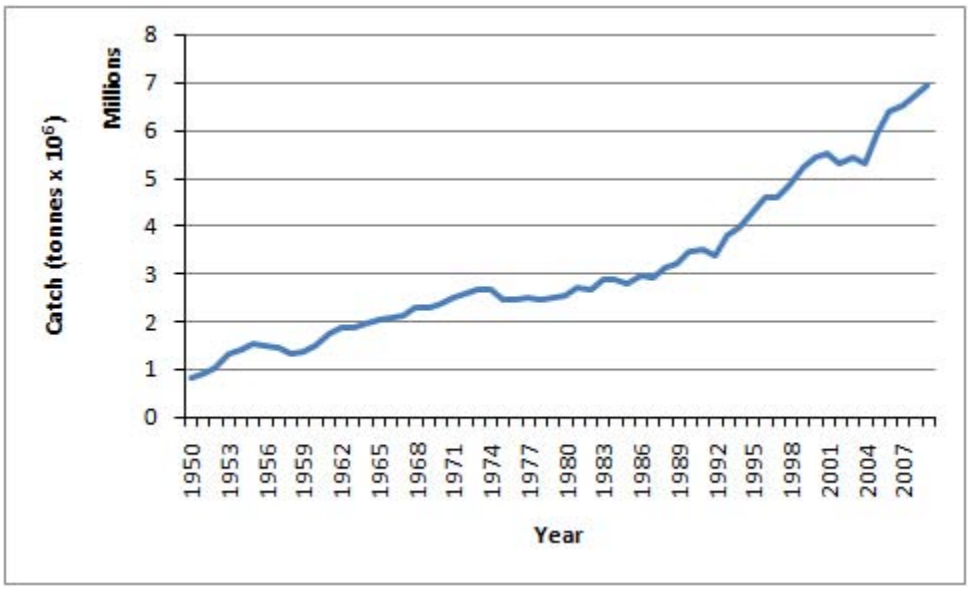
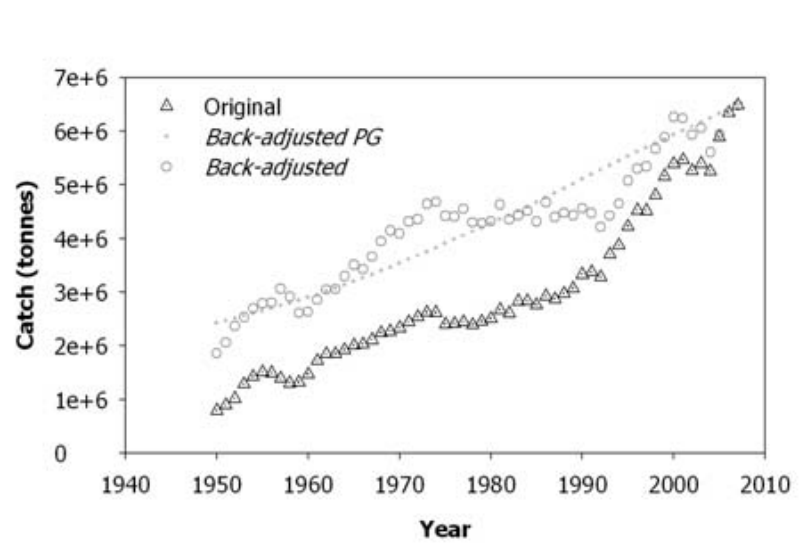


Figure 20: Trends in reported catch for all regions of Asia, 1950–2009

Adjusted catches according to Lymer and Funge-Smith (2009) indicate that the situation may have been more complicated with at least four separate phases in the development of the fisheries (Box 5).

BOX 5

ADJUSTED CATCH STATISTICS FOR ASIA

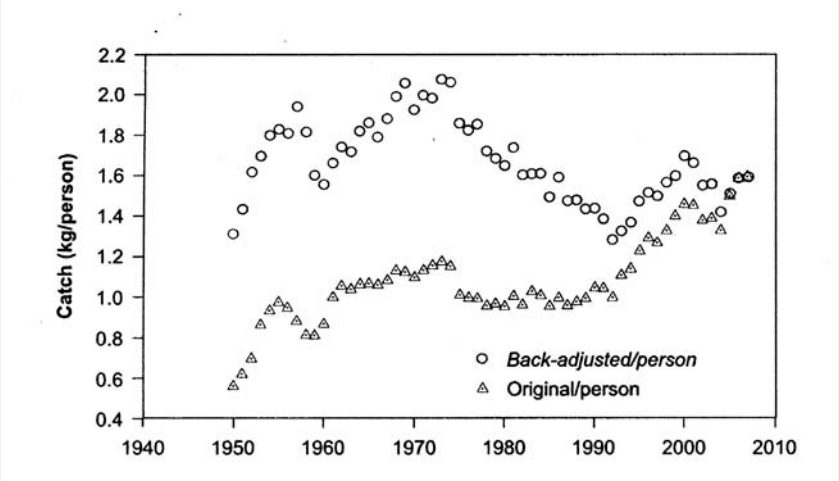


Historically modelled data of inland water capture fisheries catch in the Asia-Pacific Fishery Commission (APFIC) region. Based on the changes identified using criteria 2 and 3 and the original inland water capture statistics (original) (see Annex 2 for details).

Catches for the Asia-Pacific region adjusted for irregularities in reporting according to Lymer and Funge-Smith (2009) (see figure above).

According to the historically back-adjusted data, the total regional production has experienced four different periods: (1) a period of rapid growth between 1950 and the mid-1970s; (2) a relatively stable plateau from the mid-1970s until the early 1990s; (3) a rapid growth period until the turn of the century; and (4) then again a relatively stable period from 2000 onwards.

This indicates a very different trend to the consistent increase shown by the original FAO data in that the revised data set indicates a rapid increase in production (and production/fisher) (see figure below) until the mid-1970s, a falling catch/fisher until the mid-1990s and a rise thereafter.



Historically modelled data of inland water capture fisheries catch in the APFIC region. Based on the changes identified using criteria 1 and 2 and the original inland water capture statistics (original) (see Annex 2 for details).

The trends in the fisheries in the various regions of Asia are shown in Figure 21, and their percentage contribution to the Asian total is shown in Table 14.

Figure 21 shows that there are two distinct blocks within the Asian region: those with very high levels of capture and those where inland fisheries are considerably less important. Table 14 shows that China, South Asia and Southeast Asia all had very similar levels of production in 2009, together contributing 95 percent of the continental catch and together contributing about 60 percent to the world inland catch.

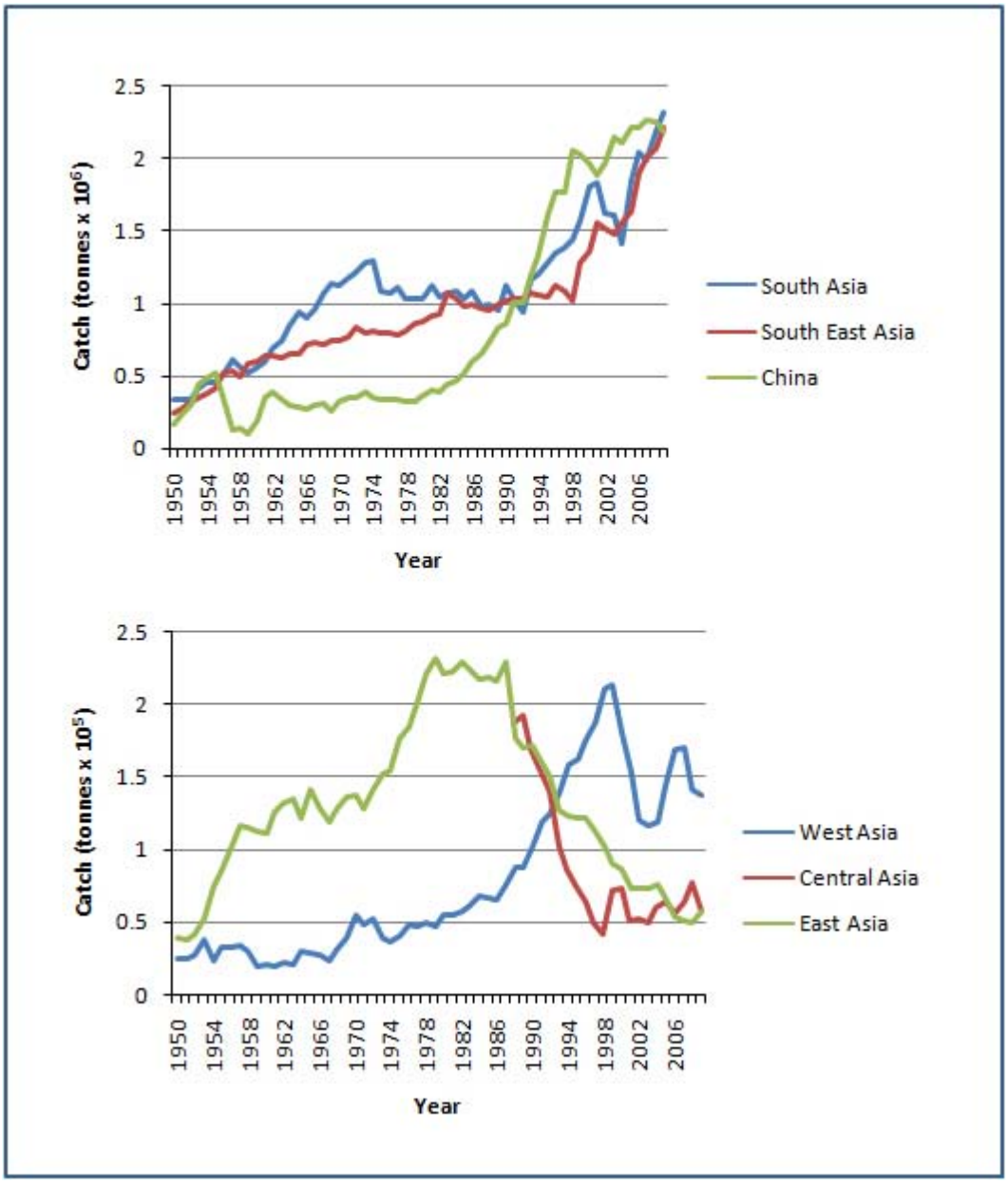


Figure 21 : Trends in reported catch in the various Asian regions, 1950–2009
(*Note*: Statistics for the Central Asian region only began being reported by country after the dissolution of the USSR)

Table 14: Percentage contribution of the various Asian regions to the Asian total inland catch in 2009

Region	Catch (tonnes)	%
South Asia	2 315 499	33.26
South-east Asia	2 210 508	31.75
China	2 184 049	31.37
West Asia	137 748	1.98
Central Asia	57 805	0.83
East Asia	56 884	0.82
Arabia	0	0.00
Total	6 962 482	100.00

Table 15 shows that fish is the single biggest source of animal protein in Asia, and at 49 percent accounts for nearly half the supply. Inland fish, at 3 percent, is the sixth most important source of animal protein on the continent.

Table 15: Production of animal protein by source in Asia in 2009 (aquatic plants are excluded from the aquaculture figures)

Protein source	Catch (tonnes)	%
Aquaculture	66 670 226	28.91
Pig meat	59 997 700	26.01
Marine fish	39 952 069	17.32
Chicken meat	25 623 677	11.11
Cattle meat	12 792 493	5.55
Inland fish	6 962 672	3.02
Sheep meat	4 293 533	1.86
Goat meat	3 527 983	1.53
Duck meat	3 193 771	1.38
Buffalo meat	3 030 368	1.31
Goose and guinea fowl meat	2 338 617	1.01
8 other categories	2 254 281	0.98
Total	230 639 399	100.00

Source: FAOSTAT.

Asian catches consist of a very large number of species, partly because of the extent and diversity of the continent (Figure 22). The number of taxonomic groups reported in the catches has risen from 39 in 1950 to 120 in 2009. At the same time, the proportion of the catch assigned to the “freshwater fishes NEI” category fell until 1995, but has since risen indicating, perhaps, that efforts to identify the catches to species have declined in recent years.

Figure 22: Trends in the number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for Asian countries, 1950–2009

Catches from Asia consist mainly of finfish, but they also contain a higher proportion of other major groups (Table 16).

Table 16: Major taxonomic groupings of catches from Asia, 2009

Major grouping	Catch (tonnes)	%
Finfish	6 031 545	86.63
Crustaceans	516 303	7.42
Molluscs	365 688	5.25
Aquatic invertebrates	46 774	0.67
Amphibians	2 172	0.03
Total	6 962 482	100.00

3.2.1 China

(China; Hong Kong Special Administrative Region; China, Macao Special Administrative Region; Taiwan Province of China)

The Chinese region is distinguished because it is the major single producer of inland aquatic products in Asia and the world. The main resources are based on several large river systems, including the Yangtse and Yellow Rivers, numerous natural lakes, and artificial reservoirs and ponds, as well as rice fields.[6]

China's catch statistics are currently under review. Figure 23 illustrates the growth of the sector since 1950, and shows an exponential trend in growth between 1975 and 2000. This has since slowed down, and indicates that the fisheries may have reached a stable level.

[6] Catches from rice fields are reported as coming from aquaculture in some countries.

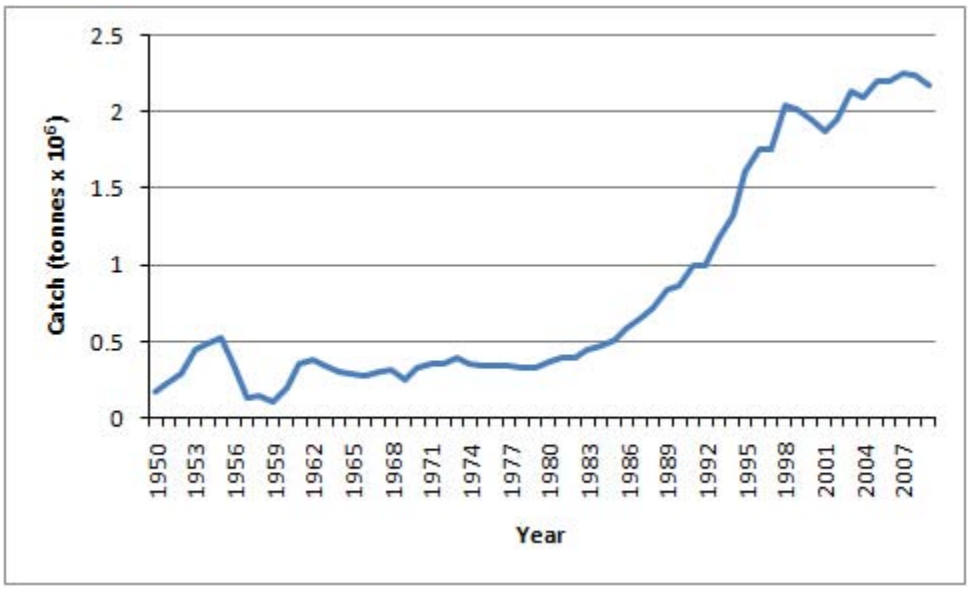


Figure 23: Trends in inland fish production from the Chinese region, 1950–2009

The major groups of organisms caught by Chinese inland water fisheries are shown in Table 17. Finfish are not generally reported individually in China, which assigns them to "freshwater fishes NEI". The table indicates that, while fishes still comprise the majority of the catch (70 percent), other groups of organisms, especially crustaceans (15 percent) and molluscs (13 percent), are caught at above the global average rates.

Table 17: Main groups of organisms caught by inland fisheries in China in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	1 526 339	69.89
Freshwater molluscs NEI	284 331	13.02
Oriental river prawn	137 659	6.30
Siberian prawn	137 659	6.30
Chinese mitten crab	52 495	2.40
Aquatic invertebrates NEI	45 430	2.08
Bighead carp	52	0.00
Common carp	13	0.00
Natantian decapods NEI	13	0.00
Grass carp (= white amur)	10	0.00
Black carp	9	0.00
Tilapias NEI	8	0.00
Total	2 184 018	100.00

3.2.2 East Asia

(Democratic People's Republic of Korea, Japan, Republic of Korea)

The East Asian region comprises the countries of the Democratic People's Republic of Korea, Japan and the Republic of Korea. All have a high dependency on aquatic foods and have developed intensive aquaculture systems. They have characteristically short, steep river systems, few natural lakes and a number of reservoirs.

Catches in the East Asian region rose steadily to a maximum of around 220 000 tonnes between 1980 and 1987. They have since declined drastically in all three of the countries to reach a combined total of 42 980 tonnes in 2009 (Figure 24) with a very slight recovery to 53 969 in 2009. The reasons for this decline are not apparent, but may be due to the relative unprofitability of inland fisheries compared with aquaculture and to pollution and environmental degradation.
Catches mainly consist of salmonids (Table 18), but characteristic of the general decline in inland fish catch is that this group declined from a high of 41 679 tonnes in Japan in 1994 to 19 505 in 2009. The main major taxa caught are finfish (77 percent) and molluscs (20 percent).

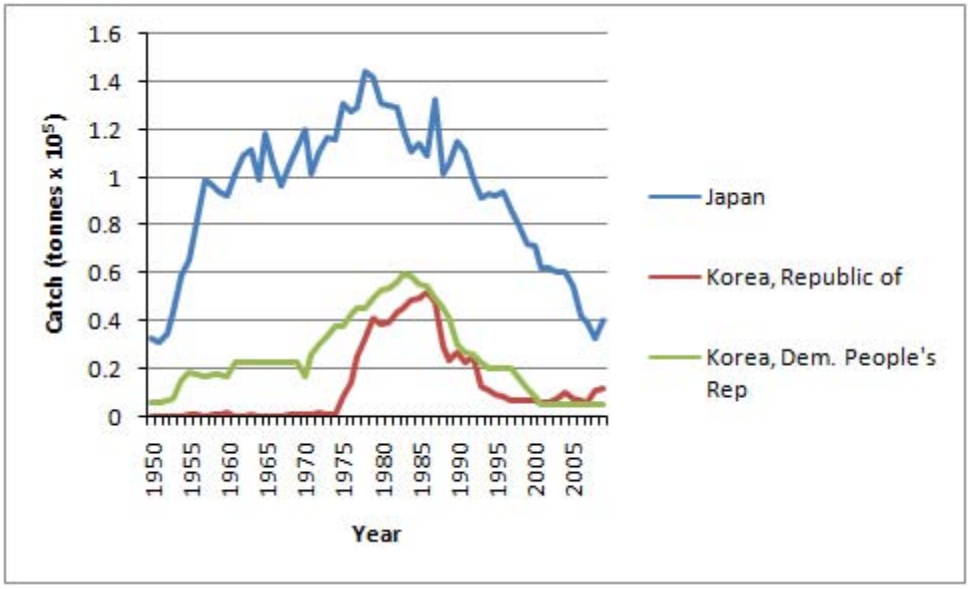


Figure 24: Trends in inland fish production from the East Asia region, 1950–2009

Table 18: Main groups of organisms caught by inland fisheries in East Asia in 2009

Taxonomic group	Catch (tonnes)	%
Chum (= keta = dog) salmon	11 886	22.02
Japanese corbicula	11 495	21.30
Freshwater fishes NEI	10 660	19.75
Freshwater molluscs NEI	5 031	9.32
Ayu sweet fish	3 632	6.73
Cyprinids NEI	3 350	6.21
Common carp	2 213	4.10
Japanese smelt	2 043	3.79
Mullets NEI	1 152	2.13
Pink (= humpback) salmon	912	1.69
Crucian carp	850	1.57
Japanese ice fish	745	1.38
10 other taxa	2 915	5.12
Total	53 969	100.00

3.2.3 South Asia

(Bangladesh, Bhutan, India, Nepal, Pakistan, Sri Lanka)

The South Asian region groups the rivers and reservoirs of the Indian subcontinent. The major single fishery here is that of the Ganges-Brahmaputra delta, although there are a number of other large river systems in India (including the Godavari, Krishna and Cauvery Rivers) and the Indus River in Pakistan.

Catches for both Bangladesh and India have continued to rise throughout the history of the fishery (Figure 25), although more recently catches from India appear to have stabilized. Other fisheries have continued to increase (Nepal and Sri Lanka) or have declined slightly (Pakistan) in the same period. Much of the apparent increase in Bangladesh may be the result of better reporting, as many floodplain and lake fisheries have been included into the estimates as well as production from rice field fisheries.

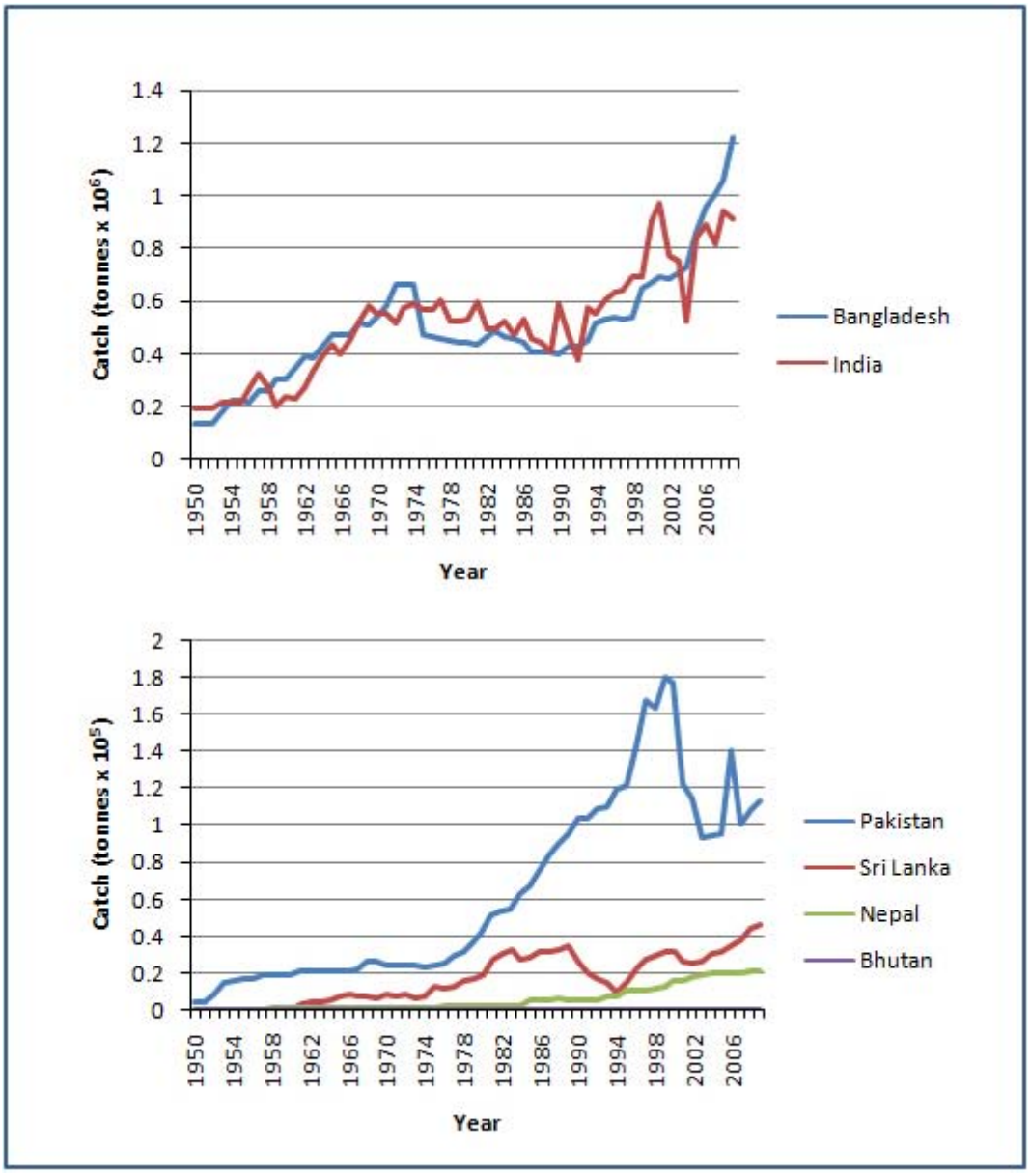


Figure 25: Trends in inland fish production from the South Asian region, 1950–2009

There are important religious and cultural issues affecting the consumption of aquatic organisms in South Asia: vegetarians in large parts of India avoid most non-fish aquatic animals, as Islamic tradition designates that some aquatic products are not *halal* (permitted) and are to be avoided; in addition, other religious or cultural traditions prevent the killing or capturing of fish (Azad, Jensen and Kwei Lin, 2009).

Over sixty percent of catches are not identified to species, and of the remainder 14 percent are cyprinids (Table 19). Very few organisms other than fish are reported in the catches, except for crustaceans (6.35 percent). Recently, exports of frogs have been banned from Bangladesh owing to fears that declining frog populations would lead to an explosive growth in insect pests. There is some evidence that some fisheries in South Asia are heavily fished as catches in Bangladesh consist mainly of young-of-the-year (0+) fish (Halls, Hoggarth and Debnath, 1999). One species of major cultural significance in the region is the hilsa shad (*Tenualosa ilisha)*, which has seen declines in inland and estuarine fisheries of Bangladesh and India over a number of years, although this species now appears to be increasing in the freshwater catches (Box 6).

Table 19: Main groups of organisms caught by inland fisheries in South Asia in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	1 491 974	64.43
Cyprinids NEI	327 717	14.15
Freshwater siluroids NEI	112 775	4.87
Hilsa shad	95 970	4.14
Freshwater crustaceans NEI	95 362	4.12
Snakeheads (= murrels) NEI	82 142	3.55
Natantian decapods NEI	36 317	1.57
Tilapias NEI	26 320	1.14
9 other taxa	46 922	2.03
Total	2 315 499	100.00

3.2.4 Southeast Asia

(Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, the Philippines, Singapore, Thailand, Timor-Leste, Viet Nam)

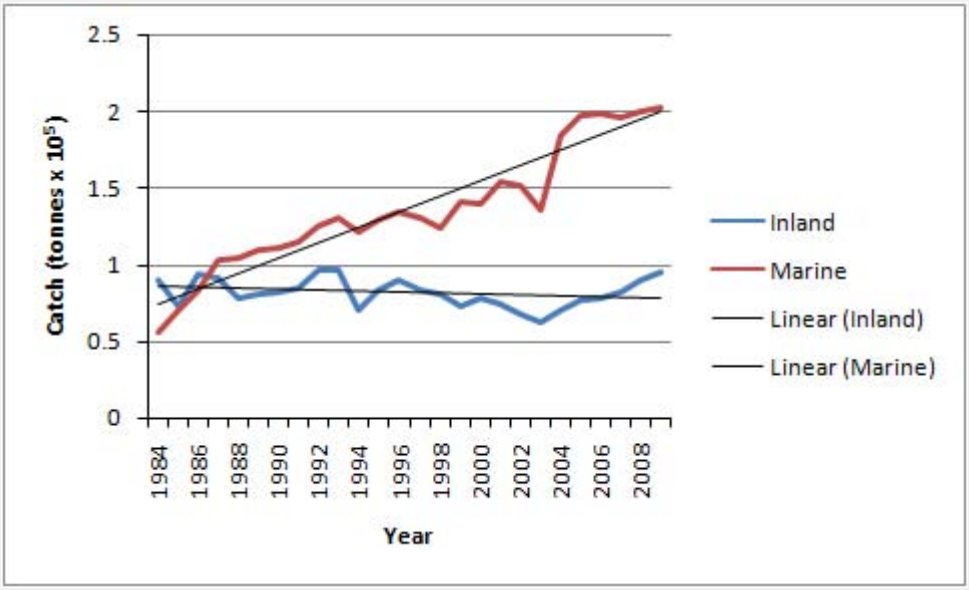
The Southeast Asian region combines two main areas, i.e. first, the Southeast Asian area proper centred around the Mekong, Salween and Irrawaddy river systems and their deltas as well as a number of other rivers, and second, the islands of Indonesia, Malaysia and the Philippines.

The period under review has seen considerable increases in catch in some countries (Figure 26), particularly Cambodia, Myanmar and Thailand. Catches in Indonesia have remained reasonably stable and even risen slightly since 1974. Catches from the Philippines have declined from a peak of 369 000 tonnes in 1983 to 186 444 000 tonnes in 2009. Of particular interest here are the Mekong basin group of countries where reported catches are considerably less than current estimates (Hortle, 2007; Lymer e*t al*., 2008a). In particular, Viet Nam, with a reported catch of only 144 800 tonnes in 2009, was estimated to have catches closer to 852 000 tonnes. Lymer *et al* (2008a) estimate that actual catches in Thailand are some five times greater than those reported in the official statistics.

BOX 6

HILSA SHAD (*TENUALOSA ILISHA*) – AN ANADROMOUS SPECIES HARVESTED IN TWO ENVIRONMENTS

This anadromous shad species is of major cultural significance in Bangladesh and Bengal (India) where it forms the basis of an important seasonal fishery. Catches of hilsa from inland waters have declined slightly or not at all since the construction of the Farraka Barrage on the Hooghly River. This is despite a popular perception that catches have declined considerably. Marine catches have been increasing throughout the recorded period at about 6.1 percent/year. The species was first recorded separately in the FAO statistics in 1984 (see figure below).



Catches of *Tenualosa ilisha* from inland and marine habitats, 1984–2009

Total catches from Myanmar were also reported to be low compared with the potential as calculated by area,[7] although reporting over the last five years seems to have rectified this. However, the considerable increases reported by Cambodia from 1999 probably arose from the incorporation of floodplain fisheries following reports by the Mekong River Commission, and Cambodia itself has declared its statistics not to be backwardly compatible before this date. The dramatic increases in the catches in Myanmar are also probably due to the re-estimation of the contribution of floodplain fisheries, although also attributed to improved management measures, such as the enhancement by inland fishing concessions.

Per capita consumption is also high in this region, with Cambodia being the highest, where detailed analysis by Hortle (2007) shows that annual consumption patterns vary between provinces, from 105.2 kg per capita in riparian provinces to 43.4 kg per capita in those that are less dependent on the river.

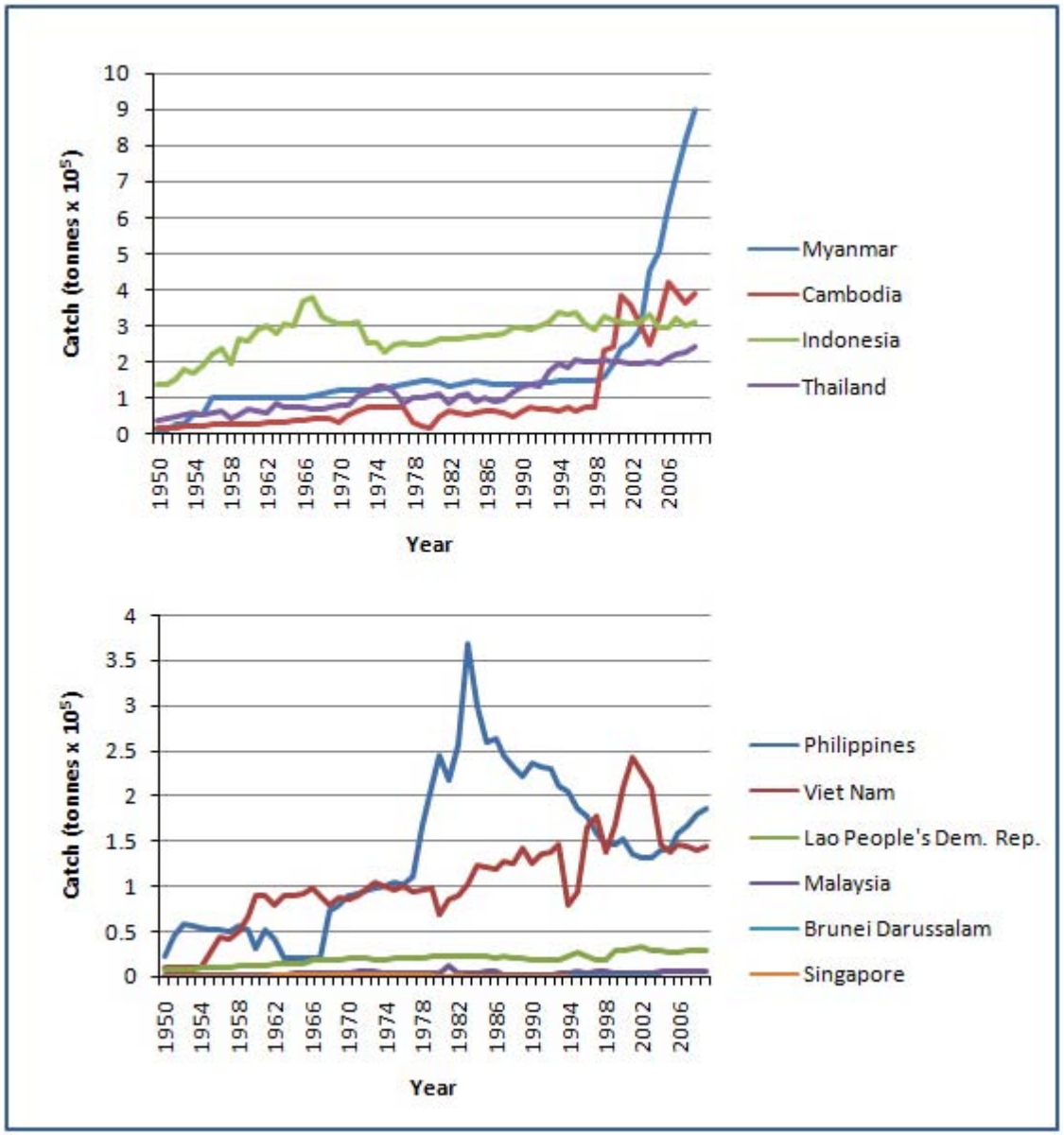


Figure 26: Trends in inland fish production from the Southeast Asian region, 1950–2009

[7] www.fao.org/docrep/004/ad497/ad497e04.htm

Catches from the Southeast Asian region are varied with a reported 63 taxa, some of which are groupings of species (Table 20). The major part of the catch consists of finfish with very small amounts of crustaceans (1.7 percent) and molluscs (2.8 percent). There are, however, indications from studies carried out by Hortle (2007) in the Lower Mekong that much of the catch of organisms other than finfish is unreported and that, in reality, the contribution of crustaceans and molluscs to diets is considerably higher than reports would suggest (Halwart *et al.*, 2006; Meusch *et al.*, 2003). Few countries report their catches at the family level, and many that do assign the majority of the catch to "freshwater fishes NEI" (72 percent), possibly because of the great fish biodiversity of the region, which means that catches consist of numerous species. The remaining 26 percent are distributed among 27 family groupings, including frogs and shrimps. The dominant species groups identified are cichlids (5.0 percent), cyprinids (4.2 percent), catfishes (3.0 percent) and snakeheads (2.9 percent). Fishing pressure has produced a noticeable diminution of the mean length of fish caught in the Mekong basin, indicating severe fishing pressure (Van Zalinge *et al.*, 2004).

Table 20: Main groups of organisms caught by inland fisheries in Southeast Asia in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	1 604 595	72.59
Nile tilapia	67 040	3.03
Freshwater molluscs NEI	61 452	2.78
Striped snakehead	61 030	2.76
Silver barb	51 090	2.31
Tilapias NEI	43 463	1.97
Torpedo-shaped catfishes NEI	33 015	1.49
Snakeskin gourami	32 052	1.45
Cyprinids NEI	26 210	1.19
Climbing perch	24 591	1.11
Natantian decapods NEI	23 512	1.06
50 other taxa	182 458	8.25
Total	2 210 508	100.00

3.2.5 West Asia

(Islamic Republic of Iran, Iraq, Israel, Jordan, Lebanon, Occupied Palestinian Territory, the Syrian Arab Republic, Turkey)

This region consists of mainly arid lands with a few important rivers such as the Tigris and Euphrates as well as part of the Caspian Sea. There are large and small lakes in Iraq and Turkey as well as numerous dams and reservoirs.

Figure 27 shows that the catch history in the three major inland fisheries producing countries differs widely. Turkey showed a fairly consistent increase until about 1984, when they stabilized around 46 000 tonnes per year thereafter. Catches were fairly stable in Iraq until the southern marshes were drained, but the fishery has apparently recovered after the partial refilling of the wetlands. Catches in the Islamic Republic of Iran reached a peak in 1999, collapsed to less than half by 2003, and have since recovered slightly. The decline of the Iranian fishery corresponds to a general decline in the clupeoid group (mostly *Clupeonella*) in the Caspian Sea fishery (see Box 7).

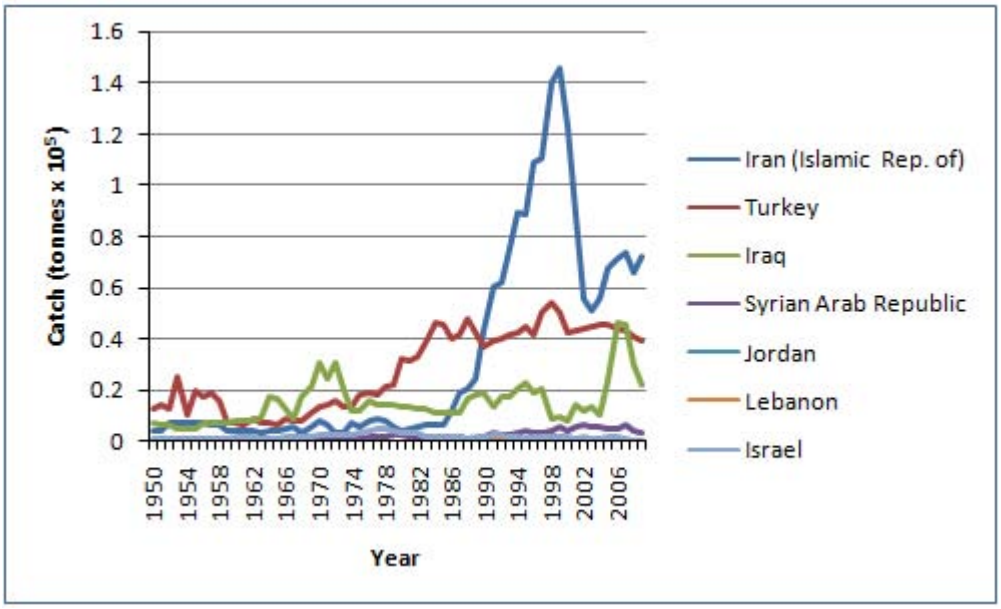


Figure 27: Trends in inland fish production from the West Asian region, 1950–2009

Catches in the West Asian area are heavily dependent on cyprinids (37.5 percent), with clupeids playing a secondary role in 2009 at 18.5 percent (Table 21). In 1998, clupeids contributed 40.33 percent of the catch against 31.55 percent of cyprinids, which provides further witness to the collapse of the *Clupeonella* stocks over the last decade (analysed in Box 7).

Table 21: Main groups of organisms caught by inland fisheries in West Asia in 2009

Taxonomic group	Catch (tonnes)	%
Black Caspian Sea sprats NEI	25 483	18.50
Common carp	18 723	13.59
Cyprinids NEI	18 133	13.16
Freshwater fishes NEI	15 506	11.26
Kutum	12 495	9.07
Tarek	10 685	7.76
Silver carp	9 154	6.65
Silversides (= sand smelts) NEI	6 184	4.49
Mullets NEI	4 547	3.30
Grass carp (= white amur)	2 750	2.00
Freshwater siluroids NEI	2 709	1.97
Freshwater molluscs NEI	2 227	1.62
Tench	1 482	1.08
21 other taxa	7 670	5.57
Total	137 748	100.00

3.2.6 Central Asia

(Afghanistan, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, Uzbekistan)

This central Asian grouping contains most of the Aral Sea basin with the Aral Sea and the Syr Darya and Amu Darya Rivers. It also includes Lake Balkhash (Kazakhstan). The statistical data set for this grouping is shorter than most, as before 1988 it was reported as a homogenous group within the former USSR area. During Soviet times, people were strongly encouraged to eat fish once a week. During these "fish days", restaurants served mainly fish dishes. This tradition disappeared when the USSR collapsed and fish became less readily available.

The major producers of inland fish in this region are Kazakhstan, which represented 58.2 percent of the catch from the region in 2009, and Turkmenistan (25.9 percent), because of their association with Lake Balkhash, the Caspian Sea and the Sea of Azov (Figure 28). Catches declined from 1989 (193 081 tonnes) to 1998 (41 966 tonnes) because these countries began recording fisheries data separately. These trends in catch can be attributed to the drying out and pollution of the Aral Sea from the water abstractions for cotton culture; Lake Balkhash is following a similar trajectory because of dams on inflowing rivers. This has damaged the important stocks of "kilka" (*Clupeonella cultriventris*) that previously formed a staple of the fishery, which had reached some 450 000 tonnes in 1974 (Box 7). The reasons for the collapse of fisheries in this region during this period have been explored by Thorpe *et al*. (2009). However, trends over the last ten years have been for a slight renewal of the fisheries, at least in Kazakhstan, although fisheries in Turkmenistan have remained relatively stable (FAO estimate) and those of Azerbaijan have continued to decline. Of the minor countries, most have remained stable or even increased, as in the case of Uzbekistan.

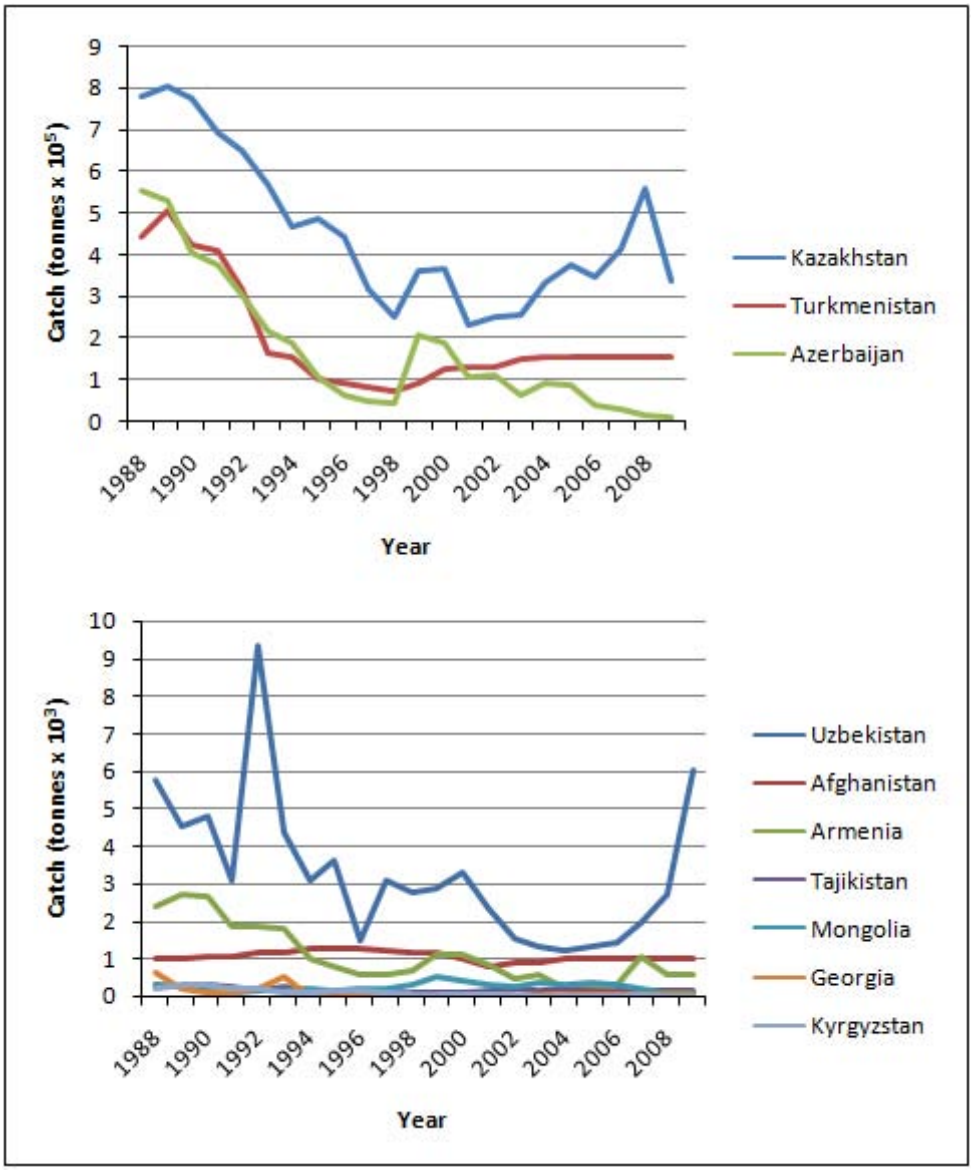


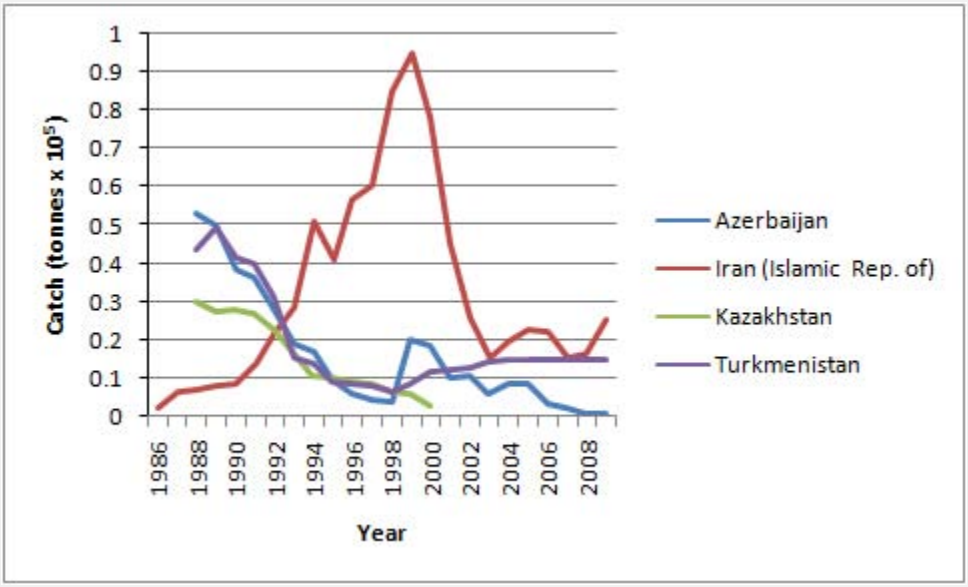
Figure 28: Trends in inland fish production from the Central Asian region, 1988–2009

BOX 7

THE BLACK SEA SPRAT (*CLUPEONELLA CULTRIVENTRIS*) – VICTIM OF MULTIPLE ENVIRONMENTAL IMPACTS

The history of the Black Sea sprat illustrates the effect of multiple environmental pressures on a species and its fishery. The Black Sea sprat is found in the Black Sea and the Sea of Azov, the Caspian and the Aral Seas, as well as in their affluent rivers. It formed a mainstay of the fisheries of the Caspian and Aral Seas and had wide-ranging economic value. The species and its fishery in Kazakhstan and Uzbekistan were severely damaged by the desiccation of the Aral Sea. The pollution of the Caspian Sea and Sea of Azov and their inflowing rivers and the accidental introduction into the Caspian of the comb jelly *Mnemiopsis leidyi* (Daskalov and Mamedov, 2007) has provoked the collapse of the fishery for this species in the Islamic Republic of Iran since 2000 and earlier in Turkmenistan (see figures below).

Trends in catch of the Black Sea sprat (*Clupeonella cultriventris)* in Central Asian countries from 1950–2009



Trends in catch of the Black Sea sprat (*Clupeonella cultriventris*) by country, 1986–2009

Further evidence for the decline in kilka is seen when the catch composition of 1988 is compared with that of 2009 (Table 22), where clupeids contributed 62.2 percent of the catch in 1988 as opposed to only 26.8 percent in 2009. These have been replaced by cyprinids (53.6 percent of 2009 total catch), pike-perch and "freshwater fishes NEI" in the rising catches of the last ten years. Other major reasons for the collapse in the fisheries in Central Asia were that, recently, no public funds have been available for the fisheries sector and thus stocking programmes have been discontinued. In addition, many of the species used in stocking programmes under the USSR were exotic and had to a large extent replaced the indigenous fauna; however, when stocking programmes stopped, the exotics were not able to maintain their populations because of the lack of suitable spawning grounds. A further aggravating factor is the lack of fisheries inspection together with large-scale unemployment, which has led to an explosion in illegal fishing.

Table 22: Main groups of organisms caught by inland fisheries in Central Asia in 1988 and 2009

Taxonomic group	1988 (tonnes)	2009 (tonnes)	1988 (%)	2009 (%)
Freshwater bream	27 227	17 464	13.37	30.21
Black and Caspian Sea sprat	126 580	15 519	62.16	26.85
Pike-perch	7 888	4 192	3.87	7.25
Roaches NEI	6 327	4 162	3.11	7.2
Crucian carp	2 364	2 806	1.16	4.85
Wels (= som) catfish	3 764	2 670	1.85	4.62
Silver carp		1 994	0.00	3.45
Common carp		1 927	0.00	3.33
Freshwater fishes NEI	1 364	1 800	0.67	3.11
Asp	410	1 441	0.20	2.49
Northern pike	1 762	1 345	0.87	2.33
Grass carp (= white amur)	1	607	0.00	1.05
18 other taxa	25 957	1 878	12.75	3.25
Total	203 644	57 805	100.00	100.00

3.2.7 Arabia

(Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, Yemen, United Arab Emirates)

This region is almost totally arid and has no reported inland catch.

3.3 Americas

The Americas are divided into four regions that are classified by state of development as much as geographical affiliation. Thus, Mexico is situated with the Central American group rather than North America.

Total catches from the four areas combined (Figure 29) rose until about 1988, and has fluctuated around a mean of about 600 000 tonnes. This is largely because gains in some countries have been offset by losses from the North American region.

The four regions of the Americas each shows a different pattern of exploitation (Figure 30), which will be commented in the appropriate section. South America contributes the most to the total production (66.7 percent) (Table 23), although administrators and researchers have admitted that estimates of production levels are low as there is a general failure to report any but the most significant landings from the main commercial markets. This leaves the commercial fisheries of some major tributaries unrecorded. Similarly, the artisanal and subsistence sectors have generally not been researched, although these may be considerable, especially among poorer riparian populations.

Figure 29: Trends in reported catch for all regions of the Americas, 1950–2009

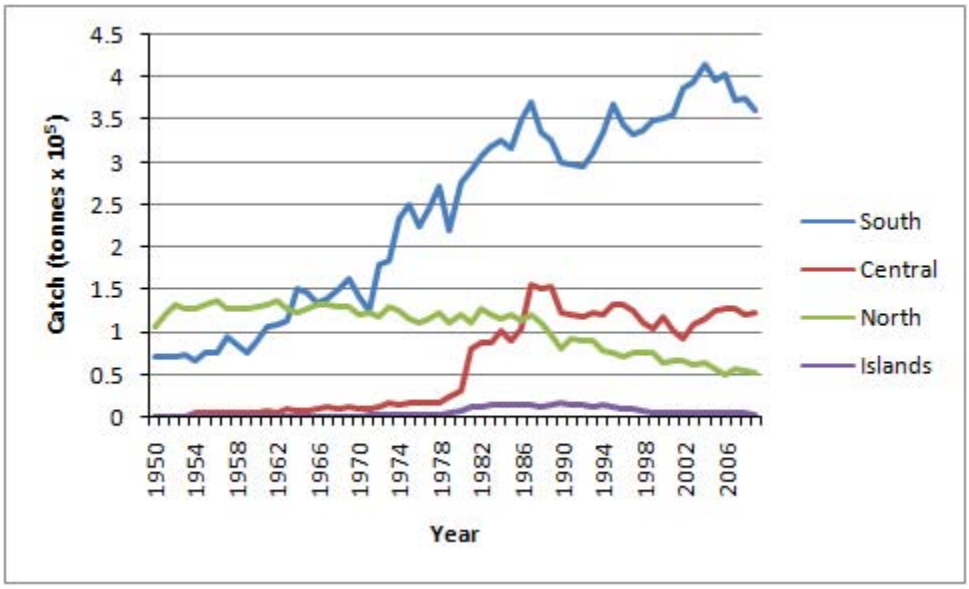


Figure 30: Trends in inland fish production from each of the four regions of the Americas, 1950–2009

Table 23: Percentage contribution of the various American regions to the American total inland catch in 2009

Subregion	Catch (tonnes)	% share
South	359 947	66.72
Central	122 013	22.62
North	53 861	9.98
Islands	3 659	0.68
Total	539 480	100.00

Inland fish is not an important component in the total animal protein resources of the continent (0.52 percent of the total supply), although fish from all sources contributed 28 percent to South and

Central American protein balances in 2009 and only 11 percent in North America, one of the lowest contributions of fish overall to protein diets of any continent (Table 24). This is because there is a distinct preference for chicken among the poor and beef among the better off. In the strongly Catholic countries of Latin America, there is a peak in fish consumption around Easter. However, this source of protein is much more significant among the people riparian to the major river and lake systems, as marketing chains to deliver fish to the wider rural are often poor. For example, in Central America inland fish contributes 1.68 percent, or more than double the continental average.

Table 24: North, Central and South America – production of animal protein by source, 2009
(aquatic plants are excluded from the aquaculture figures)

Item	Central and South America		Canada and United States of America	
	Production	%	Production 2009	%
Chicken meat	19 369 028	30.41	17 371 530	33.65
Cattle meat	18 255 648	28.67	13 146 370	25.47
Marine fish	15 363 596	24.13	5 129 458	9.94
Pig meat	6 309 641	9.91	12 387 100	24.00
Aquaculture	2 283 877	3.59	326 053	0.63
Turkey meat	589 368	0.93	2 734 953	5.30
Freshwater fish	485 619	0.76	53 861	0.10
Sheep meat	314 179	0.49	96 907	0.19
Rabbit meat	263 443	0.41	–	–
Horse meat	167 636	0.26	63 558	0.12
Goat meat	129 835	0.20	–	–
Game meat	59 301	0.09	249 561	0.48
Duck meat	41 512	0.07	57 383	0.11
Meat of other rod	17 875	0.03	–	–
Meat other camelids	17 500	0.03	–	–
Meat nes*	14 472	0.02	–	–
Total	63 682 530	100.00	51 616 734	100.00

*Not elsewhere specified.
Source: FAOSTAT; FishStat.

Catches over the whole continent consist almost entirely of fish (96.3 percent) with a few crustaceans also being caught (Table 25).

Table 25: Major taxonomic groupings of catches for the Americas in 2009

Major group	Catch (tonnes)	%
Finfish	519 740	96.34
Crustaceans	17 356	3.22
Molluscs	1 724	0.32
Aquatic invertebrates	439	0.08
Amphibians	221	0.04
Total	539 480	100.00

Figures 31 and 32 show the number of taxa and the percentage of "freshwater fishes NEI" reported for Latin America (excluding Canada and the United States of America) and North America (Canada and the United States of America), respectively. The number of species in the catch each year has risen in Latin America, where 73 taxa were reported by 2009, but has fallen since 1992 in North America.

The proportion of "freshwater fishes NEI" was highly variable from year to year in both cases, albeit with a slightly declining trend.

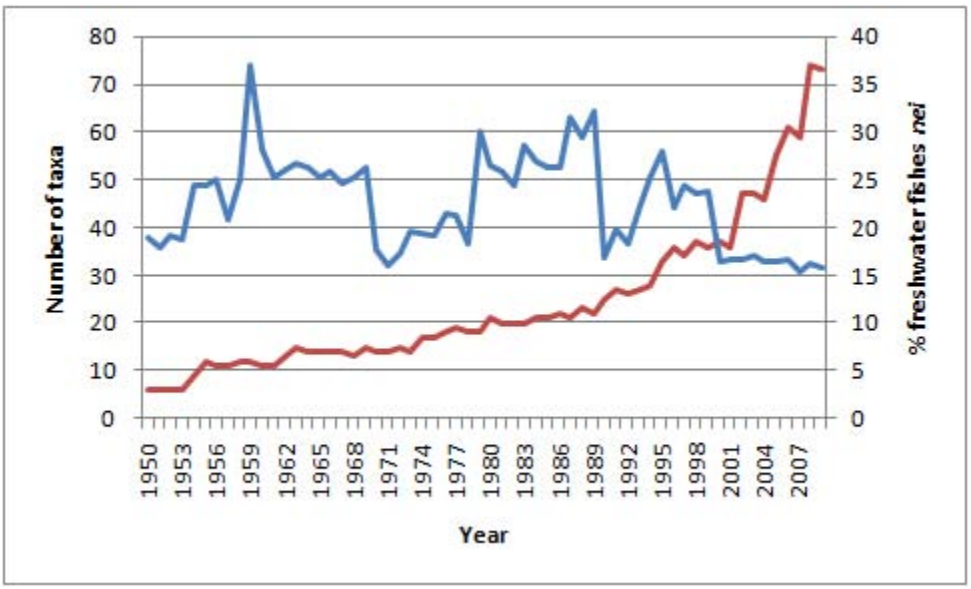


Figure 31: Trends in number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for Latin America (Central, South and islands) for 1950–2009

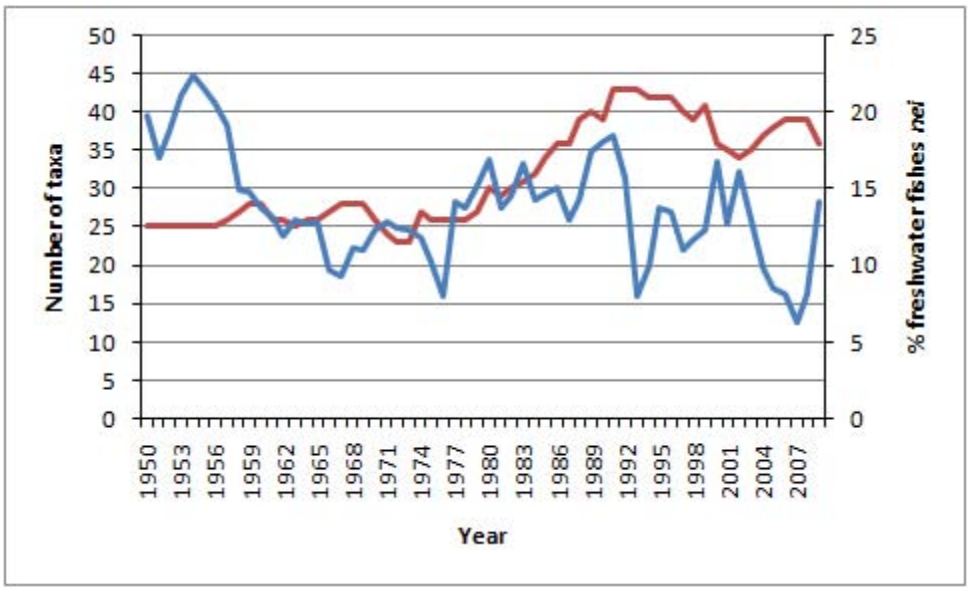


Figure 32: Trends in number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for North America for 1950–2009

3.3.1 Central America

(Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama)

The fisheries of Central America are based on a few large rivers such as the Usumacinta system in Mexico, and lakes such as Lake Nicaragua. There are also numerous reservoirs, especially in Mexico, whose fisheries are often maintained by stocking. Over 90 percent of the current Central American production comes from Mexico, with roughly 2.65 percent coming from Panama, 1.96 percent from El Salvador and 1.92 percent from Guatemala.

Mexican inland fisheries production (Figure 33) reached a peak of 147 000 tonnes in 1987, and has since fluctuated about 100 000 tonnes with a slight decline in the earlier years. The reasons for the fluctuations are unclear but may be linked to changes in stocking policy. Catches from the other countries have fluctuated wildly over the past 20 years and have tended to decline in almost all cases except for El Salvador.

Reporting of catches to taxonomic category is good with only 6.6 percent reported under the general "freshwater fishes NEI" category. Catches are a mixture of North American and South American categories with the exception of Tilapias (Table 26). The predominance of the introduced tilapias (53.3 percent) rather than native cichlids indicates the importance of stocked lake fisheries in the region. Other main taxa include the exotic cyprinids (20 percent), of which the introduced common carp is also used for stocking cooler reservoirs and dams.

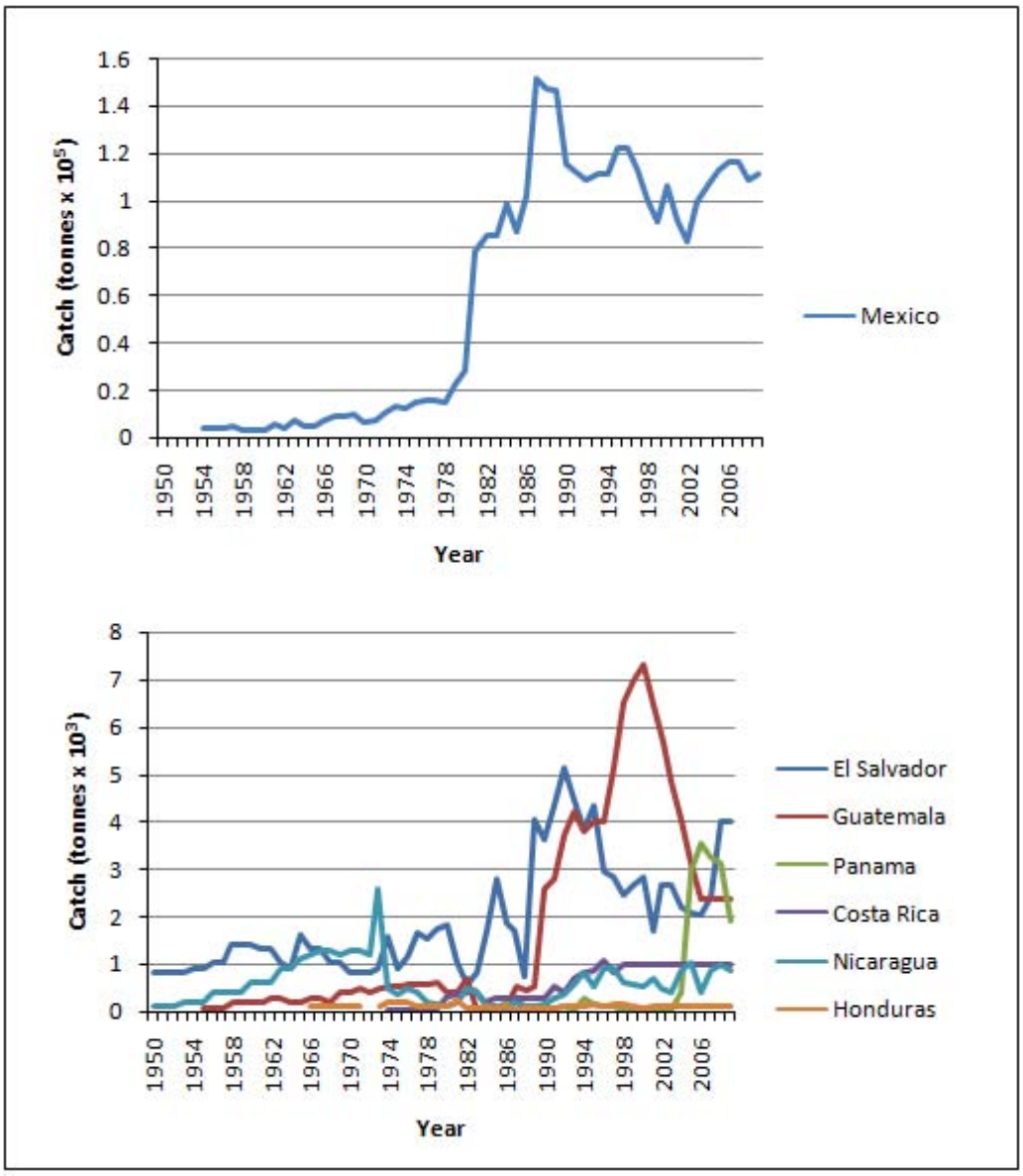


Figure 33: Inland fish production from the Central American region, 1950–2009

Table 26: Main groups of organisms caught by inland fisheries in Central America in 2009

Taxonomic group	Catch (tonnes)	%
Tilapias NEI	65 017	53.29
Common carp	24 450	20.04
Freshwater fishes NEI	8 050	6.60
Nile tilapia	3 977	3.26
River prawns NEI	3 092	2.53
Snooks (= robalos) NEI	2 593	2.13
Chirostoma spp	2 372	1.94
Cyprinids NEI	2 119	1.74
Silversides (= sand smelts) NEI	1 937	1.59
Freshwater molluscs NEI	1 723	1.41
Catfishes NEI	1 619	1.33
Cichlids NEI	1 466	1.20
17 other taxa	3 598	2.95
Total	122 013	100.00

3.3.2 North America

(Canada, the United States of America)

The fisheries of North America are based on the extensive Great Lakes system in the north, the Mississippi River and tributaries centrally and to the south, and the west-flowing rivers. Numerous other rivers and lakes are situated throughout the countries. Reported catches of inland fish in the Canada and the United States of America have declined steadily since the late 1950s (Figure 34). This is probably due to the uneconomic nature of inland fisheries compared with other types of fish production. Furthermore, management of inland fisheries for recreation (see Annex 3) and conservation have assumed progressively more importance as time goes on.

A wide range of fish are caught, particularly coregonids (21.6 percent) and percids (black bass, walleye and sunfishes, 18.9 percent) (Table 27), which form the mainstay of the Great Lakes fisheries, and salmonids, which are important in the west-flowing rivers. Salmonids formed up to 19 percent of catch in 1988, but have fallen to 1.67 percent by 2009 (see Box 9).

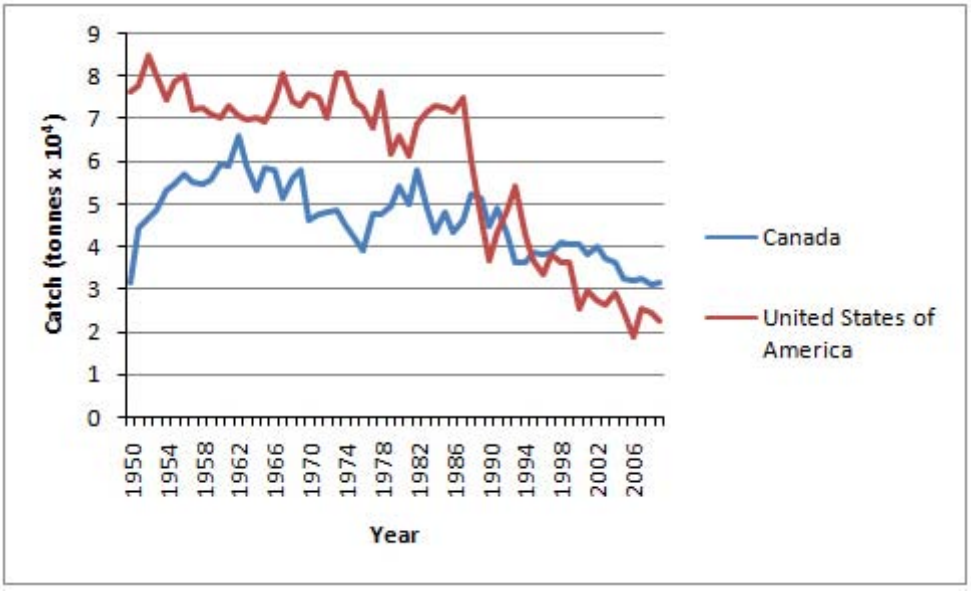


Figure 34: Inland fish production from the North American region, 1950–2009

Table 27: Main groups of organisms caught by inland fisheries in North America in 2009

Taxonomic group	Catch (tonnes)	%
Lake (= common) whitefish	11 076	20.56
Euro-American crayfishes NEI	8 536	15.85
Walleye	7 689	14.28
Freshwater fishes NEI	7 603	14.12
Pond smelt	3 585	6.66
American yellow perch	1 957	3.63
Northern pike	1 955	3.63
Catfishes NEI	1 866	3.46
Buffalo fishes NEI	1 420	2.64
Blue catfish	1 242	2.31
Alewife	955	1.77
Lake trout (= char)	841	1.56
Common carp	792	1.47
American gizzard shad	669	1.24
Lake cisco	640	1.19
20 other taxa	3 034	5.63
Total	53 861	100.00

3.3.3 South America

(Argentina, Plurinational State of Bolivia, Brazil, Chile, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Uruguay, the Bolivarian Republic of Venezuela)

South American inland fisheries are based on the large river systems of the Amazon, Orinoco and La Plata, the Pantanal wetlands of the upper Paraguay River, the Andean lakes of Argentina and Chile, Lake Titicaca and a number of reservoirs in Brazil, and the Bolivarian Republic of Venezuela. There are also many important secondary river systems such as the Essequibo in Guyana, the São Francisco in Brazil and the Magdalena in Colombia. Overall, South American inland fish production has increased by 1.75 percent/year between 1950 and 2004, but has since declined (Figure 35).

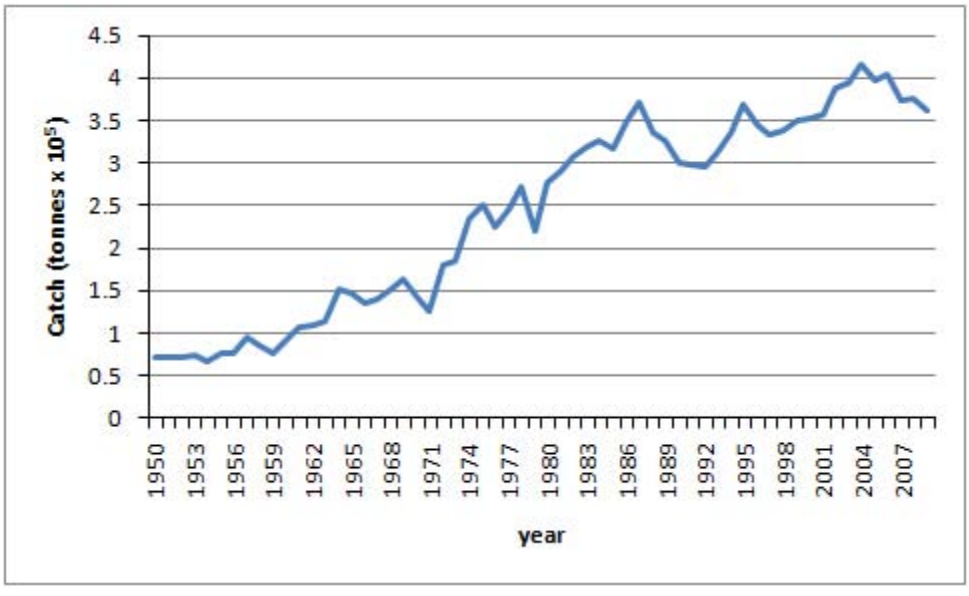


Figure 35: Inland fish production from the South American region, 1950–2009

Brazil is the major producer of inland fish in South America, contributing 66.5 percent to the 2009 total of 359 947 tonnes, and has shown the fastest consistent growth (Figure 36). Much of this is based on the commercial urban-based fleets of the Amazon (Almeida, Lorenzen and McGrath , 2004), but this only records catches by the commercial fleets operating in the main stem of the river and Amazonian catches are thus probably underestimated. Colombia was temporarily the largest producer in 1970, but the fishery has since declined considerably owing to the reclamation of the Magdalena delta floodplain, pollution and increased siltation through deforestation of the Andean slopes. Venezuelan catches increased until 1996 and have since fluctuated with a restoration in production in 2002 and a subsequent decline in production. Argentine and Paraguayan catches rose in response to an export demand for "sábalo" (*Prochilodus platensis*), but fell as stocks were adversely affected by deteriorating conditions in the Paraná River because of the numerous upstream dams (see Box 8). Catches are now dominated by medium- to small-sized species such as the Curimatidae and Characidae (33 percent), whereas some years ago the proportion of large catfishes (Pimelodidae) was somewhat higher – in 2004, for example, the pimelodid catfishes formed 27.5 percent of the catches as compared with 1.9 percent in 2009 (Table 28). The decline is probably due to local overfishing of the larger catfish species around the main urban centres of the Amazon and Orinoco Rivers as well as damming in the case of the Paraná River.

In recent years, there has been an increase in recreational fisheries, particularly in the southern part of the region. This is particularly important to the economies of the Andean lakes of Argentina and Chile. Some areas of Brazil, such as the Pantanal in Mato Grosso do Sul, are also dedicated to recreational fishing.

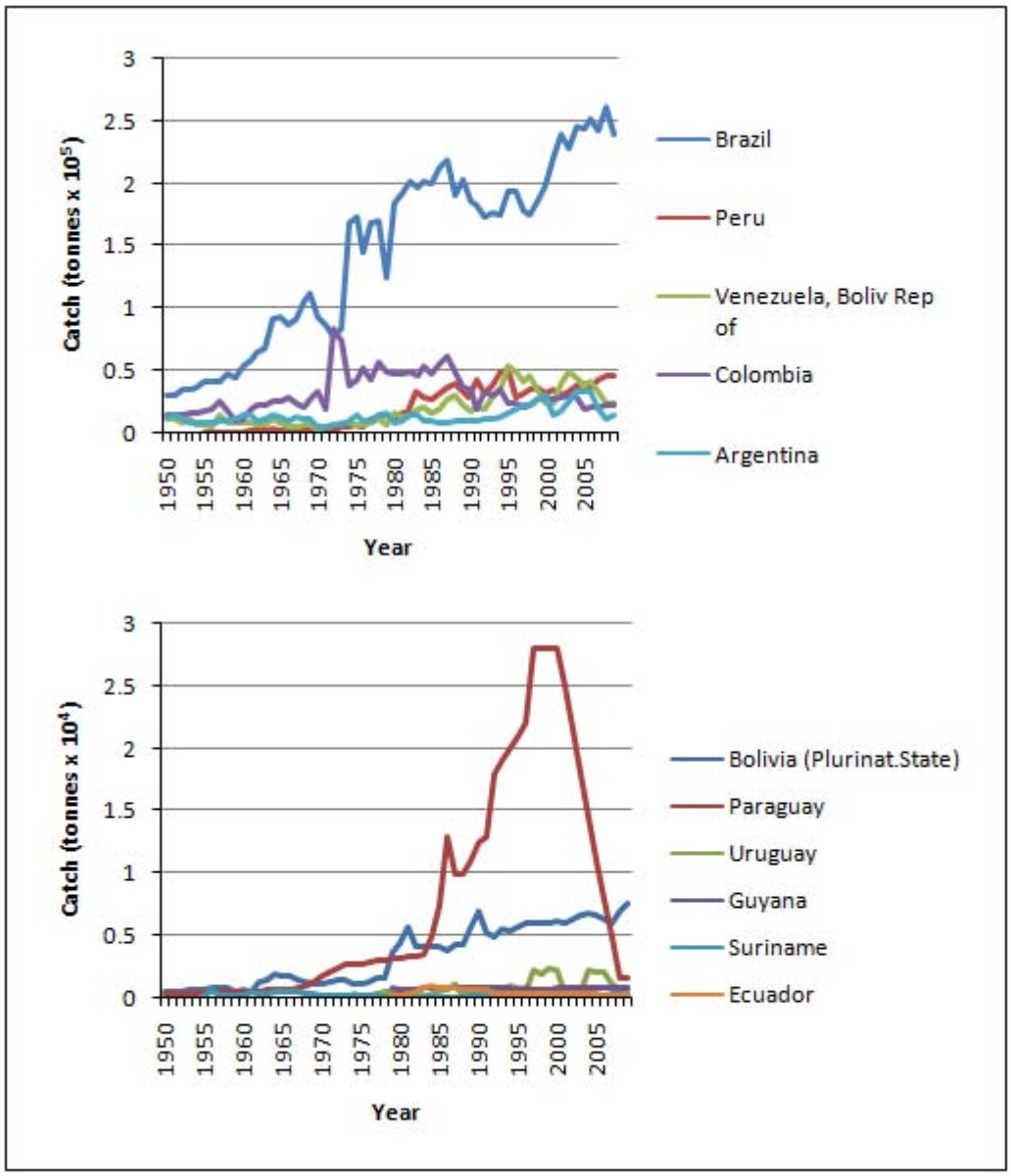


Figure 36: Inland fish production from the South American region by country, 1950–2009

Table 28: Main groups of organisms caught by inland fisheries in South America in 2009

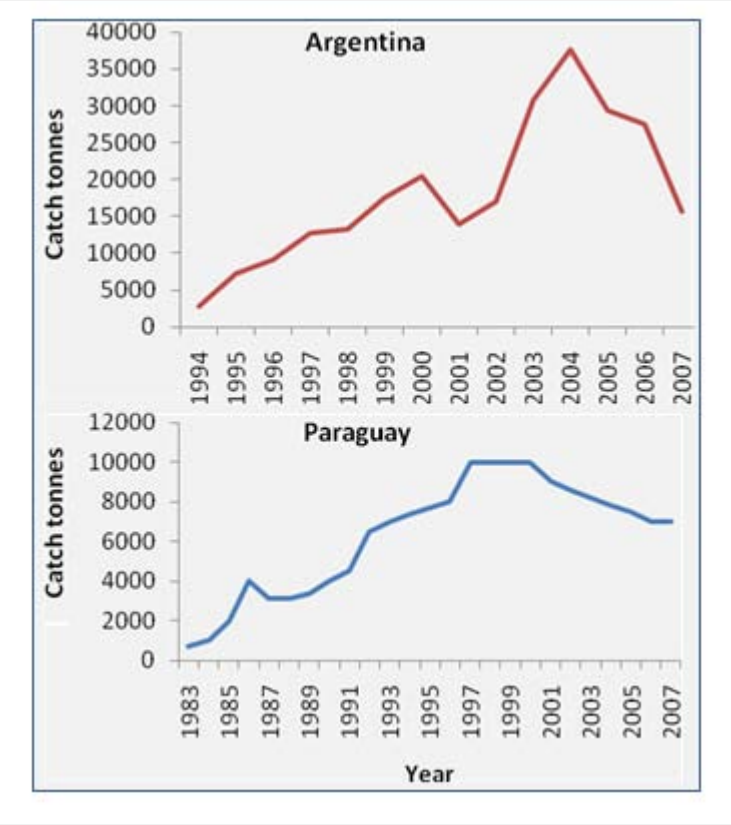
Taxonomic group	Catch (tonnes)	%
Freshwater siluroids NEI	55 620	17.75
Prochilodontids NEI	48 895	15.60
Freshwater fishes NEI	36 618	11.68
Laulao catfish	23 676	7.55
Characins NEI	21 868	6.98
Semaprochilodus insignis	15 813	5.05
Gilded catfish	13 835	4.41
Cichlids NEI	13 168	4.20
South American silver croaker	12 037	3.84
Metynnis argenteus	10 624	3.39
Hoplias aimara	9 450	3.02
Tilapias NEI	9 247	2.95
River prawns NEI	5 520	1.76
Curimata cyprinoides	5 012	1.60
Schizodon fasciatus	4 977	1.59
Cachama	4 045	1.29
Triportheus angulatus	3 239	1.03
29 other taxa	19 783	6.31
Total	313 427	100.00

BOX 8

PROCHILODUS IN THE LA PLATA RIVER SYSTEM – RESPONSE TO ENVIRONMENTAL AND FISHERIES MISMANAGEMENT

Fishes of the prochilodontid family form the mainstay of inland fisheries throughout South America. In particular, *Prochilodus lineatus* ("sábalo") and *Semaprochilodus insignis* figure largely in the catches of the Amazon, La Plata and Orinoco Rivers. Fisheries for "sábalo", aimed at export to the Brazilian and other markets, developed in Argentina and Paraguay in response to financial crises in the early 1990s. They expanded rapidly and eventually rose to levels where guidelines for reasonable levels of production were generally ignored. This, together with environmental degradation of the Paraná River owing to upstream dams, has caused a decline in the fishery in both countries (see figure below).

A similar collapse has been documented in the *Prochilodus* fisheries of the Pilcomayo River the Plurinational State of Bolivia.



Evolution of the *Prochilodus* fishery in Argentina and Paraguay

3.3.4 Islands

(Cuba, the Dominican Republic, Haiti, Jamaica)

The islands associated with the American continent include the Caribbean Islands, The Falklands (Malvinas) (UK overseas territory) and Greenland. Only 5 of the 28 islands listed in FishStatJ report any inland fisheries (Figure 37), although Cuba developed an important fishery on the numerous reservoirs through a government -sponsored stocking scheme. As a result, production rose to a relatively high level of nearly 16 000 tonnes in 1990.

The subsequent decline in this system seems to be the result of the withdrawal of government subsidies for the hatcheries that provided the fry for stocking. Other countries (the Dominican Republic and Jamaica) also adopted stocking of reservoirs as a main source of inland fish.

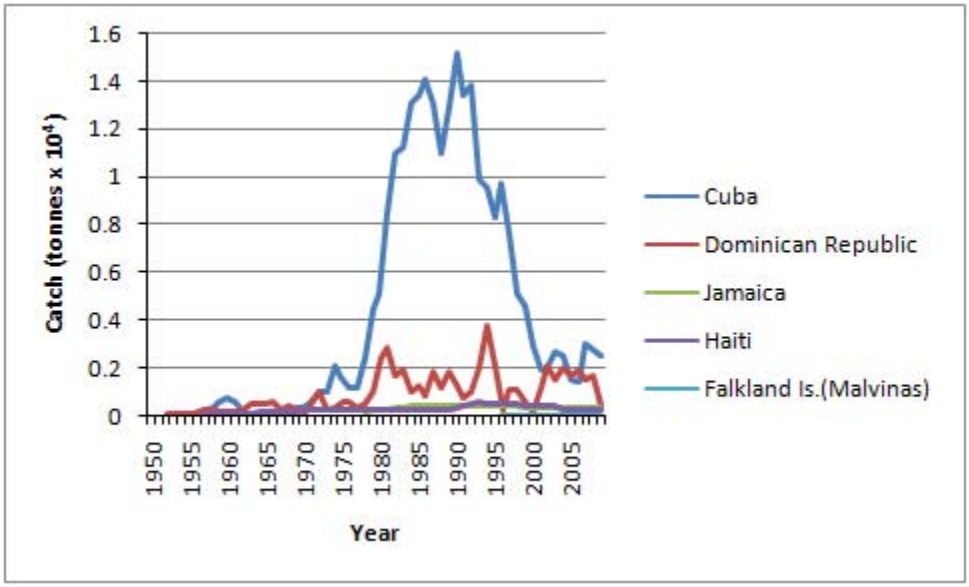


Figure 37 : Inland fish production from the islands of the Americas by country or territory, 1950–2009

The importance of this practice is shown by the fact that in 1990, at the peak of Cuban production, 99 percent of all fish captured were tilapiine cichlids (the species of choice for culture-based dam fisheries), but in 2009 only 77 percent of the catches consist of introduced tilapias (Table 29).

Table 29: Main groups of organisms caught by inland fisheries in the islands of the Americas in 2009

Taxonomic group	Catch (tonnes)	%
Blue tilapia	2 526	69.05
Freshwater fishes NEI	700	19.14
Tilapias NEI	298	8.15
Largemouth black bass	88	2.41
Common carp	28	0.77
American eel	9	0.25
Mountain mullet	9	0.25
Total	3 658	100

3.4 Europe

Europe is divided into five areas depending on their geography and political and economic history. The Russian Federation is included in Europe since the dissolution of the USSR as a statistical entity, although much of its land mass lies in Asia, and for this reason is assigned a category of its own. The Russian Federation contributes 64.8 percent of all European production (Table 30), although some of this comes from Russian Asiatic waterways. East Europe is the second most important with 12.8 percent because there are still some important food fisheries.

Table 30: Percentage contribution of the various inland European regions to the total catch in 2009

Subregion	Catch (tonnes)	%
Russian Federation	24 6137	64.78
East Europe	48 685	12.81
North Europe	36 278	9.55
West Europe	31 443	8.28
South Europe	17 415	4.58
Total	379958	100.00

Figure 38 shows that European catches rose steadily until the late 1980s after which they declined. Aps, Sharp and Kutonova (2004) trace this decline to the pressures of commercial and recreational fishing as well as to the degraded state of many of the rivers and lakes. Certainly, commercial fisheries for food in this region are now waning, partly because the fish stocks have been depleted or altered by other human interventions or because a shift has occurred in preference towards products from marine and aquaculture sources, but mainly because inland water fishers can no longer earn enough from the occupation to make it worthwhile.

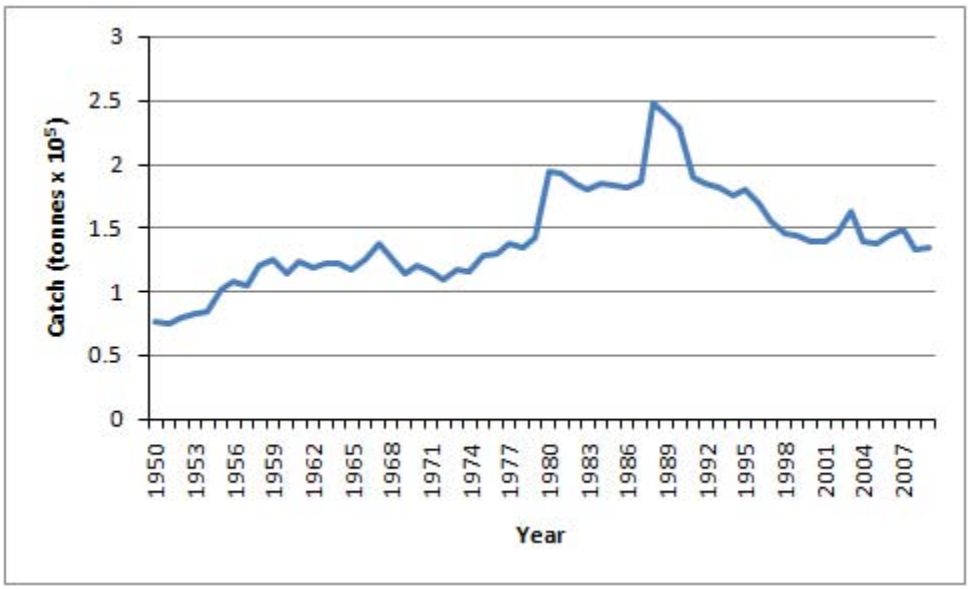


Figure 38: Trends in reported catch from the four European regions for 1950–2009, excluding the Russian Federation (the Russian Federation is treated separately in Figure 45)

Europe is heavily dependent on animal protein-based diets. Marine fish makes a very significant contribution at 18 percent of the total, but the contribution of fish from aquaculture (3.5 percent) and inland capture fisheries (0.5 percent) is very low compared with other continental areas (Table 31). Fish in total contribute only 22 percent to the animal protein budget. However, these figures are likely to be deceptive as Europe, in common with Australia and North America, imports large quantities of marine capture and aquaculture products.

Table 31: Europe – production of animal protein by source in 2009 (aquatic plants are excluded from the aquaculture figures)

Item	Catch (tonnes)	%
Pig meat	26 002 390	36.80
Chicken meat	13 389 692	18.95
Marine fish	13 007 157	18.41
Cattle meat	10 824 082	15.32
Aquaculture	2 484 585	3.52
Turkey meat	1 664 140	2.36
Sheep meat	1 138 100	1.61
Rabbit meat	505 129	0.71
Duck meat	450 627	0.64
Inland fish	379 958	0.54
10 other categories	809 887	1.15
Total	70 657 757	100.00

Source: FAOSTAT; FishStat.

Catches are heavily oriented to cyprinids and percids, although in some regions salmonids, pike and coregonids are important (Table 32).

Table 32: Main groups of organisms caught by inland fisheries in Europe in 2009 (excluding the Russian Federation)

Family	Catch (tonnes)	%
Other	49 179	38.01
Cyprinidae	33 351	25.78
Percidae	14 508	11.21
Esocidae	8 844	6.84
Coregonidae	7 806	6.03
Salmonidae	7 385	5.71
Clupeidae	4 384	3.39
Anguillidae	2 428	1.88
Cambaridae	1 500	1.16
12 other taxa	4 436	3.31
Total	129 385	100.00

The number of taxa reported in the catches increased year on year from 1950, with 13 taxa reported in 1950 to 70 taxa in 2000, and thereafter the numbers remained relatively stable. At the same time, the number of reports of “freshwater fishes NEI” decreased from over 70 percent in the 1950s to about 20 percent in the late 1980s and early 1990s, although there has been a steady increase in this category since then (Figure 39).

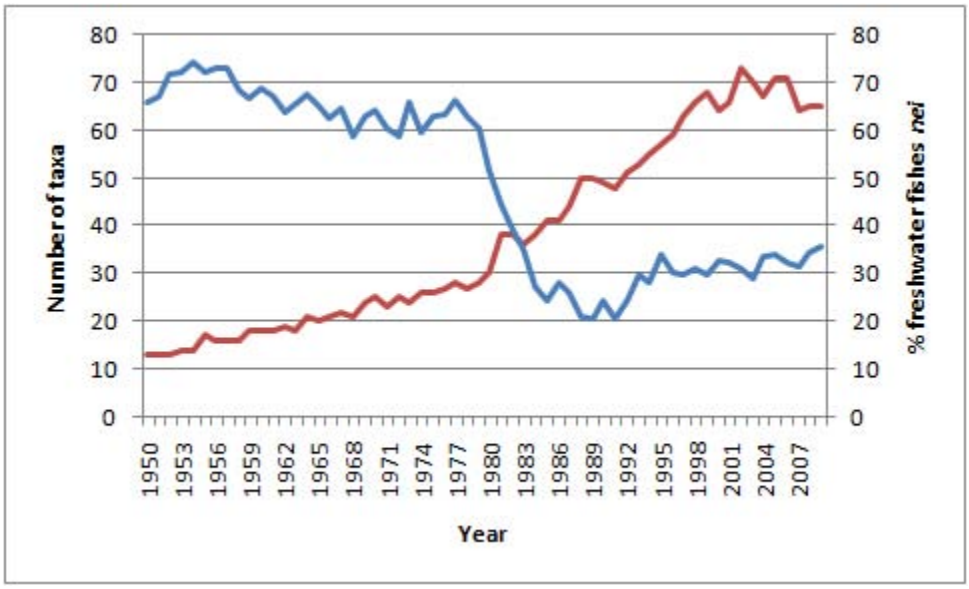


Figure 39: Trends in number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for Europe (excluding the Russian Federation) for 1950–2009

3.4.1 West Europe

(Andorra, Austria, Belgium, Channel Islands, Faroe Islands, France, Germany, Ireland, Isle of Man, Liechtenstein, Luxembourg, the Netherlands, Switzerland, United Kingdom of Great Britain and Northern Ireland)

The main freshwater resources in Western Europe are the numerous rivers, some of which are large such as the Rhine, the Rhone and the Loire Rivers. There are also some reservoirs and large lakes in some countries.

Most countries in Western Europe reserve their inland fish populations for recreational purposes. In some countries, the catch may be eaten but in others there is a catch-and-return policy. Catches are dominated by Germany at 69.27 percent of total regional catch in 2009 (Figure 40), where there are still significant commercial food fisheries. It is difficult to explain the drop in catches from 1982 to 1994, but this may be associated with changes in reporting during the period of unification, as prior to 1989 catches were reported separately for the then two German states. Catches in most other West European countries have declined steadily from peaks in the late 1980s.

Table 33 shows that a large portion of the catch (65 percent) is not identified to taxonomic group but that catches otherwise consist of a mix of salmonids, cyprinids, coregonids and other lesser groups.

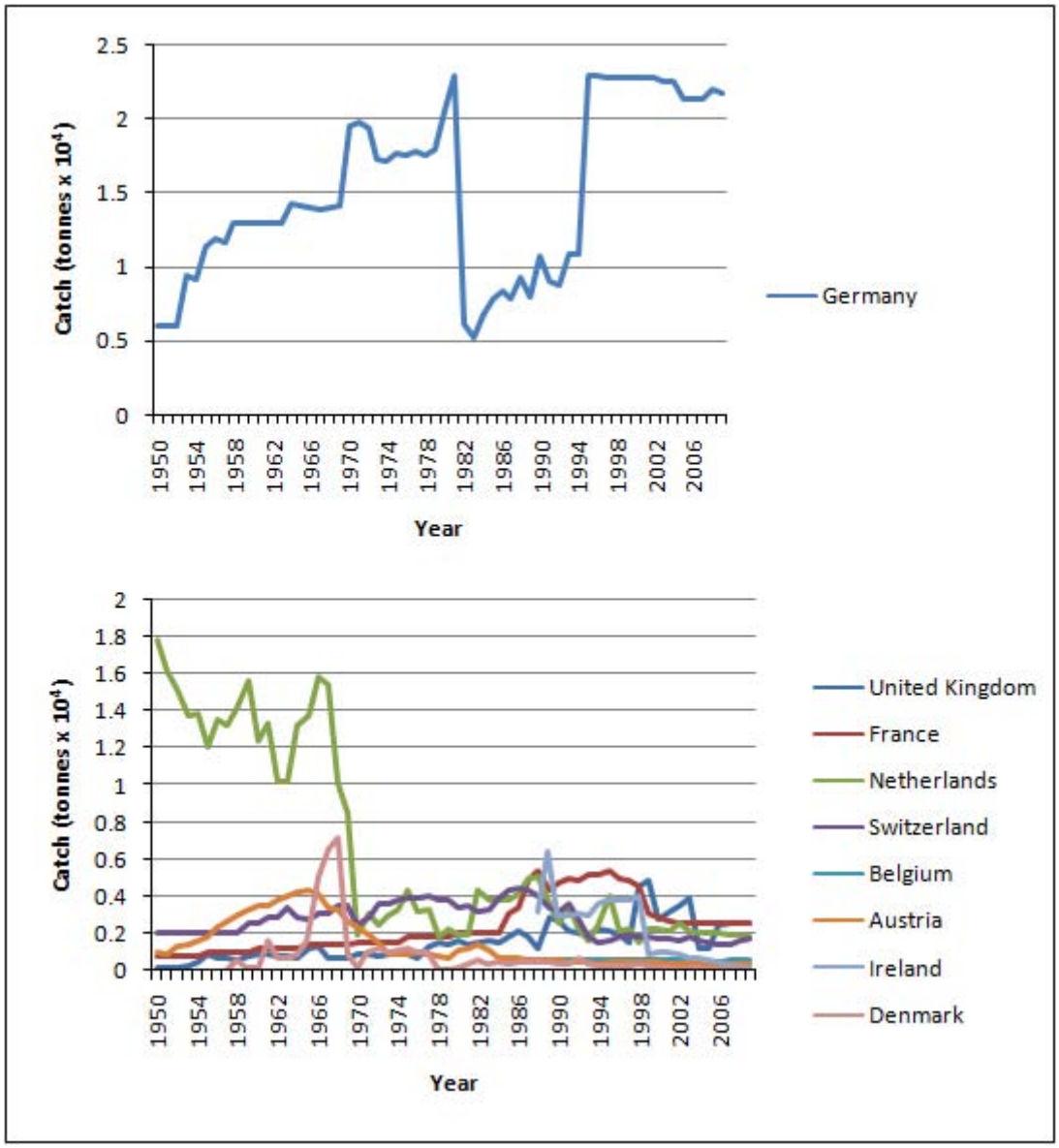


Figure 40: Inland fish production from the West European region by country, 1950–2009

Table 33: Main groups of organisms caught by inland fisheries in Western Europe in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	20 342	64.79
European eel	1 924	6.13
Whitefishes NEI	1 650	5.26
Rainbow trout	1 514	4.82
Cyprinids NEI	1 013	3.23
European smelt	790	2.52
European perch	705	2.25
Freshwater bream	477	1.52
Pike-perch	456	1.45
Roach	330	1.05
20 other taxa	2197	7.00
Total	31 398	100.00

3.4.2 North Europe

(Denmark, Estonia, Finland, Iceland, Latvia, Lithuania, Norway, Sweden)

The main aquatic resources of Northern Europe are lacustrine with extensive networks of glacial lakes throughout much of the area. There are also many short, steep rivers suitable for migratory salmonids, although some of these have been dammed.

Northern European catches are dominated by Finland, which contributed 80.7 percent of the regional catch in 2009 (Figure 41). Finland still retains an extensive commercial lake fishery sector and the recreational fishery also catches fish for consumption. A similar situation is found in Estonia, but in most other countries of the region the fisheries are purely recreational. Note that Estonia, Latvia and Lithuania only started reporting as independent countries in 1988, as their catches were included in those of the USSR prior to that date.

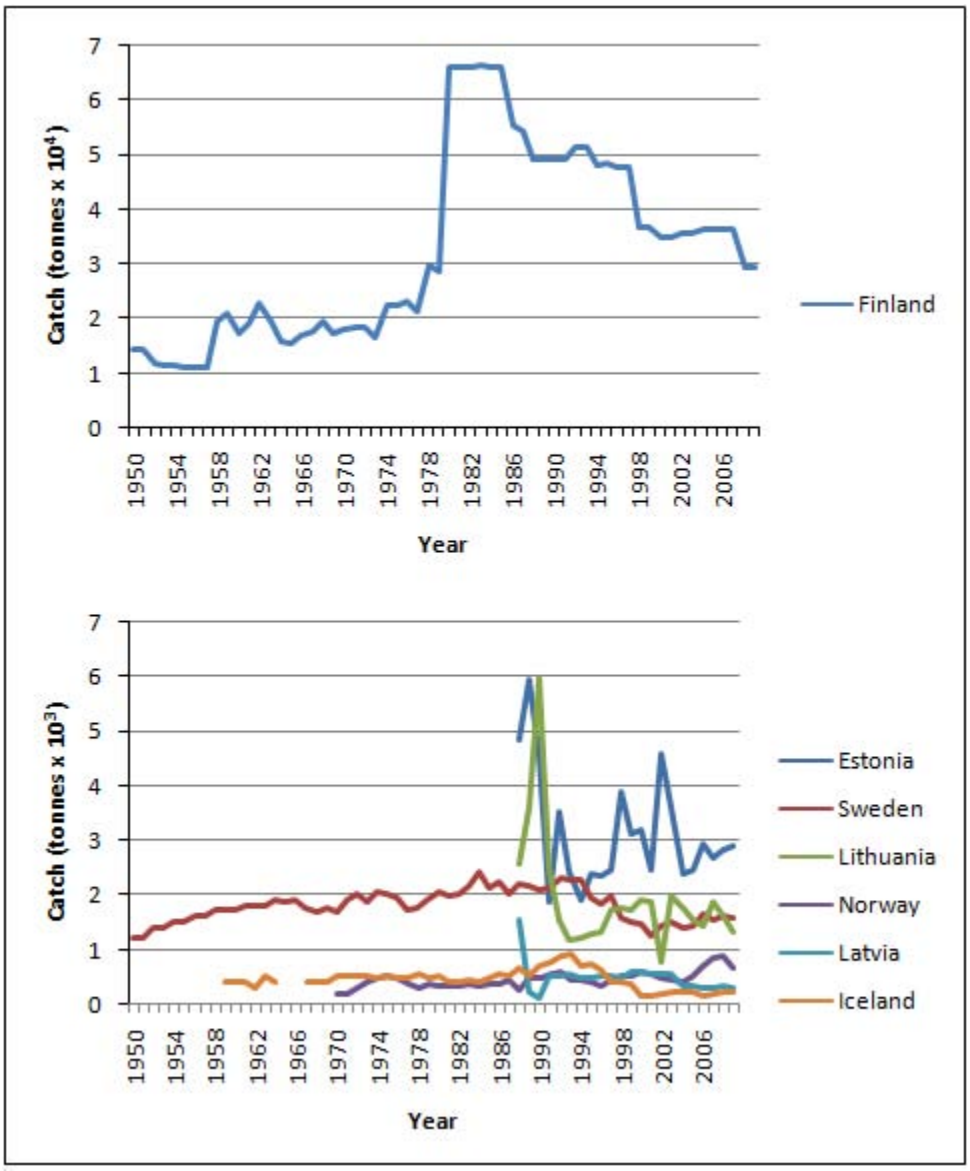


Figure 41: Inland fish production from the North European region by country, 1950–2009

Most fishes are identified to taxonomic grouping (Table 34) and catches are distributed among the percids, cyprinids, pike and coregonids. Salmonids, which contributed only 7.2 percent of the catch in 2009, have declined considerably from a high of 26 percent in 1968 (see Box 9). Similarly, coregonids have declined from 21 percent of the catch in 1968 to 16 percent in 2009.

Table 34: Main groups of organisms by family caught by inland fisheries in Northern Europe in 2009

Taxonomic group	Catch (tonnes)	%
European perch	8 374	23.92
Northern pike	7 303	20.86
Vendace	4 306	12.30
Pike-perch	3 130	8.94
Roach	2 925	8.36
Freshwater bream	2 221	6.34
European whitefish	1 257	3.59
Atlantic salmon	1 052	3.01
Rainbow trout	766	2.19
Trouts NEI	701	2.00
Burbot	622	1.78
Freshwater fishes NEI	359	1.03
Three-spined stickleback	355	1.01
16 other taxa	1 637	4.68
Total	35 008	100.00

3.4.3 South Europe

(Albania, Bosnia and Herzegovina, Croatia, Former Yugoslav Republic of Macedonia, Greece, Italy, Malta, Montenegro, Portugal, Spain)

Southern Europe has a mixture of lake and river resources. Catches from the region as a whole peaked at nearly 44 000 tonnes in 1986 and have since declined to 17 415 tonnes in 2009 (Figure 42). The major producer for many years was Spain, which still produces 34 percent of the total, followed by Italy at 28 percent, Albania at 13 percent, and Bosnia Herzegovina at 11 percent.

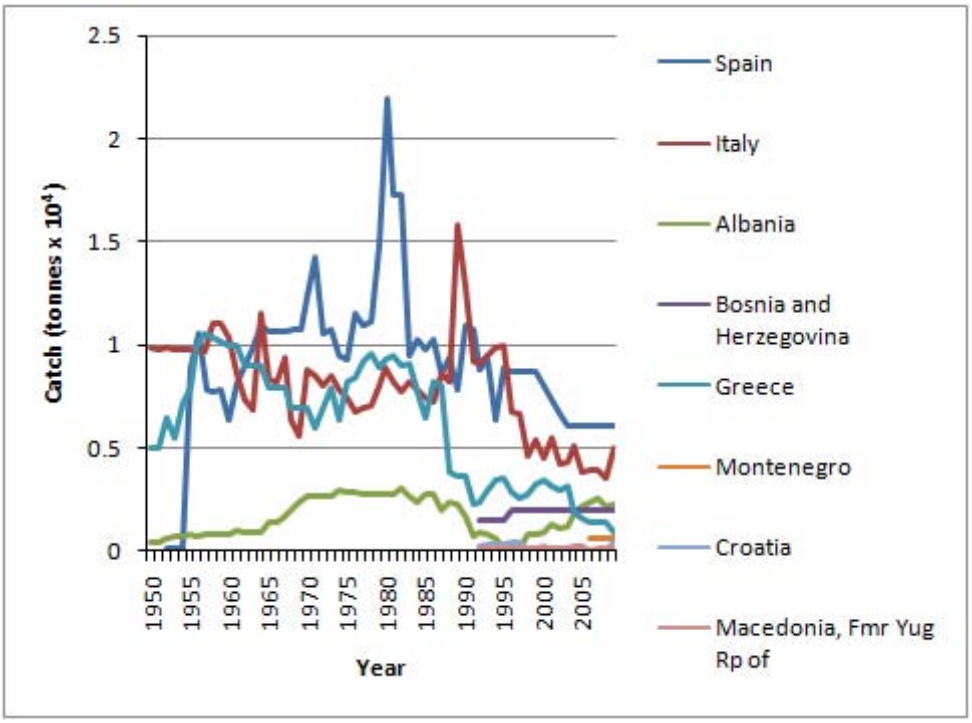


Figure 42: Inland fish production from the Southern European region by country, 1950–2009

Catches are not well defined by taxonomic group, as 57 percent were reported under the "freshwater fishes NEI" category in 2009. Cyprinids (15 percent) and salmonids (13 percent) together comprised a further 28 percent (Table 35).

Table 35: Main groups of organisms caught by inland fisheries in Southern Europe in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	9 706	56.19
Sea trout	1 806	10.46
Red swamp crawfish	1 500	8.68
Salmonoids NEI	857	4.96
Common carp	584	3.38
Bleak	535	3.10
Cyprinids NEI	369	2.14
Mullets NEI	220	1.27
Goldfish	210	1.22
Crucian carp	208	1.20
Silver carp	186	1.08
22 other taxa	1 093	6.33
Total	17 274	100.00

3.4.4 East Europe

(Belarus, Bulgaria, Czech Republic, Hungary, Republic of Moldova, Poland, , Montenegro, Romania, Serbia, Slovakia, Slovenia, Ukraine)

Eastern Europe has significant river and lake resources centred on the Danube basin, its tributaries and delta, and the Dneiper and Dneister Rivers and reservoirs of the Ukraine. To the north, Poland has an extensive lake district. Inland water fish have been an important source of food in many eastern European countries and they developed important fisheries, especially under the former centrally planned economies when they enjoyed significant government subsidies.

Analyzing the catches from eastern Europe are difficult because of the inclusion of the figures for several of the modern states (Belarus, Republic of Moldova and Ukraine) in the former USSR series before 1988. Furthermore, the former Czechoslovakia divided into the Czech Republic and Slovakia in

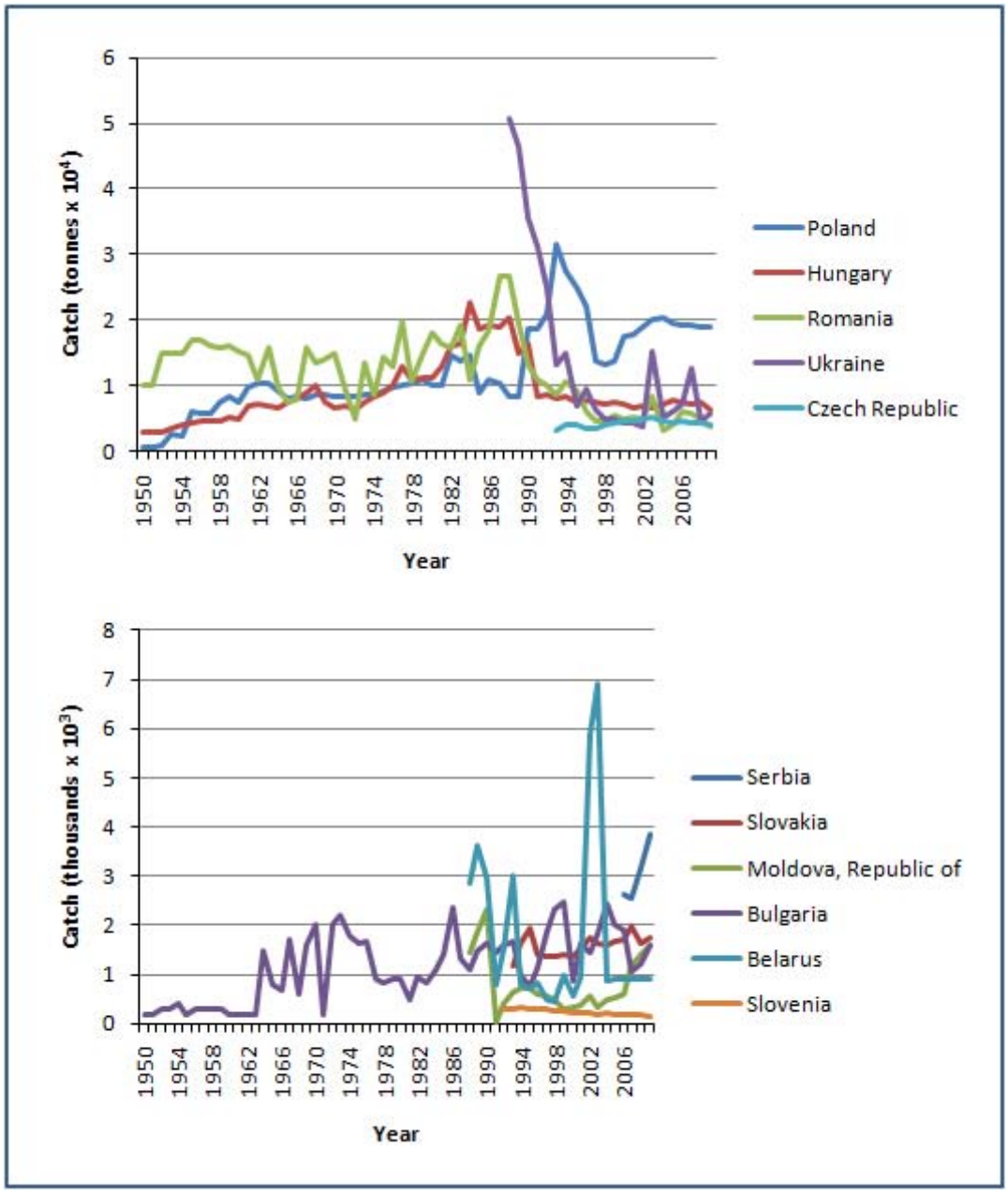


Figure 43: Inland fish production from the Eastern European region, 1950–2009
(*Top*: Major producers. *Below*: Minor producers)

1992–1993, and Yugoslavia dissolved into component states, some of which (Serbia and Slovenia) are in eastern Europe and the rest in the Southern European region. Catches from the whole region rose sharply to a peak of 132 000 tonnes in 1988, but then declined sharply as subsidies were withdrawn and market structures changed after the changes in economic regime following the collapse of the USSR. The falling trend lasted until 1998, when there was a slight recovery in the sector followed by a slow decline.

The major fish producer in the region was the Ukraine and contributed about 36 percent of the catch in 1988, when it was first recorded as an entity separate from the USSR (Figure 43). Its catches have since fallen significantly to only 12 percent of the regional total and it has been overtaken by Poland, which now contributes 38 percent, and Hungary 13 percent. Romania has suffered a similar decline from 33 percent in 1986 to only 7 percent to the 2009 total.

Catches are heavily weighted to the cyprinids (43.7 percent of total), as common carp is a favoured dish in many countries (Table 36). Otherwise a wide range of species are stocked into lakes and reservoirs to support the remaining commercial fisheries and a growing recreational sector.

Table 36: Main groups of organisms caught by inland fisheries in Eastern Europe in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	16 726	37.30
Common carp	9 598	21.41
Black and Caspian Sea sprat	3 679	8.20
Freshwater bream	2 238	4.99
Goldfish	2 001	4.46
Cyprinids NEI	1 338	2.98
Northern pike	1 123	2.50
Pike-perch	938	2.09
Silver carp	900	2.01
Crucian carp	735	1.64
Pontic shad	645	1.44
Grass carp (= white amur)	570	1.27
Roach	528	1.18
Wels (=Som) catfish	498	1.11
39 other taxa	3 322	7.41
Total	44 839	100.00

3.4.5 The Russian Federation

The Russian Federation spans both Asia and Europe, and has extensive inland water resources. In Europe, it has the Ponto-Caspian Rivers (the Volga, Don and Ural Rivers) and their numerous reservoirs. To the north, it has a series of large rivers draining into the Arctic Ocean (including the Ob, Irtysh, Lena Rivers), and to the east, there are numerous shorter rivers including the lengthy Amur, which borders China. In the centre of the country, there is Lake Baikal.

Inland fish has always been important in the Russia Federation and production stood at about 437 000 tonnes in 1988, when it first reported as a separate entity (Figure 44). Catches declined to about half that figure in 1994, but have stabilized over the last ten years. Figure 44 shows the catches from the former USSR area (includes catches from what are now the countries of Armenia, Azerbaijan, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Republic of Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan), which have reported independently after 1988. In 1988, the combined catch from these countries was 251 172 tonnes. This represented 36.5 percent of the 1988

total of these countries and that reported by the Russian Federation (688 160 tonnes), thereby accounting in part for the discontinuity in the catch time line in Figure 43.

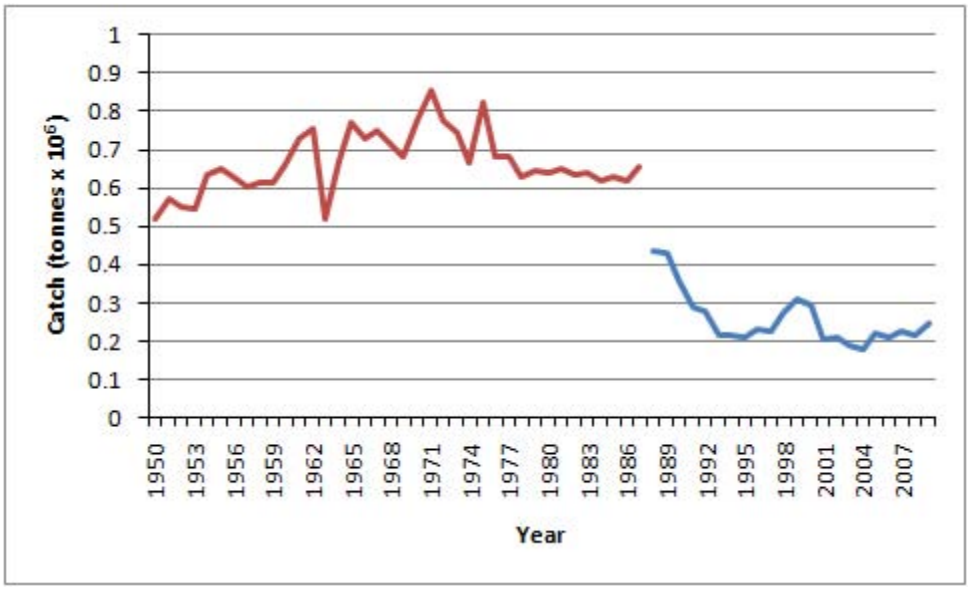


Figure 44 : Inland fish pr oduction from t he U nion of Sov iet Soc ialist R epublics, 1950–1987 (red line) and the Russian Federation, 1988–2009 (blue line)

Catches consist of 50 taxonomic groups (including a very low percentage of "freshwater fishes NEI) (Figure 45), but are centred mainly on salmonids (38 percent) and cyprinids (29 percent) (Table 37). Salmonid catches are particularly important economically and have risen considerably in recent years (see Box 9).

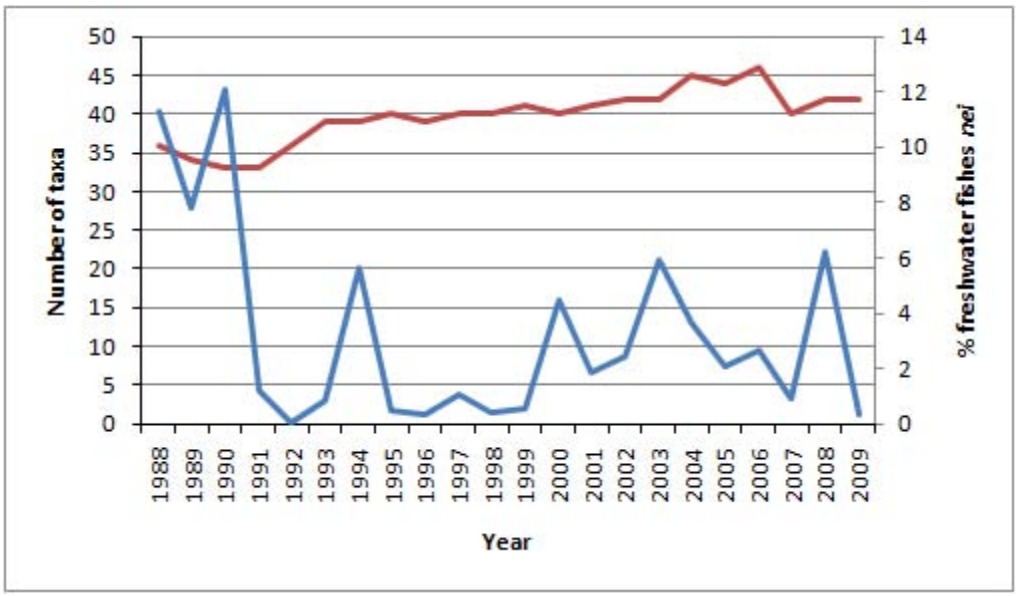


Figure 45: Trends in number of taxa (red line) and the percentage of freshwater fishes NEI (blue line) reported by year for the Russian Federation for 1988–2009

Table 37 : Main groups of organisms caught by inland fisheries in the Russian Federation in 2009

Taxonomic group	Catch (tonnes)	%
Chum (= keta = dog) salmon	41 913	17.03
Pink (= humpback) salmon	30 632	12.45
Freshwater bream	27 886	11.33
Cyprinids NEI	26 192	10.64
Northern pike	15 988	6.50
Sockeye (= red) salmon	15 403	6.26
Whitefishes NEI	13 381	5.44
Roaches NEI	12 527	5.09
Wels (= som) catfish	11 732	4.77
European perch	8 565	3.48
Smelts NEI	5 871	2.39
Orfe (= ide)	4 837	1.97
Black and Caspian Sea sprat	4 379	1.78
Freshwater crustaceans NEI	3 349	1.36
Salmonoids NEI	3 151	1.28
Tench	2 622	1.07
Pike-perch	2 515	1.02
25 other taxa	15 194	6.17
Total	246 137	100.00

3.5 Oceania

(Australia, Fiji, New Zealand, Papua New Guinea, Solomon Islands)

Oceania consists of a series of islands, many of which are small with few inland water resources. There are, however, several larger islands including Papua New Guinea with the Fly and Sepik River systems and Australia with the Murray-Darling systems and a number of smaller rivers.

The trends in inland fisheries of Oceania are shown in Figure 46. The main source of inland water fish comes from Papua New Guinea with nearly 75 percent of the combined catch (Table 38). The fishery was based mainly on the Fly River, but the introduction of species into the Sepik River has also formed the basis of a capture fishery. Catches from some island groups do not appear in FishStat: for example, the Solomon Islands record an inland subsistence fishery landing some 2 000 tonnes per year which do not appear in FishStat (FAO Fishery Country profiles[8]). Catches from Australia have always been relatively low and have declined from 1992 onwards; there was a minor fishery for the introduced common carp in the 1990s for cat food, but this later proved uneconomical. Furthermore, fish populations in the main Murray-Darling River system are severely stressed owing to river regulations and desiccation of the river channel and riparian wetlands (Gehrke *et al.*, 1995). The resource is now mainly reserved for recreational fishing (Annex 3).

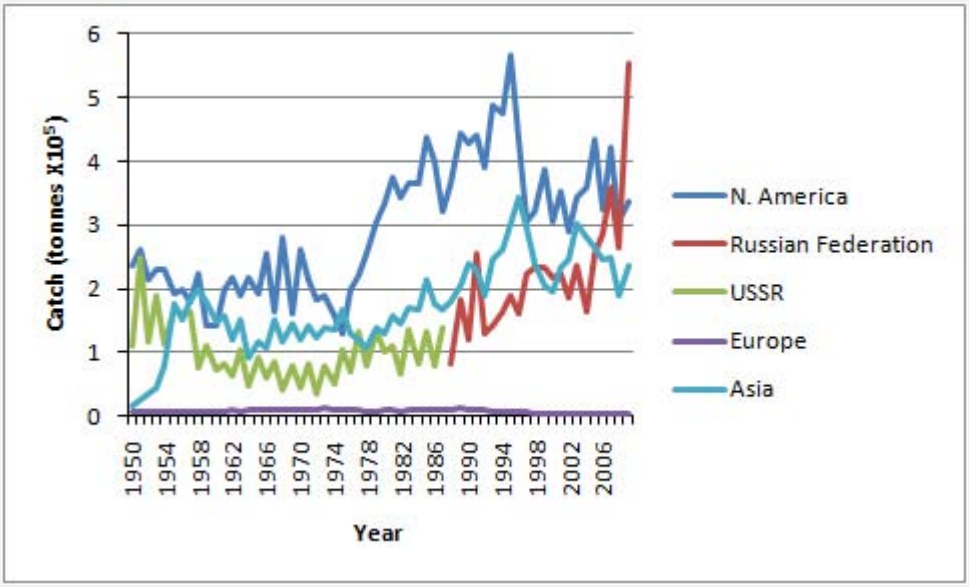
[8] www.fao.org/fishery/countrysector/FI-CP_SB/en

BOX 9

SALMON – RISE AND FALL OF A GROUP OF COMMERCIALLY IMPORTANT FISHES

Salmon are large anadromous fishes of the family Salmonidae (arbitrarily excluding trout, char, etc.) that are regularly caught both at sea and in freshwaters. The discussion here is limited to records of salmon catches from inland waters (1 130 250 tonnes as against a marine catch of 1 025 449 tonnes in 2009). Salmon have exercised the imagination of many nations, particularly in the North Temperate Zone. The various species of salmon (genera *Oncorhynchus* and *Salmo*) are also the only inland fish to appear worldwide as a canned product. Economically, they formed the mainstay of many inland (and marine) fisheries in East Asia, North America, North and West Europe and the Russian Federation (and the former USSR area before it). Catches were initially low, but rose to just over a million tonnes in 1995. Increases occurred in all continents and, in particular, in North America where they rose to 565 000 tonnes in 1995 (see figure below). Subsequently, inland salmon catches from all continents have declined with the exception of the Russian Federation, where they rose to 552 000 tonnes in 2009. At the same time, the declining trend has now been reversed, mainly because of the catches of the Russian Federation, and the world total rose to over 1.1 million tonnes in 2009.

Catches are heavily weighted to the various species of Pacific salmon (see table). Salmons are also the basis for a rapidly growing aquaculture sector, and there is concern that escapes from aquaculture have a negative impact on the fitness of wild stocks. Furthermore, aquaculture associated diseases such as *Gyrodactylus* have caused problems as in the collapse of Norwegian stocks.



Catches of salmon from inland waters of different regions, 1950–2009

Principal categories of salmon caught in inland waters in 2009

Species	Catch (tonnes)	%
Pink	590 642	52.26
Chum	358 685	31.74
Sockeye	150 485	13.31
Coho	19 758	1.75
Chinook	6 314	0.56
Atlantic	2 369	0.21
Other	1 997	0.18
Total	1 130 250	100.00

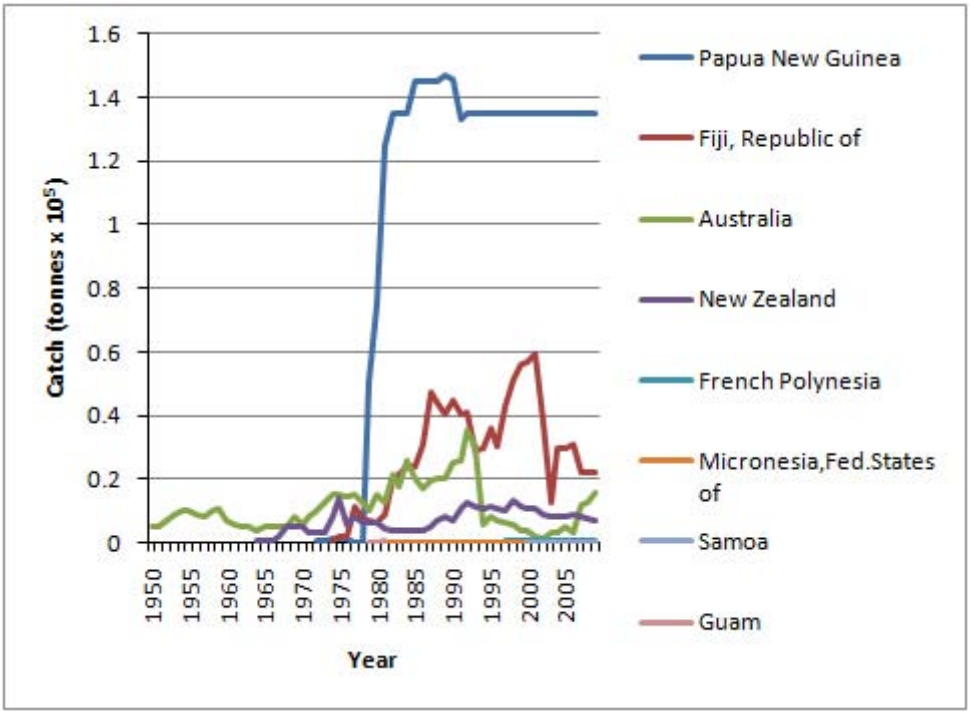


Figure 46: Inland fisheries production from Oceania by country, 1950–2009

Table 38: Percentage contribution of the various countries of Oceania to the total inland catch in 2009

Country	Catch (tonnes)	%
Papua New Guinea	13 500	74.65
Fiji	2 220	12.28
Australia	1 576	8.71
New Zealand	729	4.03
French Polynesia	53	0.29
Micronesia, Federated States of	5	0.03
Samoa	1	0.01
Guam		0.00
Total	18 084	100.00

Fish from all sources only contributes some 19 percent to the total animal protein budget in the region, with inland fisheries an insignificant 0.25 percent (Table 39). This balance is heavily influenced by Australia and New Zealand and the island states are much more dependent on marine capture fisheries (about 54 percent in 2009).

Table 39: Oceania – production of animal protein by source in 2009

Item	Catch (tonnes)	%
Cattle meat	2 804 905	38.77
Marine fish	1 199 936	16.58
Sheep meat	1 136 836	15.71
Chicken meat	989 340	13.67
Pig meat	461 335	6.38
Game meat	329 020	4.55
Aquaculture	176 370	2.44
Turkey meat	54 013	0.75
Horse meat	26 580	0.37
Goat meat	19 817	0.27
Inland fish	18 084	0.25
Duck meat	12 652	0.17
Meat NEI	4 522	0.06
Goose and guinea fowl meat	120	0.00
Total	7235539	100.00

Source: FAOSTAT; FishStat.

Forty-eight percent of the catch from the region is not identified by taxonomic group, but the remainder depend on introduced tilapia and native ariid catfishes and eleotrids (Table 40). In Fiji, the second largest producer in the region, catches are 68 percent molluscs and 21 percent crustaceans.

Table 40: Main groups of organisms caught by inland fisheries in Oceania in 2009

Taxonomic group	Catch (tonnes)	%
Freshwater fishes NEI	8 706	48.14
Mozambique tilapia	2 310	12.77
Gudgeons, sleepers NEI	1 850	10.23
Sea catfishes NEI	1 850	10.23
Freshwater molluscs NEI	1 500	8.29
Diadromous clupeoids NEI	480	2.65
River eels NEI	429	2.37
Freshwater crustaceans NEI	400	2.21
Barramundi (= giant seaperch)	350	1.94
Nile tilapia	200	1.11
River prawns NEI	5	0.03
Giant river prawn	3	0.02
Oceanian crayfishes NEI	1	0.01
Total	18 084	100.00

4. CONCLUSIONS

Records in FAO FishStat show that, globally, catches of fish and other organisms from inland waters increased at a linear rate of 2.93 percent per year from 1950 to 2009. The global rate of increase conceals substantial differences in trends between continents and subcontinental regions (Table 41).

Table 41 : Trends and mean early percentage growth for the continents and subcontinental regions, 2000–2009

Continent	Region	Catch (tonnes) 2000	Catch (tonnes) 2009	Mean annual change %	Trend
Global		8 578 430	10 323 905	2.03	Rise
Asia		5 452 674	6 962 672	2.77	Rise
	South Asia	1 801 933	2 315 499	2.85	Rise
	Southeast Asia	1 355 971	2 210 508	6.30	Rise
	China	1 953 683	2 184 018	1.18	Rise
	West Asia	180 955	137 748	–2.39	Fall
	Central Asia	73 661	57 805	–2.15	Fall
	East Asia	86 249	56 884	–3.40	Fall
Africa		2 134 034	2 423 711	1.36	Rise
	Great Lakes	774 740	898 763	1.60	Rise
	West coastal	271 943	432 821	5.92	Rise
	Sahel	337 474	333 945	–0.10	Slight fall
	Nile River	317 151	32 0547	0.11	Slight rise
	Congo basin	291 441	282 885	–0.29	Slight fall
	Southern	108 645	114 511	0.54	Slight rise
	Islands	30 000	32 828	0.94	Slight rise
	Northern	2 440	7 211	19.55	Rise
	East coastal	200	200	0.00	No change
America		539 547	539 480	0.00	No change
	North	65 953	53 861	–1.83	Fall
	Central	118 558	122 013	0.29	very slight rise
	South	351 065	359 947	0.25	very slight rise
	Islands	3 971	3 659	–0.79	Slight fall
Europe		431 461	379 958	–1.19	Fall
	Russian Federation	292 368	246 137	–1.58	Fall
	East	42 813	48 685	1.37	Rise
	North	42 709	36 278	–1.51	Fall
	West	34 393	31 443	–0.86	Slight fall
	South	19 178	17 415	–0.92	Slight fall
Oceania		20 714	18 084	–1.27	Fall
	Oceania	20 714	18 084	–1.27	Fall

Catches in Africa and Asia increased over the period for which records are available, driven largely by growth in South and Southeast Asia and in the west coastal area of Africa. Catches in Latin America remain relatively static.

The origin of the increases in catch is not clear. It is possible that actual increases in production have occurred. This is almost certain to be the case in the earlier years of the time series when inland fisheries were expanding rapidly. It is also known to be the case in individual fisheries such as that of Lake Victoria, which have been well studied (Lake Victoria Fisheries Organization). However, more recently, there are indications that the resources in Africa and Asia are heavily exploited and that real increases in production in most fisheries are unlikely at least in recent years. In these cases, the apparent increases are generally attributed to improvements in reporting, which could be achieved by incorporating catches from small-scale fisheries that have been hitherto unrecorded (see Welcomme, 1976; Coates, 2002; Lymer *et al*., 2008b for examples) or by applying better sampling and estimation techniques, as has occurred recently on the Lower Mekong (Hortle, 2007). In some cases, part of the increase could also be due to increasing human population pressures on artisanal fisheries, which are seeing increasing yields through intensified total effort even though lowered individual catches per unit effort are widespread. At the same time, the fishing down of the fish assemblages is being observed in many areas with accompanying increases in yield. Furthermore, catches for many smaller waterbodies are being enhanced by stocking. In Latin America, fisheries generally seem less heavily exploited and catches appear generally under-reported. Nevertheless, even here some fisheries have clearly declined, such as those of the Magdalena River in Colombia and the *Prochilodus* fishery of Argentina, Bolivia (Plurinational State of) and Paraguay.

Commercial freshwater fisheries in temperate regions including Australia, most of Europe (including the Russian Federation) and North America all showed decreases in catch. This may be due to environmental factors, as many of the aquatic habitats in the developed nations are highly modified to the extent that many of the anadromous species have been eliminated from certain rivers. It may also be due to social considerations, in that recreational fisheries have taken a dominant role in the use of the resource, or economical, in that fishermen can no longer make a living from inland fisheries without government subsidies. There is every indication that the eastern European fisheries and those of the Russian Federation began to decline following the change in economic system after 1988, although in the last decade there has been a tendency for the fisheries to recover in eastern Europe. Similarly, the fisheries of Central Asia, which had declined during the 1990s, have shown signs of recovery during the early 2000s.

Declines are also apparent in the stocked reservoir fisheries of centrally planned economies (such as Cuba and the countries of the former USSR), where governments have withdrawn financing of the hatcheries. De Silva and Funge-Smith (2005) have drawn attention to the fact that such operations are uneconomical in Asia without continued government support.

Records from all regions analysed indicate that reporting by taxonomic group has improved steadily. The general lowering of the proportion of fish reported under the “freshwater fishes NEI” group seems to indicate a general tightening of sampling procedures. At the same time, the number of taxonomic groups represented in the catches has increased. This may be because of the improvements in reporting, but it is highly probable that it is also a real effect attributable to the fishing-down process that occurs as exploitation intensifies. One effect that is evident is the spread of certain species around the world through introductions, either as escapes from aquaculture or to improve wild fisheries. The Nile tilapia (*Oreochromis niloticus*) is a particular example of this phenomenon. By contrast, several species are under pressure and catches of many larger species, such as the pimelodid catfishes in South America and the anadromous species such as the salmonids, have declined in recent years.

In general, the world’s inland fisheries still appear viable over all the regions examined, although environmental pressures such as damming, water abstraction and overexploitation pose a potential threat to the maintenance of present levels of catch.

REFERENCES

Aas, Ø., Thailing, C.E. & Ditton, R.B. 2002. Controversy over catch-and-release recreational fishing in Europe. *In* T.J.Pitcher & C.E. Hollingworth, eds. *Recreational fisheries: ecological, economic and social evaluation,* pp. 95–106. Oxford, Blackwell Science.

Allan, J.D., Abell, R., Hogan, Z., Revenga, C., Taylor, B.W., Welcomme, R.L. & Winemiller, K. 2005. Overfishing of inland waters. *BioScience* 55(12): 1041–1051.

Almeida, O., Lorenzen, K. & McGrath, D. 2004. The commercial fishing sector in the regional economy of the Brazilian Amazon. *In* R.L. Welcomme & Petr T., eds. *Proceedings of the second international symposium on the management of large rivers for fisheries, Volume I.* FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. FAO RAP Publication 2004/16/17.

Amarasinghe, U. & Welcomme, R.L. 2002. An analysis of fish species richness in natural lakes. *Environmental Biology of Fishes,* 65: 327–339.

Aps, R., Sharp, R. & Kutonova, T. 2004. Freshwater fisheries in Central and Eastern Europe: the challenge of sustainability. IUCN Programme Office for Central Europe. 94 pp.

Australian Department for Agriculture Fisheries and Forestry. 2003. *National recreational and indigenous fishing survey*. Canberra, Australian Department for Agriculture Fisheries and Forestry.

Azad, A.K., Jensen, K.R. & Kwei Lin, C. 2009. Coastal Aquaculture Development in Bangladesh: Unsustainable and Sustainable Experiences. *Environmental Management,* Volume 44, Number 4, October 2009.

Balzer, P., Balzer, T., Bartley, D., Choulamany, X., Funge-Smith, S., Guttman, H., Halwart, M., Luob, A., Margraf, J., Meusch E. & Pon, S. 2006. Use and availability of aquatic biodiversity in rice-based ecosystems of Southeast Asia, *Journal of Food Composition and Analysis,* Volume 19, Issues 6–7, September–November 2006: 765–766.

Baran, E. & Myschowoda. 2008. Have fish catches been declining in the Mekong river basin? *In* M. Kummu, M. Keskinen & O. Varis, eds. *Modern myths of the Mekong,* pp. 55–64. Helsinki University of Technology, Water and Development Publications.

Braimah, L.I. 2000. *Full frame survey at Lake Volta, Ghana – 1998*. Fisheries subsector capacity building project. IDAF project, Yeji, Ghana. 196 pp.

Braimah, L. I. 2001. *Volta Lake fisheries management plan*. Fisheries Subsector Capacity Building Project.

Braimah, L.I. 2003. *Fish stock assessment of major fish species of commercial importance in the Volta Lake*. FAOR report.

Caldwell, J. 2004. *World trade in crocodilian skins, 2000–2002*. Report prepared as part of the international alligator and crocodile trade study. United Nations Environment Programme, World Conservation Monitoring Centre.

Coates, D. 1995. *Inland capture fisheries and enhancement: status, constraints and prospects for food security*. International Conference on Sustainable Contribution of Fisheries to Food Security, Kyoto, Japan, 4–9 December 1995. KC/FI/95/TECH/3. FAO, Rome. 50 pp.

Coates, D. 2002. *Inland capture fishery statistics of Southeast Asia: current status and information needs*. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. FAO RAP Publication 2002/11, 113.

Cooke, S.J. & Cowx, I.G. 2004. The role of recreational fishing in global fish crises. *Bioscience,* 54: 857–859.

Cooke, S.J. & Cowx, I.G. 2006. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. *Biological Conservation,* 128: 93–108.

Daskalov, G.M. & Mamedov, E.V. 2007. Integrated fisheries assessment and possible causes for the collapse of anchovy kilka in the Caspian Sea. *ICES Journal of Marine Science,* 64: 503–511.

De Graaf, G.J. & Ofori-Danson, P.K. 1997. *Catch and fish stock assessment in stratum VII of Lake Volta*. Integrated Development of Artisanal Fisheries (IDAF), (GHA/93/008), IDAF/Technical Report/97/I. FAO, Rome. 96 pp.

Department of Fisheries and Oceans, Canada. 2003. *2000 survey highlights. Survey of Recreational Fisheries in Canada*. Ottawa, Canada, Department of Fisheries and Oceans.

De Silva, S. & Funge-Smith, S. 2005. *A review of the stock enhancement practices in the inland waters of Asia*. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. FAO RAP Publication 2005/12: 93 pp.

FAO. 1979. *Handbook of utilization of aquatic plants*. FAO Fisheries Technical Paper 187. Rome. 176 pp.

FAO. 2002. *The State of World Fisheries and Aquaculture 2002*. Rome. 150 pp.

FAO. 2004. *The State of World Fisheries and Aquaculture 2004*. Rome. 153 pp.

FAO. 2007. *The State of World Fisheries and Aquaculture 2006*. Rome. 162 pp.

FAO. 2009a. *The State of World Fisheries and Aquaculture 2008*. Rome. 176 pp.

FAO. 2009b. FishStat Plus. Capture fisheries data, 1950–2007. Rome (available at www.fao.org/fishery/statistics/software/fishstat/en).

FAO. 2009c. FAOSTAT statistical database. Rome (available at faostat.fao.org/).

Friend, R., Arthur, R. & Keskinen, M. 2009 Songs of the doomed: the continuing neglect of capture fisheries in hydropower development in the Mekong. In *Contested waterscapes in the Mekong Region* (eds F. Molle, T. Tira Foran & M. Kakonen), London, UK: Earthscan.

Gherke, P.L., Brown, P., Schiller, C.B., Moffatt, D.B. & Bruce, A.M. 1995. River regulation and fish communities in the Murray-Darling River system, Australia. *Regulated Rivers: Research and Development*, 10: 15–35.

Gulland, J.A., ed. 1970. *The fish resources of the ocean*. FAO Fisheries Technical Paper No. 97. Rome, FAO. 425 pp.

Halls, A.S., Hoggarth, D.D. & Debnath, D. 1999. Impacts of hydraulic engineering on the dynamics and production potential of floodplain fish populations in Bangladesh. *Fisheries Management and Ecology*, 6: 261–85.

Halwart, M., Bartley, D., Burlingame, B., Funge-Smith, S. & James, D. 2006. FAO Regional Technical Expert Workshop on Aquatic Biodiversity, Its Nutritional Composition, and Human Consumption in Rice-based Systems. *Journal of Food Composition and Analysis*, Volume 19, Issues 6–7, September–November 2006: 752–755.

Hap, N. & Bhattarai, M. 2009. Economics and livelihoods of small-scale inland fisheries in the Lower Mekong Basin: a survey of three communities in Cambodia. *Water Policy*, 11, Supplement 1, (2009): 31–51.

Hickley, P. 2009. Recreational fishers – social economic and management aspects. In *Fisheries, Sustainability and Development*, pp. 169–188. Stockholm, Royal Swedish Academy of Agriculture and Forestry.

Hortle, K.G. 2007. *Consumption and the yield of fish and other aquatic animals form the Lower Mekong Basin*. MRC Technical paper 16. Vientiane, Mekong River Commission. 87 pp.

Hortle, K.G., Troeung, R. & Lieng, S. 2008. Yield and value of the wild fishery in rice fields in Battambang Province, near the Tonle Sap Lake, Cambodia. *MRC Technical Paper* 18 Melong Rover Commission, Vientiane 62pp.

Lae, R. 1995. Climatic and anthropogenic effects on fish diversity and fish yields in the Central Delta of the Niger River. *Aquatic Living Resources*, 8: 43–58.

Lymer, D. & Funge-Smith, S. 2009. *An analysis of historical national reports of inland capture fishery statistics in the Asia-Pacific region (1950–2007)*. FAO Regional Office for Asia and the Pacific. Bangkok, Thailand. FAO RAP Publication 2009/18. 17 pp.

Lymer, D., Funge-Smith, S., Clausen J. & Weimin, M. 2008a. *Status and potential of fisheries and aquaculture in Asia and the Pacific 2008*. FAO Regional Office for Asia and the Pacific. Bangkok, Thailand. FAO RAP Publication 2008/15. 110 pp.

Lymer, D., Funge-Smith, S., Khemakorn, P., Naruepon, S. & Ubolratana, S. 2008b. *A review and synthesis of capture fisheries data in Thailand – Large versus small-scale fisheries*. FAO Regional Office for Asia and the Pacific. Bangkok, Thailand. FAO RAP Publication 2008/17. 51 pp.

Meusch, E., Yhoung-Aree, J., Friend, R. & Funge-Smith, S. 2003. *The role and nutritional value of aquatic resources in the livelihoods of rural people – a participatory assessment in Attapeu Province, Lao PDR*. FAO Regional Office for Asia and the Pacific. Bangkok, Thailand. FAO RAP publication 2003/11.

Mills, D.J., Westlund, L., de Graaf, G., Kura Y., Willman R. & Kelleher, K. 2011. Under-reported and undervalued: small-scale fisheries in the developing world *In* R.S. Pomeroy & N.L. Andrew, eds. *Small-scale fisheries management* CAB International. pp 1–15.

Oberdorff, T., Guegan, J-F. & Hugueny, B. 1995. Global patterns of fish species richness in rivers. *Ecography*, 18: 345–352.

Petersson, E. 2009. Inland fish and fisheries. In *Fisheries, Sustainability and Development*, pp. 147–152. Stockholm, Royal Swedish Academy of Agriculture and Forestry.

Regidor, H.A. 2004. Análisis comparativo de las capturas de pescadores artesanales y recreativos en pesquerías de uso múltiple del noroeste argentino. Memoria VI Congreso sobre Manejo de Fauna Silvestre en la Amazonía y Latinoamérica. (Available at www.revistafauna.com.pe/memo/598-601.pdf)

Royal Swedish Academy of Agriculture and Forestry. 2009. *Fisheries, Sustainability and Development*. Stockholm, Royal Swedish Academy of Agriculture and Forestry. ISBN 91-85205-87-5: 484 pp.

Saleh, M. 2008. Capture-based aquaculture of mullets in Egypt. *In* A. Lovatelli & P.F. Holthus, eds. *Capture-based aquaculture*: *global overview*. FAO Fisheries and Aquaculture Technical Paper No. 508. Rome, FAO. 298 pp.

Thorpe, A., van Anrooy, R., Bisheke, N. Niyazov, B., Mairam, K. Sarieva, M., Valbo-Jørgensen, J. & **Mena Millar, A.** 2009. The collapse of the fisheries sector in Kyrgyzstan: an analysis of its roots and its prospects for revival. *Communist and Post-Communist Studies*, 42: 141–163.

United States Department of Commerce. 2002. *Fisheries of the United States 2001*. Silver Springs, USA, National Marine Fisheries Service, Fisheries Statistics and Economics Division.

United States Fish and Wildlife Service. 1997. 1996 *National survey of fishing, hunting and wildlife-associated recreation. National overview – preliminary findings*. Washington, DC, United States Department of the Interior.

United Nations. 2011. Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2010 Revision, available at: http://www.un.org/en/development/desa/publications/world-population-prospects-the-2010-revision.html.

Van den Bossche, J.-P. & Bernacsek, G.M. 1990. *Source book for the inland fishery resources of Africa*. CIFA Technical Paper 18, 1, 2 and 3.

Van Zalinge, N., Thuok, N., Tana, T.S. & Loeung, D. 1998. *Where there is water, there is fish? Cambodian fisheries issues in a Mekong River Basin perspective*. Contribution to the Mekong Panel at the Seventh Common Property Conference of the International Association for the Study of Common Property, Vancouver, Canada, 10–14 June 1998.

Van Zalinge, N., Degen, P., Pongsri, C., Nuov, S., Jensen, J.V. Nguyen, H. & Choulamany, X. 2004. The Mekong River System. *In* R.L. Welcomme & T. Petr, eds. *Proceedings of the Second International Symposium on the Management of Large Rivers for Fisheries, Volume II*. FAO Regional Office for Asia and the Pacific, Bangkok, Thailand. FAO RAP Publication 2004/17.

Welcomme, R.L. 1976. Some general and theoretical considerations on the fish yield of African rivers. *J.Fish.Biol*., 8: 351–64.

Welcomme, R. & Lymer, D. 2009. *An audit of inland capture fisheries statistics – Africa*. FAO Fisheries Circular No. 1051. Rome, FAO.

World Bank. 2010. *The hidden harvests: the global contribution of capture fisheries*. Washington DC, World Bank. 99 pp.

ANNEX 1

Catches, in tonnes, for all countries reporting inland fish landings, 2000–2009 (in order of magnitude of catch as of 2009)

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
China	1953134	1871295	1951889	2137496	2098777	2213303	2208156	2256533	2248347	2184049
Bangladesh	670465	688920	688435	709333	732067	859269	956686	1006761	1060181	1218937
India	905700	975403	775599	757353	527290	843746	892639	823410	947208	915967
Myanmar	196060	238210	254880	290140	454260	503540	631120	717640	814740	899430
Uganda	219356	220726	221898	241810	371789	416758	367099	500000	450000	400000
Cambodia	245600	385000	360300	308750	250000	324000	422000	395000	365000	390000
Indonesia	318331	310198	304600	308526	330739	297254	293863	320802	300319	309865
Nigeria	132315	154175	187242	174968	182264	238051	223395	227107	304413	285771
Tanzania, United Republic of	271000	283354	273856	301855	312040	320566	292519	284346	281690	269402
Russian Federation	292368	206430	208522	190712	178403	219237	209376	228583	216841	246137
Thailand	201405	202500	198700	198447	203700	198730	214000	225600	228600	245500
Brazil	199159	220432	239415	227551	246101	243435	251241	243210	261280	239493
Egypt	253470	295450	292662	313428	282099	242100	256288	241743	237572	237500
Congo, Democratic Republic of	240586	227433	233800	230365	231772	230840	230588	230000	230000	230000
Philippines	151753	135845	131098	132570	140409	142181	159851	166459	179491	186444
Viet Nam	210000	243583	226958	208872	146054	138800	145800	144000	140900	144800
Kenya	210343	156763	137792	113221	119093	140199	151729	124327	127097	133286
Pakistan	176468	122468	114030	92794	93687	94644	140000	100000	108000	112355
Mexico	106817	91952	82648	99604	107203	113578	116268	116591	108853	111792
Mali	109870	100000	100000	100000	100000	100000	100000	100000	100000	100000
Ghana	74500	74500	74500	75000	75000	75000	83168	84756	85000	88700
Zambia	66671	63000	63000	66332	67725	65927	60236	73542	79403	84716
Cameroon	55000	52500	65000	55000	65000	75000	75000	74380	74000	74000

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Iran (Islamic Republic of)	123490	88335	55853	50994	55825	67066	71405	74064	65862	71781
Malawi	50000	40619	41329	53543	56463	59595	72787	66500	70019	69325
Sudan	48000	53000	52000	54000	57500	53800	52000	59810	62900	66000
Senegal	52154	50000	52000	54000	56195	55995	60305	61400	58852	58800
Sri Lanka	32340	26330	25570	26920	30780	31560	35290	38380	44500	46560
Peru	32254	35757	29968	32940	37688	40196	37466	42633	45412	45720
Japan	71252	61964	61844	60404	60499	54432	41700	39039	32626	40177
Chad	83200	75000	70000	65000	60000	55000	50000	45000	40000	40000
Turkey	42824	43323	43938	44698	45585	46115	44082	43321	41011	39187
Kazakhstan	36620	22960	24668	25195	33306	37621	34724	41366	55706	33637
Madagascar	30000	30000	30000	30000	31500	32650	32750	32630	32630	32828
Canada	40667	38140	39999	37383	36116	32269	32234	32303	31063	31379
Benin	26400	30000	29993	30000	28200	21900	29500	30200	30200	30250
Lao People's Democratic Republic	29250	31000	33440	29800	29800	26560	26925	28410	29200	30000
Niger	16250	20800	23560	55860	51466	50018	29835	29728	29960	29884
Finland	34782	34782	35563	35563	36265	36265	36513	36513	29270	29278
Congo	25438	26101	29494	31182	30338	32500	31000	30120	29362	28385
Venezuela, Bolivarian Republic of	23739	24326	40776	49090	44000	39000	42000	33500	24882	24900
Colombia	27737	26532	27738	30512	28292	19291	20000	20800	21700	22686
United States of America	25286	29527	27224	26116	29081	24809	18712	25275	24533	22482
Iraq	8378	14100	11900	13200	10581	23570	46300	45460	29986	22259
Germany	22868	22818	22798	22611	22611	21400	21442	21462	22062	21802
Nepal	16700	16700	17900	18888	19947	19983	20016	20100	21500	21500
Poland	17543	17789	18947	19994	20330	19469	19183	19059	18937	18798
Burundi	17315	8964	11000	14697	13855	14800	15750	16700	17766	17700
Ethiopia	15681	15390	12300	9213	10005	9450	9890	13253	16770	17047

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Argentina	30418	15536	18474	26596	33903	34002	33617	19695	11246	15521
Central African Republic	15000	15000	15000	15000	15000	15000	15000	15000	15000	15000
Mauritania	10000	10000	12000	12000	12000	13000	15000	15000	15000	15000
Turkmenistan	12228	12749	12812	14543	14992	15000	15000	15000	15000	15000
Sierra Leone	14000	14000	14000	14000	14000	14000	14000	14000	14000	14000
Papua New Guinea	13500	13500	13500	13500	13500	13500	13500	13500	13500	13500
Burkina Faso	8500	8500	8500	9000	9000	9000	9500	10200	11093	11800
Republic of Korea	7141	5971	5690	7539	10302	7500	6447	5803	11098	11707
Zimbabwe	13114	12300	11500	10600	10500	10420	10500	10500	10500	10500
Mozambique	19192	15076	20037	19831	27760	22991	26017	24081	28386	9546
Gabon	10417	9850	9400	9507	8293	9700	9359	9500	9500	9500
Rwanda	6726	6828	7000	7400	7826	7800	8400	9050	9050	9050
Bolivia (Plurinational State of)	6106	5940	6300	6599	6746	6660	6350	6000	6900	7568
Hungary	7101	6638	6750	6536	7242	7609	7543	7024	7394	6366
Uzbekistan	3306	2341	1564	1349	1230	1330	1431	1973	2731	6051
Morocco	1608	1660	2112	1655	850	2930	3350	4020	4440	6020
Spain	8000	7300	6600	6000	6000	6000	6000	6000	6000	6000
Ukraine	4429	4343	3823	15144	5263	6027	7171	12603	4590	5855
Angola	7000	8000	9000	10000	10000	10000	10500	9000	7500	5848
Democratic People's Republic of Korea	8000	4928	5000	5000	5000	5000	5000	5000	5000	5000
Togo	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
Italy	4565	5527	4242	4379	5099	3823	3915	3944	3552	4988
Malaysia	3549	3446	3450	3828	4119	4582	4165	4280	4353	4469
Gambia	2500	2500	2500	3000	3500	4000	4500	4865	4166	4461
Czech Republic	4654	4646	4983	5127	4528	4242	4646	4276	4164	4112
Guinea	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
El Salvador	2831	1692	2663	2673	2205	2051	2034	2422	3980	3980

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Serbia	0	0	0	0	0	0	2632	2535	3153	3846
Romania	4896	5178	4858	8278	3255	4027	6049	5665	4966	3688
Syrian Arab Republic	3991	5969	6355	5851	5451	4770	4869	6075	3784	3500
Côte d'Ivoire	10502	10502	22000	22000	4856	13145	6565	3178	3200	3200
Estonia	3190	2461	4578	3593	2373	2472	2941	2665	2835	2898
Namibia	1500	2000	2000	2500	2500	2800	2800	2800	2800	2800
United Kingdom	2743	3142	3431	3875	1120	1172	2421	2517	2529	2562
Cuba	2983	1993	2023	2698	2513	1561	1449	3058	2764	2526
France	2859	2641	2600	2600	2600	2600	2600	2600	2600	2500
Guatemala	7301	6480	5665	4850	4035	3120	2360	2360	2360	2360
Albania	955	1373	1167	1265	1807	2210	2442	2598	2187	2321
Fiji	5700	5921	3800	1263	2993	3000	3078	2188	2200	2220
Bosnia and Herzegovina	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Panama	20	20	23	26	406	2950	3555	3242	3143	1913
Netherlands	2250	2200	2578	2150	2100	2100	2100	2000	2000	1900
Slovakia	1368	1531	1746	1646	1603	1693	1718	1994	1655	1761
Paraguay	28000	25000	21500	18000	14500	11000	8000	5000	1708	1700
Switzerland	1659	1715	1544	1815	1602	1475	1422	1377	1582	1687
Republic of Moldova	344	387	565	343	487	531	612	1160	1407	1607
Bulgaria	861	1640	1453	1824	2434	2025	1916	1073	1197	1588
Australia	366	185	156	303	317	501	335	1238	1275	1576
Sweden	1459	1234	1436	1491	1393	1417	1644	1546	1614	1564
Lithuania	1912	1854	758	1959	1766	1547	1437	1874	1600	1315
Azerbaijan	18797	10893	11188	6435	9258	9001	3983	2943	1517	1202
Tunisia	832	860	870	859	1049	1224	1264	1084	1096	1191
Afghanistan	1000	800	900	900	1000	1000	1000	1000	1000	1000
Costa Rica	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Equatorial Guinea	1076	1000	950	900	850	850	900	900	900	1000

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Greece	3433	3181	3000	3166	1940	1580	1413	1439	1425	940
Belarus	553	943	5877	6925	890	900	900	900	900	900
South Africa	900	900	900	900	900	900	900	900	900	900
Nicaragua	528	700	487	405	866	1042	412	853	988	868
Uruguay	2302	451	387	551	2330	2130	2137	1200	620	801
Guyana	800	800	800	800	800	800	800	800	800	800
Liberia	4000	4000	4000	3600	3200	2800	2400	1743	763	750
New Zealand	1089	1076	900	850	801	812	865	817	752	729
Norway	578	550	500	450	405	507	679	851	874	662
Armenia	1133	866	465	569	218	250	350	1065	601	619
Montenegro	0	0	0	0	0	0	600	600	600	600
Belgium	511	511	511	511	496	496	496	512	511	511
Dominican Republic	187	1158	2102	1506	1980	1694	1911	1481	1708	432
Croatia	17	34	25	19	37	33	46	60	45	425
Suriname	200	200	200	222	242	218	200	350	350	420
Israel	1852	1286	1569	1064	1137	1396	1600	840	224	401
Jamaica	400	400	400	400	400	400	400	400	400	400
Austria	439	362	350	372	400	370	360	350	350	350
Jordan	400	350	350	350	350	350	350	350	350	350
Ecuador	350	350	300	300	250	250	233	216	199	338
Latvia	612	581	581	565	360	356	328	310	349	326
Haiti	400	400	400	400	300	300	300	300	300	300
Lebanon	20	20	297	285	265	275	270	270	270	270
Iceland	176	160	210	225	222	219	173	185	231	235
Somalia	200	200	200	200	200	200	200	200	200	200
Bhutan	260	260	240	240	220	220	200	200	180	180
Slovenia	226	206	226	195	208	202	200	196	183	164
Taiwan Province of China	549	591	599	2292	245	197	149	242	198	159

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Guinea-Bissau	150	150	150	150	150	150	150	150	150	150
Tajikistan	78	137	181	158	184	146	146	146	146	146
The former Yugoslav Republic of Macedonia	208	128	148	162	213	246	89	122	122	141
Honduras	61	111	102	100	100	100	100	100	100	100
Mongolia	425	290	263	382	305	366	326	185	88	90
Botswana	166	118	139	122	161	132	81	122	86	86
Ireland	881	902	796	615	610	521	443	178	214	86
Swaziland	70	70	70	70	70	70	70	70	70	70
French Polynesia	53	53	53	52	51	50	53	53	53	53
Georgia	22	8	10	39	51	51	50	50	50	50
Denmark	183	99	77	129	123	60	54	44	40	45
Lesotho	32	24	40	42	45	45	45	48	50	45
Cyprus	78	70	60	50	40	30	20	20	20	20
Kyrgyzstan	52	57	48	14	7	14	8	34	8	10
Micronesia, Federated States of	5	5	5	5	5	5	5	5	5	5
Falkland Islands (Malvinas)	1	1	1	1	1	1	1	1	1	1
Samoa	1	1	1	1	1	1	1	1	1	1
Total (tonnes)	8578430	8535070	8408837	8626923	8598531	9370710	9758386	9960182	10189334	10323905

ANNEX 2

Identification and effect of large changes in national reports of inland capture fisheries statistics on the global trend (1950–2007)

Calculations and text by David Lymer.

Since 1950, the Food and Agriculture Organization of the United Nations (FAO) has requested its Member Countries to report inland fisheries capture statistics as part of their fisheries reporting to the organization. From this reported data, there is an apparent increasing trend in the production from global and regional inland fisheries during the period 1950–2007 (Figure 1, Section 2 of main text) that is regularly reported in global analyses (FAO, 2002, 2004).

Several predictions have been made regarding the way in which global inland fisheries are developing based on this significant and continuous trend. These contribute to an apparent general consensus that there seems to be further potential for growth in the sector. That is, the apparent increase in global inland fisheries production appears to indicate that the global threshold of production has not yet been reached. At first sight, this trend of increasing production may encourage an immediate conclusion that all is well in the fisheries of the region and that "maximum sustainable yield" (biological or economic) in these fisheries has yet to be reached. However, it has also been reported that inland fishery production has been stable in recent years if consideration is given to the improved quality of inland fisheries data and that caution should be exercised when analysing the regional catch trend, with examples from Asia and the Pacific region (Lymer and Funge-Smith, 2009) and for the African continent (Welcomme and Lymer, 2009).

FAO has highlighted its concerns regarding the quality of inland fisheries data, as reported to FAO, in recent years (FAO, 2002, 2004, 2007, 2009) and this has also been noted far earlier (Gulland, 1970). The quality of the data reported to FAO from countries and also the estimates that FAO has to make when no data has been reported[1] mean that the global and regional aggregate inland fisheries statistics are indicative rather than absolute.

The aim of this analysis was to find if there are large changes (between years) that are significant for any individual country and to investigate further whether these changes also affect the global change of that year

Identification of large changes in inland catch data

The global inland fisheries production data (1950–2007) of the FAO FishStat database were the basis for this analysis. The data included fish, crustaceans, molluscs, etc.,[2] and all FAO inland water areas. All countries were included in the analysis and the data were manipulated using Excel (Microsoft Office 2003). The analysis was done as in Lymer and Funge-Smith (2009) with minor modifications. In brief, countries with a significant increase in annual production were identified, using:

- **Criterion 1**: Any country reporting a positive change of more than 40 percent, compared with its reported production of the previous year (the 40 percent cut off was considered to be to be well above any naturally driven variability in catch and to be a result of revision of statistics rather than any actual increase in production). This identified the number of events of large increases in country production. The countries identified using criterion 1 were filtered according to criterion 2.
- **Criterion 2**: This second stage filter selected those countries which met criterion 1 and whose inland fishery production change was at least 30 percent greater than the average annual

[1] For several countries, data extracted from FishStat Plus are not official submissions by the country, but are FAO estimates in absence of submission.

[2] Exclude production figures for marine mammals, crocodiles, corals, pearls, sponges and aquatic plants.

change in global/regional inland fishery production (1951– 007).[3] This selected those events which would have a likely impact on total regional production and the trend line.

Adjustment of catch data

The data from those countries identified under criterion 2 were adjusted backwards as follows (Lymer and Funge-Smith, 2009): those countries that were selected using criterion 2 had their production data adjusted backwards using the following formula[4] (creating a new data set [*Back-adjusted*]):

Back-adjusted catch $_{\text{year x}}$ = Original catch $_{\text{year x}}$ * (1+change $_{\text{Criterion 2 year}}$): see footnote[5]

In addition, for this analysis only, occurrences of large negative change were included if their decrease (absolute value) was more than 30 percent of the average regional increase. This adjustment smoothed out the individual large increases backwards across the data series to remove the effect of a single large increase (or decrease). Further, the new data set (*Back-adjusted)* and the original data set (*Original*) was further divided by the world population (downloaded from the Department of Economic and Social Affairs of the United Nations)[6] to obtain a measure of catch/capita.

Temporal and spatial distribution of identified large changes

Globally, inland capture fisheries data for 230 countries are recorded in FishStat (FAO FishStat Plus, 2009a [now superseded by FishStatJ]). There has been a steady increasing number of reporting countries throughout the years, from a total of 173 countries in 1950, with large leaps in the numbers of countries reporting on two occasions: (a) between 1969 and 1970, from 184 countries to 202; and (b) between 1980 and 1981, from 202 to 217. The increase between 1969 and 1970 resulted in a total increase (for all 18 countries) of 200 tonnes, and for the increase between 1980 and 1981 an increase of 100 tonnes.

The increase in catch globally between 1950 and 2007 was 8 121 426 tonnes (Table A2.1), from a total catch of 1 913 101 tonnes in 1950 to 10 034 527 tonnes in 2007 (Figure A2.1). A total of 540 events were recorded, where the change in catch from the previous year had increased more than 40 percent (Table A2.1). This corresponds to an average of 9.47 countries per year^{-1} reporting large leaps in their inland water catch data. The sum of the change of these 540 changes was 4 326 831 tonnes. The sum of the changes corresponds to 53.3 percent of the total increase in the world inland capture fisheries between 1950 and 2007. The average global increase (*G. Average*) in inland fisheries catch was 142 481 tonnes (1950–2007).

Table A2.1. The number of identified changes and their percentage contribution of the change (only increases) for the countries remaining after different cut-offs (1950–2007)

	Number of changes	Sum of change/ increase (tonnes)	Change/ world increase (%)
Total increase		8 121 426	
Criterion 1	540	4 326 831	53.3
Criterion 2	26	2 682 836	33.0

[3] Many countries with total annual production may report increases of more than 40 percent between years, however, their contribution to the global/regional total may not be sufficient to warrant further treatment.

[4] Some countries with several identified changes were subject to several adjustments (i.e. the data were revised several times).

[5] Change $_{\text{Criterion 2 year}}$ = (Original Catch $_{\text{Criterion 2 year}}$ - Original Catch $_{\text{Criterion 2 year -1}}$) / Original Catch $_{\text{Criterion 2 year -1}}$

[6] *Source*: www.un.org/en/development/desa/publications/world-population-prospects-the-2010-revision.html.

Out of the 540 events, 26 were of such magnitude that they contributed to more than 30 percent of the average increase in global inland fisheries catch (0.51 countries per year). The total change of these 26 events alone was 2 682 836 tonnes (Table A2.1) and explained 33.0 percent of the total regional increase 1950–2007. These 26 events were assigned a separate code and plotted against total change (positive/negative) and total catch (Figure A2.1).

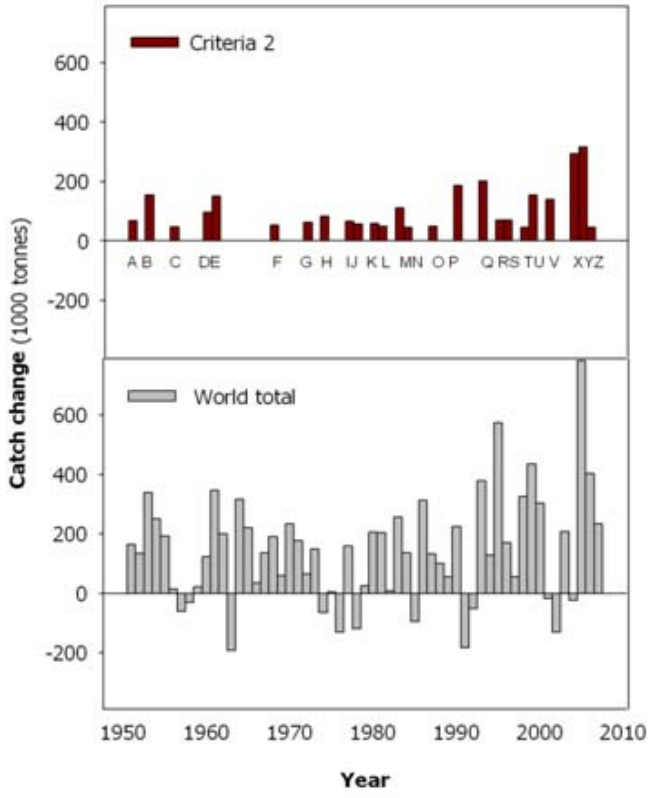


Figure A2.1: Changes (Xyear x-Xyear x-1/Xyear x-1) above 30 percent in reported production that contributed to more than 30 percent of the Asia-Pacific Fishery Commission (APFIC) regional total change in the same year (top graph); the total regional change for inland capture fishery catches 1950–2007 (bottom graph).

Note: Alphabetic code corresponds to the identified changes and countries as follows: A (1951, China); B (1953, China); C (1956, Myanmar); D (1960, China); E (1961, China); F (1968, the Philippines); G (1972, Colombia); H (1974, Brazil); I (1977, Uganda); J (1978, the Philippines); K (1980, Brazil); L (1981, Mexico and Cambodia); M (1983, the Philippines); N (1984, Democratic Republic of the Congo); O (1987, Mexico); P (1990, India); Q (1993, India); R (1995, Mali); S (1996, Viet Nam); T (1998, Nigeria); U (1999, Cambodia); V (2001, Cambodia); X (2004, Myanmar, Uganda); Y (2005, India); Z (2006, Pakistan).

The identified events (Figure A2.1) are evenly spread throughout the whole time period. The three largest individual changes are the changes: 2005 (316 456); 1993 (202 618); and 1990 (187 313); all from India.

The 26 events are due to changes in 14 countries (see note in Figure A2.1). Out of the 26 events at the global level, 16 are from 7 Asian countries, and the remaining 10 events are from 3 American countries (5 events) and 4 African countries (5 events).

Back-adjustment of catch data and catch per capita

In addition to the identified 26 events with increasing catch, 4 events of large negative change were identified, namely: China 1957 (–215 900 tonnes); Democratic Republic of the Congo 1960 (–77 500 tonnes); Cambodia 1978 (–43 800 tonnes); and Viet Nam 1994 (–67 252 tonnes). The 26 identified events (and the 4 negative events) were back calculated to estimate the historical production from inland water capture fisheries in the Asia and Pacific region. The *back-adjusted* data show that the initial production in 1950 was 3 088 488 tonnes, which suggests a 61.4 percent increase compared with the official data (Figure A2.2). In the *back-adjusted* data, the production was already above 7 400 000 tonnes in 1973, a level not reached until 1996 in the old data. For the *back-adjusted* data, there is a significant increasing trend (R^2: 0.92), as is also the case in the *original* data (R^2>0.96); however, at a much gentler increase than the old data as the initial value (1950) is higher in the *back-adjusted* data.

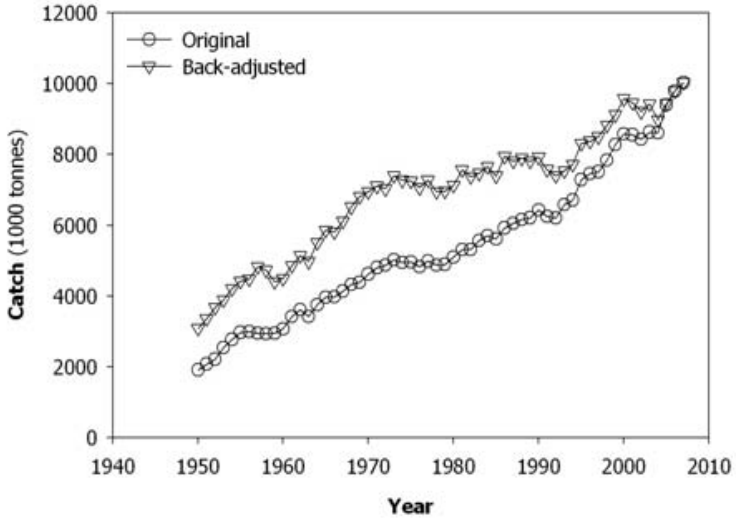


Figure A2.2: Historically modelled data of global inland water capture fisheries catch based on the changes identified using criterion 2 and the four negative changes identified (*back-adjusted*) and the original inland water capture statistics (*original*).

The catch per person differs between the *back-adjusted* and the original data set, with the highest catch/capita being recorded in 2007 for the *original* data but was already reached in 1973 for the *back-adjusted* data. Additionally, the steady increase in catch per person in the *original* data does not exist in the *back-adjusted* data, which instead decreases from 1973 onwards (Figure A2.3).

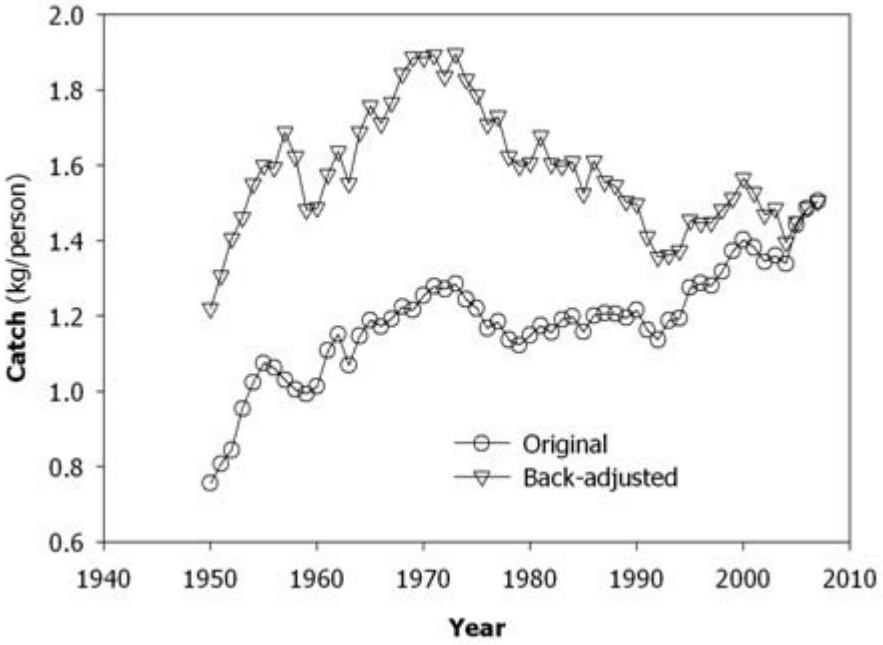


Figure A2.3 Historically modelled data of global i nland water c apture fisheries c atch/capita (person) based on the changes identified using criterion 2 and the four negative c hanges identified (*back-adjusted)* and the original inland water capture statistics (*original*).

What are the implications for interpreting the global inland fisheries trend

The analysis of the reported inland waters capture production data shows that the inclusion of new countries in the data set has a small effect on the trend in inland capture fisheries. The analysis further shows that individual countries have reported an annual increase of more than 40 percent, a total of 540 times. On average, that corresponds to more than nine countries per year reporting these very large increases in national production. Not all of these changes will significantly influence the trend of inland fisheries catch at global level (i.e. many of these countries have a relatively small contribution to total production). It is, nevertheless, noteworthy that such large increases are a common occurrence and that, overall, these identified events account for more than 53 percent of the total increase in inland water production between 1951 and 2007.

Out of the 540 events, 26 events were of a magnitude that they were greater than 30 percent of the average global change (*G. Average*) and, hence, significantly affect the global trend. These 26 events were confined to 14 countries and represent more than 33 percent of the total change between 1951 and 2007, or 2 682 836 tonnes (Table A2.1). It can be concluded, therefore, that the trend in inland catch (Figure A2.2) is significantly driven by these large changes in only 14 countries.

According to the adjusted data (historically back-adjusted), the total global production has traversed four different periods;
(1) a period of rapid growth between 1950 and the mid-1970s;
(2) a relatively stable plateau from the mid-1970's until the early 1990s;
(3) a rapid growth period until the turn of the century;[7] and
(4) a renewed period of relative stability from 2000 onwards.

In contrast, the inland fishery production data officially reported to FAO data (o*riginal*) shows a consistent increase in production throughout the period (1950–2007), and this is also reflected in a

[7] The rapid increase in total regional production and thus catch/person during the late 1990s can be largely attributed to consistent large increases in reported inland fisheries production in China and Bangladesh.

steady increase in production/capita. As a result, the rate of increased production appears slower, but catch per capita almost never declines. Again, a completely different trend emerges when using the historically back-adjusted data, with rapid increases in catch/capita until the mid-1970s and thereafter a falling catch/capita until the mid-1990s, where it again started to increase. The decrease in catch/capita is consistent with anecdotal evidence from numerous field-level sources and documented reviews of inland fisheries (e.g. Allan *et al*., 2005; Baran and Myschowoda, 2008; Hap and Bhattarai, 2009), all reporting declining catches per fisher.

While global inland fisheries production has almost certainly increased over time, possibly as a result of increasing population, it is also worth noting that there are recent reports of underestimated production in inland capture fisheries in the Asia-Pacific region (Coates, 2002; Hortle, 2007; Lymer *et al*., 2008b) and from the African continent (Welcomme, 1976; De Graaf and Ofori-Danson, 1997; van Zalinge *et al*., 1998). It can, therefore, be expected that future revisions upwards of inland fisheries production can be expected from several countries. The revised estimates for inland fisheries production from these reports alone correspond to a significant proportion of the world total inland production. It is important to note that these revised estimates do not represent a sudden increase, but almost certainly a systematic and historical underestimation of national production. The implications of this are that we must avoid falling into the trap of assuming that production is increasing when we are really only seeing a readjustment of the baseline and that from some countries, at least, there may actually be a trend of decline in the fishery being masked by the aggregation of catches and production of multiple countries.

This analysis is, in effect, a "thought experiment" using arbitrary criteria (the 40 percent increase in criterion 1 and 30 percent change in criterion 2 and simple back-adjustment of the data. As such, it represents one of several possible approaches to adjustment of irregularities in reporting. The analysis did not substantively take into account large negative revisions in criterion 1 analysis; such negative changes are fewer but could also significantly affect the data set. Another important consideration is that we have not distinguished between data reported by countries and FAO estimates. Further, the population data used for the calculation in catch/capita included the total global population, whereas the production data used did not include all of these countries (especially for the early historical data); hence, the absolute catch level is slightly lower than could be expected. However, the trend in population growth and, hence, the trend in the calculated production/capita can be considered a reliable reflection of the global situation.[8]

Inland fisheries sometimes involve international political and territorial disputes, for example in areas such as the Caspian Sea. In addition, there are disputes regarding construction of dams, irrigation schemes and pollution, which affect the fisheries in neighbouring countries, such as the Aral Sea or the Mekong basin. The multistakeholder issues surrounding freshwater use (for power, irrigation, leisure, etc.) also mean that fisheries services may not be valued highly and, as a consequence, little effort and few resource have been allocated to information gathering and management of inland fisheries. There is a growing awareness that, in certain parts of the world, inland fisheries can be a major source of protein and livelihoods, which sparked recent interest in these fisheries. Furthermore, the lack of inclusion of recreational catches and the fact that many countries still encounter great difficulties in managing and funding the collection of inland capture statistics are highlighted as major problems by FAO (FAO, 2002, 2004, 2007, 2009). In addition, the very poor breakdown into taxonomic groups reported by many countries risks biasing trend analysis by species or species groups within the inland catch data. In 2006, global inland catches classified as "freshwater fishes NEI"[9] again exceeded 50 percent (57.2 percent) of the global catch, and a most worrying trend is that these figures are actually both globally and in specific regions.

[8] This analysis could be strengthened by using the total national population data of those countries for which inland fishery production is reported.

[9] This refers to a conglomerate of many freshwater species.

In conclusion, this thought experiment highlights the need to be careful when drawing conclusions about the trend of inland water capture fisheries catches at the global level. Further, this should be taken into consideration when potential for further development is discussed.

ANNEX 3

Recreational fisheries

Prepared in collaboration with Ian Cowx and John Jorgensen.

Introduction

Recreational fisheries capture aquatic animals for leisure and sport when this does not constitute an important source of nutrition and when they are not the subject of legal or illegal trade.

Recreational fishing is pursued in both marine and inland environments, although this annex deals with inland recreational fisheries. It is usually conducted with rod and line using natural or artificial bait, although a range of other methods may be used according to local custom. Similar methods are used in subsistence fishing, so it is often extremely difficult to differentiate clearly between the two types of fisheries.

Recreational fisheries are the dominant use of inland waters fish resources in the north and south temperate zones (particularly Europe, North America, Australia, South Africa and the southern parts of South America) (see Cooke and Cowx, 2006; Hickley, 2009). The sector is also experiencing explosive development in many transition economies in Africa, Asia and Latin America. The increasing importance of recreational fishing throughout the world manifests itself in the proliferation of television programmes and in an abundance of advertisements for fishing tours and competitions available on the World Wide Web where forums for sharing photographs and exchanging experiences also can be accessed. The range of services on offer in the individual countries varies. However, there are angling associations or fishing clubs in most countries and a simple Internet search for "sport fishing" provides tens of thousands of hits and provides an overview of the variety of facilities available.

Types of recreational fishery

It is possible to distinguish three general types of recreation fisheries:

- Fishing for foreign tourists. This is widespread throughout the world, but tends to concentrate in areas known for their natural beauty or for containing fish of particular sporting value. Such areas include the Himalayas in Asia, Lake Titicaca, the Andean and Patagonian lakes and parts of the Amazon and central American lakes in Latin America, and Lake Kariba and the southern river systems in Africa. There are plenty of travel agents offering this type of service on the Internet.
- Fishing by well-off national tourists. These tourists generally reside in national urban centres, but go camping and fishing in the countryside during vacation periods. This sector flourishes throughout Europe, North America and Australia, but is developing in Latin America in places such as Santa Cruz in Bolivia (Plurinational State of), Rio Negro in Brazil, reservoirs in Venezuela (Bolivarian Republic of), throughout the lower Paraná basin and the Pantanal, and in Africa in Angola and Murchison Falls in Uganda.
- Fishing by local populations. This is closely linked to subsistence fishing in that they are generally local fisheries that also aim at providing food for the fisher and his/her family. This type of fishing can and will take place in almost any stream or waterbody, and normally does not target any particular species. Fishing by children belongs in this group, and although fishing may be a favourite pastime for them, the activity is also strongly encouraged by the parents.

Economic value of recreational fisheries

The economic potential of recreational fisheries is considerable. Direct income is generated from the sale of national fishing licences in addition to permits that may have to be paid to the owner of the fishing rights, whether this is a public or private entity. The sector also generates considerable secondary income through producers and sellers of fishing equipment, bait providers, boat renters, guides, lodge owners, travel agencies, restaurants, boat constructors, producers of books, magazines, documentaries and digital information on recreational fishing, and producers of stocking material.

The amount of money paid by people in the luxury segment is considerable. Hickley (2009) cites the standard estimate of expenditure per fisher per year in Europe as EUR 1 000. The value of a fish caught by recreational fishers is thus many times higher than that of the same fish when it is caught by a commercial food fisher. The scale of the sector is indicated in Table A3.1. Despite the considerable economic importance of this sector, it is generally unrecognized, and systematic assessment of its social and economic significance has rarely been explored in most countries.

Table A3.1: Some indicators of value of recreational fisheries

(*Note*: these values are based on the very limited information available on this generally unrecognized sector of the economy.)

Location	Recreational fishing statistics and comments
Regional statistics	
Europe	Among the 27 European Union countries, there are an estimated 25 million anglers with an estimated direct and indirect expenditure on recreational fishing in excess of USD 8 billion (Hickley, 2009).
United States of America	In 1996, 18 percent of the United States population 16 years of age and older (i.e. 35 million persons) spent 514 million angler days in freshwaters, expending USD 38.0 billion (United States Fish and Wildlife Service, 1997). In the United States, only 12 percent of the entire population have never participated in recreational angling (United States Department of Commerce, 2002).
Canada	In Canada, 3.6 million anglers spent 47.9 million angler days and caught over 232.8 million fish, while spending USD 6.7 billion, of which USD 4.7 was wholly attributed to the sport in 2000. Of these fish, some 84.6 million were retained (Department of Fisheries and Oceans, 2003).
Australia	In 2002, an estimated 3.4 million anglers in Australia contributed to 20.6 million angler days and caught in excess of 70 million finfish, while spending in excess of USD 1.3 billion (Australian Department for Agriculture Fisheries and Forestry, 2003)
Argentina	About 2 120 000 recreational fishers in a sector worth an estimated USD 100 million
Brazil	About 30 million recreational fishers in a sector worth about USD 50 million in the primary sector and USD 400 million in the secondary.
Chile	About 10 000 recreational fishers.
Cuba	About 5 600 recreational fishers.
Mexico	About 3 300 000 recreational fishers.
Paraguay	About 8 000 recreational fishers.
Global statistics	
	In 1995, it was estimated that total recreational catch worldwide is of the order of 2 million tonnes and represents an important source of animal protein in many developing countries (Coates, 1995). In 2004, it was estimated (using extrapolations from North American fisheries statistics) that total annual recreational catch worldwide may be in the order of 47 billion fish per year, of which roughly two-thirds are released (Cooke and Cowx, 2004). Kapetsky (2001) estimated that freshwater recreational fishing effort represents roughly half of the food fishing effort from a global perspective relative to all fishing effort (i.e. marine recreational and commercial fishing effort).

Environmental and social impact of recreational fishing

Globally, very little is known about how recreational fisheries affect fish stocks, and even less is known about the situation in Asian, African and Latin American countries. However, potentially the impact may be very significant; Cooke and Cowx (2004), for example, estimated that 12 percent of global fish landings comes from recreational fisheries. There is no comparable figure available for inland waters, although in waters with low productivity, such as cold mountain streams or lakes, blackwater streams and rivers and some reservoirs (see example by Regidor, 2004), recreational fisheries can be responsible for a much higher share of the catch than artisanal fisheries. Many anglers practice catch-and-release fishing in the temperate regions and now also in the tropical areas. For example, a catch-and-release fishery was described for *Cichla* spp. in the Amazon but the positive impact of this on fish survival is still being questioned and the practice remains controversial (Aas, Thailing and Ditton, 2002).

The preferred species in the fisheries varies according to the geographic area. In the mountainous areas of the tropics, the most favoured target species are the introduced species rainbow trout (*Onchorhynchus mykiss*) and brown trout (*Salmo trutta*). Recreational fishers focus on dorado (*Salminas brasiliensis*) and large catfish species in the Paraná. In the tropical lowland, a large variety of species grow big enough to be interesting as trophies, but the most favoured are *Cichla* spp., *Colossoma macropomum*, arowanas (*Osteoglossum bicirrhosum*) and big catfishes. In Asia, sporting species such as *Tor tor* are sought after in India, Nepal and Pakistan, and in Africa the preferred species are the Nile perch *Lates niloticus* and tiger fish *Hydrocynus* spp.

Several of the most popular sport fish mentioned above are also important target species for artisanal fisheries. In order to avoid conflicts, there is a tendency for recreational fisheries to centre on regions with limited artisanal fishing, for example, blackwater rivers and cold-water streams. Conflicts frequently arise between recreational and artisanal fisheries, and in developed nations this often results in buyout of the fishing rights by the recreational sector. Participation of the middle and upper classes in recreational fisheries makes the groups politically very influential and they are very well organized, which contrasts with the generally poor organization of artisanal and subsistence fishers who usually belong to the lower-income strata. The result is that current management practices (e.g. gear bans, minimum sizes, closed seasons or areas) often favour the recreational sector to the detriment of small scale fishing for consumption or for sale. An example of this is the southern part of the Pantanal in Latin America, which has effectively been reserved for recreational fishing with an estimated loss of potential food production of around 50 000 tonnes. When fishing is organized as package tours without any involvement of the local community, the benefits have almost no positive impact locally. On the other hand, recreational fishers in the first two categories frequently use local fishermen as guides, and in some places the fish caught is sold to compensate the fishers for their losses.

In developed economies where inland waters are reserved for recreation, much fishing takes place in waterbodies that have been enhanced through stocking or introductions to satisfy demands by fishers for guaranteed catches in terms of numbers or weight of specimens. There is also a general policy to the large-scale provision of leisure fishing for all classes of society where the fish are caught and returned.

Where fish resources are reserved for recreational purposes, it is common for the fish assemblages to remain reasonably pristine, despite a tendency to encourage populations of the preferred species by stocking and elimination of competitors. This means that recreational fisheries act as a stimulus for the establishment of formal or informal reserves that may restock more highly exploited areas by emigration of excess fish. In addition to stock benefits, there are benefits for aquatic ecosystems in that one of the most powerful lobbies for the conservation or rehabilitation of damaged aquatic ecosystems comes from the recreational fishing sector. Waters reserved for recreational fishing also provide a potentially exploitable stock in case of severe food need when the current financial imbalance that favours recreational fisheries may be reversed.

ANNEX 4

Crocodiles

One group excluded from the general analysis were crocodiles, as these are reported as individuals and not by weight. Furthermore, catches are mainly for skins and not for food, although the tails are eaten in many countries. Enormous numbers of crocodiles have been removed from inland waters across the world (a total of 25 180 417 since the trade was first recorded in 1972), and the yearly take is still about 1.18 million individuals (Figure A4.1), although there have been signs of a decline over the past three years. These figures can distort national fish catch estimates if due care is not taken in generating reports using FishStat Plus.

The trade in crocodile skins has been the subject of a report by Caldwell (2004), but this report deals with cultured crocodilians as well as those captured from the wild. This analysis appears to be the only one available that analyzes captures from wild sources.

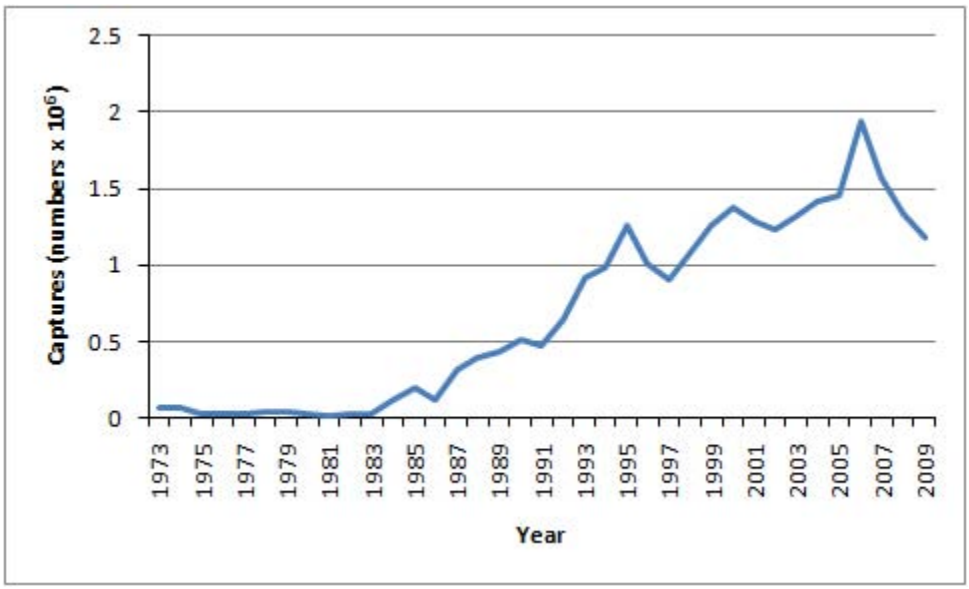


Figure A4.1: Global crocodile production (numbers) from inland waters 1972–2009

The majority of crocodilians are captured in the Americas, with South America as the principal source at about 39 percent of the yearly captures, and North America (United States of America) at over 25 percent (Table A4.1).

Table A4.1: Catch of crocodilians by continent in 2008

Country	2009	%
South and Central America	461 400	39.17
North America	297 187	25.23
Asia	234 838	19.94
Africa	126 688	10.76
Oceania	57 740	4.90
Total	1 177 853	100.00

Table A4.2 shows that the main producers in 2008 were Colombia (South America), United States of America (North America), Cambodia (Asia), and Zimbabwe and Zambia (Africa). Some notable producers, such as Uganda and the Sudan reported catches in 2006 but not in 2009. A considerable

number of individuals are produced by culture each year in some countries (Caldwell, 2004), and there may be some confusion between these and those produced by capture.

Table A4.2: Catch of crocodilians by country in 2009

Country	Quantity	%
Colombia	405 782	34.45
United States of America	297 187	25.23
Cambodia	185 000	15.71
Zimbabwe	62 101	5.27
Papua New Guinea	30 750	2.61
Guyana	28 731	2.44
Australia	26 990	2.29
Thailand	26 119	2.22
Zambia	25 575	2.17
South Africa	24 982	2.12
Indonesia	12 251	1.04
Argentina	10 831	0.92
Viet Nam	9 483	0.81
Bolivia (Plurinational State of)	7 748	0.66
Kenya	6 906	0.59
Brazil	6 569	0.56
Malawi	3 105	0.26
Botswana	1 626	0.14
Honduras	1 240	0.11
Singapore	1 086	0.09
Madagascar	1 000	0.08
Tanzania, United Republic of	790	0.07
Namibia	600	0.05
Malaysia	587	0.05
Mexico	499	0.04
Philippines	285	0.02
Taiwan Province of China	27	0.00
Ethiopia	3	0.00
Total	1 177 853	100.00

The principal species caught in 2008 were the spectacled caiman from South America, the American alligator from the United States of America, the Nile crocodile from the African countries, the estuarine crocodile from Oceania and the Siamese crocodile from Southeast Asia (Table A4.3).

Table A4.3: Numbers of principal taxonomic groupings of crocodilians caught in 2009

Species	Quantity 2009	%
Spectacled caiman	459 621	39.02
American alligator	297 214	25.23
Estuarine crocodile	232 083	19.70
Nile crocodile	126 688	10.76
Siamese crocodile	34 373	2.92
New Guinea crocodile	26 095	2.22
Morelet's crocodile	499	0.04
Cuvier's dwarf caiman	409	0.03
Broad-nosed caiman	387	0.03
Smooth-fronted caiman	322	0.03
American crocodile	160	0.01
Black caiman	2	0.00
Total	1 177 853	100.00

According to Caldwell (2004), caimans are usually harvested at about 40 kg and crocodiles at 100 kg. On this basis, the captures in 2009 were equivalent to 71 711 tonnes of crocodiles and 18 430 tonnes of caimans for a total of 90 141 tonnes. It is difficult to find any estimates for the impact of this level of abstraction of crocodilians from natural habitats, both on the populations of crocodiles themselves or on the general ecology of inland waters from which a top predator is so heavily exploited. However, some conservationist groups in South America[10] consider that the high level of exploitation, much of which is illegal and undeclared (making the present figure low relative to actual levels of capture), to be extremely damaging to some populations of the spectacled caiman.

[10] See www.endangeredspecieshandbook.org/trade_reptile_crocodiles.php

ANNEX 5

Harvest of aquatic plants

FishStat only records minimal amounts of aquatic plants as being landed throughout the world (see Figure A5.1).

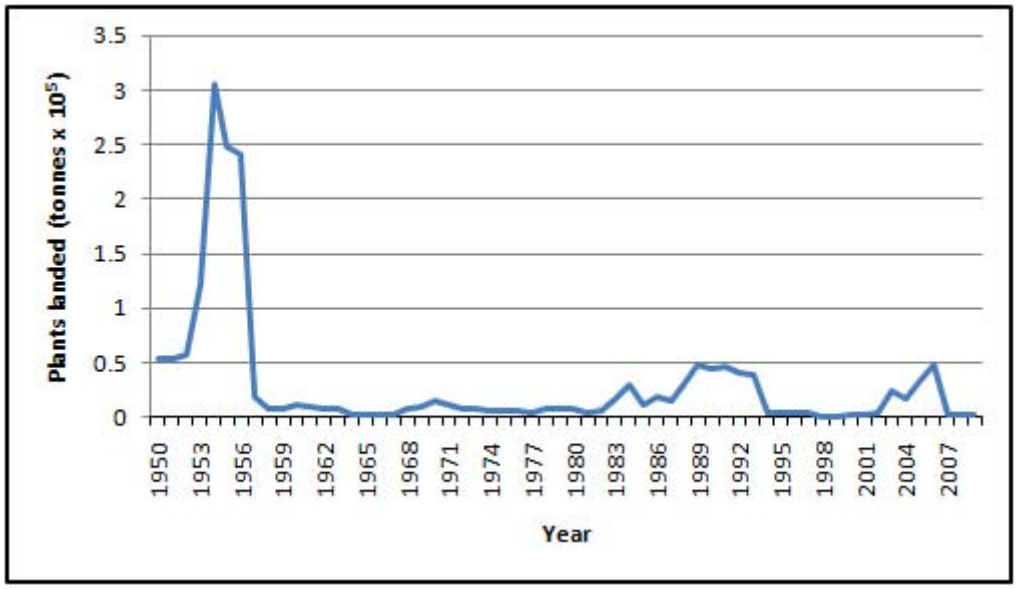


Figure A5.1: Quantities of aquatic plants recorded as landed in FAOSTAT, 1950–2009

The fact that inland plant landings are only recorded from a few countries in Asia and North America clearly does not reflect the real annual harvest of this important commodity. Aquatic plants are used throughout the world for human food, animal fodder, building materials (thatch) and fertilizers. The lack of adequate data on this group of organisms is a serious deficiency and severely distorts the value placed on inland water and wetland resources (see also FAO, 1979).

ISBN 978-92-5-107078-9 ISSN 2070-6065

9 789251 070789

I2484E/1/11.11