Title: Open Borders, Closed Seasons: Potential fisheries management tools for the Zambezi River, Southern Africa

Key words: Zambezi River; Southern Africa; Closed seasons; social and economic factors

Fisheries of the Zambezi River and its associated floodplains are an important source of food and income to inhabitants of the area. There is concern that current levels and forms of exploitation of the fisheries resources may be unsustainable, especially in the light of the current lack of management. While several means of managing the fisheries resources are being considered, given local experience, closed seasons seem to receive the most support amongst fishers, traditional authorities and government alike. However, this apparent support for closed seasons is accompanied by diverse motives and rationales amongst the stakeholders, due to a large part to the transboundary nature of the resource. This paper first examines the concept of closed seasons in river systems. This examination focuses on the biophysical, socioeconomic and institutional factors that drive both the goals of closed seasons and the means used to achieve them. A conceptual model, suggesting how these factors interact is then proposed. Data collected from the region of the Zambezi River that forms the border between Namibia and Zambia are then applied to this model. Analyses of different closed season scenarios, particularly in terms of who benefits and loses, are used in turn to inform future research and policy priorities.

Paper withdrawn but permission given to include abstract
Title: Ecoregion Conservation for Freshwater Systems, With a Focus on Large Rivers

Key words: Ecoregion; connectivity; biodiversity conservation

Conservation planning with the express purpose of protecting the aquatic biodiversity of large river systems is a relatively new endeavor. A conservation blueprint should be designed around the protection of sufficient habitat for the most wide-ranging and sensitive species, and of the physical processes that create and maintain those habitats. WWF and several other organizations have adopted an approach to large-scale planning, referred to as ecoregion conservation (ERC). An ecoregion is a large unit of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions. The boundaries of an ecoregion encompass an area within which important ecological and evolutionary processes most strongly interact. Large river basins often fit this definition. Conservation strategies that are formulated at the ecoregion scale have the potential to address the fundamental goals of biodiversity conservation: 1) representation of all distinct natural communities within conservation landscapes and protected-area networks; 2) maintenance of ecological and evolutionary processes that create and sustain biodiversity; 3) maintenance of viable populations of species; and 4) conservation of blocks of natural habitat that are large enough to be resilient to large-scale stochastic and deterministic disturbances as well as to long-term changes. Through ERC we generate a vision for what an ecoregion should look like in 50 years if its biodiversity targets are to be maintained. These targets fall into five main categories: distinct communities, habitats, and species assemblages; large expanses of intact habitats, and intact native biotas; keystone habitats, species, and phenomena; large-scale ecological processes; and species of special concern. The nature of freshwater systems requires that we go beyond identifying discrete aquatic areas on a map. A vision for a freshwater system must take into account the importance of lateral, longitudinal, and even vertical connectivity; examine threats originating upland, upstream, and even downstream; incorporate strategies for protecting hydrologic processes operating over large scales; and consider the implementation of land-based conservation strategies in the larger catchment. WWF, and partners, has undertaken ERC in a number of freshwater systems, including the Amazon, Congo, Niger, and lower Mekong Rivers. The many lessons we have derived from our work include the critical need to integrate the expertise of hydrologists with that of biologists, the importance of starting with catchments rather than small “hotspots”, and the value of integrating freshwater strategies with parallel efforts in adjacent terrestrial and marine systems. Next steps for our work involve improving the classification of aquatic habitats so that all types can be represented in a conservation blueprint; investigating the habitat requirements and metapopulation structures of select wide-ranging focal species; forecasting future threats like climate change and incorporating that information into our strategies; and conducting research to begin to identify thresholds in land use that translate into threats to aquatic biodiversity.
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Title: The Mangrove Fishes in the Benin Estuarine System: Diversity, Degradation and Management Implications

Key words: Benin, Mono river, mangrove degradation, diversity, abundance, trophic categories, multi-species fisheries, conservation issues

A preliminary study of the mangrove fishes was undertaken from March 2000 to September 2001 in the Benin estuarine lagoon system which is associated with the Mono river; a dam was constructed on this river to provide the Togo and Benin countries with electricity. The research aimed to investigate fish species diversity and ecosystem degradation impacts in order to protect and to improve the mangrove fish resources. The two dominant species of mangroves, Rizophora racemosa and Avicennia africana, are being intensively degraded for domestic use such as firewood. The fish assemblages are dominated by the detritivores and intermediates carnivores. Overall, 45 fish species belonging to 26 families were collected. Cichlidae (5 species), Eleotridae (6 species), Mugilidae (4 species) were the most speciose families. Six (6) species, Sarotherodon melanotheron (Cichlidae), Kribia nana (Eleotridae), Gerres melanopterus (Gerreidae), Hemichromis fasciatus (Cichlidae), Ethmalosa fimbriata (Clupeidae), Aplocheilichthys spilauchen (Cyprinodontidae), dominated the sample and account for about 80%. Sarotherodon melanotheron constitutes the major dominant species and account for about 29% of the total catches. Dominant species abundance was positively correlated with dissolved oxygen, pH, transparency and depth. Multi-species fisheries dominate the coastal zone with Sarotherodon melanotheron, Kribia nana, Gerres melanopterus and Ethmalosa fimbriata the major species in the commercial catches. In addition to mangrove degradation, the modification of the Mono River flooding regime, has led to the reduction of inundated plains and changes in water quality, mainly salinity, with modification of species composition: the fish composition tends to be dominated by marine and marine-estuary species (51%), whereas the number of species from inland waters (24%) tends to be reduced. Also nursery grounds and shelters were reduced, with a probable change in fish recruitment. As a results, the recent evolution of the Mono River hydrological status, combined with mangrove degradation have modified the ecological status of the Benin coastal zone, including changes in fish population. An integrated approach of the Mono River and coastal resource management/conservation, including mangrove restoration and key species (fish, shrimps, oyster, crabs...) management, is required for ecosystem recovery.
The Paraná River is the tenth longest river in the world and drains most of central South America. Surveys remain incomplete, but so far indicate at least 250 fish species. The most conspicuous man-made impacts are produced by dams, which have segmented the river and regulated its flow. These changes affect migratory fish, which are the largest and most commercially important in the basin. There are three types of fishery in the region: artisanal; subsistence and recreational. A 1938 law stated that fish ladders or hatcheries must be constructed at dams. More than a dozen fish ladders were constructed in Brazilian small rivers before the 60’s, but rarely evaluated. More recently fish ladders were built close to large dams. Studies conducted on these facilities determined the efficiency of the ladders for transporting fish but have not considered their effectiveness at conserving fish stocks. The inefficiency of fish ladders prompted hydroelectric companies to build hatcheries and in 1971 it became mandatory that one hatchery be built in every sub-basin containing a dam to increase fishery yield through stocking. Stocking of native and non-native species resulted in the widespread construction of hatcheries. Aquaculture was also promoted by Brazilian environmental agencies and hydro companies as a management alternative. Licensing, fishing gear and net mesh size restrictions; length limits and seasonal restrictions are also used to manage the fisheries. The low yield of artisanal fisheries in South-southeast Brazilian reservoirs and the virtual absence of large fish species in the high parts of the upper Paraná River basin indicate that management actions have not been satisfactory. In general, this was due to the lack of a clear purpose and poor technical and scientific information. Regulations for protecting juveniles, spawning grounds and spawning season have not been efficient and have been compromised by a lack of information on fish populations, financial resources, and limited enforcement. Management actions in the Paraná River basin, and in Brazil as a whole, have not been properly evaluated or followed by appropriate monitoring, which explains why many unsuccessful management techniques were not abandoned or corrected sooner. Lessons learnt from the upper Paraná River are i) fishery management in reservoirs needs to give equal weight to both fish production (social reasons) and the maintenance of biodiversity; ii) management actions must be focused on the integrity of the critical areas upstream of the reservoir, including the flood regime; iii) no management action should be carried out without monitoring; and iv) Fisheries legislation and control requires realism and clarity of objective, efficient communication, and the involvement of fisher organizations.
Title: Floodplain Gears Of Bangladesh: A case study in the Titas River Floodplain

Key words: Titas River; Bangladesh; fishing gears

A survey was conducted in the flood plain of the River Titas, Bharamnbaria, on gears used for fishing from July 2001 to December 2001. Before survey we categorized the fishing gears into 10 types of which 35 kinds of gears were found. During survey we found 3 kinds of gill nets, 14 kinds of seine nets, 5 kinds of long line and hook, 4 kinds of spears. The mode of operation of all gill nets was more or less same. They mainly varied regarding their mesh sizes and components such as current net was made of synthetic fiber and mesh size was 0.5 inch. On the other hand, pata jal and dhun jal were made of cotton threads and their mesh sizes were 1 and 5 inches respectively. Seine nets varied widely regarding their size, components, and mesh sizes, mode of operation and catches composition. The operational method of chapila jal/chitki jal was quite different from others aided with water agitation sound production in an encircling manner. Moi, fera, and felun jal were specialized for small shrimp and prawn. The seine nets were the mostly used gears followed by gill and set bag nets but in terms of production set bag net was most productive followed by seine and gill nets. The use of set bag net was strictly restricted to the river and canal in current water. As seine and gill nets of smaller mesh sizes were mostly operated; they must affect the floodplain fisheries by capturing fishes of all sizes and ages.
Bangladesh is a riverine country that is criss-crossed by about 230 large and small rivers. The Titas is a comparatively small floodplain river situated in the district of Brahmanbaria. It is rich in fish fauna and is the main source of capture fishery for the poor fishing community. A study was conducted in the River Titas from November 2001 to June 2002 on fish aggregation device (FDA), locally known as katha (brushpiles) an important means of fishing in this river. A total of 76 katha was surveyed and weekly catch monitoring data was collected. The size of katha ranged from 0.12 to 1.17 ha with an average size of 0.35 ha. The total production from katha was estimated 750 kg/ha/year. In combined catch, more than 47% fish were Siluriformes (catfish) including Wallogo attu, Mystus cavasius, M. gulio and M. vittatus followed by Perciformes 18.5% (Chanda nama, C. baculis and Anabas testudineus) and Cypriniformes 3.2% (Puntius sophore, P. sarana, Labeo rohita and L. gonia). Small and large prawn contributed more than 16% of total production.
Title: Estimating the benefits of water quality improvement of the Buriganga River

Key words: Buriganga River, contingent valuation, decision-making process

The contingent valuation method (CVM) has long been used to estimate the value of non-market goods and services. The CVM, a survey based value elicitation process for both use and non-use (passive use) values, asks respondents the maximum amount of money they are willing to pay (WTP) for an environmental improvement or whether they are willing to accept (WTA) in compensation to forgo the given environmental improvement. The paper examines the applicability of the application of CVM in Bangladesh. The results from a face-to-face survey conducted in 2001 to estimate the total economic values of cleanup of a dying river named Buriganga in Dhaka City shows outcomes which are not only contrary to the conventional wisdom, but also adds a new dimension to the application of the CVM in the developing country context. The major findings of this investigation include that not only are a significant proportion of the respondents willing to pay for water quality improvements, but they are also willing to contribute in non-monetary ways. When this contribution is monetised, it is estimated to be about 60.55% of the total WTP value in 2001. The development and restoration benefits of cleanup of the Buriganga River are estimated to be about US$ 7 million in a year in 2001. Thus, failure to consider such benefits in the decision-making calculus could lead to gross under-estimation of the contribution of undertaking such environmental improvement activities. Besides, the paper outlines a macro framework for cleanup of the Buriganga River considering both point and non-point sources pollution, institutional, legal, regulatory and non-regulatory issues.
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Title: Commercial fishing sector in the regional economy of the Brazilian Amazon

Key words: Amazon; South America; economics; commercial fisheries

The purpose of this study is to determine the magnitude of the fisheries sector along the Amazon River in Brazil. Total income and employment for the fisheries sector was estimated for the principal activities comprising the sector: fish processing plants, stores selling fishing gear, gas stations, restaurants, ice factories, and boatyards based on interviews conducted with businesses in 15 cities along the Amazon River. The number of fishermen, boats and total catch were estimated based on data from the Brazilian Coast Guard, Municipal Fishermen’s Unions, and fish landings in 8 cities. Results show that the fisheries sector generates R$472 million yr⁻¹ and 87,332 jobs. Most of the income and jobs were generated by the fishing activity (subsistence and commercial). It was also estimated that 5,457 fishing boats, 37,377 commercial fishermen and 87,257 tons landed along the Amazon River.
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Title: Spatial and temporal pattern of the population structure and current state of fishing exploitation of the dourada (Brachyplatystoma flavicans, Lichtenstein, 1819) along the estuary-Amazonas-Solimões system.

Key words: Amazon, South America; migration, population dynamics; Brachyplatystoma flavicans

Among the 14 species of catfishes (Siluriforms) that are explored commercially in the Amazon basin (30,000 t/year), the dourada (Brachyplatystoma flavicans) is the most caught species, representing 20% of the total marketed. From July to December, 1999 data sample was performed (n=5474) in the main landing places of catfishes along the Amazonas river: Estuary, Santarém, Manaus and Tefé in Brazil, Leticia in Colombia and Iquitos in Peru, to verify the spatial and temporal pattern of the population structure and the current state of the fishing exploration of the dourada along the system Estuary-Amazonas-Solimões. The age was determined using lapillus otoliths sampled between jul/98-jun/99. The method of Morita-Matsuishi was selected to size back-calculation and used to define its growth parameters. The growth parameters were estimated through the Method of Maximum Likelihood (MSV). The mean length was 75.76 cm (± 17.70) for the total, 74.50 cm (±17.29) for females and 67.63 cm (±14.22) for males. The commercial fishing explores all the classes of lengths known of the species, except the smallest of 20 cm. The dourada form two growth marks along a hydrological period. One in the end of the river lowering / beginning of the drought (October-November) coinciding with the migration related to the fishing season and other in the rising of the waters (February-March) during the period of migration to reproductive or feeding purposes. The commercial fishing that acts along the axis explores the dourada with two years of age group intensely, when it would be entering in the spawning stock. Through the migratory dynamics, the dourada optimizes the available resources along the system synchronizing the large movements, more 3000 km along the Amazon-Solimões system with the hydrological cycle of sequential way (larger fish moving first) and cyclical (seasonal use of the growth areas, feeding and reproduction).
Title: Testing the effectiveness of stock-enhancement in the Amazon floodplain to increase Colossoma yield

Key words: Amazon; South America; Stocking, Colossoma

Colossoma macropomum was one of the most important species in the Central Amazon fisheries but its yield has dropped to a quarter of the early 70s values. Stock enhancement tends to reduce genetic variability and, perhaps, increase parasite loads in wild populations. This technique has been used for increasing fish production in Brazilian reservoirs since the early 60s. Recently, this option is being considered to manage Colossoma populations. This study was, which aimed at testing the effectiveness of stock enhancement in Amazon floodplain lakes, indicated that a mean of 98 stocked juveniles were needed to produce one six months old fish. There was no increase in parasite abundance, but stocked fish could be easily identified in the lakes by their genetic markers. Despite an increase in abundance stock enhancement does not seem to be an economically feasible technique for managing Colossoma in floodplain lakes. Seed price is 0.06 reais/unity and market price of 300g fish is 0.9 reais (3 reais/kg), so the break-even production is of approximately 15 seed for producing 1 six month old fish.

Paper withdrawn but permission given to include abstract
The Narmada R. supports a variety of people ranging from the relatively autonomous adivasi (tribal) settlements in the forests to non-tribal rural populations. The idea of damming the Narmada was discussed as far back as the late 19th century and the project has been mired in controversy from its inception. The Narmada Valley Development Plan (NVDP) appeared in the late 1980s as an ambitious plan that envisages the building of 30 big dams, 135 medium dams and 3000 small dams on the Narmada & its tributaries. Seven big dams have already been completed and six are under construction. Construction of dams in Narmada Valley is associated with environmental degradation in the respective river basins coupled with human displacement. The Tawa dam was built on the Tawa river, a tributary of Narmada, in 1973 causing the flooding of 44 villages inhabited by adivasis. The affected people organized through a forum called Kisan Adivasi Sangathan and insisted on their rights of access to Tawa reservoir for fish rearing. In 1996 the people formed fishing cooperatives and constituted a federation, which succeeded in getting a 5 years lease of the Tawa reservoir from the provincial government of Madhya Pradesh. This lease has now been extended to 10 years. Under the earlier arrangement the Madhya Pradesh State Fishing Corporation, used to auction fishing rights to contractors leading to conflict. Since the take over by TMS in 1996 fish production of the reservoir increased three fold, the number of fishermen tripled, and the incomes of fishermen increased seven times. Management is completely participatory. Every fisher family is the member of fish cooperative called Primary Fish Cooperative Society (PFCS). Once the displaced people learnt to fish they soon became expert. Not only have the displaced peoples been rehabilitated through sustainable management of living aquatic resources, but the wetlands and their biodiversity have also been conserved.
Title: Organization and maintenance of fish diversity in shallow waters of tropical floodplain rivers

Key words: Orinoco; South America; fish diversity; invertebrates; community structure

Large Neotropical floodplain rivers harbor a disproportionately large fraction of the global diversity of freshwater fishes, yet they are poorly understood. As a starting point, we set out to characterize patterns of local assembly of fishes and macroinvertebrates among habitats of varying structural complexity through an annual flood cycle in such a river in the southern llanos of Venezuela. We collected 268 standardized seine samples that contained 54,596 individual fishes representing 156 species, and 6,973 macroinvertebrates representing 8 families. Local aquatic communities were structured in a predictable manner at multiple spatial scales; however, seasonal water level fluctuations increased variability among local communities. These results suggest that tropical river communities are continually disassembled and reassembled in a somewhat deterministic manner as the aquatic-terrestrial interface moves across the landscape. Unexplained variation in community structure appears due to unsaturated local communities (e.g., in recently formed patches or patches with low colonization rates). Interactions among seasonal hydrology, variability in habitat structural complexity, and landscape heterogeneity appear to maintain high aquatic species richness in these lowland rivers. It appears that alteration of seasonal water level fluctuation (e.g., damming) likely would have substantial and negative consequences on the maintenance of regional biodiversity pools in Neotropical floodplain rivers.
Title: Environmental Flows for Rivers: Ecological Importance, Methods and Future Challenges

Key words: Environmental flows methods, fish, rivers

Worldwide there is growing awareness of the pivotal role of the flow regime (hydrology) as a key ‘driver’ of the ecology of rivers and their associated floodplain wetlands. Ecological processes related to flow and other factors govern the ecosystem services that rivers provide to humans, such as flood absorption, water purification, production of fish and fibres. Protecting and restoring river flow regimes by providing environmental flows has become a major aspect of river basin management. Over 200 methods for determining environmental flows now exist and they are used in 50 countries worldwide. Most methodologies currently used in Australia and southern Africa (and increasingly in other countries) are holistic in their scope, recognising that it is necessary to provide for aquatic ecosystems in their entirety. This paper provides a brief history of the development of environmental flow methods and identifies key features common to ecosystem or holistic methodologies. On the basis of this overview we address two vital questions – which flows are important and what quantities and temporal patterns of flow are needed to sustain river ecosystems and their fish and fisheries? Knowledge gaps, research priorities and opportunities are discussed in terms of our capacity to predict the ecological consequences of change in river flow regimes, and managing large rivers for both biodiversity conservation and sustainable human use.
Management of spawn fishery of major carps (*catla catla*, *labeo rohita* and *cirrhinus mrigala*) in the Halda River, Bangladesh

**Key words**: Halda River; Bangladesh; fry fishery; fry rearing

The River Halda is the major natural spawning ground of major carps (*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala*) in Bangladesh. Eggs of major carps are collected and hatched in mud-pits on the riverbank. The present investigation was conducted during the April-June 2002 spawning season of major carps and deals with the development of a better hatching technology to reduce high manual labour, mass mortality of eggs and hatchlings. Six incubation systems were used for hatching and subsequent rearing of hatchlings up to five days age with river and pond water. Highly significant variations existed among different incubation systems. Hatching rate varied from 15.30% to 96.36% and maximum was in a circular plastic tank. High mortality rate in sheet incubation tanks was due to less circulation of water while in the mud-pits was due to careless traditional handling and some unfavorable ecological factors. Fry production records (1945-2002) showed that the highest collection of major carps seed was in 1946 (544,000,000 fry) and lowest in 2002 (81,212,000 fry). The price of five days old fry varied from Taka 5,000.00 per kg to Taka 12,000.00 per kg (1 US$ = Taka 55.00). A remarkable decrease in seed production was found in 2002, which might be due to man-made ecological disturbances such as the destruction of the oxbow lake spawning grounds, indiscriminate use of illegal gill nets and catch of brood fish during breeding migrations.
Title: Beyond national borders: Links between an important Mekong River medium-sized migratory carp fishery below the Khone falls in southern Laos and bag net fisheries at stream mouths in northeast Cambodia

Key words: Mekong River; Cambodia; fish migrations; gill net fishery

Many different types of fish migrate up and down the Mekong River, as well as back and forth between the Mekong and her tributaries. These migrations allow the fish to adapt and flourish within a river system that is characterized by extreme seasonal flow variations. However, despite the importance of migrating fish to people living throughout the Mekong Basin, little is known about the nature of these migrations, or the fisheries that have developed to exploit them. Even less is known about whether there have been changes in fish stocks or migration patterns in response to such factors as habitat degradation or increases in fishing activity. This paper summarizes the results of a six-year fisheries catch-effort data collection program from between 1993/1994 and 1998/1999 regarding the artisanal dry season 4-9 cm meshed mono-filament set gill net fishery at Hang Khone Village, an important fishing community situated on an island in the middle of the Mekong River just below the Khone Falls in Southern Laos. This fishery largely targets important medium-sized migratory cyprinid carps, including Mekongina erythrospila, Scaphognathops bandanensis, Labeo erythropterus, Bangana behri, Hypsibarbus malcolmi and Cirrhinus molitorella. Apart from reporting on the nature of medium-sized cyprinid dry season gill fishery below the Khone Falls, the suspected migratory patterns of the main species caught in the fishery are described, based on years of observations and reports from fishers living in southern Laos and northeast Cambodia. Finally, it is hypothesized that changes in annual catches of the different medium-sized cyprinid species caught at the Khone Falls are associated with the operation of bag net fisheries at the mouths of streams in northeast Cambodia. It is proposed that the management of these straddling fish stocks, which seasonally migrate between the Mekong River in Cambodia and Laos and the Sekong, Se San and Sre Pok Rivers in northeast Cambodia and southern Laos, needs to be addressed through the cooperative efforts of both countries, since the habitat used by the fish transcends national borders. Preliminary evidence is provided that indicates that changes in fishing activities in one country have already resulted in changes in fish catches in the other.
Title: The complex estuarine formation of six rivers (Cochin Backwater System on West Coast of India) - Distribution of Trace Metals and Nutrients

Key words: India; coastal lagoons; pollution

The Cochin Backwaters is the largest lagoon system on the western coast of India. Sixteen major industries discharge organic wastes into the system. The Backwaters receive freshwater from 6 rivers, the Periyar River contributing 33% of river discharge as well as a substantial portion of the fertilizer load. The hydrodynamic features of the estuary play the major role in controlling the water quality and pollution of the estuarine system. Trace metals in estuarine sediment show a post - monsoon enrichment of Zn, Pb, Cu and in the northern and southern limbs of the estuary. Dissolved iron has an opposite trend to that of the sediments. The strong influence of fresh water modifies the sediment to leach out chromium as inferred from low values at the bar mouth. The entire region is enriched with manganese with the lowest values around the bar mouth. High values of Zinc were noted in the east channel and low levels at the bar mouth. Nearly 80 tons of Zinc seems to have accumulated in the water body. There was significant enrichment with copper within the sediment and the biological control of copper are quite. The distribution of nickel and cobalt were similar with a low concentration of Ni indicating the absence of pollution. Metal association in Cochin backwater is probably not taking place according to textural characteristics. Apart from organic association, inorganic precipitation initiated through iron complexes seems to replicate geochemistry of sediments in the backwater. Significant correlation of iron with other metals (except Mn) indicates that elemental accumulation in sediments may be controlled by precipitation of iron on to organic matrix. The significant correlation between metals (except Mn) shows a common source of metals. The absence of correlation with Mn may be due to its sedimentary origin. Natural processes control the distribution of most metals, while Zn is influenced more by anthropogenic input. The interaction of organic carbon and clay with other elements seems to be a main factor differentiating the trace metal distribution in estuarine and coastal sediments. Cochin bar mouth and harbor region is not enriched in metals to greater levels. Strong negative correlation between salinity and nutrients within the estuary indicate that nutrient levels are controlled by upstream discharge. The estuary acts as sink for silicate during neap tide. The nutrients NO3 and PO4 were present at very low levels up to mid 60s and the levels had increased during 80's. A build up of N & P after 1975 was observed in the backwater and from 1980 onwards, the concentration remained high. The enhancement of nutrient levels has not led to any oxygen depletion. It is concluded that the estuary is acting as a sink for nutrients. Associated with the diminishing of flushing rate, a nutrient build up is taking place for the backwater system.
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Title:  A model of environmental factors driving fish production in the lower Mekong basin

Key words: Mekong River; Tonle Sap; modelling; Bayesian networks; water level variations

In tropical floodplain systems local populations are generally highly dependent upon the system’s natural aquatic resources. In such systems the annual fish production depends on a combination of biological and physical parameters, principally 1) hydrological factors; 2) environmental factors and 3) fish migrations. Developing management plans is complicated as assessing the role of each factor is usually made difficult by their diversity, their interactions or feed-back loops, and by the frequent absence of data on certain factors. We present here a tool developed to overcome these difficulties with the aim of facilitating the management of large tropical rivers.

Despite the absence of adequate regional or national statistics and comprehensive time series data, a review of existing studies has allowed, the identification of ten factors driving the fish production in the Mekong River Basin. They are 1) hydrological factors: water level, flood duration; flood timing, flooding regularity; 2) floodplain factors: bank types, flooded zone land cover, dry season refuges, bank types, turbidity; 3) biological factors: longitudinal or lateral migrations. This assessment provided the framework for the production of a model integrating the driving environmental parameters and their interactions. Fishing, that also influences fish production, is not yet part of this model focussing on hydrological and ecological factors. The model is based on Bayesian networks. The above variables are interconnected in a logical fashion and related to fish production with the connections being expressed in terms of probabilities. The model calculates conditional probabilities at each level and the overall trend resulting from the sum of interactions within the system. When quantitative information is not available, probabilities are based on local knowledge drawn from experienced biologists and fishers.

This model was developed for three groups of fishes (black fishes, white fishes and opportunists) and three geographic sectors (Upper Mekong, Tonle Sap system and Mekong Delta). The natural production that can be expected for each fish group in each sector is qualitatively expressed by a percentage between “Bad” and “Good”. This result could have been converted into tonnes of fish had statistical time series been available. The model is transparent and user-friendly. Variables having the strongest influence on fish production are identified and each variable can be easily varied to assess the consequences of various management options on fish production.
Title: Fish migration in large rivers: From phenomenology to functional mechanisms and selection pressures, and their importance in fisheries management

Key words: Migration

Migration has evolved as an adaptive response to natural variations of environmental conditions on a daily, seasonal and multi-annual basis and has been selected predominantly wherever the hazards brought about by long journeys within river systems or between marine and fresh waters exceed or equal the benefits of residency. Migration is also important for energy transfer between biomes and ecosystems, and it can play a role in maintaining populations of piscivorous resident species. Biomes visited during the life cycle and distance travelled are traditionally viewed as the essential characteristics of fish migration, and they have resulted in categorisation of fish species into holobiotic versus diadromous species, and into short-range versus long-range migrants. However, in circumstances where restoring connectivity within damaged catchments has been instituted, short-range holobiotic migrants have frequently been overlooked. Additionally, a single species of fish may move over short distances in a particular environment and over much longer distances in another, depending on environmental characteristics. Viewing fish migrations in terms of distance only is thus oversimplistic. In order to be operational and efficient, a migratory strategy must fulfil other criteria. Migrants must respond to the right cues, they must travel at the right pace and arrive within a certain time at their destination. Embryos, larvae and juveniles must find appropriate shelter and feeding grounds in order to reach the cut-off size at which they have a high probability of surviving environmental hazards, especially predation, upon their return in the main river channel. As a corollary, climatic or man-made changes of the environment that may force the fish strategy to move away from its ideal path, either spatially or temporally, are likely to compromise the migratory strategy, to an extent, which largely depends on the intensity and recurrence of the perturbation, and on the adaptability of the species. Not all species are equally adaptive, depending on how intense have been the selection pressures upon the respective values of the 'migratory' and 'resident' strategies. Here, we provide an overview of fish migration in different river systems and geographical regions, of how mechanisms and selection pressures vary between taxa and climates, and of how biodiversity and fisheries can be affected by past, present and forthcoming changes in climate, river hydrology and aquatic habitats. The emphasis is also laid on gaps in knowledge and on how to bridge these through the implementation of appropriate education, research and management tools. The development of an integrated river - and fish / fisheries - management strategy is certainly a key to sustainable development, and understanding the significance of fish migration is an obligate component of this strategy.

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Loss of habitat due to siltation, dam construction and other anthropogenic activities has been one of the primary causes of species loss in the Mekong by reducing water flow and water depth, and impairing the capacity of riverine fishes to feed, navigate and spawn. Construction of embankments for flood control and dams interferes directly or indirectly with fish migration, reproduction and ultimately survival of the species. While long term and effective measures are being sought, more effective and immediate measures are needed to protect and conserve threatened and endangered species. Aquaculture and release of fry into natural water bodies also contribute to indigenous species degradation. The decades long practice of stocking exotic and indigenous carp seed in the river and associated reservoirs make it difficult to determine the negative impact resulting from inbreeding. Indigenous species in the wild are contaminated to a level where it has become difficult to compare performance against hatchery stock. While little can be done to bring back the lost species of the Mekong, there are many freshwater species that are endangered or near extinction needing immediate measures for their protection and conservation. Establishment of an in-situ gene banks (live and/or cryogenic), in the immediate term, would ensure the maintenance of genetically pure stocks of fish while buying us the time necessary to improve habitat conditions for restocking. In situ conservation is costly requiring a great deal of time and resources. Live gene banks for fish are also costly, requiring purpose built facilities, and being labour intensive are difficult to manage. There are fewer constraints to the establishment of long-term ex situ frozen gene banks, which are thought to ideally complement habitat conservation and in situ gene banks. There are several examples of cryogenic sperm banks for fish in Europe, North and South America. They are comparatively less costly than live gene banks although some initial investment for equipment, maintenance and collection is required. Cryogenic gene banking avoids the risk of contamination, requires little space and minimal facilities. The Asian Institute of Technology (AIT) has started to understand the population structure of some important Mekong catfishes using molecular techniques and plans to start cryogenic genebanking for a limited number of important riverine species.
Fishery resources are important generators of income and food for the rural people of Amazonas State and as food for low-income urban people in the city of Manaus and smaller towns in the region. The present paper investigates which fishing and environmental variables determine the fisheries production landed in Manaus, and evaluates the relative abundance of commercial fishes in the different sub-systems of the Amazon basin. Data collectors specifically trained for the purpose registered key information on the fisheries. This information was used to test new catch indexes derived from multiple regressions with the following significant variables: number of fisherman-days fishing; distance of the fishing ground from Manaus; amount of ice carried during the fishing trip; and river level. There were no significant differences between mean catch values of the Purus, Madeira and Juruá sub-systems. These results suggest that the right bank tributaries were very similar and were the most productive in terms of commercial fishes. The Negro River and the Low-Solimões sub-systems had the lowest fish production. The Negro River has a low productivity due to its environmental characteristics and the Lower-Solimões sub-system probably has a low abundance due to higher concentrations of fishing effort near Manaus. The actual fisheries production varies according to the recent magnitude of fishing effort, environmental variations, and operational aspects of the fishing particularly ice consumption. The current open access regime of fishing already affects some species in the area, particularly the tambaqui (Colossoma macropomum), and is affecting total production in some areas, particularly in the Lower-Solimões. The results suggest that the methods of harvesting are having negative impacts on the productivity of resources in the area.
Title: Abundance, distribution and conservation status of the Irrawaddy Dolphin that inhabits the Mekong River

Key words: Mekong, Freshwater dolphins; conservation

The first dedicated research project investigating the entire Mekong River Irrawaddy Dolphin population was initiated in 2001, in collaboration with the Wildlife Conservation Society and the Cambodian Department of Fisheries. The project consists of boat and interview surveys in the upper reaches of the Cambodian Mekong River and initiation of a stranding and recovery program to establish mortality rates and causes. This research indicates that the Cambodian Mekong River Irrawaddy Dolphin (Orcaella brevirostris) population is small (with the total population possibly as low as 150 individuals) and potentially restricted in range (at least during the dry season) to the upper 190 km from Kratie to the Lao/Cambodian border. Four dedicated surveys have been conducted over this stretch of river (a total of 914 km of survey effort during 82.4 hours). Although a number of threats have been identified, by-catch in local gillnet fisheries appears to be the most significant current threat to the population’s survival. The results of this research have provided baseline data for future research and conservation efforts on the Irrawaddy dolphin population that inhabits the Mekong River. Effective conservation and management strategies will be developed and undertaken in collaboration with local government departments and through community-based consultation and management programs.
Title: Contribution of inland fisheries to rural livelihoods in Africa: Empirical evidence from the Lake Chad basin areas

Key words: Lake Chad; livelihoods

Within the very arid and difficult environment of the Sahelian region, Lake Chad and its associated riverine system have always played an extremely important role in the livelihoods of the thousands of people living in the Basin. However, due to the remoteness of the region the whole Basin is suffering an important information deficit and it is currently difficult to make accurate and up-to-date assessments of the economic (in particular inland fisheries) activities taking place within the area. The objective of this paper is to improve our knowledge and understanding of the rural livelihoods of the populations of the Basin and in particular, to assess the exact contribution of the fishing activities to the livelihoods of these communities. For this purpose, a detailed socio-economic multi-activity survey was carried out, including a participatory poverty assessment, in the three major fishing regions of the Basin (the delta of the Chari river, the Yaérés floodplain and the western shore of the Lake). The survey was completed by a series of comparative analyses of the accessibility to fishing grounds and fishing gear ownership across the different socio-economic strata of the populations. Through the detailed description of the seasonal patterns of activities, the survey shows that for the entire area, households, disregarding their wealth level, still rely to a very large extent on subsistence economy where the three major activities (fishing, farming and herding) are closely integrated. With respect to the fishing activity the survey demonstrates the central role of this activity for all wealth groups. The participatory wealth ranking exercise also reveals to what extent the communities themselves perceive ownership of fishing gears as one of the primary signs of wealth. This result is strong evidence that fishing has becomes a key-element of the wealth differentiation process in the area. This result is corroborated by the analysis of fishing ground accessibility which reveals that in some part of the Basin, only the wealthiest households have access to the whole range of water-bodies available, while the poorest households are marginalized or even excluded from these water-bodies. In other part of the Basin, in contrast, fishing activities appear to play a major role as safety-net for the poorest households. It seems therefore that there is no one-to-one relationship between the contribution of fishing activity and the wealth (or poverty) level of the households and that the well-known adage “fishermen are the poorest of the poor” does not reflect the complexity of the empirical situation observed (at least) in the Lake Chad Basin.
Title: Traditional management systems of Inland African fisheries: The case of the Lake Chad Basin’s riverine and floodplain fisheries

Key words: Lake Chad; traditional management; access; methodology

Although there exists a rich literature on fisheries traditional management systems in many parts of the world, much less information is available on African inland fisheries. The objective of this article is twofold. First to present the first regional-scale analysis of the traditional management systems operated within the Lake Chad Basin region (Sub-Saharan Africa). Second, to interpret these results using some of the concepts and frameworks developed in “Institutions and Property Rights” theory - also referred as Common Property Resources (CPR) theory. For this, 64 villages were surveyed in the three major fishing areas around the Lake Basin (the delta of the Chari river, the Yaéré floodplain and the western shore of the Lake), using methods derived from Rapid Rural Appraisal techniques. The survey, organized in semi-structured interviews, relied on a typology to distinguish three types of management systems (traditional, modern, and mixed systems). Through this typology, specific attention was given to the status and organization of the local (de facto) management system and its interaction with the modern (de jure) management system. In particular, information regarding the following aspects was collected and analyzed: operational rules (such as gear restrictions and other fishing regulations), access restriction and fees payment, conflict resolution and sanctions system, level of compliance. The results show that fishing activities within the whole Basin are still largely under the influence of the traditional management system where access to the exploited fishing grounds is limited to a well-defined user group. This user-group obeys specified operational rules defined through customs and management decisions based on local knowledge. Local authorities, such as village heads, usually enforce these rules. The prevalence of these traditional systems means that a very large portion of the fishing grounds are de facto under access regulation and that, contrarily to what is sometimes assumed or asserted for developing countries, open access fishing grounds are very rarely encountered in the Basin. A more detailed analysis shows that the few de facto open-access zones are in fact areas that traditional authorities have never entirely controlled, such as the open waters of the Lake Chad itself or water-bodies that they have had to “give up” in recent times due to the presence of armed groups. Further investigations reveal that these particular ‘open’ zones are in fact areas where illegal parallel taxation systems operated by non-legitimated government agents (e.g. armed groups) have developed in recent years, essentially as a consequence of the remoteness of the area and the increasing political instability which has been affecting the whole Basin since two decades.
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Title: Conservation strategies for diadromous fishes in Loire River (France)

Key words: Loire River; France; migrations; conservation

The Loire River is the least regulated large river in. All diadromous fish species of Western Europe are present in the watershed except European sturgeon. Conservation strategies for two anadromous species, Atlantic salmon and Allis shad, are analysed in this paper. The Allis shad of the Loire and the Garonne population are the last intact populations of this species in Europe. All others have disappeared or are severely reduced because of dam building. The Atlantic salmon population of the Loire River is also one of the last populations with the genetic capital for individuals to spend 3 winters at sea and able to return to spawning grounds located 1000 km from the sea. Classified by IUCN as endangered species, the populations in France have to face both river and estuary management. Fishing is allowed in some rivers and Allis shad supports a commercial fishery especially in the estuaries. Nevertheless, the evolution of the populations differs from one large river to another, depending on population history, intensity of river channelization and environmental policy. The current status, population level and evolution, and migration pathways are presented for both species. Fisheries management, indexes of abundance derived from fisheries and fish passes, institutional policy and tools and their impact are analysed in terms of fish conservation, river management and restoration. Several management tools are used in the Loire watershed, including enhancement, fish passes, fishing regulations, the European tool for the Environment (LIFE), the diadromous fishes committee (COGEPOMI), and the freshwater management plan (SDAGE). Some specific actions for biodiversity conservation, river restoration and management were undertaken in the 1990s. One of the most efficient for these species was the destruction of two old hydroelectric dams. Allis shad do not risk extinction but their population levels are always very low. The situation of the Atlantic salmon is critical with only four hundred of individuals being recorded every year near the spawning grounds. Efforts are needed to save these fishes and to again allow sustainable sport and commercial fishing. A more integrated concept of river and fish management is needed for the basin as a whole excepting for some localised problems such as dams.
Taking independent reviews of information requirements for large river fisheries as the starting point, an analysis is made of the areas where remote sensing has a proven or potential role. Contrary to popular belief, remote sensing approaches can be very cost effective, especially as a large library of relevant images has already been obtained for many areas. Much of this can be accessed free of charge. The main requirement for sustaining, or improving, river fisheries is improved management and rehabilitation of the environment. The ability to cost-effectively obtain information on aquatic and terrestrial environments within river basins, for both resource assessment and monitoring purposes, is the most prominent and widely proven application of remote sensing in this field. Also, in areas where reliable data are lacking, the predicted status of inland fisheries can be assessed through secondary information sources. Combining remote sensing environment data with demographic data (and other secondary sources of information) in a GIS framework can yield information on the status of fisheries, dependency of people on aquatic resources and their vulnerability to environmental change – all vital planning information. This approach offers a very powerful and cost-effect tool for resources management planning and for influencing policies. Other applications of remote sensing are reviewed based upon the cost, accuracy (sensitivity) and availability of the various technologies. For most applications, cheap or even cost free data are more than adequate. More modern remote sensing approaches now offer remarkable levels of accuracy and resolution but are still cost effective for localised applications. Generally, the constraints with remote sensing are not in the technology or cost but in its application. Remote sensing specialists generally are not sensitive to the information requirements for inland fisheries in tropical river basins. Equally, many inland fisheries specialists are not fully aware of the possibilities on offer through remote sensing. Most, for example, have difficulties viewing inland fisheries in geo-spatial terms. The problems are exacerbated by the gulf in information requirements and management objectives for large rivers between the developed and developing countries leading to a mismatch of needs, capacity and expertise. Only when these gaps are bridged will the full potential of remote sensing for river fisheries in tropical developing countries be fully realised.
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Title: The present status of the River Rhine with special emphasis on fisheries development

Key words: Rhine, Restoration; population structure; international collaboration

The Rhine basin (1,320 km, 225,000 km²) is shared by nine countries (Switzerland, Italy, Liechtenstein, Austria, Germany, France, Luxembourg, Belgium and the Netherlands) with a population of about 54 million people and provides drinking water to 20 million of them. The Rhine is navigable from the North Sea up to Basel in Switzerland and is one of the most important international waterways in the world. Floodplains were reclaimed as early as the Middle Ages, and in the 18th and 19th century the bed of the Rhine had been subjected to drastic changes to improve navigation as well as the discharge of water, ice and sediment. After 1945 until the early 1970s water pollution due to domestic and industrial wastewater increased dramatically. Since then many measures have been taken by the riparian states and communities, and by industry to reduce nutrients and pollutants. The total phosphorus inputs were reduced by 65% compared to 1985 the nitrogen inputs only declined by 26%.

Due to the improvement of the water quality the number and abundance of the majority of fish species has increased, and the Atlantic salmon, Salmo salar, which was formerly extinct, not only occurs in some tributaries but also reproduces naturally. In total over 60 species are present in the river basin. Of its indigenous ichthyofauna of 44 species only Atlantic sturgeon, Acipenser sturio, has not been observed with certainty during the last decade. Most species other than the migratory species are self-sustainable, but the overall species composition is skewed towards a few ubiquitous ones, such as roach Rutilus rutilus, and bream Abramis brama. 20 exotic species are present but nowhere dominate the fish community. New species (e.g. Abramis sapa, Proterorhinus marmoratus) now appear more frequently through the Rhine-Main-Danube canal that connects the Rhine with the Danube basin. The commercial fishery is based mainly on eel Anguilla anguilla, and pikeperch Stizostedion lucioperca. Exploitation on migratory fish species is not remunerative or in the case of salmonids completely banned. However, there is a flourishing recreational fishery. The "Salmon 2000 Programme" started by the "Rhine Ministers of Environment" under the coordination of the International Commission for the Protection of the Rhine (ICPR) has now been integrated in the Programme on the sustainable development of the River Rhine "Rhine 2020" whose main targets are in ecology restoration, flood prevention and groundwater protection. Possibilities for the restoration of the River Rhine are limited by the multipurpose use of the river for shipping, hydropower, drinking water and agriculture. Bottlenecks hampering further recovery are the numerous hydropower stations that interfere with downstream fish migration, the poor habitat diversity, the lack of lateral connectivity between main channel and floodplains and the cumulative unknown effects of thousands of synthesised components.

This paper describes the different national and international programmes for the restoration of the River Rhine and its tributaries and measures for the reintroduction of the Atlantic salmon (e.g. stocking, habitat enhancement, construction of fish passages). The salmon has fulfilled a flagship role for a general improvement of the Rhine. The most significant positive recent development is the EU Water Framework Directive: EU member states are required to compile river basin management plans and rivers should have a good ecological status by 2015.
Title: Biodiversity conservation in the Garonne river (France): Importance of side-arm channels and floodplain areas

Key words: Garonne River; France; habitat selection; side-arms

Floodplains and side-arm channels connected to the main stream contribute greatly to the welfare and the conservation of aquatic ecosystems, in that they provide spawning and nursery areas. Our study was based on a section of approximately 100 kilometres of the Garonne River located downstream from Toulouse. Five stations were chosen and sampled in winter, spring and summer in order to study the spatio-temporal assemblages of the fish community. For each sampling period, the point abundance sampling method (PAS) by electrofishing was used and several environmental variables were measured so as to determine the preferential habitat of the main species and then define the assemblages and the interactions between species. We noticed a higher diversity and density of fish in side-arm channels than in the main stream. These zones constitute either a refuge habitat against current velocity during winter waterflood or nursery areas during spring and summer. Results led us to discuss the importance of connected side-arm channels and their role in the sustainability of the fish biodiversity of large rivers. Side-arm channels also influence the community structure both directly through immigration, depending on the degree of connectivity to the river and indirectly via food supply.

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Title: Restoration Of The Fisheries Of The Susquehanna And Delaware Rivers, USA

Key words: Delaware River; Susquehanna River; anadromous fish; fishways

The Delaware and Susquehanna Rivers are the two large rivers of the Middle Atlantic Region of the United States. The Delaware is 530 km long and drains 35066 km$^2$ of land. The Susquehanna is 710 km long and drains over 71,000 km$^2$ of land. The Susquehanna provides about half of the freshwater input into the Chesapeake Bay. Historically, both of these river systems supported large runs of anadromous fish species. In the late 1800’s to early 1900’s Delaware River had the greatest landings of American shad $Alosa sapidissima$ and Atlantic sturgeon $Acipenser oxyrhyncus$ in the U.S. The Susquehanna also supported enormous shad runs. However, the migratory fish populations of both of these river systems began to decline in the early 1900’s, as a result of overfishing, pollution and habitat loss. In the Delaware, the discharge of domestic wastes into the river led to very low dissolved levels in the river. The low dissolved oxygen concentration blocked the migration of anadromous fish on the river. The construction of secondary sewage treatment plants in the 1970’s and 1980’s led to dramatic improvements in water quality. The oxygen block has disappeared. The improvements in water quality, stricter fishery harvest regulations and the construction of fishways on tributaries of the river have led to the recovery of fish populations. American shad have recovered and appear to have reached a stable population size, albeit much lower than historical levels. Striped bass $Morone saxatilis$ have recovered fully. Atlantic sturgeon populations are still very depressed, although a moratorium on harvest currently in place should aid in recovery. The Susquehanna shad population was extirpated due to the construction of four large hydroelectric dams in the lower 90 km during 1904-1931. The construction of fishways on the four dams was the catalyst for the re-establishment of the American shad runs Shad re-introduction and project evaluation activities have been undertaken over a three-decade period by numerous state, federal, and utility company partners. These activities included the culture and release of over 150 million marked larval and fingerling shad, and trap and transport of over 200,000 pre-spawned adults to suitable spawning waters above blockages. The shad population returning to the lowermost dam on the Susquehanna grew from only a few hundred to over 200,000 fish in the past 17 years.

Paper withdrawn but permission given to include abstract
Central Africa’s tropical rainforests and their associated biodiversity are being destroyed at a rate of 1 million ha/year by poorly regulated timber exploitation and slash & burn agriculture. An important component of the rainforest is the river that drains it. Although very little studied and poorly understood, these rivers drain millions of square kilometres and have been estimated to contain at least 500 fish species, of which a large percentage may be endemic. In the process of deforestation, these are being destroyed along with the trees and other wildlife.

The rainforest rivers in what is known as the Lower Guinean Ichthyological Province of Southern Cameroon, Continental Equatorial Guinea, Gabon and the People’s Republic of the Congo posses different species from those of the Sudan-Nilotic province to the north and the Congo province to the East and South. The ichthyofauna of these rivers is dominated by the Siluriformes (6 families, 23 genera, 102 species), the Characiformes (2 families, 20 genera, 62 species), the Cichlidae (17 genera, 54 species) the Cyprinidae (10 genera, 79 species) and the Mormyridae (14 genera, 49 species). Among these are a large number of ornamentals, many of which are rare and unusual, fetching high prices in Europe and North America.

The 20 million people who live in the forests of Central Africa depend heavily upon the integrity of the river ecosystem for their livelihoods. Estimates from Cameroon put the productivity of capture fisheries in forest rivers basins at 1.1 tons/km²/yr. At the basin level, this translates into a cash value of over $82.4 million per year, more than twice the value of all other non-timber forest products combined. Unfortunately, increasing population and poverty, coupled with false valuations of rainforest biodiversity, have led to unregulated logging, habitat destruction and over-exploitation. In addition, fishing rainforest rivers increasingly involves the use of poisons that are highly destructive of the entire foodweb. New and diverse natural resource management and exploitation strategies are needed to add value to rainforest river ecosystems to justify their preservation and improve the livelihoods of rainforest communities.
Aquaculture development in the Lao PDR has had a relatively short history beginning in the 1950’s and 60’s. Much of the subsequent effort given to small-scale rural aquaculture has been of increase food security and income to a predominantly rural population. In comparison very few projects in the country have focused on the management of the wild capture fishery, a resource of immense importance for the majority of communities and also a resource increasingly under threat from the expansion of large and small scale water development projects. A postgraduate research project conducted in Savannakhet province found that aquaculture is generally not an activity of the poor nor does the presence of aquaculture in a community necessarily have any flow on benefits to poorer households. In comparison wild capture fisheries are of greater importance both as a source of income and nutrition. The adoption of aquaculture was more influenced by environmental and socio-cultural factors than any need for income generation or nutrition. All communities in the study reported that their fishery had declined due to various environmental changes caused by flooding, water diversion projects, disease, and population pressure. The only management systems found were restrictions on fishing seasons and gear type in small water bodies. Water resources with greater importance to the community had few or no community management systems in place. However, all external aquatic resource intervention in these villages focused on the development and extension of aquaculture often at the behest of the community. There is a contrast between farmer orientation to production and a lack of understanding of the potential impacts of a lost fishery resource. The government and development institutions alike have focused on the production of fish for income and nutrition where, in communities with viable fish stocks, the immediate aims of aquaculture appear to be more oriented toward social and cultural benefits. The end result is that the wild capture fishery resource remains relatively ignored both within the policy arena and in practice. It is recommended that more research and development be put into the development of community awareness and locally based co-management fisheries management. This is especially important in agrarian societies such as the Lao PDR. It is also recommended that more attention be placed on framing of aquatic resources management and development in both the plans of action of governmental and non-governmental organisations.
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**Title:** Spawning migrations of characiform fishes in relation to water quality in rivers of the Amazon

**Key words:** Amazon; South America; Migration; larval drift

The Amazon fishery is mainly based on migratory species. Basic information on the management of this resource, such as migration patterns, spawning sites and nursery grounds, is lacking or incomplete in most of the basin. A group of medium to large sized characiforms (genera *Semaprochilodus, Prochilodus, Brycon, Mylossoma, Colossoma, Anodus, Triportheus*), that have wide distribution on the floodplains of the Amazon/Solimões and its tributaries descend nutrient poor clear and black water rivers, to spawn in nutrient rich, white water rivers.

This work aimed to determining whether this migration pattern is repeated for other large rivers in the Amazon, taking the occurrence of drifting larvae in the river and the presence of juveniles on the littoral vegetation of the floodplain, as evidence of spawning activity. Nine rivers represented white-water (Madeira, Juruá, Purus), clear-water (Tapajós, Trombetas, Nhamundá) and black-water (Negro, Urubu, Tefé) systems. All rivers were sampled during rising water, which is the spawning season for these species. *Mylossoma aureum, M. duriventre, Colossoma macropomum, Anodus elongatus, Triportheus elongatus, Brycon cephalus, Semaprochilodus spp* and *Prochilodus nigricans* only spawned in white-water rivers. Other species of Hemiodontidae, Prochilodontidae, *Triportheus* and *Brycon* spawned in clear and black water rivers. Total larval abundance was positively correlated with total suspended solids in water. Juvenile characiform assemblages in white water rivers were similar and dominated by large sized species, while in black and clear water rivers, fish assemblages were less similar and dominated by small sized species. This work strongly supports the hypothesis that white water rivers function as spawning grounds and their floodplains as nursery grounds for migratory characiforms. This implies that white water rivers are foci of dispersion for these species. The abundance of these species may be a consequence of their migrating towards nutrient rich habitats in order to spawn.
Title: The political ecology of the local fishing management in the lower Amazon

Key words: Amazon; Fishing accords; policy; conservation

The debate on the role of local management systems in the conservation of fishing resources swings between two opposite views. One assumes that overuse is a logical outcome of the endogenous process of individual, short-term optimization of resource use. Policy recommendations focus on establishment of conservation units with no human use, and top-down measures of restrictive use and monitoring. The other assumes that overuse is result of exogenous processes (e.g., population growth, technological introduction, market development, inappropriate policy decisions), which have weakened efficient, enduring local management systems based on group ethics, traditional knowledge, and kinship. Policy recommendations lay mostly on lowering external influences and strengthening local power in order to revive the previous systems. Recent studies have shown that both approaches can be misleading. They call for a focus on how local and external factors influence the structure of incentives driving resource use decisions at different scales should be the analytical core of potential and limitations of these local institutions. Fishing accords emerged to help riparian residents maintain control of local floodplain lakes. They have spread over the Basin as part of a regional process; yet, its performance has varied across communities according to local social and ecological factors. This study analyzes the processes of emergence, maintenance and erosion of the fishing accords by applying a theoretical framework that combines incentives at three levels: perception of scarcity (at the individual level), ability to organize (at the community level) and minimum legal support (at the regional level). The main goal is to understand the interplay between local and external factors in the emergence of the fishing accords, and to evaluate the local variance in their performance. Two communities with different level of ecological and social performance are followed to evaluate the variability of local outcomes from similar exogenous incentives. The results show that the similar history and social development shared by all communities of the Lower Amazon influenced in the emergence of fishing accords. Yet, the floodplain presents a highly heterogeneous landscape, which strongly influences the level of resource accessibility. In addition, differences in the level of social organization, and political support strongly influence in the variability in the performance of the fishing accords. Both regional and local factors may have positive or negative roles in the local management systems according to the attributes of the floodplain landscape, of the resource users and of the institutional arrangement.

Paper withdrawn but permission given to include abstract
Title: The fishery in the South Pantanal, Brazil

Key words: Pantanal; South America; Recreational fisheries

The Pantanal is the flood plain of the Upper Paraguay River Basin, located in the center of South America (16° - 22° S and 54° - 56° W). It is situated mainly in Brazil, where it occupies about 138,000 km². The Paraguay River has a typical unimodal tropical flood, which drains slowly due to the low slope, and floods a wide area for long periods. The hydrological regime is very variable because there is an alternation of groups of drier year (small floods) and wetter years (large floods). Fishing is one of the main economic activities in the Pantanal, and includes commercial, sport and subsistence fishermen at low intensities that target large, long distance, migratory. The fishery has changed radically from the 1980's. At that time professional fishing declined due to a loss of fishing power and political support after prohibition of the use of nets and castnets. The fishery is now confined to the use of hooks. Moreover, the fishing tourism sector expanded and structured itself to meet the needs of the number of sport fishermen, which grew from about 38,000 in 1994 to 59,000 in 1999. This study is based on the fisheries of the South Pantanal, which correspond to 2/3 of the area of the Pantanal, and is based on observations from 4,244 commercial fishermen and 70,628 sports fishermen. Present legislation allows only the use of hooks by all fishermen, establishes minimum size of capture for the main species, and the closure of the commercial and sport fisheries for a minimum of 3 months during the fish breeding season. Until August 1995 a capture limit of 30 kg plus one specimen per fishing trip was imposed on sport fishermen. This was subsequently reduced to 25 kg plus one specimen. Commercial fisheries were more selective than sport fisheries, capturing mostly species that have a high market price. It is difficult to accurately estimate the number of commercial fishermen because of the diffuse character of the fishery and low level of organization. Using surplus production models the stocks of the two main species showed signs of overexploitation. There is a general indication that the fishery resources are under exploited in the region, based on: the size and quality of the species landed; the current production compared with that of previous periods; the positive catch/effort relationships for the whole fish population and the main species; and because the time of response of the fisheries in one year to the flood intensity of preceding years is still about 2 years. It is recommended that (a) the Fisheries State Council be strengthened, substituting the authoritarian way adopted so far for participative management by the fishing community, (b) commercial fisheries be improved by catching under exploited species like curimbatá - Prochilodus, and by aggregating value to the fisheries product, (c) an adaptative management approach be adopted that takes into account natural environmental variations, and (d) the need for planning the integrated development of the whole upper Paraguay River Basin be recognized.

Paper withdrawn but permission given to include abstract
In 1994, China began to construct the Three Gorges Dam, for hydroelectricity and for flood control in the Yangtze River basin. The Yangtze River, the largest river in China, has about 350 fish species and considered to be the center of origin and evolution of many freshwater fish species in East Asia. 162 fish species including 44 endemic species have been found in the main channel of the Upper Yangtze where 3/5 of the lotic habitats will become a reservoir after the dam is completed. Therefore it is urgent to consider alternatives for conservation areas to protect the habitats from the environmental effects of damming. To do this, we patterned the distribution of 44 endemic fish species found in the main channel of the Upper Yangtze using an adaptive learning algorithm, self-organizing map (SOM). The SOM showed a distinct three clusters of sampling areas according to the gradients of species richness and calculated the probabilities of each species that could be found in each sampling area. Based on these results, we proposed alternative reserve areas to conserve endemic fish species found in the main channel of the Upper Yangtze. The Ming River system could be considered as a candidate reserve area to conserve 27 species including Megalobrama elongata and Onychostoma brevis, and the rivers Tuo and Chishui for another 17 species including Acipenser dabryanus. These were selected on the basis of the existing data on species composition and richness. This technique is an efficient tool to guide choice of alternative reserve areas to conserve endemic species from the impacts of the environmental changes.
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Title: Status and management of fishery resources of the Yangtze River

Key words: Yangtze River; fishery resources; status; management opinion

This paper reviews the fishery resources and the environment of the Yangtze River based on monitoring data, research and the literature. It also analyses the species composition of the fishery, fishing sites, seasonality of the fishery, the biology of the main economic fishes, the relationship of fishery and trends in the fishery as illustrated by population dynamics. The paper makes some suggestions on the fishery management in response to existing problems.
Title: Mercury concentrations in the dourada (Brachyplatystoma flavicans) used as a distribution indicator for this species along the Amazon-Solimões river, and their possible effects on human health and resource management

Key words: Pollution; mercury; fish Migration and human health

Catfish like the “dourada” Brachyplatystoma flavicans, migrate up the Amazon River to feed and breed and as a dispersal strategy between August and December. We analyzed 243 samples obtained in the principal fishing ports along a 3400 km stretch of the river to evaluate: (i) the level of mercury contamination of “dourada” in the Amazon basin, and (ii) whether mercury could be used as an indicator of the distribution of this species. Mercury concentrations were determined using atomic spectroscopy. Data on Hg concentrations in muscle tissue, plotted against length and weight, indicated that there is no relation between these variables (R^2=0,03; P< 0,4257 and R^2=0,044; P< 0,4257). In 4/5 cases Mercury concentrations in “douradas” between 75 - 80 cm fork length and 5 - 8 kg weight exceeded the maximum concentration recommended by the Ministry of health of Brazil for safe human consumption (<0,5 ?g/g): Santarém= 0,181 ?g/g, Manaus= 0,804 ?g/g, Tefé= 0,751 ?g/g, Leticia= 1,202 ?g/g and Iquitos= 0,927 ?g/g. Results also showed a differentiated standard of distribution of mercury concentrations in fish in the Amazon basin that may be associated with the existence of several groups of migratory “douradas” that mix during low water season migrations.

Paper withdrawn but permission given to include abstract
The Amur River is one of the last unregulated large rivers of the World. It has been designated the WWF Global 200 freshwater ecoregion, because of its unique biodiversity which is threatened by the growing economic development in China and Russia. The rapid converting of wetlands, losses in forest cover, overfishing and pollution have led to changes in ecosystem regime and decreases in fish resources. The Amur is part of the narrowing belt of breeding sites for many endangered bird species like oriental white stork and red-crowned crane, and is the stopover for millions of water birds on the Asia-Pacific Flyway. The fish stock has decreased by a factor of 10, especially the sturgeon and salmon, which deprives 25000 indigenous people of the source of their traditional way of life. The famous Kaluga sturgeon, which weighs up to 1000 kg needs emergency protection as well as the Amur river turtle. The Amur forms the border between Mongolia, China and Russia, and separate national efforts and disconnected project can’t solve the problem of biodiversity conservation and sustainable development. The WWF Integrated River Basin Management approach can serve as a tool for such cooperative program.
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Title: Identifying Important Sites for Conservation of Freshwater Biodiversity: Extending the Species-based Approach

Key words: Conservation; site selection

Species richness in relation to area of habitat is extremely high in many freshwater groups with an estimated 10,000 fish, 5,000 amphibians and 6,000 mollusc species dependant on freshwater habitats. Other major groups dependent upon freshwaters include, reptiles, insects, plants, and mammals. The IUCN Redlist and The Nature Conservancy assessments both indicate the serious vulnerability and degradation of inland water habitats world-wide. It is evident that there are neither the resources nor the time to protect all areas where species are under threat. Clearly a method is needed for prioritising inland water sites for conservation at both local and regional scales. The IUCN Species Programme held a workshop in June 2002 to develop a method for prioritising important inland water sites for biodiversity conservation. The goal of the workshop was to develop a method that would help to focus conservation efforts and funds at the regional scale and would serve as a tool for active conservation efforts at the local scale. The method was developed on the foundations of a review of the existing site prioritisation schemes for terrestrial, marine and freshwater ecosystems. Expert representatives for a broad range of priority taxa and for existing schemes provided input to the development of the site prioritisation method. This paper describes the development of the method, the selection criteria adopted, guidelines for their use, and the site selection procedure. The site prioritisation method is to be evaluated through a series of regional workshops in 2003.
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Title: Socio Economic Issues of Riverine Fisheries in India: Impact of Fish Passes at Barriers

Key words: Indian rivers; impact of dams; fish passes

With progressive increase in abstraction of water in India for agriculture, industry, and community use, large and medium-sized dams are being constructed across most Indian rivers. Over the last forty years almost 200 billion m$^3$ of storage has been created, intercepting almost 30% of the available surface flow. As much as 70-80% is diverted in a few major projects. The dams impound and modify monthly and weekly historical flow pattern of a river below the barrier and have led to a radical change of the river ecology. In-addition to overall loss of fish production, many diadromous species are in danger of extinction because of habitat destruction and obstruction of migratory pathways. Some fish passes have been installed but have not been effective in the absence of detailed studies on the species. The economic sustainability of the fishing community along almost 2500 Km. of the larger rivers has been affected with colossal annual loss. Data exists on the performance of fish passes, fish landing, breeding and growth on the large Indian rivers, such as Ganges (at Farakka barrage), Yamuna (Hathnikund barrage), Mahanadi (Hirakud dam and Barrage at Cuttack) and Cauveri (Mettur dam). In addition to fish loss the rare Dolphin population has decreased and isolated to sub populations by the barrages on the main arm of Ganges and its tributaries. The commercially important *H. Ilisha* has suffered enormously due to blocking of almost 1000 Km. of migratory path by the Farakka barrage (1970). Data show that production of *H. Ilisha* 1961-68 at Patna (upstream of Farakka) was 9.39 Kg./Ha. This reduced to 0.07 Kg./Ha in 1989-93.  Rivers are polluted and their deteriorating health river is also destructive. The annual riverine catch in India is currently around 1 million tons out of the 3 million ton overall inland catch, against a potential of 10 million tons including aquaculture. Socio-economic issues arise from the impacts on the fishing communities of river diversions in the major river basins and there are specific links between the dams, fish passes and the economic loss.
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Title: Status of capture fishery in river Barak, Assam, India

Key words: Barak River, India; pollution, overfishing; management; livelihoods

The Barak River is the second largest river in the State of Assam, Northeastern India. It originates in the hills of Nagaland finally enters Bangladesh where it forms part of the Meghna river system. During its meandering course through Cachar, it forms several ox-bow lakes and an extensive, seasonally inundated floodplain. The river and its floodplain support capture fisheries and fish constitutes a major part of the diet for a large section of the people. The major fishes found in the Barak include the Indian major carp, *Labeo rohita*, the large predatory catfish, *Wallago attu*, the featherbacks, *Notopterus chitala* and *N. notopterus*, and other species including *Ompok* spp., *Gudusia chapra*, *Eutrocthyus vacha*, *Ailia coila*, *Pangasius pangasius*. At least three distinct caste groups of fishermen earn their livelihood in this area. However, in recent years, the fishery in the Barak and its floodplain lakes shows stock depletion due to gross overexploitation, siltation of the river bed due to deforestation in the upper reaches coupled with indiscriminate construction of flood control devices in the middle reaches, organic pollution and bacterial contamination of river water, and discharge of effluents from a paper mill. The BOD in river water can be as high as 14 with dissolved oxygen levels occasionally plummeting to 2.4 mg l-1. The total coliform counts can range between 10,000-25,000 MPN/100 ml in certain impacted stretches. All these factors are having a disastrous impact on the ecology of the river and the diversity and density of fish populations, as well as on the economic well being of the fishermen and fish traders who depend almost exclusively on the river for their livelihood. Species of fish such as *Notopterus chitala*, *Eutrocthyus vacha*, *Ailia coila*, *Nandus nandus* have become increasingly rare in recent times. The catch per unit effort in kg/person/hour can be as low as 0.11-0.12 at impacted sites, with some fishermen collecting a mere 0.5-1.0 kg of fish a day. This is far from adequate for meeting their basic needs for food, clothing, health care and children’s education. Hence, bold and innovative management strategies need to be evolved, adopted and implemented immediately to save the rich fisheries of this river and its floodplain, as well as scores of ecosystem dependent people, who are traditionally linked to this river through their culture and livelihood.

Paper withdrawn but permission given to include abstract
The Nilwala is an important river located in the Southern part of Sri Lanka. It has a complex tributary system and a catchment area of 960Km² representing cultivated, settlement areas and natural forest areas. The tributaries have enormous natural and anthropogenic effects on physiochemical conditions and substrate in the river which determine fish distribution. This paper presents data on the fish fauna of the selected tributaries at upper elevation as well as downstream along the River Nilwala course up to Malimbada and their relationship with physiochemical conditions and the substrate. Some physiochemical parameters such as temperature, conductivity, dissolved oxygen content, biological oxygen demand, pH, salinity, water depth, flow rate, NO₃⁻ and PO₄³⁻ concentration were determined using standard techniques at 32 selected sites from upper tributaries to downstream. The percentage composition of substrate type at each site was determined. The relationships between the species distribution and with water quality parameters and the substrate type have been established. The fish fauna of these tributaries consisted of a total of 42 species, including 4 new species recorded from the Nilwala basin. The sites at upper tributaries of Nilwala river basin were of high water quality and were associated with substrates consisting of gravel and pebbles and highly correlated with characteristic species composition, while shifting water quality of intermediate sites did not show any significant correlation with species composition, which was better associated with specific substrates. As river flows to lowland areas the substrate is replaced by silt and immediate changes in water quality are reflected in the composition of the fish fauna that moves towards more tolerant species.

Paper withdrawn but permission given to include abstract
Title: The African Water Resource Database: a GIS-based analytical framework supporting natural resource planning with a specific focus on inland fisheries and integrated water resource management

Key words: Africa, Aquatic species, ArcView scripts, GIS, Inland fisheries, Metadata, Rivers, Statistical analysis, Surface water bodies, Watersheds

The African Water Resource Database (AWRD) is a Geographical Information System (GIS) that is an expansion and enhancement of the work contained in ALCOM’s Water Resource Database (WRD) for Sub-Saharan Africa, which has been extended to cover the entire African continent. The core datasets which populate the AWRD include: various depictions of surface water bodies; multiple watershed models; aquatic species; rivers; administrative boundaries; population density; soils; satellite imagery; and many other physiographic and climatological data types. To display and analyse these data, the AWRD contains an assortment of new custom-designed applications and tools. These tools are designed to facilitate integrated water resource management and planning, as a means of promoting the responsible management of inland aquatic resources and increasing food security. Currently, there are six sets of analytical modules and tools which comprise the core of the AWRD: 1) a surface waterbodies statistics module; 2) a watersheds statistics module and selection tool; 3) an aquatic species module; 4) a data classification and statistical analysis module; 5) a metadata module; and 6) various customization and user data enhancements tools. This last set of tools contains several additional statistical, data visualization, and locational referencing tools which enhance the overall analytic and data output capabilities of the AWRD. Through the AWRD's main interface, users will maintain the ability to access tabular and spatial data viewers, while also gaining the ability to test and visualize complex spatial relationships and conducting robust statistical analyses concerning the spatial extent and distribution of such relationships. Most tools come with simple and advanced options and are fully described in help menus. A set of six applications illustrating various decision support scenarios using the AWRD are available to users as examples and aids to training. Potential future enhancements to the AWRD include: a river systems analytical module; a water demand and irrigation analyzer; a run-off and flood predictor; and a basemap viewer and output module. Other possible enhancements include the development of: an on-line collaboration and data maintenance system; an internet map server; and the eventual global expansion of relevant data layers.
The Pong, Chee and Moon Rivers are the three main tributaries to the Mekong in northeast Thailand. Fisheries production from the floodplains of these rivers helps to support the livelihoods of the local people. However, information regarding the ecology and fishery resources is needed for planning sustainable management of fisheries production. Three studies were conducted in May and November 2001, and in February 2002. Samples were collected from 14 sampling stations. Detailed data was collected on the river system, water quality, plankton, benthic fauna and fish and socio-fisheries. Various community and ecological indices, multivariate method of cluster analysis and ordination multidimensional scaling were used for data analysis. The result indicated that the Pong, Chee and Moon are potamonic. There was a significant difference in water quality over the river area and over time. There were 143 genera of plankton of which there was about 26,931x10^3 unit/m^3. Blue green algae and diatoms formed the majority of phytoplankton. 26 families of benthic fauna were found at an average number of 623 individual/m^3; which were 65.0% Insects and 22.56% oligochaetes. There were 100 fish species from 28 families of which 45.54% were cyprinids. The average standing crop was 2.95 kg/rai, electrofishing and gill net for CPUE were 7.8 kg/hr and 61.6g/hr/100m. The aquatic plants consisted of 59 species, 43 species of which were the marginal type. From interviewed villages it was found that 30.69% belonged to fishers and gillnet was the most popular of fishing gear. The average diversity indexes of plankton, benthic fauna and fish were 2.99, 2.47 and 3.78 respectively. The best species abundance distribution of plankton and benthic fauna was found in the Moon river and fish fauna in the Chee River. Plankton, benthic and fish fauna were divided into 4,6 and 6 groups According to cluster analysis and MDS respectively. Similar species and abundance of plankton and fish fauna were found in November 2001 and February 2002.
Title: A preliminary study of the ecological impacts of Mahaweli river diversion scheme in Sri Lanka

Key words: Mahaweli River; Sri Lanka; impact of dams; biodiversity

The Mahaweli is the longest river (335 Km) in Sri Lanka and has played a leading role in influencing the society, economy and ecology of the country. Five large dams were constructed along the upper reaches of the river in the 1970s and 1980s. The Mahaweli development programme aimed at solving problems of unemployment, food and energy. Problems in the form of malaria outbreaks, increased human-elephant conflict, spread of invasive alien species, loss of biodiversity and fish harvest have also resulted from the dams. There was no post development evaluation of the ecological implications of the project, so the present work was undertaken to estimate the ecological repercussions. Results indicate that the Mahaweli River is associated with several important habitat types representing different climatic and edaphic situations in the country. They are tropical wet evergreen forests, moist semi-evergreen forests, moist deciduous forests, semi-natural homegardens, dry Patana grasslands and the floodplain of the river locally known as "Villus". Flood plain habitats in the downstream Mahaweli, which are important feeding habitats of elephants, appears to be the most impacted mainly due to its ecological sensitivity and vulnerability to changes in flow dynamics and water chemistry. Major post development ecological impacts include (a.) Isolation of large mammals in fragmented forests in the development area (b.) Increased human-elephant conflict (c.) Changes in physical and chemical composition of downstream water bodies, which has facilitated the spread of invasive alien species and lowering of fish harvest (d.) Disappearance and displacement of indigenous fish species (e.) Modification of the frequency, timing, quantity of the flood and disruption of natural ecosystem processes such as fish breeding and migration, growth of indigenous plant species and maintenance of dissolved nutrients in water bodies. From this it appears that the project had paid little attention to ecological implications. It can be concluded that construction of large dams and associated irrigation activities needs to be carried out with proper understanding of ecological processes of the downstream areas. In the Mahaweli existing ecological problems can be mitigated through calculated flood release to allow natural ecological processes, minimum use of agrochemicals in irrigated areas, development of jungle corridors for fragmented forests and initiation of management programmes targeting invasive alien species.

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Title: Use of radio telemetry to address critical questions related to sustainable management of fishes and improved management of hydroelectric dams: Experiences from western North American rivers

Key words: Methodology; telemetry

LGL Limited has used radio and acoustic telemetry to answer key questions related to the management and assessment of fish migrations along several of the largest river systems of western North America. These studies have involved applying over 7,500 tags to eight fish species, in eleven river systems. The work has been conducted for a diverse client base including: electrical utilities, Canadian and British Columbia fisheries management agencies, other consulting companies, First Nations and conservation groups. The experienced gained through these studies has recently been transferred to the Parana River, Brazil where radio-telemetry is being used to assess the migration of five species of riverine fishes. The tagging has assisted in answering questions on: upstream migration of adults; downstream migration of juveniles and smolts; salt to fresh water migration of adults; residence time of potential water quality indicator species in an estuary; migration rates and timing; in-river mortality and spawning success; effectiveness of fish bypass facilities; adult and juvenile behavior and survival around large dams; spawning locations; stock differentiation; and bird predation. This paper will discuss some of the key elements and results in the successful use of radio tags. The key elements to success are: trained and experienced personnel; use of tags appropriate to study question; strategic location of receivers and antenna arrays; efficient data management systems (LGL’s Telemetry Manager software) that allows for rapid processing of large amounts of data and presentation of results from tracking individuals or groups of fish on any spatial or temporal scale; and rigorous study design to ensure that the questions are clearly defined and resources are appropriately allocated between the number of tags are applied and the type and location of tracking efforts. The major results from these studies have lead to: improvement to tag design and tracking systems; better understanding of fish migrations, in-river survival and the impacts of fishing; more reliable assessments of fish populations and spawning distribution; more precise estimates of the survival of fish passing through power turbines, spillways and other fish bypass systems; redesign of bypass systems and power house operations to improve juvenile survival; modification of fishway entrance design to improve access and survival of adults; and better fisheries management.
The freshwater fishery sector of Cambodia has traditionally been managed through a system of fishing concessions awarded through an auction system. Large areas of flood forest habitat and open waters were awarded in the form of fishing lots to individuals for their exclusive control and exploitation. The system however was non-transparent and was closely controlled by a small number of powerful people. In the year 2000, 80% of the dry season shoreline of the Tonle Sap Great Lake was controlled by only 18 men. Thousands of small fishermen living in communities around the lake struggled to feed themselves as the fishing lot operators controlled the best fishing grounds and were continuing to expand their boundaries to reduce community’s access to fisheries. Reported conflicts between fishing lot operators and local fishermen escalated in the late 1990’s as the people gained confidence to speak out against injustices. In late 2000, the government of Cambodia initiated a fishery reform process which culminated in mid 2001 with the released of over 500,000 ha of commercial fishing grounds (56% of the total) to local communities as community fishing grounds. Community fishery policy was born through executive order. A Belgian funded project implemented by The Food and Agriculture Organization of the United Nations (FAO) has been working on the development of participatory natural resource management on the north shore of the Tonle Sap Great Lake since 1995. Their work and experience with community based natural resource management helped to initiate the fishery reform process. This paper provides background information on the Tonle Sap, the project “Participatory natural resource management in the Tonle Sap region”, and the current status of community fisheries development within the province of Siem Reap on the Tonle Sap Great Lake.
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Title: Managing International Rivers in the GBM Region: Indo-Bangladesh Perspectives

Key words: Ganges – Brahmaputra Rivers; international agreements; trans boundary rivers

This paper critically examines the issues related to sharing the international rivers of the Ganges-Brahmaputra-Meghna (GBM) region from Indo-Bangladesh perspectives. It provides a historical account of the water-related contentions and an in-depth analysis of the important issues that are confronted by the co-basin countries, particularly Bangladesh and India. These issues include the adverse location problem, waterlogging, information sharing, water sharing, flow augmentation, non-navigational water requirements, water quality management, and institutional constraints. It then highlights the avenues of progress that can be explored by the parties involved.
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Title: Anthropogenic Activities and Fisheries in the Ponto-Caspian Rivers

Key words: Ponto-Caspian rivers; impacts of dams; impact of irrigation; pollution; fishways

This paper considers the ecological situation of the main rivers of the Ponto-Caspian region following the large-scale hydraulic modification of their basins. Modifications include dams and reservoirs, irrigation systems, direct withdrawal of water into transfer canals, discharges of wastewaters from industry, settlements and agriculture. Fifty years ago 600-650 thousand tons of fish were caught from the Soviet waters of the Ponto-Caspian basin. This included about 200 000 tons of valuable freshwater migratory fishes such as sturgeons, herrings, bream, carp, roach, pike-perch, sabrefish, and catfish. The large-scale hydraulic modification of the principal rivers of the region, the Danube (74 reservoirs in Soviet territory alone), the Dniester (87 reservoirs), the Dnieper (650), the Don (653), the Kuban (58), the Volga (812), the Kura (79), the Terek (22), the Ural (91) led to the degradation of the fish populations and a catastrophic decrease in catches. The freshwater migratory fishes for instance declined to 60 000 tons. The dams barred species such as beluga, Atlantic and Russian sturgeons, starred sturgeon, salmon and some species of herrings from their spawning grounds. The spawning grounds of the semi-migratory species such as bream, pike-perch, carp, and sabrefish remain, but changes in water regime, have altered the area and the timing of flooding of the spawning as well as the thermal and sediment regimes. The changes in hydrological regime result in lowering reproductive success and, reducing catches. Great losses of fish also occur due to irrigation pumping stations, which pump billions of young fish on to agricultural fields. Intensive pollution of these rivers with liquid industrial and surface flows also negatively influences the reproduction of fish stocks. Recent falls in living standards and an increase in unemployment in the Ponto Caspian basins seas have led to the wide spread of poaching. These phenomena decrease the quantity of the broodstock and fish reproduction. Compensatory measures have been undertaken, such as the construction of fish-breeding plants with an output of 70 million sturgeons and more than 2 billion semi-migratory young fish a year, and the construction of fishways. These measures only slowed the rate of degradation of fish populations but have by no means compensated for the damage.
Title: Estimation of silver eel (Anguilla anguilla L.) production by large river systems: collaboration between fishermen, scientists and decision makers towards sustainable management of the resource

Key words: Loire River; France; eels; catadromy

Most Anguillid eels of the world have undergone a steep decline since the late 1980s. In the Northern Atlantic, catches of estuarine glass eel recruits have declined tenfold, continental distribution areas have become increasingly restricted to downstream areas of large rivers, and the population has disappeared from the north and south of its range. This situation is still not clearly understood as a set of human made causes are thought to act synergistically on the biological cycle of eels and both ICES have recommended reducing the fishery until a global management plan is in operation. Many aspects of eel biology are very badly known. Mating adult eels, and eggs have never been observed in the wild. In continental systems the stock / recruit relationship is still unknown. A number of models have been produced but still need validation. The relation between habitat and population parameters is badly understood. Studies and surveys are available to assess recruitment in the river systems of France, Great Britain and Spain, but to date only two known studies have focused on the estimation of pre spawner silver eels by river system: On the Frémur, a small river of Northern Brittany (France), and the Saint Laurence (Quebec, Canada). In France, a study has been undertaken on the Loire, to produce an overall biologically based management Plan. Cooperation with professional fishermen shows that each year approximately 20 m tons of glass eel and 50 000 female silver eels are caught. The effect of fishing pressure on stocks and the escapement of silver eels (maturing spawners) has been assessed by mark recapture experiment during a two years experiment. In 2001, over 1500 eels were marked and about 10% were recaptured. It was then possible to determine migration periods and relations with environmental parameters. Population characteristics are estimated in order to assess escapement of Silver eels and breeding potential of the river system. These results are presented and discussed to propose a general management plan for the species at the scale of the whole river system.
This paper develops a species-by-species approach for selecting protected areas for conservation of native freshwater fishes at the catchment scale in semi-arid regions. Input data comprise georeferenced occurrences of freshwater fishes and corresponding landscape variables, in conjunction with general quantification of occurrence, abundance and endemicity of each fish species. A conservation value for each species was derived using measures of rarity, abundance and endemism. The conservation value of an area was determined by summing the predicted probability of occurrence of each species multiplied by their corresponding conservation value. The model was applied to native freshwater fishes in the Guadiana River Basin (southern Iberian Peninsula), where native fishes are threatened by the construction of the Alqueva and Pedrogão Dams. Predictive habitat uses highlight the species that need regional conservation efforts. Our approach is a pragmatic way to address the urgent need to protect species in decline as a result of anthropogenic activities, but more research on freshwater fish distribution and organizational processes is still needed to assure persistence of the species.
The importance of the volume of freshwater fisheries production and its contribution to rural livelihoods in the Mekong Basin has been neglected from policy processes. The main cause of this neglect is widely argued to be a lack of data available to policy-makers. In order to address this policy neglect, there is currently considerable regional effort expended in gathering data on production and consumption and developing models of the Mekong Fishery. Underpinning this approach is a simplistic model of development and natural resource policy-making processes that assumes policy-makers make 'rational bureaucratic decisions', and that these decisions are based on assessment of available data. While there is some truth to such a position, it is based on a false understanding of policy and the role of scientific data in making policy decisions. It also raises concerns regarding the feasibility of ever being able to model such a complex fishery, or to gather sufficient data to be able to do so. There is clearly a need for improved understanding of the Mekong fishery and the livelihoods that it supports. The neglect of freshwater fisheries in policy is not solely attributable to a lack of data. Rather, the economies of which fisheries are such an important component have been misunderstood, largely presented as rice based agricultural economies, with fishers largely excluded from policy-making processes. This paper argues that there are more fundamental reasons for the neglect of fisheries in policy than a lack of data, and that there is a need therefore to ensure effective process of monitoring fisheries and effective participation of rural fishers in analysing their resource base, and in making decisions about its management.
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Title:  Freshwater fish biodiversity in the Yangtze River basin of China: Patterns, threats and conservation

Key words: China, the Yangtze River, freshwater, fish, biodiversity

Freshwater fish biodiversity in the Yangtze River basin consists of 361 species and subspecies of fish. Of these, 177 species are endemic. The basin is normally divided into three parts, the upper reaches, the middle reaches and the lower reaches. The “three reaches” approach is not supported by fish distribution patterns. Hydrological alterations are perhaps the largest threat to fish biodiversity in the basin. Fishes in the upper reaches will be seriously affected by the construction of the Three Gorges Dam and other dams, and action should be taken for priority conservation. The most immediate restoration need is reconnection of the Yangtze River with its lakes. The cluster of lakes in the Central Yangtze should be protected to maintain habitats for spawning, feeding and migration of migratory fishes. Our study indicates a need to identify areas of high fish biodiversity and to selected nature reserves to mitigate the loss of fish biodiversity in the Yangtze River basin.
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Title: Mediating (apparently) irreconcilable conflict – agricultural water use efficiency, Calfed, and California

Key words: Water resources; management; dispute resolution; participatory management

What can be done to manage precious water resources when stakeholders holding conflicting values seem to be locked in an intractable conflict that appeals to authority cannot resolve? A small group of stakeholders in California were able to transform a seemingly irresolvable conflict about agricultural water use into a policy consensus with broad support from stakeholders and the government. An estuary located at the confluence of the San Joaquin and Sacramento rivers, the Bay-Delta supports over 750 plant and animal species. The Bay-Delta is critical to California, supplying drinking water for two thirds of Californians and irrigation water for over 7 million acres of highly productive agricultural land. By 1995 however, it was apparent to all stakeholders that the Bay-Delta had degraded to the point that policies governing water management were desperately needed. Government and non-government stakeholders have a history of conflict leading to failed policy-making efforts. In 1995, after extensive consultations with non-government stakeholders, ten federal and state agencies cooperated to form the CALFED Bay-Delta Program (CALFED). CALFED had to overcome a long history of conflict between different stakeholder groups that had derailed many previous water quality policy-making efforts. CALFED consulted extensively with stakeholders to get their feedback and support for proposed policies. The main device for stakeholder consultation was the Bay-Delta Advisory Council (BDAC). Using BDAC and other extensive public information and consultation methods, CALFED was successful in generating support for much of what it set out to do. However, these more traditional public participation methods were not sufficient to develop enough public support for agricultural water use policy, one of the most contentious issues in California. After the failure of its initial efforts, CALFED convened a small working group of stakeholders to explore this issue outside the spotlight, assisted by a team of professional mediators. The main story I want to tell in my article is how this small group was able to create a consensus that generated stakeholder support where so many other efforts had failed. While not resolving all issues, the group was able to create a consensus policy documents that were incorporated into the official policy documents generated by the CALFED process and to gain the grudging support of stakeholder constituencies for the policy. Some of the results that have emerges so far suggest that the mediators were instrumental in helping parties (a) generate the right group culture and conditions for constructive dialogue and problem-solving; (b) reframe the problem and the science; and (c) careful manage the tensions between learning and faithfully representing constituencies who are not at the table.
Title: Fish and fisheries as barometers of change: the Murray-Darling river system, Australia

Key words: Murray-Darling River; Australia; rehabilitation; river health

The Murray-Darling river system in south-eastern Australia is the fourth longest in the world (5500 km), but its annual discharge is low and variable by global standards. The mean annual discharge is 5071 GL, or 39% of the natural discharge, reflecting major diversions for irrigation and other water supply uses. Parts of the river system are also used for navigation and electricity generation. Changed patterns and magnitudes of flow have had profound effects on riverine and floodplain communities, particularly the fish. These effects are compounded by habitat degradation, salinisation, barriers to migration, cold-water pollution downstream of large dams, alien species and overfishing. Twenty-eight species of freshwater fish are native to the Basin, and another 11 alien species have become established. Fish biodiversity has declined dramatically in the last 50 years. Ten species, as well as the entire aquatic ecological community of the lower Murray in New South Wales, are now regarded as threatened. Commercial fishing peaked around 1918, but catches were declining by the 1930s and by the 1950s Murray cod, silver perch, freshwater catfish, and to a lesser extent golden perch, were much less abundant. Since the 1970s, the introduced carp has contributed most of the catch. The commercial inland fisheries in New South Wales and Victoria are now virtually closed for all species except for carp and yabbies. A fishery for carp and bony herring remains in South Australia, with small quantities of other species. Recreational fishing is popular, but increasingly reliant on stocking with hatchery-reared fish. State and Territory Government agencies manage the water and other natural resources within their jurisdictions, but the Murray-Darling Basin Commission initiates, supports and evaluates management across the Basin. Major reforms have arose from concern over environmental degradation, particularly resulting from water demand and salinisation. Diversions have been capped at the level that prevailed in 1993-94, and this ‘cap’ is supported by still-developing plans for environmental flow management, changes to irrigation technology and water-trading arrangements to improve the efficiency of water use. An environmental audit started in 2002 to assess ecosystem ‘health’, using indicators based on hydrology, water quality, habitat, macroinvertebrates and fish. As parts of a strategy to rehabilitate native fish communities, fishways are being constructed on weirs and other barriers to restore fish passage, and solutions to cold-water pollution are being sought. Catchment and ecosystem-based management approaches are gaining prominence over approaches focusing on problems in isolation, and future management of fish resources will be inseparable from wider environmental strategies. Rehabilitating the Murray-Darling Basin is a major issue for the nation, and the success, which can be achieved in combining sustainable environmental, social and economic practices, remains to be seen.
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Title: Water, Power and Ethnic Conflict in the South Andean Region

Key words: Indigenous peoples rights; water allocation

Water cultures and local hydraulic identities play a key role in the rational management, and the sustainable and equitable distribution of water resources, especially in large river systems of the Andean region of Latin America. Indigenous and peasant water use organizations face enormous problems related to discrimination and destruction of their livelihoods and to their water management systems. The water resource distribution system is extremely unequal and disadvantages the indigenous peoples and peasant communities. Encroachment on their water rights and the neglect and destruction of their management rules by powerful exogenous sectors is increasing day by day. Not all law- and policy-making actors and institutions are aware of this fact. For example, the participants at a special Forum Session on "Water and Indigenous Peoples" in the Second World Water Forum in The Hague, 2000, came to the conclusion that "having examined the Forum documents, the indigenous peoples and their unique system of values, knowledge and practices have been overlooked in the Global Water Vision process."

There is an urgent need to counteract the discrimination and subordination of indigenous and customary water rights and management systems, regarding not just the rights to have access to water resources but also the rights to management and policy decision-making, and therefore, their representation in decision-making bodies. The aim of this paper is to present a conceptual document and the comparative research activities, with the final aim to contribute to a better comprehension of indigenous water rights in the south Andean region, to raise awareness among the decision-makers regarding the need for legal and policy changes and, finally, to contribute to a better recognition of indigenous and customary rights and water management rules in national legislation.

Paper withdrawn but permission given to include abstract
Ethiopia is endowed with a number of large rivers some of which are international. The Abay (Blue Nile), Akobo, Awash, Baro, Tekeze, Wabi Shebelle Rivers and their major tributaries support substantial flows throughout the year. Although not well studied, preliminary reports indicate that there is high diversity and abundance of fish in these large rivers. However, the resources are underexploited, which is a paradox in a country where there is critical protein deficiency. Many of the large rivers are relatively far from the centre, creating difficulties of access and hence lack of appropriate markets that prevent fishermen and investors from exploiting the resources on a large scale. Lack of the necessary fishing gears and awareness of the value of fish in the diet appears to have deterred the local people from exploiting the rivers even for household consumption. Some societies living around some of the big rivers (e.g. Baro, Akobo) are traditional fishermen. However, the fishing gears and fishing technology they use is so traditional that they could not even satisfy their small-scale household needs. Appropriate systematic studies are needed to identify the diversity and potential yield of these water bodies. The Government of Ethiopia should actively improve the infrastructures (especially road building in the different directions of the country) needed to support the fishery. Government and Non-Government organizations should encourage traditional fishermen and investors in fully exploiting the resources.

Paper withdrawn but permission given to include abstract
India has a large network of river systems of which three major rivers - Indus, Ganga and Brahmaputra - which originate in the Himalaya, drain nearly two-thirds of the land area and account for nearly the same proportion of the country’s total water resources. They form extensive floodplains and deltas. At least a part of their basins lies in neighbouring countries (China, Nepal, Pakistan and Bangladesh). The three river basins are also among the most densely populated regions of the world where human activities have influenced the landscape for several millennia.

During the past five decades, rivers have become rapidly degraded. They are extensively regulated for water diversion, flood control and hydropower by a series of dams, barrages, and embankments. Discharge of domestic and industrial effluents, besides numerous activities in the catchments, floodplains and within the river channels have rendered the water unfit for human use. The biodiversity in general and fisheries in particular have declined very sharply.

The Water (Prevention and Control) Act adopted in 1974 to regulate discharge of industrial and other effluents in surface waters, and the Ganga Action Plan started in 1985 to provide for treatment of domestic sewage in major cities along the River Ganga have aimed at improving water quality. The National River Conservation Directorate under the Ministry of Environment and Forests, has until now focussed mainly on the treatment of domestic sewage and industrial effluents, ignoring the importance of environmental flows and habitat diversity (including floodplain) to the conservation and management of river water quality as well as biodiversity, particularly fisheries on which millions of people depend for their livelihood.

The need for improving river flows and habitat restoration has now been recognised and plans are being formulated to initiate action in the Yamuna River basin starting from the uppermost parts of the watershed. While dams and barrages will continue to be in place and the embankments cannot be removed, it is proposed to focus on the restoration of floodplain areas between the two embankments and in unregulated stretches. The paper presents the conceptual framework for the proposed floodplain restoration program.
Title: The Political Economy of Transnational Water Pollution: What Do the LMB’s Data Say?

Key words: International cooperation, water pollution, border area, Lower Mekong Basin (LMB)

In many areas of the world, water resources are shared transnationally but not managed jointly. On the basis of the cross-section and time-series data of the Lower Mekong Basin (LMB) — including large sections of Thailand, Lao PDR, Vietnam and Cambodia, our OLS regressions provide some information in support of the view in the 1980s water pollution tended to be worse as a function of income in richer areas, and to improve with respect to the increase of income in poorer areas. By contrast, in the 1990s it tended to improve as a function of income in richer areas, and to be worse with respect to the increase of income in poorer areas. In most circumstances, water pollution is found to be more serious in the transnational border areas than in the other areas. The estimated coefficients on the boundary variables (BORDER1 and BORDER2) show that political influence on transnational water pollution is more significant in areas near the international border across which the river runs than in places near the international border along which the river runs. The estimated coefficients on ASEAN present conflicting information about the role of the ASEAN membership in the reduction of transnational water pollution. Thus, the authors argue that ASEAN has not been a powerful organization by which to solve the environmental problems within the LMB.
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Title: Ecological status and fisheries of the rivers of north east India

Key words: India; management; gender roles; fisheries

The first comprehensive ecological survey of northeastern rivers in India was conducted during 1998-2002. The region is endowed with numerous rivers, which harbour rich fish faunas. It is one of the 10 bio-diversity hot spots regions of the world. The survey covered 37 rivers in six northeastern states. All the major parameters on habitat variables and biotic communities were investigated. The water quality and biotic communities revealed that the rivers were in pristine condition except for a few flowing through highly inhabited area where cultural eutrophication was observed. The hill streams and plains rivers were both very rich in fish fauna and some 200 fish species were documented inhabiting the water bodies in six states. Fish of high commercial value such as Tor spp., Neolissochilus spp. Labeo spp., Barilius spp., Garra spp. and Botia spp. were plentiful in the region. The riverine fishery in this region is still in a primitive stage and managed as common property with open access. During the study, a clear interdependence of man and environment was observed. The people of the region live in complete harmony with nature, as indicated by sustainability of the pattern of exploitation of the fishery resources. The craft and gear used are also indigenous and unable to exploit substantial part of the resources. Lack of transport facilities and market is another hindrance to utilize the resource. Feminization of the fisheries sector is also advanced since the women in this region participate in both indoor and outdoor activities. Empowerment of women and their higher level of participation in fisheries is a crucial feature in the northeast especially in Meghalaya and Manipur. The roles taken by men and women are not well defined, both playing active roles in fishery and related activities. Based on the observations, the study recommended i) transfer of new fishing technologies; ii) Development of transportation and marketing facilities; iii) Creation of sustainable livelihood avenues through post-harvest activities, iv) manpower development for better exploration and exploitation of the fisheries resources and v) Creation environmental awareness to the local people.

Paper withdrawn but permission given to include abstract
Increasing multi-sectoral demands on water resources have led to water abstraction and transfer activities, and the construction of dams and embankments that have significantly altered the flood regimes of rivers throughout the world resulting in the loss of fish production and biodiversity. The current emphasis on sustainable development and biodiversity conservation is leading efforts to mitigate these impacts by means of interventions such as the release of artificial floods downstream of dams and the manipulation of water levels within impounded floodplains.

Whilst much work has been done to determine the hydrological requirements for the maintenance of salmonid populations, few equivalent studies are available from which to develop criteria for the management of hydrological regimes for fishes and fisheries in large floodplain-river systems such as the Mekong. The population dynamics of fish in such rivers are believed to respond to hydrological conditions in a density-dependent manner. A dynamic pool model incorporating sub-models describing density-dependent growth, mortality and recruitment was used to explore how hydrological conditions within a theoretical floodplain river system affect the dynamics of a common floodplain-river fish.

Graphical summaries of the response of exploitable biomass to a range of different drawdown rates, dry and flood season areas and volumes and flood season durations are presented under five different model assumptions concerning density-dependent processes. Optimal flooding patterns are also described for the model species and theoretical river system.

The patterns of predictions that emerge from the simulations provide guidelines for managing or manipulating hydrological conditions in river systems under both fixed and variable volume hydrological scenarios. As a general rule of thumb, exploitable biomass is maximised by minimising the rate of drawdown and maximising the flood duration and flood and dry season areas or volumes. However, experiences from dam and other hydraulic engineering projects suggest that these predictions should be treated with caution until we better understand the influence of hydrology on spawning behaviour, system primary production, and critical habitat availability.
Title: Fish out of water: modelling some tradeoffs between fisheries and agriculture in the floodplains of Bangladesh

Key words: Bangladesh; modeling; agriculture-fisheries interactions; irrigation; management

The extensive floodplains of Bangladesh sustain a predominantly poor rural population, 85% of whom live at an agrarian subsistence level. Whilst half the National Product is derived from agriculture, floodplain fish production is also fundamentally important providing the second most important export commodity after jute and up to 80% of the total animal protein consumed in the country. Fishing also provides livelihoods and supplementary incomes for millions of landless poor. In response to increasing population pressure and a nationwide flood control programme, the two sectors must now compete to control the availability of water on the floodplain to meet their often conflicting requirements. Employing empirical hydrological, fishery and agriculture sub-models, this paper seeks to quantify the agriculture and fisheries trade-offs associated with: (i) abstractions of water from dry-season water bodies for irrigating winter rice and a range of alternative (combinations of) crops; and (ii) sluice gate operations to control of water levels and thereby available agricultural land inside flood control schemes. The results indicate that the effects of abstraction for irrigation on the fishery can be dramatic. In the 6776 hectare site modeled, abstraction to irrigate more than 500 ha results in rapid decline in the fishery, with a complete collapse in recruitment occurring after approximately 600 hectares. Diversification into alternative winter crops is shown to have much less of an impact on the fishery by virtue of the lower water requirement. Analysis of crop profitability shows that these alternative farming systems can be more profitable, indicating a win-win scenario for the two sectors under diversification. Results also indicate that managing sluice gates to maintain higher dry-season water levels can significantly benefit the fishery with the sacrifice of very marginal amounts of land under rice. Thus management programmes at the local level that promote diversification and focus on building consensus among floodplain dwellers have the scope to greatly enhance the inland fishery with little damage to agricultural interests.

Paper withdrawn but permission given to include abstract
Cambodian food security has been analyzed from a systems perspective in terms of hydrological, ecological, economic, demographic and nutritional processes. A system dynamics model—the Tonle Area Management Simulation (TAMS)—was built as a tool to engage local resource users and their representatives with decision-makers in an extended dialogue process and to initiate a science-based framework that allows people to holistically visualize their region ecological economic system. Local participation and scientific understanding are essential elements for adaptive co-management planning. Fish from the Tonle Sap Lake and River’s seasonally inundated floodplain—possibly the world's most productive inland fishery (up to 270 kg/ha/yr harvested)—provides the dominant share of animal protein and fat consumed by over 6 million Cambodians, all of whom depend on a rice/fish-balanced diet. The Tonle Sap is the largest fish progenitor in the Mekong Basin and its productive viability determines the availability of fish to a large international population. Two key factors in the lake's biological productivity are a flood-pulse-and-expansion process that originates from the monsoon-swollen Mekong River and the extent of inundated habitat, including the quantity and quality of vegetation. Plans for Mekong River hydro-power, flood management and irrigation diversions for rice, together with intensive harvest of the lake's fish and floodplain vegetation, endanger protein and fat food security in the Lower Mekong River Basin. The significance of the Tonle Sap for food security is certain to increase, given the growth pressure of a large under-17 Cambodian population (over 50%). However, international, national and cultural forces continue to promote rice—the dominant source of carbohydrate calories—at the expense of wildstock fish—the dominant source of protein and fat—as the key to food security. TAMS provides a framework to convene people, to understand the issues of nutritionally balanced food security and to adaptively manage the interdependencies of this complex ecological and socio-economic system.

A systems thinking and group model building course has begun to prepare Cambodian faculty for their future role in adaptive management of the fishery stocks. The Tonle Area Management Simulation model (TAMS) was developed to simulate primary ecological economic system dynamics. TAMS represents the interdependent behavior of six sectors: hydraulics; vegetative inundation; gross fish production; macro-economic activity; population dynamics and protein nutrition requirements. As an educational tool, TAMS' user-interface allows creation of scenarios based on conceptual trade-offs among the above sectors. TAMS represents the initial phase of mediated modeling, provides a format to promote dialogue and group consensus on system behavior among people with interdependent but competing interests that affect fish production, nutritional and economic welfare. Simulations provide insights, such as relating population growth to per capita protein deficit, and a smaller flood pulse to fish production and harvest economics. Awareness of and consensus about such issues fosters wiser, better informed, decision-making.
Title: Biodiversity and abundance of small indigenous fish species and their interrelation with subsistence-level fishing in the old Brahmaputra River, Mymensingh, Bangladesh

Key words: Brahmaputra; Bangladesh; subsistence fishing; livelihoods; degradation of stocks

This study addresses the catch composition and abundance of small indigenous fish species (SIS) and their interrelation with the subsistence-level fishing livelihood in the Old Brahmaputra River, Bangladesh. The SIS constitute about 72% of the fish biodiversity in the river. Among the total recorded 53 species of SIS, most of the species are declining in abundance and 13 have already been listed as endangered by the IUCN. The causes of reduced abundance of these species are over-fishing, reduced flooding, siltation, agricultural and industrial pollution etc. Participatory Rapid Appraisal (PRA) methods were used to collect livelihood data of the fishermen and the catch statistics of the previous years. Reduced abundance of SIS has severely affected the traditional fishers’ livelihood and forced them to seek jobs in other sectors.

Paper withdrawn but permission given to include abstract
Bangladesh is a land of rivers with extensive floodplains. Nutrient-rich and food-rich floodplains are the most important habitats for fish and fisheries and also provide nursery and feeding grounds for hatchlings, fry, and juveniles. The frequent floods in Bangladesh cause destruction of life and property and have led to flood control measures to protect the crops and ensure increases in production. At the same time the measures to reduce the extent and duration of flooding have destroyed the habitat’s productivity and its capacity to support aquatic organisms. It is import for the management of the floodplain resources to consider fish and fisheries along with rice production in order to keep pace with the national goals to attain food security, maintain economic growth and sustainable ecosystems, and ensure social well being. This study develops a computation framework to regulate water level to reduce management conflicts between fish and rice in the floodplains. This was tested in the Jamalpur area. The production required to meet the nutritional demand for rice and fish is about 61,000 t of rice and 7,500 t of fish. Current levels of production are only 30,000 t rice and 1,000 t fish. A frontier curve is presented that shows that, with an appropriate trade-off between rice and fish, 65,000 t rice and 12,000 t of fish can be produced with existing resources by regulating the water levels. The study shows the range of water level for each flood cell that could be regulated based on tradeoffs between fish and rice production. For example in one cell, a range of water levels from 18.6m to 19.5m can meet both the demand from rice and fish in the area.
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Title: The politics of fisheries knowledge in the Mekong River Basin

Key words: Mekong; policy; conflict resolution; knowledge

The Mekong River Basin is a highly diverse ichthyofaunal resource and a highly productive fishery in both subsistence and commercial terms, which has come under increasing stress. About this there is general agreement, but beyond these generalities the level of agreement rapidly dissipates. The politics of fisheries knowledge in the Mekong River Basin involves tensions along a number of lines: fisheries consumption and production statistics used by riparian countries and those produced by consultancies for the Mekong River Commission; scientific and indigenous knowledge of fisheries; NGO and governmental articulations of the causes of fisheries decline; natural and social-science knowledge about fisheries and methodologies for achieving such knowledge; taxonomic and livelihood-oriented fisheries research; culture and capture fisheries knowledge; and basic science and EIA-driven fisheries studies.

In this paper, I examine fisheries knowledge in the Mekong River Basin in the context of the politics of its production and ownership. The paper examines the tensions over fisheries knowledge in an attempt to direct attention to the circumstances of its production. The purpose of this approach is to highlight for fisheries managers, and river basin managers more generally, the significance of understanding the politics of knowledge as a pre-requisite for using such knowledge as a management input. I argue that it is not sufficient to come up with expert knowledge that is privileged as “best estimate”, particularly in the highly complex and politicised power/knowledge milieu that is prevalent in the Mekong River Basin.
The endangered Mekong giant catfish *Pangasianodon gigas*, the endangered giant carp *Catlocarpio siamensis*, and the river catfish *Pangasianodon hypophthalmus*, are three of the largest freshwater fish in the world, measuring up to three meters in length and weighing 300 kilograms (Smith 1945). These three species are caught in the Tonle Sap River (Mekong River Basin) bagnet fishery in Cambodia. In 2000, a buy-and-release project was established to help conserve *P. gigas*, *P. hypophthalmus*, and *C. siamensis*. These species are purchased from fishermen and released alive into the Tonle Sap River. In addition, project researchers weigh, measure, tag, and collect DNA from *P. gigas* and *P. hypophthalmus* prior to release. In the short term, the purchase and subsequent release of captured wild fish decreases the probability of extinction of these species. The buy-and-release project also generates an appreciation for endangered species conservation in Cambodia. In the longer term, tagging and genetics research will help to determine the migratory patterns, habitat use, and exploitation rates of *P. gigas* and *P. hypophthalmus*. This knowledge is critical to the development of a long-term conservation strategy for these, and other, important Mekong fish species.
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Title:  New methods for the study of fish migrations in large rivers: examples from the Mekong river basin

Key words: Mekong River; fish migration; methodology

Over the past five years, the study of fish migrations has emerged as key area of fisheries research in the Mekong River Basin. Many recent studies have focused on the migrations of Mekong species, using a combination of local knowledge and catch data to infer the movements of fish throughout the basin. As a result of these studies, fisheries experts have begun to describe the patterns of fish movement in the Mekong River Basin. Based on these descriptions of migratory behavior and habitat use, current research on Mekong fish migrations includes fish tagging (both external intra-muscular insertion tags and acoustic transmitters), genetic studies, and isotope analysis. Tagging, catch, and isotope data provide strong evidence for long distance migration of two species of large and economically important catfish. The long distance migration of these catfish has important implications for both the industrial development of the river basin and the management of fisheries for migratory species.
The Mekong River’s hydrology is relatively unmodified, its water is generally of good quality, and fish passage on most major rivers is still unimpeded by large barriers. Consequently, the River and its associated wetlands continue to yield large quantities of wild fish and other aquatic animals and plants, which provide livelihoods and food security for millions of people.

Population growth and increasing standards of living are driving development of the Lower Mekong Basin (LMB), and of most concern from a fisheries perspective are water management projects (WMPs), such as dams, weirs and flood control schemes. WMPs impact the free goods, including fish and other aquatic products, provided by the natural aquatic system, goods which are not valued or undervalued, and which are used predominantly by poor people. Improved planning, which gives adequate weighting to wild fisheries is needed and may improve their conservation, but WMPs will continue to be built. The negative effects of WMPs are now well-documented, as are the technical measures to mitigate and manage impacts. Such measures include destratification of reservoirs, regulating ponds downstream of storages, aeration of reservoir releases, flow management, measures to enhance fish passage (including fishways), sediment management, habitat management and enhancement, as well as management of the fishery itself. But in practice, in the LMB there has been little effective mitigation of impacts on the wild fishery, despite Environmental Impact Assessments (EIAs) being prepared for many projects.

The EIA process could improve outcomes for fisheries, but only for the large projects for which EIA is required. The administrative frameworks for EIA have only recently been established in the LMB countries, so EIAs are only recently becoming more effective, in terms of public involvement and genuine consideration of impacts and their mitigation and management. Effective EIA requires that projects are not pre-approved, that the process is transparent and genuine, that agencies and the public are educated on fisheries impacts and mitigation, and that the public (including fishers) is involved and differing views are fairly addressed. Transboundary (international) effects on fisheries require special consideration as such impacts extend both up- and downstream. And to be effective, EIA as a process must be part of an environmental management system (EMS) which guarantees implementation of mitigation and management.

EIA does not address the majority of development impacts, because most developments are medium or small-scale and are not subject to EIA, so other processes are required if the wild fishery is to be maintained. Fisheries biologists should be provided some measure of statutory control over the environment, through changes to current Fisheries Acts, or by improved referral mechanisms in EIA or in the approvals processes of planning agencies or the agencies responsible for other sectors. Mitigation and management considerations could also be incorporated directly in the operating framework of other agencies.

Paper withdrawn but permission given to include abstract
Title: Fish and Fisheries of the major river system in the Western part of Bangladesh in relation to fisher and socio-ecological sustainability

Key words: Bangladesh; biodiversity; resource use; impacts of other uses

Bangladesh has an area of about 147,556 sq. km. It lies between 20° 34' to 26° 38' North latitude and 88° 01' to 92° 40' East longitude. Most of Bangladesh is the delta of the Ganges-Brahmaputra-Meghna river system. The present report is prepared from data collected from 1978 to 2000 and February 2001, by the Fisheries Research Group, Department of Zoology, Rajshahi University. Economically important finfish and shellfish were recorded with their relative abundance in the western half of Bangladesh, mostly in the Gangetic deltaic system. The quantity and variety of the catch of the commercial fishery have decreased from 50-90% in all river systems. During this study period the number of finfish species available to the fishery decreased from 135 to 104 species. Some riverine and floodplain species are endangered and a few are now extinct in this area. Landings and fishing grounds have been displaced from their original sites over the last 20 years due to drastic reduction in fish production. As a result most of the poorest professional fishers sell off their gear, traps and craft, and, as a last resort even their homes and land and migrate to other place, shifting to other professions. The influence of physico-chemical factors on the migratory behaviour of the native indigenous fishes from floodplain to upland water bodies was investigated. It was observed that these factors are changing and the availability of fish is directly related to them. The decline in fish abundance in the river system in due to: siltation of riverbeds due to flood control and drainage systems (FCD), irrigation, encroachment on riverbeds for agro-cropping in the dry season; over exploitation due to poverty; Government's policies for leasing, licensing and sometimes lack of control of fishing activities in the riverine system. People use the river systems in various ways. Waterways are adversely affected during the dry season when navigation is impacted by siltation. Landless poor peoples use the grassland areas of the riverine islands during the dry season for duck and animal rearing and to some extent for agro-cropping of watermelon and vegetables.
Title: Macro-zoobenthos an indicator of water pollution in the Karnafuli River-estuary, Bangladesh

Key words: Zoobenthos, indicators; pollution

The Karnafuli river, one of the most important in Bangladesh, carries huge amounts of domestic as well as industrial wastes from the port city of Chittagong. Monitoring and study of the effects of pollution in the Karnafuli requires urgent attention. One such study was made to detect the extent of pollution due to indiscriminate waste disposal. Monthly sampling was carried out during a one year period at four stations of the Karnafuli river estuary. Two of the stations were near the discharge point of the municipal drain and other two sites were used as reference sites, which have no waste disposal problems. Results on the abundance and percentage distribution of macro-zoobenthos did not show any group of organisms as being markedly dominant over other groups in the reference stations as those observed in the waste disposal zone. Results also showed that percentage of the miscellaneous group (mysid, crab larvae, amphipods, shrimp larvae) was negligible in polluted area in comparison with reference area. The bottom conditions of the waste disposal area were serious. This study also observed some localized effects of waste disposal in the Karnafuli river estuary in terms of macro-zoobenthos, thus indicating pollution.

Paper withdrawn but permission given to include abstract
Fish pass through distinct stages during their lives and habitat, food and other requirements can be specific to that life stage. This is especially true if major morphological changes take place during stage transitions. Mortality, by definition, is greatest in the early life history stages and can determine the strength of subsequent cohorts. Yet our understanding of the causes of mortality, for riverine fish in particular, is poor. Furthermore, while predation and starvation are assumed to be the primary reasons for high mortality, the links between these factors and alteration to the natural environment are virtually non-existent. Once larvae have grown to become juveniles, mortality generally declines, yet fish at this stage are often the most cryptic. They may also disperse considerable distances and thus are vulnerable to artificial barriers and other anthropogenic as well as natural threats. As adults, establishment and defence of territories, feeding, cues for reproduction and rearing of young are all critical for the production of the next generation. Yet, again, our ignorance of how environmental disturbance by the actions of humans affects these processes is profound. I present an analysis of a 7-year data set, in which I examine the sorts of clues that can enlighten us as to why the fish fauna of a highly regulated lowland Australian river is so degraded. I examine data from each of the major life history stages of several species of native and introduced fish and attempt to integrate across the entire life history.

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Title:  Status of palla (hilsa) *Tenualosa ilisha* after the construction of barrages in river *Indus* in Pakistan

Key words: Indus River; hilsa; anadromy

The palla *Tenualosa ilisha* is found in Pakistan, Iraq, Iran, India, Burma and Sri Lanka. It is a subsurface swimmer and is anadromous. It used to swim upstream to as far as Multan before the construction of the Sukkur Barrage in 1932. After the construction of the Ghulam Mohammad Barrage in 1954, its movement was restricted and was further restricted after the construction of Kotri Barrage near Hyderabad which now represents the species’ upstream limit. These developments activities have reduced the palla’s habitat, and ultimately its population. Other factors influencing the decrease in its population are the reduction of fresh water flow in the River Indus due to drought, over fishing and damaging methods of fishing. The volume of the palla catch decreased from 9,594 tones in 1976 to 3,923 tones in 1981. The decline in the population and range of palla in the Indus has affected the livelihoods of the fishermen, many of whom have lost a lucrative occupation. No studies have yet been undertaken on the decline of the species and we are unaware of its present status and extent of its catch/yield per season. Nor has research been undertaken on the effects of barrage construction on fish species in the Indus and its tributaries. A preliminary survey of this species needs to be undertaken to gather information on all possible factors that caused the decline of this species and to determine the present spawning ground and data of its catch or consumption.

Paper withdrawn but permission given to include abstract
The Yazoo River Basin (Mississippi, U.S.A.) is a floodplain river ecosystem integrating six tributary rivers that course through the interior alluvial plain of the Mississippi River. Historically the basin was covered by temperate bottomland hardwood forest, swamps and perennial backwaters subject to seasonal flood pulses. European settlement during the 1800s and early 1900s resulted in extensive deforestation of the floodplain for agricultural purposes. To protect agriculture, federally-sponsored flood control programs during the middle decades of the 20th Century incorporated construction of dams in upstream reaches of tributary rivers, clearing of forests along riparian corridors, dredging and straightening of river channels, and removal of large woody debris from channels. The principal riverine fisheries resources throughout the basin (buffaloes: Catostomidae; catfishes: Ictaluridae) are enhanced by the presence of mature riparian forests, large woody debris in river channels, and flood pulses. The fisheries are negatively impacted by activities that alter stream hydrology, convert riparian zones to early successional vegetative stages, and disconnect the rivers from their respective floodplains. Recovery of the rivers and their fisheries following these impacts takes approximately 20-30 years. The rivers serve as cultural icons for a distinct sub-culture of “river people” extant within communities throughout the Yazoo River Basin. Cultural connections to the rivers are strongest with respect to fishing in rivers (or sections of rivers) that are in advanced stages of recovery from historical flood control activities. Most fishing is recreational, but artisanal fisheries still exist. Partitioning of the fisheries within the rural sub-culture of “river people” renders main river channels as the domain of fishers in higher economic strata while floodplain backwaters are generally the domain of fishers in lower economic strata. Degradation of rivers erodes the cultural identity of both groups and can result in loss of social status within their respective communities. Proposed periodic maintenance of the region’s flood control projects is increasingly controversial as a result of greater public insight into functional dynamics of floodplain river ecosystems, coupled with changes in human value systems associated with these rivers and the living natural resources they support.
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Title:  Policy options for the development of Indian riverine fisheries

Key words:  Indian rivers; inland fisheries; environmental impacts

Fisheries contribute significantly to the Indian economy. India is endowed with rich inland fishery resources comprising 191,024 km of rivers and canals, 2.031 million ha of reservoirs, 2.381 million ha of fish ponds and irrigation tanks, 0.798 million ha of beels and oxbow lakes, and 1.437 million ha of brackish water bodies. India riverine fisheries are based on five perennial rivers over 1100-2500 km long with rich fishery resources. The contribution of inland fisheries to national fish production increased considerably remarkably in the late 90s. Major riverine fishery resources consist of major carps, minor carps, exotic carps silver and grass carp, murrel, catfish and other food fish. Riverine fisheries have been subjected to several adverse impacts like construction of dams across rivers, which impaired the reproduction of migratory fishes, discharge of industrial effluents and domestic sewerage and improper use of rivers as a dumping place for all kinds of waste, including human wastes. As a result, riverine fisheries declined and ares now threatened. For example, in one incident a large-scale mortality of fish in a 160-km long zone in River Kali 30 tons of fish perished due to pollution. The construction of the Farakka barrage across the Ganges adversely affected reproduction of the Mahseer. This paper presents a status report on Indian riverine fisheries and outlines policy options available for their overall development.

Paper withdrawn but permission given to include abstract
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Title: Horizontal distribution of the ichthyoplankton at the Sao Francisco middle river basin, Minas Gerais, Brazil

Key words: Sao Francisco River; Brazil; ichthyoplankton; larval drift

The horizontal distribution of ichthyoplankton is described in the São Francisco river, with regulated flow, and Das Velhas river, with free flow. Sampling was carried out daily during the onset of the 1998 flooding. In the Das Velhas River changes in the physical – chemical discharge were related to flows. The São Francisco River does not show any pattern. Das Velhas river had higher ichthyoplankton densities. The percentage of embryos was larger in the São Francisco, because of the proximity of the spawning area. The greatest percentage of larvae occurred in the Das Velhas River, suggesting that the spawning area may be upstream. An horizontal gradient of water velocity was detected in these rivers. The Das Velhas River also had a horizontal turbidity gradient. Changes in conductivity and temperature probably act as a environmental cues for spawning. In the Das Velhas river the larvae were grouped at the banks and in the São Francisco river, the embryos were found in the middle of the channel. The Mantel test was significant in the São Francisco River variables, but was not significant in the Das Velhas River. It was concluded that the presence of ichthyoplankton and drift obey hydrologic and hydraulic system processes.
Title: The flood pulse concept: new aspects, approaches and appraisals - an update

Key words: Flood pulse; floodplain ecology

The flood pulse concept (FPC), published during the first Large River Symposium, was based on the scientific experience of the authors and the state of published data in 1989. Since then, knowledge concerning floodplains has increased considerably, creating a large database for testing the predictions of the concept by many researchers world-wide. The FPC has proved to be an integrating approach for highly diverse and complex ecological processes in river-floodplain-systems, however some additions, modifications and restrictions have been made. Major advances have been achieved by detailed studies on the effects of hydrology and hydrochemistry, climate, paleo-climate and evolution, biogeography, biodiversity, landscape ecology but also by approaches to wetland restoration and sustainable management, including floodplains in different latitudes and continents. Flow pulses, Connectivity, the Riverine Productivity Model, the Global-Detritus-Processing-Hypothesis and the Multiple Use Concept are some of the major items stimulating the discussion on floodplain ecology and management. The paper summarizes the predictions of the FPC, evaluates their value in the light of recent data and new concepts and discusses further developments in floodplain theory.
Title: Fisheries in the Mun River: A one year trial of opening the sluice gates of the Pak Mun Dam

Key words: Mun River, Pak Mun Dam; fisheries; flow releases; livelihoods

The Mun River is one of the main tributaries of the Lower Mekong River. In 1994, the Pak Mun Dam, 6 km upstream from where the Mun enters Mekong River, was completed and inaugurated to impound water. After the impoundment, the Mun River was markedly changed in flows and water levels, which resulted in dramatic changes in the local environment. Since then, fishes and fisheries have been subjects of controversy between the fishers and government sectors (e.g. EGAT and DOF). From these arguments, the Thai Government decided to open all the sluice gates of the Pak Mun Dam from July 2001 - June 2002 to investigate the annual cycle of fishing activities, water quality, some biological aspects of fishes. The results were used to compare the status before- and after- impoundment. The major concerns, of this paper, are related to the changes in main fishing gears, annual cycle of fishing gears operation, fish yields and the composition of catches. Also included in the paper are the changes in the livelihood and income of the fishers. Management options are also discussed.

Paper withdrawn but permission given to include abstract
Title: Fish friendly structures: A new motivation in Bangladesh

Key words: Bangladesh; fish passes; polders; management

The idea of fish pass and fish friendly structures (FPFS) has been introduced in Bangladesh in the 1990s and since then four FPFS have been built in the country. The primary objectives of building these structures were to facilitate fish migration and reduce mortality rate of hatchling during movement through the FPFS gates. Primary data has been collected through field visit and focus group discussion to identify the shortcomings of the current management systems of FPFS. The key findings from this study are: (i) fish pass function better than that of fish friendly regulators in terms of fish migration (ii) due to no operational rules for gates of FPFS the hydraulic condition is not friendly for fish (iii) there is a serious lack of inter-agency coordination (iv) detrimental fishing has been observed at both up and down stream of FPFS, as a consequence these beneficial fish migration structure has turned into fish trap, and (v) the existing management bodies are dominated by government officials and rural elites. Poor fishermen and other vulnerable groups (women, minority) are not well represented in these committees.
The ichthyofauna of the Ob river basin includes two species of cyclostome and 51 species of fish belonging to 10 orders, 18 families, and 37 genera. The Ob basin is divided into four parts according to the fish fauna: rivers, including the Ob and Irtysh with their tributaries, the delta and the Ob estuary, reservoirs and lakes. The contemporary fauna of the Ob consists of: i) the widespread European-Siberian and Siberian ichthyofauna including the sturgeons (Acipenseridae), salmonids (Salmonidae), whitefish (Coregonidae) and cyprinids (Cyprinidae). ii) immigrants that are of recent origin and have penetrated from waterbodies belonging to different zoogeographical region. The others are species that have invaded from the Kara Sea, and species that have become acclimatized: wild carp pikeperch, bream, common verkhovka, Lake Balkhash perch, and Aral stickleback. The main fishing gears in the basin are seines, trawls and gill nets. There are 21 species of commercially important fish, of which only 13 species are notable including: Siberian sturgeon, nelma, peled, Siberian cisco, the muksun, pike, Siberian roach, ide, silver and golden crucian carps, perch and burbot. The Ob basin is the richest in whitefish including the Siberian cisco, followed by peled, tugun, chi, pyzh’yan, and muksun. The great abundance of the whitefish (Coregonidae) is maintained due to favorable environmental conditions: extensive foraging habitats with a rich food base, little feeding competition with other fish, and the presence of a great number of spawning grounds and wintering places. The abundance of nelma and sturgeons have greatly diminished in the basin because of the loss of spawning grounds in the Upper Ob caused by the construction of the Novousibirsk reservoir as well as due to irrational fishing practices. Ide is one of the most important commercial fish of the Ob-Irtysh basin. It is common everywhere and especially numerous in the Middle Ob (from the Irtysh mouth to the Tom’ mouth). Here it finds good spawning and foraging grounds in the river floodplains. The condition of ide from this region is higher than those from the European waters).
Managing riverine fisheries and systems is a big challenge in a country where over 75% of the families cannot feed themselves and produce only 64% of their own food requirements, and where at least 500-1,000 people died of hunger and hunger-related diseases in 2002. Eighty percent of Malawians live in rural areas and depend on farming for their livelihood. Per capita land holding and income are low, estimated at about 2 ha and US$160, respectively. The poverty of Malawians has meant pressure on catchment areas of rivers, with over-cultivation, poor management of cultivated fields, and indiscriminate cutting down of trees. In addition, there is proliferation of riverbank cultivation, as these areas offer fertile, alluvial soils from degraded upland areas. All these lead to river sedimentation, water pollution and fish habitat alteration. The dire poverty also means that fishing of mature fish stocks that migrate upstream to spawn is rampant. To date, fish species inhabiting rivers that flow into Lake Malawi such as Opsaridium microlepis, O. microcephalus, Barbus eurystomus and B. johnstonni, face a threat to extinction due to these activities. In the late 1990s, the Malawi government introduced a community participatory fisheries management program. This seems to have had little success to managing fisheries in Malawi. The paper discusses results from a recently conducted focus group discussion involving over 100 influential individuals involved in co-management of fisheries in rivers and lakes of Malawi. The complexity of managing natural resources including riverine resources in poverty-stricken communities is noted.
Title: Participatory investment and conservation opportunities as alternative non fishing income generating sources for Lake Mweru, Zambia

Key words: Luapula River; livelihoods; alternative occupations; income generation

A study was conducted in 2001 on the Mweru-Luapula fishery where there has been an over dependence on fishing that has resulted in depletion of the fish stocks and extinction of some species. Limitations have been placed on the fishery since colonial times but have never contributed to fish conservation. This study aimed at exploring alternative to the fishery through non-fishery income generating activities (NFIGAs) and set strategies which will, directly or indirectly, diversify opportunities for income generation among the target study groups and promote community participation in fish conservation. Nchelenge district on the Mweru-Luapula system has experimented with various non-fishery income generating activities, some of which have collapsed. Most fisherpersons are willing to work as community groups although little assistance is received from government institution, which are faced with constraints of financial and skilled labour. Lack of security intensification in border villages has also contributed to the collapse of some NFIGAs. It was also observed that most of the community based NFIGAs operate below par due to lack of financial and skilled labour. They are also operating without Environmental Impact Assessments. Illiteracy levels are high among fisherpersons so programme implementation is hampered. This has prompted NGOs to take up programmes in capacity building and sensitising fisherpersons. The study area has a potential for tourism because its abundant resources could be exploited and utilised commercially. These resources include open lakes and rivers, lake shores, forestry, precious stones, herbal medicine and mango and other fruit trees. Suggestions are made to build on this experience to create further opportunities to take people out of the fishery.
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Title:  Linking key attributes of the hydrological regime to ecological patterns and processes: Understanding relationships between fish and flow in an Australian subtropical river

Key words:  Australia; flow; hydrology

Identifying key attributes of the hydrological regime that are important drivers of ecological patterns and processes is critical to the understanding and effective management of river-floodplain ecosystems. Here, we describe a process to link flow to the structure and function of fish populations and assemblages. Of primary importance is the identification of key attributes of the hydrological regime that can adequately yet simply describe the main features of a river’s flow regime with respect to the magnitude, frequency, duration, timing, rate of change, seasonality and predictability of flows. These attributes are widely hypothesised to be of ecological importance across a hierarchy of spatial and temporal scales (see companion paper by Marsh and Kennard, this proceedings). We then demonstrate a simple method to explicitly define our conceptual understanding of the links between these key attributes of the flow regime and predicted biological responses. These responses include variation in the structural and functional characteristics of fish at the population level (e.g. species abundances, age structure, year class strength, reproductive phenology) and assemblage level (e.g. total density, biomass, richness, and species composition), across the spatial and temporal scale hierarchy. Finally, we attempt to validate our conceptual understanding of the links between hydrology and fish using example data from the Mary River, a sub-tropical river in south-east Queensland, Australia. Fish species composition, abundance and biomass data was collected from 17 locations sampled on 10 occasions between June 1994 and June 1997. Life history data was collected monthly between June 1997 and June 1998 for a subset of species and locations. This data was used to generate a set of biological indices describing structural and functional attributes of the fish fauna. Daily hydrological data available for each site was used to generate indices describing those key attributes of the flow regime identified as being biologically important during conceptual model development. Multivariate statistical analyses demonstrated strong relationships between hydrological and fish indices at a range of spatial and temporal scales but also revealed a substantial amount of unexplained variation in the fish data. The results highlight other potentially important causal mechanisms, particularly the interaction between hydrology, hydraulics and landscape-scale habitat features. The implications of this for effective management of river-floodplain ecosystems and their hydrology are discussed.

Paper withdrawn but permission given to include abstract
Title: Impacts of selective & non-selective fishing gears on the inland waters of Bangladesh

Key words: Bangladesh; fishing gear; regulations

In Bangladesh inland waters are arbitrarily classified as: i) Inland open waters & ii) Inland closed waters. Inland open waters are further classified into primary & secondary rivers, natural depressions (beels), flood plains, oxbow lakes, borrow-pit canals, natural canals, etc. Bangladesh is one of the largest and richest floodplain systems of the world. Including the three main rivers, 700 smaller rivers and streams totaling 22,155 km, dissect various terrains in their drift. It has a total inland water area of 4.3 million hectare (ha) of which 94% are open water capture fisheries and 6% closed water culture fisheries. An estimated 1.03 million ha rivers and estuaries, 0.82 million ha floodplains, 0.11 million ha beels and 0.06 million ha Kaptai lake offer tremendous scope and potential for augment fish production. The majority of Bangladesh fishers use traditional gears of various types, forms and sizes. One type of fishing gear may have different names in different regions, and some of the gears are named after the names of the target fish specie. The topography of the area together with the habitat of the fish plays a significant role in the selection of the fishing gear. The wide range of non-selective fishing gear used indicates that bio-diversity concerns do not prevail and that short-term socio-economic benefits are considered more important among professional as well as non-professional fisherfolk. In addition, many of these fishing gears are limited and regulated by national fishery law. Nevertheless the variation in gears shows that most fishers do not comply with the existing fishery act and fishing regulations and are not concerned with possible over-exploitation of the stocks. The catch from inland waters has declined over the decades largely due to illegal fishing methods and over exploitation. To compensate for this there is a need to regulate particular fishing gears in particular seasons and so lead to more efficient fishing and higher sustainable yield. An awareness/training programme should be extend to the fishermen to build up their knowledge of fishing laws and also to set up an effective linkage between relevant agents and the respective organizations to achieve this goal.
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Title: A strategy to rehabilitate native fish in the Murray-Darling basin, south-eastern Australia

Key words: Murray-Darling Rivers; biodiversity; rehabilitation; participatory management

The Native Fish Strategy for the Murray-Darling Basin is a substantial shift in the restoration and conservation of native fish in Australia. It engages community ownership in the restoration of fish populations in large river systems that cross jurisdictional boundaries. The strategy is long-term (50 years) but operates as a series of 10-year ‘working documents’. It introduces a management structure, which includes a scientific reference committee and a community advisory committee that includes representatives of many stakeholder groups, including indigenous peoples. The Murray-Darling is one of the world’s largest catchments, covering more than 1 million km² and one seventh of the Australian landmass. This system flows over 2500 km from source to the sea and produces agricultural produce to the value of $Aus 1 billion each year. The basin crosses the boundaries of four States and together with the Commonwealth encompasses five legislative and many governmental departmental jurisdictions. The natural ecological functioning of the Murray-Darling rivers is at risk. Native fish communities are only 10% of those prior to European settlement. Eight of the 35 native fish species are nationally threatened and 16 species are listed as threatened regionally. Eleven alien species of fish are now present and comprise 95.6% of total catch in the Murray River region. Commercial fisheries are no longer viable and the recreational fishery has substantially declined. Without intervention the levels of native fish populations in the Basin are expected to fall in the coming 40 to 50 years. The Native Fish Strategy seeks rehabilitate native fish populations to 60 per cent of their estimated pre-European settlement levels after 50 years. Native fish management in the past has generally been single issue dominated and has been undertaken on an individual State-by-State basis. This new Strategy is ecosystem based and uses on ground management, not only to improve the status of native fish in the Basin but also to increase understanding of the system. Factors contributing to the deterioration of native fish populations and fish habitats include: flow regulation, habitat degradation, lowered water quality, man-made barriers to fish movement, the introduction of alien fish species, fisheries exploitation, the spread of diseases and translocation and stocking of fish. The Strategy delivers specific goals and targets through a series of strategic actions that involve government agencies, regional catchment organisations and a wide range of community groups.
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Title: Biodiversity status of fishes inhabiting rivers of Kerala (India) with special reference to endemism, threats and conservation measures

Key words: Kerala; India; fish biodiversity, endemism, exotics, conservation

Kerala has 41 west and 3 east flowing rivers with a total length of 95,000 km and a water area of 3500 ha. These rivers originate from the Western Ghats, from elevations as high as 2800m MSL. They are inhabited by 170 fish species belonging to 12 orders and 28 families. Recently, 20 new fish species were described. Among the 170 species, 10 species are known ornamentals and 60 more have potential for development. Four species are introduced and 30 species are endemic, 18 species are critically endangered, 32 are endangered and 31 are vulnerable according to IUCN criteria. Among the 18 critically endangered species, 7 species are confined to a single locality while 5 species are confined to 2 locations in the same river. Some species showed a population reduction of about 99% over the past two decades. More than 90% of the species reported so far from Kerala were recorded from 5 major river systems, the Kabbini, Bharathapuzha, Chalakudy, Periyar and Kallada rivers. Fish species diversity shows an inverse relationship with altitude. There were significant differences in species diversity and abundance at the same altitude in different rivers. Some of the rare and endangered species are confined to upstream microhabitats and altitude appears to be significant in maintaining some of the microhabitats and habitat variables preferred by these endemic and endangered fishes. The major threats to the fish biodiversity in the rivers and streams of Kerala are habitat alteration due to deforestation and intensive agriculture within the catchments, industrial, agricultural and domestic pollution, habitat destruction by sand mining, indiscriminate fishing by dynamiting and poisons, destructive fishing using very small mesh sized net and massive removal of brood stock due to the intensification of fishing during monsoon periods. There are interactions between introduced species and indigenous ones, through competition for food and space. The declining freshwater fish biodiversity in Kerala can only be countered by management for including the protection and preservation of the microhabitats of endemic and endangered fishes, development of captive breeding techniques for threatened fishes, declaration of spawning grounds as aquatic sanctuaries, preservation of germplasm of critically and endangered species, ex situ and in situ conservation, and the framing of appropriate legislation and policy by the Govt.of Kerala against unethical exploitation of fishes.
The River Niger is the fourth most important river in Africa. It is 4200 km long with an estimated watershed area of 1 125 000 km². It traverses a variety of ecological areas shared by a number of countries in the West African Region: Guinea, Mali, Niger and Nigeria for its main course; Côte d’Ivoire, Burkina Faso, Benin, Chad, and the Cameroon for its tributaries. The mean annual flow is 6 100 m³/s. Since the beginning of the century, the River Niger has been subjected to several natural and anthropogenic perturbations: Firstly a very long drought period starting in the 1970s when the discharges decreased strongly and the areas flooded were considerably reduced. Secondly, the building of agricultural dams and numerous irrigated perimeters fed by water pumping modify the hydrologic conditions of the Niger, increasing the effects of drought. These hydrological variations led to changes in the flora of the river-floodplain system and also to fragmentation or disappearance of habitats usually occupied by numerous fish species. The biological cycle of the fish that were adapted to the former hydrological cycle was modified to varying degrees, although the species richness of the river evaluated at 260 fish species did not change. Nevertheless, fish abundance changed from 1968 to 1989, fish landings declined from 90,000 metric tons to 45,000 metric tons in the Inner Delta, and large sized species were gradually eliminated to be replaced by a sequence of small sized and more productive species. The river is fished by dynamic and labour intensive small scale fisheries, conducted by full- and part-time fishermen, using diverse fishing gears adapted to various biotopes and seasonal variations in the ecosystem and the fish communities. Women play an important role in fish processing (drying or smoking fish) and marketing. In several countries around the River Niger watershed, the fisheries have been fished-down by dramatic increases in fishing activities. Aquaculture has been introduced as an accepted strategy to meet the very high demand for fish products. Aquaculture was introduced in Nigeria and Côte d’Ivoire in the 1950s based on indigenous species of tilapias and catfishes but is still in an embryonic state. The River Niger Commission was created in 1964 and evolved in 1980 into the Niger Basin Authority (NBA) to promote cooperation among the member countries and to develop its resources, notably in the fields of energy, water resources, industry, agriculture, forestry exploitation, transport and communications.
The Oueme Delta is a large inland swamp of 9000 km² (50000 km² for the Oueme basin) situated in southern Benin, which receives an annual flood from the highlands of northern and middle Benin. A study of fish and fisheries carried out from 1999 to 2001 gave an inventory of 71 species of fish distributed in 27 families and represented 59.2 % of the total Oueme fish fauna. The mormyrids (10 species), cichlids (9 species), characids (6 species), cyprinids (5 species) and clariids (5 species) are the most numerous. The characteristics of the fish fauna in the different habitats are described. Fishing activity is practiced during the year, but it is more intense at the beginning of the dry season between November and March when fishes are confined to the channel of the river. Usual fishing gears are cast nets, various kinds of traps, gillnets of various mesh sizes, long lines, lift nets. Some methods including ‘Acadjas’ (brush parks) and ‘Ahlo’ (fish holes) are traditional techniques of fish farming adapted to the particular characteristics of the Oueme Delta. The ‘Acadja’ and the ‘Ahlo’ yields vary respectively between 1.2 and 15.5 t.ha⁻¹.yr⁻¹ (average, 5.7 t.ha⁻¹.yr⁻¹) and 0.16 to 1.6 t.ha⁻¹.yr⁻¹ (Mean 0.82 t.ha⁻¹.yr⁻¹). Because of the intensity of fishing, consequence of a constant increase in the population fishermen and the permanent reduction of the size of fish, the Oueme Delta is over-exploited and the fish biodiversity is more and more threatened. Suggestions are made for the conservation of the resources taking into account the ecological characteristics of the Delta.
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Title: Using Small-Scale Exclusion Experiments to Predict Impacts of Fishing on a Tropical Floodplain River Fish Assemblage

Key words: Orinoco River; predator prey interactions; assemblage structure

Despite the centrality of experiments in most ecological research programs, there has been little experimental work in tropical floodplain rivers. In this paper, we briefly review experimental work in tropical lotic systems, and then detail a case study of small-scale experiments that provide insight into large-scale fish assemblage patterns. In the Río Cinaruco, Venezuela, we previously have demonstrated experimentally a size-based response of multiple prey taxa to piscivore exclusion; only individuals > 40 mm responded to the exclusion. At a larger scale in the river, fishermen heavily impact large-bodied fish species using large, commercial-grade nets. As a result, some floodplain lagoons support robust populations of large-bodied piscivores, whereas others have had piscivore populations greatly reduced. In this paper, we describe differences in prey fish assemblages in netted and un-netted lagoons. In netted lagoons, assemblages are dominated by fishes > 40 mm. The two most common species in netted lagoons responded most significantly to piscivore exclusion in our small-scale experiments. We demonstrate small-scale experiments may enable prediction of larger-scale impacts on aquatic ecosystems, and that field experiments can be extremely valuable in guiding conservation strategies for large floodplain rivers.
Title: Modern modelling methods to predict fish communities in River

Key words: Garonne River; biodiversity; conservation; fish communities; artificial neural networks; methodology

Ecological communities are the expression of fundamental biological processes at various scales of time and space. Analysis of these processes and the relationships that exist in the community, their degree of importance, and their structure, requires the observation of variables related to the operation of the system. It is essential to take into account the hierarchies and the evolution of the various key factors responsible for the current state of the community when considering the design of habitat management strategies to conserve or restore a community or environment. In ichthyology, the comparison of the descriptors of the environment and of living fish species, allows us to specify the relative importance of environmental variables to the mechanisms that structure the communities. They also allow the impact of various disturbances on the aquatic biocenosis to be tested. The complexity of ecological systems often results in non-linear relations between variables, whereas the majority of proposed models assume relations to be linear.

Artificial neural networks (ANN) are not restricted by assumptions of linearity of variables and are known for their capacity to take into account the variables in their natural states. ANNs have been used successfully for the modelling of various phenomena in many scientific. In the last few years, these techniques have been shown to be excellent modelling tools that support traditional statistical techniques in the field of ecology. In this work, we use ANN to predict the local fish species richness in the Garonne river basin using 3 environmental variables (distance from the source, elevation and catchment area). Commonly, patterns of fish species richness have been investigated using simple or multi-linear statistical models. Here, we used ANN to develop stochastic models of local fish diversity. Two independent data sets were used to build and test the model and to validate it. Correlation coefficients between observed and predicted values both in testing and validation procedures were highly significant. The ANN model obtained using only 3 environmental variables succeeded in explaining about 70 per cent of the total variation in local fish species richness. Through these findings, ANNs can be seen as a powerful predictive tool compared to traditional modelling approaches. The information provided by the models seems in perfect agreement with current ecological knowledge and it has the capacity to synthesise natural phenomena hitherto difficult to understand with conventional methods.

Paper withdrawn but permission given to include abstract
Title: Ecosystem function and the basis for fish production in the Orinoco River at its floodplain

Key words: Orinoco; fish community structure; floodplain ecology

A fifteen-year study of the Orinoco River main stem and the adjacent fringing floodplain has shown that the major ecosystem functions as well as community structure can be explained to a large extent by simple hydrologic and geomorphic factors, despite the spatial complexity of the floodplain. The Orinoco system is not significantly regulated hydrologically and much of the natural vegetation types remain intact so the system can be observed in an essentially natural condition. Functional units of the floodplain consist of 2300 uncanopied floodplain lakes surrounded by floodplain forest. The annual sequence of events for any basin is dictated to a large extent by hydrology and involves an annual rise of the river by approximately 10 meters along the main stem. Individual floodplain basins differ, however, in predictable ways due to their differing mean depths, sizes, and elevations above the river channel. While the waters are unified during inundation, fish communities diverge in composition as floodwaters retract from the floodplain. Community composition can be predicted on the basis of changes in transparency, which in turn is controlled by geomorphic factors. Mass-balance analysis shows that the floodplain does not yield significant amounts of organic matter to the main channel. The floodplain functions as a closed system even though it is hydrologically open to the river, because of high efficiency in internal processing of the organic matter generated on the floodplain. Studies using carbon isotopes show that floodplain foodwebs are almost entirely dependent on algal carbon, even though algal production accounts for only approximately 2% of the available carbon on the floodplain. Use of stable isotopes of nitrogen in conjunction with estimates of secondary production by invertebrates on the floodplain shows that high fish production on the floodplain is possible, despite the focus of food chains on a relatively small carbon source, because of foodweb compression involving short food chains. Changes in critical habitat such as macrophyte mats, in the quality or quantity of the main energy source (phytoplankton and attached algae), or in food chain structure can have drastic effects on the functioning of the Orinoco floodplain. The direct linkage between ecosystem and the hydrologic and geomorphic features of the floodplain indicates that major physical alterations on the floodplain will have strong and probably adverse consequences for Orinoco floodplain ecosystem functions and fish production.

Paper withdrawn but permission given to include abstract
Fish Dynamics in the rehabilitated polders of Prey Nup (Sihanoukville, Cambodia)

Title: Fish Dynamics in the rehabilitated polders of Prey Nup (Sihanoukville, Cambodia)

Key words: Mekong, S.E. Asia, Polders, impact assessment

Physical rehabilitation (construction of dykes and water gate) along the shorelines of the Prey Nup area in 1998 was done to preserve rice field areas from being washed-off during high tides. The four first polders constructed resulted in the recuperation of about 5,500 ha for rice field cultivation. The area before was also a common dwelling place for both freshwater brackishwater and marine fish species (43 species) before the rehabilitation. Information regarding effects of seasonal variations on species richness and stock assessment were based on captures by native fishermen using 11 different kinds of fishing gears from 1998 to 2001. The influence of the renovated area on the fish community richness specific, stock recruitment and dynamics were investigated. Surveys made showed that the marine fish species (11) were completely wiped-out from this area leaving only about 31 brackish and freshwater species. These remaining species, coming from the upstream catchment areas, colonised these rice fields especially during the rainy season (June to October) when annual water level elevates to an average of 2 m. Annual catch is estimated to 3,742 tons for the whole area where 92% was captured using 6 main gears (gill nets, individual and line hooks, cast nets, traps, scoop nets). Catch during the rainy season was estimated at about 79% of the total annual catch. The three main commercial fish species captured were *Channa striata* (Trey Ptork), *Clarias spp.* (Trey Andeng), *Anabas testudines* (Trey Kranh) and *Notopterus notopterus* (Trey Slat).
Management of fisheries in large river systems is complex due to diversity of species and stocks, multiple gear, and many and diverse stakeholders. Gathering scientific and traditional knowledge is hindered by a separation of responsibility for research from the users. Management authorities are often weak and there are often conflicts. Experiences of LGL personnel in British Columbia (BC), Canada suggest that close involvement of all stakeholders in issue identification, collaborative research and collaborative management can substantially reduce conflict, improve scientific knowledge and, ultimately lead to sustainable management.

The salmon fishery in the Nass River exploits six species and numerous stocks. Research and management initiatives over the last 12 years have resulted in improvement in knowledge, management, and economic returns to the First Nation Nisga’a people. Key elements have been: the settlement of land claims that have given the Nisga’a treaty rights over the land and water, close involvement of the Nisga’a in research and management; and design and development of a harvesting research tool, the fish wheel, that simultaneously allows stock assessment, selective harvesting and minimization of by-catch.

On the Fraser River, BC, the largest freshwater fish in North America, the white sturgeon (Acipenser transmontanus) is threatened. Historic overfishing, habitat loss and degradation, reduction in food abundance, illegal harvest, and incidental catch have kept the population from rebuilding. Current development proposals threaten the remainder of the population. A conservation and public awareness campaign with close involvement of stakeholders has lead to a population assessment and monitoring program that supports over 100 trained volunteers including fishing guides, recreational fishers, First Nations and commercial fishermen, fisheries monitors and enforcement personnel, and test fishery operators. These volunteers have tagged and released over 12,000 sturgeon in the Fraser River and assisted in recapture. The program has provided the first reliable population estimates, increased public awareness, provided key biological and life history information, and has established a means of monitoring the population for recovery.

Based on these experiences LGL Limited has been assisting stakeholders in other complex systems to develop sustainable resource management. In Bristol Bay, Alaska preliminary results demonstrates that close involvement of stakeholders is leading to increased consensus, decreased conflict and potential improvements in managing the salmon fishery. Similar in Northern BC and the Yukon Territories, LGL has been assisting the Khaska Deni First Nations to develop and implement resource management plans for forestry and wildlife and assess the potential impact of resource development industries.
Title: The importance of temporal scale in determining hydrology–ecology interactions

Key words: Mary River; Australia; hydrology; models; methodology

Understanding the effect of hydrology on aquatic biota has been a major focus of research in freshwater fisheries for 20 years. A common method of determining the effect of hydrology on aquatic biota is to compare a suite of long term hydrologic indices with biological data. We propose that in determining hydrology-ecology interactions, the temporal scale for considering the effect of hydrology on biota should range from very short term (real time stress for individual organisms) to long term (habitat preferences defined by long term average conditions). We present and test an hydrologic analysis method based on conceptual models of the biological response at three distinct temporal scales that are based on the life span of target organisms: 1) The long term (multiple generations i.e. 10 years for fish) hydrologic record reflects broad biological patterns such as species richness. 2) The medium term (1-multiple generations i.e. 1-10 years for fish) hydrologic record reflects shorter term population patterns such as the abundance of certain species. 3) The short term (less than one generation) hydrologic record reflects individual species responses to short term hydrologic events such as the age distribution of a species being effected by an unseasonal flood/drought. The hydrologic analysis method presented here is based on the principles of defining the magnitude, frequency, duration, timing, rate of change and predicability at three alternative temporal scales using hydrologic indices that are ecologically meaningful. The proposed hydrologic analysis method is presented at three temporal scales for the Mary River catchment in Queensland, Australia. The conceptual models of biological response to alternative temporal scales presented here are tested in a companion paper by Kennard et al this symposium.

Paper withdrawn but permission given to include abstract
In response to the growth of Amazon commercial fisheries, a loose regional network of community-managed lakes has proliferated throughout the Amazon floodplain system. This approach has been widely perceived as a promising alternative for the sustainable management of floodplain fisheries. Over the last decade communities, NGOs, grassroots organizations, and IBAMA, the Brazilian environmental agency, have worked together to develop a co-management system for floodplain fisheries based on the legal recognition of community fishing agreements. With the main elements of the new co-management system in place it is now possible to evaluate the potential of this approach. This paper evaluates the experience of the Santarém region of the Lower Amazon, the major regional experiment in fisheries co-management. Here, while considerable progress has been made in setting up a functional co-management system, it suffers from serious problems that undermine its effectiveness and threatens its long term sustainability. The key issues are government support for enforcement and legal and institutional mechanisms through which community management organizations can capture the benefits of their efforts. The major challenge facing communities is how to escape the low equilibrium trap towards which the management system may be sliding. Organization of marketing systems for managed lakes to tap markets that value sustainably managed fish, while problematic, may be the most realistic alternative available.
Time series analysis of physical instream habitat and the riparian zone is not done as frequently as would be beneficial in understanding the fisheries aspects of the aquatic ecosystem. This paper presents two case studies to demonstrate how time series analysis may be accomplished. Time series analysis is the analysis of the variation of the physical habitat or the hydro-period in the riparian zone (in many situations, the floodplain). The key activity in time series analysis is the exploration of links between the ecology and the hydrology of the system. The first case study is of brown trout (Salmo trutta) physical habitat in the Gunnison River of western Colorado. In this case the most limiting habitat is fry habitat, but additional limits are caused by the habitat during spawning and incubation. In general, good spawning flows followed by poor incubation flows results in lower fish production than would be expected from the quality of the fry habitat alone. In contrast, good spawning and good incubation would be expected to result in fry production larger than expected. Incubation occurs during the winter months. In Colorado winters can be from cold and dry (low winter runoff) to warm and wet (high winter runoff). Time series analysis of the availability of the channel margin for use by fish or to determine the hydro-period for vegetation was done for a location on the Green River in Utah. This analysis showed the average active channel margin was 8.1 meters before completion of Flaming Gorge Reservoir and 7.3 following construction; this is an 11% reduction. The reduction in the active channel margin may not be the important change - there appears to be a change in the length of the periods when the channel margin is not flooded; hence available for colonization by vegetation. There were six years where the channel margin was not flooded for the 21 days used in the model (post-reservoir) compared to a pre-dam maximum of three. Time series analysis should be part of any investigation of changes in the aquatic ecosystem and should be added to the river discontinuity concept used by some aquatic ecologists to explain aquatic ecosystem changes that occur in a river downstream of a reservoir.
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Title: Risk assessment of a floodplain migratory fish subject fisheries and dam-operation procedures

Key words: Parana River; risk assessment; multi-purpose management; Prochilodus; modeling

In large tropical rivers there is an urgent need for the development and application of techniques that integrate existing information and take into account uncertainties to help managers in the decision-making process by formally computing the risk of future actions. Large rivers are liable to impacts including dam construction, pollution and habitat change since they are used by several stakeholders each with different objectives. The management of the basin should take into account the trade-off between different actions. Migratory fish are the first to suffer the impacts of the different management actions since they use several habitats during their life span. For example, Prochilodus lineatus of the Upper Paraná River floodplain (Brazil) uses tributaries as spawning grounds, floodplain lagoons as nursery areas and the downstream Itaipu reservoir as feeding ground. In the summer, when the river has a high flow, the population migrates to spawn and the larvae are able to colonize the lagoons if the floodplain is inundated. Regulation of flow by the upstream Porto Primavera dam seems to determine recruitment success. The juveniles spend at most two years in the floodplain and then move to Itaipu reservoir, where they become vulnerable to commercial fishing. The construction of a model that keeps track of the population as a function of fisheries and dam-related mortalities and that includes uncertainty will help decision-making by fisheries and hydroelectric managers. A lagged recruitment, survival and growth model with recruitment as a function of flood was developed for the migratory curimatid Prochilodus lineatus of the Upper Paraná River basin. The model was fitted to four historical data series using the Bayesian paradigm and posterior distributions obtained to perform a risk analysis. A risk analysis is the evaluation of the consequences of alternative management action under uncertainty. The key elements of a risk analysis are the alternative states of nature, the alternative management actions, the expected outcome of a management action for each state of nature and the probability of alternative states. The alternative states of nature considered in this model are range of values for the current biomass. The management actions considered integrate fisheries and dam-operation management. The fisheries policies considered were - no harvest, constant catch and constant harvest rate. The dam-operation procedures investigated were normal flow variability for the floodplain similar to that prior to pre-upstream dam construction, and several years of drought in a row. The expected outcomes considered were the ratio of the biomass four years in the future to the current biomass. A ratio less than 1 indicates population decline. The results indicated that the population has a highest risk of declining when both fisheries and human-induced dry periods occur. Managers of both the dam and the fisheries should coordinate their actions in order to minimize the risk of population decline.
The Magdalena river basin is the most important area of Colombia in terms of development and economy. About 80% of its population (28.4 millions) lives in the basin and traditionally its waters have produced more than 60% of the fish consumed in the country. Nonetheless from a production of nearly 80,000 tons of fish per year in the late seventies, today it produces only one tenth of that amount. Furthermore of the 10% catch today, almost half corresponds to an introduced genus, the tilapias. There are many reasons for the decline: extracting gold from sediments, removing huge areas of the alluvial plains, swamps and marshes cut off from the main channel of the river by cattle owners trying to get private property rights to swampy areas that by law and tradition belong to the state and are for public use (fishing areas); construction of dikes to hinder the floods and expansion of the cattle ranching area through forced expulsion of fishers from the marshes by armed intimidation; overfishing of the marshes and main channel of the river by landless peasants trying to survive as fishermen. Overfishing in the main channel occurs particularly during the fish migrations in the dry period that precedes Easter. The construction of hydroelectric dams in the headwater zones cuts the migration routes of the economically most important species.

Paper withdrawn but permission given to include abstract
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Title: Refining and setting to work indicators for fish exploitation rate assessment in tropical rivers

Key words:  Niger River; fishing-down process; modelling; methodology

It is accepted that models designed for single large marine stock are not relevant to multi-species fisheries. It is a challenge to propose more robust models and indicators which would be useful for assessment of the exploitation level of multi-species fisheries, especially in tropical inland waters. A recent review proposed a set of indicators to show the status of the resource by reference to the “plateau” model of catch-effort response. These indicators are mean length of individual, species composition, total yields and mean catch per fishing trip (CPUE). Despite the growing consensus on the relevance of this framework, a number of difficulties remain when one attempts to apply it operationally. Apart from the well known logistic problems more conceptual issues arise: Firstly, the lack of models and reliable data to predict useful reference values means that it is difficult to establish “normal” or “critical” size structures of fish in a tropical floodplain system? Secondly, the strong environmental seasonality affecting tropical rivers means that the observed parameters exhibit greater variations from month to month than inter-annually. Given this statement, would it be preferable to compute the annual value of one particular indicator by averaging twelve monthly estimates or by processing only data collected during a selected “meaningful” season? A monitoring system set up in the Niger Inner Delta (Mali) attempts to address these problems and obtained a database that includes 1280 records of fishing trips and actions (including trap catches) and 27000 individuals measurements. Individual lengths are more widely dispersed during the first half of the fishing campaign (corresponding to falling waters). Moreover, it appears that the proportion of small-sized fish in catches from this first half is positively correlated with the last flood peak, that leads to strong inter-annual climate-induced variations. As a practical outcome, it seems sensible to exclude data collected early in the campaign when using mean length as an indicator of exploitation level. Another result deals with the slope of the declining CPUE relationship throughout the campaign, which could be used as an indicator of the removal rate of the fish stock due to fishing. To evaluate inter-annual degradation, we propose and test the computation of variance of CPUE observed for a given campaign relative to the value predicted by a “normal” flood-CPUE response model based on data collected during the previous years.

Paper withdrawn but permission given to include abstract
Environmental governance is inherently a political process. It is a relatively unique political process because biogeophysical systems of environment are essentially non-human actors. Human actions are constrained by the rules of biogeophysical system in addition to human created rules. In order to analyze institutions-environment interaction, we need to conceptually treat biogeophysical systems of environment as an *actor* rather than a *factor* in environmental governance. Political process in governance of environment is about crafting institutions (governance strategies) to address both human problems and environmental problems simultaneously. Empirical and theoretical understanding of environmental degradation caused by human actions can be addressed by examining whether human institutions fit biogeophysical systems of environment. Young (2002: 56) coined this notion as “problem of fit.” Based on the empirical findings from the governance processes of the Rhine pollution cleanup regime, this paper argues that there are two parts in the problem of fit as a whole. The first part is that human institutions have to fit human systems (economic, political, and social contexts). The second part is that human institutions have to fit biogeophysical systems they address. The paper further asserts that if institutions fit human systems within which they operate, it is more likely to fit biogeophysical systems they address.
Title: Component and distribution of Pangasiidae family in the Mekong River Delta, South Viet Nam

Key words: Mekong Delta; Pangasiidae; overfishing; fishery management

The composition and distribution of the Pangasiidae family in the Mekong River Delta, southern Vietnam, were studied by eight samples from April 1997 to July 1999. Fish species were mainly collected by trawl, but long-lines, hand-lines and gill nets were also used at different sites along Tien and Hau rivers. The results of the investigation showed the presence of 9 species of *Pangasius* and 1 species of *Helicophagus*, of which *Pangasius bocourti*, *Pangasius conchophilus*, *Pangasius hypophthalmus*, *Pangasius larnaudii*, *Pangasius kremphi* and *Pangasius kunyit* (new species) are all of high commercial value. Almost all Pangasiid species were distributed in freshwaters, but *Pangasius kremphi* and *Pangasius kunyit* occurred mainly in brackish water. Pangasiid species were distributed mainly from Vinh Xuong to Hong Ngu in the Tien River, but they were particularly abundant at the Vam Nao confluence, in Hau River, where the current is rapid and the water deep. Pangasiid fishes play an important role in the inland fisheries of the Mekong River Delta, VietNam. Due to recent overfishing of Pangasiidae and the threat that it represents for some of these species. Increased control and management from local government is needed for sustainable fishery resource development and protection.

Paper withdrawn but permission given to include abstract
Inland fisheries make an important contribution to rural livelihoods in many developing countries. Water resources development for irrigated agriculture often has significant and complex impacts on inland fisheries, either negative or positive. The assessment and management of such impacts is important in order to minimize undesirable outcomes of irrigation development in terms of livelihoods and/or aquatic biodiversity. This paper outlines the application of a holistic and participatory approach to fisheries impact assessment of the Kirindi Oya irrigation scheme in Sri Lanka. The overall impact of irrigation development on fisheries production in the watershed has been assessed as moderately positive, with production from reservoir fisheries outweighing the estimated loss of production from river-floodplain fisheries. Stakeholders identified increased drawdown in reservoirs due to very high irrigation demand, and drainage water inflow into coastal lagoons as the main physical impacts of irrigation development on fisheries. These impacts led to conflicts between farmers and fishers regarding water management in the reservoirs and lagoons. Underlying these impacts and conflicts are weak linkages between irrigation and fisheries institutions. Stakeholders identified rehabilitation of irrigation infrastructure and increased water productivity in agriculture as key measures to reduce both, drawdown of reservoirs and drainage flows into the lagoons. Improvement of institutional arrangements for water management is crucial to resolving conflicts and ensuring an equitable allocation of water between agriculture and fisheries.
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Title: Impacts of irrigation development on capture fisheries in the rice-based farming systems of Southern Laos

Key words: Lao PDR; irrigation; rice-fish interactions; livelihoods

Fish populations inhabiting the rivers, streams, natural wetlands and paddy fields of rice-based farming systems support capture fisheries of major importance to local livelihoods. Water resources development for irrigation has the potential to impact significantly on these fisheries by modifying habitats and their connectivity, as well as patterns of exploitation. We conducted a field survey to establish the impacts of small to medium sized weir and dam irrigation schemes on local fisheries in the rice-based farming systems of southern Laos. The survey was replicated at the irrigation scheme level. Impacted sites were paired with non-impacted controls within the same watershed. Weir schemes were associated with a significant decline in households and per-area catches which was not fully explained by a concomitant change in fishing effort. Dam schemes caused no significant overall decline in catches, but a very significant re-distribution of catches and effort into the newly created reservoirs. In both weir and dam schemes, changes in catch were largely explained by changes in fishing effort. No significant impacts on fish species richness were detected. Small-to-medium sized irrigation schemes have only moderate impacts on local fisheries in rice-based farming systems. Net impacts of weirs may be more pronounced than impacts of dams. Rather than being fundamentally degraded as often assumed, fish populations and the fisheries they support can remain productive and diverse within irrigated rice systems. Protecting and enhancing wild fish stocks in such systems is likely to generate social and ecological benefits.
After more than 50 years of intensive river regulation of the Rhône River, a large restoration program has been recently initiated. This 10 year program has two main objectives: to increase the minimum flow in by-passed sections, and to restore several side-arms with varying connections to the main channel. This project was initiated by river managers and catchment residents without clearly-defined ecological objectives: the initial impetus was expressed from social and aesthetic points of view so the first task for scientists was to translate this demand into scientific terms. Currently, the program will tackle only 8 sections of the upper and lower parts of the Rhône. The total amount of funding for the restoration program is more than 150,000,000 Euros for 10 years, and the cost of the scientific survey program will approximate 5% of this amount. One early task was to determine the ecological value of the minimum flow within economic constraints. Hydraulic and biological models have been used to answer this question, focusing on long term data on fish community and habitat preferences. These studies aimed to predict changes in fish community composition related to hydrological changes (river width, depth and flow velocity) associated with discharge. Similar work using macroinvertebrate species is in progress. Secondly, river managers have appealed to scientists (including ecologists, geomorphologists, hydraulic engineers, sociologists and economists) to develop and trial scientific survey methods to evaluate the success of restoration. These include: (i) collation of relevant data, (ii) data management (creation of databases and GIS), (iii) identifying critical gaps in the knowledge base, (iv) developing novel protocols for pre-restoration assessments (v) analysing pre-restoration data and developing predictive models of the effects of restoration, (vi) measuring post-restoration responses, and (vii) explaining the success or otherwise of the restoration procedures. This is an excellent opportunity to integrate the long-term responses (e.g. fish) with short-term recolonisation patterns (e.g. macroinvertebrates) in side-arms and the main channel of the Rhône. River engineers can use this to develop protective policies for effective river management and to assess the success of river restoration at several temporal scales. A final goal of this project is to expand the predictive model to encompass the inherent variation among side-arms in their diversity, ecological response and aesthetic appeal.

Paper withdrawn but permission given to include abstract
Title: Fish Yield in Kompong Tralach Flood Plain

Key words: Mekong; small-scale fisheries

Floodplain fisheries are known for their high productivity. This high productivity results from the presence of a complex environment/ecosystem where an important fish fauna is found exploiting large expanses of seasonally inundated land made of diverse habitat types. The population living along the Mekong River basin exploits intensively these rich aquatic resources. Much is known about commercial fisheries, such as the Dai or lot fisheries, whereas the small-scale family fisheries, which researchers believe to account for an important part of the whole Mekong fishery, have only recently begun to receive more attention. At the very central part of MRC’s Assessment of Mekong Fisheries Component activities is the requirement to generate reliable figures on fish production from the Mekong Basin; these figures are essentials to the elaboration of good statistics and good information. The project was a 5-part study, which included a rapid rural appraisal, a longitudinal study of small-scale family fisheries (the Logbook Monitoring Study), the monitoring of Fishing Lot #18 & Piem Chumnik Canal Bag Net fisheries, and a Baseline Survey of 29 villages inside the Study Area. The long-term monitoring study started in mid-September that estimated that over 3,800 ‘fishers’ catch more than 2,500 tons of fish for the study area alone, an area that is just over 8,000 ha. This represents more than 300 kg/ha/year. These results are very high, considering the fact that on one hand we are including here rain-fed rice fields that are less than 10 cm deep that are inundated for only six months out of the year. Rice field fisheries are well known for their significant contribution to the overall floodplain fisheries but that alone is not enough to explain such high values.

Paper withdrawn but permission given to include abstract
Title: Addressing Common Demands of Community Fisheries in the Brazilian Amazon

Key words: Amazônia; community based fisheries; social and economic

The failure to manage fisheries in Amazônia can be traced to the instability of land tenure, inadequate legislation and public policies, the advance of cattle ranching over the floodplains (várzeas) and lack of adequate credit and incentives. Lack of management has led to alteration of the ecological process in the floodplains, a decrease in fish stock and negative social and economic impacts on local communities. In the 90s the sustainable management of fishery resources of the flooded forests and floodplains of Amazônia started to attract special attention from civil society and government, as well as from researchers. Initially, regulations and usage patterns for commercial fishing management were directed to the big undertakings. A normative approach for small communities had not yet been considered, and the main demands of the communities do not influence public fishery policies. These communities, which depend on intermediaries linked to industry, sold their produce and their rights to exploit the lakes at low prices, or were subjected to unfair barter. An effort by non-governmental organizations, fisher colonies, local communities and government, led to changes in this scenario from the mid 90’s onwards. Firstly, the importance to differentiate between fisheries and to support fishing community management actions was acknowledged as a strategy for the use and conservation of the flooded forests and their floodplains. Secondly, a reference document for the implementation of fishing agreements was released by IBAMA as an instrument for community management. Thirdly, donations to support projects in this area were proposed. The First Fishing Community Management Meeting in Amazônia, which took place in May 2002 in Manaus, Amazonas, was an important landmark for fisheries in Amazônia. Fishermen from many regions in Amazônia were assembled to exchange experiences of community management with other fishers and technicians, to evaluate the present situation including the main problems, lessons learned and necessities, and to propose actions to strengthen and to consolidate management practices developed by traditional peoples. The object of this article is (i) to record the efforts of local communities on the participatory management of fishing resources; and (ii) to make clear the existence of demands and proposals recommended by the local communities as subsidies to public policies on sustainable fishing management in Amazônia.
Title: A Comparison Of Chemical Parameters And Biotic Indices For Assessment Of Water Quality In Melen River

Key words: Melen River; Turkey; pollution; indicators; biotic indexes

The Melen River is heavily polluted with poorly treated domestic and industrial wastes. We investigated the responses of the resident and colonising components of the benthic macroinvertebrate community to municipal/industrial/agricultural pollution and evaluated biotic indices for assessing water quality. Samples were collected from 11 stations representing a wide range of types and degrees of pollution. The data were summarised using the indices BMWP (Biological Monitoring Working Party), TBI (Trent Biotic Index), BBI (Belgian Biotic Index), $H^2$ (Shannon-Wiener’s Diversity Index). Also chemical parameters were measured of 11 stations. Finally, results of biotic indices and chemical parameters were compared with each other.

Paper withdrawn but permission given to include abstract
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Nic Pacini

Title: Water for fish: Status and trends in the degradation of inland aquatic resources

Key words: Water supplies; biodiversity; pollution; water management

The growing requirements for readily available, high quality freshwater are becoming increasingly limiting to development. At the same time water quality deterioration is widespread. Risks due to chemical pollutants are not yet generally comparable to those posed by viral and bacterial contamination, however rising industrial and agricultural activities and the mismanagement of urban sewage are rapidly going to change this. This will contribute to the degradation of drinking water supplies and of the numerous ecological services provided by inland aquatic ecosystems. The role of inland aquatic resources as a source of precious fish protein for human survival is generally underestimated leading to mismanagement of this resource through the misallocation of water supplies to less valuable uses and to the further degradation of rivers and lakes due to inappropriate care. Inland fisheries have seen their living space progressively reduced by water abstractions, fragmented by dams, polluted by human activities. As a result, freshwater ecosystems are losing species at a greater rate than other ecosystems. The distribution of freshwater supplies is facing great challenges. The fossil groundwater reserves of Northern Africa, the Mediterranean, the Middle East and parts of central Asia are becoming exhausted and polluted. Nitrates, persistent organic chemicals and heavy metals are common in aquifers in Europe and in North while in Africa and southern Asia nitrate contamination due to the inappropriate disposal of human excreta represents the most serious impact. It is rarely possible to directly relate human resource exploitation to environmental consequences. Moreover, the resilience of terrestrial and aquatic ecosystems tends to dampen and delay the consequences of human impacts to the extent that these often become evident only when major ecological changes have already taken place. Global change scenarios indicate that current trends in temperature rise and environmental degradation are soon likely force managers of land and water resources to define more precise approaches and compensate the increasing resource scarcity with growing information and technical capacity inputs. This should be achieved by reducing water losses and by promoting the integration between irrigated crop production and inland aquaculture, an ancient practice in some parts of the world that, by means of better informed management and more widespread application can lead to higher overall aquatic ecosystem services.

Paper withdrawn but permission given to include abstract
A study on Population Biology of Redtail Barb (*Discherodontus ashmeadi* Fowler, 1937) in the Sirinthorn Reservoir, Ubon Ratchathani Province was conducted from January–December 2001. Data on fish catch in number were collected from gill-nets mesh size of 1.5, 2.5 and 3.5 cm., fish sexes were identified and fecundity were counted. The total number of 37 species were found. Redtail Barb comprised 12.96% of the catch by weight and 9.73% of Redtail Barb by number. Length at age of the first maturity is 5.5 cm. The spawning season of this fish were found throughout the year. The peak spawning season was from June – August. Average fecundity were from 4498 ± 242. Redtail Barb feeds mostly on insect larvae. Some biological parameters were estimated from ELEFAN – I. These included growth coefficient (K) of 1.2/year, maximum length of 14.7 cm., arbitrary age at length in zero of –0.016 year, natural mortality coefficient of 0.877/year, total mortality coefficient of 3.99/year and fishing mortality coefficient of 3.113/year. Some suggestions such as improvement of statistics data collection, use of a suitable mesh size of gillnet and study on nutritional values of the fish are given for future applications in management of Redtail Barb in Thai reservoirs.
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Title:  Catch/Effort Estimation in Karoon River (Shooshtar-Ahvaz), Khoozestan Province, South West Iran

Key words:  Karoon River; Iran; fisheries management

The Karoon is the largest river that drains into the Persian Gulf via the Arvand-Rud and Bahmanshir Rivers in Iran. Local fishermen have long fished in Karoon using artisanal methods. Since the river is more than 150 km, an 80 km part of it (from Shooshtar to Ahvaz) was selected for study. Catch and effort in Karoon River have not been systematically studied until the present study, which was carried out from Dec.2001- Dec. 2002. The area was first surveyed, then observers started to record catch by species, effort and the number of incoming boats at the 7 main landing sites in the study area. Recording of data on catch/effort was distributed randomly in each month. Each landing site was observed twice a week and collected data were extrapolated to whole month in order to estimate total catch and effort on a monthly basis. Management strategies have been formulated on the basis of the results obtained for the study area. Since inland waters in Iran are under jurisdiction and management of the Environmental Protection Organization (EPO), there may be conflicts with the fisheries sector in the adoption and implementation of management strategies.

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Title:  Open-water fisheries in Bangladesh: A critical review

Key words: Bangladesh; fisheries; management; institutions

Bangladesh is crisscrossed by some 230 rivers and numerous seasonal and perennial wetlands, which form a very rich and diverse habitat. Fish resources account for about 5% of GDP and 10% of annual export earning and provide employment for about 1.2 million full-time and 12 million part-time fishermen and workers. The fisheries sector is divided into four sub-sectors – open-water, inland capture, marine artisanal and marine industrial. Of these, the open-water fishery is the most important, contributing about 51% of the total annual catch. This paper critically reviews the status of open water fisheries in Bangladesh. It describes the major attributes of river fish ecology, and the issues this sector faces including the impacts of structural intervention, industrial pollution, agrochemicals, water withdrawal for irrigation and conversion of wetlands. The “open access” nature of the fisheries resources, particularly in the major rivers also contributes to the decline of open water fisheries. The impacts are interfering with fish migration, breeding and nursery grounds, uncontrolled fishing on the other hand is leading to an unsustainable level of fishing of the rivers. The failure to manage the open water fisheries is also an institutional failure. Although various fish habitats (inland as well as marine) may be inter linked, they are managed by different authorities and with different objectives. For example, large inland wetlands in Bangladesh are leased out by district level Land Ministry offices to generate revenue. These offices do not have any training on or understanding of fish ecology or sustainable fisheries management. The existing leasing arrangement discriminates against poor fishermen and favors rich “fish-lords.” This scheme has to be changed to allow for more participatory type community based management. In this context, this paper reviews existing policies and regulations related to fish resources and concludes with a set of short, medium and long term recommendations. Important suggestions include incorporating fish pass or fish friendly structures in major water projects, proper implementation of water and soil pollution laws, introduction and enforcement of fishing season, gear and capacity related regulations, legal and institutional reforms and above all, ensuring ownership and participation of the true fishermen in fisheries management in Bangladesh.
The Ganges Basin

Key words: Ganges river; status of fisheries; status of aquatic environment; international agreements

The Ganges Basin drains an area of 814,800 km², spans the countries India, Nepal and Bangladesh and is occupied by around 200 million people. In its lower sectors it contains some of the highest population densities in the world and also include major urban areas. There is pollution from industrial and domestic sources. There is also an intense demand for water principally for agriculture. In India all tributaries of the Ganges are controlled by barrages, which divert an estimated 66% of the flow for large-scale irrigation. Water is returned with reduced quality and increased chemical contamination. The barrages form barriers across the river. The largest is the Farraka Barrage, which diverts most of the flow down the Hooghly Canal, and has been the source of considerable political disagreement between India and Bangladesh, although a Water Sharing Agreement was reached in 1995. The upland cold-water zone in Nepal and northern India has a diverse fish community characterised by migratory and specialised torrent species. This region is thought to have suffered from the effects of erosion from excessive forest clearance. The fish zone extends up to some 1680m altitude although fishing probably does not extend above 1200m. Fishing yield are comparable to lowland Africa rivers of the same order. The upland rivers support a significant fishery which provides an unseen contribution to the welfare of the rural mountain population. The fishery across the whole of the lowland basin is driven by demand from Calcutta and Bengal where fish eating predominates. The proportion of major carps in the fishery declined from 43.5% to 29% by 1972-76 and 13% today. The reduction in dominant species may explain the success of enhancement programmes in several parts of the basin. The anadromous hilsa has also declined due to the Farrakah Barrage and the inaccessibility of the connecting canal. Significant reductions in catches of around 1600mt or 13% over 10 years were found at Allahabad and on the Ganges (Padma) in Bangladesh. Subsequent analysis shows that most of the reduction was due to reduction in rainfall and that there was a close correlation between catches and river discharge or rainfall. Clearly, any basin activity which affects discharge will impact on many aspects of river usage India has been pursuing the Ganga Action Plan to help control pollution and conserve biodiversity. Bangladesh has a National Water Management Plan and National Environmental Management Plan with aims to integrate water availability amongst multiple uses and generally to regulate water quality and conserve biodiversity. In addition to national regulatory environments, there are also annual tri-partite discussions between the states of the basin to increase international regulation. All of these policies and actions contribute to the long-term status and prospects of the basin.
Title: Irrigation systems and their fisheries in the Aral sea basin, central Asia

Key words: Amu Darya; Syr Darya; irrigation; arid zones; management

In the countries of Central Asia (Kazakhstan, Tajikistan, Kyrgyzstan, Uzbekistan and Turkmenistan) there are over 50 reservoirs which serve irrigation and hydropower production. In the basin of the Syr-Darya there are 19 reservoirs, and in the Amu-Darya 36 reservoirs. The irrigation demand is so high, than only rarely any water reaches the Aral Sea, resulting in the rapid desiccation of this sea. Irrigation systems require a novel approach to fisheries, as many economically important river fish species are unable to establish themselves in the reservoirs, and many perish in the uptakes to irrigation canals. Until the end of the era of the Soviet Union, in which the countries of Central Asia were included, fisheries management in reservoirs was effective, largely based on introduction of fish species and fish food organisms to the new irrigation systems. Interconnecting river basins with canals led to mixing of fish faunas of the major rivers, such as Amu-Darya and Syr-Darya. Fish faunas became dominated by introduced and immigrated fish species, which also dominated in fish catches. With the diversion of water for irrigation, the delta lakes in the Amu-Darya and Syr-Darya also became important fish producing water bodies, and the new water bodies established from drainage waters temporarily produced commercial quantities of fish. Since the independence of the countries of Central Asia in 1990, the former centralized management of fisheries has become fragmented, each country being dependent on its own human and material resources. Combined with the effort to dismantle the centrally planned economic system and introduce free market economy, the result has been a rapid decline in both fisheries management and control over fisheries resources. Fisheries law and regulations, dating from the former Soviet Union period, need to be updated and enforced, as today much of the fishing is uncontrolled. As a consequence of the changes, fish have become less available to the broader communities. This presentation concentrates on the fishery problems in three countries of the region: Kazakhstan, Uzbekistan and Kyrgyzstan.
Title: Present status of the commercial fisheries in the West Amazon basin

Key words: Amazon; commercial fisheries

The commercial fisheries of the Brazilian West Amazon are intense. This region includes the State of Rondonia on the border with Bolivia and the State of Amazonas on the border with Colombia. On the border with Peru fisheries are mainly for subsistence and lie outside the scope of this paper. The Brazil-Bolivia fisheries are more concentrated on scaly fish, mainly the tambaqui *Colossoma macropomum*. This fish may reach more than 40kg and is heavily exploited in the Central Amazon where individuals average less than 10kg in the fish market of Manaus. In the Itenez/Guapore river in Bolivia very large individuals, averaging more than 20kg, are still found in the commercial landings. Most of the fish caught by Bolivian fishers are sent to Santa Cruz de la Sierra or exported to Brazil. The amount caught by Brazilian fishers is consumed locally or exported to Porto Velho (capital city of the State of Rondonia) and from there to southern states. The Brazil/Colombia fisheries are concentrated upon the large migratory catfishes dourada *Brachyplatystoma flavicans* and pirahyba *B. filamentosum*. These are highly specialized and intense fisheries, covering an area of about 500,000 km², averaging 10,000 t year⁻¹. Nearly all fish are landed in the city of Leticia and from there sent by plane to Bogota. There is a complex network of middlemen, working for the large freezing warehouses in Leticia. This is the main economic activity in the region, where agriculture is incipient. As the activity is highly seasonal its effect upon people life is very severe. The average catch per unit effort has decreased consistently over the last decade and management actions comprising the whole basin are necessary.

Paper withdrawn but permission given to include abstract
Cambodia’s Great Lake the Tonle Sap is one of the most productive and important freshwater fisheries in the world. Over 300 000 tons of fish are extracted from this fishery each year supporting the livelihoods of 1.2 million people. The importance of the Tonle Sap’s freshwater fisheries as a source of income, nutrition, and livelihood security to rural Cambodia is well documented and it provides up to 60-75% of all animal protein for rural Cambodians. Over the last decade this lake has also been the site of a great deal of conflict around community fisheries as pressure on fisheries resources increase. These conflicts over fisheries resources led in early 2001 the Prime Minister of Cambodia to release 536 000 ha or 56% of commercial fishing lots back to community fisheries for public use. Nevertheless fisheries conflicts continue as the newly formed community fisheries seek to establish themselves in an environment of weak governance in which the fisheries law and relevant sub-decrees have still not been passed by the Cambodian government and one in which fisheries resources are under threat from a variety of sources including over-fishing, unsustainable fishing methods, loss of riparian vegetation, pollution, and changing hydrology due to dam construction. This paper seeks to explore the recent developments in community fisheries management through the experiences of the Fisheries Action Coalition Team (FACT) an advocacy NGO that has sought to reduce fisheries conflicts and support the expansion of community fisheries around the Tonle Sap. It will look at the history of fisheries conflicts and the paths to resolving these including the development of new fisheries laws. The paper will also examine the different models of community fisheries that are been proposed for the Tonle Sap and the role of the ADB and FAO in this. The paper will conclude by highlighting the challenge of moving towards a focus on improving the livelihoods of community based fishers around the Tonle Sap. This includes a move towards a more sophisticated position on trade in fish products without compromising the sustainability of this important fishery.
Structure of fish assemblages is influenced by environmental variations at multiple spatial and temporal scales. In the Neotropics, seasonal flooding renders the floodplain an open system in which many fish species can migrate or move locally to find adequate ecological conditions. Consequently, it has been suggested that fish assemblage structure in floodplain lakes is largely stochastic. However, recent studies concluded that fish assemblage structure could be determined mostly by environmental variables operating locally. The present work tested 1) the predictability of fish assemblage structure in the Mamoré River floodplain, Bolivia, in relation to both whole-lake (local) descriptors and lake-type categories reflecting supra-lake conditions, and 2) the general prediction that fish assemblage is structured following the piscivory-transparency-morphometry (PTM) model originally developed for the Orinoco River.

Fish species abundances were quantified in eight lakes of the Mamoré River floodplain, positioned along a spatial gradient of distance to the main river, through five high-water and four low-water surveys. We found strong relationships between fish assemblage structure and abiotic lake descriptors. Spatial variation in fish assemblage structure was stronger than temporal variation. Consistent with predictions of the PTM model, relative abundances of siluriforms and gymnotiforms declined in clearer and deeper water, whereas relative abundances of characiforms and clupeiforms increased, as expected from knowledge on the sensory capabilities of these taxa. Partitioning of variation showed that although whole-lake variables, especially transparency and water depth, play an important role in structuring fish assemblages, supra-lake variables, specifically temporal variability of water quality and connectivity, also influenced assemblage structure. These results support the notion of hierarchical control of assemblage structure. Supra-lake variables seem to operate as a primary filter that differentially limits local movement and migration as a function on lake connectivity. A secondary filter reflecting whole-lake processes appears to exert stronger control in well-connected lakes, where the migration filter might be weak. At the ordinal level, the distribution of clupeids, gymnotiforms, and siluriforms appeared to be shaped by both supra-lake and whole-lake variables. In contrast, that of characiforms did not seem limited by supra-lake variables.
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Title: The role of local communities in the generation of fisheries information based on the ecosystem approach

Key words: Data collection; information exchange; indicators; methodology

The quality and applicability of existing data collection systems for inland fisheries are increasingly being questioned. Often, these systems are based on methods that were developed for marine fisheries, although data needs for inland fisheries are very different. Furthermore, most data is not collected based on any pre-identified needs for information, but because it was requested “from above” (e.g. central government and/or international agencies and donors). This paper suggests a new approach to information generation in river fisheries, with the aim to support a management strategy based on an ecosystem approach. As part of this approach, local communities play a central role in the generation of information upon which management decisions can be made, encompassing both ‘real-time’ data and historic information (local knowledge). In such a setting, data collection and information generation is considered an integrated element of the overall management process and local communities should thus also be directly involved in this part of the management process. Any collected data and information will be of direct, and often immediate, applicability to the resource users, or “co-managers”. Experiences from the Mekong River have demonstrated the value and applicability of local knowledge. These experiences are discussed in the context of the mentioned ecosystem approach.
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Title:  Fish Movements and their implication for River Basin Management in the Mekong River Basin

Key words: Mekong; migration; conservation

Most large tropical floodplain rivers are inhabited by migratory fish species, which carry out seasonal movements between spatially and temporally separated habitats. In the Mekong River most of the important fisheries species are to greater or lesser extent migratory, and typically move between dry season refuge habitats and flood-season feeding and spawning habitats. Some species only move short distances, between river channels and adjacent flooded areas, whereas other species move several hundred kilometers between these habitats. Examples of fish movements covering over 1,000 km possibly also exist in the Mekong. This paper first briefly describes the major multi-species movements in the Mekong River. The findings are based on data collected over the past four years, largely through surveys of local ecological knowledge, supplemented with other data sources. The paper then discusses implications of such large-scale movements for resource management and development planning within the river basin. The main conclusion from this discussion is that in order to maintain the fisheries productivity of the basin, it is necessary to maintain its ecological functioning and integrity, by conserving major essential habitats and the migration corridors between these habitats, as well as maintaining the annual flood pulse, and the sediment and nutrient flows which underpin production. In terms of resource management, it is widely acknowledged that co-management processes, which are rooted in local communities, are needed for the sustainable management of fisheries resources. For migratory fishes, this poses a particular challenge because these are shared resources between distant communities, sometimes across international borders. Options for developing management frameworks that reconcile the regional inter-connectedness with the need for local management practices are discussed, including the role of international agreements.
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Title: **The translocation of recreationally satisfying fishes is detrimental to the maintenance of local biodiversity: sleepy cod (Oxyeleotris lineolatus) and other translocated species in the Burdekin River, Australia**

Key words: Burdekin River; introductions; sleepy cod

The Burdekin River contains a distinctive fish fauna characterised by endemic species and species of biogeographic significance, and by a distinct disjunction in the distribution of many species due to the presence of a large waterfall (now the site of a very large impoundment) located in the lower quarter of the river's length. Downstream of the falls, large estuarine and catadromous piscivores such as barramundi (Lates calcarifer) are common. In contrast, large piscivorous fishes are all but absent from the river upstream of the falls. Sleepy cod (Oxyeleotris lineolatus), a piscivore, was first introduced into the upper reaches of the Burdekin River by 1980 and other releases, both official and unofficial, have occurred subsequently. The population remained small and restricted to the site of introduction for a decade, but subsequently expanded in size and distribution such that sleepy cod are now present in every available tributary system of the Burdekin basin. A number of studies, although not designed to examine the impact of translocated species, are used here to examine the spread and impact of sleepy cod. Despite the occurrence of substantial temporal variation in fish abundance due to a highly irregular flow regime, negative impacts on one species, a gudgeon of elevated conservation status (Mogurnda adspersa), are evident. It is unknown whether impacts such as localised extinctions are transitory or permanent. Additional species have been introduced to the upper Burdekin River to satisfy recreational fishing demand: some deliberately, others accidentally. Such species are typified by large size and piscivorous habitat, characteristics alien and inimical to the native fish fauna. It is hypothesised that these species are likely to have even greater impact than sleepy cod in some tributary systems of the upper Burdekin River.
The present study is part of an ongoing project examining the distribution of north-eastern Australian freshwater fishes at different spatial scales in order to determine variations in freshwater fish biodiversity across the state of Queensland. It also relates observed patterns to variation in prevailing flow regime and differences in biogeography and evolutionary history. Ordination analysis clearly demonstrated the presence of five distinct biogeographic regions defined by either latitude or longitude, with the latter reflecting the persistent and ancient influence of the Great Dividing Range. Regression analysis demonstrated that differences in species richness were significantly related to basin area despite the existence of these biogeographic regions. However, analysis of variance of regression residuals revealed substantial regional variation away from the common regression line. The Wet Tropics region contained many more species per river basin than was accounted for by catchment area, whereas the eastern Cape York Peninsula, to the immediate north, was comparatively depauperate. Additional regression analyses using river position (latitude), mean annual flow and several parameters characterising flow regime variability explained a greater proportion of the observed variance than did catchment area. The relationship explaining the greatest amount of variance included mean annual flow (positive effect), a measure of perenniality (the proportion of the mean annual flow occurring during the six driest months) (positive effect) and latitude (negative effect) as predictor variables. Importantly, no significant regional variation in residuals was detected. The importance of mean annual flow as a determinant of biodiversity is discussed with respect to the availability of energy and habitat. The management implications of the research, particular in regard of environmental flow management are discussed.

Paper withdrawn but permission given to include abstract
Environmental changes in large river basins are subject to forces external to the water and to biological issues. Before 1960, the Plata river basin was almost undeveloped. The regulation of the Parana for hydroelectricity has been increasing since the early 1970’s. Water in reservoirs of the upper Parana basin currently comprises more than 70% of the mean annual discharge at its confluence with the Paraguay River. The expansion of hydroelectric generation in the upper basin brought with it an increase in industry, agriculture, transport, and settlements. These in turn have resulted in significant increases in deforestation, soil erosion, changes in water quality, and reduced fisheries opportunities in both the upper and lower basins. The fisheries of the Plata basin are lightly to moderately exploited compared to other subtropical and tropical floodplain fisheries. The fisheries were traditionally based on large potamodromous fishes caught from a fish community containing a relatively high frequency of detritivorous fish of the genus Prochilodus. The catch per fisherman per day now ranges from 11-30 kg for reservoirs situated in the Brazilian upper basin to more than 110 kg in the lower middle Parana River. Catch rates drop to 8-10 kg of high value fish/fisherman/day at the Parana-Paraguay confluence and for the Pantanal fishery. Striking differences in the fish species structure of the catch are noticeable between reservoir and floodplain fisheries, and among floodplain fisheries themselves. We have identified three main fishery states in the Plata basin across broad temporal and spatial scales. A relatively undisturbed state corresponds to the unregulated river, when fishing effort was relatively low to moderate. Here catch is mainly dominated by high valued large siluroids and characins. This state is actually represented by fisheries at the Pantanal and the Parana-Paraguay confluence and to a lesser extent by some of the remnant lotic reaches at the upper Parana. A second fishery state corresponds to the developed river, with floodplains disturbed by river regulation and other developmental activities. Here the fisheries are still supported by potamodromous fishes but fish size at capture is usually lower. Fishing effort is usually higher, the contribution by weight to the catch of less valuable Prochilodus has increased and exotics are usually included in fish captures. The disturbed floodplain fishery state is represented by fisheries of most of the lower basin and at the few unregulated reaches of the upper Parana. Fisheries in riverine reservoirs represent a third, relatively highly-disturbed fishery state. The catch of potamodromous fishes frequently descends well below 50% of the total catch and fish captures are often dominated by blackfish species, less dependent on river flows, and with an increasing importance of exotic fish species. Fish size is lower as well as fish value at landing. The Plata basin fisheries represent almost all of these states at the same time in different parts of the basin.
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Title:  Potential Of Indigenous Riverine Fish Species In Nepal

Key words: High value riverine fish, biodiversity; participatory management, production

The Kingdom of Nepal varies in altitude from 60-8848 m above sea level. Water is the most important of its natural resources and originates from glaciers, snowmelt, rainfall and ground water. For its size the country has very large water reserves comprising about 818,500 ha, of which about 6,000 rivers, including three major rivers the Koshi, Gandaki and Karnali, and their tributaries have a combined length of about 45,000 km and cover an estimated 395,000 ha (48.2%). A total of 186 fish species are present in the natural waters of Nepal, of which the majority are distributed in the river systems from subtropical to high mountain regions. Forty-three species are found in hill streams. Some riverine fish species are highly valued for sport fishing, including 18 cold-water species. The size of the riverine fish varies from Bagarius bagarius that measures up to 250 kg to Danio rerio that measures only 26 mm. Tor spp., Schizothorax spp. and Schizothoracichthys spp., Acrossocheilus hexagonolepis, Ompac bimaculatus and the eel, Anguilla bengalensis, are some of the economically important riverine fish species that fetch high prices in Nepal. Among these high value riverine fish species, Tor spp. (omnivorous), Schizothorax spp. and Schizothoracichthys spp. (phytophagus) and Acrossocheilus hexagonolepis (omnivorous) have been studied for more than a decade and, although induced breeding has been developed for them some years ago none of these species have been used for aquaculture. As these fish species are very good for angling they should be conserved and managed to maintain their populations as well as to enhance their productivity by stocking in open waters or by culture in captivity. Conservation of these high value riverine native fishes and enhancement of their populations can best be achieved by involving local fisher communities and also can provide job opportunities, help to increase economic status, and provide a good fish protein source to the local people.
The river Godavari is the second longest river in India. It traverses 1440 Km West to East and discharges into Bay of Bengal through two branches. A barrage at Dowleiswaram impounds the penultimate stretch of the river as it enters the plains. The lower reach of the river is of considerable importance and supports a commercial fishery comprising 4 species of major carps, 6 species of larger catfishes, one species of large river prawn, the migratory *Hilsa ilisha* and several smaller varieties that contributed nearly 300 t. from a 200 km stretch of the river during the 1960s. The river has 16 major tributaries almost all of which have been impounded by dams, barrages and lift irrigation schemes since the 1980s. The estuarine zone of the river forms a vast complex of creeks contributing to the mangrove ecosystem, the second largest in mainland India. The creeks join Kakinada Bay at the North East. Tidal waters from the bay and the floodwaters from the estuary contribute to the ecology of the mangrove ecosystem. From the fisheries point of view the compound impounding that has already taken place and a proposed new Polavaram Project just 75 km upstream of the existing barrage at Dowleiswaram will have considerable impacts on fish breeding and recruitment unless the dam design is optimized by incorporating regulated flows to protect the downstream reaches and estuarine system. There have been no regular fisheries statistics studies after 1970s. This paper examines (i) The existing river stretch, its characteristics and fishery potential; (ii) The proposed uses of the Polavaram dam and Dowleiswaram barrage - the contiguous stretch and their effect on fisheries; (iii) The management options for multiple uses that can be incorporated into the barrage design, without detriment to the main use and (iv) The impacts of reduced flood flows on the estuarine (mangrove ecosystem) downstream.

Paper withdrawn but permission given to include abstract
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Title: Participatory management of fisheries in the Brazilian Amazon

Key words: Amazon; community management; enforcement; policy

Fishing for human consumption is one of the most productive traditional activities in the Amazon and generates at least US$ 100 million per year. The fishery provides the principal source of protein for the Amazon’s population and supports several related industries. Exports of ornamental fish are also an important source of revenue for the region, and the sport fishery has great potential. Fisheries management in the Brazilian Amazon has until recently been conventional and centralized. The Federal Government instituted decrees regulating fishing activities by classic methods such as closed seasons during spawning migrations, limits on mesh size, minimum sizes, and the gear prohibitions. Such decrees were not always based on scientific evidence, and enforcement was not effective. Therefore, commercial fisheries developed in a regulatory vacuum, and conflicts between riverine communities and outside commercial fisherfolk proliferated during the last two decades. Many riverine communities began to implement their own management regulations, the “fishing agreements”. These agreements were developed to protect the fishing rights of community members and were not linked to environmental considerations. The IARA Project uses a participatory approach to integrate fisherfolk and riverine communities into the fisheries administration system. It includes gathering of basic information on the fishery and the socio-economic situation of the riverine populations, and monitored of fish landings at the major ports. It was soon obvious that sustainable use of várzea resources is feasible only if the ecosystem is treated as a whole, and if management include all relevant sectoral administrations in a single system. Monitoring showed progressive maturing of attitude amongst those involved in fishing agreements. As a result these agreements started to be formalized by government decrees. Community leaders have been trained in leadership, as well as in organization and maintenance of community groups. Enforcement remains a key element in the implementation of fishing agreements and the enforcement process has been formalized by creating “environmental agents.” The success of these voluntary agents has created a huge demand from communities in other regions. The IARA project was replaced by the Floodplain Natural Resources Management Project (ProVárzea) whose remit is to establish scientific, technical and policy bases for environmentally and socially sustainable conservation of natural resources of the Várzea floodplains of the central Amazon Basin region, with emphasis on fisheries resources.
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Title: Provárzea – A natural resource management project for the Amazon flood plains

Key words: Amazon; development projects; environmental degradation

The floodplains (Várzea), which constitute one of the richest ecosystems in the Amazon basin in terms of biological productivity, biodiversity and natural resources, are gradually being degraded by ongoing development trends in Amazônia, such as urban and agricultural expansion, the expansion of ranching, deforestation and the silting of rivers. Ineffective monitoring and control systems, the lack of a specific conservation strategy and management policies for the Várzea ecosystem assist this process of degradation. ProVárzea is a five-year project designed to address these problems. The general objective of the project is to establish scientific, technical and policy foundations for the environmentally and socially sustainable conservation of natural resources of the Várzea floodplains of the central Amazon Basin region, with emphasis on fisheries resources. The project, which started in June 2000, covers the whole of the Solimões/Amazon river from the Peruvian/Columbian border, down to, but not including the estuary.
The flood cycle of the river is the dominant seasonal factor, in Amazonian floodplains and fish populations are found to fluctuate greatly over the year. During inundation fish migrate into floodplain forests to feed on fruit and seeds, in an area of more than 300,000 km². Floodplain fish were captured using variously sized gill nets in white and black water areas inside and outside the floodplain forests during low, rising, high and falling water level in 1990 and 1991 in order to document patterns of species diversity, distribution, abundance and temporal dynamics and in order to describe the ecological importance of the inundated forest. Dominance varies to some extent in white water between floodplain forest (0.06) and open water (0.11) while it is unchanged in black water (0.04). Black water fish communities were more diverse. Liposarcus pardalis, Pygocentrus nattereri, and Pellona flavipinnis, were the most abundant white water fish. Plagioscion squamosissimus, Serrasalmus rhombeus, and Serrasalmus manueli were more abundant in black water. Common whitewater species such as Colossoma macropomum, Mylossoma duriventre and Osteoglossum bicirrhosum occurred almost exclusively in inundated forests. A large number of species were captured only in inundated forest in the black waters, including, Hoplias malabaricus, Osteoglossum bicirrhosus and Uaru amphiacanthoides. Catches varied with sample site, water level and direction of water level change. The average CPUE in white water was 190 and in blackwaters 41 g fish m⁻² and day, with maximum yields at low water and minimum yields at high water. A significantly higher quantity of fish was captured at falling water level. In black water, fish catches from the floodplain forest exceeded the open water catch by 183 to 550%, depending on season. Differences in respect of white water are smaller (106 - 281%). Fish communities in the area under investigation seem to be stochastically assembled, with significant differences between white and black water only. Many fish move into the floodplain forest not only to feed but for other reasons, to seek shelter, for example.
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Title:  Legal aspects of environmental flows for healthy river systems

Key words: Environmental flows; law; Murray-Darling River

The objective of this paper is to explore the legal foundations concerning environmental flows for river systems at the international, regional and national levels, and to analyse how this concept has been applied and adapted in one of the world's most advanced river basins. Several watercourse agreements contain provisions for the regulation of flows. These provisions focus mainly on the role of flow in allowing the production of electricity, protection of commercial fisheries, floatation of logs, navigation, protection against flooding or the maintenance of the self-purifying capacity of the waters. None has directly addressed the regulation of stream flows for the protection of the chemical, physical and ecological integrity of a river system. They have addressed human commercial uses of streams, without dealing with the need to sustain the ecological values of the aquatic ecosystems, including their processes and biological diversity. Notwithstanding this, some legal instruments contain principles related to environmental protection of a watercourse, which are linked to the concept of environmental flows. In the Murray Darling Basin in Australia inter-jurisdictional basin comprises an area of more than one million square kilometers, representing fourteen percent of the Australian territory. The first Agreement for the regulation of the River Murray was signed between the states of New South Wales, Victoria, South Australia and the Federal Government in 1914. In 1985, the Murray Darling Basin Agreement was adopted. This Agreement covered the entire basin and addressed integrated natural resources management across the entire basin; and established a Ministerial Council as the main policy making body under the Agreement. Queensland and the Australian Capital Territory joined the Agreement in 1996 and 1998 respectively. A growing recognition of a better balance between consumptive and non consumptive uses started in the late 1980's. Approximately ten years later, it was seen that there was a need to start returning water to the river for non consumptive purposes to achieve a healthy functioning and sustainable system. This fundamental shift in community values and attitudes is reflected in the Vision of the Basin, adopted by the Ministerial Council in March 2001. This paper will carefully describe and analyse the institutional framework for the Basin, the arrangements for restoring environmental flows, and the major issues that have been tackled. This experience will be drawn upon to learn lessons that may be applied to other river basins.

Paper withdrawn but permission given to include abstract
Title: The ecological status of the Danube River with special reference to its fish fauna

Key words: Danube; environmental degradation; rehabilitation

The ecological status of the Danube River and its fisheries prior to 1988 has been summarised by Bacalbasa-Dobrovici (1989) for the first International Large River Symposium. Since then the situation has changed in many ways: the trends of river–floodplain disintegration initiated by the major river regulation schemes in the 19th and early 20th centuries accelerated. Moreover, further hydropower dams were built along the course of the river and its major tributaries, further reducing the ecological integrity of the river-floodplain systems in several stretches. On the other hand, a number of mitigation schemes were initiated e.g. in Austria, Hungary and Romania in order to compensate for the continuing losses of riverine landscapes. The measures taken to control water pollution were partially successful and water quality along the river has shown a general improvement. The overall deterioration of riverine habitats due to pollution, river engineering and land use is reflected in the high number of endangered fish taxa. The main cause for the decline of many species is the continuing loss of riverine littoral habitats due to river engineering. Therefore the main focus of river management in several of the riparian countries is on the conservation of riverine biota, a stronger incorporation of ecological aspects in river engineering and the development of restoration programmes. Several international schemes have been proposed to undertake concerted action to improve the overall situation. There is a sound scientific basis for ecologically orientated river management along the Danube: over the past 20 years, environmental conditions, fish ecology and fisheries have been intensively studied at several research institutions by means of large-scale field surveys and experimental studies. These results allow the present ecological status to be redefined. New concepts for commercial and recreational fisheries as well as floodplain restoration were developed. The present contribution synthesises recent developments in fish ecology and fisheries of the Danube and concentrates on key management issues.

Paper withdrawn but permission given to include abstract
Author(s)
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Title:  Status and Management of Mississippi River Fisheries

Key words: Mississippi River; environmental degradation; rehabilitation; fisheries

The Mississippi River has been variously altered for navigation and flood control but supports a diverse and relatively productive fishery assemblage. In the upper, impounded reach, commercial fish harvest has increased for most species since 1945. The upper reach provides an extensive and moderately used recreational fishery resource. Limited information for the lower, unimpounded reach of the Mississippi River indicates commercial harvest is increasing. Neither the commercial nor recreational fisheries appear to be overharvested; however, fisheries for sturgeon and paddlefish should be carefully monitored. Future fisheries production may be threatened by loss of aquatic habitat, particularly extrachannel and backwater habitats, from sedimentation and constrained by altered spatial and temporal aspects of floodplain inundation. Water quality has improved substantially from formerly severely degraded conditions. Navigation affects fish survival and recruitment, and increases in navigation are forecast. Future conservation and management of the fisheries and aquatic resources of the Mississippi River will require substantial investment in effective assessment programs and achieving societal recognition of the diverse values of the resource.
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Title: Conservation and Management of Fishes in the Large Himalayan Rivers of Nepal

Key words: Nepalese Rivers; biodiversity; environmental degradation

The Himalayan kingdom of Nepal has a network of rivers and tributaries and several connecting channels, offering immense scope for expanding fisheries in this country. Well over 200 species of fishes live and breed in Nepal. Habitat alterations continue to have a major impact on the distribution, abundance of fishes in large rivers of Nepal Himalayas. The fishes of major rivers and feeder streams are perhaps least studied and poorest known natural resources. In Himalayan large rivers (Gandaki, Koshi, Karnali and Mahakali), where people have lived, fished and settled, the natural fish habitat has been modified by man for centuries. Power dams have drastically altered fish habitat and communities and blocked seasonal movement of pristine migratory fishes such as Tor tor, Schizothorax richardsoni, Anguilla bengalensis, Bagarius bagarius and Clupisoma garua etc. Many upriver habitats disturbed by dams are less congenial for rheophilic fishes such as Psilorhynchus pseudecheneis, Balitora brucei, Garra gotyla, Glyptothorax pectinopterus etc. Conservation problems of biological diverse food and game fishes living in large rivers are carefully reviewed. Development of recreational fishing in the reservoirs of large rivers is highlighted. Establishment of fish parks, aquaria and river parks in tail waters of dams is suggested as a means to heighten public awareness about economically valuable riverine fishes and to preserve them for future.
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Title: Fish diversity patterns in three large Brazilian Amazonian rivers (upper Juruá, Araguaia and Negro)

Key words: Amazonia; biodiversity

There is a need for information about the ecology of Brazilian Amazonian fishes because they sustain the artisanal fishery that provides food and cash income to most of the Amazonian human settlements. This paper brings together the results from ichthyofaunal surveys conducted at three Amazonian Rivers, the Upper Juruá, the Middle Araguaia and the Middle-Lower Negro Rivers, during the years of 1994, 1997, 1998, 2000 and 2001. In all three surveys, fishes were collected using gillnets with varied mesh sizes. Fishing sites were sampled at the low and high water season, as well as during the day and night. Fish diversity was measured using the Shannon-Weaver (H') diversity indices, based on numerical abundance. Fish diversity was compared between rivers and habitats (lakes and river sites) using rarefaction curves for species richness. The 103 fish samples made in 66 sites in the three rivers yielded a total of 3204 fishes. From these, 822, 1,150 and 1,232 fishes belonging to 90, 82 and 96 species were collected respectively at the Upper Juruá, Araguaia and Negro Rivers. Diversity indices were similar and high for all three rivers. According to the rarefaction analysis, the Negro River has the highest fish species richness and river sites have higher fish species richness than lakes in all three rivers. The highest fish diversity was observed for the river sites of the Negro and Upper Juruá Rivers, possibly due to the more pristine condition of the environment in these rivers when compared to the Araguaia, which had been subjected to the effects of deforestation and impoundment downstream. The general pattern of higher fish species diversity in riverine compared to lacustrine sites is possibly related to two factors. First, most Amazonian fishes move along the rivers, which serve as a waterway. Second, lakes may present seasonal stressful ecological conditions, such as high predation pressure and low levels of water oxygen. The ability of fishes to cope with such conditions may impose limitations in the maximum species richness of lacustrine fish assemblages.
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Title:  My Mekong: Sharing Voices of Communities from the Waters of the Mekong (A Visual Presentation)

Key words: Mekong, riparian communities

The Mekong River is the 10th largest river in the world (about 475,000 million cubic meters in terms of annual water yield), and the third largest in Asia after the Yangtze River in China and the Ganges in India. It remains one of the world's great river systems, and today, the Mekong faces grave threats of rapid development and transboundary conflicts.

For the 65 million people whose lives depend on the multitude resources in the Mekong river basin for food, water, transport and power, the development of the Mekong pose great implications to their livelihoods, culture and to their relationship with their neighboring communities and nations. The voices of local communities are overpowered by the more forceful pronouncements of policy makers about trade liberalization within a framework of economic integration and cooperation in the Greater Mekong Subregion. The Asian Development Bank (ADB), bilateral donors and foreign investors chart the course of development in the region through a master plan for region wide investments in energy (particularly hydropower), roads and navigation improvement projects, tourism, telecommunications and economic and investment infrastructure to facilitate cross-border trade. Over the last decade since this master plan was developed, more harm than benefits have accrued to local people. Of particular concern to Mekong civil society is that the current development charter in the sub-region and in the wider ASEAN does not address justly the social, economic, cultural and ecological needs of local communities in the region.

My Mekong articulates the alternative vision of local communities and other key stakeholders for the Mekong through the use of popular and creative media. It is a collection of selected photos, posters, illustrations, traditional pictographs, woodcarvings, publications and videos that convey compelling community messages and the critical issues of management and development of the Mekong waters and its resources. The My Mekong’s visual exhibition will illustrate critical regional issues and local people’s sentiments from the Mekong Delta, the Tonle Sap Great Lake to the upper watersheds of the Mekong River Basin about environmental protection, local livelihoods at risk, the preservation of ecohistory, oral histories and Dongba traditional art, and local knowledge about fish ecology and river ecosystems.

Poster presentation
Title: Fish biodiversity in Volga River

Key words: Volga River; Russia; biodiversity; environmental degradation; dams

The Volga River is Europe’s biggest river, crossing the continent from North to South and flowing across almost all climatic zones. The Volga basin is entirely situated within Russia and unites the basins of the Black, Azov, Caspian, White and Baltic Seas by a system of artificial channels. It is the main source of the water for a number of important industrial and agricultural centers. The Volga-Kama cascade provides more than 20% of the electricity producing by all hydroelectric power plants in Russia. The river Volga is one of the most regulated of all European rivers. A cascade of reservoirs have been built on the Volga mainstream and its biggest tributary, the Kama River over the last 50 years that influences the whole Volga River basin except its headwater streams and delta. There are now 12 big, and more than 300 medium and small sized reservoirs in the Volga river basin. The Volga is one of the richest European rivers in terms of fish species diversity with a fish fauna consists of 96 species belonging to 2 classes, 14 orders, 26 families and 66 genera. Yearly catch totals approximately 30000 metric tons and potential fishery productivity is assessed at between 50000 - 60000 metric tons per year. However, the regulation of the river flow by dams and technological use of river water led to considerable changes in structure and functioning of the ecosystems including the fish community. Geographically, hydrographically and biogeographically the Volga River basin is divided into three main parts, the Upper, Mid and Low Volga. The Volga-Ahtuba flood plain and the delta are treated as a kind of independent Lower Volga sub-province. After the river was blocked by dams catadromous disappeared from the Upper Volga fish fauna. The Middle Volga fish species composition was affected by river blocking to the lesser extent than the Upper Volga fish fauna. Only Black-Caspian Sea shad fully disappeared and the number of other anadromous fish decreased. The Lower Volga fish fauna is especially rich in anadromous and semi-anadromous species. Fish species diversity has been considerably enriched by introduced and invader species. There are no known eliminations of fish species from the Low Volga fish fauna, although several species show serious declines in number because of over fishing and blocking of natural spawning routes by dams built upstream.
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Title: Preliminary results on the genetic diversity and structure of the migratory catfish
_Pangasius bocourti_ in the Cambodian Mekong River

Key words: Catfish, Mekong, genetic composition; methodology

The genetic diversity and structure of two dominant species: _Pangasius bocourti_ and _Pangasianodon hypophthalmus_ was studied in rivers in Cambodia (upper Mekong (Stung Treng/below the Khone Falls and Kratie province), lower Mekong (Prey Veng province), Bassac River (Kandal province), and Tonle Sap (Siem Reap/Kompong Chnang province)) using restriction fragment length polymorphism (RFLP) analysis of mitochondrial DNA (mtDNA) D-loop region (2.1 kb). Seventeen mtDNA haplotypes from 90 fish were identified in five populations of _P. bocourti_ and 7 haplotypes from 82 fish in five populations of _P. hypophthalmus_. On average, gene diversity (genetic variation) was higher in all populations of _P. bocourti_ than in all populations of _P. hypophthalmus_: haplotypic (gene) diversity ranged from 0.576 ± 0.163 to 0.836 ± 0.065 in the five populations of _P. bocourti_ and from 0.295 ± 0.156 to 0.674 ± 0.100 in the five populations of _P. hypophthalmus_. The total fixation index (evaluating differentiation among populations) was moderate (Gst = 0.19 ± 0.04) and much higher in populations of _P. bocourti_ than in populations of _P. hypophthalmus_ (Gst = 0.06 ± 0.01). The genetic distances for each pairwise comparison (Fst) for _P. bocourti_ populations ranged from - 0.065 to - 0.008 and for _P. hypophthalmus_ populations from - 0.059 to 0.344 were not significant different, except between Mekong River in Kratie and Bassac River in Kandal province for the later populations. The adjacent haplotypes in the minimum spanning network for all populations of each species did not represent geographically distinct units. The catfish species _P. bocourti_ and _P. hypophthalmus_ should be studied with the same markers all across their natural ranges, from the triangle border to the Mekong delta. Studies with low resolution markers (e.g. mitochondrial loci) and high resolution markers (DNA microsatellites) should be combined. Data expected from high resolution markers are the effective population size, gene flow, spatio-temporal genetic structure (fish stocks) and population dynamic characteristics.
Title: The professional fishery in lacustrine systems of rivers in Central Amazon

Key words: Amazon, lake morphology; fisheries

The professional fishery of the State of Amazonas exploits the main rivers of white water of the Amazon basin (Purus, Solimões, Madeira and the upper Amazonas rivers). The várzea areas and the lakes associated with these rivers are important sources of fish production that support Amazonian professional fisheries whose annual production is around 30,000 tons. Data from two sources were matched to characterize the lacustrine professional fishery; fishing landing data from the professional fleet of Manaus from 1994 to 1996 and geomorphologic data from the exploited lakes obtained from images of the satellite JERS-1 NASDA, 1995. The lakes were grouped according to shape (Oval/Round, Horseshoe, Branched Dendritic, Stretched Dendritic, Irregular/Composed), and the total area (km²) and distance (km) from the main river were measured. The catch, fishing effort and distance of the lake from the river were grouped by categories of lacustrine shapes. In the covariance analysis, the total catch in tons was explained by the covariables: distance from the river (kilometers), fishing effort (fisherman number per fishing days) and lake shape. The model explained 72% of the catch variability, and the effort explained 32% of the data variance followed by the lake shape (18%) and distance from the river (4%). From the 276 exploited lakes, the Purus River represented about 30% exploitation, followed by the Solimões river (25%), upper Amazonas River (24%) and Madeira river (18%). The horseshoe lakes of the Purus River and the oval lakes of the lower Solimões (typical várzea lakes with less complex shapes) presented the highest values of fishing effort, indicating higher exploitation intensity. On the other hand, the dendritic lakes, known as "terra firme" lakes (more complex shapes) presented lowest effort values, with higher fishing yield values. The distance from the lake to the river indicated that systems closer to the main river were more intensely exploited than those farther from the river. This way, the spatial complexity and physical barriers indicated by shape and distance of the river in the different lacustrine systems that occur in the Amazon basin interfere in the accessibility, fishing effort levels and lacustrine fishing yield. The different availability of lakes by tributary system in the Amazon basin exploited by professional fishery operating from Manaus may represent an important factor in framing guidelines for the rational management of the lacustrine fishing resources of Central Amazon.
Title: River Niger: Neglect of Degradation and Prospects for Recovery

Key words: Niger River; Africa; pollution; impact of dams; dredging

The River Niger is the third largest in Africa and flows for 4,152 km with several major tributaries along its course. It originates in Guinea’s Fouta Djalon mountains, traverses four West African countries and enters Nigeria on its way to Atlantic Ocean. The basin covers nine other countries. The River Benue, which begins in the Cameroonian Highlands to the east, joins the Niger at Lokoja in central Nigeria. For thousands of years, the river has provided people with dynamic and rich livelihoods. The River system harbours 36 families and nearly 250 species of freshwater fish, of which 20 are found nowhere else. Eleven of the 18 families of freshwater fish that are endemic to Africa are represented in the Niger River. Data have been collected on the nature, effects and magnitude of pollution of the river at various points along its length. The most highly polluted areas are shown to be Jebba, Kainji (New Bussa), Numan, Lokoja, Ajaokuta, Asaba, Onitsha, and the Niger Delta region where the major sources of pollution arise from municipal sources (sewage, sullage and leachates), industries, agricultural activities and natural sources. The major industries that discharge their wastes are power station, sugar and confectioneries, distilleries, textiles, steel, petroleum exploration and refineries. The Warri refinery is believed to be defective with constant oil spills into the delta. The quality of water has deteriorated along the course of the river with low dissolved oxygen, high organic matter content and toxic chemicals that affect ecosystems and public health. Aquatic weeds, particularly water hyacinth invaded the river at many points affecting navigation, aquatic flora and fauna and economic activities of the populations living on the river. In recent years, the Federal Government has dredged the River Niger, resulting in unnatural drainage, fast-moving water bodies and erosion. There is an increased likelihood of flooding. Downstream communities experience flash floods at the peak of the rainy season when sluice gates are opened and people are killed, and homes, fish breeding grounds and farmlands destroyed. Regulatory bodies such as the Federal Ministry of Environment and Natural Resources, the Niger Delta Development Commission and other bodies have been working to protect the river from further degradation. However, there is a need for a holistic approach involving all stakeholders to restore the river through good river basin management practices, adjustment of economic activities to the natural carrying capacity of the river, respect for the traditional resource use patterns and awareness of the river's natural value.

Paper withdrawn but permission given to include abstract
Effects of a Fish Ladder on Migratory Fish Species at the Pak Mun Dam in Thailand

Key words: Fish ladder; Fishway; Migration; Migratory fish species; Pak Mun Dam

The Pak Mun Fish Ladder is the first of its kind installed at a hydro-power dam in Thailand across the lower Mun River 5 km upstream from its confluence with the Mekong River. A fish ladder was constructed to facilitate fish migration between the Mekong River and its tributary. It integrated the overflowing weir and submerged orifice type with these dimensions: 4 m wide, 15 m high, 92 m long and a slope of 1:6. The aim of the present study was to evaluate effectiveness of the operation of fish ladder in number of migratory species and populations ascending and descending the fish ladder. Two bamboo fish traps were installed to sample upstream and downstream fish migration at the exit of fish ladder during a 24 hr cycle for each monthly sample over one year period. The measurements show that the mean current velocity on the fish ladder was 0.6 m/sec. The upstream and downstream migration mainly occurred during the hot season from mid April to early June. The first heavy rainfall resulted in increasing numbers of upstream migratory fish. A total of 51 fish species were recorded in upstream migration and 29 species downstream. Cyprinidae accounted for 99 % of the migratory fish species. The daily maximum number of fish migrated upstream and downstream was 3,541 and 490 fishes respectively. The estimated total fish weight migrating upstream was 11 % of fish caught in the reservoir. The ascending migratory fish species consisted of 70 % fish species found in Pak Mun Reservoir. Most fish species collected were small juveniles, indicating that those migratory fish were on feeding migration. Although results indicate that a large number of fish was caught in the integrated fish ladder, the actual number of fish that successfully ascend to the reservoir is unknown.
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Title:  Stocking and Recapture of Freshwater Prawn (Macrobrachium rosenbergii) in Run-of-River Type of Pak Mun Dam in Thailand

Key words:  Freshwater prawn; Reservoir; Run-of-river dam; Stocking program; Pak Mun Dam

The Pak Mun Dam is the first run-of-river dam in Thailand. It was constructed across the lower Mun River, 5 kms upstream from its confluence with the Mekong River. Upon closure of the Pak Mun Dam in 1994, a freshwater prawn (Macrobrachium rosenbergii) stocking program was initiated to increase the value of fish production in the reservoir, which was drastically affected by the dams’ operation. Twenty two million post larvae were stocked in the reservoir from 1995 to 2000. As a run-of-river dam, some of the stocked prawns were also dispersed downstream by outflow through spillways and turbines. This study aimed to evaluate distribution and seasonal patterns of prawn production in the Pak Mun Dam. The data collected from fishermen operating in reservoir and downstream include the number and weight of prawn catch from May 1999 to April 2000. The average weight of prawn caught from the reservoir was 236.5 - 96.8 g. Freshwater prawn production was 79.5 % from the reservoir and 20.5 % downstream. The total yield was 16,646 kg/year with a value of 122,027 USD/year (1USD=37 baht), contributing to 52.3 % of the total fish catch by weight (31,811 kg/year) and 98 % of economic value from the reservoir. Records show that prawn could be harvested 8 months after stocking with an estimated recapture rate of 1 %. This study shows that the freshwater prawn stocking program has been successful in the management of the Pak Mun Dam fishery.
The Songkram River is a tributary to the Mekong River in Northeastern Thailand. It is around 430 kilometer long and covers a basin area of 13,700 km². It is one of the most important river systems of Thailand and contains large wetland areas and seasonally inundated floodplains. These floodplain areas support very productive fisheries that in turn support the livelihoods of the local people. Planning of a big water management scheme that aims to control flood and supply water for irrigation close to the river mouth is now completed. Information on impacts on fisheries is needed to serve the planner both in terms of ecological as well as socio-economic impacts. This article discusses data on inland fisheries assessment in the Songkram River Basin, which has been collected during the past four years, including both ecological and socio-economic data. The article also aims to provide an assessment of different impacts on fisheries in the Songkram River Basin. A GIS system is used as the framework for integrating data from different sources. The data demonstrate that there is a significant correlation between catch, flooding and the movement of fishes (both the movement within the Songkram system and movement between the Mekong and the Songkram). These movements are influenced by the seasonal hydrological changes, which in turn lead to the high fisheries production to serve basic food security and local economies. The capture fisheries production is estimated at 22,000-26,000 tons per year and around 80% of the total capture is consumed before entering the market. The importance of the fisheries in the Songkram is not captured with standard official statistics. For example, a high number of people involved in fisheries (around 60%) is ignored in these statistics. Therefore, information on the status of the fisheries provided in this article is essential for policy makers and planners and should be incorporated into all EIA procedures for development projects within the basin.

Paper withdrawn but permission given to include abstract
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Title: Interactions between River dolphins (*Inia geoffrensis* & *Sotalia fluviatilis*) and fisheries in the Amazon and Orinoco basins

Key words: Orinoco river; dolphins; conservation

River dolphins are endangered throughout their range by human activities. In South America one of the main threats to these species is negative interaction with fisheries. Between February 2000 and April 2001 a study was conducted to evaluate interactions of *Inia geoffrensis* and *Sotalia fluviatilis* with artisanal and commercial fisheries in the Amazon and Orinoco basins in Colombia. Through questionnaires with local fishermen and direct observations, we identified conflicts between catfish fishermen and *Inia geoffrensis*. Fishermen claim that dolphins take fish from nets and jeopardize their income. Because of this, fishermen have developed strategies to keep dolphins away from nets: these included poisoning fish, shooting dolphins and hitting the water. More than 70 events of catfish fisheries were monitored in the Amazon; in only 22 cases (31.4%) did dolphins approach the net. In 3.2% cases fish showed marks of dolphin bites. Based on these results, fishermen recognized that dolphins do not affect the fishery as much as they thought and that the collapse of the fisheries could be due to over-fishing; they also saw the effect of predators such as fish of the Family Trichomyctheridae attacking catfish. In the Orinoco, the main conflict is between *Inia* and the fishery of *Mylossoma* sp., important for local consumption in Colombia and Venezuela. As in the case of the Amazon, fishermen perceive dolphins as competitors and take direct action against them. More than 12 dead dolphins were found in this area with marks from nets and bullet wounds. Artisanal fishermen in both study areas recognized that river dolphins do not compete with them, and in some cases are useful for detecting fish. We conclude that dolphins/fisheries conflicts are relatively low level, and there are other factors creating problems for the fisheries. Governmental and local agreements are required to regulate the fisheries.

Paper withdrawn but permission given to include abstract
Title:  Modelling for aquaculture related development, poverty and needs in the Mekong Basin

Key words: Mekong; aquaculture; GIS

Water resources are important for sustainability. For livelihoods linked to river systems the river basin is the fundamental landscape unit, alongside eco-regions, property boundaries, census tracts, political divisions, and protected areas for the planning and management of aquatic resource exploitation. Riparian communities often depend on fisheries to satisfy basic needs but are increasingly vulnerable to poverty arising from limitations on their access to aquatic resources. Aquaculture development is an option in river fisheries management to better manage aquatic resource exploitation. It can provide a sustainable alternative to river- and floodplain fisheries, thus reducing the pressure on aquatic resources. Despite its potential, aquaculture is an often-neglected option in rural development. Its impact has scarcely been assessed and few projects have specifically targeted the poor. Taking into account the current focus on poverty, aquaculture development could be integrated effectively into poverty reduction programmes to diversify production systems and reduce food insecurity. A detailed assessment of resources and an analysis of the poverty processes that prevail in any specific area, determine the strategy for aquaculture development. This requires adequate focusing on areas where aquaculture development potential coincides with generally low welfare levels and limited scope for alternative sustainable resource exploitation. This study focuses on the Lower Mekong Basin where natural events and resource competition are threatening rural communities that depend on the watershed for their subsistence. A holistic farming systems approach is proposed, emphasising the potential of integrated rural smallholder systems to reduce poverty and vulnerability of artisanal fishermen’s livelihoods. The greatest scope for the development of these systems is in the humid tropics where major increases in farm productivity and profitability can probably be made through development of such systems. A Geographic Information System (GIS) is used to identify where communities depending on the river for their livelihoods could potentially benefit from the integration of aquaculture into existing farming systems. It explores potential intervention strategies and development pathways and targets at appropriate level and scale interventions aiming to improve livelihoods through sustainable aquaculture development.
Title: Mekong flood levels and Tonle Sap fish catches

Key words: Bagnet fisheries; flood levels; modeling

Observations on the bagnet (Dai) fishery for migrating fish in the Tonle Sap river, Cambodia, during 1995–2002 indicate that year-to-year variations in maximum Mekong river flood levels and related Tonle Sap floodplain inundation strongly affect the yield of this fishery, which is dominated by short-lived species. The effect of variations in the height of the flood on the fish yield and on the average size of some major species are considered in the light of indicators and processes affecting the productivity of the lake, such as sedimentation and floodplain dissolved oxygen conditions. It is hypothesized that sediments carried by the Mekong waters to the Tonle Sap Great Lake bring in the essential nutrients that feed into the lake’s food webs. The higher the flood the more sediment is brought in. This leads to improved survival and growth of fish and hence of fishery yields.

This work is part of modeling at the Mekong River Commission Secretariat aimed at predicting the consequences of modifications in the Mekong’s hydrological regime and environmental conditions for the livelihoods of the basin’s population.
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**Title: The Mekong River System**

The Mekong is the longest river in southeast Asia. From its source on the Tibetan plateau it runs for 4,800 km through China, Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam to the South China Sea, where it discharges on average 475,000 million m³ per year. The total Mekong Basin (MB) catchment area covers 795,000 km² and has 73 million inhabitants. The Lower Mekong Basin (LMB) comprises the four countries, - Cambodia, Lao PDR, Thailand and Viet Nam - that signed the 1995 river development agreement and covers 77% of the total basin with 55 million people.

The degree of inundation of the 70,000 km² floodplains depends on the strength of the monsoon, as 85-90% of the discharge is generated during the wet season from May to October. Although far from pristine, the river still is in a relative good condition. Only 2 mainstream dams (in China) have been built, but many more on the tributaries.

The number of fish species that has been found in the MB exceeds 2000. Many migrate across international borders, thus constituting trans-boundary resources.

The largest fisheries are found in the extensive floodplains in central Cambodia and the delta. A huge variety of fishing gear is used, from the most simple traps to kilometers-long fence systems. Catch levels of the capture fisheries in the LMB are estimated to top 2.6 million tons annually with a value exceeding US$ 1.7 billion. In Cambodia fisheries contribute 16% to the GDP. Strong increases in human population are matched by equal increases in fishing effort resulting in catch levels that are probably higher than ever. Major declines in stock sizes of the larger later-in-life spawning species have been witnessed. Catches are now dominated by smaller rapidly reproducing species.

In rural areas most people engage in fishing to generate part of their income and food supply. The basin-wide consumption of fish and other aquatic animals ranges from 42 - 66 kg/capita/year.

The Mekong River Commission came into being with the signing of the 1995 agreement by Cambodia, Lao PDR, Thailand and Viet Nam. It focuses on the need for cooperation in the sustainable development of the LMB. China and Myanmar have not joined yet. The member nations have agreed to prior consultation on proposed river water usage.

The most important interventions required to sustain the fisheries are: (1) Strengthening of the capacity of riparian governments in coordination and balanced decision-making on water resources development; (2) Setting up of consultation procedures on water resources and fisheries management with resource users, decision makers, researchers and donors; (3) Collection of data clarifying the contribution of fisheries to the national economy, food security and livelihoods; (4) Participation of resource users in fisheries management; (5) Protection of floodplain habitats; (6) Maintenance of highest possible flood levels and a free flowing mainstream with as many free tributaries as possible.
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Title: Yield per recruit of the pacu, *Piaractus mesopotamicus* (Holmberg, 1887) (Pisces: Characidae), in the Pantanal Mato-grossense, Brazil

Key words: Pantanal; *Piaractus mesopotamicus*; stock dynamics

The pacu, *Piaractus mesopotamicus* (Holmberg, 1887), (family Characidae, subfamily Myleinae), were classified with *Colossoma mitrei* (Berg, 1895) until recently. This species is of great importance to the fishery of the Paraguai river basin, because its economic value and flavour. The Pantanal is situated in the central South America, between 13° and 22° South latitude, and 53° and 61° West longitude of Greenwich, and covers an area of 140,000 km². It has well defined flood and drought seasons. Some features of the dynamics of pacu were studied using individual length and weight data from the commercial fishery of the Cuaiba River in the city of Cuiabá, Mato Grosso State, Brazil, from April/94 to June/95. This data has been used to derive a yield per recruit relationship, growth relationships and an estimate of maximum sustainable yield (MSY). The yield per recruit is close to the MSY and will result in overexploitation if fishing pressure increases. In addition the alteration of the Pantanal environment could lead to further pressure on the species as its main feeding habitats are being rapidly reduce in area. A policy for the conservation of this species is urgently needed.
Title: Population structure of jaraquis (*Semaprochilodus* spp) (Schomburg, 1841) in Amazon hydrographic basin rivers

Key words: Amazon, *Semaprochilodus*, growth; migration

Jaraquis (*Semaprochilodus* spp) are migratory characiforms that are exploited by a commercial fishery that lands approximately 9,000 tons per year in Manaus, Amazonas State, Brazil. The fishery takes place in the larger rivers of the basin, mainly during dispersion migrations at full flood period and reproduction migrations at the start of the flood. The jaraqui is one of the main protein sources for the low income local population. The purpose of this study is to analyse the population structure of *Semaprochilodus* spp in the main rivers of Central Amazônia (Negro, Solimões, Purus and Madeira), to contribute towards establishing a basis for the rational use of this fishery resource. Biometric data for jaraqui, as well as scales for ageing, were collected during the migratory dispersions of April - June of 1997 - 2000 and reproduction from January - March of 1997 – 2000 in the Purus, Madeira, Negro and Solimões rivers. A comparative analysis of the population was made for these different rivers. The size structure of the fish varies in the different rivers, depending on the migration period. The overall sex distribution does not vary for the four rivers, but females predominate in the larger classes and males in the smaller. Age structure differs by river and species. *S. insignis* between one and a half and two and a half years of age, were found in all four rivers. Three-year-old fish were only observed in the river Purus. Most examples of one year old *S. taeniurus* were captured in the Negro River. Fish over one year of age were observed in all four rivers. There were no significant differences in the size of the 3rd growth ring on the scales of *S. taeniurus* formed during the dispersion at 1.5 years. This indicates that the dispersion in the first years of life happens simultaneously in the Negro, Madeira, and Solimões Rivers. There is a small delay in the Purus River, where the modal value of the third ring size is slightly greater. Significant differences in the size ranges of the 3rd growth ring in *S. insignis* scales indicate this species has migratory pulses during dispersion in the rivers of Amazônia. The geographical variations in population structure, need to be considered when formulating management measures to conserve jaraquis in Amazônia.
The Chinese sturgeon (Acipenser sinensis), Dabry’s sturgeon (A. dabryanus) and the Chinese paddlefish (Psephurus gladius) are native to the Yangtze River. All were listed as national protected animals in Category I in 1989 and in the IUCN Red List (1996), of which A. sinensis was considered as Endangered, and later two as Critical Endangered. The construction of Gezhouba Dam at Yichang has blocked their migratory passage since January 1981 and may be the main reason for the decline of their stocks. A. sinensis is a large-sized, anadromous fish, that spawned in an 800 km long section of the upper reaches of Yangtze and the lower part of Jinshajiang. A new spawning ground for the Chinese sturgeon has been observed since 1982 in the 3 km to 7 km long reach just below the Gezhouba Dam. With the implementation of a series of protection measures, including a harvest ban, setting up of protected areas, and a restocking program since 1983, recruitment of juveniles in the mouth of Yangtze was relatively stable from 1982 - 2002 whereas the migratory or spawning populations were still declining. The Three Gorges Project will further negatively impact the species as the high dam will cut off about 40% of the water discharge at Yichang during October-November when Chinese sturgeon spawn. The fish have not yet been bred in captivity. A. dabryanus, a small freshwater sturgeon, mainly inhabits the upper reaches of the Yangtze. No individuals have been found below Gezhouba Dam since 1991. Documentation of the by-catches of fish indicated that the fish population had declined dramatically and they cannot reproduce naturally in the upper reaches of Yangtze and the lower reaches of Jinshajiang. Psephurus gladius, is a large-sized fish that spends most of its time in the main stem of the Yangtze and can live in the coastal water of the East China Sea. Its life history is not clear. The Gezhouba Dam separated the species into two populations an Upper-reach population and a Mid-lower reach population. The later is thought to be extinct as it was last found in 1993. A few to tens of individuals were found annually in the upper reach of Yangtze and the Jinshajiang in 1980s. A planned hydroelectric project, Jinshajiang First Period Hydroelectric Project, will totally destroy the spawning grounds used by Chinese paddlefish and Dabry’s sturgeon. Conservation programmes are needed for all these species.

Paper withdrawn but permission given to include abstract
Title: Dependence of river fisheries on river flow

Key words: Fisheries, Floods, Rivers, Rehabilitation, modeling

Much work has been done on the flow requirements for maintenance of salmonid populations but few equivalent studies are available upon which to base criteria for the management of water regimes for fishes and fisheries in large river systems. Fish in such rivers are heavily influenced by flood regimes that fluctuate naturally from year to year. Recently increasing pressure on water for a wide range of uses other than fisheries has led to damming, river training, water abstractions and water transfers that have substantially altered flood regimes of rivers throughout the world. Such alterations usually have resulted in the loss of fish production and biodiversity. The current emphasis on sustainable development and biodiversity conservation is leading to efforts to mitigate negative impacts of these changes through planning for altered river flows and the release of artificial floods from dams or polder sluices. The typical flood regime contains several characteristics that may influence the recruitment, growth and survival and growth of the individual fish species. Understanding of these characteristics will help determine flow criteria for the maintenance of floodplain fish faunas and design appropriate flood curves that maximize benefits from the water available. A companion paper (see Halls and Welcomme) describes a simulation modelling exercise designed to further explore these flow criteria and quantify the influence of different flood curves on key population parameters.
Title: Floodplain river foodwebs: generalizations and implications for fisheries management

Based on the relationship between temperature variation and flood dynamics, three types of floodplain rivers can be identified: temperate stochastic, temperate seasonal, and tropical seasonal. The degree to which flooding occurs in phase with warm temperatures and enhanced system productivity influences selection for alternative life history strategies in aquatic organisms. In addition, regional geochemistry and temporal dynamics of disturbance and recovery of local habitats within the landscape mosaic favor different life history strategies, sources of production, and feeding pathways. In most habitats, algae seem to provide the most important source of primary production entering the grazer web. Large fractions of periphyton and aquatic macrophyte production enter aquatic foodwebs in the form of detritus, and detrital consumption is greater during low-water phases. Even in species-rich tropical rivers, most of the material transfer in food webs involves relatively few species and short food chains (3-4 levels, 2-3 links). Longer food chains that involve small or rare species are common and increase ecological complexity, but probably have minor effects on total primary and secondary production. In the tropics, fishes appear to perform many ecological functions performed by aquatic insects in temperate rivers. Oftentimes, a small number of common species disproportionately influences benthic ecosystem structure, productivity, and dynamics. Similarly, a relatively small number of predatory species may exert a disproportionately large influence on prey populations, even in species-rich tropical systems. Under seasonal flood-pulse regimes, species have the opportunity to evolve adaptations to exploit predictable resources. In aseasonal flood-pulse regimes, species are more challenged to respond appropriately to relatively unpredictable patterns of resource variation, and access to floodplain habitats, while nonessential for most species, usually enhances recruitment. Seasonal rivers in nutrient-rich landscapes can sustain greater harvest than aseasonal rivers or seasonal rivers in nutrient-poor landscapes. Loss of habitat connectivity and overharvest of dominant species can have unpredictable effects on food web dynamics and community structure. Maintenance of natural flood regimes is important for maintenance of biodiversity and sustainable harvest of fishes, especially in strongly seasonal systems.
Human impacts over the whole river basin accumulate in the lower parts of large rivers, dramatically degrading the fish communities. Riverine fish are well adapted to the spatial heterogeneity and temporal dynamics of river systems often by complicated life history patterns. This in turn makes them vulnerable to the effects of modification of physical habitats and hydrology. From the perspective of ecosystem theory, the major anthropogenic disturbances of large river ecosystems have been the degradation of water, nutrients and mineral circulation and incorporation of pollutants, such as heavy metals, pesticides, etc., into ecological cycles. The Ecohydrology Concept is a conceptual tool for integrated catchment management, aimed at reducing cumulative impacts from the whole catchment on biota, and especially the fish communities. The general target of the Concept is reversal of anthropogenic degradation of water and nutrient cycles in the basin scale toward enhancement of the absorbing capacity (resistance and resilience) of ecosystems. This can be done by regulating the hydrological pattern and by modifying biota structure, in both terrestrial and aquatic phases, for the control of nutrient, sediment and freshwater biota dynamics. The Ecohydrology Concept has three principles. Firstly integration of water and biota at the catchment scale, considers three elements: Scale - Dynamics and Hierarchy of factors in the river basin. Secondly, the objective of the integration of hydrology and ecology is to increase understanding and gain new dimensions of knowledge toward achieving sustainable water use to improve quality of life in the face of increasing human population and aspirations. Thirdly, using ecosystem properties as a management tool. The numerous cases of over-engineering of aquatic systems are evidence that decision makers with technocratic backgrounds still prevail, and most of society accepts their views. The new Concept introduces solutions in the form of low-cost high-technologies, which are much more efficient in terms of processes control, from molecular level to basin scale.
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