

Lake Nasser fisheries: Recommendations for management, including monitoring and stock assessment



LAKE NASSER FISHERIES: RECOMMENDATIONS FOR MANAGEMENT, INCLUDING MONITORING AND STOCK ASSESSMENT

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LIST OF SYMBOLS AND ABBREVIATIONS

B	mean stock biomass
B_c	current average (annual) biomass; estimated current average biomass (according to the equation)
B_{MSY}	proportion of the unexploited biomass (B_0)
B_∞	maximum stock size
C	catch
E	rate of exploitation
f	index of effort
f_{MSY}	estimate of fishing effort corresponding to the estimate of maximum sustainable yield (related optimum effort)
F	fishing mortality
F_{maxYPR}	fishing mortality rate to maximize yield per recruit
F_{MSY}	optimum fishing mortality rate
MEI	morphoedaphic index
T	total catch
Y_E	yield when the stock is in equilibrium
Y_c	total current catch
Y_{MSY}	maximum sustainable yield
Y_∞	asymptotic yield
Z	total mortality rate

LIST OF ACRONYMS

CAPMAS	Central Agency for Public Mobilization and Statistics
CPUE	catch per unit effort
FMC	Fishery Management Center
GAFRD	General Authority for Fishery Resources Development
HDLDA	High Dam Lake Development Authority
JICA	Japan International Cooperation Agency
MSY	maximum sustainable yield
NIOF	National Institute for Oceanography and Fisheries SWOT strengths, weaknesses, opportunities and threats
SWOT	strengths, weaknesses, opportunities and threats
VPA	virtual population analysis
YPR	yield per recruit

EXECUTIVE SUMMARY

This study sought to improve the baseline knowledge of the fisheries of Lake Nasser and to make recommendations for the improved management of the fisheries, including stock assessment.

The study included the review of key literature, visits to fisheries infrastructure and fishing camps, and individual consultations with the key stakeholders by means of semi-structured interviews, as well as a collective stakeholder consultation workshop. A preliminary stock assessment was also undertaken using the most recent time series of catch and effort estimates.

Since its creation in the 1960s, Lake Nasser has supported important fisheries, mainly for tilapia, Nile perch, and species of *Alestes* and *Hydrocynus* (tigerfish). Most fishers operate from very basic fishing camps situated around the lakeshore or on islands. Tilapia and Nile perch are sold from the fishing camps as fresh fish, while the other species are made into a salted fish product called *muluha*.

The Lake Nasser fishery provides direct jobs for 13,000 persons and indirect jobs to an unknown number of people. In 2005, the estimated value of the fishery (including both fresh and salted fish) was around USD 17 million.

Access to the fishery is zoned. Four cooperatives and a semi-state fishing and processing company (Misr Aswan) control the access to each zone. Licenses to fishers are given based on a supporting letter by one of those cooperatives, to be presented to the General Authority for Fishery Resources Development (GAFRD) responsible for issuing fishing boat and fisher licenses. However, many boats operate without a license due to the limited control capacity of the authority.

Until recently it was a legal requirement to land all fish through the three official harbors by carrier boats owned by the coops and Misr Aswan, allowing the management authority to monitor catches from the lake. However, compliance has been low and hence a proportion of landings are unreported. This proportion is unknown, but anecdotes suggest it could be significant. More landings are now gathered by private sector carrier boats rather than the cooperatives, which stopped using theirs. This makes the catch monitoring process inefficient.

As for processing, the Misr Aswan processing facility operates below capacity as more of the catch is purchased by the private sector. Meanwhile, other private sector processors have emerged.

The current technical measures set to control the harvesting, for example (minimum mesh and fish-landing sizes, along with a 1-month closed season corresponding to the main spawning period of tilapia), are based on 17-year-old stock assessments.

Compliance with these technical measures has been poor, particularly in the past 4–5 years following the transfer of management authority from the High Dam Lake Development Authority (HDLDA) to GAFRD due to lack of resources.

In response to growing fishing effort (number of boats) and poor compliance with the technical measures, yield from the fishery has declined, with significant interannual variation. Since 1981, catch rates have declined by about 80% in a manner symptomatic of unsustainable rates of exploitation.

The results of an updated assessment suggest that the maximum yield (about 17,000 metric tons [t]) is significantly less than previous estimates and could be caught with just 1300 boats (f_{MSY})—less than half the number now operating.

Catches from the fishery exceeded Y_{MSY} in 13 out of the past 34 years. The stock biomass is predicted to be now around 10% of the unexploited biomass B_0 . This is below the proportion (20%) considered necessary to avoid recruitment overfishing.

It is recommended that a management plan be formulated with the full participation of all stakeholders with a main priority to rebuild the fish stocks of the lake to sustainable levels, at least above $0.2B_0$. This will require an updated stock assessment and better control rules.

In addition to drafting new legislation, several management measures for the fishery should be selected in consultation with key stakeholders to ensure that they can be enforced, including control over fishing effort.

Given the lack of incentives for fishers to land their catches through the official harbor channels, an alternative catch-monitoring system should be designed, in the form of a catch assessment survey or self-monitoring by the fishers using logbooks. In addition to catch, the age or size structure of fish populations should be routinely monitored to provide estimates of the fishing mortality rate, F .

Sufficient resources (staff, boats, funds, etc.) must be allocated to the management authority in order to improve compliance with any new rules and regulations introduced under the management plan.

There appears to be strong support for the creation of a co-management organization comprising representatives of the main stakeholders, including fishers with a main task to agree on stakeholder roles and responsibilities for management based upon their respective roles and responsibilities, prior to the formulation of the management plan, to ensure that relevant stakeholders have an active role in the formulation of the plan.

Study purpose and terms of reference

This report, its annexes and its associated literature review form the output against the study terms of reference, which are as follows:

- Contribute towards a literature review for Lake Nasser fisheries.
- With the WorldFish staff and consultants, set up a stock assessment survey plan for lake fisheries.
- Advise on data analysis using up-to-date methods and models.
- Conduct meetings with the main parties involved in the Lake Nasser fisheries.
- Deliver a consultation workshop and seminar on fisheries management options for Lake Nasser.
- Recommend options for improved management of Lake Nasser and Nile River fisheries management.
- Write a mission report on management options and stock assessment plans for Aswan fisheries.

Activities

The findings, conclusions and recommendations of this report were based upon (i) a review of the literature, drawing heavily from previous reviews, including Bishai et al. (2000), van Zwieten et al. (2011), Habib et al. (2014) and Habib (2015); (ii) visits to three fishing camps on the lake and to supporting infrastructure at Aswan harbor; and (iii) consultations with key stakeholders. A summary of the study activities is given in Annex 1.

Stakeholder consultation

Stakeholders who were consulted for their views about the management of the lake are listed in Table 1.

As well as asking specific questions relevant to each stakeholder, interviews with stakeholders were loosely structured around the following series of 15 questions, which were designed to improve understanding of the main issues confronting the sustainable management of the lake resources and required action to address these issues:

- What trends or changes have you observed in the fishery?
- What is the current status and health of the fishery (underexploited; fully exploited; overexploited)?
- What are the main problems, issues and weaknesses of the fishery?
- What are the main threats faced by the fishery?
- What are the good things about the fishery (i.e. its strengths and benefits)?
- Is the fishery well managed? If not, why not?
- How could the management be improved?
- Are control measures (rules and regulations) effectively (well) enforced? If not, why not?
- Should the fishery be controlled by restrictions of catch or fishing effort, by technical measures, or by a combination?
- What roles and responsibilities should or could stakeholders have in management (e.g. rule-making, monitoring, decision-making, enforcement, control, etc.)?
- What opportunities exist for the fishery (e.g. development of the Nile perch fishery, developing export markets, stock enhancement, added value, etc.)?
- How much of the catch is landed at the main harbors (the official landing sites)?
- Complete the following fish disposal pathway diagram. (See Annex 4.)
- How could monitoring of the fishery be improved?
- Do you have other comments?

Name	Position	Institution or organization
Tag El Dein Abu El Rahman	Director	HDLDA
Mr. Osama Mohammed Kamel	Chief of sector	Misr Aswan Fishing Company
Mr. Mahmoud Haseb	Executive director	GAFRD
Esmail Hagage Abd El Alla	Fisher and fish processor	-
Dr. Naguib	Director (and sediment specialist)	National Institute for Oceanography and Fisheries (NIOF)
Dr. Agaypi	Macro fauna and flora specialist	NIOF
Dr. Hussein Amar Adam	Fisheries biologist	Fishery Management Center (FMC), HDLDA
Mr. Murad Zaki Agaypi	Fisheries biologist	FMC, HDLDA
Fishers (names excluded for anonymity reasons)	Fishers	At three fishing camps affiliated with Misr Aswan Fishing Company

Table 1. Stakeholders who were consulted for their views about the management of the lake.

The responses to these questions were also used to analyze the fishery's strengths, weaknesses, opportunities and threats using the SWOT tool. (See Annex 5.)

A workshop with 20 key management stakeholders was also held in an attempt to reach consensus on the main issues confronting the sustainable management of the lake resources and required action to address these issues, improve management performance, and identify opportunities for the development of lake fisheries-dependent livelihoods. Annex 3 contains the full workshop report, including the list of participants. The SWOT analysis table is given in Annex 5, and an example of a fish disposal pathway diagram is given in Annex 4. The key findings of these stakeholder consultations are synthesized and cited in the Results and Conclusions sections where relevant.

Groups of fishers were interviewed at three fishing camps in the northern sector of the lake, which is under the control of the Misr Aswan Fishing Company. Due to travel restrictions, other locations on the lake could not be visited.

Responses given by the stakeholders consulted are summarized in Annexes 1 and 2.

A preliminary stock assessment

An aggregated multispecies biomass dynamics model was fitted to what was regarded as the most reliable and up-to-date time series of catch and effort data for fresh fish (mainly tilapia and Nile perch) in an attempt to explore likely values of key target and limit reference points for the fishery. The results were compared to those generated by earlier assessments and the current status of the fishery.

Fishery management systems

A fishery management system comprises a wide array of activities and agreements designed to ensure the rational and responsible use of living aquatic resources. These activities and agreements include governance arrangements (policies, laws, use rights, control rules, etc.), management procedures (setting objectives, control rules, performance measures, reference points, etc.), scientific advice (stock assessment, scenario modeling, etc.), compliance (surveillance, enforcement and voluntary codes) and monitoring.

The terms of reference for this study seek to generate options for the improved management of the fish resources of Lake Nasser. Stock assessments and related monitoring activities are integral to the management system, providing scientific advice and information to help design and evaluate the performance of the management system. However, these activities should be regarded as supporting, rather than driving, the management process and should be designed accordingly.

A framework for fisheries management

This study and its recommendations are structured around the fisheries management framework described by Hoggarth et al. (2006). This system recognizes that a fishery management system must acknowledge and be adapted to a wide range of influences that affect the interaction between the fishery, its stakeholders and the aquatic environment. The main components of a modern fishery management framework are illustrated in Figure 1.

This framework provides a relevant, systematic and logical structure for the review of the system currently in place to manage the fishery resources of Lake Nasser, and thereby to make recommendations for its future improvement, including stock assessment and fisheries monitoring activities.

Governing the fishery management process, and hence at the head of the framework, is the fisheries policy. This includes the goals and objectives that the management system is intended to address. Interacting with the fisheries policy are the management context and the management process. The context includes factors that will affect the way the fishery should be managed. The process includes the decision-making processes and the specific measures that are used to control the fishery. The stock assessment and research to provide the scientific advice and technical basis for the management are placed in their own box to emphasize their integral importance in the management process. Arrows between the boxes are bi-directional, reflecting the intimate and mutually reliant relationships between them. The circular arrow emphasizes that the

stock assessment process should guide the management process through regular and routine feedback. Management measures could be adjusted each year, driven by the status of the system, which is indicated by indicators and reference points (the stock assessment-management cycle). The overall system should be assessed every 3–5 years.

Each section of the review findings below begins, where relevant, with a brief introduction to the meaning and relevance of each element of the framework. The situation in Lake Nasser for that element is then described. More detailed descriptions of the framework elements are available in Hoggarth et al. (2006).

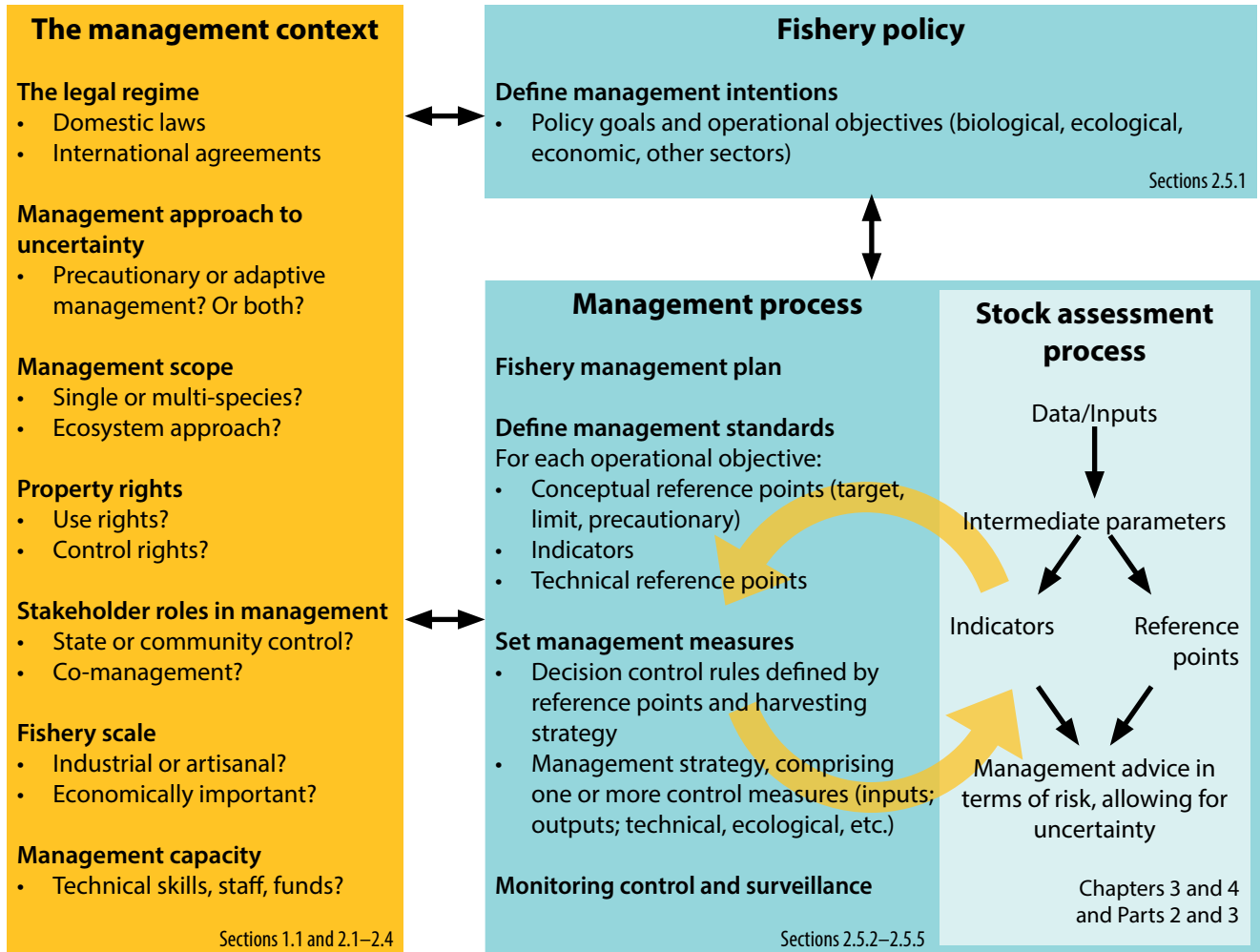


Figure 1. A framework for fishery management illustrating the different elements to be addressed in establishing a fishery management system. Source: Hoggarth et al. (2006).

Fisheries policy

A key first step for management is to specify the policies and goals that will drive the management process. A fisheries policy is usually developed at the national level. It applies to all the fisheries in the country and broadly describes the purpose for which they will be managed.

The policy should be supported by national legislation (e.g. the Fisheries Act). The policy should be compatible with any binding international legal frameworks that the country has ratified and any regional fisheries organizations to which the country belongs, as well as national legislation; e.g. concerning biodiversity conservation, protected species, etc.

Policy goals

Guided by policy, broad goals should be set, stating specific priorities for each fishery. These should focus upon achieving long-term sustainable use of the fisheries resources along with further aims related to the social and economic status of each fishery.

Fisheries policy in Egypt

According to van Zweiten et al. (2011), fisheries policy in Egypt and for Lake Nasser seeks to achieve the following:

- Increase fish production.
- Increase the contribution of Lake Nasser fisheries to the gross domestic product.
- Provide employment, particularly for young people.
- Improve the incomes and the standard of living of local fishers and their families.
- Achieve more rational and sustainable use of natural resources of the reservoir.

Operational objectives

To enable managers to monitor progress, the policy goals of each fishery should be further developed into explicit *operational objectives* (like objectively verifiable indicators in a logframe). These should be negotiated with and accepted by the stakeholders and linked to a clear time frame. They should further be linked to indicators and reference points as the basis for monitoring and management on an annual basis. Goals and objectives are usually divided into four categories (Table 2). Biological and ecological imperatives must be met first.

Goals and objectives are not always compatible; they may be conflicting, since different goals are achieved at different levels of fishing effort (Figure 2).

	Goals	Operational objectives
Biological	To maintain the target species at or above the levels necessary to ensure their continued productivity	To maintain the stock at all times above 50% of its mean unexploited level
Ecological	To minimize the impacts of fishing on the physical environment and on non-target (bycatch), associated and dependent species	To maintain all non-target, associated and dependent species above 50% of their mean biomass levels in the absence of fishing activities
Economic	To maximize the net incomes of the participating fishers	To stabilize net income per fisher at a level above the national minimum desired income
Social	To maximize employment opportunities for those dependent on the fishery for their livelihoods	To include as many of the existing participants in the fishery as is possible given the biological, ecological and economic objectives listed above

Table 2. Examples of fishery goals and operational objectives. Source: Hoggarth et al. (2006).

Policy goals and operational objectives: Lake Nasser

The literature review did not reveal any specific goals and objectives for the lake's fisheries. Indeed, it remains uncertain if such objectives have ever been formally agreed and documented. No references to specific goals or objectives, or to relevant documentation, were made by the stakeholders consulted during the study, including the current management authority (GAFRD).

An appropriate and effective management system for the lake cannot be designed or implemented until these goals and objectives are explicitly defined and approved by relevant stakeholders, and documented.

With reference to Figure 2, and based upon the information assembled and preliminary stock assessment reported on pages 30–31, it is likely that the fishery currently lies close to the point on the figure labeled “unmanaged, low cost of fishing.”

The management context

The legal regime

Under Law #124, Issued 1983, the Ministry of Agriculture has the right to do the following:

- Set minimum gear size and fish landing sizes.
- Restrict the capture of certain species of fish.
- Close areas to fishing.
- Control which fishing gears may be used.
- Determine fish license type and number permitted in each zone.

Under this law, all fishers, including crew members, must hold a valid license to fish on Lake Nasser, and all fishing boats must be licensed by the management authority (GAFRD) and have an allocated area to fish assigned by the fishing cooperative or fishing company.

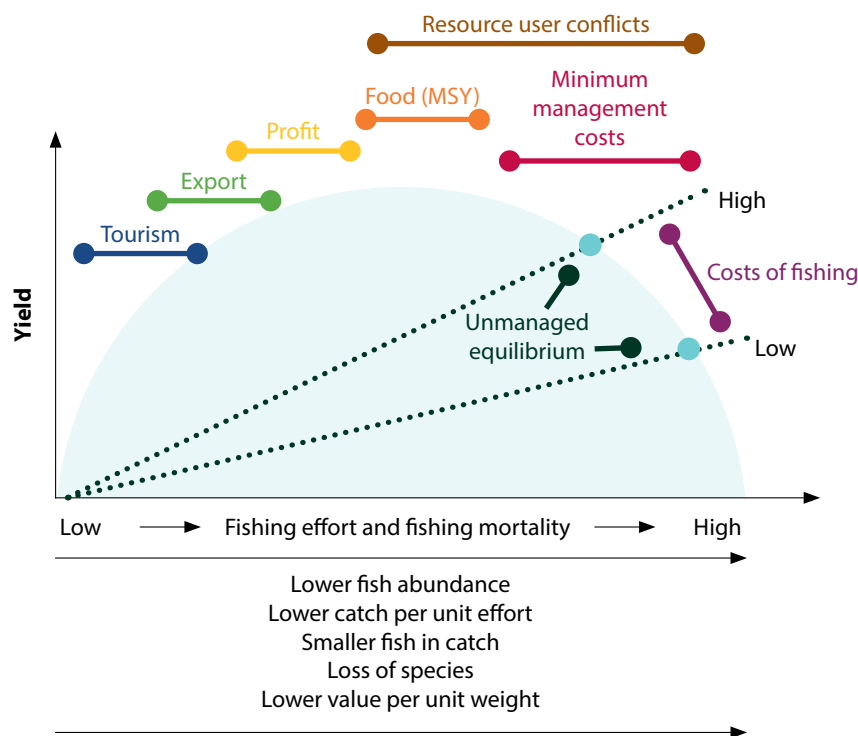


Figure 2. Possible management objectives for a multispecies resource, their likely relative positions along a scale of fishing effort, and other fishery indicators. Source: Hoggarth et al. (2006).

The Fishery Management Center (FMC) recommended the following management measures for Lake Nasser. However, it is understood that these are not included in fisheries legislation and therefore cannot be enforced by law:

- A closed season between 15 April and 15 May was introduced in 1991 to reduce the capture of mature fish (spawners), particularly tilapia, during the spawning season.
- A closed area was established in Kalabsha (2–3 years only), which was stocked with tilapia.
- A minimum mesh size of 12 centimeters (cm) has been set for bottom gill nets and trammel nets.

Many stakeholders claimed that, by law, fish may only be landed at the official harbors, where it is weighed by the HDLDA. However, these claims should be treated as questionable because it appears that no such legislation exists.

Management approach to uncertainty

The question of how fisheries can best be managed is hard to answer, because fishery managers face many uncertainties in the status and dynamics of the resource and the fisheries under their responsibility. Three main approaches are employed to address this uncertainty: (i) comprehensive rational planning; (ii) the precautionary approach; and (iii) adaptive management.

Comprehensive rational planning

This is a traditional approach to management that assumes that with research, an understanding of the resource system can be achieved that leads to effective management and control. Little or no consideration is given to uncertainty.

The precautionary approach

This approach advocates that the greater the uncertainty, the more conservative the approach should be. Precautionary management is at the core of the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries (1995). The Code of Conduct gives the following advice:

“7.5.1 States should apply the precautionary approach widely to conservation, management and exploitation of living aquatic resources in order to protect them and preserve the

aquatic environment. The absence of adequate scientific information should not be used as a reason for postponing or failing to take conservation and management measures.

7.5.2 In implementing the precautionary approach, States should take into account, inter alia, uncertainties relating to the size and productivity of the stocks, reference points, stock condition in relation to such reference points, levels and distribution of fishing mortality and the impact of fishing activities, including discards, on non-target and associated or dependent species, as well as environmental and socio-economic conditions.”

Whereas a comprehensive rational planner might aim at setting an exact fishing effort or quotas to achieve a model-predicted maximum sustainable yield (MSY), a precautionary manager would reduce the effort or quotas according to the level of uncertainty with which the MSY is estimated.

In a well-managed fishery with an expensive monitoring and analysis system, this precautionary MSY might be quite close to the model-predicted MSY. In a data-poor fishery, it should be much lower, if the fishery is to keep on the safe side.

Adaptive management

Although precautionary management is now being used, it tends to provide little information about the system being managed. Since the MSY of a fishery cannot be predicted well until it has been exceeded, too much precaution may result in a fishery falling short of its true potential, with managers never really knowing what might have been. To overcome this potential drawback, adaptive management may be used alongside the precautionary approach. Adaptive management attempts to reduce uncertainties over time in a structured process of learning by doing (Walters and Hilborn 1978).

Management actions are used or interpreted as experiments to learn more about the resource system at the same time as it is being managed. New knowledge is generated by the deliberate use of learning processes instead of sticking to rigid technical solutions that may be suboptimal. There are two main types of adaptive management, passive and active:

- Passive adaptive management adopts the best-fitting model in each year as “true” for that year, and only updates management policy according to new data that arises naturally. Passive adaptive management can make use of existing variation in the resource system as an experiment. This type of adaptive management has the greatest potential in resource systems that have a high degree of natural variation.
- Active adaptive management attempts to produce better information for the long-term management of the resource. It uses management actions to deliberately disturb the system in “probing” experiments that

are designed to enable scientists and other stakeholders to learn more quickly about the system and its dynamics.

Management approach to uncertainty: Lake Nasser

The management stakeholders of Lake Nasser fisheries have adopted the traditional comprehensive planning approach to management, where little or no consideration is given to uncertainty. It is recommended that greater acknowledgment of uncertainty be adopted in future stock assessments and decision-control rules formulated for the fishery if a more stock assessment-driven approach to management is to be pursued in the future.

Management options	Advantages/application	Disadvantages/comments
Comprehensive rational planning	<ul style="list-style-type: none"> • Assumes that management outcomes can be predicted with certainty and that available knowledge provides an adequate basis for sound management • Suitable for conditions of low or no uncertainty about resource status, etc. 	<ul style="list-style-type: none"> • High risk of failing to achieve management goals in most fisheries, due to many uncertainties about resource dynamics and the interaction with human aspects of the system, including the effects of alternative management options
Precautionary	<ul style="list-style-type: none"> • Reduces risks according to level of uncertainty and potential danger • Encourages involvement of industry in providing good data by shifting the burden of proof 	<ul style="list-style-type: none"> • May limit exploitation below maximum potential where uncertainty remains high • May limit opportunities to increase knowledge about the system if applied too rigidly
Adaptive	<ul style="list-style-type: none"> • Reduces uncertainty by experimentation and/or analysis of existing variation • Most useful in spatially structured waters (inland, coastal), and for less mobile stocks • Use “passive” approach where natural variation gives contrast • Use “active” approach for fastest learning • Can be applied within a precautionary framework by making experiments in limited areas and keeping other areas as “buffers” 	<ul style="list-style-type: none"> • Active approach requires industry commitment to principle of experimentation, which may increase variability in catches • Harder to apply in large offshore fisheries with an indivisible unit stock • Need to make large adjustments to “treatments” to generate observable effects

Table 3. Summary of the approaches to uncertainty and their advantages and disadvantages. Source: Hoggarth et al. (2006).

The existing access rights to the fishery effectively create recognized fishing areas along the lakeshore. These areas offer potential for adaptive management, where fishing areas could form management units to receive “treatments” as part of management experiments. This would require the devolution of management authority to fishers with rights over these areas to enable them to control the access of other fishers and possibly grant them rights to set rules and regulations within their boundaries.

Management scope (single, multispecies or ecosystem approach)

The traditional paradigm of fishery management is that the productivity of a stock is a property of its size and reproductive potential and that a manager needs only to control fishing activities to maintain the size of the stock and protect breeding fish to achieve a good yield. However, most fish stocks share their waters with many other fish species, of different sizes and life

histories, and are caught by a range of different fishing vessels and gears. Applying the optimum single-species management controls for all species and gears at the same time is usually impossible, and some compromises need to be made (Hoggarth et al. 2006).

Nevertheless, the assessment and management of unit stocks of single fish species can provide a good start for considering management actions even for complex ecosystems. They are likely to remain the best tools for assessing many fisheries based on one or a few main target species for many years. Where stocks interact with other species and fleets, or with the wider environment in various ways, some compromises or adjustments will also need to be made.

While approaches to dealing with technical interactions in multispecies fisheries are relatively straightforward, biological interactions are far more challenging (Table 4).

Management scope	Advantages/application	Disadvantages/comments
Single species	<ul style="list-style-type: none"> Simplifies models to main fishery control parameters (e.g. effort, catch, technical measures) 	<ul style="list-style-type: none"> Ignores interactions with other species and the wider environment May lead to overly optimistic management advice
Multispecies	<ul style="list-style-type: none"> Extends focus to all main species in fishery At simple level, aims to limit bycatch, discarding, etc. Use aggregated biomass dynamic models, or analytical models with technical interactions 	<ul style="list-style-type: none"> Analytical models with full biological interactions hard to apply Hard to optimize controls for all species simultaneously—need to accept some tradeoffs
Ecosystem	<ul style="list-style-type: none"> Seeks to maintain biological diversity, habitats and ecosystem functions Management options include use of networks of marine protected areas (MPAs), prevention of bycatches, discards and gear damage, etc. Common sense measures can be applied to “tractable” ecosystem problems 	<ul style="list-style-type: none"> Food web and trophic level models not yet useful in providing implementable management advice Hard to distinguish relative effects of fishing and environmental factors on fish stocks, and hence appropriate management responses

Table 4. Summary of alternative scope and scale of management. Source: Hoggarth et al. (2006).

Ecosystem management

The ecosystem approach aims to consider all significant interactions between species, sectors and the wider environment. The ecosystem approach implies a holistic strategy for management, aiming to ensure that flora and fauna are maintained at viable levels in their native habitats and that the integrity of ecosystems is maintained as far as possible while supporting sustainable levels of human use. The FAO has adopted the term “ecosystem approach to fisheries” and has defined its purpose as “to plan, develop and manage fisheries in a manner that addresses the multiplicity of societal needs and desires, without jeopardizing the options for future generations to benefit from a full range of goods and services provided by marine ecosystems” (Garcia et al. 2003).

Recognizing the difficulty in reconciling differences in ecosystem and fisheries management (particularly managing biological interactions), a common-sense application of the ecosystem approach has been proposed, focusing on the more tractable problems, where the relationship between cause and effect is relatively clear. These include the direct effects of fishing activity on target and nontarget species, such as those due to bycatch, incidental mortality and the destruction of habitats.

Management scope: Lake Nasser

Since the fisheries of Lake Nasser target mainly species of tilapia, single-species approaches to management have been employed. These have focused upon setting minimum net-mesh and fish-landing sizes to prevent growth and recruitment overfishing, as well as a closed season to protect spawning tilapia. Growth overfishing occurs when fish are harvested at an average size that is smaller than the size that would produce the maximum yield per recruit. Recruitment overfishing occurs when the mature adult population is depleted to a level where it no longer has the reproductive capacity to replenish itself.

Single-species approaches are likely to provide reasonable results at least in the short term until more capacity and experience make the application of more complex and data-demanding multispecies approaches possible. However, it is recommended that the

assessments used to set these regulations be updated and possibly extended to account for multiple species.

Attempts have been made in the past (1998) to fit aggregated biomass dynamics models for the multispecies assemblage, but they have used equilibrium assumptions and regression methods (Habib et al. 2014). Furthermore, it appears that the reference points generated by these models were not used to monitor management performance or to formulate control rules for the fishery.

Previous studies have acknowledged potential ecosystem influences by exploring the effects of lake-level variation on fish recruitment and yield. However, the results of these studies have not been used to manage water levels for the benefit of the lake’s fisheries.

It is therefore recommended that the effects of lake-level fluctuations on the fishery be explored in more detail. A biomass dynamics model with extra terms to account for lake-level fluctuation could provide a means to explore these effects and generate guidance for water-level management.

In recognition of ecosystem management, the management authority attempts to control destructive fishing practices, such as the use of poisons, explosives and electric fishing.

Property rights

Property rights govern who can do what with respect to the resource system. They can be divided into two groups: (i) use rights and (ii) control rights. (See Table 5)

Use rights

These govern the use of the resource and can be divided into *access rights* and *withdrawal or harvesting rights*. Access rights authorize entry into the fishery or into a specific fishing ground. Withdrawal (harvesting) rights typically involve the right to a specific amount of fishing effort (e.g. to fish for a certain amount of time or with a certain amount of gear) or the right to take a specific catch (quota or trip limit systems).

Control rights

These authorize the making of rules and imposition of restrictions. Control rights include

exclusion rights, which allow the holder to determine who may use the resource, and *alienation rights*, which enable the holder to transfer rights to others (for example, by inheritance or through sale or lease). Control rights provide the underlying basis for fisheries co-management.

Property rights: Lake Nasser

Since 1981, one company (Misr Aswan) and four cooperatives have had rights to control the access of fishers to their fishing zones (Habib 2015). Within their respective zones, the company and cooperatives allocate fishing areas to their members and are responsible for supervising their fishing activities. The nature of this supervision is unclear. Originally, each cooperative society operated carrier boats to collect catches from fishers and supply them

with food, fuel, ice and equipment. However, this arrangement has not been operating recently in the zones allocated to cooperatives, and currently Misr Aswan only operates three carrier boats.

Fishers may only (re-)apply for a fishing boat license (required by law) if their application to the management authority (GAFRD) is accompanied by a letter confirming membership in a cooperative or Misr Aswan and their fishing area allocation. A boat and fishing license effectively grants fishers access rights to the resource. It appears that there are no restrictions on the number of boat licenses that can be issued to individuals or families having membership in these organizations, and there are no restrictions on the amount of catch that can be taken.

Use rights options	Advantages/application	Disadvantages/comments
Open access	<ul style="list-style-type: none"> Absence of any property rights May be seen as most equitable arrangement by some societies 	<ul style="list-style-type: none"> Cause of the “tragedy of the commons” To be avoided where possible, or supported by strong technical measures ensuring sustainability even with high F
Access rights	<ul style="list-style-type: none"> Limitations on who may operate in a specific fishing ground (territorial use rights in fisheries [TURFs]) or fishery (limited licensing) TURFs most applicable to small-scale inshore fisheries and co-management Limited licensing applicable to larger, offshore industrial-scale fisheries 	<ul style="list-style-type: none"> Need fair and transparent allocation systems to ensure legitimacy and equity Access right holders may still race to catch fish, giving incentives to increase effort or capacity
Harvest/withdrawal rights	<ul style="list-style-type: none"> Include “input rights” to apply a certain type or amount of fishing effort (e.g. number of fish pots or days at sea) and “output rights” to take a certain catch, e.g. a specified proportion of the annual TAC (individual quotas or individual transferable quotas) May be allocated permanently or temporarily May be transferable (tradable) or not Output rights may reduce race to fish and overcapacity 	<ul style="list-style-type: none"> May increase discards for “highgrading” Individual transferable quotas may cause social disruption if efficient companies buy out smaller operators With input rights, need to monitor increase in effective F due to increasing catchability (i.e. “technology creep”) Output rights may be harder and more expensive to apply than input rights

Table 5. Summary of alternative use rights in fisheries. Source: Hoggarth et al. (2006).

Reports suggest that Misr Aswan has sought to control the price it pays for fish caught by fishers in its zone by threatening to not provide the official confirmation of their membership when its members re-apply for their boat license. It may also report its members to the aquatic police if it deems supplies of fish from its members are too low. In contrast, the cooperatives no longer operate service boats or buy fish, so they do not have this type of leverage.

Stakeholder roles in management

Fisheries may be managed purely by the state or by the fisher community. However, following the failure of many existing centralized, state-controlled management arrangements or because of economically driven reforms, a popular response has been to devolve some fishery management responsibilities to resource users and other stakeholders.

The FAO Technical Guidelines for Responsible Fisheries (1997) promote management partnerships involving the different stakeholders in the fishery. Such co-management arrangements need to be carefully negotiated and detailed in a management plan. The stakeholders involved and their roles and responsibilities will be very context dependent and may need to change over time. Their roles and responsibilities should reflect their capacity and stake in the fishery. Although there are clear benefits, experiences with co-management, including within a number of Fisheries Management Science Program projects, have shown that it is neither simple nor quick to establish (Table 6).

Management options	Advantages/application	Disadvantages/comments
Government command and control	<ul style="list-style-type: none"> • Strict, "top-down" control applicable in some large-scale fisheries, where co-management not feasible or where government control required to resolve otherwise insoluble conflicts 	<ul style="list-style-type: none"> • May not be well adapted to the special needs of local stakeholders • Usually hard to enforce and expensive to administer
Co-management/partnerships	<ul style="list-style-type: none"> • Shares roles and responsibilities for management and enforcement (particularly valuable where government capacity is limited) • Develops more effective local rules by combining local knowledge with the scientific and technical know-how of government agencies • Where users agree with the system adopted, illegal fishing and enforcement costs may be reduced • Traditional community-based management systems may be supported by government, where they are compatible with state goals, e.g. for sustainability and equity • Most common in small-scale fisheries, e.g. in coastal or inshore areas, subdivided and managed as "TURFs," but increasingly recognized as valuable in large scale fisheries also 	<ul style="list-style-type: none"> • As well as sharing management tasks, need to share decision making power and allocate use rights (e.g. in TURFs), to strengthen incentives for user participation • Potentially high costs of developing workable arrangements • Developing trust and respect among stakeholders with different perspectives, skills and knowledge requires good social development and facilitation skills • Not applicable in all situations (but conditions increasing chances of success well known) • Can create transaction and other costs for those involved (as can command and control structures)

Table 6. Co-management arrangements in fisheries management. Source: Hoggarth et al. (2006).

Stakeholder roles in management: Lake Nasser

Descriptions of the key management stakeholders and institutions and their respective roles and responsibilities are poorly documented in the literature (Habib 2015). GAFRD is the main management authority for the lake's fish resources and is responsible for monitoring and controlling the fishery, including the issuing of fishing licenses. The HDLDA was the former management authority. Responsibility for the management of the lake's resources was transferred from the HDLDA to GAFRD in May 2010. The HDLDA continues to monitor landings at the main harbors. The Fishery Management Center (FMC) of the HDLDA is responsible for research and providing scientific advice, but currently has no capacity in these fields. The National Institute for Oceanography and Fisheries (NIOF) also provides scientific advice with respect to fisheries but like FMC currently has little or no capacity at Aswan to do so. The fishing company and cooperatives allocate access rights to the fishery and grant fishers

permission to apply for a boat license to fish in their designated zones. They also provide supporting services to fishers, and in Misr Aswan's case, also purchase some of their catch.

The arrangements between institutions appear complex and far from transparent. Comprehensive stakeholder and institutional analyses remain outstanding and will need to be undertaken before changes to the existing management system can be proposed. This should include a detailed description of the institutions' management roles and responsibilities.

Scale of fishery

The scale of the fishery will also have a large bearing on the design of the management system. It can influence stakeholder roles and responsibilities, harvesting strategies, management measures (input and output controls, technical measures, etc.), fishery indicators and monitoring programs, and the relative emphasis placed upon stock assessment.



Fishers landing their catch at Aswan High Dam landing site, Lake Nasser, Aswan.

For example, large-scale fisheries may be appropriately managed using state command-and-control approaches. Harvesting strategies based upon the control of fishing effort may be difficult to enforce in small-scale fisheries partly because artisanal fishers are often among the poorest of the poor, with no alternative source of income, and politicians may be reluctant to enforce measures that may have painful short-term impacts, even if long-term benefits are possible.

At the same time, quotas can be problematic for small-scale fisheries due to poor enforcement, inaccurate catch reporting, difficulties in predicting next year's stock size and the potential catch, and the multispecies nature of stocks.

While technical measures require some capacity for enforcement to ensure that rules are complied with, enforcement may nevertheless be simpler for technical measures than for input and output controls. Technical measures that can be easily communicated, that relate intuitively to the status of the resource and that can be enforced at the community level may be very appropriate for small-scale fisheries and co-management arrangements.

For small-scale fish stocks in developing countries, Mahon (1997) has argued that management efforts should be more "management objective driven" than "stock assessment driven." For small-scale and co-managed fisheries, a greater emphasis may be placed on the use of traditional ecological knowledge and participatory appraisals.

This guidance should be considered when formulating a new management plan for the small-scale fishery of Lake Nasser.

Management capacity

Management capacity includes technical skills, staff and funds. It is important to audit management capacity when designing new management systems since it will have an enormous bearing on virtually all elements of the system design, including stakeholder roles and responsibilities, management strategy, and stock assessment methodologies, as well as monitoring, control and surveillance activities.

Management capacity: Lake Nasser

Management capacity among the Lake Nasser fishery stakeholders generally appears low. The main management authority (GAFRD) appears to have only superficial knowledge and understanding of fisheries management, and no familiarity with stock assessment.

Resources, including staff, patrol vessels and funds for monitoring, control and surveillance, are reported to be inadequate. The Director of GAFRD in Aswan estimated that the monitoring, control and surveillance budget would need to be doubled before the fishery could be effectively monitored and controlled. This lack of surveillance capacity has resulted in unreliable monitoring of the fishery, poor compliance with existing management measures, and unlicensed fishing activities.

Currently there is no provision of scientific (stock assessment) advice. Technical capacity could be built by drawing upon former FMC employees and existing NIOF staff (located in other regions of Egypt) to potentially provide stock assessment and technical advice to GAFRD to improve management. Some capacity building in the latest stock assessment models and software might be required.

Some stakeholders consulted suggested that awareness-raising among fishers of the need for management and related controls was also required.

The management process

Management can be defined as "the integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives" (Hoggarth et al. 2006). It translates the operational objectives into clear standards and ways of measuring them (through reference points and indicators) and sets the actions by which they will be achieved. The full management process for the fishery should be clearly outlined for stakeholders in a management plan.

Management plans

Management plans serve as an important reference and information source for the stakeholders involved in the management of the resource. They summarize the state of knowledge of the resource, its environment and the fishery, management objectives and strategy, details of the monitoring and evaluation approaches adopted, and agreed management roles and responsibilities of key stakeholders and any other interested parties. Guidelines for the formulation of management plans and design of monitoring programs for co-managed fisheries are described by Halls et al. (2005).

Management plans: Lake Nasser

It is understood that no management plans exist or have been formulated in the past for the fish resources of Lake Nasser. It is therefore recommended that a management plan be formulated with key stakeholders following an updated stock assessment of the lake's resources. The management plan should be updated at least every 3–5 years. The contents of the management plan should aim to include detailed descriptions of the following:

- resource and environment
- fishery
- stakeholders
- management roles and responsibilities
- fisheries policy
- goals and operational objectives for each fishery
- management standards (indicators and reference points)
- harvesting strategy
- decision-control rules
- management measures
- monitoring, control and surveillance activities
- results of previous assessments
- current assessment and required action
- recommendations.

Management standards

Indicators and reference points

To monitor the progress of the fishery and to measure the performance of management in achieving the objectives, managers need indicators and reference points. Each indicator should be linked to one or more reference points and used to track the state of the fishery

relative to those reference points. Indicators could include catch, fishing effort (f), catch per unit effort (CPUE) and fishing mortality (F).

Management performance is measured as the position of the indicator relative to the reference point, often expressed as a ratio.

Reference points are typically categorized as either *target* or *limit* reference points. Target reference points correspond to situations considered desirable and to be achieved on average, and limit reference points indicate situations that are undesirable and to be avoided at all costs. Managers would seek to reduce fishing by a certain amount if a performance indicator falls below the target reference point, and to stop fishing altogether if their limit reference point is ever breached. Precautionary reference points are those that take account of uncertainties and risk. (See page 34 of Hoggarth et al. 2006 for further details.)

Reference points and indicators are commonly based on agreed scientific procedures and/or models. Examples of common target reference points are given below:

Y_{MSY}	maximum sustainable yield (Y) in a production model
Y_{maxYPR}	maximum sustainable yield (Y) per recruit
f_{MSY}	fishing effort (f) giving maximum sustainable yield in a production model
F_{MSY}	fishing mortality (F) giving the maximum total yield in a production model
$F_{0.1}$	F at which the slope of the YPR curve is 10% of its slope at the origin
$F_{20\%SPR}$	F giving a spawning stock biomass per recruit of 20% of the unfished level
B_{lim}	biomass limit reference point; e.g. 20% of the unexploited biomass, B_0 ($0.2B_0$).

Indicators and reference points: Lake Nasser

Reference points have been estimated for single species and multiple species in Lake Nasser in the past (1998). These were Y_{MSY} and f_{MSY} and Y_{maxYPR} (Habib 2015). However, it appears they were not employed as a reference to monitor management performance or to control harvesting.

Currently, it appears that catch is the main indicator of management performance. No attempts are made to monitor other important indicators such as fishing mortality, F , or spawning stock biomass. Boat licenses or the number of active boats can provide an index of effort, but these appear poorly recorded judging by existing gaps in the records.

Management measures

The reference points described above should be agreed with stakeholders in advance and used to trigger specific conservation and management actions, also agreed in advance. Such agreements may be formalized as harvesting strategies and decision-control rules and should be described in the management plan. These jointly define how reference points will trigger particular action. Both the harvesting strategies and the control rules should be clearly specified in mathematical or logical terms and should show what management action (e.g. an adjustment to next year's level of fishing mortality, F , or total allowable catch) will be taken, depending on the positions of the indicators relevant to the reference points.



Fish trader loading fish at one of the Aswan High Dam landing sites, Lake Nasser, Aswan.

Harvest strategy

A harvesting strategy defines how the allowable catch will be determined or calculated each year. It may simply state, for example, that harvesting will be restricted to only males of the species (e.g. for crabs) or to only fish above a minimum size limit. It may also specify what level of catch will be taken depending on the current size of the fish stock. Such stock-size-dependent harvesting strategies fall into three main types: (i) constant harvest rate (i.e. fishing mortality, F , set as a proportion of the stock); (ii) constant escapement or stock size; and (iii) constant catch (usually set as a quota or total allowable catch).

Harvest strategy: Lake Nasser

For Lake Nasser, the harvesting strategy is to limit harvesting only to fish above a minimum size limit (500 grams [g] for tilapia) and to fish sizes resulting from the minimum mesh size regulations. Managers have also sought to limit harvesting to nonbreeding fish (implemented by means of a closed season).

There are no apparent efforts to apply other harvesting strategies, such as controlling fishing mortality or catch as a proportion of stock size.

Decision-control rules (defined by reference points and harvesting strategy)

Decision-control rules define what management action should be taken in response to changes in the fishery or resource status. For example, fishing effort may be allowed to increase at a given rate (e.g. 5% per annum) until the limit reference point (B_{MSY}) has been met, after which no further increases in fishing effort f or mortality F may be permitted.

For depleted stocks, the decision-control rules may first need to focus upon incremental reductions in fishing effort or fishing mortality to rebuild the stock towards a target reference point such as B_{MSY} .

Achieving agreement on decision-control rules of this nature is one of the major challenges for fishery managers, but a necessary step in the long term.

Decision-control rules: Lake Nasser

It appears that no control rules have been set for the fishery. This probably reflects the paucity

of relevant fishery indicators and reference points selected to monitor management performance and progress towards the achievement of specific objectives for the fishery. It may also explain why the resource is now (apparently) significantly depleted and beyond conventional limit reference points. (See the Summary, Conclusions and Recommendations.)

Management strategy

Once operational objectives, reference points, a harvesting strategy and decision-control rules have been defined and agreed, a management strategy can be developed. The management strategy is the *sum of all the management measures* that are selected to achieve the biological, ecological, economic and social objectives of the fishery.

Management measures are categorized as follows:

- *technical* (e.g. size limits, mesh sizes, closed seasons, closed areas and gear restrictions);
- *input* (effort) and *output* (catch) controls;
- access rights designed around input and output controls.

Technical measures control how, where and when the catch is taken and are often set as permanent regulations or changed only infrequently. Input and output measures are used to control the total amount of fishing, either as the effort applied or the catches taken. Input and output measures are most commonly used as flexible controls to supplement any technical measures and to fine tune the levels of fishing pressure each year in response to the latest stock assessment data.

Technical measures

While input and output measures attempt to control the overall level of fishing pressure, technical measures aim to control the exploitation pattern of the fishery. The main technical measures are size limits (either of the sizes of fish or the mesh sizes of the gear), closed seasons, closed areas, and gear restrictions or bans. They are usually designed to protect reproductive potential, prevent growth overfishing, or prevent the use of destructive fishing gears.

Technical measures for protecting reproductive capacity include size limits, closed areas or closed seasons that are designed to protect spawning stocks, as well as restrictions on the harvest of reproductively active animals such as mouth-brooding tilapia.

Size limits are set nominally in relation to the size at maturity or according to some technical reference point (e.g. to achieve a particular percent of spawning potential ratio [SPR], depending also on the level of F). A spawn-at-least-once policy makes a fish stock resilient to collapse even when fishing mortality rates rise above target levels.

The same types of measures can be used for preventing growth overfishing. In this case, closed areas could be set to protect juvenile or nursery grounds, or closed seasons could be designed to avoid fishing at times when fish are mostly small or reproductively active.

Technical measures may either be set with a combination of common sense and limited technical data, or using the output of models. Optimal size limits and the timings of closed seasons can be estimated using analytical yield (age-structured models) or YPR models accounting for gear selectivity. The benefits of closed areas are more difficult to predict due to the high dependence on the movement patterns of the fish, which will usually not be well known.

All such technical measures require some capacity for enforcement to ensure that rules are complied with. Enforcement may nevertheless be simpler for technical measures than for input and output controls. Technical measures also have the advantage that they can be easily communicated and can be enforced at the community level, making them appropriate for small-scale fisheries such as Lake Nasser and co-management arrangements should they evolve on the lake.

Input and output controls

Effort controls (fishing effort restrictions) aim to limit fishing mortality (F) by controlling one or more of the following factors:

- the total number of vessels in the fishery (e.g. by allocating limited access rights and restricting the number of licenses issued);
- the effort allowed by each individual vessel

(e.g. the number of gear units allowed or the number of trips that may be made each year);

- the power of individual vessels (e.g. the size or engine power of the vessels, or the types of gear that may be used).

Catch controls such as total allowable catches (quotas) indirectly control the fishing mortality, F . Quotas are not recommended for small-scale fisheries due to poor enforcement, inaccurate catch reporting, difficulties in predicting next year's stock size and the potential catch, and the multispecies nature of stocks. The fisheries of Lake Nasser appear to exhibit all of these characteristics.

Management strategy: Lake Nasser

It is understood that the management strategy for Lake Nasser comprises the following:

- **A closed season.** The season was from 15 April to 15 May to protect mature fish, particularly tilapia, during the spawning season. It appears this closure has not been effectively enforced since 2011.
- **A minimum mesh size of 12 cm for bottom-set gillnets and trammel nets.** The aim is to prevent fishers catching small tilapia (less than 25 cm in length or body weight of less than 500 g) to maintain the reproductive capacity of the stock and to prevent recruitment overfishing. These size restrictions appear to have been formulated on the basis of a YPR analysis described by Mekki (1998), but this cannot be confirmed.
- **Ad hoc stock enhancement.** Stocking of Nile tilapia fingerlings has been undertaken since 1988 following the construction of nine hatcheries by the HDLDA. The full capacity of the hatcheries was up to 150 million Nile tilapia fingerlings (although these production levels were never achieved), and the fish were stocked each year in four locations: Aswan, Garf Hussein, Abu Simbel and Tushka. Habib (2015) reports that the FMC released finger-length *O. niloticus* in the south part of Khor Kalabsha every year from 1988 to 1993 in varying numbers. A robust statistical assessment of the impacts (benefits) of this stock enhancement is required.

No input and output controls are employed. While boat and fisher licenses are required in order to fish in the lake, it appears that these

licensing systems are not used to control fishing effort. There are no restrictions on the number of vessel or fishing licenses that can be issued and no restrictions on the amount of catch that can be taken.

Monitoring, control and surveillance

A system for monitoring, control and surveillance is integral to the effective implementation and review of the management system.

Indicators of the fishery must be regularly monitored in relation to reference points. Inputs to the fishery must also be monitored. Data to estimate target and limit reference points is also required. This in turn may require data to estimate intermediate parameters as determined by the models and analytical methods employed for the stock assessment. The types and frequency of data collected will therefore be influenced by a whole host of factors, including management

objectives, harvest strategies, control rules, the management strategy, and capacity and resources. Basic data include catch, effort, abundance (CPUE), size composition of the stock (age or length frequency data), and biological data (e.g. size at maturity, natural mortality rates, etc.). Programs to enforce management measures and controls are also required.

Monitoring, control and surveillance: Lake Nasser

Data collection

Historically, data collection has focused upon catch, which until 2004 recorded catch disaggregated by species. Since 2004, the catch has been recorded as either fresh or salted (Habib 2015).

However, no catch assessment or frame surveys have been undertaken on the lake. Carrier boat landings and supplies of fish transported by road to the three main harbors are weighed and enumerated by the management authority.



Photo Credit: Ashley Halls/Worldfish

Nile perch caught in Lake Nasser, Aswan.

Carrier boat records of fish weights purchased from each fisher are used to check the total landed weight. Any fish not passing through the three main harbors will be unreported in the catch statistics. Carrier boat records also provide an estimate of the number of active vessels that can be checked against the vessel license register to estimate fishing effort.

Due to price-control mechanisms previously implemented—initially by the state, and apparently now informally by Misr Aswan—fishers often sell all or part of their catch to private traders or by themselves and often not via the three main official harbors. Official catch landings are therefore likely to underestimate the true catch of the fishery. It has not been possible to estimate the bias in the catch statistics, but anecdotal evidence suggests that it could be significant. Some fishers also report selling their catches via unofficial (unrecorded) channels to avoid paying tax on their catches if they exceed 5 metric tons (t) per annum.

Discussions held with stakeholders suggest that undocumented adjustments to estimates of catch have been made in the past to account for under-reporting and unrecorded landings, particularly during the past 15 years. To complicate matters further, GAFRD and the HDLDA appear to collect and report (and possibly adjust) their own data sets.

Both fishers and boats must hold a valid license to fish issued by the management authority (GAFRD). These licenses must be renewed each year. A vessel license register is maintained, and annual fishing effort is estimated as the number of licensed vessels appearing on this register. Any unlicensed vessels will not be included in the estimate of fishing effort. Anecdotal evidence and reports suggest that a significant proportion of vessels operating on the lake are unlicensed.

The reliability of both the catch and the effort statistics for the purposes of management is therefore questionable. Improving the rigor of basic catch and effort data collection and reporting procedures will therefore be fundamental to improving the management of the lake's resources.

No monitoring of other fishery indicators such as fishing mortality (F) or attempts to estimate (update) intermediate fishery parameters (growth and mortality) by sampling the size or age structure of the fishery are currently undertaken.

Surveillance and control

The current management authority (GAFRD) reports that its capacity and resources fall short of those necessary to effectively monitor and control the fishery by means of the existing technical measures (gear restrictions, landing size restrictions and closed season). It also appears that it is unable to enforce compliance with boat licensing requirements, as evidenced by the extent of noncompliance reported by fishers as well as GAFRD itself.

The stock assessment process

The role of stock assessment in the management process includes the identification of well-defined reference points for the fishery and the regular (e.g. annual) assessment of indicators showing the status of the fishery and the fish stock relative to the reference points.

Stock assessment is not the purpose of management, but is one step in a much larger process intended to achieve management objectives under conditions of uncertainty.

The types of stock assessments that will be appropriate mainly depend on the size and value of the fishery and the resources and capacity of the fishery service. They include initial investigations of the fishery and seek to answer simple questions such as the following:

- What types of fish are out there?
- Where are they?
- How many are there?
- What species are being caught?
- Who is catching them?
- How are they doing it?

To provide detailed management advice, the stock assessment process becomes more refined to answer the specific questions posed by fishery managers:

- How fast do the fish grow?
- How quickly do they reproduce?
- What is the best size to start catching them?
- How much can we catch sustainably?

This involves the estimation of basic intermediate parameters, such as growth rates, mortality rates, carrying capacity, maturity and reproduction, stock and recruitment, selectivity, and catchability. Indicators of the current condition of the fishery are selected and reference points estimated as a basis for developing management advice. See Hoggarth et al. (2006) for descriptions of the process, as well as conventional models and methods.

Stock assessment: Lake Nasser

No significant stock assessments have been undertaken for more than 17 years, since Mekki (1998). Previous stock assessments appear to have been preoccupied with estimating potential and maximum sustainable yields (Habib 2015). Little consideration was given to estimating corresponding input controls (fishing effort and mortality) or to estimating limit reference points associated with the (spawning) stock biomass (B_{lim}). Most of the estimates of Y_{MSY} were likely to be biased as a result of the model fitting procedures

and model assumptions. Their predictions of yield were therefore likely to have been overly optimistic—that is, too high (Hilborn and Walters 1992).

Some intermediate parameters (growth and mortality) were estimated mainly for the main species of tilapia and subsequently used for YPR assessments designed to generate advice on the optimal size at first capture under different rates of exploitation. Some selectivity and maturity studies were also undertaken (Habib 2015).

Judging by the accounts of all the stakeholders consulted, the observed trends in the fishery, and the results of the preliminary stock assessment described in the following section, the fish resources of Lake Nasser appear to be heavily or overexploited with significant overcapacity. An updated stock assessment is required to help formulate a management plan to rebuild the fishery and to manage it in a sustainable manner.



Boxes of tilapia being transferred from a service boat to a trader at Aswan High Dam landing site.

A PRELIMINARY STOCK ASSESSMENT: BIOMASS DYNAMICS MODEL

Time series of catch and effort data assembled from the HDLDA was used to fit a biomass dynamics model for fresh fish (mainly tilapia and Nile perch) based upon the Schaefer model of stock dynamics (Haddon 2001):

$$B_{t+1} = B_t + r B_t \left(1 - \left(\frac{B_t}{K} \right) \right) - c_t$$

where r is the population growth rate and K is the maximum population biomass. The model was fitted to observed catch rates in each year, I_t . The predicted catch rate for year t is

$$\hat{I}_t = \frac{\hat{C}_t}{\hat{E}_t} = qB_t$$

The best model fit was judged as the set of parameters that minimized the sum of squared normal random residual errors for CPUE:

$$SSR = \sum (I_t - \hat{I}_t)^2$$

Initial parameter estimates

K was initially set to 200,000 t based upon Gulland's potential yield estimator ($B=Y_{MSY}/0.5M$). M was set at 0.3/year based upon published estimates (see Habib 2015), and Y_{MSY} was estimated to be approximately equal to the maximum yield of fresh fish observed in 1981 (approximately 31,000 t). The value of q was initially set to 0.00035 based upon previously published estimates (Mekkawy 1998). The

biomass at the start of the time series expressed as a proportion of K —the initial proportion—was varied from 0.8 to 0.95.

Best-fitting models

The best-fitting models and corresponding target and limit reference points are summarized in Table 7. Model fit 3 is illustrated in Figure 3.

Good model fits were achieved that explained approximately 85% of the variance in the catch rates. However, great caution should be exercised when evaluating these preliminary results given the concerns expressed about the accuracy of the catch and effort data used to fit the model, the "one-way trip" of the data, and the difficulty in estimating K (Hilborn and Walters 1992).

Bearing these caveats in mind, the model predicts a maximum sustainable yield of 17,000 t with about 1300 boats (f_{MSY}). The Y_{MSY} is significantly less than previous estimates for the multispecies assemblage, but more in line with the previous single-species estimates for tilapia. (see Habib 2015) The estimate of f_{MSY} is more consistent with some of the previous estimates, both single- and multispecies. These differences reflect differences in the datasets used and the model-fitting method. The model-fitting method used here does not make the unrealistic equilibrium and regression model assumptions used in previous assessments.

ssr	158.995	161.9	159.188	Units
	Fit 1	Fit 2	Fit 3	
r	0.44703	0.4537	0.4415	yr ⁻¹
K	150000	150000	150000	t
q	0.00017	0.00017	0.00016	
B0	135000	127500	142500	T
IP	0.9	0.85	0.95	
MSY	16763.6	17013.8	16556.3	t
EMSY	1318.02	1299.28	1346.04	boats
BMSY	75000	75000	75000	t
qMSY	0.00017	0.00017	0.00016	boat ⁻¹
FMSY	0.25298	0.25728	0.24942	yr ⁻¹
M	0.3	0.3	0.3	yr ⁻¹
Z MSY	0.55298	0.55728	0.54942	yr ⁻¹

Table 7. Estimates of alternative best-fitting biomass dynamics model for Lake Nasser fresh fish assemblage.

The model suggests that catches from the fishery have exceeded Y_{MSY} (and therefore have been unsustainable) in 13 out of the past 34 years. Except in 2008, yields have been below Y_{MSY} for more than a decade, and now more than 3000 licensed (and many unlicensed) boats are fishing—almost three times the effort required to achieve Y_{MSY} . This overexploitation, coupled with poor enforcement of mesh- and landing-size restrictions and the closed season in recent years, has led to a significant decline in stock biomass, now predicted to be around 10% of the unexploited biomass B_0 . (See lower graph

in Figure 3.) This is below the proportion (20%) considered necessary to avoid recruitment overfishing (Hoggarth et al. 2006).

It is recommended that the model be re-fitted to this data using Yield software (Hoggarth et al. 2006), which can provide estimates of uncertainty surrounding the estimated parameters and reference points. As part of this re-fitting process, consideration should also be given to exploring a wider parameter space, which was not possible here due to time constraints.

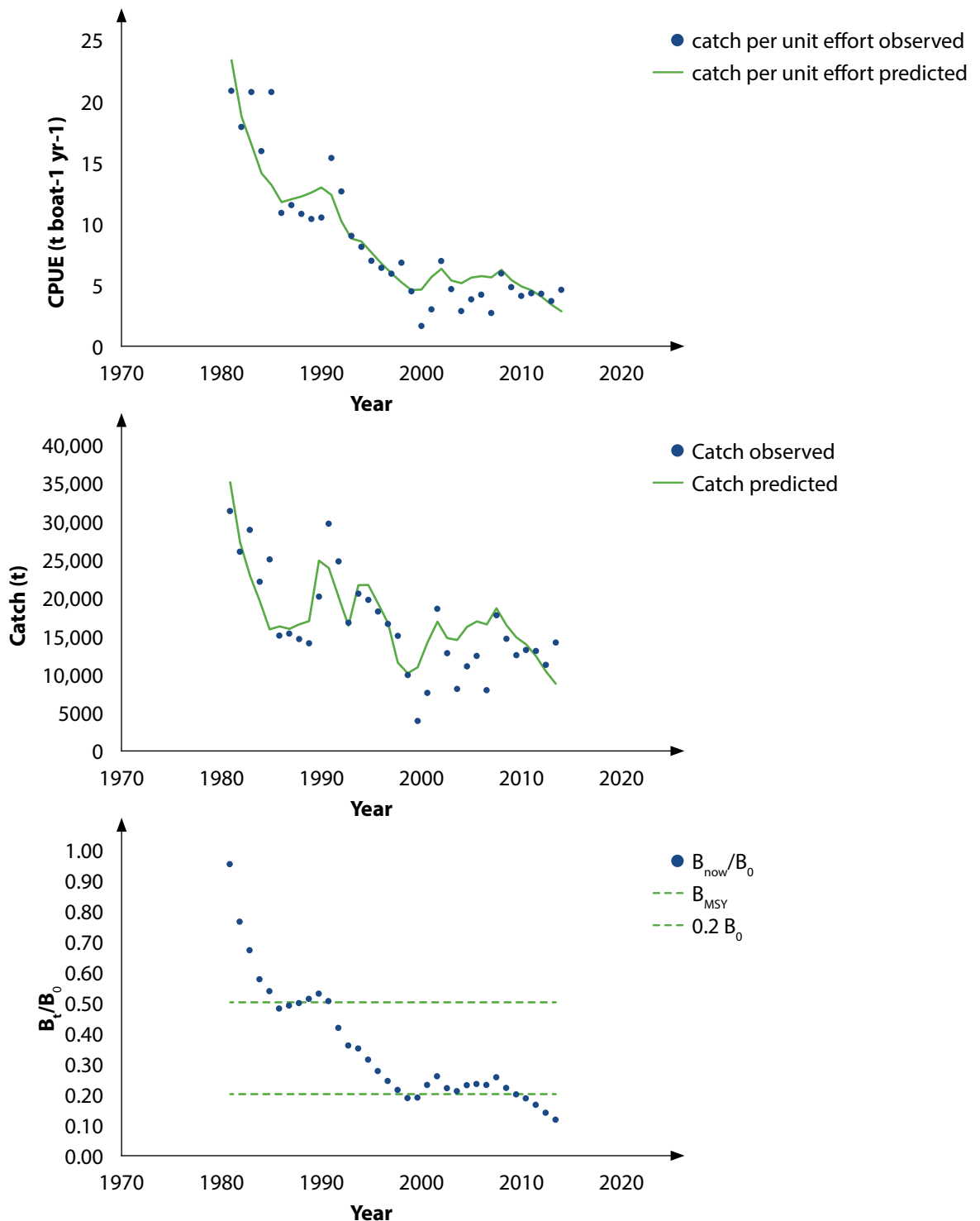


Figure 3. Biomass dynamics model fitted to the time series of catch and effort data for the fresh fish multispecies assemblage.

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Since its creation in the 1960s, Lake Nasser has supported important fisheries, mainly for tilapia, Nile perch and species of *Alestes* and *Hydrocynus* (tigerfish). The resources are exploited using gillnets, trammel nets and long lines set from small boats. After the lake filled, landings have varied from approximately 34,000 t in 1981 to about 8000 t in 2000. Recent landings have been in the order of 14,000 –19,000 t. In 2005, the estimated value of the fishery (including both fresh and salted fish) was around USD 17 million. The fishery provides livelihoods for more than 13,000 fishers and an unknown number of livelihoods in supporting sectors.

Access to the fishery is controlled by a fishing company and cooperatives, and by the fishing authority (GAFRD) responsible for issuing fishing boat and fisher licenses. However, there appears to be no cap on the number of licenses that can be issued, and many boats operate without a license because of the limited capacity of GAFRD to monitor and control the fishery.

Due to the remoteness of most fishing areas and the lack of road and market infrastructure, most landings are purchased and gathered from fishing camps by carrier boats, operated by the fishing company Misr Aswan and formerly also by the cooperatives. This created opportunities for these organizations to control the price paid to fishers for their fish. The private sector has more recently been granted access to purchase fish from fishers at free market prices. Fishers now sell a proportion of their landings to the private sector, but fishers in the area controlled by Misr Aswan are constrained by obligations to sell at least part of their catch to the company, as it grants them access rights to the resource. While it was considered a legal requirement to land all fish through the three official harbors, allowing the management authority to monitor catches from the lake, compliance is low and hence a proportion of landings are unreported. This proportion is unknown but anecdotes suggest it could be significant.

Landings of fish at Aswan harbor may be processed (filleted and frozen) before distribution locally and to major cities, including Cairo. The main processing facility is owned by

Misr Aswan, but it now operates below capacity, as more of the catch is purchased by the private sector and transported directly to markets in Cairo and elsewhere or processed by private sector companies.

While no management plans have been prepared for the fishery, attempts have been made to control the harvesting of small-sized and spawning fish using technical measures: minimum mesh and fish-landing sizes, along with a 1-month closed season corresponding to the main spawning period of tilapia. These technical measures were apparently based upon stock assessments that were undertaken more than 17 years ago.

No apparent attempt has been made to control the number of boats or fishers in the fishery by licensing, in spite of attempts to estimate the number of boats corresponding to maximum sustainable yield (Y_{MSY}) as part of these early stock assessments. However, the majority of these earlier assessments appeared to be preoccupied with estimating potential and maximum yield from the fishery rather than target and limit reference points that could be used to help control and sustain the fishery. Unfortunately, these earlier estimates of Y_{MSY} and f_{MSY} are likely to have been overly optimistic because of the model assumptions and fitting procedures applied.

Compliance with these technical measures has been poor, particularly in the past 4–5 years following the transfer of management authority from the HDLDA to GAFRD. Lack of resources and respect for GAFRD have been cited as the main reasons for this poor compliance.

In response to growing fishing effort (number of boats) and poor compliance with the technical measures, yield from the fishery has declined with significant interannual variation. Since 1981, catch rates have declined by about 80% in a manner symptomatic of unsustainable rates of exploitation. All stakeholders consulted reported declining catch rates, fish size, and in some cases, a decline in the relative abundance of the largest species of tilapia (*O. niloticus*). Local GAFRD staff described the situation as “disastrous.”

Based upon an assessment using an updated time series of catch and effort data, the maximum yield (Y_{MSY}) and corresponding fishing effort (f_{MSY}) for fresh fish (mainly tilapia and Nile perch) have been re-estimated using more up-to-date models and fitting procedures. The results suggest that the maximum yield (about 17,000 t) is significantly less than previous estimates for the multispecies assemblage, but more in line with the previous single-species estimates for tilapia. This yield would be taken by just 1300 boats (f_{MSY})—less than half the number now operating. Catches from the fishery exceeded Y_{MSY} in 13 out of the past 34 years. The stock biomass is predicted to be now around 10% of the unexploited biomass B_0 . This is below the proportion (20%) considered necessary to avoid recruitment overfishing.

It is recommended that a management plan be formulated with the full participation of all stakeholders. The plan should first seek to rebuild the fish stocks of the lake to sustainable levels, at least above $0.2B_0$, and ideally to the biomass corresponding to maximum sustainable yield B_{MSY} or above if a precautionary approach is to be adopted.

This plan should be based upon an updated stock assessment and should seek to contain all of the information listed on page 23 as necessary to management plans. Most importantly, it should contain explicit decision-control rules describing what action should be taken in response to changes in indicators in relation to agreed target and limit reference points.

Management measures for the fishery should also be selected in consultation with key stakeholders to ensure that they can be monitored and enforced and are acceptable. It is recommended that both controls over fishing effort (number of boats licensed) and technical measures be included as part of the management strategy. The management strategy should be clearly described in the plan. It may be necessary to draft new legislation in support of new management measures.

Given the apparent status of the resource, it will be necessary to reduce fishing mortality (F). This can be achieved by a combination of a reduction in the number of boats fishing and technical measures. It is recommended that no

further licenses be issued and consideration be given to reducing the number of boat (and fisher) licenses on an annual basis. The rate of effort removal could be advised on the basis of the biomass dynamics model described here but might be in the order of 10% per annum over a 5-year period.

A stock assessment based upon an analytical YPR analysis could help to guide the selection of minimum net-mesh or fish-landing sizes, as well as timing and duration of closed seasons, to provide adequate protection of spawning stocks and to minimize growth overfishing. The results of single-species assessments could be combined to provide multispecies guidance following appropriate species weighting. This would require sampling the main fish populations for their current size or age structure. An appropriate sampling design would need to be prepared.

The biomass dynamics model described on pages 30–31 should also be refitted using software (e.g. Yield) that is capable of providing estimates of uncertainty around the model parameter estimates. Projections of the response of the fishery to reductions in effort (number of boats) could be made to help guide an appropriate annual rate of reduction in boat licenses. The effects of lake levels on the fish dynamics should also be examined with appropriate models and accounted for if necessary in future assessments.

Improvements to the monitoring of the fishery will be key for the success of the management plan. Given the lack of incentives for fishers to land their catches through the official harbor channels, an alternative catch monitoring system should be designed.

This might take the form of a catch assessment survey, where catch rates of individual fishers are sampled monthly and raised by appropriate measures of effort, such as the number of active vessels, to give an estimate of catch for the lake. Sampling can be stratified by species, gear, and fishing area or zone. This type of survey requires resources, capacity and commitment.

An alternative option would be self-monitoring by the fishers. In this case, fishers use a logbook to record daily—or during certain days of the

month—their catch rates by species and gear type in return for some benefit such as access to the resource (fishing licenses) or money. Regular checks by the management authority would be necessary to control under-reporting, particularly if tax payments remain dependent upon the annual catch weight. This logbook approach has been applied successfully in the lower Mekong Basin (Halls et al. 2013). Involving fishers in the monitoring process gives fishers a sense of involvement in, and responsibility for, the management of the lake. They are therefore more likely to comply with new measures. It allows them to monitor the effect of management for themselves. This may be very important where reductions in their fishing effort will be necessary to rebuild the fish stocks of the lake.

In addition to catch, the age or size structure of fish populations should be routinely monitored to provide estimates of the fishing mortality rate, *F*. These estimates should be monitored against the target and limit reference points generated from the analytical YPR assessment and should form the basis of decision-control rules. An appropriate sampling program should be designed with samples taken either from fisher landings and adjusted for gear selectivity, or more simply using fishery-independent surveys using nonselective gear types or fleets of multi-mesh-size gillnets.

The management authority will need to improve compliance with any new rules and regulations introduced under the management plan. Sufficient resources (staff, boats, funds, etc.) should be allocated to the authority for the purposes of monitoring, control and surveillance, perhaps funded from license revenue or from the current tax on landings.

Regular reviews of the management plan should take place with the full participation of all key stakeholders, and the decision-control rules should be followed rigorously. Stock assessments should be updated annually. While capacity for stock assessment is currently lacking, opportunities exist to rebuild this capacity.

On the basis of the stakeholder consultations, there appears to be strong support for the creation of a co-management organization

comprising representatives of the main stakeholders, including fishers. This opportunity should be supported and encouraged. A key first task of this organization would be to agree on stakeholder roles and responsibilities for management based upon their respective roles and responsibilities. Indeed, this process should be undertaken prior to the formulation of the management plan, to ensure that relevant stakeholders have an active role in the formulation of the plan.

Other recommendations

It appears that the current system of property and access rights is largely responsible for under-reporting of catches and the disposal of fish via unofficial channels. Consideration might therefore be given to removing the control rights of the fishing company and cooperatives but maintaining the currently recognized access rights of fishers to their historic fishing grounds.

As a means to improve the monitoring of the fishery, consideration might also be given to changing the existing tax laws that are based upon fishers' reported catch, giving fishers a strong disincentive to report their true catch.

The effectiveness of stock enhancement should be examined to avoid unnecessary expenditure on potentially ineffective programs.

Interest in developing national and export markets for tilapia and Nile perch was expressed by some fish processors. These opportunities should be explored further and developed if potential exists.

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ANNEX 1. SUMMARY OF ACTIVITIES, PERSONS MET AND KEY FINDINGS

Date	Description of activities, persons met and key findings
5 May 2015	Literature review.
6 May 2015	Literature review.
7 May 2015	Literature review and travel to Cairo.
8 May 2015	Arrive Cairo 04:00. Preparation of report. Kick-off meeting with Malcolm Dickson.
9 May 2015	Meeting with Malcolm Dickson and Ahmed Nasr-Allah at WorldFish to discuss mission terms of reference, scope and review activities. Assembly of relevant literature and datasets.
10 May 2015	Travel to Aswan. Briefing meeting with Dr. Olfat Anwar. Review and revision of mission schedule. Visit to fisher/fish processor producing mainly salted tigerfish. Preparations for stakeholder consultation workshop. Reporting.

Date	Description of activities, persons met and key findings
11 May 2015	<p>Visit to Aswan Harbor. Met by Mr. Tag El Dein Abu El Rahman, Director of the HDLDA. Observed three carrier boats landing catch to refrigerated transport. Species included tilapia, Nile perch, marmoryds, electric fish, catfish. Most tilapia were small size and below the minimum landing size (500 g).</p> <p>However, landings and sales of these undersized fish appeared to be permitted under the auspices of the HDLDA. Some large individual fish also present, particularly Nile perch. Some salted (tigerfish) also landed by fishers. Landing records appeared comprehensive and transportation licenses were also being issued. Plenty of ice present and hygiene standards appeared reasonable but below international standards. No GAFRD staff present. Reported that up to 15 t of fish are landed daily by carrier boats and up to 12 t by pickup truck. The latter tend to arrive in the afternoon packed in boxes with ice and covered with a blanket. Four research vessels owned by the HDLDA were moored in the harbor. Reported to be operational but not used for fisheries research since 2009.</p> <p>Visit to Misr Aswan Fishing Company. Mr. Osama Mohammed Kamel, Chief of Sector. State-owned processing company. Previously handling up to 1000 t per week during peak fishing period, employing 300 full-time and 1000 part-time staff. Volume has reduced significantly as fishers now land directly to traders at unofficial locations around the lake. These landings therefore are unreported.</p> <p>Visit to Aswan Dam and High Dam Authority of the Ministry of Water Resources and Irrigation to request hydrological data for the lake. Official letter of request from WorldFish was required. Olfat to arrange.</p> <p>Meeting with Dr. Nazeh Naguib and Dr. Ishack Agaypi at NIOF. Presently, NIOF monitors lake chemistry, sediments, water quality and benthic fauna. No fisheries monitoring is undertaken, and since 1999, following the retirement of Dr. Azem, the Aswan branch of the institute has no fisheries specialists and therefore no capacity to advise the management authority with respect to fisheries management and stock assessment.</p> <p>However, significant capacity in fisheries biology and stock assessment does exist at the Alexandria and Cairo branches of NIOF. Competent staff from these branches could be transferred permanently or temporarily to Aswan to support the management authority.</p> <p>These opportunities should be discussed with Dr. Azza-El-Ganayni, Head, Fishery Department, NIOF (Tel: 01063768894).</p> <p>It was reported that the FMC of the HDLDA still exists but also no longer has any significant capacity to provide advice with respect to fisheries management. Currently, the FMC advises only on aquaculture and environmental matters.</p> <p>Meeting with Mahmoud Hasseb, Executive Director, GAFRD. GAFRD is now the main management authority/institution responsible for issuing fishing licenses, enforcing rules and monitoring the fishery to maximize fish production. Significantly, the current management situation was reported to be "disastrous." The fishery was reported to be overexploited and GAFRD lacks capacity to monitor and control the fishery. Reported having 40 members of staff (2–3 stationed at each harbor, 8 involved in monitoring, control and surveillance, and the remainder involved in administration at headquarters) and a budget of EGP 400,000 (USD 57,000) per annum. He has five small patrol boats all based in Aswan. He needs a larger boat to make extended trips (1 week) over the whole lake to improve enforcement coverage. He estimated he needs twice his current budget to carry out his mandate.</p> <p>Both GAFRD and the HDLDA collect catch data but he regards GAFRD data to be more reliable because he claims that the HDLDA does not record landings from carrier boats of less than 200 kilograms (kg). Furthermore GAFRD receives records of collected catch from carrier boats for validation of their own observations. HDLDA statistics only report catches landed via the official harbors. GAFRD appears to make ad hoc corrections to account for unreported landings made via unofficial landing sites. However, GAFRD could not provide supporting documentation or explanation of these correction factors. It appears that GAFRD has "manipulated" landings statistics to indicate improving management performance. The Director admitted that the management situation was "disastrous."</p> <p>It was evident from discussions with GAFRD that it has no clear management objectives nor management plan, no fisheries management system in place, little understanding of fisheries management, and no or little knowledge or experience of stock assessment and its role in management. Hence GAFRD appears to be struggling to manage the fishery effectively.</p> <p>The need for major support and advice was acknowledged and significant interest was expressed in a project to formulate and implement a management plan, based upon an updated stock assessment and following consultations with key stakeholders, and to build management capacity. The project should include problem identification, training in fisheries management and stock assessment, and building capacity to monitor and control the fishery. The Director expressed his wish to support and cooperate with such a project. See below for further details of the responses to questions.</p>

Date	Description of activities, persons met and key findings
12 May 2015	<p>Meeting with Dr. Hussein Amar Adam and Mr. Murad Zaki Agaybi, formerly fisheries biologists and stock assessment scientists at the HDLDA, FMC until 2011 and 2 weeks ago respectively. Until 2011, when management responsibility for the lake's fisheries resources was passed to GAFRD, the FMC provided scientific and technical advice to support the management of the lake's resources by the HDLDA. By 2011, its staff had gained 20 years' experience in fisheries biology, stock assessment and management, including overseas training. Its proposed management measures (minimum mesh sizes, minimum landing sizes and a closed season) provided the technical and scientific basis for the management of the lake's resources. It estimated potential yields from the lake and also target and limit reference points based upon surplus production and analytical (YPR) models.</p> <p>Since 2011, GAFRD has attempted to manage the fish resources of the lake with very little or no technical capacity or knowledge in fisheries management and stock assessment. (See above.)</p> <p>While the FMC still exists, it no longer employs any staff with experience or expertise in fisheries management and assessment. Furthermore, bitter rivalry appears to exist between GAFRD and the HDLDA after the former was assigned responsibility for management in 2011. Each blames the other for the apparent management failures.</p> <p>The former FMC employees consulted agreed that the FMC and GAFRD should work together, sharing responsibility for management based upon their respective strengths and stakes in the fishery. This has already been advocated to the Aswan Governorate by Dr. Adam in November 2014 but without apparent reaction. The FMC has suggested that this collaboration should also be advocated to the Minister for Agriculture.</p> <p>To improve fisheries monitoring, it was agreed that it was first imperative to gain a better understanding of fisher behavior, including the disposal (movement) of fish after capture. It would appear that currently there is little understanding of these pathways. If fishers retain or sort their catch in any way, then landings and effort reported by carrier boats at harbors cannot be relied upon to monitor catch and effort, or the size structure of the population required to estimate rates of exploitation.</p> <p>Further research is therefore necessary to determine these pathways. If fishers are retaining part of their catch, or if a significant proportion of fishers are selling their catch directly to markets or via unofficial landing sites, it will be necessary to design a catch assessment survey to estimate catch, effort and CPUE from direct observations of fisher landings supported by a frame survey to provide sample raising factors (total number of boats, boat activity coefficients, days fishing per month, etc.).</p> <p>Similarly, it will be necessary to design appropriate programs to sample whole, unsorted landings of fishers to provide unbiased estimates of the size and age structure of the population and therefore rates of exploitation (after accounting for gear selectivity) and other biological parameters.</p> <p>Following discussions with the ex-FMC scientists, it was agreed that future monitoring programs should seek to provide estimates of the size and age structure of the main species exploited, together with catch by species and effort by gear type (and boat). Scale-reading equipment to estimate fish age already exists at the FMC.</p> <p>This would allow for the monitoring of the following key indicators of management performance: Yield (Y), fishing effort (f), and annual instantaneous rate of fishing mortality (F) in relation to the following target and limit reference points: Y_{MSY}, f_{MSY}, F_{max}, $F_{0.1}$, $F_{20\%SPR}$ derived from (i) a biomass dynamics model fitted to estimates of annual catch and effort (and accounting for environmental effects; e.g. lake level or shoreline length) and (ii) an equilibrium YPR; and an equilibrium spawning stock biomass (SSB)-per-recruit model for each major target species estimated from intermediate model parameters (growth, mortality, age at first capture, gear selectivity, age at maturity, etc.). Consideration might also be given to estimating their multispecies analogues. Monitoring reliable estimates of CPUE and effort by species should also be undertaken at a minimum.</p> <p>Using the guidance produced by these models, the lake could then be managed using a precautionary approach by controlling fishing effort (number of boats) via the licensing system and/or net-mesh size and closed seasons to achieve high/maximum yields without compromising the sustainability (reproductive capacity) of the stock.</p> <p>The former FMC scientists suggested that estimating the age structure of populations of each species would require 300–400 scale samples per year per species and 100–200 length samples per month per species. Gear selectivity studies (curves/ogives) would also need to be updated.</p> <p>Reporting.</p>

Date	Description of activities, persons met and key findings
13 May 2015	<p>Stakeholder consultation workshop: 20 participants from GAFRD, fisher cooperatives, Egyptian Environmental Affairs Agency (EEAA), CARE, fishers, fishing companies and processors. Began with a short presentation outlining the objectives and purpose of the project, observed trends in the fishery, reports of stakeholders to date, and purpose of the consultation with a series of questions for discussion. (See Stakeholder Consultation Workshop Report [Annex 3] for more details.) Each stakeholder responded to the five main discussion topics. One stakeholder (Mr. Kamel Ebrahim Bekhit, Vice Chair, Mother Cooperative Society) reported his frustration with the many meetings and workshops that have been held in the past but without any subsequent action. The main findings and conclusions follow. There was a consensus that the lake fisheries are in a poor state. They are overexploited, and illegal fishing gears and practices are used by fishers. The closed season is no longer respected or observed. Landings via unofficial channels are common. Fishers have little incentive to comply with existing measures since enforcement is weak and there are no or insignificant sanctions for noncompliance. GAFRD has few resources to monitor and no longer has access to boats and equipment available to the previous management authority (HDLDA).</p> <p>Stakeholders agreed that they need to act collectively and share the responsibility for management to rebuild the stocks. Exactly what their respective roles should be requires further discussion and careful consideration, accounting for stakeholder capacity and interest. The idea of the creation of a co-management organization or body, and to co-formulate and implement a revised management plan on the basis of improved scientific advice, was strongly supported. Cooperation between all stakeholders would be required for effective management. It was suggested that fishers should play their part of monitoring and reporting illegal fishing practices and activities. Perhaps radically, it was also suggested that ice should not be supplied to fishers during the closed season to discourage them from fishing during this period.</p> <p>There was also consensus that management should be guided by scientific advice, which is currently lacking. It was furthermore agreed that the management measures (closed seasons, minimum mesh and landing sizes) should be applied. It was also acknowledged that existing measures may not be appropriate now given the observed shifts in species composition towards smaller species of tilapia (<i>zillii</i> and <i>galilaeus</i>) and therefore measures should be reviewed and revised on the basis of scientific advice. Furthermore, while generally supported by most stakeholders, the economic consequences of a closed season should be considered. Sanctions for noncompliance must form the basis of a strengthened policy towards illegal fishing. Awareness-raising among fishers of the purpose of management measures is required to encourage greater compliance. Controls over the sale of illegal mesh-size gears should be introduced. Enclosures and stock enhancement might also be considered. Processors require facilities to process large Nile perch. EEAA dismissed claims that crocodiles were impacting fish stocks. Crocodile abundance in the lake is declining rapidly. Crocodile farming was proposed as a means to protect the wild population and to support alternative livelihoods.</p> <p>If fishers continue to land their catch via unofficial channels because it is less costly, more profitable and/or more convenient, then existing attempts to census landings at the three main harbors to monitor catch may have to be replaced with a monthly, sample-based catch assessment survey supported by an annual or bi-annual frame survey. A catch assessment survey would provide more detailed information about fishing activities and effort for improving scientific advice, as well as a further means of monitoring compliance with rules and regulations, and could help to maintain regular communication between the management authority and fishers. License fee revenues might provide a potential source of funding for this survey.</p> <p>Significantly, it was reported that the price of fish landed from Lake Nasser can be lower in Cairo compared to Aswan. This might suggest that traders and processors operating through official channels are making above-normal profit from the sale of fish.</p>
14 May 2015	Reporting.
15 May 2015	Reporting.

Date	Description of activities, persons met and key findings
16 May 2015	<p>Visit to Lake Nasser to consult fishers. Three camps visited: all located in Misr Aswan Company Fishing Zone in the far north of the lake.</p> <p><i>Camp 1:</i> Fishing since 1982; based at camp for most of year except for vacations (2 months/year). Permanent home in Sohag. Use gillnets and trammel nets. Nets soak for 12–24 hours/day. Mainly drift netting for tilapia, Nile perch, tigerfish. No labeo. Three fishers based at camp each with a boat. Boat licenses are issued by GAFRD resembling a credit card with logo and barcode prepared in Cairo. Fishers are also required to hold a fishing license. Fish are landed and stored in plastic boxes with ice. Carrier boat collects catch from camp two to three times per week. Fishers paid immediately or when carrier boat returns. Fishers not happy with price paid by fishing company. Prices given are significantly lower than offered by private carrier boat operators. However, they feel obliged to sell their catch to the company, otherwise it threatens not to issue a letter (from fishing companies and cooperatives) required by GAFRD to accompany boat license renewal applications. This letter contains details of the fisher, his fishing zone and his total catch in the previous year. Tax must be paid by fishers if their annual catch exceeds 5 t as reported in a letter to the tax office by his fishing company or cooperative. Fishers seek to avoid paying this tax by ensuring that they sell less than 5 t to their company or cooperative. The remainder they sell to private carrier boats or land to other traders on the lakeshore. These private carrier boat operators then claim to the harbor authorities that they have caught the fish they are landing. However, if fishers do not sell to the fishing company, they are reported to the aquatic police. Fishers are unsure if they are required by law to sell their catch to fishing companies or cooperatives. Hence it appears that the companies and cooperatives are still attempting to control the price paid for fish bought from fishers operating in their zones. The fisher consulted reported that the fishery has never been managed with catch quotas. Aware of mesh-size regulations and minimum landing size, but reported that the fishing company accepts 250-g fish. Also aware of closed season but nobody has complied with this regulation for several years.</p> <p>Many unlicensed boats are operating, often belonging to fishers currently holding valid boat and fishing licenses. Stocks are reported to be declining because there are too many fishers. Also decline in fish size observed. Decline in the relative abundance of <i>O. niloticus</i> reported. Most fishers catch between 3 and 5 t of fish per annum. Management efforts should be directed at controlling the number of unlicensed boats and illegal fishing activities.</p> <p>Fisher reported being interested in participating in some form of co-management. Expressed the wish to be consulted regarding management decisions and would be interested to represent other fishers in a co-management body or organization.</p> <p><i>Camp 2:</i> Fishing for 12 years using gillnet, trammel nets and long line for Nile perch. Status of fishery reported to be very poor. Low fish abundance, particularly during the past 2 years. More licensed boats operating now. More licenses issued each year by GAFRD. Operates three boats with engines and three without engines. Catches approximately 7–10 kg/boat/day. Sells 70% of his catch to a private boat owner/trader in return for cash and supplies. Unlike fishing company, private traders purchase fish of all sizes, including undersize fish. Therefore, private traders appear to be supporting the capture of undersize fish. Would choose to sell all of his catch to private traders but would be reported to the aquatic police by fishing company. Reported not to have changed his net-mesh size. GAFRD last visited his camp 2–3 years ago. Don't appear very active and preoccupied with "smuggling boats." Management could be improved by redistributing the total shoreline in a more equitable manner.</p> <p>All boat license holders operate within their own fishing areas (linked to their boat license), which have remained unchanged since the fishing companies and cooperatives were established. By law, fishers have exclusive rights to fish these areas and exclude others. Can sell/transfer boat license (with fishing area). Current boat license holders can apply for any number of additional boat licenses and often fish additional boats without licenses. Would be interested in more active participation in management and be better represented in decision-making. These fishing areas (n=79?) could provide relevant spatial units for co-management.</p> <p><i>Camp 3:</i> Boat license holder associated with this camp for 30 years. Fishes with typical gears. Reports no change in relative species abundance but overall catch rates have declined from 20–30 kg/boat/day to 5–15 kg/boat/day. Many more boats operating now and closed season is not enforced. Closed season has not been observed for 4–5 years. Often catches mouth-brooding fish. Mean size of fish has declined significantly. Most new boats joining the fishery belong to existing boat license holders. Estimated that the number of unlicensed boats is similar to the number of licensed boats. The number of unlicensed boats has increased significantly during the past 5–6 years. Prior to that, most boats were licensed. Management could be improved by dissolving cooperatives, stock enhancement, introducing pensions and credit for fishers, enforcing the closed season, and re-distributing the fishing grounds in a more equitable manner. Fishing area varies greatly among fishers.</p>
17 May 2015	Reporting.
18 May 2015	Reporting.
19 May 2015	Preparation of presentation.
20 May 2015	Travel to Cairo. Mission report presentation.
21 May 2015	Travel to United Kingdom.

ANNEX 2. STAKEHOLDER CONSULTATIONS

Date	Name	Occupation or position	Organization, institution or business name
10 May 2015	Esmail Hagage Abd El Allah	Fisher and fish processor	None

No.	Question	Response
1.	What trends or changes have you observed in the fishery?	1960–1990 fishery well managed. Management problems began when inexperienced GAFRD was given responsibility for management. Since 2011 about 50% of fishers have left the fishery due to declining catch rates and yield. Small decrease in licensed vessels but unlicensed boats have increased by approximately 30%. Use of outboard engines has increased. Fewer full-time fishers, more part time with few other livelihood opportunities. This year, number of fishers has declined significantly due to decline in catch rates.
2.	What is the current status and health of the fishery (underexploited; fully exploited; overexploited)?	Overexploited due to poor management and lack of enforcement of rules and regulations.
3.	What are the main problems, issues and weaknesses of the fishery?	Fishers have no trust or confidence in management or respect for current management authority.
4.	What are the main threats faced by the fishery?	
5.	What are the good things about the fishery (i.e. its strengths and benefits)?	
6.	Is the fishery well managed? If not, why not?	No. GAFRD lacks management experience. No stock enhancement since 2011.
7.	How could the management be improved?	More scientific advice and enforcement of rules. Provide a forum for listening to the views of fishers and processors and to exchange ideas.
8.	Are control measures (rules and regulations) effectively (well) enforced? If not, why not?	No, and even compliant fishers are sometimes sanctioned. GAFRD has few staff, morale is low, relations between GAFRD and fishers are poor.
9.	Should the fishery be controlled by restrictions of catch or fishing effort, by technical measures, or by a combination?	Stock enhancement, enforcement of minimum landing size, closed season.
10.	What roles and responsibilities should or could stakeholders have in management (e.g. rule-making, monitoring, decision-making, enforcement, control, etc.)?	Cooperative should support fishers, provide training and education in fisheries management, and explain reasons for rules and regulations in the context of sustainability. Management authority should listen to the views of the fisher community. Fishers don't have the capacity to manage on their own but should participate in decision-making.
11.	What opportunities exist for the fishery (e.g. development of the Nile perch fishery, developing export markets, stock enhancement, added value, etc.)?	With good management, yields will increase. Development of export markets in Europe for tilapia and Nile perch. Consider creating more enclosures.
12.	How much of the catch is landed at the main harbors (the official landing sites)?	75%–80%. Most of the remainder sold directly to traders but this then passes through the harbors. About 5% is sold directly in markets by fishers.
13.	Complete the following fish disposal pathway diagram.	
14.	How could monitoring of the fishery be improved?	All catch should pass (be registered) through main harbor markets. Enforce issuance of transport licenses for cars. This would ensure all catch is monitored and carrier boats will then return. Fishers can sell to any carrier boat, therefore competitive market exists. All vessels should be licensed with permanent vessel serial number. Regular monitoring of boat licenses.
15.	Other comments.	

Date	Name	Occupation or position	Organization, institution or business name
11 May 2015	Mr. Osama Mohammed Kamel	Chief of Sector	Misr Aswan Fishing Company

No.	Question	Response
1.	What trends or changes have you observed in the fishery?	Yield and mean size of fish have declined. The proportion of tilapia in the catch has declined from approximately 90% to 70% and been replaced by <i>Hydrocynus</i> and <i>Alestes</i> . Nile perch formed about 10% of landings, now 5%. Increasing use of outboard engines. Fewer full-time fishers. Fishers are more opportunistic and tend to be part time. Fishers increasingly landing to unofficial sites to avoid paying harbor-related taxes, to land undersized fish and to receive cash payments for their catch. Landings are being transported to Cairo via collection and trade depots, including in Esna (160 kilometers [km] from Aswan).
2.	What is the current status and health of the fishery (underexploited; fully exploited; overexploited)?	Overexploited.
3.	What are the main problems, issues and weaknesses of the fishery?	Overfishing, poor enforcement of rules and regulations, landings at unofficial landing sites, predation by crocodiles, no stock enhancement, increasing use of small mesh gears. Landings no longer inspected for diseases and parasites.
4.	What are the main threats faced by the fishery?	GAFRD is issuing fish transportation licenses to traders on request without inspecting catch to monitor catch weights and fish size. Traders under-report (catch) weights to be transported.
5.	What are the good things about the fishery (i.e. its strengths and benefits)?	Fishery provides important source of animal protein and supporting industries, including processors, employing many staff.
6.	Is the fishery well managed? If not, why not?	GAFRD has limited management capacity.
7.	How could the management be improved?	A committee should be established to include the management authority, scientists, fishers, processors and other stakeholders to improve management. The FMC should be strengthened.
8.	Are control measures (rules and regulations) effectively (well) enforced? If not, why not?	Poor enforcement of rules because GAFRD lacks technical capacity, staff, boats and resources. When the HDLDA was managing, compliance with rules was high because the HDLDA had capacity and scientific knowledge to manage the fishery effectively.
9.	Should the fishery be controlled by restrictions of catch or fishing effort, by technical measures, or by a combination?	By closed season, mesh regulations, landing size and effort restrictions (limit fishing licenses).
10.	What roles and responsibilities should or could stakeholders have in management (e.g. rule-making, monitoring, decision-making, enforcement, control, etc.)?	See 7.
11.	What opportunities exist for the fishery (e.g. development of the Nile perch fishery, developing export markets, stock enhancement, added value, etc.)?	High-value export markets.
12.	How much of the catch is landed at the main harbors (the official landing sites)?	5%. (This estimate appears unlikely given the quantities observed to be landed.)
13.	Complete the following fish disposal pathway diagram.	
14.	How could monitoring of the fishery be improved?	Ensure that all landings pass through official channels (harbors) so that catch can be accurately enumerated.
15.	Other comments.	Crocodiles protected under the Convention on International Trade in Endangered Species (CITES). Abundance unknown.

Date	Name	Occupation or position	Organization, institution or business name
10 May 2015	Mahmoud Hasseb	Executive Director	GAFRD

No.	Question	Response
1.	What trends or changes have you observed in the fishery?	Declining catch rates, increasing number of small-sized fish being landed. Declines in abundance of <i>O. niloticus</i> , which now forms only about 25% of the catch. Approximately 70% of the catch is now below minimum legal landing size (500 g).
2.	What is the current status and health of the fishery (underexploited; fully exploited; overexploited)?	Overexploited. Situation reported to be "disastrous."
3.	What are the main problems, issues and weaknesses of the fishery?	Lack of resources to enforce rules and regulations and effectively monitor the fishery.
4.	What are the main threats faced by the fishery?	Cheap cultured fish from the Delta. Lake Nasser fisheries not price competitive. Future development of aquaculture in the Suez Canal. 70 km ² has been proposed for aquaculture development.
5.	What are the good things about the fishery (i.e. its strengths and benefits)?	
6.	Is the fishery well managed? If not, why not?	No.
7.	How could the management be improved?	More resources and staff to enforce management rules.
8.	Are control measures (rules and regulations) effectively (well) enforced? If not, why not?	No. About 80% of fishers operate illegal small-mesh nets. At least 500 unlicensed boats are operating. Long shoreline (7000 km) to patrol.
9.	Should the fishery be controlled by restrictions of catch or fishing effort, by technical measures, or by a combination?	Reported that GAFRD licenses a maximum of 3100 boats based upon the shoreline length and a quota of shoreline length per boat. Appears arbitrary and not based upon previous fisheries stock assessments.
10.	What roles and responsibilities should or could stakeholders have in management (e.g. rule-making, monitoring, decision-making, enforcement, control, etc.)?	Key stakeholders should be consulted about approach to management and scientists from NIOF could provide scientific advice.
11.	What opportunities exist for the fishery (e.g. development of the Nile perch fishery, developing export markets, stock enhancement, added value, etc.)?	Improved marketing of fish from Lake Nasser. Eco-labeling (certification).
12.	How much of the catch is landed at the main harbors (the official landing sites)?	85%–90%. Unlicensed boats cannot land at harbors. Therefore only catches from licensed boats are recorded.
13.	Complete the following fish disposal pathway diagram.	
14.	How could monitoring of the fishery be improved?	Ensuring that all vessels land at harbors as required by law. Controlling the sale of undersized (illegal size) fish at harbors. Issuing of transport permits only after catch inspection for size and weight. Monitoring the few roads around the lake may be easier than monitoring all potential landing sites.
15.	Other comments.	

ANNEX 3. STAKEHOLDER WORKSHOP REPORT

Introduction to the Youth Employment in Aswan Governorate (YEAG) Project

The donor for the YEAG project is the Government of Switzerland through the Swiss Agency for Development and Cooperation (SDC). The duration of the project is 3 years with a total sum of CHF 5 million. Partners are CARE International in Egypt and WorldFish. The project aims to increase the income of 2500 individuals and to create up to 4000 employment opportunities for disadvantaged youth, men and women in Aswan. Through a market development approach, the project will focus on high-growth value chains in horticulture, livestock and fisheries and will aim to foster entrepreneurship.

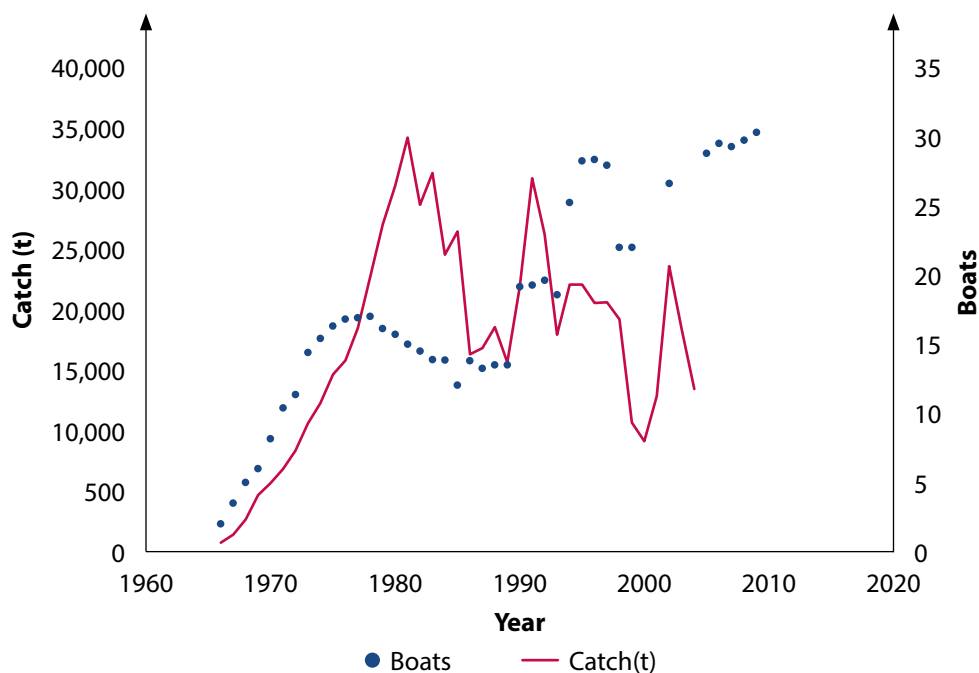
Dr. Ashley Halls

Thank you for attending this consultation meeting. I am here to be informed about the current situation of Lake Nasser fisheries and to hear ideas to be applied to enhance lake fisheries.

The most important thing is to know your experiences and knowledge and how to improve the current situation. Through meetings I have participated in over the last few days, I get a feeling that the current situation is acceptable and there are good points we can build on to enhance the fisheries.

I have to emphasize that the aim of the meeting is to know your opinions and how to work together to improve lake management. I am not here to say what you should do and what you should not do; I am here to give you advice through the information I have and to answer your questions.

I have a short presentation to explain the information I have:



Data collection on catch and number of boats shows that there is a distinction in the data. There is a regular increase in catch from 1966 to 1980, followed by a decline from 1980 to 1990, then an increase again from 1990 to 1995, to a low in 2000. Also, it is obvious that the number of boats is increasing with the decrease in catch.

If we draw a figure between catch and boat numbers, we can notice that when the number of boats increase, the catch will increase until a certain point and then the catch declines. In management science, we should reach the peak of catch without affecting the stock. The High Dam Lake Development Authority works to find modules for obtaining good fish production. Moreover, we noticed that there is a relation between catch, water level and fish behavior.

General remarks:

- Declining (decreasing) fish size is noted, which means that the fish are not living as long.
- There is a change in the species composition—a decrease in tilapia species and increase in tigerfish.
- Now, Nile tilapia represents only 25% of the total catch.
- The closed fishing season from the middle of April to the middle of May to maintain the stock has not been applied for the last few years (5 years).
- The use of illegal nets—about 80% (small mesh size)—has a bad effect on the stock.
- About 70% of tilapia catch are less than 500 g.
- Using more boats with motors to increase fish catch causes overfishing.
- We do not know the current situation of lake fisheries because we do not know the actual catch. This situation is not only here, but it is the same in other countries.
- GAFRD does not have enough equipment, facilities or budget. We should cooperate with GAFRD.
- Cooperation between the whole chain, from fisher, trader and processor to administration is a must.
- We have to put our hands together to improve this situation, set a plan, and then ask the government, management organizations and donors to apply it.
- We need cooperation and confidence to carry out the plan.

Now we are going to ask everyone about his or her opinion, idea, etc. It is recommended to respect everyone who is talking and to not interrupt.

Mr. Dahab Aly Galal, Chairman of Aswan Sons Cooperative Society

From the valuable introduction and presentation, it seems that we should focus on fishing effort, which is affected by our behavior. This depends mainly on the administrative organization and the fishers themselves, who should cooperate and carry out the regulations. Recently, the lake has been suffering from lack of security. The lake should be secured, with law enforcement taking place, because there are lots of unlicensed boats, which put pressure on the resources—in other words, there is more fishing effort. Also, illegal methods of fishing are applied by electricity, gas and explosives. We hope to have a strong enforcement of laws and strong penalties. Each cooperative and each fishing camp should stick by the number of licenses or less than it.

Mr. Esmail Hagage, Chairman of independent syndicate for fishers

We need good communication from the fishers through the last chain of the management to solve the problems. We need science. We need to enforce laws.

Eng. Asraf Mohamed Bagdade, The Egyptian Fish Marketing Company

All the development depends on the fishers, so we should increase their awareness (through teaching) of the influence of using illegal nets and the bad effect of fishing small-sized fish and how to maintain their fishing grounds to obtain the highest fish production. Apply effective law enforcement to stop smuggling of fish. Apply a closed fishing season during the spawning season of fish.

Mr. Badawe Mohran El Sayed, Fisher, trader and processor

There has been no closed fishing season since 1970 and no bad effect on the fish catch was noticed. I have 27 licenses but operate only 15 boats to catch large fish only, but other fishers apply illegal fishing methods, which in turn affects me. The cooperatives, authorities and security should work together and take severe action against fishers who do not follow the rules and regulations.

Mr. Nabil Mansour Tayah, Member of Aswan Sons Cooperative Society

I support the effective closed fishing season. The number of crocodiles is increasing; if it is permitted to catch them, the fish catch will increase because they consume a huge amount of fish.

Mr. Gamal Abdo Hassoun, Director of Nubian Coop

To begin with, I would like to thank Dr. Ashley. Governmental support is needed. Through the technical committee, the closed season was discussed, but it was found that we need EGP 1–3 million to apply it. The plan for lake management exists but the cost is high; we are ready to carry out the plan.

There is a need for scientific guidance, such as from the FMC or NIOF. There was a problem during the 1990s (fish were having an unusual smell), but no one could explain to us the reason for it. After a long time, we knew it was due to a type of aquatic plant.

Mr. Esam Abd El Nasser Hassen, Member of Nubian Coop

Thanks to Dr. Ashley. The main target is carrying out the plans. The problem is how to reach a secure point for fishing without having overfishing or overexploited stocks. We were depending on the flood season to bring fry, but with overfishing the number of fish declined and in turn the number of fry decreased too. There is a concern about restocking with fry; the number is not sufficient and they are released in certain places only. Natural enclosures were applied in certain places only, but these should be applied on the whole lake. The fishers are catching the small-sized fish because of its price; for example, the price inside the lake is 150–250 piasters, but it is sold out of the lake for EGP 15. We need a wholesale market in Aswan, like El Obour market in Cairo. Also, we would like to process lake fish and export it. New technology is needed to catch the big fish like Nile perch. The way to stop using the illegal nets is to stop importing them.

Mr. Waeel Abd El Hamaed, Trader of salted fish

Enforce the law to eliminate the illegal nets.

Mr. Tawfik Abdel Fatah, Chairman of El Takamol Coop

The problem of crocodiles is the most important, and we should find a way to reduce their number. Nowadays, they reach 4–5 meters, and one crocodile can consume 50 kg/day. It is advisable to enforce laws effectively to stop using illegal nets to catch small-sized fish. Stop selling the illegal fishing gear.

Mr. Kamal Ebrahim Bekheit, Vice Chairman of Mother Coop

We welcome Dr. Ashley and thank the donor. A few years ago, Nile tilapia made up about 90% of catch, but nowadays small-sized tilapia represents about 70%. That means that illegal fishing is increasing to catch tilapia that is less than 500 g. Most of the catch is *O. galilaeus* and *Tilapia zillii*, which become mature at the small size of 150–200 g. We would like to have a focus study on Nile tilapia through a scientific institute such as the FMC or others to develop and culture pure tilapia, so that it will once more predominate the catch by 90%.

Ms. Basma Mostafa Abbas, Environment awareness, EEAA

There is no cooperation between the administration organizations. Law enforcement is not applied effectively to stop smuggling. Lake Nasser fish is selling in Cairo cheaper than in Aswan. Crocodiles are not the main factor for catch declining. We have to study other factors that have impact on the fish catch, such as off-shore cultivation, because it could be using illegal pesticides or fertilizer.

Dr. Mohamed Ezzat, Crocodiles unit, EEAA

First of all I would like to clarify the effect of crocodiles on the fish catch. Scientifically, there is no effect of crocodiles, which we have been monitoring since 2008. I have a 10-day survey on a regular monthly basis, and the number is decreasing; for instance, in Khor El Ramla the number of crocodiles was 100 in 2008, after 2 years the number became 50, and last year the number was only 20. There is no specific study about how much a crocodile consumes per day, but when we dissected one we found the stomach contained about 1.5 kg only. I would like to declare that there are big opportunities to have crocodile farms; it is a very profitable business on the one hand and would solve your problem on the other.

Regarding the fisheries, to gain profit from the lake we have to spend more money to invest resources, and the cooperatives should play an effective role to get higher fish catch.

We should pay more attention to the fishers themselves because they are working under severe conditions and are the people who get the least benefit. If we improve their situation, probably they will stop using illegal nets to catch small fish.

Eng. Mahmoud Hasseb Hussein, Executive director of Lake Nasser GAFRD

The cooperatives should be the main partners in the studies. The reason for the recorded decline in fish catch in 2000 (8000 t as total catch) was the obligatory fish price and the debits to the two marketing companies (Misr Aswan Company and the Egyptian Fish Marketing Company).

Until 2001, there was complete cooperation between the HDLDA and GAFRD. The current situation is due to administration reasons not technical reasons. Since 2010, the security authorities have been busy with the current situation of the country, and less effort was given to enforcing laws in Lake Nasser. Changing the HDLDA from a service authority to an economic one affects our effort because we have to pay for using facilities (boats, workshops, etc.). The current situation is bad, and the species composition has changed from 50%–60% *O. niloticus* to only 25%, and *Tilapia zillii* and *O. galilaeus* predominate. We prepared the study and the plans were submitted.

Dr. Hussein Amar Adam, Lecturer, Aswan University

Enforce laws and regular inspection of the fisheries. Have an effective closed season, with the modification that the fishers stay at their camps to guard their fishing area and are permitted to catch the salted fish only. No ice will be provided. Scientific organizations should have research on a regular basis, such as NIOF, FMC, etc. Support GAFRD with human resources (more employees). Completely stop using cars for transportation, giving about 6 months as a transition period because we do not know the right weight, species composition and size composition.

Mr. Morad Zaki Agaypi, Ex-director of HDLDA

I have been working in Lake Nasser for more than 30 years. There is a very important thing missing, which is the cooperation between fishers, cooperatives, GAFRD and the HDLDA to enforce laws.

Eng. Mohamed Saad El Daein Abbas, Director of Coop and River Nile GAFRD

I am grateful for the chance to meet my friends who I have not seen for a while. The target is to help the fishers. The cooperation between different authorities is a must; there are minor problems. The fishers in the River Nile are slightly neglected and are working under hard circumstances. There is a very crucial problem, which is that fish from sewage is in the market now. At the beginning it was sold in Draw and Kom Ombo, but it has reached Aswan. We made notes and spoke to the Aswan Governor. This fish is causing different diseases.

Dr. Ashley Halls

First of all, I think and all of you agree that this was very useful. That shows that there is agreement and not a conflict.

My feeling is that there is a desire to work together with harmony, and there is a role for everyone to participate in organizing the work. There is no one responsible for management, so we have to react as administrators and scientists to move forward.

I think we have reached the point that fisheries are not in a healthy state. The fisheries of Lake Nasser have been studied for decades.

We have to look to science as a way to find ideal solutions for our problems.

There is no control over the fisheries with certain regulations, so we have to look once more to changing these circumstances.

We have to rethink the fisheries, because species composition has changed and the situation too. Do we have to apply a closed season, mesh size regulation, size to fish, etc.?

Generally, it is very important to apply a regulation when we decide on it, and we should have a penalty for not carrying it out.

We have to raise awareness and the reasons for doing that.

We have to think how we can help the fishers and stop them from catching small-sized fish, because if the traders keep buying the small fish from them that means they are encouraging them to destroy the fish stock.

We cannot determine all the solutions today or in a week or in a month.

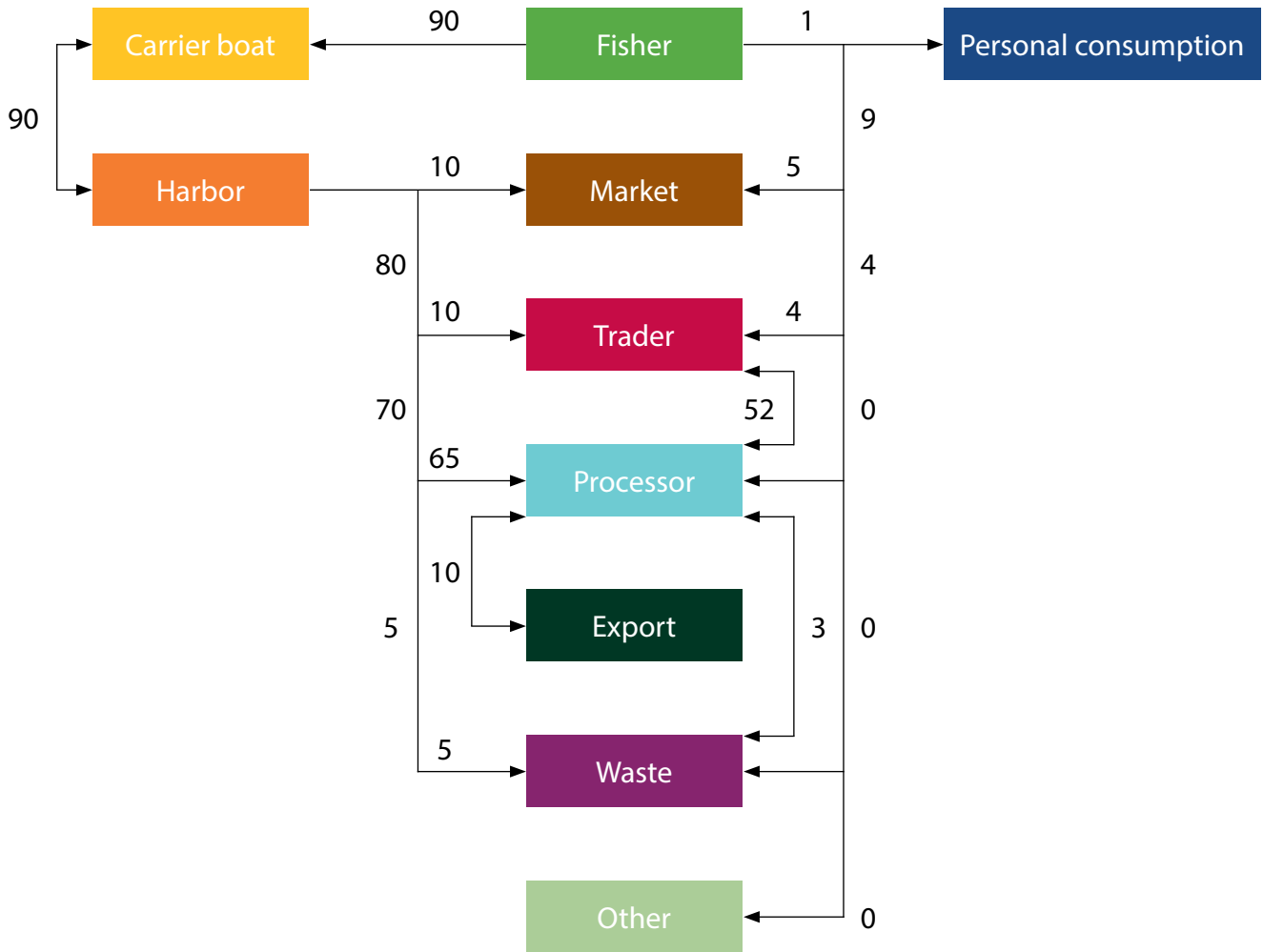
We have to cooperate and have discussions to put a plan in place that everyone can participate in. By everyone I mean the fisher, trader, processor and cooperative—and we especially would like to know the fisher's point of view. We have to know why the fisher sells fish to a smuggler.

We have to sit down together to reach a plan for co-management for the lake. If you agree, I am going to explain that to the donors. Each time we set a plan in place, all the stakeholders should attend and participate in each step. Whenever we make a plan, we should follow up with the regulations to carry it out in order to reach the ideal situation.

Stakeholder meeting participants

No.	Name	Occupation
1	Tawfik Abdel Fatah	Chair of El Takamol Coop
2	Gamal Abdo Hassoun	Director of Nubian Coop
3	Esam Abd El Nasser Hassen	Member of Nubian Coop
4	Dahab Ali Galal	Chair of Aswan Sons Coop
5	Nabil Mansour Tayah	Member of Aswan Sons Coop
6	Kamal Ebrahim Bekheit	Vice chair of Mother Coop
7	Abd El Moaety Dein Mersal	Chair of Care Coop for fishers
8	Esmail Hagage Abd El Alla	Chair of independent syndicate for fishers
9	Badawe Mohran El Sayed	Fisher, trader and processor
10	Waeel Abd El Hamaed	Trader of salted fish
11	Mahmoud Haseb Hussein	Executive director of GAFRD
12	Mohamed Saad El Daein Abbas	Director of Coop and River Nile GAFRD
13	Osama Mohamed Kamel	Director of Misr Aswan sector
14	Ashraf Mohamed Bagdade	Egyptian Fish Marketing Company
15	Osman Saad Hussein	Microfinance Care
16	Morad Zaki Agaypi	Ex-director of HDLDA
17	Dr. Hussein Amar Adam	Lecturer, Aswan University
18	Amro Mohamed El Tarry	Environment researcher, EEAA
19	Dr. Mohamed Ezzat	Crocodiles unit, EEAA
20	Basma Mostafa Abbas	Environment awareness, EEAA
21	Dr. Ashley Halls	Consultant
22	Olfat Anwar	WorldFish

ANNEX 4. FISH DISPOSAL PATHWAY DIAGRAM



ANNEX 5. SWOT ANALYSIS

Strengths	Weaknesses
<ul style="list-style-type: none"> • Institutions and administrative procedures already exist to support management. • Management authority and other key stakeholders acknowledge that fishery resource status is poor and in decline, and that strengthened and improved management is required. • Management authority recognizes need to consult key stakeholders when making decisions, and appears receptive to advice and offers of support. • Processing facilities and supporting services already exist to respond to improvements in output (landings). • There is strong interest in value-added products and exports among processors. 	<ul style="list-style-type: none"> • Current management authority (GAFRD) has limited capacity (knowledge, experience and resources) to manage resources effectively and sustainably. • There are no clear management objectives, nor management plan to achieve stated objectives. • There is uncertainty over resource status. There has been no formal stock assessment for 17 years. However, available data and most recent observations and anecdotes suggest that overcapacity exists and resources are overexploited. • There is no monitoring of indicators of resource status or management performance (fishing effort, catch rates, fishing mortality, target and limit reference points, etc.). • Some fishers report having little trust, confidence and respect for the current management authority. • GAFRD has insufficient resources to effectively enforce control measures. • There is poor understanding of fish disposal pathways, hindering effective monitoring program design. • There is unfamiliarity with the latest stock assessment models (e.g. biomass dynamics models). • Catch monitoring programs restricted only to harbors are likely to underestimate true landings.
Opportunities	Threats
<ul style="list-style-type: none"> • GAFRD acknowledges its limited capacity to manage and has expressed interest in (project) support and collaboration to improve its capacity and management performance. • Stakeholders acknowledge the poor status of the fishery and have agreed to form a co-management organization, to meet regularly, and to formulate and implement a new management plan to strengthen management. • Capacity and willingness exists locally and nationally (former FMC employees and existing NIOF staff) to potentially provide stock assessment and technical advice to GAFRD to improve management. • Issues and constraints to improve management are now well understood and outline plans to remedy the situation have been discussed and provisionally approved by key stakeholders during this mission. • Improved stock assessment approaches and models exist (e.g. extended biomass dynamics models to account for effort and environmental variation) to provide better management advice. Preliminary applications of these methods have been made. • A length-based stock assessment could be undertaken quickly and cheaply to help validate the preliminary stock assessment results generated by this mission and generate other indicators and reference points to guide future management efforts. • There is existing donor engagement and support. • There is potential for development of national and export markets for wild-caught fish from Lake Nasser. • There is potential for crocodile farming. 	<ul style="list-style-type: none"> • Increasing use of (illegal) small-mesh nets, destructive fishing practices and unlicensed boats are causing overcapacity and overexploitation of the fish resources, potentially threatening resource sustainability and dependent livelihoods and food security. • There has been recent undocumented <i>ad hoc</i> manipulation and adjustment of catch statistics to demonstrate management performance, giving the wrong impression of the status of management and the health of fish stocks. • No apparent limits are set on the number of boats that can be licensed, allowing capacity (boat numbers) to grow. • Increasing capture efficiency (catchability) is arising from more widespread use of outboard engines. • There are limited alternative livelihood opportunities for existing fishers. • Cheap cultured fish is available from the delta and elsewhere. • There may be rivalry between stakeholders who could potentially collaborate effectively to improve management performance.



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