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INLAND FISHERIES STOCK ASSESSMENT

INTRODUCTION

1. This document aims to provide basic background information to TAC in its effort to generate scientific and technical advice on the stock assessment of key commercial inland species in the CACFish area.

2. A "stock assessment" provides fishery managers with much of the information necessary to make informed decisions. It is the process of collecting and analyzing biological and statistical information to determine changes in the abundance of a stock in response to fishing effort. It describes the past and current status of a fish stock and provides answers to such questions as "How large is the stock?" and "Is the stock increasing or decreasing in size?" A complete stock assessment contains a vast array of information on both the fish "population" (a group of individual fish of a single interbreeding species located in a given area) and the fishery itself.

3. A stock assessment also attempts to predict future trends in the abundance of the managed stock, and to explore how the stock will respond, in both the short and long term, to specific management options, such as an increase in fishing pressure. Management options can then be considered based on their likelihood of achieving the stated management objectives and recommendations can be made for future research to improve data quality and reduce the uncertainty inherent in subsequent stock assessments.

4. While a "stock" is sometimes defined as an interbreeding population occupying a certain geographic area, fish stocks are often delineated on a more practical basis, management concerns such as jurisdictional boundaries or location of the fishery often being at least as

important as the biological characteristics of the fishery. From the fishery manager's point of view, a stock is thus a subset of a single species that is exploited in a particular geographical area (i.e. a management unit).

5. Within a fish stock a "cohort" is a group of fish all born in the same year (i.e. a year-class). Stock assessments often track individual cohorts over time. Short-term increases or decreases in the size of a particular stock can sometimes be explained by the existence of an exceptionally large or small cohort.

6. Stock assessment is one of the primary fisheries management instruments used to determine the state of exploitation of a fishery resource. The findings of such assessments for single- and multi-species fisheries provide the basic data needed to fix the catch level at which the resources can be sustainably exploited. A key concept in stock assessment is that of "maximum sustainable yield" (MSY), which is defined as "the highest theoretical catch yield that can be continuously taken (on average) from a stock under existing (average) environmental conditions without significantly affecting the reproduction process". MSY is typically thought of as the largest average catch that can be continuously taken from a stock under existing environmental conditions; i.e. it is the greatest number of fish that can be caught each year without impacting the long-term productivity of the stock. A related key concept applied by fisheries managers is that of "optimum yield", the amount of catch that will provide the greatest overall long-term benefit to society. The optimum yield takes into account the biology inherent in MSY, but also considers the economics and the attitudes of the public towards risk and environmental protection. The optimum yield is often less than the MSY, but can never be greater.

7. A stock assessment describes a range of life history characteristics for a species, such as information (derived from other studies) about age structure, growth, natural mortality, sexual maturity and reproduction; the geographical boundaries of the population and the stock; critical environmental factors affecting the stock; feeding habits; and habitat preferences. Drawing on the knowledge of both fishermen and scientists, stock assessments give qualitative and quantitative descriptions of the fishery for a species, past and present. Final stock assessment reports also contain all of the raw data used in the assessment and a description of the methods used to collect that data.

8. Most commercial marine and inland fish stocks are now either fully exploited or overexploited. Sustainable management of fisheries resources depends upon many factors. Included are co-management of the resources; systematic collection, analysis, use and dissemination of fisheries data and information; availability and implementation of effective national policies, strategies and associated fisheries management plans; assessment, analysis and monitoring of fisheries resources; and effective compliance monitoring and enforcement. One of the primary goals of the existing fisheries management tools (e.g. gear restrictions, minimum legal lengths, trip limits, licenses, total allowable catches and quotas, and fishing area and time restrictions) is to ensure a sustainable fishery with maximum catch (i.e. MSY) while maintaining the exploited fish stock within safe biological limits and assuring the associated natural functions of ecosystems and habitats.

9. Good fisheries management is correlated with the translation of scientific advice into practice. However, the accurate assessment of stock status is often difficult. Two types of data are collected for use in fisheries management: fishery-dependent and fishery-

independent data. Fishery-dependent data are derived from the fishing process itself and include data on commercial landings, fishing effort, catch composition (length distribution, age structure) and fishing gear; and typically involve self-reporting, on-board observers, port surveys of catch and landings, telephone surveys and/or vessel-monitoring systems. Such data are collected directly from fisheries, and fishers are their principal providers. Surveys and on-board observations provide useful information on such management issues as bycatch, discards and the capture of prohibited species.

10. Fishery-independent data are obtained from activities that do not involve commercial or recreational fisheries. These data are typically obtained from research surveys conducted by government agencies. They are collected through scientific research, surveys and direct observations; and rely on such methods as trawl, acoustic, video and side-scan sonar research surveys and tagging experiments. Scientists take samples throughout the potential range of the target fish using standardized sampling gear including trawls, seines, hydroacoustics and video. These surveys can target several species, a single species or even a specific age-class of a single species. Regardless of the target or the gear, maintaining standard survey practices over time is crucial. Changes in mesh size soak times and tow length or speed can all impact the comparability of a survey over time. Both fishery-dependent and fishery-independent data can help fulfill the requirements of stock assessments for data on catch, relative abundance and the life history of the species being evaluated.

11. Due to the often complex nature of aquatic ecosystems, stock assessments that are done for a single species should include consideration of multispecies interactions, which may be highly complicated, the modelling also taking into consideration environmental and ecosystem changes. A consensus exists that stock assessments should be done on an annual basis, and that fishery-independent data is a prerequisite for stock assessment of unexploited fisheries resources. It is worth noting that fishery-independent surveys are increasingly used to validate the data derived from fishery-dependent sources.

12. Stock assessments generate a series of estimates for stock size and "fishing mortality" (the rate at which fish are removed from the stock) over time. "Biological reference points" serve as a way to judge those estimates based on knowledge and assumptions about the species' growth, reproduction and mortality. Biological reference points give fishery managers guidance in determining whether a stock is too small or if the fishing pressure on it is too great. Managers usually set control rules that define predetermined actions to be taken when a stock meets or exceeds a certain status indicator (e.g. a reference point). Comparison of the stock's current status with historical data sets is thus made to reveal the status of the stock against biological reference points that indicate a "target" (e.g. the level of maximum harvest) or an undesired limit i.e. a "threshold" (e.g. a ratio of spawning biomass to recruitment below 20 percent). The most commonly used reference points for fisheries management include Limit Reference Points (LRPs), Target Reference Points (TRPs) and Precautionary Reference Points (PRPs). They typically incorporate information on growth, natural mortality, the stock–recruitment relationship and carrying capacity, and data from fishery-dependent (e.g. catch and fishing effort) and fishery-independent (e.g. surveys) sources. The findings of multi-year assessments provide estimations for stock abundance and biomass, distribution and density of species, and the level of fishing pressure on the stock - and thus offer management choices for a fishery or resource.

13. The mathematical and statistical techniques used to perform a stock assessment are referred to as the "assessment model". Scientists compare different assumptions within a given assessment model and may also examine a variety of such models. Ultimately, the scientists will estimate the current status of the stock relative to management targets and predict its future status given a range of management options. They will also describe the most likely outcomes of those options and the uncertainty around them.

14. One of the primary goals of a stock assessment is to estimate the uncertainty in the status of the stock and in the target and threshold values. One way to do this is with a "sensitivity analysis". To produce a stock assessment, a scientist applies appropriate models to the available data, examines the uncertainty in the models' outputs, and tests their sensitivity to changes in the underlying assumptions. The stock assessment will rate how likely each management option is to achieve its stated objectives and should quantify the risk of the option not achieving the goal. Choosing between management options is ultimately the role of the fishery manager.

15. There are many reported cases where wrong fisheries resource management decisions were taken based on poor scientific advice. However, there are also many instances where decision-makers have ignored timely and robust scientific advice. Therefore, the "total allowable catch" (TAC) (i.e. quota) limits set for commercially exploited fish stocks are frequently in excess of the best scientific advice, thus threatening the existence of the exploited fish species. Today there is broad agreement that in the face of uncertainty in scientific data a precautionary approach should be applied by decision-makers. In this context, the FAO *Code of Conduct for Responsible Fisheries* (1995) includes specific articles on the application of the precautionary approach within the context of management and conservation of fisheries resources:

> *Article 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.
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> *Article 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.
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> *Article 7.5.3:* States and subregional or regional fisheries management organizations and arrangements should, on the basis of the best scientific evidence available, *inter alia*, determine:
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> a. stock-specific target reference points, and, at the same time, the action to be taken if they are exceeded; and
> b. stock-specific limit reference points, and, at the same time, the action to be taken if they are exceeded; when a limit reference point is approached, measures should be taken to ensure that it will not be exceeded.
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> *Article 7.5.3:* In the case of new or exploratory fisheries, States should adopt as soon as possible cautious conservation and management measures, including, *inter alia*, catch limits and effort limits. Such measures should remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term

sustainability of the stocks, whereupon conservation and management measures based on that assessment should be implemented. The latter measures should, if appropriate, allow for the gradual development of the fisheries.

16. Stock assessments are common for marine fish species and are also used for freshwater species occurring in lakes, rivers, streams and reservoirs. Key Central Asian commercial inland fish include the following species: freshwater bream *(Abramis brama),* Caspian sea sprat (*Clupea cultriventris),* pike-perch (*Sander lucioperca),* roach (*Rutilus rutilus),* Crucian carp (*Carassius carassius),* wels (*Silurus glanis),* silver carp (*Hypophthalmichthys molitrix),* asp (*Aspius aspius),* common carp (*Cyprinus carpio)* and grass carp (*Ctenopharyngodon idella).* Fish production in Central Asia is reported to have decreased dramatically over the last two decades.

17. In general, there is a lack of accurate and reliable information on the status of inland fish stocks in the CACFish area. This paucity of data is due to a lack of systematic stock assessment studies as part of national fisheries management strategies, and results in difficulty in determining the national and regional status of these stocks (i.e. moderately exploited, fully exploited, overexploited, depleted or recovering). In the CACFish area, stock assessments are typically based on the analysis of fisheries-dependent data (i.e. historical data on landings) and on the limited number of stock assessment surveys and targeted research that has been accomplished. Stock assessment studies in large inland waterbodies (lakes, reservoirs) are not conducted on a regular basis. Available data suggest that the fisheries within the region have unstable patterns of exploitation, the landings fluctuating considerably from year to year. The resulting stock instability leads to economic uncertainty and negatively impacts the planning ability of fishers, processors and managers.

18. There is a clear need to develop policies, strategies and guidelines for fisheries management that will lead to the sustainable exploitation of inland fish resources based on sound scientific advice. The existing data-poor situation leads to an unacceptably high risk of over-exploitation of commercially important fish stocks and uncertainty as to the measures for stock conservation that need to be applied through management measures. Therefore, the formulation of an alternative region-wide approach to fish stock assessment would be useful. The lack of technical, institutional and financial capacity hampers the conducting of fish resource surveys and targeted research. The uncertainty of stock estimates, a result of the lack of reliable and timely data and information on the status of fish resources, is an outstanding challenge for decision-makers. In addition to a regional management strategy, the region needs standardized practical methods and protocols for assessment of the fisheries resources to address these issues.

19. TAC would have a role in development of a scientific/technical stock assessment framework that can be applied in the CACFish area, taking into consideration regional needs and future challenges. Regular assessment of stock status by TAC is expected to provide essential information and data for stock management and conservation measures, including the setting of annual catch limits for the main commercial fish stocks.

SUGGESTED ACTION FOR TAC

In the light of the above considerations, the Committee is invited to discuss and generate technical/scientific short-to mid-term guidance and an action framework, taking into account the five-year work programme of the Commission. Development of a scientific/technical stock assessment framework by identification of, among others, inland stock assessment methods with associated reference points and protocols would be a primary output that TAC may provide.