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Balanced Harvest in the real world — scientific, policy and operational issues in an ecosystem approach to fisheries

An international workshop organized by the IUCN Fisheries Expert Group of the IUCN Commission on Ecosystem Management (IUCN/CEM/FEG)
And coordinated by EBCD in close cooperation with the Food and Agriculture Organization of the United Nations (FAO)
Venue: FAO HQs, Rome, September 29-October 2, 2014

RATIONALE

Fisheries have obvious impacts on ocean biodiversity and these are expected to increase as a result of a growing demand for fish. Because of the concerns over these impacts, the international community committed, during the 2001 FAO-Iceland Conference in Reykjavik (Iceland), to aim at responsible fisheries in a healthy marine ecosystem and, consequently, the Ecosystem Approach to Fisheries (EAF) was adopted by the FAO Committee on Fisheries (COFI) in 2003. The EAF implies, among others, a commitment to sustainable use of aquatic biodiversity. Key to this commitment is the adoption of management strategies that ensure maintaining ecosystem properties, including ecosystem structure and function, consistent with the central requirement of the CBD for sustainable use (Malawi Principle).

Worldwide, fishery policies and harvest strategies are evolving rapidly from a conventional stock- or fishery-based management to a more ecosystem-conscious management. The aim is to reduce and account for collateral impact on the food chain and species assemblages, giving effect to the Law of the Sea Convention (LOSC) requirement to manage sustainably target species as well as dependent and associated species, transcribed into EAF. Although some progress has been made, it has proven difficult to put into practice the high level objectives and intentions contained in these instruments.

Moving from single species to ecosystem level management has been a major challenge both for science and management and most management strategies are still based on single species considerations. As a consequence, fisheries policies and strategies are still often based on regulations grounded in single species, conventional fisheries management and do not fully take into account the ecosystems interactions and cascading impacts across the food web. A key difficulty is in obtaining accurate representations of foodwebs that are necessary for taking trophic links into account in practical fishery management. Another challenge relates to identifying fishery management regulations that would ensure a balanced fishing pattern across trophic levels while being both socially and economically acceptable. Such regulations will necessarily address both the amount of fishing (through regulation of fishing capacity and allowable catches) and the pattern of fishing (i.e. the distribution of fishing pressure on sizes and species) with the view to ensure a more ecologically balanced harvest.

Fishing practice requires generally the selection of specific targets and sizes to satisfy market demand. “Selection” happens though seasonal availability; selection of the gear

among a large range; selection of the depth and habitat in which to operate the gear; and discarding of what cannot be sold with sufficient profit, either at sea, or at the landing place. Some fisheries, like purse-seining for anchovy are more selective than others, like shrimp trawling. At a whole, however, mature fishery sectors capture a very wide range of species and sizes and this is true for both small and large-scale fisheries. Discards tend to be reduced or practically inexistent in developing countries 'small-scale fisheries. Similarly, markets and consumers tend to be more "selective" in developed than developing countries. In all of these aspects, though, generalizations are potentially misleading.

During their historical development, fisheries have progressively "colonized a broader range of species as markets developed. In that evolving context, the fundamental tenets of conventional fisheries management have been to ensure, on each target species population a highly selective fishing pattern that tends to protect juveniles and immature individuals, concentrating fishing on adults. In addition, conventional management has tended to organize the fisheries (and the licensing system) according to a limited range of target species (or groups of species), particularly in fisheries regulated through species-based quotas. Selective fishing management strategies have been implemented through a range of management instruments including mesh size and gear regulations as well as closed seasons and areas. Coupled with a fishing effort most often beyond recommended limits, these strategies have led to profound changes in the species and size composition of fish populations and communities. It is understandable that any kind of selective removal of certain ecological components of the ecosystem (and more specifically of the food chain) will change the natural composition of a living resources community and its biodiversity, possibly resulting in changes in ecosystem structure, functioning and resilience, and affecting the sustainability and stability of fisheries yields. In addition, the phenotypic and possibly genetic evolution provoked by selective fishing adds impact on the long-term productivity of marine ecosystems, changing the growth and reproduction patterns (e.g. in Heino and Dieckman, 2008). Hence, regulations aimed at optimizing single-species fisheries need to take into consideration and be complemented by ecosystem considerations. Indeed, increasing evidences with inclusive ecological reasoning and deliberate ecosystem modelling indicate that many current management policies have a range of unintended negative impacts on the ecosystem as a whole and on the fisheries' future.

In the last few years, a "Balanced Harvest"[1] concept has been suggested by a group of scientists to reemphasize the need for a critical rethinking of current approaches to fisheries management. This concept aims to give attention to the many collateral ecological effects of fishing by avoiding unbalanced removals of particular components of the ecosystem, while supporting more sustainable fisheries (Zhou et al., 2010; Rochet et al., 2011; Garcia et al., 2011; 2012).

This proposal intends to scrutinize further the Balanced Harvest strategy, its scientific underpinnings (in the light of the new results obtained through modelling and empirical observations), and its policy and management implications (including economic ones) for

[1] It has been suggested that this strategy might also be called "**Ecologically-Balanced Harvest**" as the objective is to maintain ecosystem structure and function, or "**Physiologically-Balanced Harvest**" (Ken Andersen) as the implementation principle is that each component is harvested in proportion of its natural productivity.

both fisheries and biodiversity conservation. A range of issues will be examined at the proposed multidisciplinary workshop, such as:

- What does biodiversity really mean in relation to fisheries? What properties of biodiversity do fisheries affect and how could they be protected?
- What are practical ecosystem indicators and reference points that can assist managers to track whether ecosystem objectives are being achieved?
- What "ecosystem" or "trophosystem" are we referring to or trying to keep "balanced" (boundaries, scales and composition)?
- How can we determine the fishing pattern and intensity to maximize food production while minimize environmental impacts at ecosystem level, also taking into consideration different properties and dynamics of different ecosystems? How could Balanced Harvest be practically implemented in the real world?
- What are the technological and economic implications, including market implications of Balanced Harvest?.
- What are its implications for the modern theories of fishing rights, TACs and quotas?
- How can the situation of fisheries be globally assessed in relation a Balanced Harvest objective and criteria?
- How can industries add value to currently low-valued components to facilitate their integration in the market?
- Can cultural exchange and development of seafood processing techniques influence people's dining habits?
- How can eNGOs, food industry professionals, media, educators, and retailers play a role in better understanding and implementing balanced harvest?

The Scientific Workshop looks for cooperation with international organizations active in biodiversity and fisheries, such as IUCN, the CBD and FAO. It intends to bring together leading scientists in the field, as well as economists, managers, representatives from industry and ENGOs. A special effort will be made to provide practical solutions and advice for fisheries management, also in data poor situations. .

Desired outcomes include a wider recognition of the issues around present management policies, harvesting strategies, as well as the possible benefits and implementation challenges of Balanced Harvesting. The workshop will identify priority research needs, facilitate cooperation across multiple disciplines, and provide strategic advice to fishery and biodiversity policy-makers and managers, with the goal of increasing food production while reducing negative impacts of fisheries on marine ecosystems.

MEETING SPONSORS

The workshop is co-organized by the Fisheries Expert Group of the IUCN Commission on Ecosystem Management (IUCN-CEM-FEG) and the FAO Fisheries and Aquaculture Department. The meeting planning and implementation is coordinated by the European Bureau of Conservation and Development (EBCD) as member of IUCN. The meeting has received financial support, directly or indirectly (through meeting facilities and total or partial funding of participants) from the following institutions: FAO, EBCD, IUCN-CEM,

ISSF, NORAD, MSC, he Government of Japan, University of York (UK), Duke University (USA). Aqua-DTU Denmark, CSIRO (this section will be revised at/after the meeting),

MEETING ORGANIZATION AND PROCESS

Focus: The first scientific workshop (Nagoya, 2010) focused on modeling of BH strategies and limited empirical evidence. This meeting should review progress in modeling and focus on the practical implementation issues (operational, legal, economic, etc.).

Process: The workshop will be organized in five sessions:

1. Theory/models
2. Empirical evidence
3. Economic, Policy and management implications
4. Final conclusions

Each session will be organized around a series of **presentations**, each of which will be followed by a **discussion** for clarifications. Provisionally, 20 minutes will be allocated for the presentations and 10 minutes for discussion. Each session will end-up with an **open debate** aiming at an integration of the views expressed in the presentations, identification of coherence, convergence, divergence, conflicts and, possibly consensus. A **final wrap-up session**, at the end of the meeting will give an opportunity to decide on, e.g.: (i) main messages; (ii) post-meeting communication strategy (meeting report, joint publication, etc.) and any other matter the group would want to discuss.

The meeting will be co-chaired by FAO and IUCN-CEM-FEG. Each session will be moderated by a participant preferably not involved in presenting. Before then end of the meeting, each presenter will submit an executive summary with the key points of his/her presentation (up to a page plus figures) for the meeting report. The discussions following each presentations and each session will be summarized by rapporteurs.

Office-bearers

The meeting will be co-chaired by Gabriella Bianchi (for FAO) and Serge M. Garcia (for IUCN-CEM-FEG). The co-chairs' proposals for the different sessions, to be finalized at the meeting, are as follows:

Session	Moderator(s)	Rapporteur(s)
Theory & models	A. Bundy	G. Delius
Empirical evidence	M. Hall	D. Reid
Economic, policy & management	J. Kolding	M-J. Rochet
Conclusions	G. Bianchi	T. Charles / S.M. Garcia

The meeting will be coordinated by Despina Symons (Director EBCD) and Paolo Mattana (EBCD, meeting officer) and FAO (Valérie Schneider).

Venue: FAO Premises, Via delle Terme di Caracalla (India Room). FAO will prepare passes for each participant and send an information about access to the FAO premises.

DRAFT ANNOTATED AGENDA

Monday 29 September	
09:00 - 09:30	Opening welcomes: S. Garcia (Chair IUCN-CEM-FEG); D. Symons (Director EBCD) and G. Bianchi (FAO)
09:30 - 09:45	Nomination of a Meeting Chair(s) and session Rapporteurs
09:45 - 10:00	Adoption of the Agenda. Expected outcomes. Chair & rapporteurs
10:00 - 10:30	**Coffee break**
	SESSION 1: THEORY AND MODELS
10:30 - 11:00	**1. Balanced harvesting promotes coexistence of interacting species**. Law, R ; Plank, M. and Kolding, J.
11:00 - 11:30	**2. A reappraisal of fisheries selectivity in light of density-dependent regulation**. Andersen, K.H.; Jacobsen, N.S. and Beyer, J.
11:30 - 12:00	**3. Do unregulated, artisanal fisheries tend towards balanced harvesting**? Plank, M.; Law, R. and Kolding, J.
12:00 - 14:00	**Lunch**
14:00 - 14:30	**4. Effect of fishing intensity and selectivity on community structure and fishery production at trophic and species levels**. Zhou, S. and Smith, T.
14:30 -15:30	***Discussion on Theory & Models:*** *Summary of theory available; identifying gaps and needs for further modelling work. Implications for research and management*
15:30 – 16:00	**Coffee break**
	SESSION 2: EMPIRICAL EVIDENCE
16:00 – 16:30	**5. Changes in productivity and life-history traits in experimentally harvested guppy populations.** By Diaz Pauli, B. and Heino, M.
16:30 - 17:00	**6. The Barents sea ecosystem - balanced harvest**? By: Mauritzen, M.
Tuesday 30 September	
09:00 – 09:30	**7. Exploitation patterns in fisheries, a global meta-analysis from Ecopath models.** Kolding, J.; Bundy, A.; Christensen, V.; Steenbeek; Law, R.; Plank, M. et al.
09:30 – 10:00	**8. Maximizing fisheries yields while maintaining ecosystem structure.** Kolding, J.; Jacobsen, N.S.; Andersen, K.H. and van Zwieten, P.
10:00 – 10:30	**9. What are the ecosystem consequences of balanced fishing regimes**? Rochet, M.J.; Collie, J.; Jacobsen, N.S. and Reid, D.
10:30 – 11:00	**COFFEE BREAK**
11:00 – 12:00	***Discussion on Empirical Evidence:*** *Summary of evidence available; how to address the challenge of providing convincing evidence of the impact of selectivity in the context of communities subject to the influence of many factors.*
12:00 – 14:00	**Lunch**
	SESSION 3: ECONOMIC, POLICY AND MANAGEMENT IMPLICATIONS
14:00 – 14:30	**10. Balanced Harvesting in Fisheries: Economic insights and policy Implications**.

	Charles, A.; Garcia, S.M. and Rice, J.
14:30 – 15:00	**11. The Ecosystem Approach to Fisheries and balanced harvest: considerations for practical implementation.** Bianchi, G.
15:00 – 15:30	**COFFEE BREAK**
15:30 – 16:00	**12. Dynamic management as a means to implement the multiple objectives of a balanced harvest in developed fisheries.** Dunn, D.C.; Hobday, A.; Boustany, M. and Halpin, P.N.
16:30 – 17:00	**13. An Introduction to the MSC Fisheries Standard: current requirements and future development toward a multispecies and ecosystem approach**. Atcheson, M.; Agnew, and Lefebure, D.
	Wednesday 1 October
09:00 – 09:30	**14. Implementing balanced harvesting. Practical challenges and other implications.** Graham, N. and Reid, D.
09:30 – 10:00	**15. Challenges to the implementation of balanced harvesting systems: some ecological and technological issues.** Hall, M.
10:00 – 10:30	**COFFEE BREAK**
10:30 – 11:00	**16. Balanced harvesting and the tropical tuna purse seine fishery.** Dagorn, L.
11:00 – 11:30	**17. Preliminary reflection on a possible BH norm and harvest control rule.** Garcia, S.M., Rice, J. and Charles, A.
11:30 – 12:00	**18. A framework of indicators for balanced harvesting in small scale fisheries.** van Zwieten, P. and Kolding, J.
12:00 – 14:00	**Lunch**
14:00 – 14:30	**19. Fisheries management for BH: case of Japan**. By Makino, M.
14:30 – 15:00	**20. Discard bans and balance harvest: a contradiction in (more than) terms?** Borges, L.
15:00 – 15:30	**COFFEE BREAK**
15:30 – 16:00	**21. Management implications. The CFP as a sounding board.** Garcia, S.M.
16:00 – 17:00	***Discussions:*** *Summary of economic, policy and management implications*
	Thursday 02 October
	SESSION 4: WRAP-UP DISCUSSIONS. CONCLUSIONS. MEETING OUTCOMES
09:00 – 10:00	***Wrap-up session*** This session will intend to derive, from the available knowledge, the priority issues and practical advice for policy and management, identifying knowledge gaps and potential collaborative work. Additional questions to be addressed will be decided at the meeting but may include: • The message that could be delivered to the community regarding the scientific progress as well eventual policy and management implications of balanced harvesting; • Research questions (including data collection, modelling, empirical assessment. • Consideration of: (ii) a report, (ii) elements for a joint publication.
10:00 - 10:30	**Coffee break**

10:30 – 12:00	***Wrap-up session (Continued)***
12:00 – 14:00	**Lunch**
14:00-17:30	**FEG coordinating meeting**

Social events: A cocktail will be offered by EBCD on Monday evening. Time and place to be specified at the meeting.

PRELIMINARY LIST OF PRESENTATIONS

The intention is to give 20 minutes for the presentation and 10 minutes for clarifications and have a discussion session at the end of the session, across the entire series of presentations presented below in chronological order.

THEORY & MODELS

1. **Balanced harvesting promotes coexistence of interacting species**. By**:** Law, R; Plank, M. and Kolding, J.

How does fishing affect the coexistence of interacting species? We have been studying this problem in a simple model ecosystem containing two interacting species with life histories similar to mackerel and cod. Species coexistence is strongly affected by fishing mortality, and conventional size-at-entry fishing, with fishing set independently for each species, can lead to collapse of cod. Exploitation to achieve a fixed ratio of yield to productivity across species can also lead to collapse of cod. However, harvesting balanced to current productivity of species is a strong force to counter such loss. If balancing across species is applied to a fishery with knife-edge selection, size distributions are truncated, changing the structure of the system, and reducing its resilience to perturbations. If balancing is applied on the basis of productivity at each body size as well as across species, there is less disruption to size structure, resilience is increased and substantially greater biomass yields are possible.

2. **A reappraisal of fisheries selectivity in light of density-dependent regulation.** By: Andersen, K.H.; Jacobsen, N.S. and Beyer, J.E.

Current approaches to MSY-based fisheries management relies on minimum size catch regulation such that only the largest fish in a stock are exploited. The theoretical support for this practice has increasingly been questioned as evidence of density dependent regulation of fish stock has appeared. The standard approach to simulate fish stocks either ignores density-dependent regulation (yield-per-recruit calculations) or parameterizes density dependent effects in a stock-recruitment relationship. It is difficult to test the validity of either assumption empirically and only little work has addressed its theoretical basis. We develop a general model of a fished stock where the type of density dependent regulation is an emergent property and not prescribed a priori. We use the model to demonstrate that the classic results of maximum yield under trawl-type selectivity are indeed valid under several scenarios of density dependent regulation. However, if density dependent regulation occurs late in life then classic theoretical results of selection are invalidated and mesh size regulations aimed at targeting large fish will lead to a severe loss of potential yield. Further, a "balanced" selectivity will not lead to significant higher yield than trawl selectivity under any density dependent scenario. Our theoretic framework synthesizes classic results with recent insights on the importance of density dependent regulation in

lakes and marine systems and makes it possible to make informed decision based on the specific ecology of a stock.

3. **Do unregulated, artisanal fisheries tend towards balanced harvesting**? Plank, M.; Law, R. and Kolding, J.

What happens if fishers, who share the exploitation of an aquatic ecosystem, decide for themselves what fish to catch, in the absence of external regulations? Obviously, there is a risk that the fish stocks collapse. But if this does not happen, how do fishing activities become distributed across the resource? We examine the consequences of a model of social behaviour in which each fisher adjusts his/her gear to catch fish of a different size, if the current catch rate is low compared with that of other fishers. We do this using numerical methods based on dynamic models of size-spectra. The results show that fishing mortality at each body size becomes close to the productivity at that body size, after aggregation of overall fishers. In other words, the unregulated fishery has an inherent tendency to move towards balanced harvesting. We are currently testing this prediction on catch data from freshwater fisheries in Africa.

4. **Effect of fishing intensity and selectivity on community structure and fishery production at trophic and species levels**. By Zhou, S. and Smith, T.

Species are the building blocks of ecosystem services and environmental sustainability. In fisheries management, species are a key measurement unit for conservation and production. Although fisheries management has historically focused on single species approach, in the real world a single species never exists in any ecosystem, large or small. It is necessary to understand how alternative fishing pattern and intensity affect species composition, community structure, and fisheries yield. We use multispecies predation and competition models to explore potential effect of fishing pattern on a community at species and trophic levels. Some of the results will be presented in this talk.

EMPIRICAL EVIDENCE

5. **Changes in productivity and life-history traits in experimentally harvest guppy populations.** By Diaz Pauli, B. and Heino, M.

6. **The Barents Sea ecosystem - balanced harvest?** By: Mauritzen, M.

Abstract not yet available

7. **Exploitation patterns in fisheries, a global meta-analysis from Ecopath models.** By: Kolding, J.; Bundy, A.; Christensen, V.; Steenbeek; Law, R.; Plank, M. et al.

Abstract not yet available

8. **Maximizing fisheries yields while maintaining ecosystem structure.** By: Kolding, J.; Jacobsen, N.S.; Andersen, K.H. and van Zwieten, P.

Under the Ecosystem Approach to Fisheries an optimum fishing pattern is one that gives the highest yield while causing the least structural impact on the community. Unregulated, overall non-selective open access African inland fisheries have been observed to sustain high sustainable catches by harvesting a broad spectrum of species and sizes, often in open conflict with current management regulations in terms of mesh and gear regulations. We use a size based trophic model to theoretically explore the optimal fishing pattern in terms

of the effort on a given size range. The results are validated and compared with long term multispecies data from man-made Lake Kariba under fished and unfished conditions. Both model and observations show that the highest yields with the least structural impact on the ecosystem is obtained by predominantly targeting the smallest components of the community. These results call for a re-evaluation of the size based management regulations that are ubiquitous in most fisheries.

9. **What are the ecosystem consequences of balanced fishing regimes?** By Rochet, M-J.; Collie, J.; Jacobsen, N.S.; and Reid, D.

Balanced harvesting would require adjusting exploitation patterns to balance the pressures of all fisheries in an area with the relative productivities of the species and sizes of fish in the ecosystem. Size-based and other models used to predict the consequences of contrasted fishing regimes have produced nuanced results. Less selective (including balanced) fishing regimes tend to produce higher yields with lower ecosystem impacts in most studies, but the magnitude of the predicted differences varies. The few empirical studies available provide weak evidence that fishing patterns affect community dynamics and biodiversity; the size of the effects is not such that a strong signal can be detected among the noise of the many other factors. Balanced fishing may be difficult to implement, both because it may result in less predictable ecosystem dynamics, and owing to the complexity of translating the concept into practical management measures. It may be precautionary to avoid too selective fisheries, but whether a balanced exploitation should be aimed at remains an open question. "Balanced fishing" may be at odds with the EU landing obligation, since the latter seems to be meant to foster more selective fishing – but its actual consequences are largely unpredictable.

ECONOMIC, POLICY AND MANAGEMENT IMPLICATIONS

10. **Balanced Harvesting in Fisheries: Economic insights and policy implications.** By: Charles, A.; Garcia, S.M. and J. Rice

The widespread adoption of an Ecosystem Approach to Fisheries requires, for its implementation, a substantial broadening of the conventional scope and references used for fisheries management. Adopting and implementing a Balanced Harvesting (BH) strategy calls for broadening of the range of species and sizes caught in the ecosystem, lowering (as needed) and redistributing the exploitation rates in proportion to natural productivity. The paper examines the economic implications of this move from various perspectives: (i) the existence of multiple conflicting objectives; (ii) The economic performance measures; The economic policy options; and (iii) The distributional impacts as well as a number of issues of importance such as the effect of discounting, the valuation of ecosystem services, the role of le market and consumer demands, and the economics of management.

11. **The Ecosystem Approach to Fisheries and balanced harvest: considerations for practical implementation.** By: Bianchi, G.

The need to harvest aquatic ecosystems in ways that ensure maintenance of their structure and functioning has been felt and discussed for the past decades and has been at the heart of fisheries management approaches such Ecosystem Based Fisheries Management (EBFM) or the Ecosystem Approach to Fisheries (EAF). Practical implementation is however constrained but the availability of adequate data and information, by the difficulty in

identifying appropriate management strategies and/or set of regulations that will actually lead to the desirable fishing mortality across the food web. The presentation will consider these challenges and outline possible pragmatic approaches to move towards a more sustainable fisheries management practices at ecosystem level.

12. **Dynamic management as a means to implement the multiple objectives of a balanced harvest in developed fisheries.** Dunn, D.C.; Hobday, A.; Boustany, A.M. and Halpin, P.N.

Multispecies fisheries may offer a good analogy for how most developed countries will likely attempt to implement BH (if they choose to do so). Dynamic management measures (e.g., move-on rules or oceanographic closures) should increase selectivity, and thus afford fishermen the opportunity to target stocks for which they have more quota and avoid "choke" stocks (for which they have little quota (Very preliminary abstract)

13. **An introduction to the MSC Fisheries Standard: current requirements and future development toward a multispecies and ecosystem approach**. M. Atcheson, and D. Agnew.

The Marine Stewardship Council (MSC) is an independent non-profit organization which sets the most widely recognized global standard for sustainable fishing. The standard consists of three overarching principles that every fishery must meet to be certified sustainable. Principle one considers the status of the target stock, Principle two considers the fisheries impact on the surrounding environment and Principle 3 considers the effectiveness of management. Currently, the MSC Fisheries Standard is written for single-species fisheries with the stock status requirements based around the concept of MSY and recruitment impairment. However, several fisheries target many species simultaneously, and it is unlikely that all species will be fluctuating around Bmsy or surrogate targets at all times. Consequently, MSC has undertaken a review to identify aspects of the Standard that are challenging for mixed and multi-species fisheries, and identify options for a modified multispecies Standard.

14. **Implementing Balanced Harvesting – Practical Challenges and Other Implications:** By Graham, N. and Reid, D.

Balanced harvesting (BH), where species are exploited relative to productivity rates, is proposed as an ecologically better method of fishing compared to the current approach of targeting specific species and age groups. BH is proposed to provide higher maximum yields and maintain ecosystem structure. While firm conclusions on whether such an approach offers substantial benefits are yet to be delivered, the concept offers an alternative ecosystem based management strategy. However, there has been little discussion on how BH might be achieved in practice or the potential economic and management impacts of fishing activities. There is some confusion around the use of the term non-selective fishing when considering BH and has been taken to mean that regulation of the technical characteristics of the gear is no longer required. We argue that BH is not about unregulated, non-selective fishing; in fact the opposite is likely. If the ecosystem and individuals within are to be exploited at rates that are proportional to productivity levels then much greater control of selectivity and fishing effort will be needed and that the economic consequences of catching species with little or no monetary worth will present a major challenge for managers and the commercial fishing industry.

15. **Challenges to the implementation of balanced harvesting systems: some ecological and technological issues**. By: Hall, M.

Even though it could be demonstrated that Balanced Harvest systems are "better" ways to harvest an ecosystem, if a goal is to maintain its main characteristics of structure, functions, etc., the implementation will run into challenges from several angles. Much has been made of the economic disruptions it would cause, but little has been discussed of the ecological obstacles to its implementation in oceanic ecosystems.

Highly migratory species frequently inhabit a variety of ecosystems through their lives. Anadromous species have even more diversity of the habitats they occupy. As the harvests will have to take place throughout their lives to reduce size selectivity, the catches taken have to be distributed spatially and temporally. Some species are caught in practically pure aggregations, others are taken in very diversified groups. Sedentary and sessile species present other challenges because of the need to also incorporate spatial components in the utilization scheme (e.g. it is not only important the utilization rate of a species, but the way the harvest is distributed in space).

The technology available for the harvests must allow the levels of selectivity required for a demanding system, including species that are susceptible to exploitation because of solitary habits, or other behavioral differences.

16. **Balanced harvesting and the tropical tuna fishery.** Dagorn, L.; Ménard, F.; Chassot, E. and Filmalter J.

The talk examines how far tuna fisheries are from being managed following the balanced harvesting approach. Tropical tunas are exploited by several fishing gears (purse seine, longline, pole and line) and those gears catch target (tropical tunas) and non target species. Each fishing gear can be simplified by its size selectivity (across a range of species) and it appears that some fisheries mainly catch small fish (average 50 cm) while others mainly catch large ones (average 130 cm). We discuss the current management schemes in Tuna RFMOs and future possible directions for research and management. If tuna fisheries are still far from being managed in a balanced way, the wide range of gears used and their size selectivity represent a good opportunity to manage exploitation of specific sizes according to gear type. Management should aim at harmonizing the relative efforts from each fishing gear.

17. **Preliminary reflection on a possible BH norm and harvest control rule.** By: Garcia, S.M., Rice, J. and Charles, A.

The nature of the CBD requirement for maintaining ecosystem structure and function is briefly discussed together with the practical implications of its possible reflection as a formal norm in fisheries biodiversity management, e.g. in terms of representation, parameterization, precision, etc.

18. **A framework of indicators for balanced harvesting in small scale fisheries** – van Zwieten, P. and Kolding, J.

Recently, the idea of balanced harvest, harvesting all components in the ecosystem in proportion to their productivity, has been promoted as a unifying solution in accordance the ecosystem approach to fisheries, but this will require a fundamental change to management. Based on the theoretical background, and practicalities of securing high yielding fisheries

in inland waters, we propose framework of ecological indicators to assess the extended objectives of minimal impact on community and ecosystem structure, with empirical examples from freshwater fisheries.

19. **Fisheries management for BH: case of Japan**. By: Makino, M.

The presentation will describe the harvest pattern within the Japanese EEZ. It will, then, look more closely at the fisheries operations in the coastal area of the Shiretokoko World Natural Heritage. Possible management measures for BH will be discussed in this context.

20. **Discard bans and balance harvest: a contradiction in (more than) terms?** By Borges, L.

The talk tries to analyze the impact of the prohibition to discard in European waters in relation to the balance harvest concept. The practice of discarding part of the catch at sea is presently legal in European waters (except when high grading the catch), and in some circumstances compulsory. However, this will change from 2015 with the planned introduction of the landings obligation foreseen in the revised EU Common Fisheries Policy. If the ban is fully implemented, it is likely that fishing operations will change to maximize the space on board and quota available for high price species and sizes. I would argue that this is undoubtable the biggest change to more selective fishing than the implementation of all the technical measures adopted in the CFP in almost 30 years. In fact, the primary objective of the CFP landing obligation is to reduce unwanted catch instead of utilizing unused catch as argued in the balance harvest concept, since many stocks are still in need of recovery, while the use of otherwise discarded catch requires changes in the market that will take time to take place. Nevertheless, the implementation of a landings obligation requires either high levels of monitoring and control at sea, and/or economic incentives to fish more selective, neither which are likely to be available in Europe. Therefore, since the ban will only be partially, or most likely not implemented, the potential for more unbalance harvest is reduced.

21. **Management implications of Balanced Harvesting: The CFP as a sounding board**. By Garcia, S.M.

Expanding from the report of the first scientific meeting, The Science paper, earlier presentations and few publications on the subject, this presentation will highlight some actual and potential misconceptions on BH and examine operational management implications of Balanced Harvesting for the fish value chain, scientists and policy makers.

USEFUL REFERENCES

(to be completed at the meeting)

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