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The Management of Tuna Baitfisheries:
The Results of a Global Study

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Cover photographs:

- Baitfishing in the Azores, by Franklin Wanderley Tavares, Programa de Observação para as Pescas dos Açores (POPA)
- The Hawaiian anchovy or nehu (*Encrasicholina purpurea*), by David Itano

Executive Summary

The study

A global study was undertaken of baitfisheries that support pole-and-line tuna fisheries. Visits were made to most countries in the world where pole-and-line tuna fishing is significant - in an attempt to understand the associated bait fisheries and their management. This report endeavors to estimate current world pole-and-line tuna production, summarize the national baitfish management situations, and identify the main emerging issues across the countries with respect to baitfisheries, their management, and baitfishery management plans. In addition, suggestions are made on improving the management of these fisheries.

World pole-and-line tuna production in recent years

It is estimated that pole-and-line fishing has produced about 400,000 tonnes of tuna annually in recent years, wiith about three-quarters of this production from Indonesia, Japan, and the Maldives – with the caveat that the estimate for Indonesia is largely guesswork. Most of the significant pole-and-line fisheries have experienced major declines from previously higher levels of production, which has had impacts for baitfisheries and their management.

Baitfishery profiles

Appendix 1 contains baitfishery profiles for each of the areas visited in the study: Brazil, Ghana, Indonesia, Japan, Maldives, Azores, Senegal, Solomon Islands, the Basque Country, the Canary Islands, and the west coast of the USA.

Some major features of the baitfisheries

- The baitfisheries of the Maldives, Indonesia, and the Solomon Islands involve a large number of species (i.e. complex tropical multi-species fisheries), whereas the other fisheries make use of just a small number of species.
- In Indonesia and Japan baitfish are characteristically purchased from separate baitfish capture operations. In Senegal most of the baitfish comes from separate operations and in Ghana some does.
- Only in the Solomon Islands and the Maldives is baitfishing a discrete, stand-alone fishery. In the other areas baitfishing is a component (mostly very small) of the total amount of fishing effort on the species used as bait. In a sense, the baitfisheries are “nested” inside a larger overall fishery.
- The most dominant baitfishery trend is a decline in production that mirrors the production decline of the associated pole-and-line tuna fishery.
- There is great diversity among the various baitfisheries in the relationship between baitfishing and local communities

Management measures that are specific to baitfisheries

Presently there are only a small number of management measures that are specific to baitfisheries. The two stand-alone baitfisheries (Solomons, Maldives) are only lightly regulated, while in the cases where baitfisheries are nested in larger, overall fisheries, the management unit is the overall fishery, and most management measures are not specific to the baitfishing component.

Limits on amounts of baitfish captured

Limits on amounts of baitfish captured are not characteristic of the world’s baitfisheries. This appears to be due to perceptions of resource abundance/resilience (Solomons), inability to place catch restrictions on fishers (Maldives, Indonesia), declines in baitfishing production resulting in a sense of less urgent need for management (most locations), and the fact that a catch restriction for a nested and relatively small baitfishery characteristically has little impact on the overall fishery (most locations).

Fishery management plans for baitfisheries

- Currently there are no functional fishery management plans for any significant baitfishery in the world.
- Management plans are presently being prepared for two baitfisheries: the Maldives and the Solomon Islands.
- Fishery management plans are in place for the overall fisheries that encompass the baitfisheries of the USA west coast, and (to a degree) the Basque Country.
- Fishery management plans are not in place for the overall fisheries that encompass the baitfisheries of Indonesia, Japan, Brazil, Azores, Canary Islands, Senegal and Ghana.

What is a fishery management plan?

In the areas covered by the study there is no consistent concept of what a fishery management plan actually is: many different types of documents are called a fishery management plan.

Monitoring of baitfisheries

The monitoring of catches (i.e. collection of catch and effort information) is an essential activity in support of fisheries management. Given the simplicity of collecting, analyzing, and using that information (and the utility of the analyzed information), it is somewhat surprising that few baitfisheries are adequately and routinely monitored. The usual case is that catch and effort data are not collected, collected only during specialized research projects, collected only during the height of the fishery, or collected and not analyzed.

Baitfish resiliency

The nature of many baitfish species points to relatively high productivity and some degree of resilience to fishing: low trophic level, highly fecund, with rapid growth, and relatively short lifespans. On the other hand, this favourable productivity is often tempered to some degree by recruitment variability due to environmental influences.

Some major challenges in improving the management of baitfisheries

- Improving the outcomes of the management of baitfisheries in some countries would require a major overhaul of the entire coastal fisheries management regime – a monumental undertaking.
- Improvements in other baitfisheries require some ability to restrict a large amount of "semi-unmanageable" artisanal fishing effort.
- A significant challenge for improving most of the world's baitfisheries concerns "nested" baitfisheries. The logical way to improve management would be to deal with the overall fishery rather than tinkering with the small baitfish component, but it is uncertain what should be the appropriate role of the baitfishery and its stakeholders in improving the management of the overall fishery.

Improvements are mainly site-specific, except for monitoring

There are few improvements to baitfish management systems that would be universally applicable. In the recent past there has been a notion that fishery management plans are essential for good baitfishery management everywhere, but this is probably not the case. It has become apparent during the present study that perhaps the only improvement that is broadly applicable to the management of most baitfisheries concerns monitoring. It seems that the relatively simple process of collecting and analyzing baitfishing catch and effort data would help improve the management of most of the world's baitfisheries by providing key information for decision making. Baitfishing catch and effort data are obviously important to the dedicated baitfisheries (e.g. Solomons, Maldives), but are also of value in the "nested baitfishery" component of a large overall fishery

Fishery management plan role in improvements

- Appendix 2 is an analysis of the role of management plans in improving baitfisheries. It is concluded that management plans can be a convenient way to organize fisheries management, improve efficiency, assure that interventions are tied to objectives, guide less sophisticated managers, and promote transparency. They become even more useful in complex situations and where stakeholders are unfamiliar with fisheries management processes. In short, they are quite appropriate for the conditions commonly found where there are baitfisheries in developing countries. This desirability, however, seems to fall somewhat short of such plans being absolutely essential.
- Therefore, a blanket statement on the necessity of a fishery management plan for all baitfisheries could be too prescriptive. In addition, a template baitfishery management plan or "best practices" or "common standards" for management plans for the dedicated baitfisheries, may not be very applicable to the overall fisheries that contain nested baitfisheries.

Common elements of effective management

- If fishery management plans are not essential for effective management (i.e. where objectives are being achieved) can some essential elements be identified that are common to all effective management arrangements? Such a list (at least for baitfisheries) would probably include (a) some type of monitoring of the fishery, (b) some formal statement of the rules (e.g. plan, legal instrument, policy document), and (c) a mechanism for applying those rules.

Conclusions on stock assessment

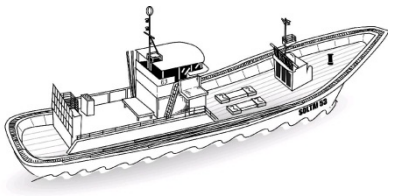
- Rather than promoting regular comprehensive baitfish assessments, another approach worth considering would be to collect and analyse catch and effort data for major trends, while opportunistically making use of more sophisticated analysis when it becomes available. Trends in catch and catch per unit of effort (CPUE) have the advantage that they are simple, easy for developing country managers to use, and are readily understood by fishers and the general public

Suggestions for research

- Because there appears to be considerable interest in researching topics that have already been well-studied, there is a need for compilation of previous baitfish research findings, including overall lessons learned.
- Another important category of research that is applicable to many baitfishing countries concerns making progress with the three "major challenges" cited above.

Specific activities for improving the management of baitfisheries

- Ideas improving baitfishery management that emerge from this report are (a) promoting the monitoring of all baitfisheries, and (b) promoting the concept of a "fisheries management framework" in countries with favorable conditions (i.e. where there is political will and stakeholders willing/able to engage). Such a framework would feature collecting/reporting/using of catch and effort data on the baitfishery and some formal statement of the rules and how they are to be applied.



1.0 Introduction

1.1 Background

Pole-and-line tuna fishing is generally recognized as having many positive characteristics, especially some of its social and environmental attributes. An important aspect of pole-and-line fishing is that it requires live baitfish – and catching baitfish is associated with both opportunities and constraints. There is a widely-held view that there are significant prospects to improve the pole-and-line fisheries (i.e. mitigate negative impacts, enhance benefits) through modifications to the baitfishing and its management.

A global study was undertaken of bait fisheries that currently support pole-and-line tuna fisheries. The instructions from ISSF to the consultant for the study allowed for considerable flexibility: determine the main features of the management of baitfisheries, especially the use of management plans. In the study most of the countries in the world were visited where pole-and-line tuna fishing is significant - in an attempt to understand the associated bait fisheries and their management.

This report endeavors to estimate current world pole-and-line tuna production, summarize the national baitfish management situations, and identify the main emerging issues across the countries with respect to baitfisheries, baitfishery management, and baitfishery management plans. In addition, comments are made on improving the management of these fisheries.

1.2 The Study

The initiative and the funding for this study came from the International Seafood Sustainability Foundation (ISSF). It is important to note that the countries visited, specific subjects examined, and methodology used were largely left to the consultant.

Fieldwork for the study began in early March 2012 and was concluded in mid-May. Eleven areas in Africa, Asia, Europe, North America, Oceania and South America were visited. A large number of individuals were contacted during travel preparations and visits. About 85 of those people were especially helpful and are listed as “main informants” in each of the 11 area summaries of Appendix 1. The work was greatly facilitated by the assistance and information provided by those individuals. In each area the one or two people who seemed most interested in the work were given an opportunity to comment on the baitfishing summary prepared after each area visit.

The study benefited significantly from extensive discussions with Dr Antony Lewis, an individual with a great amount of experience with baitfisheries. Les Clark and Dr James Ianelli also provided insight and comments on fishery management plans and stock assessment, respectively.

As a follow-up to the study, a meeting of baitfish specialists was held in August 2012 in the margins of a regional fisheries meeting in Busan, Korea. The expertise of the participants in baitfish issues covered the western Pacific, eastern Pacific, eastern Atlantic, and the Indian Ocean. The purpose of the informal meeting was to (a) comment on aspects of the present report, (b) explore appropriate approaches to some difficult issues in baitfish management, and (c) offer suggestions to ISSF on their future involvement in baitfishery issues. The results of that meeting are given in Appendix 3 of this report, which has been modified to reflect several of the views of the meeting.

Some caveats should be mentioned. Unless otherwise stated, the observations, comments and conclusions in this report refer to the fisheries in the 11 areas visited. However, because those areas represent about 95% of the pole-and-line production in the world[2], it is assumed that most of the report's findings on baitfisheries are globally applicable. Due to the nature of this world-wide study (i.e. very short area visits), the area-specific information presented in this report should be not considered comprehensive but as a brief inventory of the main baitfishing features.

Some clarification of terminology used in this report is required:

- In this report the terms "bait", "baitfish", and "baitfishery" concern live baitfish used in pole-and-line tuna fishing.
- "Pole-and-line fishing" is taken to be the same as "baitboat fishing", and refers to tuna fishing. Pole-and-line is sometimes abbreviated to P/L in tables.
- The term "tuna" is used for "principal market species of tuna": skipjack tuna, yellowfin tuna, bigeye tuna, albacore, Atlantic bluefin tuna, Pacific bluefin tuna, and southern bluefin tuna.
- A "nested" baitfishery occurs when a baitfishery is a small component of much larger overall fishery targeting the same fish resource, often on an industrial scale.
- It should be noted that in the countries visited there is no common understanding of the term "fishery management plan" or even "fisheries management". It therefore may be useful to establish that for the purpose of this report, "management" is defined to be "interventions in support of established objectives". The subject of what comprises a "fishery management plan" is complex and covered in Appendix 2 of this report.
- The Azores, Canary Islands, and the Basque Country are regions within Portugal and Spain, but for convenience they are sometimes lumped together with the other baitfishing areas and referred to as "countries".

1.3 Structure of this Report

Information gathered during the extensive fieldwork and desk research is summarized in the large Appendix 1 for the eleven primary baitfisheries studied, and organized in a standard format. This detailed body of information forms the basis of this report.

Following the introduction to the study (Section 1), an estimate of global pole-and-line tuna production is developed (Section 2). Section 3 summarizes the features of each baitfishery (drawn from the detailed descriptions in Appendix 1), then the section reviews the current situation with respect to management of baitfisheries. Suggestions for improving baitfish management are proposed in Section 4. Concluding remarks are given in Section 5. Finally, Appendix 2 provides an analysis of the role of management plans in improving baitfisheries. Country-specific references are given in the sub-sections of Appendix 1 and all references are given Section 6.

2.0 An Estimation of World Pole-and-Line Tuna Production

Although the focus of this report is the baitfishing that supports pole-and-line fishing, an attempt is made here to estimate world pole-and-line tuna production. This is because such an estimate was initially required for determining areas to be visited during the study. Those visits provided a rare opportunity to scrutinize past pole-and-line production estimates around the world in a similar way and come up with some improvements. Lastly, trends in baitfish requirements are closely related to changes in the size of the associated tuna fishery. Knowledge of whether a pole-and-line fishery is stable or increasing/declining has a major bearing on the need for, and priority given to, the management of the associated baitfishery.

Table 1 is a compilation of information from various sources on recent annual tuna production from pole-and-line fisheries in all countries where it is known to be significant.

[2] The most significant pole-and-line fishery that was not visited during the study was that of India's Lakshadweep Islands (10,000 tonnes/yr). Information on pole-and-line and bait fishing in those islands was obtained from IOTC (J.Million, per.com.), Pillai et al. (2001), and Jones (1958). To the extent possible, that information has been incorporated into this report.

Table 1: Estimates of Recent Annual Pole-and-Line Tuna Catches

(shaded areas represent areas/countries not visited in present study)

Area or Country	Recent Catches (tonnes/yr)	Other Information	Source
Indonesia	115,000	Recent catch estimates vary from 60,000 to 240,000 tonnes. All estimates are largely guesswork.	This study
Japan	110,000	There are now 26 vessels >120 GRT, 62 vessels 20-120 GRT, and around 30 active smaller vessels.	This study
Maldives	85,000	Annual catches have averaged 80,000 - 90,000 tonnes in recent years, with an all-time high of 120,000 tonnes in 2006. Many vessels have converted to handlining.	This study
Brazil	25,000	Estimate based on discussions with fishing industry and fishery specialists; ICCAT figure is somewhat lower.	This study
Senegal	12,000	The fleet size peaked in the late 1950s with 88 baitboats (now 14); Vessel productivity increased in 1980s when a new technique was developed in which a team of two baitboats stays with a tuna school for several months.	This study
India Lakshadweep	10,000	Little of this enters international trade. Baitfishing is similar to that of Maldives but smaller in scale.	M.Herrera, IOTC
Spain Basque Country	8,000	This includes about 48 baitboats that are based in the Basque Country, plus about 17 in the Cantabria region to the west of the Basque Country. Target is albacore.	This study
USA West Coast	7,000	Annual catches have been about 10,000 to 12,000 tonnes in recent years; About 2/3 of the catch (that taken close to the coast) is made by fishing with livebait. Target is albacore.	This study
Ghana	6,000	In recent years, tuna landings by baitboats have been about 30,000 tonnes per year – but 80% of those landings have actually been caught by purse seine gear. This equates to an annual catch by "pure baitboat fishing" of 6,000 tonnes/yr.	This study
Portugal Azores	5,000	Observer programme data over the period 1998 to 2010 show the catch varied from 1,480 to 13,989 tonnes. Now about 20 large tuna baitboats (31 in the late 1990s) plus about 30 smaller vessels.	This study
Spain Canary Islands	5,000	Tuna catches reached a maximum of 15,667 tonnes in 1994, and then fell rapidly in the late 1990s to 4,000 to 6,000 tonnes. The number of operating vessels that are larger than 50 GRT dropped from 68 in 1981 to 17 in 2010.	This study
South Africa	3,924	Figure given is the average annual tuna catch for the South Africa-flagged fleet in the 3-year period 2008-2010; 75% albacore. Any catches made in the Indian Ocean are attributed to the Atlantic.	ICCAT stats, M.Herrera, IOTC
Namibia	2,757	Figure given is the average annual tuna catch for the Namibia-flagged baitboat fleet in the 3-year period 2008-2010; 97% albacore; a large part of the catch is taken with dead baitfish.	ICCAT stats L.Clark, per.com.
Portugal Madeira	1,458	Figure given is the average annual tuna catch in the Madeira area in the 3-year period 2008-2010; 66% bigeye	ICCAT stats
Venezuela	993	Figure given is the average annual tuna catch in the 3-year period 2008-2010; 74% yellowfin	ICCAT stats
Solomon Islands	869	This is the 2011 production; Production in 2010 was very low because it represented the re-starting of a fishery that ceased in 2009.	This study
Mexico Baja California	400	In 2010 catch was about 500 tonnes of yellowfin, skipjack, and a small amount of bonito. In 2011 about 300 tonnes.	E.Everett, IATTC
USA Hawaii	200	The one remaining vessel (from a fleet that numbered 35 boats in the late 1940s and six boats in 1991) averages about 2 tonnes per day, but fishing is sporadic.	Gillett (2011)
Palau	100	The 2010 catch was 108 tonnes per year for the single vessel operating, according to the vessel operator. SPC estimates that catches were 100 tonnes per year in the period 1992-2000.	Gillett (2011) and SPC stats
France Basque Country	80	3 or 4 vessels catching a small quota of bluefin.	B.Caillart, per.com.
Cape Verde	74	Figure given is the average annual tuna catch in the 3-year period 2008-2010; 99% skipjack	ICCAT stats
Ecuador	20	Two or three vessels have been sporadically pole-and-line fishing but bait problems have resulted in the boats operating as longliners most of the time for the past 8 to 10 years.	E.Everett & K.Schaeffer, IATTC
Total	**398,875**		

Figure 1: Estimates of Recent Annual Pole-and-Line Tuna Catches (tonnes/yr)

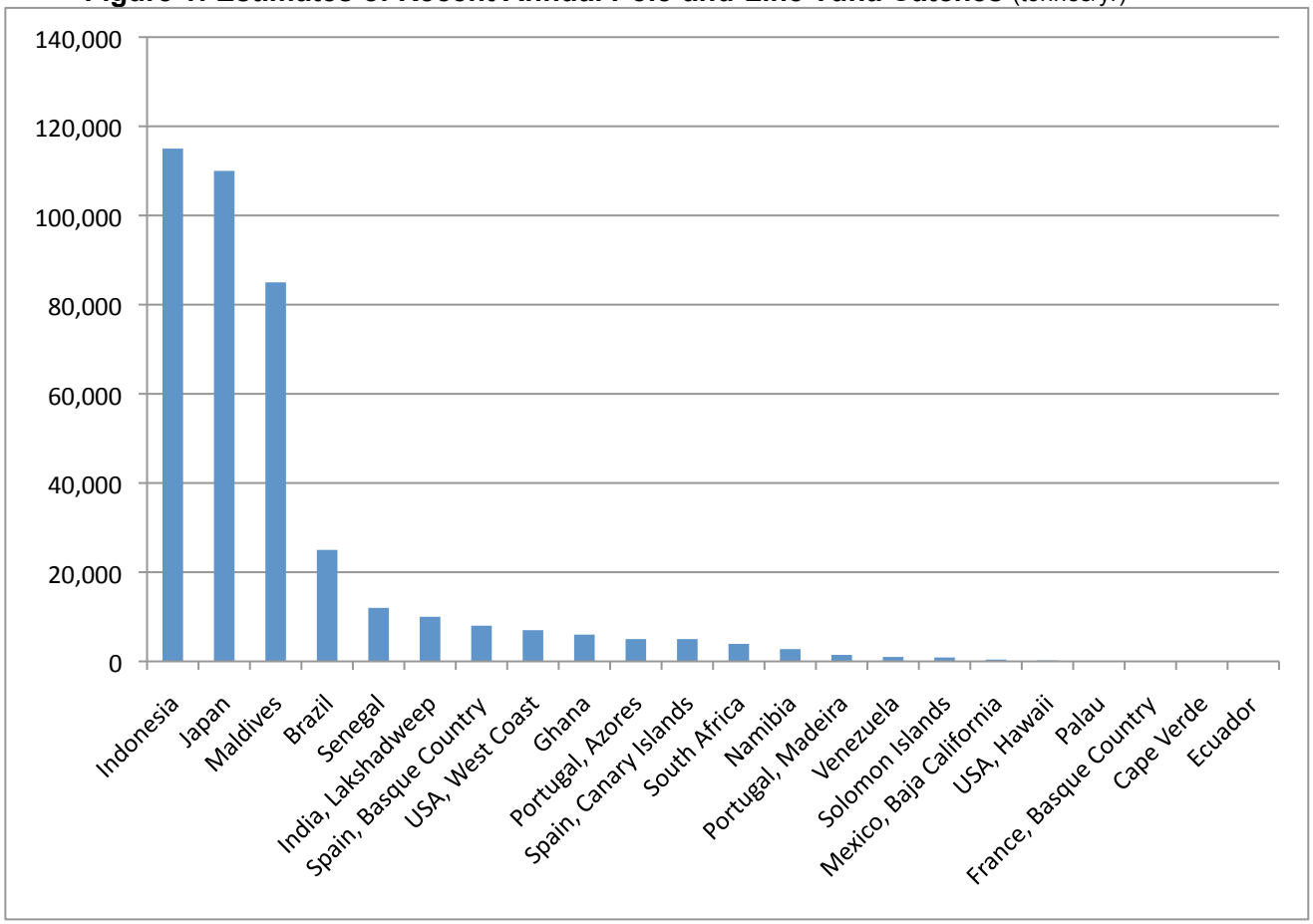
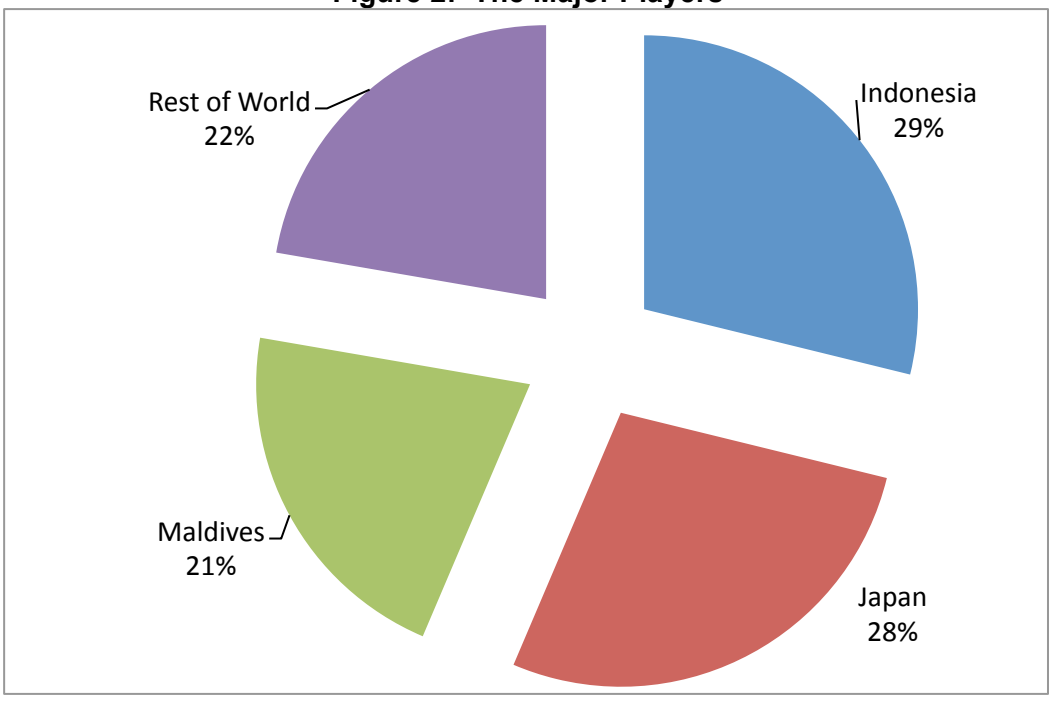


Figure 2: The Major Players



Some comments should be made on the above estimate of about 400,000 tonnes of tuna per year in recent years:

- The estimate for Indonesia is largely guesswork. Taking the range of pole-and-line tuna annual production estimates in that country (60,000 to 240,000 tonnes in recent reports)[3], the world estimate of 400,000 tonnes annually made in the present study be as little as 344,000 tonnes/yr to as much as 524,00 tonnes/yr.
- Other estimates of global pole-and-line production have been made. Joseph (2005) states that from the 1970s to the mid-2000s the world's pole-and-line catches fluctuated, mainly between 300,000 and 400,000 tonnes. By contrast, Miyake et al. (2010) indicates that pole-and-line catches were mainly between 400,000 and 500,000 during the same period.

Most of the world's pole-and-line fisheries have experienced a decline.[4] Large pole-and-line fisheries have virtually disappeared in the eastern Pacific and the Pacific Islands (and were not included in the present study). In those countries that were visited in the study, most have declined since heights reached a few decades ago. Examples include the pole-and-line fishing in Japan (peaked in the late 1970s), Basque Country of Spain (early 1970s), Canary Islands (1994), Senegal (early 1960s), and the Solomon Islands (1986). The Maldives peaked much later (2006), while it is not possible to state with any certainty the changes in Indonesia production. The trends in pole-and-line fishing in some other areas are not as clear due to a mixture of fishing techniques used (e.g. US West Coast[5], Ghana).

Declining pole-and-line production has impacts for baitfisheries and their management. The most obvious is declining demand for baitfish, which can relieve pressure on the resource. Some of the important issues addressed in the management of baitfisheries (e.g. over-exploitation, gear conflict, negative interaction with tourism) tend to fade in importance with the decline in baitfish production. Similarly, government management priorities are likely to shift away from declining fisheries. There is some possibility that pole-and-line fishing will expand remarkably due to factors that have not been important historically (e.g. consumer demand, climate change, management measures that favour pole-and-line fishing)[6]. Some people/agencies see greatly expanded pole-and-line fisheries due to recent NGO and consumer pressure, while others anticipate a continued declining trajectory due to lack of change to the fundamental underlying economics of pole-and-line fishing. In any case, major changes to the level of pole-and-line fishing would have a significant impact on the need for management of the baitfisheries.

It has become clear in the present study that there is a need to improve the estimate of pole-and-line production in Indonesia. To project past global pole-and-line trends into the future, to ascertain the potential amount of pole-and-line tuna that could be channeled into international commerce, to calculate global baitfish production, and to be able to get an idea of the demand for baitfish management in the world, it is important to have a better estimate of pole-and-line tuna catch in Indonesia.

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[3] Lower estimate: Williams and Terawasi (2009); Upper estimate Ingles et al. (2008).

[4] A recent FAO paper that covers pole-and-line fishing (Miyake et al. 2010) does not show this declining feature. This may be partly due to that paper (especialy Figure 15) not including the major pole-and-line fisheries that have ceased to exist. It also should be noted that the estimate of Japanese pole-and-line production in the FAO paper is substantially greater than that given in the present report (Appendix 1).

[5] Stocker (2005) shows that USA north Pacific pole-and-line albacore catches peaked in the late 1960s but other authors (e.g. Childers and Betcher, 2010) indicate that albacore troll catches contain an unknown proportion of pole and line catch.

[6] The subject of factors affecting the demise of pole-and-line fishing and efforts to promote such fishing is covered in Gillett (2011)

3.0 Baitfisheries and their Management: the Current Situation

3.1 National Baitfishery Features

The study collected information on specific topics related to the management of bait fisheries in each of the eleven countries visited. The topics covered were:

- General features of the live-bait pole-and-line tuna fishery
- The various baitfishing operations
- The major baitfish species
- The recent trends in the baitfishery
- The results of any baitfish stock assessment work
- The responsibility for the management of the major baitfisheries
- The major concerns that management should address
- Current management of the baitfishery
- Information on any bait fishery management plan
- The main institutional/procedural difficulties in the management of the baitfishery
- Potential for outside agency to assist in improving the management of the baitfishery

Appendix 1 contains the details of the above topics for each of the eleven countries visited. A short summary is given here in chronological order of visit.

Indonesia: There are six main areas in Indonesia where there are significant concentrations of pole-and-line vessels. The level of pole-and-line fishing has declined in most areas in recent years. Pole-and-line vessels characteristically purchase their baitfish from liftnet operations, rather than catch it themselves. There is little fisheries management specifically focused on the baitfisheries, but as with most fisheries in Indonesia some management interventions are undertaken to derive government revenue. There is no heritage of fisheries management by plan in Indonesia and fisheries management in general (especially inshore fisheries) is quite weak. The legal authority to manage baitfishing is given to the districts (two levels of government below the national government) and about 60 districts have involvement in baitfishing. Although there has been little monitoring of baitfish catches in recent years, catches are likely to have declined with the decrease in the pole-and-line fleets – and consequently concern for over-exploitation by baitfishing has probably subsided in many areas. However, the use of the same gear to catch the same species for food occurs throughout the country and has probably increased. It is difficult to separate the management of baitfishing from the management of fisheries using the same gear for food. Indonesia is moving slowly in the direction of having fishery management plans – but baitfishing is not the easiest fishery for plans, nor does baitfishing have very high government priority for management. It is conceivable that baitfish management plans could be introduced and could be effective at improving management, but there are many challenges.

Japan: The pole-and-line fleet in 2012 is about 5% of its size four decades ago, and consequently the demand for bait has declined remarkably. Pole-and-line vessels do not participate in the capture of baitfish, but rather baitfish is purchased from specialized baitfishing operations. Currently about half of the live-bait for pole-and-line fishing is from small-scale purse seines (mostly two-boat operations) and about half from set nets. There are 32 baitfishing areas in Japan which are located in 17 prefectures – all on the Pacific side of the country. Baitfisheries are not the fishing unit that is managed in Japan but rather it is the small-scale purse seine fishery and the set net fishery. The role of the national government in the management of these two fisheries is largely limited to establishing an overall framework for the management, vessel licensing, and setting a TAC for species where there is resource concern. Other aspects of management are the responsibility of prefectural governments or of fisheries associations. The most important fisheries

management issue related to baitfishing is the potential conflict between the users of different gear types. The specific measures for the management of the small-scale purse seine and set net fisheries vary between the 17 prefectures. One of the most prevalent features is the partitioning of areas into those reserved for purse seining and those for set netting. Other common management measures for these two fisheries are restrictions on target species, mesh sizes, fishing seasons, vessel sizes, and vessel numbers. Fishery management plans are not used in the management of the small-scale purse seine and set net fisheries, but rather plans are species oriented and formulated for those species where there is some resource concern – which is currently not the case for anchovy. Despite the absence of a management plan for anchovy, stakeholders feel that the fisheries management system is very effective. There is a long heritage in Japan of the current form of fisheries management and stakeholders feel there is little reason to move towards a system in which fishery management plans play a large role.

Maldives: The national economy is crucially dependent on pole-and-line fishing and by extension, baitfishing. Pole-and-line fishing effort has fallen considerably since the height of the fishery in the mid-2000s, and this has resulted in a substantial drop in the demand for baitfish. Almost all bait is currently obtained at night by stick-held dip net. Baitfishing is carried out by the pole-and-line vessels, rather than by separate baitfishing operations. Although there were concerns about the condition of baitfish resources in some atolls during 2003 to 2006, pole-and-line fishing effort has fallen about 25% since that time. Current levels of bait removal appear to be sustainable. Present management of the baitfishery is limited to just a few rules. There is a recognized need for future management to address a number of issues, including the biological sustainability of baitfish resources and the characteristic attitude of Maldivian fishers that fishery resources (including baitfish) are inexhaustible. The formulation of a baitfish management plan is underway, but such a large step in the fisheries sector (where traditions run deep) does not happen quickly. There is the strong feeling among stakeholders that in the plan much emphasis needs to be placed on educating fishers, rather than relying on (non-existent) enforcement mechanisms. The Maldives appears to be well on track for producing a baitfishery management plan that is appropriate for the country.

West Coast, USA: The US west coast albacore fishery (part of which is by pole-and-line) peaked in the late 1960s but has been steady in recent years in terms of production, and increasing in terms of number of participating vessels. The main bait species is the northern anchovy. The overall fishery for anchovy (of which fishing for albacore bait is a minor component) has declined remarkably since the 1960s due to factors mainly unrelated to fishing pressure. Baitfishing for albacore fishing is not managed as a discrete fishery, but rather the management unit is all fishing activity for the northern anchovy. The management responsibility for the northern anchovy is shared between the US federal government and the states of Washington, Oregon, and California. The Coastal Pelagic Species Fisheries Management Plan (the federal-level plan covering the northern anchovy and five other species) has two important features: (1) it distinguishes between "actively managed" and "monitored species", with anchovies being in the latter category. Should landings increase beyond a specified level, federal authorities may recommend elevating the northern anchovy to the active management category for assessment and regulatory considerations; and (2) it establishes a framework for management, rather than specifying all the details of management measures. In addition to the federal management scheme, the three states restrict anchovy fishing in a variety of ways, often oriented to mitigating commercial-sport interactions and the effect on the ecosystem of the removal of a forage species.

Brazil: The number of tuna baitboats peaked at 102 in 1982. The vessels are now based in three locations in southern Brazil: Itajai (about 20 vessels), Rio de Janeiro (14), and Rio Grande (7). The fishery for sardines (the major baitfish species) for live bait tuna fishing is

responsible for only a small component (probably less than 5%) of the total catch of Brazilian sardines. The fishery for sardines collapsed a few decades ago – due to both excess fishing pressure and adverse environmental conditions. Presently, the main management measures applicable to the live bait sardine fishery are: a closed season, numerous closed areas, a requirement that tuna vessels catch their own bait, and restrictions on fishing close to the beach. Although there is a recognized need to reduce overall sardine fishing effort, especially during periods of low sardine abundance, the degree to which the small baitfishery should be restricted, versus the purse seine fishery, (i.e. "who bears the pain? "), is a source of controversy. There is no fishery management plan for the baitfishery, or the larger sardine fishery. Management plans are not a general feature of fishery management in Brazil.

Basque Country, Spain: The tuna baitboat fishery in Spain reached its height in the late 1960s and early 1970s. In the last decade the number of tuna baitboats based in the Basque Country has declined from about 60 vessels to 48 now. Tuna boats catch their own bait using purse seine gear. There are four main bait species: Atlantic mackerel, horse mackerel, sardine, and anchovy. For all four species, the annual capture by baitfishing is a small fraction of the total catch, with most being taken by large industrial fisheries. The "fisheries" being managed are not the baitfisheries, but rather the four larger fisheries based on the four baitfish species. Those fisheries are managed by the EU following the scientific advice given by the International Council for the Exploration of the Sea. There are no formally adopted management plans for the four fisheries involving the four baitfish species, but the proposed management plans for anchovy and for horse mackerel are being followed. Those plans are both oriented to laying out the procedures for establishing TACs. The formal adoption of a fishery management plan appears to be a fairly lengthy process requiring consideration and approval from three major EU institutions.

Azores, Portugal: Tuna catches have experienced a decline in the last 15 years, but two recent years (2007, 2010) have been especially good. Baitfish is captured by tuna vessels using small purse seines or lift nets depending on the seasons/species. The official fisheries statistics do not cover the baitfishery, but observer program data show that in the past decade an annual average of about 243 tonnes of baitfish is taken. Some species that are caught for tuna bait are also taken in other fisheries, with the non-baitfish catch of those species being about twice as large. Two species (European pilchard, blue jack mackerel) account for over 90% of baitfish catches. Currently, there appears to be few, if any, "hot management issues" dealing with the baitfishery – and consequently there is little management of the bait fishery, with the exceptions of bans on (a) the catching of one fish species that has been a minor component of the baitfish catch, and (b) the selling of baitfish by baitboats. There is no fishery management plan covering baitfishing and such plans are not a characteristic of fisheries management in the Azores. Should the currently favourable conditions in the baitfishery change, the onboard observer program is well-placed to detect issues that may require management action.

Canary Islands, Spain: Tuna catches by baitboats in the past few years are about one-third of that obtained during the height of the fishery in the mid-1990s, and it can be assumed that baitfish catches have fallen similarly. Sardine (*Sardina pilchardus)* and mackerel (*Scomber japonicus*) make up most of the bait catches, but several other species are used. The status of the major baitfish species is not known, but lack of problems reported by fishery stakeholders leads to the belief that there are no major resource issues. The occasional low abundance of baitfish is a problem, but stakeholders acknowledge that it is a natural phenomenon. The amount of baitfish captured is currently limited by the poor economics of the associated tuna fishery, obviating any need for controls on catch levels. If the livebait tuna fishery declines further, the need for catch limits (and other management interventions) becomes even less important. At present there appear to be few, if any, "hot issues" in the management of the baitfisheries. There are currently no fisheries management interventions

specifically directed at the baitfishery. Consequently, there is no management plan for the bait fisheries, and such management plans are not a feature of fisheries management in the Canary Islands.

Senegal: The baitboat fleet peaked in the late 1950s at 88 vessels, with only 14 remaining at present – but the annual production per vessel has risen considerably. Baitfish for tuna fishing are captured both by the baitboats themselves and by fishing from canoes. The main bait species are the round sardinella (*Sardinella aurita*) and the Madeiran sardinella (*Sardinella maderensis)* About 400,000 tonnes of sardines are taken annually in Senegalese waters, of which far less than 1% is by baitfishing. Stock assessment work suggests that catches of small pelagics (including the major baitfish species) need to be reduced by about 50%. There is currently little management focused on the baitfishery – with the only specific legal provision for baitfishing being a minimum mesh size of 16 mm. There is no management plan for baitfishing, nor for the larger fishery for small pelagics in Senegal, but there is a proposal for an EU-financed multi-country fishery management plan for small pelagics for northwest Africa.

Ghana: The tuna baitboat fishery in Ghana started in the early 1960s and expanded from 5 baitboats in 1962 to its height of 33 in 1990. The fleet currently consists of 22 operational vessels. Recent tuna landings by baitboats have been about 45,000 tonnes per year – but 80% of those landings have actually been caught by purse seine gear. The "pure baitboat" catch is presently about 6,000 tonnes, about one-fifth of that of the early 1990s. Most of the baitfish used by tuna baitboats is caught by the baitboats themselves using small purse seine nets, with the remainder caught by canoe fishing with larger seines. The most important baitfish species is the anchovy (*Engraulis encrasicolus).* Recent surveys indicate the stocks of key small pelagics (which include the major baitfish species) are over-exploited in Ghana. Because the bait fishery is a tiny component of all fishing activity targeting key species of small pelagics, no attempt is made to manage the baitfishery by itself. The Ministry in charge of fisheries adopted a fishery management plan in 2001 which defined two fisheries management units (demersal species and small/large pelagic species). The plan is comprehensive, in that it has a substantial amount of information on the fisheries and their management, but it does not contain new management measures - the plan picks up existing regulations, many of which have not been enforced. In terms of effectiveness, the plan is often referred to as "not implemented" and "not operational". The difficulty does not lie with "the plan" but with the enforcement of restrictions - which would be necessary in any type of management scheme, with or without a management plan. The reality is that it is extremely difficult to effectively place controls on the very large amount of artisanal fishing (i.e. 13,000 canoes) that targets the same fish resources as baitfishing. In Ghana there appears to be acceptance of the desirability of the management plan approach – as evidenced by continuing efforts to produce fishery management plans and statements in official documents asserting the contribution of fishery management plans to improved governance.

Solomon Islands: The pole-and-line fishery in the Solomon Islands reached its height in 1986 with a catch of 38,644 tonnes of tuna, declined to zero in late 2009, but has recently been revived, with 2 vessels catching 869 tonnes in 2011. Baitfish (predominantly two species of stolephorid anchovies) are caught by pole-and-line vessels at night using a Japanese-style stick-held dip net. Other than as baitfish for pole-and-line fishing, there is little alternative use of the two anchovy species. Baitfishing catch per unit effort remained largely unchanged throughout 27 years of baitfish operations. Responsibility for baitfish management is shared between national, provincial, and community levels of government. The overriding management concern since the beginning of the fishery in the 1970s has involved the flow of benefits from commercial pole-and-line operations to the villages that control the areas where the baitfishing occurs. The major management interventions in the bait fishery have been (and are now) the requirements that pole-and-line fishing companies

(1) enter into baitfishing agreements with the communities that control the baitfishing grounds and pay negotiated royalties, and (2) provide baitfishing data. The now-defunct 1999 fishery management plan for tuna had a component on baitfishing. What the pole-and-line fishing company currently does with respect to arrangements for baitfishing (i.e. agreement with communities, data provision) is precisely what is prescribed in the plan. Currently a plan is being formulated that is described as being a baitfishery development plan that includes management arrangements.

3.2 Comparing the Features of the Major Baitfisheries

Table 2 presents some of the major features of the eleven baitfisheries visited during the present study.

Table 2: Features of the Major Baitfisheries

Area	Baitfishing Technique	Bait species	P/L boats catch own bait?	Discrete baitfishery?	Major trends
Brazil	"mini-purse seine gear", mostly using two skiffs and mostly during daytime.	Over 80% of the bait used for live bait fishing is the Brazilian sardine	Catch own bait	No; The sardine bait catch amounts to a small % of the overall sardine catch	Huge fluctuations in the catch of overall sardine fishery (32,000 to 228,000 tonnes/yr)
Ghana	Mostly using small purse seine gear in association with two skiffs. Light fishing is illegal.	80% is European anchovy	About 90% of bait caught by P/L boats; 10% bartered from canoes	No; Baitfish catches are tiny compared to catches of same species by canoe fishing for food	A declining trend in the overall fishery, of which the baitfishing is part of.
Indonesia	Main gear is the lift net ("*bagan*") used at night, which accounts for 70-90% of catch	Multi-species: the major groups being anchovies, sardines, and fusiliers	Mostly purchase their baitfish, rather than catch it themselves	No; Baitfishing is a component of the overall fishery that mostly targets the food market	Likely that a higher % of the baitfish species is for food than 2 decades ago
Japan	Half from small-scale purse seines and half from set nets.	Almost all is the Japanese anchovy	Purchased from specialized baitfishing operations	No; Baitfishing is a component of a much larger overall fishery that targets both the food and recreational fishing markets.	Because P/L fleet now is about 5% of its size four decades ago, a smaller % of overall anchovy harvest is now used as baitfish
Maldives	Now mostly by stick-held dipnet at night; formerly by coral head lift nets during day.	Multi-species: a dozen species dominate the catch, with the most important being the silver sprat	Catch own bait	Yes; Discrete baitfishery; Almost 100% of the catch of the important bait species in the country is for pole-and-line fishing	The average size of P/L vessels (and bait needed per vessel) has been creeping upwards over the last three decades, but in the last half decade there has been a decline in number of vessels.
Portugal Azores	Both day/night, using small purse seines or lift nets depending on seasons & species	European pilchard (1/2 the catch) and the blue jack mackerel (1/3)	Catch own bait	No; Some species that are caught for tuna bait are also subject to other larger fisheries	Small sizes of the blue jack mackerel (i.e. favourable size for bait) appear to be less abundant in recent years.
Senegal	Canoes using small purse seines mostly during daytime	3 main species: the round sardinella, the Madeiran sardinella, and the false scad	Many P/L boats buy baitfish from canoes	No; Baitfishing makes up only about 0.6% of the catch of the 3 important bait species	In recent years the other fisheries targeting the species used as baitfish have increased
Solomon Islands	Using stick-held dipnet ("bouke-ami") at night	Multi-species: many species but two anchovies make up 32% of the catch	Catch own bait	Yes; there is little, if any, fishing for the two most important baitfish species	There is nearly 20 years of baitfishing catch/effort data – and no CPUE decline is apparent
Spain Basque	Purse seine gear is used at night with lights	4 main bait species: Atlantic mackerel, horse mackerel, European pilchard, and the European anchovy	Catch own bait	No; for all four major bait species, the capture by baitfishing is a small fraction of the overall catch	In the industrial fishery for anchovy there was a decline from the height in the 1960s to a stock collapse about a decade ago.
Spain Canary Is	Large P/L boats use purse seines usually at night with lights; Small P/L boats use mainly dip-nets set just before dawn.	Main species are the chub mackerel and the European pilchard	Catch own bait	No; Baitfish are also subject to other (food) fisheries, with latter being about 10 times greater.	Large increase in overall fishing effort during the last two decades; baitfish component has declined.
USA West Coast	Mostly using lampara net during the day	Mostly the northern anchovy	Catch own bait	No; Catch of anchovies for live baitfish is small compared to the overall catch	There is a cyclical relationship between anchovies and sardines displacing each other. In the current decade sardines are dominant

Several observations can be made on the above baitfishery features. Those that have special relevance for fishery management (*and the specific implication*) are:

- The baitfisheries of the Maldives, Indonesia, and the Solomons involve a large number of species (i.e. complex tropical multi-species fisheries), whereas the other fisheries use just a small number of species. *This feature has implications for stock conservation measures. Another aspect is that with a large number of baitfish species, declines in one species are often compensated for by increases in other species, so that the total baitfish catch varies less than the variation of individual species.*
- In Indonesia and Japan baitfish are characteristically purchased from separate baitfishing operations. In Senegal most of the baitfish comes from separate operations and in Ghana some does. *This feature has implications for the range of stakeholders involved in baitfishery management*.
- Only in the Solomon Islands and the Maldives is baitfishing a discrete, stand-alone fishery. In the other areas baitfishing is a component (mostly very small) of the total amount of fishing effort on the species used as bait. In a sense, the baitfisheries are "nested" inside a larger, overall fishery. *This feature means that in many respects baitfisheries cannot be managed separately, but rather management efforts (especially those for stock conservation objectives) need to be focused on the overall fishery. It also has implications for how much a management regime is oriented to gear conflicts and competition for the fish resource. To some degree these factors result in the Maldives/Solomons baitfisheries being relatively easy to manage.*
- The most dominant baitfishery trend is a decline in production that mirrors the production decline of the associated tuna fishery. Because this feature was emphasized in Section 2 above, it was not re-emphasized in compiling Table 2. That table does show that trends in the overall fisheries are often quite different from the trends in the nested baitfisheries. *A continued decline in pole-and-line tuna production can affect the need for, and priority given to, management of baitfisheries. Where there are baitfisheries that are nested in larger fisheries, the fact that production trends can be very different in the two can justify special consideration for the baitfishery in the overall fishery management scheme.*

An important aspect of baitfishing that is not apparent in the table is the link between baitfishing and any local communities that have a strong relationship to the baitfish resource. The situation ranges from the Solomons Islands baitfishery where local villages have strong government-recognized ownership rights over the fish resources to some of the offshore semi-industrial baitfisheries where community involvement in the resource and fishing is far less discernable. *This aspect affects how much attention in a fisheries management scheme should be given to such items as social benefits and food security for local fishing communities, and whether or not approaches such as co-management should be considered.*

In discussions of baitfisheries and in comparing baitfisheries, the concept of a "tuna-to-bait ratio" is often used. In the August 2012 "Baitfish Management Think Tank" the ratio was discussed. It was pointed out that there can be difficulties in comparing ratios between pole-and-line fisheries, especially between those fisheries where bait is purchased (where pre-purchase mortality is not considered, plus the purchased bait is "hardened" bait with higher survival characteristics) and those where the pole-and-line vessel catches its own bait (where mortality estimates typically encompass the entire process from capture to use).

3.3 Management Plans and Management Measures

During the country visits information was collected on the current management of the baitfisheries. This information appears in Appendix 1 and is summarized in Table 3 below. The information on management measures in the table should not be considered exhaustive (i.e. not a comprehensive review of management legislation) but rather the main management measures from the perspective of mainly fishery managers and industry participants.

Table 3: Features of the Management of the Various Baitfisheries

Area	Current Baitfish Management Plan ?	Management Measures Specific to Baitfishery, or Applicable to Baitfishery
Brazil	No; there is no management plan for the baitfishery nor for the overall Brazilian sardine fishery.	The main current management measure specifically for live bait sardine fishery is a requirement that tuna vessels catch their own bait (i.e. no purchasing of bait). Other applicable measures are for the overall sardine fishery: (a) a closed season 15 June to 31 August, (b) specific closed areas, (c) restrictions on fishing close to the beach.
Ghana	No; there is no management plan for the baitfishery. In 2001 a management plan for the overall fishery for small pelagics was adopted, but not implemented.	None of the current management measures relevant to baitfishing are specific to baitfishing, and most are not specific for fishing for small pelagics, but rather apply to all marine fishing in Ghana. The current management measures that would, in theory, have most effect on baitfishing appear to be (1) a minimum mesh size of 25 mm for seining, (2) a general ban on the use of lights for fishing, (3) reserving fishing in shallow water (0-30 m) for artisanal fishers, and (4) banning of fishing within oil and gas infrastructure exclusion zones.
Indonesia	No; there is no management plan for the baitfishery, nor are management plans a general feature of fisheries in Indonesia.	In theory, "Ministerial Rule Number 2 of 2011 on Fishing Zones and Placement of Fishing Gear" would apply to baitfishing. It has provisions for liftnet fishing: mesh size, light intensity, and zonation for distance offshore by registered tonnage of vessel, but there appears to be little awareness of this law among baitfishery stakeholders.
Japan	No; fishery management plans in the country are species-oriented and formulated only for species where there is some resource concern, which is currently not the case for anchovy.	There are no specific management measures for baitfishing, but rather various measures for small-scale purse seine and set net fisheries. Those measures vary amongst the 17 prefectures where there is baitfishing. One of the most prevalent features is the partitioning of areas into those reserved for purse seining and those for set netting. Small-scale purse seining is often prohibited close to shore – presumably to avoid interaction with other types of fishing. Other common management measures for these two fisheries are restrictions on target species, mesh sizes, fishing seasons, vessel sizes, and vessel numbers.
Maldives	No; There is no baitfish management plan at present but such a plan is currently being formulated.	A number of measures apply specifically to the baitfishery: (a) The export of livebait species is banned; (b) Fishermen from one island are discouraged from fishing for bait in the immediate vicinity of another inhabited island; (c) Baitfishing is specifically banned from within 700 metres of a resort; and (d) If sardines are caught by baitfishing in a lagoon, baitfishing is not allowed by non-residents of that atoll.
Portugal Azores	No; there is no management plan for the baitfishery, nor are management plans a general feature of fisheries in the Azores.	Currently, there is little management of the bait fishery, with the exceptions of: (a) there is a ban on the catching of one fish species that has been a minor component of the baitfish catch: recently the catching of seabream at a size of less than 400 grams (much larger size than is useful as baitfish) has been prohibited; and (b) a ban on tuna vessels selling bait they have captured. In the Azores tuna fishing (and the associated bait fishery) have a special status – and are exempted from many management rules. An example is the exemption from the ban on fishing close to the coast with purse seines (much baitfishing done by such nets).
Senegal	No; There is no management plan for baitfishing, nor for the larger fishery for small pelagics. There are some management plans for some other fisheries in Senegal.	There is currently little management focused on the bait fishery. The only specific legal provision for baitfishing is in Decree nº 98-498 – which cites a minimum mesh size of 16 mm for baitfish nets. There are no restrictions for baitfishing on other aspects, such as prohibited areas or quotas. There are other general fisheries management measures that are applicable to all marine fisheries in Senegal, including bait fisheries. Examples are the requirement for all industrial fishing vessels to be registered and for all foreign vessels that are fishing outside a governmental fisheries agreement to carry observers.
Solomon Islands	No; there was a baitfishing component in the now-defunct national tuna management plan. A baitfishery development plan that includes management is now being prepared.	Management interventions in the baitfishery are limited to (a) the requirement for pole-and-line vessels to have an agreement with the communities that control a baitfishing ground, and (b) submission to the government logsheet data covering baitfishing activities.
Spain Basque Country	No; there is no baitfish management plan. There are no formally adopted management plans for the four overall fisheries involving the four baitfish species, but the proposed management plans for anchovy and for horse mackerel are being followed.	The "fisheries" being managed are not the baitfisheries, but rather the four overall fisheries based on the four species – which includes industrial fishing activity. The establishment and enforcement of a catch quota is the main management measure for the overall fisheries.
Spain Canary Islands	No; There is no management plan for the bait fisheries. Fishery management plans are not a feature of fisheries in the Canary Islands.	There are no management measures specifically directed at the baitfishery in the Canary Islands, but there are management measures applicable to all fisheries, including baitfishing. These include the requirement for a fishing licence from the local government for fishing inshore waters and the ban on fishing in certain areas, including close to tourist beaches and in marine reserves.
USA West Coast	No; There is no management plan specific to the baitfishery but rather a fishery management plan that covers several coastal pelagics, including anchovy.	There are no management measures specific to baitfishing at the federal level The baitfishery is not the unit of management, but rather the overall anchovy fishery – and the only management measure applicable to that fishery is a catch limit. Current catches are far below those limits. At the state level (Oregon), bans on the commercial harvest of anchovy were relaxed in 2009 to allow for commercial vessels that use the anchovy as live bait in commercial fishing operations on the catching vessel. The gear used to capture anchovy is restricted to purse seines with a maximum length of 50 fathoms (300 ft), lampara nets, and hook and line. During anchovy fishing all other species must be released unharmed. The bait fishery is open from July 1 to October 31.

From the above tables it can be seen that there are not many types of management measures that are specific to baitfisheries. Those listed are:

- Requirement that pole-and-line vessels catch their own bait
- Ban on pole-and-line vessels selling baitfish
- Ban on export of baitfish
- Preferential access to baitfish for those with resource adjacency
- Requirement to pay those with resource adjacency for access to baitfish
- Ban on fishing near tourist resorts
- Ban on catching one species of fish
- Minimum mesh size
- Maximum net size
- Bycatch release requirement
- Closed season

The small number of management measures is not surprising. The two stand-alone baitfisheries (Solomons, Maldives) are only lightly regulated, while in the cases where baitfisheries are nested in larger, overall fisheries, the management unit is the overall fishery, and most management measures are not specific to the baitfishing component.

Limits on amounts of baitfish captured do not feature in the list of baitfishery-specific management measures above. This appears to be due to perceptions of resource abundance/resilience (Solomons), inability to place catch restrictions on fishers (Maldives, Indonesia), declines in baitfishing production resulting in a sense of less urgent need for management (most locations), and the fact that a catch restriction for a nested and relatively small baitfishery characteristically has little impact on the overall fishery (most locations). As for the overall fisheries that have nested baitfisheries, some have catch limits (e.g. USA West Coast, Basque Country) but most are struggling to establish and/or enforce limits, with the large fluctuations in baitfish abundance caused by environmental factors complicating the process.

With respect to fishery management plans for the baitfisheries, some observations can be made using information from Table 3 and impressions from the country visits:

- Currently there are no functional fishery management plans for the baitfisheries.
- Management plans are presently being prepared for two baitfisheries: the Maldives and the Solomon Islands. Those two locations are stand-alone fisheries, whereas in the nested fisheries, it seems logical that any fishery management plans would cover the overall fishery.
- Fishery management plans are in place for the overall fisheries that encompass the baitfisheries of the USA West Coast, and (to a degree) the Basque Country of Spain.
- Fishery management plans are not in place for the overall fisheries that encompass the baitfisheries of Indonesia, Japan, Brazil, Azores, Canary Islands, Senegal and Ghana. The reasons for not having such plans appear to be (a) the relatively effective management system does not use fishery management plans (Japan), (b) perceived futility of management of a large amount of small-scale fishing (Indonesia, Senegal, Ghana), (c) lack of major baitfishery problems to address (Canary Is., Azores), and (d) poor past experience and/or low opinion of value of such plans (at many locations).

It also became apparent during the country visits that there is no consistent idea of what a fishery management plan actually is. In other words, many different types of documents are called a fishery management plan.

The issue of current fishery management plans and future requirements is further developed in Appendix 2.

3.4 Management Issues

To gain additional insight into baitfishery management, the inventory of current baitfishery management measures (Table 3 above) can be complemented by information on the important features of a fishery that need to be addressed and/or difficulties in the management process: "hot management issues" (Table 4).

Table 4: Hot Management Issues

Area	The Major Issues
Brazil	• Although there is a recognized need to reduce sardine fishing effort, especially during periods of low sardine abundance, the degree to which the small baitfishery should be restricted (versus the much larger industrial purse seine fishery) is a source of controversy. • Although environmental influences seem to explain low sardine abundance, there has not been much effort focused on incorporating the existing knowledge about environmental cycles into fishery management. • The contentious nature of the relationship between the two government ministries that jointly share responsibility for fisheries management results in the inability to effectively cooperate in major fisheries management efforts.
Ghana	• The resource is overfished, but it is extremely difficult to enforce reasonable/needed restrictions on a huge amount of canoe fishing activity. • Many of the existing management measures are impractical for the baitfishery (e.g. the current mesh size, ban on fishing in shallow water).
Indonesia	• Baitfishing occurs in the midst of a large amount of other fishing activity and there are huge difficulties in placing and enforcing any controls. • Most of the baitfishing occurs in waters under district government control, but at that level of government there is not much interest/capability in fisheries management. • What government interest there is in fisheries management is often oriented to the objective of the baitfishery producing government revenue. • The baitfishery experiences large fluctuations in catch levels – but much of the variation is likely to be due to factors other than baitfish catches. • There is considerable competition for baitfish between the pole-and-line fishery and the human food industry, with the latter taking the larger share.
Japan	• The most important management issue related to baitfishing appears to be the potential conflict between the users of different gear types – and much management attention is focused on separating purse seine and set net fishing operations. • Many disputes arise due to ambiguities of boundaries between various fishing areas
Maldives	• Due to the large national importance of pole-and-line fishing (and the heavy reliance on baitfish), the need to assure the sustainability of the baitfish resource is of paramount importance. • Other important management issues are the interaction between baitfishing and tourism, the need to mitigate any effects that baitfishing may have on other fisheries, and the need to change the characteristic attitude of Maldivian fishers that fishery resources (including baitfish) are inexhaustible.
Portugal Azores	• According to several stakeholders, there are currently few, if any, "hot management issues" dealing with the baitfishery. • In the recent past there was an issue over catches of seabream (a target of demersal fishing) in the baitfishery, but this issue has largely been resolved.
Senegal	• The resource is overfished, but it is extremely difficult to place controls on the large amount of artisanal fishing. • The periodic spurts of very large-scale foreign fishing for small pelagics are a concern. • Although there is a recognized need to reduce the fishing effort on small pelagics, there is an issue over the degree to which the relatively tiny baitfishery should be reduced (or given an exemption). • There is uncertainty how the resource will be partitioned between the various end uses: baitfish, domestic consumption, foreign consumption, and reduction for animal feed.
Solomon Islands	• The overriding management concern since the beginning of the fishery in the 1970s has involved the flow of benefits from commercial pole-and-line operations to the villages that control the areas where the baitfishing occurs. • The degree to which baitfishing directly/indirectly reduces fish supplies to villages has also been an issue.
Spain Basque Country	• Many stakeholders indicate that resource sustainability is by far the most important concern to be addressed by management. Other possible objectives (e.g. reduction of gear conflict) appear relatively unimportant. • The formal adoption of fishery management measures appears to be a fairly lengthy process requiring consideration and approval from three major EU institutions.
Spain Canary Is.	• Stakeholders indicate a lack of hot management issues; According to those individuals, no such issues were readily apparent during the height of the fishery in the 1990s, and presently (with the fall in baitfishing activity in the last decade) there is less cause for problems to arise. • The occasional low abundance of baitfish is a problem, but stakeholders acknowledge that it is a natural phenomenon and not attributed to fishing activity.
USA West Coast	• According to fisheries managers, considering the current low level of fishing effort, there are not many "hot" management issues. • There is some concern over commercial-sport interactions and the effect on the ecosystem of the removal of a forage species.

Some commonalities emerge from an examination of the hot issues in the table:

- The common situation of a relatively small baitfishery being nested in a huge fishery gives rise to the issues of whether the baitfishery (or aspects of it) can/should be managed separately.
- There is also the somewhat more dire situation of a baitfishery being nested in a large "semi-unmanageable" artisanal fishery that suffers from resource over-exploitation.
- In several locations the decline in pole-and-line fishing has led to a similar decline in baitfishing, leading to fewer hot management issues.
- The abundance of baitfish is often subject to large fluctuations due to environmental influences. This creates two features for the management of baitfisheries: (1) The inability of fisheries management to mitigate the variation and problems created, and (2) The complexity of establishing catch limits for an oscillating fish resource.
- Jurisdictional issues are important, including competency of the various levels of government and agency mandates. This adds complexity to the management process in about half of the countries.

3.5 Other Aspects of the Current Management of Baitfisheries

3.5.1 Management Objectives

An examination of the management measures and the hot management issues in the tables above, together with the country profiles in Appendix 1 suggests that currently the major management objectives are: sustainability of target fish resources, mitigation of negative interactions with other forms of fishing (especially small-scale fishing), mitigation of negative interactions with tourism, production of benefits for adjacent communities, reduction of bycatch, and generation of government revenue.

3.5.2 Monitoring

The monitoring of catches (i.e. collection of catch and effort information) is an important activity in support of fisheries management. Given the simplicity of collecting, analyzing, and using that information (and the utility of the analyzed information), it is somewhat surprising that few baitfisheries are adequately and routinely monitored.

The usual case is that catch and effort data are not collected, collected only during specialized research projects, collected only during the height of the fishery, or presently collected and not analyzed. The only area visited in the present survey where it was readily apparent that data specific to baitfishing are routinely collected and analyzed is the Azores, where the observer program takes on the task. In the Maldives the importance of such monitoring is recognized, and steps are being taken to establish a system.

It should be noted that, even for the nested baitfisheries, there is justification for collection of catch and effort data specific to the baitfishing (Section 4.2.1).

3.5.3 Functional Management System

Ideally, a management survey such as the present study would be able to scrutinize the current management of a fishery and judge whether there is a reasonably effective management system in place. In other words, determine whether there is a functional process to deal with threats to fisheries resource and other concerns associated with the fishery. For various reasons this was not possible.

During the short country visits it was not possible to observe the management systems (which in some cases are extremely complex) in action. In discussions with stakeholders it was often difficult to separate opinions of an effective system from wishful thinking by

stakeholders. The frequently heard “lack of complaints from the fishing industry” cannot be equated to a functional management system, especially in an era of declining baitfisheries.

Although it was not possible to determine effective baitfishery management systems, to some extent it was much easier to identify where management is definitely *not* effective. In Indonesia, Senegal, and Ghana there do not appear to be systems in place that are able to deal with major concerns related to the fishery – which relate mainly to over-exploitation of the fish resource. At those three locations the baitfisheries are nested inside overall fisheries that are difficult to control. There is some question of whether it is a management deficiency, or an unmanageable situation.

3.6 Some Aspects of the Resiliency of Baitfish

The readily available results of any stock assessment work for each of the baitfisheries is given in Appendix 1.

To examine the issue of the resilience of baitfish to fishing pressure, the baitfisheries can be placed into two categories (with a few of the fisheries being intermediate): (1) Tropical multi-species fisheries, mainly associated with islands, and (2) The small pelagic fisheries in which there are just a few target species, and that are mainly continental, temperate/subtropical, and associated with upwelling zones.

For the tropical multi-species fisheries, there have been numerous studies on the fisheries of the Solomon Islands, Indonesia, and the Maldives – as well as the baitfisheries that are no longer significant or have ceased to exist: Palau, Papua New Guinea, Fiji, and Kiribati. Most of the research has covered a relatively short duration and focused on a small number of locations. The methods used have included catch and effort data trends, egg production, indices of environmental variability, hydro-acoustic work, and relating primary productivity to baitfish yields.

CPUE baitfishery trends in Indonesia show no clear trends (Ingles et al. 2007) and in the Solomon Islands CPUE remained largely unchanged throughout 27 years of baitfish operations (Barclay 2008). In the Maldives, MRC (2011) states that because livebait utilization has linearly increased with the increase in tuna catches, there is the implication that there are no declines in availability of livebait. However, Anderson (2006) presents evidence to show that the baitfish of a few atolls in the Maldives is over-exploited, but then Anderson (2009) states that while there were particular concerns about the status of baitfish resources in some atolls during 2003-06, pole and line fishing effort has fallen about 25% since that time, with a consequent reduction in bait catch. The MSC evaluation report (Moody Marine 2010) contains an assessment that appears to be applicable to many of the tropical multi-species baitfisheries: “it is believed that current levels of bait removal are unlikely to disrupt key elements of atoll ecosystem structure and function to the point where serious or irreversible harm might occur. However, this is an area where further research would be desirable.”

In the second baitfishery category there seem to be two situations (1) the baitfishery is a tiny component of an overall fishery that is considered under-exploited, and (2) the baitfishery is a tiny component of an overall fishery that is considered over-exploited. In these fisheries very little assessment work has been done specifically on the (tiny) baitfish component, other than collection of catch and effort data in some baitfisheries.

In general for both categories of baitfishery, the nature of many baitfish species points to relatively high productivity and some degree of resilience to fishing: low trophic level, highly fecund, with rapid growth, and relatively short lifespans. On the other hand, this favourable

productivity is often tempered to some degree by recruitment variability due to environmental influences.

The subject of small pelagic species being relatively resilient to fishing pressure is discussed in more technical detail in Adam (1980) and Boehlert (1996). In general, these fish are considered to be "r-selected" (i.e. they allocate a relatively large portion of their resources to reproductive activities) and can typically be fished at younger ages and at higher levels of fishing mortality. Given a minimum population size, fisheries based on small pelagics should also have a quicker recovery from overfishing than those based on fish that place higher emphasis on the strategy of survival to reproductive age ("k-selected").

4.0 Improving Baitfishery Management

4.1 Some Observations on Improvements and Related Issues

Discussions during the country visits indicated a wide variety of ways in which the management of baitfisheries could be improved – and even different perspectives on what "improvement" means. On reflection, improvements to baitfishery management are largely about sharpening management to better attain objectives. Objectives in the current baitfisheries (Section 3.5.1 above) are mainly related to mitigating negative impacts (especially on the target fish resource) but some are related to generating benefits (e.g. to resource-owning communities, to governments).

An important concept concerning the need/difficultly of baitfishery management emerged during the country visits and subsequent information analysis. In relative terms, the management needs of a baitfishery are characteristically not that demanding. The species involved generally are fairly resilient to fishing pressure. The decline in production of most baitfisheries in recent decades results in less need for management. In many baitfisheries there is some degree of self-regulation: when catches in a particular location fall then a pole-and-line fleet will usually locate to another bait ground. On the other hand, attempts to improve baitfisheries and their management are faced with huge challenges. One of the major difficulties associated with the production from baitfisheries is resource fluctuation driven by environmental factors - something that fisheries management can do little about. Improvements to several management systems are largely dependent on successfully dealing with some very difficult problems (discussed below). Finally, as most baitfisheries are relatively small and unimportant on the national scale, governments tend to give low priority for making improvements. To some extent, this need/difficulty situation impedes the justification for, and success of, the management of baitfisheries

An option for improving baitfishery management that is sometimes mentioned is simply to wait. Many of the major problems that would normally be addressed by fisheries management (over-fishing, gear conflicts, etc.) are fading in importance as the pole-and-line fisheries decline. Limits on baitfish catches are effectively established by the current poor economics of pole-and-line fisheries. An important caveat to this concept (mentioned in Section 2.0 above) is that there is some possibility that the declines could be reversed - as indicated by the recent resurgence of interest in pole-and-line fisheries.

Significant improvements in management outcomes in several of the baitfisheries require that some "semi-intractable" issues be at least partially resolved. The two that have become apparent are:

- Improving the outcomes of the management of baitfisheries in some countries, especially Indonesia, would require a major overhaul of the entire coastal fisheries management regime – a monumental undertaking. It is naïve or impractical to expect

that baitfishing can be singled out and managed better than other fisheries in the same area, managed by the same authorities, often with similar stakeholders.

- Improvements in other baitfisheries require some ability to restrict a large amount of artisanal fishing effort. As put by one fisheries specialist, some baitfisheries are immersed "in a sea of semi-unmanageable canoe fishing that targets the same resource".

A significant challenge for making improvements in most of the world's baitfisheries concerns "nested" baitfisheries – when baitfishing is a small component of a much larger amount of an overall fishery targeting the same fish resource. The logical way to improve management would be to deal with the overall fishery rather than tinkering with the small baitfish component. From the national perspective, it may seem terribly inefficient or a waste of management resources to focus significant management attention on the minor (and mostly shrinking) baitfish component. Two questions that arise are: (1) Are tuna-related initiatives (e.g. ISSF and IPNLF campaigns) able to deal with such a broad issue? and (2) What is the appropriate role of the baitfishery and its stakeholders in improving the management of the overall fishery?

Another general observation is that improvements to baitfish management systems are mostly site-specific. There are few improvements that would be universally applicable for enhancing management outcomes. In the recent past there has been a notion that fishery management plans are essential for good baitfishery management everywhere, but for various reasons (Appendix 2) this is probably not the case. It has become apparent during the present study that perhaps the only improvement that is applicable to most baitfisheries concerns monitoring. It seems that the relatively simple process of collecting and analyzing baitfish catch and effort data could improve the management of most of the world's baitfisheries.

4.2 Specific Improvements

For each baitfishing area, Appendix 1 lists possible improvements to the management regime from the perspective of stakeholders. It can be seen that there are a wide variety of perceptions on ways in which the management of baitfisheries could be improved. As the present study is focusing on issues that emerge from many baitfisheries, those improvements that are common to many locations are of special interest. The suggestions for improvements given below are not intended to be exhaustive, but rather are those ideas that became especially evident in the course of the fieldwork of the present study.

4.2.1 Monitoring

One general objective that is recognized as being very important in the major baitfisheries of the world is the need to avoid any overfishing of the target resource. To do this usually requires a knowledge of catch and effort in the fishery, along with species composition - but it can be seen in Section 3.5.2 that such information does not appear to be collected and analyzed in most baitfisheries. In another sense, a knowledge of catch dynamics is a fundamental requirement for almost any sort of management intervention.

Baitfishing catch and effort data is obviously important to the dedicated baitfisheries (e.g. Solomons, Maldives), but it is also of value in the "nested baitfishery" component of a large overall fishery. This is because baitfishery data is likely to be of higher quality than data from an associated artisanal fishery. In some of the nested fisheries, baitfishing focuses on juvenile fish as opposed to adults in the larger associated fishery, and on shallow areas as opposed to offshore areas in the larger associated fishery – so the catch dynamics could be different. Finally, it may be possible to leverage data collection from the relatively high value

pole-and-line tuna fishery that may not be available for some of the overall associated fisheries.

4.2.2 Fishery Management Plans

The use of fishery management plans to improve the management of baitfisheries is an important and complex subject. Given the interest of various groups in promoting the concept (ISSF, IPNLF), it is discussed in some detail in Appendix 2.

In summary, the discussion in the appendix leads to the following points:

- There is presently considerable recognition of the value of fishery management plans for improving the management of baitfisheries - however, there are currently no baitfisheries in the world that have a functional fishery management plan.
- For improving the management of baitfisheries there is much interest in the subject of the desirable/essential elements of a management plan. However, there is no shortage of references and manuals that give generic elements of fishery management plan.
- Although the concept of improving baitfisheries by management plans is appealing, it is not easy to identify many examples where such plans have been successfully introduced into any type of fishery in developing countries. Fishery management plan manuals do not contain much analysis of difficulties of introducing fishery management plans.
- A comparative study of fishery management plans in another type of fishery (tuna) shows that the most challenging difficulty with introducing management plans is the failure to implement or adhere to plans after some form of formal adoption. One approach that appears to have some success is to make the plans easier to implement and include multiple mechanisms to encourage adherence.
- Although there are many positive attributes of fishery management plans, they do not appear to be absolutely essential for effective fisheries management, especially in countries with a strong heritage of fisheries management success.
- There appear to be many components that would be common among fishery management plan for the dedicated baitfisheries (e.g. Solomons, Maldives), but there is much less commonality between those and the management plans for larger overall fisheries in which baitfisheries are nested.
- A list of elements that are common to effective fishery management arrangements is likely to include (a) monitoring of the fishery, (b) some type of formal statement (e.g. plan, legal instrument, policy document) that gives the “rules of the game”, and (c) a mechanism for applying those rules.

The above points have implications for current initiatives that are attempting to improve the management of baitfisheries in the world. The points suggest that: (a) a blanket statement on the necessity of a fishery management plan for all baitfisheries could be too prescriptive, and (b) a template baitfishery management plan or “best practices” or “common standards” for management plans for the dedicated baitfisheries may not be very applicable to the overall fisheries that contain baitfisheries.

It is recommended that the concept of “fisheries management frameworks” be promoted by agencies that are attempting to improve the management of baitfisheries. Such a framework would feature collecting/reporting/using of catch and effort data on the baitfishery and some formal statement of the rules and how they are to be applied.

4.2.3 Stock Assessment

The readily available results of the stock assessment work for each baitfishery is given in Appendix 1. It can be seen that there is a large range in the types of the assessments –

from virtually nothing in some of the baitfisheries in tropical developing countries to some very sophisticated work in the small pelagic fisheries of developed temperate countries.

Increased precision of stock assessments could certainly improve the management of many of the current baitfisheries. The more sophisticated techniques are able to integrate many different types of information on baitfish resources and could give information on potential yields from a fishery and be used for projections.

It is, however, important to note some other considerations. Whereas comprehensive annual assessments might be desirable, they are costly and available resources for this type of work is typically lacking. Individuals with fisheries management responsibilities in some baitfisheries feel that fishery management plans cannot be completed (or in some cases, management measures cannot be implemented) without comprehensive assessments of baitfish stocks. This idea that "stock assessment will come to the rescue" may be constraining the use of simpler types of analysis to ascertain the need for management measures. Rather than promoting regular comprehensive baitfish assessments, another approach worth considering would be to collect and analyse catch and effort data for major trends, while opportunistically making use of more sophisticated analysis when it becomes available: "learn to walk before running".

Some additional points should be mentioned:

- Trends in catch and catch per unit of effort (CPUE) have the advantage that they are simple, easy for developing country managers to use, and are readily understood by fishers and the general public.
- There have been many assessments of baitfish resources in the various baitfisheries of the Pacific Islands region over the last 30 years by SPC, ACIAR, FAO, NMFS, national government and others. It appears that the only case where this work had an impact on management measures was in Papua New Guinea where a drop in CPUE led to restrictions on some of the baitfishing grounds (Skipjack Programme, 1984).
- The use of CPUE trends is not limited to expertise-deficient developing countries. The management of many stocks in the USA is based solely on estimates of annual harvest (e.g. the west coast anchovy fisheries (NMFS 2012)).
- It should be acknowledged that CPUE is a less than perfect indicator. One case where CPUE trends may be inadequate and more sophisticated analysis required is where a major step-up in baitfishing activity is anticipated or has occurred.
- The August 2012 "Baitfish Management Think Tank" (Appendix 3) discussed the issue of baitfishery CPUE data. That meeting indicated that the analysis of the data needs to be done cautiously and take into consideration factors that may distort a simple interpretation of the trends, such as changes in spatial distribution of baitfishing activity, moon phases, seasonal/environmental induced variability, and biological characteristics of the targeted baitfish.
- Obviously, should funding/expertise become available for more sophisticated analysis, then the condition of the baitfish resource should be assessed - and perhaps also cover the adequacy of using CPUE trends for management purposes.

The fact that CPUE trends have considerable value for stock assessment reinforces the contention expressed in Section 3.5.2 above on the need to collect catch and effort information from all baitfisheries.

4.2.4 Research

In this report "research" is considered to be the collection of information in support of management, and would therefore include the stock assessment mentioned above. In many cases the desirable research is specific to individual fisheries, but in the present study there

is special emphasis on that required at a higher level than individual fisheries. In this regard, a few suggestions can be made – with the idea that the list below is not comprehensive but rather limited to those that became particularly apparent during the present study.

From the comments on required research made by many individuals with baitfishery management responsibilities and those made in various documents, there appears to be a significant amount of "reinventing the wheel": an expressed desire to carry out research on topics that have already been well-studied. In the heyday of pole-and-line fishing in the world, much research was done on topics such as interactions with food fisheries, basic biological characteristics of particular species, baitfish mortality, and culturing bait. This fact does not eliminate the need for additional research, but it would be quite inefficient to carry out new research in ignorance of past results. The need here appears to be a compilation of previous baitfish research findings, including overall lessons learned.

In several places in this report there is mention of baitfisheries that are nested within larger overall fisheries. A very important issue which has at least some relevance to most baitfisheries in the world is the relationship of the baitfishery and its stakeholders to improving the management of the overall fishery. Attempts to manage only the relatively small baitfishery are unlikely to be successful, but there is considerable uncertainty whether anything can be done at the level of the baitfishery to improve the whole lot.

In Section 4.1 above two prevalent "semi-intractable" issues dealing with baitfishery management were mentioned: (a) the need in some countries for a major overhaul of the entire coastal fisheries management regime in order to improve the outcome of baitfish management, and (b) improvements to other baitfisheries require some ability to restrict a large amount of artisanal fishing effort, something that is extremely difficult. Research into what can and should be done in these two situations (if anything) could come up with some new approaches.

In the August 2012 "Baitfish Management Think Tank" (Appendix 3) the subject of future baitfish research was discussed. The meeting pointed out that the following research topics would also be important:

- Lessons learned from the management of some of the large baitfisheries that no longer exist, especially those of Papua New Guinea and Hawaii.
- Essential components of a baitfish monitoring program
- The application Productivity-Susceptibility Analysis (a semi-quantitative and rapid risk assessment tool that relies on the life history characteristics of a stock) or a Scale, Intensity and Consequence Analysis to some of the major baitfish species.
- The role of basic productivity of a baitfishing ground that supplies a fishery (e.g. high island vs atoll, coastal upwelling) and potential man-made impacts

4.2.5 Other

The report titled "Ensuring the Sustainability of Livebait fish" by the International Pole-and-Line Foundation (IPNLF 2012b) contains several suggestions for improving the management of baitfisheries. As the report is well-researched and obviously was written using considerable expertise, the suggestions it contains are quite valuable. The IPNLF report identifies impacts, and makes recommendations to reduce these impacts and to ensure that live baitfish fisheries are as sustainable and equitable as possible. Some of the conclusions on required research are given in Box 1.

Box 1: Some Conclusions of the IPNLF Report

A variety of solutions offer some potential for mitigation of impacts and for

improving the effectiveness, hardiness and supply of baitfish:

- **Substantial further research is urgently needed, especially studies that focus on the complex interactions between the baitfish fishery and the local fishing communities, as well as those related to baitfish culture and other alternative bait.**
- **These research initiatives need to be complemented by comprehensive fishery management plans in pole-and-line nations. These plans should include regular stock assessments and be based on the ecosystem approach and the precautionary principle and be third party audited on a regular basis.**
- **Ideally, the IPNLF would, as a priority, develop best practise guidelines for baitfish management plans and provide skill sharing, training and capacity building to develop community and coastal states' ability to manage baitfish fisheries on a long-term sustainable and equitable basis.**

From the perspective of the arguments/conclusions in the present report, the main observations on the IPNLF suggestions are that the "nested" baitfishery situation be considered and that in planning for research, past efforts on similar topics be reviewed.

5.0 Concluding Remarks

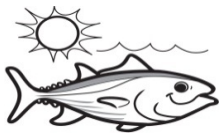
The need for additional information on the baitfisheries that support the pole-and-line fisheries of the world is being recognized by several groups. The International Pole and Line Foundation has indicated that “further research is required to understand and manage bait fisheries globally” (IPNLF 2012a). In the Maldives there has been interest in reviewing international bait fishery management practices to learn of features that may be applicable to the domestic baitfishery (Anderson 2009).

This report is a contribution to the knowledge base of the management of baitfisheries. Relative to other studies on baitfisheries, this study had the advantage of being able to visit the major baitfisheries of the world, including those that are poorly documented.

The study of the management in baitfisheries around the world has not led to examples of remarkably good management, because there is little management specifically for baitfisheries. The dedicated baitfisheries are only lightly regulated and for the baitfisheries that are nested in much larger overall fisheries, they are usually such a small component that they rarely receive much management attention.

Several areas have been identified where additional research would be desirable. Significant improvements in the management of baitfisheries could be made and those changes could result in greater benefits and/or increased sustainability of the associated pole-and-line fisheries. Because of the large diversity in baitfisheries, most improvements are specific to particular fisheries (or categories of baitfisheries), limiting the relevance of worldwide requirements or standards. Perhaps the only improvement that is broadly applicable across most baitfisheries concerns monitoring.

Agencies that are attempting to improve the management of baitfisheries in the world should consider promoting the concept of a “fisheries management framework” in countries with favorable conditions (i.e. where there is political will and stakeholders willing/able to engage). Such a framework would feature collecting/reporting/using of catch and effort data on the baitfishery and some formal statement of the rules and how they are to be applied.



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Appendix 1: Details of Baitfish Management in the Areas Visited

Maldives

Information on the major live-bait pole-and-line tuna fisheries in the country

- Staff of the newly-formed Fisheries Management Agency estimate that annual tuna catches by the pole-and-line fleet have averaged 80,000 to 90,000 tonnes in recent years. The all-time high was 120,000 tonnes in 2006.
- There are currently about 700 active pole-and-line vessels in the country. MRC (2011) states that a substantial proportion of the fleet is longer than 24m. In recent years about 50% of the fleet (about 400 vessels according to some sources) has converted to handline fishing, but many of those vessels alternate between handline and pole-and-line fishing.
- About 60% of the pole-and-line tuna catch is exported (a) frozen to Bangkok, or (b) canned to Europe. The remaining fish is consumed locally or exported as dried fish to Sri Lanka.
- The tuna-to-bait ratio cited by various authors has ranged from 7:1 to 11:1, but this may not be strictly comparable to ratios from other regions due to differences in what aspect of bait use is being compared (i.e. total bait catch vs live-bait actually broadcast)

The various baitfishing operations: types of operations, size of operations and techniques

- The baitfishery in the Maldives is very well documented. Anderson (1997) gives an idea of the multitude of studies on various aspects of the fishery:

  > Early descriptive accounts of the Maldivian fishery included some information on livebait (Jonklaas, 1967; Munch-Petersen, 1980). Accounts of livebait fishing methods are given by Anderson (1983 & 1995), Liews (1985) and Waheed and Zahir (1990). The major livebait varieties used are described by Anderson and Hafiz (1984). A brief review of the Maldivian livebait fishery was provided by Anderson and Hafiz (1988), and later reprinted in a revised form (Maniku, Anderson and Hafiz, 1990). The biology of some Maldivian livebait species (including information from studies of reproduction, growth and predation) is discussed by Blaber et al. (1990) and Milton et al. (1990a & 1990b). Seasonal, regional and interannual variations in the utilization of livebait within the Maldives are described by Anderson and Saleem (1994 & 1995); the data sheets prepared for these studies have been bound and stored at MRS (Anon, 1995a). Estimates of the size of the Maldivian livebait fishery are provided by Anderson and Hafiz (1988) and Anderson (1994). Management issues are discussed by Anderson and Hafiz (1988), Wright (1992) and Anon (1994 & 1995b). A summary of research on livebait undertaken by the Marine Research Section is given in MRS (1995).
- Anderson (2009) states that traditionally, baiting was carried out first thing in the morning. A simple, cotton lift net was used, and deployed from one side of the fishing boat using four long poles. Scraped fish paste might be used to lure the bait school over the net, when it was rapidly hauled and the captured fish transferred into the flooded hull of the fishing vessel. Starting in the 1970s a number of developments and innovations revolutionised the livebait fishery, especially the use of nylon nets, much larger pole-and-line vessels, and night baiting using lights.
- Currently, almost all bait is obtained at night by stick-held dip net.
- Bait used per fishing trip increased from 30 kg in the 1970s to about 400 - 600 kg at present, due to larger pole-and-line vessel size (MRC 2011). It has been estimated that annual baitfish harvests in the mid-2000s were about 15,000 tonnes.
- Almost 100% of the catch in the Maldives of the important bait species is for pole-and-line fishing.
- While there were particular concerns about the status of baitfish resources in some atolls during 2003-06, pole-and-line fishing effort has fallen about 25% since that time, with a consequent reduction in bait catch (Anderson 2009).

The major baitfish species

- MRC (2011) indicates that the livebait fishery is a multi-species one. Over 40 different species have been recorded, but less than a dozen dominate the catch. The single most important bait species in the Maldives is the silver sprat (*Spratelloides gracilis*).
- Anderson (1997) gives baitfish catch composition information: *Spratelloides gracilis (*38 ± 10%), Caesionidae (37 ± 9 %), Apogonidae (10 ± 3%), Engraulididae (7 ± 2%), S*pratelloides delicatulus* (5 ± 1 %), Atherinidae (1%), Pomacentridae (1%), Others (0.2%).

The recent trends in the baitfishery, including trends in catches

- The average size of pole-and-line vessels (and the associated bait requirement per vessel) has been creeping upwards over the last three decades.
- There has been a recent decline in the total number of active pole-and-line vessels and associated total demand for baitfish.
- Anderson (2009) shows an increase in annual bait usage from 3,250 tonnes in 1978-81 to 15,000 tonnes in 2003.

The results of any baitfish stock assessment work

- Anderson (1997) states there has been no stock assessment, so the status of livebait stocks is unknown. In general, it is believed to be rather difficult to overfish stocks of small, highly fecund pelagic fishes such as the sprats upon which the Maldivian livebait fishery heavily depends. There are no clear signs of overfishing so far, but given the enormous importance of the livebait fishery, it would be prudent to initiate stock assessment activities.
- Adam (2006) indicates that the Marine Research Centre is the research arm of the ministry responsible for fisheries, however, due to human resource constraints at MRC, proper and regular stock assessments are not carried out. Instead MRC provides *ad hoc* reviews and general assessments of the resources as and when required.
- Using an empirical relationship between primary productivity and small pelagic fish yield, Anderson (2006) makes an estimate of maximum sustainable yield for Maldivian baitfish of about 13,000 ± 2,000 tonnes per year.
- Anderson (2009) states that while there were particular concerns about the status of baitfish resources in some atolls

during 2003-06, pole and line fishing effort has fallen about 25% since that time, with a consequent reduction in bait catch. A baitfish monitoring programme has commenced and is focused on four northern atolls.

- MRC (2011) states that the MRC has undertaken a series of studies on the livebait fishery. Collaboration between CSIRO, Australia, and MRC, under ACIAR funding in the early mid-1980s, provided important biological information on major species. Surveys done by MRC in the 1980s and 1990s provided important insights on the fishery dynamics, its seasonal and regional variations and estimates of livebait utilization. Despite fishermen's reports of livebait shortages in recent years, livebait utilization has remained more or less constant. Data shows that livebait utilization has linearly increased with the increase in tuna catches implying that there are no declines in availability of livebait.
- The MSC assessment report (Moody Marine 2010) summarizes the situation: In short, it is believed that current levels of baitfish removal are unlikely to disrupt key elements of atoll ecosystem structure and function to the point where serious or irreversible harm might occur. However, this is an area where further research would be desirable.

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The legal authority for the management of the baitfishery and other fisheries in the Maldives is the Fisheries Law (Law No. 5/87). New fisheries legislation was drafted several years ago but has not yet been enacted. That proposed legislation requires the Minister of Fisheries to formulate fishery management plans and gives the Minister substantial powers to impose necessary fisheries management.
- Currently the responsibility for management of the baitfishery lies with the Ministry of Fisheries and Agriculture, but the situation is evolving with more governmental authority in general being devolved away from the central government.
- There is a process underway to consolidate responsibility for fisheries management within the Ministry to a newly-formed Fisheries Management Authority.
- Rules/practices based on tradition, such as the exclusion of outsiders for some baitfishing activities, are characteristically respected.

The major concerns that management should address

- Due to the large national importance of pole-and-line fishing (and the heavy reliance on baitfish), the need to assure the sustainability of the baitfish resource is of paramount importance.
- Staff of the MRC indicate that other important management issues are the interaction between baitfishing and tourism, the need to mitigate any effects that baitfishing may have on other fisheries, and the need to change the characteristic attitude of Maldivian fishers that fishery resources (including baitfish) are inexhaustible.
- Anderson (1997) articulates other important issues that need to be addressed, including destructive livebait collection, dumping excess livebait at sea, and the impacts on baitfishing of coral mining, reef fishing and black coral collecting.
- Avoiding bait wastage is a major issue. Many stakeholders stress the need to use bait more efficiently.
- MRC (2011) states the necessity for a participatory process to identify what constitutes the "management problem" which may include addressing the reasons for localized overexploitation of bait resources, the impacts of exploitation of livebait on the ecosystems, and safeguarding livelihoods of fishers.

Current management of the baitfishery, objectives and the main fisheries management tools used

Many stakeholders state that management of the fishery is currently very limited. Moody Marine (2010) indicates that the management strategy in the past was limited to monitoring of the fishery, with little or no direct intervention. Adam (2006) states that there is no "management/regulatory activity" associated with the bait fishery. However, when the subject is probed in conjunction with a broad definition of management (i.e. Are there rules, including traditional ones, governing the baitfishery?), some aspects of management emerge: [from S.Adam and H.R. Hassan (per.com.), Anderson (1997, 2009)]

- The export of livebait species has been banned since 1993
- Fishermen from one island are discouraged from fishing for bait (or anything else) in the immediate vicinity of another inhabited island.
- Baitfishing is specifically banned from within 700 metres of a resort
- Coral mining was banned on major livebait fishing reefs by a President's Office decree in 1990
- A moratorium on the collecting of black coral in the Maldives began in 1995
- If sardines are caught by baitfishing in a lagoon, baitfishing by non-residents of that atoll is not allowed.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- As of March 2012 no management plan has been implemented for any fishery in the Maldives. According to the staff of the MRC, a management plan for the grouper fishery has been formulated, but has not yet been gazetted.
- To date, the MRC has carried out much work in the process of formulating a fishery management plan for baitfishing. A source of funding (GEF) and an external partner (WWF) have been identified for a participative approach towards building the plan. In recognition of the current reality that restricting baitfishing effort is simply not possible, it is envisaged by the staff of the MRC that the major thrust of the future plan will be for activities like educating fishers to reduce baitfish waste and increase baitfish on-board longevity. There is also the thinking that baitfish monitoring is a necessary prerequisite for a successful plan, and therefore three workshops are planned to standardize measuring of bait by fishers. After that work is completed, the staff of the MRC feel strongly that "the Maldives needs some space and time to digest the results" before progressing to formulating the actual management plan for baitfishing.
- In some respects, the formulation/implementation of a baitfish management plan represents a revolutionary step in Maldivian fisheries. The success of the plan will be dependent on staff capability, adequate funding resources, and focused government attention – and has been likened to "having and raising a baby".

The type of fishery management plan

- For the future management plan, Anderson (2009) combines his local knowledge and common sense in asserting:

  > The goal of [the Maldive] baitfish management should be to prevent over-exploitation of the resources. However, any management system introduced to meet this goal will need to be very robust and simple. The biological resources on which the fishery depends are multi-species and complex. The fisheries themselves are ancient ones, with long-established traditions that will be difficult to change. The human resources available for monitoring and management are extremely limited. In short, it is unrealistic to expect MRC to conduct classic stock assessments for each baitfish species or for the Ministry to be able to introduce and operate any but the most basic management system anytime in the foreseeable future.

The elements of the plan [not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

- Staff of the MRC feel that it is premature to decide on this aspect of the future, but there is the strong feeling that due to the long/strong heritage of fishing practices in the Maldives, much emphasis needs to be placed on educating fishers rather than relying on (non-existent) enforcement mechanisms.

Information on plan effectiveness [not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- Many, if not most, reviews of the Maldives fisheries sponsored by external agencies have suggested the use of fishery management plans, including Wright (1992), Gillett (2004), Flewwelling (2006), Gomez-Hall (2006), and World Bank (2007). A fisheries specialist highly experienced in the Maldives recommended "Fishery management plans should be prepared for every commercial fishery in the Maldives" (Anderson 2006).
- The formulation of the baitfish management plan is underway, but such a large step in the fisheries sector (where traditions are strong) does not happen quickly. The fishers need to be allies of the process, not opponents – and to modify their attitudes will take time. An analogy has been drawn between the attitudes of Maldivians towards family planning (which has undergone positive change in the last few decades) and fisheries management (where the process of change is just beginning).
- Another important aspect that may add to the time requirements is emphasized by Anderson (2009): The management of the baitfish fishery, if it is to be effective, should not be treated in isolation, but must be coordinated and integrated with the management of other fisheries and resource users. Thus, while the livebait fishery may be arguably the most important reef fishery, it is only one among several.

The main institutional and procedural difficulties in the management of the baitfishery

- There appears to be a consensus that the capacity of the Ministry staff in fisheries management is insufficient and that the political will for fisheries management is often lacking.

Can an outside agency assist in improving the management of the baitfishery?

- Several stakeholders feel that the most important contribution that an outside agency could make towards improving the management of the baitfishery is to upgrade the capacity of the Ministry staff in fisheries management.

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Indonesia

Information on the major live-bait pole-and-line tuna fisheries in the country

- There are about six general areas where there are significant concentrations of pole-and-line vessels. All of those areas are located in eastern Indonesia. Various studies/individuals have commented on the major pole-and-line areas (and associated baitfishing areas): (a) North Sulawesi/Bitung (Mogogimbun, Belang); (b) Sorong (Waigeo, Batanta in Raja Ampat), further away Misool and FakFak on Irian Jaya/Papua, (c) South Sulawesi (Bone Bay, Kendari), (d) Ambon (Saparua and several areas on south Ceram), (e) Eastern Nusa Tenggara (Larantuka). (f) Other less important areas: North Sulawesi (Bacan), Tomini Bay (Luwuk, Peleng) (per.com. A.Lewis, B., J.Pet, I.Musthofa).
- Gillett and McCoy (2006) estimated that there were 132 pole-and-line vessels greater than 30 GRT operating in Indonesia: (a) Sorong: 31 vessels; most are 70 GT; (b) Bitung: About 75 vessels; most are in the range of 30 to 100 GRT; (c) Ternate: About 20 to 30; one company has 16 vessels, all below 30 GT; (d) Bone: Some vessels (20?); most are 10 to 25 GT; (e) Kendari: 22 vessels. This list does not include the small artisanal pole-and-line vessels.
- Pole-and-line tuna catch estimates vary from 60,000 t (Williams & Terawasi, 2009) to 240,000 t (Ingles et al. 2008). Banks (2010) uses Ingles et al. (2008), MSC assessors ground-truthing, and SPC/IOTC data to estimate a total tuna production by pole-and-line in Indonesia to be about 115,000 t.
- Indonesian pole-and-line vessels can be categorized as either small artisanal craft of less than 10 GT that usually sell fresh product for local consumption, or larger vessels ranging up to 100 GT that supply domestic canneries and export markets (Itano 1993). The small vessels (funae or funai), average about 11 metres in length, and mainly operate in Sulawesi Sea, north Moluccas (Ternate, Bacan, Tidore) and the Ambon area.
- The height of the pole-and-line fishery was 1998/99 and is now about 75% of that size (B.Iskandar per.com.)
- Of the pole-and-line catch that is exported, most goes to Japan (katsuobushi) or Africa and the Middle East (canned).

The various baitfishing operations: types of operations, size of operations and techniques

- The main gear for catching live baitfish is the lift net ("*bagan*"), which accounts for 70-90%, and beach seines, which account for 10-20% of live bait fish catches. The remainder is landed by small-scale purse seines and encircling gillnets. There are two general types of liftnets: the fixed type called "*bagan tancap*" which is the traditional one and the mobile liftnet called "*bagan perahu*" which is on a raft or boat and is mobile. (Ingles et al. 2007).
- Pole-and-line vessels characteristically purchase their baitfish, rather than catch it themselves.
- The only baitfishing *bagan*s are in Eastern Indonesia, but *bagan*s for food fish operate all over Indonesia.
- Where there is baitfishing by *bagan*s, about 40% is for bait, and about 60% is for human consumption, with the latter getting a significantly higher price.
- Many of the smaller pole-and-line vessels are now switching to handlining for tuna when live bait is unavailable

The major baitfish species

- In general terms, the major groups of bait species are anchovies, sardines, and fusiliers.
- An ACIAR study stated that the anchovies *Encrasicholina devisi* and *E. heterolobus* are the most important species.
- An earlier study (Subani 1982) listed 41 species/groups that have been used as baitfish in eastern Indonesia.

The recent trends in the baitfishery, including trends in catches

- ACIAR (2001) states "We have no evidence that the amount of baitfish available is declining. Rather, it appears that the bait is not being used effectively or that the conditions they are held on-board the fishing vessels are poor and a high percentage is dying…. Catch monitoring of the pole-and-line fishery has shown that there has been a decline in baitfish production, which appears to be related to handling methods and increasing human consumption."
- Ingles et al. (2007), based largely on interviews with fishers, states: "The declining trend of landed baitfishes is a serious threat to the tuna fishery. The scale of the problem is not limited to North Sulawesi, Moluccas, Tomini, and Flores Seas but appeared to be happening in a lot of places as well".
- After the completion of the ACIAR project, there has been little government monitoring of baitfish catches, but as the pole-and-line fleets in Indonesia have declined about 24% in number since the height of the fishery two decades ago, total baitfish catches in Indonesia are likely to have declined a similar amount.

The results of any baitfish stock assessment work

- The ACIAR study of tuna baitfish in eastern Indonesia was carried out 1995-2000 and involved (1) Analysis of existing baitfish catch record data for Sorong, Ambon, Bacan and Bitung. Data were from as far back as the mid-1970s, and (2) Stock assessment of anchovies in the bait grounds of Sorong, Ambon and Bacan. The study used primarily the daily egg production method to estimate anchovy biomass. The report of the study stated:

  "The data suggests that natural fluctuations in anchovy biomass exceed the amount of baitfish taken by the fisheries. Periods of short supply will occur even at low exploitation rates. The data have shown that the daily tuna catch rates have declined since 1991 along with the amount of bait being used. We have shown that this is unlikely to be due to overfishing the baitfish resource. Rather, it appears to reflect the increasing demand for these fish by humans, so that during periods of naturally low baitfish abundance, the pole-and-line fishery cannot get sufficient bait."
- Ingles et al. (2007) state: "Anchovy catch data in Fishery Management Areas that have pole-and-line fisheries do not show a clear trend over the period 2000-2004. One cannot conclude whether pole-and-lining actually affected anchovy stocks. However, there is *potential* for such an effect."
- Government stock assessment specialists indicate that no new stock assessment and little resource monitoring have occurred since the completion of the ACIAR study.

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- Fisheries management in Indonesia is under the joint responsibility of the Ministry of Marine Affairs and Fisheries and the provincial and district governments. Law Number 22 of 1999 devolves authority for government management, including fisheries. That law states that the authority for fisheries "exploration, exploitation, conservation, and management" is devolved to the provincial level (for activities within 0-12 nautical miles) and district level (0-4 miles).
- Law No.31 of 2004 Concerning Fisheries has replaced Law No.9 of 1985 on Fisheries, and according to government officials the newer law represents a more appropriate legal basis for fisheries management.
- With 33 provinces and 405 districts, the situation is complex. About 60 districts are involved with live-bait tuna fishing.
- Flewwelling and Hosch (2004) state that informal local fisheries policies in some areas come from traditional, unwritten laws handed down from generation to generation. These are referred to as "traditional law" or locally as *sasi or adat.*

The major concerns that management should address

- Catch variability: The big problem with the baitfishery is the fluctuation in catch levels – but much of the variation is likely to be due to factors other than baitfish catches.
- Catch declines: This does not appear to be due to declining bait resources, but competition for bait between the pole-and-line fishery and the human food industry, with the latter taking the larger share.
- Revenue generation: Various levels of government have the expectation of the baitfishery producing cash.
- Conflict between fishers: Some pearl farmers complain that baitfishing disturbs culture operations and produces security risks. There is at least some conflict between the operators of *bagan*s and of small purse seiners.
- Bait wastage: Research shows poor baitfish handling and storage techniques.
- Juvenile reef fish: There is growing concern that the use of juvenile reef fish as bait has large negative consequences.

Current management of the baitfishery, objectives and the main fisheries management tools used

Many stakeholders state there is no current management of the fishery. When the subject is probed in conjunction with a broad definition of management (i.e. are there rules governing the baitfishery?) some aspects of management emerge:

- At the district level all baitfishing operations are licensed and it appears that the main management objective of that licensing is the generation of government revenue through payment for the license. This is applicable to most fisheries in Indonesia, and is not a specific requirement for baitfishing.
- Exclusion of fishing in marine protected areas is applicable to baitfishing as well as other types of fishing, but in places the concept suffers from jurisdictional issues.
- There is some notion among stakeholders that baitfishing operations cannot move between districts, or at least require authorization to do so, but those stakeholders have difficulty in attributing this restriction to a specific legal instrument.
- "Ministerial Rule Number 2 of 2011 on Fishing Zones and Placement of Fishing Gear" has provisions that affect *bagan*s: mesh size, light intensity, and zonation for distance offshore by registered tonnage of vessel. This rule appears to be addressing the objectives of resource sustainability and reduction of conflict – but there is little awareness of this law among baitfishery stakeholders.
- In Ambon there exist traditional management structures for fisheries, some of which are applicable to the baitfishery.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- The development of a suitable research and management plan for the baitfisheries was an objective of the ACIAR Indonesia baitfish project (1995-2000). Policy recommendations for the conservation of baitfish resources were agreed by participants at a baitfish workshop, and some form of prototype plan was produced, but it was not implemented.
- Fishery management plans with their specified objectives are not a general feature of fisheries management in Indonesia. Often management objectives must be inferred by fisheries legislation.
- Few, if any, fisheries in the country are managed by a management plan. Some partial exceptions are:
  - 13 years ago FAO sponsored a workshop in Indonesia and produced the "Draft Management Plan of Lemuru Fishery in the Bali Straits". The document was discussed/modified and there have been attempts at implementation, however the consensus appears to be that the plan has not been fully implemented – but it is still cited by many fishery stakeholders as the most significant example of an Indonesian fishery management plan.
  - The Capture Fisheries Directorate General produced a "National Tuna Management Plan" in November 2010" but jurisdictional issues within the Ministry stalled the plan.
  - Independently, another effort to produce a national tuna management plan has come from the MSC process.
  - Fishery management plans (e.g. "Fishery management plan for the Arafura Sea") have been prepared for the 11 fisheries management areas of Indonesia, but those plans do not appear to have created much change ("Just a document", "descriptions of what fisheries exist"). As they have no legal basis for adherence, they have been described as "guidance at best".

The type of fishery management plan [not applicable]

The elements of the plan [not applicable]

Does the management plan have a legal basis or is it an advisory document? [not applicable]

Information on plan effectiveness [not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

The main constraints to formulating and implementing a fishery management plan:

- The management of the vast majority of baitfishing (and most other inshore fisheries) is located in areas under the

jurisdiction of the districts – and there are about 60 districts where baitfishing occurs. Making those government entities aware of the need for, and benefits of, fishery management plans would be an enormous task, not to mention plan implementation. "Cannot imagine getting delegates from 60 districts together to discuss/agree on baitfish management."

- As the district governments often behave like "stubborn old men", outside pressure not likely to be productive.
- From a national perspective, there is little heritage in Indonesia of the use of fishery management plans and the attempts to introduce such plans have not yielded much success. In terms of priorities for making radical changes to fisheries management schemes, the baitfisheries are relatively unimportant on the national scale and therefore would not receive much priority.

The advantages of the management plan approach:

- Transparency, encouragement of stakeholder participation, clarification of nebulous processes.
- In a country with little management of any fishery resources, a management plan can be an effective tool for educating fisheries officials.
- Several agencies are currently promoting fishery management plans in Indonesia: WWF, IMACS

The main institutional and procedural difficulties in the management of the baitfishery

- Management control has been devolved to the district level for inshore fisheries such as baitfishing, but there is limited capacity and interest in pursuing management objectives except generating revenue.
- Little heritage in Indonesia of the successful introduction of fisheries management in any fishery
- Catch data was reported to be poor in the ACIAR days (large under-reporting); the quality is likely to have declined in recent years.

Can an outside agency assist in improving the management of the baitfishery?

- There is some feeling among stakeholders that assistance is required in using baitfishing research in Indonesia and elsewhere to formulate management measures (e.g. minimum space between *bagan* operations).
- One government official cited the bluefin/CCSBT situation as a successful example of an outside agency pushing for management reform. Others indicated that the example was for something under national management jurisdiction for an export product, whereas baitfish management is under district government control and less sensitive to controls applied through export markets, and any external pushing would be futile.
- Another person cited WWF's successful dual efforts in encouraging longliners based in Bali to use circle hooks: educating fishers and applying pressure.
- It is conceivable that baitfish management plans could be introduced and could be effective at improving management, but (a) the introduction would need to occur at the district level, (b) such an exercise would necessarily take place in district(s) where baitfishing is important, (c) would take a considerable amount of time, and (d) would require outside resources as baitfishing is relatively unimportant in the country.
- WWF staff feel that the involvement of the private sector and markets is essential for management improvements.

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Japan

Information on the major live-bait pole-and-line tuna fisheries in the country

- Uosaki et al. (2011) indicate in recent years the annual Japanese pole-and-line tuna catch in the WCPFC Convention Area has been about 100,000 tonnes by "vessels greater than 20 GRT". According to official statistics, in 2010 the tuna catch by pole-and-line vessels less than 20 GRT was 10,384 tonnes. This estimate (about 110,000 tonnes/yr) is substantially lower than that given in Miyake et al. (2010).
- Japan's pole-and-line fleet is comprised of three size categories of vessels: distant water boats (>120 GRT), offshore (20-120 GRT), and coastal (< 20 GRT). JFA license records show there are 26 distant water and 62 offshore vessels currently operating. Industry representatives estimate there are now around 30 active coastal pole-and-line vessels.
- Hamilton et al. (2011) state that all distant water pole-and-line vessels are family owned businesses based in Kesennuma, Yaizu and Kagoshima. The offshore vessels market their catch in three main ports: Omaezaki (Shizuoka prefecture), Katsuura (Chiba) and Kesennuma (Miyagi). Most coastal vessels operate in relatively calm water, especially near the islands southeast of Kagoshima and east of Shizuoka.
- Operationally the pole-and-line vessels move north/south with the seasons and range widely off the Pacific side of the country. The vessels are registered in a specific port, but the location of the landing of the catch varies seasonally, with bait being purchased mostly close to the landing sites.
- Pole-and-line vessels themselves were not destroyed by the 2011 tsunami (which occurred in March when the skipjack fishing was mainly in the south) but much supporting infrastructure was lost.

The various baitfishing operations: types of operations, size of operations and techniques

- Pole-and-line vessels do not participate in the capture of baitfish, but rather they purchase it from specialized baitfishing operations.
- Currently about half of the live bait for pole-and-line fishing is from small-scale purse seines (mostly two-boat operations), and about half from set nets. Kaneda (1995) refers to the latter as "gourd-shaped set nets".
- Baitfish are not transferred directly from baitfishing operations to pole-and-line vessels, but are stored in pens ("ikesa") floating in the sea and transferred when requested by the pole-and-line vessels.
- Yoshida et al. (1977) indicate there are over 60 areas in Japan that produce live bait for pole-and-line tuna fishing. More recently Akimoto (2004) shows 32 baitfishing areas which are located in 17 prefectures.
- Baitfishing by purse seining is more common in the south of Japan and set netting in the north.
- Many set net baitfish operations in the north were destroyed during the 2011 tsunami.
- Although no pole-and-line vessels are based in Tokyo Bay, that area produces about 30% of all the baitfish in Japan. Factors responsible are the high productivity of the bay and the fact that much skipjack is landed in the area. There are records of baitfishing for pole-and-line fishing in Tokyo Bay that date from the 1700s.
- The fishing operations that produce the live baitfish for pole-and-line fishing are not exclusively focused on anchovy for the pole-and-line market; most of the anchovy catch is used for human consumption and some for recreational fishing and other uses. Those fishing operations also target non-anchovy species, including mackerel and jack mackerel.

The major baitfish species

- Yoshida et al. (1977) states that about 97% of the live bait used for pole-and-line tuna fishing is the Japanese anchovy (*Engraulis japonicus*, "katakuchi iwashi"). Other species include sardines (*Sardinops melanosticta*), scad (*Decapterus muroadji*), and the juveniles of the mackerel (*Scomber japonicus*). The report cites an average tuna-to-bait ratio of 9.7 to 1. In the 1970s about 10% of the total anchovy catch in Japan was used for live bait.
- JFA officials indicate that the vast majority of bait currently used for pole-and-line fishing is the Japanese anchovy.

The recent trends in the baitfishery, including trends in catches

- Akimoto (2004) documents the decline in the users of the live-bait: 1973 there were 2,294 pole-and-line vessels of all sizes in Japan while in 1998 there were 786. JFA license records show 88 medium/large vessels are presently licensed. Industry representatives estimate there are currently around 30 coastal pole-and-line vessels operating in the country. The pole-and-line fleet in 2012 is therefore about 5% of its size four decades ago. The use of bait for pole-and-line fishing is likely to have also declined remarkably,
- Yoshida et al. (1977) states that in 1968 about 225,000 tonnes of anchovy were taken in Japan, about 10% of which was sold as live bait. JFA catch records show that in the most recent decade the total annual catches of anchovy ranged from 381,000 to 535,000 tonnes. Due to the decline of the pole-and-line fleet, it is likely that a much smaller percentage of the total anchovy harvest is now used as live baitfish than in the 1970s.
- The tuna-to-bait ratio cited above, in conjunction with recent annual tuna landings by pole-and-line vessels cited above, suggests that the quantity of baitfish currently used for pole-and-line fishing is around 11,000 tonnes annually. This equates to less than 3% of the annual anchovy harvest.
- There is the notion that live baitfish sales for recreational fishing have increased.
- One live-baitfish dealer predicts that if the number of pole-and-line vessels buying bait in Tokyo Bay declines below 40, fishing for baitfish in the area will not be viable.

The results of any baitfish stock assessment work

- AFFRC (2011) summarizes recent stock assessment work on the Japanese anchovy (*Engraulis japonicus*). The report [in Japanese] concludes that the stock condition is stable and that fishing activity has little effect on stock size.
- It should be noted that anchovy catches for use as bait is currently a very small component of the total anchovy catch in Japan.
- Asada et al. (1983) in commenting on small pelagic species in general in Japan states; ''These species are subject to wide fluctuation in abundance over time due to a high mortality rate in the younger life stages. These fluctuations

correlate with natural causes rather than with fishery exploitation. Over-exploitation by fishing has not been a matter of serious concern."

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- Baitfisheries are not the unit under management but it is the gear type. Rather than "management of the baitfishery" it should be referred to as the management of the small-scale purse seine fishery and the management of the set net fishery. Species associated with some resource concern are also subject to management (by TAC) and could be considered a management unit.
- OECD report (2003) states "Japan employs multiple layers of fishery resource management procedures. The Fisheries Law stipulates the basic system concerning fishery operation. It provides rules and regulations for fisheries by establishing (i) a national licensing system, (ii) the prefecture governor's licensing system, and (iii) right based management system."
- The role of the national government in the management of the small-scale purse seine fishery and the set net fishery is largely limited to establishing an overall framework for the management and vessel licensing. Other aspects are the responsibility of prefectural governments or of fisheries associations.
- Ruddle (1987) comments on prefectural level fisheries management in Japan in a general sense: "Detailed regulations to control fishery operations and to ensure the conservation and rational exploitation of living aquatic resources are established, as required by local conditions, by the prefectural fisheries agency. Essentially, such regulations define closed seasons and other limitations for the various fisheries, control the kinds of gear and methods that may be employed by professional fishermen as well as those specifically for recreational fishing, establish the minimum exploitable sizes of particular marine animals, specify closed areas for the purpose of resource conservation, and set various associated rules."
- Asada et al. (1983) give information on the role of the fisheries associations in fisheries management in Japan in a general sense: "Japanese fisheries policy lays great stress on the management of fisheries resources and fishing grounds by the fishermen themselves, which is viewed as rational and desirable, and seeks to ensure implementation of this approach on a democratic basis. In this respect, the cooperative associations play a leading role in fisheries management."
- As an example of the above related to baitfishing, JFA officials indicate that the areas to be designated for small-scale purse seining and set netting are mostly put forward by fisheries associations to prefectural governments for approval.
- If a TAC is to be set for anchovies, it would be the responsibility of the national government. JFA officials state that no such quota has been established for anchovies, but harvest volumes are monitored under prefectural regulations

The major concerns that management should address

- Asada et al. (1983) states that the leading concern in the management of the various fisheries in the country has been the democratic and harmonious allocation of fishing effort in balance and conformity with the productivity of fishery resources.
- Specifically with respect to baitfishing, JFA officials indicate that most disputes arise due to ambiguities of boundaries.
- The most important management issue related to baitfishing appears to be the potential conflict between the users of different gear types – and much management attention is focused on separating purse seine and set net fishing operations.
- There do not appear to be many concerns over the level of the anchovy resource because it is thought that fishing mortality is a small component of total mortality and baitfishing is a small (and declining) component of fishing mortality.
- There does not appear to be conflict over the bait vs food use of anchovy - the same fishers sell to both markets.
- Fisheries management cannot resolve some of the major difficulties related to the future of baitfishing in Japan: the price of fuel and the sharp decline in the number of pole-and-line boats.

Current management of the baitfishery, objectives and the main fisheries management tools used

- Historically, Japanese fishery management methods were based on input restrictions such as (1) the creation of entry limitation to fishery operations, (2) the establishment of closed areas and closed seasons, (3) prohibition on specific gear use (including mesh size restrictions), and (4) restriction on size or horsepower of fishing vessels. In many respects fishery management in Japan equates to input control (OECD (2004). This situation changed in the 1990s with the introduction of TACs for some important species at the national level – but this has not included the anchovy.
- The management of the small-scale purse seine fishery and the set net fishery are oriented to several objectives, including reducing conflict among users, resource conservation, and promoting economic efficiency. As to the anchovy component of the catch, biological concern is not prominent due to the perception of the stable resource level – but it is important to note that the two fisheries often target species where there is some resource concern, such as mackerel, jack mackerel, and squid. TACs have been set for those species, and therefore form part of the fisheries management scheme for the small-scale purse seine fishery and the set net fishery.
- The specific measures for the management of the small-scale purse seine and set net fisheries vary between the 17 prefectures. One of the most prevalent features is the partitioning of areas into those reserved for purse seining and those for set netting. Small-scale purse seining is often prohibited close to shore – presumably to avoid interaction with other types of fishing. Other common management measures for these two fisheries are restrictions on target species, mesh sizes, fishing seasons, vessel sizes, and vessel numbers. Most of these measures are characteristically introduced by prefectural governments.
- Another major feature of the management of coastal fisheries in Japan (including those that target anchovy) are discussion forums – for coordination at the village, prefecture, and national levels.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- According to JFA officials, fishery management plans in Japan are species-oriented and formulated only for those species where there is some resource concern and the plans are oriented to recovery. Currently, there are such plans for a few species (e.g. mackerel, jack mackerel, and squid) sometimes targeted by the same gear that catches anchovy.
- Currently, no fishery management plans exist for anchovy – due to the absence of major resource concerns.
- Perhaps the closest arrangement to fishery management plans that is applicable to anchovies is the "gyogyo chosei kisoku", or fishery coordination rules – a document, published by each prefecture, which contains the legally enforceable rules for the management of the fisheries.

The type of fishery management plan [not applicable]

The elements of the plan [not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan? [not applicable]

Information on plan effectiveness

- Although no fishery management plans exist for anchovy, there is the perception among stakeholders (fishers, traders, government officials) that the management system is very effective. The absence of major complaints was cited by those stakeholders as an indicator of success. The fact that the fishers themselves are major drivers of the management process appears to be a key factor in the effectiveness of the system.

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- Attempts to improve the management of the fisheries in Japan that produce bait by introducing fishery management plans would appear to be a case of "If it's not broken, why fix it ?".
- Stakeholders state that there is a long heritage in Japan of the current form of fisheries management and there appears to be little reason to move towards a system in which fishery management plans play a large role.

The main institutional and procedural difficulties in the management of the baitfishery

- One of the main disadvantage of the Japanese system of coastal fishery management is the large amount of time required for the consultation process among the relevant stakeholders and levels of government.
- The large reliance on input controls is also perceived as a drawback by some stakeholders.

Can an outside agency assist in improving the management of the baitfishery?

[not applicable]

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USA, West Coast

Information on the major live-bait pole-and-line tuna fisheries in the region

- Annual tuna catches in the US west coast albacore fishery have been about 10,000 to 12,000 tonnes in recent years. Childers and Betcher (2010) state: "Albacore troll catches contain an unknown proportion of pole and line catch".
- Stocker (2005) shows that USA north Pacific pole-and-line albacore catches peaked in the late 1960s.
- Most commercial albacore fishermen use either troll or pole-and-line (baitboat) gear to harvest albacore and generally fish from mid-June to October. Because the last of the canneries in California have closed and albacore populations have shifted northward with changing oceanographic conditions, the bulk of the albacore catch now comes from Oregon and Washington. In 2010, the total harvest off the West Coast was worth over $29.5 million. (NMFS 2012)
- Precise data is not available, but NMFS staff indicate that about 400 to 600 vessels participate in the commercial albacore fishery, of which less than 100 vessels use live bait. A commercial fisherman (B.Bixler, per.com.) estimated that (a) about 50 boats use live bait, (b) the number of "large boats" (> 50 GT) to be about 12 to 14, and (c) about 2/3 of the US west coast albacore catch is made using live bait.
- Live bait is used for albacore fishing while fishing "on the coast", which is usually less than 150 nautical miles offshore. Further offshore, livebait is much less effective and therefore troll gear is used.

The various baitfishing operations: types of operations, size of operations and techniques

- Most of the bait for livebait albacore tuna fishing is captured by lampara net, used in conjunction with a skiff. Operations normally occur in shallow water (i.e. less than 6 fathoms). Fish are scooped out of the lampara net using a small volume dip net, generally able to hold five to eight pounds of anchovies.
- The baiting operation normally occurs during the day as night baiting results in greater mortality of the catch.
- A commercial fisherman (B.Bixler, per.com.) says that the albacore fleet did much of its baiting in former years in Mexican waters (now prohibited) and along the California coast. With the movement of the albacore fishing northward in recent years, Westport Washington could be considered as the major baitfishing area.
- The tuna baitfishery is based on a resource that is primarily used for other purposes. In US waters the resource is also used for human consumption and for sportfishing bait.
- The statistical information on anchovy catches usually does not distinguish between the various bait uses: (a) dead/packaged bait, (b) live bait for recreational fishing, and (c) live bait for commercial tuna fishing.
- PFMC (2011) suggests that baitfishing for sportfishing is much more significant than that for commercial tuna fishing: (a) Approximately 18 live bait vessels in southern California and two vessels in Oregon and Washington landed about 4,000 mt per year of coastal small pelagics (mostly northern anchovy and Pacific sardine) for sale to recreational anglers, and (b) Roundhaul vessels take a maximum of 1,000 mt to 3,000 mt per year of northern anchovy that are sold as dead bait to recreational anglers.
- In the 1950s and 1960s the annual US west coast catch of the northern anchovy reached 50,000 tonnes in several years. PFMC (2011) indicates that in the decade of the 2000s, total annual anchovy catches in California, Oregon and Washington ranged from 1,676 to 19,277 tonnes. Annual catches in Mexico reached a maximum of 250,000 tonnes in the 1980s but have been less than 5,000 mt in the mid-2000s.

The major baitfish species

- The target species is the northern anchovy (*Engraulis mordax*).
- Pacific sardine (*Sardinops sagax*) is also used but fishermen indicate that sardines are not as good for live bait as anchovies due to their action in the water after being broadcast.
- The Pacific Fisheries Management Council website states that the northern anchovy is a small, short-lived fish that is typically found in schools near the surface. Anchovies are found from British Columbia to Baja California and have recently appeared in the Gulf of California. Northern anchovies are divided into northern, central, and southern sub-populations. The central subpopulation (San Francisco to Baja California) used to be the focus of large commercial fisheries in the U.S. and Mexico
- Neither NMFS staff, nor fishermen are able to make an estimate of the annual catch of anchovies for live bait tuna fishing, but both groups agree that the catch of anchovies for albacore fishing is small compared to the total catch.

The recent trends in the baitfishery, including trends in catches

- NMFS staff indicate that two trends in albacore fishing impact the livebait fishery: (1) albacore have tended to move closer to the coast in recent years (where livebait fishing is most effective), and (2) the schooling behaviour of albacore has changed somewhat, making livebait fishing more effective.
- Fishermen state that the number of small albacore boats equipped with live bait wells has increased in recent years.
- Fluctuations in anchovy abundance appear to be as a result of changes in oceanographic conditions, rather than from fishing pressure. El Niño conditions have a negative effect on anchovy abundance.
- There appears to be a cyclical relationship between anchovies and sardines displacing each other. In the current decade sardines are dominating.

The results of any baitfish stock assessment work

- NMFS (2012) states: "While anchovy are thought to be abundant, there is no current information on the status of northern anchovy populations. Anchovy fisheries are managed based on annual harvest data. Scientists monitor harvest of northern anchovy, and the harvest has been low in recent years."
- The latest Coastal Pelagic Species Fishery Management Plan (PFMC 1998) states: "Recent biomass estimates (fish age over one year) for the central anchovy subpopulation from 1964 to 1995 showed that the biomass averaged 326,000 tonnes until 1970, increased to 1,596,000 in 1974, and then declined to 521,000 in 1978. During the early 1990s biomass declined to about 150,000 tonnes and then increased to 388,000 tonnes in 1995. No new stock

assessment has been made, but available evidence indicates that the 1997 abundance is at least as high as in 1995….MSY for the northern anchovy in the central population has been estimated to be 123,000 tonnes per year at a biomass level of about 733,000 tonnes. MSY should be viewed as a rough indicator of stock productivity, rather than a management goal because stock size can change dramatically from year to year."

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The Magnuson–Stevens Act is the primary law governing marine fisheries management at the USA federal level.
- The baitfishing for live bait albacore fishing is not managed as a discrete fishery, but rather the management unit is all fishing activity for the northern anchovy.
- The management responsibility for the northern anchovy (and other coastal pelagic species) is shared between the US federal government (Pacific Fisheries Management Council) and the states of Washington, Oregon, and California. This is because some fishing activity occurs within 3 miles of the coast (which is under state fisheries management jurisdiction) and some further offshore (which is under federal jurisdiction). In practice, there is considerable coordination between federal and state authorities to assure conformity.
- Characteristically, federal regulations are worded to allow joint management. As an example, the fishery management plan (FMP) covering the northern anchovy states "This FMP authorizes the use of net gear, hook and line, pots (traps), longlines, and any other type of gear as legal for the harvest of coastal pelagic species, unless specifically prohibited by state law."

The major concerns that management should address

- According to fisheries managers, considering the current low level of fishing effort, there are not many "hot" management issues. There is some concern over commercial-sport interactions and the effect on the ecosystem of the removal of a forage species. There are, however, several "forage fish campaigns" by organizations such as Pew, Oceana, and others that stress the need for greater active and/or conservative management of coastal pelagics.
- Concerns related to the management of the northern anchovy and other small pelagics off the US west coast are to some degree conditioned by the spectacular collapse of the Pacific sardine. At the high point (over 600,000 tons landed in California during the 1936–37 season) it was the largest fishery in the western hemisphere, but due to a combination of factors (including failure to restrict fishing activity) the catch degraded to virtually zero in the 1960s.

Current management of the baitfishery, objectives and the main fisheries management tools used

Federal level

- The coastal pelagic species fishery management plan (the federal-level plan covering the northern anchovy) distinguishes between "actively managed" and "monitored" species. Actively managed species (Pacific sardine and Pacific mackerel) are typically assessed annually. Seasonal closures and allocations, incidental landing allowances, and other management controls are used. The other coastal pelagic species covered by the plan (northern anchovy, jack mackerel, and market squid) are monitored to the extent that stock information is available, and management benchmarks have been established. (PFMC 2011)
- For the northern anchovy the annual overfishing limits established by the Council for the northern subpopulation and central population are 39,000 tonnes and 100,000 tonnes, respectively (PFMC 2011). Current total annual US west coast catches (in recent years from 1,676 to 19,277 tonnes) are far from those overfishing limits.
- Should landings increase, the Council may recommend elevating the northern anchovy to the active management category for assessment and regulatory considerations.
- Should the northern anchovy be actively managed at the federal level, the objectives of the management are likely to be similar to those applicable to other coastal pelagic species in the latest fishery management plan: Promote efficiency and profitability in the fishery, including stability of catch; Achieve optimum yield; Encourage cooperative and interstate management; Accommodate existing fishery segments; Avoid discard; Provide adequate forage for dependent species; Prevent overfishing; Acquire biological information and develop long term research program; Foster effective monitoring and enforcement; Use resources spent on management efficiently; Minimize gear conflicts.
- The plan also specifically states: "The highest priority of the plan is to provide for the conservation of the resource."

State level

- In Washington State (where most of the current live bait fishing for albacore occurs) new rules restricting northern anchovy catch and disposition were adopted in 2010. The new rules limit the catch, possession or landing of anchovy to 5 mt daily and to 10 mt weekly. In addition, the rules limit the amount of anchovy taken for reduction (or the conversion of fish to products such as fish meal or fertilizer) to 15% of a landing by weight. These new rules have the objective of discouraging the development of high-volume fisheries for anchovy while accommodating traditional bait fishing activity. Additional rules for anchovy fishing, such as gear and seasonal restrictions, apply to some specific areas (e.g. Puget Sound, Columbia River).
- In Oregon rules were relaxed in 2009 to allow capture of northern anchovy in a limited number of estuaries. This harvest of anchovy is limited to commercial vessels that use the anchovy as live bait in commercial fishing operations on the catching vessel. The gear used to capture anchovy is restricted to purse seines with a maximum length of 50 fathoms (300 ft), lampara nets, and hook and line. During anchovy fishing all other species must be released unharmed. The live bait fishery is open from July 1 to October 31.
- In California many of the restrictions concerning anchovy fishing are oriented to mitigating the interactions between commercial and sport fishing interests. With anchovies being displaced to some degree by sardines and with the associated fall in anchovy fishing effort, scrutiny of the anchovy fishery has declined.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have

management plans?

- In terms of general US requirements for fishery management plans, the Magnuson-Stevens Act is the principal law governing marine fisheries in the United States. The Act includes national standards for management and outlines the contents of fishery management plans. According to the NMFS website as of 2010 there were 528 individual fish stocks managed within 46 federal fishery management plans. (NMFS website)
- There is no management plan specific to the fishery for bait for albacore fishing, but rather a fishery management plan that covers several US west coast coastal pelagic species, including the northern anchovy.
- The current Coastal Pelagic Species Fishery management plan (CPS FMP) is an outgrowth of the Northern Anchovy Fishery Management Plan, which was implemented in September 1978. The Pacific Fisheries Management Council began to consider expanding the scope of the northern anchovy FMP in 1990, with the development of the seventh amendment to the FMP. In March 1995 the Council decided to proceed with developing an FMP for the entire CPS fishery. The latest amendment to the plan was published in the Federal Register in July 2009.
- The CPS fishery includes four finfish species, market squid, and krill: Pacific sardine (*Sardinops sagax*), Pacific (chub) mackerel (*Scomber japonicus*), Northern anchovy (*Engraulis mordax*), Jack mackerel (*Trachurus symmetricus*), Market squid (*Loligo opalescens*), and Krill (*Euphasiid spp*.).

The type of fishery management plan

- With respect to the management of baitfishing for albacore fishing, a major feature of the plan is that it specifies few management measures directly related to anchovy, but rather stipulates that the catch be closely monitored and should landings increase significantly or exceed an annual catch limit, the level of management would change. In this case anchovy fishing would move from the category "monitored" to "actively managed", and various measures such as seasonal closures and allocations, incidental landing allowances, and other management controls could be used.
- Another important aspect of the plan is that it establishes a framework for management, rather than specifying all the details of management interventions. The plan states that "management measures may be imposed, adjusted, or removed at any time during the year. Management measures may be imposed for resource conservation, social, or economic measures consistent with FMP procedures, goals, and objectives".
- As an example of the above feature, the plan does not specify what permits are required but rather states "separate permits or endorsements may be required for harvesting and processing or for vessels or for facilities based on size, type of fishing gear used, species harvested or processed, or other such factors that may be appropriate."

The elements of the plan

- At the general level, the plan conforms to the Magnuson-Stevens Fishery Act (MSA) requirements for fishery management plans, including stating purpose and need, how action will address the purpose and need, what the impacts will be across the biological, physical and human dimensions, why it is consistent with the MSA and other national Standards, and how it is consistent with other statutes and executive orders.
- The fishery management plan has five sections: Introduction (including a history of the plan and objectives), the framework for management (including types of management interventions), limited entry, optimum yield and MSY, and bycatch, incidental catch and allocation.
- An important feature of the CPS fishery management plan (and all management plans under the MSA Act) is that it specifies the criteria that determine when a stock is overfished.
- What is *not* included in the plan is notable: (1) Being a framework, the plan does not contain all of the specific federal management measures (2) The plan does not include all the fisheries management measures of the three states.

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

- The plan itself does not have the force of law, but the Magnuson–Stevens Act gives the Secretary of Commerce power to review, approve, and implement fishery management plans developed by the regional councils.

Information on plan effectiveness

- No information is readily available on the effectiveness of the plan on meeting its objectives.
- The fact that the plan does not contain all management measures applicable to the concerned fishery (i.e. it is a framework plan) limits its usefulness as a model for other locations in the world.

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach? [not applicable]

The main institutional and procedural difficulties in the management of the baitfishery

- Currently, there is little need for active management at the federal level. At the state level many difficulties appear to arise in reconciling differing objectives of the various stakeholders.

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Brazil

Information on the major live-bait pole-and-line tuna fisheries in the country

- ICCAT statistics indicate that in the 5-year period 2006-2010 the Brazilian baitboat (pole-and-line) fleet caught an annual average of 19,047 tonnes of skipjack (94%), yellowfin, bigeye, and albacore.
- Heriberto et al. (2000) show that annual skipjack catches peaked in 1985 at about 25,000 tonnes and the number of live-bait tuna boats peaked at 102 in 1982.
- Representatives of the fishing industry state that in recent years annual skipjack catches have been fairly constant at about 25,000 tonnes. Livebait tuna vessels are now based in three locations in southern Brazil: Itajai (about 20 vessels), Rio de Janeiro (14), and Rio Grande (7).
- Catches of the pole-and-line fishery have been constrained by the limited availability of young sardines, which are the preferred live bait but also a source of a bitter and unresolved conflict with sardine purse seine skippers who catch for canning (Castello et al. 2009).

The various baitfishing operations: types of operations, size of operations and techniques

- Currently bait for pole-and-line tuna fishing is captured close to the coast by "mini-purse seine gear", mostly using two skiffs. At present all pole-and-line vessels do their own baiting (i.e. no bait is purchased from other vessels). A typical bait net measures 300m x 30m. Most baiting occurs during the day but is sometimes done at night. Typically, a pole-and-line vessel takes on a load of 2,000 kg of bait, but some vessels can hold 3,000 kg. The best period for fishing for the preferred bait (sardine) is February to May. A total of about 1,000 to 1,400 tonnes of bait is taken annually by the pole-and-line fleet. (M.Bailon, A.Llopart, per.com.)
- Jablonski (2007) describes the purse seine sardine fishery which shares the same resource as the live-bait fishery. It is carried out by the purse seine fleets based in the states of Rio de Janeiro, São Paulo and Santa Catarina. It is directed to schools near the surface, covering from shallow areas to those with maximum depths of 70 meters, and around 30 nautical miles from the coast. The number of sardine boats increased until the 1980s, when the fleet came to a record of around 500 boats. In 2007 there were 300 active boats. Despite the significant reduction of the fleet size, the remaining boats are characterized by an elevated fishing power (larger boats, equipped with sonar, power-block and bigger nets, favoring fishing in deeper areas). This high fishing effort when applied in periods of low abundance of the stock (resulting either from overfishing or environmental factors) puts the fishery at risk (Jablonski 2007)
- The Brazilian sardine purse seine fishery had a maximum catch of 230,000 tonnes in 1973, but declined to 22,000 tonnes in 2000. The decline was attributed to overfishing and to recruitment failure due to high larval mortality in some years. (Kurtz and Matsuura, 2001).
- SINDIPI (2012) shows that the total Brazilian catch of sardines in the previous decade fluctuated from 22,000 to 83,000 tonnes.
- The fishery for sardines for live bait tuna fishing is responsible for a relatively small proportion of the total amount sardines captured in Brazil. If an annual tuna vessel bait catch of 1,200 tonnes is assumed, then in the previous decade the sardine bait catch amounted to 1.4% to 5.2% of the total sardine catch. An important point is that the baitfish catch consists mainly of juveniles, whereas the purse seine fishery (by regulation) is for adults.

The major baitfish species

- The main target of the baitfishery is the Brazilian sardine (*Sardinella brasiliensis)*. It occurs in the area between Cabo de São Tomé (22º S) and Cabo de Santa Marta (29º S).
- Two other species of clupeoid and three species of anchovies are sometimes used as bait (especially during periods of low abundance of sardines), but over 80% of the bait used for live bait tuna fishing is the sardine. Sardines are especially appreciated by tuna fishermen due to high survival rates in the bait tanks of tuna vessels.
- There is on-going work on the use of cultured fish species (e.g. tilapia) and alternate wild species (e.g. anchovy) as bait to compensate for periods of low abundance of sardines.

The recent trends in the baitfishery, including trends in catches

- Because annual catches of skipjack by live bait fishing have been fairly constant during the previous decade, it is assumed that total production of baitfish for live bait fishing has not fluctuated greatly.
- With respect to the larger purse seine sardine fishery, Gasalla and Tutui (2003) state that in the early seventies, government subsidies stimulated fisheries investment. In 1973, sardine landings reached about 228 kt, after which catches trended downward until the 1990s . Between 1975 and 1987, production values oscillated about 128 kt, and between 1988 and 1996, medium values reached only 65 kt. In 1988, a sardine stock collapse was recognized, and technical working groups proposed severe recommendations for fishery management. Catches have shown some signs of recuperation after the lowest point of 32 kt in 1990.
- Fluctuations in the catch during the past 50 years have been noticeable and can be related to excessive fishing pressure and unfavourable events during the egg production or in the initial development of the fish larvae.
- As has occurred in other regions in the world with similar current structures (e.g. California), the decline of the sardine resource has been accompanied by an increase in the anchovy population.

The results of any baitfish stock assessment work

- The Brazilian sardine is probably the most studied marine fish resource in the country. There is a massive collection of papers, theses and studies on its biology, feeding habits, biomass and population structure (Jablonski 2007).
- Cergole (1995) states that stock assessment of the Brazilian sardine has been carried out based on analysis of length frequency composition. The data were collected from commercial catches throughout the Brazilian south-eastern coast between 1977 and 1992. Age length keys were obtained by otolith ring counting and used to transform the length frequency data into age composition. Growth parameters and instantaneous mortality coefficients were estimated using age and length data. The growth parameters were: $L\infty$= 271 mm TL and K= 0.59 year-l. The mortality coefficients were: Z= 3.60 year-l, M= 0.96 year-l and F= 2.64 year-l. Stock size was estimated by Virtual Population

Analysis. It was possible to define two periods: one from 1977 to 1986 showing a relative steady state; the other from 1986 on, indicating a sharp decline in recruitment(R) and spawning stock biomass (SSB) and an increase in the fishing mortality coefficient (F). In the equilibrium period, the stock size (B), SSB and R values were estimated as 668 thousand tons, 255 thousand tons and 12.0 x 10^9 fishes, respectively; on the other hand, in 1989, these estimates were 213,000 tons, 100,000 tons and 3.0 x 10^9 fishes. The decrease was related to a combination of environmental and fishing events, the last being the predominating factor.

- Stock specific reference points, such as MSY and optimal effort levels, have been estimated for most of the large stocks targeted by industrial fisheries in Brazil, including the sardine, *Sardinella brasiliensi (*Kalikoski and Vasconcellos, 2006).
- An acoustic survey carried out by the Federal University of Rio Grande in 2010 resulted in a biomass estimation of 63,000 tonnes of sardines in Brazil, +/- 10 to 15% (L.Madueira, per.com.).

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The basic legal instrument that provides for fisheries management in Brazil is the Fisheries Law 2009.
- For almost three decades the Ministry of Environment was responsible for marine fisheries management, including that for the sardine fishery. Starting about two years ago, marine fisheries management became a joint responsibility of the Ministry of Environment and the newly formed Ministry of Fisheries and Aquaculture.
- Fishing industry representatives and academics indicate that the relationship between the two agencies is contentious and results in management inefficiencies.

The major concerns that management should address

- In the Brazilian sardine fishery, excess fleet size was identified as a contributory cause of a collapse, but poor infrastructure meant that there was little hope of enforcing a reduction (Gasalla and Tutui 2003).
- The sardine fishery is a classic example where environmental influences are routinely called upon to explain bad fishing years, but no serious attempt has been made to incorporate existing knowledge about environmental cycles into fishery management (Kalikoski and Vasconcellos, 2006).
- Gasalla and Tutui (2003) give the results of polling fisheries specialists on the decline of the Brazilian sardine. Excessive effort and oceanographic anomalies were the most frequently cited causes of the catch decline. The measure considered to be most effective in "regulating the sardine" is "limiting the number of fishing units".
- Jablonski (2007) boldly states that "solution" for the survival of the sardine fishery is much more related to the reduction of fishing effort and to the recovery of spawning biomass than to the accuracy of models involving climatic variables or ecosystem considerations. Results clearly indicate that the maintenance of the spawning stock size above a critical value is the main factor for the stock conservation and fisheries sustainability, despite any influence of environmental factors.
- Industry representatives cite a government policy that aims to increase skipjack catches by 40%, which is unlikely to occur should catches of baitfish for the pole-and-line fleet be restricted by management measures.
- Although there is a recognized need to reduce sardine fishing effort, especially during periods of low sardine abundance, the degree to which the small livebait fishery should be restricted (versus the much larger purse seine fishery) is a source of controversy.

Current management of the baitfishery, objectives and the main fisheries management tools used

- Gasalla and Tutui (2003) give the various recommendations, policies, and interventions applicable to the Brazilian sardine fishery in general over a 20 year period.
- Fishing industry representatives and academics indicate that the main current management measures applicable to the live bait sardine fishery are: (a) a closed season 15 June to 31 August, (b) specific closed areas, (c) a requirement that tuna vessels catch their own bait (i.e. no purchasing of bait), (d) restrictions on fishing close to the beach. The promotion of alternative bait species could also be considered as a management intervention.
- The main objective of the management of the general sardine fishery is to assure the sustainability of the sardine resource. The objectives for the management of the narrower live bait sardine fishery focus on sustainability, but also include promoting of the skipjack fishery, and reducing negative interactions of baitfishing with the sardine purse seine fishery, artisanal fisheries and tourism.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- There is currently no management plan for the Brazilian sardine fishery.
- Jablonski (2007) states that in 2006, the scientific committee for the sardine fishery approved a management plan but this was not implemented. That plan recommended a reduction of the fleet to the equivalent to 80 "standard" boats.
- Kalikoski and Vasconcellos (2006) state that with rare exceptions, there are no management plans for marine fisheries in Brazil.

The type of fishery management plan

[not applicable]

The elements of the plan

[not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

[not applicable]

Information on plan effectiveness

[not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- Fishery stakeholders mention "plan fatigue": often during changes of government there are analyses of the various important fisheries accompanied by different types of plans, which are frequently not implemented – leading to apathy on the part of stakeholders towards fishery plans in general.

The main institutional and procedural difficulties in the management of the baitfishery

- Jablonski (2007) notes that the resulting legislation not always follows the propositions of the scientific committee; on the contrary, the decisions on the management of the stock often passed through a "revision" due to the fishermen and industry pressure, sometimes leading to significant reductions of the proposed closed seasons and occasionally even disregarding the recommendations. For example, in 1993 a recommendation of the scientific committee for a total closure of the fisheries for a period of 28 months, as a drastic effort to guarantee economic survival, was not implemented.
- Stakeholders claim that the contentious nature of the relationship between the two government ministries that jointly share responsibility for fisheries management results in the inability to effectively cooperate in major fisheries management efforts.

Can an outside agency assist in improving the management of the baitfishery?

- As the problems outlined above are largely institutional in nature, outside efforts for improvement are unlikely to be effective. Political will is required – something that must be generated domestically.

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Spain, Basque Country

Information on the major live-bait pole-and-line tuna fisheries in the country

- Most of the tuna baitboats (pole-and-line vessels) in Europe are based in the Basque Country. They target albacore (5,000-10,000 tonnes annual catch in recent years) and bluefin tuna (500 tonnes). The albacore fishing is located much further offshore than the bluefin fishing.
- AZTI staff and fishing industry representatives indicate that about 48 baitboats are based in the Basque Country, with an additional 17 vessels based in the Cantabria region to the west of the Basque Country. A few vessels targeting only bluefin are based in the south around Gibraltar. Most vessels in the north of Spain are in the size range 32 to 37 metres.
- The live bait tuna fishery commenced on the French side of the Basque Country in the late 1940s by emulating the California technique. The fishery in Spain reached its height in the late 1960s and early 1970s.

The various baitfishing operations: types of operations, size of operations and techniques

- The four major species of bait are all caught by tuna baitboats using purse seine gear. Each vessel catches its own bait. Baitfishing occurs at night using lights for attracting fish.
- There has been a substantial amount of work on improving livebait handling and storage techniques.
- The amount of bait carried aboard a vessel varies due to well size, number of wells, and bait species (e.g. horse mackerel can tolerate higher densities). Annual bait usage depends on the chumming rate and trips per year.
- In addition to the fishery for bait, all four major species are caught by large industrial fishing techniques; mainly purse seine but to some extent pair trawling.
- AZTI staff and fishing industry representatives agree that for all four major bait species, the annual capture by baitfishing is a small fraction of the total catch, probably less than 5% for each species.
- WGANSA (2010) gives catches of anchovy from 1987 to 2000 and states an annual average of 318 tonnesis taken as live baitfish – or about 1% of the total catch of anchovy.

The major baitfish species

- There are four main bait species: Atlantic mackerel (*Scomber scombrus*), horse mackerel (*Trachurus trachurus*), sardine (*Sardina pilchardus*), and anchovy (*Engraulis encrasicolus*).
- The preferred bait for albacore fishing is anchovy, while the preferred bait for bluefin is small horse mackerel. The latter is because the fish can be carried on tuna vessels at a relatively high density and the baitfish stay close to the boat after being broadcast.
- Anchovy was not used as a bait in the period 2005-2010 because a stock collapse earlier in the decade led to a complete ban on fishing anchovies during those years.

The recent trends in the baitfishery, including trends in catches

- Baitboats have sold a substantial part of their bluefin quota to purse seine vessels, reducing the amount of bluefin live bait fishing that will be allowed in the future.
- The number of tuna baitboats based in the Basque Country has declined from about 60 vessels ten years ago to 48 now.
- The anchovy resource has recovered from its collapse about a decade ago.
- Uriarte et al. (1996) comment on the trends in the industrial fishery for anchovy. In the sixties the fishery reached its top catches (80,000 tonnes) and greatest number of vessels (about 600). Afterwards there was a discontinuous but pronounced drop in catches to 1986 (to less than 10,000 tonnes), followed by a parallel reduction in the number of purse seines (to about 300). Off Galicia, the anchovy catches first disappeared about 1960.

The results of any baitfish stock assessment work

- Uriarte et al. (1996) reviews the biology and dynamics of the anchovy population in the Bay of Biscay. They determined that the total allowable catch should be 32,000 tonnes, which was about the average level of the catches of those recent years and about the level of MSY deduced from the application of a Schaefer model to this fishery.
- The International Council for the Exploration of the Sea (ICES) has a Working Group on the Assessment of Mackerel, Horse Mackerel, Sardine, and Anchovy which periodically assesses the status of those species and provides catch options. The available information is summarized in various reports.
    - ICES (2011a) gives information for anchovy: landings recruitment, spawning stock biomass, harvest rate, and concludes: “ICES advises on the basis of the precautionary approach that catches from 1 July 2011 to 30 June 2012 should be no more than 47 000 t.”
    - ICES (2011b) gives similar types of information on the horse mackerel and concludes: “ICES advises on the basis of the MSY approach that catches in 2012 should be no more than 211 000 t.”
    - ICES (2011c) gives similar types of information on the sardine and concludes “ICES advises on the basis of precautionary considerations that landings in 2012 should be no more than 36 000 t.”
    - ICES (2011d) gives similar types of information on the Atlantic mackerel and concludes “catches in 2012 should be between 586 000 tonnes and 639 000 tonnes.”

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The legal basis for the management of the anchovy fishery (and presumably the other three baitfish species) is given in the preamble of the anchovy management plan: “the Treaty on the Functioning of the European Union, and in particular Article 43(2)”. That article states: “The Council, on a proposal from the Commission, shall adopt measures on fixing prices, levies, aid and quantitative limitations and on the fixing and allocation of fishing opportunities.”

- The EU has the responsibility of management for the four species that are important as baitfish.

The major concerns that management should address

- Discussions with AZTI staff and fishing industry representatives indicate that resource sustainability is by far the most important concern to be addressed by management. Other possible objectives (e.g. reduction of gear conflict) appear relatively unimportant.
- Uriarte et al. (1996) point to another issue that needs to be addressed in a management scheme: Due to the strong dependency of the anchovy stock on annual recruitment, the only way of avoiding these risky situations is through the implementation of a monitoring system capable of forecasting recruitment coupled with a management procedure that would regulate fishing mortality according to the expected level of the stock.

Current management of the baitfishery, objectives and the main fisheries management tools used

- The "fisheries" being managed are not the baitfisheries, but rather the four larger fisheries based on the four species – which include the industrial fishing activity. For each of the four fisheries, baitfishing forms only a very small component.
- The fisheries for the four baitfish species are managed by the EU following the scientific advice given by ICES. AZTI is involved in the monitoring of the tuna fishery and also participates in ICES in several working groups, including those related to the species that constitutes the bulk of the bait. (J.Santiago, per.com.)
- Current management is largely oriented to the objective of resource sustainability with the establishment/enforcement of a TAC being the main management measure.
- AZTI staff explain the current management arrangements:
    - The anchovy fishery is managed on the basis of a draft plan proposed by the European Commission (see following section) which has not yet received formal approval but is being followed. Formal approval requires adoption by the European Commission, the EU Council, and the European Parliament – which has not yet occurred despite on-going discussions between these three entities.
    - Horse mackerel fisheries management is in a similar state to the anchovy fishery described above: managed on the basis of a proposed management plan.
    - The basis for Atlantic mackerel fishery management is an international agreement under the North Atlantic Fisheries Organization which establishes the principles for determining fishing mortality on the species.
    - For the sardine fishery, no TAC or quotas have been established.
- Tuna fishing industry representatives explain that their baitfish catches are not counted towards the total allowable catch of the species.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- As explained above, there are no formally adopted management plans for the four fisheries involving the four baitfish species, but the proposed management plans for anchovy and for horse mackerel are being followed.
- In the European Union there are management plans for many fisheries, with examples being plans for Baltic Sea cod and for North Sea sole.

The type of fishery management plan

- The management plans for anchovy and horse mackerel are both oriented to laying out the procedures for establishing TACs for the two fisheries.
- The plans do not specify all applicable management measures. For example, the plans do not mention areas where fishing is restricted (e.g. close to the beach, in certain estuaries).

The elements of the plan

- The "Long-term plan for the anchovy stock in the Bay of Biscay and the fisheries exploiting that stock" contains the following elements:
    - The legal and policy basis of the plan are given in the preamble
    - The objectives are established as being: (a) to ensure the exploitation of the anchovy stock at high yields consistent with the maximum sustainable yield, and (b) to guarantee, as far as possible, the long-term stability of the fishery, which is a prerequisite for ensuring the economic and ecological sustainability of the fisheries sector, while maintaining a low risk of stock collapse.
    - States that the basis for setting a TAC: the EU's Scientific, Technical and Economic Committee for Fisheries has advised that the minimum spawning biomass level at which the stock could start to be harvested should be set at 24 000 tonnes and the precautionary biomass levels at 33 000 tonnes. Furthermore, the appropriate harvest rate should be 30 % of the spawning stock biomass each year, subject to appropriate restrictions.
    - Explains that the TAC is to be based on estimates of spawning biomass for anchovy made in May and June of each year, immediately prior to the management period for the fishing season from 1 July to 30 June.
    - Partitions the TAC between France and Spain.
    - Establishes that all vessels fishing for anchovy follow the EC's provisions regarding satellite-based vessel monitoring systems.
    - Stipulates that, in order to fish for anchovy in the Bay of Biscay, vessels must hold a special fishing permit
    - Requires that States designate ports in which all anchovy catches must be landed.
    - Requires an evaluation of the plan each 3 years.

- The "multi-annual plan for the western stock of Atlantic horse mackerel and the fisheries exploiting that stock" " contains the following elements:

- Establishes that the plan's objective is to maintain the biomass of western horse mackerel at a level that ensures its sustainable exploitation, and to provide the highest long-term yield.
- Gives the procedures for calculating the TAC
- Stipulates that in order to fish for western horse mackerel, vessels must hold a special fishing permit
- Requires an evaluation of the plan each 6 years.

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

- The management plans for anchovy and horse mackerel are both written as a regulation that will "enter into force on the twentieth day of its publication in the Official Journal of the European Union".

Information on plan effectiveness

- There have not yet been formal reviews of the effectiveness of the plans. The anchovy plan and the horse mackerel plan have provisions for reviews after 3 years and 6 years, respectively.
- Baitboat operators and AZTI staff indicate the lack of complaints about the plans could be indicative of plan success.

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- It appears that for those species that are the most important (e.g. anchovy, horse mackerel), there has been more effort put into the formulation of fishery management plans. Conversely, the two species of less importance (Atlantic mackerel, sardine) have not received such attention.

The main institutional and procedural difficulties in the management of the baitfishery

- The formal adoption of a fishery management plan appears to be a fairly lengthy process requiring consideration and approval from three major EU institutions.

Can an outside agency assist in improving the management of the baitfishery?

[not applicable]

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- ICES (2011d). Mackerel in the Northeast Atlantic (combined Southern, Western, and North Sea spawning components.

Main informants:

N.Goñi (AZTI), J.Santiago (AZTI), N.Zabala (Hondarribibia Assoc.), A.Uriarte (AZTI), D.Mendiola (AZTI), M.Goikoetxea (fisherman), E.Suspererregi (fisherman), L.Martin (AZTI)

Portugal, Azores

Information on the major live-bait pole-and-line tuna fisheries in the country

- Live bait tuna fishing was introduced to the Azores from the USA in the 1950s and subsequently became an economic alternative to whaling.
- Fisheries researchers and government fishery officers indicate that in the Azores there are presently about 20 large tuna baitboats, down from 31 in the late 1990s. These vessels average 24 metres in length and carry 14 to 18 crew. In addition, there is a fleet of about 30 smaller vessels (7 to 15 metres) that catch tuna with live bait. In 2011 six baitboats from Madeira fished out of the Azores.
- Baitboat tuna catch estimates derived from observer programme data over the period 1998 to 2010 show the annual tuna catch varied from 1,480 to 13,989 tonnes, with an average of 5,211 tonnes. ICCAT data show that in the 1970s annual tuna catches by baitboats in the Azores averaged 4,800 tonnes.
- Morato et al. (2002) describe the fishery. Tuna are seasonally present in the Azores area, migrating and feeding around the islands and seamounts. Adult bigeye tuna are present during April to June. They are caught at an average length of 1 m and 25 kg. Skipjack tuna are caught from June to October at a length of 45 cm (~ 3 kg). Bluefin tuna is caught in small quantities, while a few yellowfin, a more tropical species, are captured in July. Fishing success is influenced by two factors: abundance and variation in migration routes. Depending on the currents, tuna will migrate either through the archipelago or else at a distance from it, thereby preventing the fishers from reaching them.

The various baitfishing operations: types of operations, size of operations and techniques

- Baitfish are captured by the tuna vessels themselves, using small purse seines or lift nets depending on the seasons/species. Silva et al. (2011) state that blue jack mackerel (*Trachurus picturatus*) are mainly caught with purse seine nets that are 250 m long and 10–15 m in depth with a mesh size of 30–40 mm.
- Generally, fishing for trachurus occurs at night in 6 to 30 metres of water using lights and chum, while fishing for sardine occurs during the day in in 2 to 20 metres of water. On occasion bait catches are made in the open ocean.
- The official fisheries statistics do not cover the baitfishery. Estimates of catches of baitfish for tuna fishing can be derived from observer program data. In the period 1998-2010 it is estimated that the annual bait catches varied from 109 tonnes to 333 tonnes, with an average of 243 tonnes per year. (T.Morato, per. com.)
- Some species that are caught for tuna bait are also subject to other fisheries. Morato et al. (2002) explain that a few bait species, especially trachurus, are caught with small purse seines set from shore or from small boats. This fishery is especially important around the Island of São Miguel. An average of 450 tonnes a year (range of 227 to 798 tonnes) is landed in the archipelago. Santos and Hawkins (1995) state that these catches are made with seine nets, dipnets, and liftnets.

The major baitfish species

- Recent observer data show that the two major species composing the baitfish are the European pilchard (*Sardina pilchardus*; just over half of the baitfish catch) and the blue jack mackerel (*Trachurus picturatus*; about 1/3 of the baitfish catch). The remaining fraction includes the chub mackerel (*Scomber japonicus*), bogue (*Boops boops*), boarfish (*Capros aper*) and longspine snipefish (*Macroramphosus scolopax*). (Morato per.com.)
- Trachurus is the preferred bait for bigeye as it survives well in bait tanks. Sardines are less hardy but the preferred bait for skipjack because its smaller size is more appropriate for this small tuna. Because bigeye occurs earlier in the fishing season than skipjack, trachurus tends to be targeted by baitfishing earlier in the season, and sardines later. (M.Machete, per.com.)

The recent trends in the baitfishery, including trends in catches

- Tuna catches have experienced a decline in the last 15 years, but two recent years (2007, 2010) have been especially good. Baitfish catches tend to mirror this trend.
- In the last 5 years there has been an increasing number of small (7 to 15 metre) baitboats and a trend for boats of this size to convert to baitboat fishing when conditions are favourable.
- Small sizes of trachurus appear to be less abundant in recent years, and sardines more abundant.
- In the last few years the bigeye season has been much longer than normal.
- To survive, the tuna industry is increasingly (a) targeting the fresh tuna market which yields better prices, and (b) using lower-paid crew from Madeira and Cape Verde. Government support/subsidies are also a factor in the survival of the fleet.

The results of any baitfish stock assessment work

- For about 15 years the Department of Oceanography and Fisheries of the University of the Azores has been involved in a program of onboard fisheries observers. Data on baitfish catches are collected by that program and the University is presently analyzing that information.
- Santos and Hawkins (1995) cite a report of a study on age and growth of *Trachurus picturatus* from the Azores (Isidro 1990).
- According to researchers at the University of the Azores, there have been a few older PhD papers related to stock assessment of the species used for tuna bait, but the results have had limited relevance to actual fisheries management.
- According to an official of the Sub-Secretariat of Fisheries, the available information on baitfishing suggests

resource stability (R.Ferraz, per.com.).

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The responsibility for fisheries management in the Azores is shared between regional, national, and European authorities. In practice, the regional government can enact fisheries management measures that are at least as strict as those of the EU. (i.e. the Azores must follow EU rules but can go further).
- The legal basis for fisheries management at the EU level is given in Article 43(2) of the Treaty on the Functioning of the European Union which states: "The Council, on a proposal from the Commission, shall adopt measures on fixing prices, levies, aid and quantitative limitations and on the fixing and allocation of fishing opportunities.
- The legal basis for fisheries management at the Azores regional government level is the Regional Decree No.29/2010-A.
- The current fisheries resource management strategy of the Azores is based on the EU Common Fishery Policy.

The major concerns that management should address

- According to several stakeholders, there are currently few, if any, "hot management issues" dealing with the baitfishery.
- In the recent past there was an issue (highlighted by participants in the demersal handline fishery) over catches of juvenile blackspot seabream (*Pagellus bograveo*) in the baitfishery – because this species as an adult is a main target in the demersal fishery. This issue has largely been resolved (see below).
- There appears to be potential for concern over the fact that tuna/bait fisheries enjoy exclusion from many management measures (see below).
- In general, there is the feeling among fisheries stakeholders that small pelagics in the Azores area are a fairly resilient resource.

Current management of the baitfishery, objectives and the main fisheries management tools used

- Currently, there is little management of the bait fishery.
- The exceptions are: (a) there is a ban on the catching of one fish species that has been a minor component of the baitfish catch: recently the catching of the blackspot seabream at a size of less than 400 grams (much larger than the size useful as baitfish) has been prohibited; and (b) a ban on tuna vessels selling bait they have captured.
- In the Azores tuna fishing (and the associated bait fishery) have a special status – and are exempted from many management rules. An example is the exemption from the ban on fishing close to the coast with purse seines (much bait fishing is done with such nets).
- Portugal has an EU quota of trachurus, but this quota is unlikely to affect catches in the Azores because the mainland species is different.
- Monitoring of catches is a key activity in support of fisheries management, and especially important as a trigger for management interventions. The Programa de Observação para as Pescas dos Açores (POPA) onboard observer program collects information on baitfish catches - which provides important insight into the dynamics of the bait fishery, including issues that may require management.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- There is no fishery management plan for the Azores bait fishery.
- According to fisheries researchers, fishery management plans are not a characteristic of fisheries in the Azores.
- Portugal has a national "fishery management plan" which aims to maintain the sustainability of the sector and reverse the negative tendency of recent years (FAO 2006). However, that document is quite general and contains no mention of the Azores bait fishery.
- According to an official of the Sub-Secretariat of Fisheries, what comes closest to a fishery management plan are dissertations on specific fisheries by university students (R.Ferraz, per.com.).

The type of fishery management plan

[not applicable]

The elements of the plan

[not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

[not applicable]

Information on plan effectiveness

[not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- The lack of "hot management issues" related to the bait fishery understandably results in a lack of enthusiasm for formulating a plan. In addition there appears to be a general lack of awareness on the part of fisheries stakeholders of the benefits of a fishery management plan.

- It appears that the main advantage of a fishery management plan for baitfishing in the Azores would be to have pre-agreed action should problems arise in the future – allowing for a more rational and expeditious approach than that which is crisis-oriented.

The main institutional and procedural difficulties in the management of the baitfishery

- Presently, there appear to be few problems in the management of the baitfishery – or even issues requiring management attention.

Can an outside agency assist in improving the management of the baitfishery?

- An outside agency could point out the benefits of having a fishery management plan, and provide suggestions and/or a template for such a plan.

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Main informants:

M.Machete (POPA), T.Morato (Universidade dos Açores), P.Afonso (Universidade dos Açores), R.Ferraz (Sub-Secretariat of Fisheries), C.Ornelas (Captain of baitboat)

Spain, Canary Islands

Information on the major live-bait pole-and-line tuna fisheries in the country

- Delgado et al. (2005) state that the baitboat fleet based in the Canary Islands can be placed in two groups based on size and activity: (1) vessels larger than 50 GRT that do multi-day fishing trips in the waters of both the Canary Islands and neighbouring African countries and that carry ice; and (2) vessels smaller than 50 GRT that do day trips.
- Using Delgado et al. (2005) together with EIO (2001) it can be seen that the number of operating vessels larger than 50 GRT dropped from 68 in 1981 to 17 in 2010. The number of small vessels dropped from 243 in 1997 to 198 in 2010. It should be noted that "operating" could be as little as one fishing day in the year concerned. Small vessels move in/out of the live bait fishery opportunistically.
- Delgado (2006) states that tuna catches reached a maximum in 1994 of 15,667 tonnes, and then fell rapidly in the late 1990s to 4,000 to 6,000 tonnes. IEO (2011) shows that catches in the past few years are about one-third of that obtained during the height of the fishery in the mid-1990s.
- ICCAT data show that in the five-year period 2006-2010 tuna catches by baitboats in the Canary Islands area averaged 5,173 tonnes per year (44% bigeye, 41% skipjack, 7% yellowfin, 7% albacore, <1% bluefin).
- Discussions during the present study with a fishing company and the crew of a baitboat indicate that for larger vessels a fishing trip is characteristically 8 days, but could sometimes be twice as long.

The various baitfishing operations: types of operations, size of operations and techniques

- The larger baitboats catch baitfish by purse seine gear set in 40 to 50 fathoms (73 to 91 m) of water, usually at night in association with lights. A typical net for a large vessel is about 250 fathoms (457 m) in length.
- The small baitboats use mainly dip-nets set just before dawn, often chumming to aggregate the baitfish.
- Some species that are caught for tuna bait are also subject to other fisheries: *Scomber* and *Sardina* are taken as a food fish in the Canary Islands. The ratio between baitfish catches and the catches of these fish for food has apparently not been studied but discussions with a fishing company suggest that the food component could be 10 times greater.
- It is usually possible to catch sufficient bait for a fishing trip. On rare occasion there are baitfish shortages that are attributed to environmental conditions and natural variability. Because several different species are used as bait (each of which could vary independently of the other bait species) this tends to buffer huge changes in availability.
- The total amount of baitfish captured is not known, but the larger tuna vessels are required to keep logbooks that include information on baitfish catches.

The major baitfish species

- Delgado de Molina et al. (2005) state that the baitboats use principally caballa (*Scomber japonicus*) and in some cases sardina (*Sardina pilchardus*), chicharro (*Trachurus sp.*), and alacha (*Sardinella sp*.).
- Melnychuk et al. (2001) state that for fishing tuna, *B. boops* and *S. japonicus* are most commonly used, followed by the sardine (*Sardina pilchardus),* and in some places squids (e.g. La Graciosa).
- Discussions with Instituto Español de Oceanografía (IEO) staff, a fishing company and a baitboat captain indicate that (a) *Sardina pilchardus and Scomber japonicus* make up most of the bait catches (b) *S. japonicas* is the most hardy species with respect to survival in vessel bait tanks, (c) *S. pilchardus* is less hardy but the preferred bait for skipjack because its smaller size is more appropriate for this small tuna, (d) on occasion the species trompetero (longspine snipefish, *Macroramphosus scolopax*) are found in balls in the open sea and are taken for bait, (e) anchovies (*Engraulis sp.*) are sometimes taken for bait on those eastern Canary Islands that are closer to Africa, and (f) the sand smelt *(Atherina presbyter)* is sometimes used as bait and is of special interest for the present study due it its capture being prohibited for non-bait use.

The recent trends in the baitfishery, including trends in catches

- There has been a pronounced decrease in fishing effort during the last two decades. The number of days spent at sea by large baitboats tuna fishing in recent years is about of half that of the 1990s (IEO 2011). As total bait usage would tend to mirror this trend, it can be assumed that baitfish catches have declined substantially.
- Other than this decline in baitfishing effort and catches, baitboat stakeholders do not report any other remarkable trends in the bait fishery.
- The last of several tuna canneries in the Canary Islands closed in the late 1990s. Baitboat fishing has recently become more oriented to the profitable fresh fish market, both locally and in Madrid and Barcelona.

The results of any baitfish stock assessment work

- The total amount of baitfish captured is not known, but the larger vessels are required to keep logbooks that include information on baitfish catches. This logbook information is available at IEO but it has not been compiled/analyzed.
- The last significant resource survey relevant to baitfish was some acoustic work about 20 years ago.
- The status of the major baitfish species is not known, but lack of problems reported by fishery

stakeholders leads to the belief that there are no major resource issues. The fact that baitfish catches have declined substantially in recent decades (and no resource issues were apparent during the height of the fishery) reinforces this view of the present situation. Researchers stress, however, that the lack of recent resource surveys prevents a good understanding of baitfish resource conditions.

- A substantial amount of research has been done in the past by Spanish institutions on *Sardina*, due to Spanish involvement with African fisheries for this fish for canning, but the results of that work have not been specifically applied to sardines as a baitfish in the Canary Islands.

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- According to IEO researchers, fisheries management authority is partitioned between the local Canary Islands government and national/EU institutions. The local government has jurisdiction over internal waters, considered to be those waters that lie inside a line drawn around each island in straight segments from extremity to extremity (i.e. jurisdiction over bays/bights). In practice, all boats fishing in internal waters must be registered by the local government for fishing the internal waters. Boats larger than 15 metres fishing in external waters must be registered with national government. Any EU involvement in fisheries management in the Canary Island is through interaction with national institutions, rather than with the local government.
- The "Ley de Pesca" is the legal basis for local fisheries management in the Canary Islands. It originally dates from the 1980s, but was modified a few years ago. The law does not specifically address baitfishing, but contains restrictions for other fisheries, such as minimum mesh sizes and prohibited gear.

The major concerns that management should address

- Discussions with IEO staff, a fishing company and a baitboat captain suggest a lack of "burning issues" in the bait fishery; few, if any issues could be identified that require management attention. According to those individuals, no such issues were readily apparent during the height of the fishery in the 1990s, and presently (with the fall in baitfishing activity in the last decade) there is less cause for problems to arise.
- The occasional low abundance of baitfish is a problem, but stakeholders acknowledge that it is a natural phenomenon and not attributed to fishing activity.
- The amount of baitfish captured is currently limited by the poor economics of the associated tuna fishery, obviating any need for controls on catch levels. If the tuna fishery declines further, the need for catch limits (and other management interventions) becomes even less important.

Current management of the baitfishery, objectives and the main fisheries management tools used

- There is no fisheries management specifically directed at the baitfishery in the Canary Islands. As expressed by an executive of a tuna fishing company: "the fishery currently is not regulated".
- There is fisheries management in the Canary Islands and there are management measures applicable to all fisheries, including the baitfishery. These include the requirement for a fishing license from the local government for fishing inshore waters and the ban on fishing in certain areas, including close to tourist beaches and in marine reserves.
- The catching of sand smelt (*Atherina presbyter*) for food is banned, but there is no prohibition on catching this fish for bait. According to IEO staff, the rationale for the ban on catching this small fish is probably to discourage fishers from catching immature fish of other species.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- There is no management plan for the bait fisheries.
- Fishery management plans are not a feature of fisheries in the Canary Islands

The type of fishery management plan

[not applicable]

The elements of the plan

[not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

[not applicable]

Information on plan effectiveness

[not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- There is apparently not much need for management of the baitfishery, and any necessity is decreasing as baitfishing activity drops along with baitboat tuna fishing.
- The available management attention is being focused on other fisheries (e.g. demersal line fishing) where problems are perceived as being more serious.

The main institutional and procedural difficulties in the management of the baitfishery

- Lack of major issues to mitigate by management.
- Analysis of the baitfishing data held by IEO is not perceived to be a priority.

Can an outside agency assist in improving the management of the baitfishery?

- Assistance in analyzing the baitfishing data held by IEO would be helpful, but it is not certain that this would improve the management of the baitfishery.

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Senegal

Information on the major live-bait pole-and-line tuna fisheries in the region

- Fonteneau and Diouf (1994) and Charneau (1987) give some history of the baitboat fleet. The tuna baitboat fishery in Dakar has been operating since the beginning of the fifties. In the early 1960s the annual total tuna catch reached a peak at about 15,000 tonnes, while in the late 1970s, 1980s, and early 1990s the average annual baitboat tuna catch was mainly between 8,000 and 10,000 tonnes. The fleet size peaked in the late 1950s with 88 baitboats, in 1970 the number was 62, but fell to 34 in 1975. In the 1980s a new baitfish tuna fishing method was developed in which a team of two baitboats stays with a tuna school for several months.
- Sow and Ndaw (2011) give some recent information. In 2009, there were 7 Senegalese, 2 French and 7 Spanish baitboats operating out of Senegal. In that year the seven Senegalese (i.e. a portion of the fleet) baitboats landed 6.720 tonnes comprised of 1,157 t yellowfin tuna, 4,513 t skipjack tuna, 1,041 t bigeye tuna, 6 t Atlantic black skipjack y 4 t frigate tuna. .
- There are currently 6 Senegalese, 1 French, and 7 Spanish baitboats based in Senegal (all in Dakar). Recent annual tuna catches have averaged about 12,000 tonnes (T.Diouf, G.Fambey; per.com).
- The baitboats currently range in size from 32 to 42 metres and fishing trips average 20 days (J.Tomas, J.Laca; per.com.)
- Most of the livebait tuna fishing for the Dakar-based fleet occurs in the waters of Mauritania - but all baiting occurs in Senegal waters. Tuna fishing in the Senegal zone normally occurs in the winter season when cold water off Mauritania causes the tuna to move south.

The various baitfishing operations: types of operations, size of operations and techniques

- Freon et al. (1979) state that a small purse seine (senne tournante, "bolinche") is used at night to capture bait. Vessels continue to baitfish until sufficient bait for a fishing trip is captured, between 0.5 and 1.5 tonnes. Total annual baitfish catches in the period 1963-1977 ranged from 500 to 1,000 tonnes.
- Freon et al. (1979) estimate the total baitfish catch by Senegal-based baitboats in 1977 to be 511 tonnes, about half of which was *Sardinella aurita.* That same year the total catch of *S. aurita* was estimated to be about 13,000 tonnes. The total catch of the three species important as baitfish was 84,000 tonnes. Baitfishing was therefore responsible for about 0.6% of the catch of those three species.
- In recent years many of the tuna baitboats do not baitfish, but buy bait from canoes ("cayucos") of about 14 metres in length that fish with small purse seines in shallow water mostly during daytime, close to the coast. From one to three canoes work with a single baitboat. Usually during one day of baitfishing, enough bait for a fishing trip (i.e. 3,000-3,500 kg) can be obtained from the associated canoes – but it sometimes takes several days.
- In recent years the other fisheries targeting the species used as baitfish have increased. Researchers estimate that about 400,000 tonnes of sardines are now taken annually in Senegalese waters, of which far less than 1% is by baitfishing. This fishing, mainly artisanal in scale, has tremendous national importance, including food security and employment (about 15,000 people are involved in the fisheries). Large catches are also made in the neighbouring countries to the north and south of Senegal.

The major baitfish species

- Freon et al. (1979) indicate there are three principal species in the baitfishery: the round *sardinella* (*Sardinella aurita*), the Madeiran *sardinella* (*Sardinella maderensis*), and the false scad (*Caranx rhonchus*).
- Fishing captains feel that round *sardinella (which is also referred to as the "Mauritania sardine") is the superior bait due to its high survival rate in vessel bait tanks.*

The recent trends in the baitfishery, including trends in catches

- Sow and Ndaw (2011) indicate that the tuna catches of the Senegal-flagged baitboats (i.e. a portion of the fleet) have grown steadily over the last two decades and have recently averaged about 6,000 tonnes per year.
- Hallier and Delgado (2000) and ICCAT (2005) indicate that the associated-school fishing method developed by Dakar baitboats in the eighties increases the baitboat CPUE and the percentage of bigeye in the catch.
- Although the baitboat fleet has fallen during the last several decades in terms of numbers of vessels, the productivity of each vessel has risen.
- The size of the individual baitboats has grown, along with the baitfish requirements per vessel. Freon et al. (1979) state that in the 1970s between 0.5 and 1.5 tonnes was sufficient bait for a fishing trip, whereas currently vessels take on 3.0 to 3.5 tonnes of bait.

The results of any baitfish stock assessment work

- Researchers and a fishing industry representative indicate that research work was carried out on the small pelagic fish resources (including the major baitfish species) of West Africa in the period 2006-2007, covering the coastal zones from Morocco to Sierra Leon. The work included both acoustical surveys and analysis of catch and effort data. The results suggested that overall fishing effort should be reduced by 50%. (T.Diouf, D.Coulibaly; per.com.)

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- Sow and Ndaw (2011) discuss the legal basis for fisheries management in Senegal. The general objective of the government's fisheries management is to conserve fishery resources and promote their sustainable development in a manner that preserves the marine ecosystem. The legal provisions for fisheries management are contained in Law 98-32 and the associated Decree nº 98-498.
- The government agency with the responsibility for any management of the bait fishery is the Directorate of Marine

Fisheries (French abbreviation: DPM).

The major concerns that management should address

- A major issue is the feasibility and/or desirability of management of the relatively tiny baitfishery, given the reality that it operates in the midst of a huge amount of "semi-unmanageable" artisanal fishing targeting the same fish species.
- The periodic spurts of very large-scale foreign fishing for small pelagics are a concern.
- Although there is a recognized need to reduce the fishing effort on small pelagics, the degree to which the relatively tiny baitfishery should be reduced (or given an exemption) is likely to become an issue.
- Attention needs to be given to how the use of the resource will be partitioned between the various end uses: baitfish, domestic consumption, foreign consumption, and reduction for animal feed.

Current management of the baitfishery, objectives and the main fisheries management tools used

- There is currently little management focused on the bait fishery. Perhaps the only specific legal provision for baitfishing is in Decree nº 98-498 that is associated with Law 1998-32 – which cites a minimum mesh size of 16 mm for baitfish nets.
- There are no restrictions for baitfishing on other aspects, such as prohibited areas or quotas.
- There are other general fisheries management measures that are applicable to all marine fisheries in Senegal, including bait fisheries. Examples are the requirement for all industrial fishing vessels to be registered and for all foreign vessels that are fishing outside a governmental fisheries agreement to carry observers.
- Although some baitboat fishers cite a regulation that tuna baitboats must purchase bait from canoes (rather than catch it themselves), individuals with greater knowledge of the legal situation in fisheries state that it is not government requirement, but rather an agreement among fishers that results in less gear conflict in baitfishing areas.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- There is no management plan for baitfishing, or for the larger fishery for small pelagics in Senegal.
- There are management plans for some fisheries in Senegal, with the deep-water shrimp fishery being an example.

The type of fishery management plan

[not applicable]

The elements of the plan

[not applicable]

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

[not applicable].

Information on plan effectiveness [not applicable]

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- The appropriate management unit would be the small pelagic fisheries, of which the baitfishery is a very small component. Although fishery management plans have been formulated for other important fisheries in Senegal (e.g. deep-water shrimp), such a management plan has not been formulated for the fisheries for small pelagics due to the difficulty of the task. The artisanal nature of much of the fishing for small pelagics makes it "messy": hundreds of landing spots, difficulties in enforcement, problems of trying to control a traditional activity, etc.
- Fishery stakeholders acknowledge the benefits of a functional management plan for small pelagics, but there is some question of implementing management in the artisanal context.

The main institutional and procedural difficulties in the management of the baitfishery

- As above: the difficulty of attempting to management a huge artisanal fishery.

Can an outside agency assist in improving the management of the baitfishery?

- Researchers and a fishing industry representative indicate that the EU is considering embarking on a project to formulate a multi-country fishery management plan for small pelagic fisheries in West Africa.

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Main informants:

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Ghana

Information on the major live-bait pole-and-line tuna fisheries in the country

- The tuna baitboat fishery in Ghana was started by the Japanese in the early 1960s. It expanded from 5 baitboats in 1962 to its height of 33 in 1990, and then decreased to 25 in 2001 (Bannerman and Bard, 2001; Bannerman 2009). The fleet currently consists of 22 operational vessels, all of which are old Ghana-flagged Japanese-style vessels, varying in size from 49 to 60 metres in length. Bannerman (2011) states that vessels operate on a joint-venture basis, with Ghanaian owners having at least 50% of the shares.
- In the mid-1990s a type of tuna fishing commenced in which baitboats collaborate with purse seiners. Baitboats mainly fish FADs and when a productive FAD is encountered, a purse seiner is notified, it sets its net, and the catch is shared between the vessels.
- In recent years, tuna landings by baitboats have been about 30,000 tonnes per year – but 80% of those landings have actually been caught by purse seine gear. This translates into an annual catch by "pure baitboat fishing" of about 6,000 tonnes in recent years (Fisheries Commission, unpublished data). "No baitboats here have the luxury of just poling for tuna" (P.Bannerman, per.com.).
- By contrast, annual baitboat tuna catches in the early 1990s (before the baitboat/seiner collaboration began) were about 30,000 tonnes.
- Bannerman (2009) states that over 1,500 FADs are used by Ghanaian tuna vessels.

The various baitfishing operations: types of operations, size of operations and techniques

- Baitfish are mostly caught very close to shore by using small purse seine gear in association with two skiffs. According to researchers, about 90% of the baitfish are caught by the baitboats themselves using small nets (e.g. 150 meters in length), with the remainder caught by canoe fishing using much larger seines, in which case baitfish are bartered to baitboats.
- Most baitfishing occurs during daytime as in Ghana all types of fishing with lights (including baitfishing) are discouraged by law.
- Baitfishing catches are relatively tiny compared to catches of the same species by canoes fishing for food. Bannerman (2011) states that from 1988 to 2009 average annual canoe landings for four key small pelagic species (species that are also taken as bait by baitboats) were 169,465 tonnes.

The major baitfish species

- The most important baitfish species is the European anchovy (*Engraulis encrasicolus),* forming perhaps 80% of the baitfish catches. Other important baitfish are the round sardinella (*Sardinella aurita),* Madeira/flat sardinella (*S. maderensis)* and some carangid species such as the chub mackerel (*Scomber japonicus*). (P.Bannerman, per.com.)

The recent trends in the baitfishery, including trends in catches

- The actual baitfishing operations have apparently changed little in the last few decades.
- The baitfisheries are a small component of the fishing on small pelagic fish – they are also targeted by artisanal canoe fishing. With respect to the entire small pelagic fishery, Bannerman (2011) shows:
    - A generally declining trend in the landings of small pelagics, from 270,000 tonnes in 2000 to 100,000 tonnes in 2007. When broken down by species, during the period 1988 to 2009 the annual reported catches of the key four small pelagic species (which are also important bait species) showed a general decline of both round sardinella and European anchovy, while landings of the flat sardinella and chub mackerel were relatively constant.
    - Small pelagic fish landings have been fluctuating over the years because of both natural and man-made factors. Natural climatic factors (e.g. increasing sea surface temperature resulting in increasing salinity) as well as man-made pressures in the form of over exploitation and the use of illegal fishing practices (e.g. dynamite and destructive chemical practices, light fishing) are believed to have contributed to the trend.
- The baitboat/seiner collaborative fishing has led to increased tuna landings by baitboats, but as explained above, this does not equate to increased tuna catches by baitboats; there was actually a substantial decline in the last 2 decades.
- Bannerman and Bard (2001) cite some trends in the tuna fishing: (a) baitboats (many are over 40 years old) are becoming more difficult to operate due to frequent breakdowns, lack of spares and accessories; (b) an increase in capacity of the two major tuna canneries in Tema.

The results of any baitfish stock assessment work

- Bannerman (2011) summarizes the assessment work during the R/V Nansen surveys from 1981 to 2007:
    - Sardinella and anchovy biomass estimates were from 40,000 to 73,000 tonnes.
    - The potential yield of the four most important pelagic species (i.e. those cited above in section on major baitfish species) was estimated to be about 200,000 tonnes per year.
- The Nansen results have been used in conjunction with FAO-coordinated regional stock assessment meetings on small pelagics. The general finding is that the stocks of key small pelagics are over-exploited (M.Kebe, per.com.).

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- In Ghana the Ministry of Food and Agriculture (MoFA) has overall responsibility for fisheries. Fisheries management is currently carried out by the Fisheries Commission, under MoFA.
- The legal basis for fisheries management is the Fisheries Act of 2002 and the subsidiary Fisheries Regulations.
- The Republic of Ghana Fisheries and Aquaculture Policy was adopted by the Government in 2008, and further developed in 2010 in the context of the preparation of the draft five-year Fisheries and Aquaculture Development Plan 2010-2015 to provide the overall framework for managing the sector (Bannerman 2011).

The major concerns that management should address

- There is some question on the feasibility and/or desirability of the management of the relatively tiny baitfishery by itself, given the reality that it operates in the midst of a huge amount of "semi-unmanageable" artisanal fishing that targets the same fish species.
- It is extremely difficult to enforce reasonable/needed restrictions on a large amount of canoe fishing activity.
- GFC (2011) cites constraints to management in marine fisheries: (a) overcapitalization and quasi-open access, (b) inability to effectively control fishing capacity, and (c) government subsidies that encourage capacity increases.
- Future management efforts need to recognize that many of the existing management measures are impractical for the baitfishery (e.g. the current mesh size, ban on fishing in shallow water).
- The effects of oil drilling on small pelagic fisheries are a major concern. Fish and fishing activity had a very low profile in the environmental impact assessment done for the drilling.

Current management of the baitfishery, objectives and the main fisheries management tools used

- GFC (2011) gives the general objectives of fisheries management in Ghana: "Maximize fish production and increase the economic rent through first the recovery of heavily or over-exploited fish stocks and second the increase of value addition in the sector, whilst priority is given to the canoe sub-sector in the allocation of fishery resources."
- In practice, the unit of management is not "the baitfishery", but rather all fishing activity targeting key species of small pelagic fish.
- None of the current management measures relevant to baitfishing are specific to baitfishing, and most are not specific for fishing for small pelagics, but rather apply to all marine fishing in Ghana.
- The current management measures that would, in theory, have most effect on baitfishing appear to be (1) a minimum mesh size of 25 mm for seining, (2) a general ban on the use of lights for fishing, (3) reserving fishing in shallow water (0-30 m) for artisanal fishers, and (4) banning of fishing within oil and gas infrastructure exclusion zones.
- Some of these restrictions are impractical. A minimum mesh size of 25 mm is not appropriate for baitfishing (tests show that mesh sizes greater than 18 mm allow most of the target fish to pass through). In addition, anchovy is most vulnerable in shallow water, but baitboats are legally excluded from fishing in shallow water. (P.Bannerman, per.com.)
- The management measures cited above appear to be at least partially ignored by fishers, including those involved in baitfishing.
- Ghana currently does not have any marine protected areas (Bannerman 2011).

Do the bait fisheries have a formal management plan? Do other fisheries in the country have management plans?

- GCF (2011) states: "The Ministry in charge of fisheries adopted a fishery management plan (FMP) in 2001 which defined two fisheries management units (demersal species, and small/large pelagic species) and provided for each of the two groups a list of short term and long term measures aimed at (a) reducing fishing effort particularly in the industrial and semi-industrial sub-sectors, and (b) facilitating recovery of fish stocks through closed seasons and improved enforcement of technical measures. The FMP also contained some recommendations aimed at strengthening major management functions. Finally, the FMP presented a brief assessment of the ecological and socio-economic impacts of the recommended measures. The FMP 2001 measures were never implemented."
- The Ministry in charge of fisheries has not abandoned the concept of fishery management plans:
    - GCF (2011) states: "When the necessary reforms to improve the management regime of the marine fisheries are implemented, specific Fishery management plans (FMP) should be promoted. The added value of such FMPs is that they offer specific regulatory arrangements for given fisheries units (to be clearly defined) including specific management options and measures to reach given objectives with emphasis given to consensus-building. The FMP are expected to be revised annually to take into consideration change that may occur in the natural (ecosystem), economic and political spheres. Therefore they offer more flexibility and reactivity in the management regime of the concerned fisheries. They also contribute to improved governance when considering the necessary consultative mechanisms between administration, research, surveillance and producers that have to support plan formulation and the impact on the work plan of public and private institutions that will be driven by plan implementation."
    - Bannerman (2011) states: "The Department of Fisheries serves as the policy formulation and implementation secretariat of the Fisheries Commission, as stipulated by the Fisheries Act 625 of 2002. It fulfills this role by … [several activities, including]…preparing fishery resource management plans."
- In discussions and in various documents the 2001 fishery management plan is referred to as "not implemented" and "not operational".

The type of fishery management plan

- The 2001 management plan is much broader in scope than just the baitfishery; one of the two management units in the plan is "small and large pelagic species".
- The plan does not contain new management measures, but rather picks up existing regulations, many of which have not been enforced.
- The plan is comprehensive, in that it contains a substantial amount of information on the fisheries and their management: "packages fisheries management information", but it was not intended to be a document that has legal standing (i.e. not adopted as a regulation under the Fisheries Act).

The elements of the plan

- The 2001 plan includes the following elements: description of the resources, information on economic importance of the fishery, major issues, short and long term measures (technical, institutional), a brief assessment of the ecological and socio-economic impacts of the recommended measures, and MCS (P.Bannerman, per.com.)

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

- The 2001 fishery management plan was not intended to be a document that has legal standing – and did not achieve that status. The plan, however, did highlight and build on existing and enforceable regulations, such as those covering light fishing, mesh size, and restricted areas.

Information on plan effectiveness

- In discussions and in various documents the 2001 fishery management plan is refer to as "not implemented" and "not operational". Reasons cited for lack of effectiveness focus on enforcement difficulties.
- GFC (2011) gives information on the effectiveness of the management measures associated with the 2001 plan: "The regulatory abilities of these mechanisms have not yielded desired outcomes in terms of resource conservation. These are largely as a result of the weakness and even absence of enforcement…… In other words, one of the major issues in the marine fisheries sector is the extremely poor compliance of each of the three sub-sectors (canoe, semi-industrial and industrial) with fisheries regulations."
- GFC (2011) discusses an example of poor compliance with a provision in the plan banning the use of lights to aggregate fish: "The use of light aggregation for fishing is very frequent. It is estimated that 40% of canoe fishers and 50% of semi-industrial fishers are engaged in the act. Recent evidence also shows that a few industrial vessels, particularly the tuna bait boats under the pretext of collecting bait, have engaged in the act."

The main institutional and procedural difficulties in the management of the baitfishery

- It would not be logical to attempt to manage the baitfishery alone, at least not for resource sustainability purposes - the fishery is a tiny component of all fishing activity targeting key species of small pelagics.
- Present attempts at managing the entire small pelagics fishery (*and some of the associated challenges)* include placing restrictions on industrial and semi-industrial vessels (*a small component of the fishery*), a process of registering canoes (*by itself does not restrict effort*), and promoting community-based management (*a very long process*).

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- The implementation of the 2001 plan has collided with the reality of managing a large amount of artisanal fishing activity in a developing country. There are about 13,000 canoes (GFC 2011) and those fishers use over 300 landing sites in around 180 fishing villages in Ghana (Bannerman 2011). In general, artisanal fishers have yet to accept that their own fishing activities must be curtailed for the common good.
- The difficulty does not lie with "the plan" but with the enforcement of restrictions - which would be necessary in any type of management scheme, with or without a plan.
- There appears to be acceptance in Ghana of the desirability of the management plan approach – as evidenced by continuing efforts to produce fishery management plans and statements in official documents asserting the contribution of fishery management plans to improved governance (as in GFC (2011)).

Can an outside agency assist in improving the management of the baitfishery?

- As stated above, attempts at improving the management of the bait fishery alone are likely to be futile, given that the burning issue is over-exploitation and that other much larger fisheries target the same fish species.
- Improving the management of all fisheries in Ghana targeting small pelagics would be a very large long-term effort, but several donor agencies are either attempting to improve such management or have plans to do so. Bannerman (2011) and World Bank (2011) give information on those projects:
    - The World Bank's West Africa Regional Fisheries Program (US$53.8 million) has a Ghana component for "strengthening fisheries management' that includes developing fishery management plans for the key resources exploited by canoe, industrial and semi-industrial vessels.
    - The Ecosystem Approach to Fisheries Management-Nansen Project is a partnership between FAO and Norway's Institute of Marine Research. It provides technical support and knowledge of the marine ecosystems for planning, implementation and monitoring of fishery management plans in a number of sub-Sahara African countries, including Ghana.
    - The EU African Caribbean Pacific has a program called "Strengthening Fisheries Management in ACP Countries" which aims to strengthen their fisheries policy, management plans and enforcement capabilities. In Ghana the program is helping to update the fisheries masterplans and fishery management plans.

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Main informants: P.Bannerman (Ghana Fisheries Commission), M.Kebe (FAO), G.Bianca FAO)

Solomon Islands

Information on the major live-bait pole-and-line tuna fisheries in the country

- The pole-and-line fishery in the Solomon Islands began in 1971 and reached its height in 1986 with a catch of 38,644 tonnes of tuna. At one point over 30 pole-and-line vessels were operating. The overseas joint-venture partner in the pole-and-line operation ceased its involvement in 2000 during a period of ethnic tension and the pole-and-line fleet decayed during the next decade, but was enhanced in 2006 by two brand new pole-and-line vessels, provided through Japanese aid. In 2009 all pole-and-line operations ceased.
- Operations recommenced in late 2010, with a single refurbished vessel. The current pole-and-line activity (2 vessels 2011; 3 vessels 2012) represents a cautious re-entry into pole-and-line fishing by a large vertically-integrated firm with substantial experience in the fishery, in the Solomon Islands, and in the international trading of tuna. That company, National Fisheries Developments Ltd (NFD), also operates purse seiners in the country.
- Pole-and-line tuna catches in 2011 were 869 tonnes, according to NFD.

The various baitfishing operations: types of operations, size of operations and techniques

- Baitfish for pole-and-line fishing have historically been caught by stick-held dipnet ("bouke-ami").
- Barclay (2008) states that the technique was perfected by fishermen from Sarahama in Okinawa. The bouke-ami consists of a fine-gauge net, rectangular in shape with one side attached to a long pole running almost the length of the pole-and-line vessel. Baitfish are attracted at night by electrical underwater lamps which, just before the net is set, are moved to a position between the vessels and the net – and the attracted baitfish move likewise. Baitfish are then captured by raising the net, and are bucketed aboard.
- In addition to the bouke-ami, there have been some recent trials using the Indonesian-style lift net ("*bagan*").
- As to the geographic distribution of baitfishing in the country, Tiroba, (1993) indicates that the Western Province contributes over 70% of the baitfish catch and there were 78 bait grounds in that province. Barclay (2008) states that the most heavily utilized baitgrounds were Vangunu in the Marovo Lagoon, Choiseul, Munda in the Roviana Lagoon, and Raromana in the Vona Vona Lagoon. There have been considerable changes since 2008 and some closures by traditional owners (A.Lewis, per.com.).
- Barclay and Cartwright (2006) show that in the period 1973-1998 the catch per boat per night ranged from 63 to 147 buckets (a bucket is approximately 2.2 kg wet weight of baitfish).
- A system for permission and payment of royalties to baitground-owning communities was developed and used over three decades. Reef-owning communities were paid a royalty per night per vessel. Several times in the 1970s and 1980s technical advisors were brought in to train villagers to catch baitfish to sell to pole-and-line vessels yet villagers never operated a baitfishery (Barclay 2008). Currently, there are efforts to involve villagers in the actual baitfishing (Kwanairara, 2011).
- Besides baitfishing there is little, if any, fishing in the Solomon Islands for the two most important baitfish species.

The major baitfish species

- Argue and Kearney (1982) indicate that over one hundred species of baitfish are found in the waters of Solomon Islands, however, two stolephorid anchovies, *Stolephorus devisi and S. heterolobus*, both very effective bait species, account for approximately 32 per cent of the catch. Another effective bait species, the gold-spot herring (*Herklotsichthys punctatus*) accounts for a further 14 per cent.
- Dalzell and Lewis (1989) state that, although some authors have placed some of the smaller stolephorids such as *Stolephorus devisi* and *heterolobus* in a new genus, *Encrasicholina*, they maintain the older name to avoid confusion.

The recent trends in the baitfishery, including trends in catches

- The use of baitfish corresponds to the rise and fall of pole-and-line fishing in the country. Barclay and Cartwright (2006) show that annual baitfish catches in the period 1973-1998 ranged from 376 tonnes to 2,498 tonnes, while the annual catch in the 5-year period 2000-2004 ranged from 225 to 828 tonnes.
- Trends in catch per unit effort have been used to study the issue of baitfish stock depletion. Barclay (2008) states that the CPUE remained largely unchanged throughout 27 years of baitfish operations. Even if 1970s data is discounted due to deficiencies in the reporting and monitoring systems rectified in the 1980s, there is nearly 20 years of fishing without a sustained CPUE decline.
- Logging activity, which rose sharply in the early 2000s, resulted in siltation of some baitfishing grounds, reducing (or even destroying) baitfishing productivity. The cash earned by villagers from logging decreased their interest in baitfishing royalties.

The results of any baitfish stock assessment work

- Tiroba (1993) states that in November 1987 an MOU was signed by the Solomon Islands Government and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) of Australia to undertake research on the baitfish resources in Solomon Islands. The broad aims of the project were to "determine the population dynamics and biological parameters of the important baitfish stocks, determine if there is a direct trophic interaction between baitfishing and reef fish communities, determine whether management of the existing baitfishery is necessary to assure its future viability."
- Barclay (2008) commented on the results of the CSIRO work. The research found that the baitfish were not part of the same food chains as the food fish, so harvesting baitfish should not affect foodfish stocks. This research and subsequent follow-up also indicated that, although there had been reductions of reef-fish stocks around Tulagi, which was heavily fished for many years, the other heavily baitfished areas, such as the Roviana and Marovo lagoons, showed no signs of depletion in baitfish populations.
- Dalzell and Lewis (1989) show a linear relationship between baitfish catches and effort for the period 1973-1986.

- Dalzell (1993) states that the lack of pronounced curvature in the catch-effort relationship for the PNG, Solomons and Fijian bait catches may be due to the dynamics of these pole-and-line fisheries. When catches in a particular bait ground decline, either through localised overfishing or through environmental effects, the pole-and-line fleet will usually locate to another bait ground. Further, although individual species within a bait catch might decline during a fishing season, there is usually an increase in abundance of one or more of the dominant species in the catch to compensate for this.
- Argue and Kearney (1982) give the results of a comparative survey of baitfishing across the Pacific Islands: "In general, baitfish were found to be very abundant in the waters of Solomon Islands, more so than in any other country or territory in the South Pacific region, with the possible exception of Papua New Guinea."

The responsibility for the management of the major baitfisheries and the legal basis of fisheries management

- The legal basis of fisheries management in the Solomon Islands is the Fisheries Act 1998. That law states that the objective of fisheries management and development in Solomon Islands is to ensure the long-term conservation and the sustainable utilisation of the fishery resources of Solomon Islands for Solomon Islanders.
- The responsibility for management of baitfisheries is shared between various levels of government:
    - SIG (1999) indicates that management jurisdiction for bait fisheries in provincial waters lies with provincial governments. However, because of the importance of the bait fisheries to the sustainability of the pole-and-line fishery, the national government is assisting provincial governments to develop management arrangements.
    - Most of the areas where baitfishing occurs are covered by traditional management arrangements. A recent study found that nearly 85% of the inshore marine areas in the Solomon Islands are customarily owned and managed by local villages, tribal groupings and communities. There is a wide diversity of fishery management provisions between areas, but most involve traditional authorities making decisions after considering the views of their resident stakeholders.

The major concerns that management should address

- The overriding management concern since the beginning of the fishery in the 1970s has involved the flow of benefits from commercial pole-and-line operations to the villages that control the areas where the baitfishing occurs. Rawlinson (1995) writes: "Customary ownership or tenure over sea areas in the Solomon Islands still exists as a perceived and inviolable right of coastal people. Access to areas where traditional rights of tenure or usage of natural resources have become custom, and can only be maintained through negotiation of an agreement and the payment of compensation or royalty payments."
- Stone (undated) states that in the Solomon Islands "As with other countries in the Pacific baitfishing has always been contentious. There is much hearsay and ignorance associated with stock size, and reliance on the bait stocks of lagoon predators. Many villagers believe commercial bait and tuna fishing have diminished their canoe catches. A few communities refused to rent their reefs to bait fishermen on the grounds that the loss of baitfish deprives them not only of tuna (island bonito) which feed on the bait, but also [other species] …To nullify these fears and to transfer the responsibility of ensuring that responsible fishing and management takes place, FFA has recommended that a community based baitfish management system be put in place."
- Other management issues are siltation from logging activities affecting baitfishing productivity, and uncertainty over the actual traditional owners of some areas. In the height of the fishery a few decades ago, a major issue was the negative social interactions between villagers and the crews of pole-and-line vessels.
- Because the current fishery has declined considerably from its size a few decades ago, the intensity of management issues appears also to have subsided.

Current management of the baitfishery, objectives and the main fisheries management tools used

- Currently, management interventions in the baitfishery appear to be limited to (a) the requirement for pole-and-line vessels to have an agreement with the communities that control a baitfishing ground (i.e. payment of an agreed royalty), and (b) submission to the Ministry of Fisheries and Marine Resources (MFMR) logsheet data covering baitfishing activities. These requirements are related to the objectives of (1) assuring a flow of benefits to the concerned communities, and (2) assuring resource sustainability.
- According to officials of MFMR, their current involvement in the baitfishery is minimal.
- Tiroba (1993) points out that the baitfishing activity of the pole-and-line boats and their catch each year have been largely self-regulating. When catches in one baitground decreased, boats moved to other areas and stocks recovered.

Do the bait fisheries have a formal management plan? Do other fisheries in the country have plans?

- The principal fisheries legislation in Solomon Islands is the Fisheries Act 1998 (Act No. 6 of 1998). That law stipulates that fisheries management and development plans be prepared and kept under permanent review.
- FAO (2010) states that formal fishery management plans only exist for three fisheries. These are the offshore fisheries, live reef food fishery, and the beche-de-mer fishery.
    - The Solomon Islands National Tuna Management & Development Plan covers baitfishing. Bait fishing activities by pole-and-line vessels are regulated under Section 3.2(F) of the plan.
    - The plan was approved by the Minister for Agriculture and Fisheries and entered into force in June 1999. The plan itself states: (1) "The plan has no legal force in itself, however its provisions may be given legal force by being incorporated into fishing license conditions or regulations", (2) "In signing this Plan, the Minister of Agriculture and Fisheries and the Director of Fisheries have agreed to use their authority to manage the tuna fisheries in accordance with this Plan."

- With respect to baitfishing the major provisions in the plan are: (1) Local companies are required to make bait fishing agreements with holders of customary fishing rights over bait grounds, (2) Vessels may only fish in bait grounds covered by a current agreement, and (3) operators are required to submit records of catch and effort in this fishery to Fisheries Division. The plan contains a model agreement.
- The primary objective of baitfish management in the plan appears to be generation of benefits to the traditional owners of the baitfishing grounds.
- According to a 2004 review, "the plan has not been implemented in full". Tuna industry participants are less generous than the review comment with respect to the functional status the plan: "never really implemented" and "what plan?" (Gillett 2009).
- Discussion with representatives of the pole-and-line fishing company during the present study indicate that, although the baitfish management aspect of the tuna management plan is not in force, what the company currently does with respect to arrangements for baitfishing (i.e. agreement with communities, data collection) is precisely what is prescribed in the plan.

- According to a consultant contracted by the Forum Fisheries Agency, a baitfish management plan is being prepared for the Solomon Islands Government. The plan is described as a "baitfishery development plan that includes management arrangements". It focuses on Munda and nearby areas, has a community focus (i.e. articulates what adjacent villages want from baitfishing), identifies potential issues, and is intended to complement baitfish management plans to be prepared at the provincial and national level. The consultant indicated that Papua New Guinea experience and FAO documentation was used in the formulation of the plan. It is anticipated that a draft of the plan will be submitted to FFA and the Solomon Islands Government in July 2012. (N.Rawlinson, per.com.)

The type of fishery management plan

- Currently there is no plan in effect. The past plan that had a baitfishing component is described above.

The elements of the plan

- Currently there is no plan in effect. The elements of the past plan are described above

Does the management plan have a legal basis or is it purely an advisory document? Are there any mechanisms to assure adherence to the plan?

- Currently there is no plan in effect. The legal basis of the past plan is described above

Information on plan effectiveness

- The plan described above suffered from lack of implementation.

The main institutional and procedural difficulties in the management of the baitfishery

- Staff of MFMR indicate that lack of knowledge of baitfish resources is a constraint.
- From discussions with various stakeholders, the low priority given to management of the fishery (probably due to its tiny size compared to previous years) also appears to be a significant difficulty.

If no baitfish management plan exists, what are the main constraints to formulation and implementation of the plan? Are there advantages of the management plan approach?

- Both the lack of success with fishery management plans in the country and lack of models to build on are constraints.
- The advantages of the management plan approach are recognised by many stakeholders and there is considerable enthusiasm for the plan now being formulated. Some stakeholders feel that the current small size of the baitfishery does not warrant a plan, but this may change in the future if the pole-and-line fleet expands.

Can an outside agency assist in improving the management of the baitfishery?

- An outside agency (FFA) is currently supporting the formulation of a management plan.

Main documents:

- Argue, S., and R. Kearney (1982). An Assessment of the Skipjack and Baitfish Resources of Solomon Islands. SPC.
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- Dalzell, P. (1993). Small Pelagics. *In:* A. Wright and L. Hill (ed.) Nearshore Marine Resources of the South Pacific. Forum Fisheries Agency, Institute of Pacific Studies, and International Centre for Ocean Development.
- Dalzell, P. and A. D. Lewis (1989). A Review of the South Pacific Tuna Baitfisheries: Small Pelagic Fisheries Associated with Coral-Reefs. Marine Fisheries Review, 51 (4).
- FAO (2010). Solomon Islands Fishery Country Profile. Food and Agriculture Organization of the United Nations.
- Gillett, R. (2009). Tuna Management Plans in the Pacific Ocean - Lessons Learned. Forum Fisheries Agency, Honiara, 45 pages.
- Kwanairara, J. (2011). Factors that will Influence the Participation of Communities in Baitfishing Operations in Solomon Islands. Paper Submitted in partial fulfillment of the requirements for the degree of Bachelor of Applied Science, Australia Maritime College.
- Rawlinson, N. (1995). Community Monitoring of a Bait Fishery in the Solomon Islands.
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- Tiroba, G. (1993). Current Status of Commercial Baitfishing in Solomon Islands. *In*: Blaber, et al. (ed.) Tuna Baitfish in Fiji and Solomon Islands: proceedings of a workshop, Suva, Fiji, 17-18 August 1993. ACIAR Proceedings No. 52.

Main informants: N.Rawlinson (AMC), A.Lewis (consultant), A.Wickham (NFD), J.Terry (NFD), J.Peacey (MFMR), R.Manieva, (MFMR) , A.Carlos (MFMR), K.Barclay (UTS).

Appendix 2: Fishery Management Plans and Baitfisheries

Background

There is general recognition that fishery management plans have considerable value. This sentiment is embodied in FAO's Code of Conduct for Responsible Fisheries:

> Long-term management objectives should be translated into management actions, formulated as a fishery management plan or other management framework.

The use of fishery management plans has been promoted by FAO and many other entities sponsoring fisheries management work, including the World Bank, Asian Development Bank, European Union, USAID, and UK Government's Department for International Development.

Recently there has been considerable interest in the use of fishery management plans to improve the management of baitfisheries:

- The International Seafood Sustainability Foundation has stated that a sustainable pole-and-line fishery must have a management plan in place to protect important stocks of baitfish.
- The International Pole & Line Foundation indicates that it should give priority to the development of best practice guidelines for baitfish management plans.
- Greenpeace has stated: "As the long-term success of the pole and line operations depend on the bait, it is of utmost importance that the conditions are set right for the operations and adequate management plans are in place".

Management Plans: the Current Situation in Baitfisheries

The current use of fishery management plans in the baitfisheries associated with the major pole-and-line fisheries of the world is detailed in Appendix 1 and summarized in Table 3. In short, there are currently no baitfisheries in the world that have a functional fishery management plan. Two countries are preparing such plans for their baitfisheries. In those countries which have baitfisheries that are nested in larger overall fisheries, two countries have management plans for the overall fisheries, while seven countries have no such plans. There are several cases where attempts have been made to formulate/implement fishery management plans for baitfisheries (or overall fisheries containing baitfisheries) that were not successful: Brazil, Ghana, Indonesia, and the Solomon Islands.

It also became apparent during the present study that there is no consistent idea of what a fishery management plan actually is (i.e. many different types of documents are called a "fishery management plan"). This includes:

- A listing of enforceable rules
- A government policy framework for management
- A rationale and procedure for establishing and enforcing a total allowable catch
- A description of management arrangements
- A document that gives fishery information, stock assessment results, government policy, management objectives, interventions to meet those objectives, and arrangements for enforcement and plan monitoring/modification.[7]

For lack of a better term, the latter type of comprehensive plan will be referred to below as a "FAO-type plan".

During the country visits other sentiments on fishery management plans became apparent:

[7] In addition the types of plans for specific fisheries, some countries have a "national fisheries management plan" covering all fisheries in the country.

- Given the range of "things" that are sometimes considered to be a fishery management plan, many people (even individuals with fisheries management responsibilities) did not have a clear idea of what a plan should be.
- Many individuals seemed to feel that formulating a management plan is a long/complex process, and that before the plan is complete (a) comprehensive stock assessments need to be carried out on the major baitfish species, and/or (b) the solutions to the major problems in the fishery must be identified and incorporated into the plan.
- There was some feeling in a few countries that fishery management plans are not necessary for small baitfisheries, or for such fisheries without major problems, or for such fisheries that are shrinking in size.
- In several countries there is the sentiment that both management and development should be included in a plan[8], but for reasons given below this has tended to undermine plan success in some other fisheries.
- Individuals associated with baitfisheries that are apparently well-managed and without a fishery management plan dismiss the idea that such plans are universally necessary.

Fishery Management Plans: Elements and Templates

For the management of baitfisheries there is considerable interest in the subject of the desirable/essential elements of a management plan, or expressed in a slightly different way "best practise guidelines for baitfish management plans".

Bearing in mind the comment above on the variety in such plans, there is no shortage of references that give generic elements of a fishery management plan.

- The FAO "Technical Guidelines for Responsible Fisheries 4" (FAO 2000) contains an outline of possible topics in a fishery management plan[9]. It suggest 19 elements that "would normally be included in a management plan".
- The "Report of a Workshop on the Fishery and Management of Bali Sardinella in Bali Strait" (FAO 1999) has a draft management plan with elements that have been used as a template for other fisheries.
- "Design and Implementation of Management Plans" (Die 2002) gives five elements that "at a minimum, fishery management plans should contain".
- How to Manage a Fishery: A Simple Guide to Writing a Fishery Management Plan." (Hindson et al. 2005) gives an example of a plan (Atlantic mackerel) that has 10 elements.

In addition to the above manuals, the fisheries legislation of many countries specifies the required components of fishery management plans. In the United States the Magnuson-Stevens Fishery Conservation and Management Act has a section (Section 303) on "Contents of Fishery Management Plans, Required Provisions" giving six elements. The New South Wales (Australia) Fisheries Management Act 1994 has a section on "Content of management plan" giving 14 elements. The Marshall Islands Marine Resources Act 1997 gives nine elements that all fishery management plans must have.

[8] Here "development" is considered to be increasing the tangibles associated with a fisheries (e.g. docks, jobs, fish), while "management" is considered interventions in support of established objectives (e.g. protecting stocks, mitigation of negative interactions).

[9] It is interesting to note that 13 years ago FAO sponsored the workshop that produced the "Draft Management Plan of Lemuru Fishery in the Bali Straits". The document was discussed/modified and there have been ongoing attempts at implementation, however the consensus appears to be that the plan has not been fully implemented – but it is still cited by many fishery stakeholders as the most significant example of an Indonesian fishery management plan.

Examples of generic plan elements are:

- Die (2002) states that at a minimum a fishery management plan should contain: a description of the fishery especially its current status and any established user rights; the management objectives; how these objectives are to be achieved; how the plan is to be reviewed and/or appealed; and the consultation process for review and appeal.
- Hindson et al. (2005) state that in its simplest form, a fishery management plan is a document that analyzes the current situation in a fishery; sets out some principles that should be followed in management; details goals and objectives for the fishery; says how they are to be achieved; and says how they are to be monitored.

Some critical comments can be made on the above:

- Most of the manuals cited above are for "FAO-type plans", whereas the current fishery management plans associated with fisheries that contain baitfishing (e.g. US west coast, EU) are mainly other types.
- Fishery management plans can assist in the fisheries management process, but they do not eliminate what could be the most difficult task of the management process: placing controls on fishers.
- Some of the above manuals stress that the plan document should contain background and other information that can serve as a convenient reference on the fishery. This concept does not seem unreasonable by itself, but for reasons given below, it can contribute to plan failure.
- In discussions with fishery management specialists that have substantial experience in developing countries (including several associated with FAO) it is not easy to identify many examples where management plans have been successfully introduced in developing countries.
- Plans that are appropriate for developed countries with considerable fisheries management capability (where many of the success stories with fishery management plans come from) are not necessarily suitable for developing countries where cases of success in fisheries management (with or without plans) are not common.
- The manuals above are fairly thin on analysis of difficulties on introducing fishery management plans (i.e. lessons learned in plan failure).

Following from the last point, it may be useful to review the results of a comparative study of fishery management plans across several developing countries.

A Comparative Study of Fishery Management Plans

In 2009 the Pacific Island Forum Fisheries Agency commissioned a study of tuna fishery management plans (TMPs) across 15 developing Pacific Island countries. As the report of that study (Gillett 2009) could be of value in formulating fishery management plans for baitfisheries in developing countries, some of the relevant results are presented here.

The study showed that the most challenging difficulty with the fishery management plans is the failure to implement or adhere to plans after some form of formal adoption. One approach that appears to have some success is to make the plans easier to implement and include multiple mechanisms to encourage adherence.

- Easier to implement: Short/simple plans are the key, along with partitioning off of any development work, obtaining the appropriate type of external advice in plan formulation, and having a dedicated individual (plan driver) within the government fisheries agency who has primary responsibility for plan implementation.
- Multiple mechanisms to assure adherence: This could include legal requirements, formal procedures for dealing with grievances, a dedicated internal plan driver, periodic facilitation, and enhanced requirements for stakeholder consultation.

Other results of the FFA study that are relevant to baitfisheries are given in Table 5.

Table 5: Factors Affecting the Success of Tuna Management Plans (TMPs)

Factor	Comment
The major factors that affect the success of a tuna management plan	Experience over the past decade suggests the following are the most important: • Length/complexity of the plan document • Presence of mechanisms to assure adherence to the plan • How management and development are mixed in a single plan • The type of external assistance used in plan formulation
Length/complexity of the plan document	• A short/simple/understandable document is more likely to be successful than a more complete/complex document in a developing country. • The idea of having much of the information related to tuna management in one document has advantages, but if documents together are considered "the plan" – which is usually the case despite attempts by the authors to distinguish it from supporting documents - this frightens important stakeholders. • Short plans tend to force a degree of simplicity and clarity.
Mechanisms to assure adherence to a plan	• Even with a good TMP and an effective fishery management agency, mechanisms to encourage adherence to processes prescribed in the plan may be required for the proper functioning of the plan. • In countries where there are legitimate reasons for a TMP not to have the force of law, alternative mechanisms to encourage adherence to the plan become especially important. • These alternative mechanisms could include (a) formal procedures for dealing with grievances, (b) a dedicated individual within the government fisheries agency who has primary responsibility for TMP implementation, (c) enhanced requirements for stakeholder consultation, and (d) assistance from a dedicated external individual.
How management and development are mixed in a single plan	• If a TMP is to include a substantial development component, any specific development initiatives and associated recommendations should be partitioned off. Otherwise, if they are inter-twined, this often has negative impacts on implementing the broader plan - even the inherently simple components. • The "do-able" management component often gets sunk by the aspirational (and often expensive) development component.
The type of external assistance used in plan formulation	• The ideal supplier of external assistance in plan formulation would be a participant in a process (rather than the driver), have enough time and patience to proceed at the speed of co-participants (rather than trying to push the system faster than its normal rate), have broad experience in tuna fishery management, and not see his role as "selling" to the country pre-determined concepts or plan features. • Those countries that are assertive with external assistance providers as to what is needed, appropriate and practical, seem to end up more satisfied with their TMPs.
What the industry wants in a management plan	• The tuna industry generally wants rules that are binding on all parties; clear/effective mechanisms to deter non-adherence to the TMP; transparency of the decision-making process, reduction in discretionary powers of fisheries officials; and mandatory industry consultation.
Increasing plan complexity	• Attempts at increasing plan complexity (e.g. ecosystem approach, integrated management) have not met with much success. • In most cases it seems to be more appropriate to "learn to walk before you run" and achieve some success first with simple plans. • One approach to incorporating broader ecosystem considerations is to begin by adding some simple ecosystem-oriented objectives.

In applying some of these lessons to baitfishery management, some comments can be made:

- There are at least two baitfishery management initiatives underway in which management and development are both to be contained in the baitfishery plan.
- A clear statement of the "rules of the game" is not a feature of several of the template plans in the manuals cited above.
- "Mechanisms to assure adherence to a plan" does not get much mention in the manuals, implying the belief that adoption of a plan is sufficient.

Is a Fishery Management Plan Necessary for a Baitfishery?

Although it is difficult to refute some of the positive attributes of fishery management plans, there is at least some dissent from the view that such plans are universally required. In Japan the overall fisheries that contain the baitfisheries appears quite well managed (Appendix 1), yet there is no management plan. Some of the current baitfisheries are now very small as compared to the past – when there was no management plan and stakeholders assert the fishery was not poorly managed then, so they feel there is little justification for a plan. There is also the situation of disenchantment with fishery management plans: negative experience with attempting plans in the past has led some countries to discount the current necessity of plans. Finally, there is the case of baitfisheries that are nested in larger overall fisheries – it could be argued that the baitfishery component needs no fishery management plan, but rather a plan is needed at the overall fishery level.

In reflecting on value of management plans in the context of what was observed during the present study, it appears that management plans (depending on what they consist of) can be a convenient way to organize fisheries management, improve efficiency, assure that interventions are tied to objectives, guide less sophisticated managers, and promote transparency. They become even more useful in complex situations and where stakeholders are unfamiliar with fisheries management processes. In short, they are quite appropriate for the conditions commonly found where there are baitfisheries in developing countries. This desirability, however, seems to fall somewhat short of being absolutely essential.

This sentiment was similar to a remark made by a fisheries management specialist at FAO: "countries where there is no strong heritage of fisheries management success need a management plan more than the Norways and Japans of the world" (G. Bianchi, per.com.).

The contention that fishery management plans are not universally essential is reflected in the FAO Code of Conduct . That document promotes the use of "fishery management plan or other management framework".

Common Elements

If fishery management plans are not essential for effective management (i.e. where objectives are being achieved) can some essential elements be identified that are common to all effective management schemes? Such a list (at least for baitfisheries) would probably include some formal statement (e.g. plan, legal instrument, policy document) of the rules and the arrangements for applying those rules, plus the conclusion of Section 4.2.1 above: some type of monitoring of the fishery. These three items appear essential for both dedicated baitfisheries as well as those baitfisheries nested in larger overall fisheries.

Another observation that is related to common elements concerns the components of a fishery management plan. There appears to be many components that would be common to a plan for the dedicated baitfisheries, but much less commonality between those and plans baitfisheries that are nested in larger overall fisheries. In other words, fishery management plans for the Solomons and Maldives would have numerous similarities with respect to scope, types of objectives, processes, community involvement, enforcement, and other aspects, but be very different from the types of fishery management plans for the overall fisheries in which baitfishing is a small component (e.g. Ghana).

Appendix 3: The Baitfish Management "Think Tank"

In August 2012 a meeting of baitfish specialists was held in the margins of the WCPFC Scientific Committee Meeting in Busan, Korea. The participants in the meeting were M. Shiham Adam, Paul Bannerman, Bob Gillett, David Itano, Antony Lewis, Victor Restrepo, and Kurt Schaefer. The expertise of these individuals in baitfish issues covered the western Pacific, eastern Pacific, eastern Atlantic, and the Indian Ocean. The purpose of the informal meeting was to:

- Comment on aspects of the report "*Management of Tuna Baitfisheries: the results of a global study*"
- Explore appropriate approaches to some difficult issues in baitfish management
- Offer suggestions to ISSF on their future involvement in baitfishery issues

Discussions by the group led to several notable points where there was either general agreement among the participants on a concept, or where additional relevant information was brought to the attention of the group. It was agreed that the baitfish management report would benefit from an appendix documenting those points.

Comments arising from considering the report "*Management of Tuna Baitfisheries"*

The important points raised in discussions were:

- Pole-and-line production figures given in the report for Ghana for the last few years are thought to be accurate and reflect the production in the past few years by "pure pole-and-line fishing" (i.e. not made by collaborating with purse seining).
- Past estimates of world pole-and-line tuna production and associated trends appear to have omitted some important pole-and-line fisheries, such as those of the USA (up to 165,000 tonnes in the eastern Pacific and Hawaii) and Papua New Guinea (up to 48,000 tonnes).
- As the tuna-to-bait ratio is often used in discussions of pole-and-line fishing, the report should point out that there can be difficulties in comparing ratios between fisheries, especially between those fisheries where bait is purchased (where pre-purchase mortality is not considered, plus the purchased bait is "hardened" bait with higher survival characteristics) and those where the pole-and-line vessel catches its own bait (where mortality estimates typically encompass the entire process from capture to use).
- Baitfish mortality during capture, handling, and storage is important. The reduction of such mortality (i.e. minimization of wastage) should be considered a legitimate objective of the management of some baitfisheries. It is recognized that estimating such mortality can be difficult, but the various baitfisheries can be placed in categories. Baitfish survival in some baitfisheries could be improved by following best practice guidelines to reduce wastage and mortality throughout bait catching and tuna fishing operations.
- Although CPUE data on baitfisheries should be collected and such data are useful in management, the analysis of the data needs to be done cautiously and take into consideration factors that may distort a simple interpretation of the trends, such as changes in spatial distribution of baitfishing activity, moon phases, seasonal/environmental induced variability, and biological characteristics of the targeted baitfish.
- Additional attention to applying the ecosystem approach to fisheries management to baitfishery management may not be warranted – in view of the complexities involved and the fact that most baitfish management is typically not restricted to target species.

- The report could benefit by at least some mention of these points:
    - Baitfish management has been critically important in the past, with the example of the establishment of the Inter-American Tropical Tuna Commission in 1950 partially due to the over-exploitation of baitfish in near-shore waters of Costa Rica by the United States pole-and-line fishery.
    - Lessons learned from the attempt to culture baitfish species and incorporate their use into existing pole-and-line fisheries.
- Consideration should be given to citing the following in the report's section on desirable future research:
    - Lessons learned from the management of some of the large baitfisheries that no longer exist, especially those of Papua New Guinea and Hawaii.
    - Essential components of a baitfish monitoring program
    - The application Productivity-Susceptibility Analysis (a semi-quantitative and rapid risk assessment tool that relies on the life history characteristics of a stock) or a Scale, Intensity and Consequence Analysis (SICA) to some of the major baitfish species.
    - The role of basic productivity of a baitfishing ground that supplies a fishery (e.g. high island vs atoll, coastal upwelling) and potential man-made impacts

Exploring appropriate approaches to some difficult issues in baitfish management

The two "semi-intractable" issues discussed by the baitfish meeting were improvements to (a) the management baitfisheries that are nested in large fisheries suffering from over-exploitation from a large amount of artisanal fishing, and (b) management of baitfisheries that are surrounded by many poorly managed coastal fisheries.

With respect to (a), experience from the Ghana baitfishery which is nested inside a large artisanal fishery (13,000 canoes), indicates that the baitfishery stakeholders have so little leverage/opportunity to influence attitudes and behavior of the artisanal fishers. In Ghana there does not appear to be a mechanism to use aspects of the baitfishery to improve the management of the overall small pelagics fishery. The baitfish meeting felt that in these situations worldwide, what could be done by baitfishery stakeholders is to monitor and thoroughly document the baitfishery, including how small it is compared to the overall fishery plus any differences.

With respect to (b), the situation is especially prevalent in Indonesia. Although "working with local NGOs" has been cited as a possible approach, this may not necessarily address some of the underlying issues – including the huge size of the task of improving the management of the many fisheries in some areas. The baitfish meeting felt that perhaps the best approach would be to encourage work in one area where there are favourable conditions to improve the management of several fisheries (including baitfisheries) - as an example of what could be done in other areas.

Suggestions to ISSF on their involvement in baitfisheries

Various ISSF documents mention the necessity of fisheries management plans for baitfisheries. The baitfish meeting agreed that there is considerable ambiguity that contributes to confusion over the term "fishery management plan" and what formally constitutes a management plan differs between countries.

The group felt that the essential element that needs to be addressed is that all baitfisheries should be monitored and use should be made of that data to make decisions, as appropriate. ISSF should therefore consider referring more broadly to the need for a "management framework", whose centerpiece is monitoring and reporting of the baitfish

fisheries. Specifically, a management framework should include provision for collection and reporting of catch and effort data on the fishery (see Addendum below) and some formal statement of the rules and how they are to be applied.

The group recognized that ISSF has been active and effective in bringing attention to the need to consider the baitfish component in the management of pole-and-line fisheries. ISSF's future involvement should include providing assistance, in collaboration with other interested organizations such as IPNLF, for defining management frameworks for these fisheries as best practice. In addition, ISSF and other organizations like IPNLF should provide assistance in disseminating information about bait fisheries.

Addendum

Types of data that should be collected and reported to monitor baitfish fisheries:

- Date
- Location
- Gear
- Day or night
- Number of sets
- Number of buckets (or scoops) loaded aboard per day (specify average bucket/scoop weight)
- Primary species