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Food for Thought

Reflections on the success of traditional fisheries management

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The argument persists that the continued overexploitation by many fisheries around the world is evidence that current approaches to fisheries management are failing, and that more precautionary management approaches are needed. We review the available estimates of the status of fish stocks from three sources: the FAO's "State of Marine Resources", a database on scientific stock assessments, and recent estimates from statistical models designed to determine the status of unassessed fish stocks. The two key results are (i) that stocks that are scientifically assessed are in better shape and indeed are not typically declining but rebuilding, and (ii) that large stocks appear to be in better shape than small stocks. These results support the view that stocks that are managed are improving, while stocks that are not managed are not. Large stocks receive far more management attention than small stocks in jurisdictions that have active fisheries management systems, and most unassessed stocks are simply not managed. We assert that fisheries management as currently practised can (and often does) lead to sustainable fisheries, and what is needed is to actively manage the unassessed fisheries of the world. More precautionary management is not necessarily needed to ensure the sustainability of managed fisheries.

Keywords: fisheries management, overfishing, precautionary management, stock status, sustainable fishing.

Introduction

Since the mid-1990s, it has been recognized that many fisheries were overexploiting stocks and in decline, and there was near-universal agreement that fishery management systems in almost all countries needed reform. However, recently a dichotomy has developed between those who now see fisheries management as rebuilding overfished stocks and preventing overfishing in many places (Worm *et al.*, 2009), and those who consider the existing fisheries management systems as generally failing to protect the marine ecosystems on which the small- and large-scale fisheries of the world depend. Lost in this argument is a critical opportunity to objectively assess the successes and failures of fisheries management and identify successful strategies for achieving sustainable fisheries.

The purpose of this paper is to summarize what the various analyses of the status of stocks tell us, and in particular to clarify the confusion and misinterpretation of the Worm *et al.* (2009) and Costello *et al.* (2012) papers as evidenced by Pikitch (2012a, b). We will then discuss how we can use the lessons of these studies to address the critically important deficits in assessment and management faced by the many small and unassessed fisheries around the world.

Worm *et al.* (2009) reviewed the status and trends in fisheries for many regions and summarized their results as:

Marine ecosystems are currently subjected to a range of exploitation rates, resulting in a mosaic of stable, declining, collapsed, and rebuilding fish stocks and ecosystems. Management actions have achieved measurable reductions in exploitation rates in some regions.

Others either ignore the successes that have been achieved, or deny that such successes exist. "And, just as a Ponzi scheme will collapse once the pool of potential investors has been drained, so too will the fishing industry collapse as the oceans are drained of life", and "people—even those who profess great environmental consciousness—continue to eat fish as if it were a sustainable practice" (Pauly, 2009). The Worm *et al.* paper considers the status of fisheries region by region and recognizes that status and trends differ greatly in different parts of the world, whereas Pauly looks at world fisheries as one entity subject to one overall fate.

In a Perspective in Science published in the same issue as the Costello *et al.* (2012) article, Pikitch (2012a) argues that unassessed fish stocks "are in much worse shape than the relatively well-studied fisheries on which previous global status reviews have relied". Pikitch's web site, Pikitch (2012b), and media coverage of this result considered this as evidence that traditional fisheries management is failing. Pikitch has missed the most important lesson of the Costello *et al.* paper—the unassessed stocks that are declining are not managed by "traditional fisheries management"—they are typically not managed at all. You rarely manage fisheries if you don't assess them. The decline of many of the world's unassessed stocks is not a failure of fisheries management, it is a failure to implement fisheries management techniques that we know can work well.

Traditional fisheries management has a number of different connotations. Given Pikitch's text, we take her meaning to be fisheries management as practised in developed countries over the last few decades using the tools outlined in Table 1 of Worm *et al.* (2009). These traditional management tools include gear restriction, capacity reduction, total allowable catch reductions, total fishing effort reductions, closed areas, catch shares, fisheries certification and community comanagement. This form of "traditional management" typically relies on statistical stock assessments that require extensive data and expert analysis. Pikitch (2012a) suggests that these tools need to be applied in a much more precautionary manner.

Pikitch references the Worm *et al.* (2009) paper, "Rebuilding global fisheries", as an example of the status of "well-studied" fisheries. Worm *et al.* (2009) and numerous later publications that document the status of fisheries in developed countries (Hilborn *et al.*, 2012; Fernandes and Cook, 2013; Melnychuk *et al.*, 2013; Neubauer *et al.*, 2013) showed that "traditional fisheries management" has stopped the decline in fisheries that are both assessed and managed and is rebuilding stocks in many places. The managed fisheries of the world are increasingly a success story in sustainable food production and conservation of natural resources. Rather than focusing on global success or failures of fisheries, it is critical to consider the differences in fishery status among diverse groups, fishery sizes, management types, and regions, in order to begin to understand what factors contribute to the status of fisheries and to identify successful strategies.

Global fishery status databases

The RAM Legacy database (Ricard *et al.*, 2012), initially created for the working group that produced Worm *et al.* (2009), has given rise to a series of papers on the status of world fisheries, including Costello *et al.* (2012). The RAM Legacy database provides estimates of status indicators such as biomass, fishing mortality rates, and associated reference points, and is the most quantitatively robust source of fishery status available. While assessment does not necessarily equal management, knowledge of the regions represented by these assessments, together with the fact that the expense of assessment is rarely undertaken without an associated management need, indicates that the majority of these stocks do have fishery management institutions that regulate catch and enforce regulations as well as assessments.

However, the RAM Legacy database is clearly not a random sample of world fisheries; because of the intense data and cost requirements of these assessments, it is biased towards large, commercially important species in the developed world. The RAM Legacy database used in Worm *et al.* (2009) and now expanded, currently encompasses 35% of the total world catch, but is highly biased towards wealthy nations that have fisheries management systems that conduct assessments, and to major international fisheries (largely tuna) that have regional fishery management organizations (RFMOs) that also conduct assessments. The major fisheries that are not represented in the assessments are from Asia (except Japan and Russia which *are* represented), and Africa (except South Africa). The RAM assessments are also strongly biased towards industrial stocks that tend to be larger and represent a small fraction of commercially exploited species (with especially few tropical species represented).

The Food and Agriculture Organization of the United Nations (FAO) also evaluated the status of 395 stocks (FAO, 2011). These stocks represent a more diverse set of fisheries than those contained in the RAM Legacy database, including greater representation throughout the developing world, but the majority of stocks in the

Table 1. Number of RAM stocks below BMSY 5 years prior to the last year of data showing decreases and increases in biomass over the most recent five years of data for the stock.

Region	Number decreasing	Number increasing	Total number	% increasing
USA (Alaska)	5	11	16	69%
USA (East Coast)	8	16	24	67%
USA (Southeast/Gulf)	3	9	12	75%
USA (West Coast)	–	12	12	100%
Australia	3	7	10	70%
European Union	9	26	35	74%
New Zealand	7	6	13	46%
Canada (East Coast)	8	8	16	50%
Canada (West Coast)	5	2	7	29%
Europe (non EU)	3	8	11	73%
Indian Ocean		1	1	100%
Mediterranean – Black Sea	1	–	1	0%
Other	1	–	1	0%
Pacific Ocean	3	3	6	50%
Russia – Japan	4	11	15	73%
South Africa	6	3	9	33%
South America	3	3	6	50%
Atlantic Ocean	5	8	13	62%
Grand Total	**74**	**134**	**208**	64%

RAM Legacy database are also included in the FAO analysis. The FAO assessments provide categorical assessments of fishery status (ranging from depleted and recovering, fully exploited, underexploited), based on qualitative evaluations and empirical data where available. However, the FAO assessments represent only a fraction of global catch and evaluate few of the smaller fish stocks of the world.

Costello *et al*. (2012) estimated the status of fish stocks as a function of easily obtainable data such as life history traits, taxonomic group, geographic range, and various features of the catch history using statistical models fit to stocks in the RAM Legacy database, where the value of biomass relative to the biomass that produces maximum sustainable yield (B/BMSY) was known. They then estimated the status of stocks that are not in the RAM Legacy database, generally called the "unassessed stocks." The Costello *et al*. (2012) model predicted B/BMSY as a function of the variables described above. This model was then used to estimate the biomass status of 1793 unassessed stocks. While the biomass estimates provided by Costello *et al*. (2012) are highly uncertain for any individual stock, this method provided estimates for groups of stocks that are consistent with other sources of information. There is some minor overlap between the stocks in the current RAM Legacy database and the unassessed stocks, and many of the FAO stocks that are not in the RAM Legacy database are considered in the unassessed analysis.

Together, the RAM Legacy database [represented by Worm *et al*. (2009) and Ricard *et al*. (2012)], FAO (FAO, 2011), and Costello *et al*. (2012), comprise the largest set of estimates of fishery status currently available. Due to conflicting scales and metrics it is not straightforward to merge these databases into one comprehensive database of fishery status; thus we present summary results from each database separately. Taken together, though, these databases provide the best means currently available for comparing the status of global fisheries.

Comparing the status of fisheries

For the purposes of this paper we define fishery status using biomass levels and fishing mortality rates. These metrics are generally compared with reference points (e.g. BMSY, FMSY) to provide an estimate of the status of a given fishery relative to a desired benchmark. There is no general agreement on what fisheries management targets should be (Hilborn, 2007), but evaluating status relative to MSY reference points is a common practice (with the knowledge that biomass levels other than BMSY may often be desired). Broadly, we can consider biomass levels increasing towards BMSY or fishing mortality decreasing towards FMSY as positive signs of rebuilding of depleted stocks.

How then do we interpret the status of global fisheries using these available databases? Pikitch's conclusion from comparisons of Worm *et al*. (2009) and Costello *et al*. (2012) is that the world's unassessed fisheries are in worse condition (as defined by biomass) than well-studied groups. While it is true that the median B/BMSY of RAM fisheries (~0.94) is greater than the median B/BMSY (0.64) of the unassessed stocks represented by Costello *et al*. (2012), it is a mistake to construe this difference as a failure in fisheries management. In order to properly assess the success and failure of fisheries management we need to break apart the results of these databases and consider status in a more detailed manner.

To begin, understanding the distributions of catch sizes represented by different stocks is a critical step in interpreting the status of world fisheries; large industrial fisheries clearly have vastly different characteristics and challenges from those of small-scale fisheries, and it is important to parse out differences in

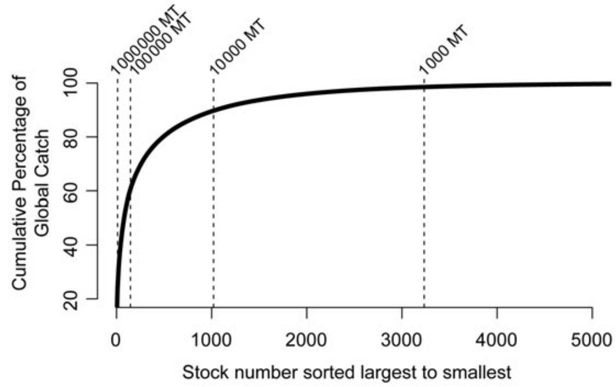

Figure 1. Average FAO catches 2000–2011. Vertical lines represent the boundary between stocks of 1 000 000 MT annual catch, 100 000 MT, 10 000 MT, and 1000 MT.

stock status between these two groups. The FAO catch data include ~20 000 units that are broken down by taxon, by country, and by FAO area (which we will refer to as "stocks"), but most of these represent very small catches. Only 11 stocks, each with an annual catch >1 000 000 MT, constitute 22% of world catch, and the next ~1000 stocks make up 90% of the world's catch (Figure 1). The smallest 16 000 stocks (annual catches of <1000 MT) amount to only 1.5% of global catch. Clearly then, global status will vary greatly depending on whether one is interested in reflecting the state of landings or in number of fisheries.

The RAM Legacy database shows that "traditional fisheries management" has succeeded in rebuilding biomass and/or decreasing fishing mortality rates to more desirable levels. Two-thirds of the stocks in Worm *et al*. (2009) were below the population size that produces maximum sustainable yield (MSY), and about one-third would be classified as "overfished", defined as abundance below half the abundance that produces MSY. However, fishing effort among RAM stocks has mostly decreased over the past decade to levels well below historic highs (Figure 2). Looking at RAM stocks with biomass levels below BMSY in the past five years, we see that 64% of these stocks have since increased their biomass levels towards BMSY (Table 1). This indicates that for these assessed (and generally traditionally managed) stocks, fishing mortality rates have decreased and biomass has been rebuilding.

Costello *et al*. (2012) analysed the condition of unassessed fisheries that by and large lack the traditional management measures used by the RAM Legacy fisheries. While in aggregate the stocks represented by RAM in Worm *et al*. (2009) have higher biomass levels than those analysed by Costello *et al*. (2012), a closer look reveals a more complex picture of fishery status for these two groups. Costello *et al*. (2012) distinguished between large and small stocks. Small stocks (average total catch per year <10 000 MT) were indeed estimated to be in much worse shape than well-studied fisheries. However, the large unassessed stocks that constitute 90% of the total unassessed fish catch were at ~90% of traditional management targets, in fact higher than for the assessed stocks reported in Worm *et al*. (2009). This is likely a consequence of the fact that the well-assessed fisheries dominantly come from the North Atlantic, where fishing pressure developed earlier, whereas the large unassessed fisheries of the world come from southern Asia, which does not have the same long history of intense industrial fishing. However, both the large and small unassessed fisheries

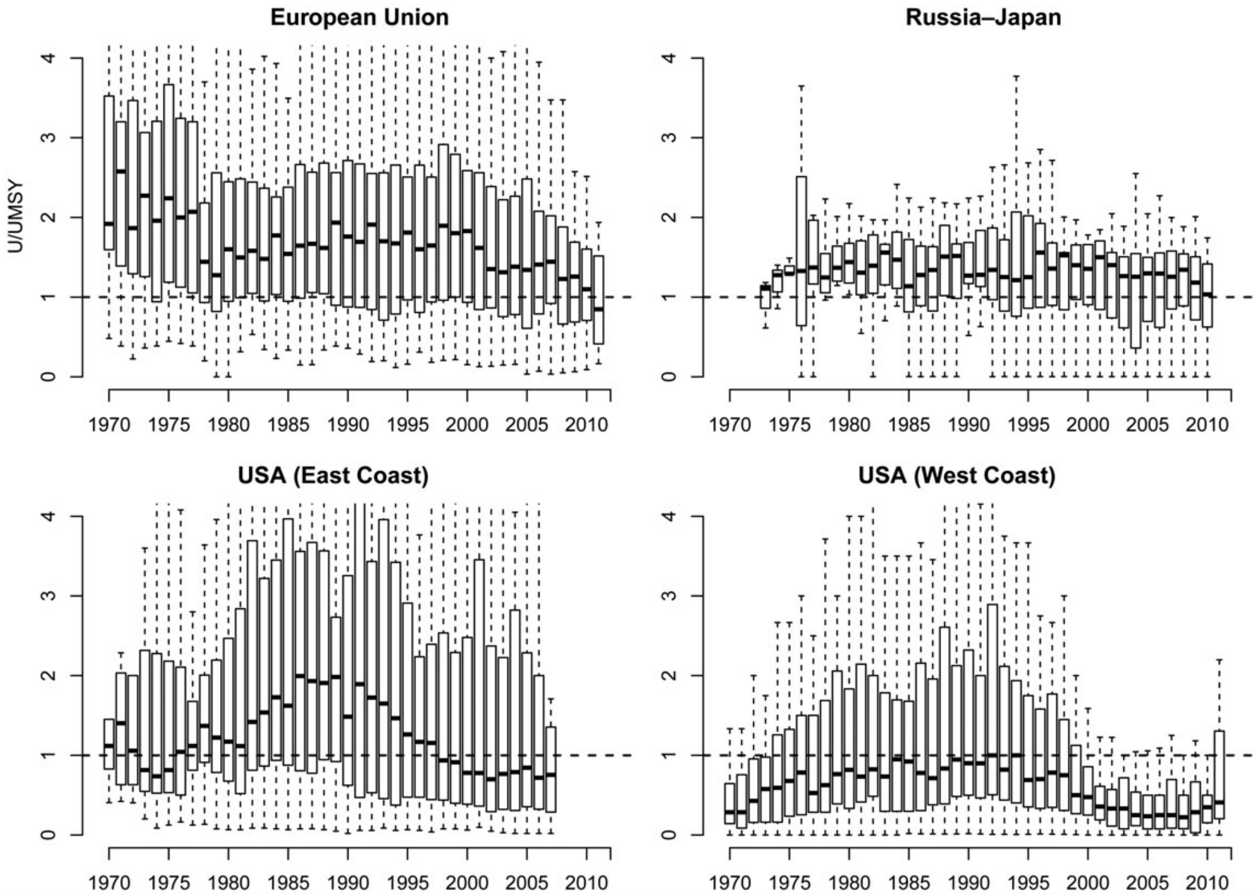

Figure 2. Boxplots of fishing mortality rate (U) scaled relative to the level that would achieve MSY (UMSY) in the European Union, Russia – Japan, the USA (West Coast) and the USA (East Coast) over time. Black horizontal lines indicate the median U/UMSY in a given year; the box areas represent the interquartile range, and the whiskers the 95% confidence intervals.

Table 2. Proportion of stocks classified in abundance status based on classification method and size of catch. Large stocks average catch >10 000 MT; small stocks catch <10 000 MT.

Method and size of stocks	Number of stocks	Below 80% BMSY	Between 80% and 120% BMSY	Over 120% BMSY
FAO assessments: large stocks	211	24%	65%	11%
FAO assessments: small stocks	91	51%	41%	9%
RAM Legacy: large stocks	74	36%	20%	43%
RAM Legacy: small stocks	255	44%	20%	36%
Costello *et al.*: large stocks	231	41%	14%	45%
Costello *et al.*: small stocks	1403	60%	13%	28%

appear to be declining. While it is true then that, as a whole, the unassessed stocks appear to be in worse condition than the assessed, a more careful look reveals stark contrasts in exploitation status depending on fishery size and geography.

Using the FAO's biomass status breakpoints of >120% BMSY (underexploited), between 120% and 80% BMSY (fully exploited) and <80% BMSY (overexploited), all three assessment methods evaluated in this paper show large stocks to be at higher relative biomass levels than small stocks (Table 2). Both the FAO and Costello estimates show small stocks to be more depleted than are the RAM Legacy small stocks. The majority of the FAO and Costello small stocks are from regions of the world that are not formally assessed (Asia and Africa), whereas all the small stocks in the RAM Legacy database are from locations with formal assessment and management. Thus we believe the better status of small stocks in the RAM Legacy database is due to the management systems in place for those small stocks. Our conclusion from comparing our three databases is that, broadly, large stocks representing the vast majority of the world's landings are in better shape than the small stocks that make up the vast number of global fisheries. However, this is likely not indicative of a fundamental trait of smaller stocks; rather, the evidence suggests that small assessed (and presumably managed) stocks are in a better state than small unassessed (and presumably unmanaged) stocks.

The relatively better status of the world's large fisheries suggests that when fisheries management is applied it can lead to sustainable outcomes, and contradicts the assertion that fisheries management itself has failed. Nevertheless, the apparent poor shape, from the perspective of biomass, of the world's small unassessed fisheries is cause for great concern. While small fisheries constitute a minute fraction of global catch, they are particularly important to the food security and ecosystem health of many communities. In addition, they are poorly studied, and their available catch data [on which the Costello *et al*. (2012) paper depends] are generally believed to be unreliable and almost certainly underestimated (Mills *et al*., 2011). As such, what little information we have on these small but important stocks is itself highly uncertain. Breaking apart fishery status according to size then allows us to acknowledge that many large fisheries, the backbone of global landings, are in good health, while realizing that for the most part small and unmanaged fisheries are indeed in strong need of reform.

Regional variation in stock status and fishing pressure trends

Along with ignoring differences in fishery size, a major problem with any global fisheries status assessment is that global analyses mask differences between places and cannot distinguish between areas where fisheries management is implemented and working, and places that are not managed. Worm *et al*. (2009) found striking differences between countries and areas: New Zealand and Alaska had never exhibited systematic overfishing; the west and east coasts of the USA and Australia had been overfished, but then fishing pressure was reduced. While Europe was much slower to reduce fishing pressure, by 2013 fishing pressure on European stocks had come down to about half of what it had been a decade earlier.

Within the FAO's major fishing areas, we can compare the status of fishery biomass abundance using the three assessment methods. Regional differences among the FAO-assessed stocks are quite large, with three regions—the Southwest Atlantic, East Central Atlantic, and Northeast Atlantic—standing out, with >30% of stocks at abundance <80% of BMSY (Table 3). In contrast, the Northwest Pacific, West Central Pacific, Northeast Pacific and Northwest Atlantic have <20% of stocks below this level. In the RAM Legacy database, all regions except the Northeast Pacific had >30% of stocks <80% of BMSY For the unassessed stocks, in all of the FAO regions considered here, >30% of their stocks were <80% BMSY, but this result is dominated by the many small stocks not considered in the FAO or RAM Legacy analysis. The conclusion is that among assessed stocks there are clear regional differences, but among unassessed stocks we do not see these differences.

The differences between regions are even stronger when one examines trends in fishing pressure rather than current abundance (Figure 2). Both the west and east coasts of the USA show dramatic reductions in fishing pressure, beginning in the late 1990s. In Europe, such reductions began later, while in Japan and eastern Russia fishing pressure has been reasonably constant. While in some cases reductions in fishing pressure are too recent to yet show subsequent increases in biomass, the reduction in fishing pressure in the heavily managed fisheries of the USA and Europe reflect a positive influence of fishery management.

There is evidence, though, that these reductions in fishing pressure among the assessed stocks are having positive effects on biomass. Among stocks that had previously declined to biomass levels below BMSY, along the west and east coast of the USA 100% and 67% (respectively) have seen subsequent rebuilding of biomass. Of the EU stocks in this group, 74% are rebuilding (Table 1). Together, the decreases in fishing mortality and evidence for biomass rebuilding among the most well-managed regions of assessed stocks provides evidence that traditional fisheries management has been effective at responding to overfishing and at rebuilding stocks.

Looking across the regions and assessment methods presented in Table 1 and Figure 2, then, we can see that the status of stocks and exploitation rates vary greatly, depending on region and the types of fisheries selected by a given assessment method. This is likely a reflection of the diversity of exploitation histories, species characteristics, economic incentives, and management capabilities seen across these regions, and provides further evidence of the challenges and limitations to grouping global fisheries into a collective group. However, highly managed areas such as the USA and Europe show particularly strong signs of successful management.

Advancing unassessed and unmanaged stocks

There is ample evidence, then, that traditional fisheries management is capable of rebuilding depleted fisheries, achieving target fishing rates, and maintaining healthy stock sizes. However, these traditional methods are expensive, often costing up to 15% of the landed value of a stock to assess and manage a fishery (Arnason *et al*., 2000), and require research vessels, highly trained fisheries scientists, and personnel to manage and enforce fishery regulations. Despite their demonstrated ability to successfully manage fisheries, traditional assessment tools like those used by the fisheries represented in the RAM Legacy database are unlikely to become viable options for the thousands of small unassessed fisheries that are most in need of effective management.

How then can we bring management to the world's fisheries? A variety of what can broadly be called data-poor stock assessments (DPSAs) are showing increasing promise as cost-effective fisheries

Table 3. Distribution of stock status by FAO region. Regional catch is the catch represented in the stocks considered by FAO (2011).

Region	FAO stocks below 80% BMSY	% RAM stocks below 80% BMSY	% Unassessed stocks below 80% BMSY	Regional catch in MMT
Northwest Pacific	12%	57%	54%	17.8
Southeast Pacific	27%	50%	59%	12.2
West Central Pacific	14%	NA	45%	10.5
Northeast Atlantic	31%	58%	60%	9.1
Eastern Indian Ocean	20%	NA	38%	5.3
Western Indian Ocean	26%	NA	49%	3.9
East Central Atlantic	52%	NA	49%	3.7
Northeast Pacific	12%	26%	64%	2.6
Southwest Atlantic	69%	NA	53%	2.0
Northwest Atlantic	18%	61%	64%	1.9

MMT, millions of metric tonnes.

management tools. Rather than attempting to fit complex population dynamics models to various data sources, these DPSAs generally rely on broader life history relationships or catch trends to infer information on the status of fished stocks. At the most reduced form, there are a variety of catch-based models (CBMs) that essentially rely on catch histories, often together with very basic life history information, to infer stock status [for instance Costello *et al*. (2012), Martell and Froese (2013) and Thorson *et al*. (2012)]. These methods are attractively simple but unlikely to be accurate enough to reliably guide the management of individual stocks.

John Caddy proposed management methods that use limited information but do not rely on assessment models (Caddy, 2002; Caddy *et al*., 2005), and Prince *et al*. (2011) describe management systems characterized by using indicators such as catch per unit effort (CPUE), length, etc., but not reliant on full statistical assessments. This approach is in place for a number of fisheries in developed countries, for instance for rock lobster in New Zealand (Starr *et al*., 1997).

Alternatively, some types of DPSAs exist that often use life history information in addition to CBMs and may provide reasonably accurate single-stock results at a much lower cost than traditional stock assessments. These DPSAs exploit trends in data such as fishery-dependent or -independent length frequencies, cpue, or density ratios across no-take marine protected area borders to provide assessment results (e.g. Ault *et al*., 2005; Prince *et al*., 2011; McGilliard *et al*., 2011; Babcock and MacCall, 2011; Kay and Wilson, 2012; Wilson *et al*., 2012). While these DPSAs generally do not provide raw estimates of stock biomass levels, they are capable of giving estimates of important metrics such as the sustainability of current fishing pressure or the current spawning potential of the population. Their results can then be used as the foundation for the implementation of adaptive, science-based fishery management practices in data-poor fisheries. It is beyond the scope of this paper to comment on the specific applicability or accuracy of particular DPSAs, but evidence is accumulating that these data-poor approaches may be a viable method of bringing management to the world's small unassessed fisheries.

Lastly, there is a growing push for fishery management approaches that take an ecosystem approach, rather than the single-species approach currently used in many fisheries (Pikitch *et al*., 2004; Palumbi *et al*., 2008). Ecosystem-based management (EBM) is likely to be especially relevant to the multitude of small-scale multispecies fisheries throughout the developing world. Under these circumstances, it is likely impossible to simultaneously achieve MSY for each individual species; rather the system should be managed to maximize its overall ability to achieve stakeholder goals. A number of tools have been proposed for achieving ecosystem-based management of fisheries. At the most complex level, ecosystem-based models, such as Ecopath or Ecosim, can be used, though the data needs for these models can be immense and the workings opaque (Pauly *et al*., 2000). Smith *et al*. (2007) provide an interesting example of adapting EBM approaches to reflect different levels of data availability, ranging from qualitative judgment up to full ecosystem models. McClanahan *et al*. (2011) present a method for assessing overall ecosystem health with respect to critical thresholds in overall fish density and ecosystem indicators. Productivity and susceptibility analyses (PSAs) allow for relatively rapid ranking of species with respect to their potential for overexploitation, and in turn identify critical species groups for management and conservation throughout an ecosystem (e.g. Patrick *et al*., 2010; Cope *et al*., 2011; Hobday *et al*., 2011). Palumbi *et al*. (2008) advocate for managing for biodiversity as the universal currency of EBM.

However, these EBM methods pose a clear challenge; given our inability to implement even single-species fisheries management in the vast majority of the world's fisheries, the task of implementing EBM on a broad scale is especially daunting. What are sorely needed are EBM frameworks that balance the need to incorporate the complexity of marine ecosystems with the practically of implementation for the world's data- and resource-limited fisheries. In addition, better tools are needed for translating EBM tools into practical management benchmarks. Ongoing research in this field is critical for ensuring continued provision of marine ecosystem services.

Summary

Has "traditional fisheries management" failed, as Pikitch suggests? The evidence is strong that where fisheries management has been applied, it has worked to both reduce fishing pressure (Figure 2) and to rebuild stocks (Neubauer *et al*., 2013, and Table 1). Examining current stock status, we can see that assessed and larger stocks are in better condition than smaller and unassessed stocks. This suggests that it is not the failure but the lack of management that drives fishery depletion.

Pikitch argues that "(the) substandard and deteriorating condition of the preponderance of fisheries is ample cause for concern" and calls "for a more precautionary approach to fisheries management". Her conclusions are drawn from interpreting the estimated decline in small unassessed fisheries as representing the performance of fisheries management. However, by examining fisheries that are actually assessed and managed, we can see that in fact fisheries management has often succeeded in reducing fishing effort and rebuilding or maintaining desirable stock sizes.

The key to improving the status of the world's fisheries does not lie in making fisheries management universally more precautionary, but rather in making fisheries management itself more widespread. It is not unreasonable to think that we can bring successful management to more of the world's fisheries. It is important to recognize that fisheries management of a truly traditional kind has been documented in many communities around the world prior to European colonization (Ruddle, 1989; Yamamoto, 1995; Lim *et al*., 1995; Johannes, 1978; 2002), centred around community-based management often with *de facto* territorial fishing rights. These truly traditional management practices were often successful at managing marine resources. While clearly the conditions facing these fisheries have changed markedly throughout the years, the precedent remains that empowering local communities with tools to be active and engaged partners in the fishery management process can help improve the state of even highly data- and resource-limited fisheries.

The majority of fish stocks remain unassessed and unmanaged. The tools that have worked in developed countries for large industrial fisheries are unlikely to be practical for the majority of the world's stocks. A range of management and assessment techniques has been explored for data-poor fisheries in both developed and developing countries, and these methods need to be tested, refined and implemented. Providing communities around the world with greater access to fishery management tools will make it easier to set responsible fishing targets that satisfy the needs of both people and marine ecosystems. Fisheries management has had both successes and failures, but looking across our best knowledge of the world's stocks, what is clearly needed is a greater application of the lessons learned from successful fisheries management.

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