THE BAREFOOT ECOLOGIST'S TOOLBOX

DR JEREMY PRINCE

LAST UPDATED : MARCH 2021

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CHAPTER ONE

INTRODUCTION TO THE BAREFOOT ECOLOGIST'S TOOLBOX

The Global Challenge of Overfishing

Overfishing has come to be recognized as a global problem, fishing down food webs around the world, threatening marine biodiversity and food security for coastal communities. Headlines trumpet the story, how global catches stopped growing during the 1990s as fisheries almost everywhere became fully exploited and some major ones began declining. And predicting that all large bodied oceanic pelagic species will be extinct by 2040. However, the headlines and global catch trends conflate vastly different stories, masking differing trends and issues in; a) the industrial scale fisheries of the developed world, b) the high seas fisheries being mainly plundered by vessels of the developed world, and c) the small-scale coastal fisheries. Less reported by the headlines is the fact that since the 1990s the industrial-scale fisheries of the developed nations (a) with relatively functional systems of governance, have largely been brought under effective management regimes. Since the early 2000s many of the world's largest fisheries have at least been stabilized and many are now rebuilding, proving what can be done to sustain fisheries with sufficient scientific resources and governmental capacity. Today sustainability problems are largely concentrated in the under-reported, under-regulated and in some cases illegal (IUU) industrial scale fisheries of the high-seas (b), as well as the small-scale artisanal coastal fisheries (c), particularly but not entirely, in developing regions of the world.

The focus of this manual is on the latter of these, the small-scale artisanal coastal fisheries (c), particularly in the context of developing tropical countries. Although most aspects of the material can be usefully applied more broadly. In many developing countries, rapidly growing human populations, along with the expanding reach of market forces and the increasing availability of new fishing technologies, are combining to fuel the escalation and extension of fishing pressure into the remotest fishing grounds, serially depleting resources and fishing down food webs (Johannes, 1978; Newton et al., 2007; Pauly, Christensen, Dalsgaard, Froese, & Torres, 1998; Sadovy, 2005). Catastrophic overfishing of coral reef fish is posing a major threat to food security, fisheries livelihoods, reef-based tourism and biodiversity of tropical countries (Newton et al., 2007; Sale & Hixon, 2015). Once common highly prized reef fish species are becoming rare almost everywhere and localized extinctions are spreading across broad regions, threatening to become global extinctions (Sadovy et al., 2003, 2013; Dulvy & Polunin, 2004). Governmental capacity for fisheries management is often extremely limited (Johannes, 1978; McClanahan & Mangi, 2004; Sadovy, 2005), and the estimation of sustainable catch levels remains an unattainable goal (Bell et al., 2009). The gap between the fish required and the potential harvests is widening, leading to a crisis for food security (Bell et al., 2009; SPC, 2015) and biodiversity (Sadovy de Mitcheson et al., 2013; Sadovy et al., 2003).

The Dominance of Developed World Industrial Scaled Fisheries

Until recently the international field of fisheries science has been ill-equipped to address the issues of small-scale fisheries and they have been largely ignored. Understandably the development of fisheries science has been largely motivated and funded by the need to assess and manage large scale-industrialized domestic and high-seas fleets from the developed nations. The flows of revenue from these fisheries have been sufficiently large to motivate developed nation governments to protect them by investing in large scale research programs and the development of effective governance frameworks. These models of governance, research, assessment and management have generally depended upon centralized top-down command and control by frameworks of regulation informed by government financed programs of big-science. Consequently, the scientific methods developed which you will learn by reading the text-books, require extensive detailed biological studies for every exploited population, as well as 10-15+ years of accurate catch and effort trend data, and / or surveys of each population's trends in abundance. Research programs of this kind are technically challenging and expensive, costing ~US$250,000 to millions per assessed stock.

The cost and complexity of conventional fisheries assessment methods has been a persistent problem for fisheries science (Walters & Pearse 1996, Mullon et al. 2005, Andrew et al. 2007, Costello et al. 2012). Inevitably, investment in research, assessment and management are linked to the political priorities of the funders which in turn have been largely determined by the value of fisheries to government coffers. Larkin (1977) proposed a rule of thumb for financing fisheries research, which is that to be sustainable, in the long term the cost of researching, assessing and managing a fishery cannot exceed ~15% of the landed value of a fishery. In this context, fisheries that depend upon small marine population's producing catches worth less than several million dollars per annum are highly problematic for our field. The aim of this manual is to solve this problem for small-scale fisheries, by making available cheap effective ways of assessing stocks, informing management and facilitating management reform.

Small-scale Fisheries

The fisheries of interest here are commonly referred to as 'small-scale fisheries' because of the scale of the component fish populations they tend to exploit, the boats deployed, their spatial extent (local & coastal), the duration of fishing trips (generally daily), of individual landings (1-100kg), as well as the scale of the supply chains that service the fishers (Teh et al. 2018). In most countries these are the fisheries with the strongest links to traditional fishing communities and they generally exploit species living in shallow (<100m) coastal, estuarine, river and lake habitats.. Traditionally small-scale fishing communities fish locally to where they live, using small (<15m) vessels often with low levels of mechanization, although the actually fishing gears now being using have been upgraded with modern technologies and materials. In most cases, they no longer rely on the less efficient fully traditional methods, and one of the symptoms of their depletion has been the increasing need of fishers to travel further afield to exploit more distant fishing grounds, often bringing them into conflict with other communities.

Small-scale fisheries catch a wide range of coastal finfish, crustacea and molluscs, which in the context of this book, will generally be lumped together under the generic term of 'fish', 'fishing' and 'fishery', unless otherwise specified. The 'fish' that small-scale fisheries tend to catch commonly feed local communities and the sea-food eating tourists in local restaurants. And with the exception of the large migratory oceanic tuna species which are caught by off-shore industrial scale fisheries, they also tend to be the mostly highly valued seafood ($USD15-70/kg in international markets) such as reef fish, lobster gastropods and bivalves. In general, the species caught by the small-scale fisheries do not range far off-shore, if at all, and so they are not much caught, or fished for, by the offshore industrial fleets.

S-Fisheries

Rather than emphasizing the 'smallness' of these fisheries, my good Argentinean friend Lobo Orensanz preferred labelling them "S-fisheries" (Orensanz et al. 2005), for the first letter of so many of the adjectives that can be used to describe them:

- Small-scale as discussed above,
- Sedentary stocks, all their life stages commonly exhibit limited mobility or a tendency to remain within, or return to limited home ranges.
- Spatially structured, their limited mobility combined with adaptation to local environments means that instead of occurring in extensive single freely-mixing homogenous populations, they tend to form complex mosaics of relatively discrete and isolated populations.
- Species diversity, generally the fishers exploit a range of species, adapting targeting practices to seasonal and long-term changes in relative abundance and catchability, aiming for a target amount of food or income per fishing trip, rather than an amount of a specific species.

Too Big to Ignore

Despite being called 'small-scale' they are numerous, Andrew et al. (2007) estimated, that by number of exploited populations, they comprise over 90% of the world's fisheries, and directly support ~40 million fishers and indirectly another ~200 million people. Although something like 80% of the world's fish production comes from just a few industrial scale-fisheries catching a relatively few finfish species supported by the world's major upwelling systems. Outside those major upwelling regions and their associated fisheries, the aggregated landings from small-scale fisheries are often larger and more important than those from industrial-scale fisheries. This is particularly true in sub-tropical and tropical regions which are less commonly blessed with major upwelling systems. Although the importance of small-scale fisheries has historically been under-appreciated or ignored because:

1. They are heavily under reported and consequently poorly represented in official statistics.
2. The have historically been impossible to assess and scientifically manage
3. Most have been the responsibility of poorly resourced national governments rather than the higher profile and better resourced international Regional Fisheries Management Organizations.

Recent studies, however, have begun emphasizing just how important these fisheries are to national economies and in particular regional coastal communities. "The Sea Around Us" project of the University of British Columbia (Zeller et al. 2016), has been synthesizing all sources of information and, to the best of their ability, reconstructing time series of seafood catches for all countries and regions, to include subsistence and un-reported international industrial catches and discards. Their results indicate something like the true importance of the small-scale coastal fisheries in relation to the offshore industrial fisheries. Around the African continent, for example, on the east coast small-scale fisheries land 91% of catches from Kenyan waters (Le Manach et al. 2015a), 97% in Tanzania (Bultel et al. 2015) and 76% in Mozambique (Doherty et al. 2015). Similarly, for the Indian Ocean island states of Madagascar (Le Manach et al. 2011) and the Seychelles (Le Manach et al. 2015b), for which the pelagic tuna caught by the industrial pelagic fleets are more important, the small-scale coastal fleets still land 76% and 75% of catches, respectively. The west coast of Africa is blessed with extremely productive upwellings of oceanic productivity, and the scale of the offshore oceanic resources is correspondingly greater, as is the scale of industrial extraction by the deepwater trawl fisheries, but small-scale fisheries still dominate catches; 52% in Ghana (Nunoo et al. 2014) and 79% in the Côte d'Ivoire (Belhabib & Pauly 2015).

Small-Scale and Data-Poor

Almost by definition small-scale fisheries are 'data-poor', meaning that there is not enough information available to assess their status and develop recommendations for their sustainable management. Although the descriptor 'data-poor' gets applied relatively loosely depending upon the context of the user.

Rich-world small-scale and data-poor

In the scientific literature 'data-poor' is commonly defined by the legislative imperative of many developed countries to set annual catch levels (ACLs) and total allowable catches (TACs). In a recent edition of Fisheries Research dedicated to the topic of data-poor fisheries, Jardim et al. (2015) defined data-poor fisheries as "lacking quantitative assessment", but in fact, implicitly meant lacking an age-structured model derived assessment capable of estimating a sustainable level of catch, rather than simpler, but still 'quantitative', forms of assessment. Surveying that same edition reveals that, while none of the 17 papers assumed there would be studies of age and growth for their data-poor fishery, 11 papers assumed time series of catch would exist, five of which also assumed an additional form of time series data, while another four assumed two forms of time series data in addition to the catch data.

Applying this exacting standard of 'data-poor', we observe that in rich developed world countries, with relatively well-resourced fisheries agencies and researchers, there is generally sufficient budget, expertise and governance for their large valuable fisheries (with relatively simple stock structures) to be well monitored, assessed with age-based model, and managed with some form of catch control system. These fisheries are proudly pointed to, and trumpeted as fine examples of successful sustainable fisheries management. Below this veneer of professional sustainable fisheries expertise there is almost always a dark under-belly of small-scale fisheries for which that same system is failing. There is no technical reason for this, small-scale fisheries could be managed in the same data-rich fashion, it is just that in reality, small-scale means low value, and a correspondingly low priority for central government budgets, so there is rarely the resources available to support the data-rich approach. With the organizational focus firmly on the larger most valuable fisheries and the scientific focus on age-based modelling to estimate sustainable catch levels, the small-scale data-poor fisheries are left quietly to 'wither on the vine.'

Climate Change

Rich-world bureaucracies all over the world like to pretend they are on top of assessing and pro-actively managing small-scale fisheries, but all over the world the reality is that they are failing. Many excuses are offered to deflect blame away from this failure of method and procedure; climate change is the latest in a long list. I do not want to divert attention away from climate change, it is alarmingly real and already driving massive changes through marine ecosystems everywhere. Climate change, inshore eutrophication, declining water flows and quality, habitat loss and pollution are all negatively, and increasingly, impacting fisheries and need to be addressed. My observation however is that, in many cases overfishing is still the major anthropomorphic driver of change, and the simplest to ameliorate if we are prepared to recognize it. In any case, regardless of the outcome of climate change and the level of habitat degradation that occurs, in most places there will still end up being some sort of fisheries left remaining, much changed and degraded no doubt, but if we ever want to find some balance with what is left of nature, we will still need to manage it as optimally as possible.

Developing world data-poor

The data-rich definition of 'data-poor' is an ocean basin away from that of developing nations for which the problem posed by small-scale fisheries has been even less tractable. Leaving aside the valuable large, highly migratory international stocks that have in effect been excised from developing world jurisdictions and made the responsibility of Regional Fisheries Management Organizations controlled by the developed nations, so that the data-rich assessment methodologies can be applied. In developing nations the capacity for managing fisheries is particularly limiting (Johannes, 1978; McClanahan & Mangi, 2004; Sadovy, 2005) and the estimation of sustainable yields of fish stocks through population modelling an unattainable goal, almost regardless of a resources' size and value (Bell et al., 2009). Time series of catch, effort and surveyed abundance are normally sparse, or lacking all together, as are the biological studies needed to parameterize population models. The resources made available by government to employ and train staff, and to support them in the field conducting comprehensive long-term data gathering, are normally insufficient, or only provided periodically through aid programs. In this context Johannes' (1998) referred to the need for data-less management. Even if sufficient data does exist there is normally insufficient technical expertise to support computationally intensive analyses. That sort of expertise and training is quickly lured away from fisheries science by the higher remuneration and prestige on offer from private companies, banks and treasury departments.

Spatial Complexity

The spatial structuring and complexity of fish stocks is a particularly pernicious complicating factor for small-scale and data-poor fisheries, particularly because it commonly goes unrecognized. A corner-stone of assessment science is the concept of the 'unit-stock'; the assumption that assessed populations act as homogenous freely-mixing units so that the effect of extracting a catch from any part of a population impacts the entire population and can be measured anywhere; the way pumping out a swimming pool from one end causes the water-level to fall at the other. In reality fisheries often act more like a mineral ore body that is mined out bit-by-bit and 'serial depletion' of component populations is common.

Reasoning that pelagic larval stages are normally too small to contend with ocean currents and are swept away into a 'common pool' of larvae, it was Thorson (1950) who originally conceived of local marine populations being demographically 'open' and receiving their recruitment from outside sources. From the 1950s through to the 1990s this conception was the dominant model used in marine ecology (e.g. Roughgarden et al. 1985; Sale 1991; Swearer et al. 2002) and it provided the context in which assessment scientists developed the concept of the 'unit of stock' (Gulland 1969) and the initial assessment models building upon it (Beverton & Holt 1957; Ricker 1958). More recently most of the theory around marine protected areas has also been developed implicitly, and only sometimes fully explicitly, using the 'common pool' model.

Evidence of self-recruitment at small scales, and for complex structuring of marine populations first began to accumulate outside the field of teleost (bony fish) research. To my knowledge it was first fully described, and recognized as a major theme for fisheries science at an international conference on invertebrate fisheries at Nanaimo, B.C. in 1994 (Orensanz & Jamieson 1998), but only gained the same priority for teleost fisheries since the NCEAS review of the topic in 2000 (Swearer et al. 2000). Today marine resources are commonly conceived of as being 'meta-populations', comprised of multiple local populations with differing forms of inter-connectivity. A term first coined by Levins which has been in common use for terrestrial systems since the 1970s. Prior to the mid 1990s it was rarely applied to marine systems (Kritzer et al. 2006), Shepherd & Brown (1993) first applied it in a marine context to describe abalone (Genus Haliotis) fisheries.

Small-scale, Data-poor, S-fisheries Everywhere

I moved to Tasmania in 1982 thinking I was going to monitor, assess and provide management advice about a unit stock of black lip abalone, which supported the state's most valuable fishery worth >AUD100 million per annum. Unlike almost any fishery I have engaged with since, that fishery began collecting relatively spatially explicit catch and effort data from its inception, and all the basic biological parameters had been well researched. I looked forward to working with a really data-rich fishery. Three years later I realized that it was not the well-understood statewide unit stock of abalone being assumed, but instead a complex array of reef-scaled meta-populations. Every reef supported at least one relatively isolated and self-recruiting population needing individualized monitoring, assessment and management, and I knew nothing about any of them. My doctoral studies had just morphed one data-rich state-wide fishery into >10,000 small-scale data-poor fisheries.

Repeatedly through my career in Australian fisheries I had the same experience; finding myself starting to work on an apparently data-rich fishery, that was inexplicably experiencing a resource crisis unpredicted by the assessment. When the knowledge of the fishers was integrated with the latest science, and the stock was divided into something approaching likely biological units, the aggregate trend-line which previously looked to be complete, was revealed as being comprised of many component trends, none of which were complete. Along with the scientists I worked with, we would be left scratching our heads and asking how that many assessments and management plans could be developed at those scales, with such small budgets and so few resources? An experience that concurs with the observation of Hilborn et al. (2005) that one of the three principal reasons for the failure of fisheries assessment and management is the mismatch between the scale of management and assessment, and the scale of biological stocks

As I write this the Total Allowable Catch of the Tasmanian abalone fishery has been reduced to below 1000t per annum, down from the ~2500t I helped reduce it to by the end of the 1990s, from its peak of around 4200t/annum in the mid-1980s. After 50 years of fishing it is apparently not as sustainable as imagined just 10 years ago (Mayfield et al. 2012). The entire east coast of Tasmania which produced ~1000t per annum for many decades has been closed to the taking abalone and has become an extensive sea-urchin barren. Some blame this change on climate induced warming, however, further north in the even warmer waters of New South Wales, populations of the same abalone species are slowly rebuilding after decades of mis-management, and the area of sea-urchin barrens is slowly shrinking. The difference between these two states, is not a differential impact of climate change, but the different determination of government and divers in the two states to accept and work with the small-scale, and complexity of their stocks.

We need to confront the fact that the established text-book style of population model-based assessment and management is working for a vanishingly few of the largest, most valuable and simplest of fisheries that can command sufficient institutional resources to save them from being data-poor. Andrew et al. (2007) estimated the system to be failing >90% of the world's fisheries, so this issue of assessing and managing small-scale and data-poor fisheries is almost universal for our field. Since the 1970s when markets for fish products and fishing gear began truly globalizing, the under-monitored and under-managed, serially depletion of freshwater and coastal marine resources has been gathering pace everywhere. Like a snowball rolling downhill. Beyond the reach of 'big-science' and relatively effective governance of the world's great volume fisheries, amongst a multitude of small-scale fisheries, global issues of food-security, and coastal marine bio-diversity, remain to be addressed by our field (Bellwood et al. 2004, Andrew et al. 2007, Newton et al. 2007). From Australia to Africa, via Latin America, the Pacific Islands and Southeast Asia, I have met dedicated, well-intentioned, and once eager fisheries scientists sitting depressed in their offices because, while happy to have their job, deep-down they know the resources made available to them are hopelessly in-adequate to do the work they want to do.

A new approach to assessing and managing small-scale and data-poor fisheries has been needed for decades, less complex, technical and expensive, which can be easily communicated in fishing communities. Johannes (1998) coined the phrase "data-less management" to advance the utility of applying simple "common sense" or "rule of thumb" management prescriptions. Presciently he suggested that the common sense, rules-of-thumb" should focus on sustaining spawning biomass. But what are they?

In the context of a village-based fishery in the developing world; you find yourself standing on a beach looking for the first time at an eclectic mix of fishing gears and little studied species lying on the bottom of hand-carved canoe. Already you know more about this fishery than any other fisheries biologist on the planet. Where do you start, and what do you do? That is what I aim to address with this manual and the toolbox of theories for changing society, methodologies for communicating, data collection, assessment and management.

Ideas for Change

The theories and methodologies described here have been developed and collected, with the support of many colleagues, over a 40-year career as a fisheries researcher working with small-scale fisheries, and a 15-year career as a free-diving commercial abalone diver.

Barefoot Ecologists with Toolboxes

The millions of small-scale and spatially structured marine populations that challenge us will never be assessed by orthodox models of assessment, nor managed effectively with top-down regulation promulgated by centralized agencies. As a government employed abalone stock assessor, I wracked my brain trying to imagine the regulatory framework required, short of paying divers handsomely, to collect the spatially explicit data I needed to apply standard assessment techniques. For a time, I remained baffled as to how this could be achieved. Until, a short time after I completed my doctoral dissertation, I found myself consulting to the last of the commercial abalone divers in British Columbia, Canada, who had just had their 64t TAC reduced to zero, effectively ending their careers. Obviously, they wanted their fishery re-opened, but the striking things was that they wanted it re-opened under different arrangements. They wanted to share out the productive abalone reefs between the divers, so that each could begin tending their own exclusive areas, like vegetable patches, rather than continue raiding across all reefs as allowed by the normal open access framework of fisheries.

That is when it hit me. That to make abalone work in a fisheries sense, the divers and fishers have to be doing it for themselves, both the science and the resulting management actions. If fine-scale fisheries data are ever going to be collected, and effective local management implemented, it will be by motivated and empowered fishers, not government employed scientists. The centralized top-down command and control form of assessment and management can only work where social systems are strong enough to regulate and control competing hunter-gatherer fishers. Small-scale fisheries need to be managed more like agriculture in which human communities work together closely to foster localized production of vegetables, fruit or grain. Under this model localized harvesters receive their own reward for husbanding productivity in their own areas. They don't take their orders from a centralized body based on some regional citric fruit assessment and management plan. Rather than regulating individual propagation and harvesting according to centralized planning processes, agricultural advisors are provided to teach local growers the principals for being productive. Farmers take the ideas provided by the advisors, and learn from their own experiences, how to apply them to their own specific conditions. While the agricultural advisors learn from the practical local experiences of farmers, synthesizing and refining generic standard operating systems with region wide applicability and feeding that knowledge back to farmers to apply.

Viewed from the perspective of empowering local communities of producers to manage themselves, rather than centralized top-down planning and control, the global challenge of sustaining small-scale data-poor fisheries also begins to look like the issue of managing rural health in developing countries (Prince 2003). Both issues confront similar geographically dispersed poor communities with low levels of formal education, and both confront similarly generic issues, with local specificities; overfishing and poor basic hygiene. The Chinese successfully and famously addressed their rural health problem in the second half of the 20th Century with their bare-foot doctor program. Through which the generic majority of local health issues, and their solutions were taught to basically trained technicians who were recruited out of, and returned into, local communities. Where they taught and applied basic treatments, such as cleaning up water sources, washing hands and providing simple electrolytes to counter gastro-enteritis. While triaging when their own resources were inadequate. Those of us interested in small-scale fisheries need to learn from that Chinese experience because a similar strategy is needed for their assessment and management. An army of barefoot ecologists needs to be trained and equipped with a generic toolbox stocked with theory, methods, strategies and tools. When that idea first occurred to me (Prince 2003) I had only the vaguest of ideas as to what that generic toolbox would contain, only that it was desperately needed, but my quest began.

New Tools for Empowering Community Based Management

Now, late in my career, by various means, I find myself with a completely effective Barefoot Ecologist's Toolbox, containing a range of concepts, algorithms, analytical tools and communication strategies, developed bespoke to address specific needs, or borrowed from generous colleagues. All selected over time by a Darwinian process of trial and error. Many things have been tried, only the most effective have been retained, and are now being made available through my biospherics.com.au website supported by this electronic book.

Their accumulation began with an idea given to me by a wise Western Australian abalone diver, the late Terry Adams. He showed me how to see through the highly variable size, and growth rates, of abalone, to the shape and appearance of their shells. Looking at their appearance first, and their absolute size second, allowed me to start distinguishing large fast-growing juveniles from small slowly growing adults. I started perceiving formerly productive abalone reefs stripped of reproductive potential because they reached the legal minimum size before maturing. And reefs full of spawning potential that were hardly fished because the adults rarely grew to legal size. I taught other commercial divers in Australia and New Zealand the same skills, and saw how interested they were to finally understand what was happening to their reefs, and how that knowledge could facilitate their developing and implementing programs of community-based management.

An editor of the Fisheries Research journal told me he would publish my description of that work if I wrote a paragraph to end the paper, on how the abalone idea applied to other species. I complied begrudgingly and without conviction, but that thought process spurred an idea for a meta-analysis to test the extent to which the idea applied more generally. With the help of the free labour provided by a student that meta-analysis led to the creation of a novel method for assessing the spawning potential of fish stocks (SPR) on the basis of the size composition of catches, relative to the size of maturation (LBSPR).

Spawning Potential Surveys

During 2012–2015 working with Palauan fishing communities to collect the catch composition and size of maturity data needed to make our first proof-of-principle LBSPR assessments of reef fish we observed that the process of collaboration and explaining the principals of LBSPR to the fishers, facilitated a community-based management initiative to reform local management. Serendipitously, the conceptual basis of LBSPR is readily understood and enables fishers to conceptualize and perceive overfishing. Community members learn to compare for themselves the size fish mature, with the size they catch or buy from the market, and understand that with few growing to adulthood there will be few young fish produced for the future. Our subsequent experience has proved that incorporated into a program of community-based science, and combined with simple communication tools, the application of LBSPR inevitably developed within artisanal fishing communities an understanding of, and ability to perceive, their own overfishing. A process that informs and empowers community-based management which we now call Spawning Potential Surveys (SPS).

Trialed in four Pacific Island nations over the last 5 – 7 years, the SPS methodology has been readily adopted in each country by the communities we work with initially, and our partners in NGOs and fishery agencies. I have been repeatedly surprised to observe how simple SPR estimates of local fish stocks galvanize the fishing communities and fishery agencies. Most of them sensed they had problems with their fish stocks, but there had been no agreement on the extent or cause of the problem, let alone how to address it. In each case the SPS process enabled them to develop a shared understanding of over-fishing and its severity, and to begin focusing on implementing potential remedies. In each country our initiatives which started regionally with just a few communities have engendered nation-wide dialogue about coastal fisheries management and trials of new management. The SPS approach is now being taken up by the South Pacific Community organization with a view to rolling out across all its member nations. Similarly, successful results are also being seen with small-scale fisheries in South America and Sri Lanka, and an initial introduction of the technique to Kenya's coastal fisheries has also been well received, attracting broader interest.

The original insight provided by the late Terry Adams has blossomed into an implementation of Bob Johannes' (1998) recommendation for "common sense" "rules of thumb" that focused on sustaining spawning biomass.

The Objective of this Book

This e-book has been written as a users' manual for all aspiring barefoot ecologists, with the aim of supporting and explaining the Barefoot Ecologist's Toolbox that is available for downloading from the biospherics.com.au website.

Like the rest of the world around me, the field of fisheries science has changed remarkably through my life-time. I began my career working for the Tasmanian Fisheries Development Authority in the early 1980s. I was the first assessment and management scientist that Authority employed, all the other scientists and technical staff were employed helping fishers to catch more fish and 'develop' more fisheries. At that time most of the aid funding for fisheries flowing from the rich-world to the developing nations was similarly orientated. We all grew up with the adage called the 'fisher principle', which is that if you:

- Give a person a fish they are fed for day, but,
- Teach a person to fish and they are fed for life.

That original statement of the 'fisher principal' leaves the open-ended emphasis on developing the fishing power of communities. Modern fishing gear and techniques are now available everywhere; out-board motors, underwater torches, braided lines and power assisted winches will be found on the remotest islands. The fishing power of most communities normally exceeds the sustainable capacity of local stocks which almost everywhere are in decline. It is time to complete the old fisher principal:

- Enable communities to fish sustainably and they will be fed for generations.

The objective of this book is to update this adage, not just by adding a few empty extra words, but by providing a practical step-by-step guide to how that can be done by fisheries practitioners and enthusiasts working in partnerships with fishing communities. The aim is to give readers access to all I have learnt and been involved in developing over the last decade using easy, accessible language rather than the language of high science (although I apologize in advance for places where this aim fails).

Structure of this Book

This book consists of 9 individually downloadable chapters, many of which are supported by downloadable materials from the same biospherics.com.au website. The intention being that the accompanying presentation or analytical framework can be worked through as the chapter is read to augment the value of the written word.

There is a logical flow to the chapters reflecting the sequence of events and processes that comprise the process of Spawning Potential Surveys, which following this introduction (Chapter 1) begins with:

CHAPTER 2: An initial description of the over-arching theory of change underpinning the SPS process.

CHAPTER 3: An overview of the activities involved in the entire SPS process placing each of its elements (workshops, community science, data collection, LBSPR assessment, management trials) within the context of the theory of change.

CHAPTER 4: A detailed description of how to run the SPS workshops, the communication strategy and materials used to facilitate them, in order to establish and maintain programs of community-based science through which management prescriptions and society changing communities of practice are developed.

CHAPTER 5: An overview of the fisheries science concepts underlying the LBSPR assessment methodology which is central to the SPS process. This chapter marks a change from focussing on the social aspects of achieving societal change with SPS, towards the technical and biological aspects of data gathering, assessment and the development of management prescriptions.

CHAPTER 6: A detailed description of the data that needs to be collected to complete LBSPR assessments, as well as the data collection protocols and materials provided to support it, and also the main issues likely to arise as the data are collected.

CHAPTER 7: A step-by-step description of how the data once collected are quality controlled and prepared prior to being used to complete LBSPR assessment.

CHAPTER 8: A step-by-step description of how the collected data, and results of preliminary analyses, are used together with software freely available from the companion barefootecologist.com.au website to complete an LBSPR assessment of a local fishery. As well as some discussion as to how the results should be interpreted and some of the things that can go wrong in completing assessments.

CHAPTER 9: A final discussion of how the results of the SPS data collection and LBSPR assessment can be simply turned into simple prescriptions for reforming management. As well as the rationale for starting the implementation of management in a small-scale and data-poor fishery by first managing the size at which fish are caught.

While following a logical progression (for the author at least) and to some extent building concepts sequentially through the chapters, some attempt has also been made to retain something of a modular structure, so that readers can use specific chapters as relatively self-supporting readers on topics, and guides to specific activities. So as to minimise the need for readers to refer backwards and forwards between chapters. The down-side of this maybe, a little much repetition for a reader working through from front to back. My apologies for that. My apologies also for the unpolished nature of these chapters, some more so than others, which may also add to the level of repetition. This is an initial draft, completed in the end with relative few resources in time to close-out a grant. My priority has been to complete something of immediate use to others that can be made available for no cost, rather than to create a final and crafted work of art. It is my hope that there will in time be future improved drafts.

Acknowledgement

The development of the Barefoot Ecologist's Toolbox would not have been possible without the generous support of my work by the David and Lucile Packard Foundation from 2014 – 2020 and I am immensely grateful to their Research and Western Pacific Programs for that support.

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