Section 2

Managing People

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2.1. SYNTHESIS

Background: Selection Does Not Guarantee Completeness

The articles in this section all relate to the social aspects of fisheries, particularly the management of people. The “human-dimensions of fisheries” are a diverse collection of disciplines involving economics, empirical social sciences, sociology, socio-psychology, political science, anthropology, human geography, and many more. For this reason, it was challenging to identify eight key articles in this area of fisheries science. Several sections in this book deal with specifics of the overarching discipline of fisheries biology, which reflects that fisheries biology remains the dominant approach to fisheries science. For space reasons, all social science-related articles have been combined into this section. This of course cannot give credit to the many seminal articles in the social science of fisheries literature that span the disciplines outlined above. Thus, it was decided to expand the Honorable Mention list to ten articles. While still not fully encompassing, it is believed that the eighteen articles cover the major streams of innovation that characterize the field of management-oriented human-dimensions studies in commercial, recreational, small-, and large-scale fisheries.

Note that the article list, due to space limitations, falls short on social science papers from fisheries sociology and anthropology. In particular, the list largely excluded articles that dealt with classical sociological and anthropological topics such as artisanal fishing communities, livelihoods, social networks, power relations, spiritual value of fisheries, religion, culture, ethics, and gender issues. I am aware of a number of key articles in these areas, some of which have accumulated very high citation rates (e.g., Callon 1988). However, many of these articles were not strongly focused on management-oriented issues, which is the core of all sections in this book. Naturally, the final choice also represented the literature knowledge of those involved in selecting the works, which was biased towards quantitative human-dimensions literature. Although advice from sociologists, political scientists, and anthropologists was solicited, it is most likely that some key publications have been missed.

Some of the key inspirations for understanding the core of the social science endeavor in fisheries—to unravel the rules of human behavior in relation to fish stocks and aquatic ecosystems—originated from political science in the context of natural resource management in general. Fisheries have often been featured as prominent cases in this literature (Ostrom
1990). Therefore, some of the articles reviewed in this section are not fisheries-specific, but instead have a more general theme in terms of how humans interact with renewable natural resources (e.g., Hardin 1968; Dietz et al. 2003).

**Early Fisheries Economics**

One important inquiry in the social sciences of fisheries has been economics. It is an unlikely coincidence that about the same time as the theory of fisheries biology became codified in textbooks (Beverton and Holt 1957; Ricker 1958), two key articles (Gordon 1954; Scott 1955) appeared that have largely set the research agenda in fisheries economics up to the present day. These articles have also strongly influenced fisheries biologists’ thinking about the consequences of open access exploitation of fisheries resources.

The innovation of Gordon (1954) was to call attention to the role of property rights (institutions, or “rules-in-use,” Ostrom 1990) for fisheries management. He illustrated that without a corrective hand, open-access and profit-maximizing behavior of the fishing industry constitute two conditions for attracting fishing effort until a so-called bionomic equilibrium is reached (not to be confused with the dynamic bioeconomic equilibrium, see Clark 2006). In this steady state, no (economic) rents (surpluses) are produced to society [note that the concept of economic rent is not to be confused with resource rent, see Bromley 2009]. The bionomic equilibrium is defined as the point where the average revenue by the industry (or by any individual fishing firm) would equal their average (or individual) opportunity costs. Thus, while at equilibrium economic surpluses will be dissipated, the industry would usually still earn income (Bromley 2009).

In Gordon’s (1954) model, the behavior of the fishing industry was represented very broadly. It was simply assumed that people enter the fishery or increase effort as long as economic rents are greater than the opportunity costs of fishing. Depending on the total cost structure of fishing, the equilibrium harvest level and corresponding fish biomass could occur at lower or greater biomass levels than the biomass that produces the maximum sustainable yield (Schaefer 1957). Hence, the bionomic equilibrium is not to be confused with overexploitation and collapse of fisheries. It is also important to realize that Gordon (1954) applied his formal analysis to a demersal fishery with two fishing grounds of differential productivity, noting that the better ground would be overfished and brought into balance with the inferior ground (which is the economic version of the ideal free distribution theory in ecology). These important aspects of the Gordon (1954) model have often been overlooked, instead assuming the bionomic equilibrium is economically wasteful and biologically unsustainable. Neither of this is necessarily true (Bromley 2009).

Gordon (1954) is credited with introducing the now famous concept of the maximum possible economic surplus, also referred to as the maximum (or net) economic yield (MEY) (Schaefer 1957). The MEY would, according to Gordon (1954), be expected to exist at the point where the marginal revenue (defined as the slope of the landings or revenue curve) would equal the marginal cost (defined as the slope of the total cost curve), graphically representing the maximum distance between the revenue and the total cost curves. A sole owner of a fishery would therefore tailor effort so as to reap the maximum possible economic rent, but in a restrictive market with few substitutes, this might come at the cost of high prices to the consumer (Bromley 2009). The idea that maximized economic rents would often correspond with much reduced effort is attractive for many researchers and stakeholders interested
in reducing fishing mortality in overfished stocks because this can result in a "zone of new consensus" between fisheries and conservation interests (Hilborn 2007).

Whenever societies (or fisheries managers) wish for greater fish populations than the bionomic equilibrium provides, this desire becomes a motivating factor to change either the property rights or fishing mortality through management regulations. In this context, Gordon (1954) was the first to emphasize property right changes as a solution in fisheries calling for (demersal) fishing grounds to be owned individually or by the state, and he was soon echoed by another prominent article of the time. In Hardin's (1968) powerful herder metaphor, unavoidable ruin of natural resources was predicted to be caused by privately rational, self-interested harvesters seeking to maximize the net benefits from resource extraction, while externalizing the extraction costs to society. Stated differently, each harvester would reap the benefits of his/her additional boat put on the common fishing ground, but neither consider nor bear all of the corresponding costs of (cumulative) overfishing the fish stock. The failure of each individual to fully internalize (recognize) the costs of overfishing to society or—perhaps more forgiving—the perception of individuals that their own small take of fish will not affect the common good noticeably, would then result in a social dilemma of overuse of the commons (Hardin 1968). Individual interests may thus trump societal interest.

Gordon (1954), and particularly Hardin (1968), left the legacy that changes to property rights in fisheries implementing either state property or private property would be needed to avoid overharvest of renewable natural resources in open-access situations (see below). A foundation for an economic rationale for management of fisheries was laid by identifying the objective that ought to be pursued (MEY), by contrasting the implications of open-access resource use relative to this ideal, and by characterizing the (economic and biological) costs of not pursuing the maximization of economic rents.

Scott (1955) published the related economic analysis of optimal use of fisheries under sole ownership. Scott's (1955) innovation is his outline of the first dynamic theory of the privately owned (optimized) fishery referring to short and long term human decision-making regarding fisheries. Note that sole (or private) ownership here means sole control of harvest, which can entail an exclusive long-term harvest privilege or ownership of the fish stocks/grounds. Scott (1955) showed how the optimal state of exploitation of a fishery under sole ownership would balance marginal current profits against marginal user costs in the long term. His explicit innovation was the accounting of costly effects of intensive harvesting in terms of the impacts on future stock size and revenues. Under the condition of optimized sole ownership, an additional unit of input (effort) or output (landings) is worth investing (effort) or taking (landings) today only if its addition to current net revenue exceeds the present value of its long-term costs in reduced future profitability. This results, theoretically at least, in keeping future returns from the fishery as high as possible, while maximizing current income. A conservative harvesting strategy is the essential result. However, such effects strongly depend on the degree of discounting of future revenue (i.e., the opportunity cost of capital), and hence on human time preferences in terms of balancing current versus future revenue. It could be privately rational for a sole owner to continually overharvest a very valuable, but slow-growing resource, and drive it to extinction if the discount rates were high (Clark 1973).

Scott (1955) also added the important theoretical insight that one must consider the ability of the operator to control the access to the fishery resource in the long term; the less control one has, the more incentive there will be to fish. Viewed differently, when an owner of a fishery has a long time horizon for planning the fishing initiatives, he/she can plan the operations
to maximize the net present value (where future benefits are discounted to a value in present
day). Scott (1955) then argued that sole ownership may bring about the best use of the fish-
ery from a social point of view (the above mentioned caveat related to high discount rates of
course still applies).

Many subsequent studies have found strong empirical support for Scott’s (1955) theo-
retical predictions. However, further research has also found that fisheries management suc-
cess is not contingent on private or state ownership; having long-term secured harvesting
rights—even group ownership and shared management of fisheries resources—can produce
similar outcomes as those available under either private (sole) and state ownership (Ostrom
1990; Dietz et al. 2003), and this condition was not foreseen by Hardin (1968) who confused
common-property with open access.

From Privatization to Common-property and the Power of Informal Institutions

Gordon (1954) and Hardin (1968), as well as many subsequent scholars, can be faulted in
hindsight for having relied exclusively upon two oversimplifications in terms of the underlying
reasons and solutions to combat overfishing from a social science perspective. The first is the
claim that only two possible institutional arrangements—government control or private prop-
erty—could sustain fisheries over the long term. The second is the assumption that harvesting
and investment behavior is driven only by individualistic behavior by harvesters seeking to
maximize expected revenue—or some other form of tangible utility. This assumes that harvest-
ers are unable to create cooperative solutions to manage sustainable fisheries. Both simplifica-
tions have been found to be wrong in specific settings and circumstances, for example in many
artisanal fisheries with co-management systems (Ostrom 1990; Gutiérrez et al. 2011).

Acheson (1975) was among the first to outline the power of voluntarily enforced territo-
rial fishing rights, and the power of local social norms, to help curtail fishing effort and main-
tain fisheries in regimes of successful self-governance. Acheson (1975) described a regime of
self-devised and enforced harvest rights—a form of common property—in the Maine lobster
Homarus americanus fishery. These arrangements constitute informal institutions (Ostrom
1990) that have helped to conserve the resource and maintain viable fisheries without signifi-
cant external input from fisheries agencies or any sort of formal institutions (laws).

Acheson (1975) identified two general types of lobster communities (provocatively called
“harbor gangs”): (1) perimeter-defended; and (2) nucleus. Perimeter-defended territories ex-
hibited the feature of more clearly delineated boundaries, which reduced encroaching on the
territory by other fishers from different “harbor gangs.” In addition, it was more difficult to
become a member of “harbor gangs” in perimeter-defended territories. This rule kept com-
unities stable and fostered communication. The system has generated a specific bioeconomic
equilibrium reflecting a healthy resource base. Although Acheson (1975) maintained that
the lobster system differed from Scott’s (1955) “sole owner,” there are similarities because
the perimeter-defended community achieved unified control over harvests and involved de-
facto (as opposed to de-jure) property rights. The important difference is one of “composi-
tion.” Scott’s (1955) sole owner seems to be a single decision maker, while Acheson’s (1975)
“gang” is a cartel of closely-related fishers. The conditions of long-term stable relationships
and closed communities were later identified by others as promoting sustainable exploitation
of common-pool-resources. Particularly noteworthy in this context is the work by Ostrom
(1990), to which I will address further below.
It is therefore not privatization *per se* that is a necessary condition for sustainable fisheries because, under the right institutional arrangements, fishing communities can effectively sustain fisheries in a self-organized manner (Acheson 1975; Ostrom 1990). Some form of long-term tenure for the resources is however needed for proper incentives to sustain fisheries to develop (Dietz et al. 2003). Note that even in this situation users can organize to overexploit fisheries because it may be economically rational for an individual—or a group—to drive a biological resource to extinction (Clark 1973).

Acheson's (1975) article inspired many scholars who were not convinced that either privatization or state control was the only possible property regimes that would sustain fisheries. In the 1980s, the political scientist Elinor Ostrom and her colleagues started to conduct and synthesize many case studies like the one by Acheson (1975). Based on hundreds of case studies, she derived general insights into the conditions under which local self-governance of fisheries and other natural resources was possible by communities of resource users leading to sustainable outcomes (Ostrom 1990; a summary of the famous nine institutional design principles can be found in Dietz et al. 2003 reprinted in this book). Ostrom (1990) found effective governance of common-pool-resources, such as fishes, were easier to achieve overall when: (1) monitoring information (of fish and users) can be verified and understood at relatively low cost; (2) rates of change in resources, resource-user populations, technology, and economic and social conditions are moderate; (3) communities maintain frequent face-to-face communication and dense social networks; (4) outsiders can be excluded at relatively low cost from using the resource; and (5) users support effective monitoring and rule enforcement (Dietz et al. 2003).

Few settings in the world are characterized by all of these conditions. The famous case study by Johannes (1978) on island fishing communities in Oceania has clearly illustrated this point. The policy and management challenge is to devise arrangements that will help to establish such institutional conditions to achieve sustainable management in the absence of ideal conditions. Success in cooperative fisheries management is most likely when local leadership meets with social capital and strong incentives of local resource users to maintain resources (Guettíeréz et al. 2011).

*Co-management*

In large-scale marine fisheries, fishing fleets are often internationally owned, meaning that community-based management in its pure form is often difficult to achieve. Indeed, many large-scale marine fisheries are controlled by governments. However, even under government control, there is a strong role for community involvement to produce better fisheries management outcomes. One of the milestone articles highlighting the many benefits of co-management between government and fisher organizations was published by Jentoft (1989).

Jentoft (1989) discussed the advantages and disadvantages of government-based fisheries management relative to more explicit co-management between government and fisher organizations. One of the key assumptions of Jentoft's (1989) work was that the legitimacy, and hence the expediency and quality, of fisheries regulations could be strongly improved by involving fisher organizations directly in the regulatory process. Up until around the 1970s, co-management was rarely accepted as a viable form of governance; this was the era of private or governmental control.
Jentoft’s (1989) research blended theoretical insight with comparative analysis of co-management systems. Co-management, according to Jentoft (1989), means that fisher organizations not only have a say in the decision-making process, but also have the authority to make and implement regulatory decisions—importantly including enforcement—on their own. Usually, there is a shared system in which governments set the general framework (e.g., laws, quotas) and user organizations may then work out the details—or help in developing them with state officials. The most important contribution one can realistically hope for is that co-management will help to bolster the legitimacy of the regulatory process. This “legitimacy premium” will serve to make management more effective and less costly—especially in the realm of monitoring, compliance, and enforcement—in comparison to government control.

Co-management is a meeting point to blend a government’s interest in sustainable resource use and protection along with the group’s interest in maintaining equal opportunities, self-determination, and self-control. The essential key to success is the sharing of management functions among government and fisher organizations. Such co-management must be strictly formal, with mutually agreed and respected procedural rules. The factors of long-term success are: (1) formal acceptance of the procedures; (2) responsible and formal leadership; (3) a competent and honest executive staff; (4) a small scale of the organization (which increases relationships and produces fewer free riders); and (5) a homogenous membership to reduce conflicts and minimize varying perspectives. We are now seeing many international fisheries programs stressing the importance of a greater involvement by fishers and fisher organizations to improve procedures, legitimacy, and compliance with regulations. One unresolved problem is the decision on who to include in the process within user organizations and how to decide upon inclusiveness. There are also conditions under which co-management is likely to fail, which Jentoft (1989) clearly outlined in his milestone article.

*Getting the Human Behavior Right*

An economic rationale for fisheries management was established in the 1950s, while newer formulations simply elaborated—and sometimes misapplied (Bromley 2009)—the early models of economically optimal solutions to the resource management problem developed by Gordon (1954) and Scott (1955). However, up to the 1990s, economic and other social-scientific models rarely represented the explicit behavioral processes of human decision-making in terms of capital investments, spatial site choice, gear choice, or entry-exit behavior. Moreover, most economic models considered long-term solutions in the steady state (equilibrium), neglecting transitional dynamics. Forecasting future conditions must however account not only for the dynamics of the fish population and the technology and behavior of the fisher community, but also include the dynamics of the behavior and technology of the regulatory apparatus (Wilen 2000). In the 1970s, many nations declared exclusive economic zones (EEZs) resulting in many fisheries moving into some form of government-regulated, restricted-access condition. Under these conditions, Gordon’s (1954) theory and predictions for open-access are expected to break down. Under regulated (managed) access, the nature of the dynamic equilibrium should be affected as much by public policy as it is by choices made by the fishing industry (Wilen 2000).

New models and theories were thus needed to represent the dynamic human behavior in fisheries-management models. Homans and Wilen (1997) were among the first (see also Smith 1968) to put forward economic models that accounted for human behavior under regulated
conditions. The authors compared predictions from a model with a behavioral representation of regulatory actions with the standard Gordon (1954) open-access prediction. They showed how the Gordon (1954) model greatly underestimated effort (capacity), biomass, and harvest, which emerged from misrepresenting the role played by increasingly stringent regulations to control harvest. Relative to the Gordon (1954) model, the regulated model predicted higher biomass and harvest levels, a higher level of fishing capacity, and a substantially shorter fishing season, which was the regulatory tool used in the model. The short fishing season “stiffled” the greater fishing capacity, which in turn, allowed biomass to be greater than in the Gordon (1954) model (Homans and Wilen 1997). To the extent that regulations were successful, they held the biomass at greater levels, which *ceteris paribus* generated higher economic rents and larger levels of fishing capacity. The latter point is worth mentioning because it explains why under regulated open access typical of many fisheries within the EEZ, so much redundant capital exists.

There are three key implications in the highly innovative paper by Homans and Wilen (1997). First, the technological and behavioral character of modern fisheries is intimately bound with nature, operation of the policy environment, and regulatory structure. This means that the technology and behavior will be affected by the regulatory structure, but will also be the attributes of the harvested populations. Second, regulated fisheries may look considerably different from what would emerge under pure open access—and they may, in fact, even be generating substantial economic rents. Finally, carefully accounting for the behavior of regulators will produce considerably different predictions than those from simple economic models. Taken together, Homans and Wilen (1997) left the legacy to better represent the interaction of policy, fisher behavior, and fish populations when attempting to generate insights of relevance to operational management. Their work placed an even greater burden on modelers to know and understand the particular features of the fisheries they are modeling, from an economic and a biological perspective. The community is still struggling with this task.

Smith and Wilen (2003) went one step further by incorporating an explicit random utility maximization (RUM) model of spatial fisher behavior into an economic-biological model. Using RUM to simulate discrete behavioral decisions was first introduced by McFadden (1974), and first applied to fisheries by Bockstael and Opaluch (1983) (see Carson et al. 2009 for an early example of a RUM from recreational fisheries, which was published in the primary literature many years after its first appearance in the gray literature). Smith and Wilen (2003) based their empirical application on the theoretical model of Sanchirico and Wilen (1999), showing how explicit modeling of fisher decisions in a spatial setting strongly altered predictions about the conservation value of marine protected areas. While this is an innovation by itself, the other key innovation is the integrated nature of the bioeconomic model by linking a calibrated model of fisher behavior to a sophisticated biological model of a sea urchin fishery. Explicit modeling of fisher behavior was accomplished much earlier than Smith and Wilen (2003), but the statistical modeling of spatial economic behavior in relation to an empirically calibrated resource model had not been done before.

Marine biologists had developed much faith in marine reserves as a management tool. However, most modeling of reserve performance had invoked strong simplifying assumptions about the behavior of fishers in response to spatial closures. Smith and Wilen (2003) showed that a realistic depiction of fisher behavior greatly altered the conclusions about the efficacy of reserves. The behavioral model showed how economic incentives determine participation and location choices of fishers. Simulations with behavioral response were compared to more
traditional biological models that presumed that effort is spatially uniform and unresponsive to economic incentives. Through this approach, Smith and Wilen (2003) demonstrated that optimistic conclusions about reserves can be an artifact of simplifying assumptions that ignore economic behavior of harvesters. Economists had previously not paid much attention to incorporating realistic descriptions of spatial processes into resource dynamic models. As a result of this work, the importance of incorporating economic behavior of commercial harvesters into models intended to forecast the implications of reserves (or other fisheries management tools) has gained acceptance.

Recreational Fisheries

My discussions of key innovations on the (management-oriented) human-dimensions of fisheries have so far mainly dealt with commercial fisheries. World-wide, recreational fisheries constitute a very important use of wild living resources in coastal areas and inland ecosystems. From an economic perspective, the basic behavior of recreational anglers can be assumed to mirror the classical models by Gordon (1954) and others, with anglers seeking to maximize their individual net utility. Economists have modeled this process such that utility is a function of days fished and the quality of fishing minus the opportunity costs of lost income and time (Anderson 1993). Social-psychologists have used other constructs to understand angler behavior, such as angler motivations (Fedler and Ditton 1994) and satisfaction (Arlinghaus 2006); the latter can be interpreted as realized utility. From an economic perspective, open access recreational fisheries are also expected to move into a bionomic equilibrium where rents (consumer surpluses) are dissipated. Note there is, in principle, nothing wrong with surpluses being dissipated as long as biological sustainability is guaranteed through proper management (daily bag limits, length-based harvest limits, stocking, effort limitations on particular fisheries).

It is important to understand that the behavior of anglers is strongly different from the behavior of commercial fishers because the determinants of behavior differ starkly. For example, while commercial fishers are mainly profit-driven, the rewards sought by recreational anglers are multi-dimensional. They entail a range of catch-related and non-catch-related components of the fishing experience (Fedler and Ditton 1994). It is important to realize that the article by Anderson (1993)—claimed to represent the “complete theory of recreational fisheries”—conceptualizes the benefit of fishing to an angler as being comprised by number of days fishing and catch rate. It thus omitted any non-catch aspects of quality, such as crowding or distance to the fishing site, which are known to strongly affect utility of anglers (Hunt 2005). Further, the general motives of fishing involve non-catch aspects—for instance relaxation in nature or social relationships (Fedler and Ditton 1994), and these aspects are under greater control by the angler and thus most easily satisfied (Arlinghaus 2006). This means that some aspect of catch and travel distance (cost) seems to be the main constraint to satisfaction by many anglers (Arlinghaus 2006). If this is the case, then Anderson’s (1993) approach to catch-rate driven fishing utility may offer a reasonable approximation. What will still vary strongly among angler types is which component of catch is most important; catch rate, size of fish, or harvest rate (Arlinghaus 2006, Johnston et al. 2010). The multi-dimensional nature of angler utility/satisfaction overall renders the prediction of the behavior of recreational anglers far more complex than the behavior of commercial fishers. Moreover, understanding the heterogeneity of angler preferences (e.g., catch-and-kill versus catch-and-release, types
of sites choices, Hunt 2005) is essential if one attempts to predict the behavioral reactions of a full population of fishers to social or ecological change (for an application see Johnston et al. 2010).

Bryan (1977) put forward an influential framework—called recreational specialization—to understand the heterogeneity of recreational anglers (see also Ditton et al. 1992). Bryan (1977) organized his typology of anglers along a continuum of very general to very particular (specialized) interests and behavior. Reflected here are distinct site attribute preferences, consumptive orientation, preferences towards quantity and size of the catch, and management actions. One can think about specialization as a range of co-varying traits and attributes of an angler, resulting in sufficiently different angler types that behave consistently across contexts and have remarkably different attitudes and opinions. One can think of differently specialized anglers as functional groups in ecological jargon or personalities from a behavioral ecological perspective.

In the many empirical studies following Bryan (1977), much support for the predictive power of the specialization construct as an organizing framework to describe angler diversity has been accumulated. For example, it has been shown that commitment to fishing, a salient sub-dimension of specialization, correlates with many managerially relevant attitudes and preferences of anglers such as likelihood to accept regulations or to engage in catch-and-release conservation behavior. The challenge remains of how to accurately and reliably measure specialization of anglers in different cultures—and then to use this characterization to predict specific behaviors. Unfortunately, despite two decades of research, no accepted operationalization of the multidimensional specialization construct has been developed to be of general use in surveys among anglers. Similarly, there is still intense debate on the proper terminology for—and on the similarity and differences of—the specialization framework to other leisure frameworks. Notwithstanding this ongoing discussion, Johnston et al. (2010) demonstrated the importance of accounting for the differently specialized angler types in a coupled social-ecological model of recreational fisheries when attempting to derive socially optimal input and output regulations. In their model, not only did the impact of recreational angling on a fish stock depend on the frequency of different angler types fishing, but also the socially optimal regulations predicted by the model were found to vary depending upon the composition of angler types. Therefore, models that ignore angler heterogeneity will not identify regulations that provide the greatest level of angler well-being and they may also put populations of fish at risk of overfishing by inaccurately predicting local angling effort levels (Johnston et al. 2010).

*Optimality Versus Adaptability in the Face of Uncertainty*

Economists are “obsessed” with finding optimal regulatory policies. But how realistic is the achievement of this objective in complex, constantly changing ecosystems and fisheries? Ludwig et al. (1993) make a compelling case that we will never know with certainty all of the variables, processes, and mechanisms driving a fishery. With that being the case, the hope for some a priori ability to identify optimal management regulations may be naïve. Instead, suitable management outcomes may be achieved by some form of trial-and-error management where policies are treated as experiments. This call resonates strongly with what is known today as active adaptive management (Walters 1986). Ludwig et al.’s (1993) article stands as a challenge to the belief of Scott (1955), Anderson (1993), Johnston et al. (2010), and others that “optimal” management is possible in practical terms (but see Sethi et al. 2005 for optimal management accounting for uncertainty). Instead, perhaps we must be content with what we
might call a “pretty good” (Hilborn 2010) outcome in the face of uncertainty. To this end, confronting the massive uncertainty inherent in most fisheries can be achieved by (Ludwig et al. 1993): (1) considering a variety of plausible hypotheses about the world; (2) considering a variety of possible strategies; (3) favoring actions that are robust to uncertainties and reversible; (4) probing and experimenting; and (5) updating assessments and policy accordingly.

One of the most dynamic and unpredictable sources of uncertainty is human behavior in fisheries. Hence, more innovations in the field of human-dimensions will be needed to better represent the behavior of fishers and policy makers in fisheries management. Perhaps in a future update of Foundations of Fisheries Science we will see an equal representation of sections on the biology and human dimensions, supplemented with some integrated sections where both fields are combined in the spirits of Smith and Wilen (2003) and Johnston et al. (2010). This is because most fisheries problems are essentially human problems—human-caused or human-mediated (Ludwig et al. 1993)—but they cannot be solved in isolation from the biological world and vice versa.

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2.2 REPRINTED ARTICLES


