

Viewpoint

The lighter side of reference points

P. Koeller

Bedford Institute of Oceanography, P.O. Box 1006, Dartmouth, NS, Canada B2Y 4A2

Received 5 September 2002; accepted 5 November 2002

Abstract

Applied fisheries science is currently undergoing a fundamental philosophical self-examination. This is due to some spectacular local failures in fish stock management in the recent past, and major international initiatives (ecosystem-based fisheries management, codes of conduct and the precautionary approach) which require interpretation and implementation. There is no shortage of responses to the call for a new collection of fish stock assessment and management systems (paradigm), often in the form of philosophical papers in the sections of scientific journals dedicated to such treatments. In this paper I offer some opinions on the opinions, viewpoints and perspectives which have gained attention over the last few years. It is a practitioner's opinion. Fish stock assessment should be modeled after medical practice in which the stock is the patient, the biologist is the doctor, and the fishery is the sustainable disease.

© 2002 Elsevier Science B.V. All rights reserved.

Keywords: Philosophy; Fisheries science; Stock assessments

I recently awoke at three o'clock in the morning in a cold sweat and an idea. If F. Scott Fitzgerald's contention is true, that in the real dark night of the soul it is always three o'clock in the morning then, I reasoned, in the real, real, real dark night of the soul it must always be three o'clock in the morning during a paradigm shift in fisheries science. One early morning some time before that I had what I thought was a great idea—a medical analogy for fish stock assessments. The stock is the patient, and the biologist is the doctor! Fortunately it rained that morning—traffic is always bad in Halifax when it rains, which meant that I had nearly an hour in the car to work out the details. Stock assessment biologists, fisheries managers and industry people often talk about the “health” of the stock, so the idea was there, latent, waiting to be born by a brilliant midwife, like evolution. Diagnosis, prognosis and treatment were analogous to

assessment, projection and, based on the biologist's advice, management action. Both stock assessment and diagnostics are concerned with a large number of often interrelated variables that can be grouped into domains that are physical, psychological, social, environmental, ecological, etc. in character. Both disciplines are divided into activities which are short-term, addressing immediate needs, and longer-term research designed to improve the effectiveness of the former. Both combine elements of science and art, with the latter element grudgingly acknowledged, admittedly more unabashedly in medicine. I thought of “fishery management” and “stock management” in medical terms. The former manages the only aspect directly associated with the “patient” which is manageable while stock management, and even better, ecosystem management, is the holistic approach to which both disciplines aspire. Given that stock assessment biologists are doctors, one might ask what kind of doctors? Considering our current knowledge of aquatic ecosystems

E-mail address: koellerp@mar.dfo-mpo.gc.ca (P. Koeller).

a medieval doctor who bleeds the patient comes to mind. What a great illustration of model error! An even better analogy was prompted by the eight o'clock news on my car radio. Apparently Taliban doctors had "harvested" blood from prisoners for transfusions to their own soldiers, with sometimes-fatal results. I wondered if these doctors took a "precautionary approach" with "reference points" based on "indicators" from monitoring equipment, or simply checked the patient's color periodically. But more about traffic lights later. By the time I arrived at the Bedford Institute I realized that this revelation had resolved a longstanding ethical problem of mine—where should my loyalties lie when the advice I give could favor the patient or the chronic disease (a sustainable fishery) depending on how I decided to interpret highly variable data? Hippocrates had defined my loyalties! By the time I reached my office I was convinced that the philosophy of medicine would save world fisheries. I took my revelation to a trusted colleague.

"It's not perfect", he said. "The patient can't talk to you, so he can't tell you where it hurts. Sounds more like a veterinarian's problem to me". I didn't like that. A stock is more than just a poodle or a pig, for Heaven's sake. I left quickly, but not before he had added "And what about Kevorkian?"

"You are taking this medical analogy much too literally. . . ." was all I could muster.

"Anyway, its been done", he said, flinging a reprint across the desk towards me. He is always flinging reprints across the desk towards me, which saves me from going to the library.

Sure enough, [Germano \(1999\)](#) had put it all down in "Ecology, statistics, and the art of misdiagnosis: the need for a paradigm shift" at the end of the last millennium. I was so deflated I went to the library. What I found was a plethora of philosophical papers on fishery science, stock assessments and management. And so I was reduced to the fate of those who have great ideas too late—I read about the ideas I already had, could have had, or had flung at me—and did a review. Why, I asked, is everyone in fisheries science philosophizing so frantically at this particular point in time?

I started with [Corkett's \(1997\)](#) contention that stock assessment is not really science but actually the logical equivalent of primitive magic. I liked the medical analogy, but witch doctors? Corkett's alternative to the

unfalsifiable stock assessment models presently being used is the "pre-science" of social engineering, defined as "institutional development based on trial and error to update blueprints based on the record of success and failures". But that, essentially, is the story of stock assessment and fishery management since their inception. What Corkett really seemed to be saying was "continue to do what you do, just don't call it science". That was fine by me. Stock assessment is harder than science. Corkett also suggests that stock assessment biologists need to philosophize more. Read on and you will see that I have grappled this to my bosom with hoops of steel.

I left stock assessment for a while and digressed into the philosophy of science itself, starting with the ultra-reductionism of [Popper \(1934\)](#) and ending with [Mayr's \(1982\)](#) nicely balanced view of what makes biology and biologists tick. Somewhere in between I stumbled across a philosophical examination of medical diagnostics, which started me going on the analogy again. [Tomassi \(1999\)](#) states that diagnostics is one of the least studied aspects in the philosophy of medicine because of traditional attitudes which simply consider it an "intuitive process" or "arcane natural art". Why, I thought, should attitudes towards stock assessments be any different? Why could not the stakeholders just accept my expert judgment, follow the doctor's orders and take their medicine? I know, I know. The stakeholders are not the patients. The stock is the patient, the stakeholders are the disease. Anyway, Tomassi proposes a variation of Baye's Theorem as a model of the diagnostic process, where the prior captures the clinician's knowledge prior to any medical tests performed. Despite problems, he notes, diagnostic software incorporating the theorem has outperformed the experts. The increasing popularity of Baysian statistics in stock assessment is of relevance here, isn't it? Consider [Harbitz's \(2000\)](#) paper in which he improves the abundance estimate from a shrimp survey by including the experience of the senior scientist in the equation. One would think that at this point Tomassi's inquiry would come to its ultimate conclusion (Baysianism and computers are the way forward). Instead, he offers an alternative strategy for inquiries into the nature of diagnostics by invoking the musings of an unlikely philosopher.

Ludwig Wittgenstein, it seems, introduced a distinction between *symptoms*, which are purely empirical

evidence for a disease (read survey monitoring results, stock health indicators) and *criteria*, which contribute to the definition of the name of that disease, and to the sense of meaning of that name. In stock management we can consider criteria as the biological reference points defining conditions of stock health which we wish to avoid. Wittgenstein pointed out the basic interchangeability of symptoms and criteria and that the choice of a criterion from a given set of phenomena may be wholly arbitrary and ad hoc. Further, he maintained that doctors successfully and correctly use words in the complete absence of any criterion–symptom distinction. There you have it. We do not need reference points. Someone should fling Wittgenstein at Hilborn (2002). More on that later, but first consider the darker side of Wittgenstein:

For Wittgenstein, claims to truth can only be assessed by the relative degree of agreement that exists about the rules used to verify them. It is the level of agreement rather than the “objective” truth itself that counts. It is what human beings say that is true and false; and they agree in the language that they use. The world of facts, which is reality, is contained within, not beyond the logical structure of language (Oliver, 1999).

Wittgenstein set out to destroy philosophy, and by many accounts succeeded. He then quit philosophy altogether and became a schoolteacher. Judging from the above description of his thinking, he would have done equally well as a biologist on the scientific advisory committees that oversaw the destruction of cod stocks in the northwest Atlantic. But back to the lighter side.

My contention, of course, is that all this philosophy is a sign that there is something seriously wrong in fishery science. The naïve student who after your lecture on the truth pipes up “Yes, but what is truth?” will be laughed out of the room when things are going swimmingly. But when we are all at an impasse, when the collective unconscious is at its wit’s end and there is *Sturm und Drang*, then the student has a point. Such times are clearly here when papers with the word “paradigm” in the title become citation classics. Take, e.g., Gilbert’s (1997) paper calling for “a new recruitment paradigm for fish stocks” and the ensuing heated exchange of comments. Myers (1997) reduces the argument to one of whether or not one believes that eggs are required to produce baby fish—a moot point

at best, but one which he has spent much of his career making! Lobster assessment biologists on the east coast of Canada, on the other hand, recently defined a minimum amount of egg production that should be achieved in order to ensure sustainability, in the complete absence of any demonstrable stock–recruitment relationship, based almost entirely on the reasonable (albeit unproved) belief that lobster eggs are required to produce baby lobsters. I suppose it is a matter of scientific rigor. If one can prove with geometric logic ($P < 0.05$) that eggs are required to produce baby fish then it follows that a certain amount of spawning stock is required to keep on producing them indefinitely. Except that amount changes continuously with the environment. We all know that too, but only brilliant quantitative types can prove it.

Another sign that fishery science is in trouble is when authors use analogies from other sciences, make up new words, and recant their own good work. All of these signs are evident in Schnute and Richards (2001). Before trashing this excellent paper I must admit that I am deeply biased against it because it coined the word “fishmetic” (derivative arithmetic) before I could get to the publisher with my version (“fishics”, derivative physics). On the face of it they are different words, but I cannot deny the similarity of the sentiment on the flip side. In any case, Schnute and Richards (2001) use numerous analogies, including the mystery novel as a metaphor for the use of fisheries models in determining the secrets of nature. It’s good, but not perfect. I mean, who is the victim and who the criminal here, anyway? I think they realized this because later in the paper they introduce the analogy of finance and fisheries. Holmes is never mentioned again. I like the finance analogy better and will elaborate it by saying that *the current revolution in stock assessment and management can be equated to the paradigm shift from Keynes’ to Hayak’s theories in the management of national economies during the last 20 years. There are parallels to the range of scientific thinking in both disciplines, from approaches which use models of reality to manage the real world, to ones that let reality manage itself.* I have managed to use the “P” word without feeling uncomfortable, but I do miss the doctor–patient relationship here. Insider trading would just be too tempting for me. Perhaps most disturbing in Schnute and Richards (2001) is their contention that models are nice “tools for thought”, but please, do not

use them to make decisions. Confessions such as “in our haste to free ourselves from descriptive naturalism, we have embraced clever but naïve abstractions of reality, and ultimately, ignorance” are just downright embarrassing, particularly since the senior author’s ignorance has been published profusely. Is *nothing* sacred during a paradigm shift?

This gets me back to The Dark Side of Reference Points. Something is seriously amiss when the fisheries science literature is infiltrated by political rhetoric, passion and poignant preambles in italics, as in reference points *were “designed by geniuses to be used by idiots” with apologies to Herman Wouk (Hilborn, 2002)*. I have steadfastly refused to read fiction since graduate school but can no longer avoid it now. Obviously Wouk had a lot to say about fisheries management. One of Hilborn’s main points, i.e. that “Contemplation about reference points... allows the scientific community to ignore the real problems...”, is brought home with an example from a fishery which has blatantly engaged in such trivial pursuits for years. This is done by repeating the phrase “*This at a time when...* (insert some terrible transgression)” four times in the same paragraph. Repeated use of a short introductory phrase is a favorite device in uplifting and passionate political speeches, as in “I have a dream...”. After trashing reference points all together (they are “like rearranging the deck chairs on the Titanic”), Hilborn (2002) takes Schnute and Richards (2001) cue and proposes “data-based”, rather than “model-based” approaches to setting quotas. I only assume that he took their cue because Schnute and Richards (2001) are not cited. Neither is Hedgepeth (1977) for that matter, but I suppose that was too long ago (albeit after the Titanic sank).

My main problem with most of the above works is not what is said (I agree with just about all of it, except maybe the witch doctoring), but that I wasn’t cited anywhere. Perhaps not entirely by coincidence I have applied many of these sentiments in my own approach to fishery management (Koeller et al., 2000). Based on my reference pointless, data-based assessment last year I managed to convince fishermen and managers to decrease the shrimp TAC on the Scotian Shelf by 40%. *This at a time when* (and I will not use the phrase more than once) biomass and catch rates have been the highest recorded (Koeller, 2002). I am not sure its legal, but my “partners” and I appear to

have applied the precautionary approach while the rest of the world is still trying to figure out exactly what it is. It’s quite simple, really. Be careful! Push away from the table! Don’t be so bloody greedy or you will lose the rest of it! Easily said, I suppose, in our neck of the woods where the shadow of the groundfish disaster still looms large. In the meantime, while the rest of the world catches up, I have become engaged in a heated local debate between the data-based and the model-based factions of my unit, one sticking to its guns and espousing the value of improved and more complex models and the other, of which I am proud to say I am one, championing the “holistic” approach using multiple indicators of stock health, transparent traffic lights and... wait for it... fuzzy logic. This activity has earned me a promotion, the chair of a committee charged with solving the problem, and public ridicule from at least half my peers. Serves me right.

And finally, you know there is something seriously wrong with fishery science when the philosophical discussion in the literature degenerates into humor. I will try to be a little more serious now. The real problem in applied fisheries science is that we fisheries scientists continue to be given impossible problems to solve and, by jingo, we continue to solve them. Back in the 1970s when managers wanted hard numbers in their advice we came up with stratified random surveys and VPA. These were just too statistically correct, elegant and convenient not to use. Now that all that has gone to hell in a hand cart managers want uncertainty in their advice. No problem there, actually. The call for ecosystem management will also be answered, despite overwhelming ignorance. Fortunately, as all this develops, the unknown facts of biology will only play a minor role. The key, Hilborn (2002) contends, is in “institutional structure”. In the future fisheries science will be about how acronyms interact, with each other and with oxymoronic catch phrases like Sustainable Development. Which leads me to coin a word of my very own—acronymious—the state of acrimony associated with the proliferation of acronyms. Well, I will be retiring soon and can afford to say no to it all. In the meantime, I will just continue to do the very best I can for my little patient.

I will conclude on a lighter note, a set of “propositions” loosely modeled on Wittgenstein’s (1921) *Tractatus Logico-Philosophicus* and based on my experiences as a stock assessment biologist

Figure 1. Tractatus Logicus-Assessmenticus

1. You can ignore the really big assumptions if you get the maths right.
 - 1.1 Bad data get better if they are used with good intentions.
 - 1.2 Do not let common sense interfere with statistical correctness.
 - 1.3 Insignificant improvements to the methodology are better than discarding a bad time series.
 - 1.3.1 Baye's Theorum can make experience scientific.
 - 1.3.2 If you do not have enough samples from the population just keep sampling the samples you have.
2. If you are certain you have found the truth you haven't looked at enough data.
 - 2.1 The more information you have, the more uncertain you will be of what is actually happening.
 - 2.1.2 If you confess your uncertainty verbally you will be ridiculed.
 - 2.1.3 If you confess your uncertainty mathematically you will be forgiven.
 - 2.2 The amount of uncertainty in an assessment is directly proportional to the amount of scientific rigor applied.
 - 2.2.1 The better you get at describing uncertainty, the worse you will be at providing useful advice.
3. In order to act, conclusions reached during scientific peer review must be assumed to be true.
 - 3.1 Conclusions reached by 10 pinheads in a day are better than those reached by 1 pinhead in a year.
 - 3.2 Accountability is indirectly proportional to the number of people in a peer review committee.

Fig. 1. Tractatus Logicus-Assessmenticus.

(Fig. 1), in the areas of statistics, uncertainty and peer review. I invite the reader to consider if these propositions would be any cause for concern in medical practice.

References

- Corkett, C.J., 1997. Managing the fisheries by social engineering: a re-evaluation of the methods of stock assessment. *J. Appl. Ichthyol.* 13, 159–170.
- Germano, J.D., 1999. Ecology, statistics, and the art of misdiagnosis: the need for a paradigm shift. *Environ. Rev.* 7, 167–190.
- Gilbert, D.J., 1997. Towards a new recruitment paradigm for fish stocks. *Can. J. Fish. Aquat. Sci.* 54, 969–977.
- Harbitz, A., 2000. Use of subjective prediction in optimal stratified sampling with application to shrimp surveys in the Barents Sea. *J. Northw. Atl. Fish. Sci.* 27, 139–150.
- Hedgepeth, J.W., 1977. Models and muddles. *Helgoländer Wiss. Meeresunters.* 30, 92–104.
- Hilborn, R., 2002. The dark side of reference points. *Bull. Mar. Sci.* 70 (2), 403–408.
- Koeller, P.A., 2002. A New Traffic Light Assessment for the Eastern Scotian Shelf Shrimp Fishery in 2001, vol. 6. Canadian Science Advisory Secretariat, 2002, 50 pp.
- Koeller, P.A., Savard, L., Parsons, D., Fu, C., 2000. A precautionary approach to assessment and management of shrimp stocks in the Northwest Atlantic. *J. Northw. Atl. Fish. Sci.* 27, 235–246.
- Mayr, E., 1982. *The Growth of Biological Thought*. Harvard University Press, Cambridge, MA.

- Myers, R.A., 1997. Comment and reanalysis: paradigms for recruitment studies. *Can. J. Fish. Aquat. Sci.* 54, 978–981.
- Oliver, P., 1999. *History of Philosophy*. Prosper Books.
- Popper, K.R., 1934. *The Logic of Scientific Discovery*. Springer, Berlin.
- Schnute, J.T., Richards, L.J., 2001. Use and abuse of fishery models. *Can. J. Fish. Aquat. Sci.* 58, 10–17.
- Tomassi, P., 1999. Logic and diagnostic. *Minerva (Internet Journal of Philosophy)* 3. <http://www.ul.ie/~philos/vol3/gnostic.html>.
- Wittgenstein, L., 1921. *Tractatus Logico-Philosophicus*. *Annalen der Naturphilosophie*.