



Food for Thought

Natural history: an approach whose time has come, passed, and needs to be resurrected[†]

Kenneth W. Able*

Marine Field Station, Rutgers, the State University of New Jersey, 800 c/o 132 Great Bay Boulevard, Tuckerton, NJ 08087, USA

*Corresponding author: tel: +1 609 296 5260 X230; fax: +1 609 296 1024; e-mail: able@marine.rutgers.edu

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The development of our understanding of fish and other marine fauna, including my own over several decades, has proceeded from basic natural history to ecology and evolution, but we often need to return to natural history to address deficiencies in our attempts to manage fisheries, conserve habitats, and model ecosystems. This resurrection of natural history is still needed because of the complex life history of fish, and many other marine fauna, and the lack of appreciation of shifting baselines in marine environments. These inadequacies are especially evident when we try to address the effects of human influences, e.g. fishing, urbanization, and climate change relative to fisheries management and conservation. A solution lies in the rebirth of natural history studies, especially at “places” such as marine field stations. Long-term monitoring, especially, continues to provide critical insights. All of these approaches are limited by inadequate appreciation and, as a result, funding. The solutions are largely site and investigation specific but would be enhanced by a greater appreciation of the advantages of comprehensive, long-term studies in natural environments, especially with regard to the increasing worldwide emphasis on conservation and habitat restoration.

Keywords: estuarine research, fisheries, fish, habitats, marine field stations, natural history, shifting baselines.

Introduction

I mulled over the essence of this article for decades. I was prompted to crystallize my thoughts by an invitation to present a keynote address at the XV European Ichthyological Congress in Porto, Portugal in September 2015. What follows represents a combination of my review of the literature on the status of natural history studies and my personal experiences in marine science.

What is natural history?

The definitions of natural history are as broad as the study itself. [Fleischner \(2005\)](#) summarized many previous attempts at definition by pointing out that they all have “a reliance on direct observation as the most trustworthy tool for learning”. Certainly, [Bartholomew’s \(1986\)](#) emphasis on the following questions captures the essence of

where most naturalists place their priorities. Natural history questions (for zoologists) are simple and straightforward. What animal is it? Where does it live? How many are there? How does it survive and reproduce? How did it come to be like it is and live where it does? There have been other thoughtful reviews of the need for natural history ([Futuyama, 1998](#); [Grant, 2000](#); [Dayton and Sala, 2001](#); [Schmidly, 2005](#)). In fact, the essence of my thoughts was so well captured by [Greene \(2005\)](#) that I considered not writing this article because of his excellent treatment. However, upon further reflection, I reconsidered because 10 years has passed and I wanted to emphasize a marine perspective, which encompasses the largest but least visible part of the biosphere. This is also where my experience lies.

Scientists’ perspectives on these and related issues are biased by their surroundings, so I will let you know mine. I have been interested

[†]Food for Thought articles are essays in which the author provides their perspective on a research area, topic, or issue. They are intended to provide contributors with a forum through which to air their own views and experiences, with few of the constraints that govern standard research articles. This Food for Thought article is one in a series solicited from leading figures in the fisheries and aquatic sciences community. The objective is to offer lessons and insights from their careers in an accessible and pedagogical form from which the community, and particularly early career scientists, will benefit.

in the natural history of plants and animals for as long as I can remember, and these interests were often fostered by my mother. I recall that natural events in my backyard and a nearby creek were always more interesting than space exploration. I found my niche in graduate school and the marine experiences there. Since then, I have long (38 years) been embedded in a major university that has placed increasing emphasis on research (especially in marine sciences) beginning in the later part of the 20th century (Clemens, 2015). During much of that time (29 years), I have been located at the Rutgers University Marine Field Station (Able, 2015). This location has provided immediate access to the cleanest estuary (Mullica River—Great Bay) in the northeastern United States and one of the cleanest on the east coast. This “place” is surrounded by a natural inlet, marshes, and a watershed with low human population density. As an indication of its uniqueness, we have captured sharks in our boat basin and harbour seals haul out on our floating docks, while bottlenose dolphins are easily observed from my office window. In fact, I endlessly tell my colleagues that fish swim under my office (in a converted Coast Guard Station, Able, 2015) during high tides. This proximity to natural habitat, during a large portion of my career, has also continuously provided a baseline for understanding the broader implications for the study of habitat and behavioural ecology as they relate to protection and restoration. My purpose here is to briefly review the decline and, it is to be hoped, rebirth of natural history studies, interspersed with some perspectives from my own career.

The decline of natural history studies

Concern about the reduced emphasis on natural history studies has been expressed in many publications or comments therein. A sampling of these includes “the naturalists are dying off” (Noss, 1996); “despite its basic role, natural history recently has been ignored and dismissed” (Dayton and Sala, 2001); “the impending extinction of natural history” (Wilcove and Eisner, 2000); “a pervasive denigration of natural history” (Cotterill and Foissner, 2010); “the virtual banishment of natural sciences in academe” (Dayton, 2003). This decline crosses faunal taxa as indicated by “The Natural History Conundrum Revisited: Mammalogy Begins at Home” (Weigl, 2009). This disdain has resulted in the comment that “Few, if any, of us would declare ‘naturalist’ to be our occupation” (Ricklefs, 2012). In fairness, there are opinions that differ from those above, including those of Arnold (2003) who contends that “natural history is alive and well”.

In addition, the decline in studies of natural history is exacerbated by paperwork associated with restrictions on field collecting and maintaining animals in the laboratory (Greene and Losos, 1988; Cooke *et al.*, 2016), and this has only gotten worse over time. In my experience, my field and laboratory research is compromised by frequent, time-consuming reviews of animal welfare protocols that are more appropriate for monkeys and white rats caged in a building than studies of live animals in nature. Further, animal rights groups compound this situation by emphasizing the lives of a few individuals to the detriment of the study of the health of populations which are often dependent on their natural habitats. As a further indication of the problem, some researchers in the United States have switched to working on invertebrates because the rules have become so onerous for vertebrates. In Europe, these regulations already apply to invertebrates such as decapods and cephalopods. In addition, the emphasis on hypothesis testing and modelling in recent decades (Fleischner, 2005) has contributed to the decline in natural history. Unfortunately, this often results in elegant hypotheses that are untestable because of an inadequate understanding of the natural history of the animals central to these tests. To be clear, the goal here is not to belittle current advances and

approaches in science, of which there are many, but to support the publication of quantitative and qualitative observations to provide the context and basis for studying mechanisms and processes (Underwood *et al.*, 2000; Guidetti *et al.*, 2014). These and other issues have crystalized the need for a rebirth of natural history studies, not in isolation, but as an integrated part of larger efforts (e.g. Louda and Higley, 2010).

I had to learn these lessons over time, from a beginning as a rather naive graduate student (with my advisor, Jack Musick, at the Virginia Institute of Marine Science), when I became interested in symbiotic associations and particularly that between a cyclopterid fish and sea scallops. While I gained insights into this association from field and laboratory observations, it became clear that I could not adequately identify the fish. This resulted in fairly extensive taxonomic studies that led to the identification of this as a new species (Able and Musick, 1976), a review of the genus *Liparis*, and the description of another new species (Able, 1976a). These identification problems all came from a frequently and intensely studied coastline. Thus, my initial lesson of how little we know of basic fish taxonomy. At the same time, I became interested in the life history and ecology of killifish, in part because many aspects of their natural history could be observed in a few centimetres of water and they were amenable to being held in small aquaria. As a result, these interests continue today. Who knew that they had such unique spawning sites (Able and Castagna, 1975) and cleaning behaviours (Able, 1976b)? Thus, I also became impressed with how little we knew of fish life history and behaviour very early on in my career.

As a *post doc* (with Bill Leggett at McGill University), I became aware of the lack of knowledge about the natural history of capelin, a mainstay of North Atlantic foodwebs (Bailey *et al.*, 1977; Vesin *et al.*, 1981), and one of the dominant larval forms in the St Lawrence estuary (Jacquaz *et al.*, 1977; Able, 1978). This interest in larval fish has continued to this day in the form of a larval time-series (once a week on night flood tides for 26 years at Little Egg Inlet, New Jersey).

A position at Rutgers University allowed the possibility of extending my studies of fish natural history in study sites ranging from heavily urbanized to nearly pristine and in the process learning much of their needs. Upon beginning as an assistant professor, I (with Churchill Grimes) became interested in the natural history of tilefish in deeper waters, in large part because a major fishery had developed for this species but no one knew much about them. Our submersible studies focused on the unique burrowing habitat of the species (Able *et al.*, 1982; Twichell *et al.*, 1985) which provided important insight into the how and why of the fishery for them, e.g. long-lines fished on the bottom. These basic natural history studies at the edge of the continental shelf and in deepwater canyons extended all along the east coast of the United States and into the Gulf of Mexico (Grimes *et al.*, 1986; Able *et al.*, 1987) over a decade. These efforts helped to define why they had such a limited spatial distribution and how their burrowing habit influenced their catches. I recount this history of early research because several of the central themes (natural history, habitat use, estuaries, and larval fish) have been sustained throughout my career. Fortunately, at Rutgers, I also had good mentors and colleagues (Norb Psuty, Rich Lutz, Fred and Judy Grassle) that understood the importance of natural history studies.

Signs of renewed attention

There are several indications that the scientific community, educators, and the general public are responding to the concerns about the decline in natural history studies. Here, I place the emphasis on marine sciences because of my greater familiarity with it. One of

the most ambitious, the Census of Marine Life (Pierrot-Bults, 2003; Snelgrove, 2010), strives to generate information on the diversity, distribution, and abundance, i.e. natural history, of marine communities throughout the world's oceans. To date, it is clear that many marine species that have been investigated are new or poorly known (Pierrot-Bults, 2003; Snelgrove, 2010). Also, there are many attempts to expand the role and significance of natural history through workshops on society, education, environmental research, and environmental management (Hampton and Wheeler, 2012). Others have fostered an appreciation of natural history by helping us understand how this interest develops in young people (Wilson, 1994).

In an entirely different approach, it is clear that the appreciation of the importance of natural history is reflected in several new journals (Northeastern Naturalist, Southeastern Naturalist, Caribbean Naturalist, and Urban Naturalist). For fish, in particular, the accumulation of natural history data and literature is expanding as a result of the increasing acceptance of Fish Base (<http://fishbase.org/>) (Palomares and Bailly, 2011).

Fortunately, the development of technology during the last several decades has opened new windows into the natural history of marine systems (Greene, 2005; Porter *et al.*, 2009). In our own studies, the use of otolith daily increments (Sogard *et al.*, 2001; Warlen *et al.*, 2002), small coded wire tags for mark-recapture studies (Able and Hales, 1997; Teo and Able, 2003; Able *et al.*, 2012), underwater video (Kimball and Able, 2012), acoustic telemetry (Szedlmayer and Able, 1993; Tupper and Able, 2000; Able and Grothues, 2007) in listening arrays (Grothues *et al.*, 2005; Grothues and Able, 2007), high-frequency acoustic video (Grothues and Able, 2007; Able *et al.*, 2013, 2014), and AUVs (Grothues *et al.*, 2009) have helped map underwater habitats and determine the distribution patterns of fish. In these instances, funding from competitive sources was available because we applied to diverse sources and seldom justified the work in terms of natural history. Rather, they addressed "needs" in terms of fisheries management, Essential Fish Habitat, habitat restoration, etc. Listening arrays have been especially helpful in understanding the temporal and spatial patterns of site fidelity for estuarine fish. For example, some tagged summer flounder (Sackett *et al.*, 2007) and striped bass (Grothues *et al.*, 2009) returned to the same estuary after overwintering great distances away. Further, when they returned, they came back to the same areas where they previously resided. These same studies found that, although departure for winter was common, the period of egress from the estuary was species specific (Able *et al.*, 2014). Also, some of these enhanced techniques applied by other investigators have broadened our understanding of fish migrations on a worldwide scale with large listening arrays (Payne *et al.*, 2010), mobile trackers (Block *et al.*, 2010), biologgers (Costa and Sinervo, 2004; Block, 2005), and pop-up tag technology (Block *et al.*, 1998).

Implications and solutions

The renewal of natural history studies, both for faculty, students, resource managers, and others, has multiple benefits in several areas, including in marine sciences. Much of this is in response to general environmental degradation on the land and in the sea. Both conservation and restoration, increasingly active areas of science, need the background of natural history studies for effective and efficient evaluation of complex biological systems (Wilson, 1985; Noss, 1998; Dayton, 2003) including in urbanized estuaries (Able *et al.*, 1998; Duffy-Anderson and Able, 1999, 2001). A return to natural history roots has also been called for in wildlife (Herman, 2002; Fleischner, 2005) and fisheries management

(Ross, 1997). None of these needs can be addressed until we return natural history to education programmes while extending its outreach to the general public (e.g. Feinsinger *et al.*, 2010). One of the most effective ways that this has happened is through collaboration with recreational and commercial fishers. They can often be wrong in their understanding of a fish species, but more often their insight and expertise is of real importance. They have been amazingly accurate in identifying where to catch a variety of target species. At the same time, our tracking has helped to inform them of tidal, diel, and seasonal habitat use patterns and migrations of which they were unaware. These exchanges have made us better natural historians and have given scientists credibility with an important user group. As another example, consider the possibility that fishers can contribute to the natural history we need based on their extensive experience (Ames, 2004; Hind, 2015).

The reason to focus on marine habitats is because our understanding of natural history is so limited there; the oceans and estuaries are the hidden part of the planet (e.g. National Research Council, 2000). This is reflected in the inability of humans to spend extended periods underwater (e.g. Collette, 1972), the limitations of vision underwater, especially in typically turbid estuaries, and the costs associated with trying to overcome these difficulties from SCUBA to rebreathers and especially submersibles. Fortunately, solutions are at hand, and in some cases always have been, but are underappreciated. For example, in marine sciences, the maintenance and enhancement of federal, state, and university-based marine field stations (remember my stated bias) has seminal importance because of the importance of "place" (Billick and Price, 2010; Kingsland, 2010; National Research Council, 2014). This presence (often long term) allows a basic understanding of the natural system (e.g. nearshore ocean, bay, or estuary), an improved understanding of system dynamics (short and long term), and, as a result, provides for the possibility of adaptive sampling which in turn can lead to serendipitous scientific discoveries (Michener *et al.*, 2009). As I write this, our field station has just experienced a major northeaster with snow accumulations up to 60 cm, winds gusting to 109 kph, and extensive flooding of nearby habitats. Within the next week I will know, based on our continuing time-series, whether this storm has influenced larval fish ingress and species composition and juvenile fish residency. More generally, and perhaps most importantly, this access to nature also enhances the development of biologists (Wilson, 1994; Janovy and Major, 2009). It certainly has for me (Able, 2015) and I think the same is true for many students, interns, and technicians with whom I have shared these experiences.

One of the most effective contributions of marine (and terrestrial) field stations is the accessibility provided for long-term studies and the accumulated knowledge that supports these (Tinkle, 1979; Brunt and Michener, 2009; Michener *et al.*, 2009; Louda and Higley, 2010). This type of contribution is evident in my studies (with Mike Fahay at NOAA-National Marine Fisheries Service—Sandy Hook, New Jersey) on the natural history of estuarine fish in the northeastern United States (Able and Fahay, 1998, 2010a). These approaches are still important, although support for them seems to be diminishing, not increasing as it should (Schmidly, 2005). These are especially critical to overcome the difficulties of interpretation associated with shifting baselines (Pauly, 1995), especially during a period of climate change in marine systems where the pace of change may be faster (Burrows *et al.*, 2011; Poloczanska *et al.*, 2013) including for fish (Rijnsdorp *et al.*, 2009). Certainly, our own studies have documented a changing fauna in New Jersey estuaries (Able and Fahay, 2010b). For example, we now know that the composition of larvae ingressing into our study estuary is changing with fewer northern species and more

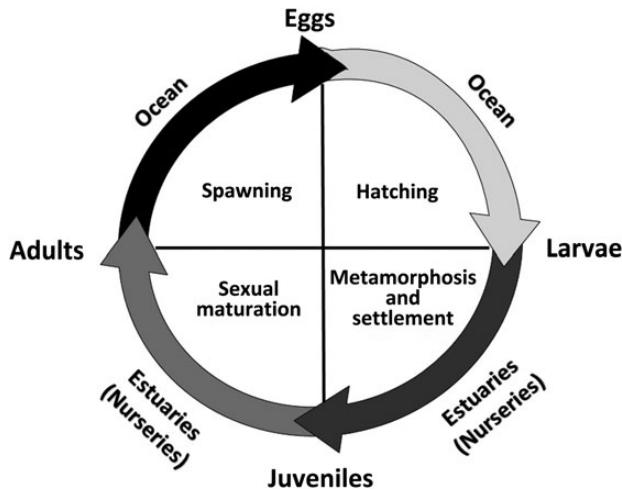


Figure 1. Many fish, and especially estuarine-dependent fish, have complex life histories that experience many population bottlenecks as they experience multiple morphologies across diverse habitats.

southern species (Able and Fahay, 2010b). This is most evident since ~2000 and has resulted, in some instances, in new fisheries that did not previously exist, such as that for Atlantic croaker (Hare and Able, 2007). These same studies have indicated a changing phenology in estuarine ingress with American eel glass eels occurring later and Conger eels occurring earlier with the resulting potential for increased predation by the latter on the former (Musumeci et al., 2014).

Decreased funding for natural history studies, either dedicated, as part of larger multi-investigator research programmes, or as part of college and university curricula, is central to the problems we face (Greene, 2005). These issues should be more easily resolved where the animal species of interest have economic value, e.g. wildlife biology or fisheries, if the resource managers could be re-enlightened as to the importance of natural history. In addition, the lack of financial support at field stations might benefit from enhanced networking (Schubel, 2015), perhaps with agricultural field stations (National Research Council, 2014; Schubel, 2015). Of certain importance is the need for long-term monitoring and experimental studies (Cody and Smallwood, 1996; Ducklow et al., 2009; Magurran et al., 2010). While monitoring is frequently championed, it is seldom supported (Sukhotin and Berger, 2013). This consistent attention, often to a particular place, is central to our ability to understand change.

The need for continued observations of natural history of fish is especially important given the uncertain taxonomy of many forms from freshwaters (especially tropical) to the deep sea, the complexity of life histories (Figure 1) (Moser et al., 1984; Miller and Kendall, 2009; Walsh et al., 2015), and the highly migratory nature of many species. These same observations are central to successful synthesis of our current understanding of the biosphere and the obligation of all scientists to translate what we know into peer-reviewed publications, books for the general public (i.e. the taxpayers who ultimately support our activities) or other forms of outreach (e.g. Matthews, 2015). All of these will augment our ability to manage and conserve fish and fisheries, help us to understand effects of man-made change, and advance our ability to interpret effects of climate change and other shifting baselines. These, in turn, can help to inform ecosystem models that we are relying on much more frequently.

Beyond the cumulative experience expressed above, I have several personal suggestions, particularly to aspiring students and

young scientists who have interests in natural history or its contribution to their research programme. These are, in no particular order: (i) choose good mentors and advisors; (ii) choose good colleagues, including graduate students and postdocs—they may result in long-term associations; (iii) teach natural history every day (in the classroom and the field, including to technicians, interns, and the general public); (iv) do not attempt to distinguish between basic and applied science—the only difference is time; (v) location, location is critical to good field studies; (vi) be observant, there is still lots to learn; (vii) do not forget to put your boots on periodically; and (viii) work hard, play hard—they complement each other.

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