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Fisheries Education in the 21st Century: Challenges and Approaches to Training the Next Generation of Fisheries Scientists

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There was a time not so very long ago, actually within the careers of many senior or retired AFS members, when limnologists, ecologists, oceanographers, agriculturists, fisheries scientists, sociologists, economists, artists, poets, writers, engineers, and lawyers really couldn't find much reason to interact professionally. Our domains were tight, tidy, and generally exclusive. Then came the twentieth century's cultural revolution and its associated environmental movement, and with them a realization that if we were going to have a future, at least one that deals realistically with structure and processes of a finite planet, we were going to have to change the way we related to one another.

Strange but wonderful things began to happen and some very special people led the way. In the 1970s an ecologist at the University of Arkansas (Douglas James) began to talk with a statistician (James Dunn) about Hutchinson's *N*-dimensional hyper-volume, and multivariate statistics for ecological application was born. During this same period, a Canadian biologist (Dick Ryder) looked at a series of lakes and figured out that you could look at depth and total dissolved solids and get a pretty good idea of what fish production probably would be...and the Morpho-edaphic Index (MEI) swept the world with its elegance. Limnologists said that they'd been trying to tell us this sort of thing for a very long time. We were smart enough to pay attention at this point and limnology became an essential element of fisheries management. Imagine doing fisheries research and management today without considering environmental influences, but "way back then" it was regularly done. Then came Ken Cummins, Tom Waters, and Art Brown who looked beyond the stream channels they were working in, experienced epiphanies, and had the courage to say that there was a connection between fish and trees; the quality and quantity of leaves and other organic material falling into a stream determine structure and production of benthic macroinvertebrate assemblages, which in turn ultimately correlate to fish production. We were reminded that fish do not grow and reproduce well unless they have something to eat, and enough of it, and that riparian zones and watersheds determine the characteristics of the buffet dinner available to fish. Their work set the foundation (although they may not have realized it at the time) for future interaction between ecologists, cartographers, and computer scientists to develop geographic information systems (GIS) which, along with multivariate statistics (mentioned above), now are standard tools in our fields. Rosemary Lowe-McConnell, Robin Welcomme, Wolfgang Junk, Peter Bayley, Richard Sparks, and Michael Goulding, each in her/his own way, and addressing different parts of the world, had the audacity to say that some rivers are supposed to flood and if allowed to do so, they'll produce a lot of fish. Qifeng Ye came to us from China and reminded us, with dignity and grace, of ancient Egyptian knowledge that flooding can be beneficial to agriculture, and furthermore that you can have fish and agriculture…and then she moved off to Australia to work with rivers "down under." Ken Bovee and his team in Ft. Collins, Colorado, through development and refinement of instream flow incremen-

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tal methodology (IFIM), made it very clear to everybody who wanted water out West, and especially to range managers, engineers, and developers, that if you dried up the rivers there wouldn't be many fish. And then there was Bob Piorkowski, a quiet and thoughtful Alaskan marten trapper who in his 30s decided to come out of the woods, go to college, and become a fisheries biologist. In his doctoral dissertation he found that escapement goals for Pacific salmon needed to consider rotting carcasses as well as egg deposition because the carcasses provided streams with essential nutrients and foraging materials for invertebrates and early life history stages of salmon. This was published by others, but it was Bob who had the idea and did the early science to show the energetic connection between the ocean and rivers: with adult salmon serving simultaneously as the "allochthonous material" and its transport mechanism…bridging oceanography and marine science with riverine fisheries management.

As we opened our doors, persons in disciplines that we'd formerly considered as "fringe elements" joined us in creating a new mainstream for natural resources professions. For example, there's Ralph Brown, a fisheries sociologist at Brigham Young University who listens to "Enya," speaks Indonesian, and can take the square root of a sonnet. Through the magic of sociological sciences, he infiltrated human relationships with natural resources and tracked those relationships much as a physician uses barium as a tracer in the human body. Mike Hudgins' work at Auburn University in the 1980s pioneered sociological research addressing the structure (including value systems) of the angling experience. During this same period, Geoff Orth (University of Alaska—Fairbanks) gave us deep insight into the lives of commercial fishers, and particularly purse seiners. There was a merging of deep currents along this theme and Bob Ditton at Texas A&M University jumped headlong into the flow, guiding an entire generation of new fisheries sociologists. Meteorologists and fisheries scientists got together in the 1970s and ultimately produced a prophetic text entitled *Climate and Fisheries.* Roger Palm (an economist) teamed up with Steve Malvestuto (a fisheries scientist) to pave the way for economic assessments of small-scale capture fisheries, and to do so using basic creel survey techniques. And on and on and on…

As the environmental movement swelled, gender and cultural diversity increased in our ranks. Returning Peace Corps Volunteers infiltrated graduate schools and brought with them global perspectives regarding humankind's relationships with the Earth's resources. Students in the biological sciences, natural resources, and agricultural fields began taking business courses and enrolling in post-graduate MBA programs. New courses sprang up throughout North America and around the world addressing environmental law, and students wearing bell bottom trousers, beads, and beards thronged to them and to law schools. Vardis Fisher's book, *Mountain Man*, and the movie from it, *Jeremiah Johnson*, inspired a new generation of wilderness wanderers, many of whom came into universities with perspectives incorporating but also transcending consumptive use of renewable natural resources. There were very deep reasons, beyond hunting and fishing, that drew these persons to the mountains and to other wilderness areas. They believed in science but they also proclaimed profound, perhaps unquantifiable, connections to the rhythms of the Earth as expressed by Annie Dillard in her book *Pilgrim on Tinker Creek* and Edward Abby in *Desert Solitaire.* They quickly recognized the roles of science-based conservation organizations in the bio-political arenas, joined (or created) these organizations, and worked their way into leadership. Once in these positions, and as members of academic advisory boards, they became advocates for inclusion of political science and communications courses in university and college natural resources curriculums. Artists of all sorts joined our ranks. In the mid 1980s, Elizabeth Sturm (University of Alaska—Fairbanks) became somewhat of a pioneer in this regard. She developed a M.S. thesis founded on her illustrations of larval fishes. However, it generated great controversy at the time because to some it was not considered "science" (but isn't the first step in science "observation?"). To their credit, Betsey's graduate committee held their ground, approved the thesis, and a beautiful piece of work became available to fisheries professionals throughout that great state. Those blessed with strong quantitative skills and equally strong linear thought processes recognized opportunity to be creative in the myriad fields of engineering and applied their gifts to natural resources and environmental issues. Along the way, through cross-disciplinary relationships, we began to assimilate culture, language, and

techniques from each other. Incredible synergism transpired.

As the environmental movement further evolved over the years, persons with little personal interest or experience in the traditions and cultures of hunting and fishing began entering academic programs in natural resources management and entering the workforce of the professions. This has transformed agencies, college and university faculties, the sort of work that is funded, and subsequently the sort of work we do. These persons tend to be respectful of consumptive use but are unwilling to limit the expression of their professional or personal identities to those realms. They see an evolving world with challenges that require a big picture approach to natural resources issues. They tend to be very inclusive in their orientations, their social and professional groups, and in terms of what they think constitutes appropriate work and position in the natural resources arenas. They are now firmly established in AFS and throughout our professional ranks, and constitute a large portion of our emerging cohort.

It is imperative that current and aspiring fisheries professionals be equipped with the tools necessary for success in the new world that they envision—and, to be quite honest, within the one where we all now dwell. Subsequently, the process of educating fisheries professionals needed to change and in fact has changed dramatically over the last half-century. Changes in management philosophies, development of new technologies, shifting demographics, globalization, and cultural shifts have directly or indirectly influenced education trends (e.g., Altbach et al. 2005). Adapting to these changes has been problematic from a pedagogical standpoint, with increasing demands on undergraduate natural resource curricula (credit limits), program constraints (e.g., shrinking faculty numbers and increased workloads), and shrinking budgets (e.g., state support). Furthermore, the mission of many academic departments has shifted away from traditional fisheries and wildlife curricula by broadening coursework (e.g., conservation biology, landscape ecology), producing a disconnect between some academic programs and the basic knowledge and skill sets necessary for successful state and federal employment (Scalet 2007). These challenges require that educators consider curriculum needs, diversity, and learning styles of students while maintaining linkages with employers so that future employees are well-equipped to contribute to aquatic resource management.

In the academic arena, recent advances in educational theory have improved our understanding of how to meet student learning needs in today's environment. Techniques that effectively promote critical and creative thinking, communication skills, and facilitate retention of science-based information are being developed and applied in a variety of disciplines. For example, the concept of linking curricula objectives with employer needs has required movement away from traditional teaching methods and toward more novel approaches (i.e., experiential learning) to accommodate student learning. In addition, when considering the student-teacher interaction, recognition of different generation's traits and learning styles (e.g., generation Z, X, Y) can help both teacher and pupil learn to be successful in today's academic environment.

The topics discussed above are a sample of the issues addressed by educators during a special symposium held during the 2009 AFS Annual Meeting in Nashville, Tennessee, entitled "Fisheries Education in the Twenty-first Century: Accommodating Change." The goal of the symposium was to highlight educational techniques and approaches that facilitate learning with respect to fisheries education in today's society. Participants covered a variety of topics related to three major themes that included: (1) curricula and the job market, (2) understanding students, and (3) effective teaching strategies.

To share this information with the AFS community, a special column in *Fisheries* will periodically feature articles from symposium participants and AFS members-at-large (educators, professionals, students). The featured articles represent the combined commitment of AFS and the Education Section to enhance fisheries education, train the next generation of fisheries scientists, and keep us all on the growing edge of our profession.

REFERENCES

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