



ESSAY

Reflections on the Legends of Canadian Fisheries Science and Management

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Canada has a long and illustrious history in fisheries science and management that has included many important discoveries related to fish biology, fisheries assessment, and management strategies (e.g., Johnstone 1977). In 2014, the Canadian Aquatic Resources Section (CARS) of the American Fisheries Society (AFS) launched a new initiative called *Legends of Canadian Fisheries Science and Management* at the AFS Annual Meeting in Québec City. The goal of the *Legends* program is to recognize fisheries professionals in Canada that have made significant lifetime contributions to the science and management of fisheries. By recognizing individuals and highlighting their accomplishments, our hope is to ensure that the next generation of fisheries professionals will remain connected to the people who laid the foundation for the fisheries work that we do today. That foundational work, much of it conducted decades ago, underpins our thinking about ecological processes and forms the basis for today's conservation and management paradigms. This essay explores our process, struggles and successes, and most importantly, highlights our *Legends of Canadian Fisheries Science and Management*.

Our process for induction into the *Legends* program is simple. Each summer, we encourage our membership to submit informal nominations (with a ~200 word free-form rationale) to the CARS President via email. Though CARS does not have specific criteria for what defines a *Legend*, Table 1 shows examples of what we have previously considered to be significant contributions. The intent is for members to identify colleagues, collaborators, peers, and mentors that they would like to honor. These candidates can be scientists, managers, administrators, or educators. The new nominees are added to our list of past nominees who have not been inducted and the updated list is sent to our Executive Committee and Past Presidents. Each person is asked to rank up to five nominees they support for induction as a *Legend* and the President then tallies the selections and shares the results with the rest of the Executive Committee (beginning in 2019, CARS plans to open up the vote to all CARS members). During a monthly conference

call, the results are discussed and the Executive Committee decides on which nominees will be inducted as *Legends*. We typically aim to induct *up to* five legends on an annual basis and the winners are formally announced at the CARS annual business meeting held at the Canadian Conference for Fisheries Research.

Legends are typically in the late stages of their career, retired, or honored posthumously. We do not recognize achievements of early or mid-career professionals, or singular accomplishments. There is no financial compensation associated with the recognition. Those recognized have their name and a brief biography added to our website (available: <https://cars.fisheries.org/legends-of-canadian-fisheries-science-and-management/>) and links are shared on CARS social media pages. Names of *Legends* are added to a plaque housed at the Queen's University Biological Station in Ontario and we present a certificate to surviving *Legends*. Short biographies are prepared by colleagues, family members, friends, collaborators, students, and admirers, and we do our best to include major contributions, awards, basic biographical information, and some fun, lesser-known information. We would wager that you did not know Zbigniew “Bob” Kabata had a book of collected poems published in Polish, or that Bill Ricker was once featured in *Sports Illustrated* (here is proof: <https://www.si.com/vault/1984/11/12/626963/fisheries-biologist-william-ricker-is-a-real-hall-of-famer-in-his-field>), or that Canada Post issued a stamp to honor Archibald Huntsman. To date, we have recognized 32 *Legends* whose careers collectively span from the early 20th century to present day (Table 1). Learning about inducted *Legends* and highlighting their careers to our membership and followers has been exciting and rewarding, and many of our members have expressed delight in hearing about the program. Living *Legends* are appreciative of the recognition and it has been an honor for us to interact with them during this process. At the end of the day, we all share a common passion for aquatic resources and our *Legends* are inspirational.

Our *Legends* are a remarkable group. Some have been awarded Canada's highest civilian honor (the Order of Canada; e.g., Henry Regier, Bob Kabata, Peter Larkin, Bill Hoar, David Schindler, Richard Beamish) or have been named Officers of the British Empire (e.g., John Dymond, Wilfred Templeman). Some have awards named in their honor (e.g., Casimir Lindsey, Helen Battle, Fred Fry, Bill Hoar, and Peter Larkin—the namesake of our own student excellence award), while others have government vessels named after them (e.g., Alfred Needler, Helen Battle, Bill Ricker). Some *Legends* were known for taxonomy (e.g., Casimir Lindsey, Don McPhail, Bev Scott, Ed Crossman, Joe Nelson, Don McAllister, Bill Ricker), most attaching their names to books starting with *Fishes of* [insert any region in Canada]. All *Legends* have had productive careers with lasting impact. To highlight a few, Bev Scott and Ed Crossman produced the magnum opus for every Canadian fish enthusiast, *Freshwater Fishes of Canada* (1973) and not to be forgotten is Joe Nelson's *Fishes of the World* (1976, 1984, 1994, 2006, 2016), which is arguably a sacred text for ichthyologists. Bill Ricker (also known as a stoney taxonomist) published the landmark paper detailing the “Ricker Curve,” which is widely used in fisheries science, among numerous other contributions. Carl Walters' papers on adaptive management have revolutionized fisheries management. Pierre Legendre's *Numerical Ecology* is a key reference for the analysis of multivariate ecological data. Daniel Pauly's *FishBase* is a hugely popular online global encyclopedia of fishes. The work of Fred Fry and Bill Hoar on the environmental biology and comparative physiology of fishes, respectively, are widely cited even today due to their applicability in a changing world and one could argue that they set the stage for Canada's knack for producing fish ecologists and physiologists. Harold Harvey defined the biological impacts of acidification on fishes, John Casselman is a modern-day saint to many anglers for his work on inland fisheries and has been inducted into the Canadian Angler Hall of Fame. Steven Campana's work on micro-otolith structure and age and growth revolutionized how we understand fish populations at fine scales, without the use of scales. Not to be undercut, Jack Vallentyne and David Schindler's whole-lake approach to understanding lake ecology solved several mysteries, such as the causes of eutrophication, and Ram Myers brought to our attention the seriousness of overfishing in the North Atlantic. It truly is humbling to learn about the lives and careers of our *Legends*.

Despite having inducted 32 *Legends*, an early struggle for the CARS membership (including the Executive Committee) has been to identify worthy individuals from under-represented groups to nominate. Beyond the difficulty of identifying Canadian fisheries professionals that have truly accomplished legendary work (e.g., few *Legends* and nominees come from a management or administration background and there is a heavy bias towards academics and scientists), we have struggled with equity, diversity, and inclusion (EDI). Rightly so, after our inaugural announcement, we did have feedback from AFS members that highlighted our lack of gender diversity and we took this criticism seriously. It was clear that the original inductees were fairly uniform in their demographic traits and ancestry (e.g., no women or indigenous people were recognized). Our untested explanation for this lack of diversity was that we were focusing on people who had, in most cases, made their mark in fisheries several decades before the present. Therefore, we thought the lack of diversity among our initial *Legends* was likely an artifact of the historical composition of

the fisheries work force rather than bias among the nominators and selection committee, although we are cognizant of potential biases when selecting elite scientists for awards (Lincoln et al. 2012). We realized that an unwanted and unintentional side effect of highlighting legends in Canadian fisheries may have been to suggest to young, aspiring fisheries professionals that only men (primarily of European ancestry) can have prolific careers in our profession. At the same time, the lack of diversity among *Legends* inductees has caused us to reflect on the progress that has been made on EDI issues in fisheries science (Arisimendi and Penaluna 2016) and that professional societies like AFS and their sections and units need to continue to refine our strategies to promote inclusion (Penaluna et al. 2017). With the *Legends* program, CARS vowed to nominate potential inductees in future years that would improve the diversity of our *Legends*. The first such action taken by CARS was to task each committee member with asking colleagues to help us to identify nominees from under-represented groups. We also scanned archives of other societies (e.g., Canadian Society of Zoologists) to identify nominees. *Legend* Helen Battle, who was the first woman in Canada to earn a doctorate in marine biology and an honorary lifetime member of the American National Association of Biology Teachers, was identified in this way. We reviewed the history of the Fisheries Research Board of Canada (Johnstone 1977), the principal federal research organization working on aquatic science and fisheries (1898–1979). Though the book was not very helpful for identifying *Legends*, Mary Arai (one of our newest Legends!) recently published an excellent in-depth look at the contributions and challenges faced by women in contributing to marine science in Canada (Arai 2016). Three generations of her own family were just inducted as *Legends*; we provide a brief summary here to give an overview of the contribution of the women in this dynasty.

Edith Berkeley (1875–1963) was a world expert on marine polychaetes, a founding scientist at what was to become Fisheries and Oceans Canada's Pacific Biological Station in Nanaimo, British Columbia, and a founding member of the Department of Zoology at the University of British Columbia. She completed her research only in a volunteer capacity because, at the time, the government and universities did not hire women for research positions. Edith's daughter, Alfreda Needler (née Berkeley; 1903–1951) also pursued aquatic sciences, earning her doctorate in Zoology at the University of Toronto, and discovering the existence of sex reversal in shrimps of British Columbia and oysters of Prince Edward Island. The family's contributions to Canadian science would continue another generation with Alfreda's daughter (and Edith's granddaughter), Mary Needler Arai (1932–2017; Purcell and Welch 2018). Mary became a world expert on jellyfish, authoring the definitive book on the biology of Scyphozoan jellyfish and teaching at the University of Calgary until her retirement. Her recent publication (Arai 2016) includes an excellent compendium of sources on the challenges women scientists faced while making important contributions to marine science.

Ultimately, by continuing to recognize our *Legends*, CARS hopes to share inspirational stories and highlight major advancements to inspire the next generation of fisheries professionals. We have aimed to have a simple process that allows flexibility in criteria and many voices to be heard. Certainly, the outcome of our process highlighted an EDI issue in fisheries sciences but we hope that our efforts have shown that AFS sections, and we, as fisheries professionals, can follow

Table 1. The 32 *Legends of Canadian Science and Management*. Further details on each *Legend* can be found at our website (<https://cars.fisheries.org/legends-of-canadian-fisheries-science-and-management/>).

Legend	Year Inducted	Legendary Contributions
Helen Battle	2015	First woman in Canada to earn a doctorate in Marine Biology and one of five women in Canada to earn a PhD prior to the Great Depression. Pioneered the use of fertilized fish eggs to study the effects of carcinogenic substances on development, opening up new avenues for cancer research.
Richard "Dick" Beamish	2015	Discovered acid rain in North America, identified new methods for aging fish, discovered a new lamprey species, provided insights into lamprey evolution and classification, and contributed to our understanding of the effects of climate on Pacific salmon and other fishes. Recognized by the International Panel on Climate Change for contributing to the Nobel Peace Prize for 2007.
Berkeley-Needler-Arai Dynasty • Edith Berkeley • Alfreda Needler • Alfred Needler • Mary Needler Arai • George Needler	2017–18	Spanning three generations and producing five eminently worthy scientists, this is a first for CARS. The contributions of each of these five individuals over their respective careers are each richly deserving of inclusion, but the decision was made to award the clan as a whole to highlight the historical linkages among these individuals. Further details are provided in the text of this article.
Steve Campana	2016	Did work on micro-otolith structure and age and growth that is the foundation by which we can understand fish populations at fine scales. Among the most cited active fisheries scientist in the world.
John Casselman	2015	Internationally renowned for his knowledge on freshwater fish species and the use of calcified structures for aging of fish. Named to the Canadian Angler Hall of Fame (2015), and awarded the American Fisheries Society Award of Excellence (2008).
Ed "E. J." Crossman	2014	A dominant figure in Canadian and international ichthyology, fisheries research, and conservation biology, particularly involving introduced and endangered species. An authority on fishes, their ecology, distribution, evolution, and systematics. An authority on esocid fishes, his special passion. Co-authored <i>Freshwater Fishes of Canada</i> with his colleague and long-time friend, W. B. (Bev) Scott.
John Dymond	2016	Many significant contributions to the taxonomy and biology of fishes, and the conservation of fish and wildlife via public education. A founder of the Federation of Ontario Naturalists and in demand as an organizer of nature studies. Served on the Great Lakes Fishery Commission as chair of the Advisory Committee of Fisheries and Wildlife Research, Ontario. Named Officer of the British Empire for his many services to the Government of Canada.
Fred Fry	2014	Remarkably diverse contributions, ranging from landmark papers in ecophysiology to practical methods in quantitative population biology to pioneering stakeholder collaboration in field research. The Canadian Society of Zoologists awards the F. E. J. Fry Award each year to recognize outstanding contributions in zoology.
William "Bill" Harkness	2017–18	Spent most of his career as Director of the Ontario Fisheries Research Laboratory at the University of Toronto, followed by Director of the Fish and Wildlife Branch in the then Ontario Department of Lands and Forests. Served as AFS President in 1950–51. Was also President of the Limnological Society of America (precursor of the Association for the Sciences of Limnology and Oceanography; 1940–41), Vice President of the American Society of Ichthyologists and Herpetologists (1940), member of the Great Lakes Fishery Commission (1955–61), and President of the International Association of Game, Fish, and Conservation Commissioners (1956–57).
Harold Harvey	2015	Pioneered the research on aquatic acidification and fish. His work informed policymaking in Canada and the United States, ultimately leading to an agreement to reduce sulphur emissions, the precursors of acid rain.
Bill Hoar	2014	Widely recognized for contributions in comparative physiology. Editor of the <i>Canadian Journal of Zoology</i> and co-editor, with D. J. Randall, of the multi-volume book series titled <i>Fish Physiology</i> . Received the Fry Award from the Canadian Society of Zoologists and, in the same year, became an Officer of the Order of Canada.
Archibald Huntsman	2014	Pioneering Canadian scientist, best known for his research on Atlantic Salmon and invention of fast freezing of fish filets. Published more than 200 scientific papers and reports. Awarded the Flavelle Medal of the Royal Society of Canada (1952) for his outstanding contribution to biological science. In 2000, Canada Post issued a stamp in his honor.
Bob Kabata	2014	Recognized as the world's expert on parasitic copepods, having named over 100 new species of parasitic copepods. A major achievement is his book on the <i>Parasitic Copepoda of British Fishes</i> with over 2000 illustrations, which he meticulously drew. Received Poland's highest decoration, the Grand Commander Cross of Polonia Restituta for his bravery as a young leader of a group of partisan soldiers in the Second World War and for his science. Received the Order of Canada in 2006 for his internationally recognized research on the biology and systematics of marine parasites.
Peter Larkin	2014	Internationally respected expert in aquatic ecology, conservation, resource management, and science policy. A Rhodes Scholar, Larkin also received the Order of Canada in 1995. CARS gives out an annual award for excellence in graduate student research and leadership that is named in his honor.

(Continues)

Table 1. (Continued)

Legend	Year Inducted	Legendary Contributions
Pierre Legendre	2015	Laid the groundwork for the development of quantitative methods to analyze multivariate ecological data and for the discipline of numerical ecology. Known for his interest and expertise in spatial, multivariate, and beta-diversity analysis. Awarded the 2005 Prix Marie-Victorin of the Government of Québec, became Officer of the National Order of Québec in 2007, and is listed as an ISI Highly Cited Researcher in Environment/Ecology.
Casimir C. Lindsey	2014	Major research contributions in biogeography, and the ecology and taxonomy of freshwater fishes in Canada. He wrote several books including <i>Biology of Coregonid Fishes</i> . The C. C. Lindsey Prize is given by the Ecology, Ethology, and Evolution Section of Canadian Society of Zoologists each year for the best student presentation within the fields of behaviour, ecology, or evolution. Has also been honored by The Wildlife Society and was named a Fellow of the Royal Society of Canada in 1974.
Donald McAllister	2014	The first Curator of Fishes at the Canadian Museum of Nature (1958–1986). Soon after arriving at the museum, began new research on the fishes of Arctic Canada and catalogued 410,000 fish specimens. Co-chaired the International Union for Conservation of Nature Species Survival Commission Coral Reef Specialist Group (1998) and was a major contributor to the Canadian Biodiversity Strategy.
John Donald “Don” McPhail	2016	Many significant research contributions on the speciation, evolution, ecology, and biogeography of freshwater fishes. Published over 85 highly cited journal papers, book chapters, and books.
Ransom “Ram” Myers	2014	Best known for his warnings on overfishing. Published a series of papers showing the systematic impacts of industrial fishing on marine resources and biodiversity at a global scale.
Joe Nelson	2014	Best known for his many editions of <i>Fishes of the World</i> , <i>Fishes of Alberta</i> , and <i>Common and Scientific Names of Fishes from the United States, Canada, and Mexico</i> . Elected President of the American Society of Ichthyologists and Herpetologists (ASIH), and received numerous awards including: the ASIH Robert H. Gibbs, Jr. Memorial Award (2002), the Robert K. Johnson Award for Excellence in Service (2010), the F. E. J. Fry Medal (2010), and the William E. Ricker Resource Conservation Award (2011).
Daniel Pauly	2016	Among the most well-known active fisheries scientists globally, Pauly created <i>FishBase</i> and the <i>Sea Around Us</i> project, and authored two widely cited papers on “shifting baselines” and “fishing down marine food webs.”
Henry Regier	2014	Dedicated to education and advocacy around the human use of aquatic systems. Maintained an expert role in policy discussions for international organizations such as the United Nations Environmental Program and the Intergovernmental Panel on Climate Change.
William Edwin “Bill” Ricker	2014	Ricker was a preeminent ecologist, entomologist, fisheries scientist, and theoretical biologist. A search online produces more than 100,000 hits for the “Ricker Curve” 60 years after he first published that landmark paper. He was the recipient of the Eminent Ecologist Award by the Ecological Society of America (1990). He also received a host of other academic and scientific awards and recognition for his achievements in areas as diverse as entomology, Sherlock Holmes, limnology, wildlife biology, and the fishing hall of fame.
David W. Schindler	2015	Directed the Experimental Lakes Area located near Kenora, Ontario. Instrumental in describing the impacts of acid rain, eutrophication, and contaminants on freshwater systems. Many accolades including: Fellow of the Royal Society of Canada (1983), Frank Rigler Award from the Canadian Limnological Society (1984), the Stockholm Water Prize (1991), Fellow of the Royal Society (2001), Natural Sciences and Engineering Research Council of Canada’s Gerhard Herzberg Canada Gold Medal for Science and Engineering (2001), the Order of Canada (Officer; 2004), the Tyler Prize for Environmental Achievement (2006), and 11 honorary doctorates.
W. B. “Bev” Scott	2014	First curator of ichthyology at the Royal Ontario Museum. Best known for publishing the legendary book, <i>Freshwater Fishes of Canada</i> , co-authored with E. J. Crossman.
Wilfred Templeton	2014	Director of the Newfoundland Fisheries Laboratory, which became the St John’s Biological Station of the Fisheries Research Board after Newfoundland became part of Canada in 1949. Authored over 250 papers on a variety of subjects from vitamin A in fish liver oils to the effects of fluctuations in ocean temperatures on marine animals. In 1982 a Government of Canada fisheries research ship was named in his honor. He was also named to the Royal Society of Canada and the Order of the British Empire.
Jack Vallentyne	2016	A Hutchinsonian biogeochemist with interests in cosmochemistry, planetary health, paleolimnology, and molecular ecology. He led the famous Fisheries Research Board/Department of Fisheries and Oceans Eutrophication Section at the Winnipeg Freshwater Institute and masterminded the creation of the Experimental Lakes Area. He also held high office in many scientific organizations, wrote several books, and was affectionately known to primary school kids as “Johnny Biosphere.”
Carl Walters	2014	Developed the concept of adaptive management in collaboration with eminent ecologist C. S. Holling. Led dozens of early workshops where fisheries professionals and ecological modelers jointly asked fishery management questions and evaluated how computers could best be integrated into fisheries management. Also developed methods for fisheries assessment, and notable long-term collaboration with Ray Hilborn, resulting in a seminal 1992 paper on quantitative fisheries stock assessment.

the guidelines prescribed by Penaluna et al. (2017). Namely, to undertake self reflection and evaluation, identify and eliminate bias, incorporate diversity and inclusion in our process, and entrench diversity and inclusion as a core value of CARS.

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