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BOOK REVIEW

***A Century of Maritime Science: The St. Andrews Biological Station*. J.M. Hubbard, D.J. Wildish & R.L. Stephenson. Eds. 2016. University of Toronto Press, Toronto, Buffalo, London, 488 pp.**

This volume provides a comprehensive review of the historical and contemporary scientific investigations conducted at the St. Andrews Biological Station (SABS) over its first 100 years. The twelve chapters are replete with detailed descriptions of a wide range of studies and the extensive bibliography and footnotes reflect the depth to which authors have gone to ensure that the legacy of the Biological Station will continue. The book's publication comes close on the heels of the Federal Government decision to close the Station's library along with most other Fisheries and Oceans research libraries, including that of the Pacific Biological Station, SABS' sibling. Hopefully researchers will find this volume a useful link to the significant accomplishments of SABS scientists.

The Biological Station was influenced by and served the research needs of many notable scientists and the volume is a veritable whos-who of marine science in Canada. Many of these scientists have research vessels named after them, *E.E. Prince*, (W.B.) *Dawson, Alfred Needler, J.L. Hart*. E.E. Prince was named the Dominion Commissioner of Fisheries in 1892 and was the main motivator for establishing the Station. W. Bell Dawson was the head of the Tidal and Current Survey and the first physical oceanographer associated with the Station. A.W.H. Needler conducted oyster research on P.E.I. in the 1920s where he was director of the Ellerslie substation. He was Station director from 1941-1954 during which time Station scientists' role in advising fisheries management grew considerably. He was part of the Canadian delegation that drew up the convention leading to the establishment of the International Commission for the Northwest Atlantic Fisheries (ICNAF). J.L. Hart was the Station director from 1954-1967 and placed more emphasis on human impacts on the marine and freshwater environment by starting a section on water pollution research. But, the most cited scientist in this book is A.G. Huntsman, an educator, leader, and advocate for women in science. In addition to fisheries research, he studied oceanography and fish processing. He curated and directed the Station from 1911-1934.

He is commemorated on a Canadian stamp, by the A.G. Huntsman Award of Excellence in the Marine Sciences, and through the Huntsman Marine Science Centre.

The context under which publically funded marine research developed in Canada is described by Eric Mills (Chapter 1). During the late 19th century, marine science was in its infancy and had to compete with agriculture, mining, forestry, and northern exploration for political attention and funding. Early marine research was driven by utilitarian needs and focused on species inventories, fishery development, and marine safety. The first marine station was built on a barge in 1899 and spent two years each in St. Andrews, Canso, Malpeque Bay, and Gaspé. After the floating station was damaged and abandoned enroute to the north shore of the Gulf of St. Lawrence in 1907, the first permanent marine research station was constructed in St. Andrews in 1908, taking advantage of "local fisheries, the richness of the marine biota, water quality, the availability of land, access to supplies, social factors and ease of access from central Canada." These same factors make St. Andrews a popular summer destination for tourists, scientists, and students alike.

As a publicly funded marine research institute, the focus of research at SABS changed with the times. Rob Stephenson (Chapter 4) describes this evolution where the Stations mandate changed from mainly supporting fisheries development in its early days to a greater emphasis on anthropogenic effects on the marine environment. Human pressures on fishery resources led to a greater emphasis on monitoring stock sizes and synoptic bottom trawl surveys were instituted in the early 1970s that covered the Scotian Shelf and Gulf of St. Lawrence. The impacts of mining, forestry and insect control on marine and freshwater ecosystems was a concern and the Station responded by developing related research programs. Atlantic Salmon aquaculture development created new demands for research in the 1970s and again the Station responded. The associated accomplishments are described by Robert Cook in Chapter 12. When the Canada *Species at Risk Act* and *Oceans Act* came into force, the Station had to take on new responsibilities related to conservation biology and ecosystem based research. This came at a time of severe funding pressure and demanded a creative approach.

The obstacles that faced women who were interested in marine science in the 1900s were many. Women were generally not

permitted on research vessels in Canada until the 1970s, making field work on ships difficult to impossible. Work along the shore in the early 1990s was hindered by Victorian dress restrictions. Married women were not allowed to work in the same laboratory as their husbands. After marriage, several female scientists continued their research and published from home. Many worked on specimens collected by others. Mary Arai (Chapter 2), who followed her grandmother Edith Berkeley and mother Alfreda Needler as a marine scientist, describes both the challenges and accomplishments of female marine scientists in Canada. Their collective contributions were considerable despite the difficulties they faced. The individual stories are well worth reading.

The high level of collaboration within SABS is made clear by the cross referencing of individual programs throughout the book. The work by the technical staff in the workshops described by Tim Foulkes (Chapter 5) was integrated with a wide variety of research. The technicians developed an array of instruments to measure fishing gear performance, leading to several improvements. Many specialized experimental tanks were constructed. One was a very large hydraulic flume tank (volume 186,200 l) to test underwater instruments for fishing gear development. When that program ended, the tank was converted into an artificial stream used to study habitat selection by freshwater fish under various feeding and flow rates. One of my summer jobs at SABS was to record observations through the acrylic viewing window for my supervisor, Phil Symons. This work is described in Chapter 7, p. 234. A number of specialized flow simulators were developed to investigate fish and bivalve behaviour, physiology, ecology, aquaculture, and response to various toxic chemicals. The associated research is described in chapters by Wildish and Robinson (Chapter 7), Peterson (Chapter 9), Wells (Chapter 11), and Cook (Chapter 12). The workshops also developed towed underwater vehicle technology for camera and diver observations of marine organisms in their natural environments. The use of this technology in scallop research is described by Caddy (Chapter 8). After the workshops closed in 1993, technology development was transferred to the Bedford Institute of Oceanography. Collaborations continued with SABS scientists in the development of more advanced vehicles equipped with digital cameras and GPS. These instruments were used for mapping coastal benthic habitat.

Physical oceanographic data were collected by SABS scientists from the beginning. Initially it was the visiting volunteer biologists who undertook the work and thus observations were mainly made in summer in the vicinity of the Station. However, before long SABS scientists were collecting data from all over Atlantic Canada including the Canadian Fisheries Expedition in 1914-1915 and Hudson Strait and Hudson Bay in 1927-1929. Blythe Chang and Fred Page (Chapter 6) describe the many physical oceanographic projects at SAS and here are a few examples. SABS oceanographers worked with fisheries scientists in two impact assessments of proposed tidal poser projects in Passamaquoddy Bay in the 1930s and 1950s. In both cases, the predicted negative impact on herring fisheries in the area led to the abandonment of the projects. These are early examples of environmental impact assessment, a process now conducted in a much more formalized manner. The Atlantic Oceanographic Group was established at SABS in 1944 and remained active under a couple of names until 1960. Originally it was a joint undertaking of the Royal Canadian Navy, the Fisheries Research Board of Canada, and the National Research Council and part of its mandate had to do with the detection of submarines. Eventually the mandate was dominated by fisheries-related issues. The oceanography program was transferred to Halifax in 1960. After a hiatus, the oceanography program was rejuvenated with the hiring of a fisheries oceanographer and additional technical staff in 1984. This led to a number of national and international collaborations that currently cover fisheries, shipping safety, aquaculture (Cook, Chapter 12), tidal power generation (again), Marine Protected Areas, harmful marine phytoplankton (Martin, Chapter 10), and invasive species.

The multifaceted and interdisciplinary nature of the environmental science and ecotoxicology research at SABS is very impressive as shown by Peter Wells' contribution (Chapter 11). He presents early examples of this type of research, but things really got underway with the establishment of the Water Pollution Section in the late 1950s. The effects of industrial pollution on Atlantic Salmon was an important driver. Forest spraying with DDT to control spruce budworm was of great concern as was the exposure of Salmon in the Miramichi and Saint John rivers to mining and pulp mill effluent, as well as eutrophication caused by food processing plants discharge. In this context, a large number of new scientists were hired to begin

applied research in environmental chemistry, aquatic ecology, and toxicology. Wells provides extensive documentation of the contributions of John Sprague and Vladimir Zitko, among many others. Field observations of Atlantic Salmon such as described by Dick Peterson (Chapter 9) coupled with laboratory experiments using specialized tanks and flumes built in the SABS workshops (Foulkes, Chapter 5, Wildish and Robinson, Chapter 7) and an impressive chemistry program produced world recognized results. Noteworthy is the citation of SABS DDT research by Rachel Carson in her very influential book, *Silent Spring*. Salmon were also being exposed to zinc and copper from mining. Lobster were being exposed to cadmium from smelting. The toxicity and behavioural effects of these metals were studied at SABS. But the list goes on. SABS responded to the oil spill created when the *Arrow* sank in Chedabucto Bay NS in 1970, to study the effects on lobster and the benthos. The effects of acid rain on aquatic organisms were studied in the 1970s. SABS personnel were instrumental in identifying domoic acid as the toxin responsible for the mussel crisis in PEI in 1987 (Martin, Chapter 10). Recent work has involved "assessing environmental impacts, identifying hazards, and assessing risks of chemical wastes" produced by the salmon aquaculture industry.

As pointed out by Jennifer Hubbard in the introduction to this impressive volume "there are many stories and research programs undertaken at the St. Andrews Biological Station that do not get the attention they deserve." One such program is Marine Fish Stock Assessment and Research. As noted earlier, Alfred Needler was a participant in establishing ICNAF (International Commission for the Northwest Atlantic Fisheries). The Canadian stock assessments for Scotian Shelf and Gulf of St. Lawrence finfish were conducted by SABS personnel as was the basic research into species distribution and demography that informed these assessments. The same personnel were involved in making the case to the Law of the Sea Convention which gave Canada exclusive jurisdiction over our 200-mile limit. By establishing the aforementioned synoptic groundfish trawl survey, monitoring the associated commercial fisheries and conducting supporting research, Canada demonstrated its capability to exercise this jurisdiction. The same data formed a significant part of the Canadian case for defining the international boundary between the US and Canada in the Gulf of Maine and on Georges Bank.

An additional chapter on this story, perhaps in the form of an article in the NSIS Proceedings, would be a significant addition to the SABS 100th anniversary.

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