

# AFS Roots: Mothers of Fishes

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## INTRODUCTION

As the American Fisheries Society (AFS) approaches its sesquicentennial, it is a time to take a moment to celebrate the increasing diversity within the Society and the pivotal role of pioneering women in shaping fisheries and aquatic sciences. Efforts to enhance diversity and inclusion in AFS have increased since the late 1980s. In 1986, AFS established the J. Francis Allen Scholarship award encouraging young women fisheries professionals (J. Francis Allen pioneered women's involvement in AFS and fisheries). In 2000, the Hutton Junior Fisheries Biology Program was created with the goal of sparking high school students' interest towards fisheries, especially individuals from underrepresented groups, including women. Most recently, in 2009, the Emmeline Moore Prize, named for the first female AFS President, was created to recognize efforts towards the promotion of demographic diversity in the Society (Figure 1). In addition, the Equal Opportunities Section, established in 1991 (Box 1), has made substantial efforts on this front, and recent AFS initiatives include the Diversity and Inclusion Special Committee (2017–2020), the 2019 special issue of *Fisheries* on diversity and inclusion, and years of publications on the subject (e.g., Moffitt 1983; Claussen and Fabrizio 1992; Flebbe 1993; Penaluna et al. 2017). In 2016, AFS joined other state and federal agencies, universities, nongovernmental organizations, foundations, and professional societies to form the

### Box 1 The AFS Equal Opportunities Section

The founding mothers of the Equal Opportunities Section (EOS) included Cay Goude, Mary Fabrizio, Chris Moffitt, and Julie Claussen, and the founding fathers included Rich Gregory, Bill Taylor, and Roy Stein. The EOS was formed in 1991 following interest by AFS members to help in addressing barriers for the inclusion of diverse members, including women (Claussen and Fabrizio 1992). Following a survey of women members in 1982, the Equal Opportunities Committee identified that 79% of the respondents wanted AFS to play an active role in removing barriers to women and other diverse talent in fisheries (Moffitt 1983). Current EOS leadership consists of a diversity of talent, and women continue to be key in leadership positions, including current EOS Chair Shivanne Nesbit. The EOS has sponsored many symposia over the past 30 years that address diversity issues of the times, including recruiting diverse talent, unconscious bias, and understanding inclusion and equity.

Diversity Joint Venture for Conservation Careers to increase diversity in the conservation workforce.

Despite all these efforts, there is still a lack of both representation and recognition of women's contributions to fisheries worldwide (Box 2). For example, women hold only a fraction of academic tenure-track, research, and federal scientist positions, though women and men attain PhDs in biological sciences at equal rates (Arismendi and Penaluna 2016). In addition, an extensive review of published peer-reviewed articles in the International Aquaculture Curated Database and JSTOR revealed that only 15% of authors are women (Chow



Figure 1. Timeline of Women in AFS, fisheries, and aquatic sciences.

#### Box 2 Further Reading, Other Amazing Women in Fisheries

In addition to the women profiled here, we recommend learning more about the work of historical figures such as J. Francis Allen, Eugenie Clark, Frances Naomi Clark, Rosa Eigenmann, Margaret Mary Smith, and Ethelwynn Trewavase. Contemporary women in fisheries and fish science that we found pioneering new directions in the field include, but are not limited to: Dahiana Arcila, Carole Baldwin, Beth Brainerd, Kassi Cole, April Croxton, Mary C. Fabrizio, Selina Heppell, Luz Patricia Hernandez, Barbara Knuth, Narriman Jiddawi, Judith Li, Paula Mabee, Christine Moffitt, Shivonne Nesbit, Jennifer L. Nielsen, Dorothy Wanja Nyingi, Melanie Okoro, Lynne Parenti, Donna L. Parrish, Monica Toledo Piza, Lucia Rapp Py-Daniel, Melanie Stiassny, Christine Thacker, Krystyna Wolniakowski, and Atsuko Yamaguchi. Recent articles, including histories of women in the American Society of Ichthyologists and Herpetologists and in the Freshwater Biological Association (Parenti and Wake 2016; Toogood et al. 2020) have even more examples. As AFS approaches its 150th anniversary, this marks an excellent time to reflect on the amazing women that we know of in fisheries inside and outside of the society. Who else can you, the reader, recommend?

et al. 2017). As a result, only 21% of most-cited fisheries articles include women authors (Branch and Linnell 2016). In the early 1980s, the membership of AFS included fewer than 15% of women, and the Society lacked women leadership (Claussen and Fabrizio 1992). Women now comprise over 25% of AFS membership (Penaluna et al. 2017). This is higher than the representation of women as AFS Presidents (7%) and AFS Fellows (13%), though this gap appears to be closing during the past decade. For the first time in AFS history (2019–2020), three of the five presidential positions are currently held by women, including Past President Jesse Trushenski, First Vice President Leanne Roulson, and Second Vice President April Croxton.

In light of the profound influence that women have had in fisheries science and AFS, we recognize contributions of some of the historical mothers of fishes and AFS, in keeping with the theme of “The Father of All the Fishes” (Murphy 2020). Women have challenged accepted wisdom in fisheries and led AFS vibrantly, especially since the 1990s (Figure 1). These vignettes highlight a range of time periods and geographies, and attempt to include a subset of well-known as well as under-recognized scientists. While we recognize that many amazing women are not profiled below (Box 3), we hope to have captured some of the diversity of contributions both inside and outside of AFS. Without these women, we would have missed fundamental leadership, novel advances, and overall progress

#### Box 3 Participation by Women in International Fisheries

While this article highlights the advancements made by women in fisheries sciences, the importance of women in fishing industries should not be overlooked. Around the world, women partake in all aspects of small-scale fisheries, yet are often not given roles in leadership or management, and policies are primarily made by men (Alonso-Población and Siar 2018). For example, participation of women in fishing practices in Vietnam is higher than 85% in some fishing related activities (such as seafood processing), yet the representation in decision making at a political level is minimal (Harper et al. 2017). Whereas women in many countries are often not found on small fishing vessels due to taboo or other discriminations, they still participate in substantial amounts of shoreline fishing or collection of shellfish (Ogden 2017). Although likely common in Asian and African countries, these fisheries are not typically considered in fisheries metrics (Tilley et al. 2020), resulting in significant underreporting of landings in some countries (Pauly and Zeller 2016). Overlooking some fishing methods, especially those that differ between men and women fisher people, may undervalue women’s roles in fisheries and reduce their potential impact on policy making for fishing industries.

in the field. By chronicling the contributions of some of the many women who helped build our science and our Society over the past 150 years, we hope to highlight the ongoing importance of women in fisheries and AFS and spark a more inclusive global fisheries community and workforce for everyone.

#### MOTHERS OF ALL THE FISHES A FEW OF THE MANY Rosa Lee (1884–1976)

Rosa Lee was the first woman scientist to work for a government fishery agency in the United Kingdom in 1905 (Southward 1996). However, when employees were transferred, she was initially not given a job offer because of her gender (Southward 1996). Following objections from colleagues, Rosa Lee was allowed to continue as a civil servant until she married, after which point regulations prevented married women from continuing to be employed (Daune-Richard and Wilson 1995). Trained as a statistician, her short career in fisheries is disproportionate to her impact. Her studies on fish growth rates revealed that older fish in some populations had slower growth rates than would be expected from aging younger fish (Lee 1912). This “Rosa Lee phenomenon” (Ricker 1969) typically resulted from a size selective process; slower growing individuals had reduced mortality. This phenomenon remains relevant to today’s stock management as slower growth rates for a fish population may occur under size selective fishing mortality, and accounting for the Rosa Lee phenomenon can reduce bias in these stock projections (Kraak et al. 2019).

#### Emmeline Moore (1872–1963)

Emmeline Moore served as the first female President of the American Fisheries Society (AFS) from 1927 to 1928 (American Fisheries Society 2017). Moore was an American ichthyologist and aquatic biologist, who earned a PhD in aquatic botany from Cornell in 1914 (Ogilvie and Harvey 2000). Her professional life spanned 50 years and can be separated into two equally impactful careers. Moore began with a 20-year career as an educator, teaching in a public school in 1895 and culminated as an assistant professor at Vassar College from 1914 to 1919 (Ogilvie and Harvey 2000). Moore’s second career began in 1920, when she was appointed as the first professional fish investigator for the state of New York (Balon et al. 1994). During this time, she collaborated on an extensive survey of Lake George. This effort was such a success that the New York state legislature approved a survey of all watersheds and appointed Moore as the lead (Balon et al. 1994). From 1926 to 1932, she headed the New York state biological survey and conducted what were the first and most comprehensive surveys of any state’s watersheds (Moffitt 2001). Throughout these surveys, Moore used her connections with universities to hire and encourage students and faculty to participate in the summer field surveys (Balon et al. 1994). She also published papers on fish culture, fish disease, and water pollution and highlighted research as a critical component of proper fishery management (Moffitt 2001). Moore retired from the New York Conservation Department after a 24-year career. In 1958, the state of New York memorialized her scientific contributions by christening a research vessel in her honor (Ogilvie and Harvey 2000). Emmeline Moore’s lasting impacts to fisheries science both through education and research are felt to this day and are recognized annually through the presentation of the AFS Emmeline Moore Prize. This prize is given for a career of promoting demographic diversity within AFS (American Fisheries Society 2020).

### Helen Irene Battle (1903–1994)

Known for pioneering the use of laboratory practices in the fisheries field and for her remarkable work in marine science and ichthyology, Helen Battle attended the University of Western Ontario and was the first woman in Canada to receive a PhD in marine biology in 1928 (Conchology 2020). She spent over 50 years teaching at the University of Western Ontario and was recognized for her dedication to science and her students through the creation of student scholarships in her name. Battle took a particular interest in encouraging young individuals to continue their interests in biology. Many of her students went on to become successful professional scientists, including Nobel Prize nominee Murray Barr (Lewis 2013). Helen also devoted much of her time to research on fish physiology and embryology, and utilized laboratory techniques that were seldom used in fisheries research before that time to answer biological questions (McMillan 2015). She published dozens of articles on a variety of aquatic and ichthyology topics including: the effects of pollution on marine fishes and drinking water, the impacts of cancerous substances on eggs, and the embryology and development of many fish species, including the first studies of Zebrafish *Danio rerio* embryology and development (Noakes 2004). Helen was also a talented artist and illustrated many of her publications with her own pen and ink drawings (available: <https://bit.ly/3d3k31a>; Western University 2020). In the early 1960s, she co-founded the Canadian Society of Zoologists and served 2 years as president of the group. In 1977, she became the first woman to receive the society's F. E. J. Fry Award for her contributions to fisheries science.

### Marjorie Courtenay-Latimer (1907–2004)

Marjorie Courtenay-Latimer was the curator at East London Museum in South Africa and she enjoyed collecting specimens to expand the natural history museum's small collection (Courtenay-Latimer 1979). In December 1938, she received a call about potential museum specimens from Captain Hendrik Goosen, a local fisherman she had befriended. Marjorie went to the docks and in the midst of a pile of dead sharks, she noticed an unusual blue fish with thick fins. She had seen nothing else like it, and knew this specimen was unique. Courtenay-Latimer enlisted the help of an assistant to carry the 127-pound fish to a taxi, whose driver she convinced to transport the fish back to the museum (Weinberg 2000). There, she examined the fish's armor-like scales, which reminded her of ancient fossilized fish (Courtenay-Latimer 1979). However, the current specimen was beginning to turn from bright blue to a dull gray color, meaning it needed to be preserved quickly. The museum did not have enough formalin to preserve the large specimen, so Courtenay-Latimer quickly identified other options. The morgue refused to store the fish, so she instead took it to a local taxidermist shop (Courtenay-Latimer 1979). She helped wrap the fish in formalin-soaked rags and then attempted to contact ichthyologist J. L. B. Smith. However, several days passed with no word from Smith, and the formalin rags were proving ineffective. The fish's internal organs were beginning to spoil, so Courtenay-Latimer authorized the taxidermist to skin and mount the specimen (Thomson 1991). Smith contacted Courtenay-Latimer the following week, and they exchanged several letters about the specimen over the next month. When Smith was able to see the fish in person, he identified it as a coelacanth, a fish that had previously been assumed extinct for several million years (Thomson 1991). He

named the species *Latimeria chalumnae* in honor of Marjorie Courtenay-Latimer and the fish's place of discovery (Smith 1939). The discovery of a living coelacanth quickly gained attention throughout the scientific community, as it was akin to finding a living dinosaur. This astounding trawl catch in 1938 would have gone unnoticed if not for Marjorie's recognition of the unique fish and her determination to preserve and identify it (Weinberg 2000).

### Lochie Jo Allen (1918–2014)

The younger sister of J. Frances Allen (namesake of the contemporary AFS award for women pursuing PhDs in fisheries science; White et al. 2013), Lochie Jo Allen strongly influenced both AFS and the fisheries field as a whole through her literary accomplishments and inclusion of women in sciences. Allen spent the earlier part of her life teaching language and music for both secondary and college-level courses, but in the mid-1970s joined AFS (Legacy 2014). Officially titled associate-editor, she is credited with bringing the first AFS *Fisheries* magazine to life. During the 9 years she served AFS, Allen edited over 50 articles (Department of the Interior, U.S. Fish and Wildlife Service 1989). Even after she retired, she co-created, published, and distributed the newsletter *Homo Piscis Rusticus*, a newsletter for the retired AFS members. It is interesting to note that both Allen sisters were talented musicians, playing wind instruments and being the only two women in the almost 70-person Triple Cities Traction Company Symphonic Band when they were teenagers. Though written evidence does not seem to exist, it is believed that Lochie Jo also helped to make the J. Frances Allen Scholarship a reality (American Fisheries Society 2014). When Lochie Jo passed away in 2014, she contributed significant personal funds to this AFS Scholarship, geared toward encouraging women scientists to successfully pursue work in fisheries.

### Rosemary Lowe-McConnell (1921–2014)

A British ichthyologist, ecologist, and limnologist, Rosemary Lowe-McConnell led an illustrious career that was both temporally and geographically extensive. Her nearly half-century of research took her from the depths of the Great Lakes of Africa, to the steamy jungles of the Amazon, and into the Natural History Museum of London (Toogood et al. 2020). During her time in Africa, Lowe-McConnell conducted foundational studies on the tilapia of the African Great Lakes and founded the East African Fisheries Research Organization in 1948, for which she briefly served as director (Bruton 1994). Lowe-McConnell described four tilapia species and subspecies endemic to Lake Jipe and the Pangani River and developed an extensive Okavango fish collection that is now housed in London's Natural History Museum. After the McConnells' move to British Guiana—now Guyana—in 1957, Lowe-McConnell worked for the former Guiana Department of Agriculture and Fisheries, conducting baseline fish surveys in unstudied areas (Stiassny and Kaufman 2015). In 1968, she served as an ichthyologist on a Royal Society expedition to Mato Grosso, Brazil (Bruton 1994) and, in 1979, assisted in research of the invasive Peacock Bass (Family: Cichlidae) in the Gatun Lake in Panama (Lowe-McConnell 2006). Lowe-McConnell contributed extensively to the written science, with more than 65 articles, books, and books chapters. Her books on tropical fish ecology (e.g., Lowe-McConnell 1977; McConnell and Lowe-McConnell 1987) remain classics in ichthyology.

### Janet McCloud (1934–2003)

Janet McCloud, a descendent of Chief Seattle, was a key figure in Native American fishing rights. During the early 1960s, conflict between tribal members and state game wardens escalated as a result of diminishing salmon runs (Chrisman 2008). Despite treaties between the tribes and the federal government that guaranteed Native Americans the right to fish, several tribal members were arrested for salmon fishing (Chrisman 2008). In 1964, McCloud helped found the Survival of American Indians Association, an activist group that would defend Native American fishing rights (Trahan 1999). She was selected as the group's first leader and organized "fish-ins"—fishing events used as demonstrations—where tribal members would use traditional nets that the state had deemed illegal (Chrisman 2008). This led to several arrests including McCloud and her husband (Trahan 1999). Janet also wrote the local newsletter *Survival News* and printed it on a used mimeograph machine in order to present her organization's perspective of the fish wars (Trahan 1999). These events gained national attention, particularly after the actor Marlon Brando and rights activist Dick Gregory were arrested at fish-ins, where they showed support for the tribes (Chrisman 2008). After a decade of protests, the 1974 court decision known as the "Boldt decision" recognized the Native American's right to 50% of the fish harvest (Chrisman 2008). The fish-ins organized by McCloud paved the way for public recognition of Native American fishing rights and a critical court decision that would shape future salmon management.

### Amalia M. Miquelarena (1952–)

Argentinian ichthyologist Amalia Miquelarena exemplifies the impact of many women ichthyologists in farther regions of the globe. As a born naturalist in uncharted lands, Miquelarena played a seminal role in the modern taxonomy of Argentinian fishes. In over 90 articles and book chapters, she described the taxonomy and biogeography for a vast region of Argentina. Her exhaustive anatomical studies helped her identify species that were previously unnoticed, including at least 18 characiforms. As an associate professor at the National University of La Plata, Miquelarena advised 12 graduate students and served as director for the Department of Systematics of the Ichthyology Institute. Concomitantly, she was curator of the fish collection at the Museum of La Plata (Argentinian National Research Council), where she also kept a senior research appointment. Although she devoted most of her career to Patagonian fishes, Miquelarena spent 10 scholar visits abroad, including one at the Smithsonian Institution, and two of them at the American Museum of Natural History (Menni et al. 2013). Miquelarena was awarded the Holmberg Award in 2002, the most prestigious recognition of ichthyologists in Argentina (López and Gómez 2013).

### Fang Fang Kullander (1962–2010)

A renowned ichthyologist, Fang Fang began her work on ichthyology in China, travelling to Sweden for a PhD at Stockholm University. She travelled extensively, especially related to her PhD study of genus *Danio*, including to Myanmar, French Guiana, Brazil, Paraguay, India, and China. During this time, she married Sven O. Kullander, completing her PhD in 2001. She was a curator for FishBase and instrumental in organizing annual symposia as well as a prominent member of numerous ichthyological societies (Aquapress 2011). Though she had an early passing, Fang

Fang published over 30 articles and book chapters, including multiple descriptions of new *Danio* species (Kullander 2011) and has been commemorated in the name of *Alburnoides fangfangae*, a small cyprinid endemic to the Osum River, Albania (Bogutskaya et al. 2010).

### Gloria Arratia (1942–)

Gloria Arratia stands among the most prolific living paleo-ichthyologists in the world. In more than 150 peer-review publications, 10 books, and 50 book chapters, she has provided an invaluable advancement to our understanding of teleostean phylogeny and evolution. Her outstanding contributions led to recognition via the prestigious Robert H. Gibbs, Jr. Memorial Award for Excellence in Systematic of Fishes (American Society of Ichthyologists and Herpetologists 2008), making her the first woman awardee in its history. Born and raised in Chile, Arratia pursued an early academic trajectory in the evolutionary biology of fishes, a yet undeveloped field in her country. During the early 1980s, she and her husband, Hans-Peter Schultze, moved to the University of Kansas and, with time, converted it into a global hub for fish systematics (Nelson et al. 2010). Arratia's meristic and morphometric studies have elucidated the diversification process of numerous fossils and recent teleosts, including the description of approximately 115 new fish taxa, and the revision of several families (e.g., Diplomystidae, Percichthyidae, and Pholidophoridae). As one of her more substantive contributions to science, Arratia served as editor-in-chief in the book series *Mesozoic Fishes*, published between 1996 and 2013, a paleontological compendium that will have a long-lasting impact on current and future ichthyologists.

### Geraldine Matolla (1964–)

Geraldine Matolla's ambition to bring sustainable aquaculture to water bodies of Eastern Africa led her to earn a BS in wildlife science at Moi University in Kenya, an MS in aquaculture from Memorial University of Newfoundland, and a PhD in fish parasitology from the University of Eldoret in Kenya (Simelton et al. 2019). Matolla holds two roles at the University of Eldoret, including a faculty position in the Department of Fisheries and Aquatic Sciences and Director for Gender Equity and Diversity (University of Eldoret 2020). Matolla is also a major contributor to the Agriculture for Food Security 2030 program, which uses sustainable agricultural and aquacultural practices to increase food security for low income countries (University of Eldoret 2020). Her multifaceted research includes fish health and disease, human dimensions within fisheries, and multifunctional land use practices in aquaculture to optimize the use of natural resources sustainability and provide Kenyan villages with reliable food sources.

### Pamela Corwin (1984–)

Pamela Corwin began as a wildlife and fisheries biologist for the South Carolina Department of Natural Resources (SCDNR) in June 2007. She grew up outdoors, exploring the fields and forests around her childhood home, and never missed a chance to go fishing. While her career goals changed many times while growing up, a common thread connecting those goals was the desire to work in a wildlife-related field. Corwin completed her undergraduate work at the College of Charleston in 2006, with a double major in anthropology and biology. After graduating, she enlisted in the South Carolina National Guard,

where her work focused on suicide prevention (Harrod 2017). During her time in the Guard, Corwin completed her MS in biology and avian ecology at The Citadel. Her work with SCDNR has allowed Corwin to combine her passion for the outdoors and fishing with her loves of art and continued work with veterans. Her artwork (Figure 2) has been used by the South Carolina trophy fish program and *South Carolina Wildlife Magazine*. She was also 1 of 10 women veterans chosen to have their artwork displayed at VA Medical Centers around the country in 2017 (Lawson 2017). The discipline and leadership skills refined during her time in the military have helped her in her work at SCDNR, where her primary focus is the restoration of American Shad *Alosa sapidissima* in the Santee River system. She has also worked on projects that focused on other native species such as sturgeon, Striped Bass *Morone saxatilis*, and Red Drum *Sciaenops ocellatus*.

I didn't become a biologist for the fame and surely not for the fortune. I became a biologist because I love and care for the great state of South Carolina—it is my home, and I love my job... We live in a society where people equate success with money, but success to a biologist is experimenting, learning, and making practical applications to do better next time.

(Corwin 2018)

#### Angela Hi'ilei Kawelo (1976–)

With a background deeply rooted in family, fishing, and Hawaiian culture, Angela Hi'ilei Kawelo recognized early that she wanted to pursue a career in environmental science and conservation (University of Hawai'i Hilo 2020). Kawelo obtained a BA in zoology with a certificate in the Marine Option Program from

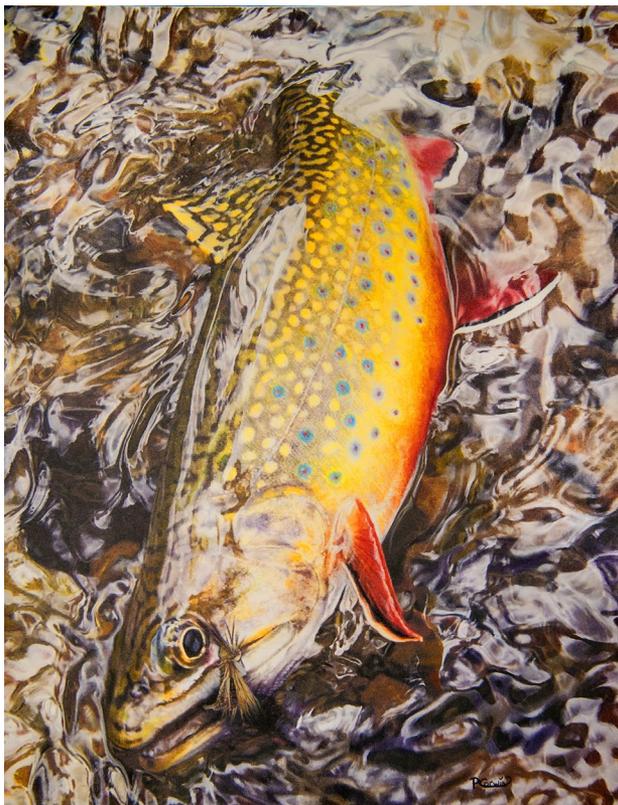


Figure 2. Brook Trout. Pamela Corwin, used with permission.

the University of Hawai'i at Mānoa. After serving as an intern for the Hawaiian Youth Conservation Corps, Hawai'i's Department of Land and Natural Resources, Kaho'olawe Island Reserve Commission, and the Ocean Institute (followed by 5 additional years of service as a research technician), Kawelo shifted focus to work as an educator and research coordinator for the He'eia fish pond on O'ahu (University of Hawai'i Hilo 2020). Indigenous Hawaiians used a well-developed system for the collection of natural resources through land divisions called an *ahupua'a*. Each *ahupua'a* was used for agriculture as well as aquaculture (Costa-Pierce 1987). Among aquacultural resources, Hawaiians use a system called a *loko kuapa* (fish pond). Using the tides and extensively engineered grates called *makahas*, collection of fish to feed the community was highly effective. A small subset of 600-800-year-old *loko kuapas* still exists today, including one in Kaneohe on the island of O'ahu. Angela Hi'ilei Kawelo saw the importance of restoring and maintaining the He'eia fish pond and founded the non-profit organization, Paepae o He'eia. This organization provides resources to the community, practices restoration, and educates the community and provides opportunities for native Hawaiians to become involved (Paepae o He'eia 2020).

#### Rima Jabado (1979–)

The Arabian Seas region (Arabian/Persian Gulf, Arabian Sea, and Red Sea) is well known for its oil and gas industry, expansive deserts, and luxurious and futuristic building projects. And now, thanks to decades of work by Rima Jabado, the waters here are known for their rich biodiversity, especially that of sharks and rays (Jabado 2019). Jabado grew up by the sea; though born in Lebanon, her family moved to Greece in 1982 after Israel occupied her home country (Laylin 2017). In Greece, she was exposed to the beauty of the ocean, a vibrant fishing industry, and the curious abundance of sharks in local fish markets. Jabado earned multiple graduate degrees, conducted shark-related volunteer projects around the world, and was served as a member in global conservation organizations. However, it was a vacation to the United Arab Emirates in 2008 that focused Jabado's attention on the dire lack of knowledge about shark and ray populations in the Arabian Seas region. This knowledge gap and the United Arab Emirates' status as fourth largest exporter of shark fins (Laylin 2017) has been a large focus of her work since. Jabado has also expanded her research to developing countries in Asia and Africa to further understand the status of sharks and rays, especially wedgefishes (Family: Rhinidae) and guitarfishes (Family: Rhinobatidae), through her Pew Fellowship in Marine Conservation. Highlights of Jabado's career include authoring or co-authoring over 50 scientific, technical, and popular publications and identification guides. She has also assisted in the development of laws and regulations that protect sharks, such as United Arab Emirates 2014 Ministerial Decree No. 500, which regulates the fishing and trading of sharks protected by CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora; Laylin 2017). She also founded and continues to lead the Elasm Project, a research and conservation organization that operates in eight countries and works to establish fisheries baseline data and inform local conservation policy (elasmoproject.com).

#### DISCUSSION

By highlighting women in fisheries whose stories we found personally and professionally moving, we celebrate diverse

dimensions of our global fisheries community and hope to lessen the gaps in representation by inspiring current and future women of AFS. This essay represents only a small fraction of pioneering women who have contributed to AFS and to fisheries science. We would like to recognize their accomplishments, but also their struggles. We celebrate their contributions and note the trend in the science and society of increasing participation. We recognize that a modern understanding of gender is not dichotomous, but we use the distinctions in time to highlight patterns of increasing recognition and inclusion by our society.

Here, we demonstrate that women have contributed positive benefits to all realms of AFS and fisheries, including marine biology, aquaculture, freshwater ecology, natural history, systematics, cultural heritage, and education (Figure 1). Historically, women have worked against tremendous obstacles to complete their education and to establish even limited careers in STEM (science, technology, engineering and mathematics) and fisheries science. Husbands, children, and homecare have been priorities falling to women in the 19th and most of the 20th centuries; wives or mothers who aspired to conduct fisheries research were often able to do so only through volunteer work with their husbands' permission (Brown 1994). Although women had been active in research prior, it wasn't until 1959 that they were allowed to join crews on scientific cruises in the United States (Duncombe 2019). Although they faced these substantial hurdles, hundreds of books and research articles were published by women, even in the early days of ichthyology (Figure 1). Their contributions undoubtedly advanced the science invaluablely, though their research was frequently uncompensated and conducted in their free time (Brown 1994).

Unfortunately, the accomplishments of pioneering women have often been marginalized and lost to history (Strochlic 2020). Such oversight is not specific to fisheries science:

Since National Geographic's founding in 1888, women have churned out achievements in science and exploration, often with only fleeting recognition.

Nina Strochlic (2020)

This pattern of historical marginalization can make fully recognizing and highlighting these achieving women difficult, as records regarding their accomplishments may not be readily available.

Though representation of women and their accomplishments is increasing compared to historical standards, much work remains to be done. As previously mentioned, women continue to be underrepresented in AFS, comprising only 25% of current membership, and remain underrepresented in leadership roles (Penaluna et al. 2017). Recognitions and awards are still predominantly awarded to men, especially those related to lifetime achievements. These patterns are not specific to the AFS parent level; similar patterns appear at the Division and Chapter levels (Figure 1). For example, in the AFS Oregon Chapter, only nine presidents have been women between 1965–2020, with eight out of nine presidencies occurring after 1983. It should be noted that, although many women have held other executive committee titles, 2018 was the first year of an Oregon Chapter Executive Committee consisting of more women than men (though this appears to have occurred in 1996 as well, when there were fewer positions; Oregon Chapter of the American Fisheries Society 2017, 2019). Similarly, 18% of presidents of the Gilbert Ichthyology Society have been women, with most occurring in the latter half of the society's existence (The

Gilbert Ichthyological Society 2020). The American Society of Ichthyologists and Herpetologists had only five women presidents prior to 2016, with the first in 1982 (Parenti and Wake 2016). These patterns highlight increasing, yet still lacking, representation by women in leadership positions within the field.

Of course, women are not alone in struggles for recognition, as there are many groups of people whose work in fisheries has gone mostly unrecognized and overshadowed. This is acutely true for scientists of minority races and non-binary genders (Abernethy et al., 2020). This is of critical importance as throughout STEM occupations in the United States, while disparities in representation and compensation of women workers is shrinking in some fields, individuals from minority backgrounds (Hispanic, Black, and Asian) continue to struggle disproportionately with these issues (Funk and Parker 2018). Though minorities make up 30–35% of the U.S. population and of the students who attain advanced degrees in biological sciences, these groups are severely underrepresented in fishery professions (Arismendi and Penaluna 2016).

It is critically important to continue to work towards equality in the sciences and look to past experiences to improve the future of fisheries and AFS. There is strong science to support the many benefits of diversifying science in general (Swartz et al. 2019; Tang-Martinez, in press) and fisheries in particular (Arismendi and Penaluna 2016). While there are many steps on the road ahead, we are heartened to see that the science and society are making progress towards more equitable representation and leadership (Figure 1). We look forward to more nuanced discussions on the many facets of improving diversity and inclusion as AFS continues to mature and grow.

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