

# Science

FINDINGS

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*“Science affects the way we think together.”*  
 Lewis Thomas

## Examining Diversity and Inclusion in Fisheries and Aquatic Sciences



Mentors train new crew members in electrofishing in Mack Creek in the H.J. Andrews Experimental Forest, Oregon. Photo by Lina DiGregorio.

### IN SUMMARY

The fisheries and aquatic sciences confront complex challenges in the overexploitation and degradation of aquatic-riparian ecosystems worldwide. Although the field comprises diverse natural resources available to diverse groups, changing the human face of its workforce so that it closely reflects everyone who depends on those resources has been slow.

Brooke Penaluna, a research fisheries biologist from the USDA Forest Service Pacific Northwest Research Station, and her collaborators analyzed data on the status of diversity and inclusion and investigated strategies to enhance these values in the workforce.

The researchers learned that in 2010, women and people of color remained a small portion of tenure-track faculty and federal government professionals. And although authorship by women and people of color had increased over time, white men still led more than 70 percent of published articles.

The researchers proposed nine action areas to enhance diversity and inclusion in 2016. In a later study, they found that the mentoring of and coauthorship with women and people of color can play important and positive roles in their career development and job satisfaction. Finally, the researchers encourage natural resource communities to expand the diversity discourse by engaging with themes in interdisciplinary diversity literature, such as equity, social justice, and intersectionality.

*“We must not only learn to tolerate our differences. We must welcome them as the richness and diversity which can lead to true intelligence.”*

—Albert Einstein.

“It’s going to be a good weekend,” said Deon Kerr, a recent graduate in fisheries sciences from Clemson University. “I got two big buckets of corn boiled up. Some sweet feed mixed in there. It’s going down!”

“You throw the strawberry Jello in there too?” said Nick Kramer, a management biologist for the Kansas Department of Wildlife and Parks.

“Oh you already know that is a staple for me!” Kerr said.

Kerr is with fellow Clemson graduate student Aaron Bunch in a 2020 episode of *The Fisheries Podcast*, hosted by Kramer and other students. Between the banter of fisheries camaraderie, such as the homemade bait Kerr was prepping for his European-style carp angling weekend, Kerr and Bunch introduced their own show—the *Fisheries Diversity and Inclusion Podcast*.

It features Bunch and Kerr navigating hard conversations alongside fun chats related to the challenges, solutions, and nuances of making their industry more inclusive to people of different ages, ethnicities, abilities, genders, religions, and cultures.

Bunch launched the podcast in 2020 soon after the Black Lives Matter protests in the United States. “I wanted to be able to do something that people who look like me will most likely listen to, to get the conversation out there,” he said, identifying himself as a White, cisgender man. He teamed up with Kerr, who is African American. Later, colleagues Lian Guo, an Asian American, and Cassidy Miles, who identifies as a White, queer, cisgender woman would, join as cohosts.

Bunch thinks the podcast, which is supported by the American Fisheries Society (AFS), builds on previous diversity work within the AFS. But he credits USDA Forest Service-led research for helping take diversity, equity, and inclusion in the industry to the next level.

“There has been a lot of work done through the AFS equal opportunity section,” Bunch said. “But when Brooke Penaluna, Ivan Arismendi, Christine Moffit, and Zachary Penney published their article prior to the [2020] social unrest and increased emphasis on diversity, equity, and inclusion initiatives, they were ahead of the curve.”

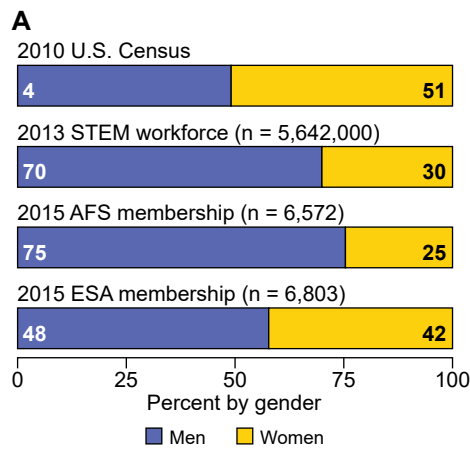
He is referring to research led by Penaluna, a research fish biologist with the USDA Forest Service Pacific Northwest (PNW) Research Station, that proposed nine action areas to improve diversity and inclusion within the AFS. “It really put a framework in place, even more so than what was already there,” Bunch said.

## Actual Numbers

“Out in the field, we hear a lot of people speak of diversity, but we didn’t have actual numbers that we were speaking to,” Penaluna said. “People would just say they wanted to expand diversity or that we lacked diversity. Other people thought the field was diverse enough. So the thought was to put numbers behind what our conversations were about and to actually look at our workforce.”

In 2016, Penaluna and Arismendi, from Oregon State University’s Department of Fisheries, Wildlife, and Conservation Sciences, published a study showing that the fisheries sciences field in the United States—from which the Forest Service draws its recruits—did not reflect the nation’s diverse population.

Their study revealed that women and people of color made up a small portion of tenure-track faculty and federal government professions. Moreover, it uncovered a profession dominated by one race and one gender.



These two graphs compare gender and race or ethnicity in the 2010 U.S. Census with the 2013 workforce in science, technology, engineering, and math (STEM); 2015 American Fisheries Society (AFS) membership; and 2015 Ecological Society of America (ESA) membership. Adapted from Penaluna et al. (2017).

Regarding race or ethnicity, the study found that 91 percent of federal fisheries scientists or managers were White, and 89 to 92 percent of academics were White. It was a stark contrast to the 2010 U.S. census that reported a racially and ethnically diverse population of 64-percent White, 16-percent Hispanic, 12-percent Black, 5-percent Asian, and 3-percent other.

To the researchers, the fisheries and aquatic sciences field’s skewed demographic is a handicap at a time when the nation needs all hands on deck. In the recent decades, a changing climate, drought, and wildfires have threatened and continue to threaten the country’s forests and watersheds.

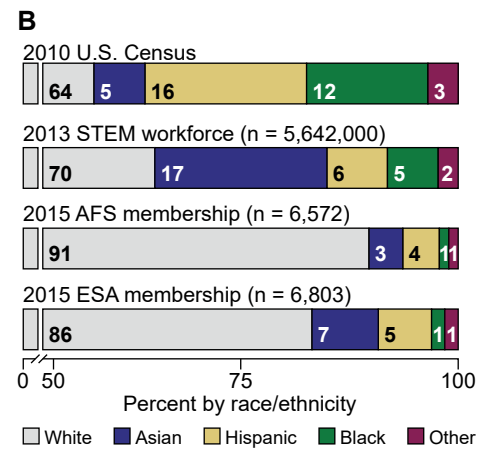
“A lot of literature in the social sciences have found that teams work better when they’re more diverse,” Penaluna said. “And if you have complicated problems, they’re better resolved when you have teams that are diverse.”

To further understand the disparities of diversity in the fisheries and aquatic sciences workforce, Penaluna partnered with collaborators in more studies over the following 6 years. They sought to understand how the sector defined diversity and inclusion, what strategies can be adapted to improve diversity, and what solutions have worked.

## Healthy Watersheds and Aquatic Habitats

While many people may think the Forest Service focuses exclusively on forested areas, the agency also protects fish and aquatic resources in 154 national forests and 20 national grasslands.

Forest Service fisheries and aquatic sciences staff collaborate with researchers from universities, state fish and wildlife agencies, tribal governments, other state and federal agencies, nonprofit organizations, and private landowners. This specialized workforce



researches and implements solutions to help threatened or endangered species, restores streams and lakes, and interacts with the public to increase awareness or recruit for citizen science projects.

However, the nation’s forests and grasslands are undergoing vast ecological and socioeconomic changes. Climate change has caused large wildfires and increases in droughts, floodings, and water temperatures. Land use changes, invasive species, and insect and disease outbreaks also put pressure on our national forests.

“These complex problems can’t be solved by a single discipline,” Arismendi said. “These

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## KEY FINDINGS

- A sharp increase in publications in the fisheries and aquatic sciences from 1975 to 2016 signals accelerating advances in these fields. Although these sciences receive widespread support for enhancing workplace diversity, the current workforce lacks diversity, especially in federal government and academia.
- The composition of the American Fisheries Society membership and the science, technology, engineering, and mathematics workforce does not align with the gender and racial or ethnic composition of the U.S. population.
- Mentorship matters. Twice as many fish biologists with mentors indicated that they were satisfied with their jobs, compared to those without mentors.



USDA Forest Service fisheries and aquatic scientists and technicians study fish, such as this coastal cutthroat trout from the Willamette River in western Oregon, to provide critical information about aquatic species and their habitat needs that are used to inform management plans for national forests. USDA Forest Service photo by Brooke Penaluna.



problems need that diverse type of knowledge in order to be solved or for innovation to happen.” That needed diversity can extend beyond disciplines to demographics.

In fact, a study by Richard Freeman and Wei Huang examined 2.4 million papers authored by researchers who had a U.S. address and found that papers written by diverse ethnic groups are cited more frequently, appear in more citations, and have higher impact factors than papers written by people from the same ethnic group.

“There are advantages to bringing in diverse individuals into your workforce,” Penaluna said. “It brings new knowledge and different perspectives. Oftentimes a new way of thinking will lead to a more comprehensive solution. It’ll be a more inclusive one that will include all people who might be depending on those resources.”

The Forest Service affirmed this view in its 2017 *Rise to the Future: National Fish and Aquatic Strategy*, which asserts the aim to

*A stream in the H.J. Andrews Experimental Forest, Oregon. USDA Forest Service photo by Steve Wondzell.*

“recruit from underrepresented groups to diversify workforce perspectives” and ensure that “the diversity of Forest Service fisheries biologists and aquatic ecologists reflects the public the agency serves.”

### Fixing a Leaky Pipeline

According to Penaluna and Arismendi’s study, the Forest Service and other agencies and universities that hire fisheries and aquatic sciences professionals have a way to go. In 2010, there was limited recruitment of women and people of color in tenure-track and federal government positions. While there was an almost equal number of doctoral degrees awarded to men and women, men dominated employment in academic and federal positions.

Survey results from the study revealed that 74 percent of federal fisheries scientists, managers, and supervisors were men, and 26 percent were women. In academia, tenure-track positions were increasingly dominated by men as their tenure matured: 73 percent of assistant professors were men, and 27 percent were women; on the other end of the spectrum, 85 percent of full professors were men, while only 15 percent were women.

Penaluna and Arismendi compared the situation to that of a leaky pipe: A diverse set of doctoral graduates apply for jobs; however, because of biases and barriers, women and people of color fall through the cracks, and White men get hired.

The researchers attributed these barriers to a phenomenon called homophily—the tendency to build social networks composed of similar individuals. For example, they found one fisheries science academic network that was composed of tenure-track faculty who obtained their doctoral degrees from the same or nearby institutions.

Addressing the inequity may require policies that eliminate barriers and encourage equal opportunities, the researchers wrote. They recommended paid family leaves; deadline extensions for responsibilities, such as grants; tenure-track milestones and performance reviews; and flexibility in other duties, such as meetings and committee work.

“Ultimately, creating a local climate that is welcoming and offers mentorship, opportunities for leadership, clear guidelines for tenure and promotion, and an open community may be important for the retention of diverse individuals,” the researchers wrote.

Bunch, who has conducted diversity and inclusion trainings, agrees: “It’s not enough to hire someone,” he said. “You have to practice inclusion to keep that individual engaged in wanting to be part of an organization.”



## Actions to Enhance Diversity and Inclusion

Research published in 2017 by Brooke Penaluna, Ivan Arismendi, Christine Moffitt, and Zachary Penney proposed the following changes to the American Fisheries Society (AFS) to enhance diversity and inclusion in fisheries and aquatic sciences professions:

1. Entrench diversity and inclusion as a core value of the AFS.
2. Undertake self-reflection and evaluation.
3. Identify and eliminate structural biases.
4. Promote diverse talent into leadership roles and prepare leaders to be agents of change.
5. Develop targeted sessions on communication, inclusion, and recognition of unconscious bias at AFS meetings.
6. Highlight family-friendly opportunities at AFS meetings.
7. Incorporate diversity and inclusion in fisheries pipelines and programs at meetings.
8. Develop a diversity and inclusion scorecard for AFS and the fisheries workforce.
9. Establish equal opportunity committees within the AFS units.

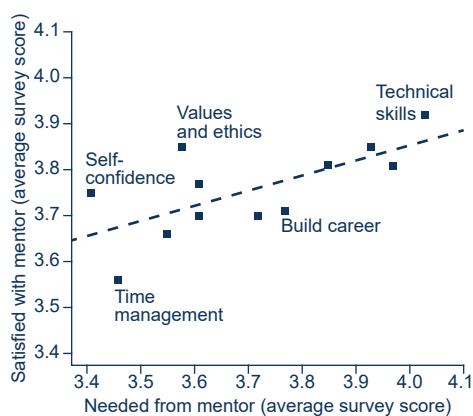
To Bunch, this includes understanding the individual's background and culture to make them feel included in the organization. "But it also needs to be within the strategic framework of these organizations to maintain that inclusive workspace and environment," he said.

## Action Areas, Mentorship, and Coauthorship

In 2017, Penaluna, Arismendi, Moffitt (from the University of Idaho), and Penney (from the Columbia River Inter-Tribal Fish Commission) proposed nine action areas to enhance diversity and inclusion in the AFS. The society describes itself as the world's oldest and largest organization dedicated to strengthening the fisheries profession and advancing fisheries science in North America.

Steve McMullin, then president of the American Fisheries Society, endorsed the proposal, saying the society needed to "move the needle on diversity," and that it is "uniquely positioned to assist in this effort because it represents fisheries professionals in education and all employment sectors."

Over the next few years, Penaluna and other researchers focused on two more strategies to increase diversity and inclusiveness within the fisheries sector: mentorship and diverse coauthorship.



The relationship between what surveyed mentees indicated they need from their mentors and their satisfaction with what they receive from their mentors. Adapted from Penaluna et al. (2020).

In 2020, Penaluna and other Forest Service researchers found that mentoring increased job satisfaction for agency fisheries biologists by two-fold. They also found that fisheries biologists of color were more likely than others to look for mentoring to build self-confidence, address conflicts, and use it to inform professional values and ethics.

"Our study showed that formal mentors arranged through an agency matching program and informal mentorship initiated by the mentee or their supervisor through professional networks are both important. Groups that are underrepresented in aquatic sciences professions may not have established networks to tap into," said Lee Cervený, a research social scientist at the PNW Research Station and a collaborator on the study. "We learned that women in aquatic professions were more interested in mentoring, but their needs were not always being addressed by informal mentoring, which suggests the need for a more intentional approach."

The next year, Penaluna, Arismendi, and Katherine McLaughlin (an associate professor of statistics at Oregon State University) examined published research from 1965 to 2017 within the U.S. fisheries science academic network. They found that although the number of articles and lead authorship by women and people of color had increased over time, White men still led more than 70 percent of published articles.

"If talented people from diverse identities are left out of science, then dominant ideas remain unchallenged and the inclusion of new ideas are limited in ways that are difficult to identify and quantify," the researchers wrote. They called for a critical evaluation of practices to increase opportunities for women and people of color.

Arismendi acknowledged that change won't happen overnight: "For better or worse, the changes will be slow. These are cultural changes, and what we see now are more conversations about these issues."

## Cultural and Generational Change

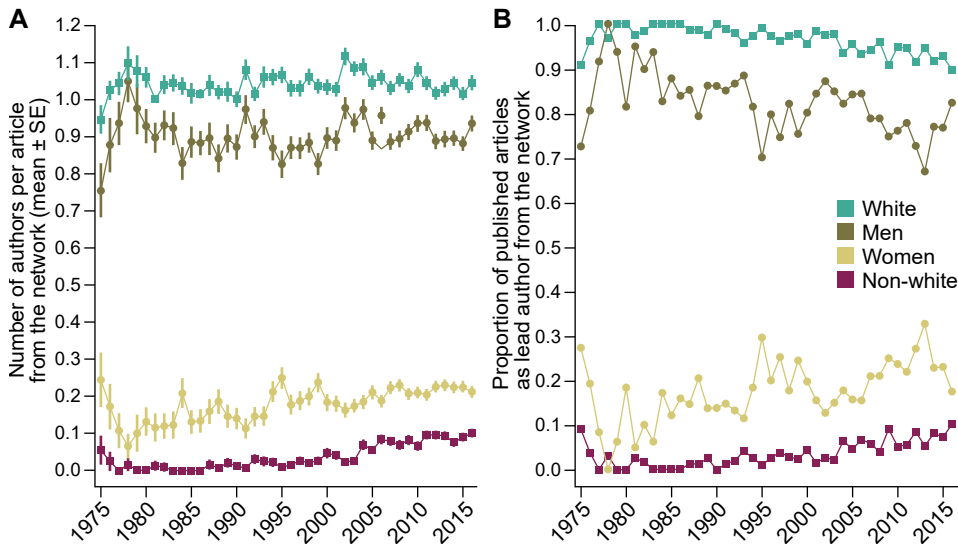
Nevertheless, there has been progress. Arismendi has seen more diversity and inclusion topics in meetings and academic departments. "We have many departments with diversity and inclusion committees that talk about these issues, initiatives to discuss these issues, or training in professional societies. We are at a point that we are seeing the same people coming to those trainings."

Fisheries and aquatic sciences professionals discuss stream research in the H.J. Andrews Experimental Forest, Oregon. Photo by Lina DiGregorio.



## LAND MANAGEMENT IMPLICATIONS

- A diverse workforce of managers and partners leads to competitive advantages, new knowledge, novel skills, and a wide variety of experiences for understanding complex natural resource problems.
- Understanding the composition of the fisheries sciences workforce is the first step to identifying where change can occur. Managers and supervisors can then integrate proposed actions into their everyday culture to foster a more inclusive workplace.
- Encouraging a culture of mentoring takes conscious effort by all management levels.



Authorship trends by gender and race or ethnicity in the U.S. fisheries science academic network between 1975 and 2016. Adapted from Arismendi et al. (2021).

Canadian fisheries and aquatic science professionals have adapted strategies proposed by Penaluna and her colleagues. Catherine Febria, associate director for FishCAST, said that the government-funded fisheries and aquatic sciences graduate training organization has included diversity, inclusion, and indigenous-related topics in its programs.

“We are well aware of the systemic barriers to accessing education and training and the importance of learning how to build partnerships early,” Febria said. “Networking is critical for career success, so we have invested in fostering and facilitating networks between trainees and the broad community of government, academia, industry, community, and indigenous partners.”

FishCAST’s strategies include an intensive Indigenous-Canada relations course for trainees and principal investigators that includes Canada’s history with indigenous peoples and its relevance to the fisheries and aquatic sciences landscape. FishCAST also recently facilitated an indigenous knowledge

field course on the shores of Lake Erie. “Our leadership and administrative team is all women, including those from equity-deserving groups,” Febria added.

In the United States, the AFS has been slowly adapting Penaluna’s nine proposed actions. “They’ve put aspects of diversity and inclusion into their mission statement and into their policies,” Penaluna said. The AFS also set up a diversity, equity, and inclusion committee that works directly with their executive committee to make sure the values are implemented at all levels of the society. It’s the next generation of fisheries and aquatic sciences professionals; however, that really seems to be getting the message.

Notably, young AFS leaders are using modern tools such as podcasts, webinars, and blog posts to promote more welcoming environments for women and people of color, as well as ways to attract them. *The Fisheries Diversity and Inclusion Podcast*, for example, promotes the Hutton Junior Fisheries Biology Program, which seeks to “inspire the next, more diverse,

generation of fisheries professionals” by offering internships for high school students.

“I have high hopes for the young generation,” Arismendi said. “They are very aware of these issues and have been discussing these openly.”

Penaluna agrees: “They’re trying to implement aspects of cultural change, which as you can imagine, is hard,” she said.

Both scientists said that they hope the trend will lean toward more inclusivity in the long term.

*“We must learn to live together  
as brothers and sisters,  
or perish together as fools.”*

—Martin Luther King, Jr.

### For Further Reading

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### Writer’s Profile

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### ***Scientist Profile***



BROOKE PENALUNA is a research fish biologist at the Pacific Northwest Research Station and the lead scientist for the H.J. Andrews Experimental Forest. Her research focuses on understanding the effects of climate change, and contemporary forest harvest and disturbances on fish and both riparian and aquatic habitats. Penaluna holds a Ph.D. in fisheries science from Oregon State University.

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