NATIONAL SOCIO-ENVIRONMENTAL SYNTHESIS CENTER

Salmon aquaculture near Klaksvík, Faroe Islands. Photo via Wikimedia Commons.

Lesson: Sustainable Agriculture: Aquaculture Scenarios

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Overview:

Aquaculture is the cultivation of finfish, shellfish, and seaweed products in ponds and sea-pen environments. It is a rapidly growing global industry that is crucial to providing high-quality seafood to global populations while managing environmental effects and addressing social inequality. Aquaculture has grown by an average of 8% annually for the past three decades and now produces half of the seafood intended for human consumption. Therefore, this is a critical time to synthesize scientific knowledge of best management practices and quantify environmental effects, while also designing social and trade systems that address nutrition, equity of access, and economic opportunities for aquaculturists within this burgeoning sector. In this lesson, learners will work together to embody the roles of diverse and novice aquaculturists. Their first charge will be to research entrepreneurial essentials such as technology and product. Building from there, they must consider the goals and constraints of their particular persona as they choose from four aquaculture economic-development scenarios as presented by Gephart et al. (2020). These scenarios were developed using qualitative methodologies and represent plausible futures that combine the degree of globalization with divergent economic development philosophies. Teams must then defend their scenario choices, highlighting how they maximized nutritional provision, sustainability, equity of access, financial opportunity, and trade relations, while accounting for the needs of their particular persona. They will articulate a development pathway that integrates economic, nutrition, and environmental goals by 2030.

Assumed Prior Knowledge:

Appropriate for undergraduate, graduate, and higher-level learners. Advanced or specialized classes may choose to go into more depth with two class sessions.

Learning Objectives:

- Learn about and manipulate four distinct scenarios for the future of global aquaculture.
- Research U.S. Department of Agriculture (USDA) resources for aquaculture and discuss the technological, environmental, economic, nutrition, and species considerations that factor into a development plan.
- Develop a sustainable development scenario for a specific persona by 2030.
- Evaluate and constructively critique peers' aquaculture-development plans.

Key Terms and Concepts:

aquaculture; sustainability; nutrition-sensitive agriculture; food security; food sovereignty; scenarios; globalization; nationalization; climate resilience

The "Hook" (suggestions for quickly engaging students):

For five minutes, explore the Monterey Bay Aquarium Seafood Watch site, which lists seafood options by their environmental sustainability measures. Write down three species of farmed (aquaculture) seafood for each category: Best Choice, Certified, Good Alternative, and Avoid. For each species, note its locale and method of production (sea pen, recirculating indoor tank, etc.). Then, consider these questions:

- If you eat seafood, how do your typical choices stack up? Is it difficult to define? Why or why not?
- Have you seen many of these fish/shellfish before?
- Did anything surprise you while exploring the information on the website?

Teaching Assignments:

Sustainable Agriculture: Aquaculture Scenarios (one, 75-min. class; extended version is two, 50- to 75- min. classes)

1. As preparation for class, have learners read Gephart et al. (2020), paying particular attention to the highlighted sections and the discussion of each of the four aquaculture scenarios. Learners should also preview the USDA website devoted to aquaculture, including the eight "Mission Areas" detailed in blue boxes toward the bottom of the page. These Mission Areas will help them find directives and resources for particular stakeholders or personae (listed under step #3 below).

2. **(10 min.)** After the "Hook" above, review the reading using the lesson PPT slides below.

   Sustainable Agriculture – Aquaculture Scenarios Slides.pptx

3. **(5 min.)** Next, the class will adopt specific personae to explore the needs and priorities of diverse stakeholders in the development of global aquaculture. Divide learners into four groups/personae of 3–4 students each (in large gatherings, there may be multiples of each group):
   - A financially struggling Iowa corn and soy farmer, whose land has lost topsoil and productivity, who wants to pursue a new career in food production.
   - A Los Angeles-based food sovereignty activist who wants to develop aquaculture in her community to support jobs and nutrition for herself and other lower-income Black, Indigenous, and People of Color (BIPOC).
   - A New England fisherman whose international cod business has declined due to increased water temperatures in the Gulf of Maine, brought on by climate change.

- A Washington, D.C.-based USDA sustainable-development expert who works internationally to support developing countries' emergent economies in food production and export aquaculture.

4. **(15 min.)** Groups should first discuss the goals, challenges, and ideal scenarios for their assigned persona to adopt an aquaculture strategy. They may research the technological possibilities for aquaculture on land and in sea pens. (Note: Skip to the tables on this website and bypass the intro paragraphs for the most useful information.) They may research appropriate species to cultivate in various climates and pen setups, including their economic and nutritional values. The USDA website devoted to aquaculture and the information from the "Hook" (Monterey Bay sustainability ratings) may also be valuable here.

5. **(5 min.)** Once they have gathered information on the technology and species they want to select for their aquaculture operations, groups should decide which of the four scenarios presented in the Gephart et al. paper (Aqua Nationalism, Aquatic Chicken, Food Sovereignty, or Blue Internationalism) will help them achieve their goals and adequately account for their specific challenges, as outlined in the previous step. For instance, while all groups should keep environmental sustainability as a priority, they need also to consider how heavily to weigh economic considerations and how that could affect the overall balance of priorities, and therefore, scenario selection.

6. **(10 min.)** Each group should now prepare a short oral presentation to profile their persona's work by the year 2030, as it relates to their technology, species, and scenario choices.
Note: Instructors may choose to limit the time commitment by having each group present informally in this meeting, without visuals. Or, instructors may dedicate more time to formal presentations by giving the rest of this time to group coordination. If the latter, this lesson will extend into the next session.

7. **(25 min.)** *In the short version*, each group now has 5 minutes to present their 2030 persona scenario; a lightning session of 2 minutes of questions from other participants will follow. *In the longer version*, the remaining 25 minutes goes into the development of the detailed group presentation. The next class is devoted to 10–15 minute formal presentations by each group, followed by 5 minutes of questions.

8. Instructors will summarize the technology, species, and considerations of each persona's scenarios, including Q&As from the class conversation, on an online discussion board after class. As homework, have learners evaluate how successfully each group has balanced their sometimes competing, sometimes symbiotic priorities as it pertains to their particular persona. Evaluative criteria may include: economic viability, environmental sustainability, proficiency in animal husbandry, nutritional adequacy, and climate resiliency.

Background Information for Instructor

1. **A 20-year retrospective review of global aquaculture**

   - This review paper provides instructors with background on the development of global aquaculture between 1997 and 2017, highlighting the integration of aquaculture into the global food system. The paper focuses on the development of inland aquaculture and gains in feed efficiency and nutritional value. It also explores the underexploited potentials of particular cultured products in filling global nutritional gaps and highlights ongoing challenges to sustainable aquaculture.
   - Naylor, R.L., Hardy, R.W., Buschmann, A.H. et al. (2021). A 20-year retrospective review of global aquaculture. *Nature, 591*, 551-563. https://doi.org/10.1038/s41586-021-03308-6

2. **Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential**
    - This article explores the uneven development (geographically) and growing importance of global aquaculture and the potential benefits and challenges that brings. It discusses non-conventional feed ingredients and the scenarios for sustainable intensification.
    - Little, D.C., Newton, R.W., & Beveridge, M.C.M. (2016). Aquaculture: a rapidly growing and significant source of sustainable food? Status, transitions and potential. *Proceedings of the Nutrition Society, 75*(3), 274-286. https://doi.org/10.1017/S0029665116000665

3. **The Future of Ocean Farming: Innovations in Aquaculture**
    - This 4-minute video gives a quick overview of updated sea-pen technologies for raising salmon in the Gulf of Maine, presenting the practice as sustainable and critical to the economy and nutrition of Americans.
    - U.S. Department of Commerce. National Oceanic and Atmospheric Administration. (2019). *The Future of Ocean Farming: Innovations in Aquaculture* [Video]. YouTube. https://www.youtube.com/watch?v=OXOXn_5PtNI

Related SESYNC Content:

- Shepon, A., Gephart, J., Golden, C.D. et al. (2021). Exploring sustainable aquaculture development using a nutrition-sensitive approach. *Global Environmental Change, 69*, 102285. https://doi.org/10.1016/j.gloenvcha.2021.102285
- Williams, L.D., Wenczel, A.A., & Taveres, J.F. (2017, May 11). *Navigating Coastal Decision-Making: Using Shellfish Aquaculture as a Model for Socio-Ecological Knowledge Development*. SESYNC. https://www.sesync.org/resources/navigating-coastal-decision-making-using-shellfish-aquaculture-model-socio-ecological
- Gephart, J., Troell, M. Henriksson, P.J.G. et al. (2017). The 'seafood gap' in the food-water nexus literature—issues surrounding freshwater use in seafood production chains. *Advances in Water Resources, 110*, 505-514. https://doi.org/10.1016/j.advwatres.2017.03.025
- Golden, C.D., Seto, K.L., Dey, M.M. et al. (2017). Does aquaculture support the needs of nutritionally vulnerable nations? *Frontiers in Marine Science, 4*. https://doi.org/10.3389/fmars.2017.00159
- Mulvaney, K.K., Pulver, S., Ryan, C.M. et al. (2015, January 7). *Using System Maps to Analyze Complex Social-Environmental Issues: Geoduck Aquaculture in the Puget Sound.* SESYNC. https://www.sesync.org/resources/using-system-maps-analyze-complex-social-environmental-issues-case-study-geoduck

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