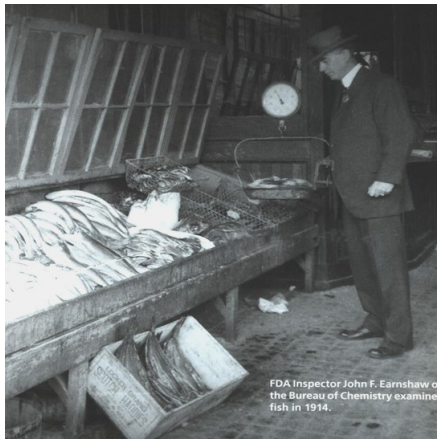
Aquaculture Overview



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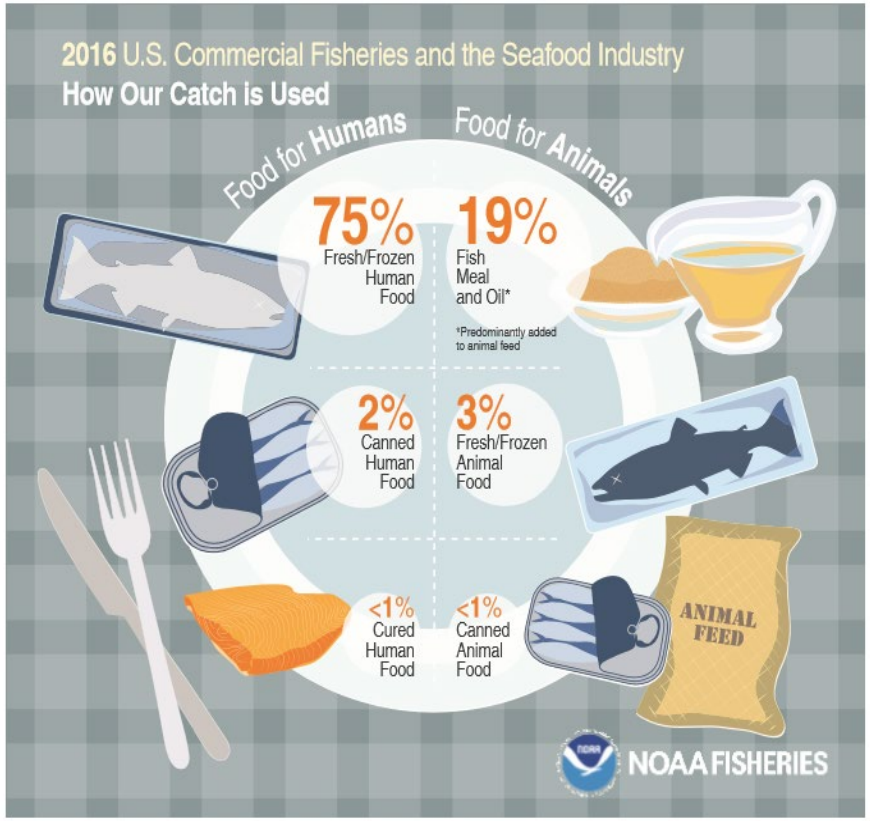
PACCARB

Aquaculture

- Aquaculture is the fastest growing food production sector globally and now provides ½ of all fish consumed by humans
- Global fish production in 2016 reached an all time high of 171 million tons
  - 88% direct human consumption
  - Aquaculture – 80 million tons
- Value of fisheries and aquaculture estimated at $362 billion
  - $232 billion estimated from aquaculture
- Globally, per capita food fish consumption grew from 9 kg in 1961 to 20.2 kg in 2015 and is growing



Aquaculture

- Aquatic products for direct and indirect human consumption have two origins
  - Capture fisheries and aquaculture
- Capture fisheries refers to the catching, processing and marketing of wild fish/shellfish
- Aquaculture is the purposeful breeding, rearing, and harvesting of fish, shellfish, algae and other organisms in all types of water environments
  - 2 main types
    - Marine – net pens in the water or tanks on land
    - Freshwater – ponds or other manmade systems

Aquaculture Production of Fish, Crustaceans and Mollusks, 2016

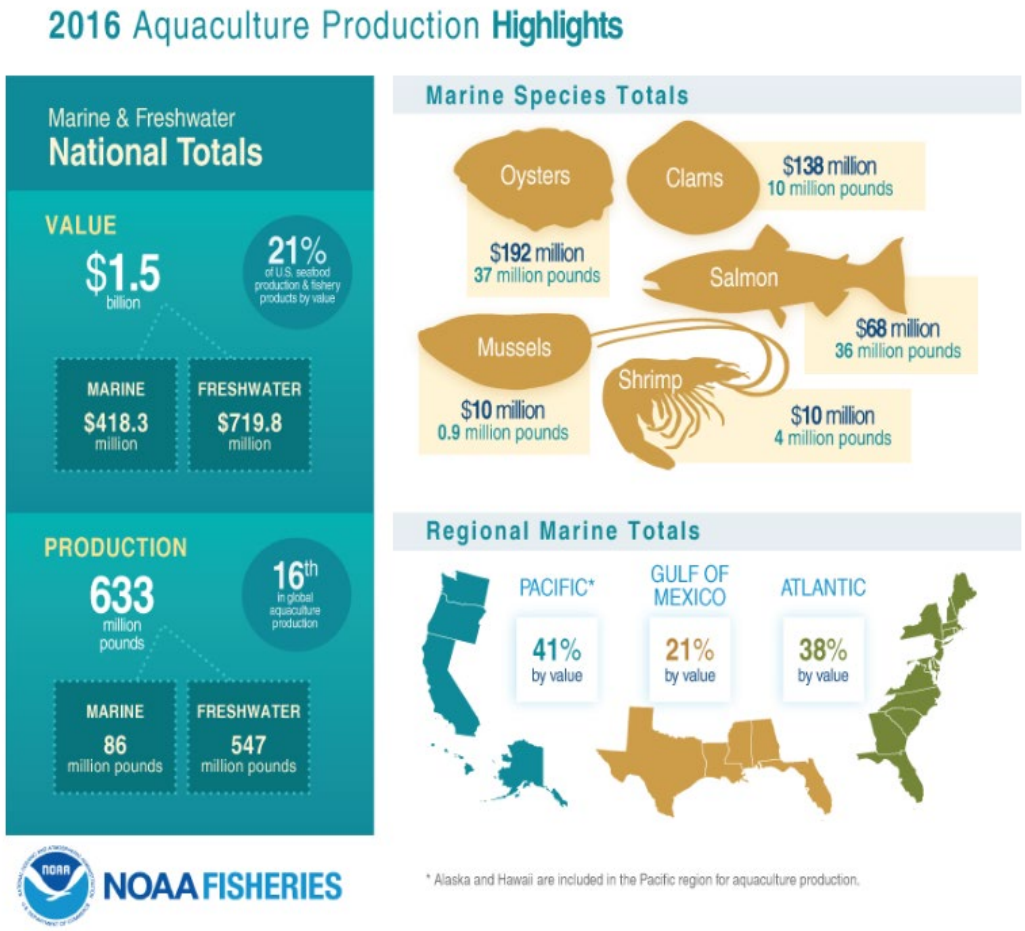
Country (ranked by volume)	Volume (metric tons)	Value (1000 US$)	Continent	Volume (metric tons)	Value (1000 US$)
China	49,244,101	144,701,658	Asia	71,546,018	196,894,906
India	5,700,000	10,644,801	Europe	2,945,076	13,530,369
Indonesia	4,950,000	8,974,309	South America	2,305,675	12,318,222
Viet Nam	3,624,538	9,345,988	Africa	1,981,897	3,481,557
Bangladesh	2,203,554	5,621,081	North America	1,041,972	3,645,128
Egypt	1,370,660	1,766,750	Oceania	210,224	1,713,951
Norway	1,326,157	7,623,688			
Chile	1,035,254	7,867,541			
Myanmar	1,017,614	1,992,111			
Thailand	962,571	2,488,403			
Philippines	796,395	1,790,726			
Japan	676,766	3,842,331			
Brazil	580,500	1,211,037			
South Korea	507,962	1,745,223			
Ecuador	451,085	2,338,810			
United States of America	444,369	1,243,960			
All others	5,139,336	18,385,715			
Total	**80,030,862**	**231,584,132**		**80,030,862**	**231,584,132**

Source: FAO, U.S. total may not agree with other estimates in this section.
Additional detail on global aquaculture production can be found in the world section.

- Asia produces 89%of the global aquaculture production of fish, crustaceans and mollusks
  - Top 5 producing countries are China, India, Indonesia, Vietnam and Bangladesh
  - U.S. ranks 16th
- U.S. is the leading global importer of fish and fishery products
  - Nearly 90% of the seafood we eat comes from abroad
  - Over ½ from aquaculture

NOAA, Fisheries of the United States, 2017.

U.S. Data

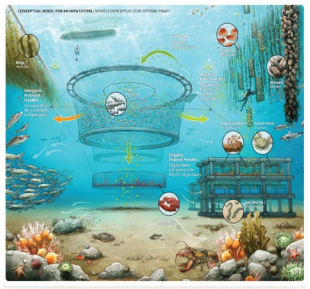


- Estimated freshwater plus marine U.S. aquaculture production was 633 million pounds with a value of $1.5 billion.
- Freshwater production is primarily catfish, crawfish and trout
- Top U.S. marine aquaculture species were:
  - Oysters ($192 million)
  - Clams ($138 million)
  - Atlantic salmon ($68 million)
- U.S. per capita consumption was 16 pounds
- U.S. consumers spent an estimated $102.2 billion

NOAA, Fisheries of the United States, 2017.

Aquaculture Techniques

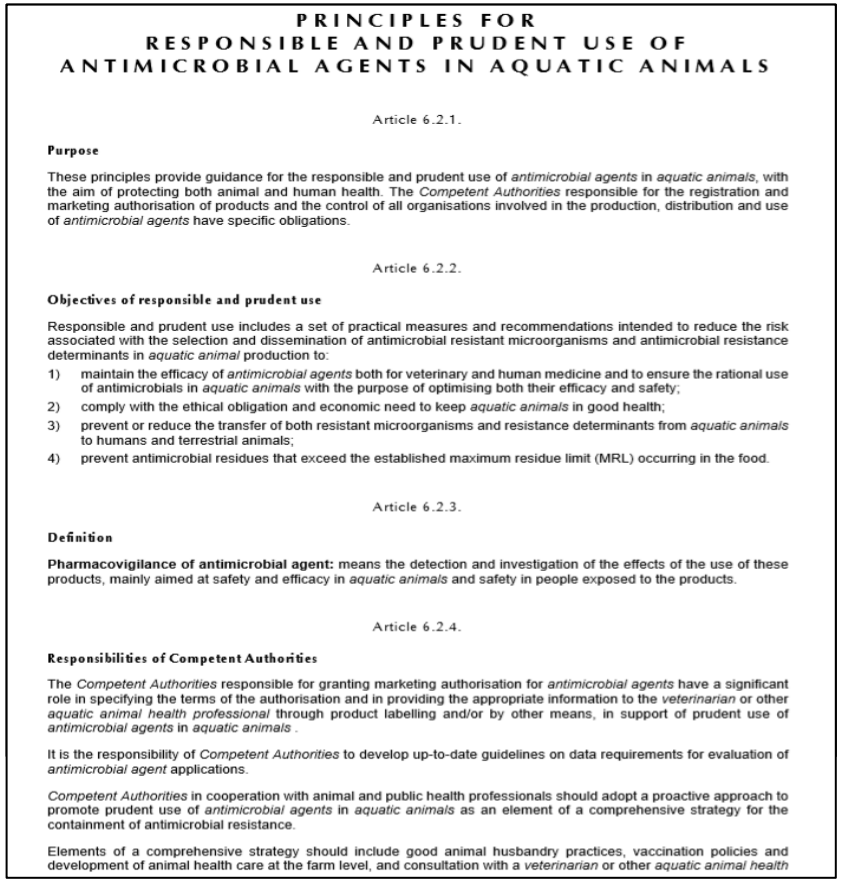
- Hatcheries - mix of a laboratory and farm, where fish and shellfish are spawned, hatched and cared for
- Pond culture - one or many earthen ponds are used to culture some freshwater species
- Cage culture - enclosed cages are submerged in aquatic environments
  - Careful protocols and monitoring help to minimize potential interactions with the environment
- Recirculating systems - fish, shellfish, and or plant-life are raised in "closed-loop" production systems that continuously filter and recycle water and waste
- Integrated Multi-Trophic Aquaculture - several species are raised together in a way that allows one species' by-products to be recycled as feed for another



https://www.fisheries.noaa.gov/insight/understanding-marine-aquaculture

Disease and Health Management Challenges

- Aquaculture, like any other type of farming has effects on surrounding ecosystems
- Significant issue is maintaining animal health and controlling disease
  - FAO estimates 40% losses due to disease
- Numerous bacterial, mycotic, viral and parasitic diseases of aquatic species
  - Bacterial pathogens include *Aeromonas*, *Pseudomonas*, *Vibrio*, *Photobacterium*, *Edwardsiella*, *Flavobacterium*, *Streptococcus* and *Mycobacterium* species
- Due to nature of dense populations, increased reliance on antimicrobials to control disease



PRINCIPLES FOR
RESPONSIBLE AND PRUDENT USE OF
ANTIMICROBIAL AGENTS IN AQUATIC ANIMALS

Article 6.2.1.

Purpose

These principles provide guidance for the responsible and prudent use of *antimicrobial agents* in *aquatic animals*, with the aim of protecting both animal and human health. The *Competent Authorities* responsible for the registration and marketing authorisation of products and the control of all organisations involved in the production, distribution and use of *antimicrobial agents* have specific obligations.

Article 6.2.2.

Objectives of responsible and prudent use

Responsible and prudent use includes a set of practical measures and recommendations intended to reduce the risk associated with the selection and dissemination of antimicrobial resistant microorganisms and antimicrobial resistance determinants in *aquatic animal* production to:

1) maintain the efficacy of *antimicrobial agents* both for veterinary and human medicine and to ensure the rational use of antimicrobials in *aquatic animals* with the purpose of optimising both their efficacy and safety;
2) comply with the ethical obligation and economic need to keep *aquatic animals* in good health;
3) prevent or reduce the transfer of both resistant microorganisms and resistance determinants from *aquatic animals* to humans and terrestrial animals;
4) prevent antimicrobial residues that exceed the established maximum residue limit (MRL) occurring in the food.

Article 6.2.3.

Definition

Pharmacovigilance of antimicrobial agent: means the detection and investigation of the effects of the use of these products, mainly aimed at safety and efficacy in *aquatic animals* and safety in people exposed to the products.

Article 6.2.4.

Responsibilities of Competent Authorities

The *Competent Authorities* responsible for granting marketing authorisation for *antimicrobial agents* have a significant role in specifying the terms of the authorisation and in providing the appropriate information to the *veterinarian* or other *aquatic animal health professional* through product labelling and/or by other means, in support of prudent use of *antimicrobial agents* in *aquatic animals* .

It is the responsibility of *Competent Authorities* to develop up-to-date guidelines on data requirements for evaluation of *antimicrobial agent* applications.

Competent Authorities in cooperation with animal and public health professionals should adopt a proactive approach to promote prudent use of *antimicrobial agents* in *aquatic animals* as an element of a comprehensive strategy for the containment of antimicrobial resistance.

Elements of a comprehensive strategy should include good animal husbandry practices, vaccination policies and development of animal health care at the farm level, and consultation with a *veterinarian* or other *aquatic animal health*

Aquatic Animal Diseases listed by the OIE

- OIE criteria include potential international spread of the pathogenic agent is likely
- At least one country demonstrates freedom from the disease in susceptible aquatic animals
- A reliable means of detection and diagnosis exists
- And
  - Natural transmission to humans has been proven or;
  - Disease shown to affect the health of cultured aquatic animals or;
  - Disease shown to affect the health of wild populations resulting in significant morbidity or mortality

The following *diseases* of fish are listed by the OIE:

- Infection with *Aphanomycesinvadans* (epizootic ulcerative syndrome)
- Infection with epizootic haematopoietic necrosis virus
- Infection with *Gyrodactylus salaris*
- Infection with HPR-deleted or HPR0 infectious salmon anaemia virus
- Infection with infectious haematopoietic necrosis virus
- Infection with koi herpesvirus
- Infection with red sea bream iridovirus
- Infection with salmonid alphavirus
- Infection with spring viraemia of carp virus
- Infection with viral haemorrhagic septicaemia virus.

The following *diseases* of crustaceans are listed by the OIE:

- Acute hepatopancreatic necrosis disease
- Infection with *Aphanomyces astaci* (crayfish plague)
- Infection with *Hepatobacter penaei* (necrotising hepatopancreatitis)
- Infection with infectious hypodermal and haematopoietic necrosis virus
- Infection with infectious myonecrosis virus
- Infection with *Macrobrachium rosenbergii* nodavirus (white tail disease)
- Infection with Taura syndrome virus
- Infection with white spot syndrome virus
- Infection with yellow head virus genotype 1.

The following *diseases* of molluscs are listed by the OIE:

- Infection with abalone herpesvirus
- Infection with *Bonamia ostreae*
- Infection with *Bonamia exitiosa*
- Infection with *Marteilia refringens*
- Infection with *Perkinsus marinus*
- Infection with *Perkinsus olseni*
- Infection with *Xenohaliotis californiensis.*

U.S. Approved Aquaculture Antibiotics

Active Ingredient	Trade Name	Generic Use	Application Method	Approval Status[a]	Withdrawal Time
Florfenicol	Aquaflor®	Antibiotic	Medicated feed	FDA approved[a] (Veterinary Feed Directive)	15 days
Oxytetracycline dihydrate	Terramycin-200®	Antibiotic	Medicated feed	FDA approved	21 days
Ormetoprim sulfadimethoxine	Romet-30®	Antibiotic	Medicated feed	FDA approved	42 days in salmonids; 3 days in catfish

Florfenicol is an approved medicated feed for use against specific pathogens in enteric septicemia (*Edwardsiella ictaluri*) in channel catfish, coldwater disease (*Flavobacterium psychrophilum*) in salmonids, furunculosis (*Aeromonas salmonicida*) in freshwater-reared salmonids, streptococcal septicemia in freshwater-reared warmwater finfish, and columnaris disease (*Flavobacterium columnare*) in freshwater-reared finfish. It is marketed as a VFD product. The withdrawal time is 15 days.

Oxytetracycline dihydrate is an in-feed medication approved 1) to control mortality in freshwater-reared salmonids due to coldwater disease associated with *F. psychrophilum*, 2) to control mortality in freshwater-reared rainbow trout due to columnaris disease associated with *F. columnare*, and 3) to mark skeletal tissue in Pacific salmon. All approved uses require a 21-day withdrawal period for harvest-size food fish species.

Ormetoprim sulfadimethoxine is an in-feed treatment approved by the FDA to control furunculosis (*A. salmonicida*) in salmonids, for which a 42-day withdrawal period is required, and to control enteric septicemia of catfish (*E. ictaluri*) in channel catfish for which a 3-day withdrawal period is required.

Disease and Health Management Challenges

- As aquaculture continues to rapidly expand, the risk of significant disease outbreaks becomes a major concern globally
- Pressing need for investment in aquatic health and greater access to disease management tools
  - Pathogen and host species data
  - Surveillance data
  - Vaccines
  - Antimicrobials
    - Stewardship programs
  - Rapid diagnostics
  - Biosecurity measures
- Need for development of sustainable aquaculture guidelines