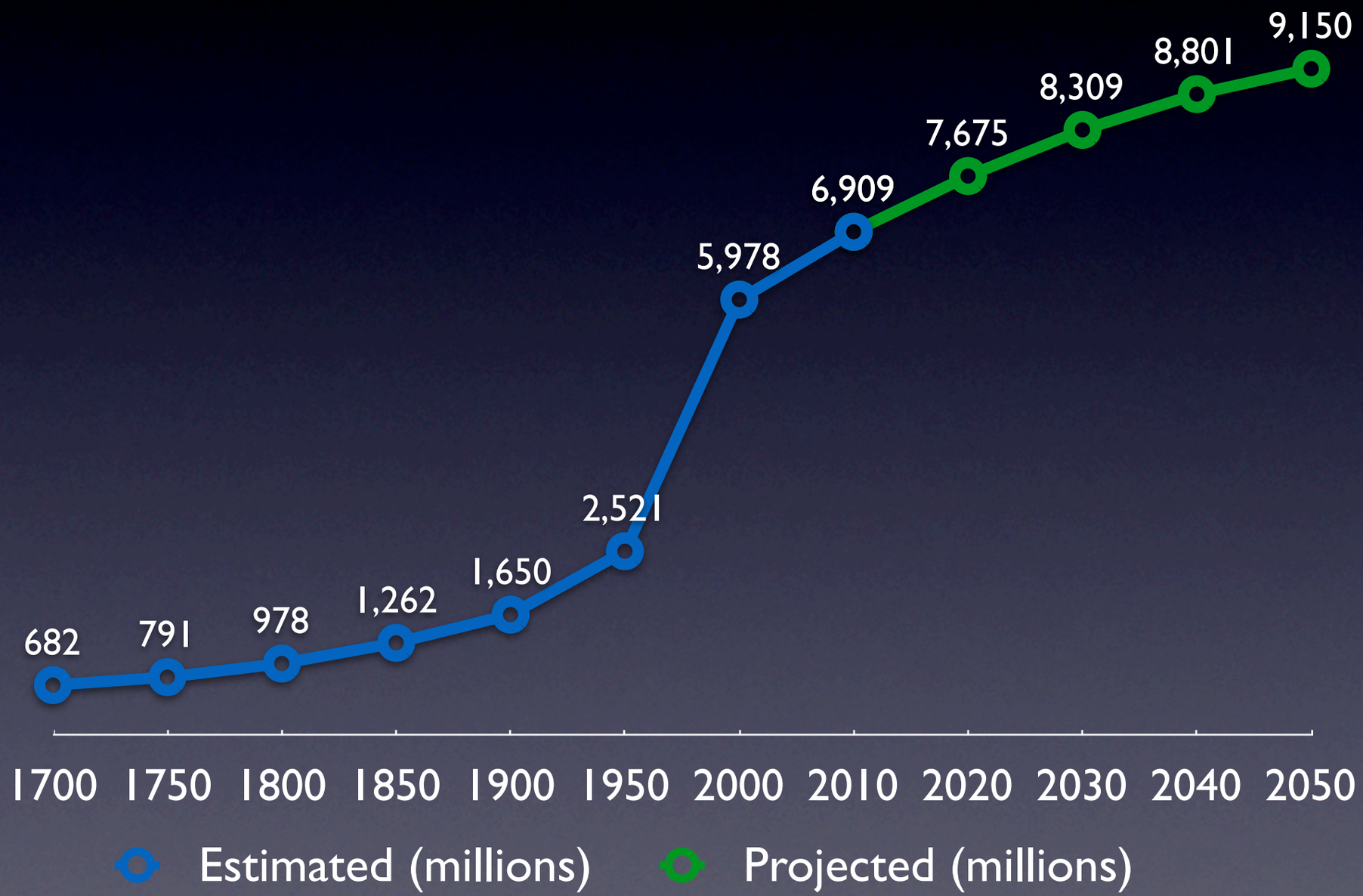
GM Salmon

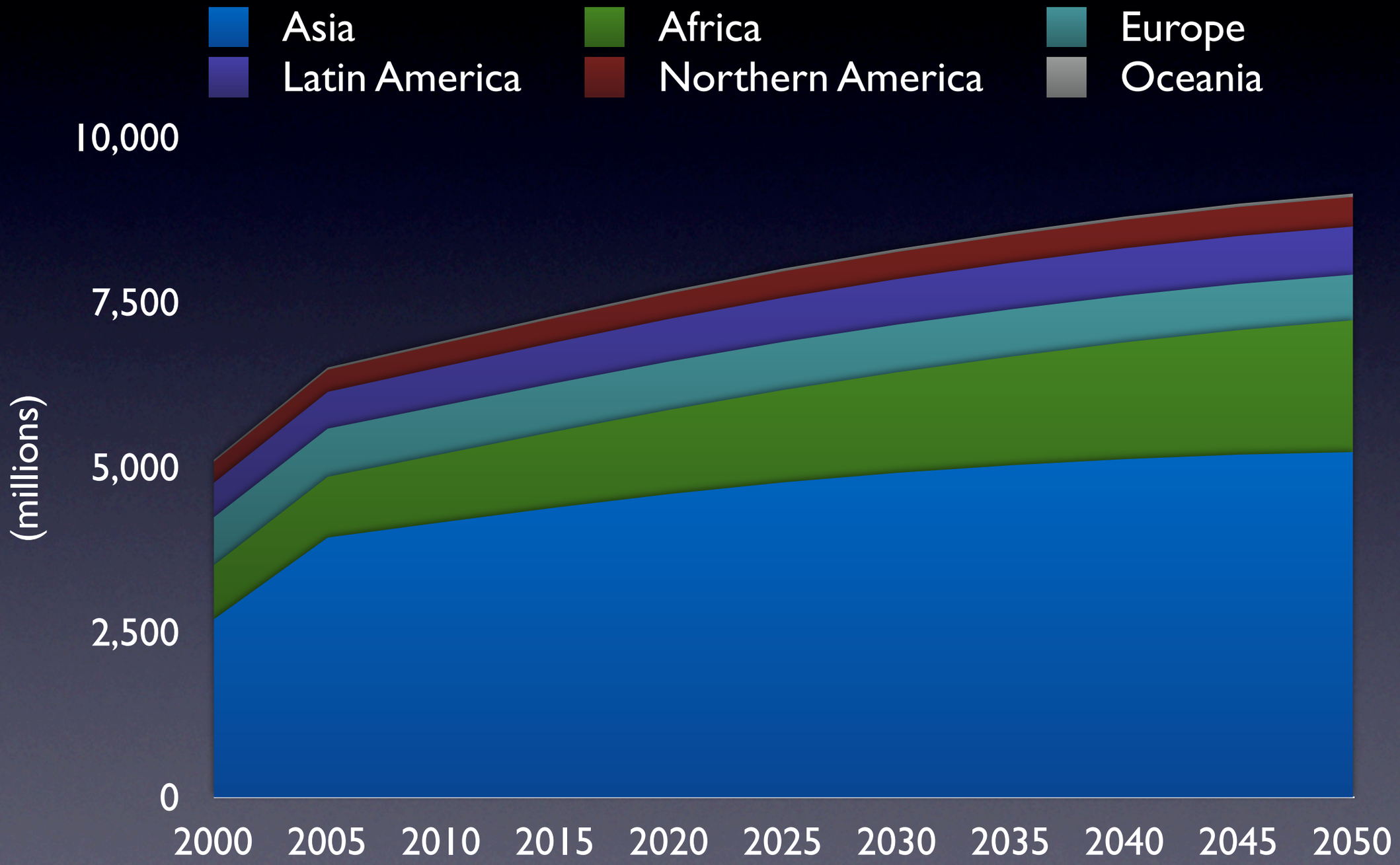
Why GMO?

- output from fisheries has effectively hit a ceiling since the mid-1980s
- any growth in seafood consumption is due to aquaculture
- improving aquaculture output to keep up with growing populations, appetites, preferences

World Population

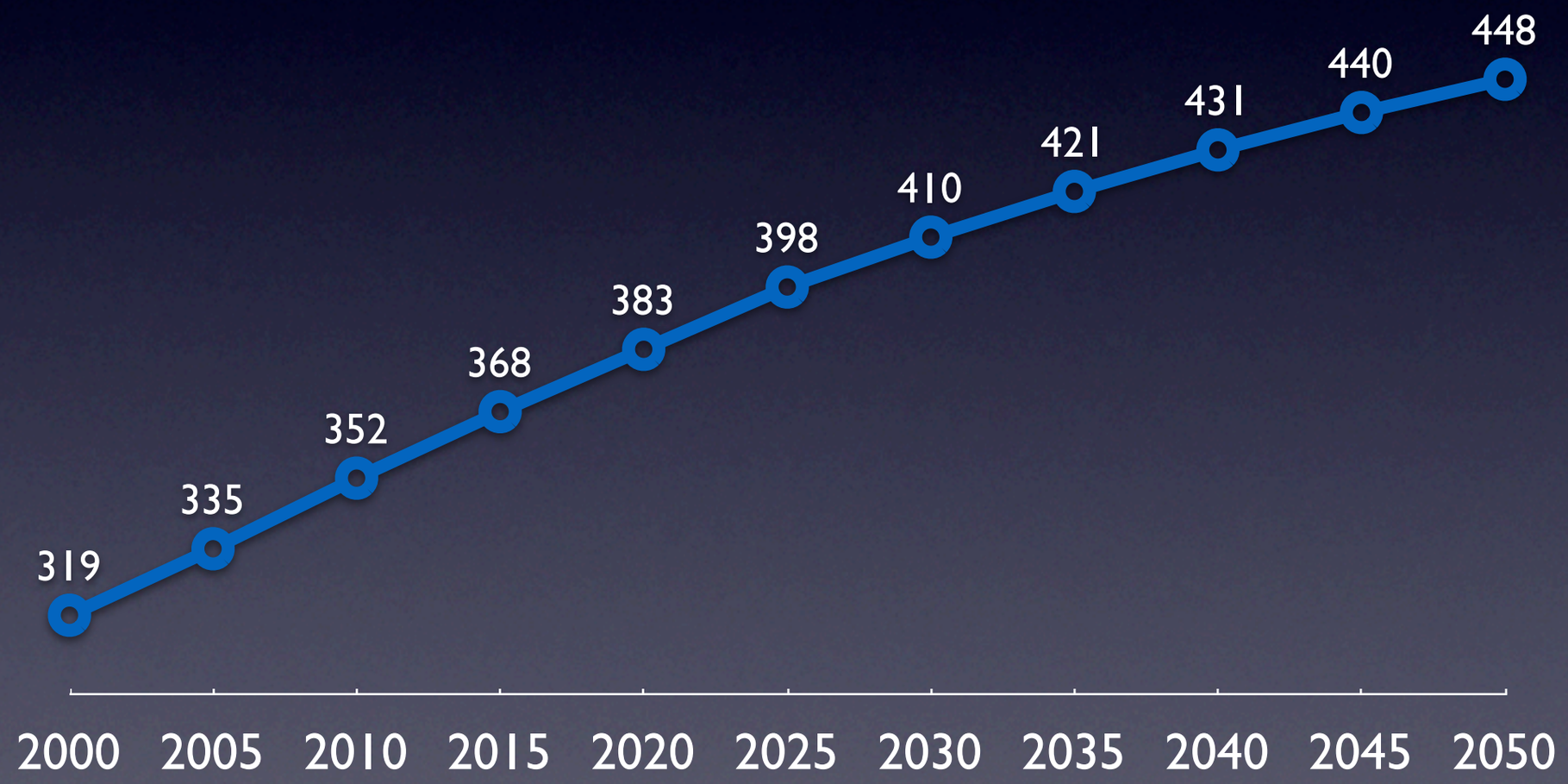


Population by Region

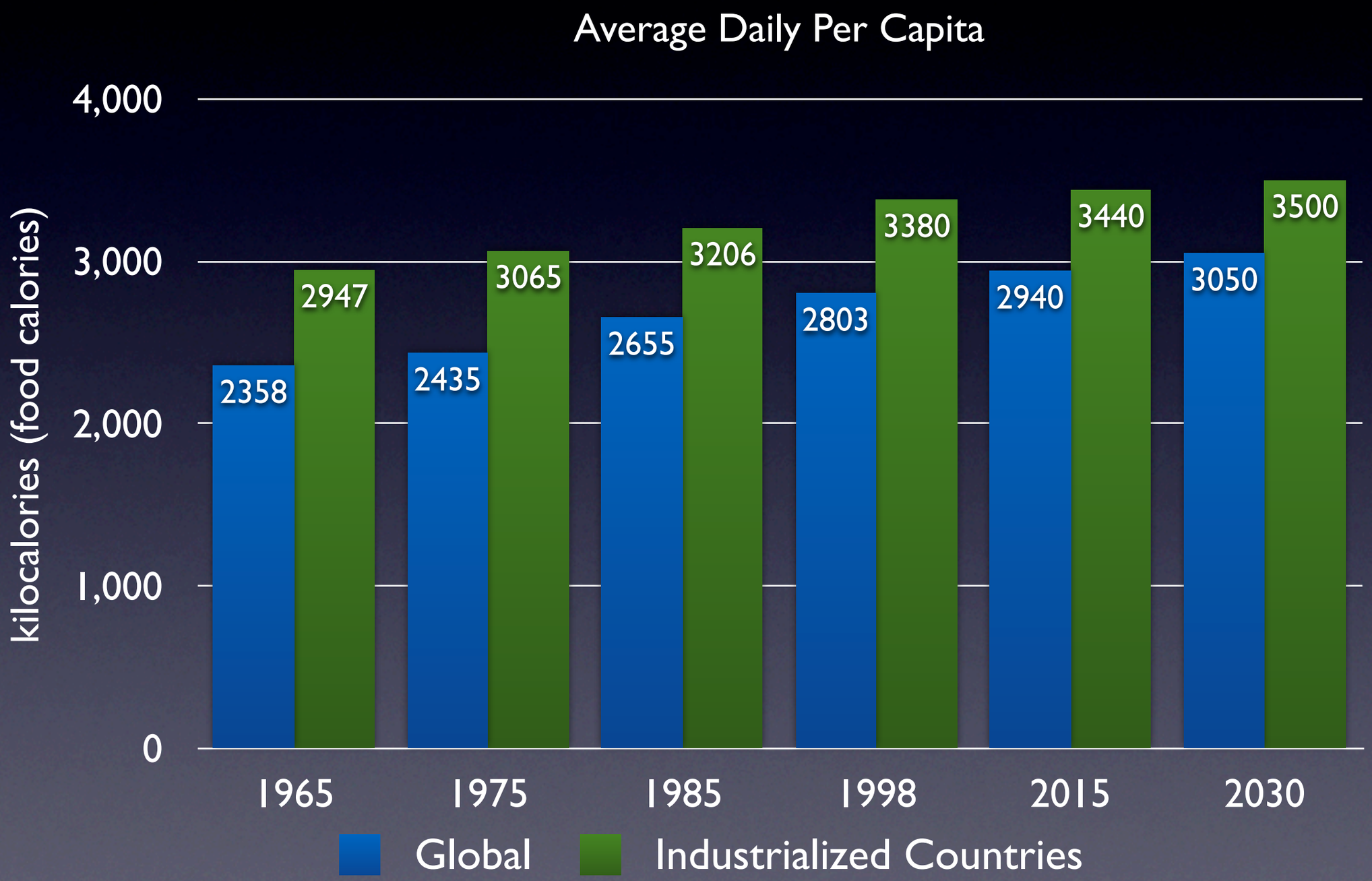


Northern America

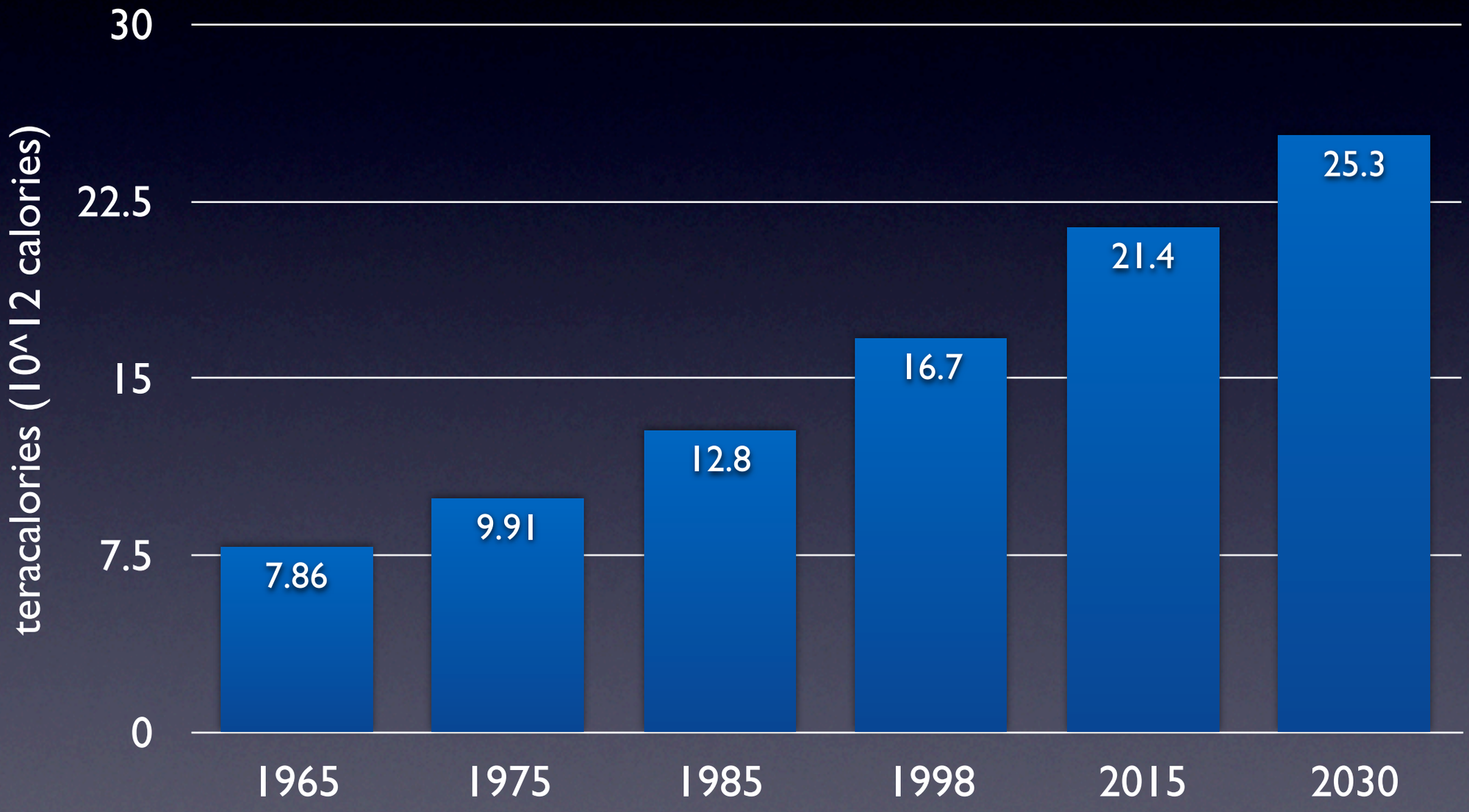
*excludes Mexico



Consumption Rates



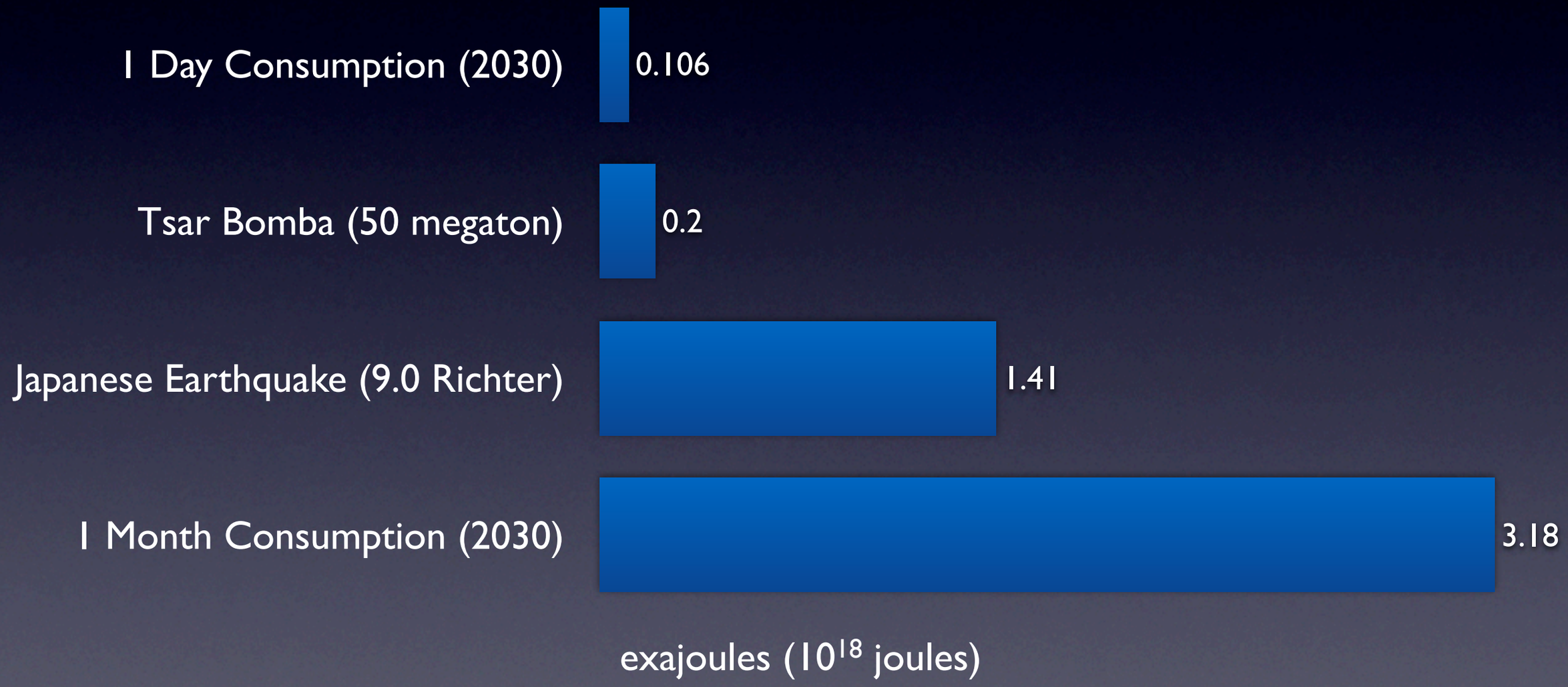
Global Total Daily Consumption



25.3 teracalories = .106 exajoules (10^{18} joules)

Energy Consumption

Relative Energy



Aquaculture

Aquaculture Issues

- Solid Waste and Effluent Pollution
  - uneaten food and waste fall to the ocean floor and build up
  - bacteria attempt to break down the sediment, lowering O_2 in the water
  - Baggiatoa form in absence of O_2 and HSO_4 and CH_4 are released through anaerobic decomposition – toxic

Aquaculture Issues

- Chemical Pollution
  - antifoulants incorporated into the materials of the netpens leach into the water – toxic to some sea life
  - pesticides used to control parasites effective at very low levels – deadly to crustaceans like the sea lice they seek to destroy

Aquaculture Issues

- Solid Waste and Effluent Pollution
  - effluents rich in nitrogen and phosphorous lead to algae blooms which die and add to the sediments below
- Chemical Pollution
  - antibiotics active in water hundreds of meters away from netpens for months – harmful to CNS, liver and promote antibiotic-resistance

Aquaculture Issues

- Escapees may
  - compete with native species for space and food
  - may spread parasites or disease to native species or other aquaculture facilities

GM Aquaculture

- fish grow more rapidly – food, pesticides, antibiotics used at a greater rate and/or greater quantities as pens have higher turnover rates
- escapees may be significantly more harmful due to their increased space and food requirements

Aquaculture Issues

- Escapees may
- interbreed
- hybridizatize

Existing Laws

- Animal Protection
- Nonindigenous and/or Invasive
- Major environmental laws

Animal Protection

- Animal Health Protection Act
  - protects “livestock” (farm-raised animals) or related industries
  - from “pests” or “any organism…allied”
  - regulates pest “articles” – harbor “pests”

Animal Protection

- Animal Health Protection Act
  - prohibits “export” via “move”
    - “export” – extra territorial or interstate move
    - “move” – includes “release to environment”

Animal Protection

- Animal Health Protection Act
  - GM salmon may be pests through alliance with actual pests (eg. sea lice)
  - GM salmon may be “articles” as they harbor pests or “disease”
    - “disease” broadly interpreted by the secretary…gene transmission?

Animal Protection

- Animal Damage Control Act
    - originally passed to contol damage from wildlife predators
    - protects fisheries and aquaculture
    - GM salmon may exhibit predatory characteristics, causing loss to fishery and aquaculture operations

Nonindigenous/Invasive

- Nonindegenous Aquatic Nuisance Prevention and Control Act
  - purpose to prevent unintentional spread of nonindigenous species through ballast water or other pathways

Nonindigenous/Invasive

- Nonindegenous Aquatic Nuisance Prevention and Control Act, amended by National Invasive Species Act
  - “nonindigenous species” any species or viable bilogical material that enters an ecosystem beyond its historic range

Nonindigenous/Invasive

- Nonindegenous Aquatic Nuisance Prevention and Control Act
- “aquatic nuisance species” nonindgenous species that threatens diversity and abundance of native species or ecological stability of infested waters, or commercial, aquacultural…activities

Nonindigenous/Invasive

- Nonindegenous Aquatic Nuisance Prevention and Control Act
  - creates inter-agency task force to identify and prevent the nonindigenous and nuisance aquatic species

Nonindigenous/Invasive

- Nonindegenous Aquatic Nuisance Prevention and Control Act
  - *Michigan v. U.S. Army Corps of Engineers (2010)*
  - multiple states – Michigan, Wisconsin, Minnesota, Ohio, and Pennsylvania sued Corps to take action under prevent Asian Carp from entering Great Lakes

Nonindigenous/Invasive

- Executive Order 13112
  - creates another inter-agency body – the Invasive Species Council
  - designed to prevent introduction of invasive species and if introduced, respond to control their populations

Environmental Laws

- Clean Water Act
  - individual fish (or humans/animals) are not “point sources”
  - netpens, however, have been found to be “point sources”
  - feces, urine, antifoulants, other additives, pesticides, antibiotics – all “pollutants”

Environmental Laws

- Clean Water Act
  - *United States Public Interest Research Group v. Atlantic Salmon of Maine, LLC*
    - found non-native fish to be "pollutants" within the meaning of the CWA
    - proof that pollutant causes harm not required

Environmental Laws

- Endangered Species Act
  - potential takings due to effects of aquaculture facilities in general, and in the estimation of some (GM salmon even riskier more resource-intensive than regular aquaculture), more pronounced

Existing Laws

	Destructive	Nonindigenous	Neither
Animal Protection			
NI or Invasive			
CWA			
ESA			

Potential Criminal Penalties

Thanks. Questions?