The NARMS Seafood Pilot Project

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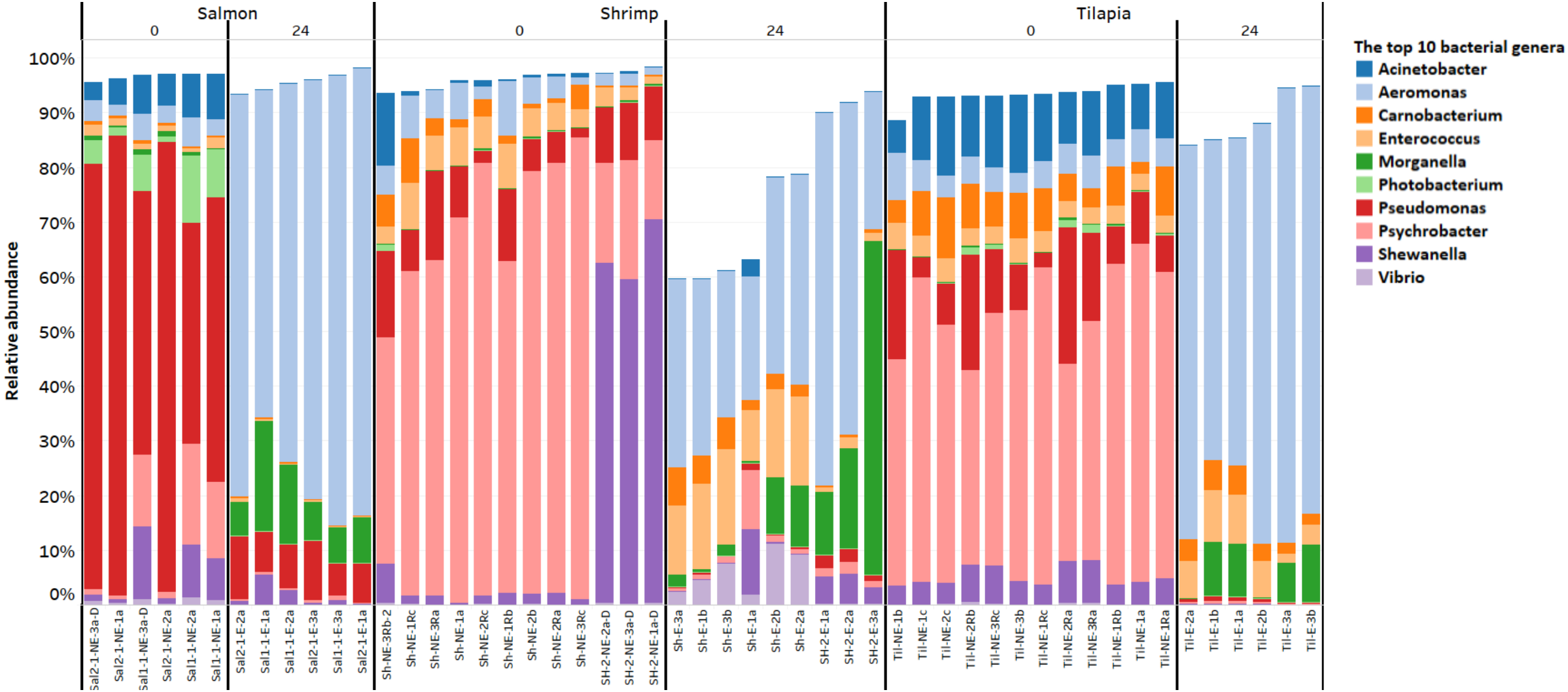
Background

- The National Antimicrobial Resistance Monitoring System (NARMS) is being enhanced to accord with a One Health framework for testing
  - Adding environmental water testing (EPA)
  - Adding companion animal (Vet-LIRN) and food animal (USDA) pathogen testing
  - Expanding scope to include additional relevant commodities
- Seafood presents opportunities for AMR to enter the U.S.
- Three antibiotics are used in aquaculture (oxytetracycline, florfenicol, sulfadimethoxine/ormetoprim)
- Study design discussions with CDC, USDA, CIPARS, FDA-CFSAN and CVM-ONADE began in 2016
- Decided to survey salmon, shrimp and tilapia
  - Excluding canned tuna, these are the top 3 most consumed seafoods in the U.S.* and also are pen raised

*Source: National Fisheries Institute, 2017

Seafood Microbiome Profiles After Enrichment

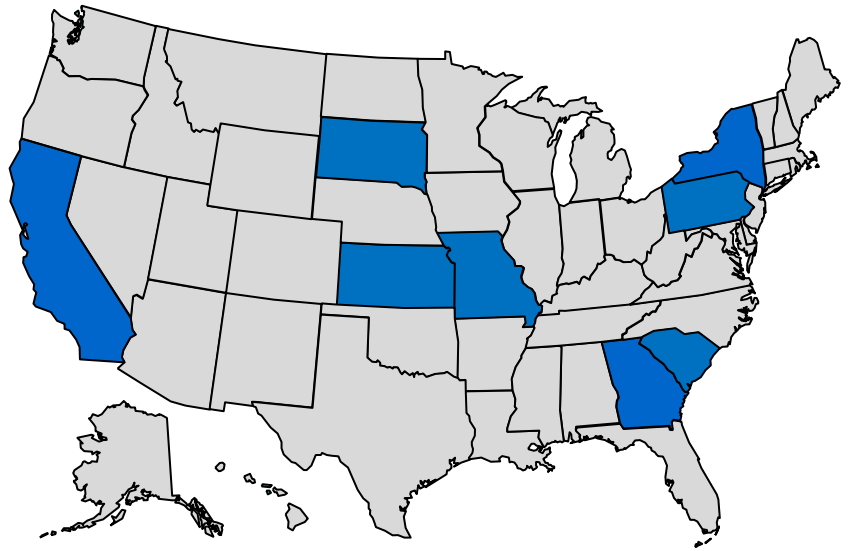


Study Design: Target Organisms

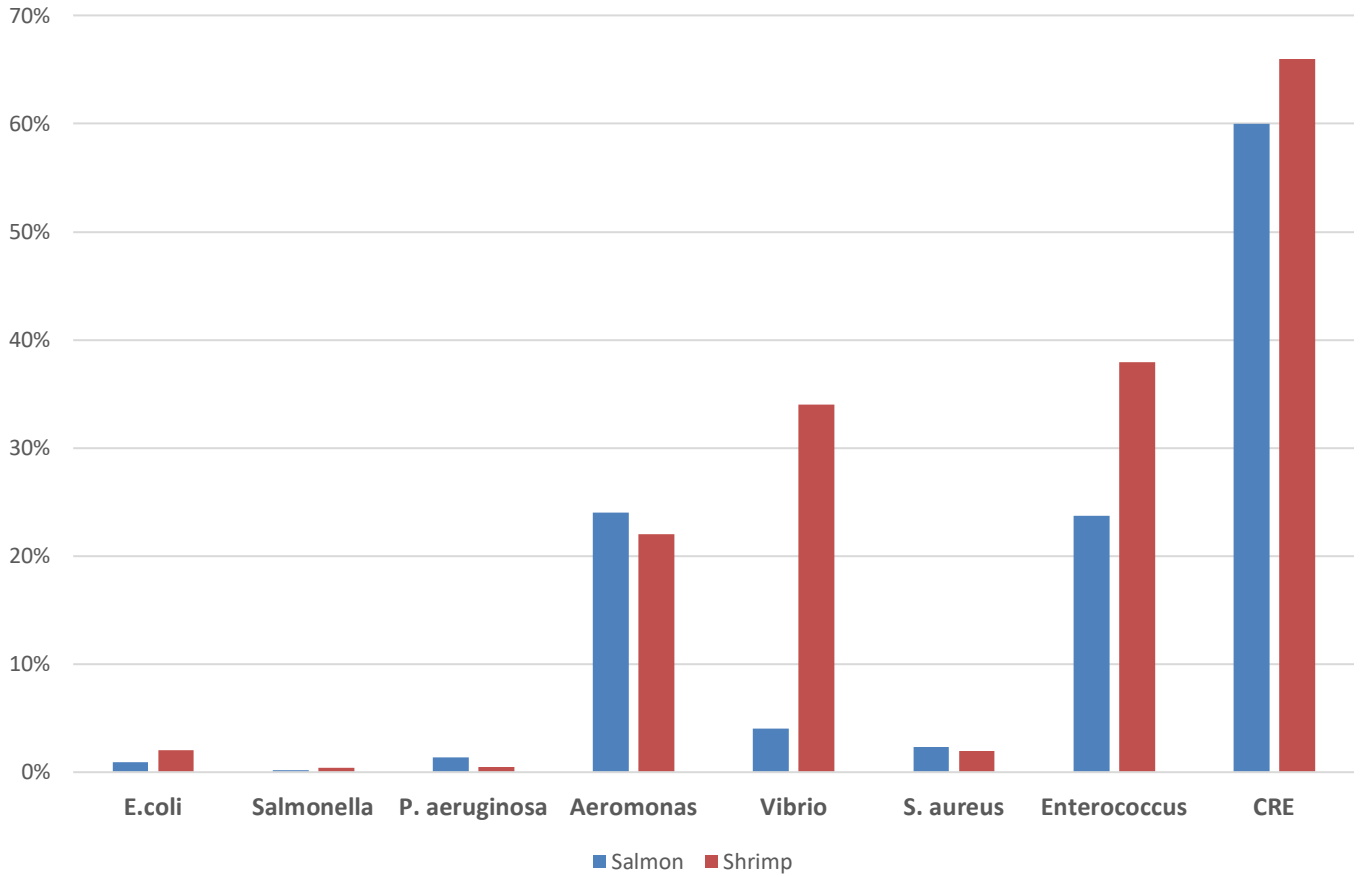
1. *E. coli*: indicator of fecal contamination
2. *Vibrio*: ubiquitous in aquatic environments and pathogenic to humans
3. *Aeromonas*: ubiquitous in aquatic environments and prevalent in all sources regardless of extraction protocol. Some also pathogenic to fish
4. *Enterococcus spp.* – Fecal indicator. Several studies demonstrated presence in raw seafood. Environmental sources have been thought to contribute to the dissemination of AMR enterococci of clinical importance
5. Carbapenem resistance– given the importance of the resistance, we performed selective enrichment for carbapenem-resistant bacteria

Seafood Plan

- One-year pilot in 8 states was initiated in Jan 2019
- Eight samples each of fresh and frozen shrimp and skin-on salmon from retail outlets
- Tilapia added in August 2019; 8 samples by 7 states
- Each state collected 8 samples of each commodity→ 768 of each commodity for the year. This puts us at 80-85% confidence in a 50% prevalence
- Complement with USDA sampling of siluriformes (catfish) at manufacturing plants (*Salmonella* only)



Prevalence of Bacteria



Other genera recovered

Citrobacter spp.
Serratia spp.
Hafnei alvei
Morganella morganii
Proteus spp.
Enterobacter spp.
Providencia spp.
Yersinia spp.
Sphingomonas paucimobilis
Pantoa spp.
Klebsiella spp.
Shewanella algae
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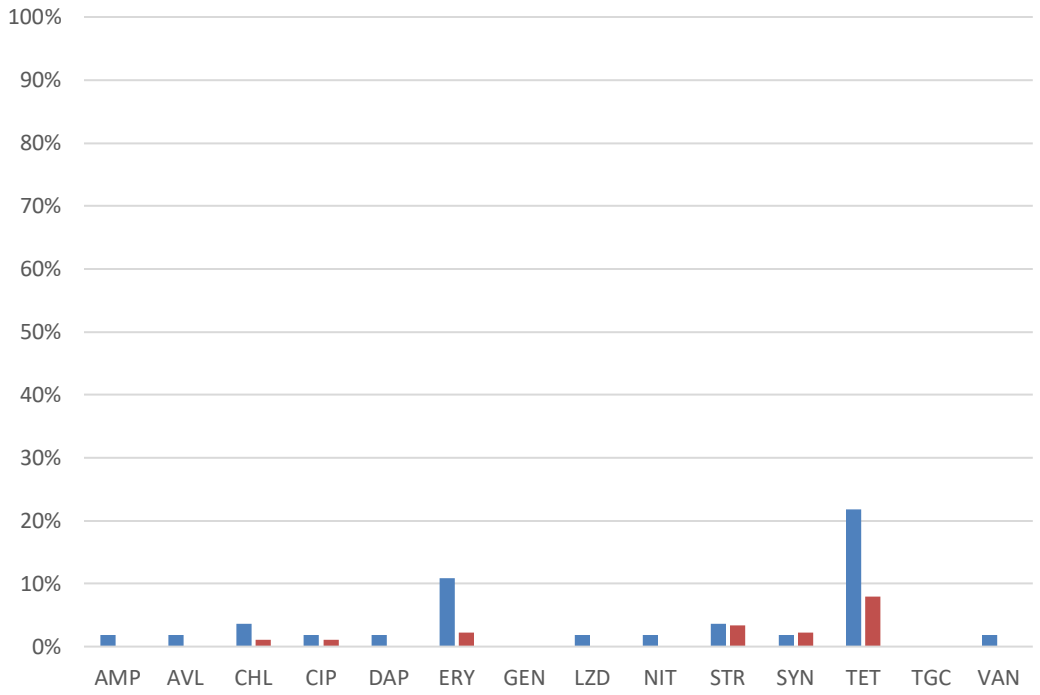
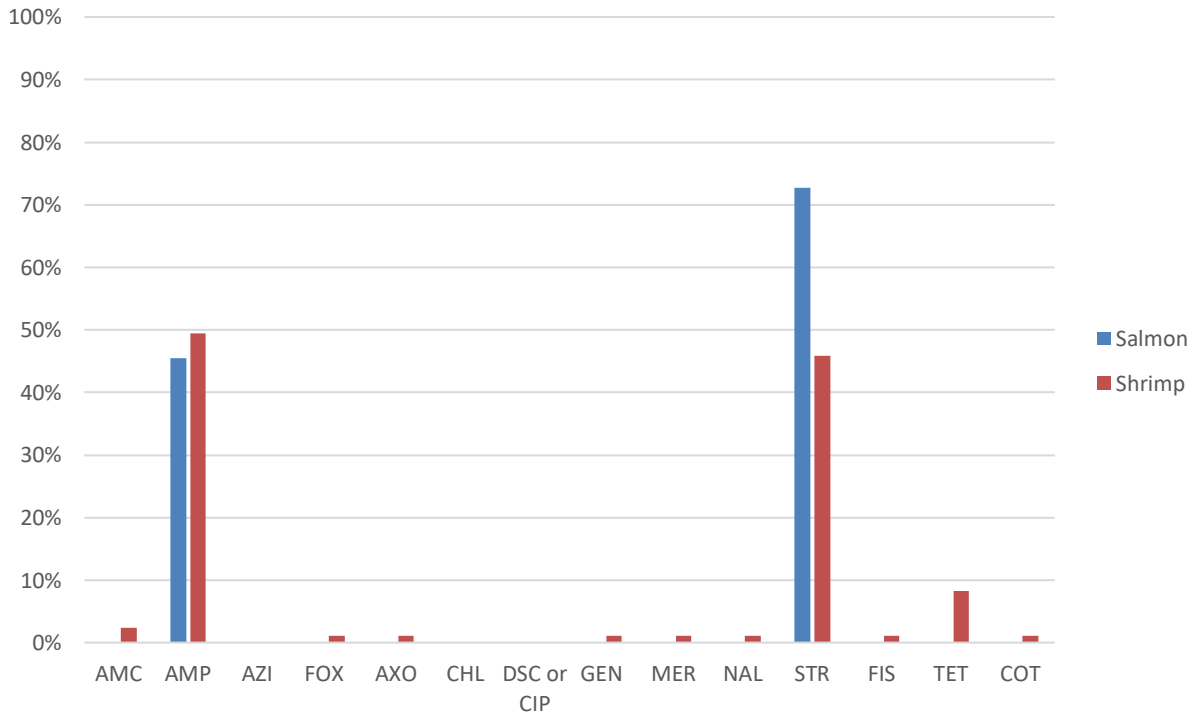
Preliminary Resistance

Enterococcus



Vibrio



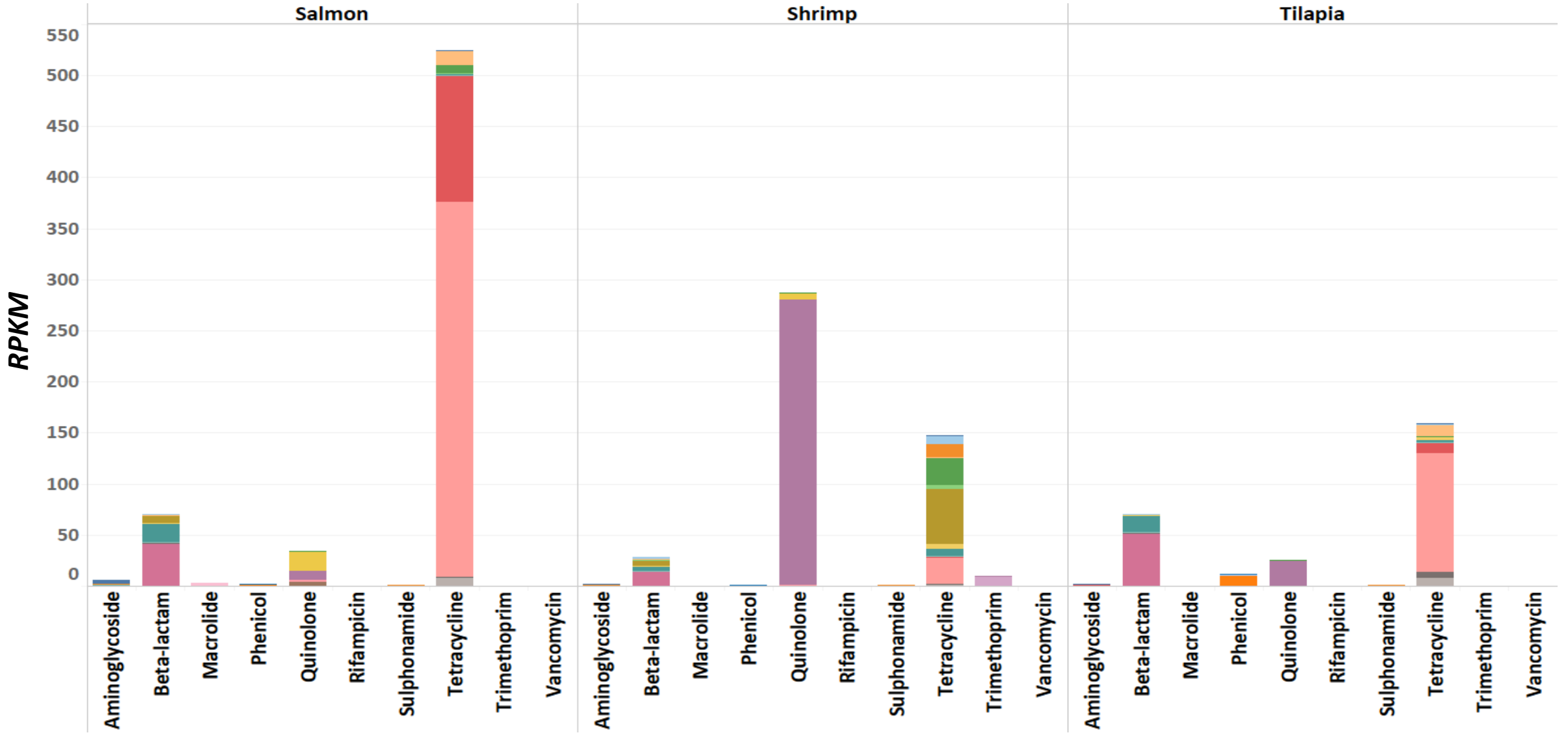
Carbapenem Resistance

- WGS was determined for 205 isolates. Only 2 had known transmissible carbapenemase genes, *blaNDM-1*
  - *Acinetobacter baumannii*

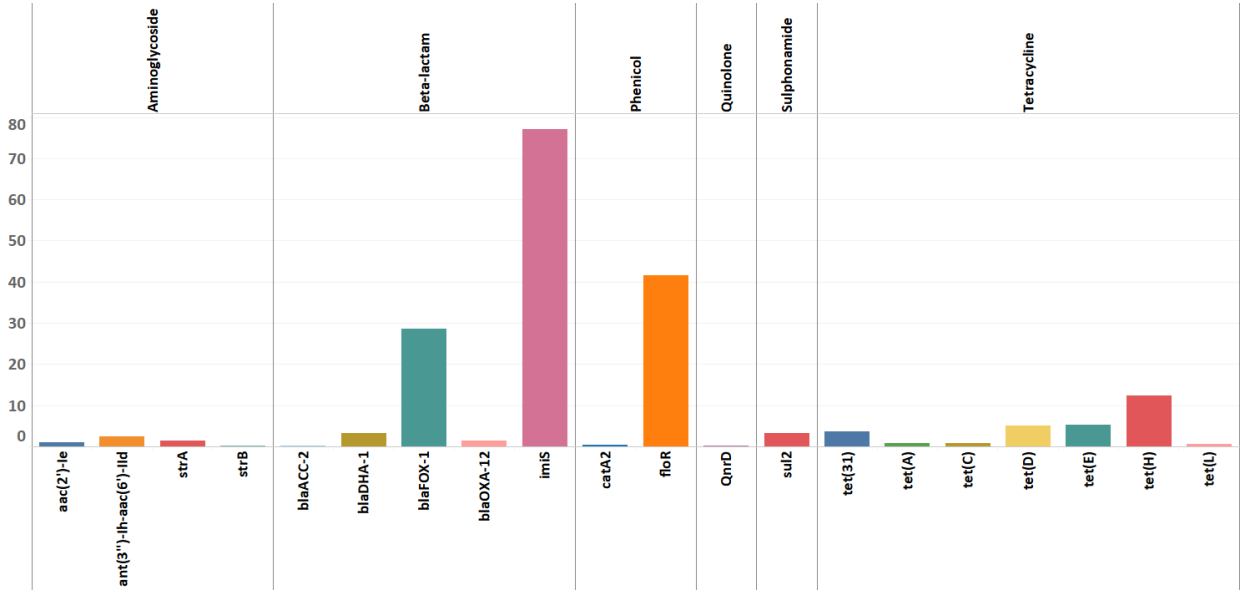
    sul2, blaNDM-1, ble, blaADC-43, tet(39), blaOXA-820, aph(6)-Id, aph(3'')-Ib, mph(E), msr(E)
  - *Aeromonas sobria*

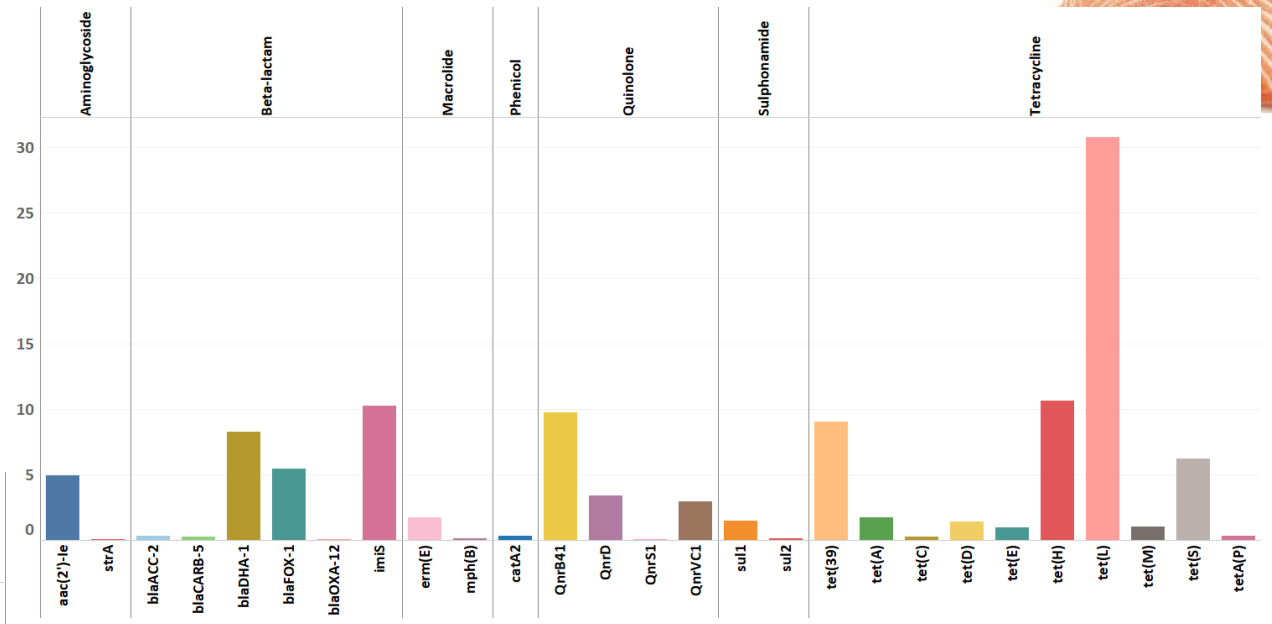
    floR, dfrA7, sul1, qacE, dfrA15, blaTRU, ant(2'')-Ia, ble, blaNDM-1, tet(A), aadA1, blaOXA, cmlA5

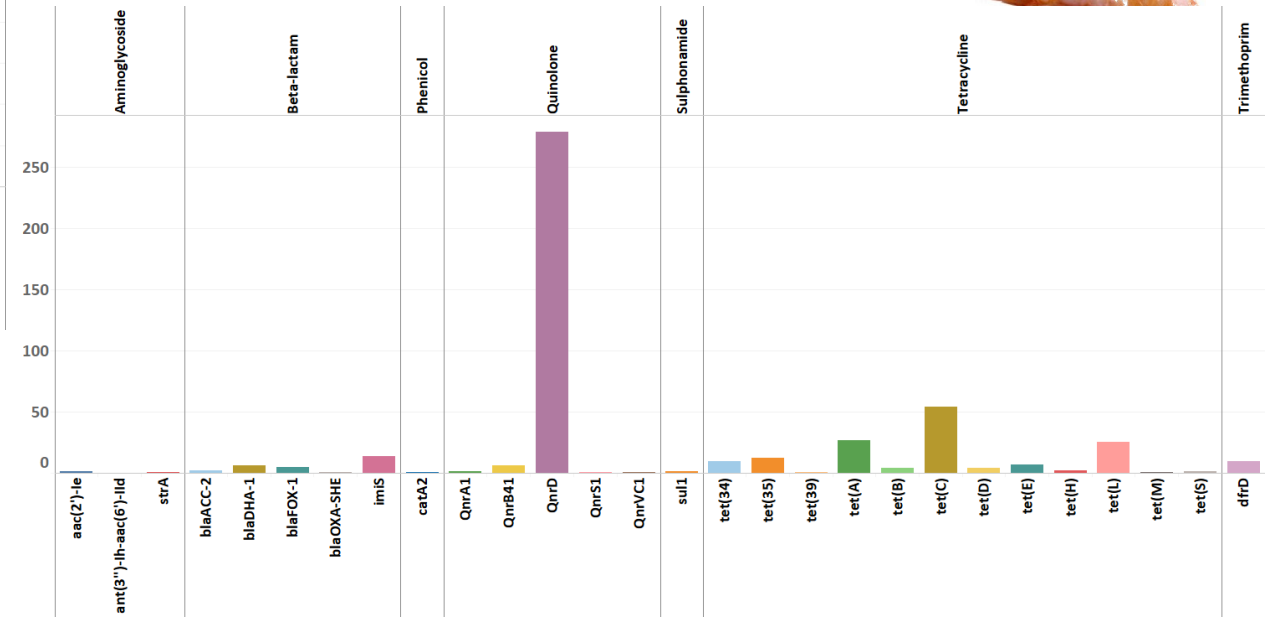
Seafood Resistome Profiling



Seafood Resistome by Source







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