

Management of Bird-Related Pathogen Risk in Shellfish Aquaculture

- NSSP: National Shellfish Sanitation Program
 - Overseen by FDA, enforced by states
 - Covers all aspects of commerce
 - Many factors go into the risk/density of guano/Campylobacter pathogen
 - Bird seasonality
 - Tidal flushing
 - Hydrodynamics
 - Tidal amplitude
 - etc.
 - Management protocol to mitigate risk is mostly just to sink cages for ~3 weeks before sale
 - 2 methods of testing for fecal coliform: meat sampling & water quality sampling
 - Meat sampling more precise
 - Water quality enforced; likely not the best means of determining likelihood of campylobacter pathogen contamination in oysters
 - Operational plan proposed by NSSP is quite vague and ambiguous, so this causes lots of variation from state-to-state
 - Bird fecal matter causes(?)/has the Campylobacter pathogen
 - Non-zero risk
 - Small amount of fecal coliform is permissible by that FDA
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High-Resolution Monitoring of Avian Communities at Mariculture Operations Yields Insights into Community Dynamics, Biogeochemistry, and Sanitation Risks

- Intake excretion model used
 - Terns and gulls most commonly observed
 - Nitrogen flux, phosphorus flux, etc. → correlates to guano flux
 - Presence of birds causes modified transport of nutrients; instead of nutrient removal that would ordinarily occur as a product of shoreline bird populations, nutrients from guano are deposited back into water column
 - Floating equipment affects bird behavior: ordinarily, during high tide birds retreat to the shoreline of estuaries, but in scenarios with floating gear, birds display a preference for congregating for congregating on floating cages, especially during high tide, as opposed to retreating to the shoreline → this introduces bacteria from guano and diminishes nutrient removal and natural cycles of nutrient flux
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Seabirds, Campylobacter, and Off-bottom Oyster Aquaculture

- 3 possible methods of seabird deterrence: tactile, auditory, and visual
- It's a priority to not harm the birds with these deterrent methods, in addition to not introducing marine plastics waste, chemicals, or anything that would be detrimental to the health of the ecosystem

- It's a definite that floating gear itself does not negatively affect/harm the seabirds that congregate on them
- Researcher developed a method of physical/tactile deterrence by way of cutting plastic zip ties at an angle and affixing them to the tops of the floating cages → effective at deterring seabirds resting on cages
- Researcher isolated bacterial colonies from guano; only 7.35% of guano samples taken were positive for Campylobacter; unknown whether or not the Campylobacter spp. Isolated from guano were actually species that cause disease in humans

Assessing the Risk of Pathogen Contamination from Roosting Birds on Aquaculture Gear

- Abundance of bird types varies with site and season
- 3 primary categories of birds types seen on aquaculture gear:
 - Diving ducks, geese, dabbling ducks
 - Gulls, cormorants, terns
 - Shorebirds and wading birds
- Herring gulls and double crested cormorants most commonly observed on floating gear (throughout six sites observed throughout RI)
- Birds use floating gear to their benefit; however, their presence on floating gear does negatively affect water quality
- Oyster farms do not negatively affect birds
- July – October = period of highest bird usage of oyster cages
- Campylobacter outbreak followed peak bird density
 - Immediately before the outbreak 140 birds/hectare was observed
- Dilution affect also observed; larger farms = lower density of birds (based upon observational data over the past year collected from 6 farms)

Risk of Pathogen Transfer from Birds is Unknown

- Not a ton of evidence of causality between oyster consumption and Campylobacter outbreaks in humans
- In spite of evidence, regulation states oyster cages must be submerged for at least 2 weeks year round
- Multitude of factors affect density of guano, including:
 - Tidal amplitude
 - Tidal exchange
 - Season
 - Gear type
 - Temperature
 - Currents
 - etc.
- Exposure to bird feces isn't a predictor of Campylobacter outbreak
- “Are we overestimating risk of enteric pathogen spillover from wild birds to humans?”

- <https://onlinelibrary.wiley.com/doi/full/10.1111/brv.12581#:~:text=The%20primary%20focus%20in%20the,colonize%20humans%20to%20cause%20infection.>
- Wild birds are often poor hosts of human pathogens
- Resubmergence or putting the cages on the beach are two proposed methods of mitigating risk but aren't actually evidence based solutions with research to back it up
- Monitoring vs. Preemptive
 - Options not based in science or understanding
 - Fecal coliform measure does not sufficiently inform risk assessment
- Blanket mitigation measures = not the best, potentially unnecessary time, money and resources
- Oysters readily take up fecal coliform
- Depuration takes 48 hours, but it's suggested that gear is submerged for up to 3 weeks → doesn't really make any sense