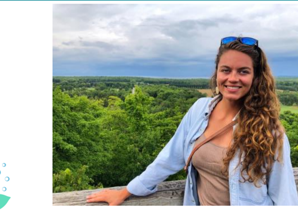
Perfluorinated environmental contaminant concentrations in sea turtle blood and eggs from Hawaii to Saipan



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Background

PFASs in the Marine Environment

- **Perfluoroalkyl substances (PFASs):** family of chemicals that are generally comprised of a completely fluorinated carbon backbone (4 - 14 in length) and a charged functional moiety of carboxylate, sulfonate, or phosphonate (Buck et al. 2011)
- Used in over 200 industrial and consumer products, from fabrics to aqueous film-forming foam (AFFF) fire suppressants (Lau et al. 2007)
- Globally distributed and highly persistent environmental contaminants
- Biomagnifiy up food chains (Lau et al. 2007)
- Known to cause toxicity in lab animals and wild species, with immunosuppression being a primary consequence (Keller et al. 2012; Lau et al. 2007)

PFASs in Marine Turtles

- Perfluorooctane sulfonate (PFOS) was found to be the most predominant PFAS in plasma of sea turtles from the Atlantic Ocean (Keller et al. 2005; Keller et al. 2012; O'Connell et al. 2010)
- In the Atlantic, concentrations are greater in certain sea turtle species, especially hawksbills, and are at levels of toxicological concern (Keller et al. 2012)
- Concentrations are not known for sea turtles in the Pacific Ocean

Goals

Identify and quantify PFASs concentrations in plasma and eggs of green and hawksbill turtles in the North Pacific to:

- Assess spatial trends longitudinally across the Pacific
- Determine species differences within the Pacific
- Determine concentration changes across clutches in one nesting season of one turtle

Methods

Samples collected for NIST Biorepository

- Biological and Environmental Monitoring and Archival of Sea Turtle tissues project (BEMAST) (Keller et al. 2014)

Plasma

- 62 live captured green sea turtles (*Chelonia mydas*)
- 6 live captured or stranded hawksbill sea turtles (*Eretmochelys imbricata*)
- 14 stranded green turtles severely afflicted with FP
- Study sites include 3 sites in the Main Hawaiian Islands (MHI), Palmyra Atoll, and the Commonwealth of the Northern Marianas Islands (CNMI) (Fig. 1)

Eggs

- Pooled **up to 3 Unhatched egg contents** from each of 12 hawksbill nests excavated from MHI beaches

Sample analyses

- Measured concentrations of 13 different PFASs via liquid chromatography tandem mass spectrometry (Keller et al. 2012)
- Used NIST Standard Reference Material (SRM) 1957 Organic Contaminants in Non-Fortified Human Serum and SRM 1947 Lake Michigan Fish Tissue as control materials

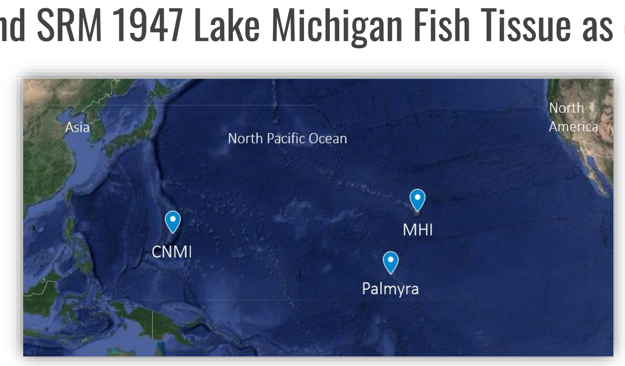

Fig. 1
Map of study sites

Plasma Results

Perflurooctane sulfonate (PFOS) predominated in green turtles (Fig. 2)

- Mean concentrations (ng/g) were highest in Hawaii (1.14 ng/g), followed by CNMI (0.524), and then Palmyra (0.155). Average detection limit was 0.049 ng/g.
- Differences across geography likely due to the islands' relative human populations, similar to spatial trends observed in the Atlantic between loggerhead sea turtle PFAA concentrations and human population in watersheds (O'Connell et al. 2010)

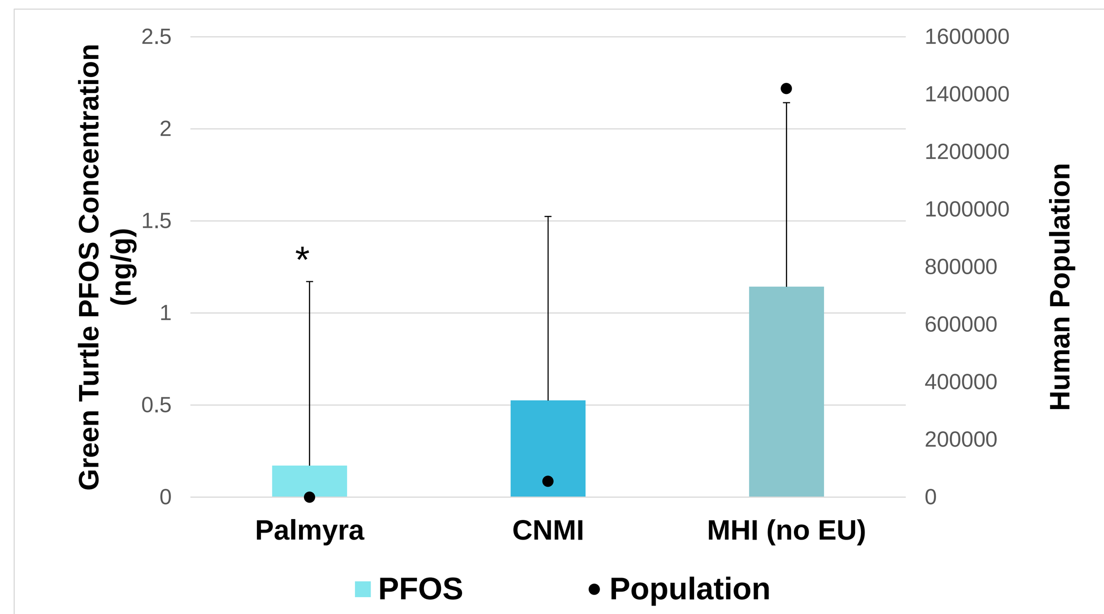

Fig. 2 Mean PFOS concentrations (ng/g) in green sea turtle plasma longitudinally across the North Pacific (bars) compared to human population (dots). Sample sizes are 10, 12, and 39. Error bars show one standard deviation. * indicates difference from other sites (p<0.05).

Perfluorononanoic acid (PFNA) predominated in hawksbills (Fig. 3)

- Concentrations did not differ between Palmyra and CNMI, likely due to low sample sizes

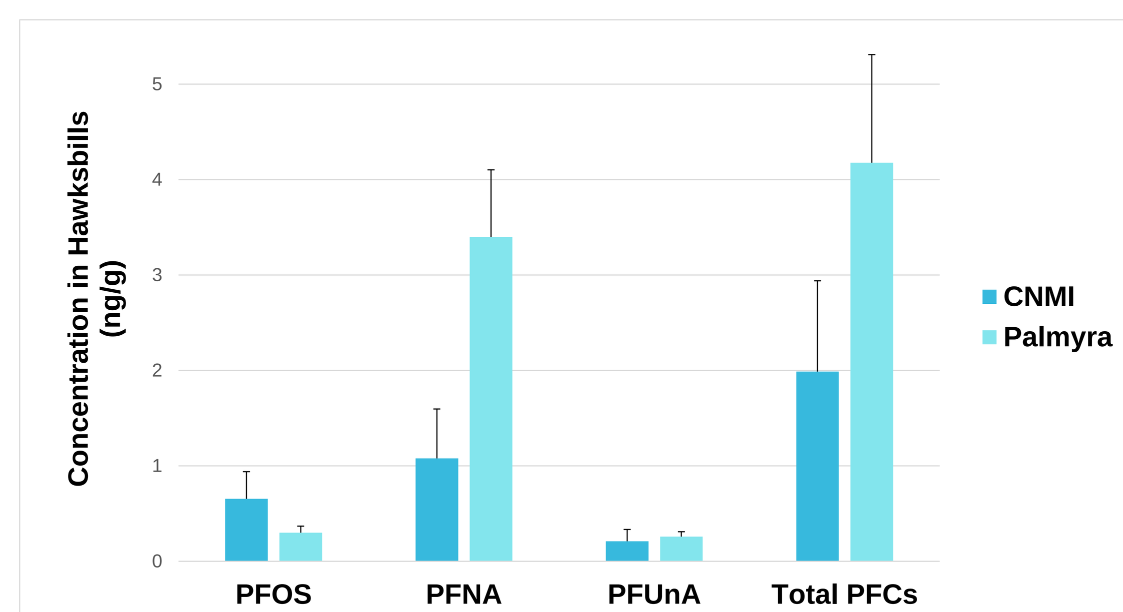

Fig. 3 Mean PFAS concentrations (ng/g) in hawksbill sea turtle plasma in the North Pacific. Error bars show one standard deviation. Sample sizes are 4 and 2.

Total PFAS concentrations were higher in hawksbills than green turtles (Fig. 4)

- Differing trophic levels likely driving dissimilarities → green turtles are herbivorous, preying on sea grass and algae primarily, while hawksbills are carnivorous and prey on sponges, shrimp, anemones, etc. (Bjorndal 1997)

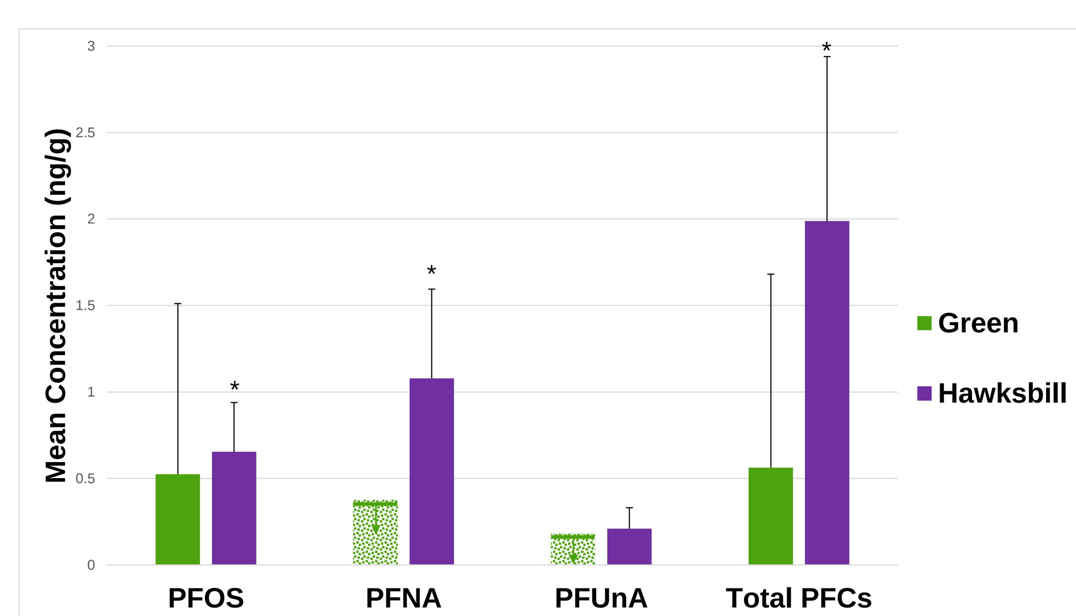

Fig. 4 Mean PFAS concentrations (ng/g) in green and hawksbill sea turtle plasma from CNMI. Patterned bars indicate that means fell below the detection limits. Error bars show one standard deviation. Sample sizes are 12 and 4. * indicates difference between species (p<0.05).

Egg Results

Presence of detectable concentrations of PFASs in hawksbill eggs indicates transfer of contaminants from mother to eggs

PFAS concentrations decreased with order of laying (Fig. 5)

- Indicates mother expels the contaminants throughout the nesting season

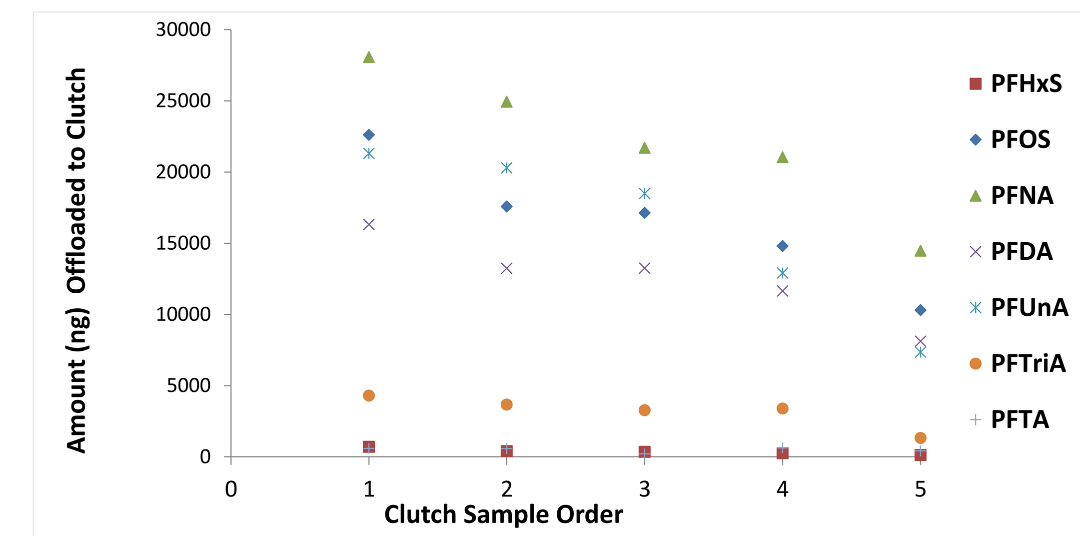

Fig. 5 PFAS concentrations (ng/g) in eggs from five clutches laid by the same hawksbill sea turtle on Maui.

Concentrations of two PFASs significantly correlated with reduced emergence success (Fig. 6)

- Perfluoroundecanoic acid (PFUnA) and perfluorotridecanoic acid (PFTriA)

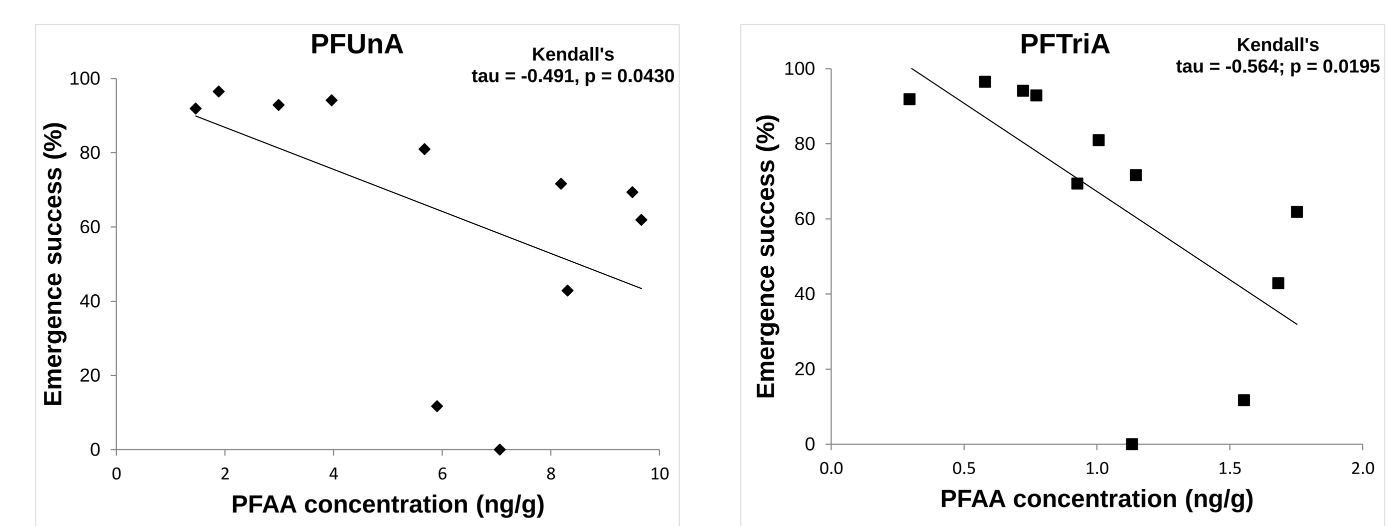

Fig. 6 Significant correlations between PFAS concentrations (ng/g) in eggs from 11 hawksbill sea turtle nests from the MHI and success of embryos emerging from the nests.

Direction for the Future

- Future studies should address the effect of PFUnA and PFTriA on hatchling development in relation to emergence success
- Research addressing the biomagnification of PFASs through trophic levels (i.e. algae and sponges) will provide a more holistic understanding of the passing of PFASs up the food web
- Investigate whether PFASs can induce low birthweight in sea turtles, as was documented in lab rodents (Grasty et al. 2003; Wolf et al. 2007)
- Dosing studies on model species to enhance general knowledge on PFAS effects in reptiles

Acknowledgments

Many thanks to the several dedicated employees, students, and volunteers that helped collect samples from these turtles and nests. Gratitude is also extended to Hawaii Pacific University and PICES for travel support allowing C. Wood to attend the 2019 PICES Conference.

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