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

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BACKGROUND

PFAAs in the Marine Environment

- **Perfluorinated alkyl acids (PFAAs):** chemicals that consist of a completely fluorinated carbon backbone and a charged functional moiety
- Used in over 200 industrial and consumer products, from fabrics to fire-fighting foams (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)

PFAAs in Marine Turtles

- Perfluorooctane sulfonate (PFOS) has been found to be the most predominant PFAA 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 PFAA concentrations in plasma and eggs of green and hawksbill turtles in the North Pacific to:

- Assess spatial trends longitudinally across Pacific
- Determine species differences within Pacific
- Determine concentration changes across clutches
- Determine correlations with nest success measures

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 Northern Marianas Islands (CNMI) (Fig. 1)

Unhatched eggs from excavations of 12 hawksbill nests across the MHI after hatchlings had emerged

Samples analyzed for 13 different PFAAs via liquid chromatography tandem mass spectrometry (Keller et al. 2012)

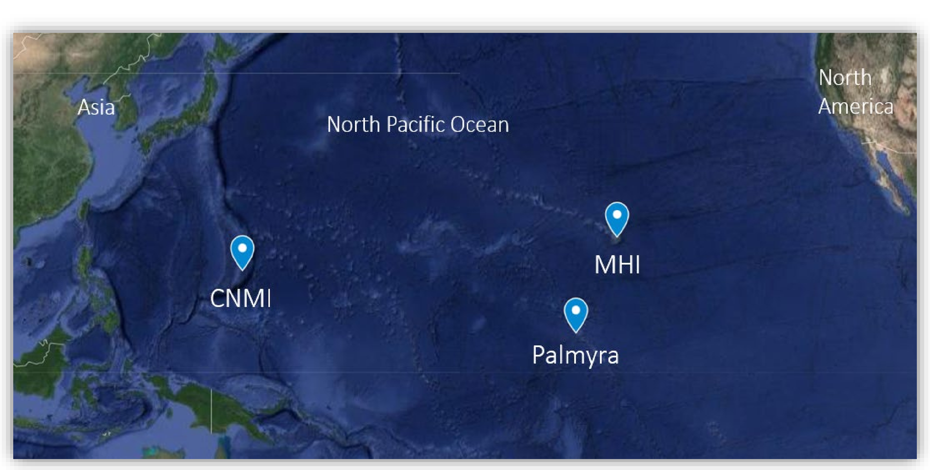

Fig. 1 Map of study sites

PLASMA RESULTS

Perfluorooctane sulfonate (PFOS) predominated in green turtles

- Mean concentrations (ng/g) were highest in Hawaii (1.14 ng/g), followed by CNMI (0.524), and then Palmyra (0.155) (Fig. 2)
- 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))

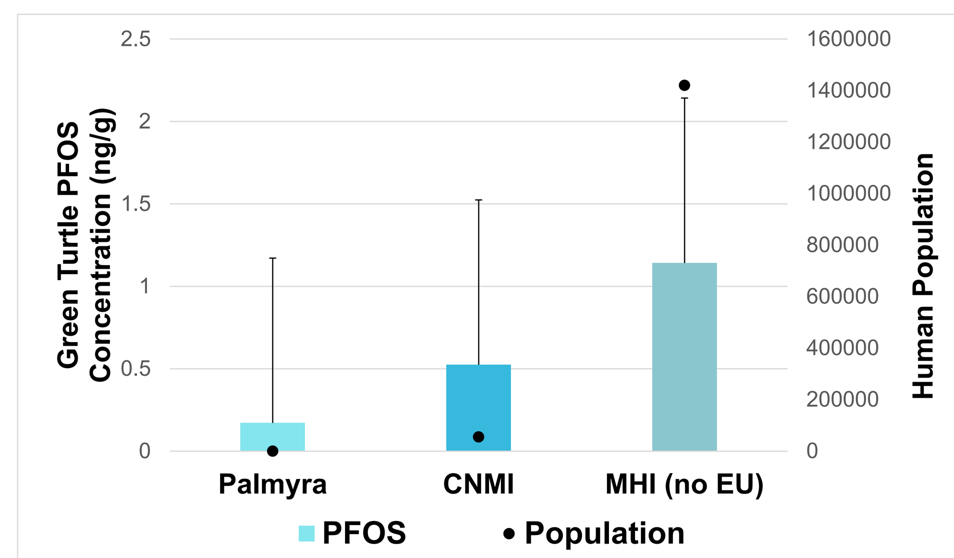

Fig. 2 PFOS concentrations (ng/g) in green sea turtle plasma longitudinally across the North Pacific (bars) compared to human population (dots). Sample sizes are 10, 12, and 39. * indicates difference from other sites (p<0.05).

Perfluorononanoic acid (PFNA) predominated in hawksbills

- Concentrations did not differ between Palmyra and CNMI likely due to low sample sizes (Fig. 3)

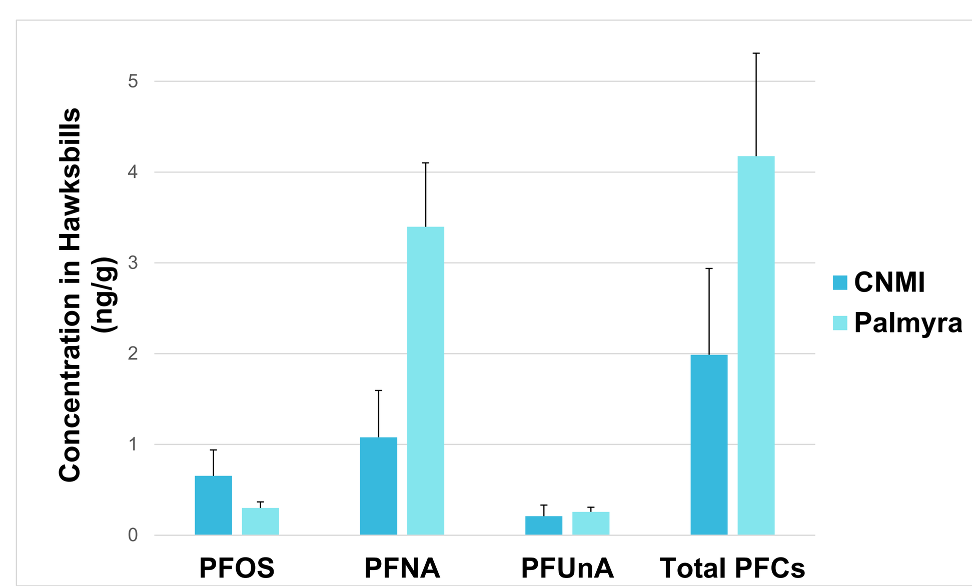

Fig. 3 PFAA concentrations (ng/g) in hawksbill sea turtle plasma in the North Pacific. Sample sizes are 4 and 2.

Total PFAA 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)

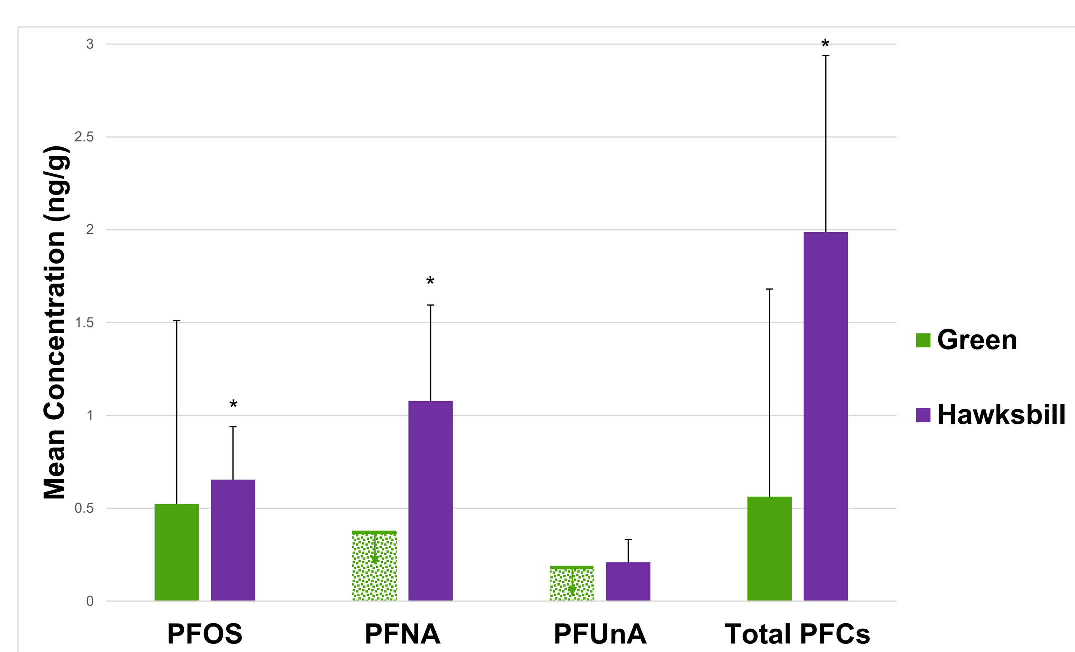

Fig. 4 Total PFAA concentrations (ng/g) in green and hawksbill sea turtle plasma from CNMI. Pattern indicates below detection. Sample sizes are 12 and 4. * indicates difference between species (p<0.05).

EGG RESULTS

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

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

- Indicates mother expels the contaminants throughout the nesting season

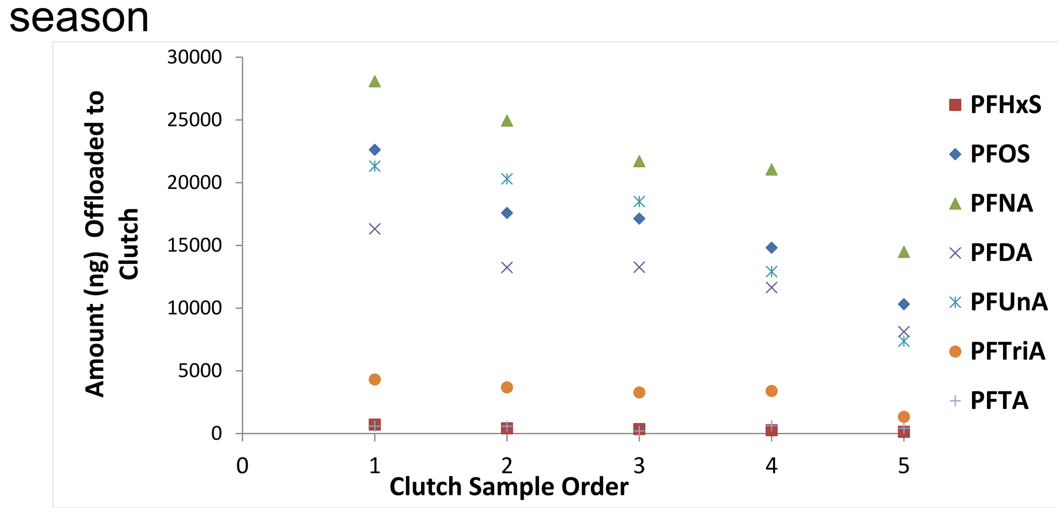

Fig. 5 PFAA concentrations (ng/g) in eggs from five clutches laid by the same hawksbill sea turtle on Maui.

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

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

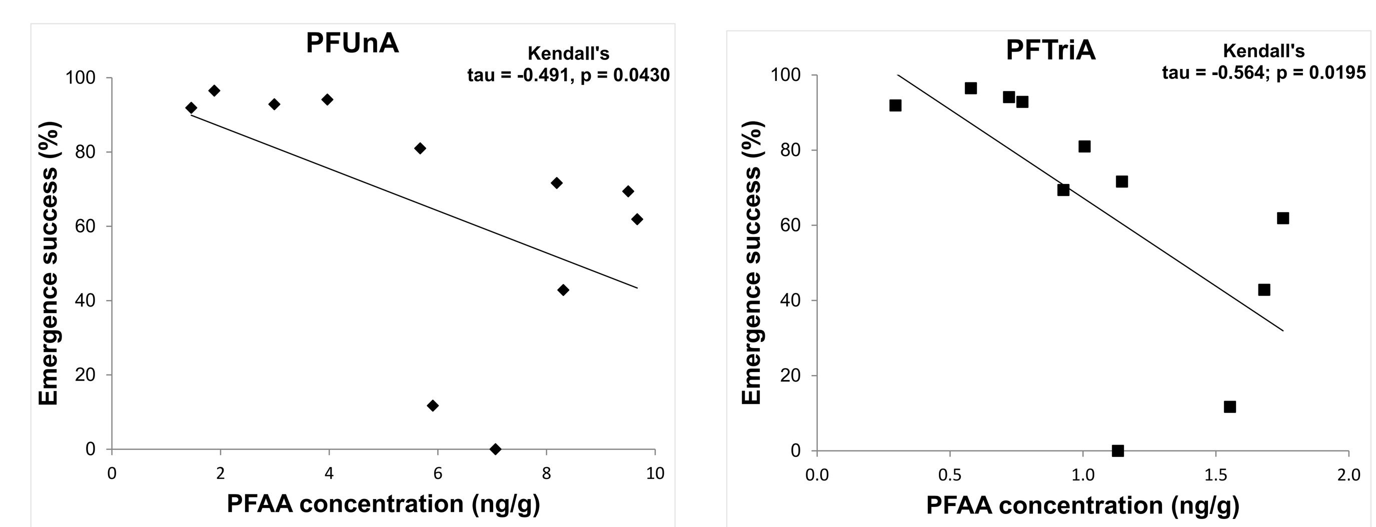

Fig. 6 Significant correlations between PFAA concentrations (ng/g) in eggs from 11 hawksbill sea turtle nests from the MHI and success of embryos emerging from the nests.

DIRECTIONS 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 PFAAs through trophic levels (i.e. algae and sponges) will provide a more holistic understanding of the passing of PFAAs up the food web

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