



## MASTER THESIS PROJECT

# MARINE PLASTIC ADDITIVES AS MOLECULAR CLOCKS

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## ABSTRACT

Photochemical degradation of plastic additives could be useful in estimating the lifetime of buoyant plastics, which has broader implications for addressing the issue of plastic pollution in the ocean. Plastic additives play a key role in plastic degradation. However, the material property change is often used to understand the ageing process which does not account for additives and spatial variability. In this work, analytical methods were developed to quantify plastic additives that could be used to determine the age of plastics in sunlit marine environments.

This study quantified ultraviolet absorbers (BP-12, UV-328, UV-326, UV-327, UV-320, UV-571, UV-P). This method utilized solid-liquid extraction (SLE) combined with ultra-performance liquid chromatography (UPLC) and a photodiode array detector. The analytical limit of detection was estimated 0.02  $\mu\text{M}$  to 0.05  $\mu\text{M}$  for all additives, except for UV-571 (0.4  $\mu\text{M}$ ). The validity of the analytical procedure was assessed by examining retention time shift, linearity, instrumental variability, reproducibility, and inter-day variability. In addition, liquid chromatography coupled with the triple quadrupole mass spectrometer (LC-MS) method was also developed to measure lower levels of additives (ng/L) using selected reaction monitoring (SRM).

This method employed a cost-effective and simple solid-liquid extraction, which had excellent recovery values. The extraction efficiency was higher than 87 percent for UV-326, and greater than 90 percent for BP-12, UV-327, UV-328. The buoy-cutting procedure was finalized using a hand planer. Based on the preliminary results, the observed concentration gradient in the additive concentration was 1.5 times for UV-P, 5.6 times for UV-320, and 3.5 times for UV-327, in the darker part compared to the sunlit part, from the plastic buoy samples from the North Pacific garbage patch.

**Keywords:** Plastic additives, photochemical degradation, plastic pollution, solid-liquid extraction, liquid chromatography-mass spectrometry.