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The Long-term effect of bleeding for *Limulus ameobocyte lysate* on annual survival and recapture of tagged horseshoe crabs

Frontiers in Marine Science

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Abstract

In the U.S., 525,000 horseshoe crabs (*Limulus polyphemus*) per year have been captured during 2013–2017, brought to biomedical facilities, and bled to produce *Limulus ameobocyte lysate* (LAL), then mostly released to the area of capture. The Atlantic States Marine Fisheries Commission estimates short-term bleeding-induced mortality to be 15% (4% to 30%), resulting in mortality of approximately 78,750 horseshoe crabs annually in recent years comprising a minor portion (<13%) of the up to one million annual coastwide landings dominated by harvest for bait. However, the long-term effect of bleeding for LAL on annual survival and spawning behavior is unknown; thus, results from short-term studies alone might underestimate bleeding effects at the population level. To address this knowledge gap, we analyzed data from the U.S. Fish and Wildlife horseshoe crab tagging database to estimate the differences in survival and recapture rates of bled and not bled horseshoe crabs tagged in the same years and geographic area. Contrary to expectation, survival was

not lower for bled crabs compared to unbled crabs. Differences varied, but survival estimates tended to be higher for bled crabs than for unbled crabs. However, biomedical culling and selection for younger or healthier animals could have resulted in biomedically tagged individuals representing a healthier subset of the overall population with subsequent higher survival. Furthermore, the tagging analysis revealed a post-bleeding reduction in capture probability, which could indicate decreased spawning activity, evident in males more than females. Continued tagging of bled and unbled crabs in the same geographic area while recording age class and sex will contribute to the further resolution of LAL production's effect on horseshoe crab populations.

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