

ESAI Best Oral Presentation at Environ 2025 winner, Sarah Nasr

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Project: Predicting River Water Temperature using Machine Learning

River water temperature (RWT) is a critical environmental driver, shaping species survival, water quality, and overall freshwater ecosystem integrity. Cold-adapted species such as Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*) have evolved within narrow thermal niches, rendering them highly sensitive to even modest temperature increases. Recent years have already seen alarming fish kill events across Irish rivers, often coinciding with extreme climatic episodes, such as the 2018 heatwave, where water temperatures soared beyond the physiological thresholds for salmonid survival.



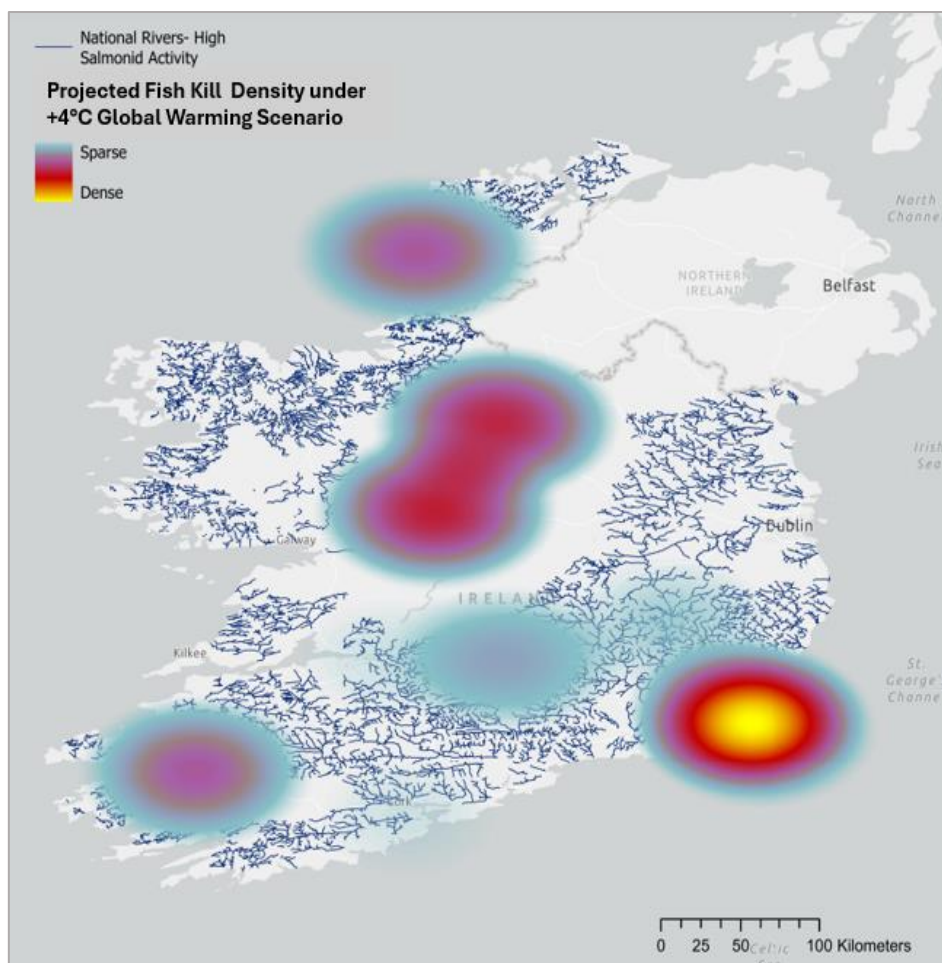
Fish kill event on the River Allow, Co. Cork in June 2018 (IFI, 2024)

The intensifying effects of anthropogenic climate change are projected to make such extreme events more frequent and severe, raising RWT levels further and placing cold-water species under mounting physiological stress. Without intervention, Ireland risks losing not only key ecological biodiversity but also species of immense cultural and economic value.

Recognizing this urgent threat, this study applied machine learning techniques to predict future RWT dynamics across Irish river systems. **Random Forest (RF)** models were trained using a suite of hydrological, meteorological, and land-use variables to simulate river temperature trajectories under global warming scenarios ranging from +1.5°C to +4°C.

The projections reveal a consistent and troubling trend: even under moderate warming (+1.5°C), a substantial number of river systems are likely to exceed critical thermal thresholds (20°C–24°C). As warming intensifies toward +3°C and +4°C, the risk of prolonged lethal temperatures grows, particularly in lowland and southeastern catchments already identified as vulnerable.

Overall, these findings underscore the urgent need for proactive river conservation strategies, targeted at both vulnerable hot spots and critical conservation zones, to safeguard Ireland’s iconic freshwater species into the future.



Projected Density of Fish Kill Risk across Ireland under a +4°C Global Warming Scenario