Climate Change Mitigation Research Programme

Salmonids in Hot Water, Summer 2018

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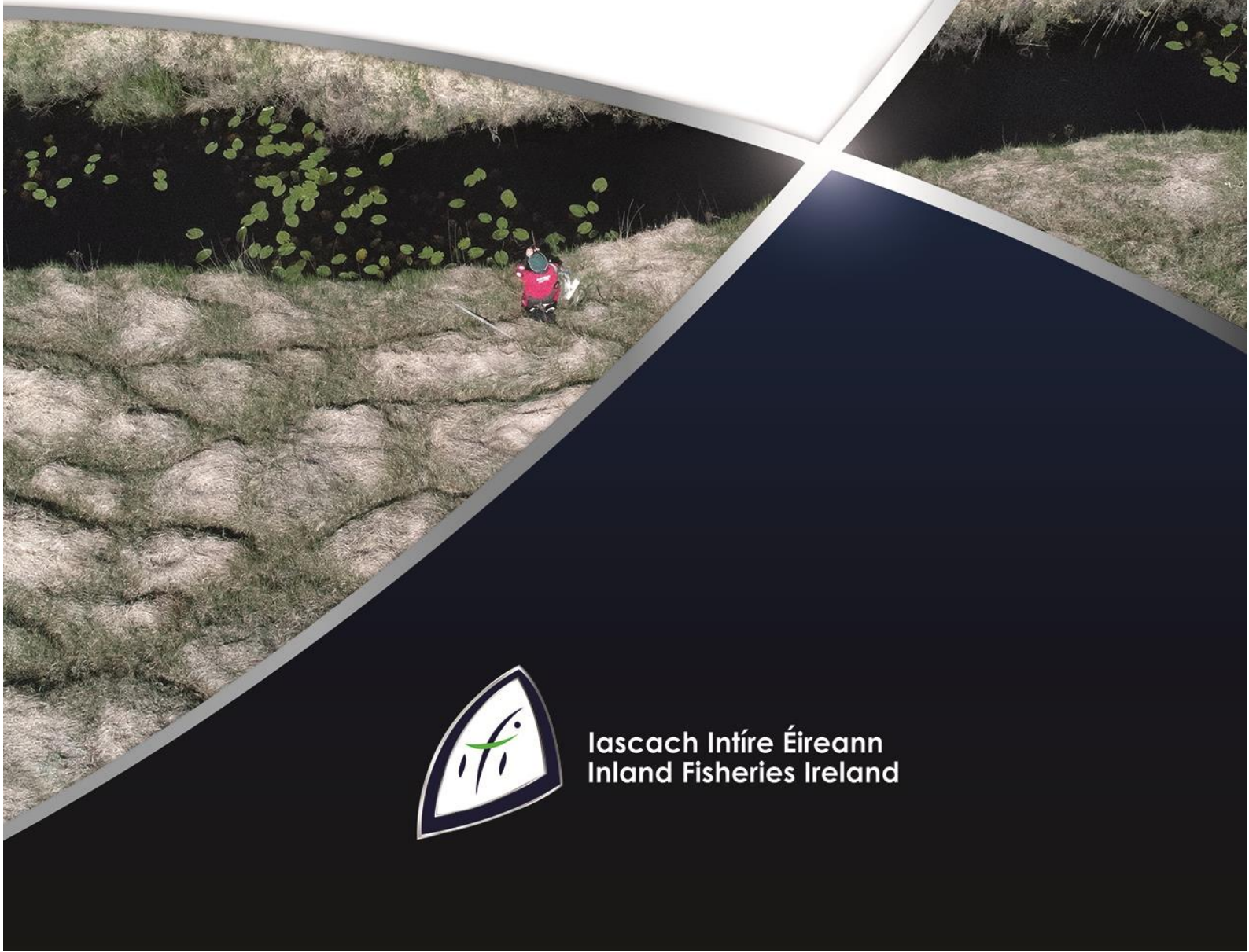

Iascach Intíre Éireann
Inland Fisheries Ireland

Salmonids in Hot Water, Summer 2018; A taste of things to come for Ireland's freshwater fish species

A brief note on water temperatures recorded in rivers and lakes during the hot dry summer of 2018

Introduction

Climate change has been identified by Inland Fisheries Ireland (IFI) as one of the greatest threats facing fish populations and the wider aquatic environment in the medium to long term. Climate change refers to shifts in ambient temperature regime, and to changes in the frequency and intensity of extreme weather and climate events (Desmond *et al*., 2017). Sir David Attenborough warned recently at the 24th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP24) that "*if we don't take action, the collapse of our civilisations and the extinction of much of the natural world is on the horizon"*. At the same conference the UN Under-Secretary-General of Global Communications Alison Smale stated "*Rising global temperature, record levels of greenhouse emissions, and increasing impacts of climate change require urgent and measurable action on the part of everyone*". Changes in Ireland's climate are in step with and comparable to global trends. Temperatures have already increased by 0.8^{o}C since 1900 and changes are projected to increase over the coming decades (Desmond *et al*., 2017). Climate change will have widespread impacts on Ireland's environment, including habitat and the biota within.

Water temperature plays an important role in almost every aspect of fish life and adverse levels of temperature can affect fish behaviour, growth, survival and disease resistance. Fish response to increasing temperature will vary according to their thermal tolerances and life stage; however a negative response is expected for cold-water species (e.g. Arctic char, Atlantic salmon and brown trout/sea trout), while warm water species (e.g. roach) and cool-water species (e.g. pike and perch) are likely to be positively affected to varying degrees. Considerable uncertainties and research gaps remain in relation to the impacts of climate change on Irish fish species, populations and habitats. In response, IFI have been carrying out some pilot studies to monitor water temperatures in various catchments across Ireland to assess the risk posed to fish communities by warm weather events. This data and further detailed information from IFI's new climate change mitigation research programme (CCMRP) will be used to undertake a vulnerability risk assessment for key fish species and their habitats and to develop climate proofing strategies for individual catchments.

Met Éireann confirmed recently that the summer of 2018 was one of the hottest and driest on record in Ireland. Absolute drought and heat wave conditions were recorded at many weather stations between May and July and mean air temperatures were above their long-term average for June and July. These extreme weather events represent a growing threat to sensitive cold-water fish species such as brown trout, Arctic char and Atlantic salmon. These cold-water fish require water temperatures largely below 20°C to survive. Above this temperature these fish species experience reduced growth, survival and reproductive capacity and heightened stress that can leave them more vulnerable to disease and predators (Williams *et al*., 2015). For brown trout, the ideal temperature thresholds for feeding and growth are generally reported as below 19.4°C, with prolonged periods (≥7 days) beyond this limit potentially lethal, and temperatures above 24.7°C lethal in the short term (Elliot *et al*, 1995b). The optimal temperature for Arctic char is 14.4 to 17.2°C while 22 to 24°C is their potentially lethal temperature range. Atlantic salmon are slightly more tolerant with an upper lethal limit of 26.7°C (Elliott and Elliott, 2010).

Preliminary analysis of water temperature data from summer 2018

A series of *in situ* shielded temperature loggers were installed in five catchments with a geographic distribution from east to west in early summer 2018 (Dublin rivers –Dargle catchment (11 sites) (Plate 2), Dodder (8 sites) and Varty (6 sites)), the Clodiagh River (4 sites) in Co. Offaly and the Owenriff River in Co. Galway (16 river sites and 6 lakes) (Plates 1, 5 and 6). These loggers recorded water temperature data throughout summer 2018 and most were removed in late September 2019. Additionally a permanent temperature logger is located at IFI's research centre on the River Erriff upstream of Aasleagh Falls, Co. Mayo (Plates 3 and 4).

Plates 1 and 2: Owenriff River (left) and River Dargle (right)

Plates 3 and 4: River Erriff at Aasleagh Falls (left) normal summer levels, summer 2006 and (right) drought conditions, summer 2018

Water temperatures exceeded ideal temperature thresholds for cold-water fish species across the catchments surveyed with some experiencing lethal temperatures during summer 2018. Examples of temperatures recorded are shown in Figures 1 to 3. The highest temperatures were recorded in the Owenriff catchment, Co. Galway, where water temperatures exceeded the ideal thermal thresholds of brown trout and Atlantic salmon at numerous times during June and July. This catchment provides important spawning and nursery habitat for brown trout and salmon migrating from Lough Corrib. Average recorded water temperatures for the Owenriff main river channel for June and July were 18.6^{o}C with lethal water temperatures (>24.7^{o}C) achieved over 13 days in the main channel, tributaries and lakes simultaneously. The maximum water temperature recorded was 28^{o}C (Fig. 1). One small lake (Lough Mall) dried out in the catchment (Plates 1 and 2). The Owenriff tributaries were somewhat cooler with a maximum of 25.5^{o}C recorded during the same time period. Lake surface water temperatures in the same catchment averaged 19.4^{o}C, reaching a maximum of 25.6^{o}C over the same period. Notably, bottom temperatures in most lakes remained below 16^{o}C, suggesting that they may provide cold water refuges for adult salmonids during warm weather. These results mean that usable habitat for trout in the Owenriff catchment was greatly reduced during summer 2018 and this may contract further, in the coming decades, without intervention, due to increasing temperature associated with climate change.

Plates 5 and 6. Lough Mall, Owenriff catchment; Left - May (before the drought) and Right - July (during the drought) 2018.

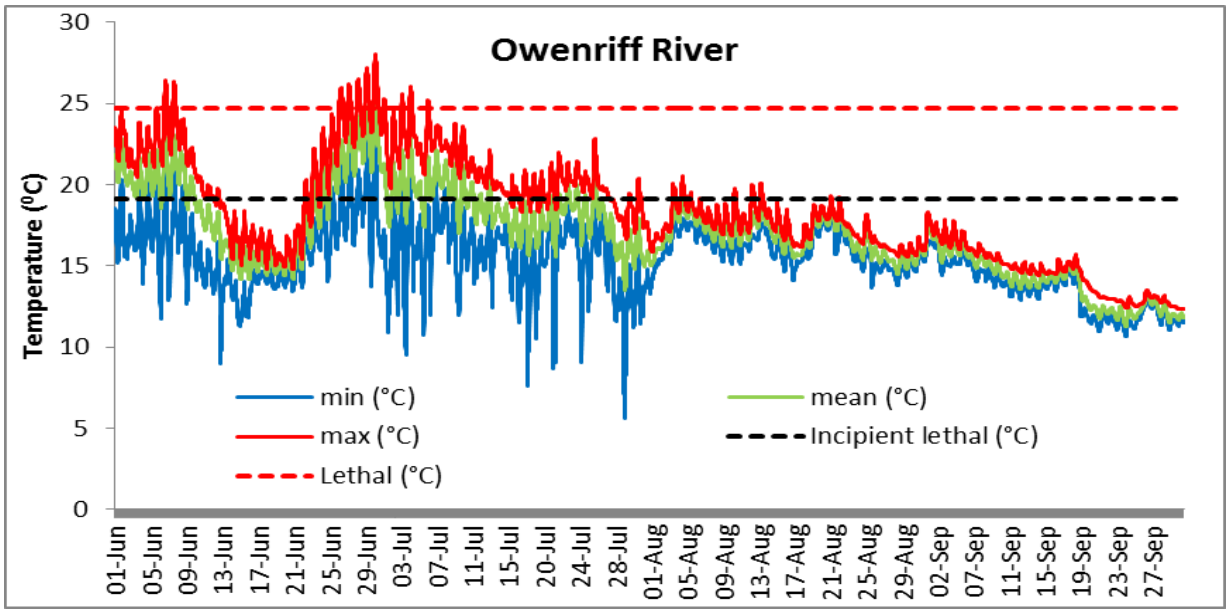

Figure 1: Water temperatures (min, mean, and max) recorded in the Owenriff River for June-September 2018. Black dashed line indicates upper water temperature threshold and red dashed line indicates the lethal temperature threshold for brown trout.

Water temperatures were slightly cooler on the River Erriff, IFI's National Salmonid Index Catchment, located only a few kilometres west of the Owenriff River, but nearer to the coast at the head of Killary Harbour. Water temperatures at IFI's Aasleagh Falls research station on the River Erriff reached a maximum water temperature of 25.6°C (average for June and July = 17.5°C) (Fig. 2 and photos 3 and 4). Although the River Erriff was slightly cooler than the Owenriff River IFI staff experienced some salmon mortality due to a combination of high water temperatures and low water levels in that catchment. Water temperatures recorded in the midlands (e.g. Clodiagh River, Co. Offaly) and east (e.g. Dargle River, Co. Wicklow) (Fig. 3) catchments, were also high but less severe. The Dargle River recorded average water temperatures of 14.8°C and a maximum of 21.5°C (Fig. 4). While figures reported from the Clodiagh River were slightly higher (average water temperatures of

16.4°C and a maximum of 22°C) (Coghlan, pers. comm.). Although both catchments experienced temperatures exceeding ideal water temperature thresholds (>19.4°C) for brown trout during the warmest weeks, neither catchment reached lethal day time temperatures at the sites surveyed.

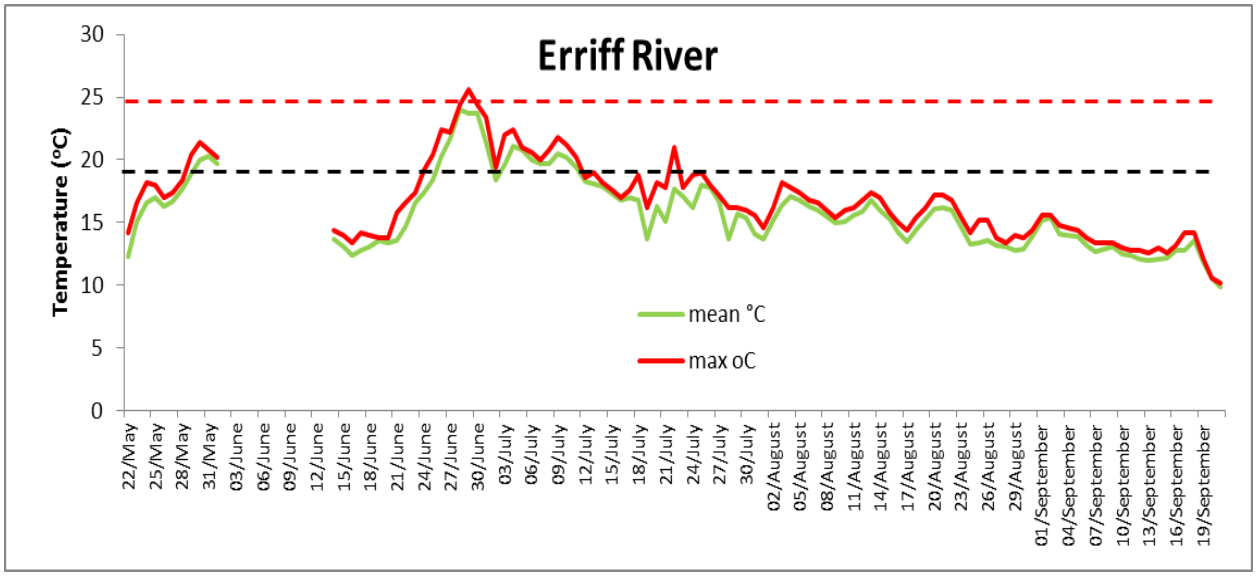

Figure 2: Water temperatures (min, mean, max) recorded in the Erriff river for June-September 2018, Black dashed line indicates upper water temperature threshold and red dashed line indicates the lethal temperature threshold for brown trout.

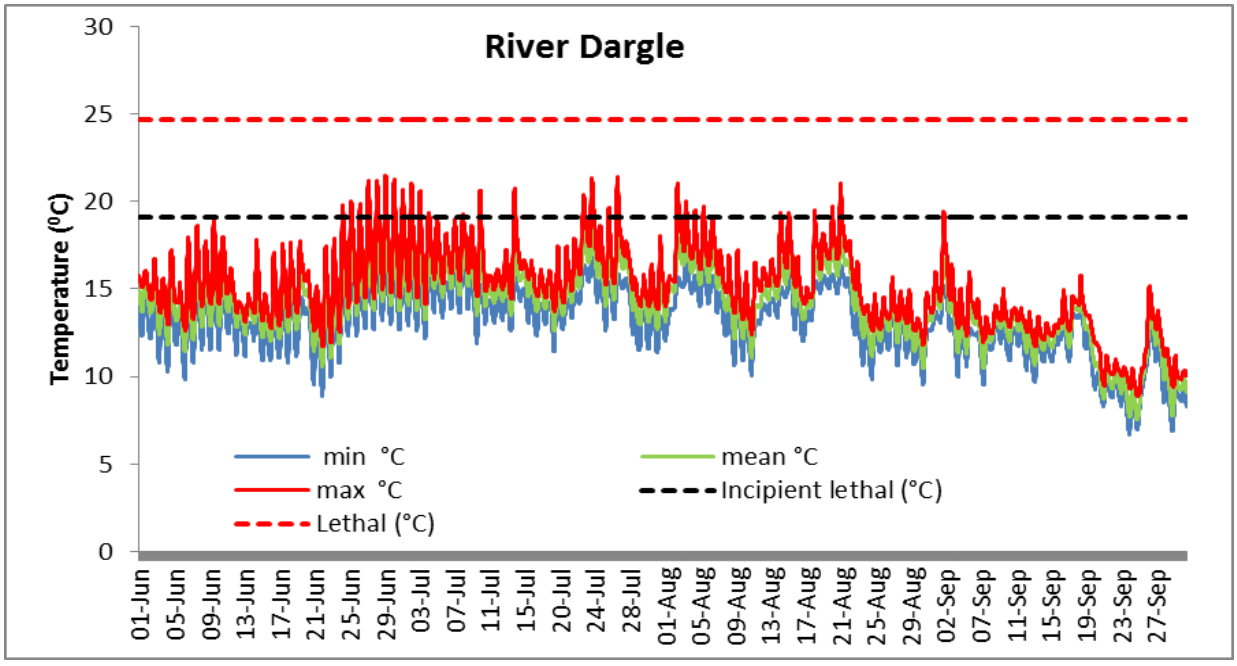

Figure 3: Water temperatures (min, mean, and max) recorded in the River Dargle for June-September 2018. Black dashed line indicates upper water temperature threshold and red dashed line indicates the lethal temperature threshold for brown trout.

Discussion

The 2018 summer water temperatures need to be considered in the context of climate change predictions. High resolution climate models for Ireland project an increase of 1 to 1.6^{o}C in mean annual air temperatures with hot days getting warmer by 0.7-2.6^{o}C and the largest increases are predicted in the east of the country (Nolan, 2015; O' Sullivan *et al*., 2016). If temperatures continue on this trajectory it will pose an increased risk to sensitive cold-water fish species particularly in vulnerable catchments such as the Owenriff. If such air temperature increases were reflected in the catchments examined in this study, then even the relatively cooler catchments would have frequent occurrences of mean water temperature above the ideal thermal thresholds of brown trout and salmon. More worryingly the Owenriff catchment and similar catchments of this type could become inhospitable for brown trout and Atlantic salmon over much of the summer period in the future. Extended periods with water temperatures above 19°C are likely to increase mortalities and negatively impact fish fitness. These increasing temperatures could lead to localised extinctions of our native fish diversity and economic losses (e.g. angling resource) to local areas. As a result of this there is considerable uncertainty about the future of fish conservation and management (angling) in Ireland. During summer 2018 IFI appealed for anglers to cease salmon fishing until the period of high temperatures and low water levels ended. Some pike angling competitions were also cancelled by angling clubs. More conservation measures such as this will become all too frequent in the future as the impacts of climate change become more pronounced.

The difference in water temperature between the Owenriff and other catchments is likely due to the presence of extensive shade provided by tree cover in the Dargle and Clodiagh in contrast to the Owenriff, where it is limited to the lower reaches of the system (see photos). Therefore mitigation and adaptation strategies are required immediately to begin buffering water temperature against these extreme temperature events, particularly in high-risk catchments. One strategy is to plant trees to protect rivers from high water temperatures. The benefits of this in protecting rivers from high water temperatures are well documented (e.g. Poole and Berman, 2001; Johnson *et al*., 2015; O' Briain *et al.*, 2017); however planting trees is not a 'silver bullet' as the effectiveness of these measures depends on other factors such as water quality, discharge and the state of the supporting habitat. Nonetheless planting trees in suitable locations is a starting point in any climate proofing strategy because of its proven effect and multiple benefits (Naiman and Decamps, 1997).

IFI will be identifying the priority areas for tree planting and other measures over the coming years through their new project (CCMRP). This on-going research work will allow IFI and others to target resources and prioritise measures. IFI recommends that strategies should be catchment and

nationally based and should include raising awareness of the impacts of climate change on Ireland's fisheries, promote general education and targeted initiatives in the sector.

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Inland Fisheries Ireland
3044 Lake Drive,
Citywest Business Campus,
Dublin 24,
Ireland.
D24 Y265

www.fisheriesireland.ie
info@fisheriesireland.ie

+353 1 8842 600