Climate Change Mitigation Programme Annual Report

2020

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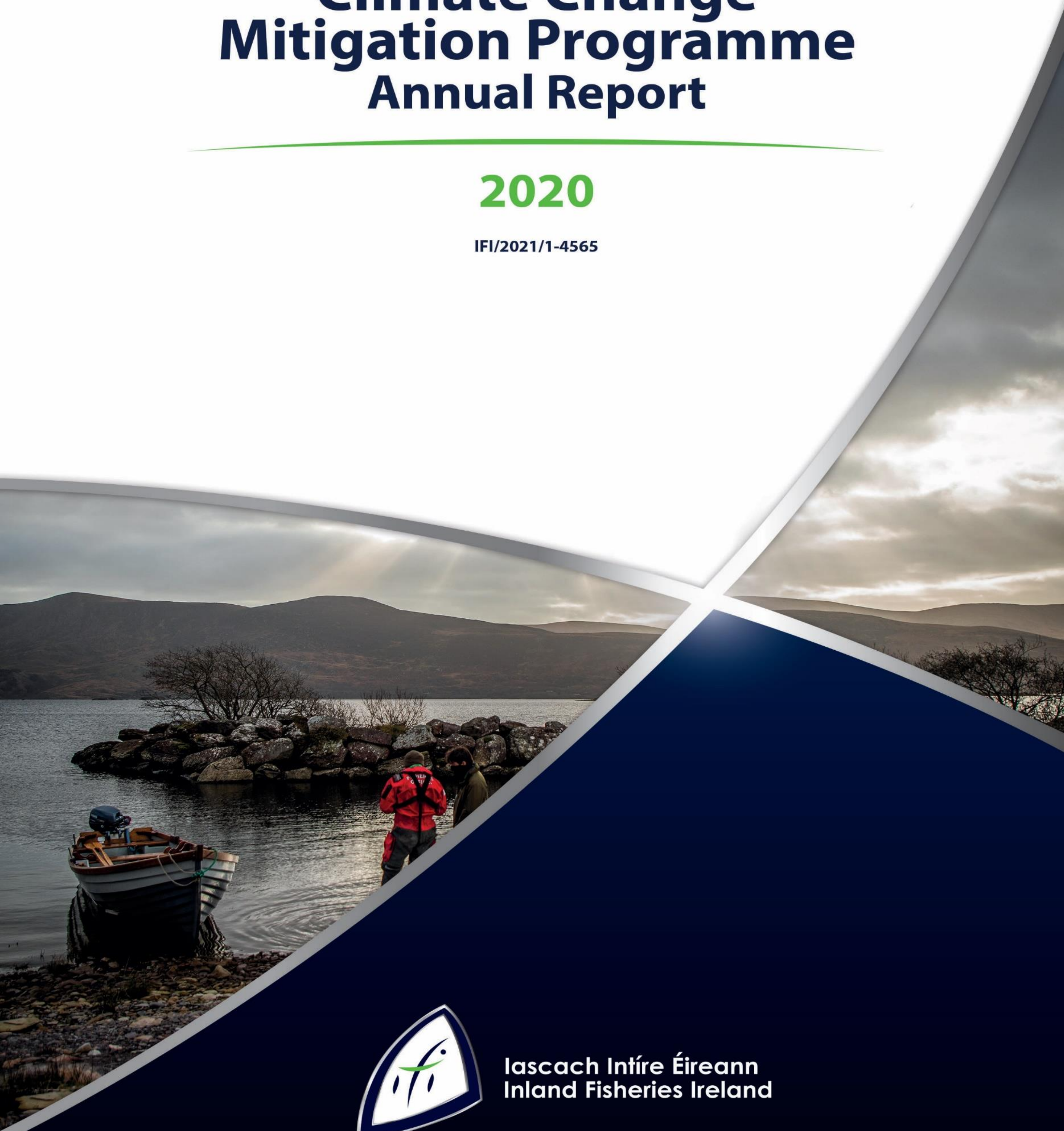

Iascach Intíre Éireann
Inland Fisheries Ireland

Inland Fisheries Ireland

Climate Change Mitigation Research Programme

Annual Report – 2020

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Contents

1. Introduction

Climate change has been identified by Inland Fisheries Ireland (IFI) as one of the greatest current and future threats facing the wider aquatic environment and fish populations. Considerable uncertainties and research gaps remain in relation to the impacts of climate change on Irish fish species, populations and habitats. In response to this, IFI established a Climate Change Mitigation Research Programme (CCMRP) in 2019 to build an evidence-based assessment programme to assess the impact of climate change on the Irish fisheries sector in both freshwater and estuarine environments, with the aim being to inform and build capacity for fisheries conservation and protection measures.

1.1 Climate change and fish species

Climate change is predicted to cause increases in air temperature, heatwaves, dry periods/droughts and heavy precipitation events (Nolan and Flanagan, 2020). The main impacts of climate change on fish species are predicted to be on their distribution, abundance, phenology (timing), species composition and community structure and dynamics (Comte *et al*., 2012). The fisheries associated impacts are also altered flow regimes, increases in water temperature (and resulting decrease in oxygen concentration) and loss of habitat (Solheim *et al*., 2020; O' Keefe *et al*., 2018). Food-webs will also be altered with unpredictable consequences for fish production (Cochrane *et al*., 2009). Increasing risks of new invasive species and spreading of water borne diseases provide additional concern (Cochrane *et al*., 2009). Additionally, the effects of existing anthropogenic pressures (e.g., nutrient enrichment, hydro-morphological changes, and invasive species) on freshwater environments and their fish species are likely to interact with climate change associated pressures (e.g., rising temperatures and droughts) and seriously affect freshwater fish species and other aquatic life (Comte *et al*., 2013; Gutowsky *et al*., 2018).

1.1.1 Water temperature

The most prevalent impact of climate change will be on the thermal regime and mostly a warming of water temperatures (Pletterbauer *et al*., 2018). Water temperature is one of the most important factors in aquatic ecosystems. Water temperature has an influence on water chemistry, for example the amount of dissolved oxygen in a waterbody decreases as it gets warmer and some compounds are more toxic to aquatic life at higher temperatures. Water temperature can also influence water quantity measurements and the types of organisms that live in water bodies. It also applies a major influence on biological activity and growth. Most aquatic organisms have a preferred temperature range and as temperatures rise above or below the preferred range the number of individuals of a species will decrease and eventually die (Pletterbauer *et al*., 2018).

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 (e.g. Jonsson and Jonsson, 2010; Pletterbauer *et al*., 2018). 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 (Mohsenie *et al*, 2003; Pletterbauer *et al*., 2018). Changes in water temperature are primarily influenced by the depth of the water and the amount of solar radiation received at a site. High water temperatures, low flow and low dissolved oxygen in combination can be catastrophic and cause fish kills.

1.1.2 Flow regime (droughts and floods)

Climate change is also expected to affect the flow regime and in turn, cause loss of habitat, change community composition and behavioural habits of fish (O' Keeffe *et al*., 2018). The effects of low flow begin with a reduction in wetted habitat area for fish and their invertebrate prey. Mean water velocity (and depth) is reduced which can result in fish moving from riffles and glides to pools. With increasing severity of flow reduction and duration, periphyton proliferation and siltation due to low water velocity can change benthic invertebrate communities to those less suitable as fish prey. Fish growth rate can decline, and mortality increase and can be carried through the life stages and depress reproduction and potential egg production of affected year classes (Bond *et al*., 2008). Angling opportunities can be reduced at low flow and fish kills can occur as river discharge also influences the response of thermal regimes to increased air temperatures (Pletterbauer *et al*., 2018). Therefore where drought becomes more frequent, freshwater dependent biota will suffer directly from changed flow conditions and drought inducing temperature increases. Additionally, increased temperature will accompany decreased oxygen and increased and increased pollutant concentration (Pletterbauer *et al*., 2019). Flooding events can also have a strong negative influence on diadromous fish, through migration difficulties for both spawners and smolts, as well as degradation of spawning and juvenile habitats.

1.2 Objectives

The primary objective is to build an evidence-based assessment programme to assess the impact of climate change on the Irish fisheries sector in both freshwater and estuarine environments, with the aim to inform and build capacity for fisheries conservation and protection measures. The work will be carried out through a series of work packages, including the establishment of a long-term fish, water temperature and other environmental variables monitoring network, developing species distribution models, undertaking a vulnerability assessment for key fish species in Ireland and assessing mitigation strategies. The project will use advanced mapping tools to model stream temperature and other variables and identify waterbodies at risk from climate change impacts.

This report summarises the progress of the IFI Climate Change Mitigation Research Programme in 2020 and presents preliminary findings from the water temperature (T_w) network installed in the Erriff River catchment (National Salmonid Index Catchment - NSIC).

2. Methods

2.1 Establish a long-term national index catchment monitoring network

The approach taken to design a large-scale long term national index catchment monitoring network, within which a range of variables (e.g. water temperature, flow velocity) and biota (e.g. fish) expected to respond to climate change will be measured was adapted for Ireland from that developed for Scottish streams (Jackson *et al*., 2016). The purpose of the index catchment network is to document changes in lake, river and estuarine ecosystems that occur in response to different land use and climate pressures. The data collected will inform risk assessment, mitigation measures and future policy.

Traditional monitoring (e.g. low frequency spot sampling) cannot resolve or provide IFI's scientists with the necessary information to understand the processes driving many aspects of river, lakes or estuaries because the water body properties can be completely altered by short-term weather-related physical disturbances. High frequency water temperature data will be collected in all index catchments and additional data will be collected in a subset of these.

An index catchment approach was chosen as this provides numerous benefits, such as reduction of costs and ease of planning (Jackson *et al*., 2016). The methods used to select index catchments and sites are described below.

2.1.1 Index catchment selection

Index catchments were chosen to represent the range of landscape variables controlling Irish freshwater waterbodies to provide an understanding of spatial variability and long-term change. A GIS project was initiated to identify index monitoring catchments to represent a broad range of environmental variables in catchments across Ireland. The catchment selection process began by constraining the network to near natural catchments (e.g. catchment without large hydropower facilities and without major drainage works). Cross-border catchments and those less than $<25km^2$ were also removed. Catchments were chosen to span the whole of Ireland with coverage from east to west and north to south. Distance to coast was calculated to represent continentality and influence of maritime climate on inland weather conditions (Jackson *et al*., 2016). Geology was included and categorised as non-calcareous, mixed and calcareous. To maximise the benefits of the network to IFI we included the National Salmonid Index catchment (Erriff River catchment) and other catchments where relevant long-term data was available (e.g. Water Framework Directive monitoring sites, EPA/OPW hydrometric monitoring stations, etc.).

2.1.2 Site selection at the catchment scale

Firstly, candidate sites were selected every 500m throughout each catchment on the EPA river layer (WaterBodies.DBO.EPA_RiverNetwork) using Arc GIS 10.5. A range of landscape variables were derived for each 500m site to cover the full range of observed environmental gradients and combinations of controlling variables as recommended by numerous authors (Isaak *et al*.,2010 and 2011; Jackson *et al*., 2016 and Nagel *et al*. (2017)). Final monitoring sites within each catchment were chosen to cover the range of landscape controls observed in Irish rivers (Table 1). To ensure that the chosen sites were representative of the environmental characteristics across each catchment pairwise scatterplots comparing all sites to selected sites were used. A visual sense-check was then undertaken to remove all sites >300m elevation and difficult to access sites (H&S, resources, time). Existing monitoring sites were added to the site selection where sites did not overlap to ensure maximum value from existing resources (e.g. IFI monitoring sites and OPW/EPA hydrometric stations).

The advantage of this type of network is that it will have high statistical power to separate the relative importance of predictor variables thereby allowing large-scale water temperature predictions (Jackson *et al*., 2016). Additionally it has also been recommended that combining a large-scale stream temperature database with new advanced mapping tools (geospatial analysis tools) will provide useful data for describing the thermal heterogeneity of streams and rivers (Isaak *et al*., 2017).

Table 1: Landscape variables used in the site selection process at the catchment scale

Variable	Comment
Latitude/longitude (x y)	Included as a primary control in the site selection process
Strahler stream order	Used to define stream size based on a hierarchy of tributaries from source to sea in each stream network
Distance to sea (m)	Influence of continentality & maritime climate
Elevation (m)	This is used as a surrogate for air temperature as elevation normally influences air and water temperature. It can also be an indication of stream size.
Hill shading	Amount of shading provided by the landscape, which strongly influences solar radiation. Hill shading was calculated for both summer and winter, to encompass the annual variability due to changes in azimuth, zenith angles and day length.
Upstream catchment area (m^2)	This is used as a proxy for river discharge
Gradient (slope) (%)	Transit times, bed friction and channel morphology are influenced by channel slope, slope can alter the amount of time available for energy exchange processes.
Channel orientation	This variable is important for receipt of solar radiation, shading banks alters energy exchange process, orientation affects the amount of solar radiation reaching the stream and the shading effects of banks and vegetation, with north/south channels experiencing maximum exposure to incoming radiation and east/ west channels the minimum.
Shading level (% forest cover)	Influence the incident of incoming solar radiation, shading the reach
Drained channel	Catchment responsiveness – three categories: non-drained, mixed or drained
Area of upstream lakes	Catchment responsiveness and ability to heat water
Land use	Key role in controlling thermal regime through effects on catchment responsiveness and residence times, which influence time available for energy exchange processes
Majority land use	Categories include: Agricultural, urban, natural or coniferous
Geology	Groundwater/surface water interactions

2.1.3 River T_w monitoring network

IFI began establishing a national river water temperature (T_w) monitoring network in 2019. Water temperature data loggers were deployed at each selected river site in index catchments following stringent quality control procedures. A standardised deployment method was developed (Fig. 2.1). Each data logger was anchored using rebar and was shielded using 10mm white pvc drainpipe to prevent exposure to direct sunlight. An alternative deployment method was used for deep sites (i.e. data loggers were weighted using a breeze block and anchored using chain) (Fig. 2.2).

Each data logger was programmed to record T_w every 30 minutes (reporting resolution 0.2 °C). Field deployed dataloggers were calibrated against an internal reference logger which was in turn calibrated by a certified laboratory. Each logger is downloaded every 6-12 months and replaced by a calibrated unit annually.

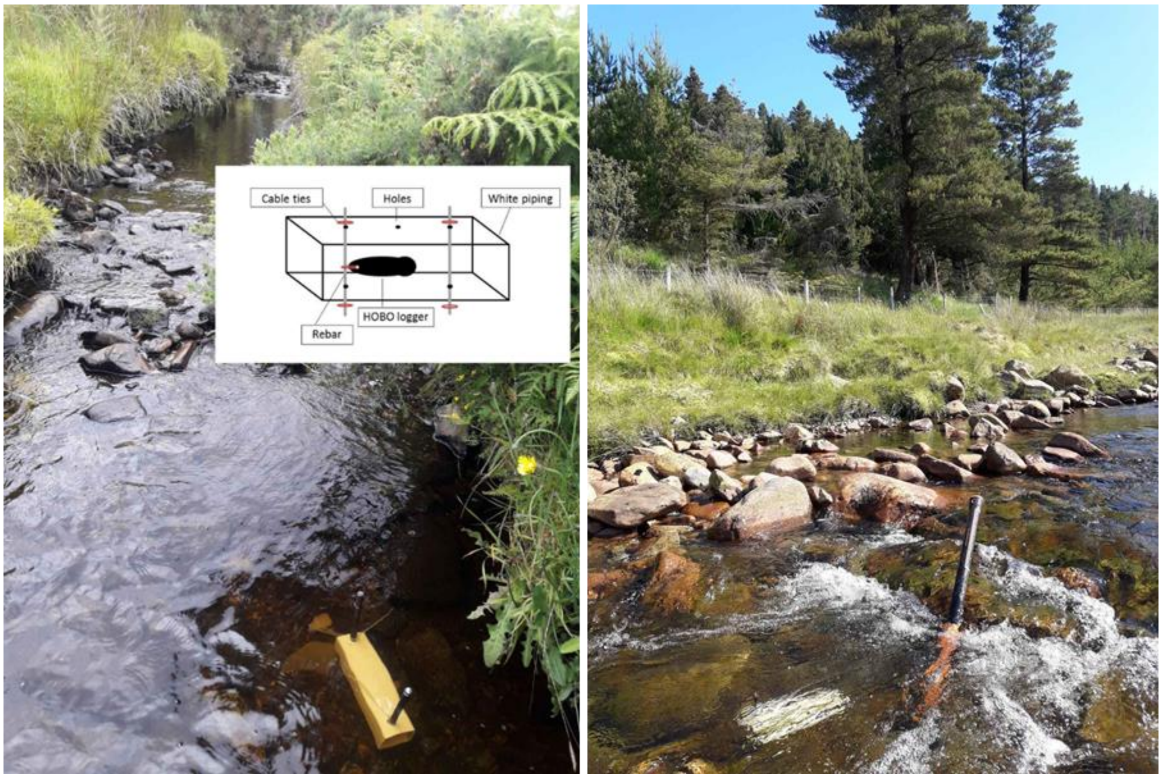

Figure 2.1 T_w data loggers *in situ* in shallow river sites

Fig. 2.2. Deploying a T_w data logger in a deep river site

2.1.4 Lake T_w monitoring network

Lake ecosystems are sensitive indicators of catchment modification and climatic conditions, and they are often referred to as the "canaries" in the landscape. Many of the modifications to the landscape and climate will be expressed firstly in lake ecosystems (Adrian *et al*., 2009). Therefore by understanding the implications of these changes at a regional level the expected ecosystem change can be predicted and planned for.

To monitor the full extent of change associated with climate in lakes it is necessary to monitor indicators at an appropriate timescale. A network of T_w data loggers was deployed in four lakes from north to south within three catchments. A real time high frequency data buoy will also be installed in a midland's lake during 2021. Additional data loggers, e.g. such as dissolved oxygen will also be added to this network during 2021. A thermistor chain (i.e. a series of T_w loggers suspended on a chain at equal distances from lake surface to lakebed) was deployed in each lake using similar T_w data loggers to those that are used in the national river T_w network. The number of data loggers deployed in each lake varied depending on the maximum depth of the lake (Fig. 2.3). Data loggers were programmed to record water temperature every 30 minutes.

Preliminary analysis of the physical properties of Tawnyard Lough, such as the thermal stratification structure (heatmap plots) and water body stability (Schmidt stability and Lake number), were analysed using the rLakeAnalyzer package (Read *et al*., 2011; Winslow *et al*., 2019). Lake Analyzer is a set of open-source tools that allows users to calculate common indices for lake physical states, such as Schmidt stability. These indices are calculated according to established literature with a time series output format. The Lake Analyzer program was created for the rapid analysis of large volumes of high-frequency data collected from instrumented lake buoys.

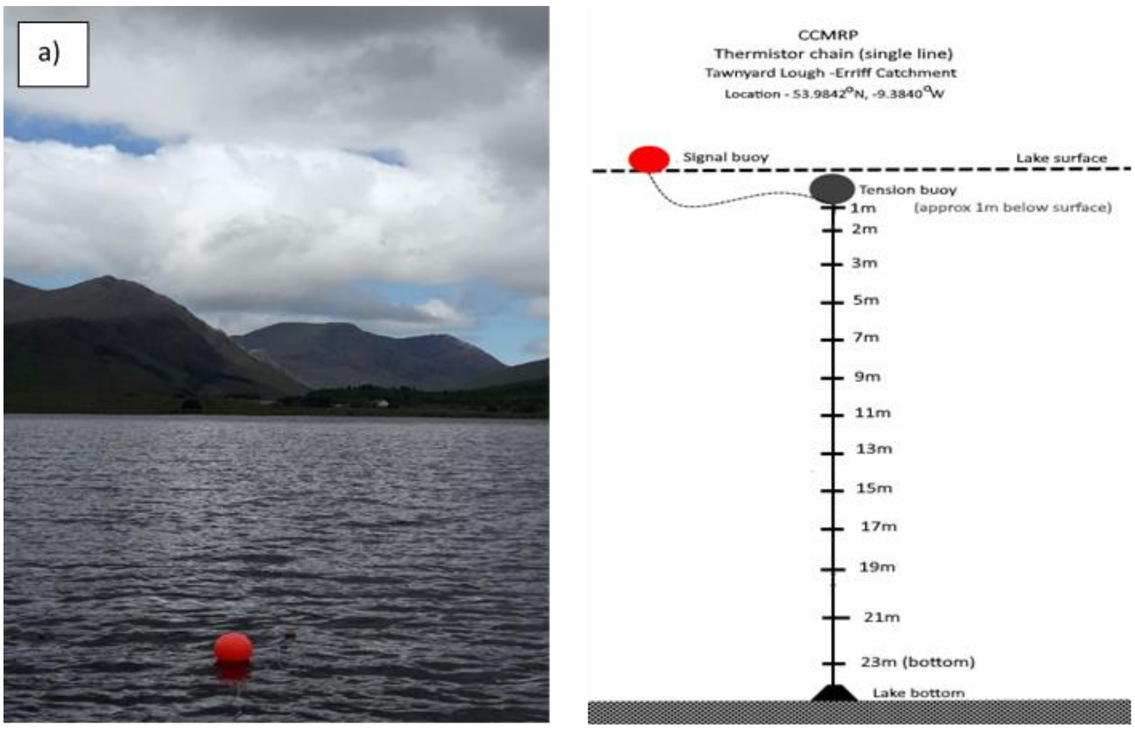

Fig. 2.3. Schematic showing thermistor chain set up on Tawnyard Lough (NSIC)

2.1.5 Meteorological data

Automatic weather stations were strategically located at three sites close to or within index catchments (IFI Glenties, Co. Donegal; IFI NSIC (Co. Galway); the lower River Barrow catchment (Co. Kilkenny) (Figure 3.1) where monitoring sites are not close to Met Eireann's national monitoring network. Each weather station has an integrated sensor suite and records air temperature, wind speed and direction, precipitation and barometric pressure data every 30 minutes. This data is downloaded by IFI staff once a month and is also visible via a free app (www.weatherlink.com).

2.1.6 Data management

It is essential that all the data is traceable and quality controlled, therefore a data management plan has been drafted and will be developed further during 2021. A centralised database is currently being developed which will incorporate ArcGIS Survey123 and dashboard capabilities for standardised on site data collection and tracking the data logger deployment and turnover.

3. Results

3.1 Establish a long-term national index catchment monitoring network

A total of nine index catchments were selected with a good representation across Ireland of N, S, E W. Monitoring sites were then chosen using appropriate landscape covariates and a site selection and validation process. The selected index catchments include the Gerbera, Co. Donegal, Erriff, Co. Mayo, Doonbeg, Co. Clare, Ilen Co. Cork, Cummeragh/Currane, Co. Kerry, Nore, Counties Kilkenny, Laois and Tipperary, Vartry and Dargle, Co. Wicklow and Dodder, Co. Dublin (Fig. 3.1).

3.1.1 River T_w monitoring network

A total of 213 river temperature loggers have been deployed to date in nine catchments between September 2019 – present.

- *Northwest:* Gweebarra - 28 data loggers.
- *West*: Erriff River (NSIC) - 35 data loggers; Doonbeg – 11 data loggers.
- *Southwest:* Ilen – 25 data loggers; Cummeragh/Currane – 17 data loggers.
- *Southeast:* Nore – 46 data loggers.
- *East:* Vartry - 13 data loggers; Dargle - 21 data loggers; Dodder - 17 data loggers.

3.1.2 Lake T_w monitoring network

Thermistor chains were deployed over the deepest part of four lakes in the Gweebarra, Erriff and Currane/Cummeragh catchments. A total of 58 T_w data loggers have been deployed in the four lakes.

- *Northwest:* Lough Barra - 7 data loggers (approx. max depth – 12m).
- *West*: Tawnyard Lough (NSIC) - 13 data loggers (approx. max depth – 24m).
- *Southwest:* Currane, Lough – 19 data loggers (approx. max depth - 35m); Derriana Lough – 19 data loggers (approx. max depth – 35m).

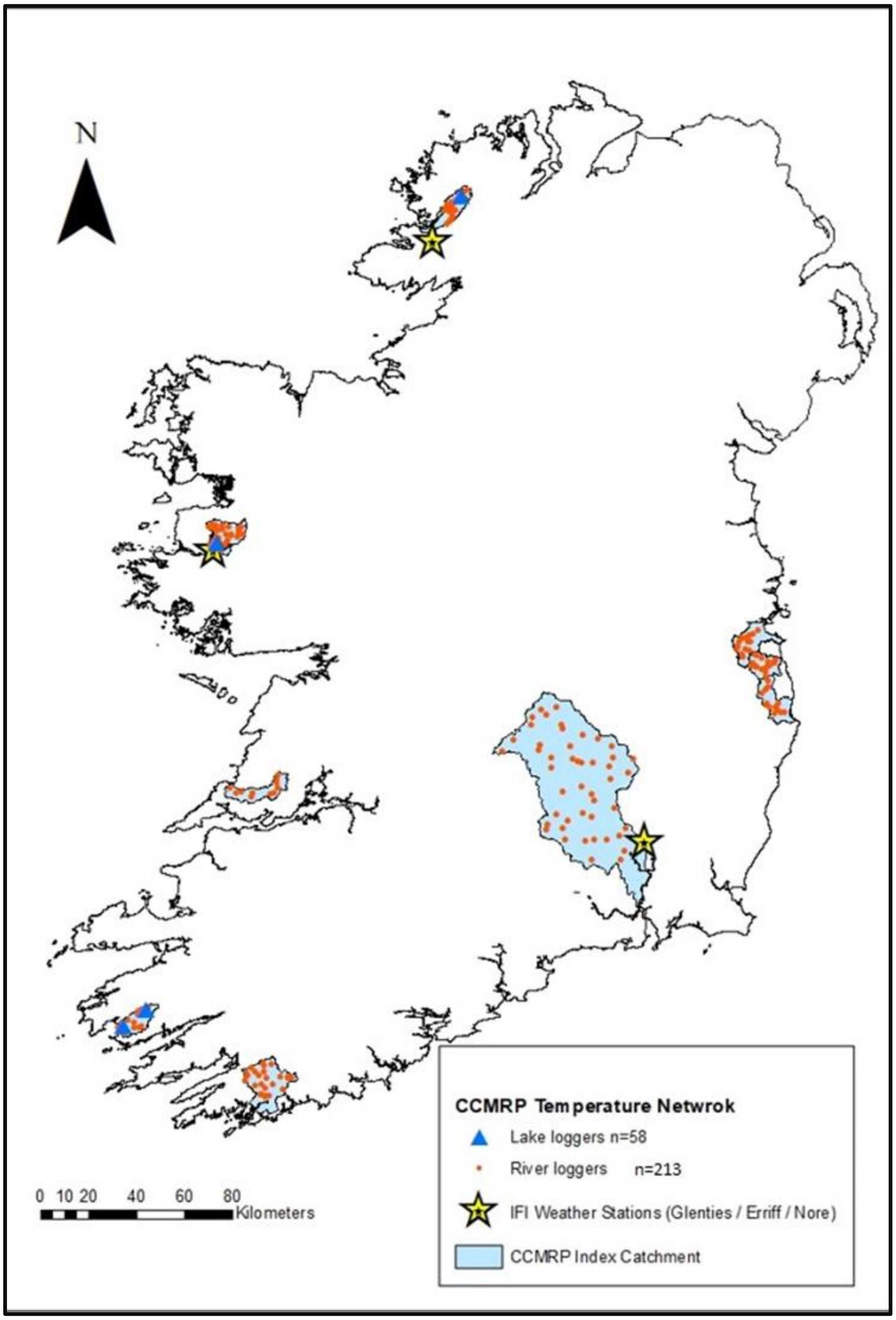

Figure 1.1: IFI's national climate change index catchment monitoring network. Locations of river T_w and lake T_w monitoring sites are shown. IFI weather station locations are also highlighted.

3.2 Case Study - Erriff River catchment (NSIC)

The Erriff River system has been designated as the National Salmonid Index catchment (NSIC) by IFI. A dedicated research station with fish counting and trapping facilities is located at Aasleagh Falls near the mouth of the river. A downstream Wolf-type fish trap is also located on the Black (Owenduff) River downstream of Tawnyard Lough. The research facility supports a wide range of fisheries scientific research and monitoring activities. Long-term rod catch and other data is also available for the system. In addition there are three OPW hydrometric stations present in the catchment.

3.2.1 T_w monitoring network

In total 519 candidate monitoring sites were selected for the Erriff River catchment (NSIC) using Arc GIS 10.5. Landscape variables were calculated for each site and from these 36 monitoring sites were selected based on the standardised site selection criteria (Fig. 3.2). A T_w monitoring network was initiated across the catchment at the selected sites on the 22nd of June 2019 (Fig. 3.2). These sites are representative of the range of environmental variables across the catchment. A single thermistor chain, comprising of 13 T_w data loggers was also deployed over the deepest part of Tawnyard Lough on the 14th of June 2019.

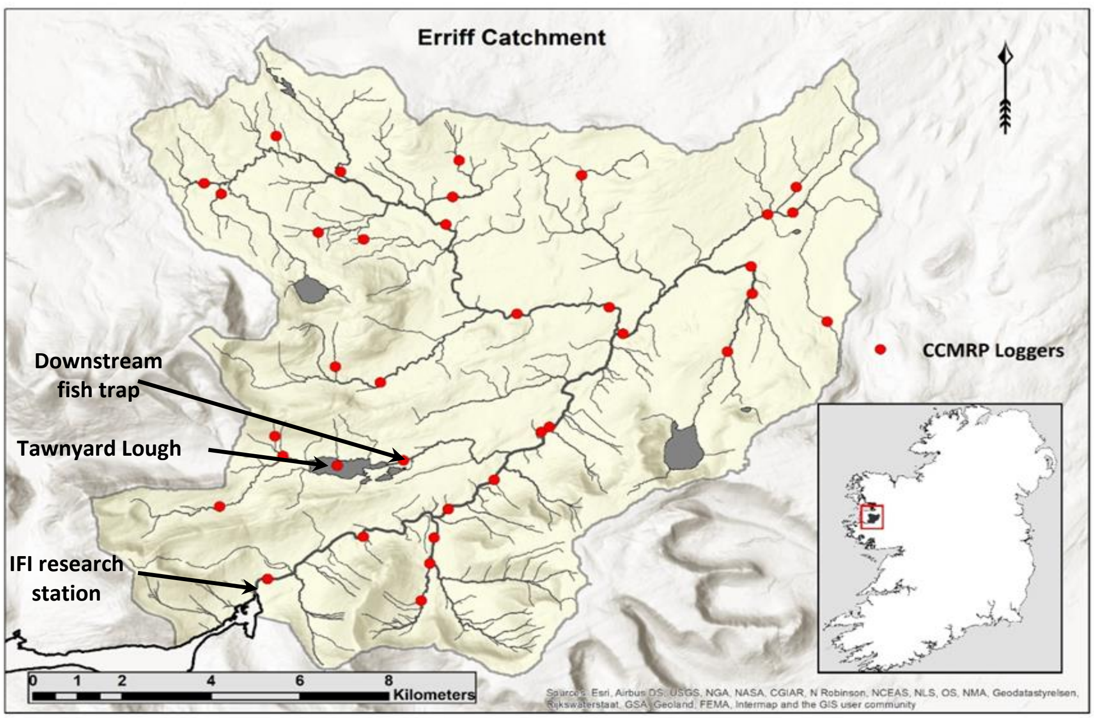

Fig. 3.2: T_w monitoring network in the Erriff River catchment (NSIC).

3.2.2 Long-term T_w trends 2007-2020 (Aasleagh Bridge)

Water temperature metrics were available from the NSIC research station at Aasleagh falls from 2007 to 2020. These data were used to investigate the number of high temperature days (>20°C). In total 120 events occurred where the average daily water temperature exceeded 20°C (Fig. 3.3). The number of thermal stress days show an increasing trend at the site between 2007-2020.

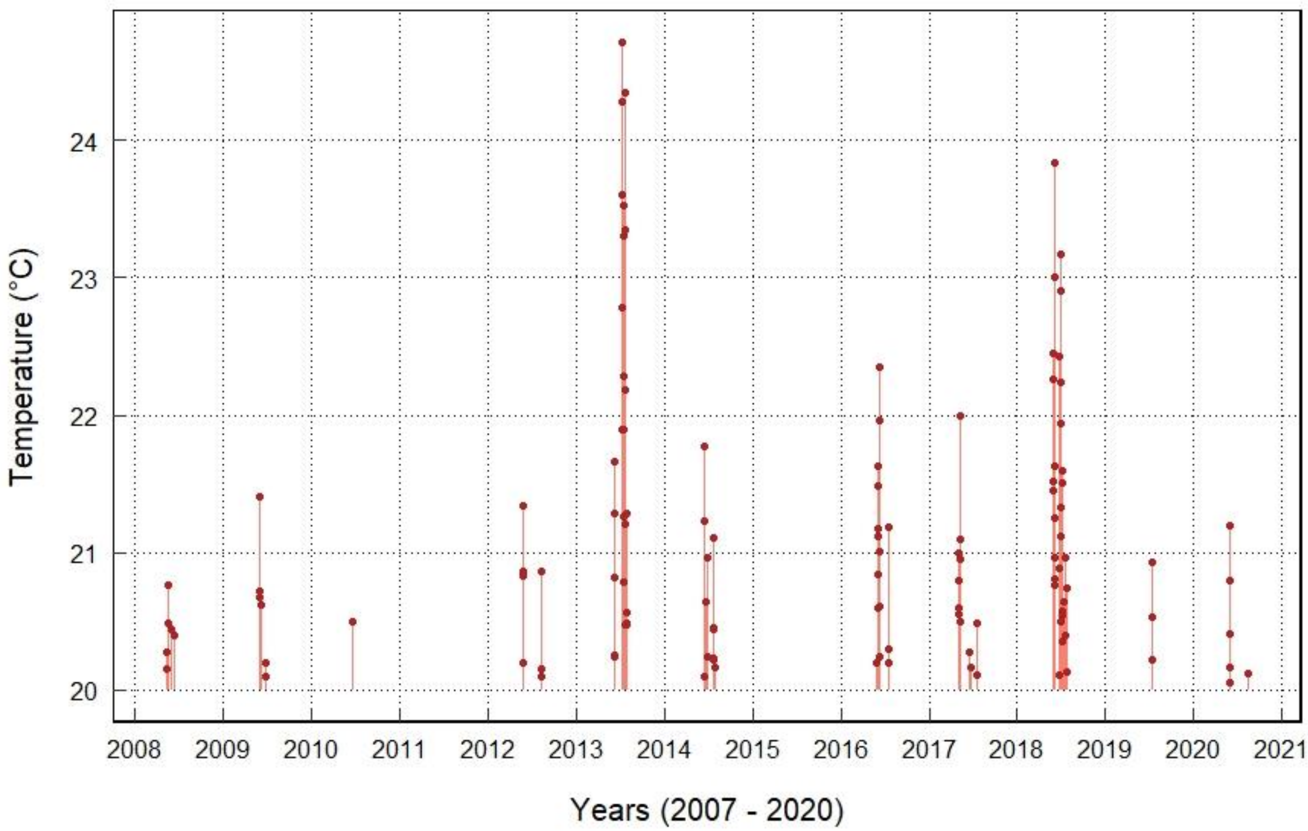

Fig. 3.3: Frequency of hot days (>20°C T_w) on the Erriff River (NSIC) research station, 2007-2020

3.2.3 Thermal metrics in the Erriff (NSIC) catchment

The thermal regime across the catchment was summarized by calculating 28 temperature metrics across 5 categories (Isaak *et al*., 2018). These include: 1) Magnitude; 2) Variability, 3) Frequency, 4) Timing and 5) Duration for seven sites within the catchment (Table 3.1). Water temperatures within the study area network exhibited spatial and temporal variation observed across the catchment. Mean water temperature for 2019/2020 was 10.5 °C, mean winter and summer temperatures were 6.1°C and 15.6 °C, respectively. A total of 6 thermal stress days were recorded (>20°C) and 1 cold day (<2°C). Highest water temperatures recorded occurred on the 14th of July in the Erriff River main channel (Station ERIFF09) where temperatures in excess of 23°C were recorded on 1/6/2019 and 14/07/2019.

Table 3.1 Descriptive statistics of temperature metrics calculated from half-hourly Tw data collected from seven monitoring sites with full year coverage within the Erriff River (NSIC) catchment, June 2019 to August 2020.

Thermal Metrics (7 sites)	Mean (°C)	Median (°C)	SD (°C)	Minimum (°C)	Maximum (°C)
M1. Mean annual temperature	10.5	10.2	0.6	9.8	11.7
M2. Mean winter temperature	6.1	6.0	0.3	5.5	7.1
M3. Mean spring temperature	7.3	4.3	3.6	3.3	11.3
M4. Mean summer temperature	15.6	15.9	0.7	13.6	17.1
M5. Mean August* temperature	15.1	15.3	0.7	13.3	16.6
M6. Mean autumn temperature	10.2	10.2	0.3	9.6	11.3
M7. Minimum daily temperature	2.0	1.8	0.7	0.8	4.6
M8. Minimum weekly average temperature	4.6	4.6	0.5	3.6	5.9
M9. Maximum daily temperature	21.8	21.7	1.4	17.2	23.8
M10. Maximum weekly average temperature	15.3	14.4	2.0	13.2	19.3
M11. Annual degree days	2905	2553	631.3	2437	4036
V1. Annual standard deviation	4.4	4.6	0.4	3.0	4.8
V2. Winter standard deviation	1.7	1.7	0.2	0.9	2.1
V3. Spring standard deviation	2.3	1.4	1.5	0.6	4.0
V4. Summer standard deviation	1.8	1.8	0.2	1.1	2.1
V5. Autumn standard deviation	3.0	3.1	0.3	2.0	3.3
V6. Range in extreme daily temperatures	19.8	20.1	1.6	15.2	22.0
V7. Range in extreme weekly temperatures	10.7	10.0	2.2	7.2	14.8
F1. Frequency of hot days (>20°C)	0.4	0.0	1.2	0.0	6.0
F2. Frequency of cold days (<2°C)	0.0	0.0	0.2	0.0	1.0
T1. Date of 5% of degree days	23	21	4.9	17	32
T1. Date of 25% of degree days	175	192	29.6	126	197
T3. Date of 50% of degree days	222	232	18.3	191	240
T4. Date of 75% of degree days	274	279	11.7	254	291
T5. Date of 95% of degree days	322	325	8.8	307	333
D1. Growing season length	298	304	13.6	275	316
D2. Duration of hot days (>20°C)	0.3	0.0	0.7	0.0	3.0
D3. Duration of cold days (<2°C)	0.0	0.0	0.0	0.0	0.0

3.2.4 Mean T_w variation in the Erriff River catchment

The variation in mean water temperature during the hottest week of 2019 across the Erriff River catchment (per stream order) was calculated (Table 3.2). Highest water temperatures were observed in the Erriff River main channel and Derrycraff River based on stream order groupings (Fig. 3.4).

Table 3.2 Mean T_w observed on the hottest week of 2019 in the Erriff River catchment

Stream Order	Average Temp	Median	SD	Minimum	Maximum
5	18.8	18.8	0.2	18.4	18.9
4	17.7	17.7	0.6	17.1	18.9
3	17.1	17.1	1.1	15.1	19.0
2	16.0	16.2	1.1	14.1	17.2
1	15.9	16.3	0.9	14.5	16.4
All	17.2	17.2	1.3	14.1	19.0

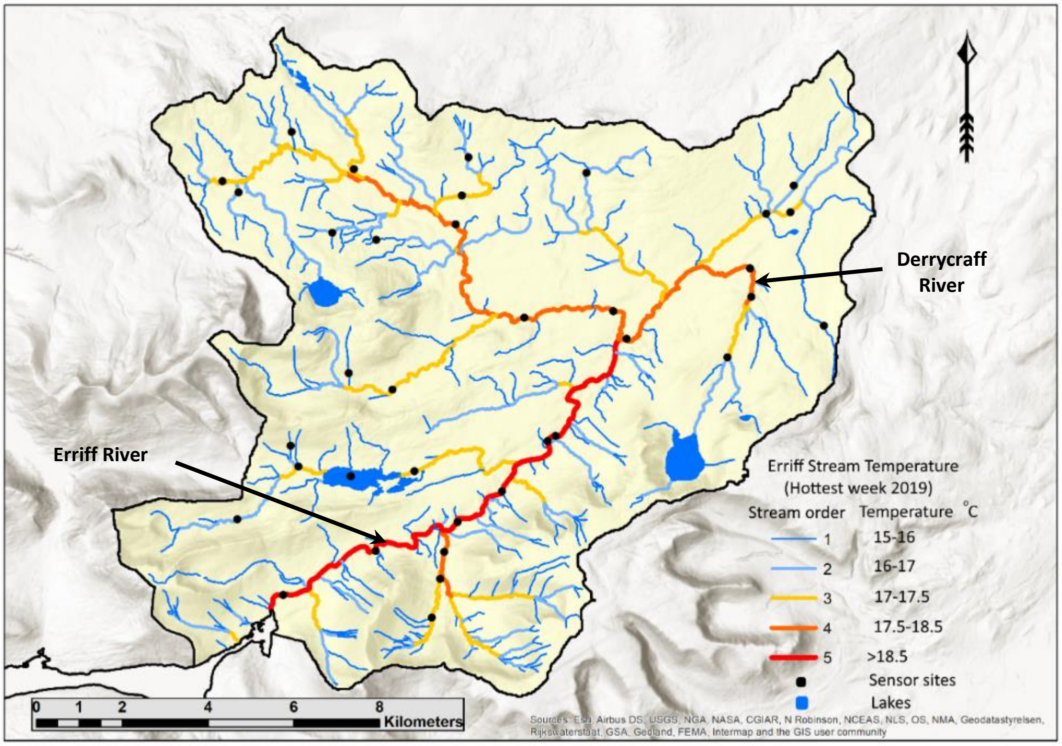

Fig. 3.4 Mean T_w/stream order during the hottest week of 2019 across the Erriff catchment.

3.2.5 Erriff River (NSIC) catchment summary 2020

The IFI Erriff meteorological data was used in conjunction with T_w data (Site 1 T_w monitoring network) and the Erriff River NSIC fish trap data to visualise the relationship between climate events and fish migration events on the Erriff during 2020 (Fig. 3.5). The relationship between air temperature (T_A) and T_w at the site is shown (Fig. 3.5). The highest recorded T_A was 25.9°C on 30/05/2020 while the coldest air temperature record was -2.9 °C on the 18/01/2020. The highest T_A was accompanied by a corresponding T_w of 21.43°C (with a daily low of 18.46°C); however the highest T_w (21.95°C) occurred one day later 01/06/2020 when the T_A was 24.5°C. The hottest average weekly period occurred in August where the highest T_w was 20.22°C (with a daily low of 18.07°C) on 12/08/2020 when T_A reached 22.8°C. February was the wettest month with a total of 369mm rainfall and the biggest flood of the year occurred on 09/02/2020. April was the driest month of the year in 2020, with a total of 27mm recorded, 39% of the total dry days occurred in April and May (Fig. 3.5).

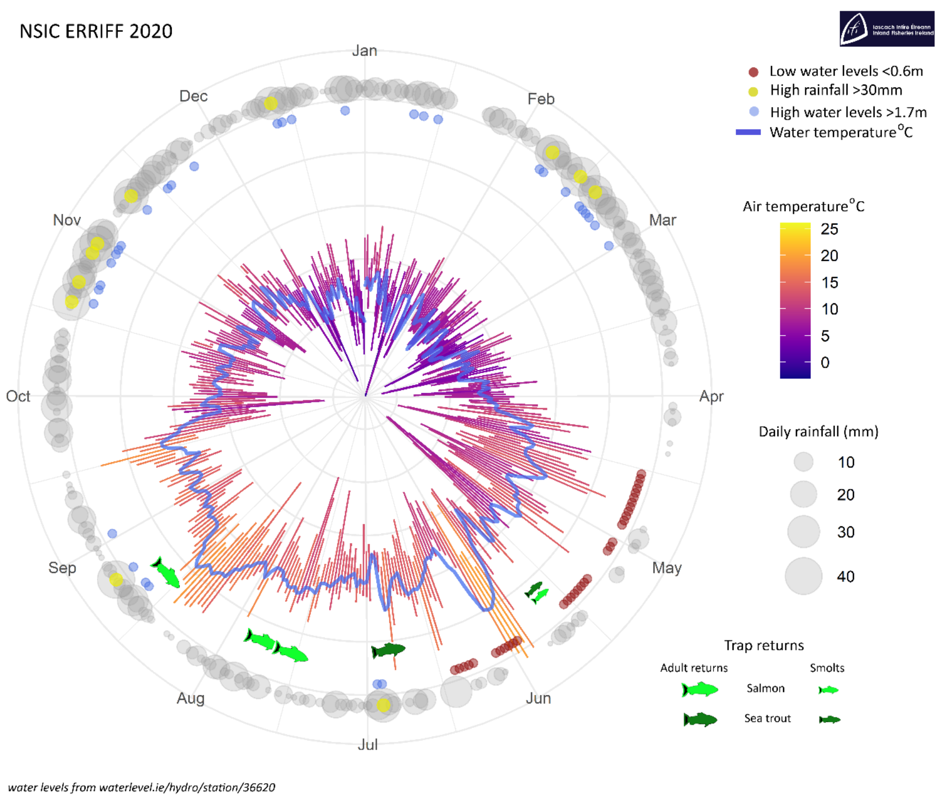

Fig. 3.5 Summary infographic showing T_A (°C), T_w (°C), rainfall (mm) and fish returns collected at the Erriff River research facility (NSIC) during 2020. Water levels are also shown. Data sources: IFI weather station, IFI T_w monitoring network, OPW water level and IFI NSIC fish data.

3.2.6 Tawnyard Lough T_w monitoring

T_w data for 2019 was downloaded from the thermistor chain (13 data loggers) in Tawnyard Lough during February 2020. This revealed the occurrence of lake stratification over a period of approximately seven weeks between 08/07/2019 and 22/08/2019 (Fig. 3.6). The stratification period appeared to have three stages, with two major wind events wind events reducing water column stability on each occasion by pushing the metalimnion ever further until eventually becoming fully mixed (Fig. 3.6). This gradual disintegration of water column stability is also highlighted by the Schmidt stability score (J/m^{-2}) that shows a decrease over time in the effort required to break the stratification process (Fig. 3.7).

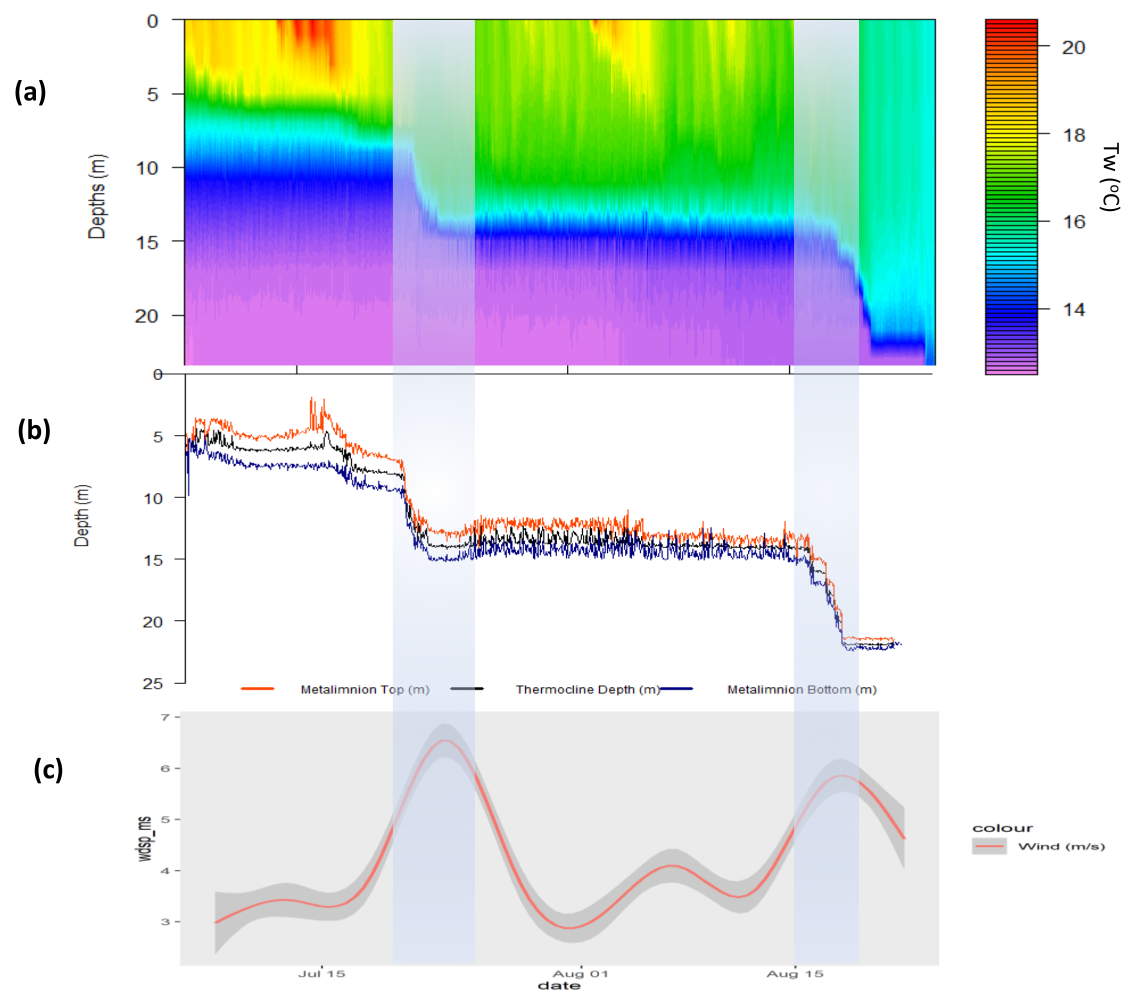

Figure 3.6. Data from Tawnyard Lough, July 8th to 22nd August 2019, (a) T_w plot (b) Thermocline depth and metalimnion thickness (c) wind speed (m/s^{-1}) from Met Eireann weather station in Newport, Co. Mayo. Light transparent band indicates a major wind event and its impact on the stratification processes.

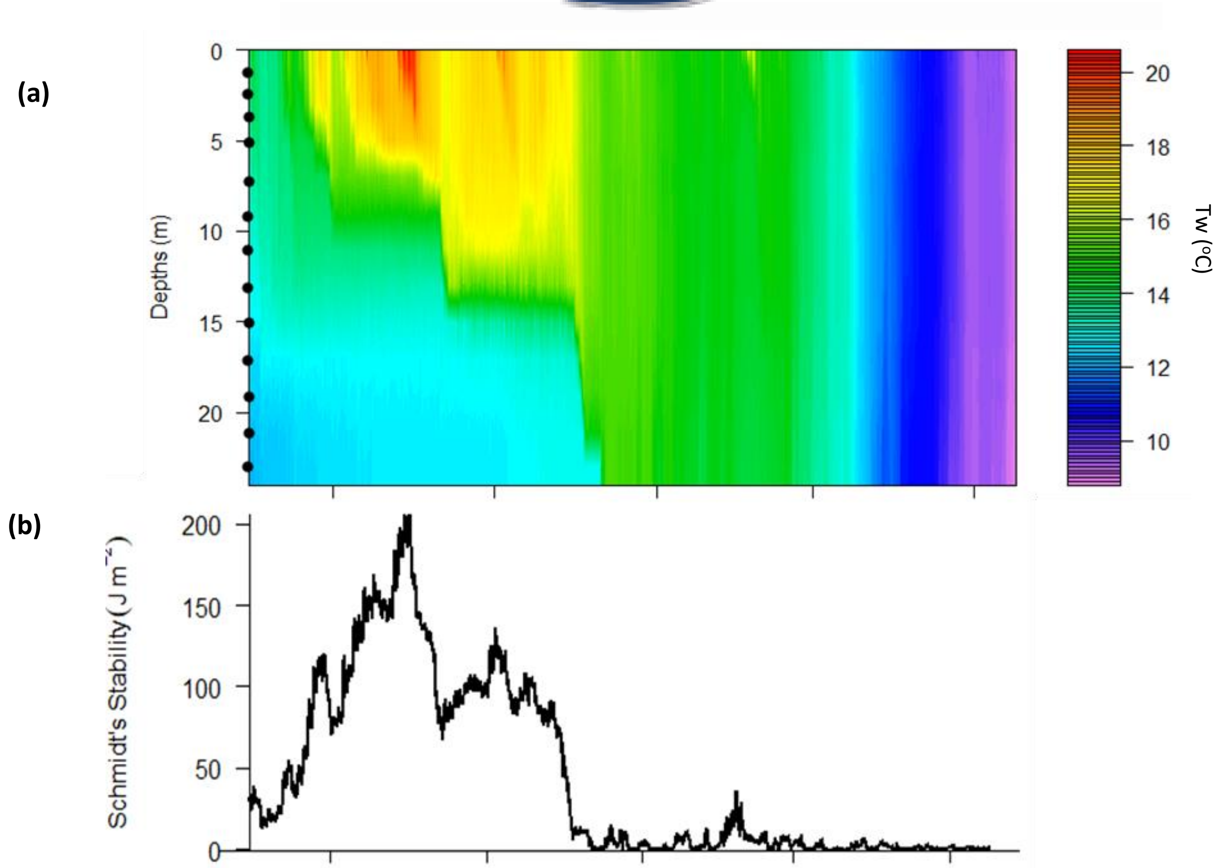

Figure 3.7: Data from Tawnyard Lough, June-November 2019. a) T_w plot (Thermistor chain loggers are shown on left edge). b) Schmidt stability (J/m^{-2}).

4. Summary

IFI's Climate Change Mitigation Research Programme (CCMRP) is building an evidence-based assessment programme to assess the impact of climate change on sensitive species. This work will inform and build capacity for fisheries conservation and protection measures. This report outlines the catchment and site selection process for IFI's long-term national index catchment monitoring network. Progress to date on the initiation of the T_W monitoring network in rivers and lakes is also described. Preliminary data from the Erriff River catchment (NSIC) is also displayed.

A long-term national index catchment monitoring network has been established in rivers and lakes across nine catchments representing the range of landscape variables in near natural catchments across Ireland. To date a total of 213 river T_w data loggers and 58 lake T_w data loggers have been deployed in nine catchments.

The case study from the Erriff index catchment summarises results from the T_w monitoring network installed in 2019. In total 519 candidate monitoring sites were identified for the Erriff catchment, landscape variables were calculated for each site, from which 36 monitoring sites were selected based on a range of site selection criteria. The resulting T_w monitoring network covers the range of relevant landscape characteristics observed in the Erriff. Thermal metrics from the stream network on the Erriff catchment (June 2019 to August 2020) exhibited a mean water temperature of 10.5 °C; mean winter and summer temperatures were 6.1°C and 15.6 °C, respectively. A total of 6 thermal stress days were recorded (>20°C) and 1 cold day (<2°C). The Erriff weather station recorded the highest air temperature of 25.9°C on the 30th of May 2020 and the coldest air temperature record was -2.9 °C on the 18th of January 2020.

Long-term T_w metrics were analysed from the NSIC trap facility on the Erriff River at Asleagh falls from 2007 to 2020. An increasing number of thermal stress days over time were observed between 2007-2020. In total 120 events occurred where the average daily water temperature exceeded 20°C. Thermal stress will begin to occur for salmonids when water temperatures are >19°C (Elliot and Elliot, 2010). It is important to identify where these limits may occur in stream and rivers during summer droughts (and during other seasons), identify risk areas and mitigate if necessary. Preliminary findings suggest that the main Erriff River channel is exceeding these critical thresholds during heatwave periods.

Temperatures of flowing waters control many physicochemical processes and affect the ecology of aquatic organisms and communities. Description of thermal regimes in flowing waters is key to understanding physical processes, enhancing predictive abilities, and improving bioassessments. Thermal regimes of rivers and streams in the nine index catchments will identify important drivers of thermal regimes in the varying river systems (Lake fed, spring fed, spate etc.).

The established CCMRP national T_w network will provide high quality scientific data to support management, conservation and protection of fish species and their habitats from climate change risks. The framework and future modelling of stream temperature will build an evidence-based research programme to assess the impact of climate change on the Irish fisheries sector and provide scientific advice to support fisheries managers.

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