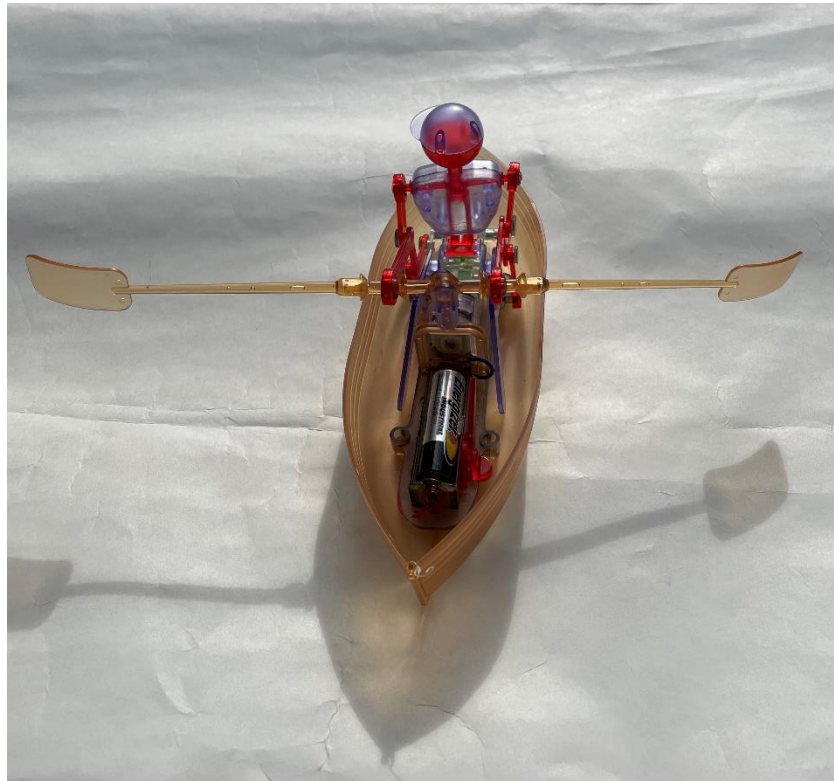


Impacts of recreational activities on riverine fish

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Submitted to Swansea University in fulfilment of the requirements for
the Degree of MSc by Research in Biosciences



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Summary

Freshwater environments sustain many pressures caused by anthropogenic activities.

This thesis explored some of these impacts. The thesis is divided into three chapters. The overall aim of the thesis was to research how anthropogenic activities impact freshwater fish and assess how users of rivers perceive their own impacts. Chapter one is a systematic literature review on the effects of riverine recreational activities on fish with a focus on behaviour. This was done to identify knowledge gaps and to determine if recreational disturbances can disrupt natural fish behaviours. It confirmed that fish react negatively to human disturbances sometimes with sublethal affects, the fishes normal behaviours were suppressed, such as, reproductivity and foraging in favour for anti-predatory behaviours. It also highlighted that future studies need to focus on indirect impacts from non-motorised boats, anglers and swimmers on fish and their natural behaviours. Chapter two gathered information from a survey, that was sent out to recreational river users, about how people use rivers as a resource and how they feel conflicts between groups could be managed. There were 230 responses to the questionnaire, it was evenly responded to by anglers, boaters and “others” (walkers, swimmers and cyclists). The anglers and boaters were found to access rivers less when they got older whereas other river users accessed them more. Respondents were found to use rivers frequently, at least once a week, and were accessing them all over Wales. There was clear zoning between boaters and anglers, boaters preferred daytime during winter months and when the river was in high flow compared to anglers who preferred summer and low to medium flows. The majority of participants (60%) felt that conflict was an issue experienced by river users, but that pollution and rubbish affected their enjoyment more. There was disparity between ages as well, anglers that were older were more likely to think there was a conflict and were less likely to support free access whilst the opposite was true for boaters and other users. A sentiment analysis indicated that boaters in general use a wider variety of words in their language when responded to the open text comments compared to anglers, but they all had “trust” as the most shared emotion. Most respondents agreed that greater dialogue would help reduce conflict but that spatial or temporal zoning might not be useful. The outcomes of this research highlighted the conflict between humans on rivers and the fact that conflicts prevent proper management of rivers. The questionnaire revealed the pattern of usage of rivers and the interaction between river users.

Chapter three is an experiment to quantify how fish behaviour to an avian predator changed after frequent exposure to a model kayak. There was a clear change in the way the fish responded to the avian predator model by the end of the week each time. The latency to respond to the model predator increased, the locations of the fish changed and the number of fish visible increased, these all suggest that the fish were habituating to the kayak model which in turn reduced their anti-predatory behaviours. The results suggest that the fish were not as vigilant by the end of the week and were bolder which would make them more vulnerable to predation, which would potentially affect their survival rate.

The research can be used to begin to understand what impacts humans have on fish in rivers and how severe they truly are. The research can be expanded upon and then used to develop management techniques for rivers and their users.

Declaration of Statements

Declaration

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed: 

Date: 5th August 2022

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit reference. A bibliography is appended.

Signed: 

Date: 5th August 2022

I hereby give my consent for my work, if relevant and accepted, to be available for photocopying and for inter-library loan after expiry of a bar on access approved by the university.

Signed: 

Date: 5th August 2022

The University's ethical procedures have been followed and, where appropriate, that ethical approval has been granted.

Signed: 

Date: 5th August 2022

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iii. Justification and aims of the thesis

Other than angling, the indirect impacts of recreational activities on fish are poorly known. However, in recent years as the popularity of water sports has increased conflict has ensued between anglers and other recreational users. Anglers have typically claimed almost exclusive rights to the use of rivers in Wales and England. They argue that other river users, especially boaters (kayakers, canoeists) disturb the fish and ruin their fishing. However, there is very little scientific evidence to back up this claim. Boaters claim that there is very little disturbance from their sports, and that they should be allowed to access rivers freely (Horton, 2022; Stanford, 2021). Therefore, the first aim of this thesis was to carry out a literature review (Chapter 1) in order to assess to what extent fish are affected by recreational disturbances with a focus on behavioural responses. This is important because, unlike survival or physiological stress which have been well studied, the behavioural responses of fish to recreational disturbances have seldom been examined but this information is needed to inform future impact studies.

In Chapter 2, a questionnaire was developed in order to gain a better understanding of how people use rivers in Wales and how they perceive conflict over river access. Such information is essential in order to improve river access while minimizing conflict. Access to rivers can help improve mental and physical health but currently only 3% are freely accessible to the public in Wales and England (Horton, 2022; Wynn-Davies, 2021). It was hoped that the results of the questionnaire might help inform a strategy to improve river access that acknowledges the different needs and perspectives of different river users.

Finally, and given the paucity of data (and contradictory results) on the behavioural responses of fish to recreational disturbances reviewed in Chapter 1, a disturbance experiment was conducted under controlled mesocosm conditions. The aim of the experiment was to evaluate how fish behaviour changes after frequent disturbances from a model kayak. It had been proposed that regular disturbances can make fish become more vulnerable to predation (Imre et al., 2016). Therefore my hypothesis was to that regularly disturbed fish would become less responsive over time to the sight of a model predator, perhaps by reducing their startle responses and their latency to respond (Ferrari et al., 2010; Vilhunen, 2006). I tested this on juvenile brown trout because they are distributed all over Europe and are popular sports fish. They also have similar reactions to other salmonids which are targeted by anglers.

Chapter 1. A systematic literature review of how freshwater fish respond to disturbances by recreational users

1.1. Introduction

Rivers are an important resource for humans they provide ecosystem services, they are used for drinking water, transportation, commercial fishing and recreation (Zajicek & Wolter, 2019). It is unknown how long humans have used rivers for recreation but in recent decades recreational activities involving freshwater have become more popular than ever (Jacobsen et al., 2014). This is important because access to blue spaces helps improve mental and physical health for humans (Buckley, 2013).

There is clear evidence that some recreational activities have detrimental impacts on wildlife (Lewin et al., 2007; Shannon et al., 2017). Most of this evidence has been gathered by studying birds but little data concerning effects on fish and other aquatic animals (Schafft et al., 2021; Slabbekoorn et al., 2010; Stott, 2019). Recreational activities directly affect vegetation cover around banks and the water quality which in turn decreases habitat availability and reduces their quality (Butler et al., 2021). Habitat loss can result in increased mortality from many factors, usually because species must relocate to areas with higher numbers of predators (Jacobsen et al., 2014). One of the ways aquatic birds have been affected is that they have become habituated to disturbance from humans (Schafft et al., 2021; Slabbekoorn et al., 2010; Stott, 2019). Schafft et al., (2021) concluded that this habituation has led to the aquatic birds being at higher risk for predation, leading to reduction in population levels and overall fitness. The diversity of birds in climatic regions has been reduced because of non-motorised recreational activities in their natural habitats (Stott, 2019). In other cases, human presence has prevented birds from using the sites for nesting or has led the birds to abandon their young (Stott, 2019). It is evident that birds change their behaviour due to humans, these changes are almost certain to occur in other species, but research of other species is scant (Slabbekoorn et al., 2010).

Studies focussing on fish have looked at the direct impacts to health and welfare mainly from catch and release fishing (Card & Hasler, 2021; Cooke et al., 2006; Jensen et al., 2010; Klefoth et al., 2008, 2011) and noise pollution from motorboats (Bruintjes & Radford, 2013; Jacobsen et al., 2014; Maxwell et al., 2018; Mickle, 2017; Simpson et al., 2016). There are few studies concerning human presence disturbing fish especially how humans disturb their natural

behaviours (Bejder et al., 2009). Fish have been shown to exhibit stress responses to human presence such as metabolic and opercula rate changing, activity levels dropping, avoidance behaviour and reduced foraging (Kusku, 2020; Mickle, 2017). These responses are caused by human presence; therefore, fish may respond the same or more detrimentally to disturbance from freshwater recreational activities. There is a gap in scientific information available about how freshwater fish' behaviour is affected when exposed to recreational activities. There are also relatively few studies concerning whether disturbing fish change their natural behaviours such as foraging, anti-predatory behaviours and reproduction (Venohr et al., 2018), this information is vital to river management because changes to natural behaviours can have sublethal effects and populations could collapse (Graham & Cooke, 2008; Mickle, 2017). Studies have not looked at the subtle impacts of using rivers as a recreational resource (Murchie et al., 2008; Venohr et al., 2018). Most studies that have examined the effects of recreation have used camera setups in rivers and lakes to monitor behaviours, because there are so many environmental influences in the natural environment it has proved difficult to draw conclusions.

Indirect disturbances were focused on for the review with a few direct disturbances to address the overall picture of recreational activities in rivers. There are very intense pressures on rivers from recreation in a way that is not seen in the marine environment because of the size of them and because people densely populating areas near rivers (Graham & Cooke, 2008). Rivers are also governed by strict rules that are easier to implement than in marine environments (Venohr et al. 2018). The rules set in rivers often have little scientific evidence to back them up. The aim of this literature review (Chapter 1) was to examine how freshwater fish respond to disturbances from recreational activities with a focus on behaviours.

1.2. Materials and methods

1.2.1. Search for research papers

I used Google Scholar, Web of Science and Google to investigate how anthropogenic impacts affect freshwater fish with a focus on behaviour. Peer reviewed as well as non-peer reviewed literature such as, government reports and reports compiled by public bodies were used at the number of studies were limited. Any document published between 1980 and March 2022 was considered for inclusion in this study. Documents were searched for by using search terms in combinations. The searches used were “recreational impact on behaviour”, “recreational impact on fish behaviour”, “recreational impact on fish behaviour + freshwater”, “recreation + fish behaviour + freshwater”, “angling + fish behaviour + freshwater”, ““freshwater fish AND “behaviour” AND “kayaking””, “anthropogenic disturbance, fish behaviour, “freshwater” OR “aquatic””, “anthropogenic recreation, fish behaviour, “freshwater” OR “aquatic”, “recreation + freshwater fish”, “freshwater recreational fishery “disturbance””, “anti-predatory behaviour in fish changing after disturbance”. Papers found from these searches were then used to find further papers from their reference lists that fit into the line of research. When papers could not be found or accessed from literature reviews, the literature reviews themselves were used in the study. The papers were categorised into four types of disturbance: human presence, catch and release, non-motorised boating and noise. Articles were included if they met the following criteria: (i) freshwater environment – focussing on rivers, (ii) fish had to be one of the study organisms, (iii) recreational activities had to be assessed, (iv) direct impacts on fish, (v) published with a version in English. To distinguish and select articles for this systematic literature review the guidelines from Preferred Reporting Items for Systematic Review and Met-Analyses (PRISMA) (Hutton et al., 2015) were used (Figure 1.1.).

Overall, 107 articles were found from Google Scholar, Web of Science and manual searches. To ensure there was no bias from using Google Scholar, three different computers were used to compare the same search terms, the search terms brought up the same 100 articles for each. From these articles, 63 were selected as they contained the key words searched for. Two records were excluded after further evaluation as they were about fish in aquaculture. Eight studies were also excluded because the focus of the studies was on the effects of recreation on birds, turtles and invertebrates, not on fish. Next, four studies were removed because they focused on recreation in the marine environment which involved motorsports as the main disturbance, this is not as common in freshwater so did not fit well with this study. For the systematic literature review 58 articles were included.

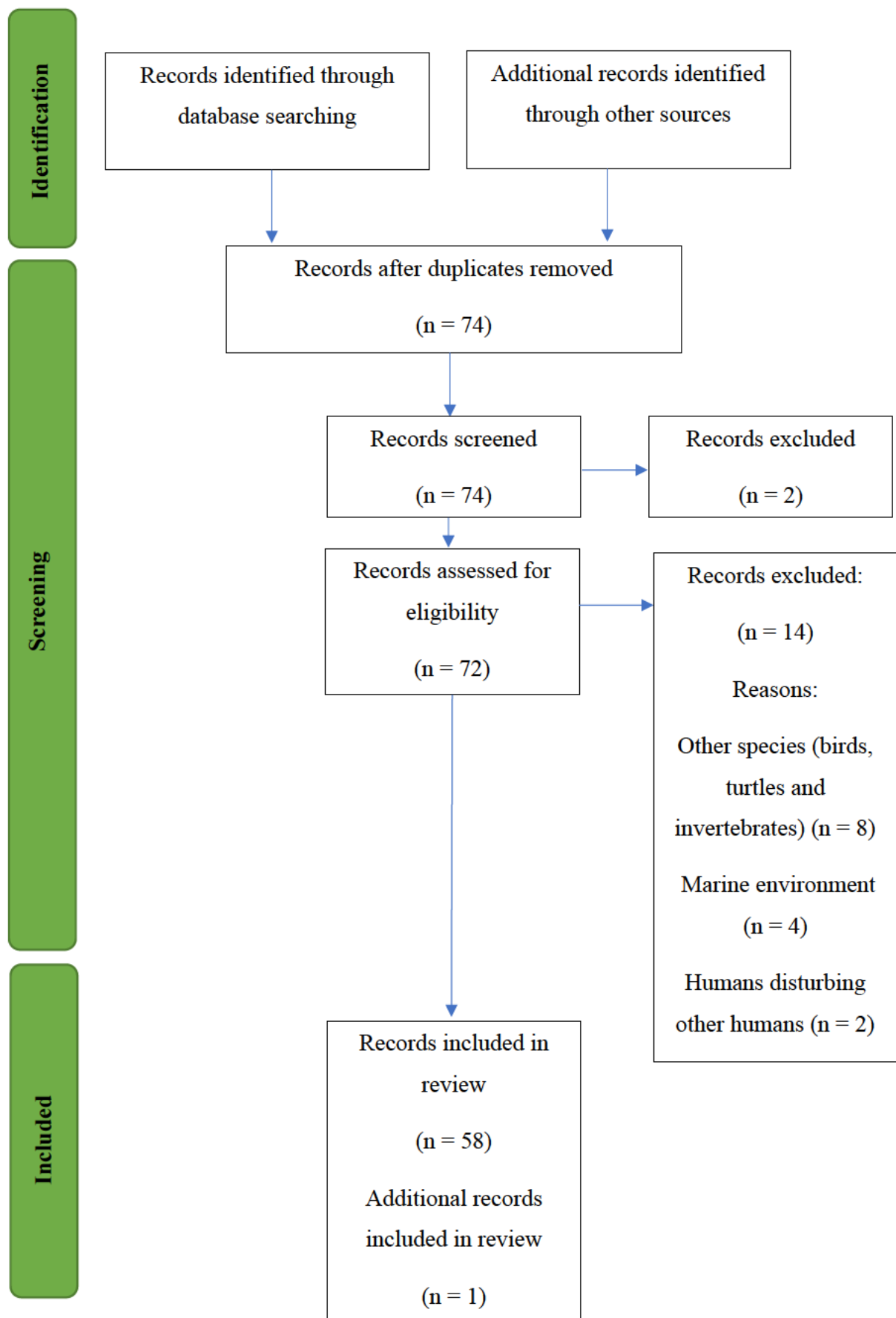


Figure 1.1. Flow chart detailing selection of articles following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

1.3. Results and Discussion

1.3.1. Temporal trends

In the last fifteen years there has been an increase in the studies examining how fish respond to human disturbances. Of the 58 publications included in this systematic review two were written in the 1980s compared to 37 from the last ten years (Figure 1.2.), many more peer-reviewed papers in the last thirty years. There is an increase because there are more papers published each year. Another explanation is the need for conclusive information on how fish respond to recreational activities to help determine better management strategies to protect fish as these are lacking (Arlinghaus, 2006). The first studies in the 1980s involved the use of underwater monitoring to view the impact of boat noise on fish behaviours and a review investigating how recreations effects the freshwater ecosystem (Liddle & Scorgie, 1980; Mueller, 1980). In the mid 2000's welfare of fish was examined after catch and release angling, investigating how it affects cardiac rate, metabolism and behaviour (e.g., Cooke et al., 2004; Cooke, Ostrand, et al., 2003; Cooke, Steinmetz, et al., 2003; Cooke & Sneddon, 2007; Huntingford et al., 2006). In the 2010s noise from motorboats was the focus for studies, investigating how fish physiology and behaviour changes after exposure (e.g., Bruintjes & Radford, 2013; Maxwell et al., 2018; Sebastianutto et al., 2011; Shafiei Sabet et al., 2015; Slabbekoorn et al., 2010). Since 2015 there has been an increase in studies looking at how recreation including swimming and non-motorised boats effect fish welfare and behaviour (e.g., Meyer et al., 2021; Schafft et al., 2021; Shannon et al., 2017; Stott, 2019).

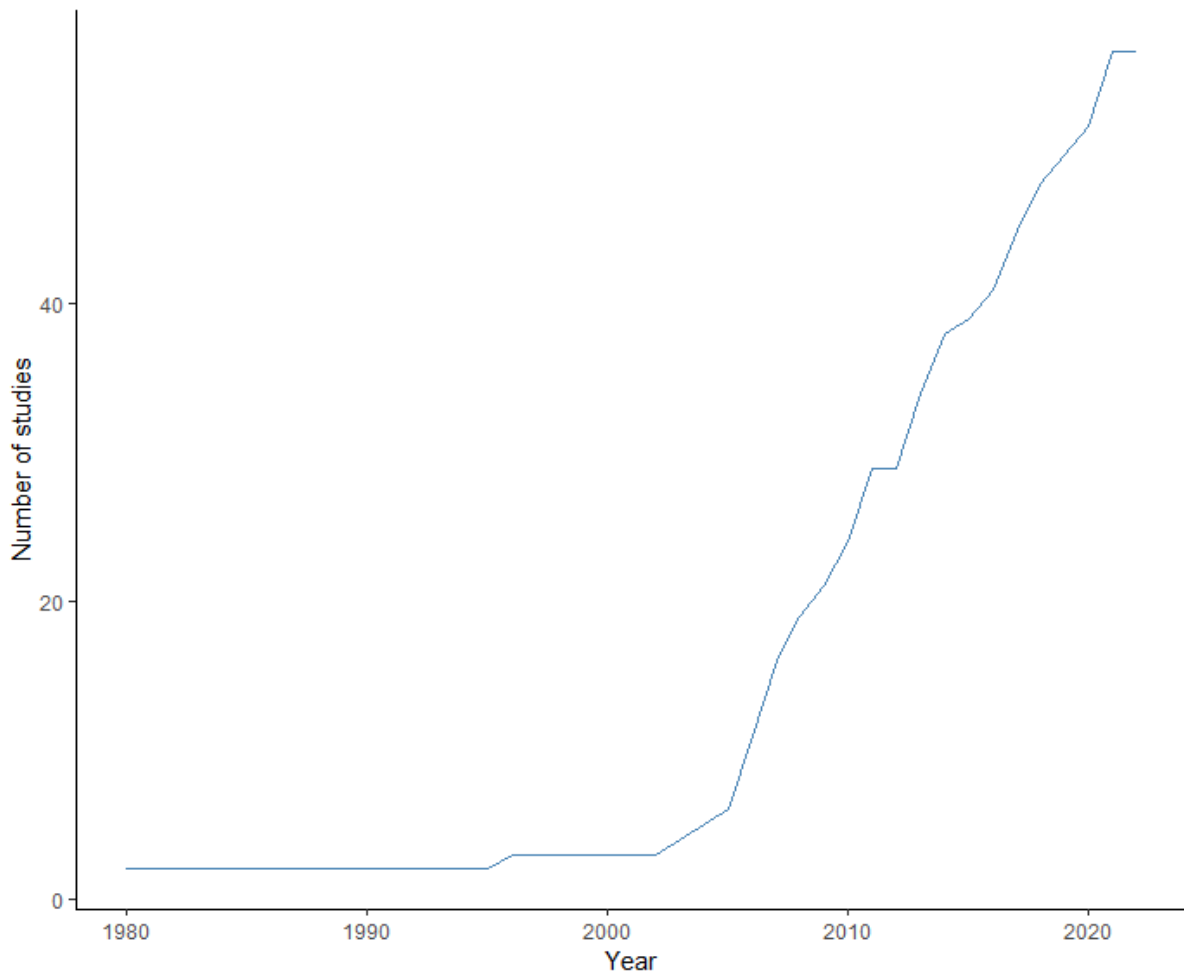


Figure 1.2. Cumulative frequency of research into recreational disturbances and fish response changing over the years and becoming more prominent in recent years (n = 58).

1.3.2. Study species

The study species was extracted from all 58 of the publications, however, only 24 studies had specific species. Largemouth bass (*Micropterus salmoides*) was the most popular study species with six separate studies (Table 1.1.). Centrarchidae was the most studied family of fish, studied 11 times, this could possibly be due to most studies being situated in North America where these are popular fish for anglers (Cooke et al., 2004; Suski et al., 2005). These fish have also been well studied before so there is data for their normal behaviours to use in comparison with new studies (Graham & Cooke, 2008).

Table 1.1. 24 studies out of 58 examined specific species of fish. The number of times these fish species have been studied within the 24 studies found.

Species name	Common name	Family	Number of studies
<i>Anguilla anguilla</i>	European eel	Anguillidae	1
<i>Aplodinotus grunniens</i>	Freshwater drum	Sciaenidae	1
<i>Argyrosomus japonicus</i>	Mulloway	Sciaenidae	1
<i>Coregonus albula</i>	Vendace	Salmonidae	1
<i>Crenichila lepidota</i>	Pike cichlid	Cichlidae	2
<i>Cyprinus carpio</i>	European carp	Cyprinidae	2
<i>Danio rerio</i>	Zebrafish	Cyprinidae	1
<i>Esox lucius</i>	Northern pike	Esocidae	4
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	Gasterosteidae	1
<i>Lepomis macrochirus</i>	Bluegill	Centrarchidae	2
<i>Lepomis megalotis</i>	Longear sunfish	Centrarchidae	1
<i>Micropterus dolomieu</i>	Smallmouth bass	Centrarchidae	2
<i>Micropterus salmoides</i>	Largemouth bass	Centrarchidae	6
<i>Moenkhausia bonita</i>	Tetra	Characidae	1
<i>Neolamprologus pulcher</i>	Daffodil cichlid	Cichlidae	1
<i>Notropis volucellus</i>	Mimic shiners	Cyprinidae	1
<i>Oncorhynchus mykiss</i>	Rainbow trout	Salmonidae	1
<i>Oreochromis niloticus</i>	Nile tilapia	Cichlidae	1
<i>Perca flavescens</i>	Yellow perch	Percidae	1
<i>Perca fluviatilis</i>	European perch	Percidae	1
<i>Pimephales notatus</i>	Bluntnose minnows	Cyprinidae	1
<i>Pomacentrus amboinensis</i>	Ambon damselfish	Pomacentridae	1
<i>Prochilodus lineatus</i>	Streaked prochilod	Prochilodontidae	1
<i>Rutilus rutilus</i>	Common roach	Cyprinidae	1
<i>Salmo salar</i>	Atlantic salmon	Salmonidae	1
<i>Salmo trutta</i>	Brown trout	Salmonidae	1
<i>Sander vitreus</i>	Walleye	Percidae	1
<i>Tinca tinca</i>	Tench	Cyprinidae	1

1.3.3. Trends in design of research papers

The majority of the records used in this systematic review were literature reviews and meta-analysis's (n = 24, 42%) (Figure 1.3.), these reviews focused on impacts on population levels (Buckley, 2013; Lewin et al., 2007) whereas in situ experiments (n = 20, 34%) tended to focus on disturbance to individuals (Bruintjes & Radford, 2013; Monk & Arlinghaus, 2017; Twardek et al., 2017). The literature reviews provided a concise overview of information that had been previously collected about how fish respond to disturbances. Laboratory experiment made up 12% (n = 7) of the records used in this review. Laboratory experiments focused on individual responses to disturbance and were closely monitored in controlled conditions which is advantageous for evaluating the fish's specific behaviour changes to each disturbance. The problem is that this is not a natural system, just a simulated one, so conclusions must be drawn cautiously (Slabbekoorn et al., 2010). Noise disturbance to fish has mostly been researched in laboratories (Table 1.2.) which was evidenced by this project (Graham & Cooke, 2008).

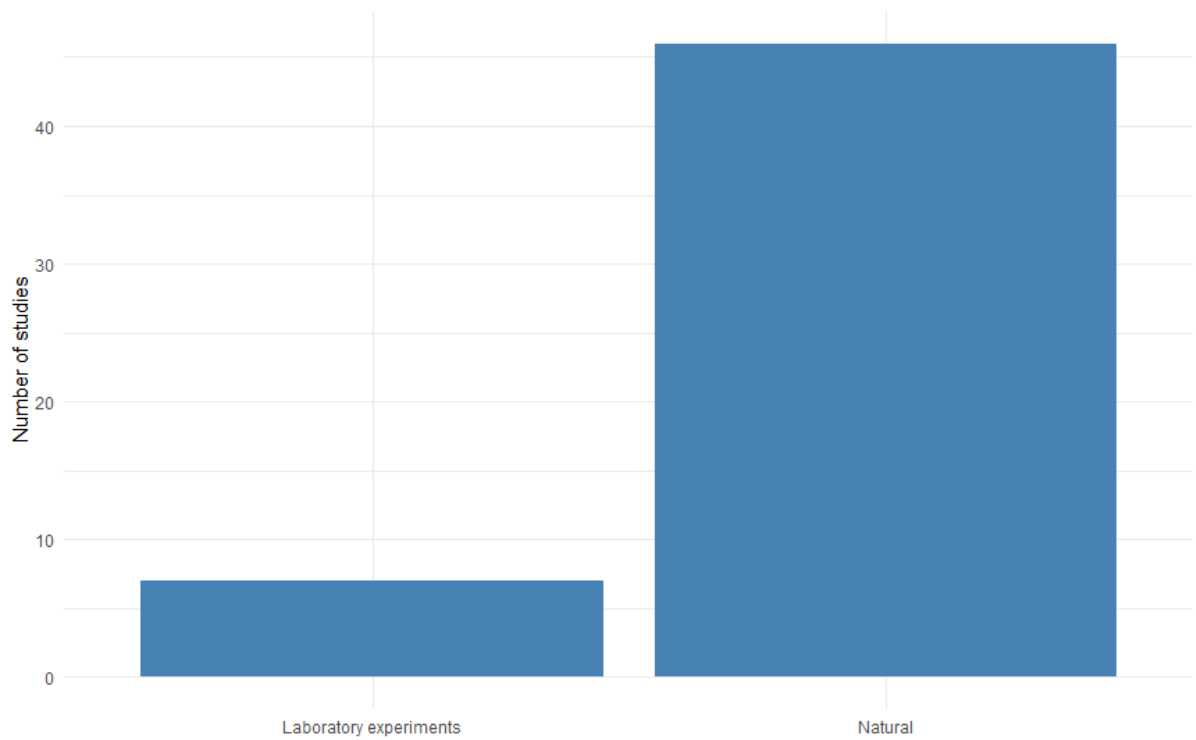


Figure 1.3. The type of study that was involved in all records used in this literature review (n = 58).

1.3.4. Geographical trends

Research on the impacts on wildlife from recreational activities has been concentrated in Canada and Germany (Figure 1.4.) accounting for 34% (20) and 26% (15) of the studies globally. Research in Canada has focussed on impacts from noise pollution, 45% (nine out of 20) of studies involved lakes and river with aims to protect fisheries stocks and welfare (e.g., Graham & Cooke, 2008; MacLean et al., 2020; Maxwell et al., 2018). Angling impacts followed closely behind with 35% studies (seven out of 20) researching how catch and release effects commercially important fish and what the repercussions mean for fisheries stocks (e.g., Cooke et al., 2006; Cooke & Sneddon, 2007; Gingerich et al., 2007; Raby et al., 2014). The Centrarchidae family has been the most used in experiments in Canada with seven of the surveys taking place in Lake Opinicon, Ontario and one close by in Manitoba where they are popular sportfish with anglers. Centrarchidae fish are often apex predators that structure fish communities and shape the ecosystem around them, therefore, if too many the food web could collapse, because of this there is interest from fisheries management and the conservation viewpoint (Maxwell et al., 2018; Twardek et al., 2017). Protected areas where recreation is banned at certain sensitive periods of the year such as spawning season have been put in place to avoid harming population levels in Canada (Twardek et al., 2017). Other studies in Canada involved literature reviews, which included investigating how navigation effects fish assemblages in rivers and how mortality from predation effects fish released from fishing gears (Gutreuter et al., 2006; Raby et al., 2014).

In Germany 53% (eight out of 15) studies focused on fishing impacts to fish welfare and population levels (e.g., Robert Arlinghaus, 2006; Klefoth et al., 2008, 2011; Monk & Arlinghaus, 2017). Apart from fishing the three studies tested the impact of noise on fish behaviours (Jacobsen et al., 2014; Kusku, 2020; Slabbekoorn et al., 2010), some literature studies went on to investigate the impact of non-motorised recreational activities on the freshwater ecosystems (Meyer et al., 2021; Schafft et al., 2021; Schmidt & Gassner, 2006). Two studies focused on how navigation through rivers by recreational users' effects fish assemblages and welfare (Wolter & Arlinghaus, 2003; Zajicek & Wolter, 2019). In the rest of Europe studies focussed on similar topics, for example in the UK (11 studies) literature reviews assessed the effects of water sports and ecotourism on freshwater animals and plants (e.g., Huntingford et al., 2006; Shannon et al., 2017; Stott, 2019). In Italy, Norway, Switzerland, Denmark and Sweden field studies tested how benthic fish react to anthropogenic noise disturbances and the effects of swimmers and angling on fish reproduction and migratory

behaviours (e.g., Jensen et al., 2010; Sebastianutto et al., 2011; Tjärnlund et al., 1996; Weisbrod et al., 2007).

Studies in the USA (eight) have centred around recreational activities in rivers and how they are disturbing the behaviours of popular fish for angling such as the largemouth bass and longear sunfish with the noise from the boats and the presence of humans (e.g., Fleissner & Mensinger, 2021; Mueller, 1980). There were two studies identified in South America, in Brazil, one of which was a field study using underwater cameras to monitor the disturbance from snorkellers in freshwater streams and the other was a review investigating how tourist monitoring is altering fish behaviour (Bessa & Gonçalves-de-Freitas, 2014; Teresa et al., 2011). One study took place in South Africa which studied the impacts of motorboats in rivers on fish in a review (Whitfield & Becker, 2014).

Australian (five) and New Zealand (two studies) have performed literature reviews on how to monitor and manage recreation in the future to limit the impacts on freshwater ecosystems (e.g., Bejder et al., 2009; Buckley, 2013; Butler et al., 2021; Liddle & Scorgie, 1980). The reviews in New Zealand have also looked at the impacts of catch and release fishing to fish physiology, behaviour and welfare and how radio and acoustic telemetry studies can be used to monitor the impacts of recreation (Davie & Kopf, 2011; Jellyman & Jellyman, 2009).

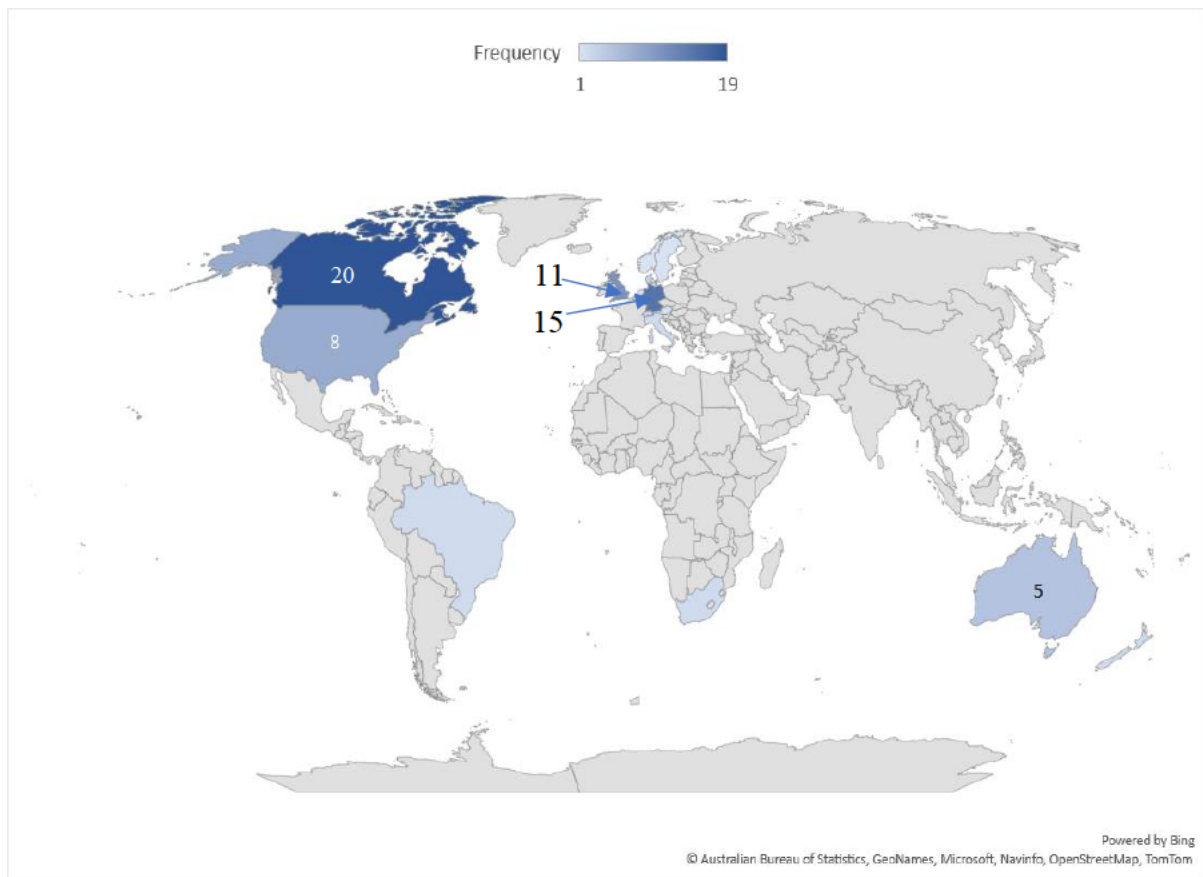


Figure 1.4. Number of publications per country, numbers are displayed for countries with more than five publications.

1.3.5. Evidence of behavioural changes

The evidence from the 58 studies included in this review suggests that fish respond to disturbances from recreational activities in ways that negatively affect their fitness with potentially sublethal effects (Table 1.1.). The extent of the response from the fish to the disturbance in the wild to is not known due to the lack of reliable studies in the field and the small selection of species that have been used in experiments. The studies show variation in fish' response depends on multiple factors such as the type of species, environmental conditions, level of human disturbance, time of year, depth of water, length of time the activity takes and type of recreational activity (Liddle & Scorgie, 1980; Slabbekoorn et al., 2010; Venohr et al., 2018). The findings show that fish become stressed when exposed to recreational activities, the consensus was that fish's normal behaviours were potentially negatively affected (Maxwell et al., 2018; Slabbekoorn et al., 2010; Whitfield & Becker, 2014). Reduced foraging rates, reduced fitness, reduced reproductivity and reduced activity were noted in studies focusing on impacts to behaviour in fish (Table 1.). Studies focused on noise as the factor in disturbance from recreation, particularly how it invokes stress responses in the fish. This literature review will help to inform future studies about which areas of the topic are lacking research. When determining how fish respond to recreation experiments care should be taken to perform trials with variations in temperature of water and duration of disturbances. The activity levels of fish before and after disturbances should then be compared to baseline levels for each species. The findings suggests that reproduction after disturbances has been most studied and growth has been least studied (Davie & Kopf, 2011). One reason for lack of studies about growth changes was because of the difficulty and expense of monitoring in the field over long periods of time. Studies mentioned that reduced growth is a sign of chronic stress (Cooke & Sneddon, 2007; Davie & Kopf, 2011; Slabbekoorn et al., 2010). Only one study looked directly at growth rates after catch and release, 20 northern pike were monitored over seven months, their growth rates were reduced compared to fish that were not caught (Klefoth et al., 2011). It is interesting that growth was not assessed more in disturbance experiments because this is a good indicator of stress and therefore should be investigated as a key metric (Davie & Kopf, 2011). The studies that involved species specific experiments often did not have a large experimental group (Card & Hasler, 2021; Cooke et al., 2004; Mueller, 1980). Card & Hasler (2021) included 48 fish in their study and Cooke et al., (2004) included 37. In future research larger groups should be used to collect more accurate data. Seven studies focused on reproduction and it was the most used metric in the records used for this systematic review (Table 1.1.), this is likely because of its use when assessing if fish stocks will be impacted in

the future. The studies that looked at impacts of angling focused on reproduction because that is deemed important along with angling mortality and growth for sustainable fisheries (Cooke & Sneddon, 2007). Anti-predatory behaviours are an important metric to monitor because if the fish habituate to human disturbance, then there is a chance that they could lose their wariness to predator activity, leaving themselves vulnerable to attack (Bejder et al., 2009; Klefoth et al., 2011; Simpson et al., 2015). Only two of the studies looked at how antipredator responses were affected by recreational disturbance. Furthermore, individual characteristics of species should be assessed alongside reproduction, foraging and growth because these could be more important indicators of sublethal disturbance from recreation (Bejder et al., 2009; Klefoth et al., 2008; Meyer et al., 2021).

Table 1.2. Impacts on freshwater ecosystems from recreational activities taken from a selection of records used in this systematic review that focused on fish and their behaviour.

Author	Type of Study	Focus of study	Type of Disturbance	Effect on fish
Venohr et al., 2018	Literature review	Freshwater ecosystem	Boating, bathing and angling	Bathing induced estrogenic effects on fish reproduction and physiology (Weisbrod et al., 2007). Motor boating effected fish mortality by predation and changing swimming speed, physiology, behaviour, ecology, biological functions, communication and habitat structure (Graham & Cooke, 2008; Jacobsen et al., 2014; Simpson et al., 2016; Whitfield & Becker, 2014; Wolter & Arlinghaus, 2003). Non-motorised boating cause sublethal physiological disturbances in fish (Graham & Cooke, 2008). Angling effected fish directly by changing their demography, abundance and increased disease and mortality (Lewin et al., 2007).
Meyer et al., 2021	Literature review	Waterways	Non-motorised recreation – bathing, snorkelling and diving studied for fish	Negative effects from bathing and snorkelling for fish were increased avoidance behaviour, lower abundances, reduced aggression from territorial fish and reduced reproduction (Bessa & Gonçalves-de-Freitas, 2014; Schmidt & Gassner, 2006; Teresa et al., 2011).
Liddle & Scorgie, 1980	Literature review	Plants and animals	Water-based and shore-based recreation – boating, angling and swimming	Motorised boats were found to not affect fish production. Canoeing was found to affect fish productivity. Angling impacts were not found and stated to not be known.
Whitfield & Becker, 2014	Literature review	Fish	Motorboats	Motorboat noise increased stress levels and disrupted reproduction (Gutreuter et al., 2006; Slabbekoorn et al., 2010). Passage of boats breaks up fish schools and increased avoidance behaviour (Mueller, 1980). Reduced territorial behaviour of <i>Gobius cruentatus</i> and nest caring from <i>Chromis</i> (Picciulin et al., 2010; Sebastianutto et al., 2011).
Simpson et al., 2016	In situ and laboratory experiments	Ambon damselfish (<i>Pomacentrus amboinensis</i>)	Motorboats	Noise exposure in field and the laboratory reduced foraging efficiency. In the field damselfish became twice as likely to be caught by predators after exposure.

Author	Type of Study	Focus of study	Type of Disturbance	Effect on fish
Maxwell et al., 2018	In-situ experiment – Lake Opinicon, Canada	Largemouth bass (<i>Micropterus salmoides</i>) - Motorboat noise on parental care	Motorboat	Motor noise did not change time on nest, pectoral fin beats or number of turns however changes to nest tending and brood guarding were measured.
Davie & Kopf, 2011	Literature review	Fish - catch and release	Angling	Increased stress, reduced reproduction, increased disease susceptibility, delayed mortality and suppressed feeding and growth.
Arlinghaus et al., 2013; Arlinghaus, 2006	Literature review	Fish	Angling	Avoidance behaviour from carp and largemouth bass for up to three years after hooking event.
Gingerich et al., 2007	In situ experiments – Lake Opinicon - Canada	Bluegill (<i>Lepomis macrochirus</i>) - catch and release	Angling	Delayed mortality in fish when water temperature was higher. Fish also lost equilibrium more at higher temperatures with longer air exposure which leads to increase in predation. Reduced reproductive effort was seen after catch and release.
Bessa & Gonçalves-de- Freitas, 2014	In situ experiments	Cichlid fish (<i>Crenichila lepidota</i>)	Tourism	Human presence prevented fish from nesting and subdued their territorial and reproductive behaviours.

Author	Type of Study	Focus of study	Type of Disturbance	Effect on fish
Cooke et al., 2004	In situ experiment – held in enclosures in lake Opinicon	Fish - cardiac disturbance	Angling	Largemouth bass (<i>Micropterus salmoides</i>) exhausted quicker than fish in laboratory conditions. Their heart rates increased with increasing temperatures.
Slabbekoorn et al., 2010	Literature review	Rainbow trout (<i>Oncorhynchus mykiss</i>) - Noise pollution underwater	Motorboat	Heart rate and cortisol increase in captive fish when exposed to boat noise. Rainbow trout did not experience any detrimental impacts on their growth, survival or susceptibility to disease when exposed to noise in fish tanks.
Cooke & Sneddon, 2007	Literature review	Fish - Catch and release	Angling	All kinds of recreational fishing causes individual fish to experience injury and stress. Severity of injury will change depending on fisherman's behaviour and environmental conditions.
Raby et al., 2014	Literature review	Fish - Catch and release	Angling	Post release predation was observed in the wild released from recreational fishing rods in Atlantic sailfish (<i>Istiophorus albicans</i>), Black marlin (<i>Makaira indica</i>), Bonefish (<i>Albula vulpes</i>) and red snapper (<i>Lutjanus campechanus</i>). Fish experience loss of equilibrium after release.
Stott, 2019	Literature review	Wildlife	Water sports	Shoal cohesion was broken up by pressure waves from boats. Non – motorised boats also disturbed fish.

Author	Type of Study	Focus of study	Type of Disturbance	Effect on fish
Jacobsen et al., 2014	In situ experiment – Lakes	Fish - Boat noise effect on behaviour with and without angling	Angling and boating	Roach (<i>Rutilus rutilus</i>), perch (<i>Perca fluviatilis</i>) and pike (<i>Esox Lucius</i>) did not change their response to the boat whether it was with or without angling. Habitat change in roach but not perch and pike. Roach and perch swimming speeds increased during disturbances; pike did not change swimming speed.
Jensen et al., 2010	In situ experiment – Norway	Atlantic salmon (<i>Salmo salar</i>) - Catch and release	Angling	There was no change in migratory behaviour before or after catch and release events.
Card & Hasler, 2021	In situ experiment	Freshwater drum (<i>Aplodinotus grunniens</i>) - Catch and release	Angling	Orientation was impaired after catch and release incidents.
Klefoth et al., 2008	In situ –Rivers and lakes	Catch and release angling	Angling	Pike (<i>Esox lucius</i>) did not change their movement and distance to shore after catch and release events (only 20 fish tested). Pike experienced short term disturbance, reduced activity, from catch and release fishing.
Mueller, 1980	In situ experiment	Longear sunfish (<i>Lepomis megalotis</i>) - Recreational boating	Motorboats and non-motorised boats	Nest defence by male fish was abandoned when boats were in proximity to nests and travelling slowly.

Author	Type of Study	Focus of study	Type of Disturbance	Effect on fish
Graham & Cooke, 2008	Laboratory experiment	Largemouth bass (<i>Micropterus salmoides</i>) - Noise disturbance from recreation	Motorboats and non- motorised boats	Cardiac output increased in largemouth bass when exposed to all types of boat noise. The recovery time for cardiac output took ~15 minutes after paddling disturbance compared to ~40 minutes recovery from combustion engine. The level of disturbance to the bass from the canoe and trolling motor was like that of predator attacks.
Mickle & Higgs, 2018	Literature review	Anthropogenic noise	Motorboats and non- motorised boats	Boat noise reduced foraging efficiency and activity levels in wild mullet (<i>Argyrosomus japonicus</i>) (Payne et al., 2015), zebrafish (<i>Danio rerio</i>) (Sabet et al., 2015) and three-spined stickleback (<i>Gasterosteus aculeatus</i>)
Baktoft et al., 2013	In situ experiment – Lake in Denmark	Pike (<i>Esox Lucius</i>) - Handling after angling	Angling	Higher temperatures after handling led pike to reduce activity.
Bruintjes & Radford, 2013	In situ experiment	Cichlid fish (<i>Neolamprologus pulcher</i>) - Anthropogenic noise on social behaviour	Motorboats	Nest digging behaviour was reduced once the fish were exposed to boat noise along with decreased defence against predators of their nests. Aggression increased during and after noise exposure. Stress levels increased along with avoidance which led to reduced foraging due to noise exposure.
Schafft et al., 2021	Meta - analysis	Shore and water-based wildlife	Angling, bathing and boating	Fish experienced elevated mortality from human disturbance paired with reduced breeding success. Individuals' vigilance decreased after exposure to recreational angling, boating and swimming. The results varied for how fish reacted to the humans bathing, there is very little data about how this effects behaviour.

1.3.6. Disturbance from noise pollution

Noise pollution in the aquatic environment from motorboats was examined by sixteen studies as a disturbance from recreational activities (Table 1.2.). Noise has the potential to disrupt communication and prey and predator detection whilst also deterring fish from foraging grounds and reproductive areas (Fleissner & Mensinger, 2021; Mickle & Higgs, 2018). Noise levels have been increasing in and near the aquatic environment over the last century (Mickle & Higgs, 2018; Slabbekoorn et al., 2010). Noise disturbance caused fish to respond in the same way that they would respond to a threat from a predator in all studies except Maxwell et al. (2018) and Jacobsen et al., (2014). Parental care was not affected in largemouth bass, and pike did not change their activity levels respectively, however, there was an increase in cortisol production in largemouth bass from boat noise played intermittently. The lack of reaction from pike was potentially because they were not used to potential threats due to their lack of past experiences with potential threats (Jacobsen et al., 2014). White noise and boat noise have been found to increase cortisol production in fish in the laboratory and if this stress is prolonged then fish would experience reduced growth and reproduction (Slabbekoorn et al., 2010). However, perch and roach have been found to become habituated to motorboat noise after 11 days of exposure, which could mean stress is not chronic for all species. The perch and roach, however, reduced their avoidance behaviour due to habituation to disturbance which could affect their mortality by predation (Mickle & Higgs, 2018; Simpson et al., 2016). Jacobsen et al., (2014) also found that roach changed the area of habitat they used when exposed to motorboat noises, increasing their potential to be displaced into higher risk habitats where less food may be available or more predators may be present. These combining factors could lead to high mortality rates that are not observed immediately so it is important to monitor over time how fish respond to the disturbances. High mortality rates after exposure were not observed in these experiments, however, this could be due to the length of studies (Buckley, 2013; Raby et al., 2014).

Overall stress from noise has been found to impact natural behaviours such as foraging efficiency, avoidance, aggression, shelter response, habitat use and activity levels (Bejder et al., 2009; Klefoth et al., 2011; MacLean et al., 2020; Maxwell et al., 2018; Simpson et al., 2015). Physiological changes from anthropogenic noise were increased metabolic rate and increasing glucocorticoid (cortisol) levels (Bruitjes & Radford, 2013; Mickle, 2017; Slabbekoorn et al., 2010). Physiological changes were found by Graham & Cooke (2008) they used largemouth bass and measured heart rate and stroke volume during and after exposure to

a canoe paddling, trolling engine and combustion engine. All the noise disturbances from the experiment increased cardiac output, canoe paddling increased cardiac output by ~20% while the combustion engine caused a ~40% increase. The fish took ~15 minutes to settle their cardiac rate after exposure to the noise from canoe paddling and ~40 minutes to recover from the combustion engine. The time the fish took to recover from the canoe was similar to the recovery from predator attempt and swimming activity (Cooke et al., 2003a). Whereas the recovery from the combustion motor took the same time as recovery from moderate exercise (Cooke et al., 2003b). Maxwell et al. (2018) reported that largemouth bass only changed their parental behaviours during the exposure to boat noise and not after, which is differing from Graham & Cooke (2008) potentially because physiological reactions last longer than behavioural. Slabbekoorn et al., (2010) noted that if the juvenile salmonids are exposed to less intense noise for longer periods of times it can be more detrimental to their health than louder shorter noises such as combustion engines. Maxwell et al., (2018) drew different conclusions stating that the largemouth bass had a significant cortisol response from the boat noises that were not continuous, this could be because responses are species dependent. Only Kusu (2020) conducted a long-term study of noise effects on fish, the study ran for 120 days and found that the Nile tilapia reduced their response over time to the boat noise. Most of the studies focused on immediate effects from noise disturbance because of the cost of long-term monitoring. These studies show that anthropogenic noise disturbance has the potential to cause sublethal effects, even when the noise is relatively quiet. However, more experiments need to be conducted in the field with larger study groups and for longer periods of time to determine if the fish's habituation to anthropogenic noise is affecting their antipredator behaviours.

1.3.7. Boat disturbance excluding noise

Non-motorised boats such as canoes and kayaks interestingly can affect because they produce sound that can disturb fish even if they are relatively quiet (Graham & Cooke, 2008). The impacts from non-motorised boat noise on fish have not been properly studied yet (Fleissner & Mensinger, 2021; Liddle & Scorgie, 1980). Graham & Cooke, (2008) was one of the only studies found that investigated how canoe paddling disturbed fish. Mueller (1980) also looked at paddling impacts however, the study was limited because of equipment available at the time and the short amount of time between disturbance events. In both studies fish responded to the paddling disturbance with disruption to their behaviour and physiology such as moving away from nests and increase in heart rate and stroke volume (Graham & Cooke, 2008; Mueller,

1980). In 1978 Marnell et al. concluded that fish breeding is reduced by the disturbance from canoeing, however they could not state this for all species. Mueller (1980) found that longear sunfish were displaced from their nest 71% of the time when a canoe went overhead compared to only 3% of the time when a fast-moving motorboat passed over. There is evidence from these studies that show fish might be harmed more by slow-moving boats than fast boats. There needs to be further investigation into the extent of the disturbance before informing any recreational measures because of the limitations to these studies. Noise is not the only disturbance that occurs from non-motorised boats, and it is important to note that disturbance from these boats has been properly investigated for wildfowl but not for fish (Graham & Cooke, 2008; Schafft et al., 2021; Stott, 2019). Pressure waves and displacement of water from these kinds of boats were mentioned by Stott (2019) and MacLean et al. (2020) as factors that could displace fish and disrupt schools. The effect of pressure waves from paddled boats on fish behaviour has not been explored yet.

1.3.8. Angling disturbances

Jacobsen et al. (2014) investigated the combined effects of boating and angling disturbances to fish behaviours, this was the only study found that looked at this combination. Three studies stated that angling causes ecological disturbance to fish even when they are not being caught, because fish react to the human presence the same way they react to a predator (Bessa & Gonçalves-de-Freitas, 2014; Lewin et al., 2007; Liddle & Scorgie, 1980). Klefoth et al. (2011) did not agree with this and concluded that human presence from angling does not disturb fish. Similarly, in Jacobsen's study the fish did not change their response when angling was introduced from the boat, however, the effects to their behaviour were potentially masked by the stress from the boating disturbance which could not be teased apart. Even though the fish did not react specifically to angling incidents Jacobsen could not conclude that angling does not disturb fish because of the uncertainty. Schafft et al. (2021) suggested that angling may not cause much disturbance compared to other recreational activities due to the solitary and quiet nature of the sport.

1.3.9. Catch and release angling

Angling can have direct impacts on fish from the physical act of catching them, which was noted in 11 studies, as it can affect reproduction, foraging efficiency, predation mortality, flight

response, nest defence, swimming activity and vigilance (Baktoft et al., 2013; Card & Hasler, 2021; Jacobsen et al., 2014; Klefoth et al., 2008; Schafft et al., 2021). One of the most obvious impacts of fishing is the damage to tissue from hooking which can increase susceptibility to disease and therefore increase mortality rates. Another visible impact is the loss of equilibrium after release which Gingerich et al., (2007) found the fish were then six times more likely to suffer from predation than fish that were able to swim off straight away, other behavioural and physiological impacts were not always as clear (Huntingford et al., 2006). Catch and release impairs fish's behaviours and compromises their physiological state which can then result in delayed mortality, this is often obscured by interacting factors when determining fishing effects on fisheries (Card & Hasler, 2021; Closs et al., 2016). Growth rate decreased in fish that had been caught and released compared to fish who had not been handled before in three separate studies (Cooke & Sneddon, 2007; Davie & Kopf, 2011; Klefoth et al., 2011). Reduced growth is a result from chronic stress along with reduced fitness and immune response (Cooke & Sneddon, 2007; Davie & Kopf, 2011; Jellyman & Jellyman, 2009).

Stress from fishing incidents was suggested to cause mortalities due to metabolic exhaustion, if the fish survive, they would still be recovering for days after the event (Cooke et al., 2004, 2006; Cooke & Sneddon, 2007; Davie & Kopf, 2011). Furthermore, stress from catch and release may negatively affect reproductive function in brown trout, a popular sport fish in the UK, which is often used for modelling effects to salmonids behaviours, the quality of reproductive output from fish can also be reduced (Davie & Kopf, 2011; Huntingford et al., 2006). Reproduction is an important factor to maintaining fisheries stock levels and the unseen effects can result in collapse of the population.

Another issue found by two studies was that after catch and release fishing fish were less likely to defend their nests and likely to abandon them due to stress which impaired their reflexes, this has negative repercussion for viability of offspring (Davie & Kopf, 2011; Klefoth et al., 2008). Similarly, four studies found that northern pike experienced high stress after catch and release which was seen via reduced swimming immediately after handling and increased glucose levels for 96 hours after (Baktoft et al., 2013; Klefoth et al., 2008, 2011; Schwalme & Mackay, 1985). One study found that carp and largemouth bass increased avoidance of humans up to three years after being handled, the fish are therefore being disturbed for long periods after being caught (Klefoth et al., 2013). Not all natural behaviours have been affected by catch and release, Jensen et al. (2010) found that Atlantic salmon did not significantly change their migratory behaviours after handling. Rapp et al. (2012) also found that the common carp

recover quickly after handling and there were only minor physiological changes immediately after release. These however were the only studies found that did not record a change to behaviours after catch and release. One of the clear results from the literature was that the magnitude of impact from these incidents depended on behaviour of the angler (handling and air exposure) and the environmental conditions (temperature and water quality). Three studies agreed that if the temperatures were high at the time of catch and release then fish were more likely to experience chronic stress and detrimental impacts to their behaviours and physiology (Cooke et al., 2004, 2006; Cooke & Sneddon, 2007; Gingerich et al., 2007).

1.3.10. Further disturbance from recreation

This review focussed on the impacts on fish from boating mainly motorised and fishing because they have been the most studied. Three studies were found to Butler et al. (2021), Graham & Cooke, (2008), Schafft et al. (2021) also briefly review the impacts from recreational swimming in freshwater environments. Schafft performed a meta-analysis of ecological impacts from water-based recreation including swimming impacts however, they found that there were very few records of the impacts except about toxins from sunscreen entering the water which significantly affect fish health. They found that impacts to all taxa from recreational activities were significantly negative. Graham & Cooke (2008) found from a previous study, that could not be accessed online, that swimming did not influence smallmouth bass reproductive behaviour as much as canoeing did. Butler et al. (2021) performed the only in situ experiment found that investigated the impacts from wading and swimming on the freshwater ecosystem, they concluded that disturbance to benthic habitats from wading could have more knock-on effects than swimmers that affect the water quality. Only one of the studies mentioned the impacts of swimming on fish behaviour, which were minimal compared to a paddled boat (Graham & Cooke, 2008). A lot of the impacts from this recreational activity are unknown however, there should still be limitations to numbers of people allowed to use sights according to Butler et al. (2021) because of the disturbance they cause (Butler et al., 2021; Meyer et al., 2021).

1.3.11. Conclusion

This systematic review has revealed that research into physiological disturbance to fish from humans is lacking. Most of the research has focused on direct impacts to biodiversity and the ecosystem rather than the individuals. It has also shown that more research needs to be focused

on long term impacts and in situ experiments where interacting factors are taken into account. Feedback to a range of activities from fish has not been properly quantified. It is however, clear that fish react to various types of recreational activities in rivers however this depends to some degree on the species, environmental conditions and age. One way fish react to disturbance is by increasing time spent hiding and reducing time spent foraging or breeding. Motorboats have been shown here to have negative effects on fish due to the noise pollution and propellor action causing increased stress and reduction of reproduction output quality (Graham & Cooke, 2008; Whitfield and Becker 2014; Maxwell et al., 2018; Mickle and Higgs 2018; Zajeck and Wolter 2019; Maclean et al., 2020). The studies showed that paddled boats are equally detrimental to nesting fish along with motorised boats due to the slow speed that they pass through nest sites at prolonging the disturbance and driving fish from nests (Mueller 1980; Stott 2019). Angling disturbance was not as consistent when looking at indirect consequences from their presence and the effect on fish varies greatly between species. Direct effects from angling were clearly detrimental to fish especially when environmental conditions were extreme. Results from swimming disturbances were inconsistent with no clear conclusion to draw from these studies. Noise pollution was the most studied topic in relation to disturbing fish and their behaviours and swimming was the least studied.

It is important to note that due to the nature of the study it has been limited by publication bias. Some studies in this topic which did not perform as well as the ones found in this literature review were not published. The study was also limited due to the lack of solid studies in the areas researched. These limitations will all influence the conclusions drawn, therefore they should be cautiously interpreted. Future research should work to address management of freshwater waterways in a sustainable way. No research appears to have addressed the subject of human presence disturbing fish's natural behaviours.

There is opportunity for this information to be used to design surveys to better understand recreational impacts to better inform river management. Future research should focus on in situ fish responses to different types of recreational activities at varying frequencies and varying distances. The research should also look at the impacts of the activities in different environments such as different turbidity levels, different temperature levels, different species of fish and different river/lake depths. The overall goal of this literature review was to evaluate the available information about recreational activities and their impacts to freshwater fish. This would then begin to inform regulatory bodies in their response to recreational concerns on

rivers. Especially as conflict is likely to increase with the increasing uptake of recreational activities.

Chapter 2. Assessing perceptions on river access

2.1. Introduction

In recent decades recreational river use has increased massively, as this has occurred the benefits of using natural blue spaces have also become clearer, such as improving mental health and wellbeing (Arnberger et al., 2018; Buckley, 2019; Gascon et al., 2017; Hines, 2017; Lackey et al., 2019; McManus et al., 2011; Poulsen et al., 2022; Völker & Kistemann, 2011; White et al., 2020, 2021). In the USA sports such as stand-up paddle boarding increased in numbers by 61.6% from 2013-2016 and kayaking also increased by 14.9% in the same time frame (Stott, 2019). These recreational activities are important to many humans because of the benefits they provide to their wellbeing, mental health and social needs (Venohr et al., 2018; Government, 2019; Gwent Angling Society, 2020). In recent years because of the increasing number of people using rivers, conflict has developed over ownership and access rights. There are currently no statutory public rights of recreational access in inland rivers in Wales, so there is no clarity about who has the right to access rivers. However, as much as 97% of rivers are not accessible to the public in the UK (Government, 2019; Stanford, 2021; Wynn-Davies, 2021; Horton, 2022). The conflict has revolved around boaters and anglers using the rivers at the same time. Anglers believe the boats disturb the fish and therefore ruin their sport; boaters believe they should be able to access rivers freely and that there is little to no disturbance (Wynn-Davies, 2021). This has led to a dispute between the groups that does not have a simple solution (Dudley, 2017).

Anglers in Wales must pay for the right to fish and are given strict rules about when and where they can fish, as well as how many fish they can catch in order to protect spawning fish and juveniles (Dudley, 2017; Gwent Angling Society 2020). Private owners and fishing clubs' own stretches of riverbank which then cause disputes about whether boaters should be allowed to access these stretches of rivers (Wynn-Davies, 2021). Boaters at this time do not have free use of the rivers, "River Access For All" was set up in 2011 to campaign for the public right of navigation (Dudley, 2017). Common Law and the Magna Carta (1215) has been brought up in this argument many times to try to prove that there was an assumed right to navigate rivers in England in the past (Church et al., 2007; Church & Ravenscourt, 2006; Dudley, 2017; Horton, 2022). However, some believed now that because all rivers are privately owned this prevents the right to navigate (Gwent Angling Society, 2020; Stanford, 2021). The Government's stance has been to promote voluntary access, to be developed between owners of the riverbanks and

boaters (Church & Ravenscroft, 2011). The disputes between anglers and boaters have at times led to heated discussions and physical altercations, at present there is no clear resolution in the pipeline (Church & Ravenscourt, 2006). Surveys have previously revealed differences in values and opinions between river users (National Assembly for Wales Commission, 2010). The questionnaire was designed to better understand why action has not been taken to research the implications of human disturbance to riverine fish. Conflict between river users means that protection for rivers is not as effective. The aims of the questionnaire (Chapter 2) were to quantify how people use rivers in Wales and to collect information on their opinions about issues facing rivers and how to resolve these.

2.2. Materials and Methods

2.2.1. Background

To determine how different groups of rivers stakeholders' access and use rivers in Wales as a resource a questionnaire was designed with the help of representatives from each group e.g., anglers, kayakers, canoeists, swimmers and river managers. The topic of interest was decided with advice from each group. Questions were then drafted and edited by a the supervisory team at CSAR before being sent out. A pilot questionnaire was conducted to ensure the questions were addressing the issues that river users were facing. The pilot study was sent to members of each activity group. After approval from each member of the pilot study the questionnaire was ready for circulation. The questionnaire was first sent out in November 2021 to all angling groups with valid email addresses in Wales these were found using the Welsh Angling Club Directory and then was also distributed out by Canoe Wales to their members, after this the questionnaire was posted onto CSAR's (Centre of Sustainable Aquatic Research) Facebook and Twitter pages while also requesting for it to be posted to wild swimming clubs pages. The questionnaire was also sent to any river users that were known to us. The questionnaire was created using SurveyMonkey (SurveyMonkey: The World's Most Popular Free Online Survey Tool). In total 230 responses were collected by the end of January; the questionnaire was closed on the 31st of January 2022. The user groups that did not fit into boating (n = 97) or angling (n = 87) categories were excluded from further analysis because of the lack responses (walking n = 18, swimming n = 23, cycling n = 1, other n = 4).

2.2.2. Developing the questionnaire

The first four questions were designed to obtain information about their main activity on the river, their age, the region of Wales they mainly access rivers in and the specific river catchments they access (multiple choice). The next four questions identified how often users accessed rivers each year, the time of year, the time of day and the type of river flow they prefer, this was used to determine where there might be overlap between the user groups. The last four questions focused on opinions the users have about issues to do with river basin management. The first asked about the conflict between groups and if they thought it was an issue, this was a yes, no or do not know question. Users were then asked to what extent different factors such as water quality, rubbish and river users effect their enjoyment from never to very often (Likert scale). For the eleventh question of the questionnaire the participants were asked to rank if their own use of the rivers affects others enjoyment from definitely affecting others

to definitely not. The twelfth question was used to find out how river users felt about promoting greater access to rivers and finally the thirteenth question helped to determine what measures may be successful in reducing conflicts such as temporal and spatial zoning, introducing charges and limiting number of users they were given a Likert scale to answer which would make the greatest difference to them.

2.2.3. Analysis of responses

All data was analysed using R version 4.0.2 (R Core team 2022). Chi-squared tests were used to test the difference in answers between anglers and boaters for question one to question nine and question 12 because the answers were categorical. Cumulative link mixed model was used to assess the degree of consensus among participants from the R package *ordinal* with the *clmm2* function for question 10, 11 and 13 (Christensen, 2019; Mangiafico, 2016). The consensus of respondents was analysed with the *agrm* package (Ruedin & Aeppli, 2021). The percentage overlap method was used to account for seasonality, location, flow and diel preferences between river users by calculating the overlap (Krebs, 1999). To identify the difference in opinion between the user groups the stressors and management actions were plotted against percentage of respondents who strongly agreed and agreed to the questions (support) and consensus.

2.2.4. Sentiment analysis

Sentiment analysis (Misuraca et al., 2020) was performed in R version 4.0.2 on the open response section (n = 64) of question 13. Sentiment analysis (Mäntylä et al., 2018) and text mining (Silge & Robinson, 2017) were employed to further understand the views and emotions of the respondents. Text was initially processed by converting it into a Corpus which could then be used to complete the steps needed for simplifying it. The text had to be converted so that the sentiment analysis could be applied. Firstly, everything was converted to lower case then all numbers and punctuation was removed, using a library of common English stop words (r source “smart”) such as like, the, a and what these could also be removed to simplify the text. The words were then manually stemmed so that similar words were analysed as one such as, boat canoe and kayak or rivers and waterways were treated as the same. A word cloud was built to visualise the most common words used. The Syuzhet (Jockers, 2015; Naldi, 2019) library was then used to calculate sentiment values for the eight emotions (Figure 2.1.), that

they have used to categorise 10,748 English words, within the two main groups of respondents (anglers and boaters). Word networks were made to view the correlation between words for boaters and anglers. The emotional sentiment was then plotted in a bar chart by group to visualise the overall sentiment. The number of times the words were used in each group were then counted and their correlations were used to build word networks.



Figure 2.1. The sentiments that analysis with Syuzhet library on R breaks text down into.

2.3. Results

From November 1st 2021 to 31st January 2022 the survey had 230 responses from anglers (n = 87, 38%), boaters (including any paddling sport such as kayaking and canoeing, n = 97, 42%) and others (including walkers, cycling and swimmers, n = 46, 20%).

2.3.1. Demographic of respondents

The respondent groups were all at different ages (Kruskal-Wallis test, $\chi^2 = 11.734$, $p = 0.003$), others (mean = 43.4 years, SD = 13.7) and boaters (mean = 47.3 years, SD = 14.3) were significantly younger than the anglers (mean = 52.1 years, SD = 12.8).

The respondents were focused in the South East (32%) and South West (24%) of Wales, however, they did select 40 of the different rivers across Wales. The amount of use of rivers was different across the regions (Fisher's exact test, $p = 0.008$). The respondent groups also varied where they were most likely to access the rivers. The boaters were most common in the North East, the others were located mostly in the South West whilst the anglers were mostly using rivers in the Mid East (Figure 2.2.).

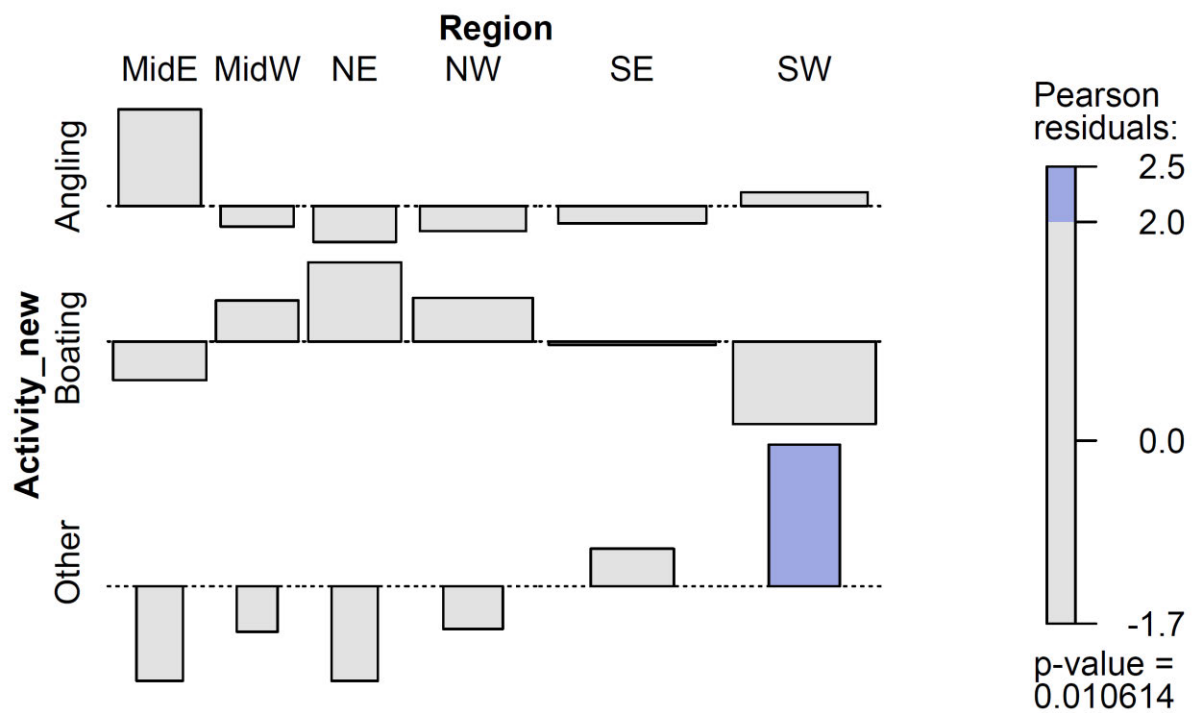


Figure 2.2. Association plot between user groups and region. The statistically positive residuals are show in blue and the statistical significance of the overall test of no association is shown at the bottom right. The proportion of the sample size is represented by the size of the rectangle. The height of the rectangle is proportional to the deviation from the random expectation of no association.

2.3.2. Frequency of river use

The respondents visited between one and 14 rivers, and this was significantly different depending on their age ($t = -2.443$, $p = 0.015$), the group they belonged to (other; $t = -2.739$, $p = 0.007$) and the interaction between age and group (other $\times$ age $t = 2.743$, $p = 0.007$; Generalised Linear Model fitted with quasi-poisson link). The older the boaters and anglers were the fewer rivers they accessed however, for others the older they got the more rivers they accessed. The anglers and others visited a similar number of rivers each year (anglers mean = 3.6 rivers; other mean = 3.5 rivers; $\chi^2 = 13.08$, $df = 2$, $p = 0.001$), the boaters visited the most rivers frequenting on average 4.8 rivers.

The number of visits to the rivers each year varied between one and 31 with a median of 20 visits and a mean of 19.4 visits a year ($SD = 10.45$). There was no significant difference in how often the different groups visited rivers in one year ($p = 0.168$) or the users age ($p = 0.520$) and region ($p = 0.633$; Generalised Linear Model fitted with quasi-poisson link). The more often the respondents went to the rivers per year the larger the variety rivers that they visited (Generalised Linear Model fitted with quasi-poisson link; parameter estimate = 0.03622, $SE = 0.01193$, $t = 3.0.36$, $p = 0.003$).

2.3.3. Temporal trends in river use

The user groups differed between times of year that they used the river (Fisher exact test, $p < 0.001$), showing clear seasonal zoning. Boaters were more likely to access rivers during the winter months whilst anglers were more likely to access rivers during the summer months (Figure 2.3.). Anglers were significantly more likely to use rivers in twilight and night conditions compared to boaters and others (Figure 2.4.; Fishers exact test, $p < 0.001$), showing that there is temporal zoning between the user groups.

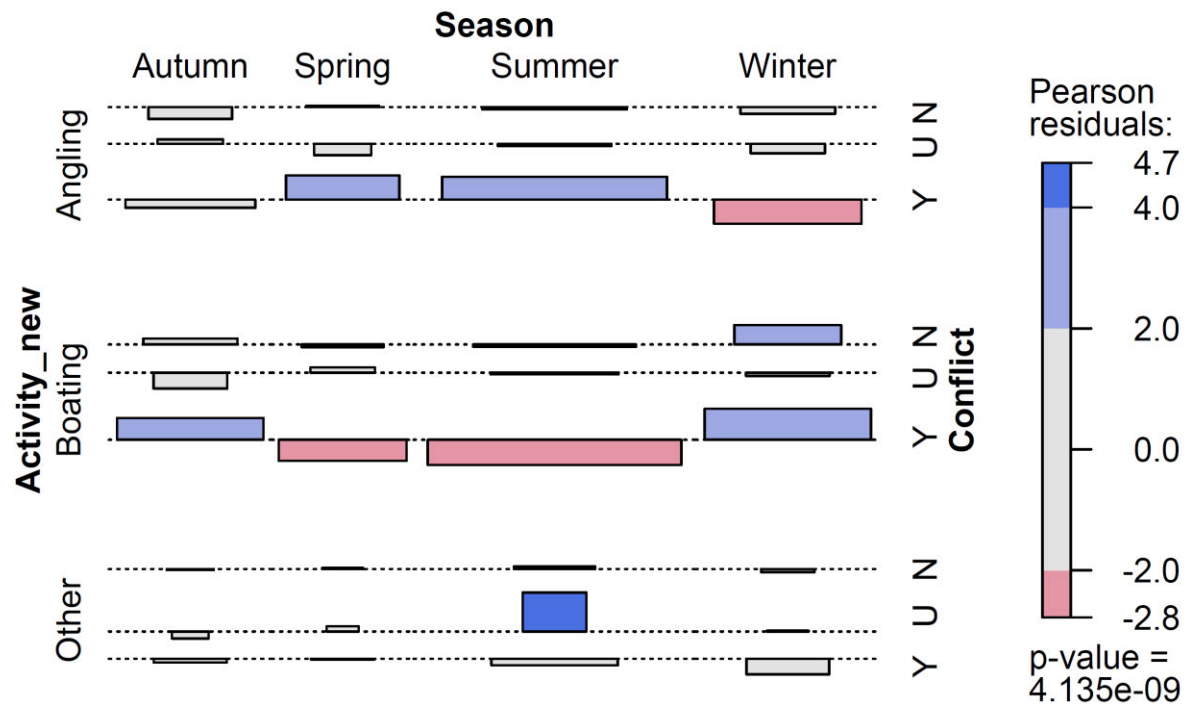


Figure 2.3. The association between season and the user groups (anglers, boaters and other) and how this corresponds to their view on whether there is conflict between the groups (Yes, No, Undecided). The statistically positive residuals are shown in blue whilst the negative ones are shown in red, the statistical significance of whether there is no association is shown at the bottom right. The height of the rectangle corresponds to the deviation from the random expectation of no association whilst the size relates to the sample size.

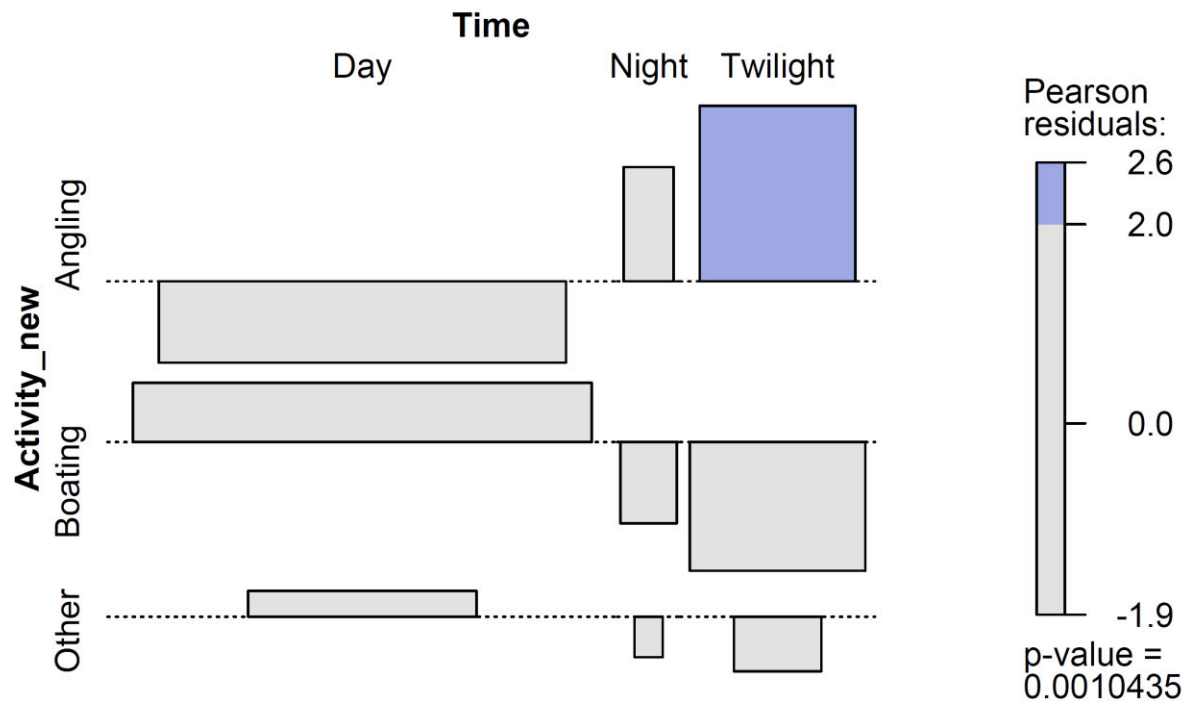


Figure 2.4. The association between user group and time they access rivers. The statistically positive residuals are shown in blue and the statistical significance of whether there is no association is shown at the bottom right. The height of the rectangle corresponds to the deviation from the random expectation of no association whilst the size relates to the sample size.

2.3.4. Flow conditions

The flow of the river the respondents liked best depended on the activity that user belonged to (Figure 2.5.; Fisher exact test, $p < 0.001$). The boaters preferred the high flows compared to the others who preferred the low flows. Anglers did not mind what flow state they used the rivers in.

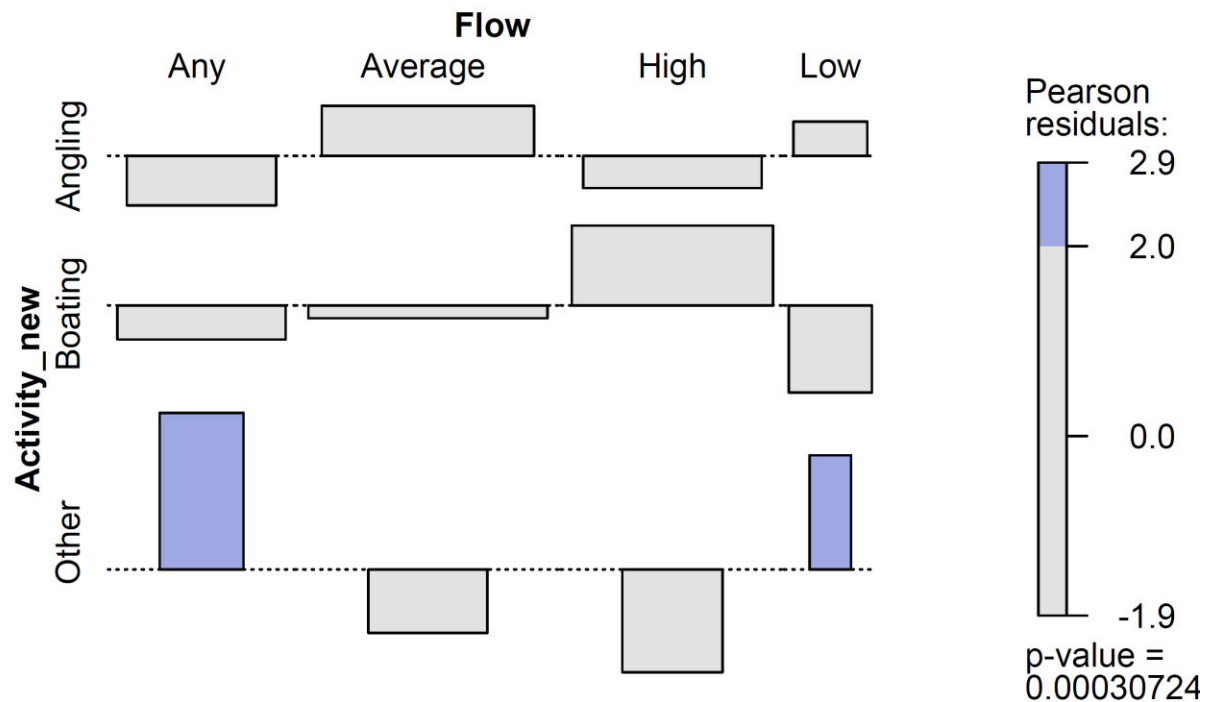


Figure 2.5. Association plot between user groups and the flow of the river which they prefer for their activity. The statistically positive residuals are shown in blue and the statistical significance of whether there is no association is shown at the bottom right. The height of the rectangle corresponds to the deviation from the random expectation of no association whilst the size relates to the sample size.

2.3.5. Overlap between groups

The user groups all accessed rivers in different locations, during different seasons and times of day and at different flows. Location overlap was mostly between boaters and anglers (overlap = 84%) compared to anglers and others (overlap = 69%). Seasonal overlap was the greatest for anglers and others (overlap = 95%) than it was between boaters and anglers (overlap = 60%). During the winter boaters were the most dominant users (84%) they also preferred to use them during winter (36% of use), anglers preferred to use rivers during summer (63% of use) and were dominant users then (49%).

The diel overlap between the groups was similar for anglers and boaters (overlap = 80%) and between anglers and others (overlap = 81%), river user all preferred accessing the rivers during the day (86%). The anglers that used the rivers at night and twilight (26%) were the most dominant at that time of day (79%).

Overlap between river flow was mostly between anglers and boaters (overlap = 87%) than it between anglers and others (overlap = 63%). Average flow was preferred by most users (43% of use), 61% of use of high flows was from boaters. The majority of users who preferred low flows were anglers (50% of use).

2.3.6. View on conflict

Most users thought that there was a conflict between the different users of rivers (60%), 25% of respondents thought there was not a conflict, and the rest were not sure (15%). Between the user groups they answered this question with differing opinion (Fisher exact test, $p = 0.003$). Anglers most strongly agreed that there was a conflict (70%, 95CI = 59.4-78.2%), followed by boaters (58%, 95CI = 49.2-67.1%), then by others (36%, 95CI = 20.7-54.2%). The hypothesis of mutual independence was rejected (Likelihood Ratio test, $\chi^2 = 95.32$, $df = 28$, $p < 0.001$). There was a three-way interaction between the different user groups, season and conflict which was indicated by log-linear modelling (Likelihood Ratio test, $\chi^2 = 28.48$, $df = 12$, $p = 0.005$). Boaters felt the conflict was more likely to occur in winter than spring and summer, whereas anglers felt that the conflict was most likely during spring and summer rather than winter.

The age of the respondents also affected the answer to how they perceived conflict. Conflict was more commonly perceived by anglers (deviance_{2,191} = 6.42, $p = 0.04$) especially when they were older (deviance_{2,189} = 8.20, $p = 0.02$). Younger boaters were more likely to think that there was a conflict compared to older boaters, this was the opposite of anglers (Figure 2.6.).

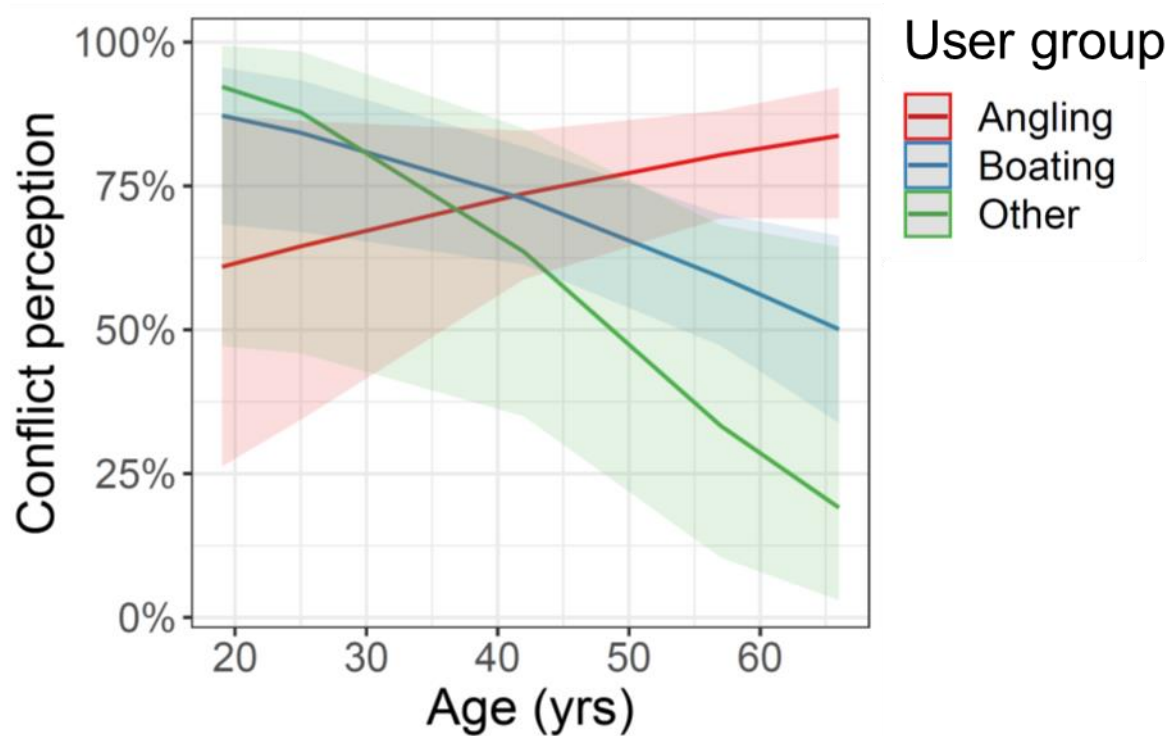


Figure 2.6. The age of user groups and how they perceived the conflict between the groups on rivers. The lines show the predicted proportion of respondents who believe there is conflict between the users of rivers and there are 95% confidence envelopes.

2.3.7. Greater access

Most of the respondents would prefer a greater access to rivers (63%) however, this opinion changed between the groups (Fischer exact test, $p < 0.001$). Only 28% of anglers supported opening up access of rivers compared to 91% of boaters and 74% of others. The anglers and boaters had almost exactly opposed views for greater access which was indicated by inspection of the Pearson residuals. Boaters are keen for greater access whereas anglers are opposed to this.

2.3.8. Rater effects

The responses to the questionnaire were significantly different depending on the question being considered (type III analysis of deviance, $x^2 = 752.7$, $df = 11$, $p < 0.001$), the user group (anglers, boaters and others) they belonged to ($x^2 = 60.3$, $df = 2$, $p < 0.001$), their perception of the conflict ($x^2 = 31.2$, $df = 1$, $p < 0.001$) and what time of year they typically used rivers ($x^2 = 13.8$, $df = 3$, $p = 0.003$). The analysis revealed that anglers responded to the questionnaire in contrast to the boaters (estimate = -0.76, $z = -6.15$, $p < 0.001$) and others (estimate = -0.45, $z = -2.51$, $p = 0.012$). Those who felt there was conflict between anglers and boaters responded contrastingly to those who felt there was no conflict (estimate = 0.52, $z = 4.12$, $p < 0.001$). The yes and no responses to whether users felt their own use of rivers detracted from the enjoyment of others were similar and did not differ from random expectation (estimate = -0.030, $z = -1.73$, $p = 0.084$).

2.3.9. Stressors

Water pollution was the stressor that most detracted from the enjoyment of rivers (estimate = 2.12, $z = 11.95$, $p < 0.001$), then rubbish (estimate = 2.05, $z = 11.46$, $p < 0.001$). Swimmers (estimate = -1.11, $z = -5.94$, $p < 0.001$) and walkers (estimate = -1.82, $z = -9.02$, $p < 0.001$) had a low impact on enjoyment of rivers especially when compared to boaters (estimate = -0.24, $z = -1.37$, $p = 0.170$) and anglers which had the same results. River users disagreed on which river stressors had the most impact to their enjoyment (Figure 2.7.). Anglers scored stressors higher than the boaters and other user groups but with less agreement between them.

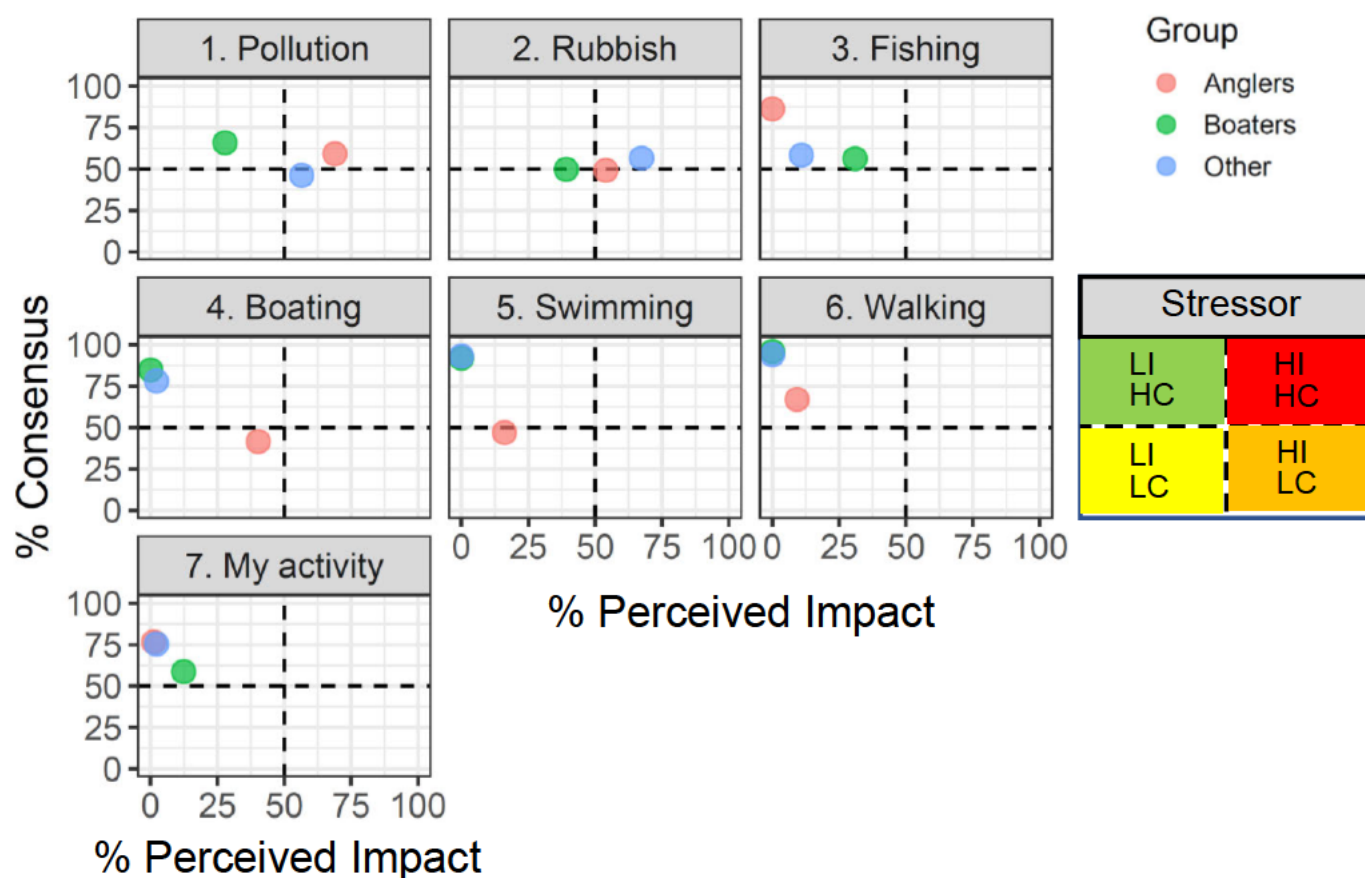


Figure 2.7. The river stressors against their perceived impact and how much consensus there was within a user group. The grid is split into four quadrants which indicate Low Impact with High consensus (LI, HC); Low Impact with Low consensus (LI, LC); High Impact with High consensus (HI, HC); and High Impact with Low consensus (HI, LC).

2.3.10. River management

Greater dialogue was the management measure that had the most respondents support (estimate = 3.11, $z = 16.45$, $p < 0.001$), introducing charges for river usage was then the second most supported (estimate = 0.38, $z = 2.11$, $p = 0.034$) with limiting numbers of users being the next most supported strategy (estimate = 0.35, $z = 1.98$, $p = 0.048$). There was not much support for spatial ($p = 0.45$) or temporal zoning ($p = 0.43$). Plotting the degree of consensus for the benefit of management actions for each group reveals that there were differing views between the three (Figure 2.8.). Anglers seemed to agree with management actions being put in place more than the other user groups but did not have high consensus between themselves. Introducing charges and limiting users were supported by anglers far more than the other groups.

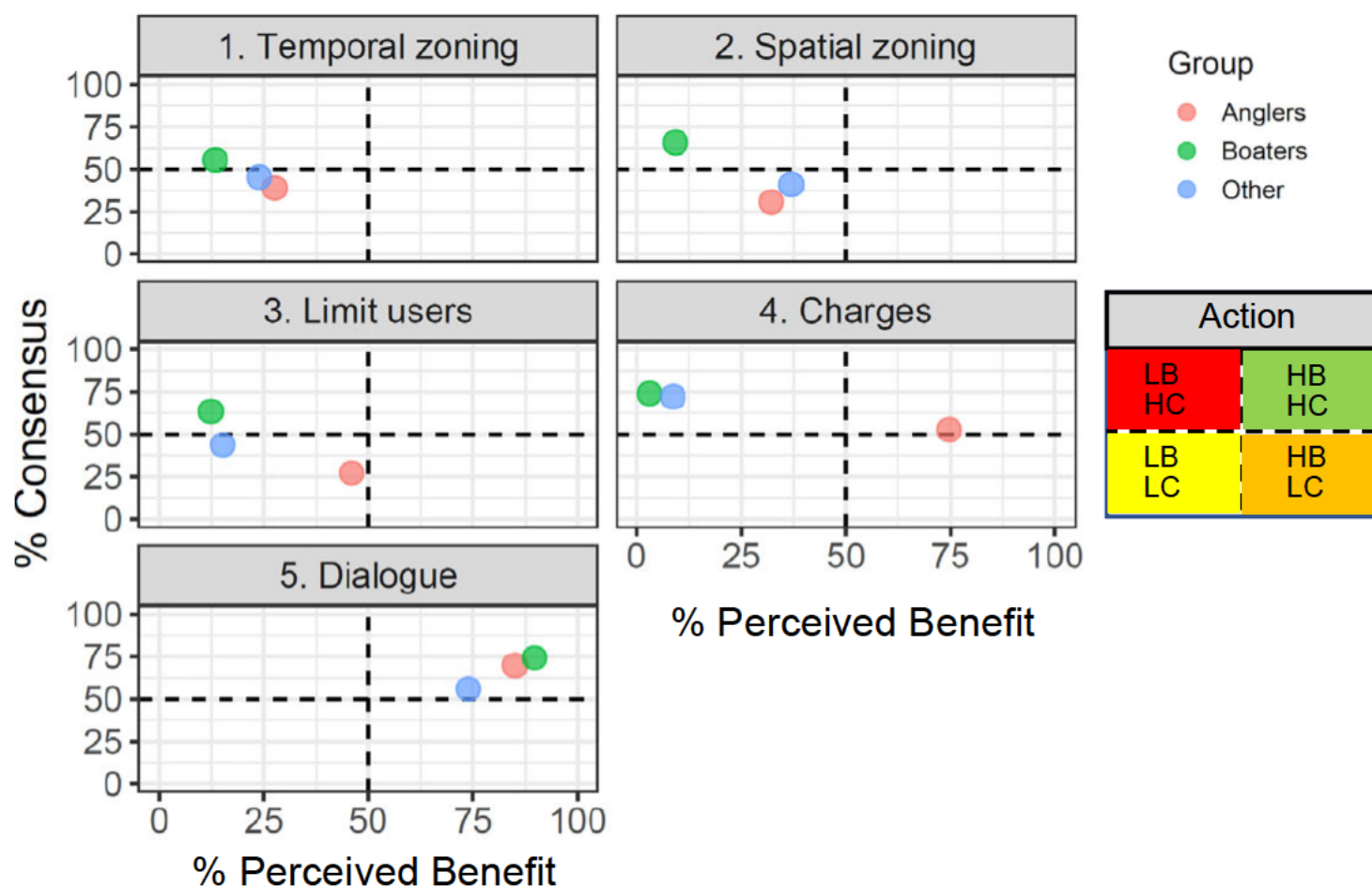


Figure 2.8. Management actions and their perceived benefit compared to consensus within the groups of users. The grid is split into four quadrants which indicate Low Impact with High consensus (LI, HC); Low Impact with Low consensus (LI, LC); High Impact with High consensus (HI, HC); and High Impact with Low consensus (HI, LC).

2.3.11. Sentiment analysis

There were 64 respondents to the open comment section at the end of question 13 which accounted for 30% of the total number of respondents. There was an even dispersal of respondents from the different user groups (Fisher's exact test, $p = 0.241$), indicating that there would be broadly representation of each group. The respondents who believed there was a conflict between river users were more likely to respond than by chance (Fisher's exact test, $p = 0.045$), however, this was not a strong association. Emotional analysis using the syuzhet lexicon showed that there was a similar use of the words between river users, trust was the most commonly used emotion in the comments (Figure 2.9.).

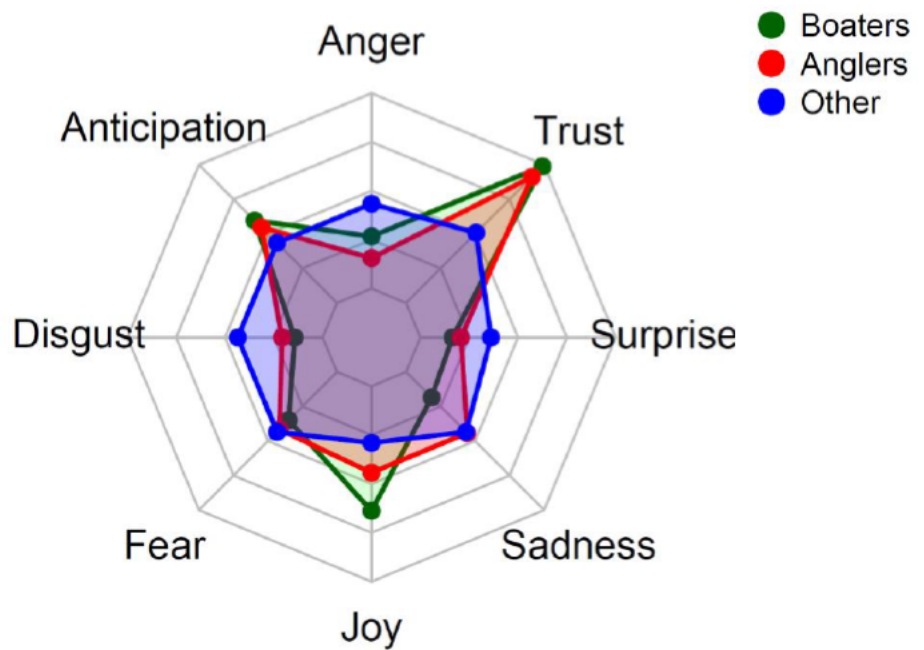
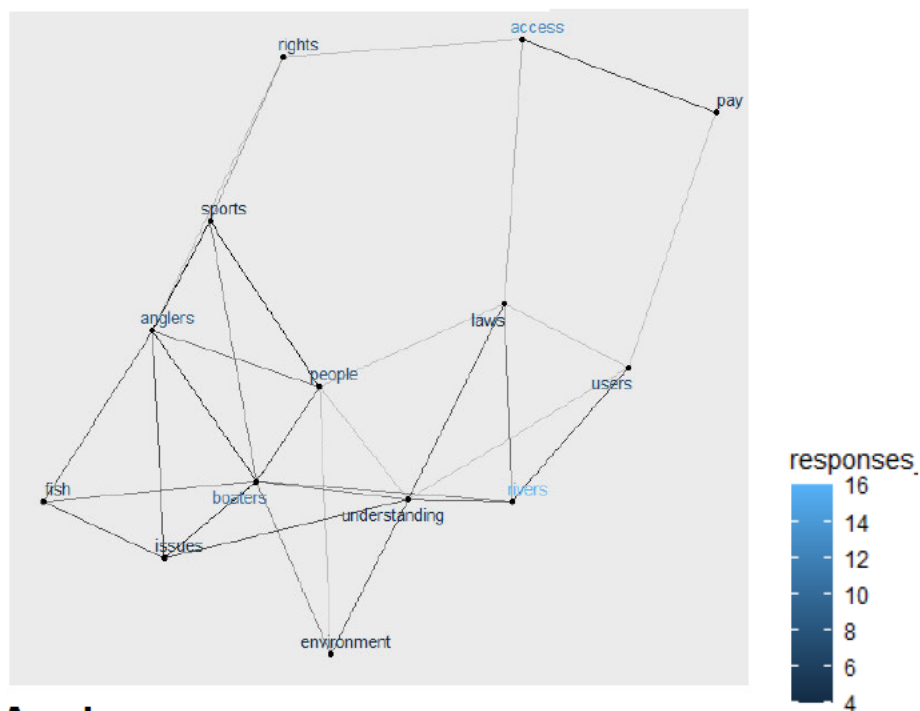


Figure 2.9. Syuzhet lexicon sentiment analysis of the open comment section used by respondents to the questionnaire. The radar plot shows the emotional profile of respondents according to the eight emotions used by syuzhet.

2.3.12. Word networks

Boaters used a more complex language compared to anglers as shown by the larger use of common terms (boaters, $n = 14$, anglers, $n = 11$) and the larger numbers of connections per term (Figure 2.10., boaters = 4.2 connections/term, $SD = 1.72$, anglers = 3.0 connections/term, $SD = 1.34$). Seven of the 14 most used terms by the boaters were shared with the anglers, including terms such as “environment”, “understanding”, “people” and “rights”. Words that were only shared by anglers were “land”, “enforcement” and “licences” (Table 2.1.).

Boaters



Anglers

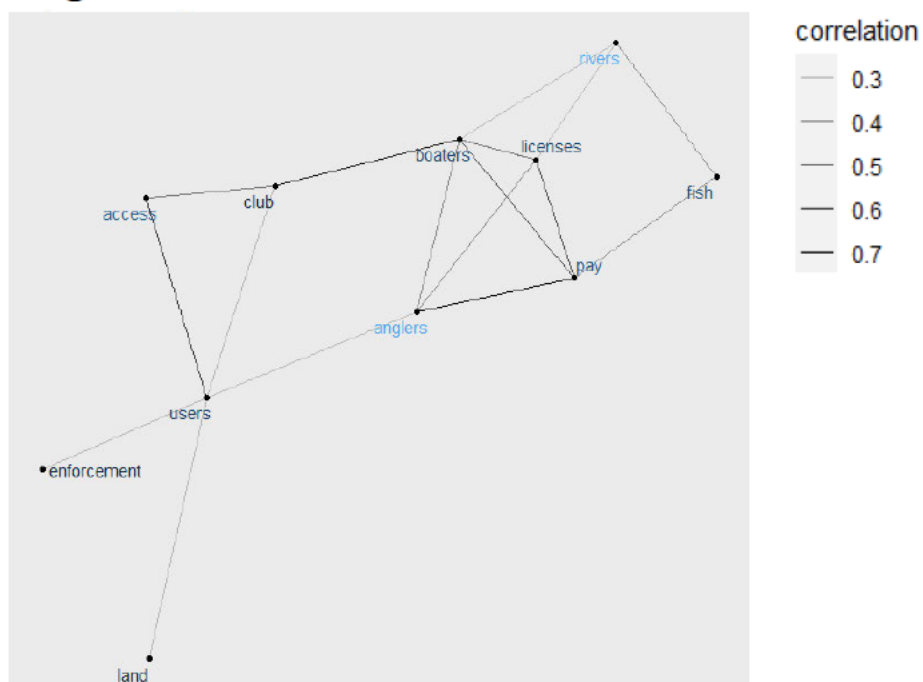


Figure 2.10. The word network analysis comparing the terms most commonly used by boaters and anglers, showing the association between words.

Table 2.1. The terms that were shared between the angler and boater respondents and the terms that were not shared from the responses to the open comment box.

Term	User Group	
	Boaters	Anglers
Shared		
'Fish'	X	X
'Boaters'	X	X
'Rivers'	X	X
'Users'	X	X
'Anglers'	X	X
'Access'	X	X
'Pay'	X	X
Private		
'Issues'	X	
'Environment'	X	
'Understanding'	X	
'Laws'	X	
'People'	X	
'Sports'	X	
'Rights'	X	
'Land'		X
'Enforcement'		X
'Club'		X
'Licenses'		X

2.4. Discussion

In this survey we used statistical and consensus analysis to quantify what people think about the state of river access in Wales. The participants were given the option to answer the questions with their own comments at the end to make sure the questionnaire was not prescriptive (Baumgartner & Steenkamp, 2006).

Questionnaires have the potential to be biased and not be representative of the overall study subjects (Baumgartner & Steenkamp, 2006). It can be common for people with stronger views to be the likeliest to respond to a survey because they are invested in the subject (Brown et al., 2012; Marshall, 2005). In this survey commenters on question 13 (potential measures to help reduce conflict between competing river users) were more likely to think that conflict is a significant problem for river basin management in Wales however, the effect from these respondents was minimal, they did not skew the results to be more focused on conflict. The questionnaire was available from November to January (3.5 months), leaving plenty of time for people to respond, it received 50% of the responses within the first 30 days. The number of respondents from each group (anglers, boaters and others) were quite similar and they were spread all over Wales which was shown by the large number of different rivers ($n = 40$) that were being accessed and that there were respondents living in each area of Wales. The internal consistency of the questionnaire was demonstrated by the test – retest approach, although the variation in responses to similar questions was high. The questionnaire responses are shown to be robust because of this.

The views of the river users in Wales were quite different between the groups that responded, the anglers (28%) were not very supportive of free access compared to the boaters (91%). These views were similar to what was found in the survey that was executed in person in 2009, where 73% of boaters wanted there to be new legislation put in place to regulate access to rivers, whilst only 12% of anglers were in favour of this (National Assembly for Wales Commission, 2010). England and Wales do not have the right to free access to rivers for all users which is common across Europe (National Assembly for Wales Commission, 2010). Most of the length of rivers in Wales (71%) can be enjoyed by recreational users however, only 3% of this is free to access by the public (Government, 2019; Horton, 2022; Stanford, 2021; Wynn-Davies, 2021; Young & Bertram, 2008), it is clear why some recreational users are looking for legislation to change and are promoting free access.

2.4.1. Access issues

Most of the respondents to the study (60%) felt that access to rivers and the conflict it causes was an important issue, however, the respondent groups each felt differently about the conflict, this was inversely related to views on free access. The boaters and others agree with each other that there should be free access to rivers for all and they did not think that there was a conflict on the rivers, the anglers on the other hand the anglers felt there should not be free access to rivers. The activity the respondents used rivers for was not the only category that affected the views in the questionnaire, age also seemed to influence the responses. Older anglers were more opposed to free access than their younger counterparts, they also were more likely to think that there was a conflict on rivers. The boaters and others were more likely to think there was conflict if they were younger and more positive towards free access. It is obvious from the responses that conflict is a problem in Wales, however, to better understand and hopefully resolve the conflict, demography of respondents must be accounted for when reviewing how people view river usage. Fischer et al. (2020) found in a study taken across Europe older people (>55 years old) were not as positive about green spaces and biodiversity than younger people. This study agrees with this in relation to blue spaces and access to them. Views on flood risks have been found to be different depending on age (Scaini et al., 2021). Age and gender differences of the community need to be considered when making decisions about resolving conflict in blue spaces, however, in this study gender was not included (Begg et al., 2018).

Recreational river users are a heterogeneous group, they use rivers differently (walking, cycling, boating, angling or swimming) and are at varying ages, they likely differ in other demographic parameters as well. The river users' frequent rivers at different times of the day and different seasons as well as using rivers in various areas. The users have significantly different views from each other about what river access is and what it should be. The river users from this study all agreed with each other about water pollution and rubbish detracting from the enjoyment of rivers.

2.4.2. Potential future solutions

All respondents wanted cleaner rivers, focusing on factors that users all agreed about could help bring the groups together and reduce the conflict towards each other, this could then help to improve cleanliness of rivers and improve them. The sentiment analysis applied to the

open text comments shows that the most common emotion of Welsh recreational river users was “trust”, and that all respondents would want greater dialogue to help resolve conflict over access to rivers. Even though zoning between times river users’ frequent rivers was found in the survey, the respondents were not in favour of spatial and temporal zoning to reduce conflict. Boater respondents said they prefer to use rivers in winter months and with high flow conditions whilst anglers were preferring different conditions. Anglers were accessing rivers at twilight and at night when none of the other groups would be partaking in their activity.

The majority of the respondents who would prefer for charges to be introduced to rivers to help reduce conflict were anglers (75%), a very small number of boaters and others (5%) would prefer this method. Interestingly, enforcing licenses onto unpowered craft that uses non-tidal rivers was one of the main recommendations made by the 2010 Inquiry into Access to Inland Water in Wales (National Assembly for Wales Commission, 2010), however, going from the results of this questionnaire this would not be supported by boaters or any other users except anglers. The study also found that anglers and boaters did not agree when it came to voluntary access agreements with 78% of anglers in support and 22% of boaters.

In question 12 when asked about whether the regulatory agents should be promoting greater access to rivers in Wales 85% of boaters and others agreed but anglers (28%) mostly did not agree. To help us reach several of the UN Sustainable Development Goals the public having access to blue spaces would be vital. It is known that access to blue spaces and clean water greatly improves health and wellbeing and can even help to reduce mental illness developed from stress which is faced by younger generations along with preventing risk of premature death (Britton et al., 2020; Bell et al., 2017; Foley & Kistemann, 2015; White et al., 2020, 2021). With climate change resulting in at least 80% European cities becoming much hotter and drier in the next 100 years, infrastructure needs to be developed such as improving access to blue and green spaces so that heat stress and exhaustion risk can be prevented (Carter, 2011; Zhao et al., 2021). Being able to access rivers in close proximity will be vital for the health and wellbeing of all inhabitants of Europe. To start improving the access to rivers there needs to be a good understanding of what the river user’s views, goals and values are. This study shows how valuable it is to use statistical modelling and text mining to better understand the views of respondents and the emotion they are conveying when discussing conflict of river use.

The study could be used to understand why conflict arises on rivers and where and when conflict is occurring. A limitation of the study was questionnaire respondents being prevented from choosing more than one activity that they partake in. The questionnaire was mostly answered by anglers and boaters, these two groups are likely to have the most polarising opinions about the conflict on rivers. A limitation for the sentiment analysis was that not all respondents left open comments to the questionnaire, so there could be a bias towards respondents who felt the strongest left comments. The questionnaire responses can be used to help river management focus on next steps and ease conflict. Future research should focus on the impacts of conflicts between river users. Then looking into what the best strategy would be going forward for protecting all aspects of the rivers.

Chapter 3. An experimental test of impacts of disturbance on fish behaviour

3.1. Introduction

Recreational impacts in freshwater habitats have previously focused on birds with little regard for fish and other aquatic species (Slabbekoorn et al., 2010; Stott, 2019). Birds have been found to have impaired reproduction and foraging from human disturbance (Schafft et al., 2021; Stott, 2019). Recreational tourists cause flight reactions in birds which results in extra expenditure of energy as well as dislocation to areas with potential for higher risk of predation and less food (Schafft et al., 2021).

Fish such as salmonids respond to the threat of predation by trying to escape and it has been found that their responses to predators can be changed by their individual experiences, such as exposure to recreation (Kelley & Magurran, 2003). Anti-predatory behaviours in fish also include vigilance, freezing, erratic swimming, rapid acceleration or deceleration and hiding (Gerlai, 2013). Using these behaviours must be balanced between the cost of responding and the benefit of escaping from a predator (Petersson & Järvi, 2006). When animals are avoiding predators, they are unable to do anything else such as reproducing or foraging (McDowall, 2006). If the animal needs to feed, they will have to decrease any anti-predatory behaviours and put themselves at risk (Lima & Bednekoff, 2015). Repeated disturbances to fish from recreation could change their anti-predatory behaviours, this has not been previously investigated in the field or in laboratory conditions (Whitfield & Becker, 2014). Fish have been found to avoid areas where recreation is common and this disturbs their natural behaviours and can compromise their anti-predatory behaviours, often due to habituation (Meyer et al., 2021; Simpson et al., 2016; Whitfield & Becker, 2014). The disruptions to their behaviour need to be quantified to assess how detrimental disturbing fish is to their survival and reproduction (Tarlow & Blumstein, 2007).

Habituation occurs when a frequent stimulus has no negative interaction with the animal, so the animal will desensitize to the stimulus and will reduce its response (Bejder et al., 2009; Blumstein, 2016; Cyr & Romero, 2009; Domenici, 2010; Eaton et al., 1977; Ferrari et al., 2010; Geffroy et al., 2015; Petersson & Järvi, 2006; Schleidt et al., 1983). Frequently disturbed individuals can be more at risk of exposure to disease and predation due to chronic stress (Cyr & Romero, 2009). If an individual has desensitized (habituated) to a stimulus this does not

mean they have stopped being stressed by the stimulus (Cyr & Romero, 2009). Chronic stress can be a result from constant exposure to stressors which reduce time spent foraging and reproducing (Cooke & Sneddon, 2007; Davie & Kopf, 2011; Mickle, 2017; Slabbekoorn et al., 2010). Chronic stress leads to suppressed growth, reproduction and immune response as well as a weakened cardiovascular system (Cyr & Romero, 2009; Mateus et al., 2017; Mickle, 2017; Sadoul & Geffroy, 2019; Tarlow & Blumstein, 2007). Habituation to certain stressors can also lead to spill over where the animal no longer recognises more threatening sources (Geffroy et al., 2015). Stress and anxiety in fish can be measured by recording the time they spend undercover, the cortisol levels in the water, the time they spend close to the walls of a tank (thigmotaxis) and their heart rate (Cooke et al., 2004; Graham & Cooke, 2008; Maxwell et al., 2018; Slabbekoorn et al., 2010; Whittaker et al., 2021). Habituation can be measured by recording latency to respond to stimulus over time as well as velocity and distance that the fish travel after the stimulus is repeated (Post & von der Emde, 1999; Staven et al., 2019).

Salmonids are often used in experiments because they are popular farmed and sports fish. Brown trout (*Salmo trutta*) are a model species due to their well-documented behaviours and because they react in similar ways as other salmonids even when juvenile (Lobón-Cerviá & Sanz, 2017). Video analysis has been used to analyse behavioural responses of animals in many situations; it is a good way of collecting data without creating further disturbances (Mueller, 1980). The videos can then be used to quantify the change in behaviour over time (Fleissner & Mensinger, 2021; MacLean et al., 2020). The aims of the experiment were to quantify how fish respond to a repeated disturbance and to evaluate whether this changes their behaviour when responding to a known predator. Regular exposure to disturbances has been found to cause habituation (Ferrari et al., 2010). If their startle response reduces over time when the fish become used to the disturbance, the fish could then become more vulnerable to predation (Imre et al., 2016). The aim is also to assess whether the fish will habituate to a model predator. If freshwater fish experience many small stresses such as, constant recreational disturbances, and become habituated to disturbances then there is the risk of mortality and even a collapse of the ecosystem (Vilhunen, 2006; Imre et al., 2016).

3.2. Methodology

3.2.1. Mesocosm - Simulating human disturbances and predator attacks

The simulated predator attack methodology was adapted from the protocol described by Roberts et al., (2011) and used a model bird similar to (Petersson & Järvi, 2006). In total 72 juvenile brown trout (*Salmo trutta*) (64 – 190 mm) resident to the River Tawe in South Wales were caught over 13 weeks starting from 8th August 2021 and finishing on 12th November 2021, ethical approval was gained before starting. Six trout were caught each Monday morning using a HT-2000 electrofishing backpack set within 50-200V and 50-2000Hz. The fish were netted then transferred to a transport tank (80L) filled with fresh water from the river. The six fish were taken back to CSAR to acclimatise in a bucket filled with half river water and half tank water for 20 minutes. The fish were then introduced to the flume tank (L: 240 cm W: 60 cm D: 25 cm) filled to 20 cm depth (240 L) with dechlorinated and UV treated tap water. The water temperature was controlled at $15 \pm 0.5^{\circ}\text{C}$. The flow rate of the tank was 12.78 L/min, to simulate river conditions whilst still being able to monitor the fish from the overhead cameras.

The flume tank had two ends blocked from access by fish using a mesh panel gates, the upstream end was used to introduce and remove the model kayak (Figure 3.2.; L: 24 cm, W: 8 cm) without the fish seeing. The gates were operated by a pulley system. The upstream end contained the spray bar, the downstream end had an overflow connected to a 200 L sump, housing a submersible pump which recirculated the water. White plastic walls (60 cm) surrounded the tank to limit fish movements from experiment area and to stop other disturbances. The experimental area was W: 60 cm, L: 200 cm, H: 20 cm. Two fluorescent bulbs were set to a 12-hour light/dark cycle at 120 lux to imitate an overcast day. The model kingfisher (Figure 3.1.; Wingspan: 23 cm, H: 9 cm, L: 17 cm, D: 9 cm) was hung on a pulley system above the tank with a cover to obscure it from the vision of the fish when not in use. The tank had six refugia's (Figure 3.3.; W: 10 cm, L: 20 cm) spaced evenly throughout the tank to provide the fish with cover from above.

The fish were left in the tank undisturbed for >21 hours before testing began. The fish were fed to satiation with frozen bloodworms each day at 5 pm. The water was changed at the end of the week and the tank was cleaned.

3.2.2. Experiment

Continuous filming was carried out from when the fish entered the flume tank on Monday morning until they were removed on Friday mornings using an aerial CCTV camera (ANNKE MODEL: C51N). Experiments began on Tuesday mornings at 9 am when the kingfisher was dropped into the tank and then pulled back up once. The fish were left undisturbed until 10 am when the model kayak was placed into the tank from the covered upstream end and then pulled across towards the downstream end and back again. The model kayak had a small motor powering the oars to imitate a person rowing at a constant rate. The model kayak was pulled across and back every hour from 10 am until 3 pm from Tuesdays until Thursdays, the model kingfisher was dropped at 9 am and 4 pm from Tuesdays until Thursdays as well. Videos were then played back using VLC media player 3.0.16 (VideoLAN) and Kinovea 0.9.5. Two metrics of movements were recorded: distance travelled per swim occasion and velocity of swim occasion, this was done because activity levels are known to be impacted after or during a fright response (Jacobsen et al., 2014). The tank was split into 10 cm x 10 cm cells so the location of the head of the fish could be recorded and then the randomness of distribution could be measured, the method was adapted from Duarte et al. (2011). The location of the fish and number visible was recorded every 10 minutes from 8 am until 5 pm, however, during the disturbance the frequency of recordings was increased to every 5 seconds for 15 seconds of disturbance. The latency for the fish to move from the beginning of the disturbance was measured as reaction time is a key metric to understanding habituation to a disturbance (Bejder et al., 2009; Mickle, 2017; Schafft et al., 2021), this method of measuring latency was similar to Voellmy et al., (2014). The category “before” the disturbance was the 30 minutes before a disturbance started and “during” was classified as the five seconds from the bird being introduced and 30 seconds from the kayak being introduced.

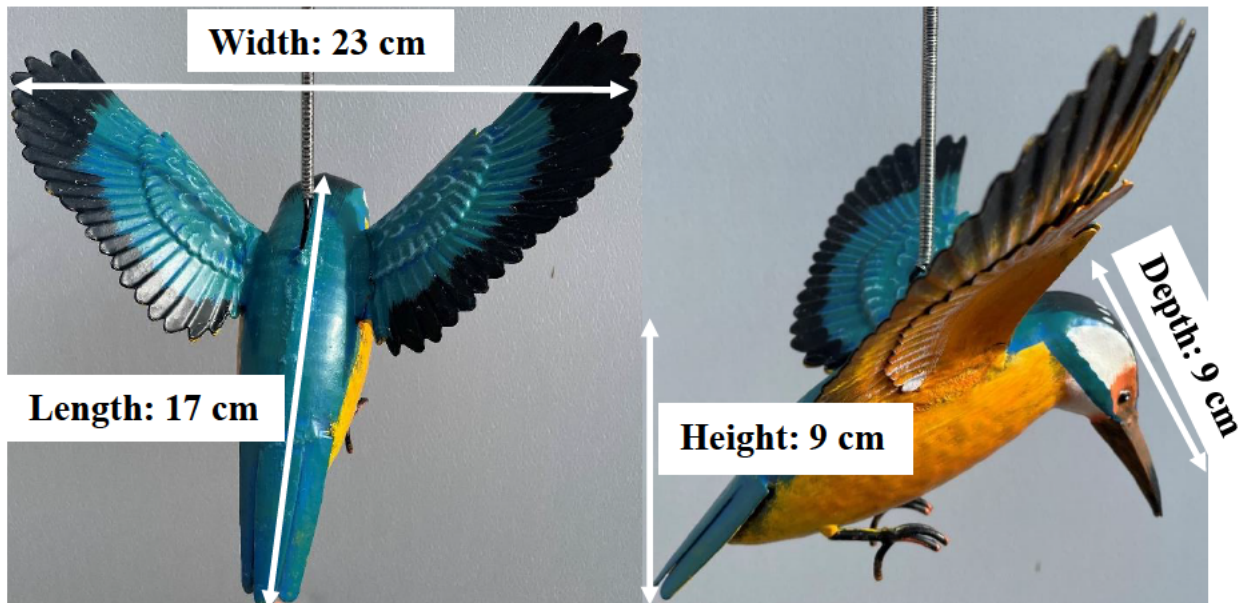


Figure 3.1. View of the back and side of the model kingfisher used as to simulate a predator attack.

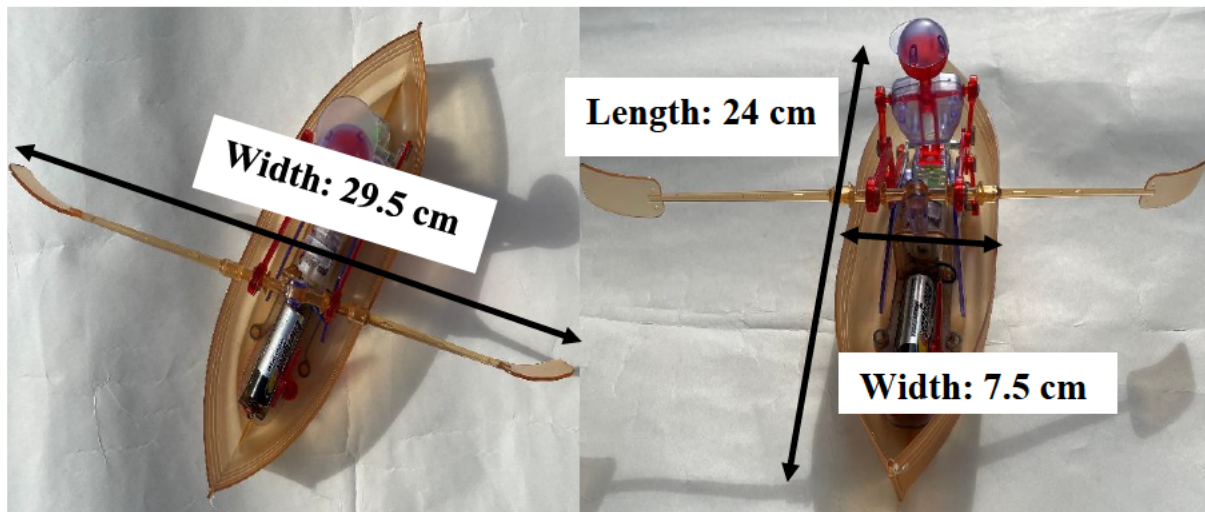


Figure 3.2. View of the top of the model kayak and the front used to simulate a recreational disturbance.

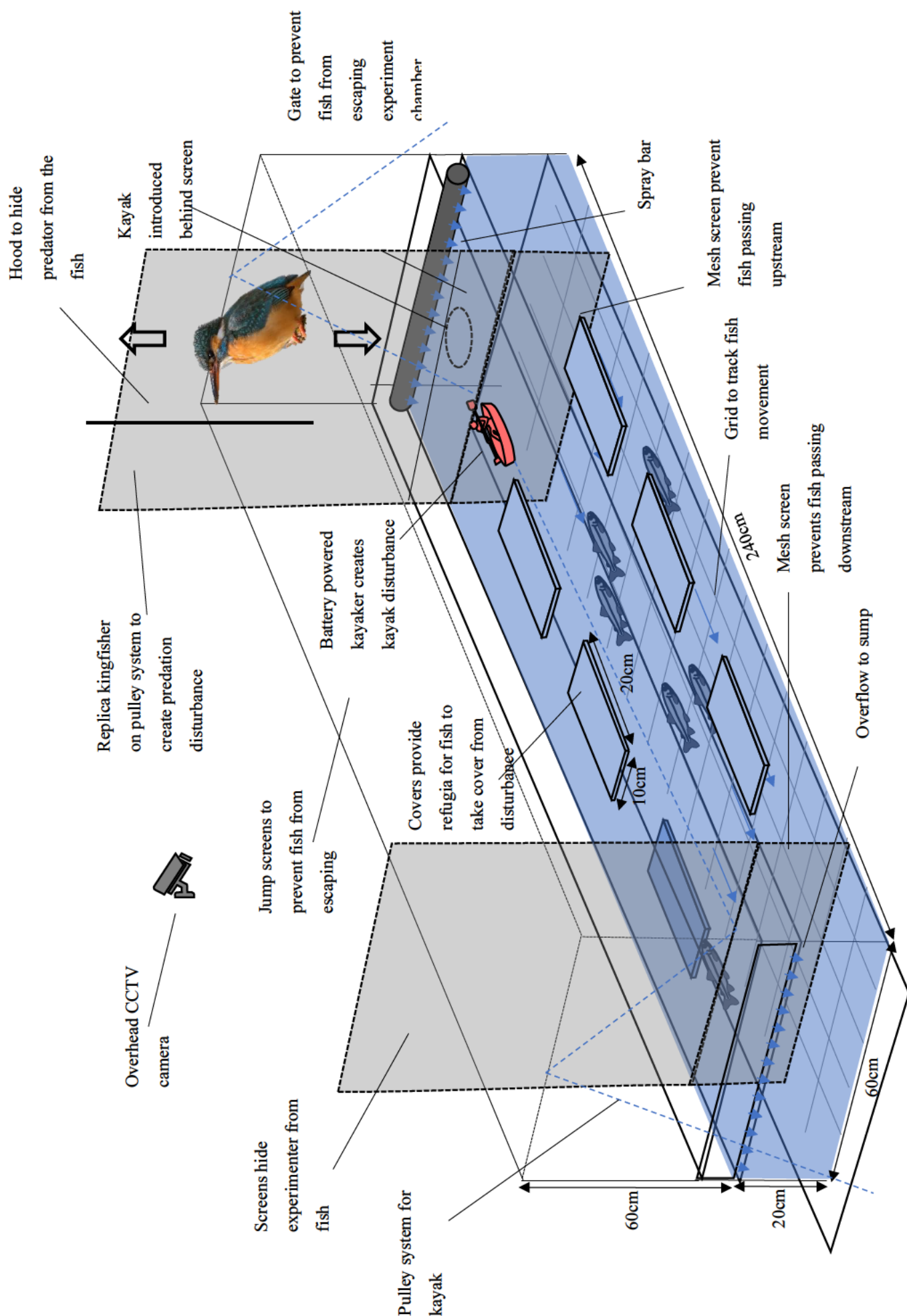


Figure 3.3. The experimental setup showing how the kingfisher and kayak were deployed into the tank. The tank has six covers for six fish with an experimental area and two hidden areas accessible to experimenters so that there would be no further disturbance to fish.

3.2.3. Statistical analysis for glms and chi squared

All data was analysed using R version 4.0.2 (R Core team 2022). Plots were constructed using the “ggplot2” package in R (Wickham, 2014). Models were created using the “lmerTest” and “glmer” packages in R (Kuznetsova et al., 2020). Model simplification was achieved by using the “bbmle” package in R (Bolker, 2022). Global models were created for each dependent variable analysis with the most complex containing all relevant terms as predictors to the least complex containing none. The “AICctab” function from the “bbmle” package was used to choose models within 2 Δ AICc of each other for consideration. The assumptions of the models were checked using the “mcp.fnc” function from the package “LMERConvenienceFunctions” to create plots in R (Tremblay et al., 2020).

To assess whether there was difference in velocity that the brown trout travelled at from the morning bird disturbance (Event 1) to the afternoon bird disturbance (Event 8) the following predictors were included in the global model: timing (before/during), event (AM bird disturbance and PM bird disturbance), day (Tuesday to Thursday), week (12 separate weeks, treated as a random factor to prevent pseudo replication). The “AICctab” function was used to obtain AICc numbers. The model with the lowest AIC number was compared to models within 2 Δ AIC of it, for this analysis there were two with the same AIC numbers. (1) Velocity ~ Event*Timing + Day + (1|Week) (AICc = 8011.7, Δ AICc = 0) (2) Velocity ~ Event + Timing + Event*Timing + Day + (1|Week) (AICc = 8011.7, Δ AICc = 0). The models were tested against each other using the “anova” function. The models were not significantly different so the simplest model that explained the data was chosen, model 1. Model 1 did not meet the assumptions, so the dependent variable was transformed by adding one and square rooting to rectify this. The model met the assumptions and was selected: $\text{Sqrt}(\text{Velocity} + 1) \sim \text{Event} * \text{Timing} + \text{Day} + (1|\text{Week})$.

To analyse whether the distance travelled was affected by the event the global model predictors were replicated from the velocity analysis. The model was again compared to the other models using “AICctab” function. There were three models within 2 Δ AICc numbers of the lowest AICc value. (1) Distance ~ Event*Timing + Day + (1|Week) (AICc = 6877.9, Δ AICc = 0). (2) Distance ~ Event + Timing + Day + (1|Week) (AICc = 6879.2, Δ AICc = 1.3). (3) Distance ~ Timing + Day + (1|Week) (AICc = 6879.3, Δ AICc = 1.4). Model number 3 was chosen because it contained the fewest terms, and the Event was not a significant predictor so could be excluded. The model did not meet assumptions, so the dependent variable was log transformed

to create a more robust model. The changed model met the assumptions and was selected: $\log(\text{Distance} + 1) \sim \text{Timing} + \text{Day} + (1|\text{Week})$.

To analyse how the fish used the space in the tank over the week and throughout the experiment linear models were created with the predictors being day and week. The package “report” was used to find the confidence intervals and the average means. The average means were compared against the confidence intervals to find the whether the fish were located randomly around the tank.

To analyse the latency of the fish (how long they took to move since the beginning of the disturbance) the predictors from the velocity model were repeated without the Timing predictor because there was only one level of timing here. Two models were compared with each other because they had similar AICc numbers. (1) $\text{Latency} \sim \text{Event} + \text{Day} + (1|\text{Week})$ (2) $\text{Latency} \sim \text{Day} + (1|\text{Week})$. The models were tested against each other using the “anova” function and model 1 was selected because it was a significantly better fit. This model did not meet assumptions, so the dependent variable was transformed by adding one and square rooting. The assumptions were met and this model was chosen: $\text{Sqrt}(\text{Latency} + 1) \sim \text{Event} * \text{Day} + (1|\text{Week})$.

To analyse whether the percentage of visible fish changed per event or over the week the predictors from the velocity model were repeated in a global model. The two models with the closest AIC numbers were compared to each other. (1) $\text{Visible} \sim \text{Event} + \text{Timing} + \text{Day} + (1|\text{Week})$ (2) $\text{Visible} \sim \text{Event} * \text{Timing} + \text{Day} + (1|\text{Week})$. The first model was chosen because the interaction was not statistically significant. The model assumptions were met for this model: $\text{Visible} \sim \text{Event} + \text{Timing} + \text{Day} + (1|\text{Week})$, family = Binomial.

3.3. Results

3.3.1. Velocity

The velocity the fish travelled ranged from 0.20 cm/s to 395.28 cm/s. The mean velocity was 41.69 cm/s $\pm$ 0.732 SE. Velocity did not change from the first disturbance event of the day (bird) to the last one of the day (bird). There was a significantly positive increase in velocity during the disturbance compared to before (Figure 3.4.; estimate = 71.379, SE = 3.039, $t = 23.487$, $p < 0.001$). There was no significant change in velocity from day one to day three.

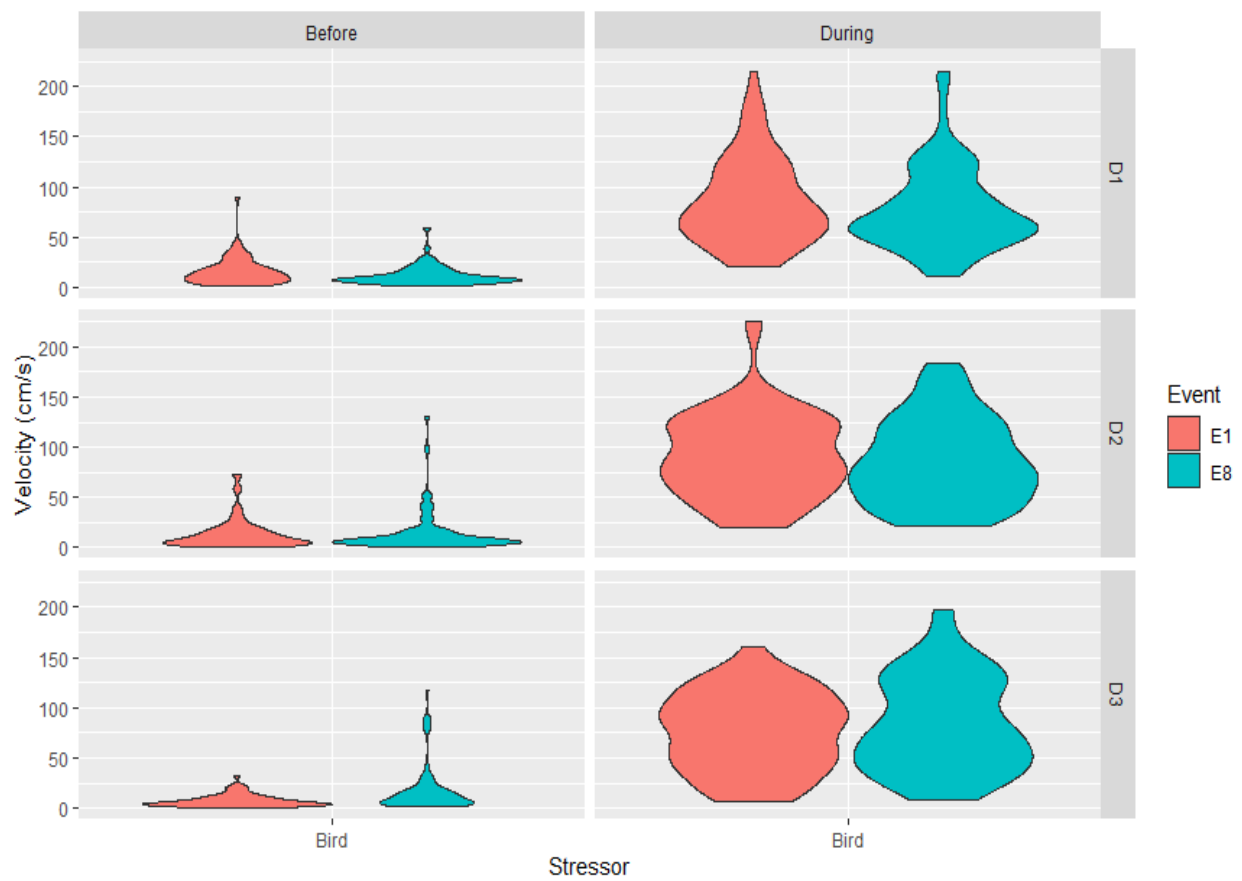


Figure 3.4. The velocity the brown trout travelled during six swim occasions before and during the bird disturbance in the morning and the afternoon.

3.3.2. Distance

The distance travelled by the fish during the disturbance from the bird was significantly different to the distance they travelled before the bird (estimate = 0.21636, SE = 0.03543, $t = 5.781$, $p < 0.001$, Figure 3.5.). The minimum distance travelled was 10 cm and the maximum distance was 186.82 cm in one continuous movement. The mean distance was $23.66 \text{ cm} \pm 0.56$. The distance travelled during event one and event eight did not significantly change. The distance also did not change from day one to day three.

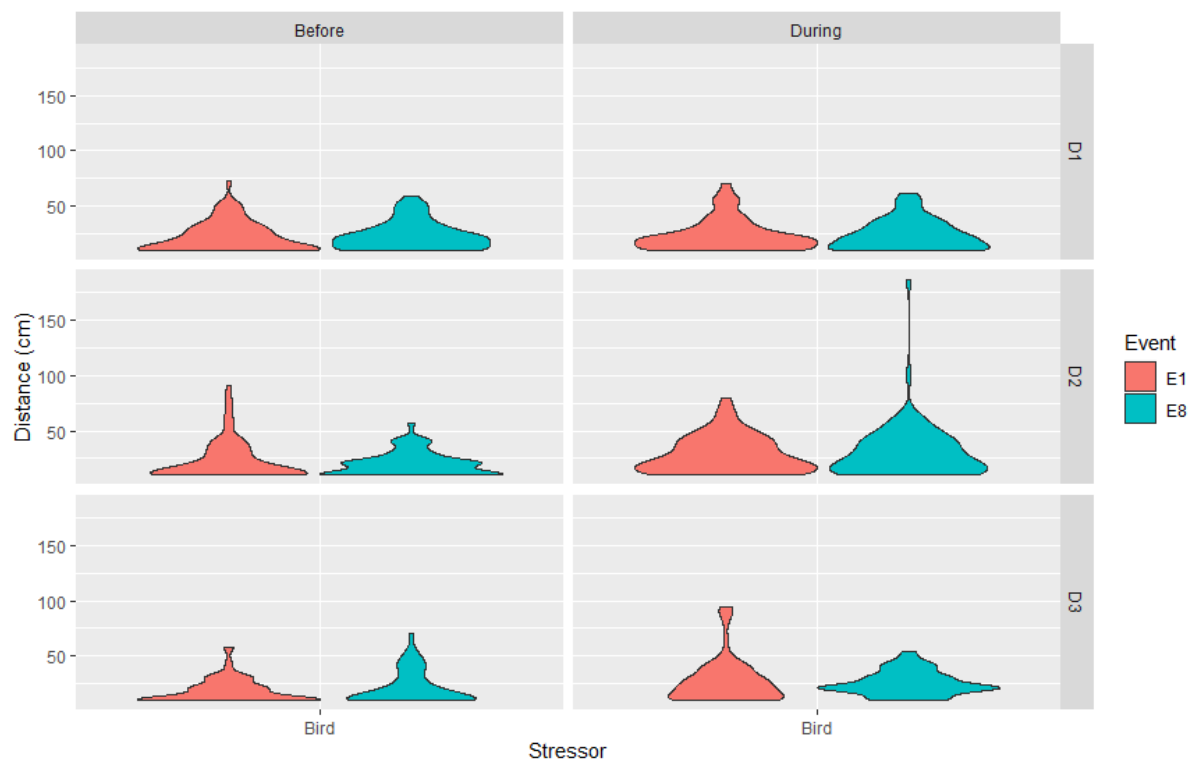


Figure 3.5. The distance that the fish travelled before and during the bird disturbances in the morning and the afternoon.

3.3.3. Latency

The amount of time the fish took to start moving from the beginning of the disturbance (latency) ranged from 0 to 40 seconds. The mean latency was 3.629 seconds $\pm$ 0.11663 (SE). The latency had a significantly positive relationship from days one to days two (estimate = 0.454, SE = 0.167, $t = 2.718$, $p = 0.007$) and three (estimate = 0.879, SE = 0.169, $t = 5.195$, $p < 0.001$). The mean latency during day one was 0.45 s which was more than half the mean latency on day three 1.09 s. The latency did not change between events one and events eight however, event eight on day two was significantly different to event one on day one (estimate = 0.545, SE = 0.233, $t = 2.334$, $p = 0.02012$). The relationship between latency, disturbances and days is shown in Figure 3.6.

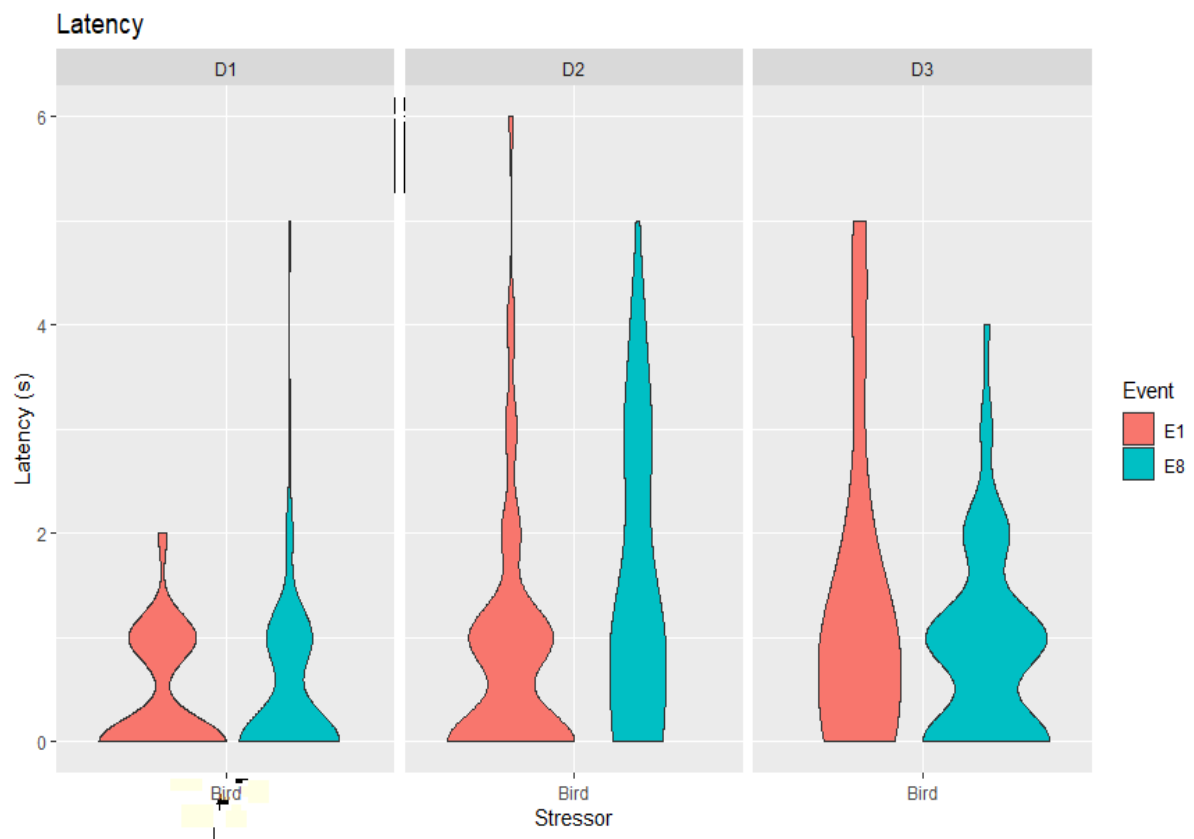


Figure 3.6. The latency of the fish to move from the beginning of the bird disturbance.

3.3.4. Location in tanks

The fish were not randomly distributed in the tank throughout each day of the experiment (Figure 3.7.). The locations of the fish were significantly different each day (estimate = 1.99, SE = 0.80, $p < 0.001$). The fish were not randomly distributed in the tank for weeks four, five, seven, nine, ten, eleven and twelve but were randomly distributed for weeks one, two, three, six and eight. The locations were significantly different each week (estimate = 1.99, SE = 0.80, $p < 0.001$, Figure 3.8.).

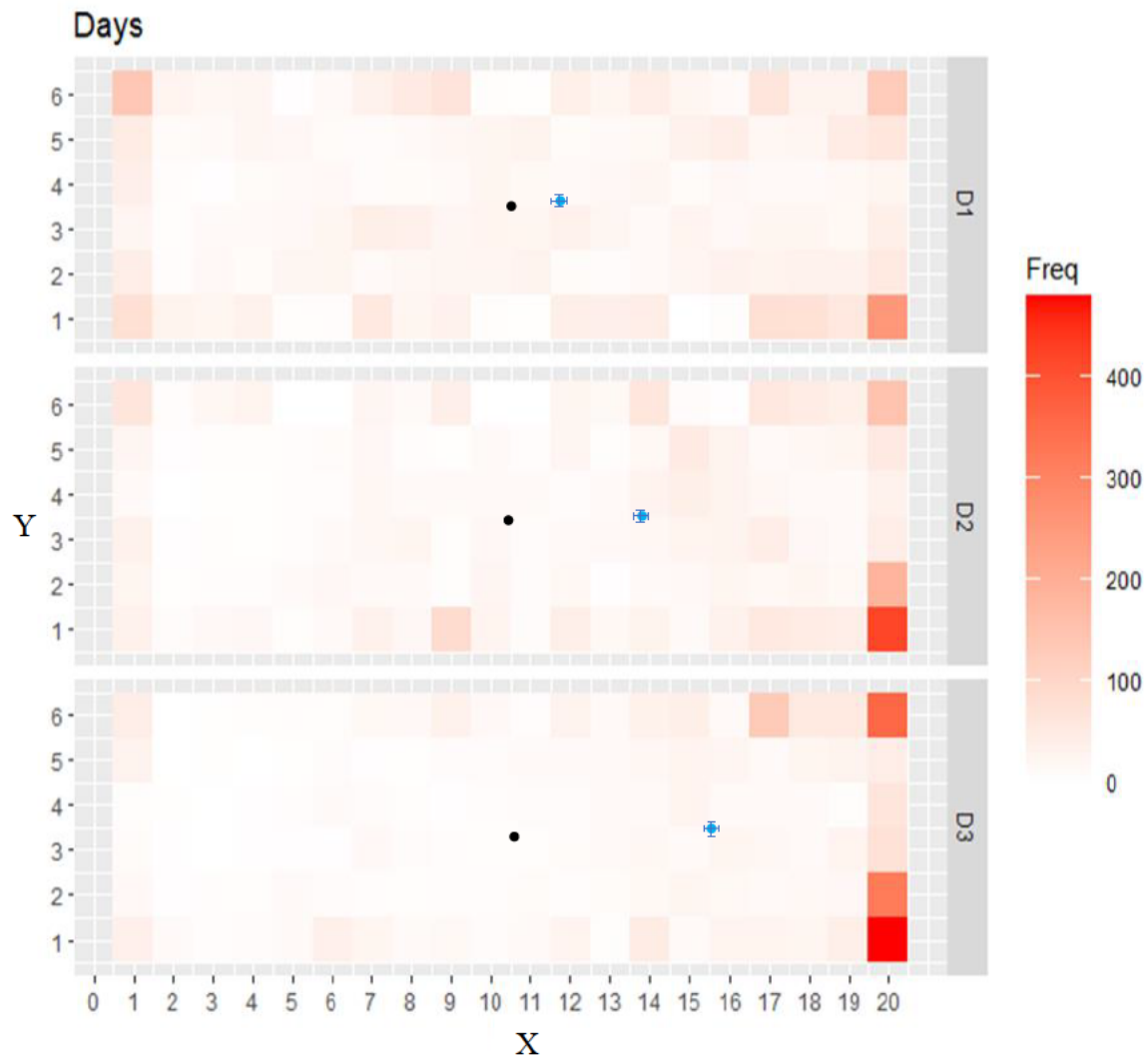


Figure 3.7. The frequency of locations of the fish in the tank from day one to day three over the 12 weeks of study. The black dot indicates the predicted centroid of the grid, the blue dot indicates the actual centroid of the fish (95% CI).

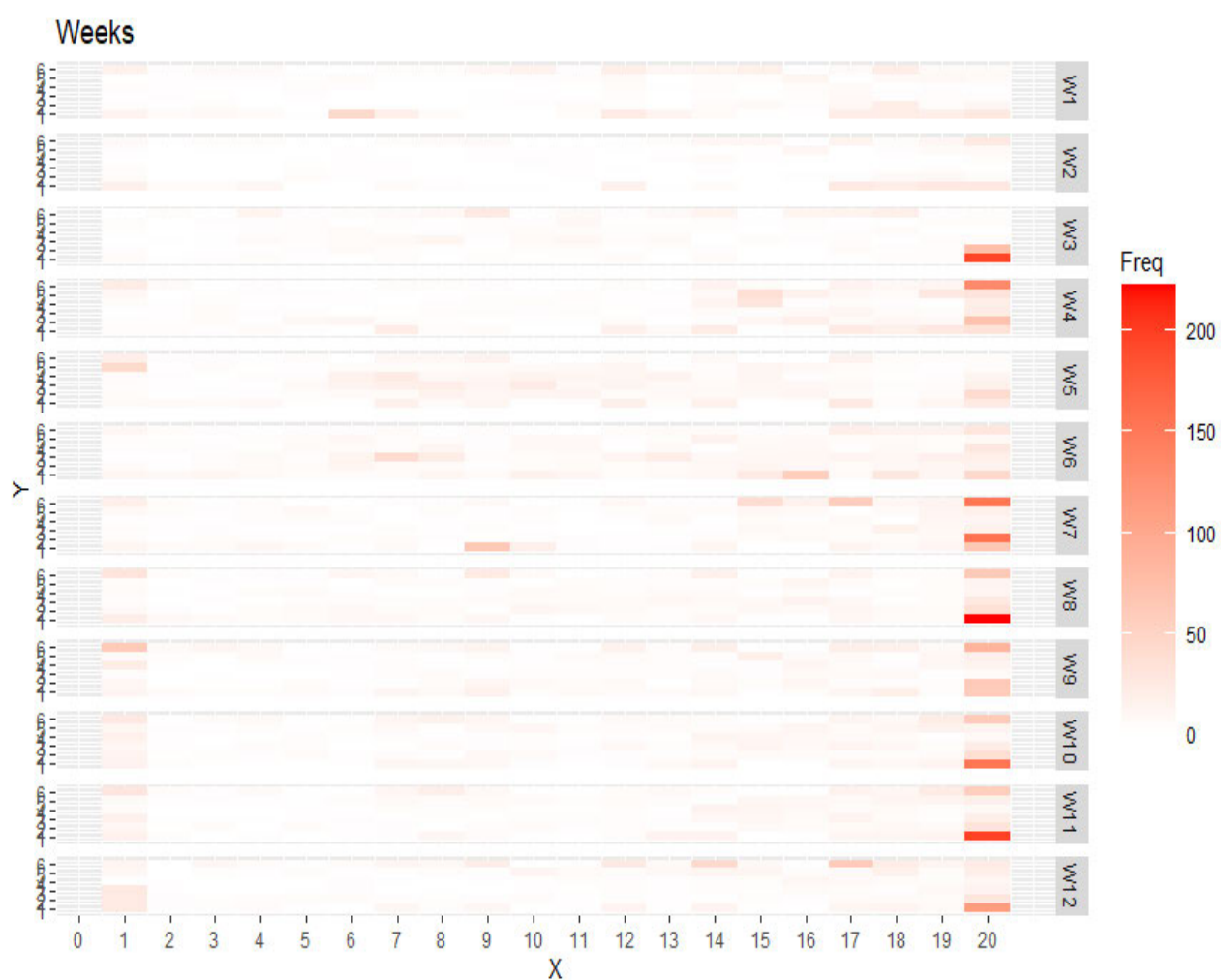


Figure 3.8. The frequency of locations used in the tank over the 12 weeks of the experiment.

3.3.5. Proportion of fish visible

The proportion of fish visible was significantly different from event one to event eight (estimate = 0.116, SE = 0.340, $z = 3.404$, $p < 0.001$). There were more fish visible before the disturbance compared to during the disturbance (estimate = 0.183, SE = 0.041, $z = 4.408$, $p < 0.001$) and there was also significantly more fish visible after the disturbance compared to before (estimate = 0.154, SE = 0.042, $z = 3.690$, $p < 0.001$). There was a significantly negative relationship between the proportion of fish under cover compared to out in the open between days one, two (estimate = -0.230, SE = 0.040, $z = -5.777$, $p < 0.001$) and three (estimate = -0.168, SE = 0.039, $z = -4.247$, $p < 0.001$). The median number of fish visible over the weeks was four. The relationship between days, events, timing and proportion of visible fish is show in Figure 3.9.

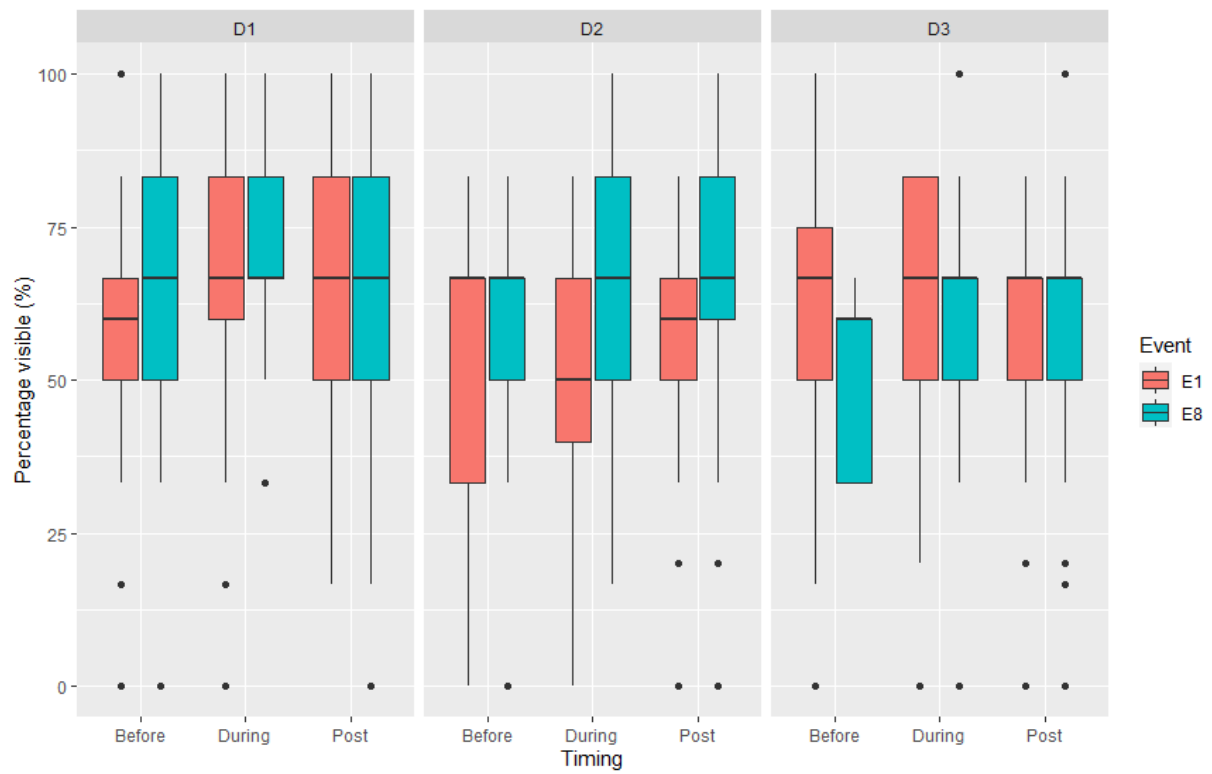


Figure 3.9. Percentage of fish visible during day between the first bird disturbance (9 am) being dropped into the tank and the last one of the day (4 pm).

3.4. Discussion

The laboratory experiment found that brown trout exposed to repeated disturbance from a model kayak will take longer to react to the disturbance from a model kingfisher. Once they responded to the disturbance, they travelled the same distance and speed after three days of kayak and kingfisher disturbances. The fish moved from being dispersed over the tank to being distributed at the low flow end of the tank. As demonstrated by (Hartman, 1963) juvenile brown trout prefer to be positioned in an area of still water especially during cooler conditions. This is similar to what was observed in this experiment (Figure 3.7. and 3.8.) as the fish congregated towards the downstream end of the tank where there was less flow.

The latency increasing over the experiment would suggest that the fish had become habituated to constant stimulus from the kayak resulting in the increased time to respond to the kingfisher. The speed at which animals move away from predators (escape latency) is critical to escape success along with responsiveness, reaction distance and directionality. Escape latency refers to the time interval between the beginning of the stimulus and the first response (Domenici, 2001, 2010). If the fish had become habituated to the kayak and increased their escape latencies, this would increase their vulnerability to predation (Domenici, 2010). Habituation is common when animals are repeatedly exposed to stimulus with benign interactions, the animals become bolder and less vigilant which leads to them being more vulnerable to predation (Ferrari et al., 2010; Geffroy et al., 2015; Goldenberg et al., 2014; Schleidt et al., 1983). Habituation to a repeated stimulus is also a fatigue response because the sensory receptors become less sensitive to frequently repeated stimuli (Ferrari et al., 2010). Habituation can be beneficial to the fish because it maximises the time the fish spend foraging and reproducing and prevents energy being wasted on escaping (Vilhunen, 2006; Voellmy et al., 2014). If fish continually react to low-risk threats they will then have to compensate for lost energy by foraging at times when predation is more likely (Voellmy et al., 2014). Schleidt (1983) found that angel fish (*Pterophyllum eimecki*) habituated very quickly in a laboratory setting to a frequently presented stimulus and it was the relative rareness of predators that stops the fish from habituating to them the wild. The brown trout in this experiment may have habituated to the kayak because it was frequently present with no negative interaction (Domenici, 2010). By the end of the week the fish latency to the kingfisher had increased possibly due to reduced vigilance and sensory fatigue which would explain why they took longer to notice the predation risk (Jones & Godin, 2010). Voellmy et al. (2014) found that guppies with shorter latencies, because of previous exposure to adult aggression, were more likely to survive predation than their counterparts who

had not been exposed to any aggression. The brown trout in this experiment would therefore be more vulnerable to predation by the end of the experiment. Teleost fish take 5-10 msecs to respond to a threat stimulus, the brown trout in this experiment were similarly taking 0.4 seconds to respond to the kingfisher at the beginning of the week whereas, by the end of the week were taking around 1 second (Eaton et al., 1977). It is beneficial for the brown trout to habituate to the kayak because it reduces energy expenditure on unnecessary escapes but not if it leads to impaired threat assessment (Vilhunen, 2006). The latency might also have been affected by the distance of the fish from where the model kingfisher was introduced, the further the fish were away from the simulated predator the longer they would take to respond (Domenici, 2001).

Towards the end of the experiment the brown trout remained at the downstream end of the tank (Figure 3.7.) whereas, the kingfisher was introduced at the upstream end, this could contribute to why the fish took longer to respond. Flight initiation distance has been found to reduce when animals become habituated to disturbances, so fish at the end of the tank may not have reacted at all to the kingfisher, but the ones closest would still react (Geffroy et al., 2015). When fish take longer to respond to predators it increases their vulnerability even if they respond by moving fast because there is now limited time and space to escape (Blumstein, 2016; Goldenberg et al., 2014). During a predator attack fish can remain frozen as an antipredator response as some predators have poor eyesight and rely on motion to detect prey (G. E. Brown & Dreier, 2002; Domenici, 2010; Jones & Godin, 2010). The escape response depends on the cost of flight which is worked out by the availability of food and hiding places, if the cost of flight is high then the fish may not escape (Domenici, 2010). The fish in this experiment had food readily available to them so this should not have affected their response. The increased latency from the brown trout to respond to the kingfisher will lead to increased vulnerability to predation (Kelligrew et al., 2021; Voellmy et al., 2014).

Location in the tank was not random, the fish moved around the tank and the pattern was significantly different from day one to day three, increase in boldness has been shown to change where fish locate themselves (Geffroy et al., 2015). This suggests that the fish were acclimatising to the tank and choosing the downstream end of the tank for conserving energy because of the high stress situation (Hartman, 1963). The fish also may have not been moving often to conserve energy further suggesting they were under stress (Spagnoli et al., 2016). The velocity of water influences fish distribution patterns in rectangular tanks similar to the one used in this experiment (Duarte et al., 2011). Duarte et al. (2011) zebrafish had the opposite

relationship with water flow and distribution around the tank, they preferred the high velocity areas, this was stated to be species specific. Rainbow trout have been found to behave similarly to the brown trout in this experiment, preferring low flows (Ross et al., 1995). Reduced tank exploration, erratic swimming, staying close to the walls (thigmotaxis) and freezing are behaviours that are displayed when the fish are under stressful conditions (Egan et al., 2009; Whittaker et al., 2021). This may explain why the fish were heterogeneously distributed around the tank because they have reduced tank exploration and remained in place. There can be large differences between individuals in the way they react to stress, this could also influence the results (Spagnoli et al., 2016). The locations of the fish also differed each week, this may have been to do with the changing seasons and food availability in the rivers where they were collected. The fish seemed to prefer the downstream end of the tank by the last week compared to the first, during winter fish are more likely to spend time saving energy in areas of less flow (Duarte et al., 2011).

The number of fish visible increased by the end of the week. The fish were not using the covers as much by the end of the week which potentially was due to increased boldness and habituation (Vilhunen, 2006). Fish stay close to places or refuge or under cover to have a quick escape from predation (Anderson, 2001) and when they are anxious (Whittaker et al., 2021). Fish will remain close to refuge for easy escape, however, when they habituate and become bolder, they venture further away from refuge and can become more vulnerable (Domenici, 2010). The majority of fish being visible by the end of the week compared to the beginning suggests that they have habituated the two models being deployed and have become bolder. Bolder fish are more vulnerable to predation because they are less vigilant (Geffroy et al., 2015; Goldenberg et al., 2014; Roberts et al., 2011). Measuring association of fish with refugia would help to further conclude about changes to boldness from the beginning to the end of the experiment.

The magnitude of response (velocity and distance) from the fish to the kingfisher did not change over the time. The velocity and distance travelled staying the same would suggest that the fish are taking longer to recognise the threat but are still perceiving the threat the same throughout. An animal's instincts change depending on their personal experience, when the experience is non-threatening, such as the repeated kayak model, this leads to failure to quickly recognise predator threats (Geffroy et al., 2015). Getting populations of fish from different rivers that have different predators may result in different reactions to the kayak and kingfisher. In future the experiment should be performed on fish with different experiences i.e. from different species and different populations to better portray the impact of repeated disturbance

on a community. Voellmy et al. (2014) found that minnows and sticklebacks reacted differently to exposure to boat noises. The sticklebacks had reduced their latency whilst the minnow's latency remained the same, potentially other species of fish will react differently to the kayak than the brown trout. The fish in this experiment clearly changed their startle response by taking longer to process the predator, however, their other reactions did not change. This would suggest the brown trout habituated to the constant disturbance and did not have the same alertness as the beginning of each week. This would imply that the fish were more vulnerable to predation at the end of the experiment. This information could be used to design more complex experiments running testing whether changing conditions would amplify the effects of disturbance. This experiment draws attention to the lack of quantitative evidence in this area. As there are many factors working in a river the experiment would need to be carried out in situ and ex situ to understand if reactions from the fish are repeated. Work would need to be done to monitor the long term effects of human disturbance from recreation. This experiment is just the starting point for this topic and the results should be read with caution as there are many contributing factors to physiological changes.

General conclusions and recommendations

The literature review highlighted that there is a lack of scientific evidence about how fish respond to prolonged recreational disturbances. However, the studies that have investigated disturbance to fish were finding that there were detrimental impacts to their natural behaviours and in turn their vulnerability. The fish increased their time avoiding stressors and this then prevented them from foraging and reproducing. Interestingly, motorboats and non-powered boats both disturbed fish and drove the fish from their preferred spots. The impacts from angling were not as well understood because the focus had mainly been on catch and release and not how angling affects behaviour in communities. The effects from all disturbance were amplified when environmental conditions were worse such as high temperatures, low water levels and low oxygen levels. The most studied form of disturbance was noise, which clearly disturbed natural behaviours and it was found that even the noise from paddling can elicit a response from fish. Recommendations from the review would include experiments which are performed on wild fish that live within various freshwater environments in different conditions. This study should be used to inform river management bodies about the need to understand stressors on freshwater systems. This review indicates that stressors such as recreational disturbance could become sublethal depending on their frequency and environment. In future research should focus on the dynamics between recreational activity and physiological responses from fish. As there has been an increase in uptake of water sports there needs to be quantifiable results available to make regulations for rivers, so that the overall ecosystem is not unknowingly suffering.

During the questionnaire that was undertaken it was clear that the different user groups (anglers, boaters and others) had different opinion about whether there was conflict on rivers in Wales and whether there should be free access to these rivers. Their opinions also differed depending on their age. It also showed that most users would support greater dialogue between the groups to help improve conflict. One of the major issues that users all felt should be addressed is the pollution in rivers, tackling this as a whole community would improve relations between users and river health. It was clear from this questionnaire and previous studies that improving river access will help wellbeing and physical health for the public in Wales and England. However, this should be done by consulting with many river users about how they view the issues and what their goals are for access.

The experimental work in the mesocosm found that the juvenile brown trout changed their anti-predatory behaviours when exposed to a model kayak frequently. Brown trout increased their

latency to respond to the kingfisher possibly because they were becoming bolder and less vigilant after being exposed frequently to the kayak. Brown trout also spend less time under cover after the kayak disturbances as well as changing their position to be at the downstream end of the tank. These results suggest that the fish have habituated to the disturbance and therefore reduced their anti-predatory behaviours. Further studies should focus on field work to find whether a full-size kayak would elicit the same response in different areas, conditions and at different times of the year. Using different species of fish and at different life stages may change the results, this should also be investigated.

References

- Anderson, T. W. (2001). Predator responses, prey refuges, and density dependent mortality in marine fish. *Ecology*, 82(1), 245–257. <https://doi.org/10.1890/0012-9658>
- Arlinghaus, R., Cooke, S. J. & Potts, W. (2013). Towards resilient recreational fisheries on a global scale through improved understanding of fish and fisher behaviour. *Fisheries Management and Ecology*, 20(2–3), 91–98. <https://doi.org/10.1111/fme.12027>
- Arlinghaus, Robert. (2006). Overcoming human obstacles to conservation of recreational fishery resources, with emphasis on central Europe. *Environmental Conservation*, 33(1), 46–59. <https://doi.org/10.1017/S0376892906002700>
- Arlinghaus, Robert, Cooke, S. J., Schwab, A. & Cowx, I. G. (2007). Fish welfare: a challenge to the feelings-based approach, with implications for recreational fishing. *Fish and Fisheries*, 8(1), 57–71. <https://doi.org/10.1111/j.1467-2979.2007.00233.x>
- Arnberger, A., Eder, R., Allex, B., Ebenberger, M., Hutter, H. P., Wallner, P., Bauer, N., Zaller, J. G. & Frank, T. (2018). Health-Related Effects of Short Stays at Mountain Meadows, a River and an Urban Site—Results from a Field Experiment. *International Journal of Environmental Research and Public Health* 2018, Vol. 15, Page 2647, 15(12), 2647. <https://doi.org/10.3390/IJERPH15122647>
- Baktoft, H., Aarestrup, K., Berg, S., Boel, M., Jacobsen, L., Koed, A., Pedersen, M. W., Svendsen, J. C. & Skov, C. (2013). Effects of angling and manual handling on pike behaviour investigated by high-resolution positional telemetry. *Fisheries Management and Ecology*, 20(6), 518–525. <https://doi.org/10.1111/FME.12040>
- Baumgartner, H. & Steenkamp, J.-B. E. M. (2006). *Response biases in marketing research*. in Grover, R., Vriens, M. (Eds.), *The Handbook of Marketing Research: Uses, Misuses, and Future Advances*. SAGE Publications, Inc., Thousand Oaks, CA, USA. [https://books.google.co.uk/books?hl=en&lr=&id=RymGgxN3zD4C&oi=fnd&pg=PA95&dq=\(Baumgartner+and+Steenkamp,+2006+questionnaire&ots=a4q-LuR5s4&sig=Vub7S848o3YPRDhOZ3aT6CF1fH8&redir_esc=y#v=onepage&q=\(Baumgartner%20and%20Steenkamp%2C%202006%20questionnaire&f=false](https://books.google.co.uk/books?hl=en&lr=&id=RymGgxN3zD4C&oi=fnd&pg=PA95&dq=(Baumgartner+and+Steenkamp,+2006+questionnaire&ots=a4q-LuR5s4&sig=Vub7S848o3YPRDhOZ3aT6CF1fH8&redir_esc=y#v=onepage&q=(Baumgartner%20and%20Steenkamp%2C%202006%20questionnaire&f=false)
- Begg, C., Callsen, I., Kuhlicke, C. & Kelman, I. (2018). The role of local stakeholder participation in flood defence decisions in the United Kingdom and Germany. *Journal of Flood Risk Management*, 11(2), 180–190. <https://doi.org/10.1111/JFR3.12305>

- Bejder, L., Samuels, A., Whitehead, H., Finn, H. & Allen, S. (2009). Impact assessment research: use and misuse of habituation, sensitisation and tolerance in describing wildlife responses to anthropogenic stimuli. *Marine Ecology Progress Series*, 395, 177–185. <https://doi.org/10.3354/MEPS07979>
- Bessa, E. & Gonçalves-de-Freitas, E. (2014). How does tourist monitoring alter fish behavior in underwater trails? *Tourism Management*, 45, 253–259. <https://doi.org/10.1016/J.TOURMAN.2014.04.008>
- Blumstein, D. T. (2016). Habituation and sensitization: new thoughts about old ideas. *Animal Behaviour*, 120, 255–262. <https://doi.org/10.1016/J.ANBEHAV.2016.05.012>
- Bolker, B. (2022). *Package “bbmle” Title Tools for General Maximum Likelihood Estimation*. <https://github.com/bbolker/bbmle>
- Britton, E., Kindermann, G., Domegan, C. & Carlin, C. (2020). Blue care: a systematic review of blue space interventions for health and wellbeing. *Health Promotion International*, 35(1), 50–69. <https://doi.org/10.1093/HEAPRO/DAY103>
- Brown, G. E. & Dreier, V. M. (2002). Predator inspection behaviour and attack cone avoidance in a characin fish: The effects of predator diet and prey experience. *Animal Behaviour*, 63(6), 1175–1181. <https://doi.org/10.1006/ANBE.2002.3024>
- Brown, G., Weber, D., Zanon, D. & de Bie, K. (2012). Evaluation of an online (opt-in) panel for public participation geographic information systems surveys. *International Journal of Public Opinion Research*, 24(4), 534–545. <https://doi.org/10.1093/ijpor/eds001>
- Bruintjes, R. & Radford, A. N. (2013). Context-dependent impacts of anthropogenic noise on individual and social behaviour in a cooperatively breeding fish. *Animal Behaviour*, 85(6), 1343–1349. <https://doi.org/10.1016/J.ANBEHAV.2013.03.025>
- Buckley, R. (2013). Next steps in recreation ecology. *Frontiers in Ecology and Environment*, 11(8), 399–399. www.frontiersinecology.org
- Buckley, R. (2019). Therapeutic mental health effects perceived by outdoor tourists: A large-scale, multi-decade, qualitative analysis. *Annals of Tourism Research*, 77, 164–167. <https://doi.org/10.1016/j.annals.2018.12.017>

- Butler, B., Pearson, R. G. & Birtles, R. A. (2021). Water-quality and ecosystem impacts of recreation in streams: Monitoring and management. *Environmental Challenges*, 5, 100328. <https://doi.org/10.1016/j.envc.2021.100328>
- Card, J. T. & Hasler, C. T. (2021). Physiological effects of catch-and-release angling on freshwater drum (*Aplodinotus grunniens*). *Fisheries Research*, 237, 105881. <https://doi.org/10.1016/J.FISHRES.2021.105881>
- Carter, J. G. (2011). Climate change adaptation in European cities. *Current Opinion in Environmental Sustainability*, 3(3), 193–198. <https://doi.org/10.1016/J.COSUST.2010.12.015>
- Christensen, R. (2019). *Ordinal: Regression Models for Ordinal Data*. R Package. https://www.researchgate.net/publication/271196601_Ordinal_Regression_Models_for_Ordinal_Data
- Church, A., Gilchrist, P. & Ravenscroft, N. (2007). Negotiating Recreational Access Under Asymmetrical Power Relations: The Case of Inland Waterways in England. *Society & Natural Resources*, 20(3), 213–227. <https://doi.org/10.1080/08941920601117298>
- Church, A. & Ravenscourt, N. (2006). Power, resource mobilisation and leisure conflict on inland rivers in England. In *Tourism, Power and Space*. Routledge. <https://doi.org/10.4324/9780203392096-18>
- Church, A. & Ravenscroft, N. (2011). Politics, research and the natural environment: the lifeworlds of water-based sport and recreation in Wales. *Leisure Studies*, 30(4), 387–405. <https://doi.org/10.1080/02614367.2011.572993>
- Closs, G., Krkosek, M. & Olden, J. (2016). *Conservation of Freshwater Fishes* - Google Books. Cambridge University Press. https://books.google.co.uk/books?hl=en&lr=&id=tcLrCgAAQBAJ&oi=fnd&pg=PA37&dq=Recreation+%2B+fish+behaviour+%2B+freshwater+&ots=5kVeg4EQia&sig=vIwm-Q-ezmPXKHKh-DQNoCfMs7Y&redir_esc=y#v=onepage&q=Recreation%20%2B%20fish%20behaviour%20%2B%20freshwater&f=false
- Cooke, S. J., Bunt, C. M., Ostrand, K. G., Philipp, D. P. & Wahl, D. H. (2004). Angling-induced cardiac disturbance of free-swimming largemouth bass (*Micropterus salmoides*)

- monitored with heart rate telemetry. *Journal of Applied Ichthyology*, 20(1), 28–36.
<https://doi.org/10.1111/J.1439-0426.2004.00494.X>
- Cooke, S. J., Danylchuk, A. J., Danylchuk, S. E., Suski, C. D. & Goldberg, T. L. (2006). Is catch-and-release recreational angling compatible with no-take marine protected areas? *Ocean & Coastal Management*, 49(5–6), 342–354.
<https://doi.org/10.1016/J.OCECOAMAN.2006.03.003>
- Cooke, S. J., Ostrand, K. G., Bunt, C. M., Schreer, J. F., Wahl, D. H. & Philipp, D. P. (2003). Cardiovascular Responses of Largemouth Bass to Exhaustive Exercise and Brief Air Exposure over a Range of Water Temperatures. *Transactions of the American Fisheries Society*, 132(6), 1154–1165. <https://doi.org/10.1577/T02-059>
- Cooke, S. J. & Sneddon, L. U. (2007). Animal welfare perspectives on recreational angling. *Applied Animal Behaviour Science*, 104(3–4), 176–198.
<https://doi.org/10.1016/J.APPLANIM.2006.09.002>
- Cooke, S. J., Steinmetz, J., Degner, J. F., Grant, E. C. & Philipp, D. P. (2003). Metabolic fright responses of different-sized largemouth bass (*Micropterus salmoides*) to two avian predators show variations in nonlethal energetic costs. *Canadian Journal of Zoology*, 81(4), 699–709. <https://doi.org/10.1139/z03-044>
- Cyr, N. E. & Romero, L. M. (2009). Identifying hormonal habituation in field studies of stress. *General and Comparative Endocrinology*, 161(3), 295–303.
<https://doi.org/10.1016/J.YGCEN.2009.02.001>
- Davie, P. S. & Kopf, R. K. (2011). Physiology, behaviour and welfare of fish during recreational fishing and after release. [Http://Dx.Doi.Org/10.1080/00480169.2006.36690](http://Dx.Doi.Org/10.1080/00480169.2006.36690), 54(4), 161–172. <https://doi.org/10.1080/00480169.2006.36690>
- de Bell, S., Graham, H., Jarvis, S. & White, P. (2017). The importance of nature in mediating social and psychological benefits associated with visits to freshwater blue space. *Landscape and Urban Planning*, 167, 118–127.
<https://doi.org/10.1016/J.LANDURBPLAN.2017.06.003>
- Domenici, P. (2001). The scaling of locomotor performance in predator–prey encounters: from fish to killer whales. *Comparative Biochemistry and Physiology Part A: Molecular*

& *Integrative Physiology*, 131(1), 169–182. [https://doi.org/10.1016/S1095-6433\(01\)00465-2](https://doi.org/10.1016/S1095-6433(01)00465-2)

- Domenici, P. (2010). Context-dependent variability in the components of fish escape response: integrating locomotor performance and behavior. *Journal of Experimental Zoology Part A: Ecological Genetics and Physiology*, 313A(2), 59–79. <https://doi.org/10.1002/JEZ.580>
- Duarte, S., Reig, L., Masaló, I., Blanco, M. & Oca, J. (2011). Influence of tank geometry and flow pattern in fish distribution. *Aquacultural Engineering*, 44(2), 48–54. <https://doi.org/10.1016/J.AQUAENG.2010.12.002>
- Dudley, M. (2017). “Muddying the waters: recreational conflict and rights of use of British rivers.” *Water History* 2017 9:3, 9(3), 259–277. <https://doi.org/10.1007/S12685-017-0193-2>
- Eaton, R. C., Bombardieri, R. A. & Meyer, D. L. (1977). The Mauthner-initiated startle response in teleost fish. *Journal of Experimental Biology*, 66(1), 65–81. <https://doi.org/10.1242/JEB.66.1.65>
- Egan, R. J., Bergner, C. L., Hart, P. C., Cachat, J. M., Canavello, P. R., Elegante, M. F., Elkhayat, S. I., Bartels, B. K., Tien, A. K., Tien, D. H., Mohnot, S., Beeson, E., Glasgow, E., Amri, H., Zukowska, Z. & Kalueff, A. v. (2009). Understanding behavioral and physiological phenotypes of stress and anxiety in zebrafish. *Behavioural Brain Research*, 205(1), 38–44. <https://doi.org/10.1016/J.BBR.2009.06.022>
- Ferrari, M. C. O., Elvidge, C. K., Jackson, C. D., Chivers, D. P. & Brown, G. E. (2010). The responses of prey fish to temporal variation in predation risk: sensory habituation or risk assessment? *Behavioral Ecology*, 21(3), 532–536. <https://doi.org/10.1093/BEHECO/ARQ023>
- Fischer, L. K., Neuenkamp, L., Lampinen, J., Tuomi, M., Alday, J. G., Bucharova, A., Cancellieri, L., Casado-Arzuaga, I., Čeplová, N., Cerveró, L., Deák, B., Eriksson, O., Fellowes, M. D. E., Fernández de Manuel, B., Filibeck, G., González-Guzmán, A., Hinojosa, M. B., Kowarik, I., Lumbierres, B., ... Klaus, V. H. (2020). Public attitudes toward biodiversity-friendly greenspace management in Europe. *Conservation Letters*, 13(4), e12718. <https://doi.org/10.1111/CONL.12718>

- Fleissner, E. R. & Mensinger, A. F. (2021). *Investigating the Changes in Fish Behavior in Response to Anthropogenic Sound A THESIS SUBMITTED TO THE FACULTY OF THE UNIVERSITY OF MINNESOTA BY.*
- Foley, R. & Kistemann, T. (2015). Blue space geographies: Enabling health in place. *Health & Place*, 35, 157–165. <https://doi.org/10.1016/J.HEALTHPLACE.2015.07.003>
- Gascon, M., Zijlema, W., Vert, C., White, M. P. & Nieuwenhuijsen, M. J. (2017). Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health*, 220(8), 1207–1221. <https://doi.org/10.1016/J.IJHEH.2017.08.004>
- Geffroy, B., Samia, D. S. M., Bessa, E. & Blumstein, D. T. (2015a). How Nature-Based Tourism Might Increase Prey Vulnerability to Predators. *Trends in Ecology & Evolution*, 30(12), 755–765. <https://doi.org/10.1016/J.TREE.2015.09.010>
- Geffroy, B., Samia, D. S. M., Bessa, E. & Blumstein, D. T. (2015b). How Nature-Based Tourism Might Increase Prey Vulnerability to Predators. *Trends in Ecology & Evolution*, 30(12), 755–765. <https://doi.org/10.1016/J.TREE.2015.09.010>
- Gerlai, R. (2013). Antipredatory Behavior of Zebrafish: Adaptive Function and a Tool for Translational Research: [Http://Dx.Doi.Org/10.1177/147470491301100308](http://Dx.Doi.Org/10.1177/147470491301100308), 11(3), 591–605. <https://doi.org/10.1177/147470491301100308>
- Gingerich, A. J., Cooke, S. J., Hanson, K. C., Donaldson, M. R., Hasler, C. T., Suski, C. D. & Arlinghaus, R. (2007). Evaluation of the interactive effects of air exposure duration and water temperature on the condition and survival of angled and released fish. *Fisheries Research*, 86(2–3), 169–178. <https://doi.org/10.1016/J.FISHRES.2007.06.002>
- Goldenberg, S. U., Borcharding, J. & Heynen, M. (2014). Balancing the response to predation-the effects of shoal size, predation risk and habituation on behaviour of juvenile perch. *Behavioral Ecology and Sociobiology*, 68(6), 989–998. <https://doi.org/10.1007/S00265-014-1711-1/TABLES/4>
- Government, W. (2019). *Access to Inland Waterways Welsh Government Outline Policy Intent*. <https://gov.wales/taking-forward-wales-sustainable-management-natural->
- Graham, A. L. & Cooke, S. J. (2008). The effects of noise disturbance from various recreational boating activities common to inland waters on the cardiac physiology of a

- freshwater fish, the largemouth bass (*Micropterus salmoides*). *Aquatic Conservation: Marine and Freshwater Ecosystems*, 18(7), 1315–1324. <https://doi.org/10.1002/aqc.941>
- Gutreuter, S., Vallazza, J. M. & Knights, B. C. (2006). Persistent disturbance by commercial navigation alters the relative abundance of channel-dwelling fishes in a large river. *Canadian Journal of Fisheries and Aquatic Sciences*, 63(11), 2418–2433. https://doi.org/10.1139/F06-129/SUPPL_FILE/F06-129A.PDF
- Hartman, G. F. (1963). Observations on Behavior of Juvenile Brown Trout in a Stream Aquarium During Winter and Spring. <https://doi.org/10.1139/F63-051>, 20(3), 769–787. <https://doi.org/10.1139/F63-051>
- Hines, R. K. (2017). Review of Literature: Potential Benefits of Urban Nature Exposure and Stream Corridor Recreation | Illuminare. *Illuminare*, 15. <https://scholarworks.iu.edu/journals/index.php/illuminare/article/view/20415>
- Horton, H. (2022, 4. June). How ministers squashed proposals to expand right to roam in England. *The Guardian*. <https://www.theguardian.com/environment/2022/jun/04/right-to-roam-england-access-to-green-space-proposals>
- Huntingford, F. A., Adams, C., Braithwaite, V. A., Kadri, S., Pottinger, T. G., Sandøe, P. & Turnbull, J. F. (2006). Current issues in fish welfare. *Journal of Fish Biology*, 68(2), 332–372. <https://doi.org/10.1111/J.0022-1112.2006.001046.X>
- Hutton, B., Salanti, G., Caldwell, D. M., Chaimani, A., Schmid, C. H., Cameron, C., Ioannidis, J. P. A., Straus, S., Thorlund, K., Jansen, J. P., Mulrow, C., Catala-Lopez, F., Gotzsche, P. C., Dickersin, K., Boutron, I., Altman, D. G. & Moher, D. (2015). The PRISMA Extension Statement for Reporting of Systematic Reviews Incorporating Network Meta-analyses of Health Care Interventions: Checklist and Explanations. <https://doi.org/10.7326/M14-2385>, 162(11), 777–784. <https://doi.org/10.7326/M14-2385>
- Imre, I., di Rocco, R. T., Brown, G. E. & Johnson, N. S. (2016). Habituation of adult sea lamprey repeatedly exposed to damage-released alarm and predator cues. *Environmental Biology of Fishes*, 99(8–9), 613–620. <https://doi.org/10.1007/S10641-016-0503-Z/FIGURES/2>

- Jacobsen, L., Baktoft, H., Jepsen, N., Aarestrup, K., Berg, S. & Skov, C. (2014). Effect of boat noise and angling on lake fish behaviour. *Journal of Fish Biology*, 84(6), 1768–1780. <https://doi.org/10.1111/JFB.12395>
- Jellyman, D. & Jellyman, D. (2009). A review of radio and acoustic telemetry studies of freshwater fish in New Zealand. *Marine and Freshwater Research*, 60(4), 321–327. <https://doi.org/10.1071/MF08112>
- Jensen, J. L. A., Halttunen, E., Thorstad, E. B., Næsje, T. F. & Rikardsen, A. H. (2010). Does catch-and-release angling alter the migratory behaviour of Atlantic salmon? *Fisheries Research*, 106(3), 550–554. <https://doi.org/10.1016/J.FISHRES.2010.08.013>
- Jockers, M. (2015). *GitHub - mjockers/syuzhet: An R package for the extraction of sentiment and sentiment-based plot arcs from text*. <https://github.com/mjockers/syuzhet>
- Jones, K. A. & Godin, J. G. J. (2010). Are fast explorers slow reactors? Linking personality type and anti-predator behaviour. *Proceedings of the Royal Society B: Biological Sciences*, 277(1681), 625–632. <https://doi.org/10.1098/RSPB.2009.1607>
- Kelley, J. L. & Magurran, A. E. (2003). Learned predator recognition and antipredator responses in fishes. *Fish and Fisheries*, 4(3), 216–226. <https://doi.org/10.1046/J.1467-2979.2003.00126.X>
- Kelligrew, C., Tian, S., Weiss, M., Williams, D. M. & Blumstein, D. T. (2021). The effect of white noise on behavioral and flight responses of blue-tailed skinks. *Current Zoology*, 67(1), 125. <https://doi.org/10.1093/CZ/ZOAA046>
- Klefoth, T., Kobler, A. & Arlinghaus, R. (2008). The impact of catch-and-release angling on short-term behaviour and habitat choice of northern pike (*Esox lucius* L.). *Hydrobiologia* 2008 601:1, 601(1), 99–110. <https://doi.org/10.1007/S10750-007-9257-0>
- Klefoth, T., Kobler, A. & Arlinghaus, R. (2011). Behavioural and fitness consequences of direct and indirect non-lethal disturbances in a catch-and-release northern pike (*Esox lucius*) fishery. *Knowledge and Management of Aquatic Ecosystems*, 403(403), 11. <https://doi.org/10.1051/KMAE/2011072>
- Krebs, C. J. (1999). *Ecological methodology* (Second edition.). Benjamin/Cummings.
- Kusku, H. (2020). Acoustic sound-induced stress response of Nile tilapia (*Oreochromis niloticus*) to long-term underwater sound transmissions of urban and shipping noises.

- Environmental Science and Pollution Research*, 27(29), 36857–36864.
<https://doi.org/10.1007/S11356-020-09699-9/FIGURES/4>
- Kuznetsova, A., Brockhoff, P. B. & Christensen, R. H. B. (2020). *Package “lmerTest”* (pp. 1–31). <https://doi.org/10.18637/jss.v082.i13>
- Lackey, N. Q., Tysor, D. A., McNay, G. D., Joyner, L., Baker, K. H. & Hodge, C. (2019). Mental health benefits of nature-based recreation: a systematic review. *Https://Doi.Org/10.1080/11745398.2019.1655459*, 24(3), 379–393.
<https://doi.org/10.1080/11745398.2019.1655459>
- Lewin, W. C., Arlinghaus, R. & Mehner, T. (2007). Documented and Potential Biological Impacts of Recreational Fishing: Insights for Management and Conservation. *Http://Dx.Doi.Org/10.1080/10641260600886455*, 14(4), 305–367.
<https://doi.org/10.1080/10641260600886455>
- Liddle, M. J. & Scorgie, H. R. A. (1980). The effects of recreation on freshwater plants and animals: A review. *Biological Conservation*, 17(3), 183–206.
[https://doi.org/10.1016/0006-3207\(80\)90055-5](https://doi.org/10.1016/0006-3207(80)90055-5)
- Lima, S. L. & Bednekoff, P. A. (2015). Temporal Variation in Danger Drives Antipredator Behavior: The Predation Risk Allocation Hypothesis. *Https://Doi.Org/10.1086/303202*, 153(6), 649–659. <https://doi.org/10.1086/303202>
- Lobón-Cerviá, javier & Sanz, N. (2017). *Brown Trout: Biology, Ecology and Management - Google Books* (Vol. 1). Wiley.
https://books.google.co.uk/books?hl=en&lr=&id=tSg6DwAAQBAJ&oi=fnd&pg=PA13&dq=brown+trout&ots=dnlyptsoTL&sig=2a--n3DM-DVdN1ingfZmGQiPKyo&redir_esc=y#v=onepage&q=brown%20trout&f=false
- MacLean, K., Prystay, T. S., Lawrence, M. J., Zolderdo, A. J., Gutowsky, L. F. G., Staaterman, E., Gallagher, A. J. & Cooke, S. J. (2020). Going the Distance: Influence of Distance Between Boat Noise and Nest Site on the Behavior of Paternal Smallmouth Bass. *Water, Air, and Soil Pollution*, 231(4), 1–11. <https://doi.org/10.1007/S11270-020-04470-9/TABLES/2>
- Mangiafico, S. (2016). *Summary and Analysis of Extension Program Evaluation in R*. Descriptive Statistics for Likert Data. Introduction to Cumulative Link Models (CLM)

- for Ordinal Data. Confidence Intervals for Medians.
 Rcompanion.Org/Handbook/(Pdfversion:Rcompanion.Org/Documents/RHandbookProgramEvaluation.Pdf.
https://www.researchgate.net/publication/305436975_Summary_and_Analysis_of_Extension_Program_Evaluation_in_R
- Mäntylä, M. v., Graziotin, D. & Kuuttila, M. (2018). The evolution of sentiment analysis—A review of research topics, venues, and top cited papers. *Computer Science Review*, 27, 16–32. <https://doi.org/10.1016/J.COSREV.2017.10.002>
- Marshall, G. (2005). The purpose, design and administration of a questionnaire for data collection. *Radiography*, 11(2), 131–136. <https://doi.org/10.1016/j.radi.2004.09.002>
- Mateus, A. P., Power, D. M. & Canário, A. V. M. (2017). Stress and Disease in Fish. *Fish Diseases: Prevention and Control Strategies*, 187–220. <https://doi.org/10.1016/B978-0-12-804564-0.00008-9>
- Maxwell, R. J., Zolderdo, A. J., de Bruijn, R., Brownscombe, J. W., Staaterman, E., Gallagher, A. J. & Cooke, S. J. (2018). Does motor noise from recreational boats alter parental care behaviour of a nesting freshwater fish? *Aquatic Conservation: Marine and Freshwater Ecosystems*, 28(4), 969–978. <https://doi.org/10.1002/aqc.2915>
- McDowall, R. M. (2006). Crying wolf, crying foul, or crying shame: alien salmonids and a biodiversity crisis in the southern cool-temperate galaxioid fishes? *Reviews in Fish Biology and Fisheries* 2006 16:3, 16(3), 233–422. <https://doi.org/10.1007/S11160-006-9017-7>
- McManus, A., Newton, W., Scepi, G. & Spano, M. (2011). *Identifying the health and well-being benefits of recreational fishing*.
<https://espace.curtin.edu.au/handle/20.500.11937/27359>
- Meyer, N., Schafft, M., Wegner, B., Wolter, C., Arlinghaus, R., Venohr, M. & von Oheimb, G. (2021). A day on the shore: Ecological impacts of non-motorised recreational activities in and around inland water bodies. *Journal for Nature Conservation*, 64, 126073. <https://doi.org/10.1016/J.JNC.2021.126073>
- Mickle, M. (2017). *Behavioural, Morphological and Physiological Impacts of Anthropogenic Noise on Freshwater Fish*. <https://www.mendeley.com/reference->

manager/reader/72761f45-3e4a-35c8-8dda-c3dea8b74493/4a876f0d-43d8-a767-050e-f5a035d9c09f/

- Mickle, M. & Higgs, D. (2018). Integrating techniques: a review of the effects of anthropogenic noise on freshwater fish. *Canadian Journal of Fisheries and Aquatic Sciences*, 75(9), 1534–1541. <https://doi.org/10.1139/cjfas-2017-0245>
- Misuraca, M., Forciniti, A., Scepi, G. & Spano, M. (2020). *Sentiment Analysis for Education with R: packages, methods and practical applications*. <https://doi.org/10.48550/arxiv.2005.12840>
- Monk, C. T. & Arlinghaus, R. (2017). Encountering a bait is necessary but insufficient to explain individual variability in vulnerability to angling in two freshwater benthivorous fish in the wild. *PLOS ONE*, 12(3), e0173989. <https://doi.org/10.1371/JOURNAL.PONE.0173989>
- Mueller, G. (1980). *Effects of Recreational River Traffic on Nest Defense by Longear Sunfish*. Transactions of the American Fisheries Society . <https://afspubs.onlinelibrary.wiley.com/doi/abs/10.1577/1548-8659%281980%29109%3C248%3AEORRTO%3E2.0.CO%3B2>
- Murchie, K. J., Hair, K. P. E., Pullen, C. E., Redpath, T. D., Stephens, H. R. & Cooke, S. J. (2008). Fish response to modified flow regimes in regulated rivers: research methods, effects and opportunities. *River Research and Applications*, 24(2), 197–217. <https://doi.org/10.1002/RRA.1058>
- Naldi, M. (2019). *A review of sentiment computation methods with R packages*. <https://doi.org/10.48550/arxiv.1901.08319>
- National Assembly for Wales Commission. (2010). *Sustainability Committee Inquiry into Access to Inland Water in Wales, Cardiff, UK*. 65. www.assemblywales.org
- Petersson, E. & Järvi, T. (2006). Anti-predator response in wild and sea-ranched brown trout and their crosses. *Aquaculture*, 253(1–4), 218–228. <https://doi.org/10.1016/J.AQUACULTURE.2005.08.012>
- Post, N. & von der Emde, G. (1999). The “novelty response” in an electric fish: response properties and habituation. *Physiology & Behavior*, 68(1–2), 115–128. [https://doi.org/10.1016/S0031-9384\(99\)00153-5](https://doi.org/10.1016/S0031-9384(99)00153-5)

- Poulsen, M. N., Nordberg, C. M., Fiedler, A., DeWalle, J., Mercer, D. & Schwartz, B. S. (2022). Factors associated with visiting freshwater blue space: The role of restoration and relations with mental health and well-being. *Landscape and Urban Planning*, 217, 104282. <https://doi.org/10.1016/J.LANDURBPLAN.2021.104282>
- Raby, G. D., Packer, J. R., Danylchuk, A. J. & Cooke, S. J. (2014). The understudied and underappreciated role of predation in the mortality of fish released from fishing gears. *Fish and Fisheries*, 15(3), 489–505. <https://doi.org/10.1111/FAF.12033>
- Rapp, T., Hallermann, J., Cooke, S. J., Hetz, S. K., Wuertz, S. & Arlinghaus, R. (2012). Physiological and behavioural consequences of capture and retention in carp sacks on common carp (*Cyprinus carpio* L.), with implications for catch-and-release recreational fishing. *Fisheries Research*, 125–126, 57–68. <https://doi.org/10.1016/J.FISHRES.2012.01.025>
- Roberts, L. J., Taylor, J. & Garcia de Leaniz, C. (2011). Environmental enrichment reduces maladaptive risk-taking behavior in salmon reared for conservation. *Biological Conservation*, 144(7), 1972–1979. <https://doi.org/10.1016/j.biocon.2011.04.017>
- Ross, R. M., Watten, B. J., Krise, W. F., DiLauro, M. N. & Soderberg, R. W. (1995). Influence of tank design and hydraulic loading on the behavior, growth, and metabolism of rainbow trout (*Oncorhynchus mykiss*). *Aquacultural Engineering*, 14(1), 29–47. [https://doi.org/10.1016/0144-8609\(94\)P4425-B](https://doi.org/10.1016/0144-8609(94)P4425-B)
- Ruedin, D. & Aeppli, C. (2021). *Package “agrmt” Type Package Title Calculate Concentration and Dispersion in Ordered Rating Scales*. <https://doi.org/10.1023/A:1010374114305>
- Sadoul, B. & Geffroy, B. (2019). Measuring cortisol, the major stress hormone in fishes. *Journal of Fish Biology*, 94(4), 540–555. <https://doi.org/10.1111/JFB.13904>
- Scaini, A., Stritih, A., Brouillet, C. & Scaini, C. (2021). Flood Risk and River Conservation: Mapping Citizen Perception to Support Sustainable River Management. *Frontiers in Earth Science*, 9, 510. <https://doi.org/10.3389/FEART.2021.675131/BIBTEX>
- Schafft, M., Wegner, B., Meyer, N., Wolter, C. & Arlinghaus, R. (2021). Ecological impacts of water-based recreational activities on freshwater ecosystems: a global meta-analysis.

- Proceedings of the Royal Society B: Biological Sciences*, 288(1959), 20211623.
<https://doi.org/10.1098/rspb.2021.1623>
- Schleidt, W. M., Shalter, M. D. & Carawan, T. C. (1983). The Effect of Spatial Context on Habituation to a Predator Model. *Zeitschrift Für Tierpsychologie*, 61(1), 67–70.
<https://doi.org/10.1111/J.1439-0310.1983.TB01326.X>
- Schmidt, M. B. & Gassner, H. (2006). Influence of scuba divers on the avoidance reaction of a dense vendace (*Coregonus albula*) population monitored by hydroacoustics. *Fisheries Research*, 82(1–3), 131–139. <https://doi.org/10.1016/J.FISHRES.2006.08.014>
- Schwalme, K. & Mackay, W. C. (1985). The influence of exercise–handling stress on blood lactate, acid–base, and plasma glucose status of northern pike (*Esox lucius*). *Canadian Journal of Zoology*, 63(5), 1125–1129. <https://doi.org/10.1139/Z85-170>
- Sebastianutto, L., Picciulin, M., Costantini, M. & Ferrero, E. A. (2011a). How boat noise affects an ecologically crucial behaviour: The case of territoriality in *Gobius cruentatus* (Gobiidae). *Environmental Biology of Fishes*, 92(2), 207–215.
<https://doi.org/10.1007/S10641-011-9834-Y/FIGURES/4>
- Sebastianutto, L., Picciulin, M., Costantini, M. & Ferrero, E. A. (2011b). How boat noise affects an ecologically crucial behaviour: The case of territoriality in *Gobius cruentatus* (Gobiidae). *Environmental Biology of Fishes*, 92(2), 207–215.
<https://doi.org/10.1007/S10641-011-9834-Y/FIGURES/4>
- Shafiei Sabet, S., Neo, Y. Y. & Slabbekoorn, H. (2015). The effect of temporal variation in sound exposure on swimming and foraging behaviour of captive zebrafish. *Animal Behaviour*, 107, 49–60. <https://doi.org/10.1016/J.ANBEHAV.2015.05.022>
- Shannon, G., Larson, C. L., Reed, S. E., Crooks, K. R. & Angeloni, L. M. (2017). Ecological Consequences of Ecotourism for Wildlife Populations and Communities. In *Ecotourism's Promise and Peril* (pp. 29–46). Springer International Publishing.
https://doi.org/10.1007/978-3-319-58331-0_3
- Silge, J. & Robinson, D. (2017). *Text Mining with R: A Tidy Approach*. O'Reilly Media, Inc.
<https://books.google.co.uk/books?hl=en&lr=&id=qNcnDwAAQBAJ&oi=fnd&pg=PP1&dq=silge+and+robinson+text+mining&ots=Q1zYcrFWuW&sig=6Hu9lesgrTJMpFSP>

p5coXXxSOP8&redir_esc=y#v=onepage&q=silge%20and%20robinson%20text%20mining&f=false

- Simpson, S. D., Purser, J. & Radford, A. N. (2015). Anthropogenic noise compromises anti-predator behaviour in European eels. *Global Change Biology*, 21(2), 586–593.
<http://mc.manuscriptcentral.com/LongRequest/gcb?DOWNLOAD=TR...v7qR35gQCV2J9phUPa2v8jVMtpXxvzJWLcyNVeDpugGkiqQFNSReWzBHsUr>
<http://mc.manuscriptcentral.com/LongRequest/gcb?DOWNLOAD=TR...v7qR35gQCV2J9phUPa2v8jVMtpXxvzJWLcyNVeDpugGkiqQFNSReWzBHsUr>
- Simpson, S. D., Radford, A. N., Nedelec, S. L., Ferrari, M. C. O., Chivers, D. P., McCormick, M. I. & Meekan, M. G. (2016). Anthropogenic noise increases fish mortality by predation. *Nature Communications*, 7, 10544.
<https://doi.org/10.1038/NCOMMS10544>
- Slabbekoorn, H., Bouton, N., van Opzeeland, I., Coers, A., ten Cate, C. & Popper, A. N. (2010). A noisy spring: the impact of globally rising underwater sound levels on fish. *Trends in Ecology & Evolution*, 25(7), 419–427.
<https://doi.org/10.1016/J.TREE.2010.04.005>
- Spagnoli, S., Lawrence, C. & Kent, M. L. (2016). Stress in Fish as Model Organisms. *Fish Physiology*, 35, 541–564. <https://doi.org/10.1016/B978-0-12-802728-8.00013-8>
- Stanford, P. (2021, 2. October). Inside the battle for Britain's rivers. *The Telegraph*.
<https://www.telegraph.co.uk/environment/0/inside-battle-britains-rivers/>
- Staven, F. R., Nordeide, J. T., Imsland, A. K., Andersen, P., Iversen, N. S. & Kristensen, T. (2019). Is habituation measurable in lumpfish cyclopterus lumpus when used as cleaner fish in atlantic salmon salmo salar aquaculture? *Frontiers in Veterinary Science*, 6(JUL), 227. <https://doi.org/10.3389/FVETS.2019.00227/BIBTEX>
- Stott, T. (2019). Water Sports and Water-Based Recreation. *Outdoor Recreation*, 331–359.
https://doi.org/10.1007/978-3-319-97758-4_13
- Suski, C. D., Cooke, S. J., Killen, S. S., Wahl, D. H. & Tufts, B. L. (2005). Behaviour of walleye, *Sander vitreus*, and largemouth bass, *Micropterus salmoides*, exposed to different wave intensities and boat operating conditions during livewell confinement.

- Fisheries Management and Ecology*, 12(1), 19–26. <https://doi.org/10.1111/j.1365-2400.2004.00415.x>
- Tarlow, E. M. & Blumstein, D. T. (2007). Evaluating methods to quantify anthropogenic stressors on wild animals. *Applied Animal Behaviour Science*, 102(3–4), 429–451. <https://doi.org/10.1016/J.APPLANIM.2006.05.040>
- Teresa, F. B., Romero, R. D. M., Casatti, L. & Sabino, J. (2011). Fish as indicators of disturbance in streams used for snorkeling activities in a tourist region. *Environmental Management*, 47(5), 960–968. <https://doi.org/10.1007/S00267-011-9641-4/FIGURES/4>
- Tjärnlund, U., Ericson, G., Lindesjö, E., Petterson, I., Åkerman, G. & Balk, L. (1996). Further studies of the effects of exhaust from two-stroke outboard motors on fish. *Marine Environmental Research*, 42(1–4), 267–271. [https://doi.org/10.1016/0141-1136\(95\)00053-4](https://doi.org/10.1016/0141-1136(95)00053-4)
- Tremblay, A., Canada, S. & Ransijn, J. (2020). “*LMERConvenienceFunctions*” *Model Selection and Post-Hoc Analysis for (G)LMER Models*. <https://doi.org/10.1016/j.jml.2008.02.002>
- Twardek, W. M., Elvidge, C. K., Wilson, A. D. M., Algera, D. A., Zolderdo, A. J., Loughheed, S. C. & Cooke, S. J. (2017). Do protected areas mitigate the effects of fisheries-induced evolution on parental care behaviour of a teleost fish? *Aquatic Conservation: Marine and Freshwater Ecosystems*, 27(4), 789–796. <https://doi.org/10.1002/AQC.2718>
- Venohr, M., Langhans, S. D., Peters, O., Hölker, F., Arlinghaus, R., Mitchell, L. & Wolter, C. (2018a). The underestimated dynamics and impacts of water-based recreational activities on freshwater ecosystems. *https://doi.org/10.1139/Er-2017-0024*, 26(2), 199–213. <https://doi.org/10.1139/ER-2017-0024>
- Venohr, M., Langhans, S. D., Peters, O., Hölker, F., Arlinghaus, R., Mitchell, L. & Wolter, C. (2018b). The underestimated dynamics and impacts of water-based recreational activities on freshwater ecosystems. *https://doi.org/10.1139/Er-2017-0024*, 26(2), 199–213. <https://doi.org/10.1139/ER-2017-0024>
- Vilhunen, S. (2006). Repeated antipredator conditioning: a pathway to habituation or to better avoidance? *Journal of Fish Biology*, 68(1), 25–43. <https://doi.org/10.1111/J.0022-1112.2006.00873.X>

- Voellmy, I. K., Purser, J., Simpson, S. D. & Radford, A. N. (2014). Increased Noise Levels Have Different Impacts on the Anti-Predator Behaviour of Two Sympatric Fish Species. *PLOS ONE*, 9(7), e102946. <https://doi.org/10.1371/JOURNAL.PONE.0102946>
- Völker, S. & Kistemann, T. (2011). The impact of blue space on human health and well-being - Salutogenetic health effects of inland surface waters: a review. *International Journal of Hygiene and Environmental Health*, 214(6), 449–460. <https://doi.org/10.1016/j.ijheh.2011.05.001>
- Weisbrod, C. J., Kunz, P. Y., Zenker, A. K. & Fent, K. (2007). Effects of the UV filter benzophenone-2 on reproduction in fish. *Toxicology and Applied Pharmacology*, 225(3), 255–266. <https://doi.org/10.1016/J.TAAP.2007.08.004>
- White, M. P., Elliott, L. R., Gascon, M., Roberts, B. & Fleming, L. E. (2020a). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research*, 191, 110169. <https://doi.org/10.1016/J.ENVRES.2020.110169>
- White, M. P., Elliott, L. R., Gascon, M., Roberts, B. & Fleming, L. E. (2020b). Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research*, 191, 110169. <https://doi.org/10.1016/J.ENVRES.2020.110169>
- White, M. P., Elliott, L. R., Grellier, J., Economou, T., Bell, S., Bratman, G. N., Cirach, M., Gascon, M., Lima, M. L., Löhmus, M., Nieuwenhuijsen, M., Ojala, A., Roiko, A., Schultz, P. W., van den Bosch, M. & Fleming, L. E. (2021). Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports 2021 11:1*, 11(1), 1–12. <https://doi.org/10.1038/s41598-021-87675-0>
- Whitfield, A. K. & Becker, A. (2014). Impacts of recreational motorboats on fishes: A review. *Marine Pollution Bulletin*, 83(1), 24–31. <https://doi.org/10.1016/J.MARPOLBUL.2014.03.055>
- Whittaker, B. A., Consuegra, S. & Garcia de Leaniz, C. (2021). Personality profiling may help select better cleaner fish for sea-lice control in salmon farming. *Applied Animal Behaviour Science*, 243, 105459. <https://doi.org/10.1016/J.APPLANIM.2021.105459>
- Wickham, M. H. (2014). *Package “ggplot2” Type Package Title An implementation of the Grammar of Graphics.*

- Wolter, C. & Arlinghaus, R. (2003). Navigation impacts on freshwater fish assemblages: the ecological relevance of swimming performance. *Reviews in Fish Biology and Fisheries* 2003 13:1, 13(1), 63–89. <https://doi.org/10.1023/A:1026350223459>
- Wynn-Davies, S. (2021, 27. September). Anglers block paddle-boarders going under bridge as battle escalates. *Daily Mail*. <https://www.msn.com/en-gb/travel/news/anglers-block-paddle-boarders-going-under-bridge-as-battle-escalates/ar-AAOSMgB?ocid=entnewsntp>
- Young, J. & Bertram, C. (2008). A Strategic Plan for Water Related Recreation in Wales. *The University of Brighton*.
- Zajicek, P. & Wolter, C. (2019). The effects of recreational and commercial navigation on fish assemblages in large rivers. *Science of The Total Environment*, 646, 1304–1314. <https://doi.org/10.1016/j.scitotenv.2018.07.403>
- Zhao, L., Oleson, K., Bou-Zeid, E., Krayenhoff, E. S., Bray, A., Zhu, Q., Zheng, Z., Chen, C. & Oppenheimer, M. (2021). Global multi-model projections of local urban climates. *Nature Climate Change* 2021 11:2, 11(2), 152–157. <https://doi.org/10.1038/s41558-020-00958-8>

Appendix

Ethics approval

16/17 17/18 18/19 19/20 20/21 **21/22**

Student Projects Ethics Assessment - 21/22

Please note form is shown for 21/22. Any previously completed assessments can be accessed using the session links shown in the top right-hand side of the page.

Please complete self-assessment as accurately as possible. Once complete, ensure you have ticked the declaration box before submitting to your supervisor. If after saving, there are errors in your self-assessment, to clear the error before starting new assessment please contact: [Sridevi Kanamarlapudi](#)

Student Details

Name:	Charlotte Brockington
Level:	7
Course:	Research Study
Project Supervisor:	Prof. Carlos Garcia De Leaniz
Last Updated Date:	15 Nov 2021, 9:18 a.m.
Last Reviewed Date:	15 Nov 2021, 9:23 a.m.
Reviewed by:	Carlos Garcia De Leaniz

Projects Ethics Assessment Status

Project Title	Status	Approval Number
Response of brown trout to disturbance by Kayakers	Completed	SU-Ethics-Student-151121/4499
River users questionnaire	Completed	SU-Ethics-Student-151121/4734
	In Progress	

Additional forms to be submitted as part of this assessment and their status(only Project Supervisor can submit additional forms to relevant Committee):

- AWERB Review Form(STU_BIOL_190685_270921160036_1) - Approved Proposal :AWERB Group DECISION Details

Chapter 2 Questionnaire

Number	Question	Possible responses
1	Which is the main leisure activity you use Welsh rivers for?	Boating, Angling, Walking, Swimming, Cycling or Other
2	What is your age group?	<20, 20-34, 35-49, 50-65 or >65
3	In what region of Wales do you predominantly access rivers?	North East, North West, Mid-West, Mid-East, South East or South West
4	How many of these river catchments do you access?	List of rivers in Wales
5	On average how often do you access Welsh rivers each year?	Once a year or less, 2-9 times a year, 10-19 times a year, 20-30 times a year or >30 times a year
6	At what time of the year do you access Welsh rivers the most?	Spring, Summer, Autumn or Winter
7	At what time of the day do you access Welsh rivers the most?	In daylight, at twilight or at night-time
8	What flows are best for your enjoyment of rivers?	Lower than average flows, Higher than average flows. Average flows or any flows it does not matter to me
9	Do you think conflict between different users is a major problem for river basin management in Wales?	Yes, No or I do not know
10	Do these factors or users detract from your enjoyment of rivers? Scale from Never to Very Often for each factor	Water quality, Rubbish, Anglers, Kayakers/canoes/rafts, Swimmers and Walkers
11	Do you feel your own use of rivers detracts from the enjoyment of other river users?	Definitely, very Probably, Probably, Possibly, Probably not or Definitely not
12	Do you think regulatory agencies should be promoting a greater access of rivers in Wales?	Yes, No or I do not know/I am not sure
13	How do you feel about these potential measures to help reduce conflict between competing rivers users? Scale from Strongly disagree to strongly agree for each measure	Temporal zoning, Spatial zoning, Limiting the number of users, Introducing charges and Promoting greater dialogue

Raw data Chapter 2

Receptor ID	Sentiment ID	Activity?	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Q39	Q40	Q41	Q42	Q43	Q44	Q45	Q46	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56	Q57	Q58	Q59	Q60	Q61	Q62	Q63	Q64	Q65	Q66	Q67	Q68	Q69	Q70	Q71	Q72	Q73	Q74	Q75	Q76	Q77	Q78	Q79	Q80	Q81	Q82	Q83	Q84	Q85	Q86	Q87	Q88	Q89	Q90	Q91	Q92	Q93	Q94	Q95	Q96	Q97	Q98	Q99	Q100	Q101	Q102	Q103	Q104	Q105	Q106	Q107	Q108	Q109	Q110	Q111	Q112	Q113	Q114	Q115	Q116	Q117	Q118	Q119	Q120	Q121	Q122	Q123	Q124	Q125	Q126	Q127	Q128	Q129	Q130	Q131	Q132	Q133	Q134	Q135	Q136	Q137	Q138	Q139	Q140	Q141	Q142	Q143	Q144	Q145	Q146	Q147	Q148	Q149	Q150	Q151	Q152	Q153	Q154	Q155	Q156	Q157	Q158	Q159	Q160	Q161	Q162	Q163	Q164	Q165	Q166	Q167	Q168	Q169	Q170	Q171	Q172	Q173	Q174	Q175	Q176	Q177	Q178	Q179	Q180	Q181	Q182	Q183	Q184	Q185	Q186	Q187	Q188	Q189	Q190	Q191	Q192	Q193	Q194	Q195	Q196	Q197	Q198	Q199	Q200	Q201	Q202	Q203	Q204	Q205	Q206	Q207	Q208	Q209	Q210	Q211	Q212	Q213	Q214	Q215	Q216	Q217	Q218	Q219	Q220	Q221	Q222	Q223	Q224	Q225	Q226	Q227	Q228	Q229	Q230	Q231	Q232	Q233	Q234	Q235	Q236	Q237	Q238	Q239	Q240	Q241	Q242	Q243	Q244	Q245	Q246	Q247	Q248	Q249	Q250	Q251	Q252	Q253	Q254	Q255	Q256	Q257	Q258	Q259	Q260	Q261	Q262	Q263	Q264	Q265	Q266	Q267	Q268	Q269	Q270	Q271	Q272	Q273	Q274	Q275	Q276	Q277	Q278	Q279	Q280	Q281	Q282	Q283	Q284	Q285	Q286	Q287	Q288	Q289	Q290	Q291	Q292	Q293	Q294	Q295	Q296	Q297	Q298	Q299	Q300	Q301	Q302	Q303	Q304	Q305	Q306	Q307	Q308	Q309	Q310	Q311	Q312	Q313	Q314	Q315	Q316	Q317	Q318	Q319	Q320	Q321	Q322	Q323	Q324	Q325	Q326	Q327	Q328	Q329	Q330	Q331	Q332	Q333	Q334	Q335	Q336	Q337	Q338	Q339	Q340	Q341	Q342	Q343	Q344	Q345	Q346	Q347	Q348	Q349	Q350	Q351	Q352	Q353	Q354	Q355	Q356	Q357	Q358	Q359	Q360	Q361	Q362	Q363	Q364	Q365	Q366	Q367	Q368	Q369	Q370	Q371	Q372	Q373	Q374	Q375	Q376	Q377	Q378	Q379	Q380	Q381	Q382	Q383	Q384	Q385	Q386	Q387	Q388	Q389	Q390	Q391	Q392	Q393	Q394	Q395	Q396	Q397	Q398	Q399	Q400	Q401	Q402	Q403	Q404	Q405	Q406	Q407	Q408	Q409	Q410	Q411	Q412	Q413	Q414	Q415	Q416	Q417	Q418	Q419	Q420	Q421	Q422	Q423	Q424	Q425	Q426	Q427	Q428	Q429	Q430	Q431	Q432	Q433	Q434	Q435	Q436	Q437	Q438	Q439	Q440	Q441	Q442	Q443	Q444	Q445	Q446	Q447	Q448	Q449	Q450	Q451	Q452	Q453	Q454	Q455	Q456	Q457	Q458	Q459	Q460	Q461	Q462	Q463	Q464	Q465	Q466	Q467	Q468	Q469	Q470	Q471	Q472	Q473	Q474	Q475	Q476	Q477	Q478	Q479	Q480	Q481	Q482	Q483	Q484	Q485	Q486	Q487	Q488	Q489	Q490	Q491	Q492	Q493	Q494	Q495	Q496	Q497	Q498	Q499	Q500	Q501	Q502	Q503	Q504	Q505	Q506	Q507	Q508	Q509	Q510	Q511	Q512	Q513	Q514	Q515	Q516	Q517	Q518	Q519	Q520	Q521	Q522	Q523	Q524	Q525	Q526	Q527	Q528	Q529	Q530	Q531	Q532	Q533	Q534	Q535	Q536	Q537	Q538	Q539	Q540	Q541	Q542	Q543	Q544	Q545	Q546	Q547	Q548	Q549	Q550	Q551	Q552	Q553	Q554	Q555	Q556	Q557	Q558	Q559	Q560	Q561	Q562	Q563	Q564	Q565	Q566	Q567	Q568	Q569	Q570	Q571	Q572	Q573	Q574	Q575	Q576	Q577	Q578	Q579	Q580	Q581	Q582	Q583	Q584	Q585	Q586	Q587	Q588	Q589	Q590	Q591	Q592	Q593	Q594	Q595	Q596	Q597	Q598	Q599	Q600	Q601	Q602	Q603	Q604	Q605	Q606	Q607	Q608	Q609	Q610	Q611	Q612	Q613	Q614	Q615	Q616	Q617	Q618	Q619	Q620	Q621	Q622	Q623	Q624	Q625	Q626	Q627	Q628	Q629	Q630	Q631	Q632	Q633	Q634	Q635	Q636	Q637	Q638	Q639	Q640	Q641	Q642	Q643	Q644	Q645	Q646	Q647	Q648	Q649	Q650	Q651	Q652	Q653	Q654	Q655	Q656	Q657	Q658	Q659	Q660	Q661	Q662	Q663	Q664	Q665	Q666	Q667	Q668	Q669	Q670	Q671	Q672	Q673	Q674	Q675	Q676	Q677	Q678	Q679	Q680	Q681	Q682	Q683	Q684	Q685	Q686	Q687	Q688	Q689	Q690	Q691	Q692	Q693	Q694	Q695	Q696	Q697	Q698	Q699	Q700	Q701	Q702	Q703	Q704	Q705	Q706	Q707	Q708	Q709	Q710	Q711	Q712	Q713	Q714	Q715	Q716	Q717	Q718	Q719	Q720	Q721	Q722	Q723	Q724	Q725	Q726	Q727	Q728	Q729	Q730	Q731	Q732	Q733	Q734	Q735	Q736	Q737	Q738	Q739	Q740	Q741	Q742	Q743	Q744	Q745	Q746	Q747	Q748	Q749	Q750	Q751	Q752	Q753	Q754	Q755	Q756	Q757	Q758	Q759	Q760	Q761	Q762	Q763	Q764	Q765	Q766	Q767	Q768	Q769	Q770	Q771	Q772	Q773	Q774	Q775	Q776	Q777	Q778	Q779	Q780	Q781	Q782	Q783	Q784	Q785	Q786	Q787	Q788	Q789	Q790	Q791	Q792	Q793	Q794	Q795	Q796	Q797	Q798	Q799	Q800	Q801	Q802	Q803	Q804	Q805	Q806	Q807	Q808	Q809	Q810	Q811	Q812	Q813	Q814	Q815	Q816	Q817	Q818	Q819	Q820	Q821	Q822	Q823	Q824	Q825	Q826	Q827	Q828	Q829	Q830	Q831	Q832	Q833	Q834	Q835	Q836	Q837	Q838	Q839	Q840	Q841	Q842	Q843	Q844	Q845	Q846	Q847	Q848	Q849	Q850	Q851	Q852	Q853	Q854	Q855	Q856	Q857	Q858	Q859	Q860	Q861	Q862	Q863	Q864	Q865	Q866	Q867	Q868	Q869	Q870	Q871	Q872	Q873	Q874	Q875	Q876	Q877	Q878	Q879	Q880	Q881	Q882	Q883	Q884	Q885	Q886	Q887	Q888	Q889	Q890	Q891	Q892	Q893	Q894	Q895	Q896	Q897	Q898	Q899	Q900	Q901	Q902	Q903	Q904	Q905	Q906	Q907	Q908	Q909	Q910	Q911	Q912	Q913	Q914	Q915	Q916	Q917	Q918	Q919	Q920	Q921	Q922	Q923	Q924	Q925	Q926	Q927	Q928	Q929	Q930	Q931	Q932	Q933	Q934	Q935	Q936	Q937	Q938	Q939	Q940	Q941	Q942	Q943	Q944	Q945	Q946	Q947	Q948	Q949	Q950	Q951	Q952	Q953	Q954	Q955	Q956	Q957	Q958	Q959	Q960	Q961	Q962	Q963	Q964	Q965	Q966	Q967	Q968	Q969	Q970	Q971	Q972	Q973	Q974	Q975	Q976	Q977	Q978	Q979	Q980	Q981	Q982	Q983	Q984	Q985	Q986	Q987	Q988	Q989	Q990	Q991	Q992	Q993	Q994	Q995	Q996	Q997	Q998	Q999	Q1000
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75	1312406592	Boating (in 20-34	South West	Teifi	Autumn	In daylight	Higher than average flows	Yes	Sometimes	Very often	Never	Never	Possibly	Disagree	Undecided	Strongly agree
76	1312408583	1 Boating (in 50-65	North West	Conwy	Autumn	In daylight	Higher than average flows	Yes	Sometimes	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
77	13124196231	Boating (in 20-34	North West	Conwy	Winter	In daylight	Higher than average flows	Yes	Seldom	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
78	1312427082	Boating (in 50-65	North West	Dee / Dyfrdwy	Autumn	In daylight	Average flows	No	Very often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
79	1312439871	Other	South East	Taff / Tal	Summer	In daylight	Average flows	Yes	Often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
80	13124477551	Boating (in 20-34	North West	Conwy	Autumn	In daylight	Average flows	Yes	Often	Often	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
81	1312457368	0 Swimming (35-49	Mid-West	Wye / Gwy	Summer	In daylight	Average flows	I do not know	Very often	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
82	1312475669	Angling	South East	Omorfe / Ogwr	Autumn	At twilight	Average flows	Yes	Often	Often	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
83	13124791349	Boating (in 20-34	South East	Afan	Autumn	In daylight	Average flows	No	Often	Often	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
84	13125174264	Boating (in 50-65	North East	Dee / Dyfrdwy	Spring	In daylight	Average flows	I do not know	Sometimes	Seldom	Never	Never	Possibly Not	Disagree	Disagree	Disagree
85	13125187162	Boating (in 50-65	North East	Severn / Hafren	Winter	In daylight	Any flows, it does not matter to me	Yes	Sometimes	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
86	13125198497	Boating (in 50-65	North West	Afan	Autumn	In daylight	Average flows	Yes	Often	Seldom	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
87	13125200714	Boating (in 50-65	North West	Towy / Twiwl	Autumn	In daylight	Higher than average flows	Yes	Very often	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
88	13125251202	Boating (in 50-65	South West	Dyfi	Summer	In daylight	Average flows	No	Often	Sometimes	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
89	13125604292	Boating (in 35-49	Mid-East	Dee / Dyfrdwy	Summer	In daylight	Average flows	No	Often	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
90	13125872618	Other	South East	Wye / Gwy	Summer	In daylight	Any flows, it does not matter to me	I do not know	Seldom	Seldom	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
91	13125872618	Boating (in 20-34	Mid-East	Dee / Dyfrdwy	Summer	In daylight	Higher than average flows	I do not know	Often	Often	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
92	13126121404	1 Boating (in 35-49	South East	Ely / Eila	Summer	In daylight	Average flows	I do not know	Often	Often	Sometimes	Sometimes	Definitely Not	Disagree	Disagree	Strongly disagree
93	13126165514	9 Boating (in 35-49	Mid-West	Elbow / Ewby	Winter	In daylight	Higher than average flows	Yes	Sometimes	Often	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
94	13127279794	5 Boating (in 35-49	North West	Conwy	Spring	In daylight	Higher than average flows	No	Seldom	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
95	13127592710	Boating (in 35-49	North West	Dee / Dyfrdwy	Summer	In daylight	Average flows	No	Often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
96	13127832611	-4 Walking (50-65	South East	Wye / Gwy	Spring	In daylight	Any flows, it does not matter to me	Yes	Very often	Often	Seldom	Seldom	Possibly Not	Disagree	Disagree	Strongly disagree
97	13127951083	1 Boating (in 35-49	South East	Elbow / Ewby	Winter	In daylight	Average flows	No	Seldom	Often	Sometimes	Sometimes	Possibly Not	Disagree	Disagree	Strongly disagree
98	13128086175	0 Angling (50-65	South East	Wye / Gwy	Summer	In daylight	Higher than average flows	Yes	Sometimes	Never	Often	Often	Possibly Not	Disagree	Disagree	Strongly disagree
99	13128474039	4 Boating (in 35-49	North West	Conwy	Winter	In daylight	Average flows	Yes	Very often	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
100	13128614128	Other	Mid-West	Ely / Eila	Winter	In daylight	Any flows, it does not matter to me	No	Sometimes	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
101	13128660094	-1 Swimming (35-49	Mid-East	Uk / Wyg	Summer	In daylight	Any flows, it does not matter to me	Yes	Seldom	Seldom	Never	Never	Sometimes	Disagree	Disagree	Strongly disagree
102	13128800905	Angling	South East	Uk / Wyg	Summer	In daylight	Average flows	No	Often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
103	13129002118	Angling	South East	Ely / Eila	Autumn	In daylight	Average flows	Yes	Often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
104	13129836336	Walking	Mid-West	Aeron	Spring	In daylight	Any flows, it does not matter to me	No	Sometimes	Often	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
105	13130963036	Angling	Mid-West	Dee / Dyfrdwy	Summer	In daylight	Average flows	Yes	Sometimes	Seldom	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
106	13133740727	Angling	South East	Taff / Tal	Spring	In daylight	Average flows	No	Often	Often	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
107	13133743465	1 Angling	South East	Neath / Nedd	Summer	At twilight	Average flows	Yes	Very often	Often	Never	Never	Sometimes	Disagree	Disagree	Strongly disagree
108	13133868202	0 Angling	South West	Teifi	Summer	At night-time	Average flows	Yes	Often	Often	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
109	13134008922	Angling	North West	Cefni	Autumn	In daylight	Higher than average flows	Yes	Sometimes	Never	Very often	Often	Possibly Not	Disagree	Disagree	Strongly disagree
110	13134074248	-1 Angling	North East	Dee / Dyfrdwy	Autumn	In daylight	Any flows, it does not matter to me	I do not know	Sometimes	Never	Seldom	Seldom	Definitely Not	Disagree	Disagree	Strongly disagree
111	13134191548	Angling	South East	Elbow / Ewby	Summer	At twilight	Average flows	No	Sometimes	Never	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
112	13134248441	Angling	South West	Tawe	Spring	In daylight	Average flows	Yes	Often	Seldom	Seldom	Seldom	Definitely Not	Disagree	Disagree	Strongly disagree
113	1313437671	1 Angling	North West	Saint Gwyrfai & Llynfi	Summer	In daylight	Any flows, it does not matter to me	Yes	Very often	Very often	Never	Often	Definitely Not	Disagree	Disagree	Strongly disagree
114	13134404358	-2 Angling	South East	Dwyfor	Summer	At twilight	Lower than average flows	Yes	Often	Often	Never	Often	Possibly	Disagree	Disagree	Strongly disagree
115	13134483306	Angling	Mid-West	Rheidol	Summer	At twilight	Average flows	Yes	Often	Sometimes	Never	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
116	13134500227	Angling	South East	Conwy	Summer	In daylight	Higher than average flows	Yes	Never	Seldom	Often	Often	Possibly Not	Disagree	Disagree	Strongly disagree
117	13134502921	6 Angling	North West	Aeron	Autumn	In daylight	Higher than average flows	Yes	Often	Never	Often	Often	Definitely Not	Disagree	Disagree	Strongly disagree
118	13134562951	1 Angling	South East	Dwyfor	Summer	In daylight	Higher than average flows	Yes	Often	Never	Often	Often	Possibly Not	Disagree	Disagree	Strongly disagree
119	13134567254	1 Angling	South East	Elbow / Ewby	Summer	In daylight	Higher than average flows	Yes	Very often	Seldom	Never	Sometimes	Definitely Not	Disagree	Disagree	Strongly disagree
120	13134594153	Angling	South East	Wye / Gwy	Winter	In daylight	Any flows, it does not matter to me	No	Sometimes	Seldom	Never	Never	Sometimes	Disagree	Disagree	Strongly disagree
121	13134598743	Angling	Mid-East	Towy / Twiwl	Summer	At night-time	Higher than average flows	Yes	Sometimes	Seldom	Never	Sometimes	Definitely Not	Disagree	Disagree	Strongly disagree
122	13134692438	Angling	South West	Loughor / Lluchwr	Winter	In daylight	Average flows	No	Seldom	Sometimes	Never	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
123	13135526831	Swimming	Mid-East	Uk / Wyg	Summer	In daylight	Average flows	No	Often	Seldom	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
124	13135652114	Swimming	South East	Dyfi	Summer	In daylight	Any flows, it does not matter to me	I do not know	Sometimes	Very often	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
125	13137093235	Swimming	Mid-West	Dyfi	Summer	In daylight	Average flows	Yes	Very often	Sometimes	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
126	13137183836	Swimming	South West	Dyfi	Summer	In daylight	Any flows, it does not matter to me	I do not know	Sometimes	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
127	13137195236	Swimming	South West	Dyfi	Summer	In daylight	Average flows	Yes	Sometimes	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
128	13137296558	Angling	South West	Afan	Summer	At twilight	Average flows	Yes	Sometimes	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
129	13137670956	Swimming	Mid-West	Rheidol	Summer	In daylight	Any flows, it does not matter to me	I do not know	Seldom	Seldom	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
130	13137752180	Boating (in 50-65	North East	Conwy	Spring	In daylight	Average flows	Yes	Very often	Very often	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
131	13137804555	Boating (in 35-49	North East	Aeron	Autumn	In daylight	Any flows, it does not matter to me	Yes	Sometimes	Often	Seldom	Seldom	Possibly	Disagree	Disagree	Strongly disagree
132	13137828134	0 Boating (in 50-65	North East	Conwy	Summer	In daylight	Average flows	Yes	Seldom	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
133	13137909764	Boating (in 35-49	Mid-West	Aeron	Winter	In daylight	Higher than average flows	I do not know	Sometimes	Very often	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
134	13137996860	Boating (in 35-49	North West	Neath / Nedd	Autumn	In daylight	Average flows	Yes	Often	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
135	13138193750	Boating (in 50-65	North East	Conwy	Summer	In daylight	Any flows, it does not matter to me	No	Sometimes	Never	Sometimes	Never	Possibly Not	Disagree	Disagree	Strongly disagree
136	13138241423	Boating (in 50-65	North East	Omorfe / Ogwr	Winter	In daylight	Higher than average flows	Yes	Sometimes	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
137	13138322385	Boating (in 50-65	North East	Conwy	Summer	In daylight	Average flows	No	Sometimes	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
138	13138614407	0 Boating (in 50-65	South West	Neath / Nedd	Summer	In daylight	Higher than average flows	Yes	Sometimes	Often	Seldom	Never	Possibly Not	Disagree	Disagree	Strongly disagree
139	13138723274	-1 Swimming	Mid-West	Aeron	Autumn	At twilight	Lower than average flows	No	Seldom	Often	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
140	13138771581	1 Boating (in 20-34	South East	Conwy	Summer	In daylight	Higher than average flows	Yes	Often	Very often	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
141	1313908437	Boating (in 50-65	Mid-East	Dee / Dyfrdwy	Winter	In daylight	Average flows	Yes	Sometimes	Sometimes	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
142	13139043875	Swimming	Mid-West	Dyfi	Summer	In daylight	Higher than average flows	I do not know	Often	Sometimes	Seldom	Seldom	Possibly Not	Disagree	Disagree	Strongly disagree
143	1313972569	Boating (in 20-34	South East	Dee / Dyfrdwy	Summer	In daylight	Any flows, it does not matter to me	Yes	Sometimes	Sometimes	Never	Never	Possibly Not	Disagree	Disagree	Strongly disagree
144	13139869924	1 Angling	South East	Taff / Tal	Winter	In daylight	Average flows	Yes	Often	Seldom	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
145	1314029958	Angling	Mid-East	Wye / Gwy	Spring	In daylight	Average flows	No	Sometimes	Never	Sometimes	Sometimes	Possibly	Disagree	Disagree	Strongly disagree
146	13140358458	Boating (in 50-65	North East	Conwy	Autumn	In daylight	Any flows, it does not matter to me	Yes	Often	Often	Never	Never	Possibly	Disagree	Disagree	Strongly disagree
147	13140495241	Walking	North West	Tawe	Summer	In daylight	Higher than average flows	I do not know	Very often	Never	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree
148	13141257505	Restline (in 35-49	North East	Afan	Autumn	In daylight	Any flows, it does not matter to me	Yes	Sometimes	Sometimes	Never	Never	Definitely Not	Disagree	Disagree	Strongly disagree

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R script Chapter 2

Questionnaire – Chapter 2

```
#####  
#####  
  
#plot word relationships#  
  
set.seed(222)  
  
library(stringr)  
  
library(dplyr)  
  
library(gapminder)  
  
library(readr)  
  
library(widyr)  
  
library(ggplot2)  
  
library(ggraph)  
  
library(tidytext)  
  
#install.packages("igraph")  
  
library(igraph)  
  
Just.responses <- read.csv("~/Questionnaire responses/Just responses.csv")  
  
  
review_words <- Just.responses %>% unnest_tokens(output = word, input =  
Other..please.specify.) %>% anti_join(stop_words, by = "word") %>% filter(str_detect (word,  
"[:alpha:]")) %>% distinct()  
  
Boating <- subset(Just.responses, Activity2 == "Boating")  
  
Angling<- subset(Just.responses, Activity2 == "Angling")  
  
Other<- subset(Just.responses, Activity2 == "Other")  
  
#count the number of times users have said word, filter out correlations mentioned less than 5  
times
```

```
users_who_mention_word <- review_words %>% count(word, name = "responses_n")%>%  
filter(responses_n >=5)
```

```
#####users_who_mention_word <- db_bing %>% count(word, name = "responses_n")%>%  
filter(responses_n >=2)### don't use this
```

```
# find out correlation between words, get rid of correlations less than 0.2
```

```
word_correlations<- review_words %>% semi_join(users_who_mention_word, by =  
"word")%>% pairwise_cor(item = word, feature = Respondent.ID)%>% filter(correlation  
>0.22)
```

```
#build a word network plot
```

```
graph_from_data_frame(d = word_correlations, vertices = users_who_mention_word  
%>% semi_join(word_correlations, by = c("word" = "item1"))) %>%  
ggraph(layout="fr") +  
geom_edge_link(aes(alpha = correlation))+geom_node_point()+geom_node_text(aes(color  
= responses_n, label=name), repel = TRUE)+ ggtitle("Responses from all users")
```

```
##### cleaning above code up # function to generate word graph
```

```
generate_word_graph <-function(review_words, min_responses_n = 5, min_correlation = 0.2)  
{ users_who_mention_word <- review_words %>% count(word, name = "responses_n")%>%  
filter(responses_n >=min_responses_n)  
  
word_correlations<- review_words %>% semi_join(users_who_mention_word, by =  
"word")%>% pairwise_cor(item = word, feature = Respondent.ID)%>% filter(correlation  
>min_correlation)
```

```
graph_from_data_frame(d = word_correlations, vertices = users_who_mention_word
                      %>% semi_join(word_correlations, by = c("word" = "item1")))
%>% ggraph(layout="fr") +
  geom_edge_link(aes(alpha = correlation))+geom_node_point()+geom_node_text(aes(color
= responses_n, label=name), repel = TRUE)
}
```

```
review_words%>%
```

```
  generate_word_graph(min_responses_n = 5, min_correlation = 0.2)
```

```
##### Boating word relationships
```

```
review_wordsB <- Boating %>% unnest_tokens(output = word, input = Other..please.specify.)
%>% anti_join(stop_words, by = "word") %>% filter(str_detect (word, "[:alpha:]")) %>%
distinct()
```

```
#count the number of times users have said word, filter out correlations mentioned less than 5
times
```

```
users_who_mention_word <- review_wordsB %>% count(word, name = "responses_n")%>%
filter(responses_n >=4)
```

```
#####users_who_mention_word <- db_bing %>% count(word, name = "responses_n")%>%
filter(responses_n >=2)### don't use this
```

```
# find out correlation between words, get rid of correlations less than 0.2
```

```
word_correlations<- review_wordsB %>% semi_join(users_who_mention_word, by =
"word")%>% pairwise_cor(item = word, feature = Respondent.ID)%>% filter(correlation
>0.2)
```

```
#build a word network plot
```

```
graph_from_data_frame(d = word_correlations, vertices = users_who_mention_word

  %>% semi_join(word_correlations, by = c("word" = "item1")) %>%
ggraph(layout="fr") +

  geom_edge_link(aes(alpha = correlation))+geom_node_point()+geom_node_text(aes(color
= responses_n, label=name), repel = TRUE,) + ggtitle("Responses from Boating users")
```

Angling word relationships

```
review_wordsA <- Angling %>% unnest_tokens(output = word, input = Other..please.specify.)
%>% anti_join(stop_words, by = "word") %>% filter(str_detect (word, "[:alpha:]")) %>%
distinct()
```

#count the number of times users have said word, filter out correlations mentioned less than 5 times

```
users_who_mention_word <- review_wordsA %>% count(word, name = "responses_n")%>%
filter(responses_n >=4)
```

```
#####users_who_mention_word <- db_bing %>% count(word, name = "responses_n")%>%
filter(responses_n >=2)### don't use this
```

find out correlation between words, get rid of correlations less than 0.2

```
word_correlations<- review_wordsA %>% semi_join(users_who_mention_word, by =
"word")%>% pairwise_cor(item = word, feature = Respondent.ID)%>% filter(correlation
>0.2)
```

#build a word network plot

```
graph_from_data_frame(d = word_correlations, vertices = users_who_mention_word
```

```
%>% semi_join(word_correlations, by = c("word" = "item1")) %>%
ggraph(layout="fr") +
```

```
geom_edge_link(aes(alpha = correlation))+geom_node_point()+geom_node_text(aes(color
= responses_n, label=name), repel = TRUE,) + ggtitle("Responses from Anglers")
```

Others word network

```
review_wordsO <- Other %>% unnest_tokens(output = word, input = Other..please.specify.)
%>% anti_join(stop_words, by = "word") %>% filter(str_detect (word, "[:alpha:]")) %>%
distinct()
```

#count the number of times users have said word, filter out correlations mentioned less than 5 times

```
users_who_mention_word <- review_wordsO %>% count(word, name = "responses_n")%>%
filter(responses_n >=2)
```

```
##users_who_mention_word <- db_bing %>% count(word, name = "responses_n")%>%
filter(responses_n >=2)### don't use this
```

find out correlation between words, get rid of correlations less than 0.3

```
word_correlations<- review_wordsO %>% semi_join(users_who_mention_word, by =
"word")%>% pairwise_cor(item = word, feature = Respondent.ID)%>% filter(correlation
>0.3)
```

#build a word network plot

```
graph_from_data_frame(d = word_correlations, vertices = users_who_mention_word
```

```
%>% semi_join(word_correlations, by = c("word" = "item1")) %>%
ggraph(layout="fr") +
```

```

geom_edge_link(aes(alpha = correlation))+geom_node_point()+geom_node_text(aes(color
= responses_n, label=name), repel = TRUE,) + ggtitle("Responses from Other users")

#####

####

# sentiment analysis using syuzhet library #

#install.packages("syuzhet")

library(syuzhet)

#character vector

review <- as.character(Just.responses$Other..please.specify.)

# Sentiment analysis

get_nrc_sentiment("happy")

get_nrc_sentiment("excitment")

s <- get_nrc_sentiment(review)

#combine text and sentiment columns

review_sentiment<-cbind(Just.responses$Other..please.specify., s)

#bar plot for sentiment

par(bg="White")

barplot(colSums(s), col = rainbow(10), ylab = "Count", main = "Sentiment Analysis for
Questionnaire Responses")

```

```
corpus<-iconv(Just.responses$Other..please.specify., to = "UTF-8")
```

```
corpus<-Corpus(VectorSource(corpus))
```

```
inspect(corpus[1:5])
```

```
# Clean text
```

```
corpus<-tm_map(corpus, tolower)
```

```
corpus<- tm_map(corpus, removePunctuation)
```

```
corpus<-tm_map(corpus, removeNumbers)
```

```
cleanset<-tm_map(corpus, removeWords, stopwords("english"))
```

```
#get rid of gaps
```

```
cleanset<-tm_map(cleanset, stripWhitespace)
```

```
# Term document matrix
```

```
tdm<-TermDocumentMatrix(cleanset)
```

```
tdm
```

```
tdm<-as.matrix(tdm)
```

```
#Bar plot
```

```
par(bg="white")
```

```
w<-rowSums(tdm)
```

```
w<- subset(w, w>=6)
```

```
barplot(w,las = 2, col = "skyblue", main = "All users most used words")
```

```
# Sentiment analysis
```

```
#install.packages("lubridate")
```

```
#install.packages("scales")
```

```
#install.packages("reshape2")
```

```
library(syuzhet)
```

```
library(lubridate)
```

```
library(ggplot2)
```

```
library(scales)
```

```
library(reshape2)
```

```
library(dplyr)
```

```
#Subset data - data frame has been changed to J if that is deemed acceptable, otherwise changed  
J to Just.responses
```

```
Boating <- subset(Just.responses, Activity2 == "Boating")
```

```
Angling<- subset(Just.responses, Activity2 == "Angling")
```

```
Other<- subset(Just.responses, Activity2 == "Other")
```

```
# read file
```

```
apple <- read.csv("~/Questionnaire responses/Just responses.csv")
```

```
tweets<- iconv(apple$Other..please.specify., to = "UTF-8")
```

```
# Obtain sentiment scores
```

```
s<-get_nrc_sentiment(tweets)
```

```
head(s)
```

```
tweets<-data.frame(tweets)
```

```
barplot(colSums(s), las = 2, col = rainbow(10), ylab = "Count", main = "Sentiment Scores from  
Questionnaire Comments")
```

```
#Just for boating
```

```
Boating1<-iconv(Boating$Other..please.specify., to = "UTF-8")
```

```
b<-get_nrc_sentiment(Boating1)
```

```
barplot(colSums(b), las = 2, col = rainbow(10), ylab = "Count", main = "Sentiment Scores from  
Boating Responses")
```

```
#Just for Angling
```

```
Angling1<-iconv(Angling$Other..please.specify., to = "UTF-8")
```

```
a<-get_nrc_sentiment(Angling1)
```

```
barplot(colSums(a), las = 2, col = rainbow(10), ylab = "Count", main = "Sentiment Scores from Angling Responses")
```

```
#Just for others
```

```
Other1<-iconv(Other$Other..please.specify., to = "UTF-8")
```

```
o<-get_nrc_sentiment(Other1)
```

```
barplot(colSums(o), las = 2, col = rainbow(10), ylab = "Count", main = "Sentiment Scores from Other Responses")
```

```
#Build corpus for boating
```

```
library(tm)
```

```
corpus<-iconv(Boating$Other..please.specify., to = "UTF-8")
```

```
corpus<-Corpus(VectorSource(corpus))
```

```
inspect(corpus[1:5])
```

```
# Clean text
```

```
corpus<-tm_map(corpus, tolower)
```

```
corpus<- tm_map(corpus, removePunctuation)
```

```
corpus<-tm_map(corpus, removeNumbers)
```

```
cleanset<-tm_map(corpus, removeWords, stopwords("english"))
```

```
#get rid of gaps
```

```
cleanset<-tm_map(cleanset, stripWhitespace)
```

```

# Term document matrix

tdm<-TermDocumentMatrix(cleanset)

tdm

tdm<-as.matrix(tdm)


#Bar plot


p<-rowSums(tdm)

p<- subset(p, p>=6)

barplot(p,las = 2, col = "skyblue", main ="Most used words - Boaters")


#Build corpus for Angling


corpus<-iconv(Angling$Other..please.specify., to = "UTF-8")

corpus<-Corpus(VectorSource(corpus))

inspect(corpus[1:5])


# Clean text


corpus<-tm_map(corpus, tolower)

corpus<- tm_map(corpus, removePunctuation)

corpus<-tm_map(corpus, removeNumbers)

cleanset<-tm_map(corpus, removeWords, stopwords("english"))

```

```

#get rid of gaps

cleanset<-tm_map(cleanset, stripWhitespace)


# Term document matrix

tdm<-TermDocumentMatrix(cleanset)

tdm

tdm<-as.matrix(tdm)


#Bar plot


l<-rowSums(tdm)

l<- subset(l, l>=6)

barplot(l,las = 2, col = "skyblue", main ="Most used words - Angling")


#Build corpus for Other

Other[Other==""] <- NA

#deletes everything because of x column

#Other2<-na.omit(Other)

Other2<-Other[!(is.na(Other$Other..please.specify.)),]


corpus<-iconv(Other2$Other..please.specify., to = "UTF-8")

corpus<-Corpus(VectorSource(corpus))

inspect(corpus[1:5])

```

```
# Clean text
```

```
corpus<-tm_map(corpus, tolower)
```

```
corpus<- tm_map(corpus, removePunctuation)
```

```
corpus<-tm_map(corpus, removeNumbers)
```

```
cleanset<-tm_map(corpus, removeWords, stopwords("english"))
```

```
#get rid of gaps
```

```
cleanset<-tm_map(cleanset, stripWhitespace)
```

```
# Term document matrix
```

```
tdm<-TermDocumentMatrix(cleanset)
```

```
tdm
```

```
tdm<-as.matrix(tdm)
```

```
#Bar plot
```

```
c<-rowSums(tdm)
```

```
c<- subset(c, c>=3)
```

```
barplot(c,las = 2, col = "skyblue", main ="Most used words - Other")
```

```
#####
```

Wordcloud

```
2#####
```

```
library(tm)
```

```
stp_wrds <- get_stopwords(source="smart") # snowball is an alternative , however, smart has  
more words included
```

```

#the term document matrix won't work check video again

# match those words with first data frame and remove them

w<-rowSums(tdm)

w <-data.frame(names(w),w)

colnames(w)<- c("word", "freq")

w1 <- anti_join(w, stp_wrds, by = "word")

cleanset<-tm_map(corpus, removeWords, stopwords("english"))

#get rid of gaps

cleanset<-tm_map(w1, stripWhitespace)

```

```

# Term document matrix

tdm<-TermDocumentMatrix(db_bing)

tdm

tdm<-as.matrix(tdm)

```

```

# For word cloud

```

```

par(bg="white")

w<-rowSums(tdm)

w<- subset(w, w>=6)

library(wordcloud)

w1<-sort(rowSums(tdm), decreasing =TRUE)

```

```
set.seed(222)

wordcloud(words = names(w1), freq = w1, max.words = 200, random.order = F, min.freq = 2,
  colors = brewer.pal(8,"Dark2"), scale = c(5,0.3), rot.per =0.3)

library(wordcloud2)

w <-data.frame(names(w), w)

colnames(w)<- c("word", "freq")

wordcloud2(w, size =0.8, shape = "circle", minSize = 1)
```

Raw data Chapter 3

Number visible

1	Observatio	Date	Time	Condition	Stressor	N_tot	N_open	Locatio	X	Y	Day	Event	Week
2	1	10/08/2021	08:00:00	Pre	Bird	6		1 L1	2	17	D1	E1	W1
3	2	10/08/2021	08:10:00	Pre	Bird	6		3 L2	1	17	D1	E1	W1
4	3	10/08/2021	08:10:00	Pre	Bird	6		3 L3	2	17	D1	E1	W1
5	4	10/08/2021	08:10:00	Pre	Bird	6		3 L4	2	17	D1	E1	W1
6	5	10/08/2021	08:20:00	Pre	Bird	6		2 L5	1	17	D1	E1	W1
7	6	10/08/2021	08:20:00	Pre	Bird	6		2 L6	2	17	D1	E1	W1
8	7	10/08/2021	08:30:00	Pre	Bird	6		2 L7	1	18	D1	E1	W1
9	8	10/08/2021	08:30:00	Pre	Bird	6		2 L8	2	17	D1	E1	W1
10	9	10/08/2021	08:40:00	Pre	Bird	6		1 L9	1	18	D1	E1	W1
11	10	10/08/2021	08:50:00	Pre	Bird	6		1 L10	5	16	D1	E1	W1
12	11	10/08/2021	09:00:00	During	Bird	6		3 L11	1	4	D1	E1	W1
13	12	10/08/2021	09:00:00	During	Bird	6		3 L12	2	2	D1	E1	W1
14	13	10/08/2021	09:00:00	During	Bird	6		3 L13	5	16	D1	E1	W1
15	14	10/08/2021	09:00:05	During	Bird	6		2 L14	1	12	D1	E1	W1
16	15	10/08/2021	09:00:05	During	Bird	6		2 L15	4	13	D1	E1	W1
17	16	10/08/2021	09:00:10	During	Bird	6		4 L16	1	12	D1	E1	W1
18	17	10/08/2021	09:00:10	During	Bird	6		4 L17	1	12	D1	E1	W1
19	18	10/08/2021	09:00:10	During	Bird	6		4 L18	6	1	D1	E1	W1
20	19	10/08/2021	09:00:10	During	Bird	6		4 L19	4	1	D1	E1	W1
21	20	10/08/2021	09:00:15	During	Bird	6		3 L20	1	1	D1	E1	W1
22	21	10/08/2021	09:00:15	During	Bird	6		3 L21	1	12	D1	E1	W1
23	22	10/08/2021	09:00:15	During	Bird	6		3 L22	1	12	D1	E1	W1
24	23	10/08/2021	09:10:00	Post	Bird	6		3 L23	1	1	D1	E1	W1
25	24	10/08/2021	09:10:00	Post	Bird	6		3 L24	1	12	D1	E1	W1
26	25	10/08/2021	09:10:00	Post	Bird	6		3 L25	1	12	D1	E1	W1
27	26	10/08/2021	09:20:00	Post	Bird	6		2 L26	1	12	D1	E1	W1
28	27	10/08/2021	09:20:00	Post	Bird	6		2 L27	1	12	D1	E1	W1
32	31	10/08/2021	09:40:00	Pre	Kayak	6		3 L31	1	7	D1	E2	W1
33	32	10/08/2021	09:40:00	Pre	Kayak	6		3 L32	6	11	D1	E2	W1
34	33	10/08/2021	09:50:00	Pre	Kayak	6		2 L33	1	7	D1	E2	W1
35	34	10/08/2021	09:50:00	Pre	Kayak	6		2 L34	1	12	D1	E2	W1
36	35	10/08/2021	10:00:00	During	Kayak	6		3 L35	1	7	D1	E2	W1
37	36	10/08/2021	10:00:00	During	Kayak	6		3 L36	1	13	D1	E2	W1
38	37	10/08/2021	10:00:00	During	Kayak	6		3 L37	6	18	D1	E2	W1
39	38	10/08/2021	10:00:05	During	Kayak	6		3 L38	1	7	D1	E2	W1
40	39	10/08/2021	10:00:05	During	Kayak	6		3 L39	1	13	D1	E2	W1
41	40	10/08/2021	10:00:05	During	Kayak	6		3 L40	6	18	D1	E2	W1
42	41	10/08/2021	10:00:10	During	Kayak	6		5 L41	1	14	D1	E2	W1
43	42	10/08/2021	10:00:10	During	Kayak	6		5 L42	3	20	D1	E2	W1
44	43	10/08/2021	10:00:10	During	Kayak	6		5 L43	4	19	D1	E2	W1
45	44	10/08/2021	10:00:10	During	Kayak	6		5 L44	4	20	D1	E2	W1
46	45	10/08/2021	10:00:10	During	Kayak	6		5 L45	6	18	D1	E2	W1
47	46	10/08/2021	10:00:15	During	Kayak	6		5 L46	1	14	D1	E2	W1
48	47	10/08/2021	10:00:15	During	Kayak	6		5 L47	4	20	D1	E2	W1
49	48	10/08/2021	10:00:15	During	Kayak	6		5 L48	5	19	D1	E2	W1
50	49	10/08/2021	10:00:15	During	Kayak	6		5 L49	6	18	D1	E2	W1
51	50	10/08/2021	10:00:15	During	Kayak	6		5 L50	6	20	D1	E2	W1
52	51	10/08/2021	10:10:00	Post	Kayak	6		3 L51	1	17	D1	E2	W1
53	52	10/08/2021	10:10:00	Post	Kayak	6		3 L52	1	17	D1	E2	W1
54	53	10/08/2021	10:10:00	Post	Kayak	6		3 L53	6	14	D1	E2	W1
55	54	10/08/2021	10:20:00	Post	Kayak	6		2 L54	1	17	D1	E2	W1
56	55	10/08/2021	10:20:00	Post	Kayak	6		2 L55	6	14	D1	E2	W1
57	56	10/08/2021	10:30:00	Post	Kayak	6		1 L56	6	14	D1	E2	W1
58	57	10/08/2021	11:00:00	During	Kayak	6		2 L57	1	12	D1	E3	W1
59	58	10/08/2021	11:00:00	During	Kayak	6		2 L58	1	17	D1	E3	W1
60	59	10/08/2021	11:00:05	During	Kayak	6		3 L59	1	13	D1	E3	W1
61	60	10/08/2021	11:00:05	During	Kayak	6		3 L60	1	17	D1	E3	W1
62	61	10/08/2021	11:00:05	During	Kayak	6		3 L61	2	18	D1	E3	W1
63	62	10/08/2021	11:00:10	During	Kayak	6		4 L62	1	13	D1	E3	W1
64	63	10/08/2021	11:00:10	During	Kayak	6		4 L63	1	17	D1	E3	W1
65	64	10/08/2021	11:00:10	During	Kayak	6		4 L64	2	15	D1	E3	W1
66	65	10/08/2021	11:00:10	During	Kayak	6		4 L65	2	18	D1	E3	W1
67	66	10/08/2021	11:00:15	During	Kayak	6		4 L66	1	13	D1	E3	W1
68	67	10/08/2021	11:00:15	During	Kayak	6		4 L67	1	17	D1	E3	W1
69	68	10/08/2021	11:00:15	During	Kayak	6		4 L68	2	15	D1	E3	W1
70	69	10/08/2021	11:00:15	During	Kayak	6		4 L69	2	18	D1	E3	W1
71	70	10/08/2021	11:10:00	Post	Kayak	6		2 L70	1	13	D1	E3	W1
72	71	10/08/2021	11:10:00	Post	Kayak	6		2 L71	6	12	D1	E3	W1
73	72	10/08/2021	11:20:00	Post	Kayak	6		3 L72	6	12	D1	E3	W1
74	73	10/08/2021	11:20:00	Post	Kayak	6		3 L73	6	12	D1	E3	W1
75	74	10/08/2021	11:20:00	Post	Kayak	6		3 L74	6	13	D1	E3	W1
76	75	10/08/2021	11:30:00	Post	Kayak	6		4 L75	1	7	D1	E3	W1
77	76	10/08/2021	11:30:00	Post	Kayak	6		4 L76	6	12	D1	E3	W1
78	77	10/08/2021	11:30:00	Post	Kayak	6		4 L77	6	12	D1	E3	W1
79	78	10/08/2021	11:30:00	Post	Kayak	6		4 L78	6	13	D1	E3	W1
80	79	10/08/2021	11:40:00	Pre	Kayak	6		4 L79	1	7	D1	E4	W1
81	80	10/08/2021	11:40:00	Pre	Kayak	6		4 L80	6	12	D1	E4	W1
82	81	10/08/2021	11:40:00	Pre	Kayak	6		4 L81	6	12	D1	E4	W1
83	82	10/08/2021	11:40:00	Pre	Kayak	6		4 L82	6	13	D1	E4	W1
84	83	10/08/2021	11:50:00	Pre	Kayak	6		2 L83	6	12	D1	E4	W1

85	84	10/08/2021	11:50:00	Pre	Kayak	6	2 L84	6	13	D1	E4	W1
86	85	10/08/2021	12:00:00	During	Kayak	6	4 L85	5	12	D1	E4	W1
87	86	10/08/2021	12:00:00	During	Kayak	6	4 L86	6	12	D1	E4	W1
88	87	10/08/2021	12:00:00	During	Kayak	6	4 L87	6	12	D1	E4	W1
89	88	10/08/2021	12:00:00	During	Kayak	6	4 L88	6	13	D1	E4	W1
90	89	10/08/2021	12:00:05	During	Kayak	6	3 L89	6	12	D1	E4	W1
91	90	10/08/2021	12:00:05	During	Kayak	6	3 L90	6	12	D1	E4	W1
92	91	10/08/2021	12:00:05	During	Kayak	6	3 L91	6	13	D1	E4	W1
93	92	10/08/2021	12:00:10	During	Kayak	6	4 L92	1	17	D1	E4	W1
94	93	10/08/2021	12:00:10	During	Kayak	6	4 L93	1	17	D1	E4	W1
95	94	10/08/2021	12:00:10	During	Kayak	6	4 L94	4	17	D1	E4	W1
96	95	10/08/2021	12:00:10	During	Kayak	6	4 L95	6	12	D1	E4	W1
97	96	10/08/2021	12:00:15	During	Kayak	6	3 L96	1	17	D1	E4	W1
98	97	10/08/2021	12:00:15	During	Kayak	6	3 L97	1	18	D1	E4	W1
99	98	10/08/2021	12:00:15	During	Kayak	6	3 L98	1	19	D1	E4	W1
100	99	10/08/2021	12:10:00	Post	Kayak	6	2 L99	1	20	D1	E4	W1
101	100	10/08/2021	12:10:00	Post	Kayak	6	2 L100	2	19	D1	E4	W1
102	101	10/08/2021	12:20:00	Post	Kayak	6	2 L101	3	19	D1	E4	W1
103	102	10/08/2021	12:20:00	Post	Kayak	6	2 L102	5	11	D1	E4	W1
104	103	10/08/2021	12:30:00	Post	Kayak	6	1 L103	2	17	D1	E4	W1
105	104	10/08/2021	12:40:00	Pre	Kayak	6	1 L104	5	9	D1	E5	W1
106	105	10/08/2021	13:00:00	During	Kayak	6	2 L105	1	20	D1	E5	W1
107	106	10/08/2021	13:00:00	During	Kayak	6	2 L106	2	15	D1	E5	W1
108	107	10/08/2021	13:00:05	During	Kayak	6	3 L107	1	12	D1	E5	W1
109	108	10/08/2021	13:00:05	During	Kayak	6	3 L108	1	20	D1	E5	W1
110	109	10/08/2021	13:00:05	During	Kayak	6	3 L109	2	15	D1	E5	W1
111	110	10/08/2021	13:00:10	During	Kayak	6	3 L110	1	17	D1	E5	W1
112	111	10/08/2021	13:00:10	During	Kayak	6	3 L111	1	20	D1	E5	W1
113	112	10/08/2021	13:00:10	During	Kayak	6	3 L112	3	16	D1	E5	W1
114	113	10/08/2021	13:00:15	During	Kayak	6	3 L113	1	17	D1	E5	W1
115	114	10/08/2021	13:00:15	During	Kayak	6	3 L114	1	20	D1	E5	W1
116	115	10/08/2021	13:00:15	During	Kayak	6	3 L115	2	16	D1	E5	W1
117	116	10/08/2021	13:10:00	Post	Kayak	6	1 L116	6	18	D1	E5	W1
118	117	10/08/2021	13:20:00	Post	Kayak	6	2 L117	3	18	D1	E5	W1
119	118	10/08/2021	13:20:00	Post	Kayak	6	2 L118	5	16	D1	E5	W1
120	119	10/08/2021	13:30:00	Post	Kayak	6	3 L119	1	7	D1	E5	W1
121	120	10/08/2021	13:30:00	Post	Kayak	6	3 L120	3	18	D1	E5	W1
122	121	10/08/2021	13:30:00	Post	Kayak	6	3 L121	5	16	D1	E5	W1
123	122	10/08/2021	13:40:00	Pre	Kayak	6	2 L122	1	18	D1	E6	W1
124	123	10/08/2021	13:40:00	Pre	Kayak	6	2 L123	5	16	D1	E6	W1
125	124	10/08/2021	13:50:00	Pre	Kayak	6	1 L124	4	16	D1	E6	W1
126	125	10/08/2021	14:00:00	During	Kayak	6	3 L125	1	13	D1	E6	W1
127	126	10/08/2021	14:00:00	During	Kayak	6	3 L126	1	14	D1	E6	W1
128	127	10/08/2021	14:00:00	During	Kayak	6	3 L127	4	16	D1	E6	W1
129	128	10/08/2021	14:00:05	During	Kayak	6	2 L128	2	18	D1	E6	W1
130	129	10/08/2021	14:00:05	During	Kayak	6	2 L129	2	18	D1	E6	W1
131	130	10/08/2021	14:00:10	During	Kayak	6	2 L130	1	20	D1	E6	W1
132	131	10/08/2021	14:00:10	During	Kayak	6	2 L131	2	18	D1	E6	W1
133	132	10/08/2021	14:00:15	During	Kayak	6	2 L132	1	20	D1	E6	W1
134	133	10/08/2021	14:00:15	During	Kayak	6	2 L133	2	18	D1	E6	W1
135	134	10/08/2021	14:10:00	Post	Kayak	6	1 L134	6	9	D1	E6	W1
136	135	10/08/2021	14:40:00	Pre	Kayak	6	2 L135	5	11	D1	E7	W1
137	136	10/08/2021	14:40:00	Pre	Kayak	6	2 L136	6	9	D1	E7	W1
138	137	10/08/2021	14:50:00	Pre	Kayak	6	3 L137	2	1	D1	E7	W1
139	138	10/08/2021	14:50:00	Pre	Kayak	6	3 L138	5	11	D1	E7	W1
140	139	10/08/2021	14:50:00	Pre	Kayak	6	3 L139	6	1	D1	E7	W1
142	141	10/08/2021	15:00:00	During	Kayak	6	2 L141	5	12	D1	E7	W1
143	142	10/08/2021	15:00:05	During	Kayak	6	2 L142	2	3	D1	E7	W1
144	143	10/08/2021	15:00:05	During	Kayak	6	2 L143	6	14	D1	E7	W1
145	144	10/08/2021	15:00:10	During	Kayak	6	2 L144	6	3	D1	E7	W1
146	145	10/08/2021	15:00:10	During	Kayak	6	2 L145	6	19	D1	E7	W1
147	146	10/08/2021	15:00:15	During	Kayak	6	2 L146	6	4	D1	E7	W1
148	147	10/08/2021	15:00:15	During	Kayak	6	2 L147	6	20	D1	E7	W1
149	148	10/08/2021	15:10:00	Post	Kayak	6	2 L148	1	19	D1	E7	W1
150	149	10/08/2021	15:10:00	Post	Kayak	6	2 L149	1	20	D1	E7	W1
151	150	10/08/2021	15:20:00	Post	Kayak	6	3 L150	1	17	D1	E7	W1
152	151	10/08/2021	15:20:00	Post	Kayak	6	3 L151	1	19	D1	E7	W1
153	152	10/08/2021	15:20:00	Post	Kayak	6	3 L152	3	17	D1	E7	W1
154	153	10/08/2021	15:30:00	Post	Kayak	6	3 L153	1	17	D1	E7	W1
155	154	10/08/2021	15:30:00	Post	Kayak	6	3 L154	1	19	D1	E7	W1
156	155	10/08/2021	15:30:00	Post	Kayak	6	3 L155	3	17	D1	E7	W1
157	156	10/08/2021	15:40:00	Pre	Bird	6	3 L156	1	19	D1	E8	W1
158	157	10/08/2021	15:40:00	Pre	Bird	6	3 L157	3	17	D1	E8	W1
159	158	10/08/2021	15:40:00	Pre	Bird	6	3 L158	6	3	D1	E8	W1
160	159	10/08/2021	15:50:00	Pre	Bird	6	4 L159	1	14	D1	E8	W1
161	160	10/08/2021	15:50:00	Pre	Bird	6	4 L160	1	18	D1	E8	W1
162	161	10/08/2021	15:50:00	Pre	Bird	6	4 L161	2	14	D1	E8	W1
163	162	10/08/2021	15:50:00	Pre	Bird	6	4 L162	3	15	D1	E8	W1
164	163	10/08/2021	16:00:00	During	Bird	6	2 L163	2	3	D1	E8	W1
165	164	10/08/2021	16:00:00	During	Bird	6	2 L164	3	12	D1	E8	W1
166	165	10/08/2021	16:00:05	During	Bird	6	4 L165	1	18	D1	E8	W1
167	166	10/08/2021	16:00:05	During	Bird	6	4 L166	2	19	D1	E8	W1
168	167	10/08/2021	16:00:05	During	Bird	6	4 L167	2	20	D1	E8	W1
169	168	10/08/2021	16:00:05	During	Bird	6	4 L168	3	12	D1	E8	W1

170	169	10/08/2021	16:00:10	During	Bird	6	2 L169	3	12	D1	E8	W1
171	170	10/08/2021	16:00:10	During	Bird	6	2 L170	5	4	D1	E8	W1
172	171	10/08/2021	16:00:15	During	Bird	6	2 L171	1	20	D1	E8	W1
173	172	10/08/2021	16:00:15	During	Bird	6	2 L172	3	12	D1	E8	W1
174	173	10/08/2021	16:10:00	Post	Bird	6	2 L173	1	20	D1	E8	W1
175	174	10/08/2021	16:10:00	Post	Bird	6	2 L174	2	11	D1	E8	W1
176	175	10/08/2021	16:30:00	Post	Bird	6	1 L175	6	9	D1	E8	W1
177	176	10/08/2021	16:40:00	Post	Bird	6	3 L176	1	19	D1	E8	W1
178	177	10/08/2021	16:40:00	Post	Bird	6	3 L177	4	12	D1	E8	W1
179	178	10/08/2021	16:40:00	Post	Bird	6	3 L178	6	8	D1	E8	W1
180	179	10/08/2021	16:50:00	Post	Bird	6	2 L179	1	19	D1	E8	W1
181	180	10/08/2021	16:50:00	Post	Bird	6	2 L180	6	4	D1	E8	W1
182	181	10/08/2021	17:00:00	Post	Bird	6	4 L181	2	18	D1	E8	W1
183	182	10/08/2021	17:00:00	Post	Bird	6	4 L182	4	2	D1	E8	W1
184	183	10/08/2021	17:00:00	Post	Bird	6	4 L183	4	12	D1	E8	W1
185	184	10/08/2021	17:00:00	Post	Bird	6	4 L184	6	1	D1	E8	W1
186	185	10/08/2021	10:40:00	Pre	Kayak	6	0			D1	E3	W1
187	186	10/08/2021	10:50:00	Pre	Kayak	6	0			D1	E3	W1
188	187	10/08/2021	12:50:00	Pre	Kayak	6	0			D1	E5	W1
189	188	10/08/2021	14:20:00	Post	Kayak	6	0			D1	E6	W1
190	189	10/08/2021	14:30:00	Post	Kayak	6	0			D1	E6	W1
191	190	10/08/2021	16:20:00	Post	Bird	6	0			D1	E8	W1
192	191	11/08/2021	08:10:00	Pre	Bird	6	2 L185	1	20	D2	E1	W1
193	192	11/08/2021	08:10:00	Pre	Bird	6	2 L186	6	1	D2	E1	W1
194	193	11/08/2021	08:20:00	Pre	Bird	6	1 L187	1	7	D2	E1	W1
195	194	11/08/2021	08:30:00	Pre	Bird	6	2 L188	1	7	D2	E1	W1
196	195	11/08/2021	08:40:00	Pre	Bird	6	1 L189	6	3	D2	E1	W1
197	196	11/08/2021	09:00:00	During	Bird	6	2 L190	2	20	D2	E1	W1
199	198	11/08/2021	09:00:05	During	Bird	6	2 L192	1	20	D2	E1	W1
200	199	11/08/2021	09:00:05	During	Bird	6	2 L193	5	20	D2	E1	W1
201	200	11/08/2021	09:00:10	During	Bird	6	2 L194	6	1	D2	E1	W1
202	201	11/08/2021	09:00:10	During	Bird	6	2 L195	6	12	D2	E1	W1
203	202	11/08/2021	09:00:15	During	Bird	6	2 L196	6	1	D2	E1	W1
204	203	11/08/2021	09:00:15	During	Bird	6	2 L197	6	12	D2	E1	W1
205	204	11/08/2021	09:10:00	Post	Bird	6	3 L198	1	1	D2	E1	W1
206	205	11/08/2021	09:10:00	Post	Bird	6	3 L199	1	2	D2	E1	W1
207	206	11/08/2021	09:10:00	Post	Bird	6	3 L200	6	14	D2	E1	W1
208	207	11/08/2021	09:20:00	Post	Bird	6	3 L201	1	1	D2	E1	W1
209	208	11/08/2021	09:20:00	Post	Bird	6	3 L202	1	14	D2	E1	W1
210	209	11/08/2021	09:20:00	Post	Bird	6	3 L203	6	14	D2	E1	W1
211	210	11/08/2021	09:30:00	Post	Bird	6	2 L204	6	1	D2	E1	W1
212	211	11/08/2021	09:30:00	Post	Bird	6	2 L205	6	14	D2	E1	W1
213	212	11/08/2021	09:40:00	Pre	Kayak	6	3 L206	1	1	D2	E2	W1
214	213	11/08/2021	09:40:00	Pre	Kayak	6	3 L207	2	10	D2	E2	W1
215	214	11/08/2021	09:40:00	Pre	Kayak	6	3 L208	5	15	D2	E2	W1
216	215	11/08/2021	09:50:00	Pre	Kayak	6	2 L209	5	2	D2	E2	W1
217	216	11/08/2021	09:50:00	Pre	Kayak	6	2 L210	6	13	D2	E2	W1
218	217	11/08/2021	10:00:00	During	Kayak	6	4 L211	1	17	D2	E2	W1
219	218	11/08/2021	10:00:00	During	Kayak	6	4 L212	2	12	D2	E2	W1
220	219	11/08/2021	10:00:00	During	Kayak	6	4 L213	5	20	D2	E2	W1
221	220	11/08/2021	10:00:00	During	Kayak	6	4 L214	6	14	D2	E2	W1
222	221	11/08/2021	10:00:05	During	Kayak	6	3 L215	1	18	D2	E2	W1
223	222	11/08/2021	10:00:05	During	Kayak	6	3 L216	5	20	D2	E2	W1
224	223	11/08/2021	10:00:05	During	Kayak	6	3 L217	6	14	D2	E2	W1
225	224	11/08/2021	10:00:10	During	Kayak	6	4 L218	1	12	D2	E2	W1
226	225	11/08/2021	10:00:10	During	Kayak	6	4 L219	1	20	D2	E2	W1
227	226	11/08/2021	10:00:10	During	Kayak	6	4 L220	4	14	D2	E2	W1
228	227	11/08/2021	10:00:10	During	Kayak	6	4 L221	5	20	D2	E2	W1
229	228	11/08/2021	10:00:15	During	Kayak	6	3 L222	1	18	D2	E2	W1
230	229	11/08/2021	10:00:15	During	Kayak	6	3 L223	2	17	D2	E2	W1
231	230	11/08/2021	10:00:15	During	Kayak	6	3 L224	5	20	D2	E2	W1
232	231	11/08/2021	10:10:00	Post	Kayak	6	1 L225	6	7	D2	E2	W1
233	232	11/08/2021	10:20:00	Post	Kayak	6	1 L226	5	6	D2	E2	W1
234	233	11/08/2021	10:30:00	Post	Kayak	6	3 L227	1	7	D2	E2	W1
235	234	11/08/2021	10:30:00	Post	Kayak	6	3 L228	1	13	D2	E2	W1
236	235	11/08/2021	10:30:00	Post	Kayak	6	3 L229	5	6	D2	E2	W1
237	236	11/08/2021	10:40:00	Pre	Kayak	6	2 L230	1	3	D2	E3	W1
238	237	11/08/2021	10:40:00	Pre	Kayak	6	2 L231	5	6	D2	E3	W1
239	238	11/08/2021	10:50:00	Pre	Kayak	6	3 L232	1	3	D2	E3	W1
240	239	11/08/2021	10:50:00	Pre	Kayak	6	3 L233	1	7	D2	E3	W1
241	240	11/08/2021	10:50:00	Pre	Kayak	6	3 L234	2	12	D2	E3	W1
242	241	11/08/2021	11:00:00	During	Kayak	6	3 L235	1	12	D2	E3	W1
243	242	11/08/2021	11:00:00	During	Kayak	6	3 L236	1	18	D2	E3	W1
244	243	11/08/2021	11:00:00	During	Kayak	6	3 L237	6	12	D2	E3	W1
245	244	11/08/2021	11:00:05	During	Kayak	6	4 L238	1	19	D2	E3	W1
246	245	11/08/2021	11:00:05	During	Kayak	6	4 L239	1	20	D2	E3	W1
247	246	11/08/2021	11:00:05	During	Kayak	6	4 L240	2	18	D2	E3	W1
248	247	11/08/2021	11:00:05	During	Kayak	6	4 L241	6	12	D2	E3	W1
249	248	11/08/2021	11:00:10	During	Kayak	6	4 L242	1	19	D2	E3	W1
250	249	11/08/2021	11:00:10	During	Kayak	6	4 L243	1	19	D2	E3	W1
251	250	11/08/2021	11:00:10	During	Kayak	6	4 L244	2	18	D2	E3	W1
252	251	11/08/2021	11:00:10	During	Kayak	6	4 L245	2	18	D2	E3	W1
253	252	11/08/2021	11:00:15	During	Kayak	6	4 L246	1	20	D2	E3	W1
254	253	11/08/2021	11:00:15	During	Kavak	6	4 L247	1	20	D2	E3	W1

Latency of reaction

1	Date	Time	Swim occasion	Sti	Swim oc	Timing	latency	Stressor	Day	Week	Event
2	10/08/2021	08:59:49		08:59:49		1 During		0 Bird	D1	W1	E1
3	10/08/2021	08:59:49		08:59:49		2 During		0 Bird	D1	W1	E1
4	10/08/2021	08:59:49		08:59:49		3 During		0 Bird	D1	W1	E1
5	10/08/2021	08:59:49		08:59:50		4 During		1 Bird	D1	W1	E1
6	10/08/2021	08:59:49		08:59:50		5 During		1 Bird	D1	W1	E1
7	10/08/2021	08:59:49		08:59:50		6 During		1 Bird	D1	W1	E1
8	10/08/2021	10:00:11		10:00:11		1 During		0 Kayak	D1	W1	E2
9	10/08/2021	10:00:11		10:00:12		2 During		1 Kayak	D1	W1	E2
10	10/08/2021	10:00:11		10:00:12		3 During		1 Kayak	D1	W1	E2
11	10/08/2021	10:00:11		10:00:12		4 During		1 Kayak	D1	W1	E2
12	10/08/2021	10:00:11		10:00:12		5 During		1 Kayak	D1	W1	E2
13	10/08/2021	10:00:11		10:00:12		6 During		1 Kayak	D1	W1	E2
14	10/08/2021	11:00:17		11:00:17		1 During		0 Kayak	D1	W1	E3
15	10/08/2021	11:00:17		11:00:17		2 During		0 Kayak	D1	W1	E3
16	10/08/2021	11:00:17		11:00:19		3 During		2 Kayak	D1	W1	E3
17	10/08/2021	11:00:17		11:00:19		4 During		2 Kayak	D1	W1	E3
18	10/08/2021	11:00:17		11:00:37		5 During		20 Kayak	D1	W1	E3
19	10/08/2021	11:00:17		11:00:39		6 During		22 Kayak	D1	W1	E3
20	10/08/2021	11:59:07		11:59:07		1 During		0 Kayak	D1	W1	E4
21	10/08/2021	11:59:07		11:59:07		2 During		0 Kayak	D1	W1	E4
22	10/08/2021	11:59:07		11:59:10		3 During		3 Kayak	D1	W1	E4
23	10/08/2021	11:59:07		11:59:11		4 During		4 Kayak	D1	W1	E4
24	10/08/2021	11:59:07		11:59:11		5 During		4 Kayak	D1	W1	E4
25	10/08/2021	11:59:07		11:59:12		6 During		5 Kayak	D1	W1	E4
26	10/08/2021	12:59:27		12:59:27		1 During		0 Kayak	D1	W1	E5
27	10/08/2021	12:59:27		12:59:27		2 During		0 Kayak	D1	W1	E5
28	10/08/2021	12:59:27		12:59:27		3 During		0 Kayak	D1	W1	E5
29	10/08/2021	12:59:27		12:59:28		4 During		1 Kayak	D1	W1	E5
30	10/08/2021	12:59:27		12:59:28		5 During		1 Kayak	D1	W1	E5
31	10/08/2021	12:59:27		12:59:36		6 During		9 Kayak	D1	W1	E5
32	10/08/2021	13:58:53		13:58:53		1 During		0 Kayak	D1	W1	E6
33	10/08/2021	13:58:53		13:58:54		2 During		1 Kayak	D1	W1	E6
34	10/08/2021	13:58:53		13:58:54		3 During		1 Kayak	D1	W1	E6
35	10/08/2021	13:58:53		13:58:54		4 During		1 Kayak	D1	W1	E6
36	10/08/2021	13:58:53		13:58:55		5 During		2 Kayak	D1	W1	E6
37	10/08/2021	13:58:53		13:58:58		6 During		5 Kayak	D1	W1	E6
38	10/08/2021	14:59:15		14:59:18		1 During		3 Kayak	D1	W1	E7
39	10/08/2021	14:59:15		14:59:18		2 During		3 Kayak	D1	W1	E7
40	10/08/2021	14:59:15		14:59:19		3 During		4 Kayak	D1	W1	E7
41	10/08/2021	14:59:15		14:59:19		4 During		4 Kayak	D1	W1	E7
42	10/08/2021	14:59:15		14:59:21		5 During		6 Kayak	D1	W1	E7
43	10/08/2021	14:59:15		14:59:22		6 During		7 Kayak	D1	W1	E7
44	10/08/2021	16:00:01		16:00:01		1 During		0 Bird	D1	W1	E8
45	10/08/2021	16:00:01		16:00:01		2 During		0 Bird	D1	W1	E8
46	10/08/2021	16:00:01		16:00:01		3 During		0 Bird	D1	W1	E8
47	10/08/2021	16:00:01		16:00:01		4 During		0 Bird	D1	W1	E8
48	10/08/2021	16:00:01		16:00:01		5 During		0 Bird	D1	W1	E8
49	10/08/2021	16:00:01		16:00:02		6 During		1 Bird	D1	W1	E8
50	11/08/2021	09:01:20		09:01:20		1 During		0 Bird	D2	W1	E1
51	11/08/2021	09:01:20		09:01:21		2 During		1 Bird	D2	W1	E1
52	11/08/2021	09:01:20		09:01:21		3 During		1 Bird	D2	W1	E1
53	11/08/2021	09:01:20		09:01:22		4 During		2 Bird	D2	W1	E1
54	11/08/2021	09:01:20		09:01:23		5 During		3 Bird	D2	W1	E1
55	11/08/2021	09:01:20		09:01:23		6 During		3 Bird	D2	W1	E1
56	11/08/2021	10:00:36		10:00:36		1 During		0 Kayak	D2	W1	E2
57	11/08/2021	10:00:36		10:00:41		2 During		5 Kayak	D2	W1	E2
58	11/08/2021	10:00:36		10:00:42		3 During		6 Kayak	D2	W1	E2
59	11/08/2021	10:00:36		10:00:42		4 During		6 Kayak	D2	W1	E2
60	11/08/2021	10:00:36		10:00:43		5 During		7 Kayak	D2	W1	E2
61	11/08/2021	10:00:36		10:00:44		6 During		8 Kayak	D2	W1	E2
62	11/08/2021	10:58:55		10:58:55		1 During		0 Kayak	D2	W1	E3
63	11/08/2021	10:58:55		10:58:57		2 During		2 Kayak	D2	W1	E3
64	11/08/2021	10:58:55		10:58:57		3 During		2 Kayak	D2	W1	E3
65	11/08/2021	10:58:55		10:58:59		4 During		4 Kayak	D2	W1	E3
66	11/08/2021	10:58:55		10:59:00		5 During		5 Kayak	D2	W1	E3
67	11/08/2021	10:58:55		10:59:01		6 During		6 Kayak	D2	W1	E3
68	11/08/2021	11:59:03		11:59:03		1 During		0 Kayak	D2	W1	E4
69	11/08/2021	11:59:03		11:59:04		2 During		1 Kayak	D2	W1	E4
70	11/08/2021	11:59:03		11:59:05		3 During		2 Kayak	D2	W1	E4
71	11/08/2021	11:59:03		11:59:05		4 During		2 Kayak	D2	W1	E4
72	11/08/2021	11:59:03		11:59:05		5 During		2 Kayak	D2	W1	E4
73	11/08/2021	11:59:03		11:59:06		6 During		3 Kayak	D2	W1	E4
74	11/08/2021	13:00:11		13:00:11		1 During		0 Kayak	D2	W1	E5
75	11/08/2021	13:00:11		13:00:11		2 During		0 Kayak	D2	W1	E5
76	11/08/2021	13:00:11		13:00:11		3 During		0 Kayak	D2	W1	E5
77	11/08/2021	13:00:11		13:00:12		4 During		1 Kayak	D2	W1	E5
78	11/08/2021	13:00:11		13:00:12		5 During		1 Kayak	D2	W1	E5
79	11/08/2021	13:00:11		13:00:13		6 During		2 Kayak	D2	W1	E5
80	11/08/2021	13:58:40		13:58:41		1 During		1 Kayak	D2	W1	E6
81	11/08/2021	13:58:40		13:58:43		2 During		3 Kayak	D2	W1	E6
82	11/08/2021	13:58:40		13:58:44		3 During		4 Kayak	D2	W1	E6
83	11/08/2021	13:58:40		13:58:45		4 During		5 Kayak	D2	W1	E6
84	11/08/2021	13:58:40		13:58:45		5 During		5 Kayak	D2	W1	E6
85	11/08/2021	13:58:40		13:58:46		6 During		6 Kayak	D2	W1	E6
86	11/08/2021	14:59:27		14:59:27		1 During		0 Kayak	D2	W1	E7
87	11/08/2021	14:59:27		14:59:41		2 During		14 Kayak	D2	W1	E7
88	11/08/2021	14:59:27		14:59:52		3 During		25 Kayak	D2	W1	E7
89	11/08/2021	14:59:27		14:59:53		4 During		26 Kayak	D2	W1	E7
90	11/08/2021	14:59:27		14:59:55		5 During		28 Kayak	D2	W1	E7
91	11/08/2021	14:59:27		14:59:57		6 During		30 Kayak	D2	W1	E7
92	11/08/2021	15:59:33		15:59:33		1 During		0 Bird	D2	W1	E8
93	11/08/2021	15:59:33		15:59:33		2 During		0 Bird	D2	W1	E8

94	11/08/2021	15:59:33	15:59:33	3 During	0 Bird	D2	W1	E8
95	11/08/2021	15:59:33	15:59:34	4 During	1 Bird	D2	W1	E8
96	11/08/2021	15:59:33	15:59:34	5 During	1 Bird	D2	W1	E8
97	11/08/2021	15:59:33	15:59:34	6 During	1 Bird	D2	W1	E8
98	12/08/2021	09:00:00	09:00:00	1 During	0 Bird	D3	W1	E1
99	12/08/2021	09:00:00	09:00:00	2 During	0 Bird	D3	W1	E1
100	12/08/2021	09:00:00	09:00:01	3 During	1 Bird	D3	W1	E1
101	12/08/2021	09:00:00	09:00:01	4 During	1 Bird	D3	W1	E1
102	12/08/2021	09:00:00	09:00:01	5 During	1 Bird	D3	W1	E1
103	12/08/2021	09:00:00	09:00:02	6 During	2 Bird	D3	W1	E1
104	12/08/2021	09:59:58	09:59:58	1 During	0 Kayak	D3	W1	E2
105	12/08/2021	09:59:58	10:00:01	2 During	3 Kayak	D3	W1	E2
106	12/08/2021	09:59:58	10:00:02	3 During	4 Kayak	D3	W1	E2
107	12/08/2021	09:59:58	10:00:07	4 During	9 Kayak	D3	W1	E2
108	12/08/2021	09:59:58	10:00:07	5 During	9 Kayak	D3	W1	E2
109	12/08/2021	09:59:58	10:00:08	6 During	10 Kayak	D3	W1	E2
110	12/08/2021	11:00:06	11:00:06	1 During	0 Kayak	D3	W1	E3
111	12/08/2021	11:00:06	11:00:06	2 During	0 Kayak	D3	W1	E3
112	12/08/2021	11:00:06	11:00:06	3 During	0 Kayak	D3	W1	E3
113	12/08/2021	11:00:06	11:00:07	4 During	1 Kayak	D3	W1	E3
114	12/08/2021	11:00:06	11:00:07	5 During	1 Kayak	D3	W1	E3
115	12/08/2021	11:00:06	11:00:08	6 During	2 Kayak	D3	W1	E3
116	12/08/2021	12:00:36	12:00:36	1 During	0 Kayak	D3	W1	E4
117	12/08/2021	12:00:36	12:00:36	2 During	0 Kayak	D3	W1	E4
118	12/08/2021	12:00:36	12:00:37	3 During	1 Kayak	D3	W1	E4
119	12/08/2021	12:00:36	12:00:37	4 During	1 Kayak	D3	W1	E4
120	12/08/2021	12:00:36	12:00:39	5 During	3 Kayak	D3	W1	E4
121	12/08/2021	12:00:36	12:00:39	6 During	3 Kayak	D3	W1	E4
122	12/08/2021	13:04:44	13:04:44	1 During	0 Kayak	D3	W1	E5
123	12/08/2021	13:04:44	13:04:45	2 During	1 Kayak	D3	W1	E5
124	12/08/2021	13:04:44	13:04:46	3 During	2 Kayak	D3	W1	E5
125	12/08/2021	13:04:44	13:04:47	4 During	3 Kayak	D3	W1	E5
126	12/08/2021	13:04:44	13:04:48	5 During	4 Kayak	D3	W1	E5
127	12/08/2021	13:04:44	13:04:49	6 During	5 Kayak	D3	W1	E5
128	12/08/2021	13:59:41	13:59:41	1 During	0 Kayak	D3	W1	E6
129	12/08/2021	13:59:41	13:59:42	2 During	1 Kayak	D3	W1	E6
130	12/08/2021	13:59:41	13:59:46	3 During	5 Kayak	D3	W1	E6
131	12/08/2021	13:59:41	13:59:46	4 During	5 Kayak	D3	W1	E6
132	12/08/2021	13:59:41	13:59:47	5 During	6 Kayak	D3	W1	E6
133	12/08/2021	13:59:41	13:59:47	6 During	6 Kayak	D3	W1	E6
134	12/08/2021	14:59:58	14:59:58	1 During	0 Kayak	D3	W1	E7
135	12/08/2021	14:59:58	15:00:00	2 During	2 Kayak	D3	W1	E7
136	12/08/2021	14:59:58	15:00:00	3 During	2 Kayak	D3	W1	E7
137	12/08/2021	14:59:58	15:00:00	4 During	2 Kayak	D3	W1	E7
138	12/08/2021	14:59:58	15:00:00	5 During	2 Kayak	D3	W1	E7
139	12/08/2021	14:59:58	15:00:01	6 During	3 Kayak	D3	W1	E7
140	12/08/2021	16:00:09	16:00:09	1 During	0 Bird	D3	W1	E8
141	12/08/2021	16:00:09	16:00:09	2 During	0 Bird	D3	W1	E8
142	12/08/2021	16:00:09	16:00:09	3 During	0 Bird	D3	W1	E8
143	12/08/2021	16:00:09	16:00:09	4 During	0 Bird	D3	W1	E8
144	12/08/2021	16:00:09	16:00:09	5 During	0 Bird	D3	W1	E8
145	12/08/2021	16:00:09	16:00:09	6 During	0 Bird	D3	W1	E8
146	24/08/2021	09:00:00	09:00:01	1 During	1 Bird	D1	W2	E1
147	24/08/2021	09:00:00	09:00:01	2 During	1 Bird	D1	W2	E1
148	24/08/2021	09:00:00	09:00:01	3 During	1 Bird	D1	W2	E1
149	24/08/2021	09:00:00	09:00:01	4 During	1 Bird	D1	W2	E1
150	24/08/2021	09:00:00	09:00:01	5 During	1 Bird	D1	W2	E1
151	24/08/2021	09:00:00	09:00:02	6 During	2 Bird	D1	W2	E1
152	24/08/2021	09:59:04	09:59:14	1 During	10 Kayak	D1	W2	E2
153	24/08/2021	09:59:04	09:59:15	2 During	11 Kayak	D1	W2	E2
154	24/08/2021	09:59:04	09:59:15	3 During	11 Kayak	D1	W2	E2
155	24/08/2021	09:59:04	09:59:15	4 During	11 Kayak	D1	W2	E2
156	24/08/2021	09:59:04	09:59:15	5 During	11 Kayak	D1	W2	E2
157	24/08/2021	09:59:04	09:59:15	6 During	11 Kayak	D1	W2	E2
158	24/08/2021	11:00:26	11:00:27	1 During	1 Kayak	D1	W2	E3
159	24/08/2021	11:00:26	11:00:39	2 During	13 Kayak	D1	W2	E3
160	24/08/2021	11:00:26	11:00:39	3 During	13 Kayak	D1	W2	E3
161	24/08/2021	11:00:26	11:00:39	4 During	13 Kayak	D1	W2	E3
162	24/08/2021	11:00:26	11:00:39	5 During	13 Kayak	D1	W2	E3
163	24/08/2021	11:00:26	11:00:40	6 During	14 Kayak	D1	W2	E3
164	24/08/2021	11:59:40	11:59:40	1 During	0 Kayak	D1	W2	E4
165	24/08/2021	11:59:40	11:59:41	2 During	1 Kayak	D1	W2	E4
166	24/08/2021	11:59:40	11:59:41	3 During	1 Kayak	D1	W2	E4
167	24/08/2021	11:59:40	11:59:41	4 During	1 Kayak	D1	W2	E4
168	24/08/2021	11:59:40	11:59:42	5 During	2 Kayak	D1	W2	E4
169	24/08/2021	11:59:40	11:59:43	6 During	3 Kayak	D1	W2	E4
170	24/08/2021	13:17:26	13:17:31	1 During	5 Kayak	D1	W2	E5
171	24/08/2021	13:17:26	13:17:33	2 During	7 Kayak	D1	W2	E5
172	24/08/2021	13:17:26	13:17:34	3 During	8 Kayak	D1	W2	E5
173	24/08/2021	13:17:26	13:17:58	4 During	32 Kayak	D1	W2	E5
174	24/08/2021	13:17:26	13:17:58	5 During	32 Kayak	D1	W2	E5
175	24/08/2021	13:17:26	13:17:58	6 During	32 Kayak	D1	W2	E5
176	24/08/2021	13:59:26	13:59:32	1 During	6 Kayak	D1	W2	E6
177	24/08/2021	13:59:26	13:59:33	2 During	7 Kayak	D1	W2	E6
178	24/08/2021	13:59:26	13:59:34	3 During	8 Kayak	D1	W2	E6
179	24/08/2021	13:59:26	13:59:34	4 During	8 Kayak	D1	W2	E6
180	24/08/2021	13:59:26	13:59:35	5 During	9 Kayak	D1	W2	E6
181	24/08/2021	13:59:26	13:59:36	6 During	10 Kayak	D1	W2	E6
182	24/08/2021	14:59:10	14:59:18	1 During	8 Kayak	D1	W2	E7
183	24/08/2021	14:59:10	14:59:19	2 During	9 Kayak	D1	W2	E7
184	24/08/2021	14:59:10	14:59:20	3 During	10 Kayak	D1	W2	E7
185	24/08/2021	14:59:10	14:59:22	4 During	12 Kayak	D1	W2	E7
186	24/08/2021	14:59:10	14:59:22	5 During	12 Kayak	D1	W2	E7

Velocity and distance

1	Observation Date	Start Time (If swim occasion	Duration	Distance (c	Velocity (cr	Condition	Stressor	No. of fish	Not presen	Day	Week	Event
2	1 10/08/2021	08:57:19	4	1.92	30	15.625 Before	Bird		6	Not presen	D1	W1 E1
3	2 10/08/2021	08:57:26	6	1.76	31.62278	17.96749 Before	Bird		6	Not presen	D1	W1 E1
4	3 10/08/2021	08:57:29	3	2.24	10	4.464286 Before	Bird		6	Not presen	D1	W1 E1
5	4 10/08/2021	08:57:30	5	2.56	10	3.90625 Before	Bird		6	Not presen	D1	W1 E1
6	5 10/08/2021	08:57:32	2	0.84	10	11.90476 Before	Bird		6	Not presen	D1	W1 E1
7	6 10/08/2021	08:57:34	1	0.84	10	11.90476 Before	Bird		6	Not presen	D1	W1 E1
8	7 10/08/2021	08:59:49	1	0.37	22.36068	60.43427 During	Bird		6	Present	D1	W1 E1
9	8 10/08/2021	08:59:49	2	0.27	20	74.07407 During	Bird		6	Present	D1	W1 E1
10	9 10/08/2021	08:59:49	3	0.5	10	20 During	Bird		6	Present	D1	W1 E1
11	10 10/08/2021	08:59:50	4	0.2	10	50 During	Bird		6	Present	D1	W1 E1
12	11 10/08/2021	08:59:50	5	0.3	10	33.33333 During	Bird		6	Present	D1	W1 E1
13	12 10/08/2021	08:59:50	6	0.5	40	80 During	Bird		6	Present	D1	W1 E1
14	13 10/08/2021	09:59:58	4	0.66	30	45.45455 Before	Kayak		6	Not presen	D1	W1 E2
15	14 10/08/2021	09:59:58	5	0.3	10	33.33333 Before	Kayak		6	Not presen	D1	W1 E2
16	15 10/08/2021	09:59:58	6	0.2	10	50 Before	Kayak		6	Not presen	D1	W1 E2
17	16 10/08/2021	09:59:59	3	0.5	31.62278	63.24555 Before	Kayak		6	Not presen	D1	W1 E2
18	17 10/08/2021	10:00:00	1	0.63	30	47.61905 Before	Kayak		6	Not presen	D1	W1 E2
19	18 10/08/2021	10:00:00	2	1.06	50	47.16981 Before	Kayak		6	Not presen	D1	W1 E2
20	19 10/08/2021	10:00:11	1	0.27	41.23106	152.7076 During	Kayak		6	Present	D1	W1 E2
21	20 10/08/2021	10:00:12	2	0.33	22.36068	67.75964 During	Kayak		6	Present	D1	W1 E2
22	21 10/08/2021	10:00:12	3	0.67	10	14.92537 During	Kayak		6	Present	D1	W1 E2
23	22 10/08/2021	10:00:12	4	0.57	40	70.17544 During	Kayak		6	Present	D1	W1 E2
24	23 10/08/2021	10:00:12	5	1	10	10 During	Kayak		6	Present	D1	W1 E2
25	24 10/08/2021	10:00:12	6	0.3	10	33.33333 During	Kayak		6	Present	D1	W1 E2
26	25 10/08/2021	10:58:27	6	0.44	10	22.72727 Before	Kayak		6	Not presen	D1	W1 E3
27	26 10/08/2021	10:59:08	5	0.72	20	27.77778 Before	Kayak		6	Not presen	D1	W1 E3
28	27 10/08/2021	10:59:09	3	0.92	53.85165	58.5344 Before	Kayak		6	Not presen	D1	W1 E3
29	28 10/08/2021	10:59:09	4	0.2	10	50 Before	Kayak		6	Not presen	D1	W1 E3
30	29 10/08/2021	10:59:14	2	0.92	20	21.73913 Before	Kayak		6	Not presen	D1	W1 E3
31	30 10/08/2021	10:59:16	1	2.52	50	19.84127 Before	Kayak		6	Not presen	D1	W1 E3
32	31 10/08/2021	11:00:17	1	0.48	20	41.66667 During	Kayak		6	Present	D1	W1 E3
33	1 10/08/2021	11:00:17	2	0.76	72.11103	94.88293 During	Kayak		6	Present	D1	W1 E3
34	2 10/08/2021	11:00:19	3	0.24	14.14214	58.92557 During	Kayak		6	Present	D1	W1 E3
35	3 10/08/2021	11:00:19	4	0.52	30	57.69231 During	Kayak		6	Present	D1	W1 E3
36	4 10/08/2021	11:00:37	5	1.6	53.85165	33.65728 During	Kayak		6	Present	D1	W1 E3
37	5 10/08/2021	11:00:39	6	1.08	40	37.03704 During	Kayak		6	Present	D1	W1 E3
38	6 10/08/2021	11:55:49	6	0.36	22.36068	62.113 Before	Kayak		6	Not presen	D1	W1 E4
39	7 10/08/2021	11:55:52	4	0.52	20	38.46154 Before	Kayak		6	Not presen	D1	W1 E4
40	8 10/08/2021	11:55:52	5	0.32	10	31.25 Before	Kayak		6	Not presen	D1	W1 E4
41	9 10/08/2021	11:55:53	2	0.64	40	62.5 Before	Kayak		6	Not presen	D1	W1 E4
42	10 10/08/2021	11:55:53	3	0.68	10	14.70588 Before	Kayak		6	Not presen	D1	W1 E4
43	11 10/08/2021	11:58:58	1	0.52	14.14214	27.19641 Before	Kayak		6	Not presen	D1	W1 E4
44	12 10/08/2021	11:59:07	1	0.56	22.36068	39.92979 During	Kayak		6	Present	D1	W1 E4
45	13 10/08/2021	11:59:07	2	3.36	53.85165	16.02728 During	Kayak		6	Present	D1	W1 E4
46	14 10/08/2021	11:59:10	3	0.44	20	45.45455 During	Kayak		6	Present	D1	W1 E4
47	15 10/08/2021	11:59:11	4	0.52	20	38.46154 During	Kayak		6	Present	D1	W1 E4
48	16 10/08/2021	11:59:11	5	0.64	28.28427	44.19417 During	Kayak		6	Present	D1	W1 E4
49	17 10/08/2021	11:59:12	6	1.2	10	8.333333 During	Kayak		6	Present	D1	W1 E4
50	18 10/08/2021	12:58:08	6	0.44	10	22.72727 Before	Kayak		6	Not presen	D1	W1 E5
51	19 10/08/2021	12:58:09	4	0.4	10	25 Before	Kayak		6	Not presen	D1	W1 E5
52	20 10/08/2021	12:58:09	5	0.68	10	14.70588 Before	Kayak		6	Not presen	D1	W1 E5
53	21 10/08/2021	12:58:30	3	0.92	40	43.47826 Before	Kayak		6	Not presen	D1	W1 E5
54	22 10/08/2021	12:58:32	1	1.28	30	23.4375 Before	Kayak		6	Not presen	D1	W1 E5
55	23 10/08/2021	12:58:32	2	0.48	10	20.83333 Before	Kayak		6	Not presen	D1	W1 E5
56	24 10/08/2021	12:59:27	1	0.32	40	125 During	Kayak		6	Present	D1	W1 E5
57	25 10/08/2021	12:59:27	2	0.68	41.23106	60.63391 During	Kayak		6	Present	D1	W1 E5
58	26 10/08/2021	12:59:27	3	0.4	40	100 During	Kayak		6	Present	D1	W1 E5
59	27 10/08/2021	12:59:28	4	1.4	50	35.71429 During	Kayak		6	Present	D1	W1 E5
60	28 10/08/2021	12:59:28	5	0.4	30	75 During	Kayak		6	Present	D1	W1 E5
61	29 10/08/2021	12:59:36	6	0.68	30	44.11765 During	Kayak		6	Present	D1	W1 E5
62	30 10/08/2021	13:58:13	6	0.6	22.36068	37.2678 Before	Kayak		6	Not presen	D1	W1 E6
63	31 10/08/2021	13:58:14	5	0.32	30	93.75 Before	Kayak		6	Not presen	D1	W1 E6
64	1 10/08/2021	13:58:15	4	0.44	22.36068	50.81973 Before	Kayak		6	Not presen	D1	W1 E6
65	2 10/08/2021	13:58:48	3	0.68	14.14214	20.79726 Before	Kayak		6	Not presen	D1	W1 E6
66	3 10/08/2021	13:58:49	2	0.64	14.14214	22.09709 Before	Kayak		6	Not presen	D1	W1 E6
67	4 10/08/2021	13:58:51	1	1.16	42.42641	36.57449 Before	Kayak		6	Not presen	D1	W1 E6
68	5 10/08/2021	13:58:53	1	0.68	20	29.41176 During	Kayak		6	Present	D1	W1 E6
69	6 10/08/2021	13:58:54	2	0.24	20	83.33333 During	Kayak		6	Present	D1	W1 E6
70	7 10/08/2021	13:58:54	3	1.16	40	34.48276 During	Kayak		6	Present	D1	W1 E6
71	8 10/08/2021	13:58:54	4	1.08	40	37.03704 During	Kayak		6	Present	D1	W1 E6
72	9 10/08/2021	13:58:55	5	1.16	31.62278	27.26101 During	Kayak		6	Present	D1	W1 E6
73	10 10/08/2021	13:58:58	6	2.56	50	19.53125 During	Kayak		6	Present	D1	W1 E6
74	11 10/08/2021	14:44:35	6	0.68	30	44.11765 Before	Kayak		6	Not presen	D1	W1 E7
75	12 10/08/2021	14:44:37	5	1.2	40	33.33333 Before	Kayak		6	Not presen	D1	W1 E7
76	13 10/08/2021	14:44:40	4	0.92	50.9902	55.42413 Before	Kayak		6	Not presen	D1	W1 E7
77	14 10/08/2021	14:48:26	3	1.48	10	6.756757 Before	Kayak		6	Not presen	D1	W1 E7
78	15 10/08/2021	14:50:57	2	1.16	10	8.62069 Before	Kayak		6	Not presen	D1	W1 E7
79	16 10/08/2021	14:50:58	1	1.24	30	24.19355 Before	Kayak		6	Not presen	D1	W1 E7
80	17 10/08/2021	14:59:18	1	0.32	20	62.5 During	Kayak		6	Present	D1	W1 E7
81	18 10/08/2021	14:59:18	2	1.72	41.23106	23.97154 During	Kayak		6	Present	D1	W1 E7
82	19 10/08/2021	14:59:19	3	0.84	31.62278	37.64616 During	Kayak		6	Present	D1	W1 E7
83	20 10/08/2021	14:59:19	4	1.32	31.62278	23.95665 During	Kayak		6	Present	D1	W1 E7
84	21 10/08/2021	14:59:21	5	1	14.14214	14.14214 During	Kayak		6	Present	D1	W1 E7
85	22 10/08/2021	14:59:22	6	0.76	30	39.47368 During	Kayak		6	Present	D1	W1 E7
86	23 10/08/2021	15:56:22	5	1.52	31.62278	20.80446 Before	Bird		6	Not presen	D1	W1 E8
87	24 10/08/2021	15:56:23	6	0.52	14.14214	27.19641 Before	Bird		6	Not presen	D1	W1 E8
88	25 10/08/2021	15:56:24	3	3.76	31.62278	8.410313 Before	Bird		6	Not presen	D1	W1 E8
89	26 10/08/2021	15:56:24	4	2.16	50.9902	23.60657 Before	Bird		6	Not presen	D1	W1 E8
90	27 10/08/2021	15:56:28	2	3.68	31.62278	8.593146 Before	Bird		6	Not presen	D1	W1 E8
91	28 10/08/2021	15:59:43	1	4.64	41.23106	8.886004 Before	Bird		6	Not presen	D1	W1 E8
92	29 10/08/2021	16:00:01	1	0.2	10	50 During	Bird		6	Present	D1	W1 E8
93	30 10/08/2021	16:00:01	2	0.52	28.28427	54.39283 During	Bird		6	Present	D1	W1 E8

94	93	10/08/2021	16:00:01	3	1.76	20	11.36364	During	Bird	6	Present	D1	W1	E8
95	94	10/08/2021	16:00:01	4	0.44	30	68.18182	During	Bird	6	Present	D1	W1	E8
96	95	10/08/2021	16:00:01	5	0.68	40	58.82353	During	Bird	6	Present	D1	W1	E8
97	96	10/08/2021	16:00:02	6	0.24	20	83.33333	During	Bird	6	Present	D1	W1	E8
98	97	11/08/2021	08:53:54	6	0.52	30	57.69231	Before	Bird	6	Not presen	D2	W1	E1
99	98	11/08/2021	08:55:36	5	4.08	36.05551	8.837135	Before	Bird	6	Not presen	D2	W1	E1
100	99	11/08/2021	08:55:40	4	1.24	30	24.19355	Before	Bird	6	Not presen	D2	W1	E1
101	100	11/08/2021	09:00:59	2	1	72.11103	Before	Bird	6	Not presen	D2	W1	E1	
102	101	11/08/2021	09:00:59	3	0.56	41.23106	73.62689	Before	Bird	6	Not presen	D2	W1	E1
103	102	11/08/2021	09:01:00	1	4.44	90.55385	20.39501	Before	Bird	6	Not presen	D2	W1	E1
104	103	11/08/2021	09:01:20	1	0.6	64.03124	106.7187	During	Bird	6	Present	D2	W1	E1
105	104	11/08/2021	09:01:21	2	0.6	50	83.33333	During	Bird	6	Present	D2	W1	E1
106	105	11/08/2021	09:01:21	3	0.72	80	111.1111	During	Bird	6	Present	D2	W1	E1
107	106	11/08/2021	09:01:22	4	0.6	40	66.66667	During	Bird	6	Present	D2	W1	E1
108	107	11/08/2021	09:01:23	5	0.32	70.71068	220.9709	During	Bird	6	Present	D2	W1	E1
109	108	11/08/2021	09:01:23	6	0.44	44.72136	101.6395	During	Bird	6	Present	D2	W1	E1
110	109	11/08/2021	09:59:26	6	3.92	10	2.55102	Before	Kayak	6	Not presen	D2	W1	E2
111	110	11/08/2021	09:59:31	5	1.92	10	5.208333	Before	Kayak	6	Not presen	D2	W1	E2
112	111	11/08/2021	09:59:34	4	1.44	20	13.88889	Before	Kayak	6	Not presen	D2	W1	E2
113	112	11/08/2021	10:00:17	3	0.68	10	14.70588	Before	Kayak	6	Not presen	D2	W1	E2
114	113	11/08/2021	10:00:18	1	0.48	50	104.1667	Before	Kayak	6	Not presen	D2	W1	E2
115	114	11/08/2021	10:00:18	2	0.44	40	90.90909	Before	Kayak	6	Not presen	D2	W1	E2
116	115	11/08/2021	10:00:36	1	2.16	31.62278	14.64017	During	Kayak	6	Present	D2	W1	E2
117	116	11/08/2021	10:00:41	2	2.32	30	12.93103	During	Kayak	6	Present	D2	W1	E2
118	117	11/08/2021	10:00:42	3	1.02	22.36068	21.92224	During	Kayak	6	Present	D2	W1	E2
119	118	11/08/2021	10:00:42	4	1.24	22.36068	18.03281	During	Kayak	6	Present	D2	W1	E2
120	119	11/08/2021	10:00:43	5	1.6	41.23106	25.76941	During	Kayak	6	Present	D2	W1	E2
121	120	11/08/2021	10:00:44	6	0.24	10	41.66667	During	Kayak	6	Present	D2	W1	E2
122	121	11/08/2021	10:56:07	6	2.56	30	11.71875	Before	Kayak	6	Not presen	D2	W1	E3
123	122	11/08/2021	10:58:30	5	0.68	40	58.82353	Before	Kayak	6	Not presen	D2	W1	E3
124	123	11/08/2021	10:58:31	3	1.52	20	13.15789	Before	Kayak	6	Not presen	D2	W1	E3
125	124	11/08/2021	10:58:31	4	0.4	31.62278	79.05694	Before	Kayak	6	Not presen	D2	W1	E3
126	125	11/08/2021	10:58:38	1	0.76	31.62278	41.60892	Before	Kayak	6	Not presen	D2	W1	E3
127	126	11/08/2021	10:58:38	2	0.4	22.36068	55.9017	Before	Kayak	6	Not presen	D2	W1	E3
128	127	11/08/2021	10:58:55	1	0.92	41.23106	44.81637	During	Kayak	6	Present	D2	W1	E3
129	128	11/08/2021	10:58:57	2	1.76	36.05551	20.48609	During	Kayak	6	Present	D2	W1	E3
130	129	11/08/2021	10:58:57	3	1.84	22.36068	12.15254	During	Kayak	6	Present	D2	W1	E3
131	130	11/08/2021	10:58:59	4	1.2	31.62278	26.35231	During	Kayak	6	Present	D2	W1	E3
132	131	11/08/2021	10:59:00	5	1.24	41.23106	33.25085	During	Kayak	6	Present	D2	W1	E3
133	132	11/08/2021	10:59:01	6	0.56	30	53.57143	During	Kayak	6	Present	D2	W1	E3
134	133	11/08/2021	11:49:18	6	1.6	10	6.25	Before	Kayak	6	Not presen	D2	W1	E4
135	134	11/08/2021	11:50:26	5	1.24	10	8.064516	Before	Kayak	6	Not presen	D2	W1	E4
136	135	11/08/2021	11:50:27	4	1.68	10	5.952381	Before	Kayak	6	Not presen	D2	W1	E4
137	136	11/08/2021	11:55:17	3	3.92	10	2.55102	Before	Kayak	6	Not presen	D2	W1	E4
138	137	11/08/2021	11:55:32	2	3	10	3.333333	Before	Kayak	6	Not presen	D2	W1	E4
139	138	11/08/2021	11:58:39	1	0.76	40	52.63158	Before	Kayak	6	Not presen	D2	W1	E4
140	139	11/08/2021	11:59:03	1	0.6	40	66.66667	During	Kayak	6	Present	D2	W1	E4
141	140	11/08/2021	11:59:04	2	0.56	53.85165	96.16366	During	Kayak	6	Present	D2	W1	E4
142	141	11/08/2021	11:59:05	3	0.36	22.36068	62.113	During	Kayak	6	Present	D2	W1	E4
143	142	11/08/2021	11:59:05	4	0.56	10	17.85714	During	Kayak	6	Present	D2	W1	E4
144	143	11/08/2021	11:59:05	5	1.92	22.36068	11.64619	During	Kayak	6	Present	D2	W1	E4
145	144	11/08/2021	11:59:06	6	1.28	10	7.8125	During	Kayak	6	Present	D2	W1	E4
146	145	11/08/2021	12:59:29	6	2.12	50.9902	24.05198	Before	Kayak	6	Not presen	D2	W1	E5
147	146	11/08/2021	12:59:33	5	3.36	20	5.952381	Before	Kayak	6	Not presen	D2	W1	E5
148	147	11/08/2021	12:59:54	4	1.24	14.14214	11.40495	Before	Kayak	6	Not presen	D2	W1	E5
149	148	11/08/2021	12:59:55	3	0.6	50	83.33333	Before	Kayak	6	Not presen	D2	W1	E5
150	149	11/08/2021	12:59:56	2	1	90.55385	90.55385	Before	Kayak	6	Not presen	D2	W1	E5
151	150	11/08/2021	12:59:57	1	1.56	44.72136	28.66754	Before	Kayak	6	Not presen	D2	W1	E5
152	151	11/08/2021	13:00:11	1	0.6	40	66.66667	During	Kayak	6	Present	D2	W1	E5
153	152	11/08/2021	13:00:11	2	1.36	72.8011	53.53022	During	Kayak	6	Present	D2	W1	E5
154	153	11/08/2021	13:00:11	3	0.52	40	76.92308	During	Kayak	6	Present	D2	W1	E5
155	154	11/08/2021	13:00:12	4	0.8	64.03124	80.03905	During	Kayak	6	Present	D2	W1	E5
156	155	11/08/2021	13:00:12	5	0.48	30	62.5	During	Kayak	6	Present	D2	W1	E5
157	156	11/08/2021	13:00:13	6	0.56	22.36068	39.92979	During	Kayak	6	Present	D2	W1	E5
158	157	11/08/2021	13:54:36	3	0.84	20	23.80952	Before	Kayak	6	Not presen	D2	W1	E6
159	158	11/08/2021	13:54:52	4	1.2	36.05551	30.04626	Before	Kayak	6	Not presen	D2	W1	E6
160	159	11/08/2021	13:54:52	5	0.6	22.36068	37.2678	Before	Kayak	6	Not presen	D2	W1	E6
161	160	11/08/2021	13:54:53	6	1.4	36.05551	25.75394	Before	Kayak	6	Not presen	D2	W1	E6
162	161	11/08/2021	13:57:50	1	2	31.62278	15.81139	Before	Kayak	6	Not presen	D2	W1	E6
163	162	11/08/2021	13:57:52	2	2.76	14.14214	5.123962	Before	Kayak	6	Not presen	D2	W1	E6
164	163	11/08/2021	13:58:41	1	1.6	30	18.75	During	Kayak	6	Present	D2	W1	E6
165	164	11/08/2021	13:58:43	2	1.08	10	9.259259	During	Kayak	6	Present	D2	W1	E6
166	165	11/08/2021	13:58:44	3	1.28	20	15.625	During	Kayak	6	Present	D2	W1	E6
167	166	11/08/2021	13:58:45	4	0.4	10	25	During	Kayak	6	Present	D2	W1	E6
168	167	11/08/2021	13:58:45	5	0.6	10	16.66667	During	Kayak	6	Present	D2	W1	E6
169	168	11/08/2021	13:58:46	6	1.72	14.14214	8.222172	During	Kayak	6	Present	D2	W1	E6
170	169	11/08/2021	14:41:00	5	0.32	10	31.25	Before	Kayak	6	Not presen	D2	W1	E7
171	170	11/08/2021	14:41:00	6	0.36	14.14214	39.28371	Before	Kayak	6	Not presen	D2	W1	E7
172	171	11/08/2021	14:41:01	4	1.32	14.14214	10.71374	Before	Kayak	6	Not presen	D2	W1	E7
173	172	11/08/2021	14:41:07	3	2.08	58.30952	28.03342	Before	Kayak	6	Not presen	D2	W1	E7
174	173	11/08/2021	14:41:10	2	2.16	20	9.259259	Before	Kayak	6	Not presen	D2	W1	E7
175	174	11/08/2021	14:58:43	1	3.16	70	22.1519	Before	Kayak	6	Not presen	D2	W1	E7
176	175	11/08/2021	14:59:27	1	1.68	40	23.80952	During	Kayak	6	Present	D2	W1	E7
177	176	11/08/2021	14:59:41	2	0.64	40	62.5	During	Kayak	6	Present	D2	W1	E7
178	177	11/08/2021	14:59:52	3	0.76	20	26.31579	During	Kayak	6	Present	D2	W1	E7
179	178	11/08/2021	14:59:53	4	2.32	58.30952	25.13341	During	Kayak	6	Present	D2	W1	E7
180	179	11/08/2021	14:59:55	5	2.92	31.62278	10.82972	During	Kayak	6	Present	D2	W1	E7
181	180	11/08/2021	14:59:57	6	1.4	41.23106	29.45075	During	Kayak	6	Present	D2	W1	E7
182	181	11/08/2021	15:58:58	6	1.76	14.14214	8.035304	Before	Bird	6	Not presen	D2	W1	E8
183	182	11/08/2021	15:58:59	5	2.6	40	15.38462	Before	Bird	6	Not presen	D2	W1	E8
184	183	11/08/2021	15:59:01	4	1.32	22.36068	16.93991	Before	Bird	6	Not presen	D2	W1	E8
185	184	11/08/2021	15:59:03	3	1.08	30	27.77778	Before	Bird	6	Not presen	D2	W1	E8
186	185	11/08/2021	15:59:04	2	2.52	20	7.936508	Before	Bird	6	Not presen	D2	W1	E8

187	186	11/08/2021	15:59:05	1	2.6	41.23106	15.8581	Before	Bird	6 Not presen	D2	W1	E8
188	187	11/08/2021	15:59:33	1	0.32	20	62.5	During	Bird	6 Present	D2	W1	E8
189	188	11/08/2021	15:59:33	2	0.59	22.36068	37.89946	During	Bird	6 Present	D2	W1	E8
190	189	11/08/2021	15:59:33	3	0.4	14.14214	35.35534	During	Bird	6 Present	D2	W1	E8
191	190	11/08/2021	15:59:34	4	0.64	50	78.125	During	Bird	6 Present	D2	W1	E8
192	191	11/08/2021	15:59:34	5	1.68	186.8154	111.1997	During	Bird	6 Present	D2	W1	E8
193	192	11/08/2021	15:59:34	6	0.64	50	78.125	During	Bird	6 Present	D2	W1	E8
194	193	12/08/2021	08:56:43	6	5.56	10	1.798561	Before	Bird	6 Not presen	D3	W1	E1
195	194	12/08/2021	08:56:58	5	8.44	14.14214	1.675608	Before	Bird	6 Not presen	D3	W1	E1
196	195	12/08/2021	08:57:00	4	3.68	22.36068	6.076272	Before	Bird	6 Not presen	D3	W1	E1
197	196	12/08/2021	08:57:04	3	1.48	14.14214	9.555497	Before	Bird	6 Not presen	D3	W1	E1
198	197	12/08/2021	08:57:17	2	2.64	22.36068	8.469954	Before	Bird	6 Not presen	D3	W1	E1
199	198	12/08/2021	08:57:54	1	4.44	22.36068	5.036189	Before	Bird	6 Not presen	D3	W1	E1
200	199	12/08/2021	09:00:00	1	1.16	90	77.58621	During	Bird	6 Present	D3	W1	E1
201	200	12/08/2021	09:00:00	2	1.4	31.62278	22.5877	During	Bird	6 Present	D3	W1	E1
202	201	12/08/2021	09:00:01	3	0.16	10	62.5	During	Bird	6 Present	D3	W1	E1
203	202	12/08/2021	09:00:01	4	1.24	80.62258	65.01821	During	Bird	6 Present	D3	W1	E1
204	203	12/08/2021	09:00:01	5	1.68	10	5.952381	During	Bird	6 Present	D3	W1	E1
205	204	12/08/2021	09:00:02	6	0.36	31.62278	87.84105	During	Bird	6 Present	D3	W1	E1
206	205	12/08/2021	09:59:42	6	1.2	10	8.333333	Before	Kayak	6 Not presen	D3	W1	E2
207	206	12/08/2021	09:59:43	5	4.24	30	7.075472	Before	Kayak	6 Not presen	D3	W1	E2
208	207	12/08/2021	09:59:54	1	0.52	58.30952	112.1337	Before	Kayak	6 Not presen	D3	W1	E2
209	208	12/08/2021	09:59:55	2	0.76	60	78.94737	Before	Kayak	6 Not presen	D3	W1	E2
210	209	12/08/2021	09:59:55	3	0.32	20	62.5	Before	Kayak	6 Not presen	D3	W1	E2
211	210	12/08/2021	09:59:56	4	1.16	50.9902	43.95706	Before	Kayak	6 Not presen	D3	W1	E2
212	211	12/08/2021	09:59:58	1	1.24	41.23106	33.25085	During	Kayak	6 Present	D3	W1	E2
213	212	12/08/2021	10:00:01	2	1.54	50.9902	33.11052	During	Kayak	6 Present	D3	W1	E2
214	213	12/08/2021	10:00:02	3	3.12	89.44272	28.66754	During	Kayak	6 Present	D3	W1	E2
215	214	12/08/2021	10:00:07	4	0.92	30	32.6087	During	Kayak	6 Present	D3	W1	E2
216	215	12/08/2021	10:00:07	5	0.48	10	20.83333	During	Kayak	6 Present	D3	W1	E2
217	216	12/08/2021	10:00:08	6	0.24	30	125	During	Kayak	6 Present	D3	W1	E2
218	217	12/08/2021	10:59:12	4	1.24	14.14214	11.40495	Before	Kayak	6 Not presen	D3	W1	E3
219	218	12/08/2021	10:59:12	5	3.08	41.23106	13.38671	Before	Kayak	6 Not presen	D3	W1	E3
220	219	12/08/2021	10:59:12	6	3	72.11103	24.03701	Before	Kayak	6 Not presen	D3	W1	E3
221	220	12/08/2021	10:59:27	3	5	53.85165	10.77033	Before	Kayak	6 Not presen	D3	W1	E3
222	221	12/08/2021	10:59:34	1	0.6	22.36068	37.2678	Before	Kayak	6 Not presen	D3	W1	E3
223	222	12/08/2021	10:59:34	2	0.4	22.36068	55.9017	Before	Kayak	6 Not presen	D3	W1	E3
224	223	12/08/2021	11:00:06	1	1.08	50.9902	47.21314	During	Kayak	6 Present	D3	W1	E3
225	224	12/08/2021	11:00:06	2	0.64	67.08204	104.8157	During	Kayak	6 Present	D3	W1	E3
226	225	12/08/2021	11:00:06	3	2	58.30952	29.15476	During	Kayak	6 Present	D3	W1	E3
227	226	12/08/2021	11:00:07	4	1.44	104.4031	72.50213	During	Kayak	6 Present	D3	W1	E3
228	227	12/08/2021	11:00:07	5	0.52	30	57.69231	During	Kayak	6 Present	D3	W1	E3
229	228	12/08/2021	11:00:08	6	2.76	14.14214	5.123962	During	Kayak	6 Present	D3	W1	E3
230	229	12/08/2021	11:56:02	4	0.92	14.14214	15.37189	Before	Kayak	6 Not presen	D3	W1	E4
231	230	12/08/2021	11:56:02	5	0.56	10	17.85714	Before	Kayak	6 Not presen	D3	W1	E4
232	231	12/08/2021	11:56:02	6	0.56	22.36068	39.92979	Before	Kayak	6 Not presen	D3	W1	E4
233	232	12/08/2021	11:56:03	3	1.6	14.14214	8.838835	Before	Kayak	6 Not presen	D3	W1	E4
234	233	12/08/2021	11:56:04	1	0.68	14.14214	20.79726	Before	Kayak	6 Not presen	D3	W1	E4
235	234	12/08/2021	11:56:04	2	0.76	10	13.15789	Before	Kayak	6 Not presen	D3	W1	E4
236	235	12/08/2021	12:00:36	1	1.12	40	35.71429	During	Kayak	6 Present	D3	W1	E4
237	236	12/08/2021	12:00:36	2	1.44	28.28427	19.64186	During	Kayak	6 Present	D3	W1	E4
238	237	12/08/2021	12:00:37	3	0.48	20	41.66667	During	Kayak	6 Present	D3	W1	E4
239	238	12/08/2021	12:00:37	4	1.16	10	8.62069	During	Kayak	6 Present	D3	W1	E4
240	239	12/08/2021	12:00:39	5	1.68	30	17.85714	During	Kayak	6 Present	D3	W1	E4
241	240	12/08/2021	12:00:39	6	1.16	60.82763	52.43761	During	Kayak	6 Present	D3	W1	E4
242	241	12/08/2021	13:03:57	6	2.6	70.71068	27.19641	Before	Kayak	6 Not presen	D3	W1	E5
243	242	12/08/2021	13:04:02	5	2.24	50	22.32143	Before	Kayak	6 Not presen	D3	W1	E5
244	243	12/08/2021	13:04:03	4	2.56	20	7.8125	Before	Kayak	6 Not presen	D3	W1	E5
245	244	12/08/2021	13:04:06	3	0.92	41.23106	44.81637	Before	Kayak	6 Not presen	D3	W1	E5
246	245	12/08/2021	13:04:08	2	0.84	67.08204	79.85957	Before	Kayak	6 Not presen	D3	W1	E5
247	246	12/08/2021	13:04:09	1	1.32	22.36068	16.93991	Before	Kayak	6 Not presen	D3	W1	E5
248	247	12/08/2021	13:04:44	1	1.28	50.9902	39.83609	During	Kayak	6 Present	D3	W1	E5
249	248	12/08/2021	13:04:45	2	0.08	31.62278	395.2847	During	Kayak	6 Present	D3	W1	E5
250	249	12/08/2021	13:04:46	3	1.64	10	6.097561	During	Kayak	6 Present	D3	W1	E5
251	250	12/08/2021	13:04:47	4	1.28	20	15.625	During	Kayak	6 Present	D3	W1	E5
252	251	12/08/2021	13:04:48	5	1.2	30	25	During	Kayak	6 Present	D3	W1	E5
253	252	12/08/2021	13:04:49	6	1.24	50	40.32258	During	Kayak	6 Present	D3	W1	E5
254	253	12/08/2021	13:58:54	6	1.2	10	8.333333	Before	Kayak	6 Not presen	D3	W1	E6
255	254	12/08/2021	13:58:55	5	1.64	14.14214	8.623253	Before	Kayak	6 Not presen	D3	W1	E6
256	255	12/08/2021	13:58:56	4	3.68	20	5.434783	Before	Kayak	6 Not presen	D3	W1	E6
257	256	12/08/2021	13:59:00	3	0.6	14.14214	23.57023	Before	Kayak	6 Not presen	D3	W1	E6
258	257	12/08/2021	13:59:01	2	3.16	10	3.164557	Before	Kayak	6 Not presen	D3	W1	E6
259	258	12/08/2021	13:59:22	1	0.48	40	83.33333	Before	Kayak	6 Not presen	D3	W1	E6
260	259	12/08/2021	13:59:41	1	0.68	30	44.11765	During	Kayak	6 Present	D3	W1	E6
261	260	12/08/2021	13:59:42	2	4.08	31.62278	7.750681	During	Kayak	6 Present	D3	W1	E6
262	261	12/08/2021	13:59:46	3	1.44	44.72136	31.0565	During	Kayak	6 Present	D3	W1	E6
263	262	12/08/2021	13:59:46	4	0.56	20	35.71429	During	Kayak	6 Present	D3	W1	E6
264	263	12/08/2021	13:59:47	5	0.48	36.05551	75.11565	During	Kayak	6 Present	D3	W1	E6
265	264	12/08/2021	13:59:47	6	0.24	20	83.33333	During	Kayak	6 Present	D3	W1	E6
266	265	12/08/2021	14:59:10	6	4	40	10	Before	Kayak	6 Not presen	D3	W1	E7
267	266	12/08/2021	14:59:46	4	1.28	20	15.625	Before	Kayak	6 Not presen	D3	W1	E7
268	267	12/08/2021	14:59:46	5	0.56	14.14214	25.25381	Before	Kayak	6 Not presen	D3	W1	E7
269	268	12/08/2021	14:59:47	3	1.64	14.14214	8.623253	Before	Kayak	6 Not presen	D3	W1	E7
270	269	12/08/2021	14:59:49	1	1.32	22.36068	16.93991	Before	Kayak	6 Not presen	D3	W1	E7
271	270	12/08/2021	14:59:49	2	0.28	10	35.71429	Before	Kayak	6 Not presen	D3	W1	E7
272	271	12/08/2021	14:59:58	1	1.88	102.9563	54.76399	During	Kayak	6 Present	D3	W1	E7
273	272	12/08/2021	15:00:00	2	0.68	40	58.82353	During	Kayak	6 Present	D3	W1	E7
274	273	12/08/2021	15:00:00	3	0.44	10	22.72727	During	Kayak	6 Present	D3	W1	E7
275	274	12/08/2021	15:00:00	4	2.08	22.36068	10.75033	During	Kayak	6 Present	D3	W1	E7
276	275	12/08/2021	15:00:00	5	0.56	14.14214	25.25381	During	Kayak	6 Present	D3	W1	E7
277	276	12/08/2021	15:00:01	6	2.32	50	21.55172	During	Kayak	6 Present	D3	W1	E7
278	277	12/08/2021	15:59:59	6	1	30	30	Before	Bird	6 Not presen	D3	W1	E8
279	278	12/08/2021	16:00:00	4	2.48	50.9902	20.56056	Before	Bird	6 Not presen	D3	W1	E8

R script Chapter 3

Experiment – Chapter 3

```
> library(nlme)

> library(lmerTest)

> library(lme4)

> library(sjPlot)

>

> # load data

>

> Speed <- read.csv("~/Velocity and distance for r.csv")

> Velocitynew <- read.csv("~/Behaviour experiment/Velocity$event.csv")

> # create a global model

>

> global.model<-lmer(Velocity~Event+Timing + Event*Timing + Day +(1|Week), REML =
TRUE, na.action = "na.fail", data = Velocitynew)

>

> # create null model

>

> null.model<-lmer(Velocity~1+(1|Day),na.action = "na.fail", data = Velocitynew)

>

> # use the AICctab function to find the right model

>

> library(arm)

> stdz.global.model<-standardize(global.model, standardize.y = FALSE)

> summary(stdz.global.model)
```

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: Velocity ~ c.Event + c.Timing + c.Event * c.Timing + Day + (1 | Week)

Data: Velocitynew

REML criterion at convergence: 7995.6

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.4895	-0.5428	-0.0780	0.3458	4.4240

Random effects:

Groups	Name	Variance	Std.Dev.
Week	(Intercept)	64.68	8.043
Residual		956.33	30.925

Number of obs: 825, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	46.3879	2.9517	19.3506	15.716	1.78e-12 ***
c.Event	0.2511	2.1570	809.1492	0.116	0.907
c.Timing	69.3473	2.1636	810.3805	32.051	< 2e-16 ***
DayD2	3.5686	2.6073	808.5842	1.369	0.171
DayD3	-1.9431	2.6521	809.7927	-0.733	0.464
c.Event:c.Timing	-4.1075	4.3143	808.4776	-0.952	0.341

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

```
(Intr) c.Event c.Tmng DayD2 DayD3
c.Event   -0.004
c.Timing  -0.012 -0.004
DayD2     -0.431  0.000  0.002
DayD3     -0.425  0.014  0.047  0.482
c.Event:c.Tm 0.000  0.002  0.000 -0.019  0.014
>
> # AIC = 8011.7 for v1
>
>
> # create other models to compare
> v1<- lmer(Velocity~ Event + Timing + Day + (1|Week), data = Velocitynew)
> v2<- lmer(Velocity ~ Event*Timing + Day +(1|Week), data = Velocitynew)
> v3<- lmer(Velocity ~ 1 + (1|Week), data = Velocitynew)
> v4<- lm(Velocity~ Event + Timing + Day, data = Velocitynew)
> v5<- lmer(Velocity ~ Event + Day + (1|Week), data = Velocitynew)
> v6<- lmer(Velocity ~ Event + Timing + (1|Week), data = Velocitynew)
> v7<- lmer(Velocity ~ Timing + Day + (1|Week), data = Velocitynew)
>
> library(bbmle)
```

```
> AICctab(null.model, global.model, v1, v2, v3, v4, v5, v6, v7, nobs = 825, weights = TRUE,
base = TRUE, sort = TRUE)
```

```
      AICc  dAICc  df weight
global.model 8011.7  0.0 8 0.4445
v2          8011.7  0.0 8 0.4445
v1          8015.4  3.6 7 0.0724
v7          8016.7  5.0 6 0.0368
v6          8022.8 11.1 5 0.0017
v4          8060.0 48.3 6 <0.001
v5          8681.9 670.2 6 <0.001
v3          8694.3 682.6 3 <0.001
null.model  8702.6 690.9 3 <0.001
```

```
> # global.model and v2 have same AICc value = 8011.7
```

```
> # must test against each other
```

```
>
```

```
>
```

```
> summary(global.model)
```

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: Velocity ~ Event + Timing + Event * Timing + Day + (1 | Week)

Data: Velocitynew

REML criterion at convergence: 7995.6

Scaled residuals:

```
Min    1Q  Median    3Q    Max
```

-2.4895 -0.5428 -0.0780 0.3458 4.4240

Random effects:

Groups	Name	Variance	Std.Dev.
--------	------	----------	----------

Week	(Intercept)	64.68	8.043
------	-------------	-------	-------

Residual		956.33	30.925
----------	--	--------	--------

Number of obs: 825, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	11.742	3.478	36.971	3.376	0.00174 **
EventE8	2.238	2.999	808.387	0.746	0.45578
TimingDuring	71.379	3.039	810.008	23.487	< 2e-16 ***
DayD2	3.569	2.607	808.584	1.369	0.17148
DayD3	-1.943	2.652	809.793	-0.733	0.46396
EventE8:TimingDuring	-4.108	4.314	808.478	-0.952	0.34134

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	EvntE8	TmngDr	DayD2	DayD3
EventE8		-0.428			
TimingDurng		-0.428	0.486		
DayD2		-0.372	0.013	0.014	

DayD3 -0.375 0.000 0.024 0.482

EvntE8:TmnD 0.296 -0.695 -0.702 -0.019 0.014

> summary(v2)

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: Velocity ~ Event * Timing + Day + (1 | Week)

Data: Velocitynew

REML criterion at convergence: 7995.6

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.4895	-0.5428	-0.0780	0.3458	4.4240

Random effects:

Groups	Name	Variance	Std.Dev.
Week	(Intercept)	64.68	8.043
Residual		956.33	30.925

Number of obs: 825, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	11.742	3.478	36.971	3.376	0.00174 **
EventE8	2.238	2.999	808.387	0.746	0.45578
TimingDuring	71.379	3.039	810.008	23.487	< 2e-16 ***

```

DayD2          3.569    2.607 808.584  1.369 0.17148
DayD3          -1.943    2.652 809.793 -0.733 0.46396
EventE8:TimingDuring -4.108    4.314 808.478 -0.952 0.34134

```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

```

      (Intr) EvntE8 TmngDr DayD2  DayD3
EventE8   -0.428
TimingDurng -0.428  0.486
DayD2     -0.372  0.013  0.014
DayD3     -0.375  0.000  0.024  0.482
EvntE8:TmnD  0.296 -0.695 -0.702 -0.019  0.014

```

> # choose v2 model because includes just interactions but same AIC

> summary(v4)

Call:

lm(formula = Velocity ~ Event + Timing + Day, data = Velocitynew)

Residuals:

```

      Min       1Q   Median       3Q      Max
-74.626 -13.051 -4.818   8.865 139.405

```

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	12.5802	2.4469	5.141	3.41e-07 ***
EventE8	0.3765	2.2195	0.170	0.865
TimingDuring	69.5104	2.2229	31.271	< 2e-16 ***
DayD2	3.8515	2.6845	1.435	0.152
DayD3	-1.5126	2.7263	-0.555	0.579

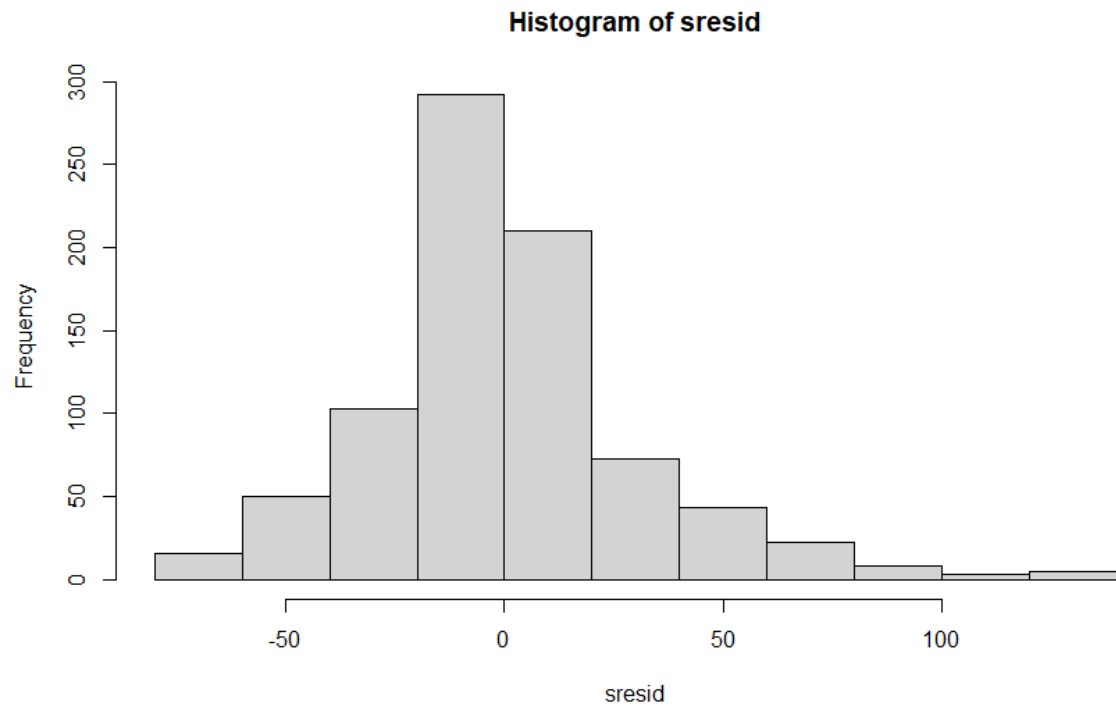
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 31.87 on 820 degrees of freedom

Multiple R-squared: 0.5466, Adjusted R-squared: 0.5444

F-statistic: 247.1 on 4 and 820 DF, p-value: < 2.2e-16

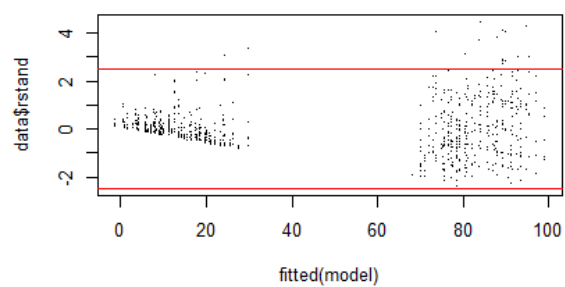
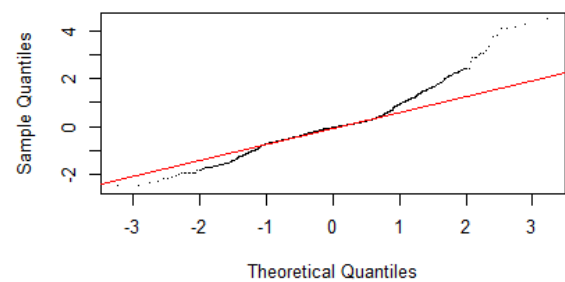
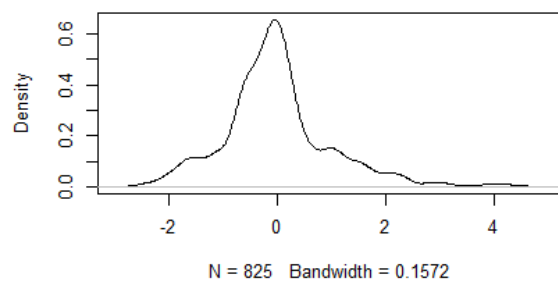
```
> sresid<-resid(global.model, type = "pearson")
> hist(sresid)
```



✓

```
> library(LMERConvenienceFunctions)
```

```
> mcp.fnc(v2)
```



```

>
>
> v2<- lmer(sqrt(Velocity+1) ~ Event*Timing + Day +(1|Week), data = Velocitynew)
>
>
> plotLMER.fnc(v2) # homoscedistesity
effect size (range) for Event is 0.2083517
effect size (range) for Timing is 5.560793
effect size (range) for Day is 0.4204233
>
> summary(v2)

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: sqrt(Velocity + 1) ~ Event * Timing + Day + (1 | Week)

Data: Velocitynew

REML criterion at convergence: 3475.5

Scaled residuals:

    Min     1Q  Median     3Q     Max
-3.0782 -0.6449 -0.1001  0.5439  3.5472

Random effects:

Groups   Name      Variance Std.Dev.
Week    (Intercept) 0.244    0.494

```

Residual 3.837 1.959

Number of obs: 825, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	3.3941	0.2173	38.6794	15.617	<2e-16 ***
EventE8	0.2084	0.1900	808.3996	1.097	0.2730
TimingDuring	5.5608	0.1925	810.0931	28.887	<2e-16 ***
DayD2	0.1280	0.1652	808.6061	0.775	0.4384
DayD3	-0.2924	0.1680	809.8704	-1.740	0.0822 .
EventE8:TimingDuring	-0.3396	0.2733	808.4945	-1.243	0.2144

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	EvntE8	TmngDr	DayD2	DayD3
EventE8		-0.434			
TimingDurng		-0.434	0.486		
DayD2		-0.377	0.013	0.014	
DayD3		-0.380	0.000	0.023	0.482
EvntE8:TmnD		0.300	-0.695	-0.702	-0.019

>

>

```

>
#####
####

> ## distance

> # create a global model

>

> global.model<-lmer(Distance~Event+Timing + Event*Timing + Day +(1|Week), REML =
TRUE, na.action = "na.fail", data = Velocitynew)

>

>

> # create null model

>

> null.model<-lmer(Distance~1+(1|Day),na.action = "na.fail", data = Velocitynew)

>

> # create other models to compare

> d1<- lmer(Distance ~ Event+Timing + Day + (1|Week), data = Velocitynew)

> d2<- lmer( Distance ~ Event*Timing + Day +(1|Week), data = Velocitynew)

> d3<- lmer(Distance ~ 1 + (1|Week), data = Velocitynew)

> d4<- lm(Distance ~ Event + Timing + Day, data = Velocitynew)

> d5<- lmer(Distance ~ Event + Day + (1|Week), data = Velocitynew)

> d6<- lmer(Distance ~ Event + Timing + (1|Week), data = Velocitynew)

> d7<- lmer(Distance ~ Timing + Day + (1|Week), data = Velocitynew)

> AICctab(null.model, d1, d2, d3, d4, d5, d6, d7, nobs = 825, weights = TRUE, base = TRUE,
sort = TRUE)

```

```

      AICc   dAICc  df weight

```

```

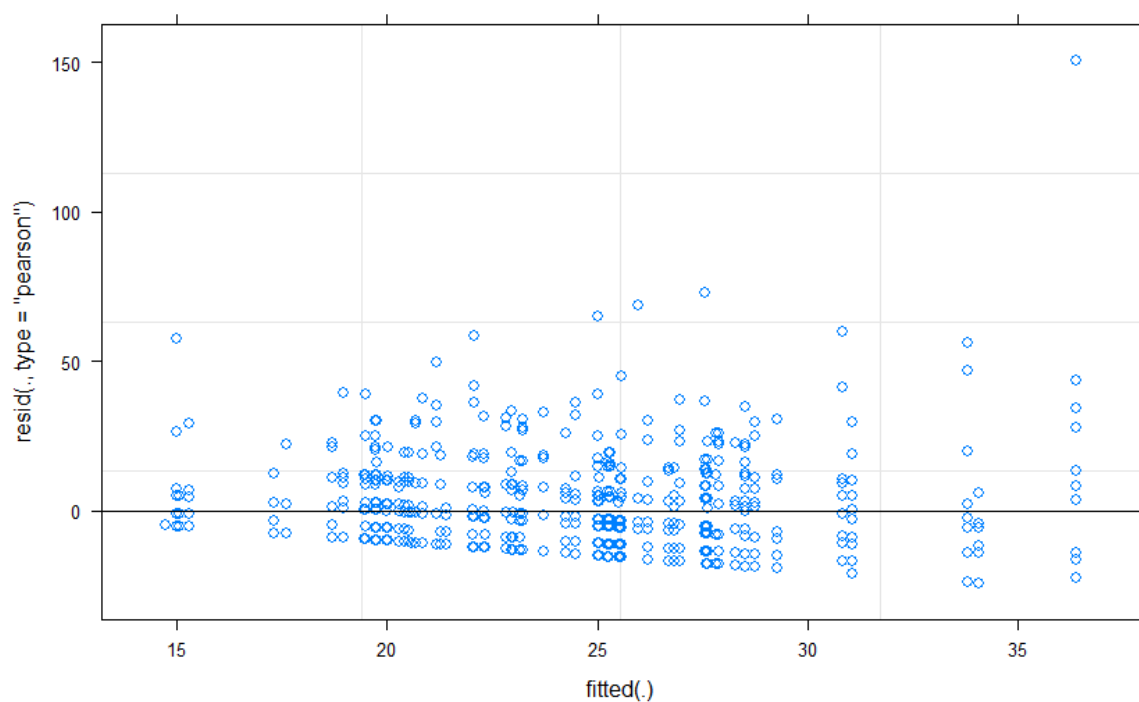
d2      6877.9  0.0 8 0.49
d1      6879.2  1.4 7 0.25
d7      6879.3  1.4 6 0.24
d6      6884.2  6.4 5 0.02
d5      6905.0 27.1 6 <0.001
d3      6910.7 32.9 3 <0.001
d4      6914.3 36.5 6 <0.001
null.model 6936.7 58.8 3 <0.001

```

```
>
```

```
>
```

```
> plot(d7)
```



```
> anova(d7)
```

Type III Analysis of Variance Table with Satterthwaite's method

	Sum Sq	Mean Sq	NumDF	DenDF	F value	Pr(>F)
--	--------	---------	-------	-------	---------	--------

```
Timing 6271.0 6271.0 1 812.55 26.2186 3.809e-07 ***
```

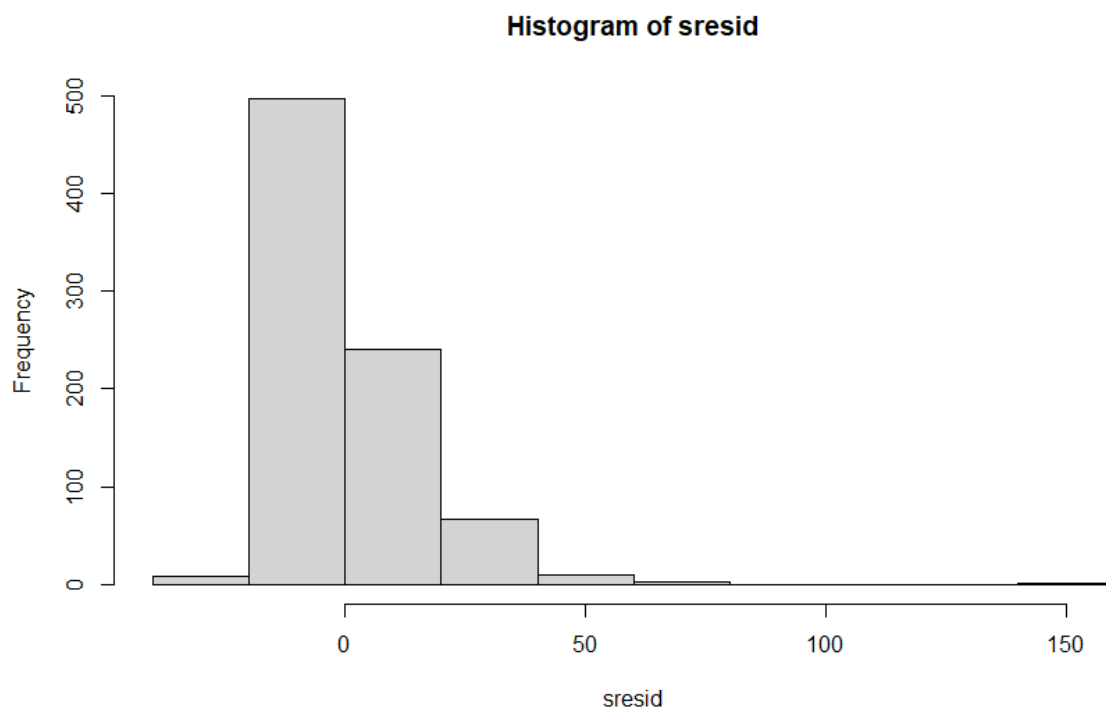
```
Day 1098.2 549.1 2 811.17 2.2958 0.1013
```

```
---
```

```
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
> sresid<-resid(d7, type = "pearson")
```

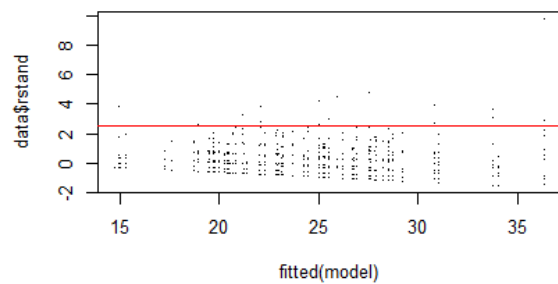
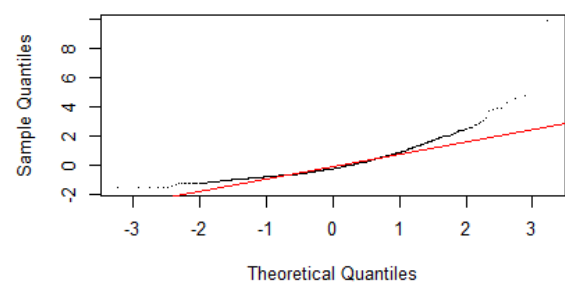
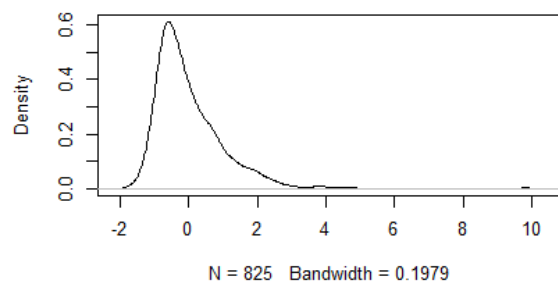
```
> hist(sresid)
```



```
>
```

```
> library(LMERConvenienceFunctions)
```

```
> mcp.fnc(d7)
```



```
> plotLMER.fnc(d7)
```

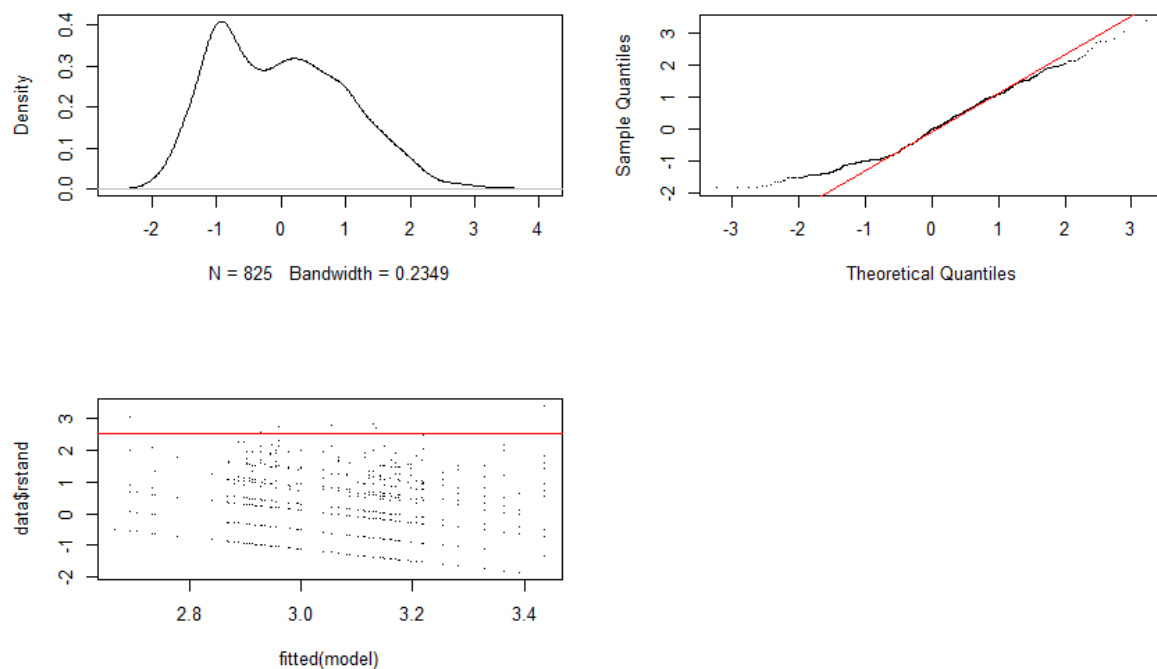
effect size (range) for Timing is 5.540175

effect size (range) for Day is 2.569766

```
>
```

```
> d7<- lmer(log(Distance+1) ~ Timing + Day + (1|Week), data = Velocitynew)
```

```
> mcp.fnc(d7)
```



```
> summary(d7)
```

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: $\log(\text{Distance} + 1) \sim \text{Timing} + \text{Day} + (1 \mid \text{Week})$

Data: Velocitynew

REML criterion at convergence: 1344.1

Scaled residuals:

Min	1Q	Median	3Q	Max
-1.8571	-0.8857	-0.0364	0.7409	3.3608

Random effects:

Groups	Name	Variance	Std.Dev.
Week	(Intercept)	0.01986	0.1409

Residual 0.28618 0.5350

Number of obs: 825, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	2.92206	0.05476	24.53378	53.361	< 2e-16 ***
TimingDuring	0.21636	0.03743	812.35131	5.781	1.06e-08 ***
DayD2	0.04622	0.04510	810.58124	1.025	0.306
DayD3	-0.02704	0.04587	811.79650	-0.589	0.556

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	TmngDr	DayD2
TimingDurng	-0.342		
DayD2	-0.403	0.002	
DayD3	-0.412	0.047	0.482

#creating heatmap for week and day of locations of the fish

creating separate heatmaps for each day

library(ggplot2)

Location <- read.csv("~/Day+X,Y.csv")

m1<-subset(Location, Day == "D1", select = c(X,Y,Freq))

m2<-subset(Location, Day == "D2", select = c(X,Y,Freq))

m3<-subset(Location, Day == "D3", select = c(X,Y,Freq))

```
ggp<-ggplot(m1, aes(Y,X)) + geom_tile(aes(fill = Freq))+
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =
guide_colourbar(barwidth = 2,
```

```
barheight = 13)) +ggtitle("Day 1")
```

```
ggp + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
ggp2<-ggplot(m2, aes(Y,X)) + geom_tile(aes(fill = Freq))+ coord_fixed()+guides(fill =
guide_colourbar(barwidth = 2,
```

```
barheight =
13))+scale_fill_gradient(low = "white", high = "red")+ggtitle("Day 2")
```

```
ggp2 + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
ggp3<-ggplot(m3, aes(Y,X)) + geom_tile(aes(fill = Freq))+ coord_fixed()+guides(fill =
guide_colourbar(barwidth = 2,
```

```
barheight =
13))+scale_fill_gradient(low = "white", high = "red")+ggtitle("Day 3")
```

```
ggp3 + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
#work it out by week
```

```
Location.r <- read.csv("~/Location r.csv")
```

```
df = Location.r
```

```
t<-table(df$X.X.Y., df$Week)
```

```
t
```

```
#write.csv(t, "table.csv")
```

```
df=Location.r
```

```
t3<-table(df$X, df$Y, df$Week)
```

```
t3
```

```
#write.csv(t3, "Week+X,Y.csv")
```

```
Week <- read.csv("~/Week+X,Y.csv")
```

```
#plot for days
```

```
g<-ggplot(Location, aes(Y,X)) + geom_tile(aes(fill = Freq))+  
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =  
guide_colourbar(barwidth = 2,barheight = 13)) + ggtitle("Days")+
```

```
facet_grid(rows = vars(Day))+ scale_y_continuous(breaks=seq(0,6,1))  
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")
```

```
g
```

```
#vertical grid
```

```
g1<-ggplot(Week, aes(Y,X)) + geom_tile(aes(fill = Freq))+  
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =  
guide_colourbar(barwidth = 2,barheight = 13)) + ggtitle("Weeks")+
```

```
facet_grid(~factor(Week, levels = c("W1", "W2", "W3", "W4", "W5", "W6", "W7", "W8",  
"W9", "W10", "W11", "W12")))+ scale_y_continuous(breaks=seq(0,6,1))  
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")
```

```
g1
```

```
# reorder facets
```

```

Week_new<-Week

Week_new$Week<- factor(Week_new$Week, levels =c("W1", "W2", "W3", "W4", "W5",
"W6", "W7", "W8", "W9", "W10", "W11", "W12"))

#horizontal grid

g1<-ggplot(Week_new, aes(Y,X)) + geom_tile(aes(fill = Freq))+ scale_fill_gradient(low =
"white", high = "red")+guides(fill = guide_colourbar(barwidth = 2,barheight = 13)) +
ggtitle("Weeks")+

  facet_grid(Week~.)+                                scale_y_continuous(breaks=seq(0,6,1))
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")

g1

# testing

>

#####
#####

> # randomness test by 95% CI

> Location.r <- read.csv("~/Location r.csv")

> library(report)

Warning message:
package ‘report’ was built under R version 4.0.5

> library(psych)

Attaching package: ‘psych’

```

The following objects are masked from ‘package:ggplot2’:

%+%, alpha

The following objects are masked from 'package:arm':

logit, rescale, sim

```
> lm1<- lm(X~Day, data = Location.r)
```

```
> lm2<- lm(X~Week, data = Location.r)
```

```
> report(lm1)
```

We fitted a linear model (estimated using OLS) to predict X with Day (formula: $X \sim \text{Day}$). The model explains a statistically significant and very weak proportion of variance ($R^2 = 3.94\text{e-}03$, $F(2, 9644) = 19.07$, $p < .001$, adj. $R^2 = 3.73\text{e-}03$). The model's intercept, corresponding to Day = D1, is at 3.40 (95% CI [3.34, 3.47], $t(9644) = 101.44$, $p < .001$). Within this model:

- The effect of Day [D2] is statistically significant and negative (beta = -0.28, 95% CI [-0.37, -0.18], $t(9644) = -5.67$, $p < .001$; Std. beta = -0.14, 95% CI [-0.19, -0.09])

- The effect of Day [D3] is statistically non-significant and negative (beta = -0.03, 95% CI [-0.12, 0.07], $t(9644) = -0.54$, $p = 0.591$; Std. beta = -0.01, 95% CI [-0.06, 0.04])

Standardized parameters were obtained by fitting the model on a standardized version of the dataset. 95% Confidence Intervals (CIs) and p-values were computed using the Wald approximation. Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

2: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

```
> summary(report(lm1))
```

We fitted a linear model to predict X with Day. The model's explanatory power is very weak ($R^2 = 3.94e-03$, adj. $R^2 = 3.73e-03$). The model's intercept is at 3.40 (95% CI [3.34, 3.47]). Within this model:

- The effect of Day [D2] is statistically significant and negative ($\beta = -0.28$, 95% CI [-0.37, -0.18], $t(9644) = -5.67$, $p < .001$, Std. $\beta = -0.14$)

- The effect of Day [D3] is statistically non-significant and negative ($\beta = -0.03$, 95% CI [-0.12, 0.07], $t(9644) = -0.54$, $p = 0.591$, Std. $\beta = -0.01$)

Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

2: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

```
> report(lm2)
```

We fitted a linear model (estimated using OLS) to predict X with Week (formula: $X \sim \text{Week}$). The model explains a statistically significant and very weak proportion of variance ($R^2 = 0.02$, $F(11, 9635) = 17.15$, $p < .001$, adj. $R^2 = 0.02$). The model's intercept, corresponding to Week = W1, is at 3.16 (95% CI [3.00, 3.32], $t(9635) = 38.92$, $p < .001$). Within this model:

- The effect of Week [W10] is statistically non-significant and positive ($\beta = 0.17$, 95% CI [-0.04, 0.37], $t(9635) = 1.58$, $p = 0.114$; Std. $\beta = 0.08$, 95% CI [-0.02, 0.19])

- The effect of Week [W11] is statistically non-significant and positive ($\beta = 0.05$, 95% CI [-0.15, 0.26], $t(9635) = 0.49$, $p = 0.623$; Std. $\beta = 0.03$, 95% CI [-0.08, 0.13])

- The effect of Week [W12] is statistically significant and positive (beta = 0.48, 95% CI [0.27, 0.69], $t(9635) = 4.55$, $p < .001$; Std. beta = 0.24, 95% CI [0.14, 0.35])
- The effect of Week [W2] is statistically non-significant and negative (beta = -0.06, 95% CI [-0.32, 0.19], $t(9635) = -0.48$, $p = 0.632$; Std. beta = -0.03, 95% CI [-0.16, 0.10])
- The effect of Week [W3] is statistically significant and negative (beta = -0.23, 95% CI [-0.45, -7.12e-03], $t(9635) = -2.02$, $p = 0.043$; Std. beta = -0.11, 95% CI [-0.23, -3.61e-03])
- The effect of Week [W4] is statistically significant and positive (beta = 0.43, 95% CI [0.23, 0.64], $t(9635) = 4.15$, $p < .001$; Std. beta = 0.22, 95% CI [0.12, 0.32])
- The effect of Week [W5] is statistically non-significant and positive (beta = 0.07, 95% CI [-0.14, 0.27], $t(9635) = 0.62$, $p = 0.535$; Std. beta = 0.03, 95% CI [-0.07, 0.14])
- The effect of Week [W6] is statistically non-significant and negative (beta = -0.16, 95% CI [-0.36, 0.04], $t(9635) = -1.53$, $p = 0.125$; Std. beta = -0.08, 95% CI [-0.18, 0.02])
- The effect of Week [W7] is statistically significant and positive (beta = 0.44, 95% CI [0.24, 0.64], $t(9635) = 4.32$, $p < .001$; Std. beta = 0.22, 95% CI [0.12, 0.32])
- The effect of Week [W8] is statistically significant and negative (beta = -0.21, 95% CI [-0.41, -1.54e-03], $t(9635) = -1.98$, $p = 0.048$; Std. beta = -0.10, 95% CI [-0.21, -7.80e-04])
- The effect of Week [W9] is statistically significant and positive (beta = 0.55, 95% CI [0.34, 0.76], $t(9635) = 5.20$, $p < .001$; Std. beta = 0.28, 95% CI [0.17, 0.38])

Standardized parameters were obtained by fitting the model on a standardized version of the dataset. 95% Confidence Intervals (CIs) and p-values were computed using the Wald approximation. Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

2: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

```
> summary(report(lm2))
```

We fitted a linear model to predict X with Week. The model's explanatory power is very weak ($R^2 = 0.02$, adj. $R^2 = 0.02$). The model's intercept is at 3.16 (95% CI [3.00, 3.32]). Within this model:

- The effect of Week [W10] is statistically non-significant and positive (beta = 0.17, 95% CI [-0.04, 0.37], $t(9635) = 1.58$, $p = 0.114$, Std. beta = 0.08)
- The effect of Week [W11] is statistically non-significant and positive (beta = 0.05, 95% CI [-0.15, 0.26], $t(9635) = 0.49$, $p = 0.623$, Std. beta = 0.03)
- The effect of Week [W12] is statistically significant and positive (beta = 0.48, 95% CI [0.27, 0.69], $t(9635) = 4.55$, $p < .001$, Std. beta = 0.24)
- The effect of Week [W2] is statistically non-significant and negative (beta = -0.06, 95% CI [-0.32, 0.19], $t(9635) = -0.48$, $p = 0.632$, Std. beta = -0.03)
- The effect of Week [W3] is statistically significant and negative (beta = -0.23, 95% CI [-0.45, -7.12e-03], $t(9635) = -2.02$, $p = 0.043$, Std. beta = -0.11)
- The effect of Week [W4] is statistically significant and positive (beta = 0.43, 95% CI [0.23, 0.64], $t(9635) = 4.15$, $p < .001$, Std. beta = 0.22)
- The effect of Week [W5] is statistically non-significant and positive (beta = 0.07, 95% CI [-0.14, 0.27], $t(9635) = 0.62$, $p = 0.535$, Std. beta = 0.03)
- The effect of Week [W6] is statistically non-significant and negative (beta = -0.16, 95% CI [-0.36, 0.04], $t(9635) = -1.53$, $p = 0.125$, Std. beta = -0.08)
- The effect of Week [W7] is statistically significant and positive (beta = 0.44, 95% CI [0.24, 0.64], $t(9635) = 4.32$, $p < .001$, Std. beta = 0.22)
- The effect of Week [W8] is statistically significant and negative (beta = -0.21, 95% CI [-0.41, -1.54e-03], $t(9635) = -1.98$, $p = 0.048$, Std. beta = -0.10)
- The effect of Week [W9] is statistically significant and positive (beta = 0.55, 95% CI [0.34, 0.76], $t(9635) = 5.20$, $p < .001$, Std. beta = 0.28)Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

2: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

```
> describeBy(X~Day, data = Location.r)
```

Descriptive statistics by group

Day: D1

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
X	1	3448	3.4	1.93	3	3.38	2.97	1	6	5	0.08	-1.53	0.03

Day: D2

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
X	1	3065	3.12	1.93	3	3.03	2.97	1	6	5	0.3	-1.45	0.03

Day: D3

	vars	n	mean	sd	median	trimmed	mad	min	max	range	skew	kurtosis	se
X	1	3134	3.38	2.04	3	3.34	2.97	1	6	5	0.15	-1.63	0.04

```
> summary(lm1)
```

Call:

```
lm(formula = X ~ Day, data = Location.r)
```

Residuals:

Min	1Q	Median	3Q	Max
-2.4020	-2.1246	-0.3759	1.8754	2.8754

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	3.40197	0.03354	101.442	< 2e-16 ***
DayD2	-0.27734	0.04889	-5.673	1.44e-08 ***
DayD3	-0.02609	0.04860	-0.537	0.591

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.969 on 9644 degrees of freedom

(91 observations deleted due to missingness)

Multiple R-squared: 0.003939, Adjusted R-squared: 0.003732

F-statistic: 19.07 on 2 and 9644 DF, p-value: 5.442e-09

```
> mean(X~Day, data = Location.r)
```

```
[1] NA
```

Warning message:

In mean.default(X ~ Day, data = Location.r) :

argument is not numeric or logical: returning NA

```
> summary(lm2)
```

Call:

lm(formula = X ~ Week, data = Location.r)

Residuals:

Min	1Q	Median	3Q	Max
-2.7056	-1.9513	-0.2217	2.0011	3.0694

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	3.15663	0.08111	38.919	< 2e-16 ***
WeekW10	0.16558	0.10477	1.580	0.1140
WeekW11	0.05133	0.10451	0.491	0.6233
WeekW12	0.47985	0.10552	4.548	5.49e-06 ***
WeekW2	-0.06270	0.13091	-0.479	0.6320
WeekW3	-0.22607	0.11170	-2.024	0.0430 *
WeekW4	0.43200	0.10411	4.149	3.36e-05 ***
WeekW5	0.06508	0.10484	0.621	0.5348
WeekW6	-0.15768	0.10290	-1.532	0.1255
WeekW7	0.43941	0.10180	4.317	1.60e-05 ***
WeekW8	-0.20535	0.10398	-1.975	0.0483 *
WeekW9	0.54898	0.10552	5.203	2.00e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 1.955 on 9635 degrees of freedom

(91 observations deleted due to missingness)

Multiple R-squared: 0.01921, Adjusted R-squared: 0.01809

F-statistic: 17.15 on 11 and 9635 DF, p-value: < 2.2e-16

>

>

> lm3<- lm(Y~Day, data = Location.r)

> summary(lm3)

Call:

lm(formula = Y ~ Day, data = Location.r)

Residuals:

Min	1Q	Median	3Q	Max
-14.558	-4.841	2.085	4.442	8.159

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	11.8408	0.1045	113.34	<2e-16 ***
DayD2	2.0744	0.1523	13.62	<2e-16 ***
DayD3	3.7176	0.1514	24.55	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.135 on 9644 degrees of freedom

(91 observations deleted due to missingness)

Multiple R-squared: 0.05931, Adjusted R-squared: 0.05912

F-statistic: 304 on 2 and 9644 DF, p-value: < 2.2e-16

> report(lm3)

We fitted a linear model (estimated using OLS) to predict Y with Day (formula: $Y \sim \text{Day}$). The model explains a statistically significant and weak proportion of variance ($R^2 = 0.06$, $F(2, 9644) = 304.04$, $p < .001$, adj. $R^2 = 0.06$). The model's intercept, corresponding to Day = D1, is at 11.84 (95% CI [11.64, 12.05], $t(9644) = 113.34$, $p < .001$). Within this model:

- The effect of Day [D2] is statistically significant and positive ($\beta = 2.07$, 95% CI [1.78, 2.37], $t(9644) = 13.62$, $p < .001$; Std. $\beta = 0.33$, 95% CI [0.28, 0.38])
- The effect of Day [D3] is statistically significant and positive ($\beta = 3.72$, 95% CI [3.42, 4.01], $t(9644) = 24.55$, $p < .001$; Std. $\beta = 0.59$, 95% CI [0.54, 0.63])

Standardized parameters were obtained by fitting the model on a standardized version of the dataset. 95% Confidence Intervals (CIs) and p-values were computed using the Wald approximation. Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

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Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

>

```
> lm4<-lm(Y~Week, data = Location.r)
```

```
> report(lm4)
```

We fitted a linear model (estimated using OLS) to predict Y with Week (formula: $Y \sim \text{Week}$). The model explains a statistically significant and weak proportion of variance ($R^2 = 0.04$, $F(11, 9635) = 33.80$, $p < .001$, adj. $R^2 = 0.04$). The model's intercept, corresponding to Week = W1, is at 12.40 (95% CI [11.89, 12.90], $t(9635) = 48.13$, $p < .001$). Within this model:

- The effect of Week [W10] is statistically significant and positive (beta = 1.50, 95% CI [0.85, 2.16], $t(9635) = 4.52$, $p < .001$; Std. beta = 0.24, 95% CI [0.13, 0.34])
- The effect of Week [W11] is statistically significant and positive (beta = 2.21, 95% CI [1.56, 2.86], $t(9635) = 6.67$, $p < .001$; Std. beta = 0.35, 95% CI [0.25, 0.45])
- The effect of Week [W12] is statistically significant and positive (beta = 1.01, 95% CI [0.35, 1.67], $t(9635) = 3.01$, $p = 0.003$; Std. beta = 0.16, 95% CI [0.06, 0.26])
- The effect of Week [W2] is statistically significant and positive (beta = 1.22, 95% CI [0.41, 2.04], $t(9635) = 2.94$, $p = 0.003$; Std. beta = 0.19, 95% CI [0.06, 0.32])
- The effect of Week [W3] is statistically significant and positive (beta = 2.20, 95% CI [1.51, 2.90], $t(9635) = 6.20$, $p < .001$; Std. beta = 0.35, 95% CI [0.24, 0.46])
- The effect of Week [W4] is statistically significant and positive (beta = 2.80, 95% CI [2.15, 3.45], $t(9635) = 8.47$, $p < .001$; Std. beta = 0.44, 95% CI [0.34, 0.55])
- The effect of Week [W5] is statistically significant and negative (beta = -1.37, 95% CI [-2.02, -0.72], $t(9635) = -4.12$, $p < .001$; Std. beta = -0.22, 95% CI [-0.32, -0.11])
- The effect of Week [W6] is statistically non-significant and positive (beta = 0.48, 95% CI [-0.16, 1.12], $t(9635) = 1.48$, $p = 0.138$; Std. beta = 0.08, 95% CI [-0.02, 0.18])
- The effect of Week [W7] is statistically significant and positive (beta = 2.85, 95% CI [2.22, 3.48], $t(9635) = 8.82$, $p < .001$; Std. beta = 0.45, 95% CI [0.35, 0.55])

- The effect of Week [W8] is statistically significant and positive (beta = 1.74, 95% CI [1.09, 2.39], $t(9635) = 5.27$, $p < .001$; Std. beta = 0.27, 95% CI [0.17, 0.38])
- The effect of Week [W9] is statistically non-significant and positive (beta = 0.49, 95% CI [-0.16, 1.15], $t(9635) = 1.48$, $p = 0.140$; Std. beta = 0.08, 95% CI [-0.03, 0.18])

Standardized parameters were obtained by fitting the model on a standardized version of the dataset. 95% Confidence Intervals (CIs) and p-values were computed using the Wald approximation. Warning messages:

1: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

2: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

3: 'data_findcols()' is deprecated and will be removed in a future update.

Its usage is discouraged. Please use 'data_find()' instead.

> summary(lm4)

Call:

lm(formula = Y ~ Week, data = Location.r)

Residuals:

Min	1Q	Median	3Q	Max
-14.249	-4.883	1.862	5.378	8.972

Coefficients:

Estimate	Std. Error	t value	Pr(> t)
----------	------------	---------	----------

```

(Intercept) 12.3993 0.2576 48.133 < 2e-16 ***
WeekW10 1.5029 0.3328 4.516 6.36e-06 ***
WeekW11 2.2143 0.3319 6.671 2.68e-11 ***
WeekW12 1.0095 0.3351 3.012 0.00260 **
WeekW2 1.2222 0.4158 2.940 0.00329 **
WeekW3 2.2010 0.3548 6.204 5.73e-10 ***
WeekW4 2.8014 0.3307 8.472 < 2e-16 ***
WeekW5 -1.3716 0.3330 -4.119 3.84e-05 ***
WeekW6 0.4842 0.3268 1.482 0.13849
WeekW7 2.8502 0.3233 8.815 < 2e-16 ***
WeekW8 1.7391 0.3302 5.266 1.42e-07 ***
WeekW9 0.4946 0.3351 1.476 0.14001

```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 6.209 on 9635 degrees of freedom

(91 observations deleted due to missingness)

Multiple R-squared: 0.03715, Adjusted R-squared: 0.03605

F-statistic: 33.8 on 11 and 9635 DF, p-value: < 2.2e-16

>

>

```

#####
#####

```

> # Latency data

```

> # reporting lmm

> # load data

> Latency <- read.csv("~/Latency brown trout MSc with type of stimulus.csv")

> Latency.event <- read.csv("~/Behaviour experiment/Latency event.csv")

> library(nlme)

> library(lmerTest)

> library(lme4)

> library(MuMIn)

> # test model using bbmle packae

>

> # create a global model

>

> global.model<-lmer(latency~Event + Event*Day + Day +(1|Week), REML = TRUE,
na.action = "na.fail", data = Latency.event)

>

> # create null model

>

> null.model<-lmer(latency~1+(1|Day),na.action = "na.fail", data = Latency.event)

>

> # create other models to compare

> l1<- lmer(latency~Event + Day + (1|Week), data = Latency.event)

> l2<- lmer(latency ~Event*Day +(1|Week), data = Latency.event)

> l3<- lmer(latency ~ 1 + (1|Week), data = Latency.event)

> l4<- gls(latency ~ Event, data = Latency.event)

> l7<- lmer (latency ~ Day + (1|Week), data = Latency.event)

```

```
> AICctab(null.model, l1, l2, l3, l4, l7, nobs = 398, weights = TRUE, base = TRUE, sort = TRUE)
```

	AICc	dAICc	df	weight
l2	1160.3	0.0	8	0.846
l7	1164.3	4.0	5	0.115
l1	1166.4	6.1	6	0.039
l3	1202.6	42.3	3	<0.001
null.model	1232.4	72.1	3	<0.001
l4	1258.8	98.5	3	<0.001

```
>
```

```
>
```

```
> anova(l2)
```

Type III Analysis of Variance Table with Satterthwaite's method

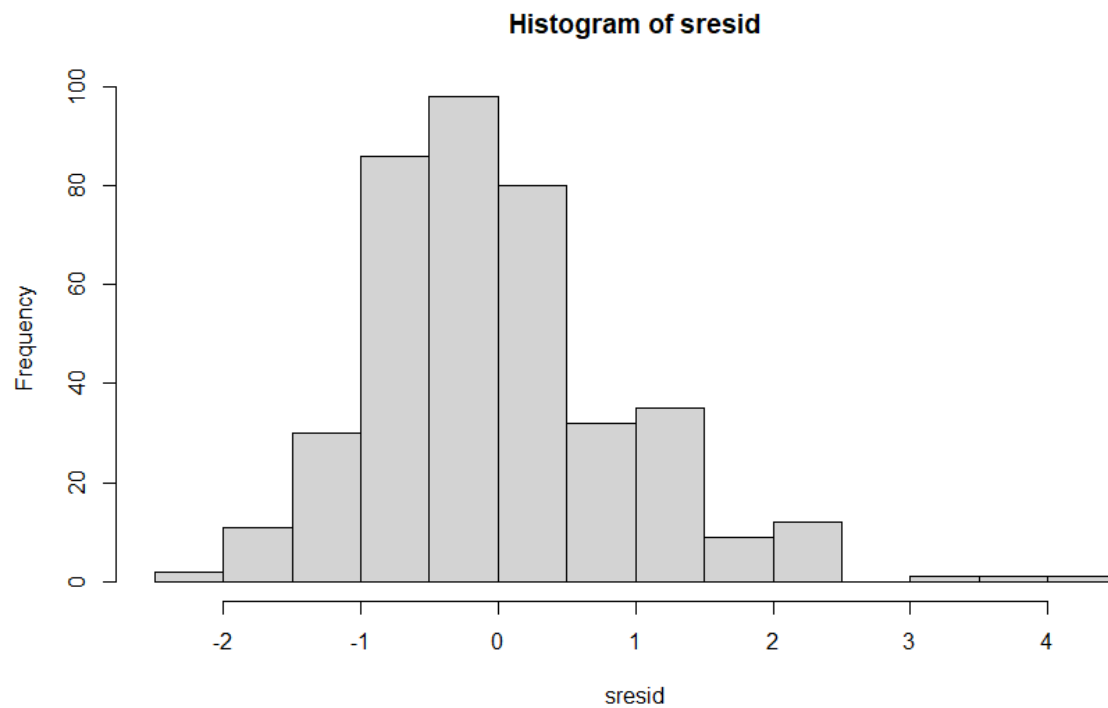
	Sum Sq	Mean Sq	NumDF	DenDF	F value	Pr(>F)
Event	2.026	2.0260	1	381.89	2.1348	0.144814
Day	47.049	23.5244	2	382.58	24.7878	7.54e-11 ***
Event:Day	12.099	6.0493	2	381.79	6.3742	0.001892 **

```
---
```

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

```
> sresid<-resid(l2, type = "pearson")
```

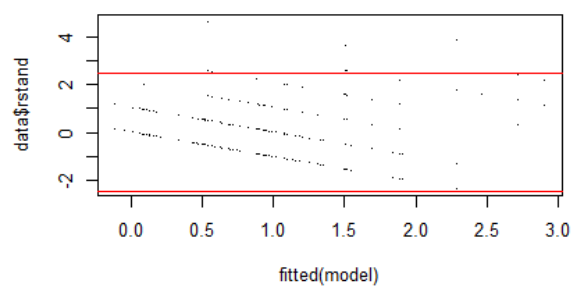
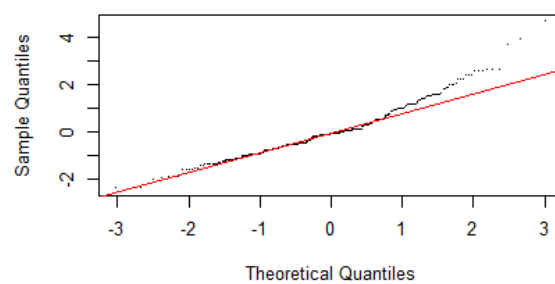
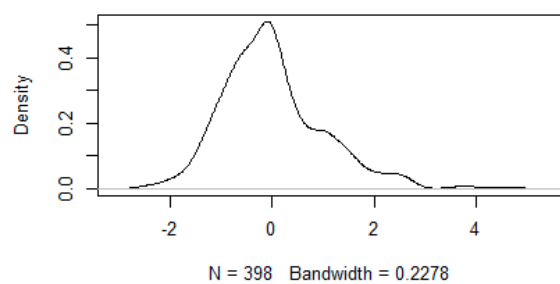
```
> hist(sresid)
```



✓

```
> library(LMERConvenienceFunctions)
```

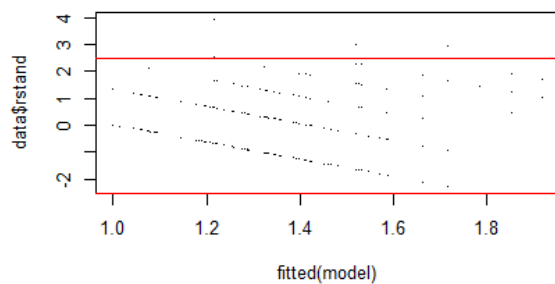
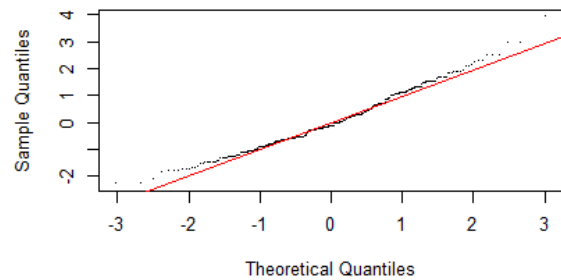
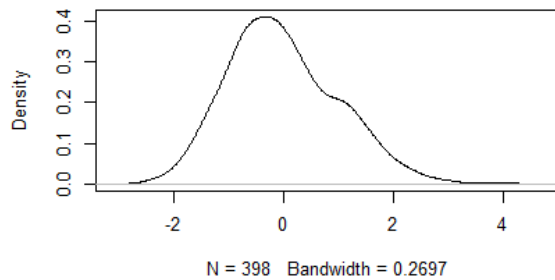
```
> mcp.fnc(l2)
```



```
> l2<- lmer(sqrt(latency+1) ~Event*Day +(1|Week), data = Latency.event)
```

```
>
```

```
> mcp.fnc(l2)
```



```
>
```

```
> summary(l2)
```

Linear mixed model fit by REML. t-tests use Satterthwaite's method ['lmerModLmerTest']

Formula: $\sqrt{\text{latency} + 1} \sim \text{Event} * \text{Day} + (1 | \text{Week})$

Data: Latency.event

REML criterion at convergence: 269.6

Scaled residuals:

Min	1Q	Median	3Q	Max
-2.2453	-0.6661	-0.1376	0.6385	3.8539

Random effects:

Groups	Name	Variance	Std.Dev.
Week	(Intercept)	0.02765	0.1663
Residual		0.10246	0.3201

Number of obs: 398, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	df	t value	Pr(> t)
(Intercept)	1.16857	0.06105	22.57817	19.140	1.89e-15 ***
EventE8	0.01676	0.05335	380.80730	0.314	0.75355
DayD2	0.14624	0.05488	382.49921	2.665	0.00803 **
DayD3	0.28239	0.05560	382.61605	5.079	5.94e-07 ***
EventE8:DayD2	0.18467	0.07668	381.72393	2.408	0.01649 *
EventE8:DayD3	-0.08511	0.08017	381.64569	-1.062	0.28912

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr)	EvntE8	DayD2	DayD3	EE8:DD2
EventE8		-0.437			
DayD2		-0.425	0.486		
DayD3		-0.419	0.480	0.478	
EvntE8:DyD2		0.304	-0.696	-0.716	-0.342

```
EvntE8:DyD3 0.291 -0.665 -0.323 -0.686 0.464
```

```
>
```

```
#####  
#####
```

```
# Proportion of fish visible
```

```
> # Proportion of fish visible generalised linear mixed model
```

```
>
```

```
>
```

```
> # load data
```

```
> Proportion <- read.csv("~/Proportion of fish under cover .csv")
```

```
> Proportionnew<- read.csv("~/Behaviour experiment/Proportion$event.csv")
```

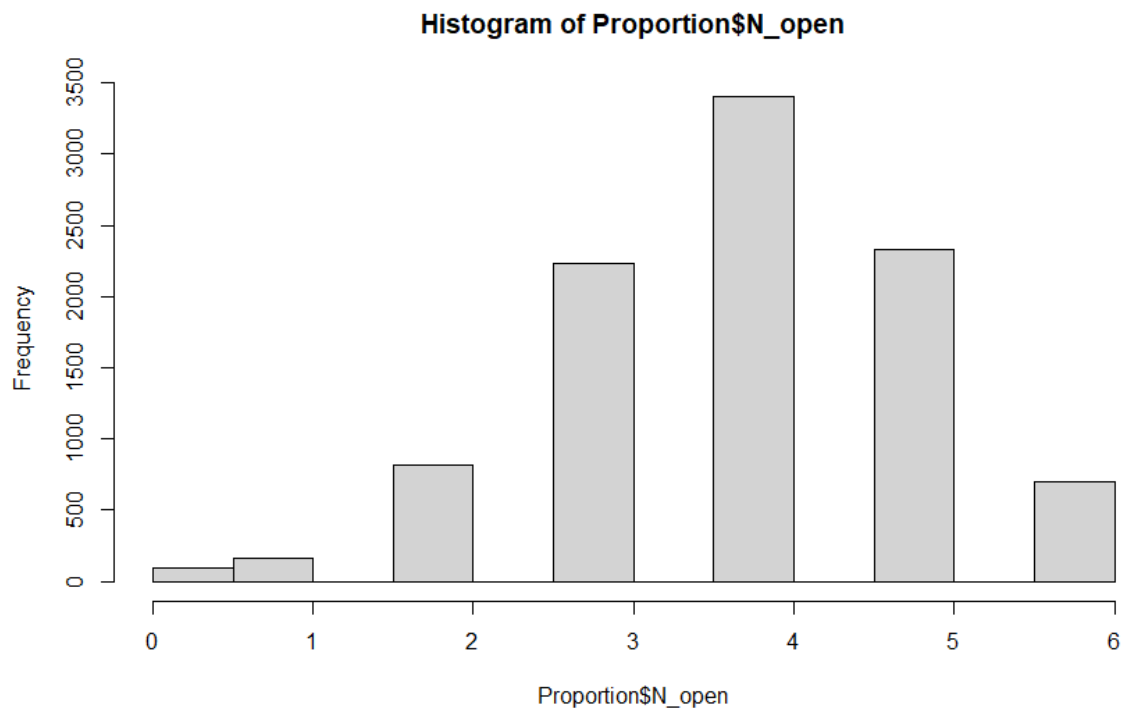
```
>
```

```
> # Checking distribution of data
```

```
> # plot histogram
```

```
>
```

```
> p <- hist(Proportion$N_open,)
```



> # p looks normal

> attach(Proportionnew)

The following objects are masked `_by_` .GlobalEnv:

Location, Week

The following objects are masked from Proportionnew (pos = 3):

Date, Day, Event, Location, N_cover, N_open, N_total, Observation, Percentage, Stressor,
Time, Timing,

Week, X, X.1, Y

The following objects are masked from Proportionnew (pos = 11):

Date, Day, Event, Location, N_cover, N_open, N_total, Observation, Percentage, Stressor,
Time, Timing,

Week, X, X.1, Y

>

> # combine the two columns for the model

>

> prop<-cbind(N_open, N_cover)

>

> library(lme4)

> library(lmerTest)

> # create global model

>

> model1<-glmer(prop~Event + Timing + Event*Timing + Day + (1|Week), family =
binomial, na.action = "na.fail", data = Proportionnew)

>

>

> #

> # create null model

>

> model.null1<-glmer(prop~1+(1|Day), family = binomial, na.action = "na.fail", data =
Proportionnew)

>

> #rank the models by AICc

>

```

> # create other models to compare

> p1<- glmer(prop~Event+Timing + Day + (1|Week), family = binomial,na.action = "na.fail",
data = Proportionnew)

> p2<- glmer(prop ~Event*Timing + Day +(1|Week), family = binomial,na.action =
"na.fail",data = Proportionnew)

> p3<- glmer(prop ~ 1 + (1|Week), family = binomial,na.action = "na.fail",data =
Proportionnew)

> p4<- glm(prop ~ Event + Timing + Day, family = binomial,na.action = "na.fail",data =
Proportionnew)

> p5<- glmer(prop ~ Event + Day + (1|Week),family = binomial, na.action = "na.fail",data =
Proportionnew)

> p6<- glmer(prop ~ Event + Timing + (1|Week), family = binomial,na.action = "na.fail",data
= Proportionnew)

> p7<- glmer (prop ~ Timing + Day + (1|Week), family = binomial,na.action = "na.fail",data
= Proportionnew)

> AICctab(model.null1, p1, p2, p3, p4, p5 ,p6, p7,  nobs = 2895, weights = TRUE, base =
TRUE, sort = TRUE)

```

	AICc	dAICc	df	weight
p1	8507.5	0.0	7	0.7939
p2	8510.3	2.8	9	0.1993
p7	8517.1	9.6	6	0.0066
p5	8525.0	17.5	5	<0.001
p6	8539.6	32.1	5	<0.001
p3	8577.5	70.0	2	<0.001
p4	8838.9	331.4	6	<0.001
model.null1	8883.0	375.5	2	<0.001

```

>

```

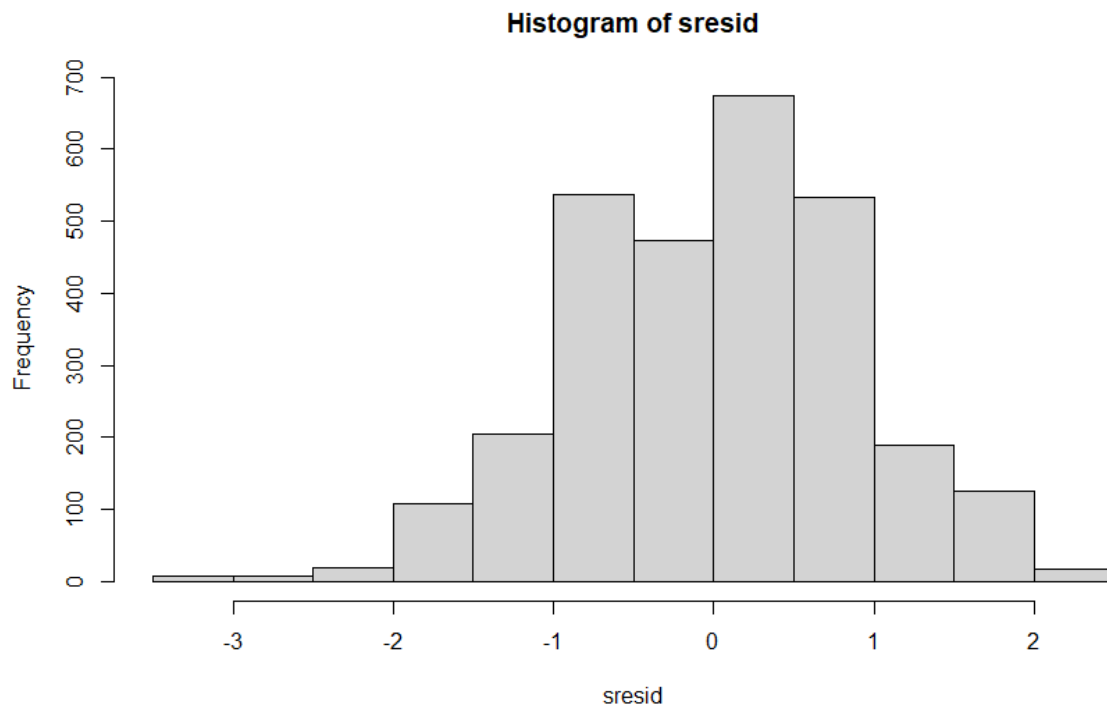
```
> anova(p1)
```

Analysis of Variance Table

	np	Sum Sq	Mean Sq	F value
Event	1	21.754	21.754	21.754
Timing	2	21.987	10.994	10.994
Day	2	36.002	18.001	18.001

```
> sresid<-resid(p1, type = "pearson")
```

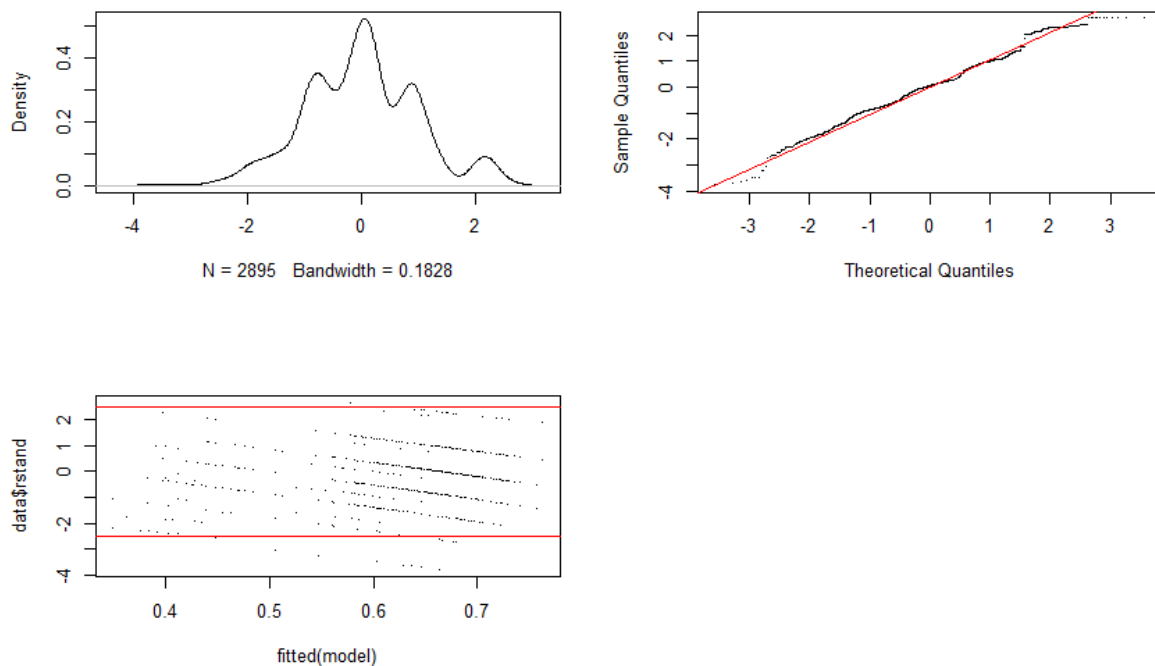
```
> hist(sresid)
```



```
>
```

```
> library(LMERConvenienceFunctions)
```

```
> mcp.fnc(p1)
```



```
> plotLMER.fnc(p1)
```

log odds are back-transformed to probabilities

effect size (range) for Event is 0.02732472

effect size (range) for Timing is 0.04282541

effect size (range) for Day is 0.05613623

```
> summary(p1)
```

Generalized linear mixed model fit by maximum likelihood (Laplace Approximation)
[`glmerMod`]

Family: binomial (logit)

Formula: $\text{prop} \sim \text{Event} + \text{Timing} + \text{Day} + (1 \mid \text{Week})$

Data: Proportionnew

AIC	BIC	logLik	deviance	df.resid
8507.5	8549.3	-4246.7	8493.5	2888

Scaled residuals:

Min	1Q	Median	3Q	Max
-3.4462	-0.6512	0.0429	0.6900	2.1764

Random effects:

Groups Name	Variance	Std.Dev.
-------------	----------	----------

Week (Intercept)	0.1325	0.364
------------------	--------	-------

Number of obs: 2895, groups: Week, 12

Fixed effects:

	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	0.42075	0.11175	3.765	0.000167 ***
EventE8	0.11571	0.03399	3.404	0.000664 ***
TimingDuring	0.18289	0.04149	4.408	1.04e-05 ***
TimingPost	0.15369	0.04165	3.690	0.000224 ***
DayD2	-0.23007	0.03982	-5.777	7.59e-09 ***
DayD3	-0.16759	0.03946	-4.247	2.16e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Correlation of Fixed Effects:

	(Intr) EvntE8	TmngDr	TmngPs	DayD2
EventE8	-0.082			

TimingDurng -0.174 -0.192

TimingPost -0.158 -0.314 0.560

DayD2 -0.161 -0.039 0.012 -0.025

DayD3 -0.175 0.008 0.021 0.010 0.493

#####

####

plot proportions over day and event

Proportionnew <- read.csv("~/Behaviour experiment/Proportion event.csv")

library(ggplot2)

Prop<-ggplot(Proportionnew, aes(Stressor, Percentage, fill = Event))+geom_boxplot()+facet_grid(.~Day)+ylab("Percentage visible (%)")

Prop

Prop2<-ggplot(Proportionnew, aes(Timing, Percentage, fill = Event)) +
geom_boxplot()+facet_grid(.~Day)+ylab("Percentage visible (%)")

Prop2

#####

####

plots for Velocity and Distance

Velocity <- read.csv("~/Velocity and distance for r.csv")

library(dplyr)

```
Velocitynew<-subset(Velocity, Event == "E1", select = c("Velocity","Stressor", "Day"))
```

```
Velocitynew <- read.csv("~/Behaviour experiment/Velocity$event.csv")
```

```
velocity<-ggplot(Velocitynew, aes(Stressor, Velocity, fill = Event))+geom_violin()+facet_grid(Day~ Timing)+ylab("Velocity (cm/s)")
```

```
velocity
```

```
disturbance<-ggplot(Velocitynew, aes(Stressor, Distance, fill = Event))+geom_violin()+facet_grid(Day ~ Timing)+ylab("Distance (cm)")
```

```
disturbance
```

```
# plots for location of fish
```

```
#creating heatmap for week and day of locations of the fish
```

```
# creating separate heatmaps for each day
```

```
library(ggplot2)
```

```
Location <- read.csv("~/Day+X,Y.csv")
```

```
m1<-subset(Location, Day == "D1", select = c(X,Y,Freq))
```

```
m2<-subset(Location, Day == "D2", select = c(X,Y,Freq))
```

```
m3<-subset(Location, Day == "D3", select = c(X,Y,Freq))
```

```
ggp<-ggplot(m1, aes(Y,X)) + geom_tile(aes(fill = Freq))+  
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =  
guide_colourbar(barwidth = 2,
```

```
barheight = 13)) +ggtitle("Day 1")
```

```
ggp + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
ggp2<-ggplot(m2, aes(Y,X)) + geom_tile(aes(fill = Freq))+ coord_fixed()+guides(fill =
guide_colourbar(barwidth = 2,
barheight
=
13))+scale_fill_gradient(low = "white", high = "red")+ggtitle("Day 2")
ggp2 + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
ggp3<-ggplot(m3, aes(Y,X)) + geom_tile(aes(fill = Freq))+ coord_fixed()+guides(fill =
guide_colourbar(barwidth = 2,
barheight
=
13))+scale_fill_gradient(low = "white", high = "red")+ggtitle("Day 3")
ggp3 + scale_y_continuous(breaks=seq(0,6,1)) +scale_x_continuous(breaks=seq(0,20,1))
```

```
#work it out by week
```

```
Location.r <- read.csv("~/Location r.csv")
```

```
df = Location.r
```

```
t<-table(df$X.X.Y., df$Week)
```

```
t
```

```
#write.csv(t, "table.csv")
```

```
df=Location.r
```

```
t3<-table(df$X, df$Y, df$Week)
```

t3

```
#write.csv(t3, "Week+X,Y.csv")
```

```
Week <- read.csv("~/Week+X,Y.csv")
```

```
#plot for days
```

```
g<-ggplot(Location, aes(Y,X)) + geom_tile(aes(fill = Freq))+  
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =  
guide_colourbar(barwidth = 2,barheight = 13)) + ggtitle("Days")+
```

```
facet_grid(rows = vars(Day))+ scale_y_continuous(breaks=seq(0,6,1))  
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")
```

g

```
#vertical grid
```

```
g1<-ggplot(Week, aes(Y,X)) + geom_tile(aes(fill = Freq))+  
coord_fixed()+scale_fill_gradient(low = "white", high = "red")+guides(fill =  
guide_colourbar(barwidth = 2,barheight = 13)) + ggtitle("Weeks")+
```

```
facet_grid(~factor(Week, levels = c("W1", "W2", "W3", "W4", "W5", "W6", "W7", "W8",  
"W9", "W10", "W11", "W12")))+ scale_y_continuous(breaks=seq(0,6,1))  
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")
```

g1

```
# reorder facets
```

```
Week_new<-Week
```

```
Week_new$Week<- factor(Week_new$Week, levels =c("W1", "W2", "W3", "W4", "W5",  
"W6", "W7", "W8", "W9", "W10", "W11", "W12") )
```

```
#horizontal grid
```

```

g1<-ggplot(Week_new, aes(Y,X)) + geom_tile(aes(fill = Freq))+ scale_fill_gradient(low =
"white", high = "red")+guides(fill = guide_colourbar(barwidth = 2,barheight = 13)) +
ggtitle("Weeks")+

    facet_grid(Week~.)+                                scale_y_continuous(breaks=seq(0,6,1))
+scale_x_continuous(breaks=seq(0,20,1))+xlab("X")+ylab("Y")

g1

# Plots for latency

Latency.event <- read.csv("~/Behaviour experiment/Latency event.csv")

p<-ggplot(Latency.event, aes(x=Stressor, y=latency

    , fill=Event)) +

geom_violin()+ labs(

    title = "Latency",

    x = "Stressor",

    y = "Latency (s)"

)+facet_wrap(~Day)

P

```

Table 2.1. Functions and packages used in R to analyse the open comments from question 13.

	Functions			
Packages	Analysing sentiment with BING lexicon	Analysing emotion and sentiment with syuzhet lexicon	Analysing most used words	Analysing word relationships
<i>ggplot2</i>	<i>geom_col</i> – plots a column chart			
<i>tidytext</i>	<i>unnest_tokens</i> – splits a column into single words			<i>stop_words</i> – used to remove words that do not add meaning to sentences
<i>dplyr</i>	<i>anti_join</i> – returns all rows in one data frame that does not match values in other dataset			<i>distinct</i> – remove duplicate rows
	<i>get_sentiments</i> – apply sentiment from bing lexicon			
	<i>inner_join</i> – merged data frame without stop words and data frame with sentiment from bing			<i>anti_join</i>

	<i>count</i> – computed sentiment counts for each user group			
	<i>mutate</i> – deduct negative sentiment from positive			
<i>tidyr</i>	<i>spread</i> – changed data frame from long to wide format			
<i>stopwords</i>	<i>get_stopwords</i> – get stop words from stopwords package			
<i>widyr</i>				<i>pairwise_cor</i> – find the correlation of words
<i>syuzhet</i>		<i>get_nrc_sentiment</i> – gets emotions and valence from syuzhet lexicon		
		<i>review_sentiment</i> – review sentiment of words		
<i>tm</i>			<i>Corpus</i> – creates a text document for text mining	

			<i>TermDocumentMatrix</i> – works out the frequency of words used	
			<i>tm_map</i> – cleaned up the text document	
<i>ggraph</i>				<i>geom_node</i> – draws nodes of the word network