Habitats and Biodiversity in the Crane Catchment

Smarter Water Catchments Initiative

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Contents

1. Introduction

1.1. Background

The Crane Catchment consists of eight rivers and streams: the River Crane, Yeading Brook East, Yeading Brook West, Upper Duke of Northumberland's River, Lower Duke of Northumberland's River, the Longford River, Whitton Brook, and Portlane Brook. These rivers span five London Boroughs: Harrow, Hillingdon, Ealing, Hounslow and Richmond. There is a total of about 60km of river corridors in the catchment, along which there are parks, fields, walking trails, natural areas, etc., much of which is accessible to the public. In addition to open and green spaces, there are several main highways that intersect the catchment, along with many smaller roads, urban and suburban areas. Heathrow Airport, the UK's largest airport, also falls within the catchment area.

The catchment and its river system have benefitted from numerous organisations and associated projects aimed at improving water quality, green spaces, biodiversity, and access to the river. At the heart of these efforts is the Crane Valley Partnership, which brings together charities, businesses, community groups, etc. to collectively improve this catchment. Their efforts are aimed at protecting and restoring the Crane Valley's habitats and associated biodiversity, as well as creating more opportunities for people to enjoy these natural spaces.

The Crane Catchment supports a rich, biodiverse ecosystem and provides precious access to nature to nearby communities. Systematic monitoring undertaken by the Environment Agency has identified 17 species of fish within the catchment. Expanding this number to include other records, there have been 26 species of recorded. Systematic EA monitoring has also identified over 300 species of aquatic invertebrates in the catchment. Along the catchment's waterbodies, there is a mosaic of habitats, including eight UK priority habitat types. These diverse habitats can support thousands of species of terrestrial plants and animals. Some of these plants and animals are threatened in the UK, and therefore their presence reflects the ecological value of the Crane catchment.

As an urban catchment, the habitats and biodiversity of the Crane Valley face various anthropogenic pressures. Threats include water pollution, habitat loss and degradation, air pollution, noise pollution, connectivity loss, invasive species, among others. A better understanding of the species that are present in the catchment area, their distribution, and the threats they currently face will help to target future conservation efforts.

This report, written by ZSL on behalf of the Citizen Crane project, is part of the Smarter Water Catchment Programme's baseline evidence gathering to inform future actions by Crane Valley Partnership partners. Within this report, we use existing species and habitat data to provide this baseline understanding. However, it is important to note that the findings have not yet been checked by local experts and stakeholders to ground truth. It is also possible that outstanding data exists that has not been included here. Next steps will involve consulting local experts to help interpret these findings and identify any missing data to be included in this baseline analysis.

1.2. Aims of report

This report aims to:

1. collate and review the available data on habitats and key species within the river corridors of the Crane catchment,
2. identify habitats and species data gaps and priorities for additional surveys and investigations, and
3. present the data in a report and send to stakeholders for the next steps of data ground truthing and identification of priority actions needed to enhance the wildlife of the river corridors.

2. Methods

2.1. Study area

The study area, shown in Figure 1, encompasses both the in-channel and terrestrial areas surrounding the rivers in the Crane catchment. Habitat and species data were collected for the river corridor, considered to be 50m either side of the channel, and from Sites of Importance for Nature Conservation (SINCs) and Open Space that adjoin the rivers.

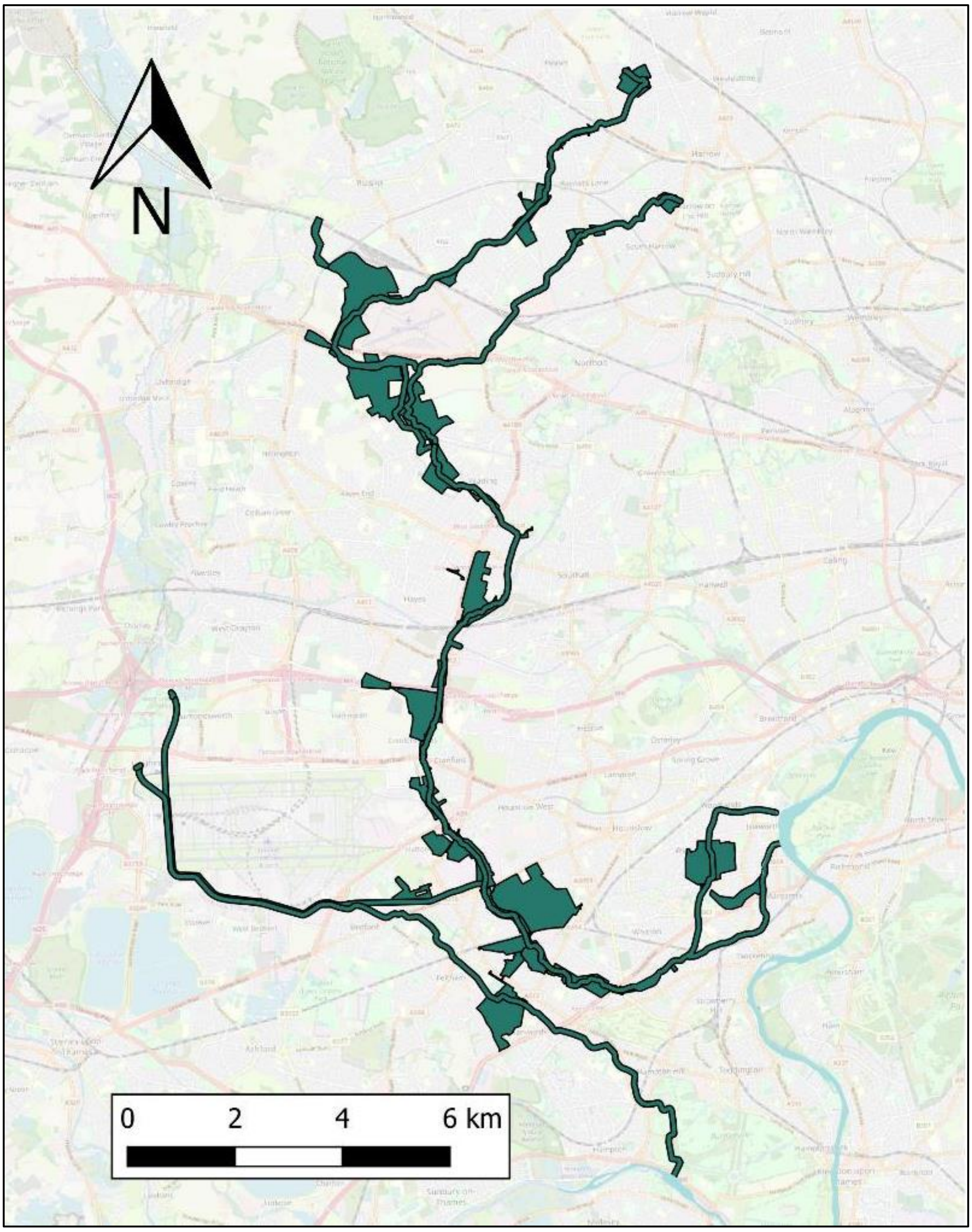


Figure 1: Biodiversity and habitats study area in the Crane catchment.

2.2. Data gathering

Emails were sent out to borough ecological officers, wildlife specialists, Heathrow ecological officers, and all Crane Valley Partnership members asking for anyone with relevant data to please get in touch. The responses received all said that data is stored in GIGL. For a list of those contacted, please see Appendix II.

Table 1: Primary sources of data, along with the subject they covered, and how they were accessed.

Source	Data subject	Accessibility
Environment Agency	Freshwater invertebrates, freshwater fish, macrophytes	Open access at https://environment.data.gov.uk/ecology/explorer/
Greenspace Information for Greater London (GIGL)	Terrestrial species presence, terrestrial species absence, habitats, designated areas	Licensed access as agreed between GIGL and Thames Water (See Appendix I for a full list of organisations that submit environmental records to GIGL)
Zoological Society of London	Eel monitoring data, hedgehog habitat suitability	Internal access
Citizen Crane	Riverfly Monitoring Initiative data	Internal access
Centre for Ecology and Hydrology	Land cover map 2015 (1990-2020 available with appropriate license)	License required. More information at https://www.ceh.ac.uk/ukceh-land-cover-maps
Friends of the River Crane Environment (FORCE)	Reports on water voles and bats in the catchment (reports covering other topics are available, but only these included in this report)	Open access at https://www.force.org.uk/wildlife/wildlife-surveys/

2.3. Analysis

All mapping was carried out in QGIS3, the free mapping software. Data analysis and graphics were conducted using R 4.1.1, a free software environment for statistical computing and graphics (R Core Team 2021). Analyses for each dataset are explained throughout the report, with the results and interpretation relevant to each analysis immediately following.

3. In-channel species

3.1. Water Framework Directive (WFD) classifications

3.1.1. Analysis

The WFD classifications for fish and invertebrates were researched and reported. These assessments are designed to monitor the status of water bodies in different aspects of environmental health using routinely collected data. These results were compared to results in the fish and aquatic invertebrate sections of this report.

3.1.2. Results and discussion

The WFD classifications for fish and invertebrates follow a qualitative scale with five possible categories: Bad, Poor, Moderate, Good and High. The ecological and biological classifications are based on results from multiple elements. The fish and invertebrate classifications use the EA monitoring data analysed later in this report, which follow a standardised methodology. The species and their associated abundance caught in these samples are then compared to expected catches based on the type of river using a metric called the Ecological Quality Ratio (UK Technical Advisory Group (WFD-UKTAG) 2008). Based on the resulting value of this metric, the element is then assigned a classification category.

Two major pollution events have taken place in the Crane Catchment, the first in 2011, followed by another in 2013. The 2011 incident was a direct result of infrastructure failure during routine maintenance by Thames Water at an outfall where the A4 road crosses the Crane River in Cranford (Gray 2013). Untreated sewage was discharged into the river, and it is estimated that during the incident, all river invertebrates and over 10,000 fish were killed. This pollution event is believed to have devastated the aquatic life on the Crane for 20km downstream of the source, with different ages and species of fish being impacted, including mature eels, pike and carp (FORCE 2011; Gray 2013). The pollution event in 2013 occurred due to work at a site in Cranford resulting in the fracturing of a pipe that was transporting sewage sludge between two sewage works, causing significant fish kills but with invertebrate communities not impacted as badly as they were during the previous event. The impacts of these two events are reflected in the WFD classification for River Crane. For this reason, the baseline classification for fish in the River Crane from 2013-2015 is 'Poor'.

Table 2: River Crane WFD classifications for ecological, biological, fish and invertebrates 2013-2019 (Environment Agency 2022a).

Classification Item	2013	2014	2015	2016	2019
Ecological	Poor	Poor	Poor	Poor	Moderate
Biological quality elements	Poor	Poor	Poor	Poor	Moderate
Fish	Poor	Poor	Poor	Moderate	Moderate
Invertebrates	Poor	Moderate	Moderate	Moderate	Moderate

The WFD classification for fish on the River Crane improved from ʼPoor ʼto ʼModerate ʼbetween 2015 and 2016. Invertebrates improved from ʼPoor ʼto ʼModerate ʼbetween 2013 and 2014. These improvements align with the results found in this report's analysis of EA monitoring data. It is also expected that improvements in invertebrate populations are seen first in a recovering ecosystem, followed by fish populations.

The Yeading Brook is located upstream of the pollution events, so was no impacted

Table 3: Yeading Brook WFD classifications for ecological, biological, and invertebrates 2013-2019 (Environment Agency 2022b).

Classification Item	2013	2014	2015	2016	2019
Ecological	Moderate	Moderate	Moderate	Moderate	Moderate
Biological quality elements	Poor	Poor	Poor	Poor	Poor
Invertebrates	Poor	Poor	Poor	Poor	Poor

Due to the lack of monitoring for fish on the Yeading Brook, this element was not assessed by the WFD. The reason for the lack of monitoring is unknown. Invertebrates on the Yeading Brook have been classified as 'Poor' since 2013, with no improvements noted. Based on the low scores across all invertebrate index values at Yeading Brook sampling locations (Table 3 above), this 'Poor' classification is to be expected.

WFD monitoring has ensured the collection of data at long-term monitoring sites, using standardised methodology. This allows us to observe changes in the freshwater fish and invertebrate communities and understand how freshwater ecology has been impacted by environmental threats. Monitoring of invertebrates has been consistent and will continue in the catchment. However, EA resources have been reduced over recent years, which means much of the routine fish monitoring has been cut. Many of the sites in the catchment haven't been monitored for fish since 2016. Encouragingly, there are plans to return to these sites and continue monitoring. According to the EA fisheries team, three sites on the River Crane are due to be surveyed for fish this year, as they are on a six-year sampling cycle (Phil Belfield, pers. comm.). However, the monitoring programme for this year has not yet been confirmed. For this reason, it is important to maintain clear and close communication with the EA's fisheries team in the catchment, to understand their plans and coordinate efforts.

3.2. *Environment Agency freshwater fish data*

3.2.1. Analysis

Data were limited to those collected by electrofishing and catch per unit effort (CPUE) was calculated for each sample using a species 'abundance and fishing area. Results from the first run of electrofishing were used, because the number of runs differed by sample. The run number can affect the number of fish caught, so to keep methods standardised, we used first run only. Where the number of individuals of a particular species had been estimated and recorded as a range (0 to 9, 10 to 99, 100 to 999, etc.) the number of individuals was estimated to be 1/3 the maximum of this range (0 to 9 = 3, 10 to 99 = 33, 100 to 999 = 333), as recommended by statistics experts from the EA (Judy England, pers. comm.). To analyse trends in fish diversity at long-term sampling sites in the catchment, the Shannon diversity index was calculated. This index uses the number of species sampled, as well as the abundance of these species (in this case, CPUE) to show the degree of diversity in a fish sample. This is a common approach to analysing diversity in fish communities (Shin et al. 2005). Shannon diversity indices for each site were plotted over time, and linear trends were calculated.

The EA has also recorded length for larger fish species at some of the sample sites. Comparing the change in distribution of individuals' lengths over time can reveal if the habitat supports all life stages of a population (reproduction, successful recruitment, and maturation to adult). This data was plotted using histograms for certain species at four long term monitoring sites.

3.2.2. Results and discussion

There were 13 EA fish sampling locations between 2000 and 2019 (the most recent data was collected from in 2019), and 16 different species of fish caught at these locations (Table 4). However, another source cites as many as 26 species of fish as present in the Crane Catchment (FORCE 2018). The fish listed in this report that were not discovered during EA sampling are listed in Table 5. The EA data results showed that seven of these 13 locations have over three years of data recorded (Figure 2). Two of these are located on the Upper DNR, two on the Lower DNR, and three on the River Crane. The two sampling locations on the Yeading Brook had less than three years of data. The lack of long-term fish monitoring on the Yeading Brook East and West limits our understanding of fish communities in these water bodies.

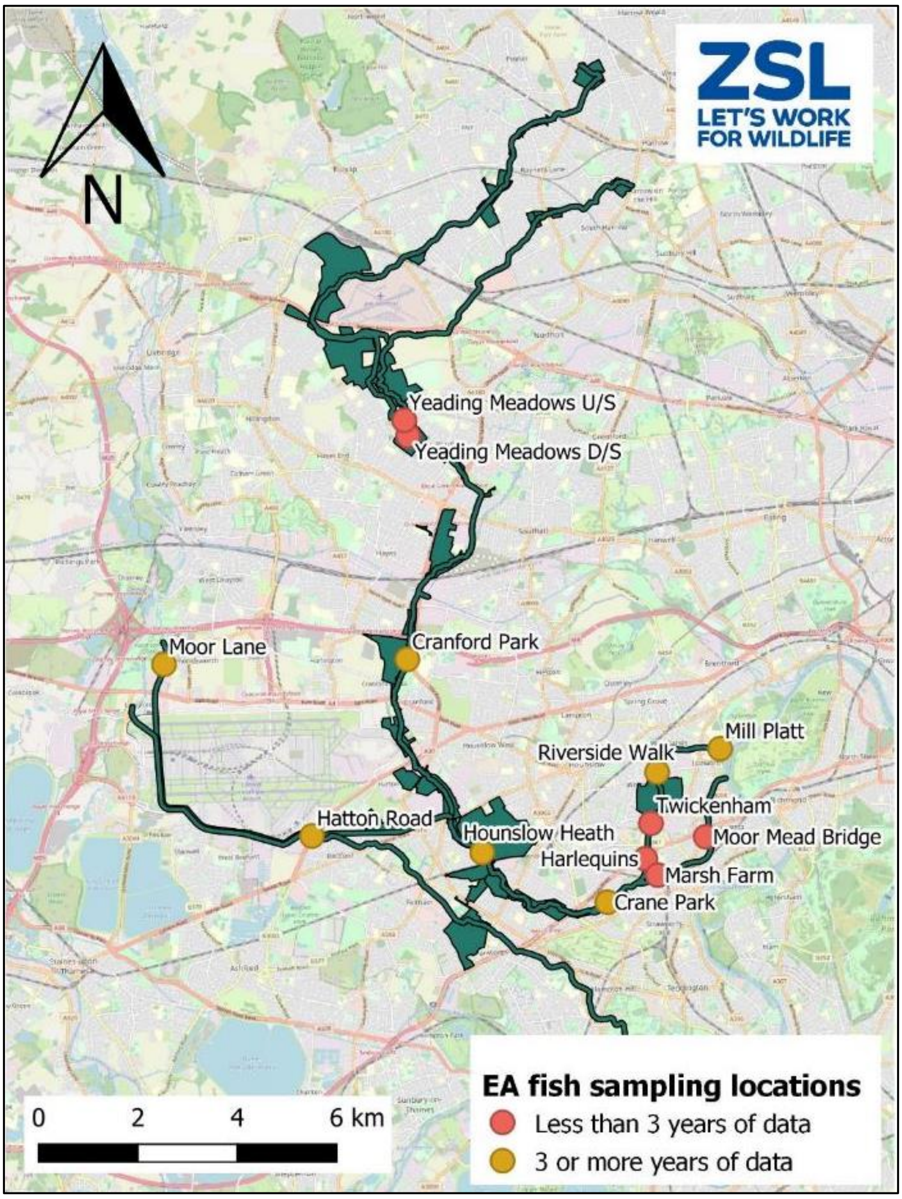


Figure 2: EA fishing sampling locations

Table 4: Fish species caught in the Crane catchment since 2000 during routine EA monitoring.

Scientific name	Common name
Barbus barbus	Barbel

Alburnus alburnus	Bleak
Cottus gobio	Bullhead
Leuciscus cephalus	Chub
Abramis brama	Common bream
Cyprinus carpio	Common carp
Leuciscus leuciscus	Dace
Anguilla anguilla	European eel
Gobio gobio	Gudgeon
Phoxinus phoxinus	Minnow
Perca fluviatilis	Perch
Esox lucius	Pike
Rutilus rutilus	Roach
Barbatula barbatula	Stone loach
Tinca tinca	Tench
Gasterosteus aculeatus	3-spined stickleback

Table 5: 10 fish species reported in the Tidal Crane fish report, that were not found during EA sampling (FORCE 2018).

Scientific name	Common name
Rutilus rutilus x Abramis brama	Roach Bream hybrid
Cyprinus carpio carpio	Mirror carp
Oncorhynchus mykiss	Rainbow trout
Scardinius erythrophthalmus	Rudd
Dicentrarchus labrax	European sea bass
Osmerus eperlanus	European smelt
Platichthys flesus	Flounder
Chelon ramada	Thin lipped grey mullet
Pomatoschistus microps	Common goby
Salmo trutta	Sea trout (brown trout)

Shannon Diversity Index

Fish diversity is an important indicator of freshwater ecosystem health (Shin et al. 2005). For all EA sampling locations, a Shannon Diversity Index was calculated. This metric considers both the species diversity and abundance by calculating the proportion of the total fish population that each species comprises. In this instance, the calculation used the number of species caught in a sample, as well as abundance of each species (for more details about how the index is calculated, see Appendix III). A high Shannon Diversity Index score indicates high species diversity, while a low score indicates little to no species diversity (Nolan & Callahan 2015). For example, a sample that found only one species of fish would score a 0 because there is no possibility of encountering a different species, meaning no diversity. In contrast, a sample with a higher number of species that all have similar abundances will have a high diversity index score.

Shannon Diversity Index scores are plotted below by water body, with individual site scores identified by point colour (Figures 3-6). There is no maximum diversity index value, which means the Shannon Diversity Index scores are most useful for comparing values across sites, as well as trends in index values at a particular site over time. Looking at index values across all sites, the highest score was 1.75, and the minimum was 0. Linear trends were calculated by water body rather than site because there were not enough data to calculate trends for each site (Figures 3-6). The most recent EA fish data available for this analysis was from 2018.

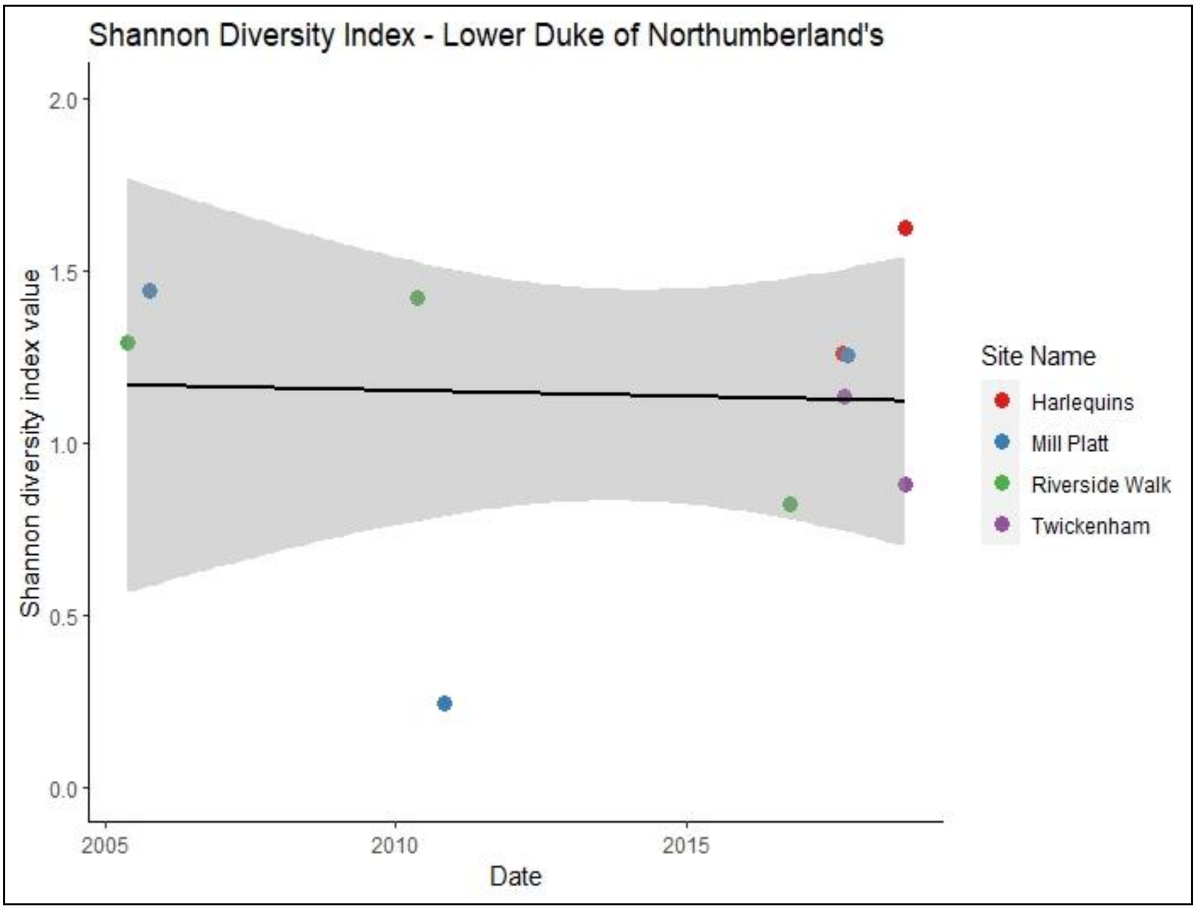


Figure 3: Shannon Diversity Index scores on the Lower Duke of Northumberland s River. The black line shows the linear regression model, while the grey shaded area shows standard error in the linear model.

The lower stretch of the Duke of Northumberland's River has consistently maintained diversity index scores above 1.0 (Figure 3). There was a drop in diversity at Mill Platt in 2010, which was before the first major pollution incident, so the cause of this drop is unknown. From then, no sampling took place in the Lower Duke of Northumberland's River until 2016. By 2017, diversity had improved at Mill Platt, and remained just below or above 1.0 at other sites. Due to the gap in sampling between 2010 and 2016, this data does not demonstrate the impacts of the two major pollution events.

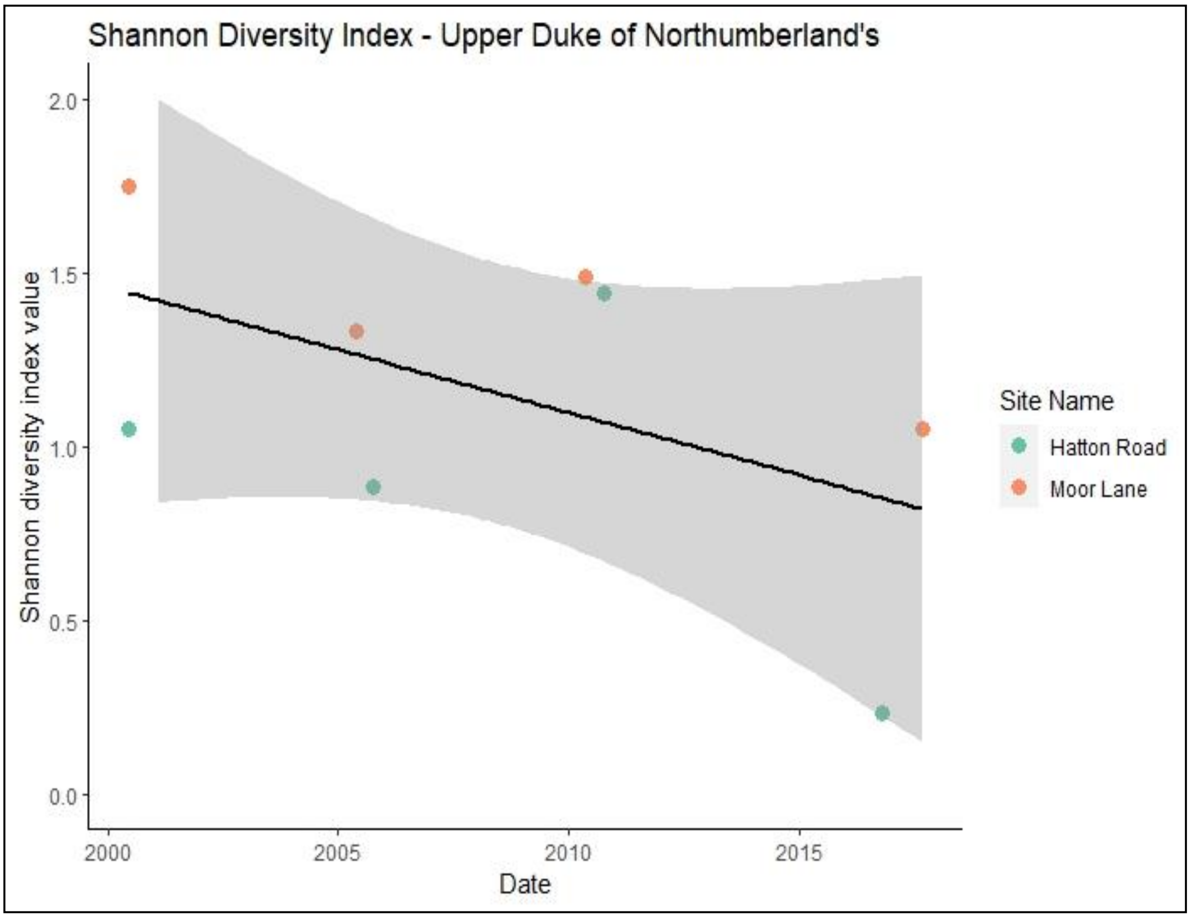


Figure 4: Shannon diversity index scores on the Upper Duke of Northumberland s River. The black line shows the linear regression model, while the grey shaded area shows standard error in the linear model.

The two sampling sites on the Upper Duke of Northumberland's River have been experiencing an average decline in Shannon Diversity Index values since 2000 (Figure 4). Hatton Road has consistently lower scores than Moor Lane. The most recent diversity index scores were the lowest recorded for these two sites, with the Hatton Road score at 0.25.

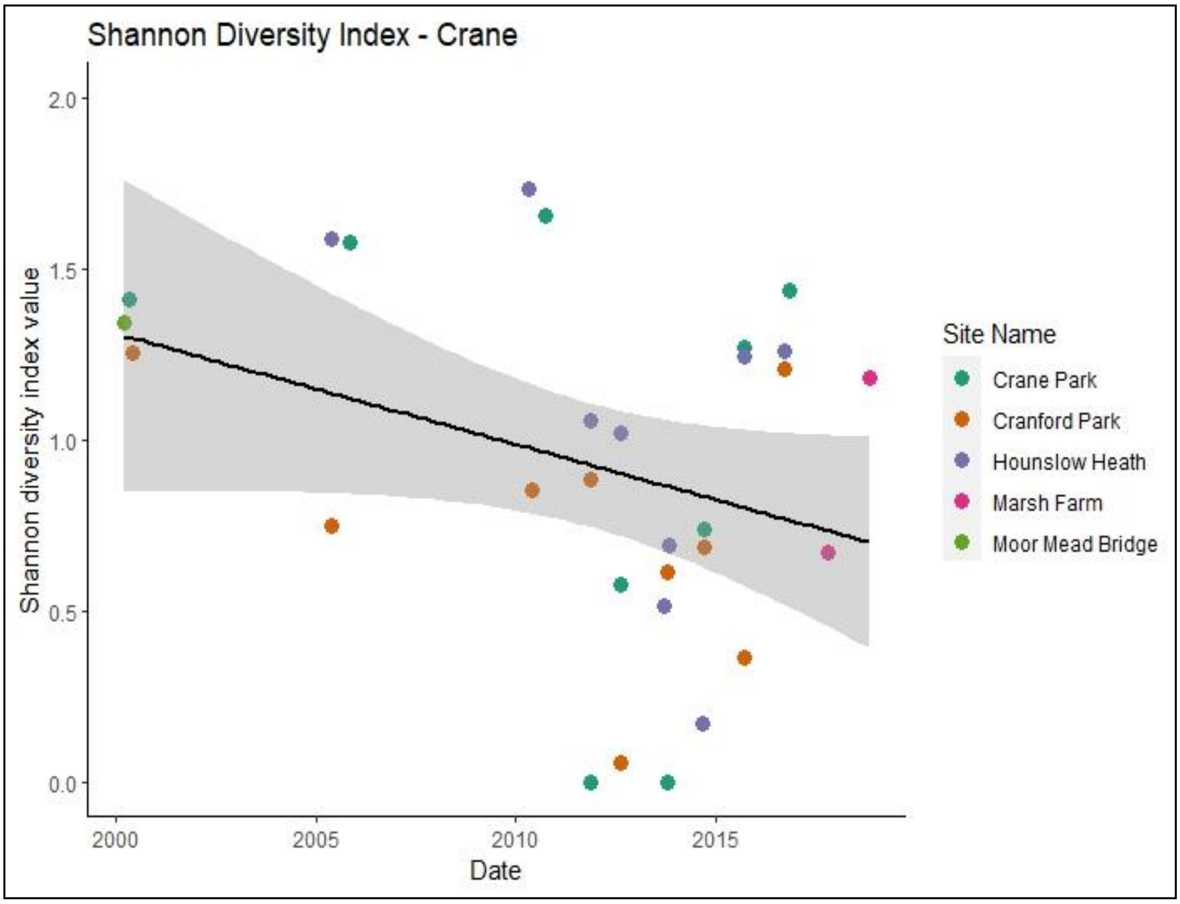


Figure 5: Shannon diversity index scores on the River Crane since 2000. The black line shows the linear regression model, while the grey shaded area shows standard error in the linear model.

On the River Crane, diversity index values have also been declining on average since 2000. Until 2010, the index was over 1.0 for most samples (Figure 5). However, after 2010, there is a clear and significant drop in diversity index values across three regularly monitored sites (Crane Park, Cranford Park, and Hounslow Heath). This drop coincides with a major pollution even that took place just north of Cranford Park in October 2011 (Crane report 2015). As a result, fish populations downstream of Cranford Park were completely wiped out. Another major pollution incident in 2013 had additional detrimental impacts, deferring the river's recovery (Crane report 2015). The impacts of these events can be clearly seen in Figure 5, where Shannon diversity index values dropped below one and remained there between 2010 and 2015. The one exception is Hounslow Heath, which showed signs of recovery in 2012, however experienced another drop in diversity after 2013. Index values remained below 1.0 at all monitored sites until after 2015, at which point there is a significant rise.

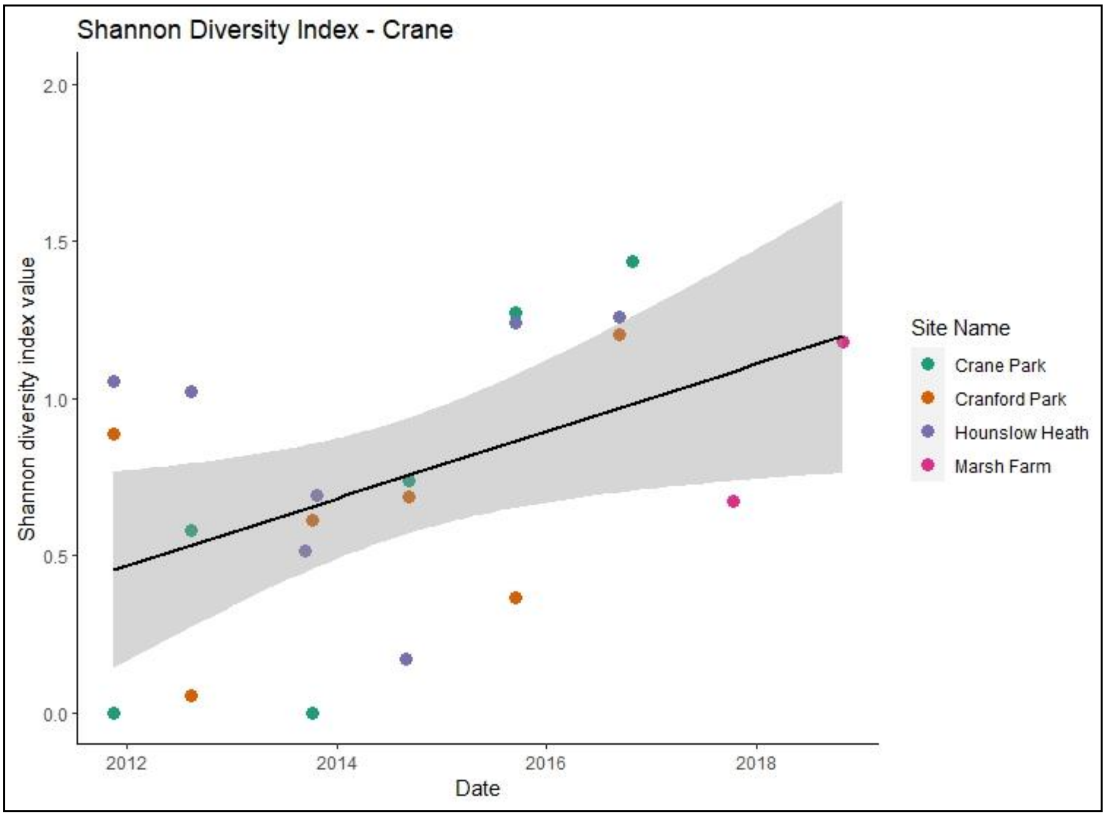


Figure 6: Shannon diversity index scores on the River Crane since 2012. The grey shaded area shows standard error in the linear model.

While long-term trends show an overall decline on average, short term trends (since 2012) show an increasing linear trend in Shannon diversity index values (Figure 6). This increase since the second pollution event in 2013 years suggests that the ecosystem has been continually recovering, with diversity index scores in 2017 and 2018 approaching levels observed before both pollution events. To understand the current state of fish diversity in the catchment, it would be enlightening to have recent data that could then be compared with the above.

The two sites on the Yeading Brook, Yeading Meadows upstream and Yeading Meadows downstream, only had one sample each. This was not enough data to calculate trends or show any change over time, so they are not included on the plots above. The 2013 sample from Yeading Meadows upstream had a Shannon Diversity index value of 0.8, while the 2013 sample from Yeading Meadows downstream had an index value of one.

Fish length

Along with species diversity, fish size can be an important indicator of ecological function (Shin et al 2005). Populations with an even distribution of lengths (larger, older fish ready to spawn, as well as smaller juveniles) indicate sustainable populations. Declines in average fish size over time can be a symptom of environmental pressures, for example habitat disruption or pollution (Shin et al 2005). Fish lengths in the Crane catchment have been recorded by the EA at certain sites, for certain species. The species with length recorded, and therefore included in this analysis, are listed in Table 6, which includes basic information about each.

Table 6: Common name, Latin name, length, description, and image for four fish species included in the fish length analysis.

Common name	Scientific name	Average length (mm)	Length at reproductive maturity (mm)	Description	Photo
Chub	*Squalius cephalus*	300-400	135 (Mann et al 1975)	Medium-sized predatory fish commonly found in UK freshwater	
Dace	*Leuciscus leuciscus*	150-250	179 (Fishbase)	Small-medium fish that shoals in shady areas of rivers and streams	
Roach	*Rutilus rutilus*	100-400	140 (Fishbase)	Omnivorous small-medium fish found in lakes and slow-moving rivers	
Gudgeon	*Gobio gobio*	70-150	93 (Fishbase)	Small bottom-feeding fish found in canals and rivers with sand or gravel bottoms	

To show the change in fish lengths at each site, Figures X-Y are length-frequency histograms for the above species at the only four sampling sites with over three years of fish length data recorded: Crane Park, Cranford Park, Hounslow Heath, and Hatton Road. In a healthy population with acceptable water quality and plentiful habitats available for all age classes, we would expect to see a range of lengths in the length-frequency distribution. It is important to know the species ʼlengths at reproductive maturity (as listed in Table 6 above) when interpreting length-frequency histograms because it shows whether the habitat at that site can sustain the full life cycle of the species.

Chub

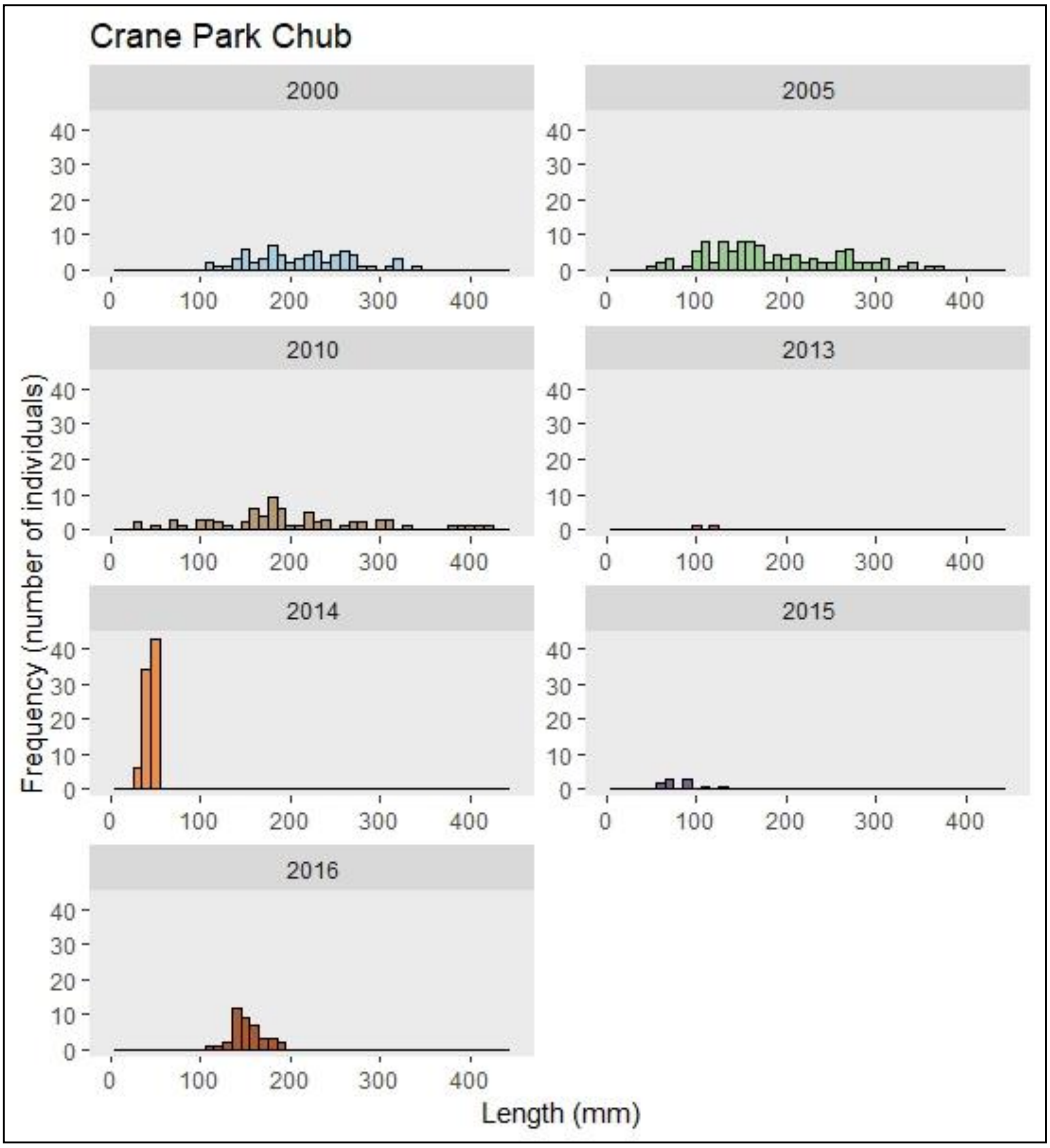


Figure 7: Chub (Squalius cephalus) histograms of lengths at Crane Park.

- Crane Park chub lengths (Figure 7) demonstrate normal distributions in 2000, 2005, and 2010.
- Average lengths in these years were, respectively, 213.3mm, 186.8mm, and 199.6mm. These distributions indicate a healthy population, with older, larger adults that have reached maturity (135mm), and smaller juveniles.
- The low numbers of fish reflected in 2013 is likely a result of the 2011 and 2013 pollution events.
- The spike in smaller chub in 2014 could reflect restocking of juvenile chub in the river. The absence of larger fish may suggest that the habitat is not suitable for larger, more mature chub. Or this could show that this population of chub do not grow as large as others. An analysis on fish age would be necessary to make this distinction.

- The restocked numbers in 2014 are not then reflected in 2015, suggesting the individuals released moved on to other areas, or did not survive.
- The average length and number of individuals caught both appear to increase in 2016, with several fish caught having reached maturity. This suggests the population may have started to recover, but more recent data is needed to confirm this is the case.

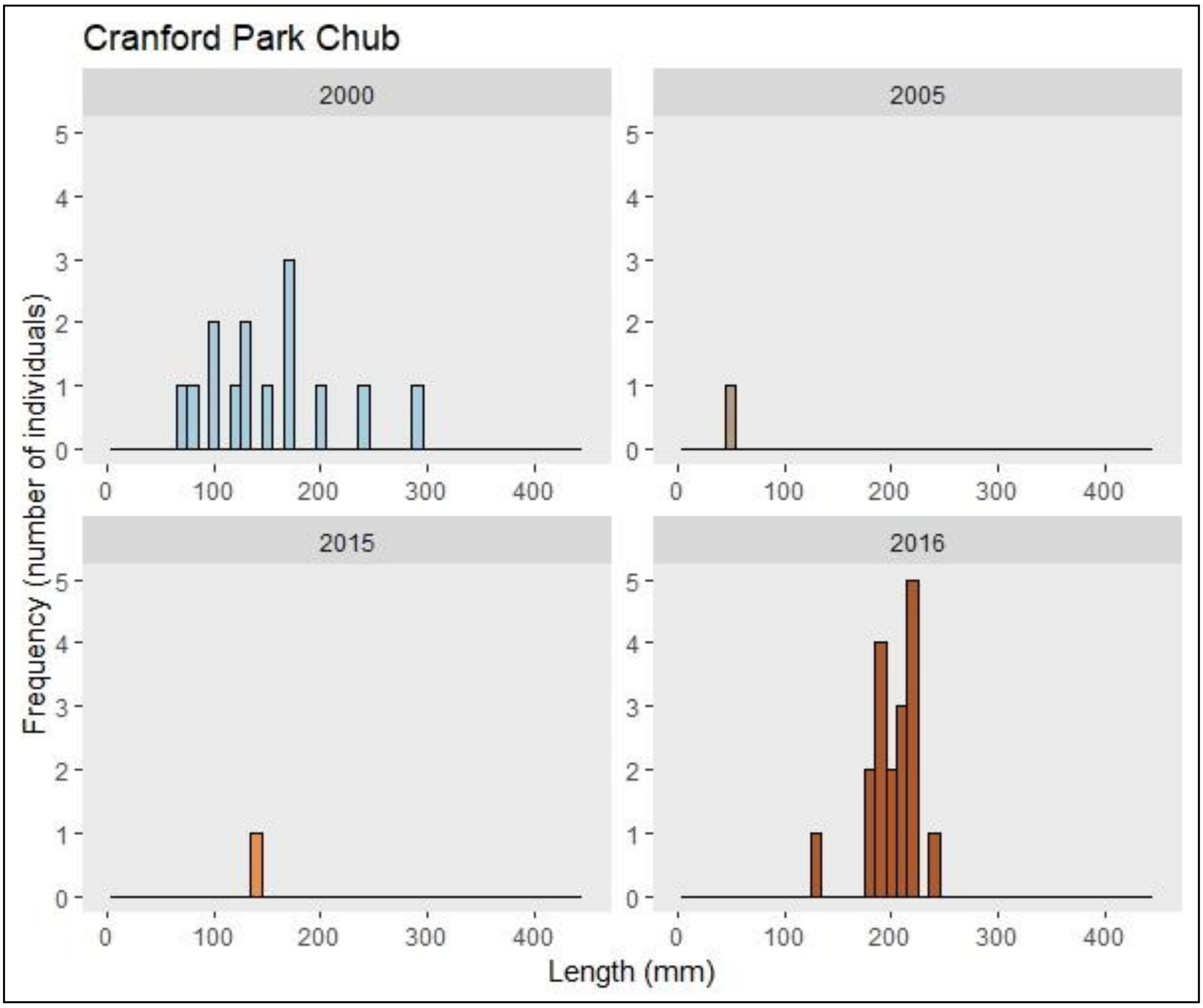


Figure 8: Chub (Squalius cephalus) histograms of lengths at Cranford Park.

- Across all years, the number of chub caught at Cranford Park is low.
- Low numbers of fish caught in 2005 is reflected across most sites and species. 2005 was a notable drought year (Cole & Marsh 2006), which likely meant that there was not suitable habitat available for larger individuals, as water levels were likely very low.
- Low numbers of chub caught in 2015 is likely a result of the pollution events in 2011 and 2013.
- Numbers of individuals increase in 2016. This, again, is seen across many sites and species in the catchment, suggesting favourable conditions for fish in this year.

- While this increase and presence of mature fish suggests a recovering system, more recent data is needed to confirm.

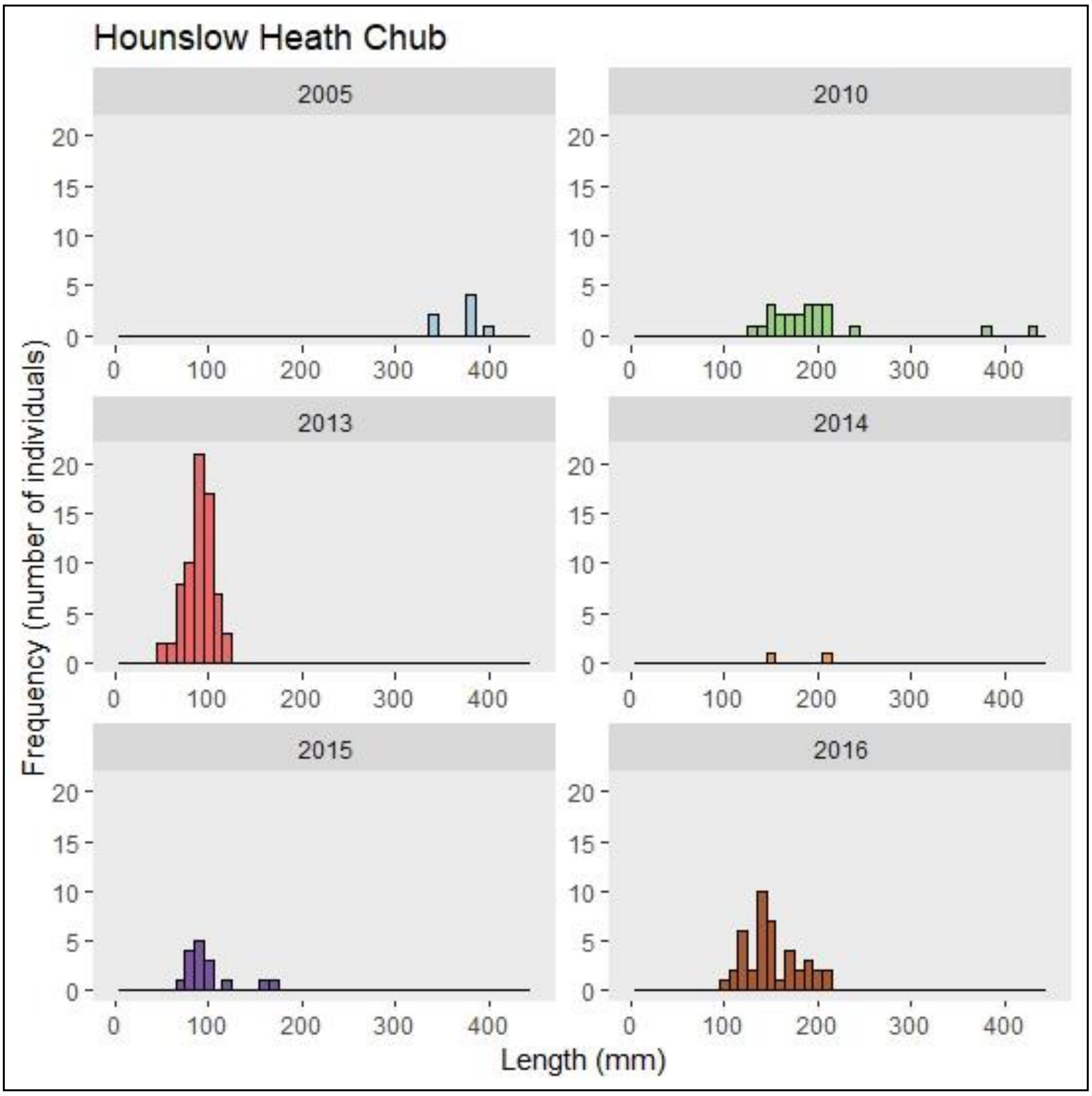


Figure 9: Chub (Squalius cephalus) histograms of lengths at Hounslow Heath.

- Again, we see the impacts of harsh conditions for fish due to drought in 2005.
- The reason for the 2013 spike may be due to juvenile restocking after the 2011 pollution event.
- 2015 and 2016 show evidence of recruitment but given the lack of mature fish caught at the site it suggests fry have moved in from other parts of the river.
- We need more recent data to be sure that self-sustaining populations are becoming re-established.

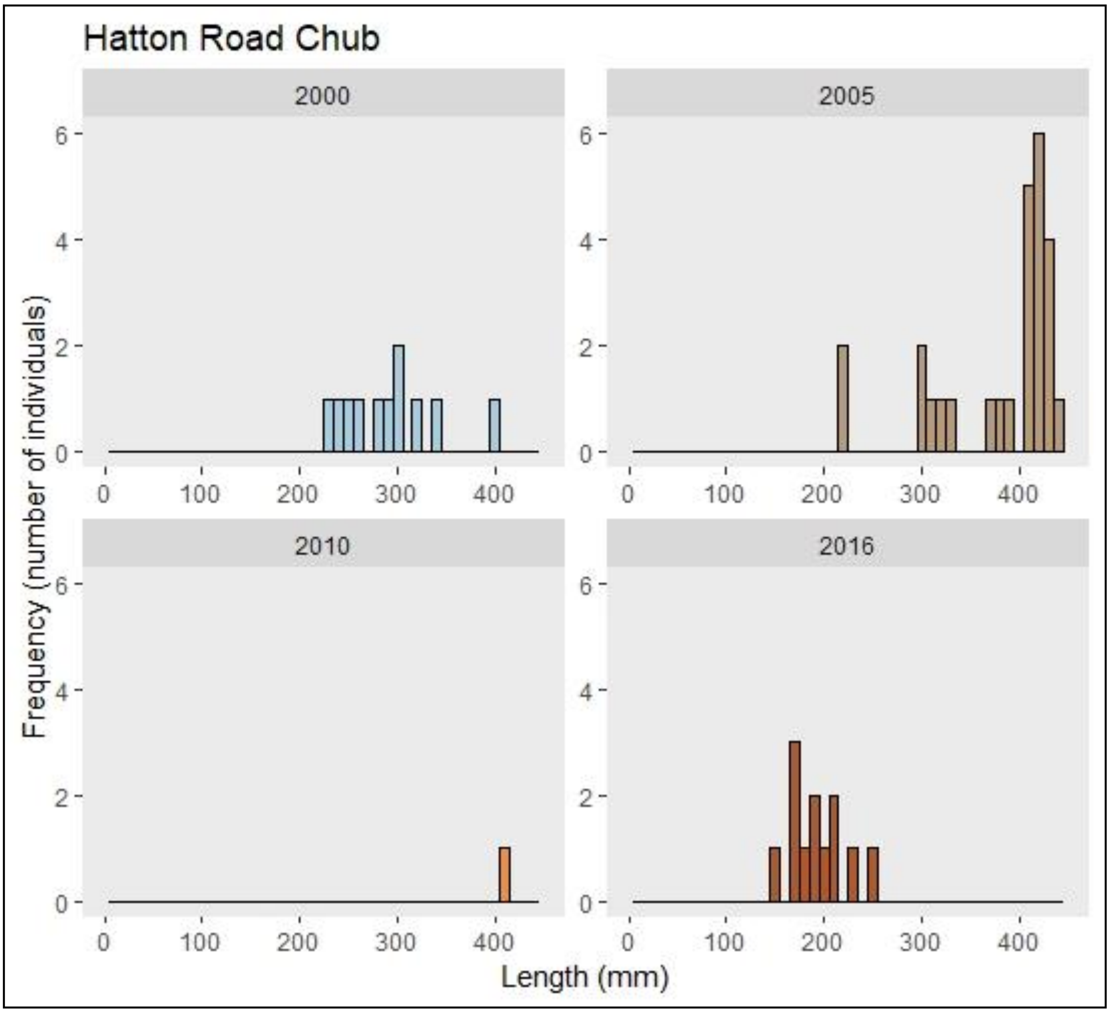


Figure 10: Chub (Squalius cephalus) histograms of lengths at Hatton Road.

- Decline in numbers between 2005 and 2010 is striking and indicates and unstable population.
- The lack of juveniles in 2010 and presence of only one larger adult could be a result of several factors. Firstly, sometimes high flow after heavy rain can flush juveniles through the river system. Also, larger chub will predate smaller juvenile chub, which means that juveniles will avoid the adults.
- Encouraging to see clear signs of recruitment in 2016, which suggests possible recovery. However, updated data is needed.

Dace

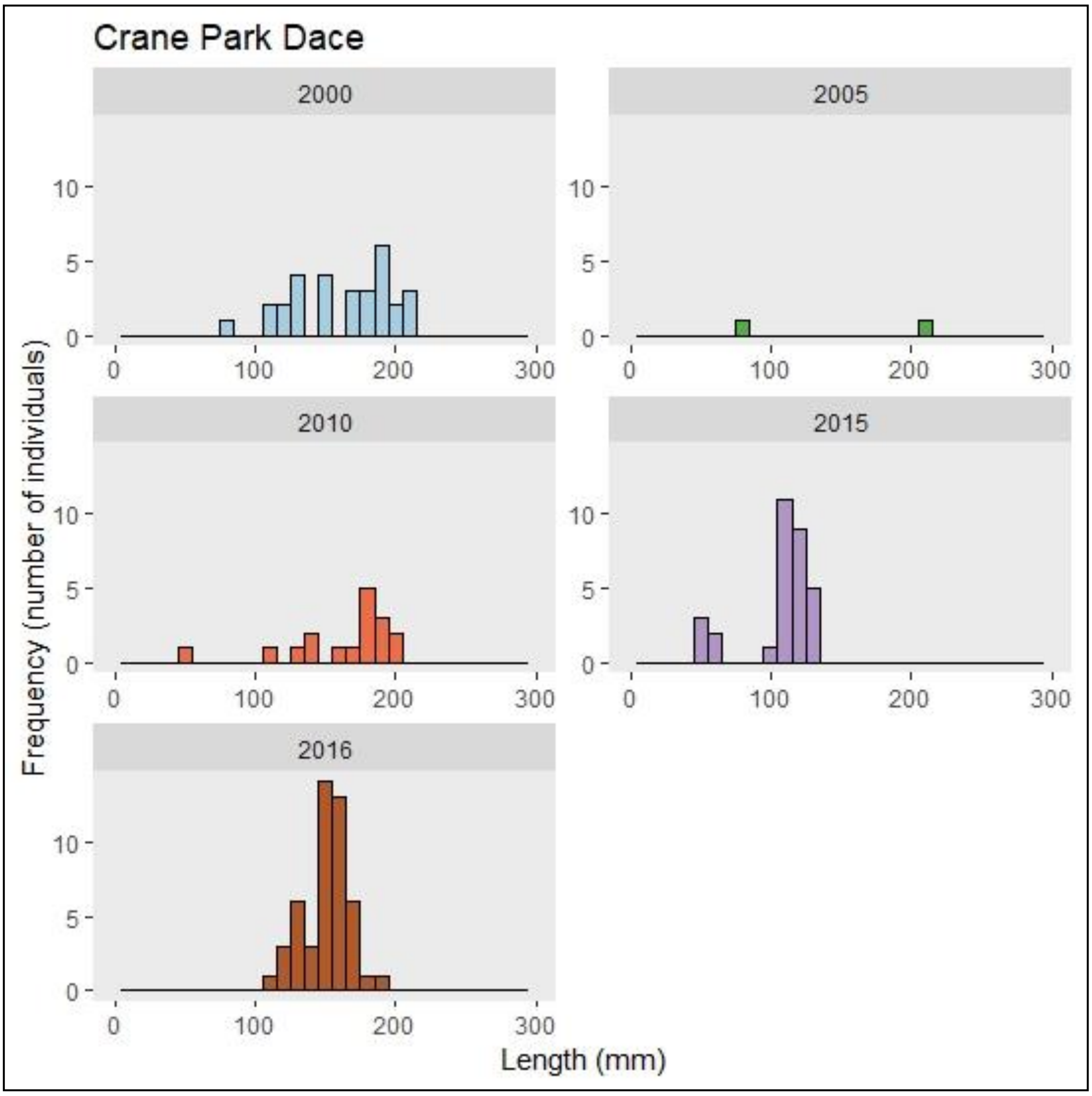


Figure 11: Dace (Leuciscus leuciscus) histograms of lengths at Crane Park.

- Overall, numbers of dace caught at this site are low.
- As previously mentioned, the very small numbers of fish in 2005 numbers reflect a bad year for fish.
- 2010 results show fairly spread distribution of older, bigger fish along with smaller juveniles.
- No dace caught during Crane Park sampling in 2013 and 2014, likely due to pollution events.
- 25 small individuals were caught in 2015, all under length at maturity (179mm).
- 2016 shows further recovery, with the average length over 150mm, and both juveniles and more mature fish present. The average length in this distribution is below average for mature dace. It may be that dace in the Crane don't grow as large as they do in other river systems. This could be explored further by incorporating fish age into the analysis.

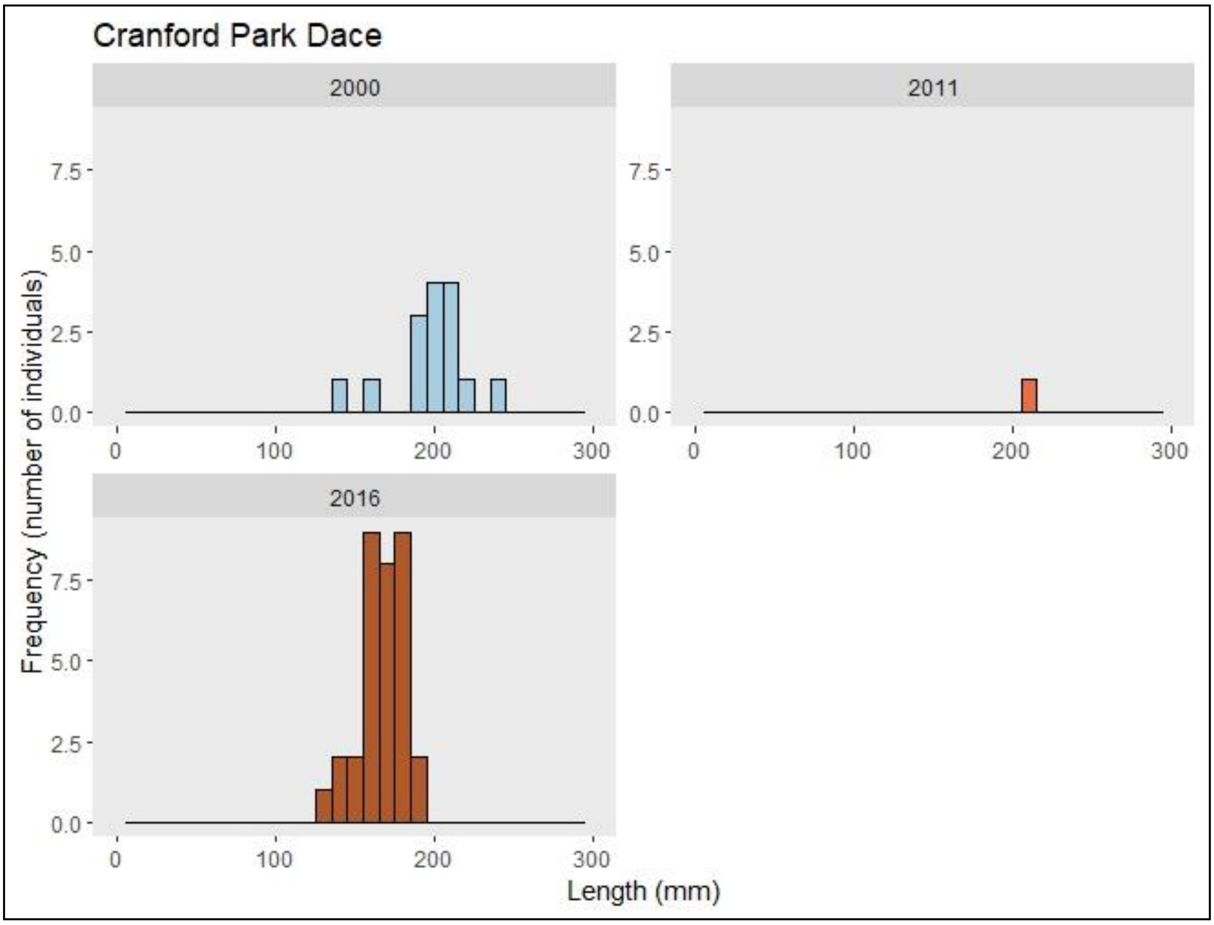


Figure 12: Dace (Leuciscus leuciscus) histograms of lengths at Cranford Park.

- Dace at Cranford Park were absent from the site between 2011 and 2016. In 2011, only a single dace was caught.
- As mentioned above, analysing fish age data would help understand the typical lengths of dace at this site.
- Return of a more ‘normal’ distribution in dace length in 2016, which again appears to be a good year for fish in the catchment.
- More data is needed to determine if this return has been sustainable.

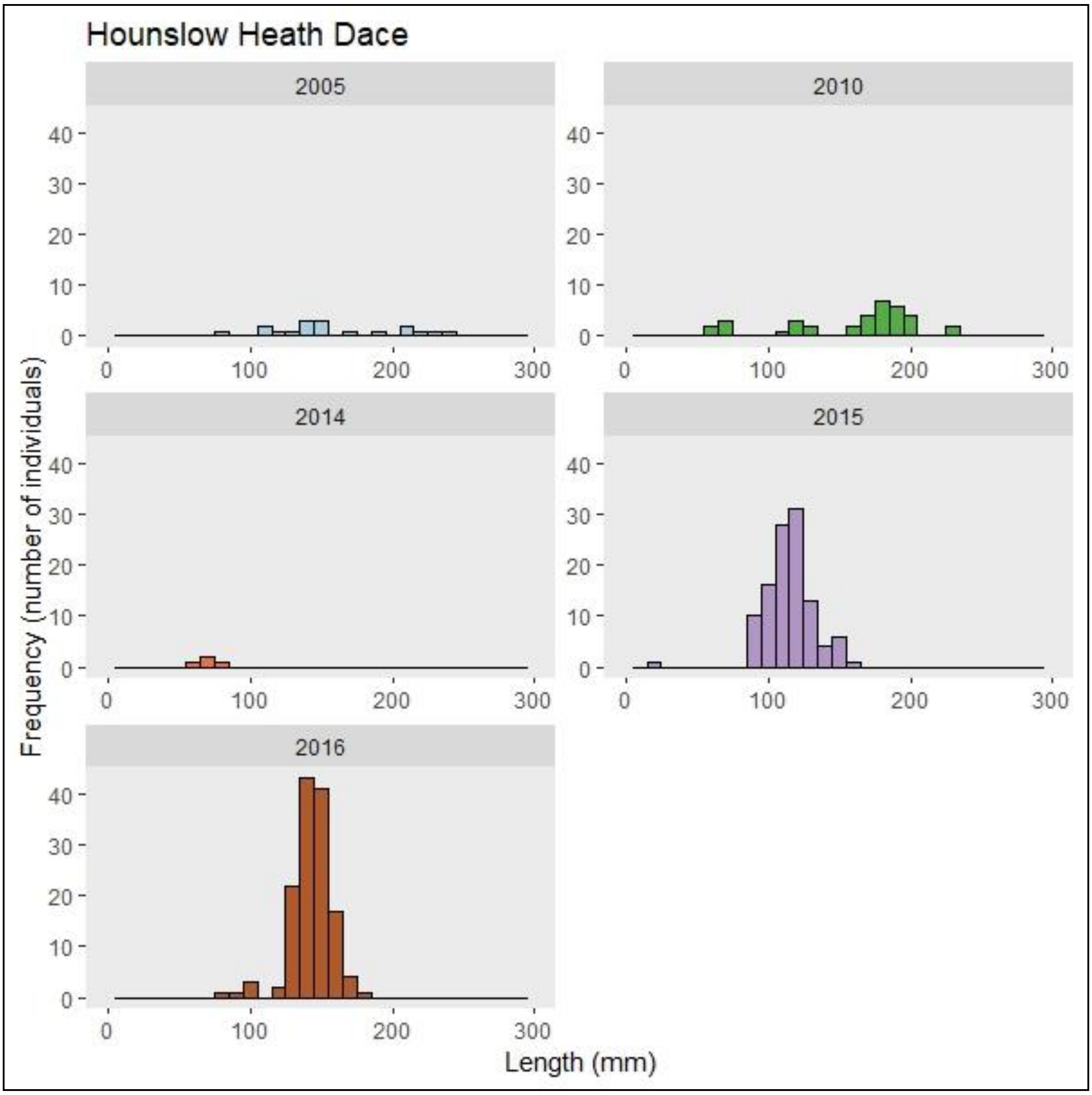


Figure 13: Dace (Leuciscus leuciscus) histograms of lengths at Hounslow Heath.

- Numbers of dace at Hounslow Heath in years prior to 2015 are comparable to numbers at other sites.
- There are several possible reasons for the increase in numbers in 2015 and 2016. Dace migrate fairly frequently, and could have migrated to habitats at this site from other areas of the reason.
- Because they are migratory, river barriers can obstruct their movement, and could be why we see fewer numbers at other sites.
- This may suggest that this site has (or had in 2016) favourable habitat for dace (moving water, limited suspended sediment, and gravel or rock bottom).

Gudgeon

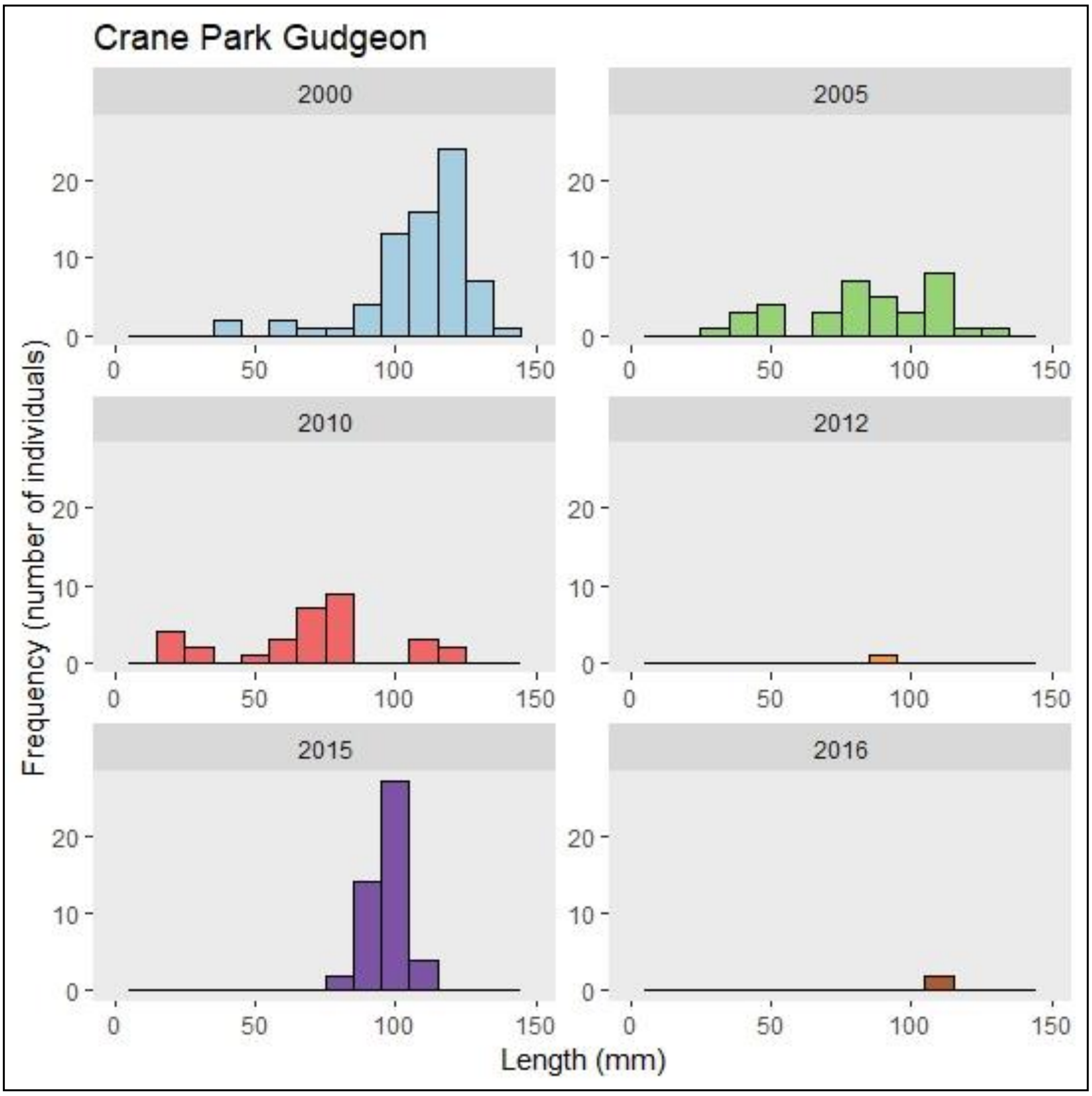


Figure 14: Gudgeon (Gobio gobio) histograms of lengths at Crane Park.

- The post-2010 decline observed in 2012 is likely explained by the 2011 pollution event.
- The 2015 increase may be due to restocking of juveniles, but the reason for the subsequent decrease in 2016 is unknown.
- More post 2013 data would be helpful to better understand what the current state of the gudgeon population is at this site.

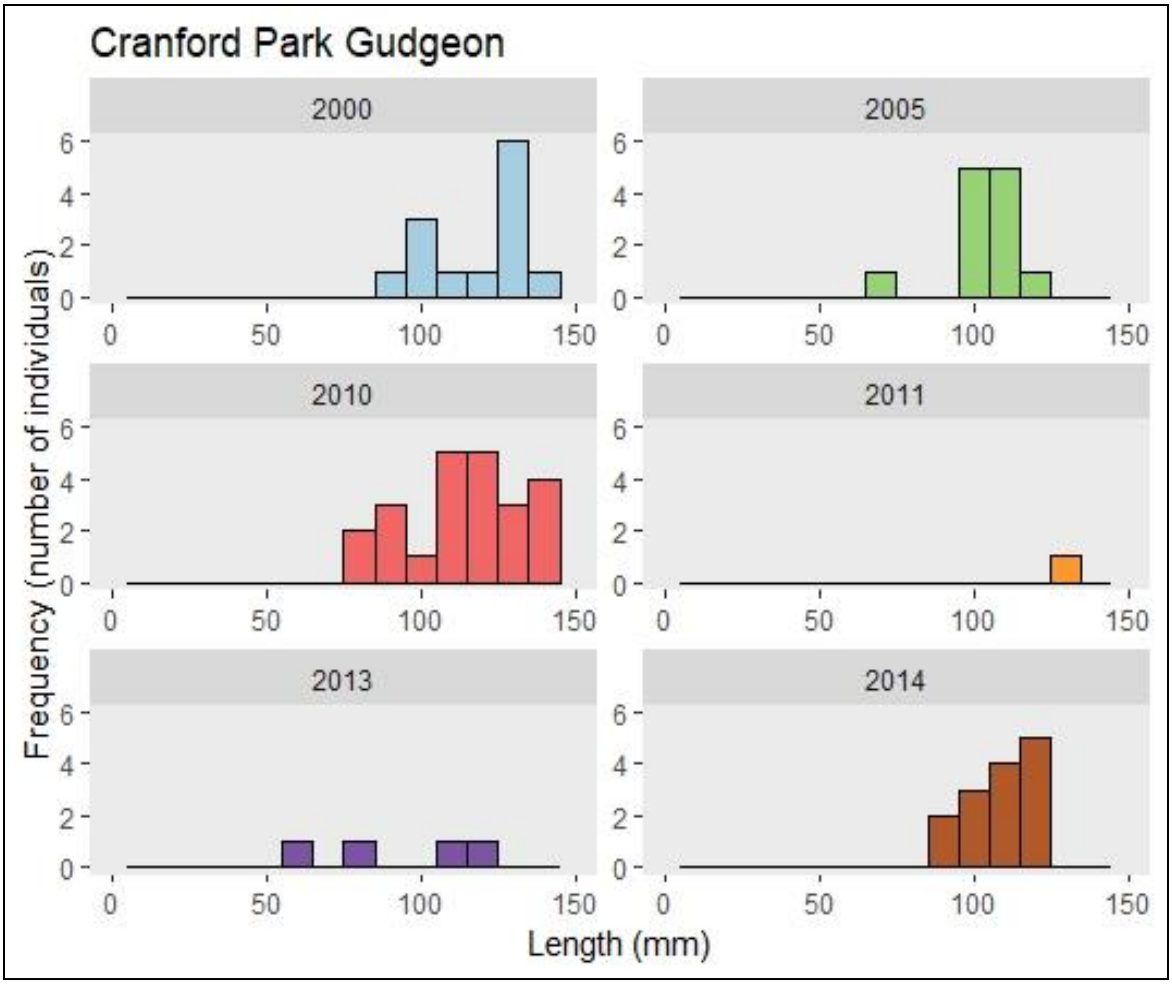


Figure 15: Gudgeon (Gobio gobio) histograms of lengths at Cranford Park.

- Overall, numbers of gudgeon at this site have remained low.
- The post-2010 decline observed is likely due to pollution events.
- The 2014 increase may be due to restocking of juveniles, but no gudgeon were caught at this site in 2015 or 2016.
- If there was restocking, this suggests it was unsuccessful, or that the fish migrated to other areas.
- More recent data would help determine whether this species is once again present at this site.

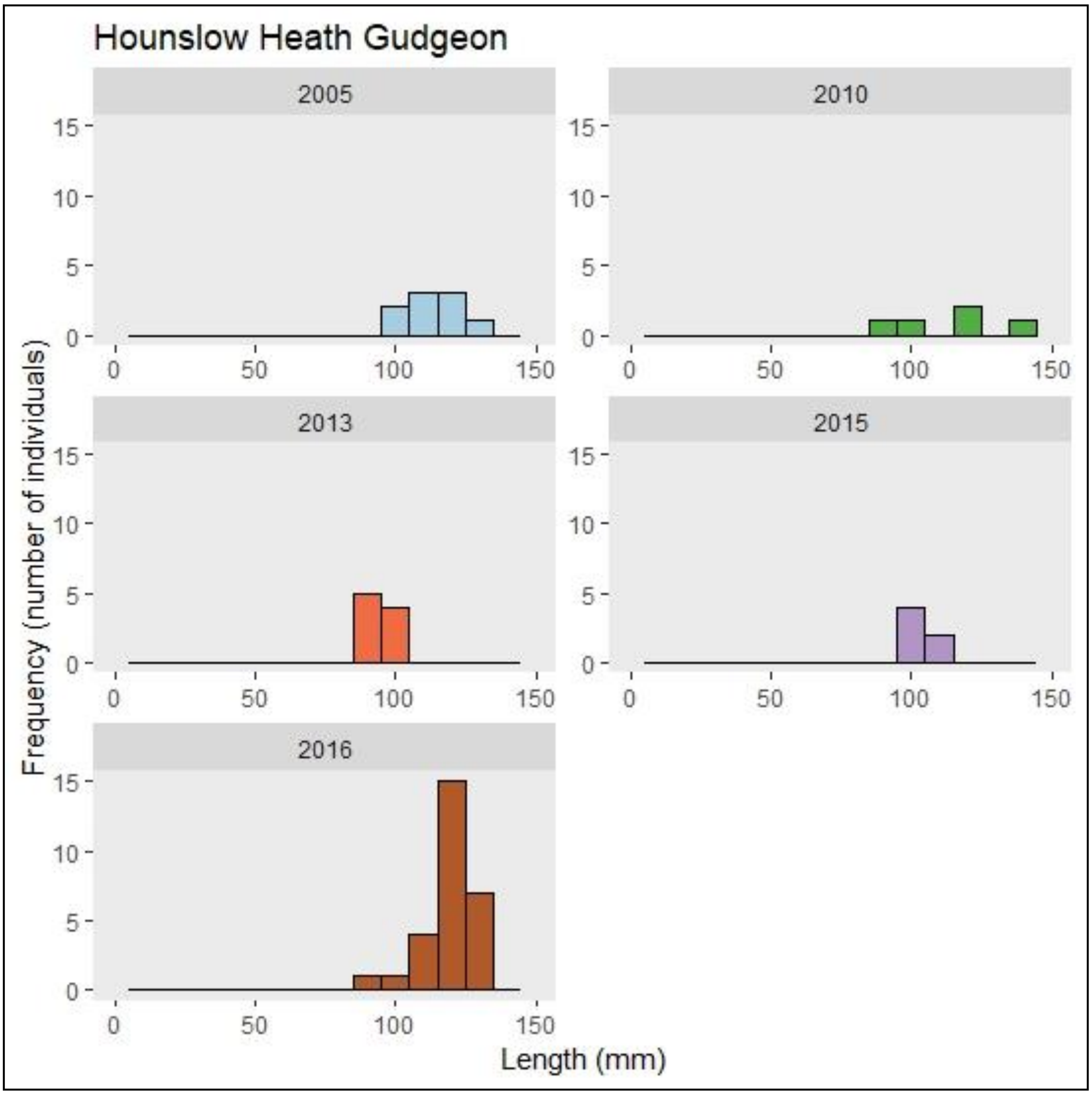


Figure 16: Gudgeon (Gobio gobio) histograms of lengths at Hounslow Heath.

- Prior to 2016, numbers of gudgeon were very low, and mostly larger adults were recorded.
- 2016 shows a more promising distribution of fish lengths, and an increase in number of fish caught.
- This increase could be due to restocking, and is a promising sign. However, there is no recent data that confirms whether these numbers and distribution have been sustained.

Roach

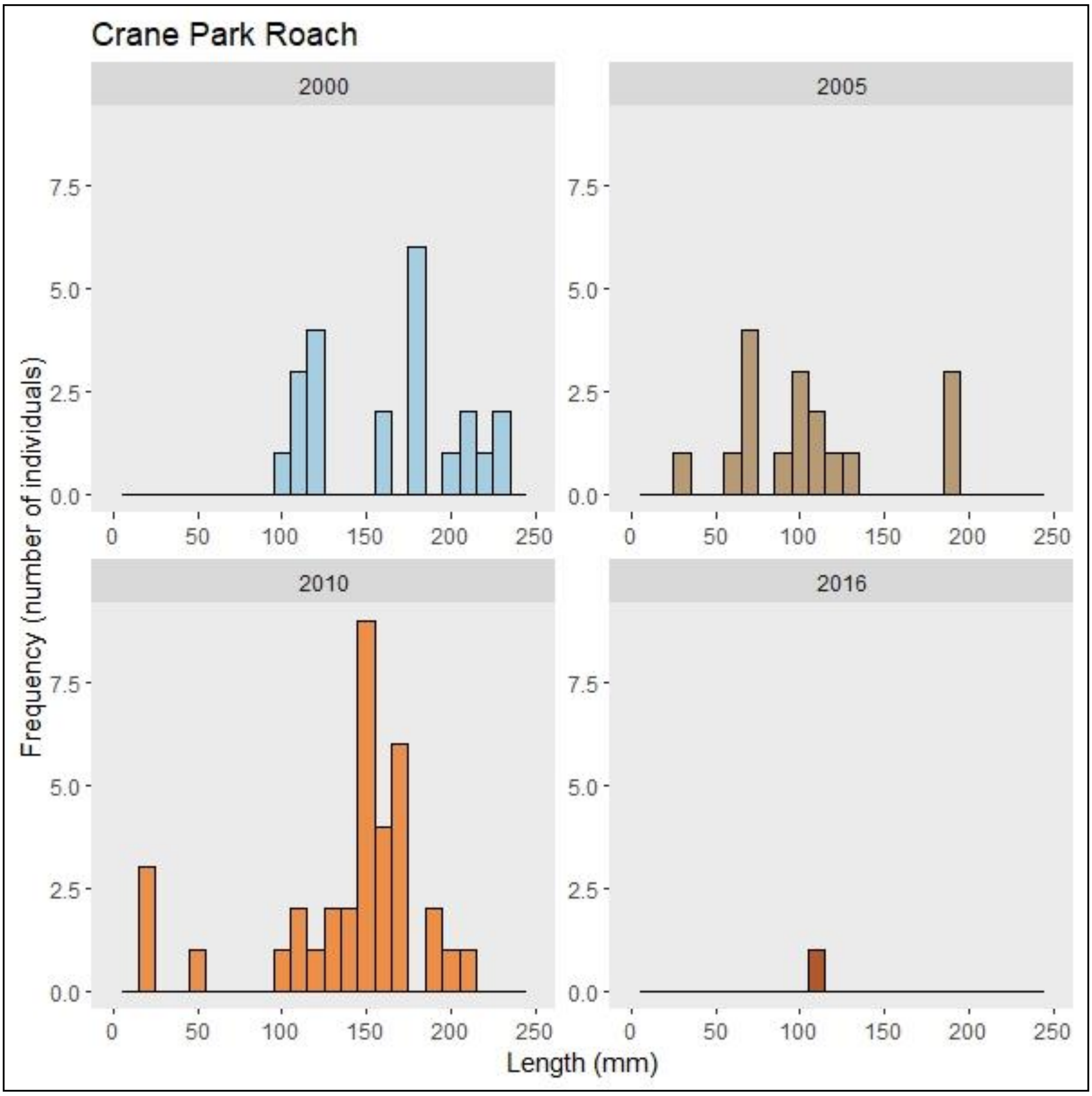


Figure 17: Roach (Rutilus rutilus) histograms of lengths at Crane Park.

- Prior to the two major pollution events, Crane Park data showed a widely spread distribution of roach lengths, and relatively high frequencies.
- Roach were not found at Crane Park from 2011-2015, likely due to the pollution events in 2011 and 2013.
- The next time a roach was caught at Cranford Park, it was in 2016, and was only one individual.
- It would be interesting to see if roach have made any further recovery since 2016.

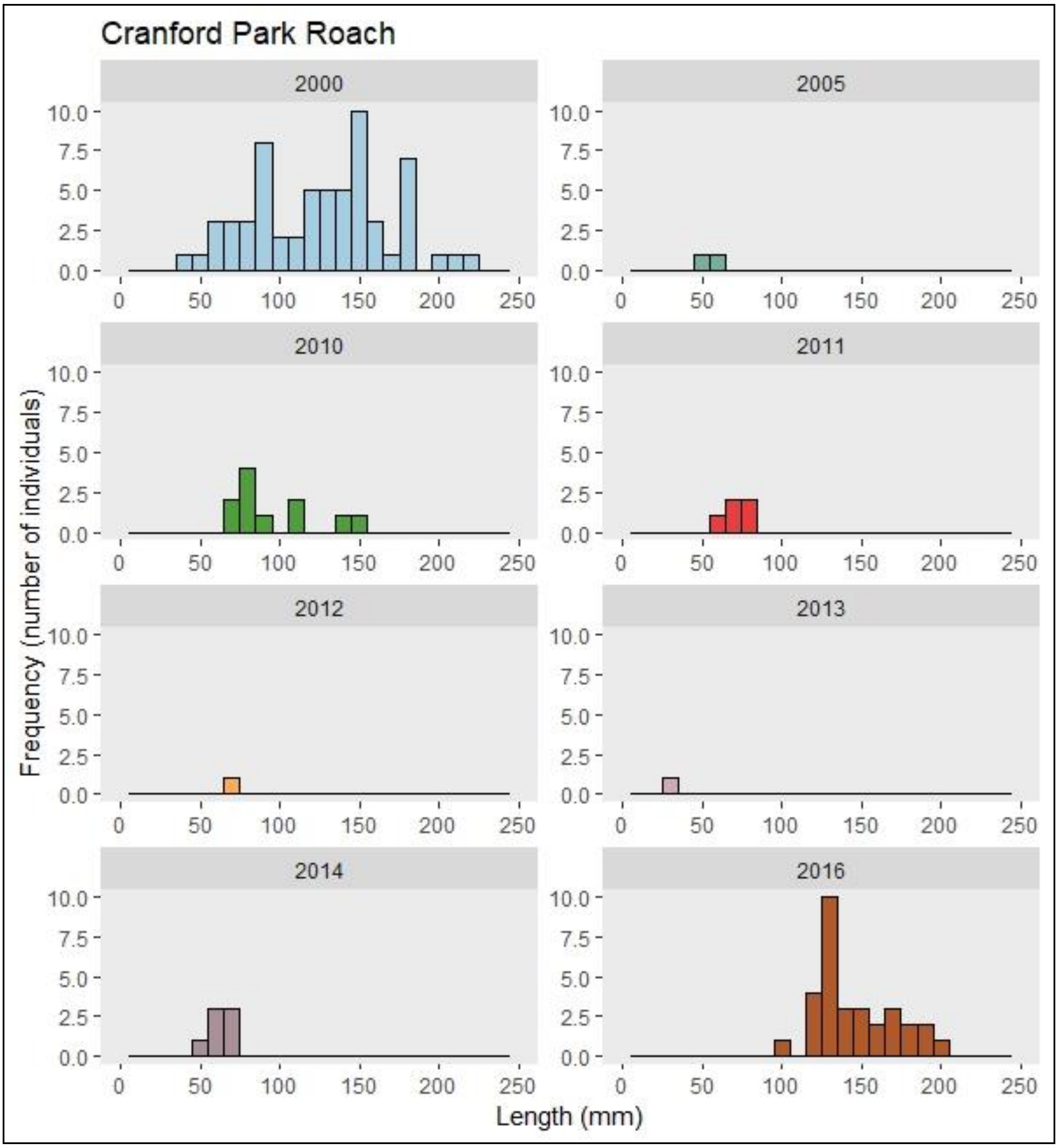


Figure 18: Roach (Rutilus rutilus) histograms of lengths at Cranford Park.

- 2000 data shows a nice spread of roach lengths, suggesting a stable population at Cranford Park. The presence of smaller juveniles suggests that recruitment was taking place at this site.
- 2005 continually proves to be a bad year for fish, with only a few smaller roach being caught at this site.
- While numbers are low in 2010, there are both juveniles and adults present, which is a positive sign.
- However, there are further declines in 2011, and after the pollution events in 2012 and 2013 hardly any roach are found at this site.

- The increase observed in 2016 could be due to restocking. Again, data across all sites show 2016 as a strong year for fish. Recent data is needed to determine whether this increase has been sustained.

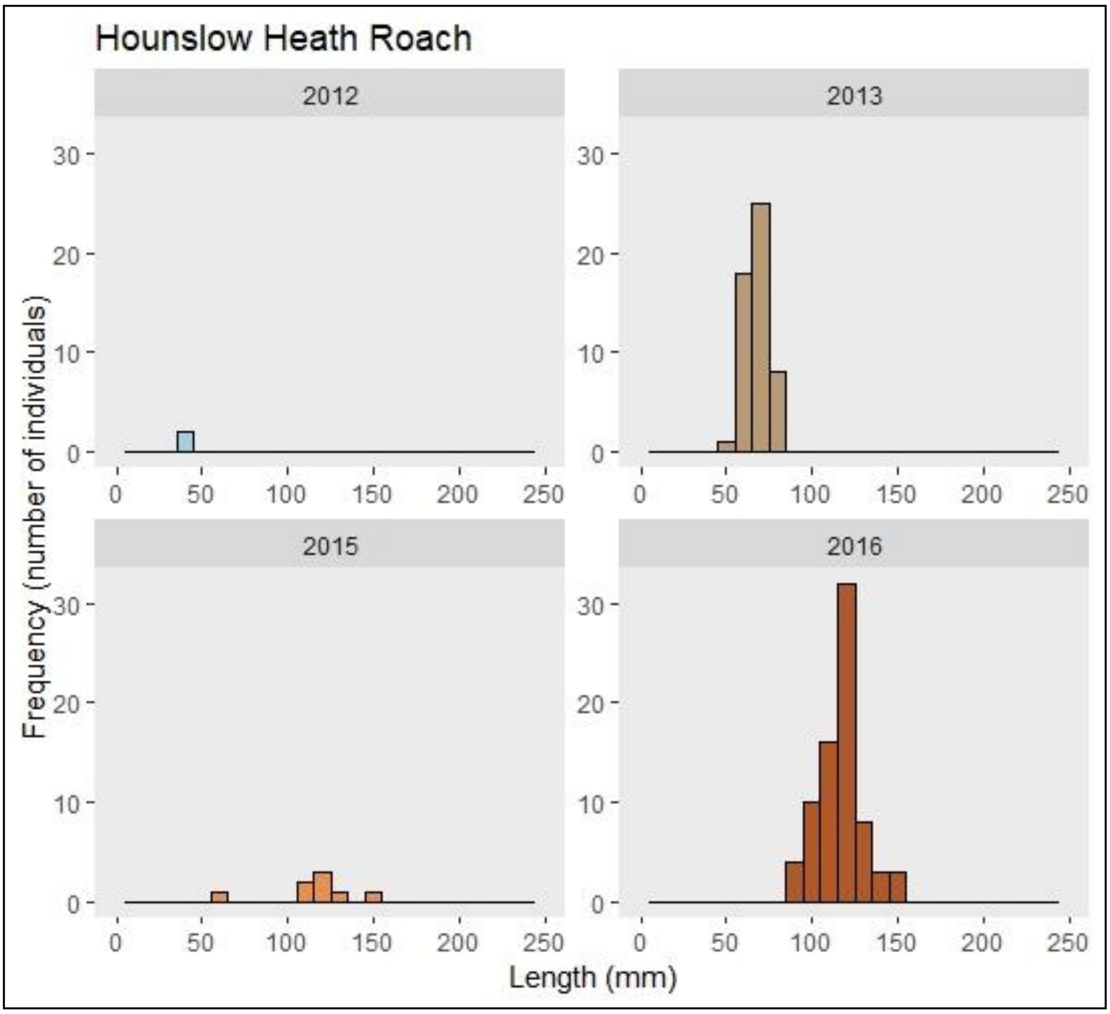


Figure 19: Roach (Rutilus rutilus) histograms of lengths at Hounslow Heath.

- Roach at Hounslow Heath were not found before 2012.
- The spike observed in 2013 in smaller fish is likely due to restocking after pollution events.
- These numbers unfortunately decline in 2015, and with only 1 smaller juvenile caught, there are limited signs of recruitment.
- There is a significant increase in numbers of roach in 2016. The reason for this is unknown, but again it must be noted that data from all sites indicate that 2016 was a great year for fish populations in the catchment.

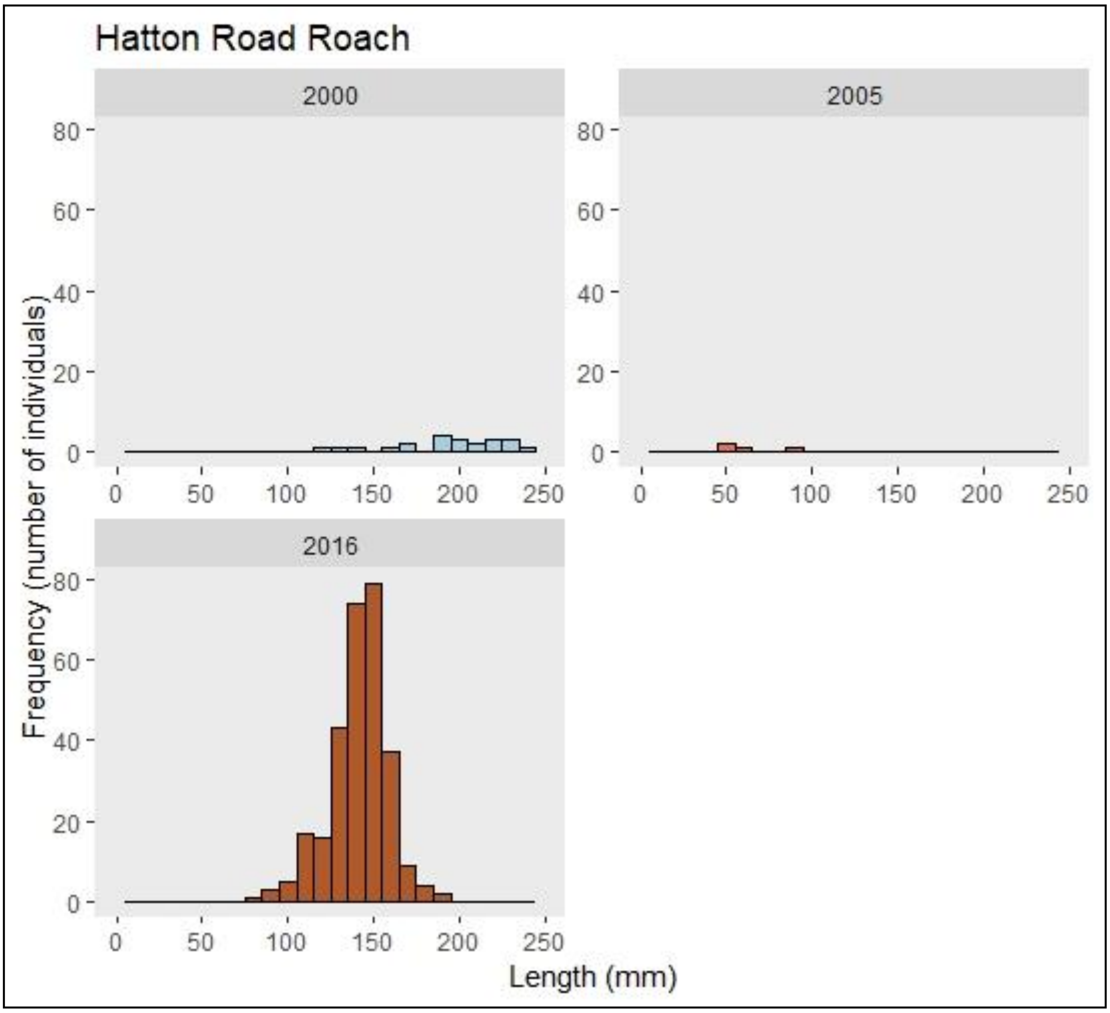


Figure 20: Roach (Rutilus rutilus) histograms of lengths at Hatton Road.

- Roach at Hatton Road were not found between 2005 and 2016. The reason for this is unknown, but similarly, only one chub was found at Hatton Road between 2005 and 2016. This may demonstrate that Hatton Road was not a
- There is a significant increase in numbers of roach in 2016. The reason for this is unknown, but again it must be noted that data from all sites indicate that 2016 was a great year for fish populations in the catchment.

Overall, across all species and sites, there is significant variation in the number of individuals caught during sampling. This suggests that fish populations within the catchment have been unstable in the monitoring timeframe (2000-2016). For example, monitoring in 2005 across all sites in the Crane catchment shows low catches and diversity, while 2016 monitoring shows generally higher catches and an increase in species diversity despite almost complete decimation of fish populations following the major pollution events in 2011 and 2013. This fluctuation in catch numbers, length distribution and population structure often indicate unstable fish populations. This instability can be due to factors such as drastic flows, pollution events, temperature fluctuations and predation, which are often intensified by the alteration of natural flow regimes and the lack of functional habitat for species to move between to complete their lifecycles.

3.3. ZSL eel data

3.3.1. Analysis

The Zoological Society of London, in partnership with Friends Of the River Crane Environment, London Wildlife Trust, Thames Water and local volunteers, monitored the upstream migration of the Critically Endangered European eel at two different locations in the lower Crane. A site at Crane Park (Figure 21) was monitored, using a simple trap, from 2011 to 2013. From 2015 to 2018, a trap in an eel pass commissioned by ZSL was monitored at Mogden Sewage Treatment Works.

To account for variable effort (time eel traps were in operation), catch per unit effort (CPUE) was calculated for each year. This simple calculation takes the total catch for the year divided by the total time the traps were in place and functioning properly. CPUE was then plotted over time to show the change in eel presence.

3.3.2. Results and discussion

The locations of the two ZSL eel monitoring sites can be seen in Figure 21.

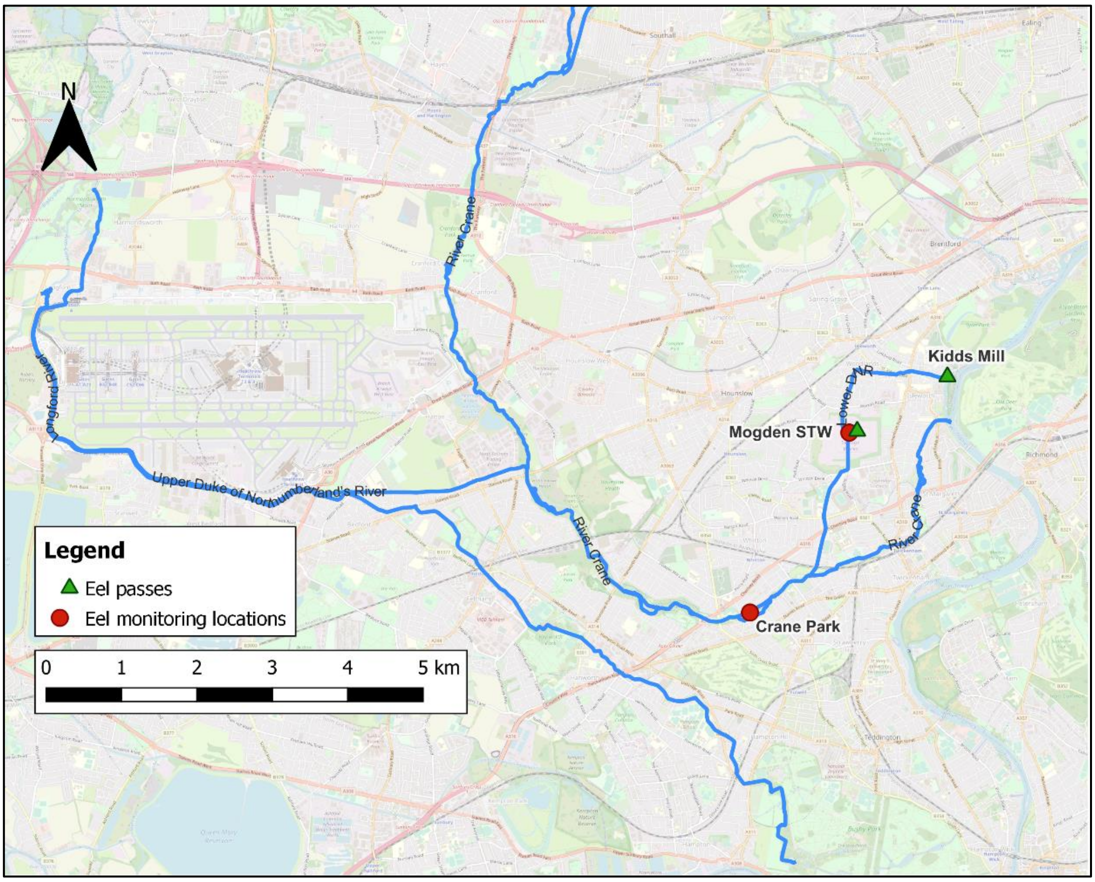


Figure 21: ZSL eel monitoring locations.

The Crane Park monitoring site did not record any eels between 2011 and 2013, so a graph has not been included for this site. Recording a zero catch at Crane Park did not prove an absence of eel in the river but suggested barriers downstream were obstructing elver migrating in from the Thames. There was a pollution event in October 2011, but the river had recovered sufficiently to support eel migration when monitoring began in April 2012, so this is not suspected to be the cause of the absence of eels. The evidence was used by ZSL to secure funding for eel passes for the major tidal structure at Kidds Mill in 2015 at the base of the river, and in 2015 the smaller flow gauging weir at Mogden Sewage Treatment Works (ZSL 2021). Monitoring at Mogden in 2015 to 2018, confirmed recruitment of elver from the Thames into the river system, using these new eel passes.

The results from the Mogden monitoring are displayed using catch per unit effort in Figure 22 (raw data by year: 565 individuals caught in 2015, 946 in 2016, 588 in 2017, and 150 in 2018) (ZSL 2021).

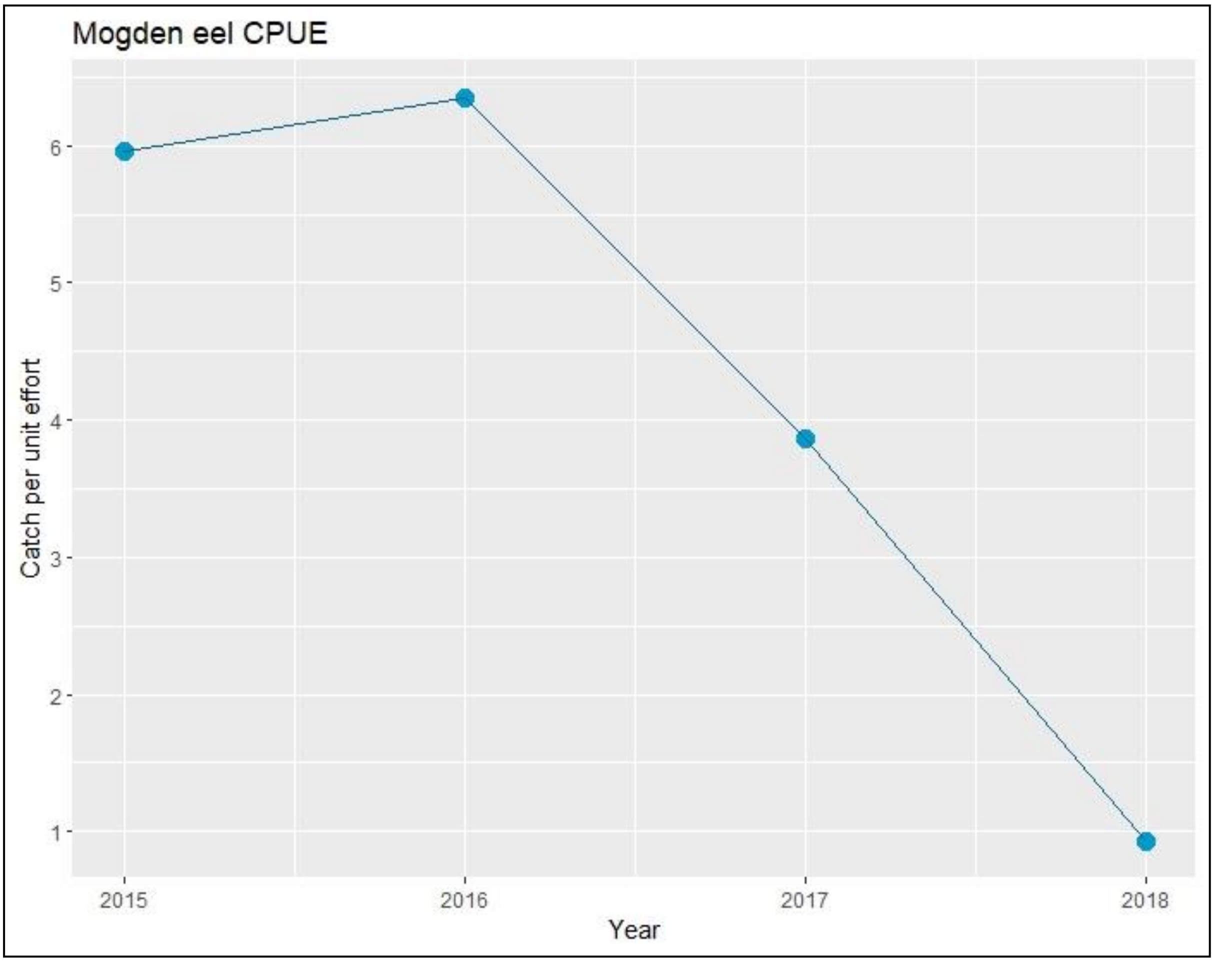


Figure 22: CPUE for eel catches at Mogden

ZSL have trapped elver for 16 years in the wider Thames basin at 22 sites (Pecorelli et al. 2019). Variation of catches between years is seen at all sites. There are many factors that impact catches and may account for these variations. Some of these factors include changes in recruitment from the North Atlantic across Europe (analysed and reported by The International Council for the Exploration of the Sea (ICES) annually), flow dynamics in the tidal Thames, and behaviour of eel at the weirs where the traps are located. The aim of trapping at Mogden STW was to demonstrate recruitment of elver into the Crane. A 2021 study by OHES recorded an eel biomass of 1.6 g m^2 and a range of eel sizes between 100mm (young of the year) up to 340mm in the Lower DNR (Tomlinson & Hands 2021). The impacts of barriers on fish migration, including eels, in the Crane catchment is explored in depth in a separate report.

3.4. EA freshwater macroinvertebrate data

3.4.1. Analysis

Sampling locations were limited to those that had more than 10 years of data recorded and fell within the study area. Macroinvertebrate data were further limited to samples collected by standardised 3-minute kick-netting. Environment Agency freshwater macroinvertebrate data include a number of pre-calculated environment indices, each one calculated using presence/absence of certain species that are sensitive to a particular stressor. Using a multi-metric approach, in which multiple indices are analysed and trends are compared, can help to identify which stressors may be impacting invertebrate populations in a water body (Extence et al. 2017). This analysis focused on four indices, which are listed and explained in Table 7.

Table 7: Environment Agency aquatic macroinvertebrate indices used to analyse macroinvertebrate health at long-term sampling sites.

Acronym	Full name	Stressor/Indicator	Interpretation
BMWP-ASPT	Biological Monitoring Working Party - Average Score Per Taxa (now updated to WHPT)	Organic pollution	Low ASPT indicates pollution-sensitive species are not present, suggesting high organic pollution
NTAXA	Number of taxa	General environmental health	Low NTAXA indicates low species diversity
LIFE	Lotic-invertebrate Index for Flow Evaluation	Flow	Low LIFE score indicates low flow, slow-moving or still water
PSI	Proportion of Sediment-sensitive Invertebrates	Sediment	Low PSI score indicates high sedimentation, often linked to a low LIFE score (slower flows increase sedimentation)

3.4.2. Results and discussion

Long-term sampling locations in the catchment with at least 10 years of data available were identified and mapped (Figure 23). There were nine sampling sites in the catchment that fit this criteria. Sampling locations in the relevant EA datasets are referred to by ID number, rather than site name. The site names on the graphs and the maps have been set for ease of reference, but their EA ID numbers are also included on the map

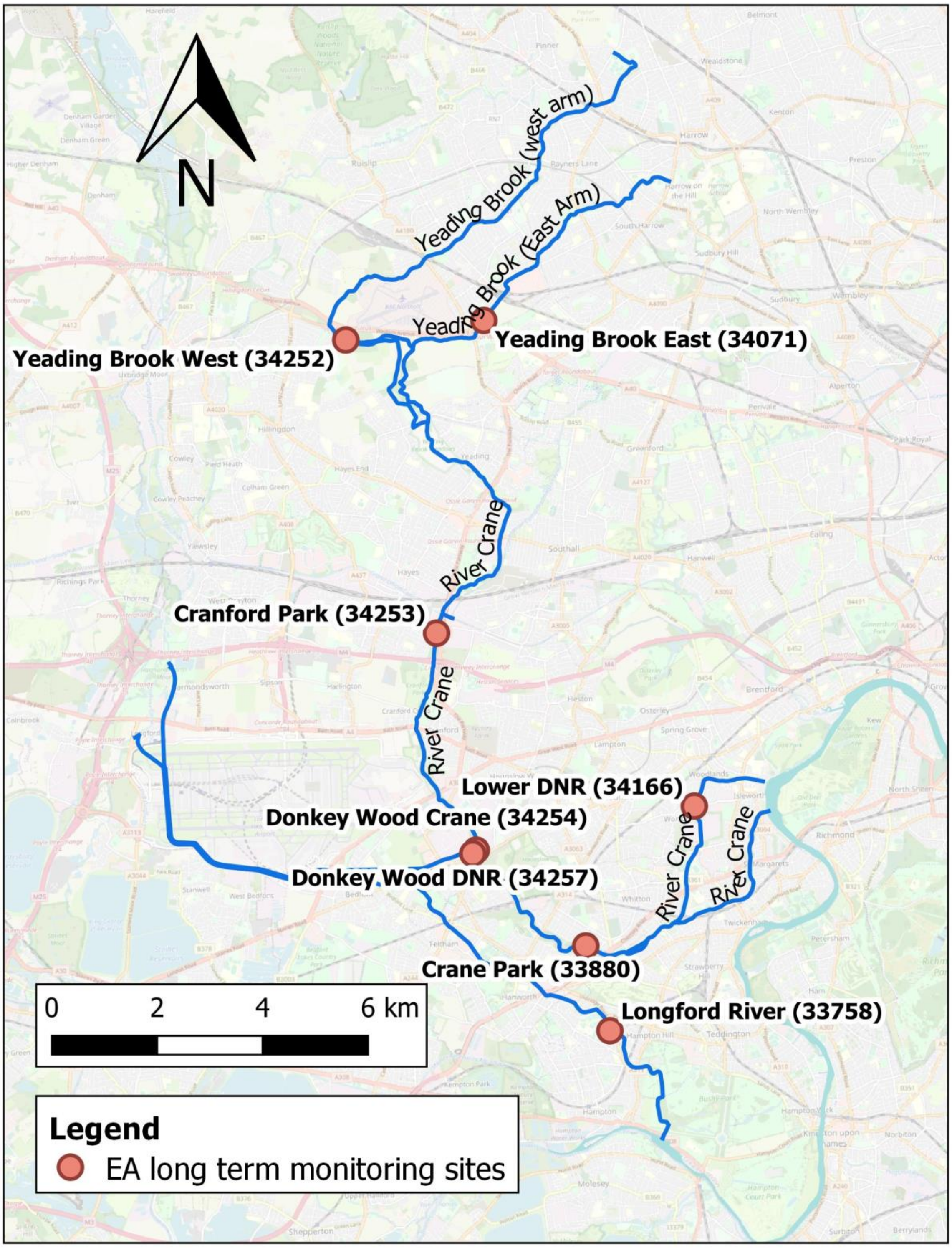


Figure 23: Map of long-term EA aquatic invertebrate monitoring locations with at least 10 years of data (EA site ID numbers in parenthesis).

The species listed in Table 8 are invertebrate species found in the Crane catchment over the past 10 years that, according to Leeming & England 2004, have a limited distribution in London and are associated with clean and higher quality rivers.

Table 8: Invertebrate species found in the Crane catchment that are associated with clean and high quality rivers (Leeming & England 2004).

Scientific name	Taxon group
Agapetus fuscipes	Insect - caddis fly (Trichoptera)
Athripsodes cinereus	Insect - caddis fly (Trichoptera)
Ceraclea dissimilis	Insect - caddis fly (Trichoptera)
Ceraclea senilis	Insect - caddis fly (Trichoptera)
Cyrnus trimaculatus	Insect - caddis fly (Trichoptera)
Glyphotaelius pellucidus	Insect - caddis fly (Trichoptera)
Goera pilosa	Insect - caddis fly (Trichoptera)
Lype	Insect - caddis fly (Trichoptera)
Molanna angustata	Insect - caddis fly (Trichoptera)
Polycentropus flavomaculatus	Insect - caddis fly (Trichoptera)
Rhyacophila dorsalis	Insect - caddis fly (Trichoptera)
Calopteryx splendens	Insect - dragonfly (Odonata)
Baetis scambus	Insect - mayfly (Ephemeroptera)
Centroptilum luteolum	Insect - mayfly (Ephemeroptera)
Ephemera danica	Insect - mayfly (Ephemeroptera)
Bithynia leachii	Mollusc

The four invertebrate indices included in this analysis were already calculated for each sample within the EA datasets. These values were plotted by index, and by water body (Figures 24-28). There were enough data to calculate linear trends for each site.

Table 9: ASPT score thresholds and their associated water quality descriptions.

ASPT score	Quality
>/= 6	Excellent
5.0 - 4.9	Good
4.2 - 4.9	Fair
3.0 - 4.1	Poor
< 3	Seriously Polluted

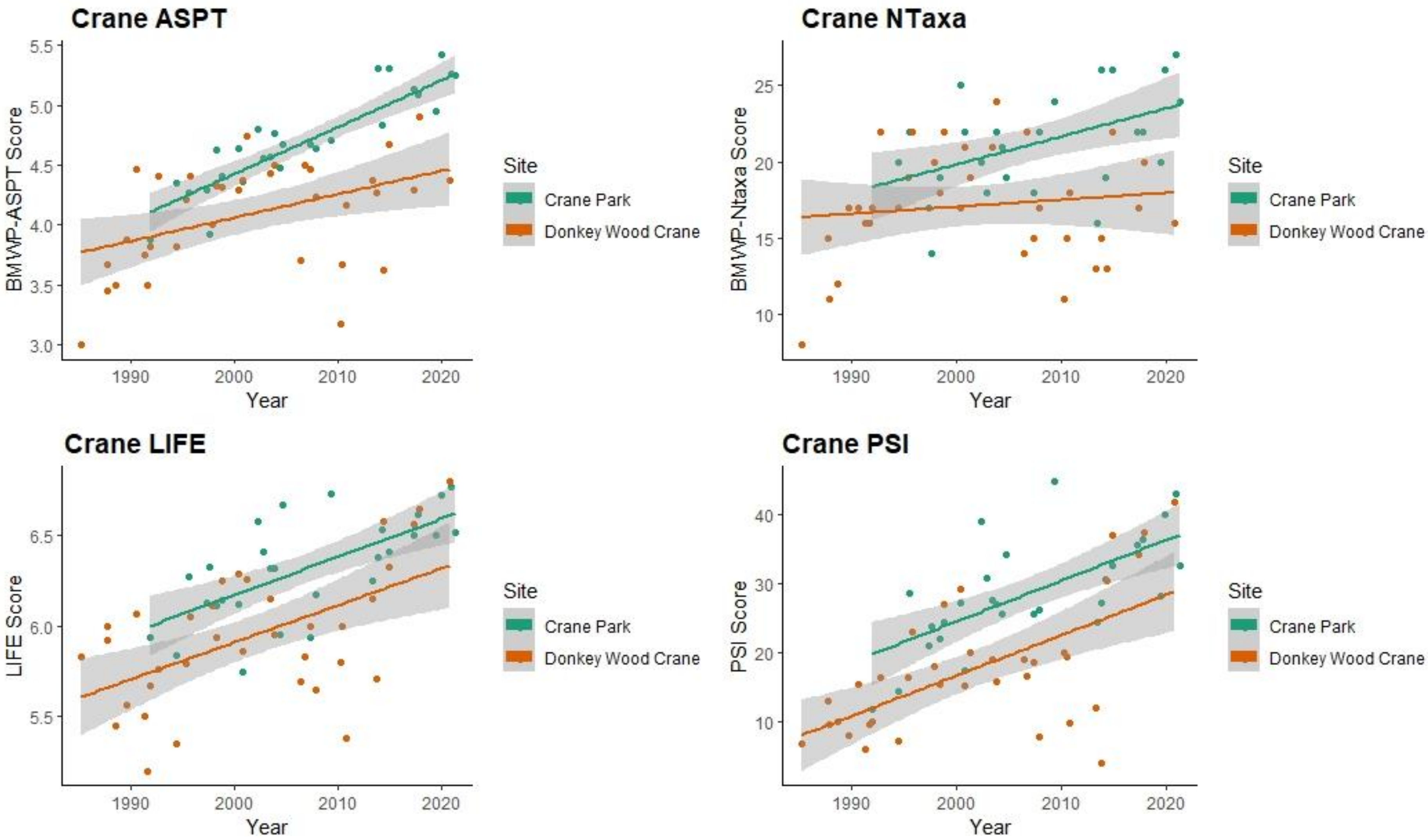


Figure 24: ASPT, NTaxa, LIFE and PSI scores for the two monitoring sites on the River Crane. The grey shaded area shows standard error in the linear models.

Linear trends for two of the River Crane monitoring sites (the two sites furthest upstream) increased between 1990 and 2020 for all four indices. The impacts of the 2011 pollution event can clearly be seen at site the 'Lower Crane 'site (in purple), with a clear drop observed across all indices and water quality represented by ASPT reaching into the “Poor” status category. However, in the past 5 years these two sites have recorded the highest values for almost every index, indicating recovery in these aquatic invertebrate communities.

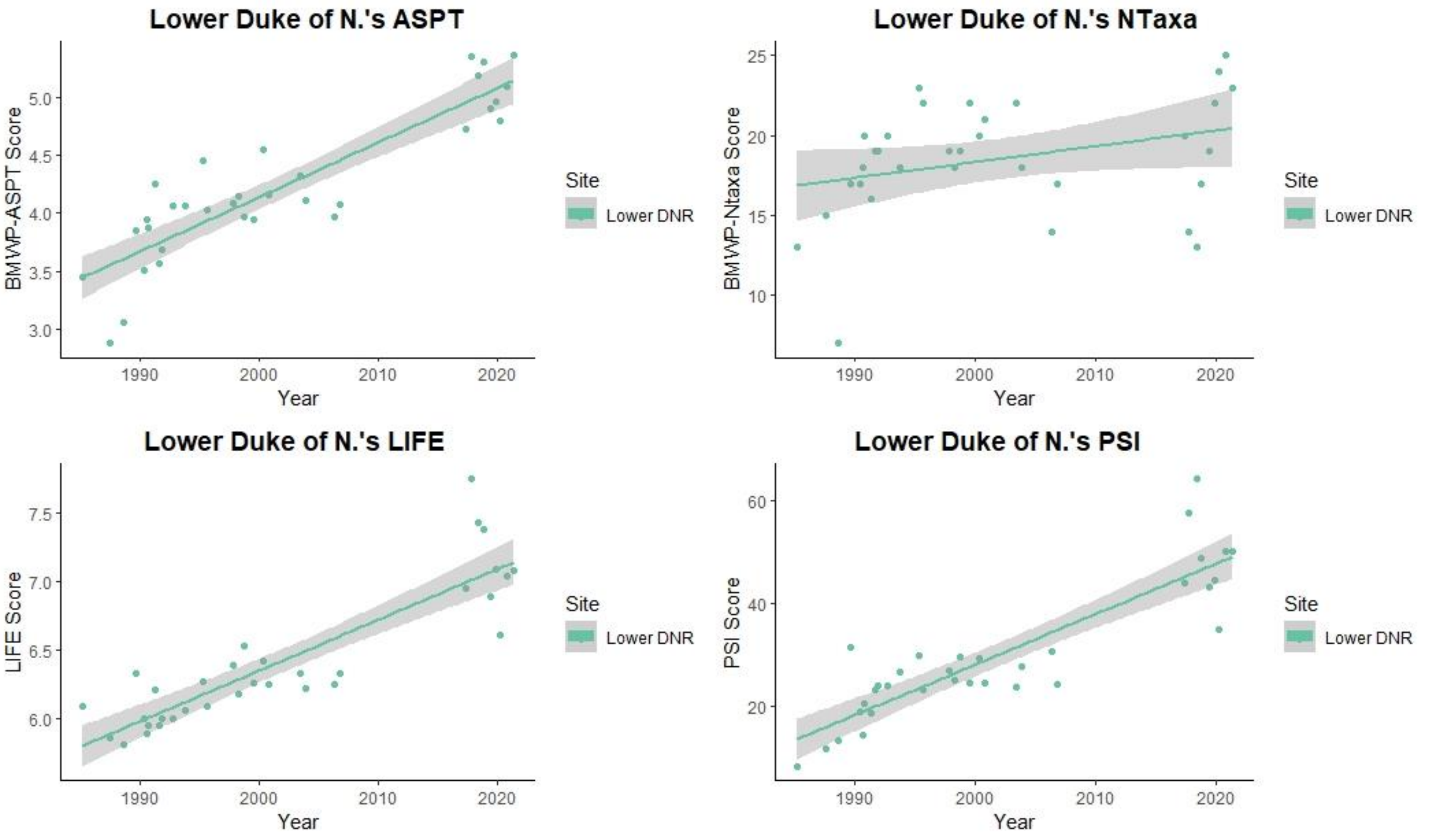


Figure 25: ASPT, NTaxa, LIFE and PSI scores for the one site on the Duke of Northumberland’s River. The grey shaded area shows standard error in the linear models.

One of the Duke of Northumberland's monitoring sites is located on the lower stretch of the river, just before its confluence with the River Thames. This site has experienced consistent improvements across all four indices. Recent years in particular show notable increases in LIFE, PSI, and ASPT scores.

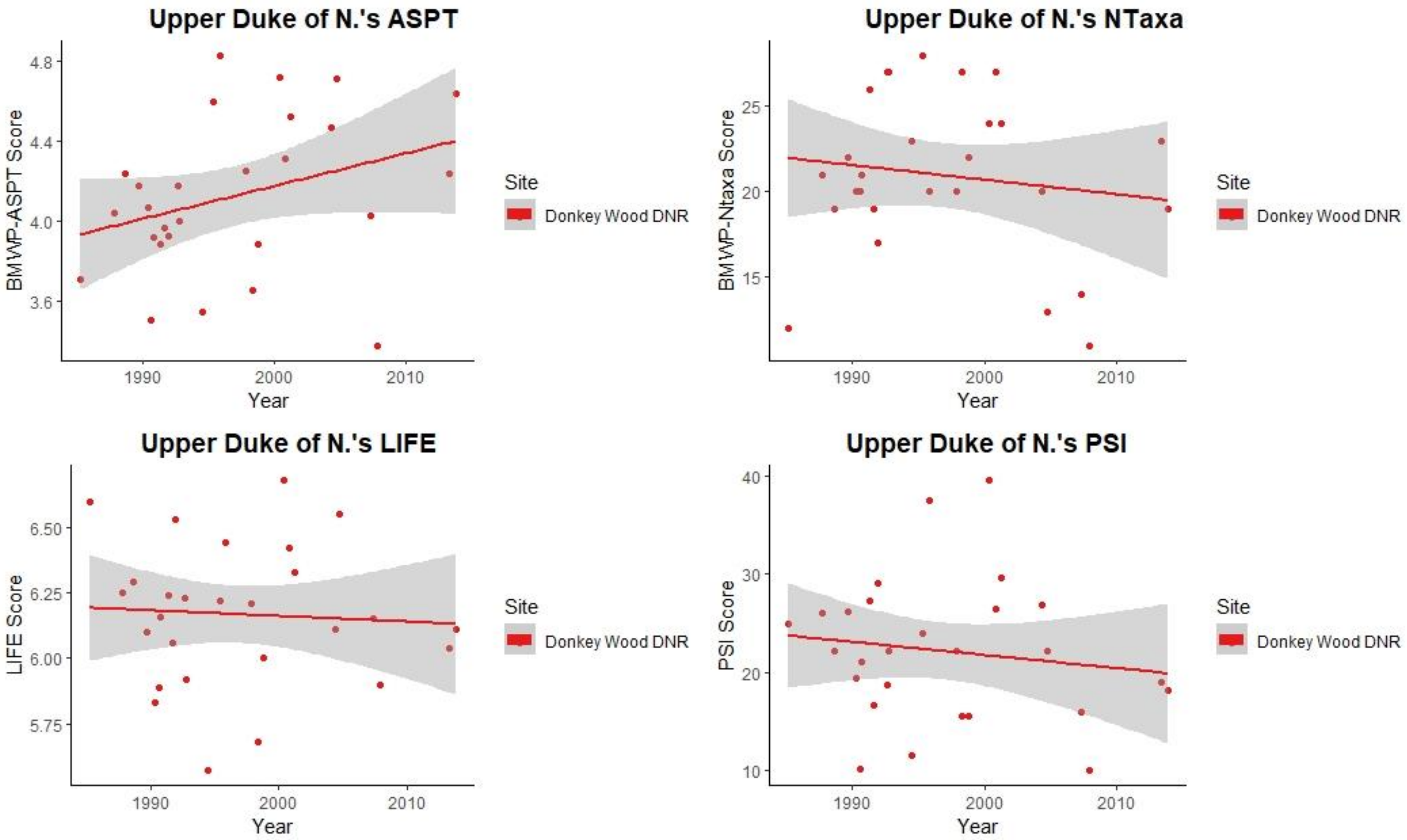
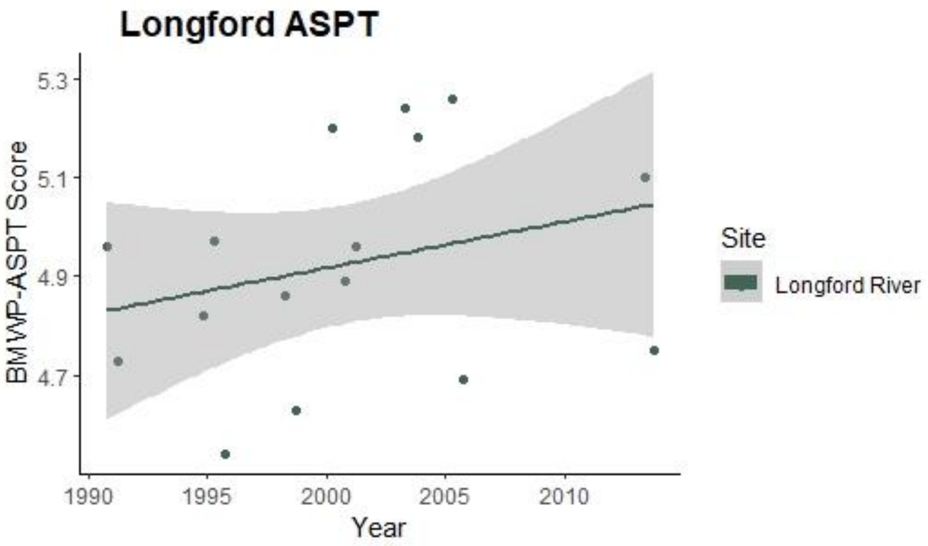
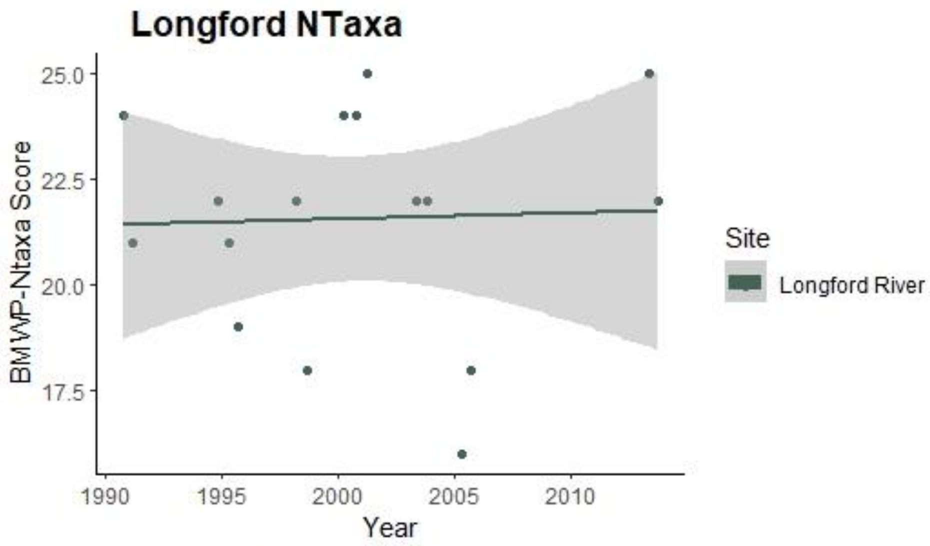
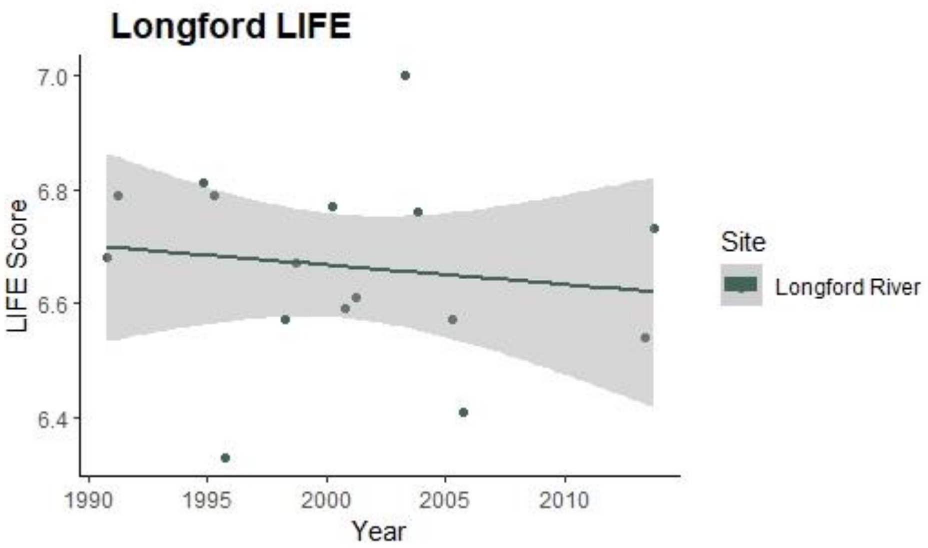


Figure 26: ASPT, NTaxa, LIFE and PSI scores for the one site on the Duke of Northumberland's River. The grey shaded area shows standard error in the linear models.

The monitoring site located on the Upper DNR, just before its confluence with the River Crane, has seen declines across all indices but one: BMWP. This suggests that low flow and resulting sedimentation are becoming increasingly problematic to invertebrate communities at this site. These data are consistent with the fish data above.







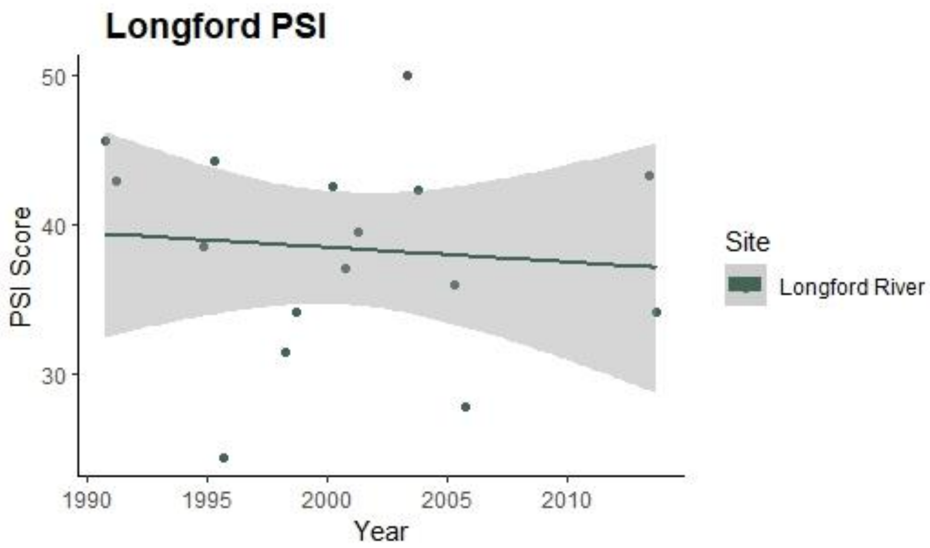


Figure 27: ASPT, NTaxa, LIFE and PSI scores for the three monitoring sites on the Longford River. The grey shaded area shows standard error in the linear models.

Monitoring on the Longford River took place from 1990-2015. While PSI and LIFE scores appear to be in gradual decline according to linear trends, even the lowest LIFE and PSI scores at this site are higher than those from the other catchment monitoring sites. ASPT and NTaxa are also relatively high scoring for this site, indicating that this is an environment that has supported healthy aquatic invertebrate communities. The lack of data since 2015 means that it is impossible to know if this is still the case.

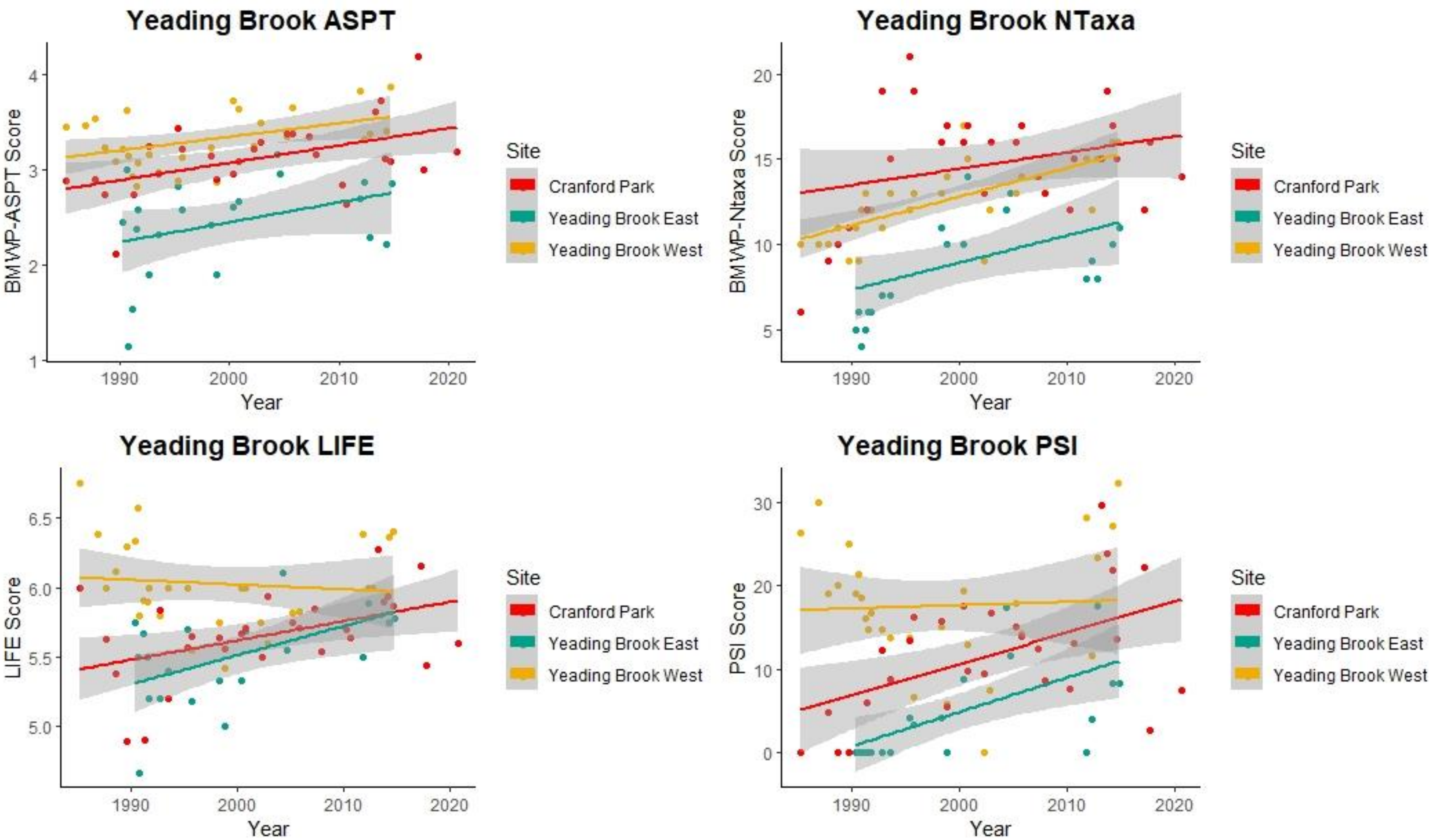


Figure 28: ASPT, NTaxa, LIFE and PSI scores for the three monitoring sites on the Longford River. The grey shaded area shows standard error in the linear models.

All index values for the three sites on the Yeading Brook are significantly lower than those located on the other water bodies. This suggests these sites not only suffer from poor water quality (all three sites fall within the "Poor" or "Seriously Polluted" categories for ASPT score), but also suggests possible sedimentation and low flow. According to the linear models, all four indices have been improving for two of the Yeading Brook Sites. However, the site located on Yeading Brook West has seen a gradual decline in LIFE and PSI scores. It should be noted that Yeading Brook East and Yeading Brook West are separate watercourses that eventually join together into the Yeading Brook.

3.5. Riverfly Monitoring Initiative (RMI) data

3.5.1. Analysis

Riverfly Monitoring Initiative (RMI) sampling has been conducted in the Crane catchment in 11 locations since 2014. The sampling follows standardised methodology developed for citizen scientists (Brooks et al. 2019). Trained volunteers complete a 3-minute kick sample at a sample site, and an overall score is then calculated for that sample using the species identified and their associated values (Brooks et al. 2019). This score serves as an early indicator of water pollution, based on pollution-sensitive species. Each site has a 'trigger level ʾscore, and if a site scored below this level, the Environment Agency would be contacted to survey the river and investigate any sources of pollution. Sample sites were mapped (Figure 29), and results for each location were plotted over time. The trends in these data were compared to trends in EA invertebrate ASPT score data, as both are indicators of ecological health in relation to water quality.

3.5.2. Results and discussion

The RMI sampling locations are marked on the map in Figure 29. The findings from these locations are presented by water body. The only water body with no sampling locations was the Longford River.

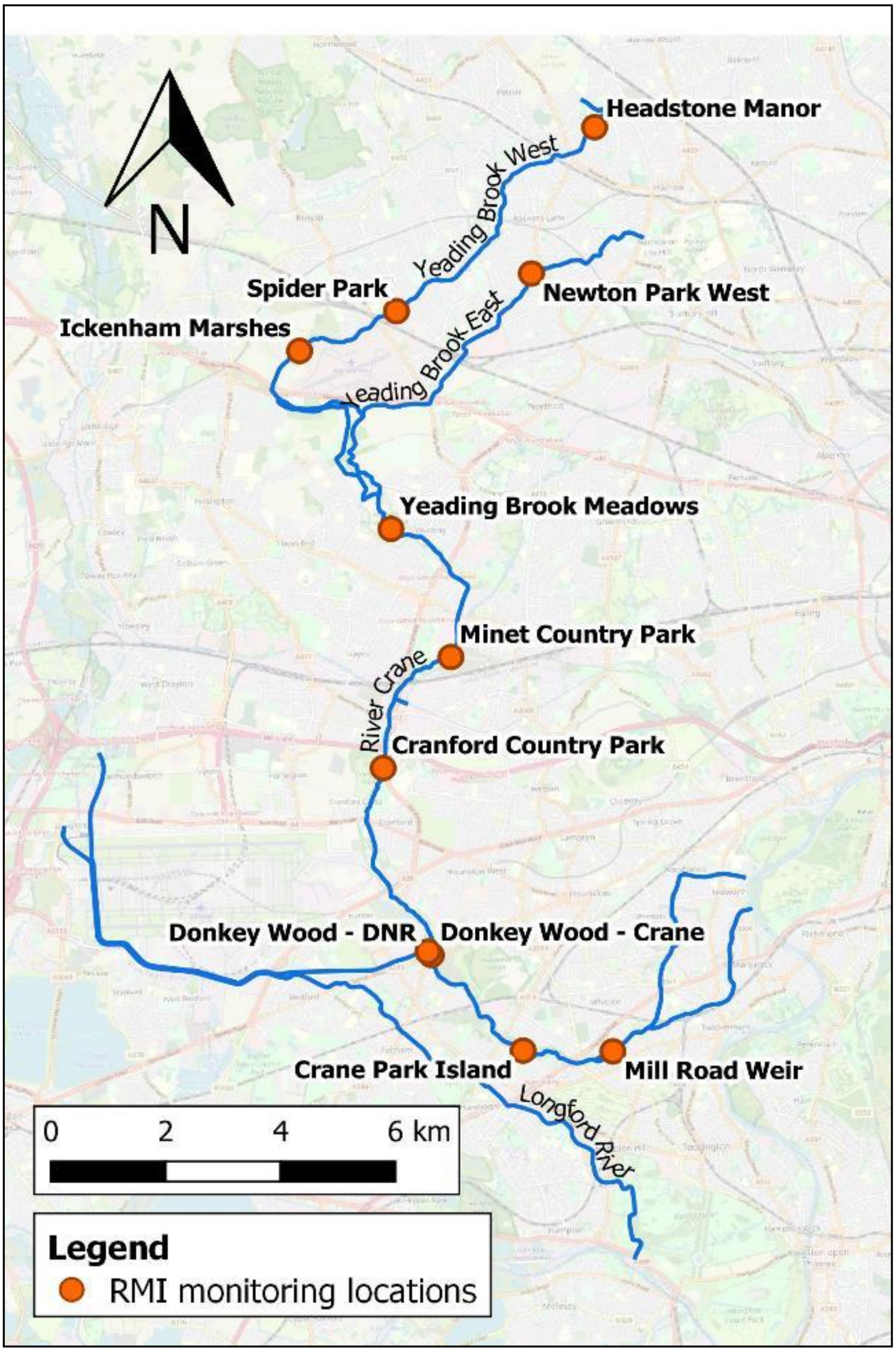


Figure 29: RMI sampling locations in the Crane catchment.

Figures 30-32 show the RMI scores for all sites in the Crane catchment. The scores for each site are plotted by water body (Crane, Yeading Brook, Duke of Northumberland's), and linear models for each site are included. The RMI scores from Yeading Brook sites were significantly lower than other water bodies, with almost all samples scoring between 0 and 6. In contrast, on the River Crane, scores ranged from 0 to 12. This aligns with findings from the EA invertebrate data analysis, which also found that samples from the Yeading Brook had significantly lower invertebrate index scores than other water bodies.

According to the plotted results, all sites in the Crane catchment have experienced, on average, a decline in RMI score (besides Yeading Brook Meadows). As an indicator of water quality, this suggests a deterioration in water quality across the catchment. This finding is in contrast with the trends in EA's ASPT scores for the catchment over the same time frame, which show an improvement over time. In theory, as these RMI and ASPT are both water quality indicators, they should therefore follow the same trends. The reason for this disparity is unknown and should be further investigated.

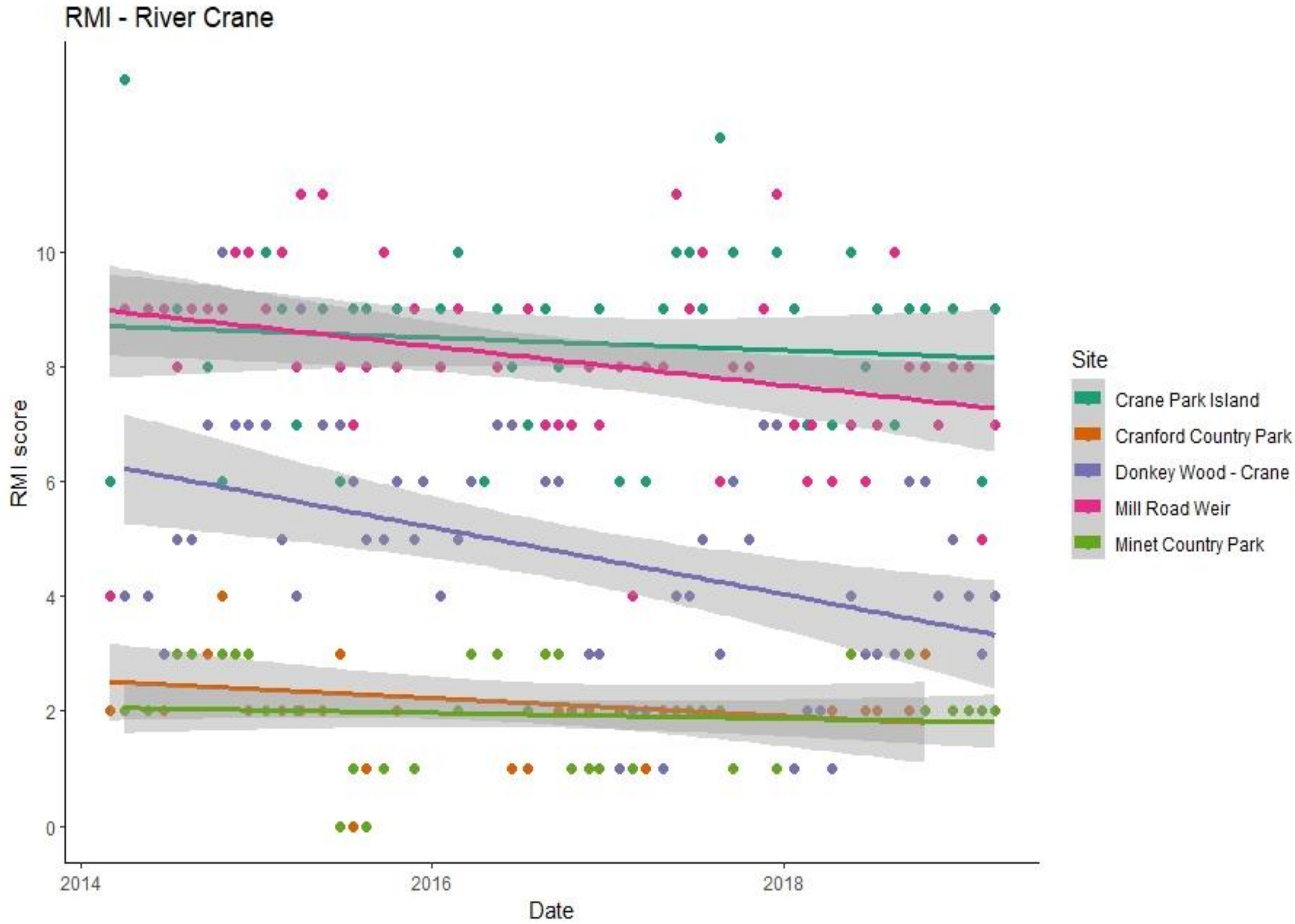


Figure 30: RMI results and fitted linear regression by site on the River Crane. The grey shaded areas show standard error in the linear models.

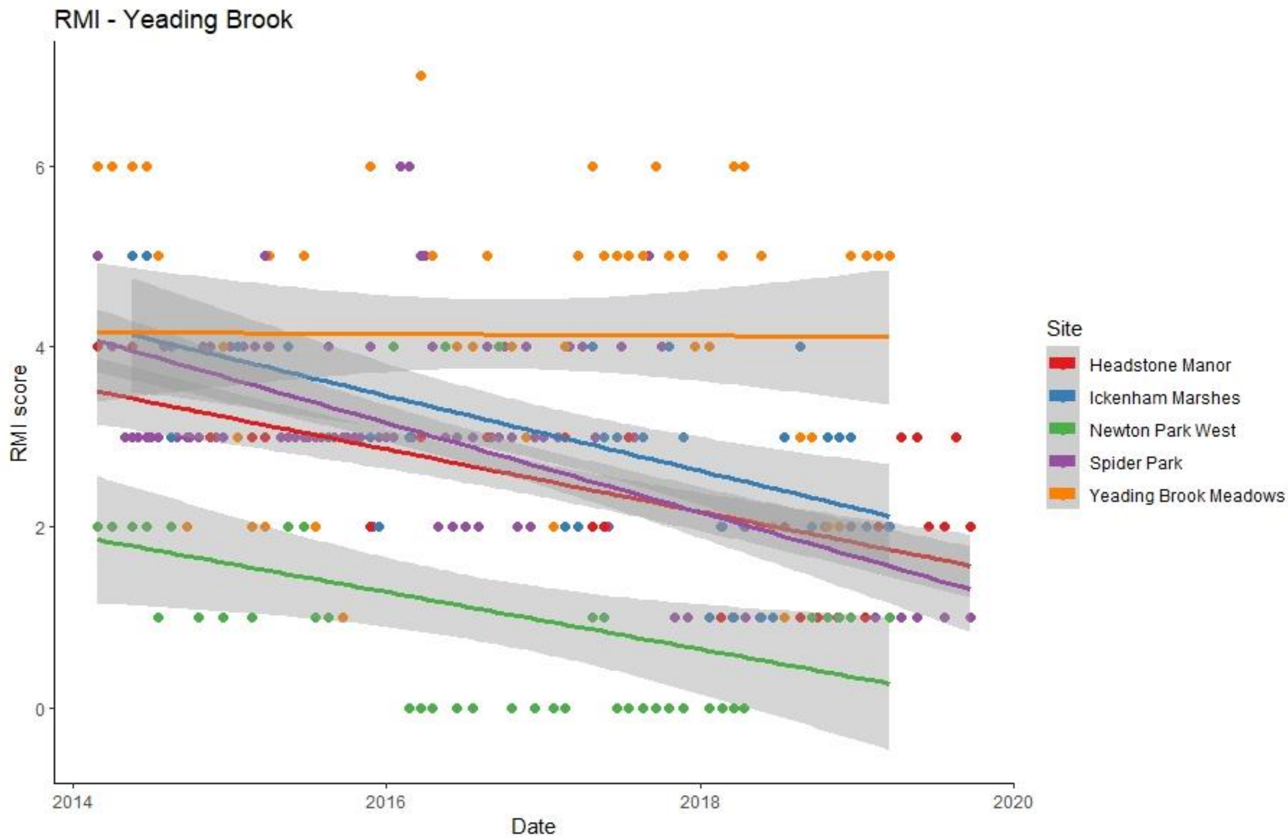


Figure 31: RMI results and fitted linear regression by site on the Yeading Brook. The grey shaded areas show standard error in the linear models.

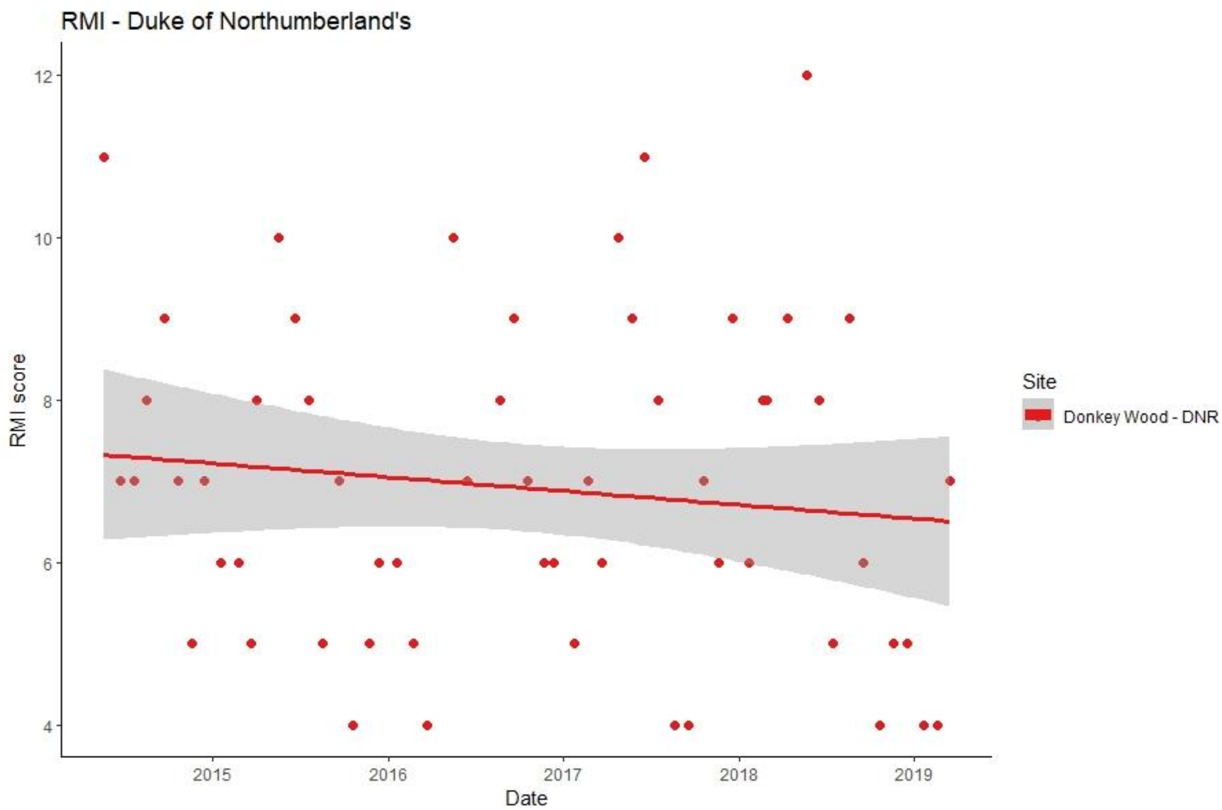


Figure 32: RMI results and fitted linear regression by site on the Duke of Northumberland s River. The grey shaded areas show standard error in the linear models.

4. Terrestrial Species

4.1. GIGL presence/absence species data analysis

Species data stored in the GIGL database comes from many different sources, and date back as far as 50 years. Some data are submitted by environmental organisations or councils who have conducted or commissioned systematic ecological sampling of a particular area. Other data are submitted by members of the public who have observed and identified an animal. The limitations associated with data gathered from many sources are discussed in the limitations section, on page 86. Each individual observation includes associated information about location, species, date, etc. Most data in GIGL report species ʾobservations as an exact point, however some are shown at courser scales. To keep findings standard throughout the analysis, and to stay confidently within the focus area bounds, only point data was analysed. Upon receipt from GIGL, data had already been split into the following taxonomic groups: amphibians, birds, invertebrates, mammals, plants, and reptiles. Presence (and where available, absence) data for identified species and groups of interest, listed in Figure 33, were mapped separately, showing changes in distributions since 2000 over 5-year increments. These species and groups of interest to investigate were identified by the Smarter Water Catchments team.

Mammals	Birds	Invertebrates	Reptiles	Plants
• Water voles • Badgers • Hedgehogs • Bats	• Kingfisher • Owls • Other raptors	• Priority species	• Slow worms • Lizards • Snakes	• Veteran trees

Figure 33: Identified terrestrial groups and species of interest, as identified by the Smarter Water Catchments team.

Along with analysing the species distribution data, species-specific habitat and population connectivity requirements for the above species of interest were investigated and reported.

4.2. Results and discussion

4.2.1. Mammals

Water vole (Arvicola amphibius)

The European water vole lives alongside water bodies, building burrows into riverbanks and feeding on waterside plants (The Wildlife Trusts 2022a). This species has been heavily predated by the American mink and has also suffered from extreme habitat loss (The Wildlife Trusts 2022a). Due to these threats and subsequent population declines, the species is protected under the Wildlife and Countryside Act 1981.

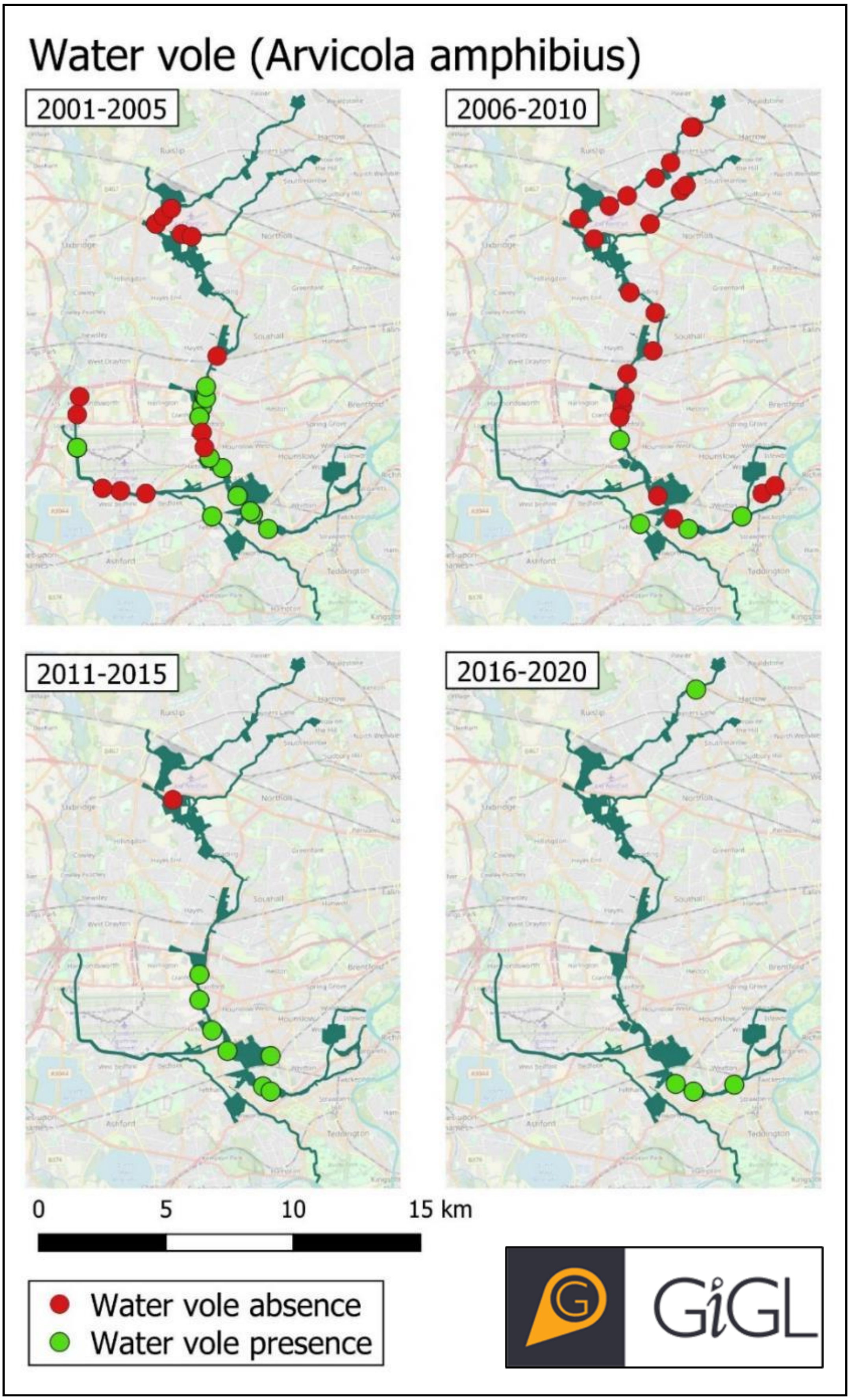


Figure 34: Water vole presence and absence GIGL data from 2000-2020.

According to GIGL presence/absence data, the distribution of water vole tends to be concentrated around Hounslow Heath and Crane Park. There has been a considerable decline in water vole survey efforts. The extensive survey efforts between 2001-2010, seen by the high number of presence/absence points on the two top maps, were carried out by the London Wildlife Trust. However, these surveys have not been repeated since 2010. The observations shown from 2016-2020 were all sightings submitted to GIGL by members of the public. While it is possible that water voles are present on the Yeading Brook West, it is recommended to ground truth this observation from 2016, submitted by a member of the public.

The ideal water vole habitat is made up of large reed beds and grazing marsh sites, without the presence of predatory mink (MacPherson & Bright 2011). When considering plans to improve connectivity for water voles, an important consideration is connectivity between populations. It has been found that the most successful populations are larger, well-connected populations. Smaller and patchier populations, often called "islands," are at much higher risk of extinction (MacPherson & Bright 2011). However, when they exist closer together and with greater frequency, these smaller "islands" allow for immigration of individuals between populations and help to reinforce the larger population by introducing genetic diversity. In addition to population dynamics, another important consideration for water vole connectivity is to ensure that habitats are not only connected linearly as they follow the river channel but are also connected laterally to habitats that are found alongside the river, such as wetlands, reedbeds and smaller streams within the river corridor.

Water Vole Case Study

Despite a disappearance of the water vole in Greater London from over 72% of the sites they occupied prior to 1997, a few populations remain around London's periphery including in the Lower Crane corridor. In addition to presence absence data that they provide GIGL, London Borough of Richmond Upon Thames (LBRuT) have commissioned two tranches of water vole surveys in recent years (FOA Ecology Ltd 2016). From 2016 to 2018, LBRuT surveyed the Duke of Northumberland's River (DNR) at Twickenham Stadium four times. Based on these surveys water vole populations appeared stable to 2017 but were absent in 2018, believed to likely be a result of mink predation and leaving just a small group on Crane Park Island nature reserve. Surveys carried out in 2020 on the DNR near Twickenham Stadium, the Stoop Stadium and Kneller Gardens and on the Crane River at Little Park and near Hospital Bridge Road, all reporting no signs of water vole presence at these areas despite some of these being known to contain small populations of water vole (FOA Ecology Ltd 2020).

Since 2021 as part of a plan to restore water vole populations through re-introduction, LBRuT contractors and volunteers from Friends Of the River Crane Environment (FORCE) have been using latrine rafts to monitor remaining populations. Habitat mapping has also been carried out to identify key areas of habitat that are currently being used by vole but also areas that could be improved to support water vole in the future.

Mink monitoring is taking place in LBRuT in targeted areas where mink have either been spotted or left field signs near extant water vole populations. LBRuT have plans to upgrade monitoring technology and extend their mink monitoring to monitor more locations on the DNR and the Crane River.

Habitat improvement works are taking place in preparation for the return of water voles, for instance. Riparian thinning and coppicing works have started at three locations within the Little Park site at the river's edge and aims to increase light levels to provide graduated vegetation height and promote the growth of marginal vegetation along the river edge/bank which water voles require for shelter and feeding habitat (pers. comms. Steve Marshall, LBRuT) In the future, to support the re-introduction of water vole, LBRuT plan to work alongside FORCE, ZSL and other partners to support a multi method, community engaged long term monitoring plan for water vole.

Badgers (Meles meles)

The European badger lives in a variety of habitat types, including grassland, heathland, farmland, woodland, and suburban areas. Badgers live underground in burrows called setts, and are omnivorous, feeding on small mammals, worms, as well as fruit and other plants. Badger populations in England and Wales have been increasing (Matthews et al. 2018). Persecution of badgers was a threat to the species until the Protection of Badgers Act was introduced in 1992. Since then, the species ʾprimary threats include roads, habitat loss, illegal persecution, and legal badger culls due to spread of bovine tuberculosis. Badgers are also protected under the Wildlife and Countryside Act, 1981.

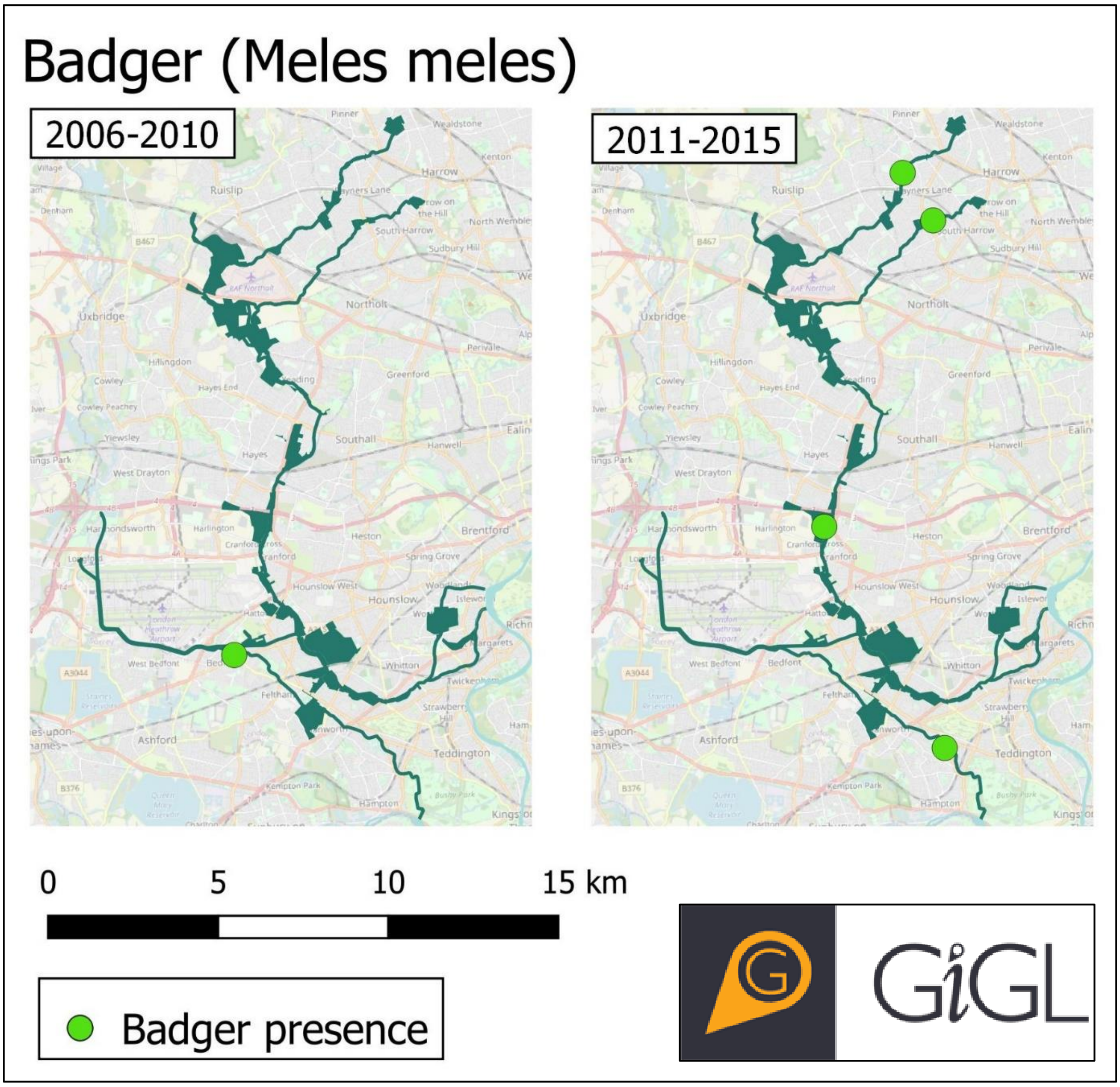


Figure 35: Badger presence GIGL data from 2006-2015.

Badger monitoring across the catchment has been minimal, according to the data stored through GIGL. There have been no badger occurrences recorded since 2015 in the catchment. The occurrences on the Longford River shown on the maps above were observed badger setts from Habitat Surveys carried out by Royal Parks, however this has not taken place since 2015.

When considering connectivity for badgers, roads are a primary concern (Matthews et al. 2018). Badgers need a well-connected network of suitable habitat that are not intersected by major roads, including areas where they can create setts. Their setts are most often located in woodlands or hedgerows.

Hedgehogs (Erinaceus europaeus)

The European hedgehog is a mostly nocturnal animal that feeds on a variety of invertebrates and is commonly found in parks, gardens, and the edges of woodland (The Wildlife Trusts 2022b). The main threats to hedgehogs include habitat loss, pesticides, and roads (Mammal Society 2022). Due to these threats, hedgehog populations around the UK have been in decline, and they have been identified by the Red List for Britain's Mammals as at risk of extinction in Britain. They are also provided partial protection under the Wildlife & Countryside Act.

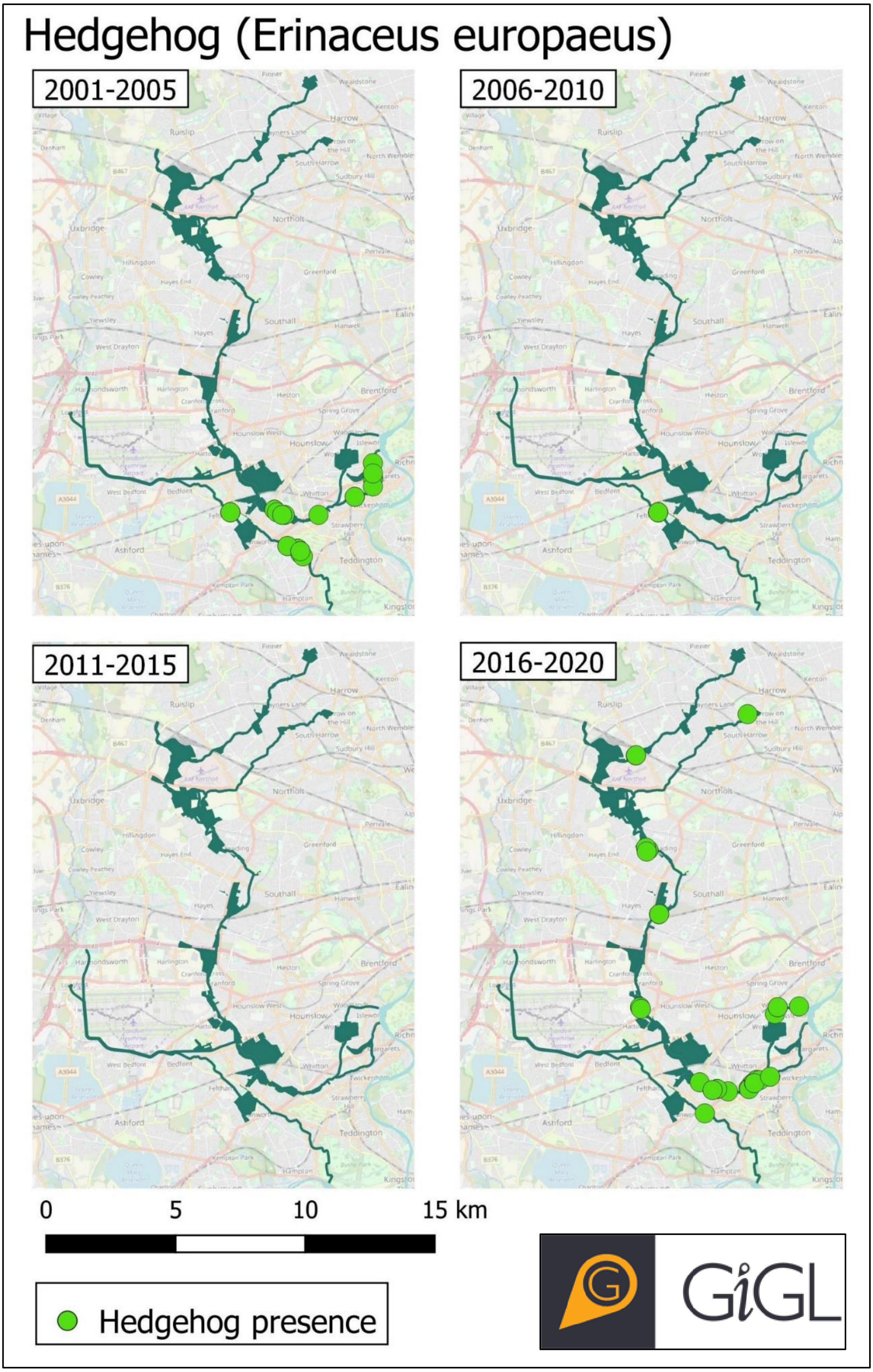


Figure 36: Hedgehog GIGL presence data from 2000-2020.

GIGL's hedgehog presence data from 2016-2020 shows hedgehog sightings along every water body of the catchment, besides the Upper Duke of Northumberland's River. The sightings are concentrated in the lower part of the River Crane and Duke of Northumberland's River. Most of these data were submitted to GIGL from two sources: the People's Trust for Endangered Species' Big Hedgehog Map project, and the London Wildlife Trust hedgehog survey. The People's Trust for Endangered Species' Big Hedgehog Map asks members of the public to submit hedgehog sightings in the UK. The absence of any hedgehog sightings from 2011-2015 most likely reflects the lack of effort, rather than a complete absence of hedgehogs. However, additional data would be needed to confirm this.

In London, hedgehogs have been found most commonly in gardens, allotments, and parks (Turner et al 2021). One of the main challenges to their connectivity in urban and suburban areas, and one of the main causes of their mortality, is traffic and roads. For this reason, to support urban and suburban hedgehog populations, there needs to be a connected network of gardens, allotments, and parks.

Hedgehog suitability map

Hedgehog sightings data from several organisations that collected and collate citizen science data were used to create a hedgehog habitat suitability map (Turner et al. 2021). Researchers from the Institute of Zoology used spatial occurrence data from several sources, spatial environmental predictor variables, and threats to hedgehogs to identify the areas with the most preferred hedgehog habitat in London. The resulting habitat suitability shapefile was clipped to the study area, and areas of preferred hedgehog habitat were identified.

Figure 37 below shows the habitat suitability map produced by Turner et al 2021, clipped to the report's terrestrial study area. This map is presented as a heatmap, with the red and orange areas indicate hedgehog "hotspots", or areas more suitable areas for hedgehog habitat, while blue and green areas indicate less suitable habitat areas. The habitat suitability for hedgehogs across London was calculated using a model that looked at hedgehog occurrence records and location variables such as green spaces, infrastructure, and presence of competitive species (i.e. badgers), and determined which variables meant that hedgehogs were more likely to be present. As expected from the GIGL data map above, the most concentrated areas of suitable hedgehog habitat in the study area are along the lower Crane, the Longford River, and the lower Duke of Northumberland's River.

Along with providing valuable information about hedgehog habitat in the catchment, this spatial dataset provides a useful example of the type of output that can be created using citizen science sightings data.

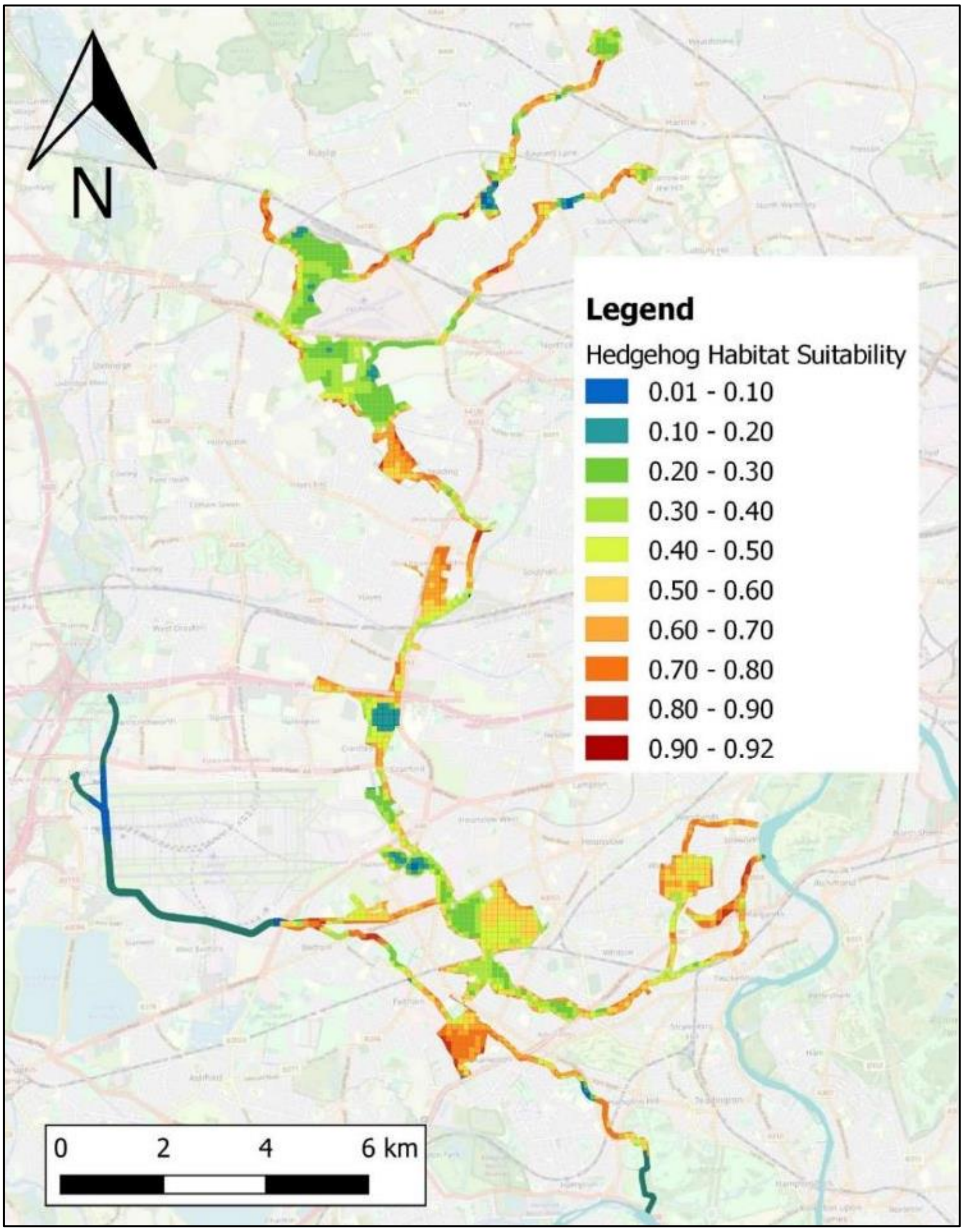


Figure 37: Hedgehog habitat suitability map in the study area, using spatial results from Turner et al 2021. Note that the suitability layer does not cover the Duke of Northumberland s River beyond its confluence with the Longford River.

Bats

There are 7 species of bat that have been identified within the study area (Table 10) out of 17 total UK-breeding bat species. All species of bat in the UK feed on insects, so when foraging for food, they are found in areas where insects are plentiful (Bat Conservation Trust 2022). Rivers and other water bodies are ideal habitats, as they provide water for rehydration, and they attract insects. Roosting locations differ based on species and time of year, but common roosting areas include trees, buildings, and underground. Bat populations face many threats, including habitat loss, roads, wind farms, and cat attacks, among others (Bat Conservation Trust 2022). In the UK, all species of bats are protected under the Wildlife & Countryside Act, along with their roosting sites.

Table 10: Bat species identified within the study area, by common and Latin name, and accompanying images.

Scientific name	Common name	Habitat	Image
Plecotus auritus	Brown Long-eared Bat	• Grassland • Heathland • Woodland	
Pipistrellus pipistrellus	Common Pipistrelle	• Grassland • Heathland • Farmland • Wetland • Woodland • Suburban	
Myotis daubentonii	Daubenton's Bat	• Freshwater • Woodland	
Nyctalus leisleri	Lesser Noctule	• Woodland • Farmland	
Pipistrellus nathusii	Nathusius's Pipistrelle	• Freshwater/ Riparian • Woodland	
Nyctalus noctula	Noctule Bat	• Grassland • Heathland • Farmland • Wetland • Woodland • Suburban	
Pipistrellus pygmaeus	Soprano Pipistrelle	• Woodland • Parks and gardens	

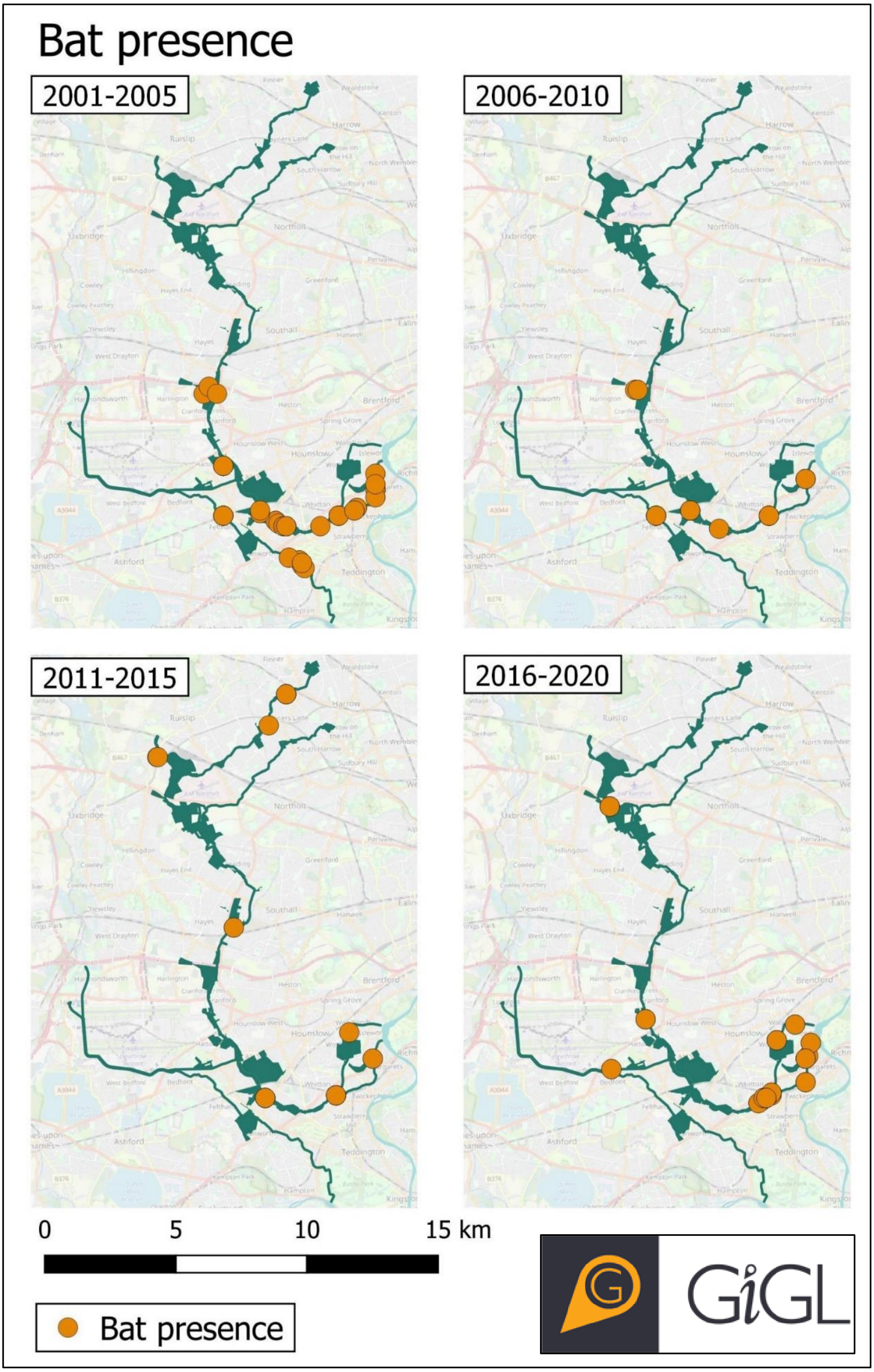


Figure 38: Presence of bats in the study area.

All 7 species have been observed in the study area at some point in the past 5 years. Some of the observations from these recent years have been submitted by Animal Ecology and Wildlife Consultants, who have conducted surveys using mist nets and harp traps. Another source of data from 1997-2016 was the Bat Conservation Trust's Bat Monitoring Program – Waterway Survey. According to their website, these surveys have been restricted since the COVID-19 pandemic. Another source of data is the London Bat Group, which is a voluntary charity who acts throughout London to protect bats and educate other about the importance of their conservation.

There are several important elements to preserve bat habitat connectivity. Bats prefer areas with 'landscape elements' such as trees, shrubs, or other tall structures (Frey-Ehrenbold et al. 2013). Furthermore, bats prefer areas that have a connected network of these elements. Bats also prefer areas with tall elements, such as trees, rather than open areas that may only have a few short hedges. One of the main threats to bat connectivity are roads, which should be a high priority consideration when improving connectivity for bats (Frey-Ehrenbold et al. 2013). This means creating or maintaining connected corridors for bats with suitable habitat and tall elements that do not cross any main roads. This also means prioritising areas that avoid main, busy roads when creating bat habitats.

Bat Case Study

In addition to the presence/absence data that has been reported to GIGL, there have also been bat surveys undertaken in the catchment, which help determine the presence of different bat species in the catchment. In 2020, Friends of River Crane Environment (FORCE) installed an Anabat Swift bat detector at two different locations near Kneller Gardens (Briggs et al. 2020). The data collected by these detectors were analysed by the Bat Conservation Trust, and the findings showed that six species of bat had been detected over the entire monitoring period (about two weeks in total). These six species were all reflected in the GIGL data, with only the brown long-eared bat not being detected. The most detected species were soprano pipistrelle and common pipistrelle.

Table 11: Bat species identified near Kneller Gardens in 2020.

Scientific name	Common name
Pipistrellus pipistrellus	Common Pipistrelle
Species not identified, but likely to be *Myotis daubentonii*	Myotis species (likely Daubenton's bat)
Nyctalus leisleri	Lesser Noctule
Pipistrellus nathusii	Nathusius's Pipistrelle
Nyctalus noctula	Noctule Bat
Pipistrellus pygmaeus	Soprano Pipistrelle

The Friends of River Crane Environment (FORCE) also installed an Anabat Swift bat detector at four locations within Donkey Woods during four separate survey periods between May and August 2021 (Briggs 2021). There was a total of 39 nights monitored across all four monitoring periods. During this monitoring, all seven of the bat species that were reported in the GIGL data were detected. Again, the Myotis species was difficult to verify, but was thought to most likely be Daubenton's bat as this is the most common Myotis species in the area. Again, the most common species were the soprano pipistrelle and the common pipistrelle.

The diversity of species found in these two areas of the Crane both sites suggests that there is currently good foraging and habitat available. The presence of the brown long-eared bat at Donkey Wood indicates that this area provides dark, wooded areas that this species prefers (Briggs 2021). However, the reports also note that there are several other species that are local to the borough but have not been found in these areas of the catchment. These species are the Natterer's bat, and the serotine bat (Briggs 2021). The serotine bat has recently undergone drastic declines in London and has become rare to detect. To improve understanding of bats in the catchment, it is suggested that trapping and radio tracking surveys be undertaken, to confirm the species that are present and to understand where bats are roosting at these sites.

4.2.2. Birds

Owls

All five of Britain's resident owl species have been recorded within the study area (Table 12). Most owls are active at night or at dawn, but some species, such as the short-eared owl, hunt during the day. While some of these species share similarities, they do not all have the same habitat preferences (listed in Table 12). All five of these species are protected under the Wildlife and Countryside Act.

Table 12: The four species of owl that have been identified within the study area, along with their habitat preferences and images.

Scientific name	Common name	Habitat	Image
Strix aluco	Tawny owl	• Woodland • Places with trees (gardens, parks, hedgerows)	
Tyto alba	Barn owl	• Feed in tall grassland • Roost in barns, hollow trees, nest boxes	
Athene noctua	Little owl	• Mixed farmland • Open wooded (not woodland) • Can be found in a range of habitat	
Asio otus	Long-eared owl	• Mixed woodland • Farmland	
Asio flammeus	Short-eared owl	• Farmland • Grassland	

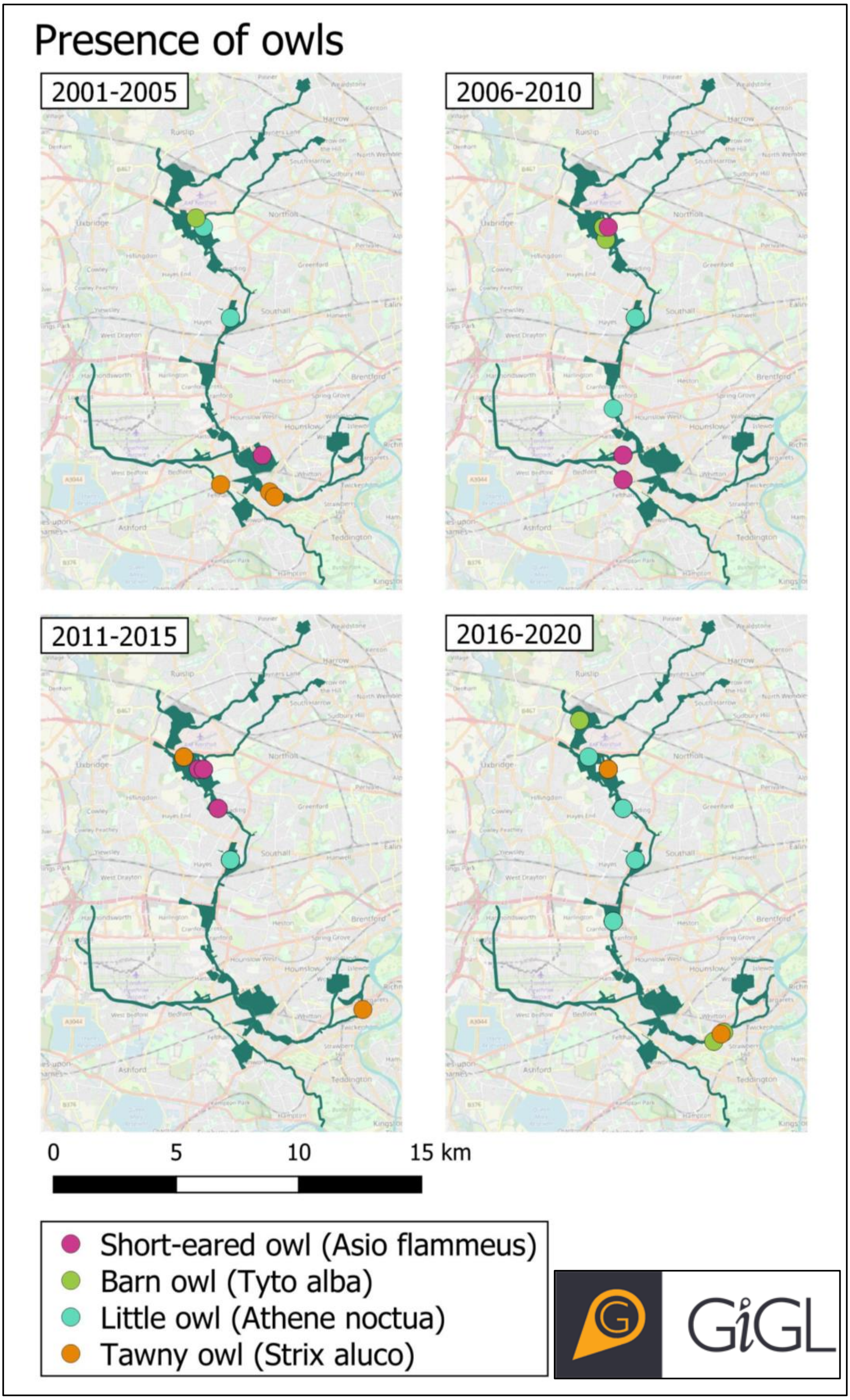


Figure 39: Presence of four species of owls in the study area.

Four of these owl species have been recorded in the study area at least once since 2016, as seen in the maps of Figure 39. The long-eared owl was recorded in 2000 but has not been recorded in the study area since then. The species with the most recorded sightings since 2016 is the little owl. However, due to GIGL data limitations, this does not necessarily mean that it is the most abundant. The main sources of owl occurrence data submitted to GIGL are London Natural History Society Bird Records, and surveys commissioned by the Wildlife Trust or local boroughs. Other sources include Habitats and Heritage species records, London Birdwatching web records, River Crane Sanctuary Wildlife records, and submissions from the public.

As seen by their presence in this urban catchment, many owls inhabit areas in or around urban settings. This is due to the diverse array of habitats found in urban environments, many of which support their prey of choice – rodents (Fröhlich & Ciach 2019). However, owls tend to be strongly impacted by noise pollution, and will not be found in areas where noise impacts their ability to hunt effectively. Studies have found that in urban or suburban areas, owl mortality is higher when roads cut off connectivity between preferred habitats (Silva et al. 2012).

Falcons and other birds of prey

There have been seven bird of prey species (buzzards, hawks, and falcons) identified in the study area since 2016. These species share some similarities, including that they are all predatory species that tend to feed on small birds, mammals, reptiles, and insects. They also share some physical traits including hooked bills, sharp talons, and heightened hearing and sight for hunting. Many of these species occupy similar habitat types, but some are far less abundant than others. For example, it is estimated that there are only 900-1,500 breeding pairs of merlin in the UK, compared to 57,000-79,000 breeding pairs of buzzards (RSPB). These species face many threats, including illegal persecution, rodent poison, pesticides, and loss of habitat area and connectivity. All bird of prey, and their nests, are protected under the Wildlife and Countryside Act 1981.

Table 13: Birds of prey identified within the study area, their habitat types, and an image.

Scientific name	Common Name	Habitat	Image
Buteo buteo	Buzzard	• Woodland • Farmland • Grassland • Heathland	
Falco subbuteo	Hobby	• Woodland • Farmland • Grassland • Heathland • Urban/Suburban • Wetland	

Falco tinnunculus	Kestrel	• Farmland • Grassland • Heathland • Urban/Suburban	
Falco columbarius	Merlin	• Farmland • Grassland • Heathland • Wetland	
Falco peregrinus	Peregrine falcon	• Heathland • Farmland • Wetland • Urban/Suburban	
Milvus milvus	Red kite	• Grassland • Heathland • Farmland • Woodland • Urban/Suburban	
Accipiter nisus	Sparrowhawk	• Grassland • Heathland • Farmland • Woodland • Urban/Suburban	

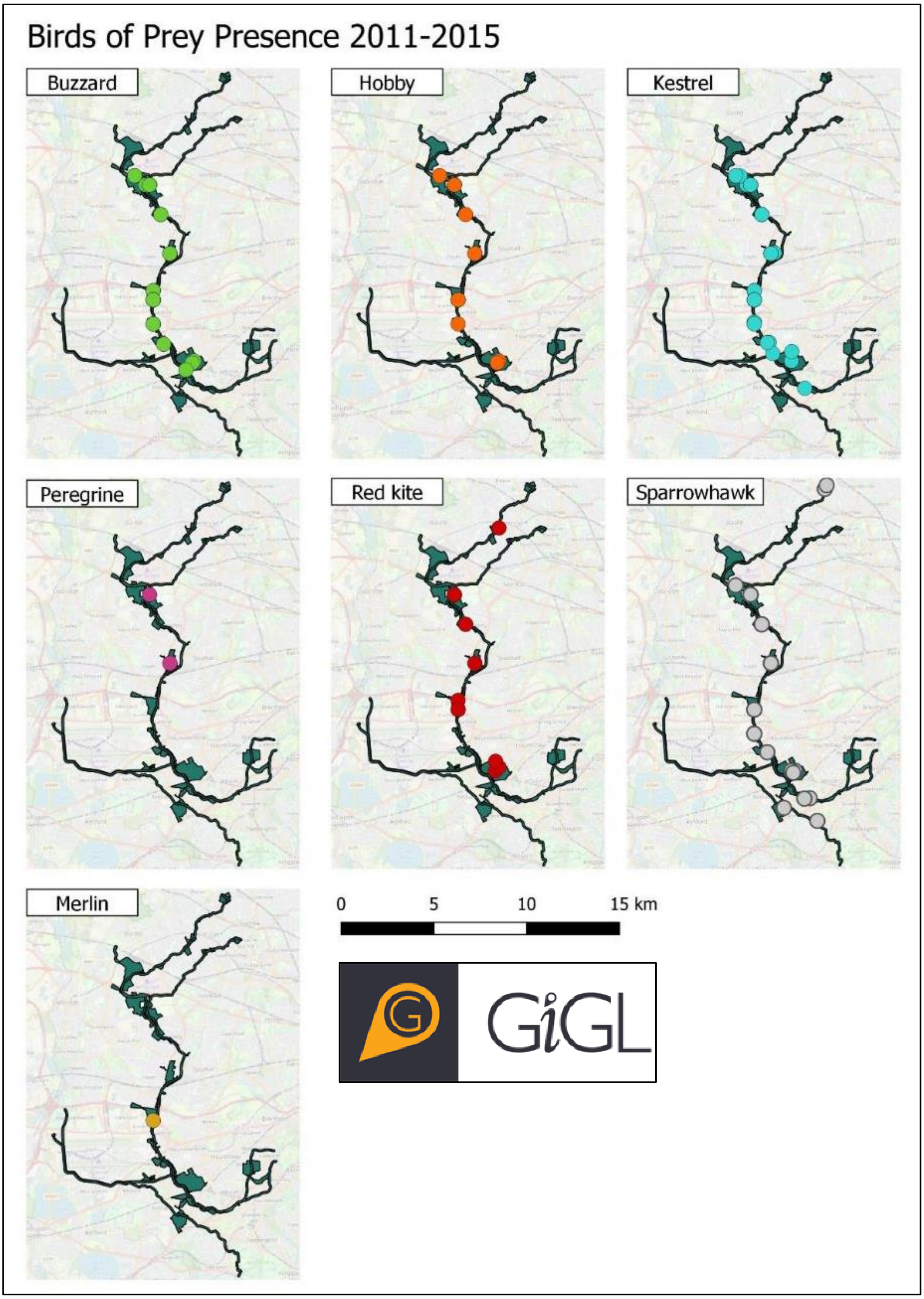


Figure 40: Birds of prey presence in the study area by species from 2011-2015.

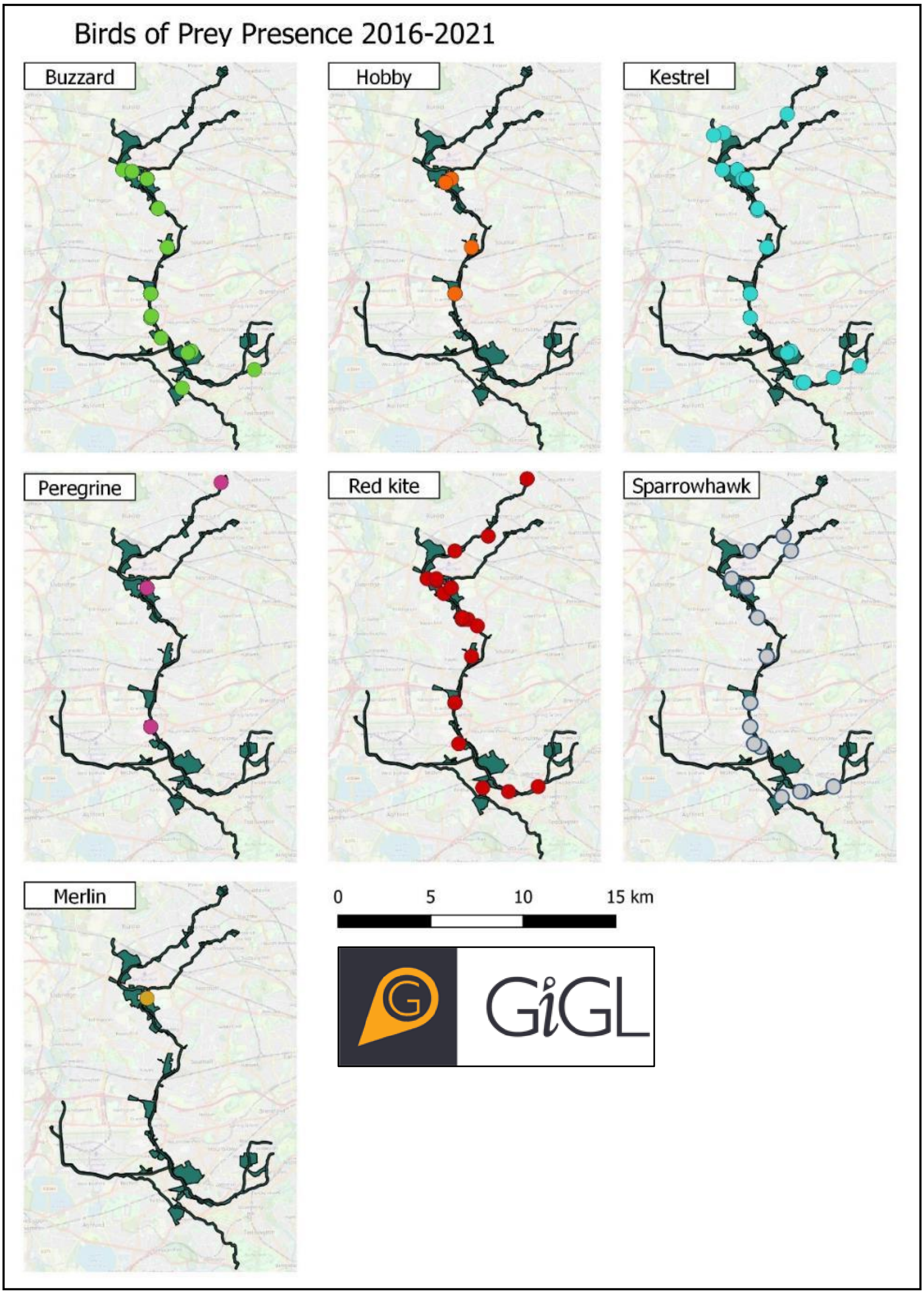


Figure 41: Birds of prey presence in the study area by species from 2016-2021.

The most notable changes observed in birds of prey presence recorded from 2011-2015 (Figure 40) and 2016-2021 (Figure 41) was with hobbies and red kites. The number of occurrences of hobby declined, while the occurrences of red kites increased. Further investigation is needed to discover if this is due to changes in species populations, or changes in observance effort. There were two additional birds of prey species that were recorded in the study area 20 years ago but have not been recorded since: the osprey *(Pandion haliaetus*) and the honey buzzard (*Pernis apivorus*). These are both rare species, with limited numbers of UK breeding pairs. Observations of both species were made in Hounslow Heath. Most of the birds of prey GIGL records were from local borough surveys, London Natural History Society records, London Birdwatching Web Records, London Wildlife Trust records, and members of the public.

Kingfisher (Alcedo atthis)

The kingfisher is a striking, colourful bird that lives near waterways. They create nests burrowed into riverbanks or alongside lakes and hunt small fish. Their hunting strategy involves perching on branches above shallow water, and then diving suddenly to catch their prey. Threats to kingfishers include habitat loss and degradation, pollution, and poor waterway management (The Wildlife Trusts 2022c). The kingfisher is protected under the Wildlife and Countryside Act.

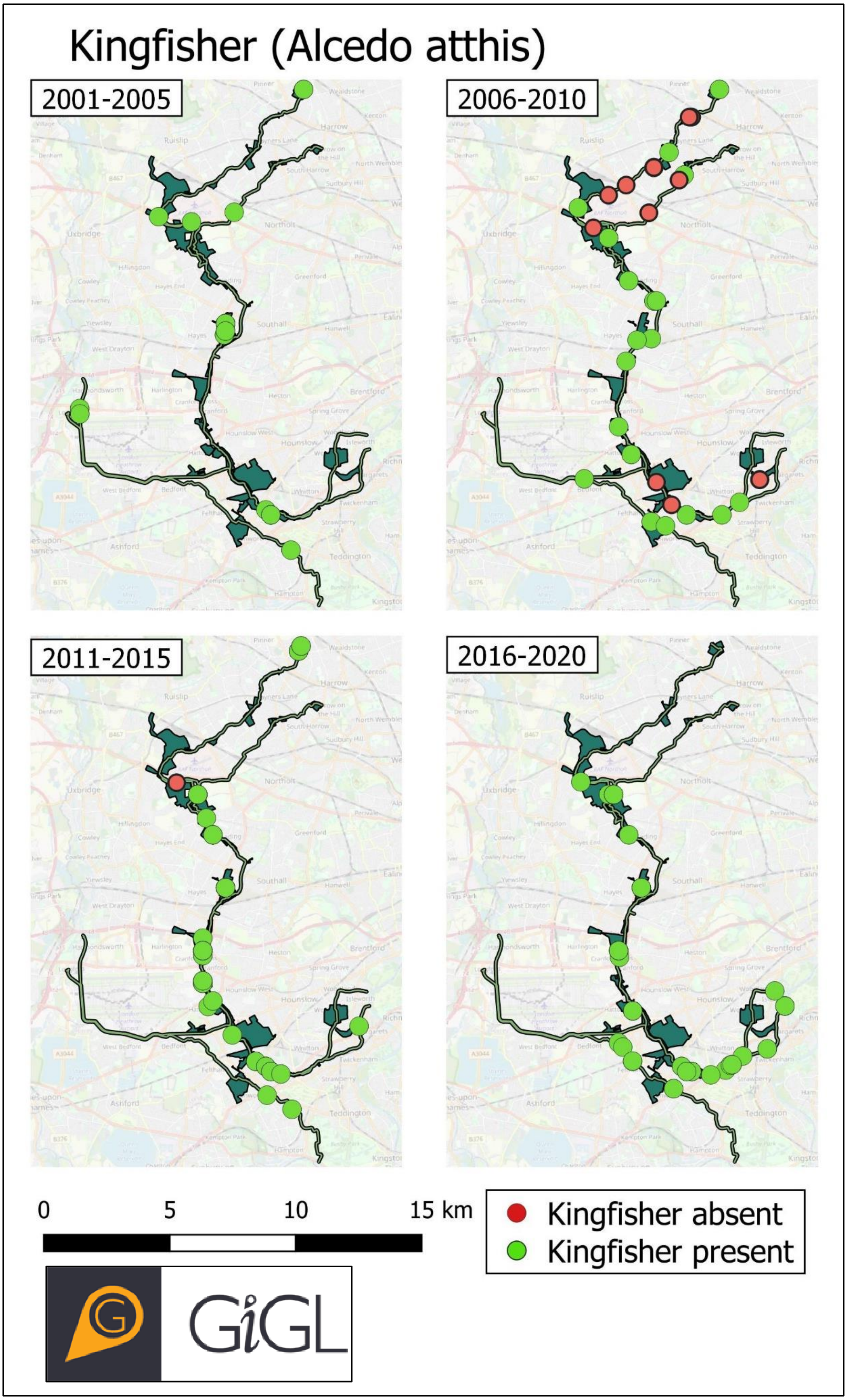


Figure 42: Presence and absence of kingfishers in the study area.

Kingfisher presence and absence has been well recorded throughout the study area. These data have been submitted to GIGL from many sources, the most common of which are London Natural History Society bird records, and wildlife surveys carried out by local boroughs. According to GIGL data, over the past 20 years kingfishers have been observed in most parts of the study area, and along all waterbodies in the catchment except the Upper Duke of Northumberland's River. Observations along the Yeading Brook East and Yeading Brook West appear to have decreased in the past five years, but this may be due to sampling effort rather than kingfisher presence. Further investigation is needed to confirm the reason behind this decline.

The GIGL data suggests good connectivity for kingfishers throughout most catchment waterbodies. However, surveys would need to be completed to assess habitat suitability. Kingfishers are extremely sensitive to bad water quality and areas with low dissolved oxygen, as these areas will not sustain plentiful fish populations that kingfishers feed on (Vilches et al. 2012). Other considerations for kingfisher connectivity are minimising rockfills in rivers to preserve areas suitable for kingfisher nesting, as well as perches for fishing (Vilches et al. 2012).

4.2.3. Reptiles

There have been four species of reptiles identified within the study area (Table 14), out of 6 native UK reptile species. These species have similar habitat requirements, and sometimes occupy overlapping niches. Due to their similarities, they also face similar threats, namely the loss and fragmentation of habitats. All species of reptile in the UK are protected under the Wildlife and Countryside Act 1981.

Table 14: Four species of reptiles identified in the study area, along with habitat types and images.

Scientific name	Common name	Habitat	Image
Vipera berus	Adder	• Grassland • Heathland • Woodland	
Zootoca vivipara	Common lizard	• Grassland • Heathland • Woodland	
Natrix helvetica	Grass snake	• Freshwater and wetlands • Grassland • Heathland • Woodland	
Anguis fragilis	Slow worm	• Grassland • Heathland • Woodland • Gardens	

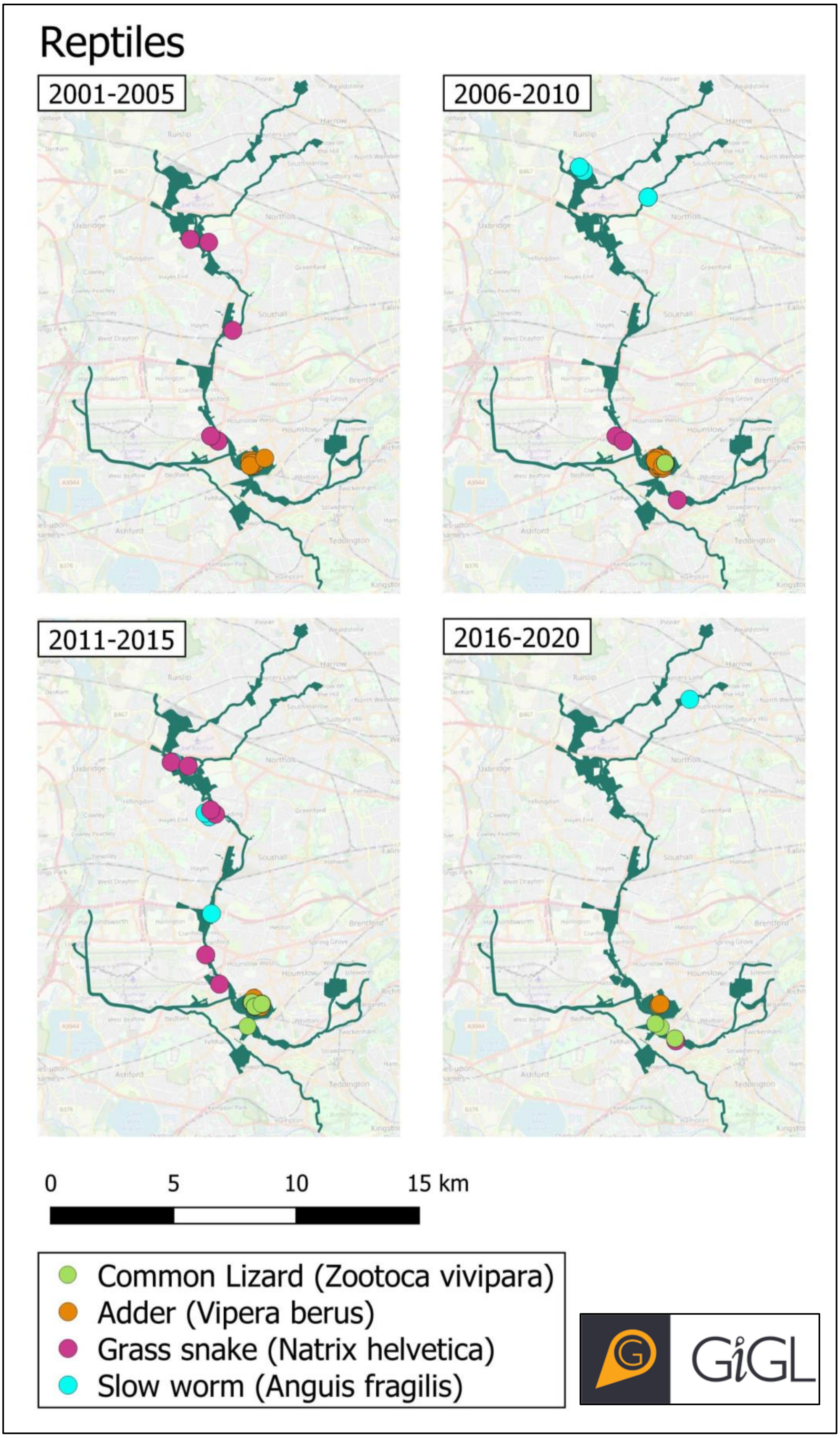


Figure 43: Presence of lizards, adders, grass snakes and slow worms in the study area.

The GIGL presence data shows that all four species of reptile have been recorded in the study area since 2016. These recordings are concentrated along the River Crane, in Hounslow Heath and Pevensey Road Nature Reserve. The number of occurrences recorded on the Yeading Brook have declined since 2011-2015. This does not necessarily mean that presence of these species has declined in these areas but could instead be due to reduced effort. The reason for this decline would need to be further investigated through reptile surveys in these areas. The GIGL data was submitted from a variety of sources including surveys conducted by local boroughs, Connecting London's Amphibian & Reptile Environments (CLARE) surveys conducted by the London Amphibian and Reptile Group (LARG) and GIGL, and a survey commissioned by Metronet.

These four reptile species are limited in their movements, and therefore cannot disperse very far. This means that in urban areas, connectivity is often a threat to these populations (Edgar et al. 2010). Without a safe network of decent quality habitats, urban populations of these reptile species can face genetic bottleneck (François et al. 2021). In this scenario, a small, isolated population with limited genetic diversity will face a loss in robustness and will be more vulnerable to extinction. Therefore, to sustain healthy populations, they need both large areas of intact habitat, as well as smaller areas of habitat that are well connected. For these species, this would primarily include grassland, heathland, and woodland, as well as dense hedgerows. Adders prefer a dense hedgerow network, and heathlands or medio-European thickets.

4.2.4. Terrestrial Invertebrates

There was a large diversity of terrestrial invertebrates found in the study area. Looking more closely at the species recorded in these areas, there were 23 species identified that are listed under selected international, national and London designations (these designations are listed in Appendix IV). Just to note, some of the species listed here spend part or most of their life cycle as aquatic organisms, for example caddisflies. These species are identified here as "terrestrial invertebrates" because they were observed in the terrestrial environment, and not during aquatic surveys.

Table 15: Designated terrestrial invertebrate species recorded in the Crane catchment from 2016-2021.

Scientific Name	Common Name	Taxon Group
Lucanus cervus	Stag Beetle	Invertebrates – Beetles
Pyrochroa coccinea	Black-headed Cardinal Beetle	Invertebrates – Beetles
Coenonympha pamphilus	Small Heath	Invertebrates – Butterflies
Limenitis camilla	White Admiral	Invertebrates – Butterflies
Lycaena phlaeas	Small Copper	Invertebrates – Butterflies
Lycaena phlaeas eleus	A Butterfly	Invertebrates – Butterflies
Ochlodes sylvanus	Large Skipper	Invertebrates – Butterflies
Satyrium w-album	White-letter Hairstreak	Invertebrates – Butterflies

Thecla betulae	Brown Hairstreak	Invertebrates – Butterflies
Thymelicus lineola	Essex Skipper	Invertebrates - Butterflies
Thymelicus sylvestris	Small Skipper	Invertebrates - Butterflies
Ceraclea senilis	A Caddis Fly	Invertebrates - Caddis Flies
Libellula fulva	Scarce Chaser	Invertebrates - Dragonflies & Damselflies
Somatochlora metallica	Brilliant Emerald Dragonfly	Invertebrates - Dragonflies & Damselflies
Sympetrum striolatum	Common Darter	Invertebrates - Dragonflies & Damselflies
Calamotropha paludella	Bulrush Veneer	Invertebrates - Moths
Diarsia rubi	Small Square-spot	Invertebrates - Moths
Euplagia quadripunctaria	Jersey Tiger	Invertebrates - Moths
Hoplodrina blanda	Rustic	Invertebrates - Moths
Spilosoma lutea	Buff Ermine	Invertebrates - Moths
Timandra comae	Blood-vein	Invertebrates - Moths
Tyria jacobaeae	Cinnabar	Invertebrates – Moths

Butterfly Conservation Hertfordshire & Middlesex is very active in the catchment, conducting regular surveys and submitting updated records to GIGL. Their efforts could be, in part, why a much higher number of protected moths and butterflies have been identified in the catchment compared to other invertebrate groups.

4.2.5. Plants

There have been three designated plant species identified in the catchment since 2016.

Table 16: Designated plant species identified in catchment since 2016 according to GIGL data.

Scientific name	Common name	Habitat	Location
Oenanthe silaifolia	Narrow-leaved Water-dropwort	• Alongside rivers • Grassland	Yeading Brook Meadows
Marrubium vulgare	White Horehound	• Grassland • Open ground	Crane Park
Tilia platyphyllos	Large-leaved Lime	• Woodland • Urban/suburban	Yeading Brook West – Brook Common

4.2.6. Non-native invasive species

The species listed in Table 17 are all invasive species that have been identified in the study area, according to GIGL data. GIGL created this data layer from invasive species identified by the London Invasive Species Initiative (LISI), which is based on Schedule 9 of the Wildlife and Countryside Act 1981, the UK Water Framework Directive Technical Advisory Group's invasive species list, and LISI expert knowledge. For more information, visit http://www.londonisi.org.uk/what-and-where/species-of-concern/.

Table 17: Invasive plant and animal species that have been recorded in the study area according to GIGL data. The greyed cells indicate species that have not been recorded in the study area in the past five years.

Plants	Mammals	Birds	Crustaceans
False acacia (*Robinia pseudoacacia*)	Chinese Muntjac (*Muntiacus reevesi*)	Ring-necked Parakeet (*Psittacula krameri*)	Signal Crayfish (*Pacifastacus leniusculus*)
Giant Hogweed (*Heracleum mantegazzianum*)	American Mink (*Neovison vison*)		Chinese Mitten Crab (*Eriocheir sinensis*)
Himalayan Balsam (*Impatiens glandulifera*)			
Japanese Knotweed (*Fallopia japonica*)			
Butterfly-bush (*Buddleja davidii*)			
Canadian Waterweed (*Elodea canadensis*)			
Cherry Laurel (*Prunus laurocerasus*)			
Evergreen Oak (*Quercus ilex*)			
Floating Pennywort (*Hydrocotyle ranunculoides*)			
Gallant Soldier (*Galinsoga parviflora*)			
Goat's-rue (*Galega officinalis*)			

Green Alkanet (*Pentaglottis sempervirens*)	
Highclere Holly *(Ilex aquifolium x perado = I. x altaclerensis)*	
Himalayan Knotweed *(Persicaria wallichii)*	
Kashmir Balsam (*Impatiens balfourii*)	
Least Duckweed *(Lemna minuta)*	
New Zealand (*Pigmyweed Crassula helmsii*)	
Nuttall's Waterweed (*Elodea nuttallii)*	
Orange Balsam (*Impatiens capensis*)	
Parrot's-feather (*Myriophyllum aquaticum*)	
Small Balsam (*Impatiens parviflora*)	
Snowberry *(Symphoricarpos albus)*	
Three-cornered garlic *(Allium triquetrum)*	
Tree Cotoneaster *(Cotoneaster frigidus)*	
Tree-of-heaven *(Ailanthus altissima)*	
Turkey Oak *(Quercus cerris)*	
Water Fern *(Azolla filiculoides)*	
Water-lettuce *(Pistia stratiotes)*	

In addition to the invasive species from GIGL records, we received records of several non-native invasive species from other sources, including personal communication with Rob Gray (Chair and Director - Crane Valley CIC) and Adam Cheeseman (Heathrow Airport). These records have not been reported to GIGL, so instead we have listed them here. Exact locations are unknown.

Table 18: Invasive non-native species identified in the catchment from sources outside of GIGL.

Scientific name	Common name	Year(s)	Location	Source
Neovison vison	American Mink	2018	Lower Crane	Rob Gray (pers. Comm.)
Corbicula fluminea	Asiatic clam	2022	River Crane at Mill Road	RMI data
Eriocheir sinensis	Chinese Mitten Crab	2016 – 2021	Lower Crane	Rob Gray (pers. Comm.)
Galega officinalis	Goat's-rue	2012 – 2021	Banks of Longford River and access track, central stretch near Terminal 5	Heathrow airport (pers. Comm.)
Dikerogammarus villosus	Killer shrimp	2021	Lower Duke of Northumberland River	Heathrow airport (pers. Comm.)
Species unknown	Monkey flower	2012 – 2021	Longford and Duke of Northumberland rivers on instream features.	Heathrow airport (pers. Comm.)
Impatiens capensis	Orange balsam	2012 – 2021	Longford and Duke of Northumberland rivers throughout on instream features	Heathrow airport (pers. Comm.)
Trachemys scripta elegans	Red-eared Terrapin	2016 – 2021	Upper Duke of Northumberland southern stretch	Heathrow airport (pers. Comm.)
Symphoricarpos albus	Snowberry	Unknown	Lower Crane	Rob Gray (pers. Comm)
Azolla filiculoides	Water fern	2012 – 2017	Longford River upstream of inverted siphons.	Heathrow airport (pers. Comm.)

Several species above were included in the list of species from GIGL, but according to GIGL data had not been recorded in the study area in the past 5 years. Others, including the red-eared slider terrapin, killer shrimp, and Asiatic clam, among others, were not recorded in the GIGL data. This shows that there may be more invasive species in the catchment that are not in the GIGL dataset, and therefore have not been listed.

In a separate report titled 'Invasive Non-Native Plant Species Survey in the Crane catchment', a method for surveying invasive plant species in the Crane catchment was trialled and evaluated. These surveys focused on three species of invasive plants: Giant Hogweed (*Heracieum mantegazzianum*), Japanese Knotweed (*Reynoutria japonica*), and Floating Pennywort (Hydrocotyle ranunculoides). The results of these surveys, identifying the locations of these invasive species in the catchment, are presented below in Figures 44-46.

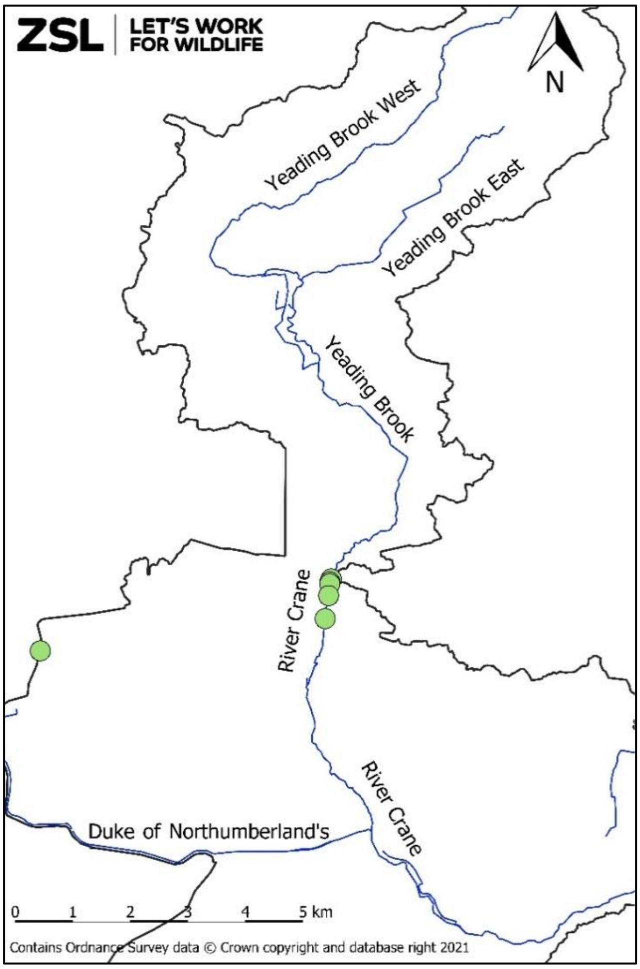


Figure 44: Floating pennywort results

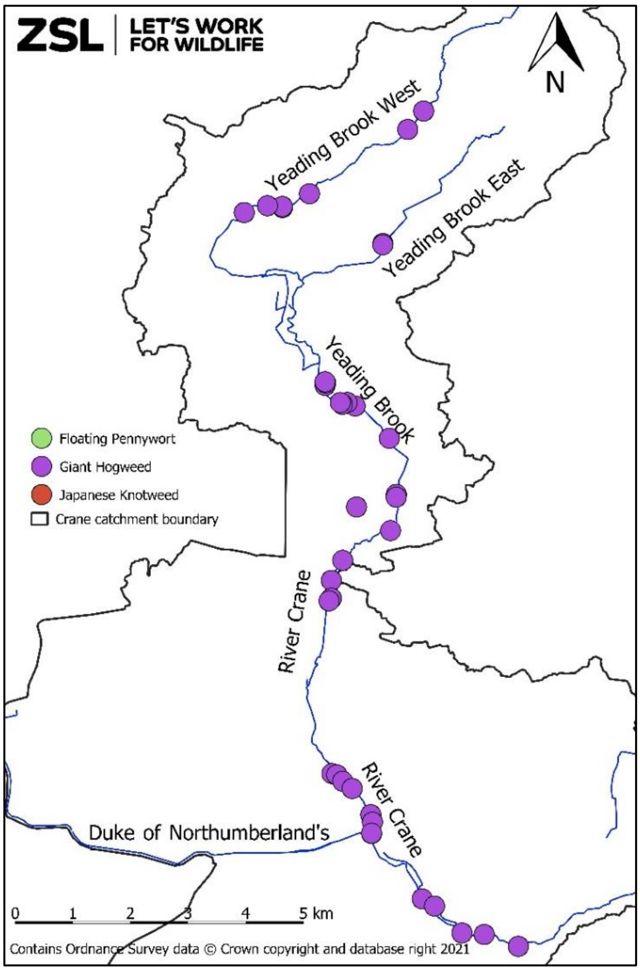


Figure 45: Giant hogweed results

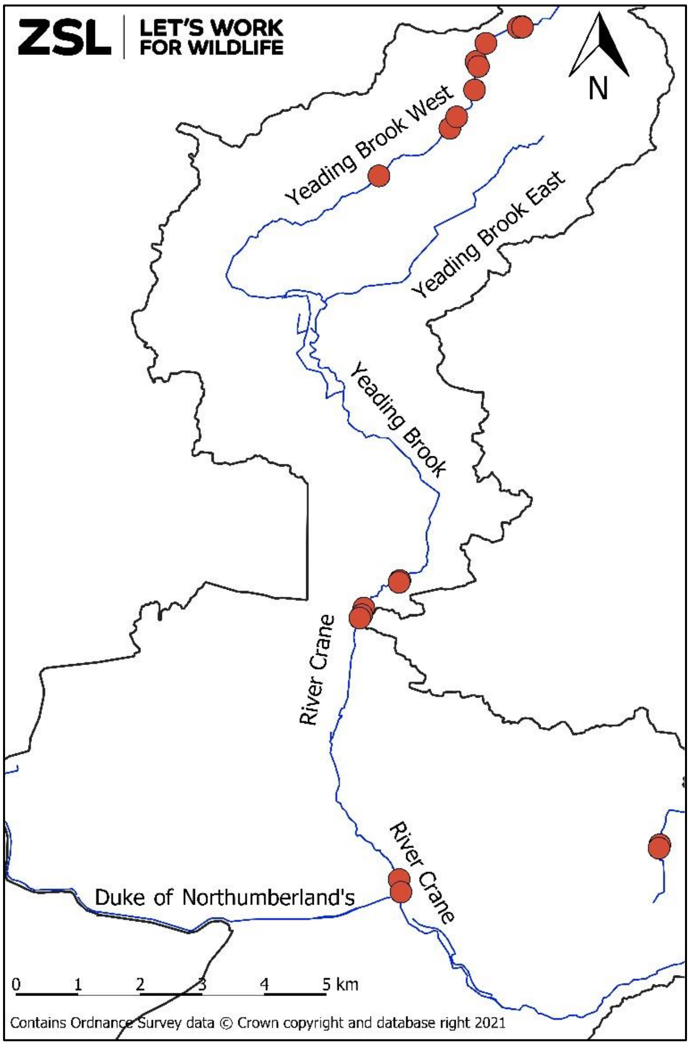


Figure 46: Japanese knotweed results

5. Habitats and designated areas

5.1. GIGL habitat data

5.1.1. Analysis

GIGL's habitat data is compiled from numerous sources, including from habitat surveys commissioned by Greater London Council, London Ecology Unit and Greater London Authority in the 80s, 90s and 00s. This fine-scale spatial data breaks down each borough into smaller polygons of varying sizes and lists the habitat types and their percentage coverage found within each polygon. Habitat types in this dataset are described using Joint Nature Conservation Committee (JNCC) habitat classifications. The UK Biodiversity Action Plan (BAP) priority habitats that are present within the study area were identified. The names of locations in the 'Example location in study area' in the table below are taken from the GIGL database.

5.1.2. Results and discussion

According to GIGL habitat data, the most common habitat types in the study area included semi-improved grassland, amenity grassland, native woodland, and scrub. Because of the fine-scale nature of the GIGL habitat data, it was not possible to display this in a map. Instead, the eight UK Biodiversity Action Plan (BAP) priority habitat types found in the study area, according to this dataset, have been listed in Table 19. These priority habitats have been identified on the national scale as most threatened, and in need of conservation efforts.

Table 19: UK BAP priority habitat types found in the study area, and a sample image of each.

Habitat type	Image	Example location in study area
Acid grassland		Feltham Marshalling Yards Nature Reserve
Arable and horticultural		Field south of Colnbrook Bypass and West of Stanwell Moor Road
Heathland		Hounslow Heath
Native woodland		Yeading Brook Fields, Gutteridge Wood
Reedbeds		Crane Park, LWT Reserve, marshland and river corridor
Rivers and streams		Longford River, River Crane, Duke of Northumberland's River, Yeading Brook

Still water		Ickenham Marsh, Yeading Brook corridor south
Marsh (referred to as "swamp" in GIGL data)		Newton Farm Ecology Park, Pond
Wet woodland (not identified in the GIGL data, but confirmed to be present in the catchment by Joe Pecorelli pers. comm.).		Donkey Wood, Pevensey

Because of the limitations of the GIGL habitat data as mentioned above, more work needs to be done to map out the priority habitat areas in the catchment. A map with more examples of priority habitat types will be produced for the State of the Crane report after consultation with stakeholders

5.2. Centre for Ecology and Hydrology (CEH) land cover

5.2.1. Analysis

CEH have been using satellite imagery to map land cover since 1990. The classes of land cover used in this dataset are based on the broad habitats defined by the UK BAP (Jackson, 2000). This data layer provides a much lower resolution overview of habitat in the catchment, compared to the extremely fine-scale GIGL habitat data layer. CEH reviews the satellite imagery and updates this data layer every year. The version used here was provided by Thames Water and is from 2015.

5.2.2. Results and discussion

The CEH land cover spatial layer, seen in Figure 47, gives a broader overview of habitat types, and provides an indication of where some of the habitats listed above may be found within the study area. However, this data layer is not so useful when looking for detailed information about habitat types and how certain areas are classified. For example, the entire area of Hounslow Heath is classified as improved grassland, when parts of this area should be heathland or acid grassland.

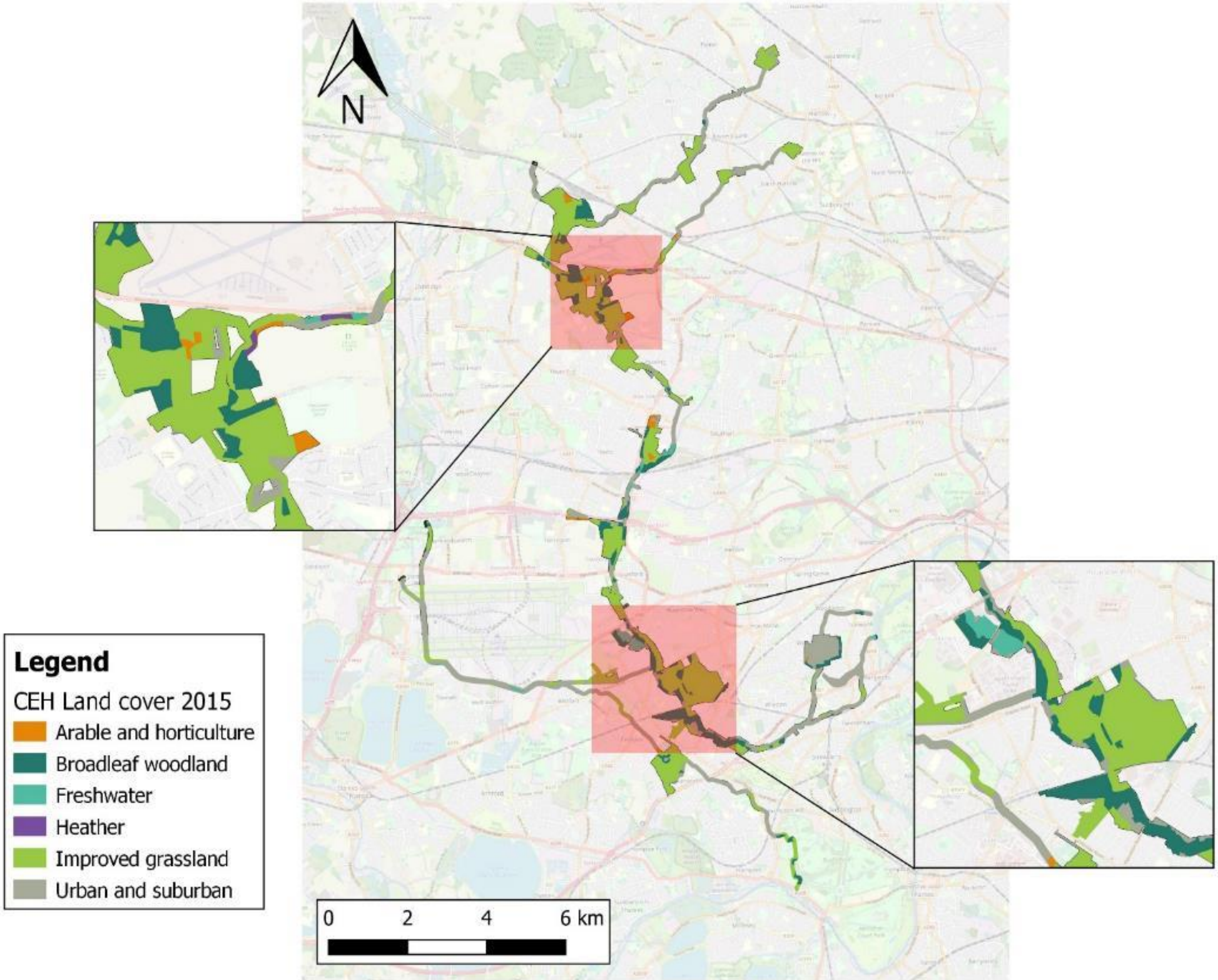


Figure 47: CEH 2015 land cover spatial data, clipped to the study area.

5.3. GIGL designated area data

5.3.1. Analysis

The focus area was expanded to the entire catchment when looking at designated areas, because some fall outside of the study area. GIGL's database includes nationally, regionally, and locally designated areas. These sites were identified and mapped.

5.3.2. Results and discussion

Within the catchment, there are 3 types of protected areas (Table 20). These areas offer varying levels of protection over habitats and wildlife. For example, there are legal requirements for managing SSSI sites in England, including permission from the relevant government body to carry out certain activities on or around the SSSI site. SINCs, on the other hand, are locally selected areas that are locally monitored and managed.

Table 20: Designated areas for habitat or species conservation at the local, national, and international level, and their total areas within the catchment.

Name	Type of designation	Area in catchment (ha)
Site of Special Scientific Interest (SSSI)	National	103.99
Sites of Importance for Nature Conservation (SINC)	Local	5732.02
Ramsar	International	376.3

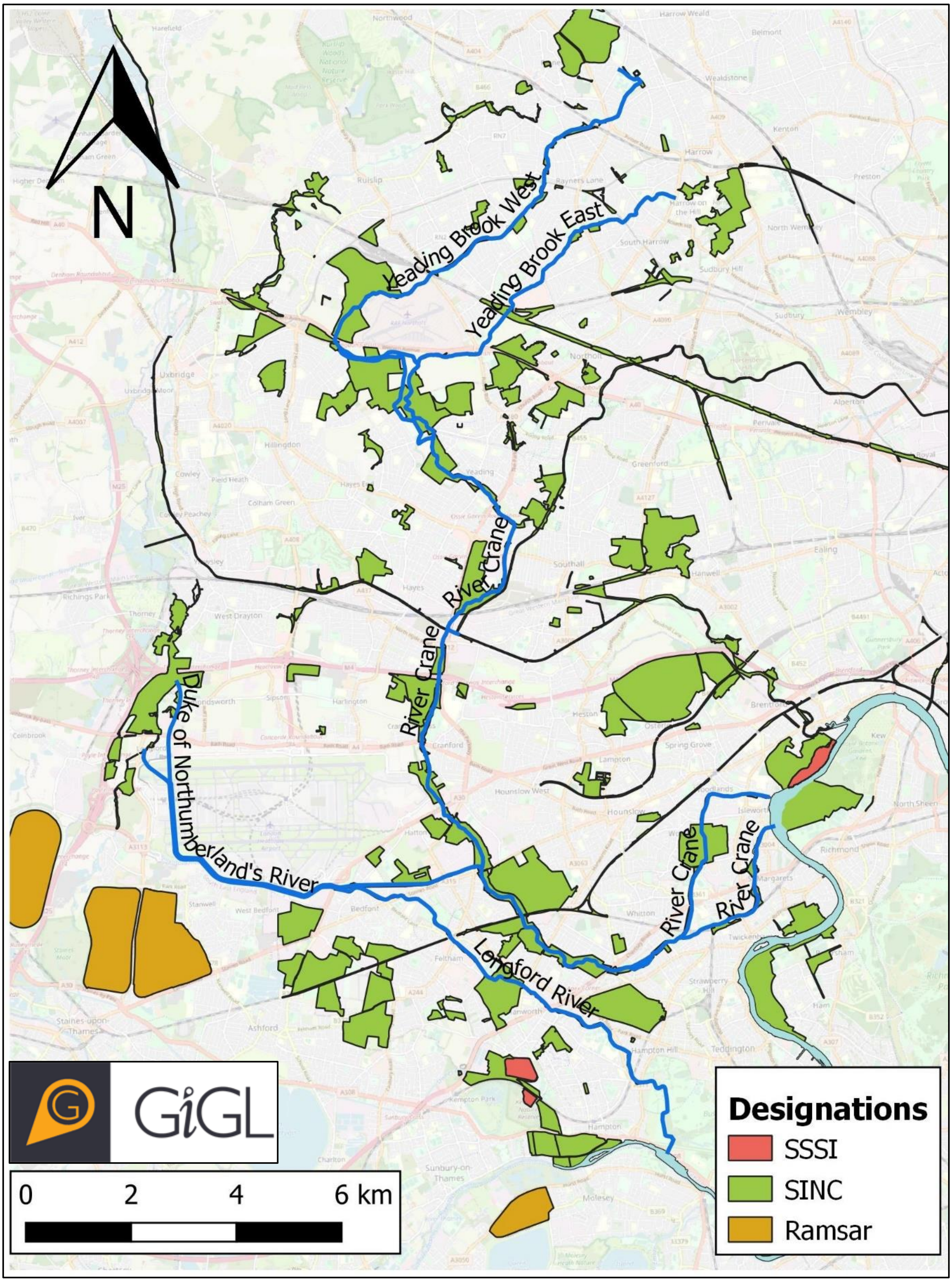


Figure 48: Protected areas identified within the catchment, and their relevant designations.

6. Summarised findings

Table 21 summarises the numbers of species of the different species groups investigated, as well as habitat types.

Table 21: Summarised findings for the different sections covered in this report.

Group/habitat	Number of species/habitats	Most recent data
Fish	26	2018
Aquatic Invertebrates	309	2021
Mammals (excluding bats)	31	2020
Bats	7	2020
Reptiles	4	2020
Birds of prey (excluding owls)	7	2020
Owls	5	2020
Designated invertebrates	22	2020
Designated plants	3	2020
Invasive species	36	2020
BAP habitats	9	2020

7. Recommended Next Steps

7.1. Stakeholder engagement

The first recommended next step would be to approach local stakeholders and experts to review these findings and add any additional insight that may not be captured within this report. Part of this stakeholder engagement process should be to determine whether there are more data available for biodiversity and habitats in the catchment. If so, these data should then be incorporated into this baseline analysis. Finally, stakeholder knowledge and experience should be used to help shape plans for conservation action in the catchment.

Based on the sources of GIGL data and CVP members delivering projects on the ground for wildlife, the following organisations will be invited to future stakeholder engagement activities:

- Bat Conservation Trust
- British Trust for Ornithology
- Butterfly Conservation Hertfordshire and Middlesex
- Ealing Wildlife Group

- Environment Agency
- Harrow Nature Conservation Forum
- Heathrow Airport Ltd
- London Amphibian and Reptile Group
- London Bat Group
- London Natural History Society
- London Wildlife Trust
- Natural England
- People's Trust for Endangered Species
- Royal Parks – Bushy Park
- Royal Society for the Protection of Birds
- Thames Water
- Thames21
- The Conservation Volunteers
- The five Local boroughs
- Zoological Society of London

For a full list of contributors to GIGL, see Appendix I.

7.2. In-channel species

The health and biodiversity of the aquatic ecosystem is dependent on that of the surrounding river corridor, and vice-versa. Aquatic invertebrates make up the base of the food chain for many groups of animals including fish, birds, and bats, among others. A water body that supports a plentiful, biodiverse community of aquatic invertebrates will subsequently support greater biodiversity and abundance of species higher up the food chain both within river channels, and in the surrounding river corridors. However, as previously shown, many invertebrates are sensitive to water quality, and the impacts of pollution. Some species are sensitive to flow and sedimentation, which are largely dictated by a river's geomorphology For recommendations about how to improve water quality, see Citizen Crane reports (https://www.cranevalley.org.uk/project-archive-library/). For detailed recommendations about how to improve geomorphology in the catchment to increase biodiversity, see the Cartographer report. Taking on board these recommendations will greatly improve biodiversity in aquatic invertebrates, the benefits of which will be seen all the way up the food chain.

Invertebrate monitoring priorities should include continued surveying of long-term monitoring sites in the catchment. These sites include Yeading Brook East, Yeading Brook West, Cranford Park, Donkey Wood DNR, Donkey Wood Crane, Longford River, Crane Park, Lower DNR, and Lower Crane (Figure 23). Surveys should follow standard EA sampling methodology, to calculate long and short-term trends in the data. Along with continued monitoring of these long-term sites, introducing monitoring into data-poor areas of the catchment is recommended. The only invertebrate monitoring on the Upper Duke of Northumberland's River has been at the confluence with the River Crane, which leaves most of this river unmonitored. Additional monitoring along this water body will help understanding of diversity in invertebrate communities.

Further investigation is needed to understand the divergence in RMI and EA invertebrate trends. Both RMI score and the EA's ASPT score are designed to indicate

Data collection and monitoring priority for fishes would be up to date sampling at long-term sampling sites, as the most recent samples are from 2019. Ideally, monitoring would follow on with Environment Agency WFD monitoring methods and continue at long-term monitoring sites, to allow for comparison with historic data, and to calculate short and long-term trends. For fish, these long-term sites include Moor Lane, Hatton Road, Cranford Park, Hounslow Heath, Crane Park, Riverside Walk, and Mill Platt (Figure 2). This would allow for a current baseline to be set for fish diversity. It would also be important to ensure that during this sampling, the species included in the length frequency distribution analysis (chub, dace, gudgeon and roach) are measured for length. This would help determine if fish populations have re-stabilised and are self-sustaining at sites that were greatly impacted by the major pollution events in 2011 and 2013. No firm conclusions could be drawn about the current populations of these species from the length distribution analysis, because the most recent data was from 2017. There are gaps in EA fish monitoring in the Yeading Brook East, Yeading Brook West, and the Longford River. Introducing monitoring to these water bodies would give a baseline understanding of fish populations in these rivers for future comparison.

To further understand the status of fish and invertebrate communities on the upper Duke of Northumberland's River, it would also be useful to obtain the raw fish monitoring data from Heathrow Airport. We were sent one of the reports written about this data, but without raw data, we were unable to provide an analysis for this report.

Ecological conservation priorities, based on these findings, should focus on improving water quality and fish habitat. As the analysis on fish and invertebrates show, these communities are extremely sensitive to water quality. In addition to water quality, fish population growth is likely limited in the catchment due to the lack of deeper waters for mature fish. A small proportion of mature individuals means that recruitment is restricted, and populations are unsustainable. Suitable habitat must be created for larger, more mature individuals that need deeper water, while nursery and juvenile habitats must also be preserved or created where necessary. Juveniles need shallower water with plenty of vegetation for hiding and feeding. As well as ensuring these habitats are present, connectivity between habitats must also be improved. For more detailed recommendations on how to improve the riverine habitats for fish populations, see the fish barrier report (ref?).

7.3. Terrestrial species and connectivity

While GIGL species 'presence/absence data provides a general overview of terrestrial species' distributions in the study area, it does not allow for analysing population changes. Because GIGL presence/absence data is not standardised for effort, it is impossible to calculate population sizes. Despite this limitation, GIGL species 'presence/absence data provides valuable information regarding effort including showing the distribution of data collection effort, where these efforts have successfully observed the species in question, how the distribution of effort has changed over time, and who has been collecting this data.

This type of data can also be used to predict species 'habitat preferences and use this to map species-specific habitat suitability in the catchment. This methodology was used by Turner et al 2021 to produce the hedgehog suitability map, which used GIGL data along with other citizen science hedgehog sightings data. Depending on the amount of sightings data available, this could potentially be replicated for other species.

Estimating species 'population sizes and changes in populations over time would require data from surveys that use the same methodology and allow for standardisation of effort. For example, the fish, eel, and aquatic invertebrate monitoring surveys and data. While this is difficult to implement for all species across the entire catchment, it could be done for selected flagship species in certain hotspot areas in the catchment. GIGL data could help determine where to focus survey efforts for flagship species. For example, GIGL data shows Hounslow Heath has been a hotspot for reptiles. Initial monitoring would set baseline, with continued monitoring showing changes over time.

The next step should be to review the key species' list with local stakeholders and adjust or amend as collectively decided is necessary. It would also be useful to request all CVP partners send habitat and biodiversity reports to CVP, to archive this information and improve access and knowledge about the data that exists. If any raw data accompanies these reports, it would be useful to archive this data in Excel or another data processing format.

Due to the sensitivity of certain species, the maps included here are not able to be spread or shared publicly. This is to protect these species from potential harm. In addition, due to GIGL policies, the raw data used to make the maps (for non-sensitive species) cannot be shared publicly, or with any other partners who do not have GIGL license. This is important to keep in mind when planning future monitoring, and deciding which organisations will be managing data, conducting analyses, and writing reports.

Finally, when sharing information about species in the catchment with the public through the Smarter Water Catchment StoryMap, we recommend using this as a public engagement tool. The map could be used as a platform for members of the public to submit sightings of certain species. This not only raises awareness and educates people about the biodiversity of the Crane catchment, but it also encourages and inspires people to get directly involved in conservation. With sufficient resources to recruit and train volunteers, the growth of citizen science wildlife survey activity in the catchment can be supported. Target species and survey areas can be tailored to address evidence gaps highlighted in this report.

7.4. Non-native invasive species

Presence of non-native invasive species (INNS) is often an indicator of a degraded ecosystem. While some of these species do not have a negative impact on the overall function of the system, others can further add to the damage. Studies suggest that INNS are not the "drivers" of ecosystem degradation but are "passengers" (MacDougall & Turkington 2005). This means that the system is impacted by environmental factors such as pollution, and these species are not as affected as other native species may be and are therefore more successful in this degraded system (Didham et al. 2005). According to the biotic resistance theory, an important defence against most INNS is restoring a thriving natural ecosystem that supports a species-rich native community (Teixeira et al. 2017).

Restoration efforts in the catchment will help restore biotic communities and build resistance to harmful INNS. However, there may be habitats in the catchment where INNS are threatening the viability of certain species or habitats, and therefore require an INNS removal plan. In these cases, it is important to identify the area threatened by the impact of the INNS species and develop a plan for remedial action. This process of identifying habitats/species that require action and developing a plan should be undertaken in consultation with stakeholders. A few species of concern that may require action in the catchment include the American mink (*Neovison vison*) and floating pennywort (*Hydrocotyle vulgaris*), giant hogweed (*Heracleum mantegazzianum*) and Japanese knotweed (*Reynoutria japonica*). A methodology for surveying INNS plant species using citizen scientists was trialled by ZSL and is detailed in the INNS mapping report.

7.5. Habitats

The GIGL habitat data provides detailed information about habitat types in the study area. This data showed that there are eight BAP habitats found within the study area. Using the current data, while it is possible to identify the general locations of these habitats, it is impossible to precisely calculate their coverage of the study area. This dataset is currently being updated by GIGL, and the new, updated version may be ready for use later this year. When considering location-specific conservation plans, this data will be useful in order to know the locations of different habitat types, including UK BAP habitats.

The CEH land cover data layer displayed here is from 2015, because this is the version we were sent from Thames Water. There are updated versions of this layer, most recently from 2020, as well as older versions from as far back as 1990. These versions from different time frames could be used to show change in land cover in the catchment from 1990-2020. To access these various data layers, a license administered through CEH is required.

Habitat conservation priorities in the catchment should be discussed with local stakeholders. It is particularly important to engage with London Wildlife Trust, the local boroughs, and other organisations who are the principal managers and/or owners of the SINCs. Their specialised knowledge of these sites will contribute to the overall status of habitats in the catchment and build a better picture of which habitats and areas of the catchment require priority action. The outputs of this prioritisation process could then be used to advise Smarter Water Catchment investment in wildlife outcomes.

7.6. Connectivity

Connectivity relates to both biotic communities and abiotic environmental features. Biotic connectivity allows species to move around different patches of habitat and mix with other populations (Hilty et al. 2020). Abiotic connectivity allows environmental elements such as sediment, water, and organic materials to move to different areas within a system (Hilty et al. 2020). Both forms of connectivity encourage population viability, genetic structure, disease resistance, invasive species resistance, and ecosystem services (Teitelbaum et al. 2020). Without connectivity between different habitats and populations, species are at greater risk of local extinction due to many threats including disease, invasive species, lack of genetic diversity, environmental catastrophe, etc.

Species-specific connectivity considerations have been noted throughout this report. Conservation action with the aim of improving connectivity often have one or two target species, which act as flagship species for the catchment. This means that by improving connectivity for these target species, by default other species will benefit from improved habitats and connectivity. Target species are often specialist species, which are more likely to be impacted by fragmentation (for example, water voles). In contrast, generalist species are not likely to be disrupted by loss of connectivity (for example, ducks and squirrels). The questions listed below provide a helpful guide for improving connectivity in a freshwater river catchment (Wissmar & Beschta 2002):

1. What physical and biological factors presently limit riparian populations and communities?

2. What geomorphic and hydrological regimes have been historically modified and presently limit the connectivity of riparian and aquatic ecosystems?
3. What native riparian species have been eradicated or displaced?
4. What exotic plant species have invaded the riparian system?
5. What geomorphic and hydrological regimes provide the most favourable future physical habitat and biological conditions?
6. What are the target species or desired future riparian communities?
7. What are the expected recovery times and successional patterns for the riparian communities?

Using the questions above as a guide, a spatial connectivity plan should be developed in collaboration with stakeholders. This plan will identify opportunities in the catchment to improve connectivity for specific taxa.

5.7. Areas for future inclusion

The scope of this report is SINCs and the river corridor that fall within the catchment boundaries. However, it has been noted that there are additional areas that fall outside this boundary that would be valuable to include in future habitat and biodiversity work in the catchment. It is therefore advised that the analyses undertaken in this report are repeated for the following additional areas: Portlane Brook, Bedfont Lakes County Park, Syon Park, and Bushy Park.

7.7. Limitations

7.7.1. EA fish and invertebrate data

The Environment Agency's freshwater fish and invertebrate monitoring provides standardised time-series data for multiple locations in the Crane catchment. The main limitation in these datasets was the lack of fish data since 2019. In addition, these data-gathering exercises are concentrated at certain sampling locations, meaning that understanding of in-channel species trends is limited to these set monitoring points.

7.7.2. GIGL species presence/absence

Unlike the EA datasets with standardised methodologies, presence/absence terrestrial species data provided by GIGL were not standardised. In other words, effort was not included, making it impossible to standardise for effort. This makes it difficult to ascertain whether patterns in the data are a result of inconsistent effort, or an accurate reflection of terrestrial species distribution. Similarly, there is significant variation in the quality of data provided by GIGL. While some data in the GIGL database were collected by ecological consultants who have been trained in species identification, other data were reported by laypersons whose identifications were not double checked. Because of these significant limitations, the most meaningful takeaway from this data is an understanding of where survey and observation efforts have been concentrated, and the species that have been reported within the catchment.

Finally, GIGL's database relies on its partners regularly sending in their most recently collected data. This may be inconsistent between organisations, which means some data may be missing from the database. For example, Heathrow's ecological officers reported that all data is sent to GIGL. However, when interrogating the GIGL database, it was found that some of the data included in their reports is not available through GIGL.

6.1. Summary of Recommendations

Below is a summary of all recommendations from this report to improve our baseline understanding of habitats and species in the Crane catchment.

In channel species:

1. Collect, or work with the EA to collect, updated electrofishing data from sites with long-term data. This includes species' abundance, length, and age.
2. Maintain clear and close communication with the EA's fisheries team in the catchment, to understand their plans and coordinate sampling efforts.
3. Improve understanding of the fish that live in the Yeading Brook East and the Yeading Brook West, to fill in these data gaps. This may be through electrofishing or other sampling methods. Again, working with the EA or Citizen Crane volunteers to achieve this will be important.
4. The fish data suggests that the in-channel environment at Hatton Road is under threat, however further investigation at this site is needed to determine if this is true, and how to address it.
5. To get a better understanding of the fish length distribution data, further analysis incorporating fish ages should be undertaken.
6. Collect, or work with the EA to collect, more recent invertebrate data from the Longford River, as the most recent EA data is from 2015.
7. Investigate the disparity between RMI and EA invertebrate data trends.

Terrestrial species:

8. Survey the Yeading Brook West for water voles to confirm whether they are present in this area, as suggested by a sighting reported to GIGL.
9. Implement hedgehog surveys in the catchment as there are limited sightings from recent years available in the GIGL data.
10. Investigate whether hobby presence in the catchment has declined, as GIGL data suggests. This could be investigated in partnership with the BTO.
11. Conduct kingfisher surveys along the Yeading Brook East and Yeading Brook West, as their presence appears to have decreased in the past five years. Survey results will determine whether this is due to a decrease in effort, or a decline in the species' presence along these water bodies.
12. Conduct reptile surveys on the Yeading Brook to determine if the declines in presence from GIGL data since 2015 are due to population declines, or reduced effort.
13. Follow up with GIGL about their data sharing policies, particularly regarding the restrictions on sharing sensitive species' distribution data with the public.
14. Use species data to inform management plans for specific sites. For example, introduce areas with dog walking prohibited to benefit species like hedgehogs.
15. Follow up with Heathrow Airport to learn more about the bird population suppression techniques used in the catchment (no reply from Andy Baxter andy.baxter@birdstrike.co.uk).

Habitats

16. Maintain communication with GIGL to learn about the updated habitat data layer they are developing. This spatial habitat data layer, when available, could serve as a useful starting point when confirming the locations of priority habitats in the catchment.
17. Ground truth or identify the locations of priority habitats in the catchment through stakeholder engagement. The workshop in April will provide an opportunity to begin this process, and the results will be presented in a map to be included in the State of the Crane report.
18. When improving habitat connectivity, develop a spatial connectivity plan in collaboration with stakeholders to identify opportunities in the catchment to improve connectivity for specific taxa.

Other

19. Request data from GIGL from the areas of future inclusion: Portlane Brook, Bedfont Lakes County Park, Syon Park, and Bushy Park.
20. Ground truth overall findings from this report with stakeholders at the April workshop.
21. Encourage members of the public to submit sightings of wildlife in the catchment through the online form.
22. Key messages from this report will be drawn out and included in the State of the Crane report.

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Appendices

Appendix I: GIGL contributors

GIGL partners contribute data to the GIGL database. The full list of GIGL partners is listed here:

- Affinity Water
- Amphibian and Reptile Conservation
- Butterfly Conservation (Herts & Middx, Cambridgeshire and Essex, Surrey)
- City of London
- City of Westminster
- Diocese of London
- Environment Agency
- Essex Field Club
- Greater London Authority

- Kent Amphibian and Reptile Group
- Lee Valley Regional Park Authority
- LivingRoofs.org
- London Amphibian and Reptile Group
- London Bat Group
- London Borough of Barking and Dagenham
- London Borough of Barnet
- London Borough of Bexley
- London Borough of Bromley
- London Borough of Camden
- London Borough of Ealing
- London Borough of Hackney
- London Borough of Hammersmith and Fulham
- London Borough of Haringey
- London Borough of Harrow
- London Borough of Havering
- London Borough of Hounslow
- London Borough of Islington
- London Borough of Lambeth
- London Borough of Lewisham
- London Borough of Merton
- London Borough of Newham
- London Borough of Redbridge
- London Borough of Richmond
- London Borough of Southwark
- London Borough of Sutton
- London Borough of Tower Hamlets
- London Borough of Wandsworth
- London Fungi Group
- London Geodiversity Partnership

- London Natural History Society
- London Wildlife Trust
- Network Rail
- People's Trust for Endangered Species
- Royal Borough of Greenwich
- Royal Borough of Kensington and Chelsea
- Royal Borough of Kingston upon Thames
- Thames Water (Crane catchment)
- The Royal Parks
- Transport for London (incl. London Underground and Metronet)
- Woodlands Farm Trust
- Zoological Society for London

Appendix II: Data contacts

The following experts were contacted to ask about existing species and habitat data they may hold or have knowledge of:

- Philip Briggs
- Tasha Hunter (Richmond)
- Jennifer Hedges (Hillingdon)
- Keiron Derek Brown (London Natural History Society)
- Steve Marshall (Wild Future)
- Paul Busby
- Steve Bolsover (Harrow Nature Conservation Forum)
- All Crane Valley Partnership members (list?)

Appendix III: Shannon Diversity Index

The Shannon Diversity Index is calculated using the following formula:

$H' = - \sum p_i * \ln p_i$

$p_i = n/N$

where H' is the species diversity index, p_i is the proportion of individuals of i-th species in a whole community, n is the number of individuals of a given species, and N is the total number of individuals in a community (Shannon & Weaver, 1949).

Appendix IV: Designations included in GIGL database

The designations included in GIGL's 'designated species' data layer are listed here:

Type	Full name
National Legislation	The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)
National Legislation	The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 5)
International	Birds Directive Annex 1
International	Habitats Directive Annex 2 - priority species
International	Habitats Directive Annex 2 - non-priority species
International	Habitats Directive Annex 4
International	Habitats Directive Annex 5
National Legislation	Natural Environment and Rural Communities Act 2006 - Species of Principal Importance in England (section 41)
National Legislation	Wildlife and Countryside Act 1981 (Schedule 1 Part 1)
National Legislation	Wildlife and Countryside Act 1981 (Schedule 5 Section 9.1 (killing/injuring))
National Legislation	Wildlife and Countryside Act 1981 (Schedule 5 Section 9.1 (taking))
National Legislation	Wildlife and Countryside Act 1981 (Schedule 5 Section 9.4a)
National Legislation	Wildlife and Countryside Act 1981 (Schedule 5 Section 9.4b)
National Legislation	Wildlife and Countryside Act 1981 (Schedule 5 Section 9.4c)
National Legislation	Wildlife and Countryside Act 1981 (Schedule 8)
National Legislation	Protection of Badgers Act (1992)
London Priority List	London Priority Species
Red Data List	Bird Population Status - red
Red Data List	IUCN (2001) - Critically endangered
Red Data List	IUCN (2001) - Data Deficient
Red Data List	IUCN (2001) - Endangered
Red Data List	IUCN (2001) - Extinct
Red Data List	IUCN (2001) - Extinct in the wild
Red Data List	IUCN (2001) - Regionally Extinct
Red Data List	IUCN (2001) - Lower risk - near threatened
Red Data List	IUCN (2001) - Vulnerable

Other rare/scarce	Nationally Rare. Excludes Red Listed taxa
Other	Nationally rare
Local	London Species of Conservation Concern