Appendices to:

The effect of construction activity on SPA waterfowl; a case study of the Abberton Reservoir Enhancement Scheme

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September 2017

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Appendix to Chapter 2

Appendix 2.1: Abberton Reservoir Site of Special Scientific Interest (SSSI) citation

Abberton Reservoir was notified as a SSSI in 1988 under Section 28 of the Wildlife & Countryside Act 1981 as amended, having initially been designated (under the 1949 Act) in 1955. The Abberton Reservoir SSSI covers an area of 716.3ha with the majority of the SSSI also statutorily protected (Abberton Reservoir Sanctuary) by the Wild Birds order 1967.

Abberton was notified as a SSSI for the following reasons:

"It (Abberton Reservoir) is the largest freshwater body in Essex with a water area of about 500 ha, and one of the most important reservoirs in Britain for wildfowl. About thirty thousand birds visit the reservoir annually including internationally important members of one species and nationally important members of twelve others. It is also one of a handful of sites in Britain where Cormorants nest inland in trees"

"The Reservoir was created between 1939 and 1941 by damming Layer Brook near its junction with the Roman River and flooding the long shallow valley to the south-west. Most of the water, however, is pumped from the River Stour, about nine miles to the north. Abberton Reservoir is less than five miles from the coast and its primary role is a roost for the local estuarine population of wildfowl. It is outstandingly important as an autumn arrival point, moulting and wintering locality for wildfowl. Thirteen species of waterfowl occur in nationally important numbers, including Wigeon, whose winter numbers are of international significance, Mute Swan, Gadwall, Shoveler, Pochard, Tufted Duck, Goldeneye, Goosander and Coot"

"The breeding colony of Cormorants is unique in Great Britain, the birds nesting in trees instead of the customary cliff ledges and rocky inlets. The colony was established in 1981 with 9 nests, and has grown rapidly to more than 200 pairs over 3 per cent of the British breeding population. The site boundary includes a strip of pasture and recently planted woodland surrounding the reservoir. Some of the pastures are damp and unimproved and form feeding areas for Lapwing, Curlew and Golden Plover in winter and nest sites for Yellow Wagtail and Redshank. The improved grassland is extensively grazed by Wigeon, wild and feral geese. Marginal fields at the western end of the reservoir, managed on rotation as grass or arable, are also included in the site. The reservoir is mostly bordered by a concrete apron and access road, but the south-western arm has an inaccessible natural shoreline with willow and reed swamp grading into damp grassland. This provides cover, feeding and breeding habitat for invertebrates, waterfowl and other birds, and provides some additional botanical interest with species such as Lesser Reedmace *Typha angustifolia*, Glaucous Bulrush *Schoenoplectus tabernaemontani*, Golden Dock *Rumex maritimus*, Whorled Mint *Mentha x verticillata*, Lesser Skullcap *Scutellaria minor* and Small Pondweed *Potamogeton berchtoldii"*

Appendix 2.2: Abberton Reservoir Special Protection Area (SPA) citation

Abberton Reservoir was designated as a SPA on 5th December 1991. Following the SPA review, the Abberton Reservoir citation was updated on the 5th May 2006 and qualifies for the following reasons

ARTICLE 4.1 QUALIFICATION (79/409/EEC)

During the breeding season the area regularly supports: *Phalacrocorax carbo* (North-western Europe) 7% of the population in Great Britain 5-year mean, 1993-1997

Over winter the area regularly supports:

- *Anas clypeata* (North-western/Central Europe) 1.6% of the population 5-year peak mean 1991/92-1995/96

- *Anas crecca* (North-western Europe) 2.5% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Anas penelope* (Western Siberia/North-western/North-eastern Europe) 0.2% of the population 5-year peak mean 1991/92-1995/96
- *Anas strepera* (North-western Europe) 1.7% of the population 5-year peak mean 1991/92-1995/96
- *Aythya ferina* (North-western/North-eastern Europe) 4.4% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Aythya fuligula* (North-western Europe) 3.1% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Bucephala clangula* (North-western/Central Europe) 2.7% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Cygnus olor* (Britain) 1.9% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Fulica atra* (North-western Europe - wintering) 11% of the population in Great Britain 5-year peak mean 1991/92-1995/96
- *Podiceps cristatus* (North-western Europe - wintering) 1.3% of the population in Great Britain 5-year peak mean 1991/92-1995/96

ARTICLE 4.2 QUALIFICATION (79/409/EEC): AN INTERNATIONALLY IMPORTANT ASSEMBLAGE OF BIRDS

Over-winter the area regularly supports: 39,763 waterfowl (5-year peak mean 1991/92-1995/96). Including: *Podiceps cristatus* (Great Crested Grebe), *Anas Penelope* (Wigeon), *Anas strepera* (Gadwall), *Anas crecca* (Teal), *Anas clypeata* (Shoveler), *Aythya ferina* (Pochard), *Aythya fuligula* (Tufted Duck), *Bucephala clangula* (Goldeneye*), Fulica atra* (Coot).

Appendix 2.3: Abberton Reservoir Ramsar Site citation

Abberton Reservoir was designated as a wetland of international importance under the Ramsar Convention 1971 on 24th July 1981. An undaed citation was issued by the JNCC on 5th May 2006.

Abberton Reservoir Ramsar is classified as a human made inland wetland and covers an area of 726.6ha. Abberton Reservoir qualifies as a Ramsar site under the following criteria:

Ramsar criterion 5 Assemblages of international importance - species with peak counts in winter:

23787 waterfowl (5-year peak mean 1998/99 - 2002/2003)

Ramsar criterion 6 – species / populations occurring at levels of international importance. Qualifying Species / populations (as identified at designation) with peak counts in spring / autumn:

Gadwall, *Anas strepera strepera*, NW Europe	550 individuals, representing an average of 3.2% of the GB population (5-year peak mean 1998/99 - 2002/03)
Northern shoveler, *Anas clypeata*, NW & C Europe	377 individuals, representing an average of 2.5% of the GB population (5-year peak mean 1998/99 - 2002/03)

Species with peak counts in winter:

Eurasian wigeon, *Anas penelope*, NW Europe	2888 individuals, representing an average of 1.6% of the population (5-year peak mean 1991/92 - 1995/96)

Species / populations identified subsequent to designation for possible future consideration under criterion 6. Species with peak counts in spring/autumn:

Mute Swan, *Cygnus olor*, Britain	87 individuals, representing an average of 1% of the population (5-year peak mean 1998/99 - 2002/03)
Common pochard, *Aythya ferina*, NE & NW Europe	4373 individuals, representing an average of 1.2% of the population (5-year peak mean 1998/99 - 2002/03)

Appendix 2.4: Construction elements of The Abberton Scheme – a summary

Main dam and associated structures

- Raising of the main dam by 2.9m from 19.8m AOD to 22.7m AOD. Granular and clay material to complete the core of the main dam to be supplied from an on-site borrow pit.
- Raising of the valve tower, situated on the main dam, from 19.86m AOD to 22.5m AOD.
- The existing swallow hole will be raised from 17.8m AOD to 21.3m AOD with a weir to determine top water level fixed at 21m AOD.
- Reinforcement of the existing dam tunnel to account for additional pressure resulting from the enlarged dam.

Offtake pumping station

- The reservoir will continue to supply water to customers (via the treatment works) throughout construction. In order to achieve this a temporary offtake pumping station (TOTPS) will be constructed whilst work to raise and refurbish the existing offtake pumping station (OTPS) occurs.

B1026 road diversion and raising of the causeway

- A 1.8km stretch of the B1026 road between Layer-de-la-Haye Church and the B1026 causeway will be diverted to account for the enlargement of the reservoir.
- The B1026 causeway will be raised by 0.5m from 20m AOD to 20.5m AOD and will separate the Main and Central Sections.
- A new pumping station at the causeway will be constructed allowing water to be pumped from the Central Section to the Main Section. This water is natural inflow from Layer Brook at the Western Section which enters the via a weir structure.

Col dam construction and perimeter road construction

- Four earth col dams (mini dams) named Billets, Moulshams, Peldon and Glebe will be created. These are positioned in naturally low areas of land and are designed to hold back water at high levels.
- All of the clay and granular components of the col dams will be constructed from material won from borrow pits on site.
- A new perimeter road around the Main Section will be created using the concrete slabs and road removed from the perimeter of the existing reservoir. The removed material will be crushed and processed on site.

Appendix to Chapter 3

Appendix 3.1: Example of weekly construction programme (from April 2011)

Abberton Scheme Project 5 - Short term look ahead programme 059

Page 1 of 8

carillion

Programme area: Offtake Pumping Station

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: Abberton Scheme Project 5 Reservoir Enhancement

Project Week No. 69 | 70

Period Commencing Monday 11/04/2011

Print Date: 07/0/11
Prepared by: Ella Roebuck
Supervisor: Ray Jones
Manager: Andy Paton
Dist: Internal / LiveLinks

Activity ID	Activity Description	MS No.	Lift Plan?	Resource / Attendance	11-Apr-11 M	12-Apr-11 T	13-Apr-11 W	14-Apr-11 T	15-Apr-11 F	16-Apr-11 S	17-Apr-11 S	18-Apr-11 M	19-Apr-11 T	20-Apr-11 W	21-Apr-11 T	22-Apr-11 F	23-Apr-11 S	24-Apr-11 S	Comments
	Temporary Offtake PS																		
1 A/B	Access (vehicular & pedestrian) and site maintenance	MS099	N/A	Carillion (RJ)															
2 A/B	Surge Vessel 2 higher draindown pipework & backfill	MS164 & MS186	N/A	Carillion (RJ)															
3 A/B	Lay water pipes into TOTPS		N/A	Carillion (RJ)															
4 A/B	Concrete seal to 1200dia pipes passing through piles	TBC		Bell Formwork															
5 A/B	Install Blind Tank TW's and excavate	TBC	N/A	Carillion (RJ)															Subject to solution to service clash and temporary works approval
6 A/B	Scaffolding for the grouting of the stoplogs	TBC	N/A	Tone Scaffolding															Subject to TW's and MS approval
7 A/B	Grouting of stoplogs (lift at a time)	TBC	N/A	Carillion (RJ)															Subject to TW's and MS approval
8 A/B	Move Sheet piles	MS266 & MS	TBC	Carillion (RJ) (N J Cranes)															ON HOLD
9 A/B	Dredging Operation	TBC	TBC	Aquatic Engineering															Delivery and offload of plant on Thursday 14th
10 A/B	Erect crash deck	MS242	-	MCE London (Benchmark)															Subject to temporary works approval
11 A/B	Install roof & remaining wall panels to acoustic building	TBC	TBC	MCE London (TPC)															Subject TW's and MS approval
12 A/B	Dismantle crash deck netting and handrail	TBC	TBC	MCE London (Benchmark)															Subject TW's and MS approval
13 A/B	Install internal cladding panels	TBC	TBC	MCE London (TPC)															
14 A/B	Fix doors, louvres and hatches	TBC	TBC	MCE London (ALPS)															
	E&C Building																		
15 A/B	Adapt scaffold to N&W tower and strike internal scaffold	MS174		Swift Brickwork (Benchmark)															
16 A/B	Steelwork angles over doors	MS243		Swift Brickwork (Bore Fabrications Forklift															
17 A/B	Install metal staircase	TBC		Swift Brickwork (Bore Fabrications Forklift															
18 A/B	Upper level roof screed	TBC		Swift Brickwork (Stockford)															
19 A/B	Main level roof screed	TBC		Swift Brickwork (Stockford)															

carillion

Programme area: **Offtake Pumping Station**

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: **Abberton Scheme Project 5 Reservoir Enhancement**

Project Week No. 69 | 70

Period Commencing Monday 11/04/2011

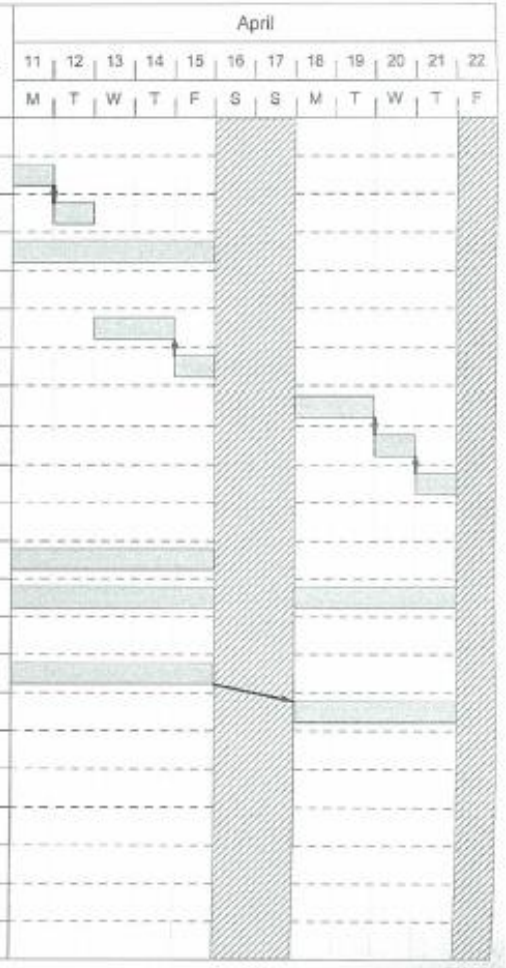
Print Date: 07/04/11
Prepared by: Ella Roebuck
Supervisor: Ray Jones
Manager: Andy Paton
Dist: Internal / LiveLinks

Activity ID	Activity Description	MS No.	Lift Plan?	Resource / Attendance	11-Apr-11 M	12-Apr-11 T	13-Apr-11 W	14-Apr-11 T	15-Apr-11 F	16-Apr-11 S	17-Apr-11 S	18-Apr-11 M	19-Apr-11 T	20-Apr-11 W	21-Apr-11 T	22-Apr-11 F	23-Apr-11 S	24-Apr-11 S	Comments
	E&C Building Cont																		
20 A/B	Render to top of drum store walls	TBC		Swift Brickwork															
21 A/B	Install switchroom flooring	TBC		Swift Brickwork (Rhino)															
22 A/B	Install roof coverings	TBC		Swift Brickwork (Rhino)															
23 A/B	Install roof grills	TBC		Swift Brickwork (Rhino)															
24 A/B	Strike drum store scaffold	MS179		Swift Brickwork (Benchmark)															
22 A/B	Erect external gantry beam	TBC	TBC	J West															Actual date TBC to fit around other operations in area
23 A/B	Install Equipment frames for inverters	TBC		N Class															To be fitted around screeding exclusion zone
24 A/B	Cables towards building	TBC		McAndrews / Morrisons															Once scaffolding has been struck
24 A/B	1st fix Mechanical and Electrical	TBC		Colstens															
	Layer Flume																		
25 A/B	Construction of apron slabs			Bell Formwork															
	Potable/Sewer Drain																		
26 A/B	Fill line	MS239 & MS240	MS240	Perco															
27 A/B	Pressure test line	MS239 & MS240	MS240	Perco															Client witness required

Abberton Reservoir Pipelines Installation Programme

07/04/11

ID	Activity	MS REF	Start	Finish	Dur.
1	**Broadmeadows Inlet Diversion**	MS131			
2	Allow Concrete to cure for Thrust Block.		07/04/11	11/04/11	0.6w
3	ESW to reinstate flows.		12/04/11	12/04/11	0.2w
4	Construct S/V & A/V concrete chambers at B/meadows		11/04/11	15/04/11	1w
5	**710mm Connection**	MS131			
6	ESW to shut / drain down 710mm Main.		13/04/11	14/04/11	0.4w
7	Cut & cap existing Langham Main next 710mm connection.		15/04/11	15/04/11	0.2w
8	Reinforcement & formwork to thrust block		18/04/11	19/04/11	0.4w
9	Cast Concrete Thrust Block		20/04/11	20/04/11	0.2w
10	Allow Concrete to cure for Thrust Block		21/04/11	28/04/11	1w
11	**Main Run 1200mm Dia Twin Pipeline**	MS160			
12	Welding twin 1200mm from CH855-CH912.		11/04/11	15/04/11	1w
13	Excavating & installing 2 HV's & 1 fibroptic, plus LV.		11/04/11	25/04/11	2w
14	**1200mm Dia Twin Run Pipeline OTPS**	MS160			
15	To be fitted 2-CT1218 V077 / V078 / V080 / 2-CR1219 / V082		08/04/11	15/04/11	1.2w
16	(Line B) from B-B1205 to B-T1202		18/04/11	25/04/11	1w
17					
18					
19					
20					
21					
22					



Abberton Scheme Project 5 - Short term look ahead programme 059

carillion

Programme area: Valve Tower

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: Abberton Scheme Project 5 Reservoir Enhancement

Project Week No. 69 | 70

Period Commencing Monday 11/04/2011

Print Date: 07/04/11
Prepared by: Kirk Vincent
Supervisor: John Standing
Manager: Andy Finnigan
Dist: Internal / LiveLink

Activity ID	Activity Description	MS No.	Resource / Attendance	11-Apr-11 M	12-Apr-11 T	13-Apr-11 W	14-Apr-11 T	15-Apr-11 F	16-Apr-11 S	17-Apr-11 S	18-Apr-11 M	19-Apr-11 T	20-Apr-11 W	21-Apr-11 T	22-Apr-11 F	23-Apr-11 S	24-Apr-11 S	Comments
	Valve Tower																	
1 A/B	Scaffolding to External Walkway	MS 216	Tone (Squibbs)															
2 A/B	Walkway & Slab Demolition	MS 158	Squibbs															
3 A/B	Wet Well Scaffolding	Req	Tone (Squibbs)															
4 A/B	Dry Well scaffolding Adaptions		Tone (Carillon)															
5 A/B	Pressure Washing Walls	Req	Carillon															Subject to safe access during demolition
6 A/B																		
	Swallow Hole																	
7 A/B	Scaffolding for Crash Deck	MS 209	Tone (Squibbs)															
8 A/B	Coring to pipe	MS 197	Squibbs															Subject to safe access around other activities
9 A/B	Clearing out Swallow Hole		Carillon															
	Outlet tunnel																	
10 A/B	Clean tunnel and concrete finishing works	MS 230	Balfa															
11 A/B	Resin Injection	Req	Carillon															
12 A/B																		
13 A/B																		
14 A/B																		
15 A/B																		
16 A/B																		

Project title:

carillion

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: Abberton Scheme Project 5 Reservoir Enhancement

Project Week No. — Period Commencing Monday 11/04/2011

Print Date: 07/04/11
Prepared by: Kirk Vincent
Supervisor: John Standing
Manager: Andy Finnigan
Dist: Internal / LiveLinks

Work area: Structures

Activity ID		Activity Description	MS No.	Resource / Attendance	69 M 11-Apr-11	69 T 12-Apr-11	69 W 13-Apr-11	69 T 14-Apr-11	69 F 15-Apr-11	69 S 16-Apr-11	69 S 17-Apr-11	70 M 18-Apr-11	70 T 19-Apr-11	70 W 20-Apr-11	70 T 21-Apr-11	70 F 22-Apr-11	70 S 23-Apr-11	70 S 24-Apr-11	Comments
		Shotcrete Trial Panel																	
17	A/B																		
18	A/B	Offer Trail Panel Inspection																	Awaiting Approval
19	A/B																		
		Tailbay																	
20	A/B	Shutters to Bay 2	Req	Bells															
21	A/B	Reinforcement To Bay 2	Req	Bells															
22	A/B	Concrete Bay 2	Req	Bells															
23	A/B	Reinforcement To Bay 1	Req	Bells															
24	A/B	Concrete Bay 1	Req	Bells															
25	A/B	Shutters to Bay 3 1st half	Req	Bells															
26	A/B	Reinforcement to Bay 3 1st half	Req	Bells															
27	A/B	Concrete to Bay 3 1st half	Req	Bells															
28	A/B	Excavate sump	Req	Carillion															
29	A/B	Re Bar delivery		Carillion															
30	A/B	Clay Bund to Tailbay & Toe drain outlet pipe diversion	Req	Carillion															
31	A/B	Crane / Pump pad updating	Req	Carillion															Subject to Temp works approval
32	A/B	Slab for Shotcrete pad	Req	Carillion															Subject to shotcrete approval
33	A/B																		
34	A/B																		

carillion

Programme area: Causeway

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: **Abberton Scheme Project 5 Reservoir Enhancement**

Project Week No. | Period Commencing Monday | 11/04/2011

Print Date: 07/04/11
Prepared by: Andy Finnigan
Supervisor: John Standing
Manager: Andy Finnigan
Dist: Internal / LiveLinks

				69							70							
				11-Apr-11	12-Apr-11	13-Apr-11	14-Apr-11	15-Apr-11	16-Apr-11	17-Apr-11	18-Apr-11	19-Apr-11	20-Apr-11	21-Apr-11	22-Apr-11	23-Apr-11	24-Apr-11	
Activity ID	Activity Description	MS No.	Resource / Attendance	M	T	W	T	F	S	S	M	T	W	T	F	S	S	Comments
	Billets Col Dam Pumping Station - Electrical Building																	
1 A/B	Building Works	MS 171	MCE London															
2 A/B	Ramp	MS 151	Bell Formwork															Installed when required to tie in with Builders works !
3 A/B																		
4 A/B	Joint Cables at Building		EDF															
5 A/B	Fit CT Chamber		EDF / Siemens															
6 A/B																		
	Causeway Pumping Station - Electrical Building																	
7 A/B	Building Works	MS 171	MCE London															Due for completion - Friday 15th April
8 A/B	Ramp	MS 151	Bell Formwork															Installed when required to tie in with Builders works !
9 A/B																		
10 A/B	Construct Transformer Base		JMH Construction															Scheduled to commence 18th April
11 A/B																		
12 A/B	Install Transformer and GRP Housing		EDF															Scheduled for 20th April
13 A/B	Install cables from Transformer to Building		EDF															
14 A/B	Install Electric Meters to Billets & Causeway Buildings																	Scheduled for w/c 16th May
15 A/B																		
16 A/S																		
17 A/S																		
18 A/S																		

carillion

Carillion Civil Engineering SE

(To be updated and issued Thursday afternoon)

Project title: Abberton Scheme Project 5
Reservoir Enhancement

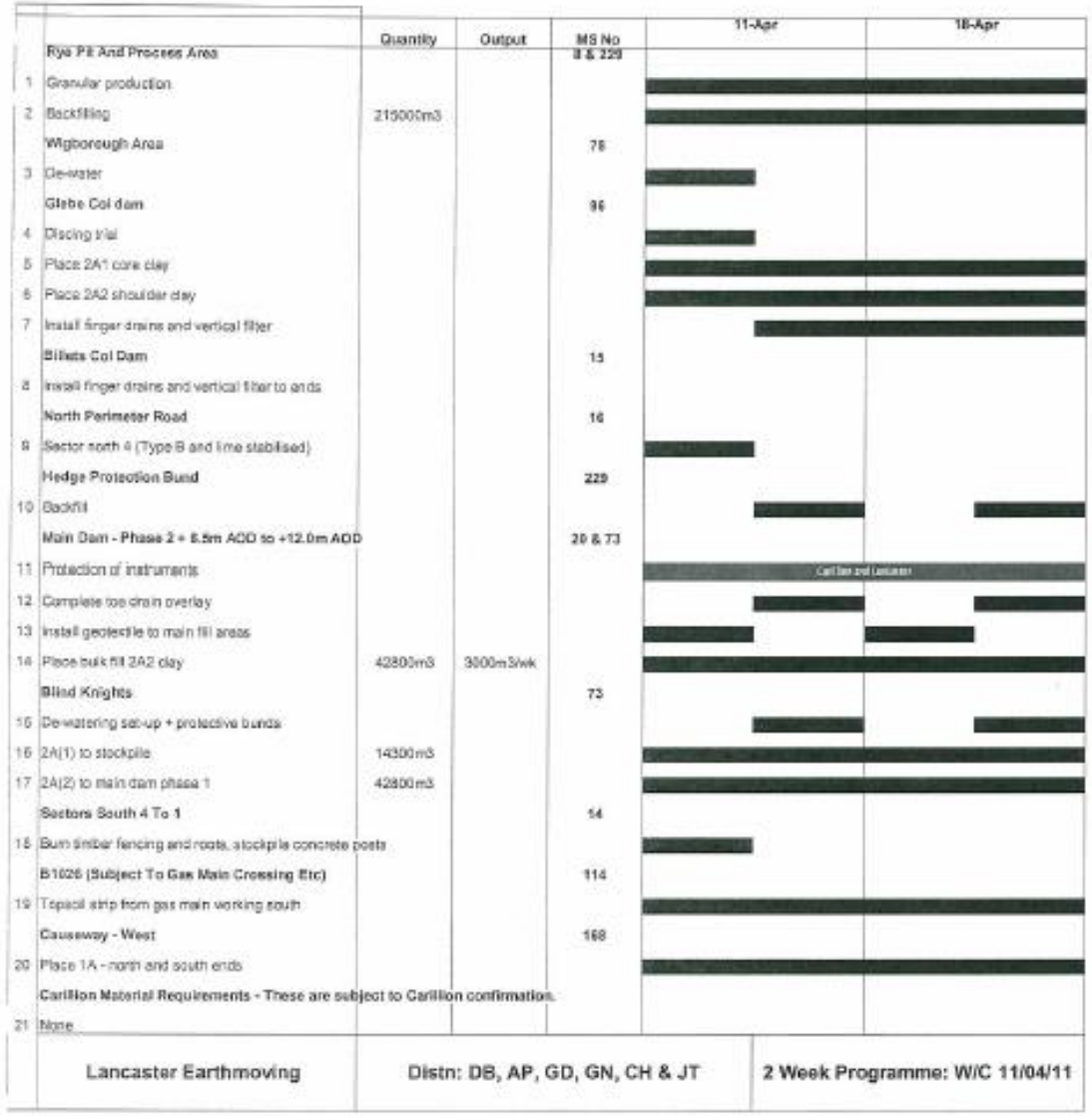
Period Commencing Monday
11/04/2011

Project Week No. 69 | 70

Print Date: 07/04/11
Prepared by: Andy Finnigan
Supervisor: John Standing
Manager: Andy Finnigan
Dist: Internal / LiveLinks

Work area: Structures

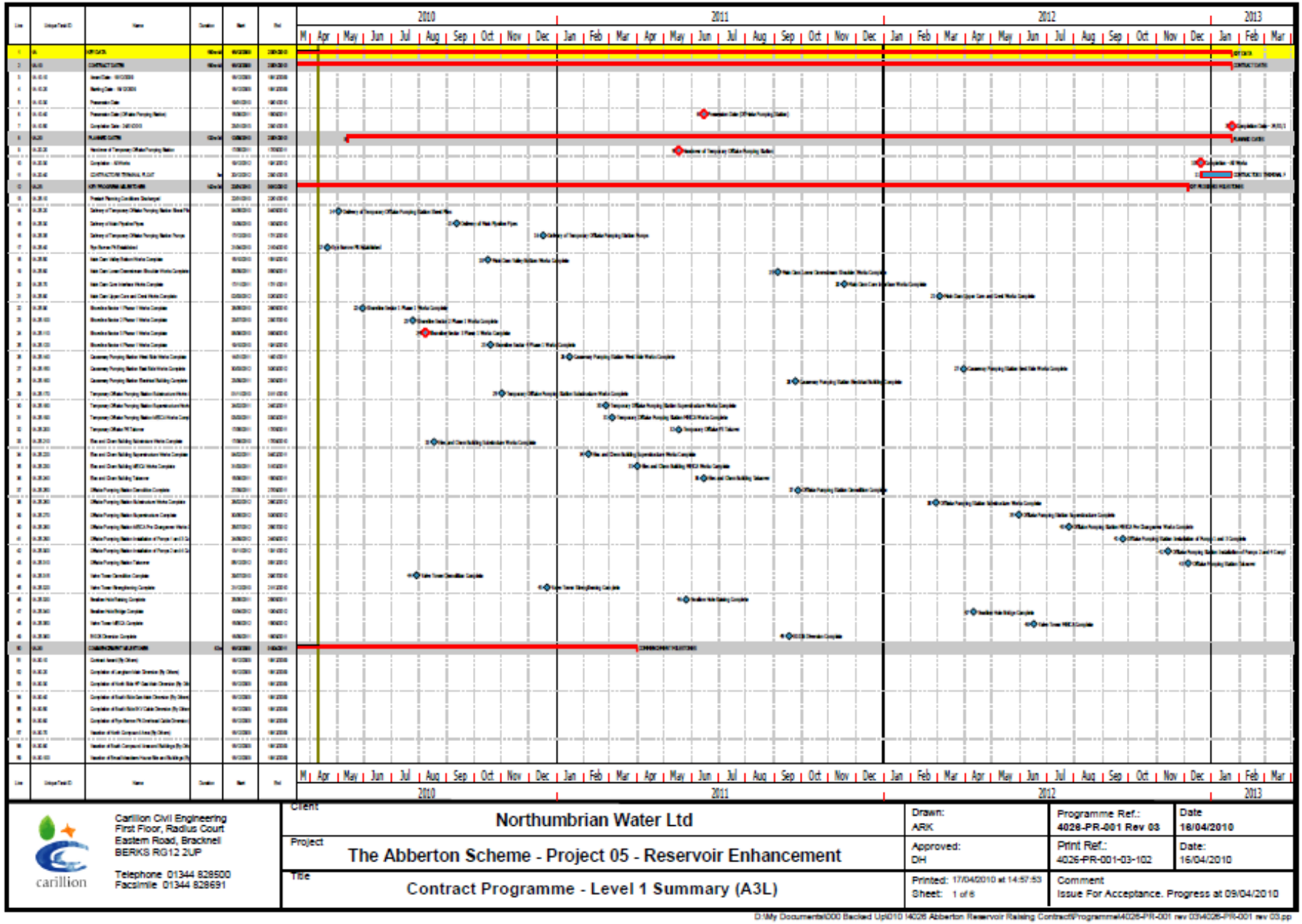
Activity ID	Activity Description	MS No.	Resource / Attendance	11-Apr-11 M	12-Apr-11 T	13-Apr-11 W	14-Apr-11 T	15-Apr-11 F	16-Apr-11 S	17-Apr-11 S	18-Apr-11 M	19-Apr-11 T	20-Apr-11 W	21-Apr-11 T	22-Apr-11 F	23-Apr-11 S	24-Apr-11 S	Comments
	Causeway Pumping Station																	
19 A/B	Traffic Management	MS 128	Traffic Management Solutions															
20 A/B	De-Water / Over-Pumping	MS 201	Carillion															
21 A/B	Seal Main Reservoir side Dam Board	req'd !!	Red 7 Marine															
22 A/B	Pressure Wash/Clean	MS 162	Carillion															
23 A/B	Re-locate Pumps	req'd !!	Carillion															
24 A/B	Install Access	req'd !!	TONE / Bell Formwork															
25 A/B	Fix Reinforcement to Base Slab	req'd !!	Bell Formwork															
26 A/B	Fix Formwork & Kickers to Base Slab	req'd !!	Bell Formwork															
27 A/B	Concrete Base Slab	req'd !!	Bell Formwork															
28 A/B																		
29 A/B																		
30 A/B	Remove Road/Expose Culvert Roof	req'd !!	Carillion															
31 A/B	Drill Dowel Bars	req'd !!	Allied Diamond Drilling															
32 A/B																		
	School Lane - Petrol Interceptor																	
33 A/B	Installation	req'd !!	Carillion															Weather dependant
34 A/B																		
35 A/B																		
36 A/B																		

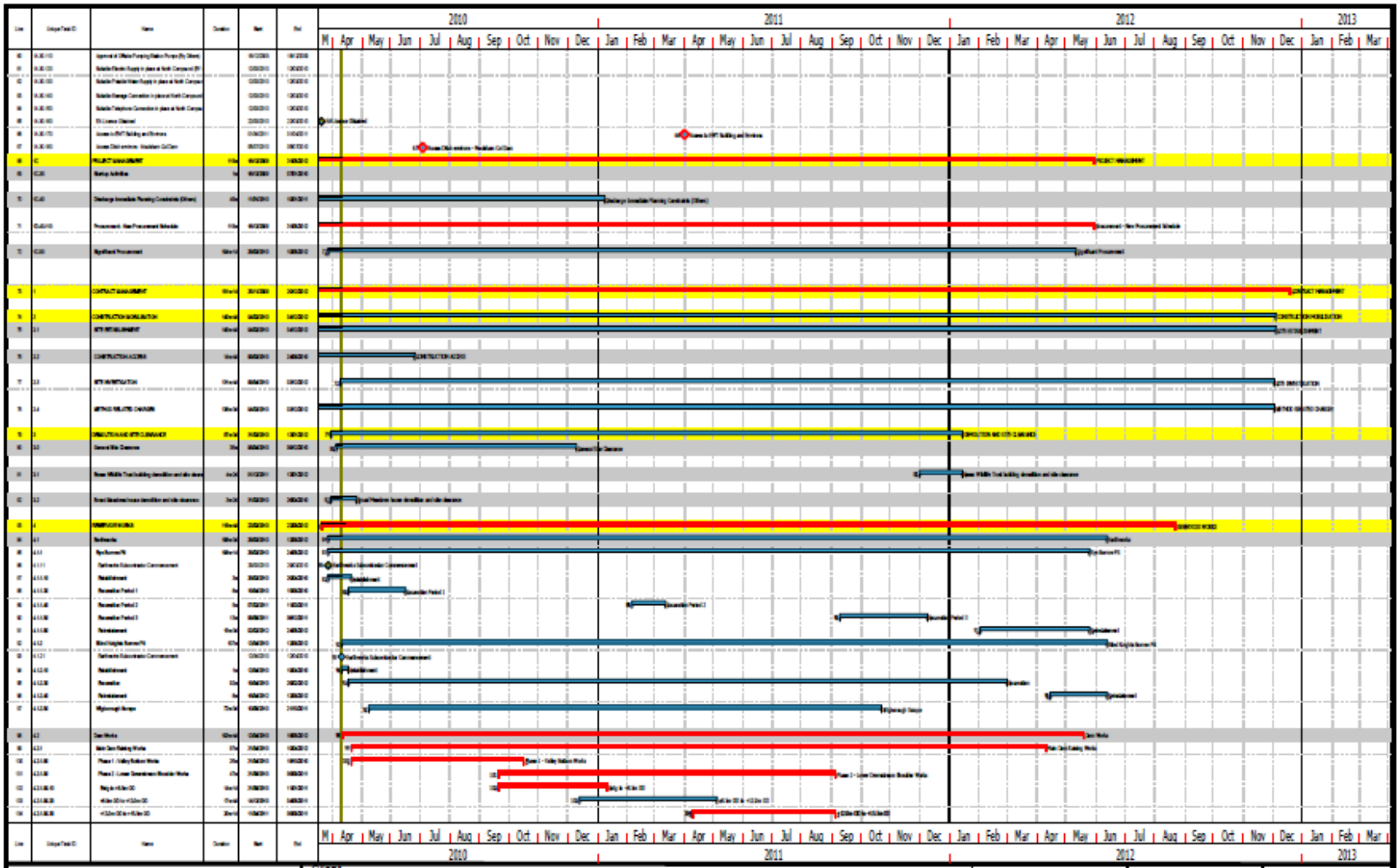


		Quantity	Output	MS No	11-Apr	18-Apr
	Rye Pit And Process Area			8 & 229		
1	Granular production					
2	Backfilling	215000m3				
	Wigborough Area			78		
3	De-water					
	Glebe Col dam			96		
4	Discing trial					
5	Place 2A1 core clay					
6	Place 2A2 shoulder clay					
7	Install finger drains and vertical filter					
	Billets Col Dam			15		
8	Install finger drains and vertical filter to ends					
	North Perimeter Road			16		
9	Sector north 4 (Type B and lime stabilised)					
	Hedge Protection Bund			229		
10	Backfill					
	Main Dam - Phase 2 + 8.5m AOD to +12.0m AOD			29 & 73		
11	Protection of instruments				Carillion and Lancaster	
12	Complete toe drain overlay					
13	Install geotextile to main fill areas					
14	Place bulk fill 2A2 clay	42800m3	3000m3/wk			
	Blind Knights			73		
15	De-watering set-up + protective bunds					
16	2A(1) to stockpile	14300m3				
17	2A(2) to main dam phase 1	42800m3				
	Sectors South 4 To 1			14		
18	Burn timber fencing and roots, stockpile concrete posts					
	B1026 (Subject To Gas Main Crossing Etc)			114		
19	Topsoil strip from gas main working south					
	Causeway - West			168		
20	Place 1A - north and south ends					
	Carillion Material Requirements - These are subject to Carillion confirmation.					
21	None					

Lancaster Earthmoving | **Distn: DB, AP, GD, GN, CH & JT** | **2 Week Programme: W/C 11/04/11**

Appendix 3.2: Example of updated monthly construction programme (shortened high level summary from April 2010)





Carillion Civil Engineering
First Floor, Radius Court
Eastern Road, Bracknell
BERKS RG12 2UP

Telephone 01344 828500
Facsimile 01344 828691

Client: Northumbrian Water Ltd

Project: The Abberton Scheme - Project 05 - Reservoir Enhancement

Title: Contract Programme - Level 1 Summary (A3L)

Drawn: ARK	Programme Ref.: 4026-PR-001 Rev 03	Date 16/04/2010
Approved: DH	Print Ref.: 4026-PR-001-03-102	Date: 16/04/2010
Printed: 17/04/2010 at 14:57:57 Sheet: 2 of 6	Comment Issue For Acceptance. Progress at 09/04/2010	

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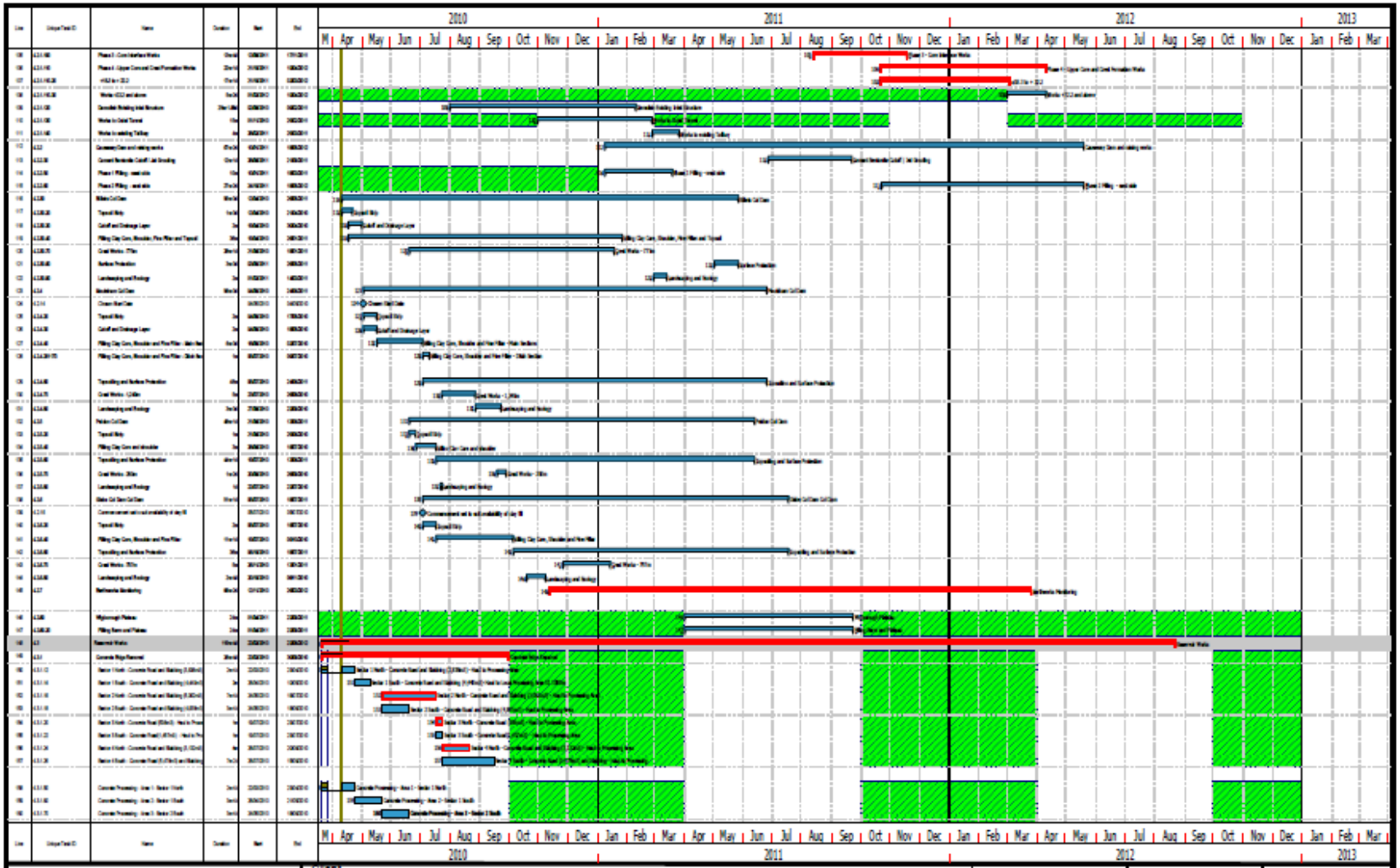

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Client: Northumbrian Water Ltd	Drawn: ARK	Programme Ref.: 4026-PR-001 Rev 03	Date: 16/04/2010
Project: The Abberton Scheme - Project 05 - Reservoir Enhancement	Approved: DH	Print Ref.: 4026-PR-001-03-102	Date: 16/04/2010
Title: Contract Programme - Level 1 Summary (A3L)	Printed: 17/04/2010 at 14:56 Sheet: 3 of 6	Comment: Issue For Acceptance. Progress at 09/04/2010	

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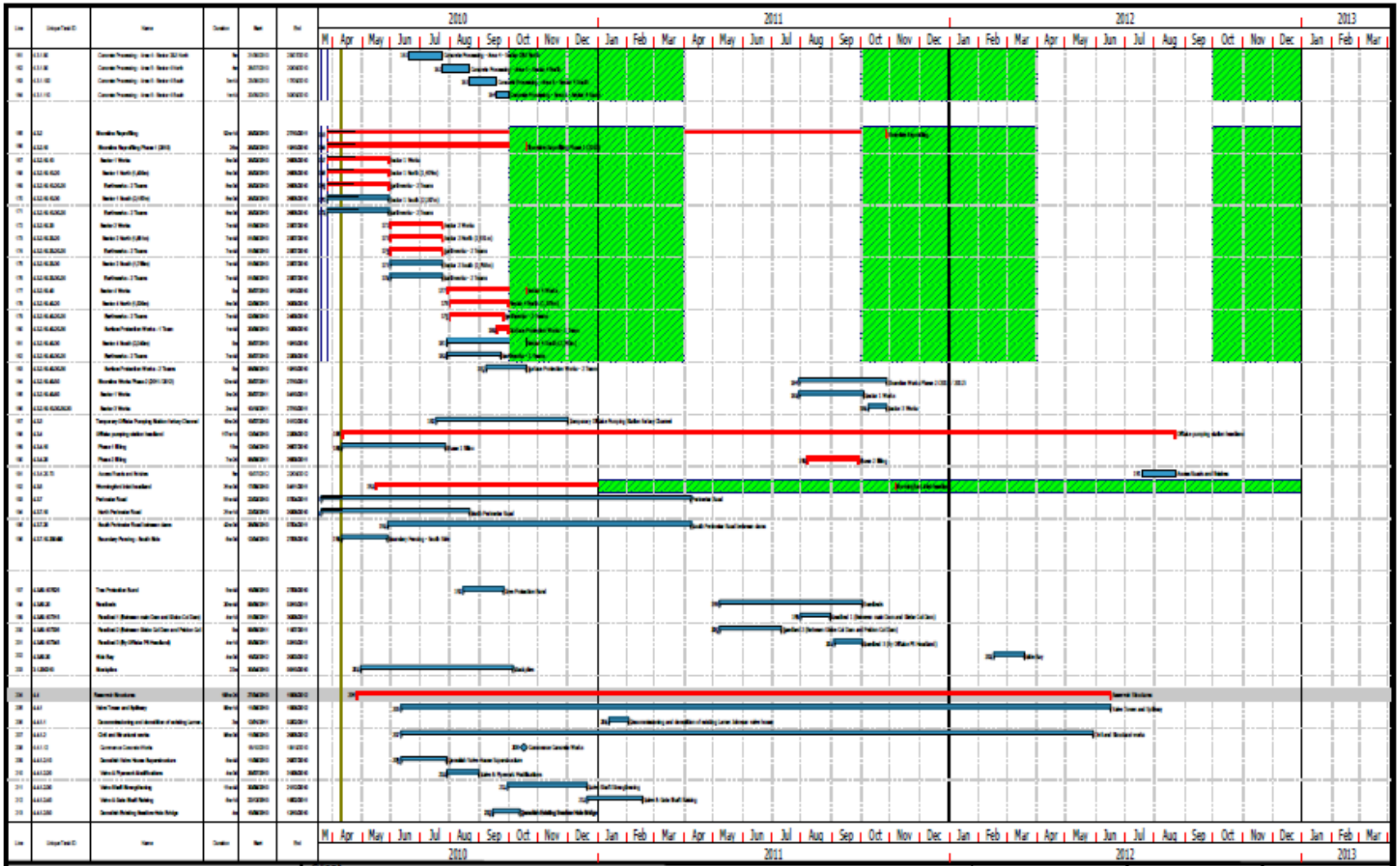

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Client: Northumbrian Water Ltd	Drawn: ARK	Programme Ref.: 4026-PR-001 Rev 03	Date 16/04/2010
Project: The Abberton Scheme - Project 05 - Reservoir Enhancement	Approved: DH	Print Ref.: 4026-PR-001-03-102	Date: 16/04/2010
Title: Contract Programme - Level 1 Summary (A3L)	Printed: 17/04/2010 at 14:58:04 Sheet: 4 of 6	Comment: Issue For Acceptance. Progress at 09/04/2010	

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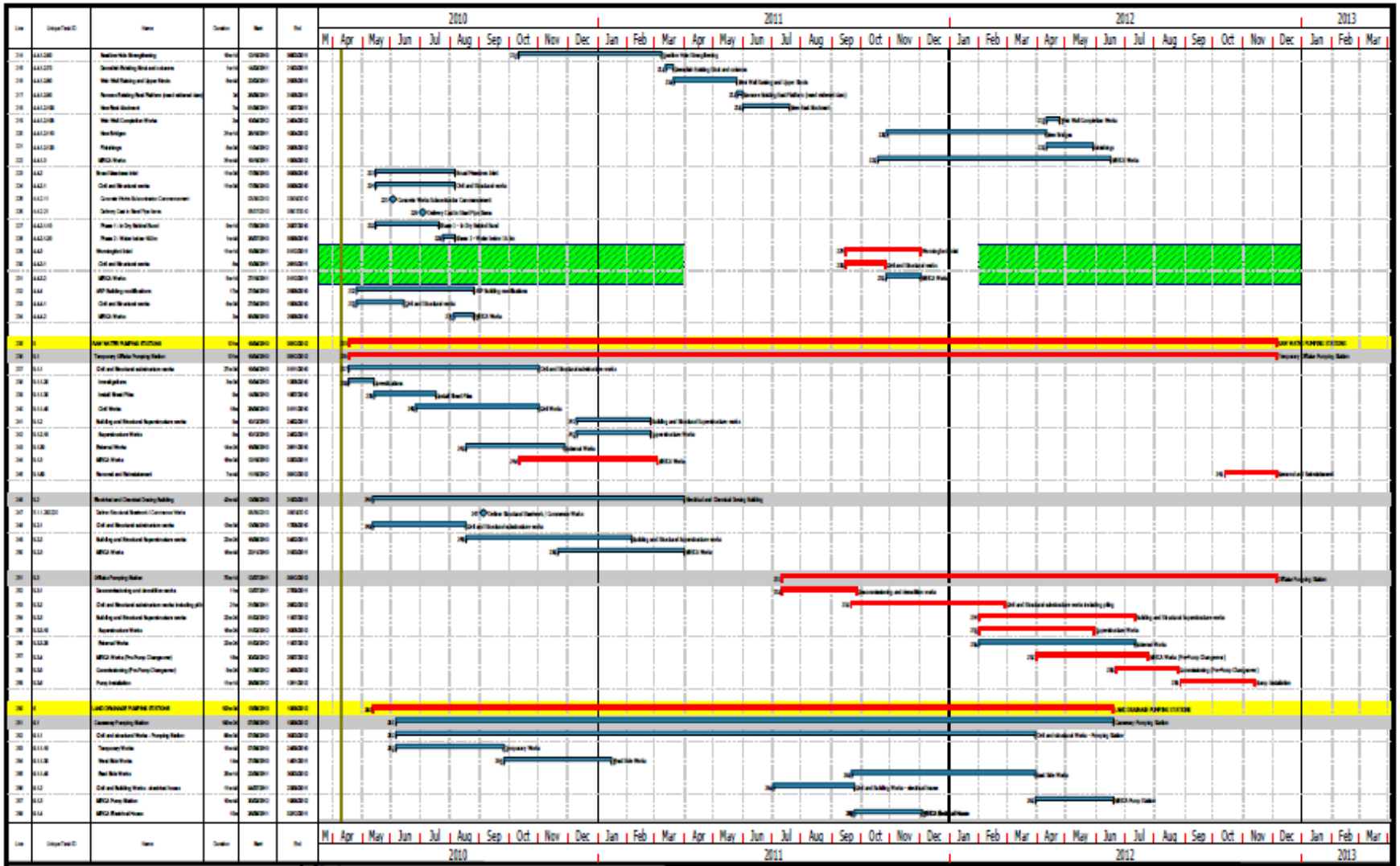

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Client: Northumbrian Water Ltd	Drawn: ARK	Programme Ref.: 4026-PR-001 Rev 03	Date 16/04/2010
Project: The Abberton Scheme - Project 05 - Reservoir Enhancement	Approved: DH	Print Ref.: 4026-PR-001-03-102	Date: 16/04/2010
Title: Contract Programme - Level 1 Summary (A3L)	Printed: 17/04/2010 at 14:58:08 Sheet: 5 of 6	Comment: Issue For Acceptance. Progress at 09/04/2010	

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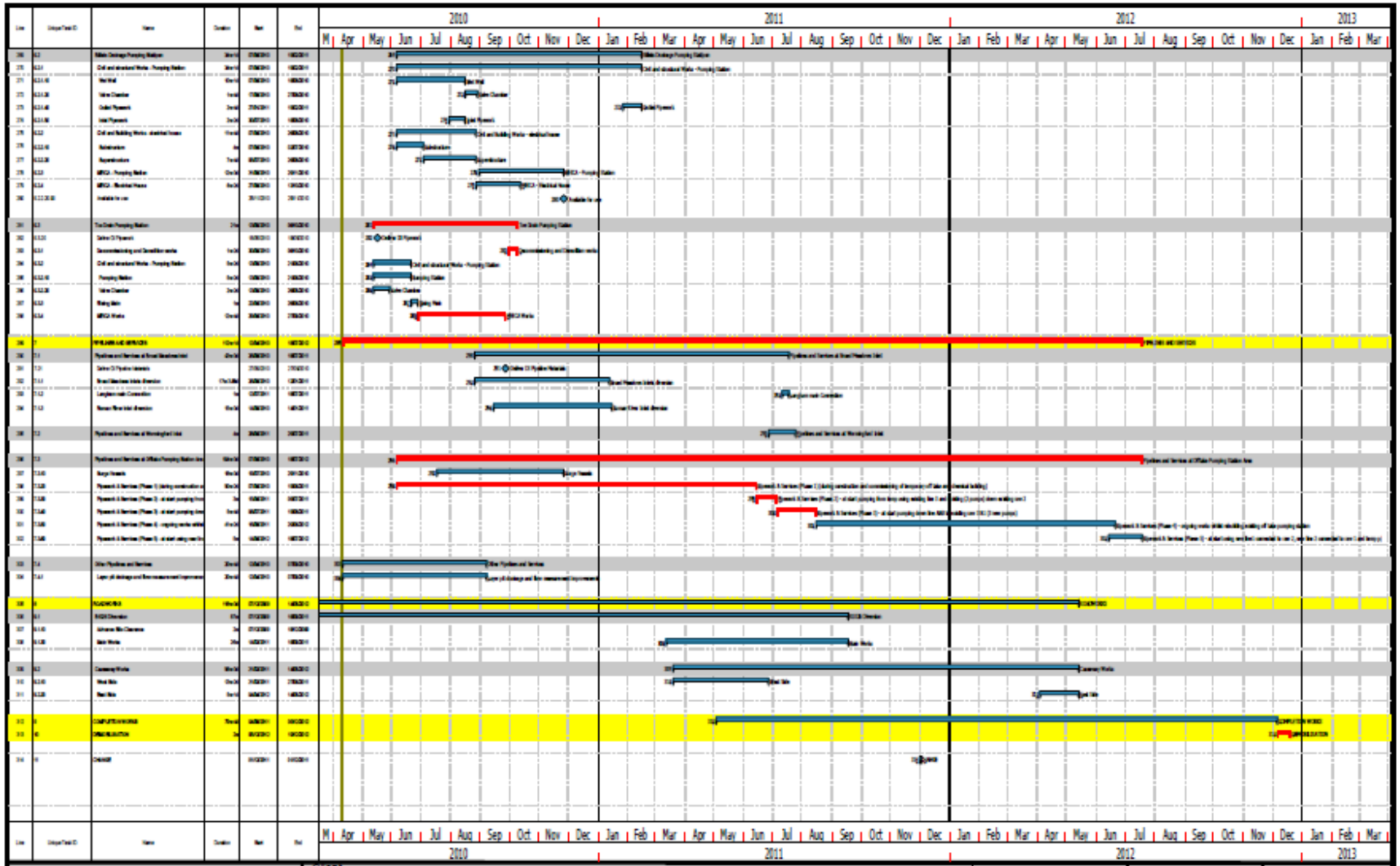

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Client: Northumbrian Water Ltd	Drawn: ARK	Programme Ref.: 4026-PR-001 Rev 03	Date: 18/04/2010
Project: The Abberton Scheme - Project 05 - Reservoir Enhancement	Approved: DH	Print Ref.: 4026-PR-001-03-102	Date: 16/04/2010
Title: Contract Programme - Level 1 Summary (A3L)	Printed: 17/04/2010 at 14:58:11 Sheet: 6 of 6	Comment: Issue For Acceptance. Progress at 09/04/2010	

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Appendix to Chapter 4

Appendix 4.1: R script examples

Data were loaded into R (version 3.3.2) using the R interface R Studio (R Core, 2015) and explored using plotting functions and standard tests such as Shapiro-Wilk test for normality. Following the data exploration phase, repeated for each data set and species, appropriate statistical tests were applied. Examples are provided.

#set directory to data file locations and read in file

#ensure header = TRUE to retain column names an sep = “,” due to csv file

< Premths <-read.table("Premths.csv", header = TRUE, sep = ",")

#attach and view data, also check structure and use summary to check factors and integers

< Attach(Premths)

< View(Premths)

< Str(Premths)

#view simple plot of data

< plot(Year,Tot.Count , xlab = "Year", ylab = "Total waterfowl count", pch=10, las=1, frame = F, cex.axis=0.75)

#view histogram of data, Q-Qplot and run Shapiro Wilk test to test for normality

< hist(Tot.Count)

< qqnorm(Tot.Count);qqlne(Tot.Count)

< Shapiro.test(Tot.Count)

#data not normal – run Levene test for equal variances (install Rcmdr and Lawstat package)

< Levene.test(Tot.Count,Year)

#equal variances assumed, run Kruskal-Wallis test

< Kruskal.test(Tot.Count,Year)

can run post hoc test if significant Kruskal-Wallis result (p<0.05)

< posthoc.kruskal.nemenyi.test(Tot.Count ~ Year, dist – “Chisquare”

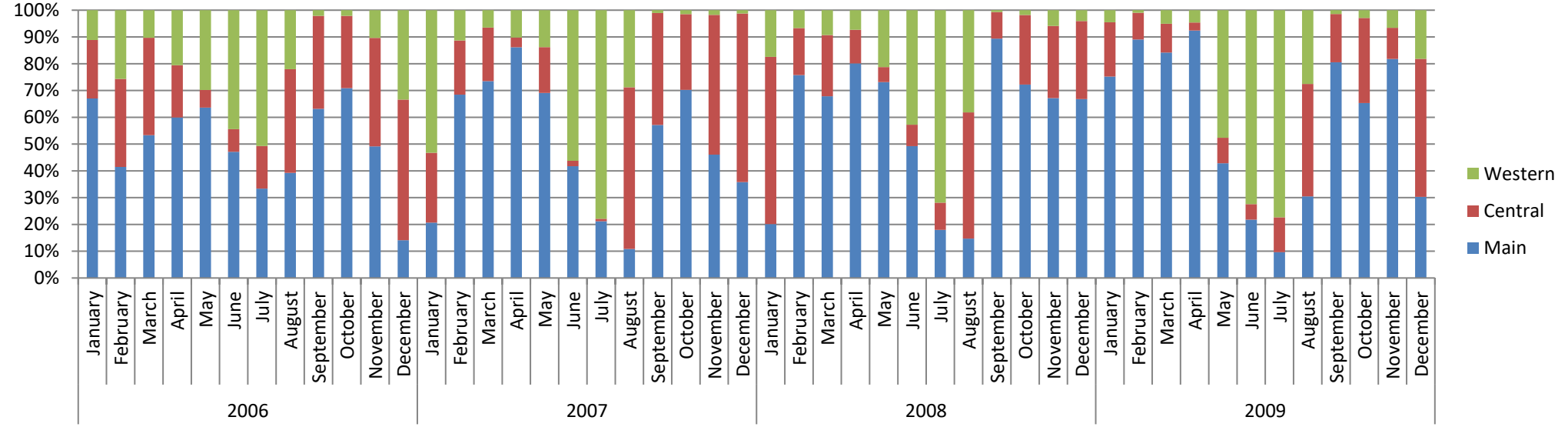
#for comparison between pre and during (total and section analysis) run Mann-Whitney U test (checking data meets assumptions)

< Wilcox.test(Main.P,Main.D)

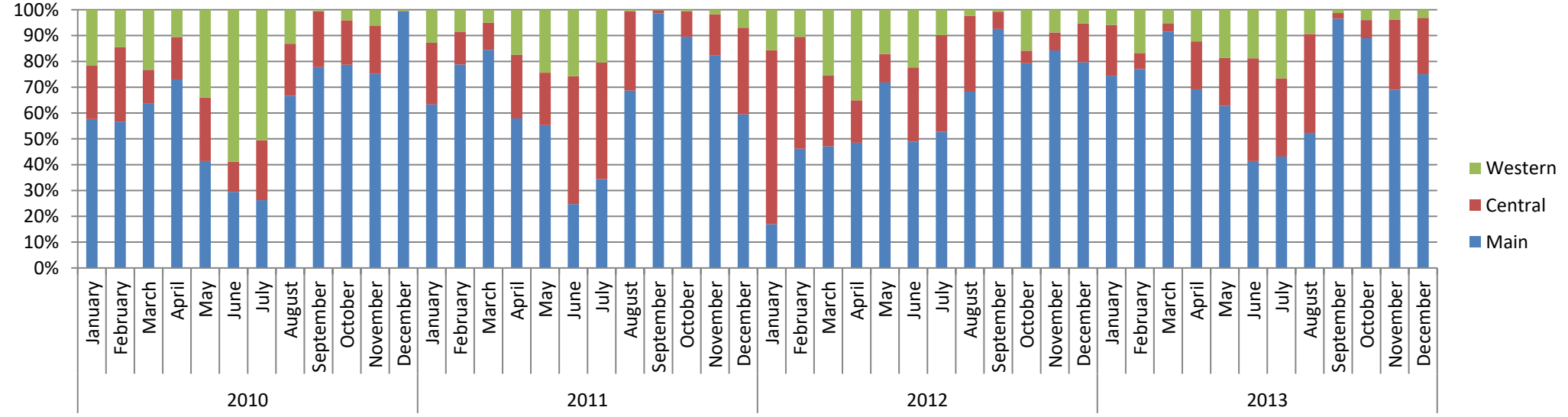
#see direction of difference using alternative argument and paired = F for non-paired samples

< Wilcox.test(Main.P,Main.D, paired = FALSE, alternative = ‘less’)

Appendix 4.2: Percentage of Abberton Reservoir waterfowl in each section (2006 – 2013)



Appendix Figure 4.1: Percentage of total Abberton Reservoir waterfowl (GA, SV, T, W, CO, TU, PO, MS & GG) within the Main, Central and Western Sections (2006 – 2009)



Appendix Figure 4.2: Percentage of total Abberton Reservoir waterfowl (GA, SV, T, W, CO, TU, PO, MS & GG) within the Main, Central and Western Sections (2010 – 2013)

Appendix 4.3: Cluster analysis using Anselin Local Moran's I index and Ripleys K-Function

Gadwall

Appendix Table 4.1: Cluster analysis of Gadwall (GA) distribution over four years prior to construction activity (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Anselin Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	-	-	2		300	Significant clustering
		HL	<1	-	-			
		LH	<1	<1	1			
		NS				96		
	October – March	HH	10	1	1		300	Significant clustering (0 – 800m) Non-significant dispersal 800m +
		HL	-	-	<1			
		LH	<1	<1	1			
		NS				88		
2007	April – September	HH	<1	<1	3		500	Significant clustering
		HL	<1	<1	-			
		LH	2	1	1			
		NS				93		
	October – March	HH	6	<1	-		500	Significant clustering
		HL	<1	<1	-			
		LH	4	<1	1			
		NS				88		
2008	April – September	HH	<1	-	4.1		400	Significant clustering
		HL	-	<1	-			
		LH	<1	<1	1			
		NS				93		
	October – March	HH	-	<1	5		500	Significant clustering
		HL	-	<1	-			
		LH	1	<1	<1			
		NS				92		
2009	April – September	HH	<1	<1	7		500	Significant clustering
		HL	-	-	-			
		LH	1	3	2			
		NS				86		
	October – March	HH	9	<1	2		300	Significant clustering (0 – 700m) Non-significant dispersal 700m +
		HL	<1	<1	<1			
		LH	<1	<1	1			
		NS				85		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Appendix Table 4.2: Cluster analysis of Gadwall (GA) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	6	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				91		
	October – March	HH	5	<1	<1		200	Significant clustering (0 – 900m) Non-significant clustering at 1000m
		HL	<1	-	<1			
		LH	<1	-	<1			
		NS				92		
2011	April – September	HH	6	<1	<1		300	Significant clustering
		HL	-	<1	<1			
		LH	-	-	2			
		NS				91		
	October – March	HH	4	-	-		400	Significant clustering
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				94		
2012	April – September	HH	4	<1	<1		200	Significant clustering (0 – 900m) Non-significant clustering at 1000m
		HL	-	<1	-			
		LH	-	<1	-			
		NS				94		
	October – March	HH	4	<1	<1		300	Significant clustering (0 – 900m) Non-significant clustering at 1000m
		HL	-	-	<1			
		LH	-	<1	<1			
		NS				93		
2013	April – September	HH	1	-	<1		200	Significant clustering to 600m
		HL	-	<1	-			
		LH	-	-	-			
		NS				98		
	October – March	HH	1	-	-		200	Significant clustering except at 700m
		HL	-	-	<1			
		LH	-	-	-			
		NS				98		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Shoveler

Appendix Table 4.3: Cluster analysis of Shoveler (SV) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	4	-	<1		400	Significant clustering (0 – 800m) Non-significant dispersal 800m +
		HL	<1	<1	<1			
		LH	-	-	<1			
		NS				93		
	October – March	HH	3	-	<1		400	Significant clustering Non-significant dispersal at 1000m
		HL	<1	<1	<1			
		LH	-	<1	1			
		NS				94		
2007	April – September	HH	2	-	<1		300	Significant clustering except at 100m (non-significant clustering) Non-significant dispersal at 100m
		HL	<1	>1	-			
		LH	-	-	-			
		NS				96		
	October – March	HH	4	<1	<1		300	Significant clustering
		HL	-	<1	-			
		LH	<1	<1	1			
		NS				93		
2008	April – September	HH	4	1	<1		300	Significant clustering
		HL	-	-	<1			
		LH	<1	<1	<1			
		NS				91		
	October – March	HH	2	<1	-		300	Significant clustering
		HL	<1	-	-			
		LH	<1	<1	<1			
		NS				95		
2009	April – September	HH	4	<1	<1		300	Significant clustering Non-significant dispersal 900m +
		HL	<1	-	-			
		LH	-	-	-			
		NS				94		
	October – March	HH	6	<1	<1		300	Significant clustering
		HL	-	<1	-			
		LH	1	<1	<1			
		NS				90		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Appendix Table 4.4: Cluster analysis of Shoveler (SV) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	4	<1	-		300	Significant clustering Non-significant dispersal at 900 & 1000m
		HL	-	-	-			
		LH	-	-	<1			
		NS				94		
	October – March	HH	4	-	<1		300	Significant clustering to 600m then non-significant dispersal
		HL	<1	-	-			
		LH	<1	<1	1			
		NS				92		
2011	April – September	HH	4	<1	<1		300	Significant clustering non-significant dispersal at 1000m
		HL	-	<1	<1			
		LH	<1	<1	<1			
		NS				93		
	October – March	HH	8	<1	<1		300	Significant clustering to 800m then non-significant dispersal
		HL	-	<1	<1			
		LH	<1	<1	1			
		NS				89		
2012	April – September	HH	7	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				90		
	October – March	HH	2	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	-	<1	<1			
		NS				95		
2013	April – September	HH	6	<1	<1		400	Significant clustering
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				91		
	October – March	HH	6	<1	<1		300	Significant clustering to 800m then non-significant dispersal
		HL	<1	<1	-			
		LH	-	<1	<1			
		NS				91		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Teal

Appendix Table 4.5: Cluster analysis of Teal (T) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)				Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	1	-	-		500	Significant clustering
		HL	-	-	<1			
		LH	-	-	-			
		NS				98		
	October – March	HH	4	<1	-		500	Significant clustering
		HL	-	<1	-			
		LH	-	<1	3			
		NS				92		
2007	April – September	HH	<1	-	<1		200	Significant clustering at 200 & 300m. Non-significant at 100, 400 – 800m and non-significant dispersal at 1000m
		HL	1	-	<1			
		LH	-	-	-			
		NS				98		
	October – March	HH	4	<1	<1		500	Significant clustering
		HL	-	-	-			
		LH	-	-	-			
		NS				95		
2008	April – September	HH	3	<1	-		400	Significant clustering
		HL	-	-	<1			
		LH	-	-	<1			
		NS				96		
	October – March	HH	4	<1	-		500	Significant clustering
		HL	-	<1	-			
		LH	-	-	<1			
		NS				92		
2009	April – September	HH	1	<1	<1		300	Significant clustering
		HL	<1	-	-			
		LH	-	-	-			
		NS				97		
	October – March	HH	10	<1	<1		300	Significant clustering
		HL	<	-	-			
		LH	1	<1	<1			
		NS				85		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Appendix Table 4.6: Cluster analysis of Teal (T) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	8	<1	<1		500	Significant clustering
		HL	-	-	-			
		LH	<1	<1	2			
		NS				88		
	October – March	HH	7	1	1		500	Significant clustering
		HL	-	-	-			
		LH	<1	1	2			
		NS				85		
2011	April – September	HH	4	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	-	<1	<1			
		NS				93		
	October – March	HH	7	1	1		300	Significant clustering to 600m Non-significant dispersal from 700m
		HL	<1	-	-			
		LH	-	1	<1			
		NS				88		
2012	April – September	HH	3	<1	<1		200	Significant clustering to 800m Non-significant dispersal at 900 & 1000
		HL	-	-	-			
		LH	-	<1	<1			
		NS				95		
	October – March	HH	7	<1	<1		300	Significant clustering
		HL	<1	-	<1			
		LH	-	<1	1			
		NS				89		
2013	April – September	HH	2	<1	<1		200	Significant clustering Non-significant dispersal at 1000m
		HL	-	-	-			
		LH	-	-	-			
		NS				97		
	October – March	HH	7	1	1		300	Significant clustering
		HL	<1	<1	-			
		LH	<1	1	<1			
		NS				97		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Wigeon

Appendix Table 4.7: Cluster analysis of Wigeon (WN) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	2	-	-		400	Significant clustering
		HL	-	1	<1			
		LH	-	-	-			
		NS				95		
	October – March	HH	5	1	<1		300	Significant clustering to 7700m then non-significant dispersal
		HL	<1	<1	-			
		LH	-	<1	1			
		NS				91		
2007	April – September	HH	10	-	-		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	<1	-	-			
		LH	<1	<1	1			
		NS				86		
	October – March	HH	7	<1	<1		400	Significant clustering
		HL	-	-	-			
		LH	2	1	<1			
		NS				87		
2008	April – September	HH	7	1	>1		300	Significant clustering
		HL	-	-	-			
		LH	1	1	<0			
		NS				88		
	October – March	HH	8	<1	<1		300	Significant clustering
		HL	<1	-	<1			
		LH	<1	1	<1			
		NS				86		
2009	April – September	HH	1	<1	-		500	Significant clustering
		HL	<1	-	<1			
		LH	-	-	-			
		NS				97		
	October – March	HH	3	-	<1		500	Significant clustering
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				94		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Appendix Table 4.8: Cluster analysis of Wigeon (WN) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	7	<1	<1		300	Significant clustering
		HL	-	<1	-			
		LH	-	<1	<1			
		NS				90		
	October – March	HH	3	<1	-		200	Significant clustering to 700m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				94		
2011	April – September	HH	7	<1	<1		300	Significant clustering
		HL	-	-	<1			
		LH	<1	<1	1			
		NS				89		
	October – March	HH	4	2	1		100	Significant clustering to 600m then non-significant dispersal
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				91		
2012	April – September	HH	3	<1	-		200	Significant clustering to 800m then non-significant dispersal
		HL	<1	-	<1			
		LH	-	-	-			
		NS				96		
	October – March	HH	5	<1	-		300	Significant clustering to 900m then non-significant dispersal
		HL	<1	-	-			
		LH	-	1	<1			
		NS				92		
2013	April – September	HH	4	<1	-		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	<1	<1	<1			
		LH	-	-	<1			
		NS				93		
	October – March	HH	5	1	<1		200	Significant clustering to 800m then non-significant dispersal
		HL	-	-	-			
		LH	-	-	-			
		NS				92		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Coot

Appendix Table 4.9: Cluster analysis of Coot (CO) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	7	<1	<1		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	-			
		LH	-	-	<1			
		LL	-	-	-			
		NS				91		
	October – March	HH	1	<1	<1		200	Significant clustering to 800m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	-			
		LL	-	-	-			
		NS				97		
2007	April – September	HH	8	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				89		
	October – March	HH	12	<1	1		300	Significant clustering
		HL	-	-	<1			
		LH	1	1	1			
		LL	-	-	-			
		NS				81		
2008	April – September	HH	11	<1	<1		300	Significant clustering
		HL	-	-	-			
		LH	<1	1	1			
		LL	-	-	-			
		NS				83		
	October – March	HH	10	1	1		300	Significant clustering
		HL	-	-	-			
		LH	1	<1	1			
		LL	-	-	-			
		NS				83		
2009	April – September	HH	11	2	1		300	Significant clustering to 900m then non-significant dispersal
		HL	-	<1	-			
		LH	<1	1	1			
		LL	-	-	-			
		NS				81		
	October – March	HH	5	1	<1		300	Significant clustering except non-significant dispersal at 1000m
		HL	-	-	<1			
		LH	1	<1	<1			
		LL	-	-	-			
		NS				90		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; LL = statistically significant low value; NS = non-significant.

Appendix Table 4.10: Cluster analysis of Coot (CO) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	11	1	<1		300	Significant clustering to 800m then non-significant dispersal
		HL	-	<1	-			
		LH	<1	1	1			
		LL	-	-	-			
		NS				82		
	October – March	HH	15	<1	<1		300	Significant clustering
		HL	<1	-	-			
		LH	1	1	2			
		LL	-	<1	4			
		NS				74		
2011	April – September	HH	7	<1	<1		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	-	-	-			
		LH	1	1	1			
		LL	-	-	-			
		NS				88		
	October – March	HH	13	<1	<1		500	Significant clustering
		HL	-	-	<1			
		LH	6	3	2			
		LL	-	-	7			
		NS				65		
2012	April – September	HH	5	1	1		500	Significant clustering
		HL	-	-	-			
		LH	2	1	1			
		LL	-	-	-			
		NS				87		
	October – March	HH	9	<1	<1		300	Significant clustering then non-significant dispersal at 900 & 1000m
		HL	-	<1	-			
		LH	<1	1	1			
		LL	-	-	-			
		NS				85		
2013	April – September	HH	10	1	<1		100	Significant clustering to 600m then non-significant dispersal
		HL	-	<1	<1			
		LH	-	<1	<1			
		LL	-	-	-			
		NS				94		
	October – March	HH	11	0	1		300	Significant clustering then non-significant dispersal at 900 & 1000m
		HL	<1	-	<1			
		LH	1	1	1			
		LL	-	-	<1			
		NS				81		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; LL = statistically significant low value; NS = non-significant.

Tufted Duck

Appendix Table 4.11: Cluster analysis of Tufted Duck (TU) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	3	<1	<1		200	Significant clustering to 600m then non-significant dispersal
		HL	<1	-	<1			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				94		
	October – March	HH	3	<1	<1		200	Significant clustering to 700m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				95		
2007	April – September	HH	8	1	<1		300	Significant clustering to 800m then non-significant dispersal
		HL	-	-	-			
		LH	1	1	1			
		LL	-	-	-			
		NS				86		
	October – March	HH	8	1	1		200	Significant clustering to 600m then non-significant dispersal
		HL	-	-	-			
		LH	<1	-	1			
		LL	-	-	-			
		NS				86		
2008	April – September	HH	4	<1	-		300	Significant clustering
		HL	-	-	-			
		LH	1	<1	<1			
		LL	-	-	-			
		NS				92		
	October – March	HH	8	1	1		200	Significant clustering to 600m then non-significant dispersal
		HL	-	<1	-			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				87		
2009	April – September	HH	6	<1	<1		300	Significant clustering to 800m then non-significant dispersal
		HL	<1	-	<1			
		LH	<1	<1	1			
		LL	-	-	-			
		NS				89		
	October – March	HH	6	<1	<1		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	-			
		LH	1	<1	<1			
		LL	-	-	1			
		NS				87		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; LL = statistically significant low value; NS = non-significant.

Appendix Table 4.12: Cluster analysis of Tufted Duck (TU) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	5	<1	1		200	Significant clustering to 600m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				91		
	October – March	HH	6	2	2		200	Significant clustering to 800m then non-significant dispersal
		HL	<1	-	<1			
		LH	-	<1	<1			
		LL	-	-	-			
		NS				87		
2011	April – September	HH	6	2	2		300	Significant clustering to 700m then non-significant dispersal
		HL	-	-	<1			
		LH	<1	<1	1			
		LL	-	-	-			
		NS				85		
	October – March	HH	-	1	1		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	-			
		LH	<1	1	<1			
		LL	-	-	-			
		NS				94		
2012	April – September	HH	6	<1	-		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	<1			
		LH	1	1	<1			
		LL	-	-	-			
		NS				88		
	October – March	HH	6	1	1		100	Significant clustering to 600m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		LL	-	-	-			
		NS				89		
2013	April – September	HH	1	<1	<1		100	Significant clustering to 600m then non-significant dispersal
		HL	<1	-	-			
		LH	-	-	<1			
		LL	-	-	-			
		NS				97		
	October – March	HH	6	3	1		300	Significant clustering to 800m then non-significant dispersal
		HL	<1	-	-			
		LH	<1	<1	1			
		LL	-	-	-			
		NS				87		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; LL = statistically significant low value; NS = non-significant.

Pochard

Appendix Table 4.13: Cluster analysis of Pochard (PO) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)				Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	2	<1	-		200	Significant clustering to 800m Non-sig clustering at 900m and non-significant dispersal at 1000m
		HL	-	-	-			
		LH	-	-	<1			
		NS				96		
	October – March	HH	1	<1	<1		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				95		
2007	April – September	HH	2	-	<1		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	-	-	-			
		LH	-	<1	<1			
		NS				95		
	October – March	HH	2	<1	<1		200	Significant clustering to 800m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				95		
2008	April – September	HH	7	<1	<1		300	Significant clustering
		HL	<1	<1	-			
		LH	<1	1	1			
		NS				97		
	October – March	HH	3	<1	<1		200	Significant clustering to 700m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				94		
2009	April – September	HH	9	1	<1		300	Significant clustering to 600m then non-significant dispersal
		HL	-	-	-			
		LH	<1	<1	<1			
		NS				87		
	October – March	HH	6	1	2		300	Significant clustering to 700m then non-significant dispersal
		HL	-	-	<1			
		LH	<1	1	<1			
		NS				89		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant.

Appendix Table 4.14: Cluster analysis of Pochard (PO) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	6	<1	<1		300	Significant clustering to 900m then non-significant dispersal
		HL	-	<1	-			
		LH	-	<1	1			
		NS				91		
	October – March	HH	3	-	<1		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				95		
2011	April – September	HH	6	2	2		300	Significant clustering to 900m then non-significant dispersal
		HL	<1	<1	<1			
		LH	<1	<1	1			
		NS				86		
	October – March	HH	4	<1	1		200	Significant clustering to 700m then non-significant dispersal
		HL	-	<1	-			
		LH	-	<1	<1			
		NS				93		
2012	April – September	HH	5	<1	<1		200	Significant clustering to 700m then non-significant dispersal
		HL	-	-	<1			
		LH	-	-	<1			
		NS				93		
	October – March	HH	2	<1	<1		200	Significant clustering to 900m then non-significant dispersal
		HL	-	-	-			
		LH	-	<1	<1			
		NS				97		
2013	April – September	HH	1	<1	<1		100	Significant clustering to 700m then non-significant dispersal
		HL	<1	-	-			
		LH	-	<1	-			
		NS				96		
	October – March	HH	4	<1	-		300	Significant clustering except at 1000m (non-significant dispersal)
		HL	-	<1	<1			
		LH	<1	<1	<1			
		NS				93		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant

Mute Swan

Appendix Table 4.15: Cluster analysis of Mute Swan (MS) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	6	<1	<1		300	Significant clustering to 800m then non-significant dispersed
		HL	<1	<1	<1			
		LH	-	-	1			
		NS				91		
	October – March	HH	3	<1	-		300	Significant clustering to 900m then non-significant dispersed
		HL	-	<1	-			
		LH	-	-	<1			
		NS				95		
2007	April – September	HH	8	1	1		300	Significant clustering
		HL	<1	<1	<1			
		LH	<1	1	<1			
		NS				85		
	October – March	HH	6	<1	<1		500	Significant clustering
		HL	<1	-	-			
		LH	-	-	-			
		NS				92		
2008	April – September	HH	5	<1	<1		200	Significant clustering to 700m then non-significant dispersed
		HL	-	-	<1			
		LH	-	<1	<1			
		NS				92		
	October – March	HH	6	1	<1		200	Significant clustering to 700m then non-significant dispersed
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				91		
2009	April – September	HH	10	1	1		300	Significant clustering to 900m then non-significant dispersed
		HL	<1	<1	<1			
		LH	<1	1	1			
		NS				84		
	October – March	HH	5	<1	-		300	Significant clustering to 800m then non-significant dispersed
		HL	<1	-	<1			
		LH	<1	<1	<1			
		NS				93		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant

Appendix Table 4.16: Cluster analysis of Mute Swan (MS) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	7	1	<1		200	Significant clustering to 700m then non-significant dispersed
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				90		
	October – March	HH	3	<1	<1		300	Significant clustering to 900m then non-significant dispersed
		HL	<1	<1	<1			
		LH	-	<1	<1			
		NS				93		
2011	April – September	HH	8	<1	<1		500	Significant clustering
		HL	<1	-	-			
		LH	2	1	1			
		NS				85		
	October – March	HH	6	1	<1		300	Significant clustering
		HL	<1	-	-			
		LH	<1	1	<1			
		NS				89		
2012	April – September	HH	8	1	<1		300	Significant clustering to 900m then non-significant dispersed
		HL	<1	<1	-			
		LH	<1	<1	1			
		NS				86		
	October – March	HH	2	<1	<1		500	Significant clustering
		HL	-	-	-			
		LH	<1	1	2			
		NS				93		
2013	April – September	HH	3	<1	-		300	Significant clustering
		HL	<1	-	-			
		LH	-	<1	<1			
		NS				95		
	October – March	HH	2	<1	<1		300	Significant clustering to 900m then non-significant dispersed
		HL	-	-	-			
		LH	-	-	-			
		NS				96		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant

Great Crested Grebe

Appendix Table 4.17: Cluster analysis of Great Crested Grebe (GG) distribution over four years pre-construction (2006 – 2009). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2006	April – September	HH	5	<1	<1		400	Significant clustering
		HL	<1	<1	<1			
		LH		<1	1			
		NS				93		
	October – March	HH	4	<1	<1		300	Non-significant clustering
		HL	<1	<1	<1			
		LH			<1			
		NS				94		
2007	April – September	HH	3	<1	<1		300	Non-significant clustering at 100m, significant clustering between 200m – 500m. Non-significant clustering 600 – 800m, non-significant dispersal 900m & 100m
		HL	<1		<1			
		LH						
		NS				96		
	October – March	HH	8	<1	<1		300	Significant clustering
		HL	<1		<1			
		LH	<1	<1	1			
		NS				88		
2008	April – September	HH	3	<1			300	Significant clustering to 400m then non-significant dispersal
		HL			<1			
		LH			<1			
		NS				96		
	October – March	HH	6	<1	<1		300	Significant clustering to 500m then non-significant dispersal
		HL	<1	<1	<1			
		LH	<1	<1	1			
		NS				89		
2009	April – September	HH	4	<1	<1		500	Significant clustering
		HL	<1	<1	<1			
		LH	<1	2	2			
		NS				88		
	October – March	HH	11	<1	1		300	Significant clustering to 700m then non-significant dispersal
		HL	<1	<1				
		LH	<1	<1	<1			
		NS				86		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant

Appendix Table 4.18: Cluster analysis of Great Crested Grebe (GG) distribution over four years during construction (2010 – 2013). Classification and significance according to Anselin Local Moran's I index and expressed a percentage across Abberton Reservoir (all three sections). Distribution type and distance at which GA showed maximum clustering is according to Ripleys K-Function.

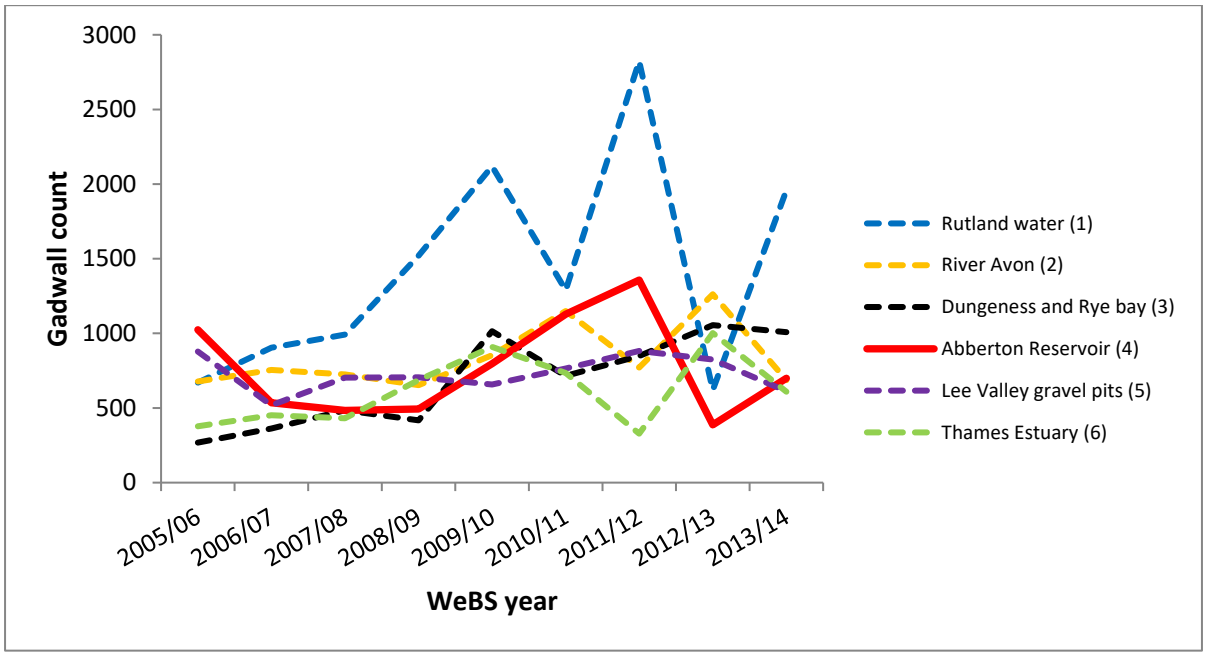
Year	Months	Local Moran's I Index (p-values) expressed as % cells of reservoir (all three sections)					Ripleys K-Function	
		Cluster classification	0.001	0.01	0.05	NS	Distance band	Ripleys K-Function distribution
2010	April – September	HH	4	<1	<1		200	Significant clustering
		HL	<1		<1			
		LH			<1			
		LL						
		NS				95		
	October – March	HH	8	1	2		300	Significant clustering to 800m Non-significant dispersal at 900m & 1000m
		HL	<1	<1	<1			
		LH	<1	<1	1			
		NS				86		
2011	April – September	HH	5	<1	<1		200	Significant clustering to 600m Non-significant dispersal from 700m
		HL	<1	<1	<1			
		LH		<1	<1			
		LL						
		NS				93		
	October – March	HH	12	1	3		300	Significant clustering to 800m Non-significant dispersal from 700m
		HL	<1					
		LH	<1	<1	<1			
		LL			<1			
		NS				81		
2012	April – September	HH	6	<1	<1		200	Significant clustering to 500m Non-significant dispersal from 600m
		HL	<1		<1			
		LH	<1		<1			
		LL						
		NS				92		
	October – March	HH	5	<1	<1		300	Significant clustering
		HL	<1					
		LH	<1	<1	<1			
		LL						
		NS				94		
2013	April – September	HH	5	<1			300	Significant clustering Non-significant dispersal at 1000m
		HL	<1	<1				
		LH		<1	<1			
		LL						
		NS				94		
	October – March	HH	13	<1			500	Significant clustering
		HL	1	<1	<1			
		LH	5	<1	<1			
		LL			<1			
		NS				78		

Where HH = statistically significant cluster of high values; HL = statistically significant high value outlier surrounded by low values; LH = statistically significant outlier of low value surrounded by high values; NS = non-significant

Appendix 4.4: Species trend data

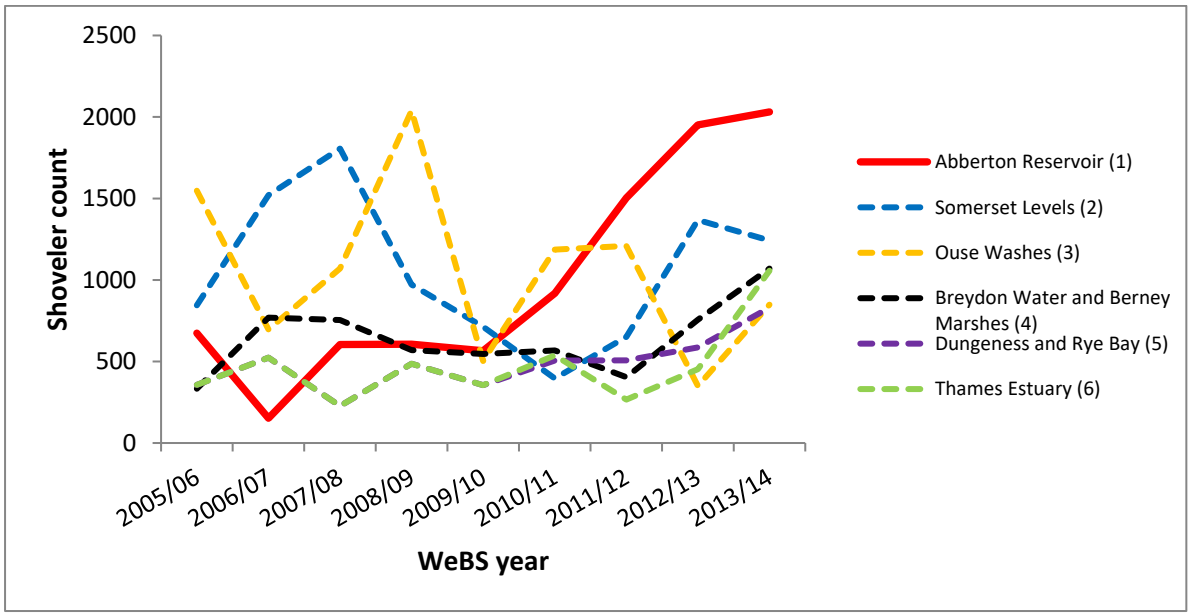
Data taken from WeBS reports available online at http://www.bto.org/volunteer-surveys/webs/publications/webs-annual-report

Gadwall



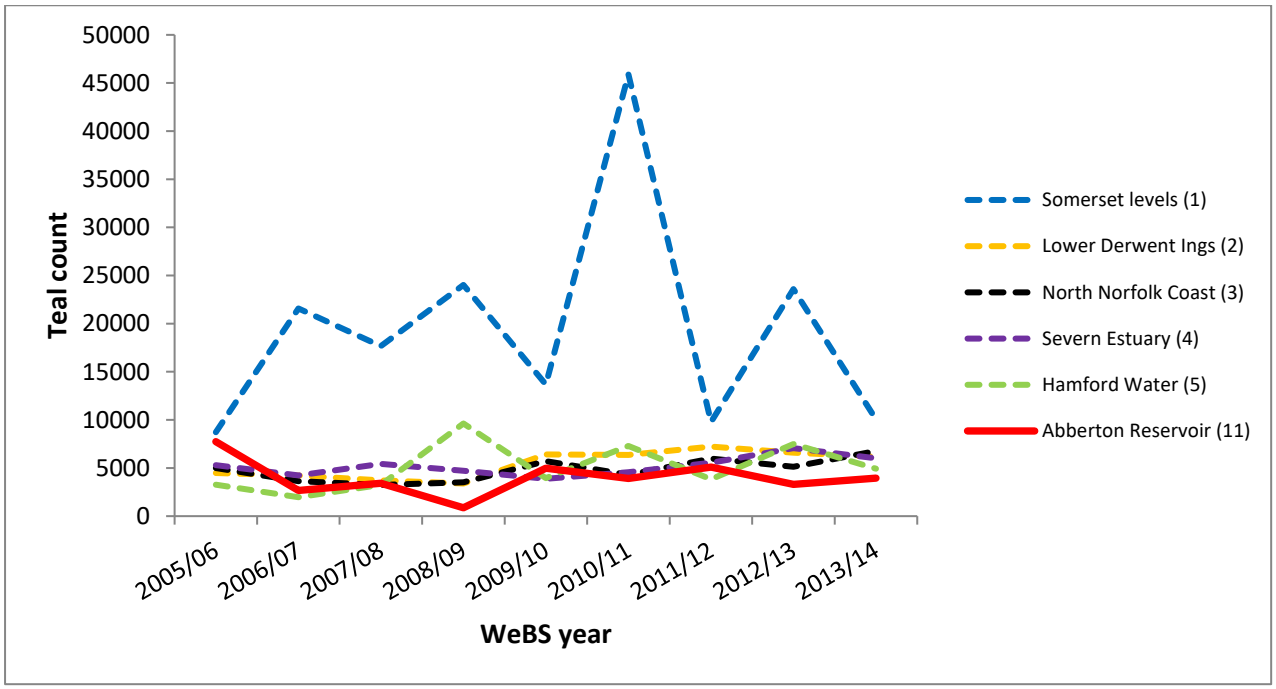
Appendix Figure 4.3: Annual peaks between years 2005/6 and 2013/4 for Gadwall. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Shoveler



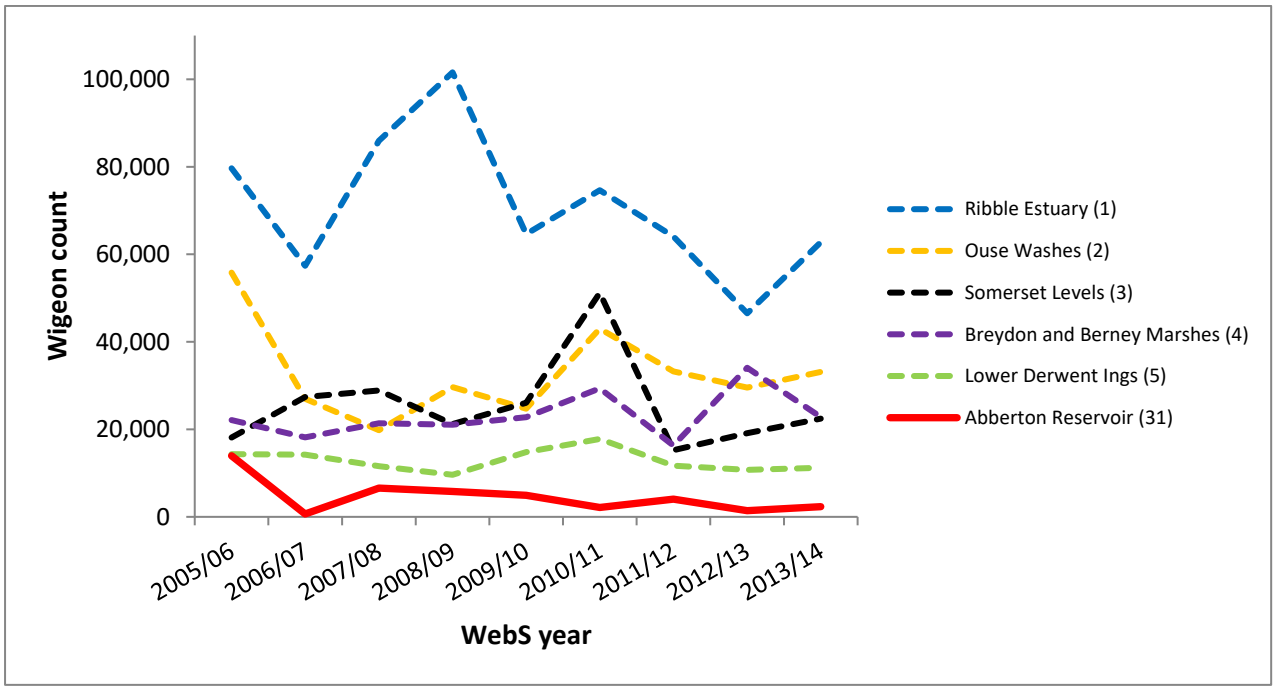
Appendix Figure 4.4: Annual peaks between years 2005/6 and 2013/4 for Shoveler. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Teal



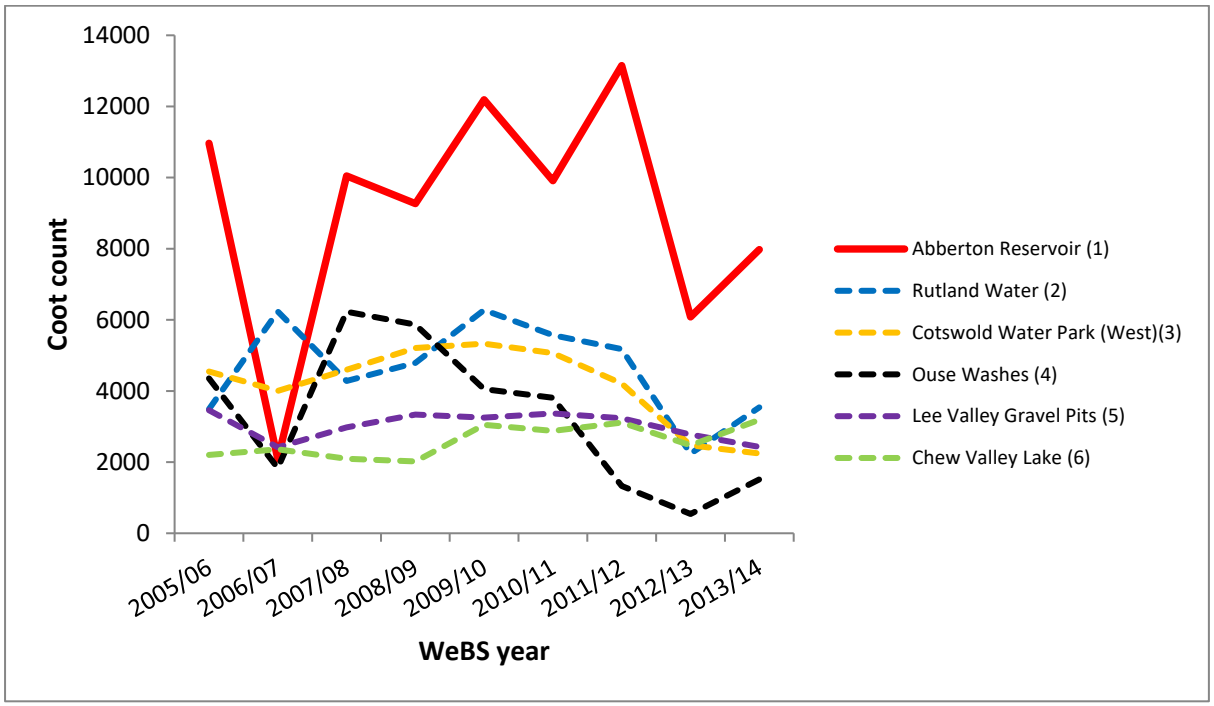
Appendix Figure 4.5: Annual peaks between years 2005/6 and 2013/4 for Teal. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Wigeon



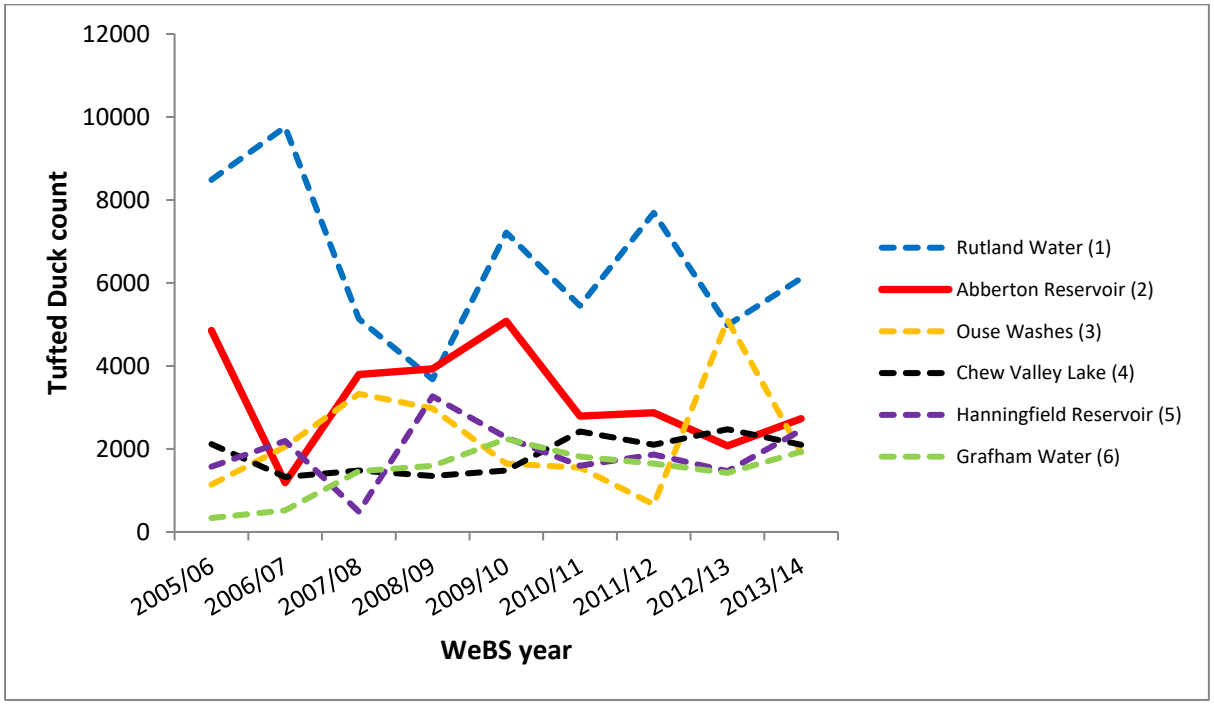
Appendix Figure 4.6: Annual peaks between years 2005/6 and 2013/4 for Wigeon. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Coot



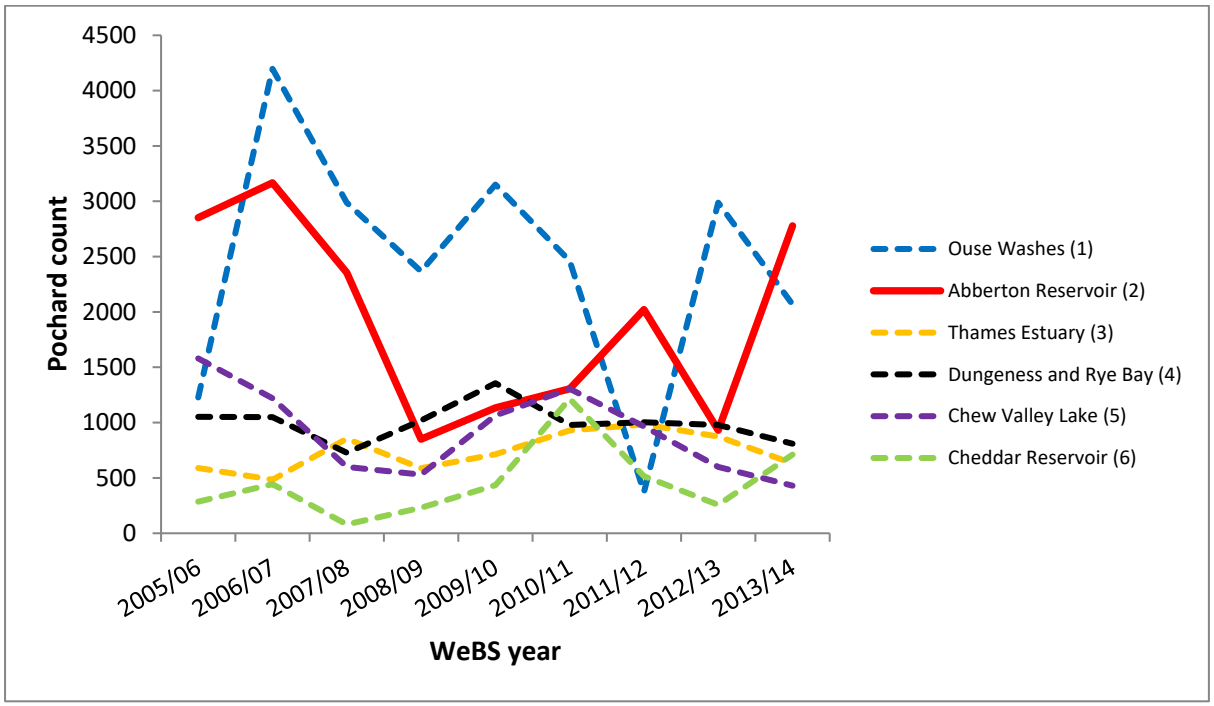
Appendix Figure 4.7: Annual peaks between years 2005/6 and 2013/4 for Coot. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Tufted Duck



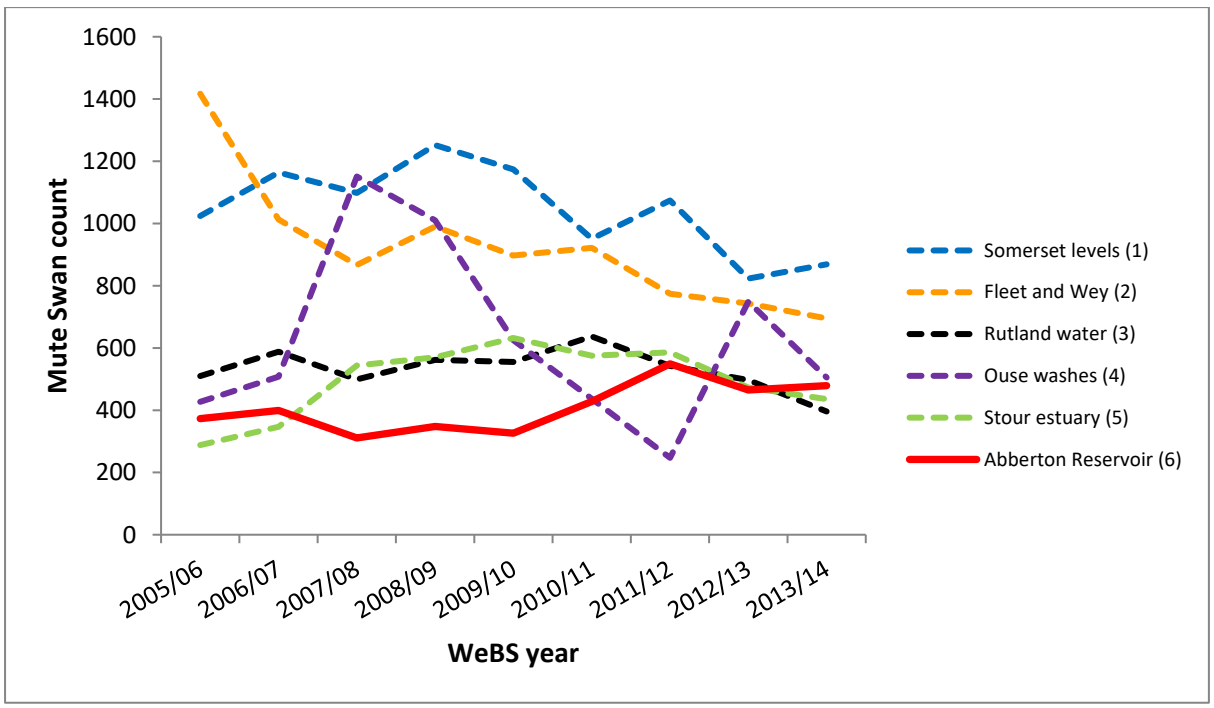
Appendix Figure 4.8: Annual peaks between years 2005/6 and 2013/4 for Tufted Duck. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Pochard



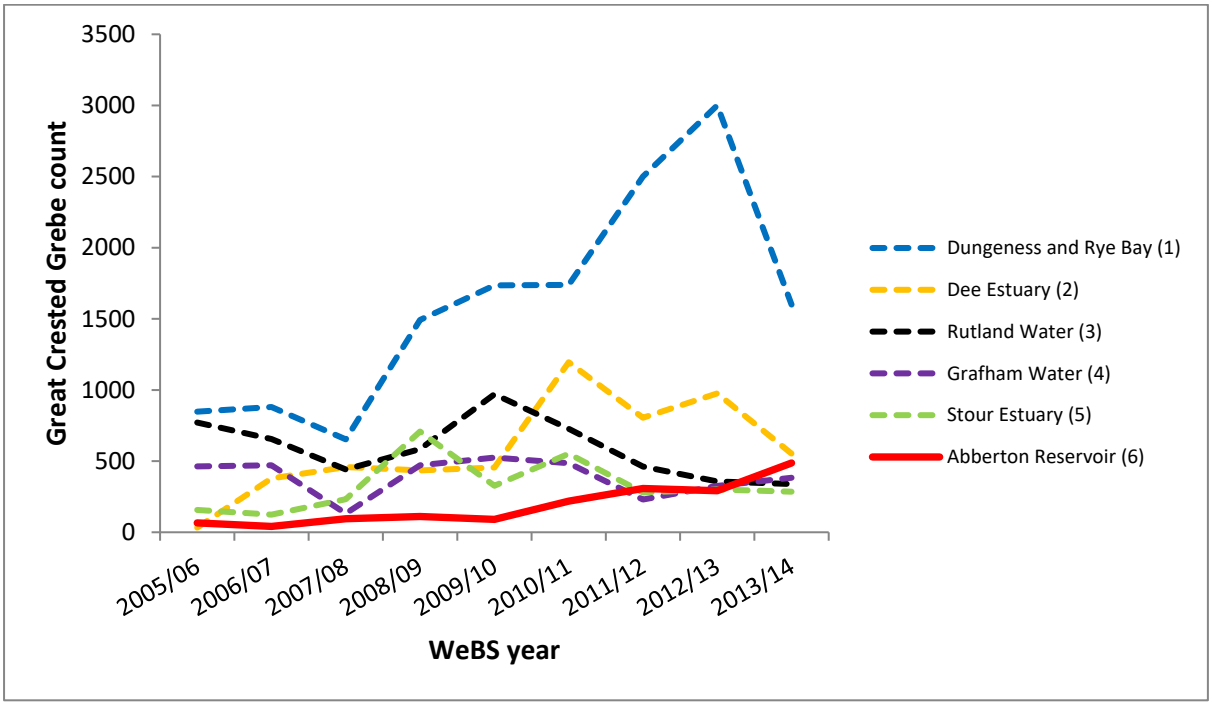
Appendix Figure 4.9: Annual peaks between years 2005/6 and 2013/4 for Pochard. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Mute Swan



Appendix Figure 4.10: Annual peaks between years 2005/6 and 2013/4 for Mute Swan. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Great Crested Grebe



Appendix Figure 4.11: Annual peaks between years 2005/6 and 2013/4 for Great Crested Grebe. Peaks are as reported by WeBS (Wetland Bird Survey) for the top five sites in Britain (site importance rank as per 2014/15 report) and for Abberton Reservoir.

Appendix to Chapter 5

Part A: Pre – construction (2006 – 2009)

5.1A: Spatial autocorrelation (Morans I) results

Appendix Table 5.1: Results of spatial autocorrelation showing the Moran's I statistic for the months April – September for all species pre-construction (years 2006 – 2009). NA refers to where counts for that month/year were zero

Year	Month	Spatial autocorrelation pattern (Moran's I statistic)								
		Gadwall	Shoveler	Teal	Wigeon	Coot	Tufted Duck	Pochard	Mute Swan	Great Crested Grebe
2006	April	-0.017	0.052	0.008	-0.006	0.039	0.039	-0.004	0.043	-0.008
	May	-0.019	NA	-0.002	NA	-0.004	0.006	-0.002	-0.002	0.034
	June	-0.000	-0.001	NA	NA	0.000	0.060	NA	0.256	0.095
	July	-0.002	NA	NA	-0.002	0.041	-0.003	NA	0.391	-0.000
	August	0.000	0.167	0.272	NA	0.316	0.445	0.431	0.297	0.289
	September	0.379	0.395	0.337	0.558	0.152	0.366	0.409	0.235	-0.237
2007	April	-0.004	-0.003	-0.006	0.126	0.050	0.497	-0.006	-0.002	-0.006
	May	0.232	-0.004	NA	NA	0.507	0.551	-0.003	-0.016	0.001
	June	-0.001	NA	NA	NA	-0.004	0.171	-0.002	0.081	0.084
	July	NA	NA	NA	NA	NA	NA	NA	0.371	-0.003
	August	0.236	-0.001	-0.001	NA	0.510	0.380	0.318	0.270	-0.003
	September	0.278	0.098	0.108	0.622	0.532	0.4559	0.379	0.199	0.096
2008	April	0.020	0.128	-0.006	NA	0.108	0.414	-0.006	0.028	0.139
	May	-0.006	-0.001	Na	-0.002	0.249	-0.002	NA	0.068	0.076
	June	0.017	NA	-0.002	NA	0.466	0.074	NA	0.262	0.100
	July	NA	NA	NA	NA	0.294	-0.001	-0.001	0.191	0.003
	August	0.005	NA	NA	NA	0.328	0.167	-0.002	0.209	-0.003
	September	0.296	0.372	0.366	0.574	0.536	0.622	0.451	0.391	0.313
2009	April	0.009	-0.002	-0.002	-0.002	0.299	0.459	0.348	0.174	0.079
	May	-0..003	-0.002	NA	NA	-0.002	-0.002	NA	0.406	0.173
	June	-0.002	NA	NA	NA	0.276	0.443	NA	0.269	-0.003
	July	NA	NA	NA	NA	0.387	NA	NA	0.350	-0.002
	August	0.464	0479	-0.002	0.001	0.520	0.473	0.465	0.457	0.222
	September	0.582	0.565	0.453	0.033	0.623	0.214	0.457	0.135	0.474

5.2A: Hurdle model results

Gadwall

Appendix Table 5.2: Summary table of Hurdle model results for Gadwall pre construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	1.799	0.349	5.153		
2007	-0.548	0.196	-2.800	<0.01	-
2008	0.481	0.165	2.924	<0.01	+
Main section	-0.746	0.156	-4.788	<0.001	-
% macrophyte	-0.006	0.002	-2.633	<0.01	-
Temperature	0.071	0.021	3.556	<0.001	+
Total rainfall	-0.013	0.003	-4.459	<0.001	-
Zero hurdle model (binomial with logit link)					
Intercept	-0.636	0.293	-2.168		
2008	0.505	0.149	3.384	<0.001	+
2009	-0.755	0.177	-4.273	<0.001	-
Main Section	-0.958	0.114	-8.377	<0.001	-
% macrophyte	0.011	0.002	7.189	<0.001	+
Water depth	-0.324	0.045	-7.225	<0.001	-
Temperature	-0.0323	0.014	-2.393	<0.05	-
Wind speed	-0.103	0.014	-7.538	<0.001	-
Total rainfall	-0.008	0.002	-4.298	<0.001	-

Appendix Table 5.3: Summary of likelihood ratio test for significant terms in the pre-construction Gadwall hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-3028	16	30.272	<0.001
Section	-3024	18	23.372	<0.001
% macrophyte	-3016	18	6.778	<0.01
Temperature	-3019	18	11.955	<0.001
Total rainfall	-3022	18	18.737	<0.001
Zero model				
Year	-3047	16	68.691	<0.001
Section	-3044	18	64.143	<0.001
% macrophyte	-3037	18	50.422	<0.001
Water depth	-3038.4	18	51.459	<0.001
Temperature	-3015.4	18	5.6086	<0.05
Wind speed	NA	NA	NA	NA
Total rainfall	-3022.3	18	19.405	<0.001

N.B. likelihood ration test failed to compute for wind due to difference in size of model datasets

Shoveler

Appendix Table 5.4: Summary table of Hurdle model results for Shoveler pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	1.8404	0.1126	16.346		
2007	-0.8291	0.1739	-4.768	<0.001	-
2008	-0.2896	0.1443	-2.006	<0.05	-
Zero hurdle model (binomial with logit link)					
Intercept	0.247426	0.388913	0.636		
2007	-0.799135	0.199817	-3.999	<0.001	-
2009	-1.614102	0.252463	-6.393	<0.001	-
Main Section	-0.667689	0.149317	-4.472	<0.001	-
% macrophyte	0.009195	0.001979	4.647	<0.001	+
Water depth	-0.354550	0.055456	-6.393	<0.001	-
Temperature	-0.069404	0.016400	-4.232	<0.001	-
Wind speed	-0.145519	0.020775	-7.005	<0.001	-
Total rainfall	-0.013847	0.002489	5.563	<0.001	-

Appendix Table 5.5: Summary of likelihood ratio test for significant terms in the pre-construction Shoveler hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	NA	NA	NA	NA
Zero model				
Year	-1971	12	78.477	<0.001
Section	-1941	14	18.425	<0.001
% macrophyte	-1943	14	21	<0.001
Water depth	-1952	14	40.192	<0.001
Temperature	-1941	14	17.686	<0.001
Wind speed	Error	Error	Error	Error
Total rainfall	-1950	14	35.013	<0.001

N.B. likelihood ration test failed to compute for wind due to difference in size of model datasets and values for year could not be calculated due to it being the only variable retained within the count model

Teal

Appendix Table 5.6: Summary table of Hurdle model results for Teal pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	4.184166	1.729180	2.420		
2007	-2.045453	1.008428	-2.028	<0.05	-
2009	-1.800291	0.646609	-2.784	<0.001	-
Main Section	-0.910989	0.283940	-3.208	<0.001	-
Water depth	-2.216022	0.087057	-2.481	<0.01	-
Temperature	0.120497	0.038462	3.133	<0.001	+
Total rainfall	-0.034297	0.010244	-3.348	<0.001	-
Zero hurdle model (binomial with logit link)					
Intercept	0.887203	0.629382	1.410		
2007	-1.531164	0.343043	-4.463	<0.001	-
2009	-3.081326	0.607298	-5.074	<0.001	-
% macrophyte	-0.013443	0.006807	-1.975	<0.05	-
Water depth	-0.913783	0.120299	-7.596	<0.001	-
Temperature	-0.104514	0.025196	-4.148	<0.001	-
Wind speed	-0.145997	0.034134	-4.277	<0.001	-
Total rainfall	-0.014076	0.003912	-3.598	<0.001	-
% macrophyte*water depth	0.009566	0.002623	3.647	<0.001	+

Appendix Table 5.7 Summary of likelihood ratio test for significant terms in the pre-construction Teal hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-925	18	31.23	<0.001
Section	-914	20	10.187	<0.001
% macrophyte	-910	20	1.6302	0.20
Water depth	-912	20	5.8537	0.02
Temperature	-914	20	9.4032	<0.001
Wind speed	-910	20	1.8767	0.17
Total rain	-914	20	10.027	<0.001
Zero model				
Year	-943	18	68.412	<0.001
% macrophyte	-918	19	18.292	<0.001
Water depth	-946	19	73.431	<0.001
Temperature	-918	20	17.709	<0.001
Wind speed	-921	20	22.627	<0.001
Total rainfall	-916	20	14.548	<0.001
Water depth*macrophyte	-915	20	12.562	<0.001

Wigeon

Appendix Table 5.8: Summary table of Hurdle model results for Wigeon pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	5.92791	0.85789	6.910		
2007	-3.38670	0.78152	-4.333	<0.001	
Water depth	-0.18483	0.05354	-3.452	<0.001	
Wind speed	-0.20033	0.09008	-2.224	<0.05	
Water depth*wind speed	-0.05261	0.01138	-4.621	<0.001	
Zero hurdle model (binomial with logit link)					
Intercept	-2.404795	0.525100	-4.580		
2007	-0.583390	0.215566	-2.706	<0.01	
2008	0.922260	0.231734	3.980	<0.001	
2009	-3.468322	0.730999	-4.745	<0.001	
Main Section	-0.485918	0.169531	-2.866	<0.001	
% macrophyte	0.031026	0.005076	6.113	<0.001	
Temperature	0.099038	0.023929	4.139	<0.001	
Wind speed	-0.371326	0.032745	-11.340	<0.001	
Total rainfall	-0.027564	0.003303	-8.344	<0.001	
Water depth*% macrophyte	-0.006279	0.001820	-3.4500	<0.00	

Appendix Table 5.9: Summary of likelihood ratio test for significant terms in the pre-construction Wigeon hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-22.42	12	227.01	<0.001
Section	-2130	19	1.9382	>0.05
Water depth	-2270	18	282.37	<0.001
Wind speed	-2148	18	38.454	<0.001
Water depth*wind speed	-2139	19	20.453	<0.001
Zero model				
Year	-2227	17	196.88	<0.001
Section	-2132	19	7.7468	<0.01
% macrophyte	-2162	18	66.634	<0.001
Water depth	-2146	18	35.188	<0.001
Temperature	-2138	19	18.63	<0.001
Wind speed	-2225	19	193.77	<0.001
Total rainfall	-2179	19	101.25	<0.001
Water depth*% macrophyte	-2135	19	12.207	<0.001

Coot

Appendix Table 5.10: Summary table of Hurdle model results for Coot pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	-4.253341	0.663109	-6.414		
2007	-0.383294	0.141836	-2.702	<0.01	-
2008	1.555784	0.199495	7.799	<0.001	+
% macrophyte	0.003853	0.001393	2.766	<0.01	+
Temperature	0.523388	0.040291	12.990	<0.001	+
Wind speed	0.406989	0.058731	6.930	<0.001	+
Total rainfall	-0.013636	0.002183	-6.247	<0.001	-
Temperature*wind speed	-0.032728	0.003725	-8.786	<0.001	-
Zero hurdle model (binomial with logit link)					
Intercept	2.646e-01	2.287e-01	1.157		
2007	-1.083e+00	1.119e-01	-9.673	<0.001	-
2008	-2.331e-01	1.002e-01	-2.325	<0.05	-
2009	-1.182e+00	1.173e-01	-10.079	<0.001	-
Main Section	-1.870e+00	8.714e-02	-21.458	<0.001	-
Temperature	-2.591e-02	9.912e-03	-2.614	<0.01	-
Wind speed	-8.982e-02	9.718e-03	-9.243	<0.001	-
Total rainfall	-5.091e-03	1.245e-03	-4.099	<0.001	-
% macrophyte*Water depth	-3.713e-03	1.049e-03	-3.541	<0.001	-

Appendix Table 5.11: Summary of likelihood ratio test for significant terms in the pre-construction Coot hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-6458	19	90.048	<0.001
Section	-6415	21	2.8001	>0.05
% macrophyte	-6417	21	7.6675	<0.01
Temperature	-6.521	20	215.56	<0.001
Wind speed	-6475	20	124.42	<0.001
Total rainfall	-6588	21	348.9	<0.001
Wind speed*total rainfall	-6452	21	76.749	<0.001
Zero model				
Year	-6502	19	178.11	<0.001
Section	-6636	21	446.44	<0.001
% macrophyte	-6448	20	70.073	<0.001
Temperature	-6417	21	6.7227	<0.01

Wind speed	-6462	21	97.155	<0.001
Total rainfall	-6422	21	17.123	<0.001
% macrophyte*water depth	-6419	21	12.626	<0.001

Tufted Duck (*A. fuligula*)

Appendix Table 5.12: Summary table of Hurdle model results for Tufted Duck pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	0.991588	0.273022	3.632		
2009	0.439024	0.113837	3.857	<0.001	+
% macrophyte	0.003460	0.001132	3.058	<0.001	+
Water depth	0.435673	0.049990	8.715	<0.001	+
Temperature	0.028593	0.010151	2.817	<0.001	+
Wind speed	0.060896	0.020252	3.007	<0.001	+
Water depth*wind speed	-0.041561	0.005807	-7.156	<0.001	-
Zero hurdle model (binomial with logit link)					
Intercept	2.653896	0.338494	7.840		
2007	-0.722642	0.109600	-6.593	<0.001	-
2008	-0.379095	0.125409	-3.023	<0.001	-
2009	0.989346	0.114139	-8.668	<0.001	-
Main Section	-0.350012	0.094973	-3.685	<0.001	-
% macrophyte	0.009241	0.001054	8.768	<0.001	+
Temperature	-0.263046	0.020355	-12.923	<0.001	-
Wind speed	-0.285741	0.032990	-8.662	<0.001	-
Total rainfall	-0.01931	0.001377	-7.937	<0.001	-
Temperature*wind speed	0.016824	0.002224	7.564	<0.001	+

Appendix Table 5.13: Summary of likelihood ratio test for significant terms in the pre-construction Tufted Duck hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-7195	17	24.929	<0.001
% macrophyte	-7.188	19	9.4279	<0.01
Water depth	-7.218	18	70.526	<0.001
Temperature	-7.187	19	7.8957	<0.01
Wind speed	-7218	18	70.221	<0.001
Water depth*wind speed	-7208	19	50.66	<0.001

Zero model				
Year	-7.232	17	99.143	<0.001
Section	-7189	19	12.855	<0.001
% macrophyte	-7220	19	75.063	<0.001
Temperature	-7336	18	306.38	<0.001
Wind speed	-7228	18	89.865	<0.001
Total rainfall	-7217	19	68.762	<0.001
Wind speed*temperature	-7212	19	59.196	<0.001

Pochard

Appendix Table 5.14: Summary table of Hurdle model results for Pochard pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	1.307653	0.417862	3.129		
Main Section	0.788411	0.150736	5.230	<0.001	+
% macrophyte	-0.003386	0.001774	-1.909	<0.05	-
Wind speed	-0.104010	0.022603	-4.602	<0.001	-
Total rainfall	0.019845	0.003871	5.127	<0.001	+
Zero hurdle model (binomial with logit link)					
Intercept	-0.453495	0.571241	-0.794		
2007	-0.932165	0.167449	-5.567	<0.001	-
2009	-1.298736	0.200444	-6.978	<0.001	-
Main Section	-1.147375	0.119324	-9.616	<0.001	-
% macrophyte	0.008321	0.001671	4.981	<0.001	+
Wind speed	-0.369124	0.086555	-4.981	<0.001	-
Total rainfall	-0.008927	0.001909	-4.677	<0.001	-

Appendix Table 5.15: Summary of likelihood ratio test for significant terms in the pre-construction Pochard hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Section	-2939	18	26.109	<0.001
% macrophyte	-2927	18	3.5765	<0.05
Wind speed	-2933	18	15.952	<0.001
Total rainfall	-2942	18	32.308	<0.001
Zero model				
Year	-2980	16	108.18	<0.001
Section	-2965	18	78.777	<0.001

% macrophyte	-2938	18	24.085	<0.001
Wind speed	-3020	17	188.76	<0.001
Total rainfall	-2937	18	22.99	<0.001

Mute Swan

Appendix Table 5.16: Summary table of Hurdle model results for Mute Swan pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	-1.2758423	0.3112342	-4.099		
2007	-0.2178176	0.1104185	-1.973	<0.05	-
2008	0.4425068	0.1267140	3.492	<0.001	+
Main Section	-0.3080446	0.0936687	-3.289	<0.001	-
Temperature	0.1019638	0.0140765	7.244	<0.001	+
Wind speed	0.0987164	0.0204780	4.821	<0.001	+
Total rainfall	0.0137376	0.0023212	5.918	<0.001	+
Wind speed*total rainfall	-0.0013774	0.0003281	-4.198	<0.001	-
Zero hurdle model (binomial with logit link)					
Intercept	-5.3969312	0.4566764	-11.818		
2007	0.5954090	0.1064294	5.594	<0.001	+
2008	0.6448887	0.1248800	5.164	<0.001	+
2009	0.6783360	0.1125808	6.025	<0.001	+
Main Section	-0.3233610	0.0861341	-3.754	<0.001	-
% macrophyte	0.0162641	0.0010760	15.116	<0.001	+
Temperature	0.1991899	0.0273706	7.278	<0.001	+
Wind speed	-0.0573306	0.0070914	-8.085	<0.001	-
Total rainfall	0.0366957	0.0138231	2.655	<0.01	+
Temperature*total rainfall	-0.0026539	0.0007581	-3.501	<0.001	-

Appendix Table 5.17: Summary of likelihood ratio test for significant terms in the pre-construction Mute Swan hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Year	-6777	17	53.652	<0.001
Section	-6755	19	11.13	<0.001
Temperature	-6674	19	48.844	<0.001
Wind speed	-6762	18	24.891	<0.001
Total rainfall	-6769	18	38.248	<0.001
Wind speed*total rainfall	-6759	19	18.805	<0.001

Zero model				
Year	-6781	17	61.181	<0.001
Section	-6757	19	13.572	<0.001
% macrophyte	-6898	19	296.72	<0.001
Temperature	-6827	18	153.28	<0.001
Wind speed	-6785	19	70.681	<0.001
Total rainfall	-6788	18	75.576	<0.001
Temperature*total rainfall	-6768	19	35.404	<0.001

Great Crested Grebe (*P. cristatus*)

Appendix Table 5.18: Summary table of Hurdle model results for Great Crested Grebe pre-construction

Variable	Estimate	Standard error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Intercept	-2.242024	0.524630	-4.274		
Main Section	0.786769	0.302283	2.603	<0.01	+
Temperature	0.074558	0.022268	3.348	<0.001	+
Total rainfall	0.010412	0.002912	3.567	<0.001	+
Zero hurdle model (binomial with logit link)					
Intercept	-4.464348	0.241342	-18.498		
2007	-0.484277	0.183152	-2.644	<0.01	-
2008	0.568719	0.142830	3.982	<0.001	+
2009	0.310867	0.147772	2.104	<0.05	+
% macrophyte	0.028348	0.003995	7.095	<0.001	+
% macrophyte*water depth	-0.005912	0.001343	-4.401	<0.001	-

Appendix Table 5.19: Summary of likelihood ratio test for significant terms in the pre-construction Great Crested Grebe hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Section	-2247	14	6.6965	<0.01
Temperature	-2250	14	11.121	<0.001
Total rainfall	-2251	14	12.851	<0.001
Zero model				
Year	-2268	12	48.526	<0.001
% macrophyte	-2281	13	74.448	<0.001
% macrophyte*water depth	-2288	12	86.938	<0.001

Part B: During – construction (2010 – 2013)

5.1B: Spatial autocorrelation (Morans I) results

Appendix Table 5.20: Results of spatial autocorrelation showing the Moran's I statistic for the months April – September for all species during construction (years 2010 – 2013). NA refers to where counts for that month/year were zero.

Year	Month	Spatial autocorrelation pattern (Moran's I statistic)								
		Gadwall	Shoveler	Teal	Wigeon	Coot	Tufted Duck	Pochard	Mute Swan	Great Crested Grebe
2010	April	0.093	-0.001	-0.002	-0.001	0.179	0.284	0.134	-0.008	-0.004
	May	-0.003	-0.001	NA	NA	0.437	-0.002	NA	0.668	0.449
	June	NA	NA	NA	-0.003	0.299	-0.015	NA	0.141	-0.002
	July	0.455	-0.001	NA	-0.003	0.376	0.297	-0.001	0.347	-0.005
	August	0,314	0.356	0.469	0.048	0.274	0.188	0.309	0.474	-0.008
	September	0.444	0.213	0.493	0.073	0.529	0.446	0.210	0.304	0.429
2011	April	0.051	-0.021	0.384	0.038	0.073	0.153	-0.002	0.049	0.1337
	May	-0.007	0.003	NA	-0.004	0.199	0.443	-0.001	0.242	-0.001
	June	-0.002	0.049	-0.002	0.000	0.414	-0.003	-0.002	0.268	-0.001
	July	0.365	0.217	0.319	0.020	0.421	0.445	0.332	0.442	-0.006
	August	0.522	0.193	0.519	0.088	0.435	0.510	0.368	0.513	0.095
	September	0.498	0.647	0.581	0.149	0.568	0.584	0.567	0.635	0.468
2012	April	0.055	0.370	0.083	-0.006	0.279	0.346	-0.002	0.307	0.042
	May	-0.006	NA	NA	NA	0.026	-0.003	NA	0.407	0.098
	June	0.208	-0.001	-0.001	-0.002	0.254	0.158	0.218	0.136	0.002
	July	0.223	-0.001	-0.001	-0.002	0.460	0.423	0.256	0.611	0.152
	August	0.447	0.510	0.463	0.041	0.391	0.604	0.342	0.467	0.312
	September	0.389	0.433	0.446	0.066	0.523	0.183	0.460	0.273	0.308
2013	April	-0.011	0.068	-0.003	-0.002	-0.011	-0.012	-0.003	-0.005	-0.007
	May	0.139	-0.002	-0.002	-0.001	0.085	0.149	-0.001	0.145	-0.011
	June	0.337	0.052	-0.001	0.000	0.349	0.328	-0.001	0.452	0.610
	July	0.223	0.018	0.053	-0.002	0.446	0.556	0.466	0.519	-0.003
	August	-0.005	-0.006	-0.006	-0.001	-0.008	-0.005	-0.005	-0.009	-0.004
	September	0.113	0.477	0.358	0.096	0.521	0.389	0.216	0.404	0.294

5.2B: Hurdle model results

Gadwall

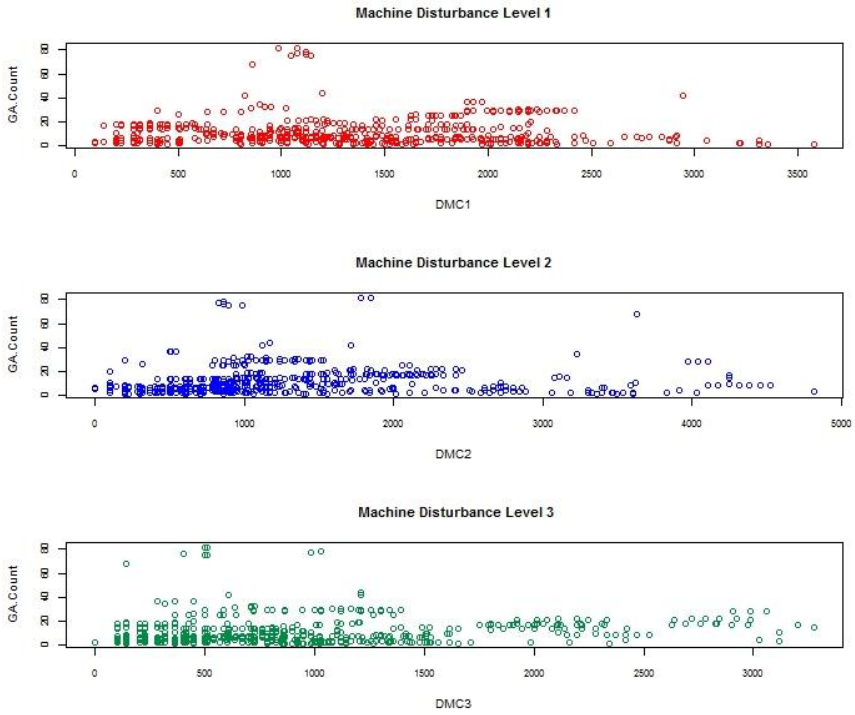
Appendix Table 5.21: Summary table of Hurdle model results for Gadwall during construction

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	-6.541e-01	4.441e-01	-1.473		
2011	3.420e-01	1.684e-01	2.031	<0.05	+
2012	-6.186e-01	1.499e-01	-4.128	<0.001	-
2013	-4.380e-01	2.064e-01	-2.122	<0.05	-
Main section	2.790e-01	8.596e-02	3.245	<0.001	+
Water depth	-1.013e-01	2.366e-02	-4.284	<0.001	-
Temperature	1.223e-01	2.523-e-02	4.849	<0.001	+
Wind speed	1.422e-01	3.830e-02	3.714	<0.001	+
Macrophyte %	2.358e-03	1.232e-03	1.915	<0.05	+
Total rainfall	8.400e-03	1.174e-03	7.158	<0.001	+
Construction (DTC3)	4.617e-04	8.538e-05	5.407	<0.001	+
Temp *Wind speed	-6.571e-03	3.064e-03	-2.144	<0.05	-
Machine construction disturbance					
Construction (DMC2)	-1.261e-04	6.445e-05	-1.956	<0.05	-
Construction (DMC3)	5.063e-04	8.086e-05	6.262	<0.01	+
People construction disturbance					
Construction (DPC1)	1.347e-04	6.618e-05	2.036	<0.05	-
Construction (DPC3)	3.492e-04	8.095e-05	4.314	<0.001	+
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	-2.294e-00	3.638e-01	-6.307		
2012	3.633e-01	1.791e-01	2.028	<0.05	+
2013	-9.063e-01	2.036e-01	-4.451	<0.001	-
Main Section	-7.336e-01	1.361e-01	-5.391	<0.001	-
Water depth	-8.858e-02	4.274e-02	-2.073	<0.05	-
Temperature	-4.724e-02	1.242e-02	-3.802	<0.001	-
Wind speed	6.080e-02	1.803e-02	3.371	<0.001	+
Macrophyte %	1.350e-02	2.209e-03	6.112	<0.001	+
Total rainfall	-6.947e-03	1.656e-03	-4.197	<0.001	-
Construction (DTC1)	-3.245e-04	5.867e-05	-5.532	<0.001	-
Construction (DTC2)	2.482e-04	5.408e-05	4.590	<0.001	+
Construction (DTC3)	4.588e-04	1.145e-04	4.007	<0.001	+
Water depth *macrophyte %	-2.269e-03	9.748e-04	-2.327	<0.05	-
Machine construction disturbance					
Construction (DMC1)	-1.430e-04	5.480-05	-2.609	<0.01	-
Construction (DMC2)	-2.133e-04	9.722e-05	-3.518	<0.001	-

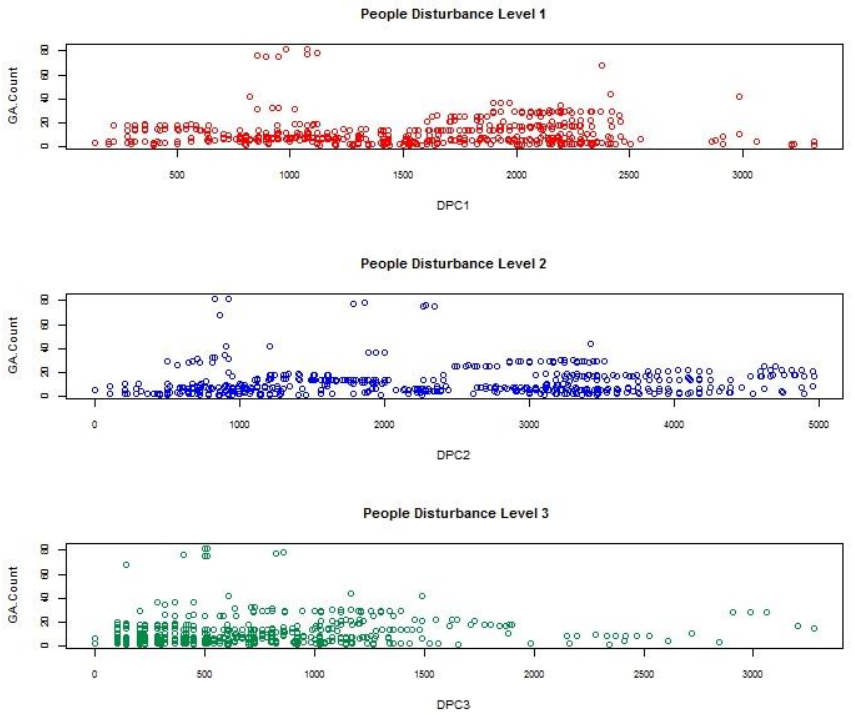
Appendix Table 5.22: Summary table of likelihood ratio test for significant terms during construction Gadwall hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-3276	24	107.96	<0.001
Section	-3227	26	10.336	<0.001
Water depth	-3231	26	18.211	<0.001
Temperature	-3286	22	129.46	<0.001
Wind speed	-3285	22	125.9	<0.001
% macrophyte	-3223	26	3.6408	<0.05
Total rainfall	-3246	26	48.226	<0.001
Construction (DTC3)	-3235	26	27.507	<0.001
Wind *Temperature	-3224	26	4.6441	0.03
Machine construction disturbance				
Construction (DMC2)	-3463	27	5.0904	0.02
Construction (DMC3)	-3480	27	39.456	<0.001
People construction disturbance				
Construction (DPC1)	-3402	26	4.6479	0.03
Construction (DPC3)	-3409	26	18.81	<0.001
Zero hurdle model				
Total construction disturbance				
Year	-3222	24	60.617	<0.001
Section	-3234	26	24.127	<0.001
Water depth	-3235	25	25.115	<0.001
Wind speed	-3245	25	46.218	<0.001
% macrophyte	-3244	25	44.74	<0.001
Temperature	-3229	26	14.537	<0.001
Total rainfall	-3222	26	18.848	<0.001
Construction (DTC1)	Error	Error	Error	Error
Construction (DTC2)	Error	Error	Error	Error
Construction (DTC3)	-3230	26	16.476	<0.001
Water depth *% macropyte	-3224	26	5.503	0.02
Machine construction disturbance				
Construction (DMC1)	Error	Error	Error	Error
Construction (DMC2)	-3465	27	9.3447	<0.001
Construction (DMC3)	-3476	27	31.679	<0.001
People construction disturbance				
Construction (DPC1)	-3460	26	121.56	<0.001
Construction (DPC3)	-3401	26	4.0898	0.04

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.1: Gadwall distribution associated with distance to each Machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.2: Gadwall distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Shoveler

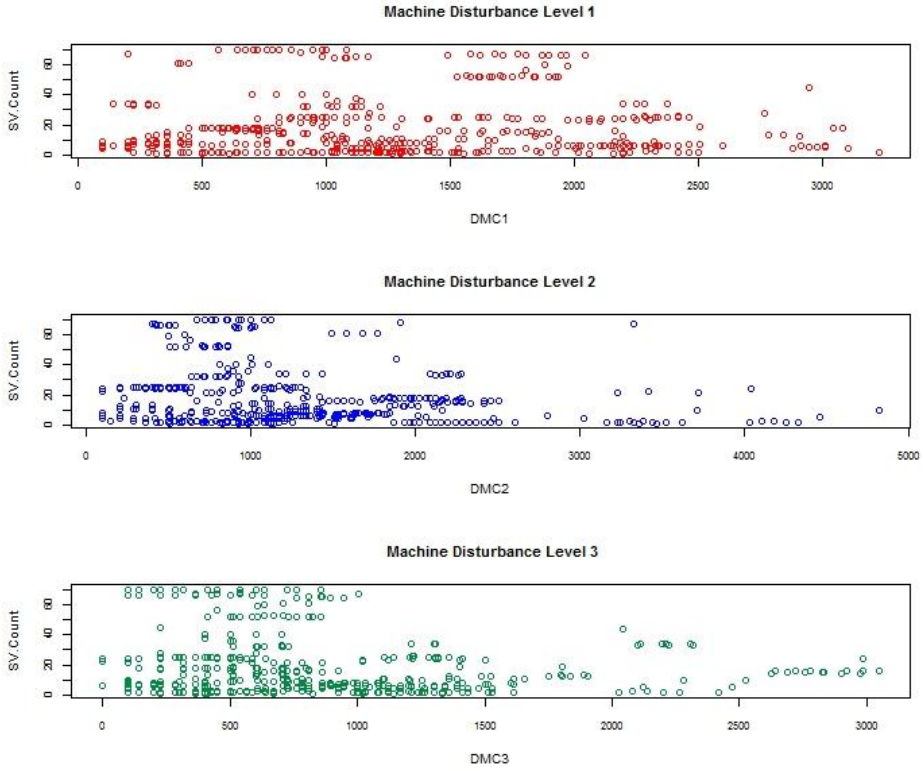
Appendix Table 5.23: Summary table of Hurdle model results for Shoveler

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	1.286e+00	4.473e-01	2.876		
2012	7.749e-01	2.330e-01	3.26	<0.001	+
Main section	1.330e+00	1.404e-01	9.469	<0.001	+
Water depth	-8.556e-02	3.107e-02	-2.754	<0.01	-
Temperature	6.695e-02	1.795e-02	3.730	<0.001	+
Wind speed	-7.046e-02	2.204e-02	-3.197	<0.001	-
Total rainfall	-1.027e-02	2.563e-03	-4.005	<0.001	-
Construction (DTC1)	2.271e-04	8.981e-05	2.529	<0.01	+
Construction (DTC3)	4.040e-04	1.089e-04	3.711	<0.001	+
Machine construction disturbance					
Construction (DMC2)	-2.993e-04	9.099e-05	-3.289	<0.001	-
Construction (DMC3)	5.013e-04	1.313e-04	3.819	<0.001	+
People construction disturbance					
Construction (DPC1)	2.091e-04	9.272e-05	2.255	<0.05	+
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	5.770e-01	3.052e-01	1.890		
2011	5.884e-01	2.410e-01	2.441	<0.01	+
2012	8.396e-01	2.453e-01	3.422	<0.001	+
2013	6.939e-01	2.234e-01	3.107	<0.001	+
Main Section	-9.444e-01	1.216e-01	-7.768	<0.001	-
Water depth	-2.839e-01	3.407e-02	-8.332	<0.001	-
Temperature	-1.634e-01	2.098e-02	-7.788	<0.001	-
Macrophyte %	1.182e-02	1.624e-03	7.279	<0.001	+
Total rainfall	-2.507e-02	5.165e-03	-4.854	<0.001	-
Construction (DTC1)	-4.585e-04	5.301e-05	-8.648	<0.001	-
Temperature * Total rainfall	1.114e-03	2.667e-04	4.179	<0.001	+
Machine construction disturbance					
Construction (DMC1)	-2.580e-04	5.486e-05	-4.702	<0.001	-
Construction (DMC2)	-4.860e-04	5.833e-05	-8.331	<0.001	-
Construction DMC3)	2.216e-04	9.822e-05	2.256	<0.05	+
People construction disturbance					
Construction (DPC1)	-7.363e-04	5.765e-05	-12.772	<0.001	-
Construction (DPC3)	-1.089e-03	5.985e-05	-2.116	<0.05	-

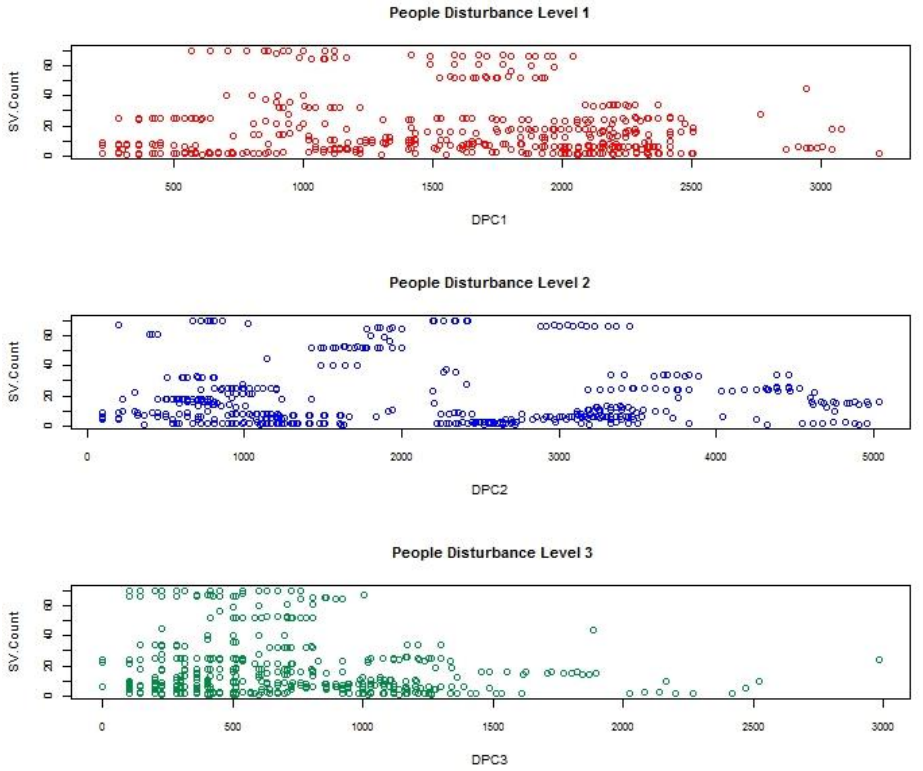
Appendix Table 5.24: Summary table of likelihood ratio test for significant terms during construction Shoveler hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-3316	21	59.087	<0.001
Section	-3323	23	73.14	<0.001
Water depth	-3291	23	7.6623	0.01
Temperature	-3294	23	14.54	<0.001
Wind speed	-3292	23	9.9732	<0.00
Total rainfall	-3295	23	15.49	<0.001
Construction (DTC1)	-3290	23	5.9017	0.02
Construction (DTC3)	-3292	23	10.812	<0.001
Machine construction disturbance				
Construction (DMC2)	-3291	26	11.924	<0.001
Construction (DMC3)	-3291	26	13.047	<0.001
People construction disturbance				
Construction (DTC1)	-3251	25	5.7776	0.02
Zero hurdle model				
Total construction disturbance				
Year	-3295	21	16.985	<0.001
Section	-3314	23	54.303	<0.001
Water depth	-3323	23	71.718	<0.001
Temperature	-3334	22	93.443	<0.001
Wind speed	-3288	23	3.4195	0.06
Macrophyte %	-3313	23	52.741	<0.001
Total rainfall	-3309	22	43.654	<0.001
Construction (DTC1)	-3309	23	43.782	<0.001
Temperature * Total rainfall	-3292	23	9.8496	<0.001
Machine construction disturbance				
Construction (DMC1)	Error	Error	Error	Error
Construction (DMC2)	-3307	26	45.288	<0.001
Construction (DMC3)	-3287	26	4.5617	0.03
People construction disturbance				
Construction (DPC1)	-3248	25	105.36	<0.001
Construction (DPC2)	-3251	25	5.1521	0.02

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.3: Shoveler distribution associated with distance to each Machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.4: Shoveler distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Teal

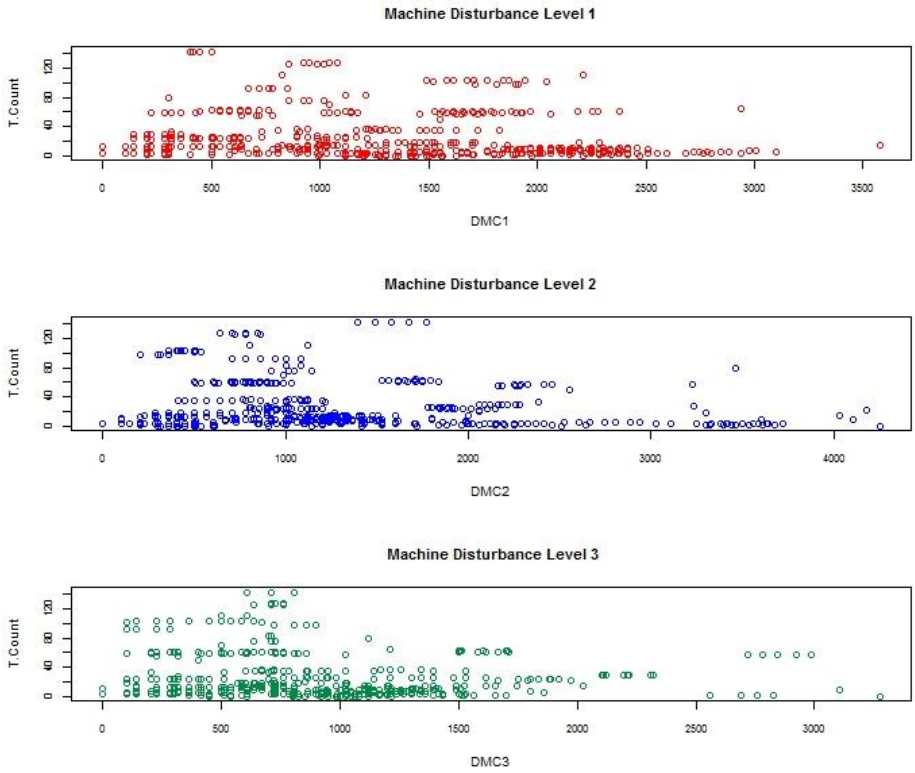
Appendix Table 5.25: Summary table of Hurdle model results for Teal

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	3.570e+00	1.015e+00	3.516		
2011	-6.243e-01	2.795e-01	-2.233	<0.05	-
2012	-7.304e+00	3.020e-01	-2.418	<0.05	-
2013	-1.05e+00	3.268e-01	-3.214	<0.001	-
Main section	1.504e+00	1.499e-01	10.034	<0.001	+
Water depth	-1.210e-01	3.090e-02	-3.916	<0.001	-
Construction (DTC1)	-3.164e-04	9.513e-05	-3.326	<0.001	-
Construction (DTC3)	3.604e-04	1.346e-04	2.677	<0.01	+
Temp * Wind speed	2.001e-02	7.338e-03	2.727	<0.01	+
Machine construction disturbance					
Construction (DMC1)	-3.079e-04	8.648e-05	-3.560	<0.001	-
People construction disturbance					
Construction (DPC1)	-2.315e-04	3.797e-05	-6.097	<0.001	-
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	-2.186e+00	2.870e-01	-0.762		
2011	-4.880e-01	2.201e-01	-2.217	<0.05	-
2012	3.647e-01	1.814e-01	2.011	<0.05	+
2013	3.197e-01	1.645e-01	1.944	<0.05	+
Water depth	-2.870e-01	4.216e-02	-6.807	<0.001	-
Temperature	-1.216e-02	1.287e-02	-9.452	<0.001	-
Wind speed	-1.260e-01	1.710e-02	-7.366	<0.001	-
Macrophyte %	1.111e-02	2.097e-03	5.295	<0.001	+
Total rainfall	-1.188e-02	1.851e-03	-6.416	<0.001	-
Construction (DTC1)	-3.500e-04	5.764e-05	-6.072	<0.001	-
Construction (DTC2)	2.565e-04	5.360e-05	4.784	<0.001	+
Construction (DTC3)	7.431e-04	1.124e-04	6.612	<0.001	+
Water depth*% macrophyte	-2.911e-03	1.104e-03	-2.637	<0.01	-
Machine construction disturbance					
Construction (DMC2)	-4.313e-04	5.529e-05	-7.801	<0.001	-
Construction DMC3)	4.946e-04	9.967e-05	4.962	<0.001	+
People construction disturbance					
Construction (DPC1)	-6.704e-04	5.173e-05	-12.958	<0.001	-

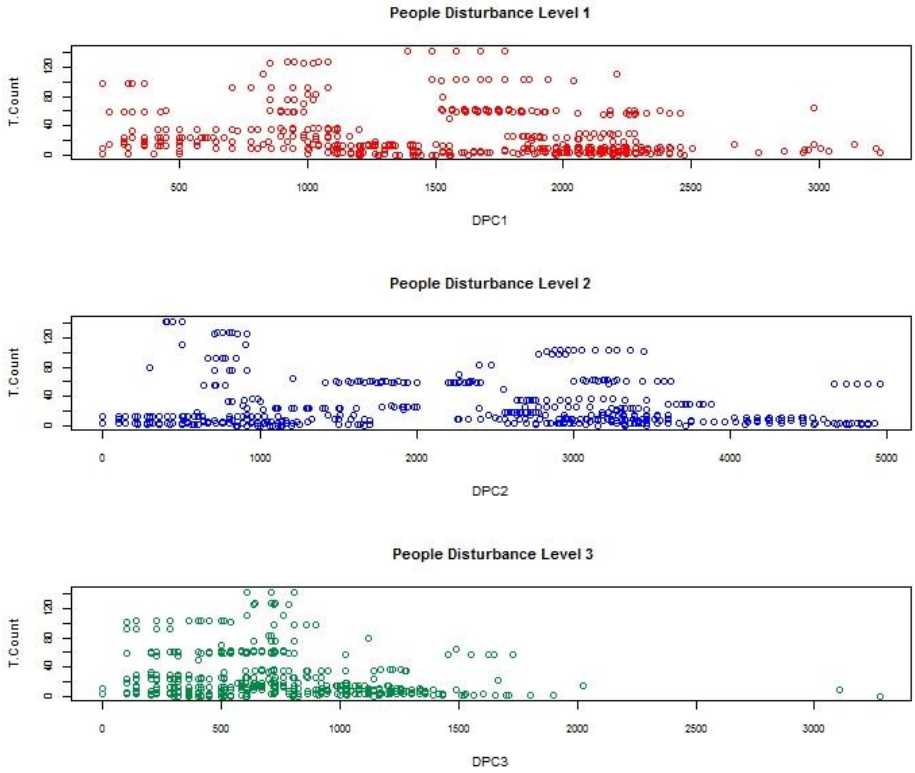
Appendix Table 5.26: Summary table of likelihood ratio test for significant terms during construction Teal hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-35493	22	12.007	<0.01
Section	-3531	24	87.1950	<0.001
Water depth	-3491	24	7.1646	<0.01
Construction (DTC1)	-3493	24	11.438	<0.001
Construction (DTC3)	-3490	24	6.1741	<0.01
Temperature*wind speed	-3491	24	7.1861	<0.01
Machine construction disturbance				
Construction (DMC1)	Error	Error	Error	Error
People construction disturbance				
Construction (DPC1)	-3590	19	5.9744	<0.01
Zero hurdle model				
Total construction disturbance				
Year	-3503	22	30.556	<0.001
Water depth	-3551	23	127.8	<0.001
Temperature	-3540	23	106.17	<0.001
Wind speed	-3518	23	61.46	<0.001
% macrophyte	-3502	23	28.849	<0.001
Total rainfall	-3511	24	46.557	<0.001
Construction (DTC1)	-3499	24	23.198	<0.00
Construction (DTC2)	Error	Error	Error	Error
Construction (DTC3)	-3510	24	44.564	<0.001
Water depth*% macrophyte	Error	Error	Error	Error
Machine construction disturbance				
Construction (DMC2)	Error	Error	Error	Error
Construction (DMC3)	-3635	23	22.85	<0.001
People construction disturbance				
Construction (DPC1)	-3634	19	95.153	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.5: Teal distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.6: Teal distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Wigeon

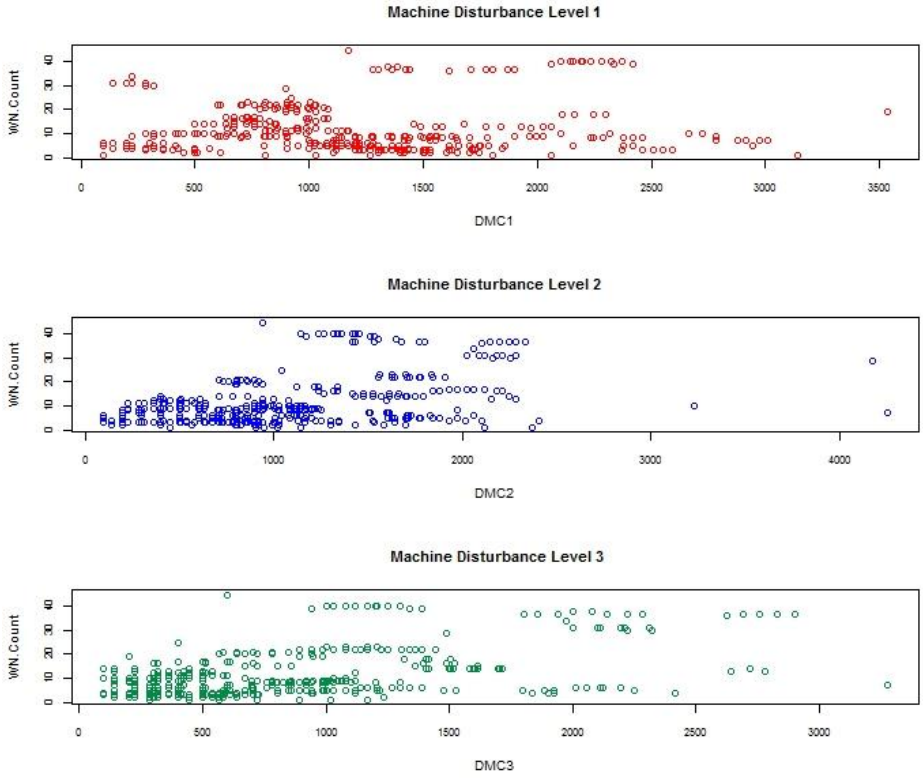
Appendix Table 5.27: Summary table of Hurdle model results for Wigeon

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	1.160e+00	2.155e-01	5.382		
Main Section	3.557e-01	1.344e-01	2.647	<0.01	+
Water depth	-4.561e-02	2.245e-02	-2.032	<0.05	-
Construction (DTC2)	3.486e-04	7.221e-05	4.827	<0.001	+
Construction (DTC3)	6.884e-04	7.560e-05	9.107	<0.001	+
Machine construction disturbance					
Construction (DMC2)	2.366e-04	8.261e-05	2.865	<0.001	+
Construction (DMC3)	5.008e-04	7.633e-05	6.562	<0.001	+
People construction disturbance					
Construction (DPC2)	0.0002407	0.0001010	2.384	<0.05	+
Construction (DPC3)	0.0006422	0.0001385	4.638	<0.001	+
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	-6.544e+00	8.555e-01	-7.649		
2011	1.487e+00	3.784e-01	3.931	<0.001	+
2012	1.108e+00	3.784e-01	3.931	<0.01	+
2013	1.358e+00	3.832e-01	3.545	<0.001	+
Temperature	1.292e-01	4.853e-02	2.663	<0.01	+
Wind speed	4.259e-01	6.889e-02	6.183	<0.001	+
% macrophyte	1.081e-02	1.776e-03	6.088	<0.001	+
Total rainfall	-1.619e-02	2.811e-03	-5.759	<0.001	-
Construction (DTC1)	-3.632e-04	6.682e-05	-5.436	<0.001	+
Construction (DTC2)	3.927e-04	5.364e-05	7.321	<0.001	-
Construction (DTC3)	4.577e-04	1.167e-04	3.923	<0.001	-
Temperature*Wind speed	-3.303e-02	5.683e-03	-5.812	<0.001	+
Machine construction disturbance					
Construction (DMC1)	-2.991e-04	6.761e-05	-4.423	<0.001	-
Construction (DMC2)	-6.600e-04	7.381e-05	-8.941	<0.001	-
Construction DMC3)	5.479e-02	1.102e-04	4.972	<0.001	+
People construction disturbance					
Construction (DPC1)	-7.809e-04	6.986e-05	-11.179	<0.001	-
Construction (DPC2)	-2.364e-04	6.954e-05	-3.400	<0.001	-

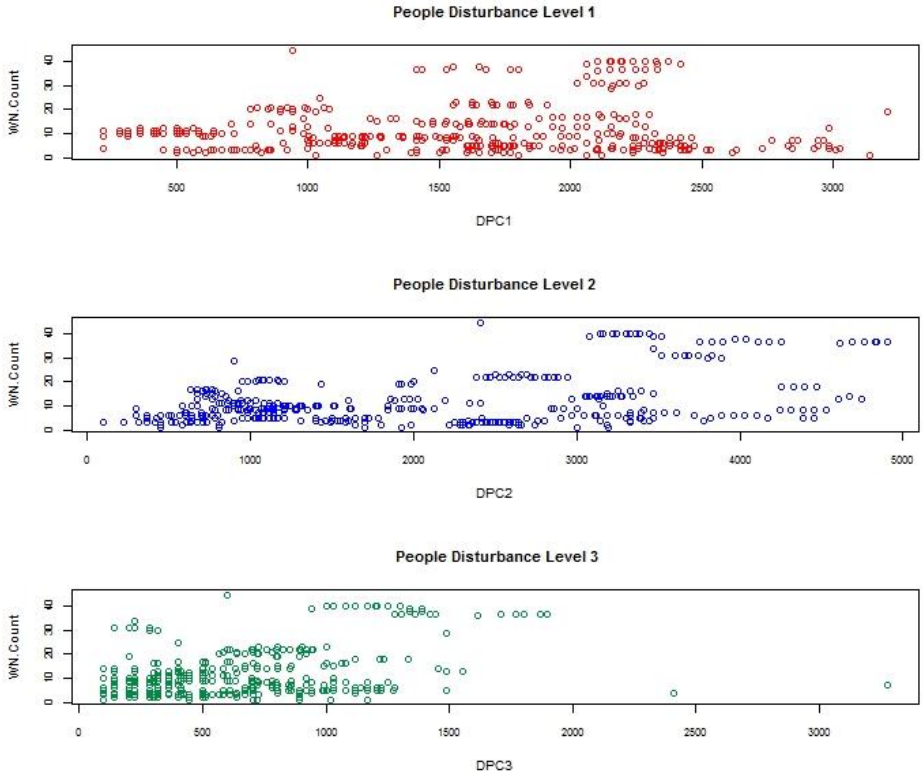
Appendix Table 5.28: Summary table of likelihood ratio test for significant terms during construction Wigeon hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-2501	18	9.0813	<0.05
Section	-2500	20	7.4196	<0.01
Water depth	-2691	20	388.55	<0.001
Construction (DTC2)	-2510	20	25.909	<0.001
Construction (DTC3)	-2531	20	69.401	<0.001
Machine construction disturbance				
Construction (DMC2)	-2572	18	8.0122	<0.001
Construction (DMC3)	-2586	18	36.185	<0.001
People construction disturbance				
Construction (DPC2)	-2546	20	11.214	<0.001
Construction (DPC3)	-2553	20	24.788	<0.001
Zero hurdle model				
Total construction disturbance				
Year	-2507	18	20.338	<0.001
Temperature	-2556	19	119.19	<0.001
Wind speed	-2517	19	39.833	<0.001
% macrophyte	-2515	20	36.342	<0.001
Total rainfall	-2516	20	38.911	<0.001
Construction (DTC1)	Error	Error	Error	Error
Construction (DTC2)	-2516	20	39.689	<0.001
Construction (DTC3	-2504	20	15.492	<0.001
Temperature*total wind speed	-2513	20	32.43	<0.001
Machine construction disturbance				
Construction (DMC1)	Error	Error	Error	Error
Construction (DMC2)	-2592	18	49.307	<0.001
Construction (DMC3)	-2578	18	21.244	<0.001
People construction disturbance				
Construction (DPC1)	-2586	20	90.282	<0.001
Construction (DPC2)	-2547	20	12.785	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.7: Wigeon distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.8: Wigeon distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Coot

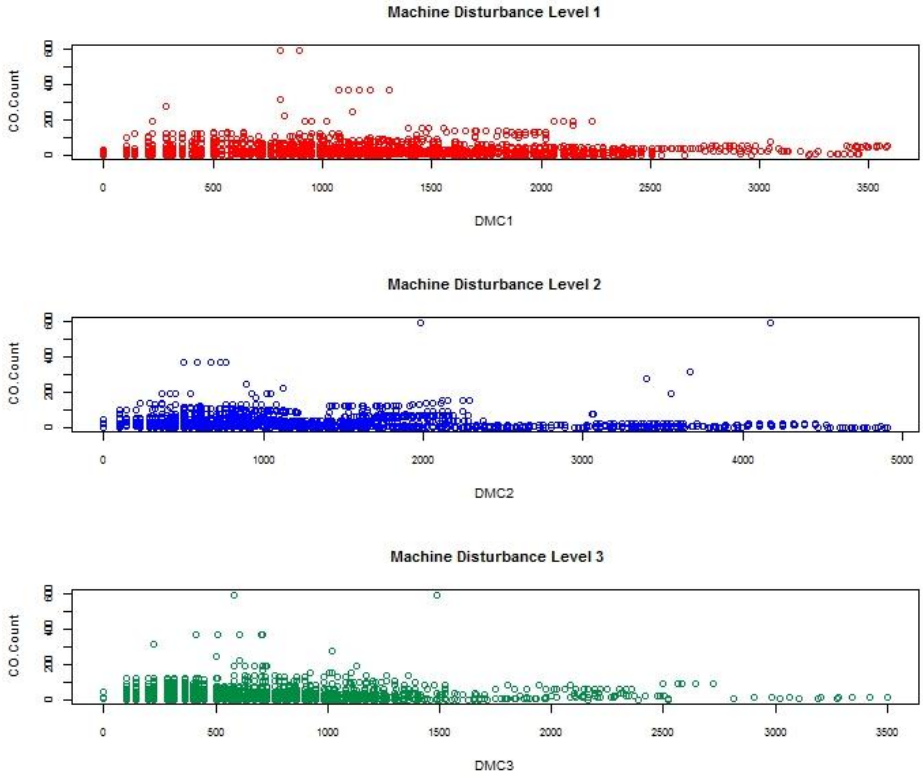
Appendix Table 5.29: Summary table of Hurdle model results for Coot

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	9.754e-01	3.287e-01	2.967		
2001	-7.357e-01	2.137e-01	-3.443	<0.001	-
2012	-9.919e-01	1.471e-01	-6.743	<0.001	-
2013	-6.783e-01	1.462e-01	-4.639	<0.001	-
Main Section	8.474e-01	1.552e-01	5.461	<0.001	+
Water depth	-1.182e-01	3.043e-02	-3.884	<0.001	-
Temperature	1.149e-01	1.737e-02	6.616	<0.001	+
Wind speed	1.906e-01	2.668e-02	7.144	<0.001	+
Total rainfall	1.11e-02	2.311e-03	4.807	<0.001	+
Wind speed*total rainfall	-2.664e-03	3.782e-04	-7.043	<0.001	-
Machine construction disturbance					
Construction (DMC1)	1.196e-04	4.983e-05	2.399	<0.05	+
Construction (DMC2)	-5.724e-04	7.463e-05	-7.670	<0.001	-
Construction (DMC3)	2.948e-04	5.000e-05	5.896	<0.001	+
People construction disturbance					
Construction (DPC1)	-1.470e-04	6.726e-05	-2.185	<0.05	-
Construction (DPC3)	-2.886e-03	8.162e-05	-3.536	<0.001	-
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	2.292e+00	1.847e-01	12.407		
2012	1.033e+00	1.037e-01	9.961	<0.001	+
2013	8.205e-01	1.026e-01	7.995	<0.001	+
Main Section	2.556e+00	8.727e-02	-17.835	<0.001	-
Water depth	2.745e-01	2.781e-02	9.873	<0.001	+
% macrophyte	2.458e-02	1.669e-03	14.728	<0.001	+
Temperature	-1.490-01	7.290e-03	-20.435	<0.001	-
Wind speed	-1.091e-01	9.830e-03	-11.099	<0.001	-
Total rainfall	1.299e-02	9.676e-04	-13.427	<0.001	-
Construction (DTC1)	-5.883e-04	3.671e-05	-16.027	<0.001	-
Water depth*% macrophyte	-6.07e-03	6.003e-04	-10.117	<0.001	-
Machine construction disturbance					
Construction (DMC1)	-3.258e-04	4.486e-05	-9.347	<0.001	-
Construction (DMC3)	-1.710e-03	6.508e-05	-2.627	<0.01	-
People construction disturbance					
Construction (DPC1)	-4.069e-04	3.792e-05	-10.730	<0.001	-
Construction (DPC2)	-1.748e-04	3.647e-05	-4.793	<0.001	-
Construction (DPC3)	-3.135e-04	7.082e-05	-4.427	<0.001	-

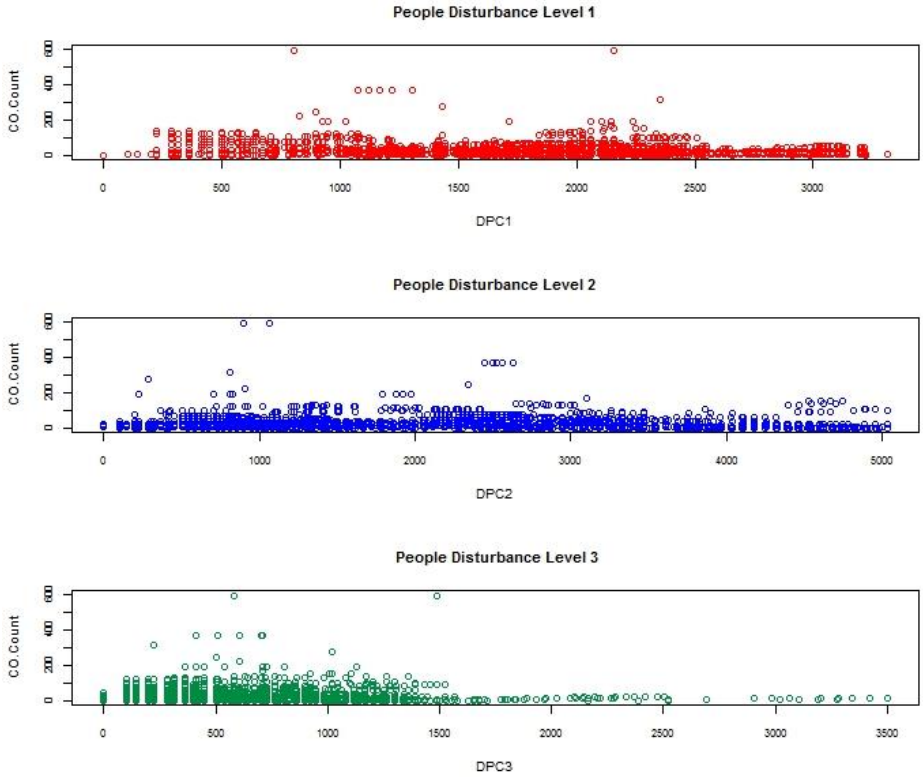
Appendix Table 5.30: Summary table of likelihood ratio test for significant terms during construction Coot hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-11006	22	63.571	<0.001
Section	-11028	24	107.31	<0.001
Water depth	-11005	24	60.102	<0.001
Temperature	-11054	24	159.49	<0.001
Wind speed	-11009	23	67.845	<0.001
Total rainfall	-11018	22	87.634	<0.001
Wind speed*total rainfall	-11000	24	49.992	<0.001
Machine construction disturbance				
Construction (DMC1)	-11626	26	13.148	<0.001
Construction (DMC2)	Error	Error	Error	Error
Construction (DMC3)	-11634	26	29.189	<0.001
People construction disturbance				
Construction (DPC1)	-11564	26	18.776	<0.001
Construction (DPC3)	-11565	26	19.844	<0.001
Zero hurdle model				
Total construction disturbance				
Year	-11058	22	167.51	<0.001
Section	-11124	24	298.91	<0.001
Water depth	-11039	23	127.96	<0.001
% macrophyte	-11094	23	238.66	<0.001
Temperature	-11197	24	445.15	<0.001
Wind speed	-11038	24	125.93	<0.001
Total rainfall	-11074	24	198.36	<0.001
Construction (DTC1)	Error	Error	Error	Error
Water depth*% macrophyte	-11028	24	107.27	<0.001
Machine construction disturbance				
Construction (DMC1)	Error	Error	Error	Error
Construction (DMC3)	-11629	25	21.012	<0.001
People construction disturbance				
Construction (DPC1)	-11604	26	99.219	<0.001
Construction (DPC2)	-11570	26	30.003	<0.001
Construction (DPC3)	-11565	26	21.415	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.9: Coot distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.10: Coot distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Tufted Duck

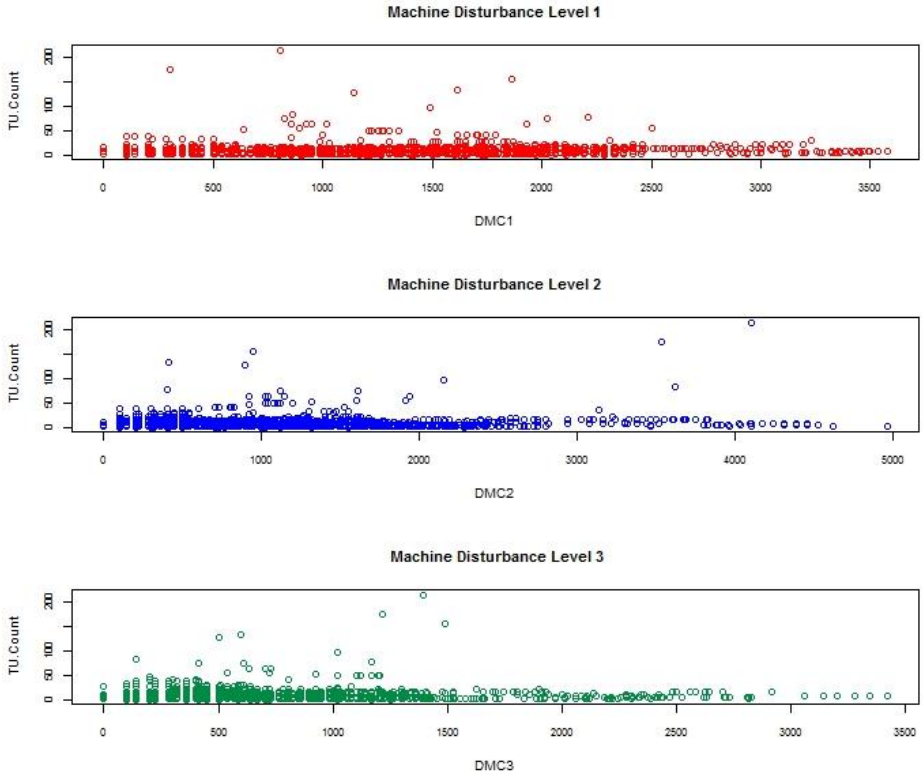
Appendix Table 5.31: Summary table of Hurdle model results for Tufted Duck

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	1.939e-01	1.690e-01	1.148		
2011	-1.085e+00	9.208e-02	-11.784	<0.001	-
2012	-1.257e+00	8.003e-02	-15.709	<0.001	-
2013	-9.235e-01	8.245e-02	-11.201	<0.001	-
Main Section	3.816e-01	6.623e-02	5.762	<0.001	+
Temperature	1.555e-01	6.702e-03	23.207	<0.001	+
Wind speed	1.026e-01	7.962e-03	12.885	<0.001	+
Construction (DTC1)	2.163e-04	3.122e-05	6.929	<0.001	+
Construction (DTC3)	-2.111e-04	5.284e-05	-3.995	<0.001	-
% macrophyte*water depth	1.144e-03	3.962e-04	2.886	<0.001	+
Machine construction disturbance					
Construction (DMC1)	2.366e-04	2.875e-05	8.231	<0.001	+
Construction (DMC3)	-1.836e-03	4.623e-05	-3.973	<0.001	-
People construction disturbance					
Construction (DPC1)	6.082e-05	3.046e-05	1.997	<0.05	+
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	2.413e+00	2.160e-01	11.170		
2012	1.346e+00	1.237e-01	10.879	<0.001	+
2013	1.066e+00	1.147e-01	9.297	<0.001	+
Main section	-1.504e+00	1.057e-01	-14.228	<0.001	-
% macrophyte	3.193e-02	2.068e-03	15.437	<0.001	+
Water depth	5.391e-01	3.507e-02	15.372	<0.001	+
Temperature	-1.948e-01	8.133e-03	-23.950	<0.001	-
Wind speed	-1.135e-01	1.077e-02	-10.542	<0.001	-
Total rainfall	-2.014e-02	1.157e-03	-17.413	<0.001	-
Construction (DTC1)	-7.084e-04	4.014e-05	-17.648	<0.001	-
Construction (DTC3)	-3.178e-04	8.503e-05	-3.737	<0.001	-
% macrophyte*Water depth	-7.287e-03	6.760e-04	-10.780	<0.001	-
Machine construction disturbance					
Construction (DMC1)	-4.064e-04	4.009e-05	-10.137	<0.001	-
Construction (DMC2)	-3.457e-04	4.751e-05	-7.277	<0.001	-
Construction (DMC3)	-1.862e-04	7.550e-05	-2.467	<0.01	-
People construction disturbance					
Construction (DPC1)	-4.471e-04	4.237e-05	-10.554	<0.001	-
Construction (DPC2)	-3.896e-04	3.560e-05	-10.945	<0.001	-
Construction (DPC3)	-4.969e-04	7.689e-05	-6.462	<0.001	-

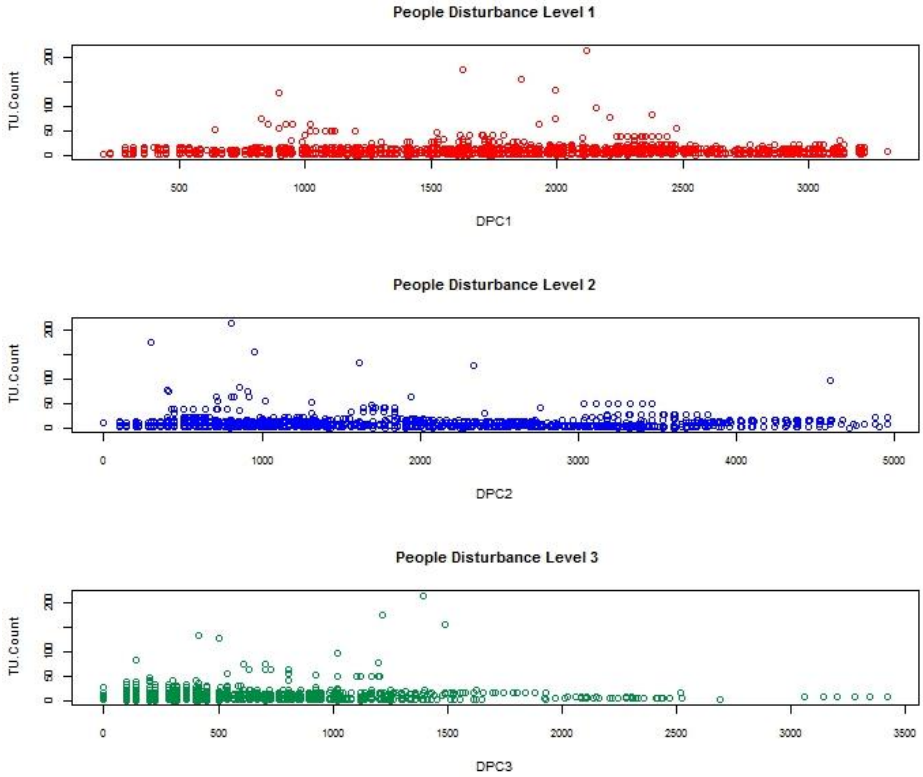
Appendix Table 5.32: Summary table of likelihood ratio test for significant terms during construction Tufted Duck hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-8154	24	256	<0.001
Section	-8041	26	31.503	<0.001
% macrophyte	-8037	25	23.495	<0.001
Water depth	-8035	25	19.527	<0.001
Temperature	-8279	26	506.53	<0.001
Wind speed	-8106	26	160.99	<0.001
Construction (DTC1)	-8053	26	55.858	<0.001
Construction (DTC3)	-8034	26	18.119	<0.001
Water depth*% macrophyte	-8029	26	8.3859	<0.001
Machine construction disturbance				
Construction (DMC1)	-8560	26	77.875	<0.001
Construction (DMC3)	-8531	26	19.175	<0.001
People construction disturbance				
Construction (DPC1)	-8467	26	5.5152	<0.05
Zero hurdle model				
Total construction disturbance				
Year	-8152	24	252.77	<0.001
Section	-8118	26	185.83	<0.001
% macrophyte	-8168	25	285.83	<0.001
Water depth	-8175	25	299.84	<0.001
Temperature	-8352	26	652.81	<0.001
Wind speed	-8083	26	114.49	<0.001
Total rainfall	-9206	26	361.87	<0.001
Construction (DTC1)	-8152	26	254.03	<0.001
Construction (DTC3)	-8032	26	14.28	<0.001
Water depth*% macrophyte	-8087	26	122.79	<0.001
Machine construction disturbance				
Construction (DMC1)	-8566	26	88.954	<0.001
Construction (DMC2)	Error	Error	Error	Error
Construction (DMC3)	-8524	26	6.3204	<0.01
People construction disturbance				
Construction (DPC1)	-8512	26	95.991	<0.001
Construction (DPC2)	-8522	26	115.46	<0.001
Construction (DPC3)	-8486	26	42.742	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.11: Tufted Duck distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).



Appendix Figure 5.12: Tufted Duck distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).

Pochard

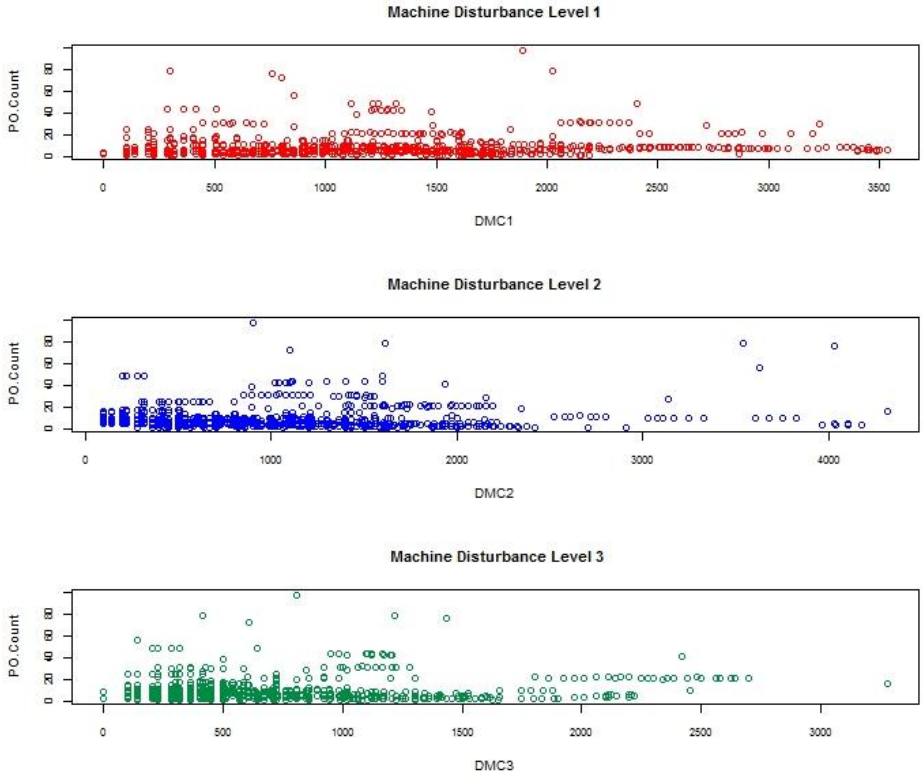
Appendix Table 5.33: Summary table of Hurdle model results for Pochard

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	-9.546e-02	3.927e-01	-0.243		
2012	-5.738e-01	1.974e-01	-2.907	<0.001	-
2013	-5.328e-01	2.127e-01	-2.505	<0.01	-
% macrophyte	2.827e-03	9.123e-04	3.099	<0.001	+
Temperature	1.421e-01	1.278e-02	11.118	<0.001	+
Construction (DTC2)	-4.238e-04	5.335e-05	-7.945	<0.001	-
Construction (DTC3)	5.928e-04	7.178e-05	8.258	<0.001	+
Wind speed*total rainfall	1.653e-03	6.025e-04	2.744	<0.01	+
Machine construction disturbance					
Construction (DMC1)	1.509e-04	4.496e-05	3.356	<0.001	+
Construction (DMC3)	3.499e-04	6.818e-05	5.132	<0.001	+
People construction disturbance					
Construction (DPC1)	3.227e-04	4.472e-05	7.217	<0.001	+
Construction (DPC2)	8.760e-05	4.420e-05	1.982	<0.05	+
Construction (DPC3)	4.153e-04	1.002e-04	4.145	<0.001	+
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	1.391e+00	2.697e-01	5.156		
2012	5.892e-01	1.421e-01	4.146	<0.001	+
2013	8.424e-01	1.285e-01	6.555	<0.001	+
Main Section	-1.318e+00	1.323e-01	-9.958	<0.001	-
% macrophyte	2.615e-02	2.463e-03	10.616	<0.001	+
Water depth	4.148e-01	4.383e-02	9.465	<0.001	+
Temperature	-1.322e-01	9.710e-03	-13.620	<0.001	-
Wind speed	-1.076e-10	1.266e-02	-8.496	<0.001	-
Total rainfall	-1.957e-02	1.542e-03	-12.697	<0.001	-
Construction (DTC1)	-6.560e-04	4.530e-05	-14.482	<0.001	-
Construction (DTC2)	-2.048e-04	4.319e-05	-4.743	<0.001	-
% macrophyte*water depth	-5.516e-03	8.057e-04	-6.846	<0.001	-
Machine construction disturbance					
Construction (DMC1)	-5.108e-04	4.520e-05	-11.302	<0.001	-
Construction (DMC2)	-6.781e-04	4.863e-05	-13.944	<0.001	-
People construction disturbance					
Construction (DPC1)	-4895e-04	4.719e-05	-10.372	<0.001	-
Construction (DPC2)	-5.022e-04	3.755e-05	-13.376	<0.001	-
Construction (DPC3)	-6.017e-04	9.017e-05	-6.673	<0.001	-

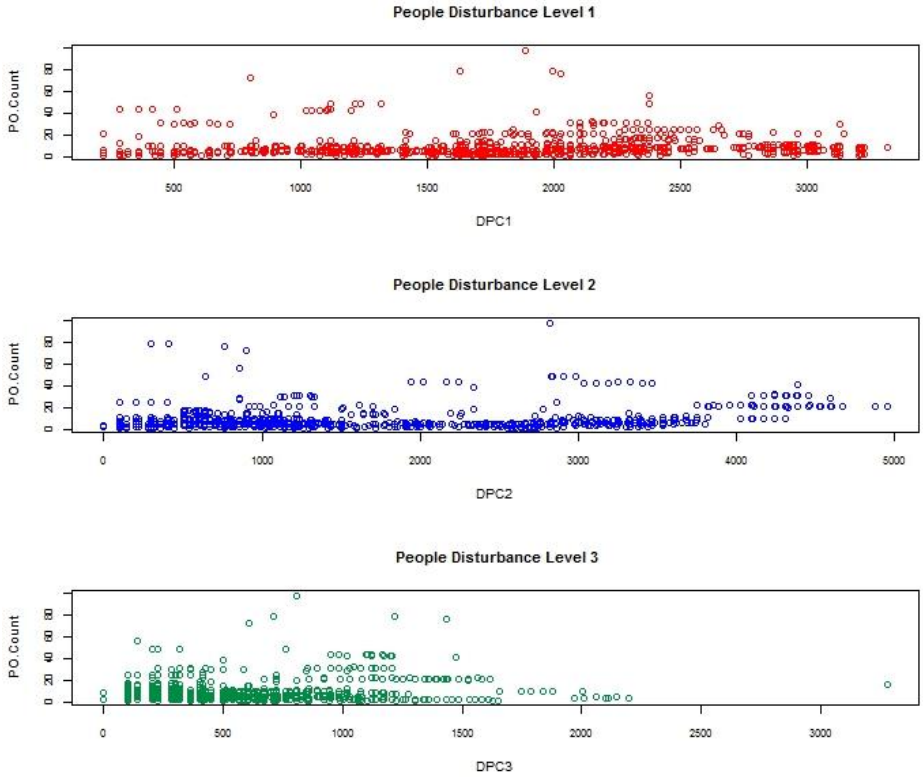
Appendix Table 5.34: Summary table of likelihood ratio test for significant terms during construction Pochard hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-4930	23	29.634	<0.001
% macrophyte	-4927	25	24.423	<0.001
Temperature	-4979	25	128.98	<0.001
Construction (DTC2)	-4956	25	81.737	<0.001
Construction (DTC3)	-4937	25	44.469	<0.001
Wind speed*total rainfall	-4918	25	5.7458	<0.05
Machine construction disturbance				
Construction (DMC1)	-5192	25	14.816	<0.001
Construction (DMC3)	-5190	25	9.5334	<0.01
People construction disturbance				
Construction (DPC1)	-5142	27	40.219	<0.001
Construction (DPC2)	-5124	27	3.6955	<0.05
Construction (DPC3)	-5128	27	13.443	<0.001
Zero hurdle model				
Total construction disturbance				
Year	-4.954	23	77.987	<0.001
Section	-4957	25	83.591	<0.001
% macrophyte	-4985	24	140.08	<0.001
Water depth	-4972	24	113.4	<0.001
Temperature	-5015	25	200.66	<0.001
Wind speed	-4950	25	69.93	<0.001
Total rainfall	-5017	25	203.41	<0.001
Construction (DTC1)	-4985	25	141.12	<0.001
Construction (DTC2)	-4923	25	16.665	<0.001
Water depth*% macrophyte	-4940	25	49.86	<0.001
Machine construction disturbance				
Construction (DMC1)	-5230	25	89.094	<0.001
Construction (DMC2)	Error	Error	Error	Error
People construction disturbance				
Construction (DPC1)	-5158	27	73.542	<0.001
Construction (DPC2)	-5182	27	119.68	<0.001
Construction (DPC3)	-5142	27	40.175	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.13: Pochard distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.14: Pochard distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Mute Swan

Appendix Table 5.35: Summary table of Hurdle model results for Mute Swan

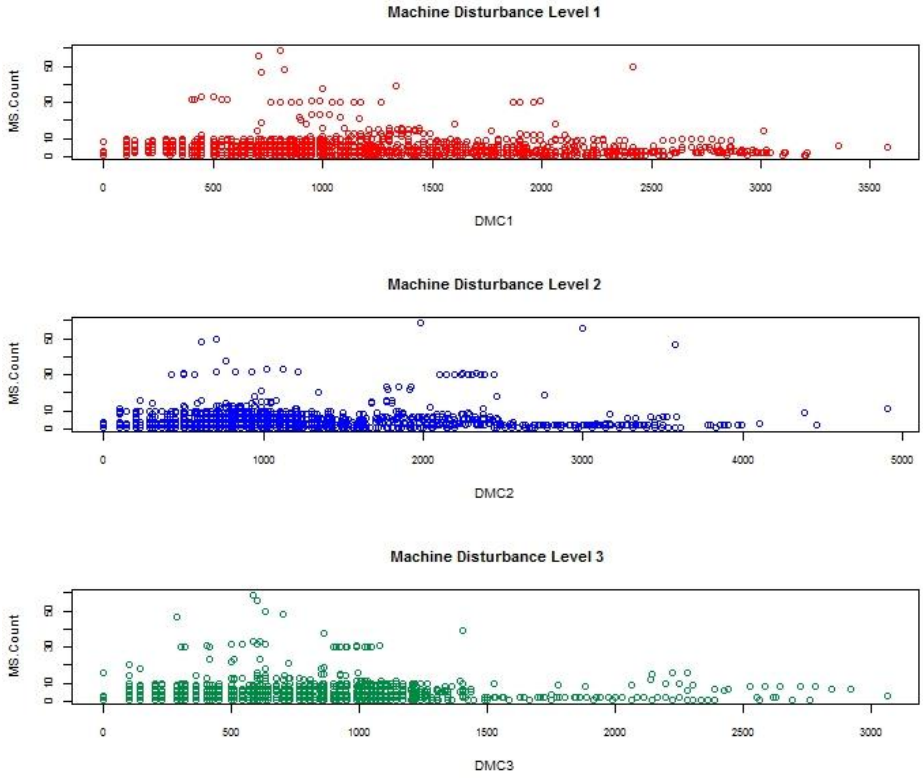
Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	5.939e-01	3.463e-01	1.715		
2011	-6.342e-01	1.170e-01	-5.421	<0.001	-
2012	-5.609e-01	1.098e-01	-5.108	<0.001	-
Water depth	-1.115e-01	1.897e-02	-5.881	<0.001	-
Temperature	9.428e-02	1.788e-02	5.273	<0.001	+
Total rainfall	4.934e-03	9.330e-04	5.289	<0.001	+
Wind speed	6.689e-02	2.874e-02	2.327	<0.05	+
Construction (DTC1)	-2.835e-04	6.254e-05	-4.532	<0.001	-
Construction (DTC2)	2.463e-04	4.816e-05	5.115	<0.001	+
Temperature*wind speed	-6.173e-03	2.093e-03	-2.950	<0.001	-
Machine construction disturbance					
Construction (DMC1)	-1.364e-04	5.994e-05	-2.276	<0.05	-
Construction (DMC2)	-2.824e-04	6.801e-05	-4.152	<0.001	-
Construction (DMC3)	4.316e-04	8.067e-05	5.350	<0.001	+
People construction disturbance					
Construction (DPC1)	-4.409e-04	8.797e-05	-5.012	<0.001	-
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	-5.826e+00	3.745e-01	-15.558		
2011	1.170e+00	1.343e-01	8.716	<0.001	+
2012	8.505e-01	1.324e-01	6.423	<0.001	+
2013	-5.558e-01	1.731e-01	-3.211	<0.001	-
% macrophyte	2.752e-02	2.115e-03	13.007	<0.001	+
Water depth	3.669e-01	3.533e-02	10.384	<0.001	+
Temperature	9.175e-02	1.889e-02	4.857	<0.001	+
Wind speed	1.625e-01	3.072e-02	5.291	<0.001	+
Total rainfall	-2.034e-03	9.931e-04	-2.048	<0.05	-
Construction (DTC1)	-3.091e-04	3.943e-05	-7.838	<0.001	-
Construction (DTC3)	6.170e-04	8.744e-05	7.056	<0.001	+
% macrophyte*water depth	-5.314e-03	6.854e-04	-7.753	<0.001	-
Temperature*wind speed	-6.156e-03	2.322e-03	-2.651	<0.01	-
Machine construction disturbance					
Construction (DMC1)	-1.950e-04	3.860e-05	-5.051	<0.001	-
Construction (DMC2)	1.335e-04	5.021e-05	2.660	<0.01	+
Construction (DMC3)	5.487e-04	7.325e-05	7.490	<0.001	+
People construction disturbance					
Construction (DPC1)	-3.863e-04	3.912e-05	-9.875	<0.001	-

Construction (DPC2)	2.337e-04	4.437e-05	5.268	<0.001	+
Construction (DPC3)	4.398e-04	8.068e-05	5.450	<0.001	+

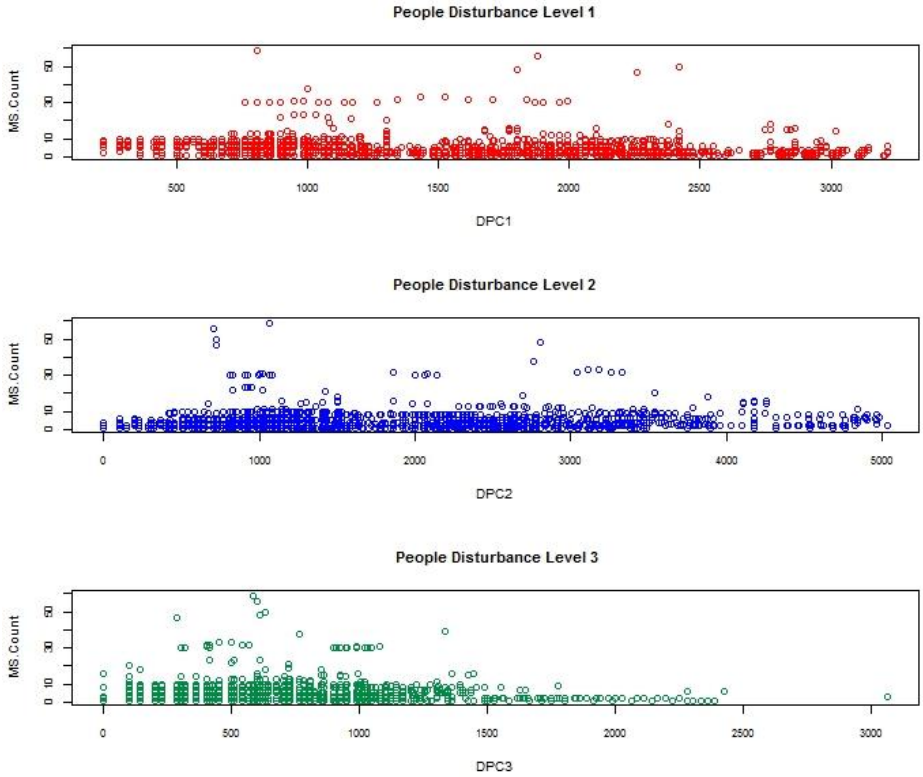
Appendix Table 5.36: Summary table of likelihood ratio test for significant terms during construction Mute Swan hurdle model (to achieve X^2 value for each variable)

Dropped term	**LogLik**	**df**	**Chi-square statistic**	***p*-value**
Count model				
Total construction disturbance				
Year	-6077	22	60.397	<0.001
Water depth	-6066	24	36.683	<0.001
Temperature	-6068	23	42.384	<0.001
Total rainfall	-6061	24	28.17	<0.001
Wind speed	-6052	23	9.5143	<0.01
Construction (DTC1)	-6067	24	40.054	<0.001
Construction (DTC2)	Error	Error	Error	Error
Temperature*wind speed	-6052	24	8.8018	<0.001
Machine construction disturbance				
Construction (DMC1)	-7334	25	7.1158	<0.01
Construction (DMC2)	-7343	25	25.961	<0.001
Construction (DMC3)	-7347	25	32.955	<0.001
People construction disturbance				
Construction (DPC1)	-6949	26	96.76	<0.001
Zero hurdle model				
Total construction disturbance				
Year	-6175	22	256.21	<0.001
% macrophyte	-6164	23	233.37	<0.001
Water depth	-6114	23	132.99	<0.001
Temperature	-6066	23	38.108	<0.001
Wind speed	-6077	23	60.391	<0.001
Total rainfall	-6049	24	4.2366	<0.05
Construction (DTC1)	-6070	24	45.605	<0.001
Construction (DTC3)	-6071	24	47.036	<0.001
% macrophyte*water depth	-6079	24	62.972	<0.001
Temperature*wind speed	-6051	24	6.9163	<0.01
Machine construction disturbance				
Construction (DMC1)	-7341	25	20.277	<0.001
Construction (DMC2)	-7334	25	6.796	<0.01
Construction (DMC3)	-7357	25	53.052	<0.001
People construction disturbance				
Construction (DPC1)	-6938	26	76.198	<0.001
Construction (DPC2)	-6920	26	38.73	<0.001
Construction (DPC3)	-6914	26	27.645	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.15: Mute Swan distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).



Appendix Figure 5.16: Mute Swan distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).

Great Crested Grebe

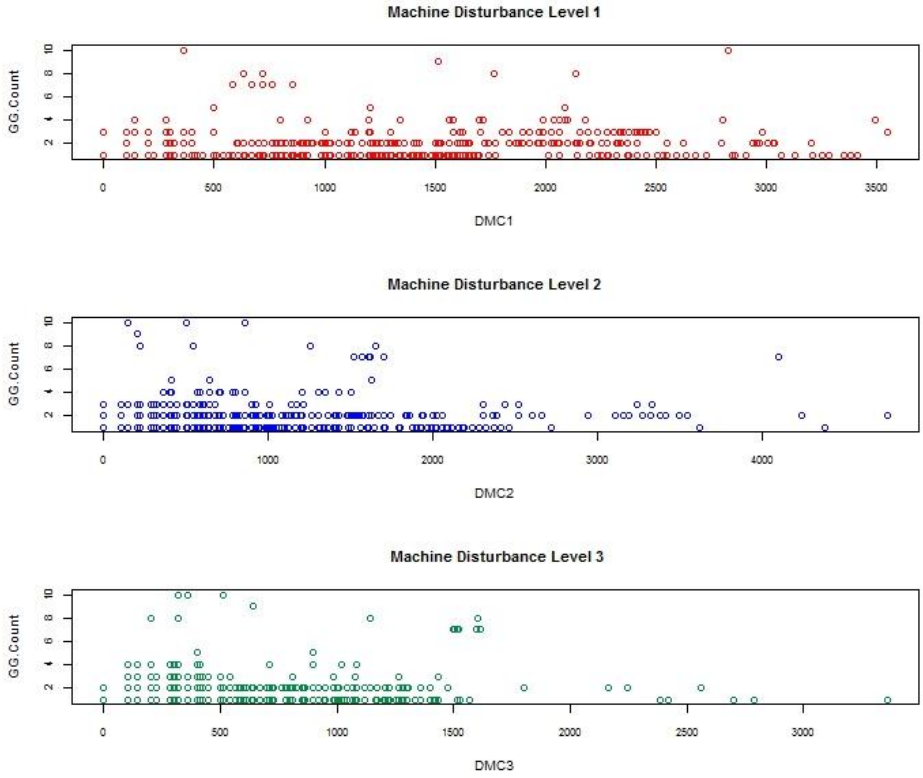
Appendix Table 5.37: Summary table of Hurdle model results for Great Crested Grebe

Variable	Estimate	Std. Error	Z value	Significance (*p*-value)	Relationship
Count model (truncated negative binomial with log link)					
Total construction disturbance					
Intercept	-2.620e+00	4.995e-01	-5.245		
2011	-6.768e-01	2.757e-01	-2.455	<0.01	-
2013	-5.816e-01	2.309e-01	-2.519	<0.01	-
Main Section	4.511e-01	1.871e-01	2.412	<0.05	+
Temperature	8.297e-02	1.707e-02	4.859	<0.001	+
Wind speed	1.142e-01	2.442e-02	4.675	<0.001	+
Total rainfall	7/.064e-03	2.135e-03	3.309	<0.001	+
Construction (DTC1)	5.530e-04	1.285e-04	4.304	<0.001	+
Construction (DTC3)	3.595e-04	1.706e-04	2.107	<0.05	+
Water depth*DTC1	-7.472e-05	1.722e-05	-4.313	<0.001	-
Machine construction disturbance					
Construction (DMC1)	2.388e-04	3.448e-05	6.927	<0.001	+
Construction (DMC2)	-1.905e-04	8.780e-05	-2.170	<0.05	-
Zero hurdle model (binomial with logit link)					
Total construction disturbance					
Intercept	-8.120e-01	3.090e-01	-2.628		
2011	8.280e-01	2.329e-01	3.556	<0.001	+
2012	1.822e+00	2.459e-01	7.412	<0.001	+
2013	1.305e+00	2.333e-01	5.594	<0.001	+
Main Section	-1.162e+00	1.565e-01	-7.424	<0.001	-
% macrophyte	2.223e-02	3.047e-03	7.297	<0.001	+
Water depth	4.509e-01	5.416e-02	8.324	<0.001	+
Temperature	-1.494e-01	2.141e-02	-6.981	<0.001	-
Total rainfall	-2.814e-02	4.484e-03	-6.277	<0.001	-
Construction (DTC1)	-5.061e-04	5.310e-05	-9.532	<0.001	-
Construction (DTC2)	2.154e-04	5.273e-05	4.085	<0.001	+
Construction (DTC3)	-1.005e-03	1.324e-04	-7.592	<0.001	-
% macrophyte*water depth	-6.787e-03	1.025e-03	-6.621	<0.001	-
Temperature*total rainfall	9.935e-04	2.262e-04	4.392	<0.001	+
Machine construction disturbance					
Construction (DMC1)	-3.040e-04	5.319e-05	-5.717	<0.001	-
Construction (DMC2)	-5.065e-04	6.089e-05	-8.319	<0.001	-
Construction (DMC3)	-5.382e-04	1.100e-04	-4.893	<0.001	-
People construction disturbance					
Construction (DPC1)	-2.874e-04	4.949e-05	-5.806	<0.001	-
Construction (DPC3)	-1.143e-03	1.193e-04	-9.580	<0.001	-

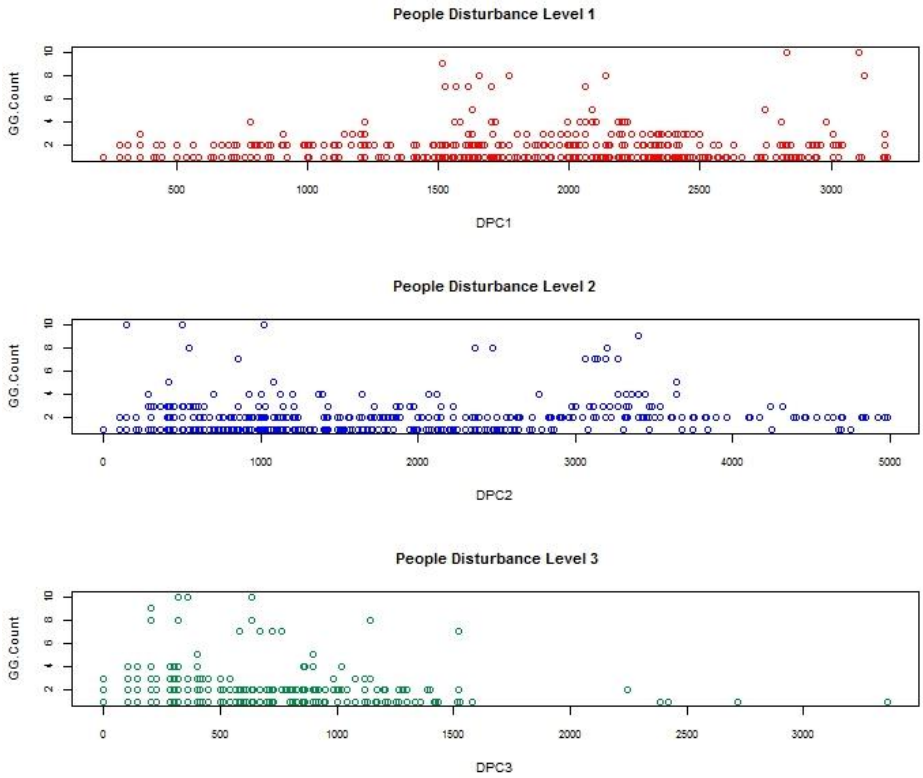
Appendix Table 5.38: Summary table of likelihood ratio test for significant terms during construction Great Crested Grebe hurdle model (to achieve X^2 value for each variable)

Dropped term	LogLik	df	Chi-square statistic	*p*-value
Count model				
Total construction disturbance				
Year	-2445	25	7.1023	>0.05
Section	-2444	27	6.0136	<0.01
Temperature	-2453	27	22.134	<0.001
Wind speed	-2451	27	19.87	<0.001
Total rainfall	-2446	27	9.65	<0.01
Construction (DTC1)	-2451	26	18.646	<0.001
Construction (DTC3)	-2444	27	4.9461	<0.05
Water depth*DTC1	-2452	25	21.989	>0.001
Machine construction disturbance				
Construction (DMC1)	-2651	26	8.2816	<0.001
Construction (DMC2)	-2649	26	3.0994	>0.05
Zero hurdle model				
Total construction disturbance				
Year	-2488	25	93.581	<0.001
Section	-2465	27	46.757	<0.001
% macrophyte	-2470	26	57.924	<0.001
Water depth	-2490	26	96.356	<0.001
Temperature	-2486	26	89.017	<0.001
Total rainfall	-2492	26	100.13	<0.00
Construction (DTC1)	-2469	27	54.491	<0.001
Construction (DTC2)	-2448	27	13.865	<0.001
Construction (DTC3)	-2468	27	52.891	<0.001
% macrophyte*water depth	-2465	27	46.733	<0.001
Temperature*total rainfall	-2447	27	10.345	<0.001
Machine construction disturbance				
Construction (DMC1)	-2658	26	22.137	<0.001
Construction (DMC2)	-2670	26	45.324	<0.001
Construction (DMC3)	-2657	26	19.16	<0.001
People construction disturbance				
Construction (DPC1)	-2653	22	20.173	<0.001
Construction (DPC3)	-2682	22	78.099	<0.001

N.B. Error is where the likelihood ration test failed to compute due to difference in size of model datasets



Appendix Figure 5.17: Great Crested Grebe distribution associated with distance to each people disturbance category (DPC1, DPC2 and DPC3).



Appendix Figure 5.18: Great Crested Grebe distribution associated with distance to each machine disturbance category (DMC1, DMC2 and DMC3).

5.3: R script examples

```
#Data overview and exploration

 <- hist(T.Count)

#mean and variance #over-dispersed

 <- mean(T.Count); var(T.Count)

#look for outliers and remove any that are obvious

 <- dorchart(T.Count)

#look at relationship with environmental variables

 <- plot(W.Depth,T.Count)

#check for collinearity between variables #panel plot #remove any variables with VIF>3

 <- z1 <- cbind(T$T.Count, T$Month, T$Year, T$Day, T$Section, T$M.Pct, T$Dist.S, T$W.Depth,
 T$Temp, T$Windhigh ,T$Windspd, T$Total.rainfall, T$DTC1, T$DTC2, T$DTC3)

 <- colnames(z1) <- c("T", "Month", "Year", "Day", "Section", "M.Pct", "Dist.S", "W.Depth", "Temp",
 "Windhigh", "Windspd",  "Total.rainfall", "T1", "T2", "T3")

 <- pairs(z1, lower.panel = panel.smooth)

 <- vif(z1)

 <- cor.test(Dist.S,DTC1)

#run Hurdle model #add pscl, ggplot, lmtest & faraway packages added

 <- ft9<- formula(T.Count ~
 Year+Month+Section+W.Depth+Temp+Windspd+DTC1+DTC2+DTC3+Tempt*Windspd |
 Month+M.Pct+W.Depth+Temp+Windspd+DTC1+DTC2+DTC3

 < ht9<- hurdle(ft9, dist = “negbin”, link = “logit”)

 <- AIC(ht9)

 #compare model fit/significant difference with previous model

 <-lrtest(ht9,ht8)

 <- summary(ht9)

 <- xyplot(residuals(ht9)~fitted(ht9))

 <- qqnorm(residuals(ht9));qqline(residuals(ht9))
```

#obtain X^2 values for each variable within the model for reporting purposes. #remove each one and use lrtest to compare with MAM. #for Teal during construction using variable 'year' for the count component of total construction model
#ht7 = MAM

```
<- Y<- formula(T.Count~Section+W.Depth+Temp+Windspd+DTC1+DTC3+Temp*Windspd |
Year+W.Depth+Temp+Windspd+M.Pct+Total.rainfall+DTC1+DTC2+DTC3+W.Depth*M.Pct)

Yr2<- hurdle(Y, dist = "negbin", link = "logit")

lrtest(ht7,Yr2)
```

#graphs #month and level of disturbance #ensure Mass & Lattice package on

```
<- Month<- factor(Month,levels = c("April", "May", "June", "July", "August", "September"))

<- plot(Month,Level_dist, cex.lab = 0.8, cex.axis = 0.7, las = '1', pch = 18, xlab = "Month", ylab =
"Level of disturbance")
```

#plot three graphs, one window

```
<- par( mfcol = c(3, 1))

<- plot(DTC1,T.Count, col = "red", main = "Total Disturbance Level 1", cex.main = 1, cex.lab = 0.9,
cex.axis = 0.8)

<- plot(DTC2,T.Count, col = "blue", main = "Total Disturbance Level 2", cex.main = 1, cex.lab = 0.9,
cex.axis = 0.8)

<- plot(DTC3,T.Count, col = "springgreen4", main = " Total Disturbance Level 3", cex.main = 1, cex.lab
= 0.9, cex.axis = 0.8)
```