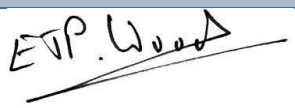
Mark and Capture Study 2024 Glass Eel Season on River Severn Population Estimate and Exploitation Rate.

Contacts:

Please address questions and comments to:
Peter Wood, peterwood@glasseel.com

	Name	Position	Signed	Date
Author	Peter Wood			17/06/2024

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Revisions

Rev No.	Description	Pages
1.0	Draft	
1.1	Formalisation of the report	All
2.0	Issue	All

Navigation

Cross references within Microsoft Word or Portable Document Format (pdf) versions of this document use hyperlinks. To follow a [link] to a figure, table, or other reference, use the ctrl key with a mouse click. To return the departure point in the text, use Alt + ← (left arrow).

Contents

Abstract

A research paper that reported the methodology and results of research to estimate the Glass Eel (Anguilla anguilla) population of the River Severn and the exploitation rate of the fishery through a Mark-Release-Capture trial was published in 2020 [ref 1]. This trial process was repeated in each of the subsequent years.

This reports the method and results of the trial for the 2024 season.

The size of the glass eel population that was directly affected by the fishery was estimated be 23,244 kg. The exploitation rate of the affected population was estimated to be 3.36%.

These results and those of the previous years are discussed in the context of other published research by CEFAS that estimated the recruitment to the Severn Estuary to be in excess of 400,000kg.

A key finding is that the mark and recapture methodology can be used to provide consistent measures of a migratory population that transits a control space.

The Author

Peter Wood holds a master's degree in Aquatic Sciences from the University of Stirling and founded the Sustainable Eel Group.

References

Ref No. and Title	Source	Author	Date
1. Estimation of glass eel (Anguilla anguilla) exploitation in the Severn Estuary, England	Wiley: Fisheries Management and Ecology	Miran Aprahamian Peter Wood	23-08-202
2. SPP107 Worst case glass eel entrainment assessment for HPC	CEFAS	Brian Robinson, David Maxwell, Mark Breckels	Rev 3 26/04/2021
3. ICES. 2023. Workshop on accounting for fishers and other stakeholders' perceptions of the dynamics of fish stocks in ICES advice (WKAFPA).	ICES..		2023

1 2024 Summary

Fishing started on the 27th February and finished on the 14th April; a total of 781.55 kg was caught (Figure 1- Daily catch of glass eel). There was an early start to the season with exceptional catches not observed for more than 4 decades. (See video link in section 9)

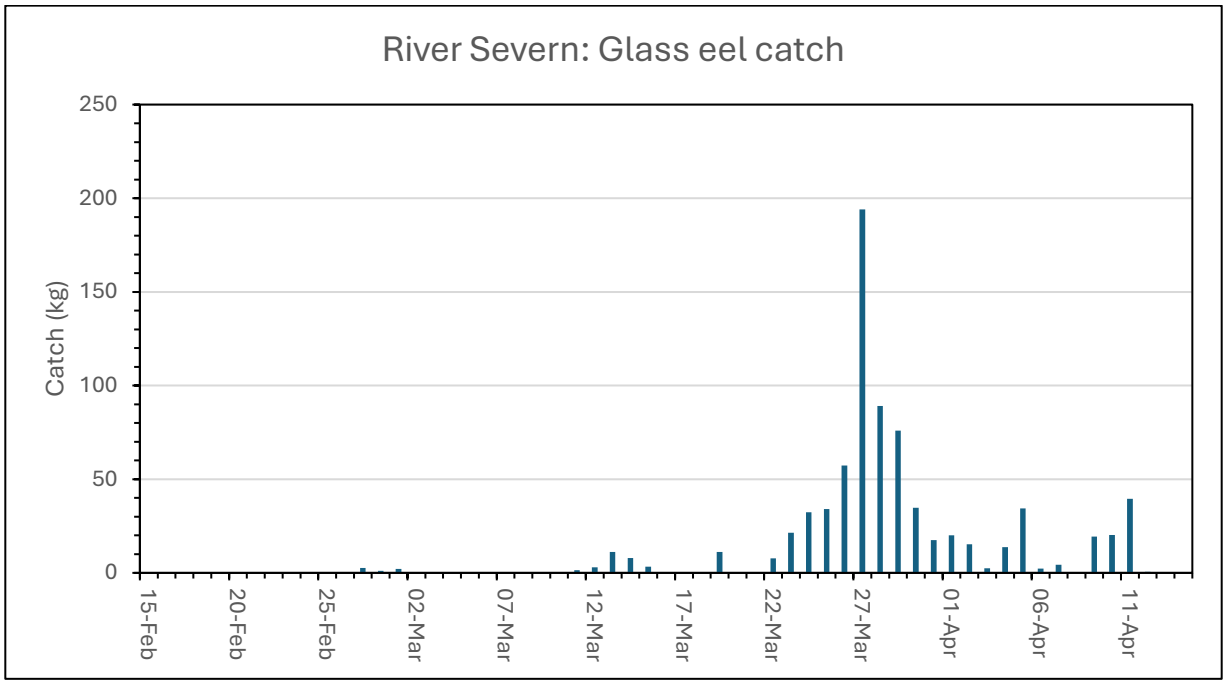


Figure 1- Daily catch of glass eel

A mark and recapture exercise to estimate population size and exploitation rate was carried out using the same methodology as used in 2020, 2022 and in 2023 and reported in reference 1.

A 12.5kg sample of fish was caught, marked and released between Epney and the Gloucester/Maisemore weirs before any significant catches were recorded giving clean start to the study.

The size of the glass eel population was estimated be 23,244 kg. The overall exploitation rate was estimated to be 3.36%

2 Introduction

The Eel (Anguilla anguilla) is listed by CITES as a critically endangered species. Reliable estimates of both the size of the population exploited by a fishery and the effectiveness of the latter (the fraction caught) are essential for the proper management and regulation. In addition, it provides data necessary to effectively identify, plan, deploy and measure other interventions such as, to remove migratory barriers, prevent the loss of habitat and the restoration of the same.

3 Background

This mark and recapture study was carried out using the same methodology as used in 2020, 2022 and in 2023 and reported in reference 1. The Joint Nature Conservation Committee is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation. The JNCC, was requested to provide intellectual assistance in the design and

implementation of the study to build on the successful work of the prior years and to provide oversight to assure the integrity of the work.

4 The Mark and Recapture Method

This is a general description of the context and how the mark and recapture study is organised. A discussion of the specifics for the 2024 season are discussed in paragraph 5.1

4.1 Structure of the Population

The population to be measured is migrating by a process of selective tidal transport up the River Severn. The overall population, arriving from the Bristol Channel, becomes divided into shoals by the action of the varying intensity of spring and neap tides. The front of a given shoal is determined by the reach of the flood tide in a succession of tides of increasing height, the back of the shoal is brought forward by the longer period of the flow of the incoming tide, downstream of the point of maximum reach. The overall effect is to create a shoal from an otherwise dispersed population. This process can be disrupted by adverse temperature and salinity caused by weather and fresh water from the river catchment.

The bunching of the migrating population into a number of shoals facilitates the effectiveness of the mark and recapture method.

4.2 The Fishery

The fishery uses hand dip nets which are regulated both for size and their method of use. The glass eels are caught in a period of 1 to 2 hours after the tide has started to ebb. The glass eels continue to swim against the ebb flow close to the banks for this limited period having been stimulated to enter the body of the water column by the incoming tide, before settling to the bottom to wait for the next flood tide.

The hand nets are faced down stream and rely upon the glass eels swimming into the net. This is a passive fishery unlike active fisheries where hand nets are used to scoop the fish from an area of concentration (typically caused by a barrier) or caught in an industrial sized trawl towed by a fishing vessel.

The extent of the fishery is from Framilode to Tewksbury weir, a distance about 25 miles. The lower limit is determined by the transition from an estuary to a river, the upper by the weir limiting the reach of the tide. The full extent of the fishery is not necessarily active. The fishery is limited in time by regulation from February 15th to April 28th, the effective start date for the Severn being mid-March due to the low temperature. The fishing effort is limited to 56 nets/people.

4.3 Mark and Recapture

The process can be summarised as:

1. Catch a sample of glass eels from the front of a shoal
2. Mark with a red dye (Rhodamine β)
    a. Set up controls to observe any toxicity See Appendix B Rhodamine ß Control
        i. Dyed
        ii. Undyed
    b. Have redundant control samples to protect against failures
3. Release a quantified sample, dispersed throughout the range of the shoal
4. Recapture through the fishing effort of the fishery
    a. Count the number of dyed fish in a majority sample of the catch
    b. Measure the quantity of the overall catch

5 River Severn: Glass eel Population Estimate

5.1 Trial 1

Method: Mark Recapture Date: 22 March – 14th April 2024

5.2 Release details:

- Stain: March 20 2024
- Release Date: March 22 -2024
- Tide HW Sharpness 06.16 GMT 6.5 M
- Mass released: 12.5 kg
- Number of glass eel / kg: 2,500 glass eels per kg.
- Number of glass eel released: 31,250
- Dye used: Rhodamine β
- Release: From Epney to Lower Parting at 8 sites (1.56 kg per site)

5.3 Recapture Details and Population Size estimate:

5.3.1 Exploitation Rate:

- Number or marked glass Eels recaptured: 981
- Exploitation rate: 3.14% (981/31,250*100) (U95 3.33%)
- Catch examined for dye: 729.67 kg
- Catch not examined for dye: 44.1 kg (Fish caught 27 /02 – 21/03)
- Total Catch: 781.55 kg
- Population estimates: 23,244 kg ((729.67 / 0.0314)
- Overall exploitation Rate (%): 3.36% (781.55 / 23,244*100)

Note that the population is calculated only on the basis of the catch examined. This is a conservative approach as in principle the overall population is the total catch/exploitation rate of the subsample.

5.4 Discussion – Trial Process

5.4.1 Conditions

The tidal, freshwater flow, temperature and weather conditions were favourable for the mark and recapture study and for fishers to catch the glass eels. The main factors were that the high freshwater discharge and the height of the top of the spring of tides was insufficient to significantly flood the weirs at Maisemore and Gloucester (top right hand of Fig_Apx A-2 – Release and Recapture Zone). This created a closed control volume with few of the shoal escaping up stream before the fishing of the subject shoal had ceased. A closed control volume removes the requirements concerning the dispersal of the marked sample within the shoal as the whole is contained.

The period of fishing was also limited. 88% of the catch was sampled within the 18 days of clear persistence of the dye (see Apx_Table B-1 – Dye Persistence in Control) mitigating the risk of undercounting.

Fishing ceased on the 14th April and some video data is available to determine that on 24/04/2024 some of the shoal successfully negotiated the migratory barriers of the weirs on subsequent spring tides.

5.4.2 Controls

Samples of the dyed glass eels were retained from the sample to be released to observe the persistence of the dye and toxicity.

The air supply of one control group failed with near 100% mortality. There was 1 mortality in the dye control group at 14 days after exposure and 1 mortality in the undyed control group at 15 days. Each of the control group was some 1000 individuals. There was no impact of the dye and no observed changes in behaviour between the control and challenge groups.

6 Comparison with previous years

6.1 At the time of mark recapture

The Effort in the table below is the sum of the product of the tides fished and the number of fishers. It is in effect the number of catches returned to the mandatory collection point.

Year	Catch (kg)	Effort	Population (kg)	Exploitation rate (%)
2020(a)	656.92	305	24,690	2.66
2022(a)	340.13	198	10,460	3.25
2022(b)	286.70	130	9,029	3.18
2023	483.36	167	76,402	0.63
2024	729.67	282	23,244	3.14

6.2 Over the Season

Year	Catch (kg)	Effort	Population (kg)	Exploitation rate (%)
2020	1,913.24	998	24,690	7.75
2022	936.85	474	10,460 – 19,489	4.81 – 8.96
2023	562.76	241	76,402	0.74
2024	781.55	306	23,244	3.36

6.3 CEFAS 2012 – 2013 Study

Cefas estimated the abundance of glass eel in 2012 and 2013 [ref 2]:

Survey Period	Glass eel (t) Mean	Glass eel (t) L95	Glass eel (t) U95
Feb 2012	249.2	206.6	298.8
Feb 2013	638.7	494.2	860.5
Apr 2013	433.6	333.2	562.7
Including peak abundance events			
Feb 2012	304.2	237.7	390.0
Feb 2013	779.7	568.6	1,123.2
Apr 2013	529.3	383.3	734.6

The total catch (APB returns) in 2012 and 2013 was 3.82 t and 8.66 t, respectively giving exploitation rates of <1.8% and <2.6% in 2012 and 2013, very similar to the estimates from the more recent mark and recapture studies.

7 Reasonableness Test approach - Sense Check

The following reasonableness check has been made in accordance with the guideline of reference 3.

It should be recognized that the population estimate and exploitation rate is a local estimate based on the shoal of glass eels located between Epney and the weirs at Gloucester. It does not include the recruitment that has already reached the Tewkesbury waters (Lower Lode) as demonstrated by the catch of 8.8 kgs 13/03/2024 and 7.9 kgs 14/03/2024 before the marked glass eels were released. Nor does it include any estimate of further recruitment from the upper estuary due to the subsequent tides driving the selective tidal transport system. It would be reasonable to assume the mark and capture method is therefore an underestimate of the total recruitment but an accurate estimate of the exploitation rate.

Local sense checking by stakeholders demonstrates an increase in glass eel recruitment against current perceptions of stock data. These differences of stock perception between stakeholders and regulators need to be recorded, communicated and evaluated. If there is not a logical explanation, they require further investigation.

8 Conclusions

The four Mark and Recapture studies carried out over five seasons from 2020 to 2024 (2021 missing due Covid 19) show the method to give consistent results with exploitation rates of the shoal that is the subject of the study in the range of 0.63% to 3.14%. The low rate of 0.63% is an outlier due to the fishery being closed.

The seasonal exploitation rates, extrapolating the sampling to the total catch varies from 0.074% to 8.96%.

A limitation of the population estimates are that these are only for the shoals that are directly affected by the fishery. The rest of the population that migrates before and after the regulated period of the fishing season is not observed and therefore the values are highly conservative. Anecdotal evidence from observations in May 2024 on the Severn, Tone and Parrett are that active migration continues. See the video links in section 9. The shoal population estimates are an order of magnitude less than the CEFAS 2012/2013 estimated abundance of glass eels in the Bristol Channel, from which the Wye, Parrett, Tone and Severn derive their populations, which was in the range of 206,600kg (lower 95% confidence level) to 1,123,200 kg (upper 95% confidence level) [Table 4 of ref 2].

9 2024 Catch Videos:

River Severn April 2024

www.glasseel.com/elver-season-videos-2024/

River Severn May 2024

https://glasseel.com/river-severn-may-2024/

River Tone March 2024

www.glasseel.com/march-2024-river-tone/

River Parrett May 2024

www.glasseel.com/may-2024-river-parrett/

Appendix A Mark and Recapture Trial photos

A.1 Counting Report

A Vaki MicroMacro counter was used weigh and weight profile, a sample of glass eels to establish the average number of glass eels per kg. The average was 2500 individuals per kg.

VAKI

Counting report

UK GLASS EELS

Description: TANK 11 Counted by:

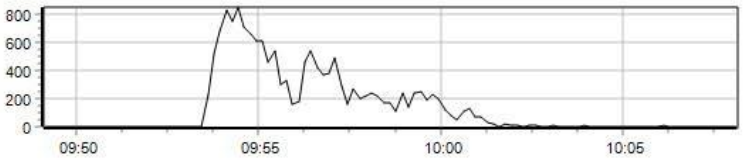
Date: *1.4.2024 10:08*

Channel 1 Size settings: 3 g

Channel Count: **2551** Total Count: **2551**

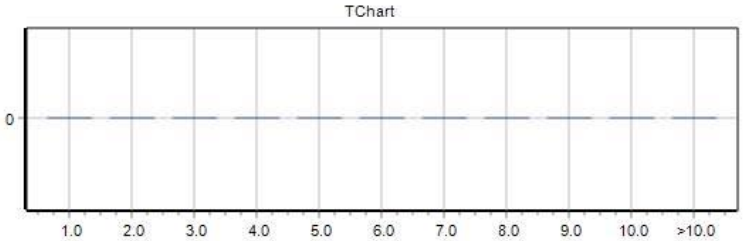
Average: 130 fry/min Over load time: 0:00:0 Duration: 0:19:37

Comments:



Average Weight:**0.0 gr.** Std deviation: **0.0 gr.**

Total biomass: **0 g** Sample size **0**



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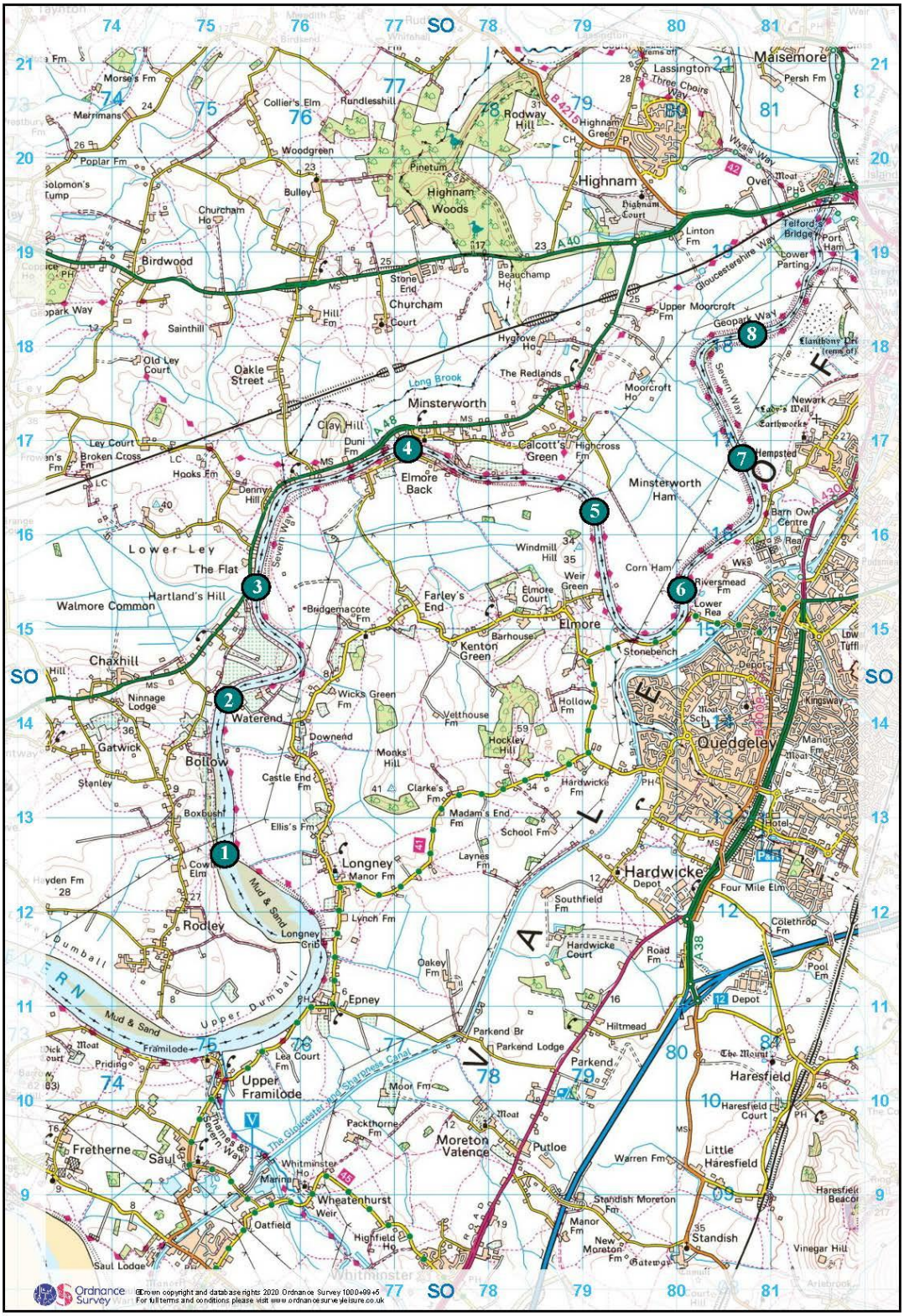
Counted with Micro/Macro counter from Vaki version 402402

Fig_Apx A-1 -– Release of Marked Glass Eels (Rhodamine β)



1 of 1

Fig_Apx A-2 – Release and Recapture Zone

Appendix B Rhodamine ß Control

B.1 Impact of Staining

Two regimes were adopted to test the toxicity of Rhodamine ß

Staining method. UK GE standard 0.1 gms of Rhodamine ß per litre 200 pieces of glass eels per litre

Trial 150 litres 15 gms Rhodamine ß 12.5 kgs glass eels. Exposure 9.5 hours

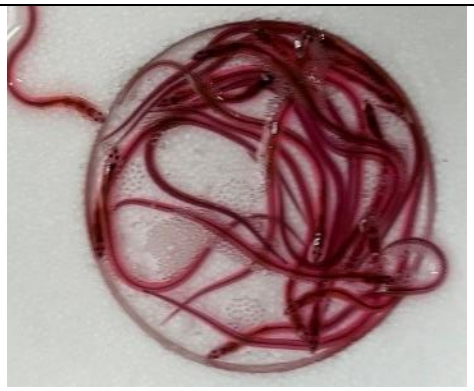
pH shift 7.6 Start 6.75 End. May have to consider buffering staining tank

Exposure 4.5 hours and 9 hours.

Rhodamine ß 0.1 gm /litre			Temp 12°C	
5 litre tanks		1000	200 pieces per litre	
Trial 1	Mortality		Control	
Day	Tank 1 4.5 hrs	Tank 2 9.0 hrs	Tank 3	Notes
Mar-17	start			
Mar-18	0	0		
Mar-19	0	0		
Mar-20	0	0	0	Mark 12.5 kgs
Mar-21	0	0	0	
Mar-22	0	0	0	Release
Mar-23	0	0	0	
Mar-24	0	0	0	
Mar-25	0	0	0	
Mar-26	0	1	0	
Mar-27	0	0	0	
Mar-28	0	0	0	
Mar-29	0	100%	0	air failed tank2
Mar-30	0	x	0	
Apr-01	1	x	0	
Apr-02	0	x	1	
Apr-03	0	x	0	
Apr-04	0	x	0	
Apr-05	0	x	0	
Apr-06	0	x	0	
Apr-07	0	x	0	
Apr-08	0	x	0	
Apr-09	0	x	0	
Apr-10	0	x	0	
Apr-11	0	x	0	
Apr-12	0		0	

Trial 2	Mortality		
Day	Tank 1 4.5 hrs	Tank 2 9.0 hrs	Notes
Apr-13	7	1	
Apr-14	0	0	
Apr-15	0	0	
Apr-16	0	0	
Apr-17	0	0	
Apr-18	0	0	
Apr-19	0	0	
Apr-20	0	0	
Apr-21	0	0	
Apr-22	0	0	
Apr-23	0	0	
Apr-24	0	0	
Apr-25	0	0	
Apr-26	0	0	
Apr-27	0	0	
Apr-28	0	0	
Apr-29	0	0	

Apx_Table B-1 – Dye Persistence in Control

Day 0			Day 15	
Day 2			Day 18	
Day			Day 24	
Day 12				

B.2 Summary: Mark Recapture

Date	Glass eel caught (kg)	Glass eel caught (number)	Number of marked glass eel recovered	Cumulative number of Glass eel recovered	Exploitation rate	Cumulative catch (kg)	Population estimate (kg)
23-Mar	21.46	53,650	17	17	0.05%	21.46	39,449
24-Mar	32.44	81,100	0	17	0.05%	53.90	99,081
25-Mar	34.00	85,000	83	100	0.32%	87.90	27,469
26-Mar	57.36	143,400	0	100	0.32%	145.26	45,394
27-Mar	194.11	485,275	372	472	1.51%	339.37	22,469
28-Mar	89.14	222,850	0	472	1.51%	428.51	28,371
29-Mar	75.90	189,750	104	576	1.84%	504.41	27,366
30-Mar	34.78	86,950	109	685	2.19%	539.19	24,598
31-Mar	17.48	43,700	82	767	2.45%	556.67	22,680
01-Apr	20.08	50,200	38	805	2.58%	576.75	22,389
02-Apr	15.24	38,100	72	877	2.81%	591.99	21,094
03-Apr	2.38	5,950	15	892	2.85%	594.37	20,823
04-Apr	13.80	34,500	0	892	2.85%	608.17	21,306
05-Apr	0.00	0	0	892	2.85%	608.17	21,306
06-Apr	34.42	86,050	24	916	2.93%	642.59	21,922
07-Apr	2.32	5,800	38	954	3.05%	644.91	21,125
08-Apr	4.42	11,050	20	974	3.12%	649.33	20,833
09-Apr	0.46	1,150	0	974	3.12%	649.79	20,848
10-Apr	19.42	48,550	0	974	3.12%	669.21	21,471
11-Apr	20.26	50,650	0	974	3.12%	689.47	22,121
12-Apr	39.62	99,050	7	981	3.14%	729.09	23,225
13-Apr	0.00	0	0	981	3.14%	729.09	23,225
14-Apr	0.58	1,450	0	981	3.14%	729.67	23,244