Cyfoeth Naturiol Cymru
Natural Resources Wales

Cardiff Bay Fish Pass Report 2022

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Author: Brendan Adair

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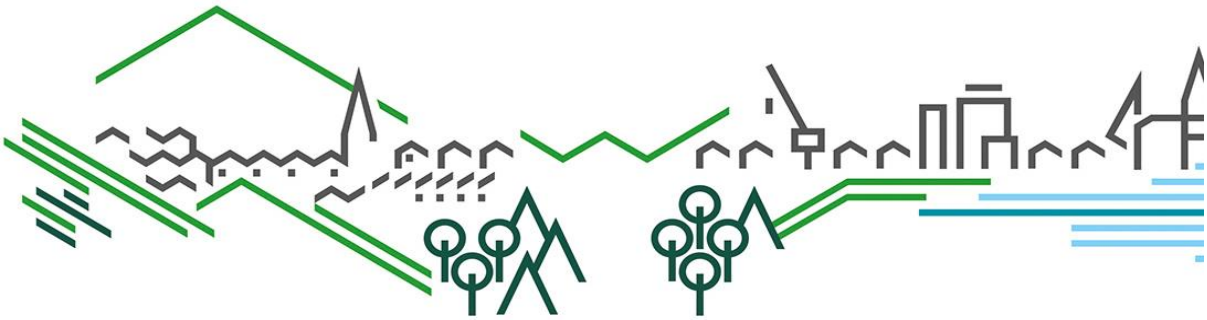
NRW



Natural Resources Wales

Who we are and what we do

Natural Resources Wales manages how we use and enjoy Wales' natural resources to benefit people, the economy and the environment. Our purpose is to make sure that we all maintain, use and enhance Wales' natural resources now and for the future. Natural Resources Wales influences how we and others manage, use and enjoy Wales' natural resources to benefit people, the economy and the environment. Our purpose is to make sure that we all maintain, use and enhance Wales' natural resources now and for the future. We have been established by the Welsh Government and given this purpose because Wales faces many challenges - challenges for its people and communities, for its economy and for its environment and wildlife. These challenges include securing energy and fuel supply; provision of jobs and income; tackling the threats of climate change and flooding; and improving people's health and wellbeing. Natural Resources Wales brings together the work of the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales, as well as some functions of Welsh Government.

We believe that by unlocking the potential that lies within Wales' resources, by managing them and using them in a more joined up and integrated way, they can help to meet the challenges we face. We work for the people of Wales to make sure they and their homes are protected from environmental incidents like flooding and pollution. We provide opportunities for them to learn, use and benefit from Wales' natural resources. We work for Wales' economy and enable the sustainable use of natural resources to support jobs and enterprise. We help businesses and developers to understand and consider environmental limits when they make important decisions. We work to maintain and improve the quality of the environment for everyone. We make the environment and natural resources more resilient to climate change and other pressures.

We work to make sure that Natural Resources Wales is an efficient, effective and capable organisation that works for the people and environment of Wales.

Published by:
Natural Resources Wales
Rivers House
Fortran Road
St Mellons, Cardiff
CF3 0EY
Tel: 03000 65 3192

Email: enquiries@naturalresourceswales.gov.uk

Website: www.naturalresourceswales.gov.uk / www.cyfoethnaturiolcymru.gov.uk

Further copies of this report are available from: Brendan Adair
Email: Brendan.adair@cyfoethnaturiolcymru.gov.uk
Tel: 03000 65 3036

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Introduction to Cardiff Bay

Cardiff bay is a large impoundment located at the base of the River Taff and Ely catchments. The impoundment was created by the construction of a barrage in 2001 which regulates river flow into the Severn Estuary. The Taff and Ely catchments offer habitat to a wide array of native fishes including the endangered, Atlantic Salmon (*Salmo salar*). Monitoring of Atlantic salmon commenced in 2001, however the current vaki system has been used since 2005.

A denil fish pass was constructed alongside the barrage which allows for fish migration on all tides. The fish pass has a minimum flow of 3 cumecs regardless of the flow into Cardiff bay. The main denil pass closes for 4 hours over high tide to prevent salt water ingress into Cardiff bay. During this time, an auxiliary pass (secondary pass) operates which maintains a passage through the structure. The pass is utilised by multiple species including Atlantic salmon, sea trout (*Salmo. trutta*), mullet (*Chelon labrosus*) and sea bass (*Dicentrarchus. labrax*).

A Vaki Riverwatcher infrared fish counter has been installed on the main and auxiliary pass heads to monitor fish numbers through the barrage. The Vaki operates by emitting multiple infrared beams between two scanner plates and generates a silhouette when a target passes between the plates. It also records water temperature, direction of travel and sensor visibility. The silhouette enables us to identify the object passing through and estimate its size.

2022 Aims

The aims and objectives of this year's monitoring is the continued operation of the Vaki riverwatcher and the enumeration of fish passage into the Cardiff Bay impoundment via the main and secondary fish passes.

Counter Efficiency

The efficiency of the Vaki counter to physically detect a fish is 95% (Davis, 2011). This efficiency estimate is applied to the detected number of fish, to produce a validated monthly main pass fish count (EM_z):

$$EM_z = \frac{M_z}{Ef_i}$$

Where M_z is the actual main pass Vaki count for each month and Ef_i is the relevant efficiency estimate for the dataset.

Extrapolation of denil pass sides of the main pass

Fish can enter Cardiff bay undetected by swimming up the left or right hand side of the denil pass close to high tide (Figure 1). Work by Davis 2011 identified the proportion of salmon which bypass the vaki and enter the bay undetected. For every one salmon detected on the vaki, 0.625 and 0.452 salmon migrate on the left and right side of the vaki. This correction factor is considered a temporal constant but is revalidated periodically.

Fish Movement in 2022

A raw count of 6826 fishes of mixed species and size were detected passing through the fish pass. This is a 752% and a 2378% increase from 2018 and 2019 respectively (Figure 2). In 2020 and 2021, the full migration season was not monitored due to equipment failure. However, the 2020 and 2022 season mark a step up in fish activity through the pass.

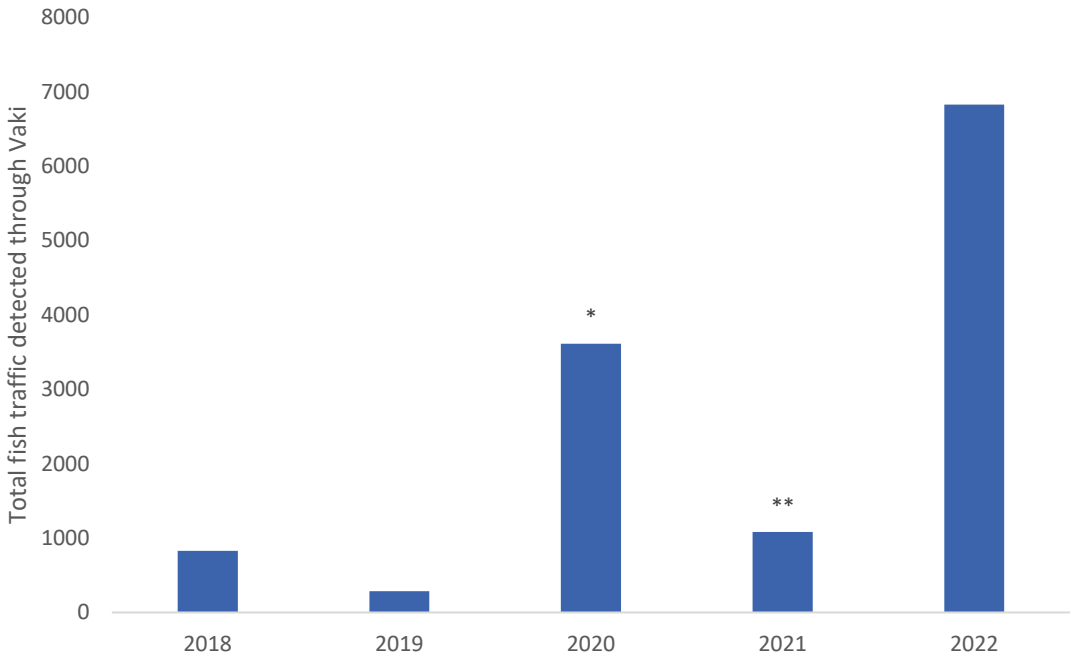

Figure 2: Cumulative fish detections (all sizes and species) from the vaki over the past 5 years.

*** Monitored April – August.**
**** Monitored full season except August**

The length frequency of the fish using the pass showed that most fish were below 55cm, the traditional salmonid threshold (Figure 3). Of the fish >55cm, vaki silhouettes were used to determine the species. Most fish using the pass in 2022 were not salmonids but large mullet and bass.

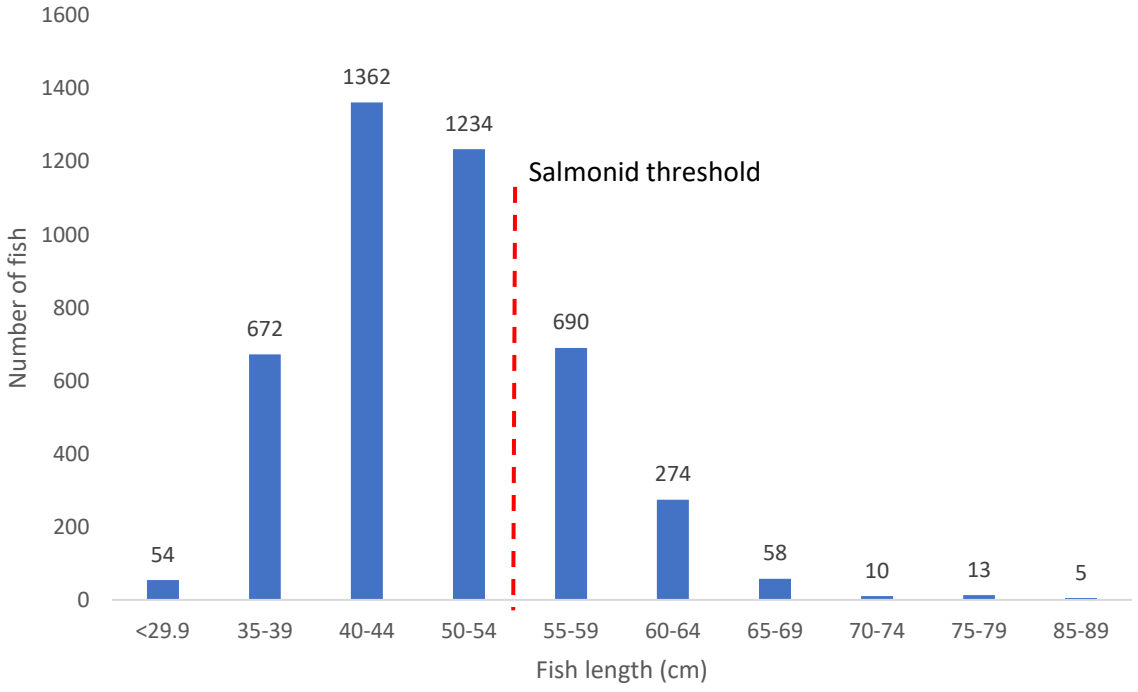

Figure 3: Size distribution of all fish detected on the vaki in 2022

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Salmonid Estimate

The number of raw salmonid detections through both the main and auxiliary passes in 2022 was 43 fish. All of these detections were travelling upstream. Several factors are used in the differentiation of salmonids (>55cm) and non-target species. Chief of these after size of the target is the silhouette generated by the Vaki. By using this combination of factors, a high degree of accuracy could be achieved. Only fish that could be clearly and confidently identified as salmonid were included in the count. The increase in non-salmonid fish traffic is a concern that will need further investigation to ensure the robustness of the count is maintained.

After extrapolation for Vaki efficiency and denil pass use, **the final run estimate for 2022 is 85 fish**. A breakdown of this run can be observed in Table 1.

Table 1: A breakdown of salmonid movement through the Cardiff bay fish pass.

Date	Week No:	Main Pass Weekly	Main Pass Cumulative	Main Pass Cumulative Extrapolated	Auxiliary Pass Weekly	Auxiliary pass Cumulative	Total Cumulative	Total Cumulative Extrapolated
04/01 to 11/04	1-14	Maintenance period						
12/04 to 18/04	15	2	2	4	0	0	2	4
19/04 to 25/04	16	0	2	4	0	0	2	4
26/04 to 02/05	17	0	2	4	0	0	2	4
03/05 to 09/05	18	1	3	6	0	0	3	6
10/05 to 16/05	19	0	3	6	0	0	3	6
17/05 to 23/05	20	1	4	8	0	0	4	8
24/05 to 30/05	21	3	7	15	0	0	7	15
31/05 to 06/06	22	2	9	19	0	0	9	19
07/06 to 13/06	23	10	19	39	0	0	19	39
14/06 to 20/06	24	2	21	44	0	0	21	44
21/06 to 27/06	25	5	26	54	0	0	26	54
28/06 to 04/07	26	1	27	56	0	0	27	56
05/07 to 11/07	27	1	28	58	0	0	28	58
12/07 to 18/07	28	2	30	62	0	0	30	62
19/07 to 25/07	29	5	35	73	0	0	35	73
26/07 to 01/08	30	1	36	75	0	0	36	75
02/08 to 08/08	31	3	39	81	0	0	39	81
09/08 to 15/08	32	0	39	81	0	0	39	81
16/08 to 22/08	33	0	39	81	0	0	39	81
23/08 to 29/08	34	0	39	81	0	0	39	81
30/08 to 05/09	35	0	39	81	0	0	39	81
06/09 to 12/09	36	1	40	83	0	0	40	83
13/09 to 19/09	37	0	40	83	0	0	40	83
20/09 to 26/09	38	0	40	83	0	0	40	83
27/09 to 03/10	39	0	40	83	0	0	40	83
04/10 to 10/10	40	0	40	83	0	0	40	83
11/10 to 17/10	41	0	40	83	0	0	40	83
18/10 to 24/10	42	0	40	83	1	1	41	84
25/10 to 31/10	43	0	40	83	1	2	42	85
01/11 to 07/11	44	0	40	83	0	2	42	85
08/11 to 14/11	45	0	40	83	0	2	42	85
15/11 to 21/11	46	0	40	83	0	2	42	85
22/11 to 28/11	47	0	40	83	0	2	42	85
29/11 to 05/12	48	0	40	83	0	2	42	85
06/12 to 12/12	49	0	40	83	0	2	42	85
13/12 to 19/12	50	0	40	83	0	2	42	85
20/12 to 26/12	51	0	40	83	0	2	42	85
27/12 to 31/12	52	0	40	83	0	2	42	85

The timing of salmonids using the pass is heavily bias towards spring fish (Figure 3). This is reflective of the decline in returning grilse which is a pattern widespread across Wales (CEFAS, 2021).

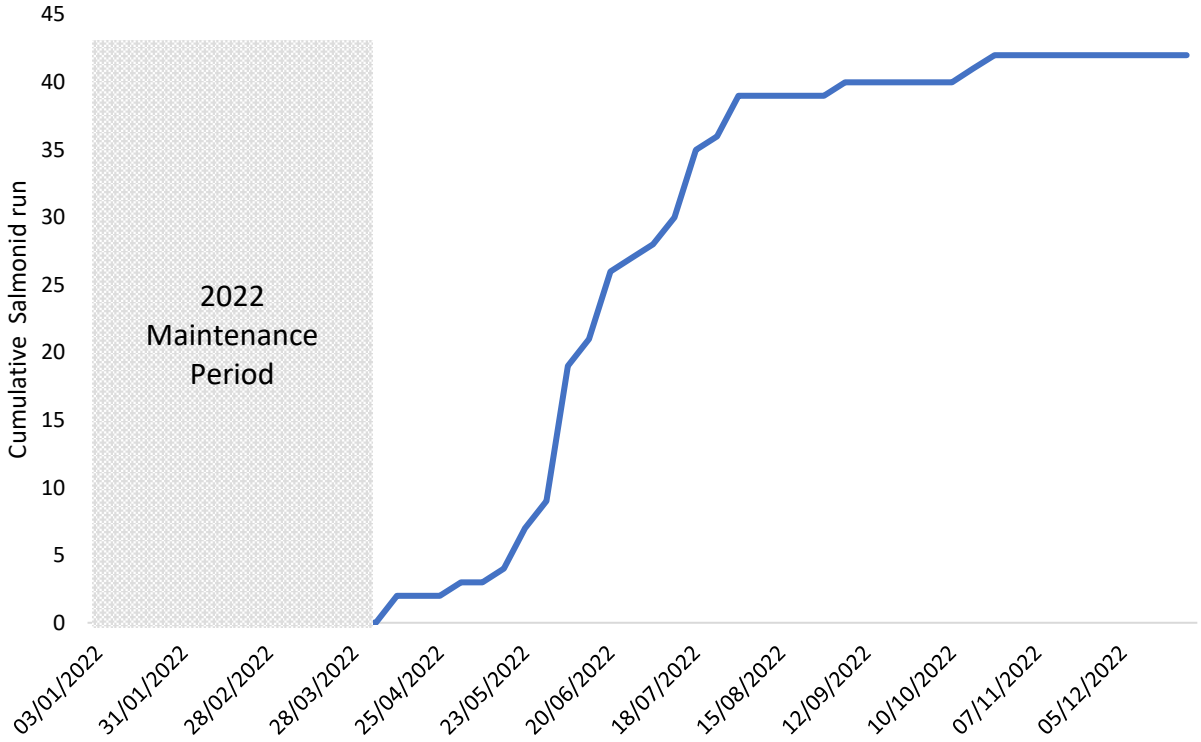

Figure 3: Run timing of Salmonids using the fish pass. This data is cumulative and extrapolated for vaki efficiency and denil pass use.

The 2022 estimate is the poorest run estimate on record for this monitoring station. Salmon numbers in Wales are declining (CEFAS, 2021) and 2022 represents a further down turn in numbers compared to previous years (Figure 4). Rod catch on the River Wye and Usk also reflected a poor year in 2022 (unpublished data). Rod catch for these rivers is strongly influcenced by river flow. During the 2022 fishing season, rivers were very low throught Wales and angler effort was also low (unpublished data). Flows in the river Taff/Ely were no exception, however, flows through the fishpass remained constant and fish were able to pass throughout the year. The fish pass maintained a minimum flow of 3 cumecs throughout 2022. The minimum flow means that fish passage was always possible despite dry conditons. However low fish numbers may have been exacerbated by the very low flows/hot weather in 2022.

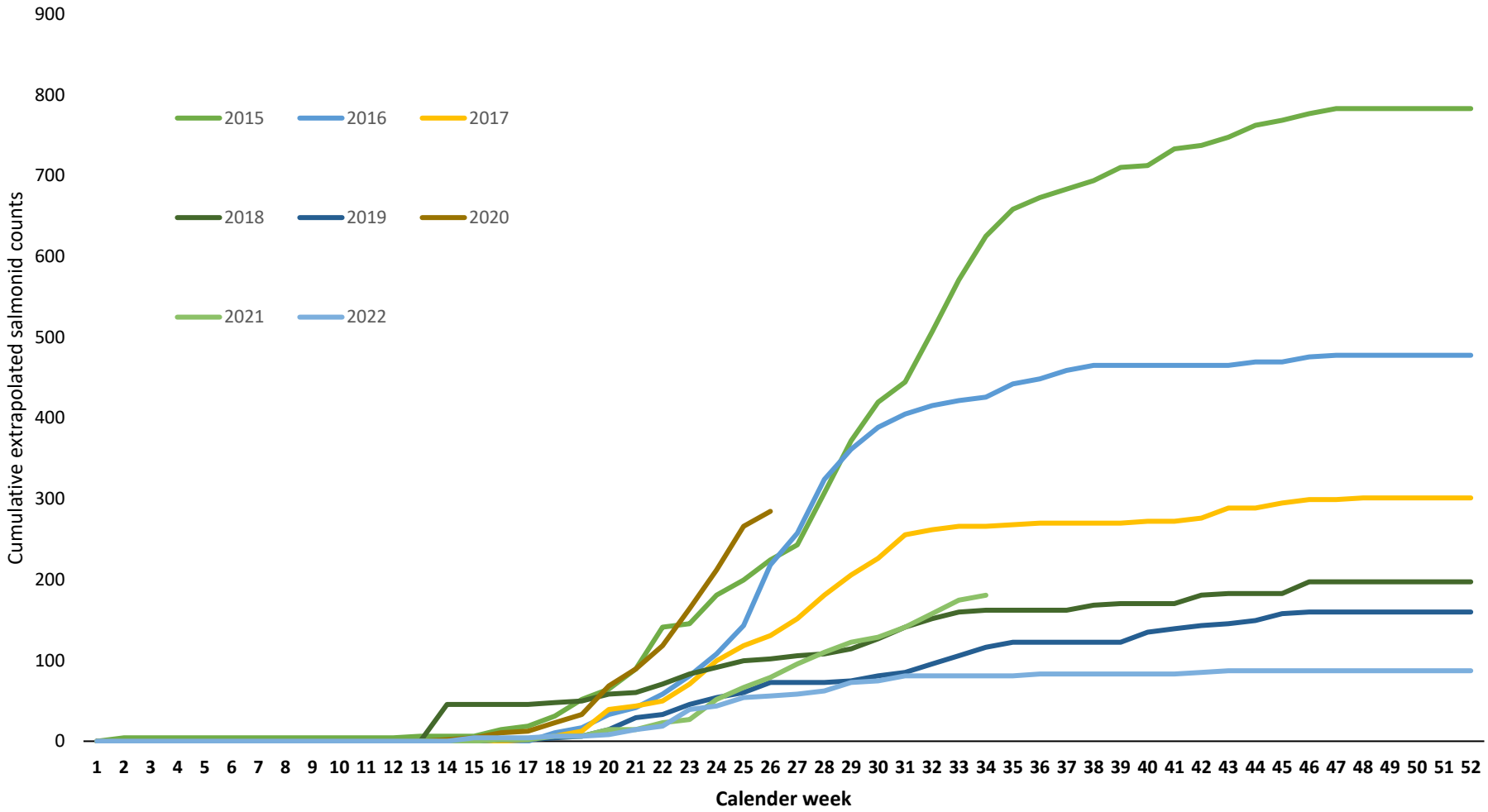

Figure 4: Salmonid run timings over the past 8 years. This data is cumulative and extrapolated for vaki efficiency and denil pass use.

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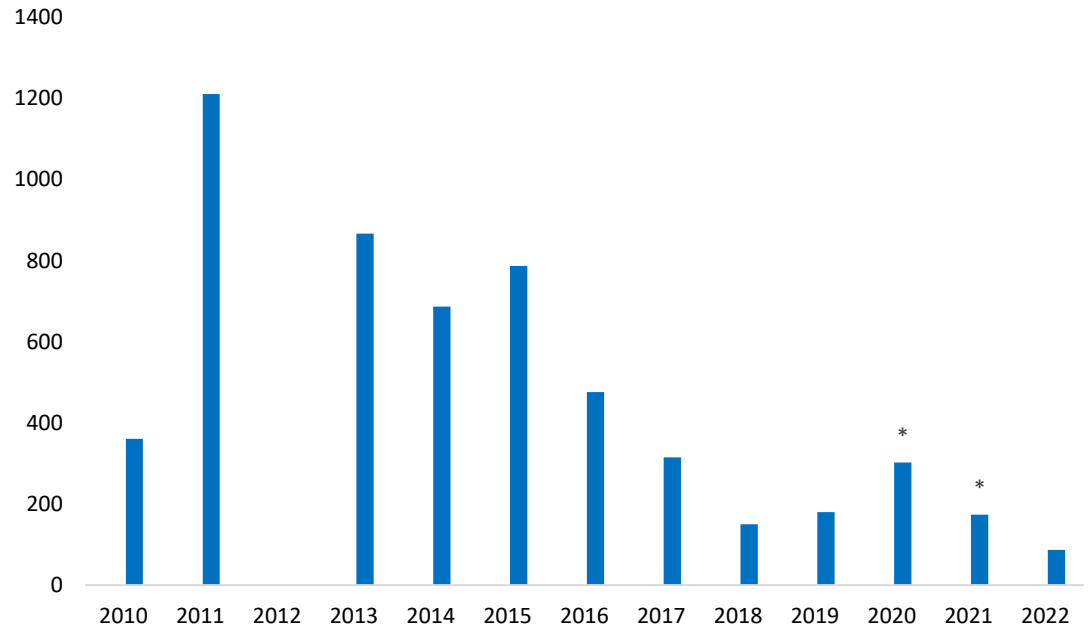

Figure 5: Extrapolated and validated salmonid count over time through the fish pass
*** Denotes incomplete monitoring year.**

Future work

The increase of large bass and mullet using the pass in 2022 demonstrates the need for sound species apportionment methods to avoid over-estimating the salmonid run estimate. In 2023, one of the primary aims will be to re-validate the species apportionment methods to ensure they are robust enough to deal with large non-target species. This will be done using optical cameras. Once a list of known-species events is drawn up, the characteristics of the silhouettes can be critiqued more thoroughly. The optical cameras will also be used to re-validate the efficiency of the vaki.

References

Centre for Environment, Fisheries and Aquaculture Science (CEFAS) (2021). Assessment of Salmon stocks and Fisheries in England and Wales Report.

Davis. J.L (2011) Monitoring Cardiff Main Pass using DIDSON to validate the Vaki Fish Counter. Ref: FAT/11/09.

Special thanks:
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