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DOWNSTREAM FISH MIGRATION ALONG THE LOW MEUSE RIVER

Action D2

Report on the silver eel fishery performed at 3 CH in 2019 and 2020

In partnership with UNAMUR

Deliverable – Report silver eel fishery

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I. Introduction

After the validation of the technique by the feasibility study performed in 2018 (A2 – Fishing protocol report), a silver eel fishery has been established on 3 HPP (Andenne, Ampsin and Lixhe) in order to:

- Catch silver eels and tag them with acoustic tags for the telemetry study ongoing in 2019 (Action D2).
- Contribute to increase of the knowledge of the silver eel population in the Meuse (link with A2 performed by UNAMUR).

II. Material and Methods

The applied fishery method tends to reproduce a proofed method performed for 20 years in the Mosel River, Germany in the Framework of the Eel Initiative (). Profish has visited a professional fisherman of this river on the 24th of October 2017. The protocol used below is directly inspired from the observed method in Germany. The protocol was the same for 2019 and 2020 fisheries campaigns.

II.1 Site localization

The fishery has been installed upstream the power station of Andenne (CHA), Ampsin-Neuville (CHN) and Lixhe (CHL). At each site, 3 lines of 5 fyke nets were installed in the direct upstream of the HPP forebay, along the bank of the river (Figure 1, 2 & 3). The fyke nets opening were heading downstream, which is a particularity of this method.

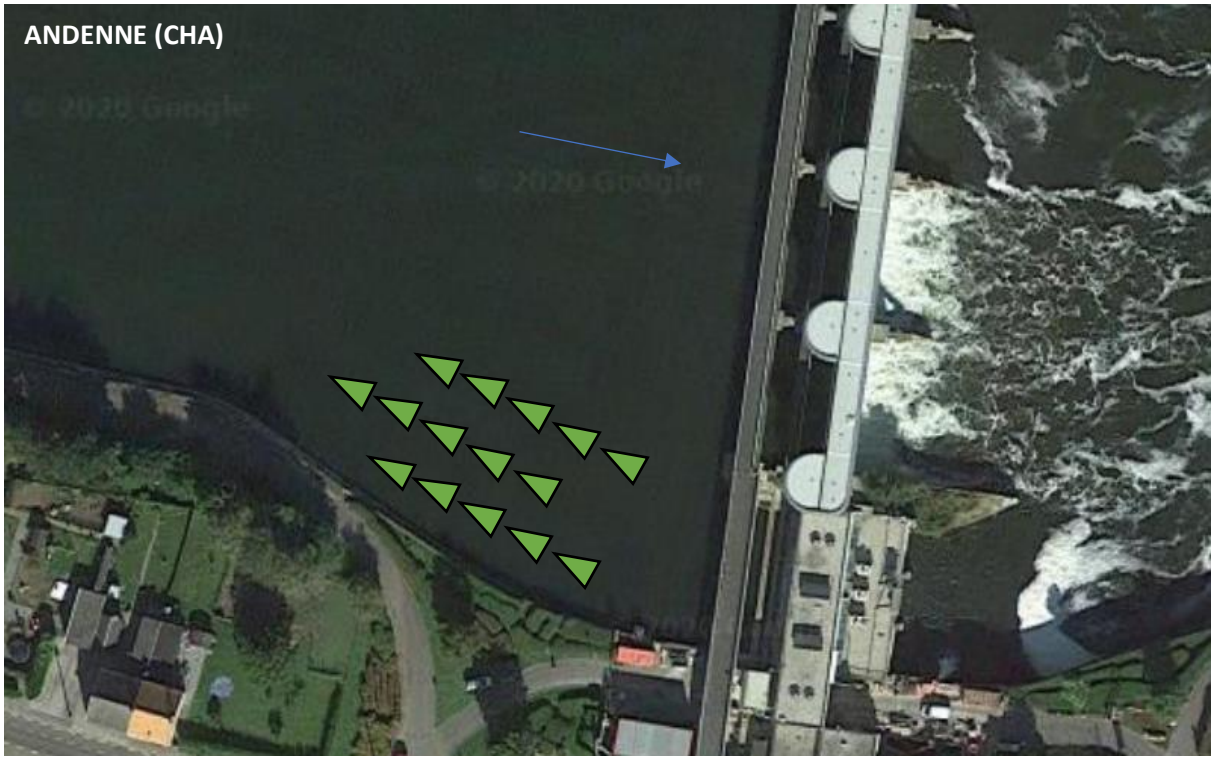


Figure 1: Andenne fishery system with 3 lines of 5 fyke nets. Green triangle represents a fyke net, the blue arrow is the main flow direction.

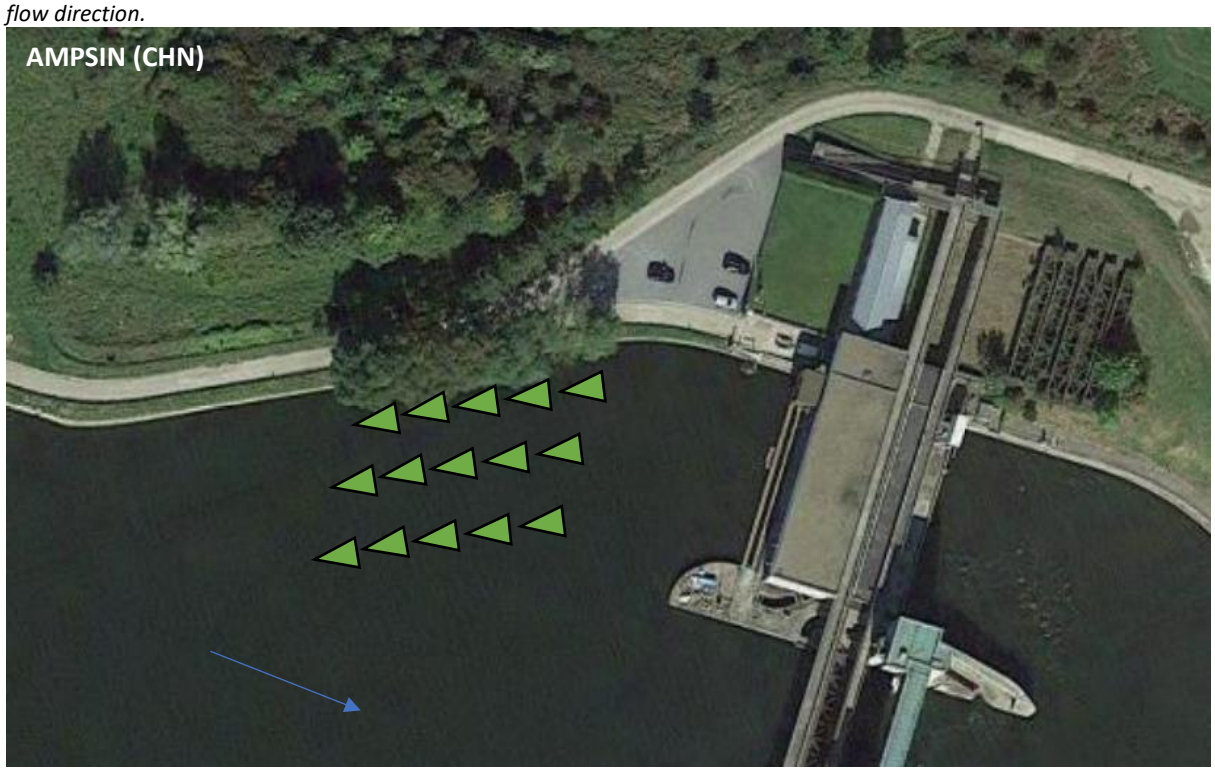


Figure 2 : Ampsin fishery system with 3 lines of 5 fyke nets. Green triangle represents a fyke net, the blue arrow is the main flow direction.

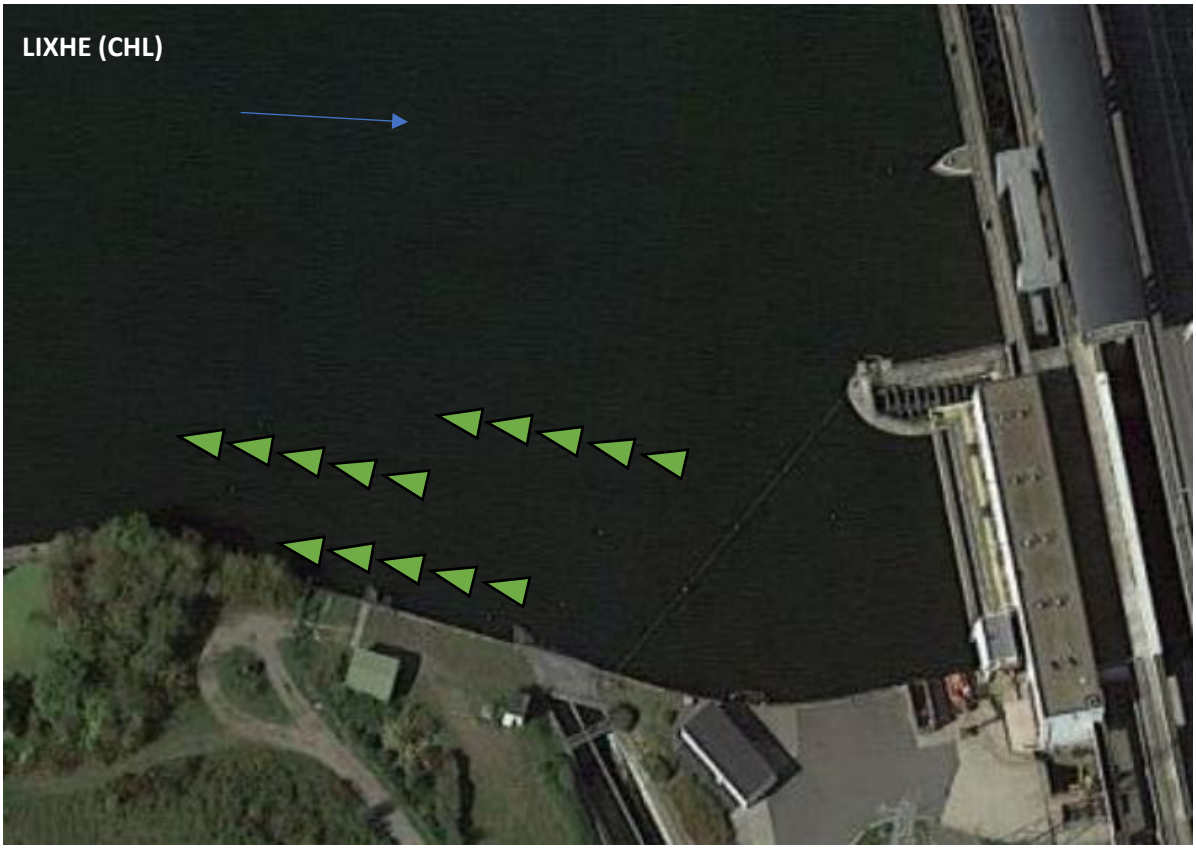


Figure 3 : Lixhe fishery system with 3 lines of 5 fyke nets. Green triangle represents a fyke net,the blue arrow is the main flow direction.

II.2 Fish catching system

After the performance test of 2018, 2 modifications were planned to our catching system:

- Fyke nets used had still 55 cm diameter of opening, but a total length of 2.5 m in place of 3.7 m, which is easier to handle in the water current and has the same catching capacity.
- Use 5 lines of 3 fyke nets instead of 3 lines of 5 fyke nets.

The first modification has been realised, but the second one was not easy to realize on site due to the site configuration. The HPP forebays are quite narrow, and it was not that easy to dispose 5 lines of nets each along the other, without crossing lines and having trouble to lift them. So, we finally stayed with 3 lines of 5 fyke nets on each site.

5 fyke nets were attached along a line made by a rope of 8 mm of diameter. 2 m was kept between the tail of a fyke net and the head of the next fyke net. A steel anchor (16 kg) was used to anchor each line of fyke net on the bottom of the river, with the tail of each fyke net pointing upstream, and the head pointing downstream. This way, eels are caught when swimming back upstream after avoiding the screen of the power station. This disposition presents also an advantage concerning the debris as the debris of the river will be less clogging the net but presents the disadvantage to be limited to low discharge and misses therefore the peaks of eel migration.

At the downstream end of the line, around 5 m of chain was used as weight, and then a buoy was allowing the operator to lift the net-line from downstream to upstream. The Figure 4 presents the global installation of the nets.

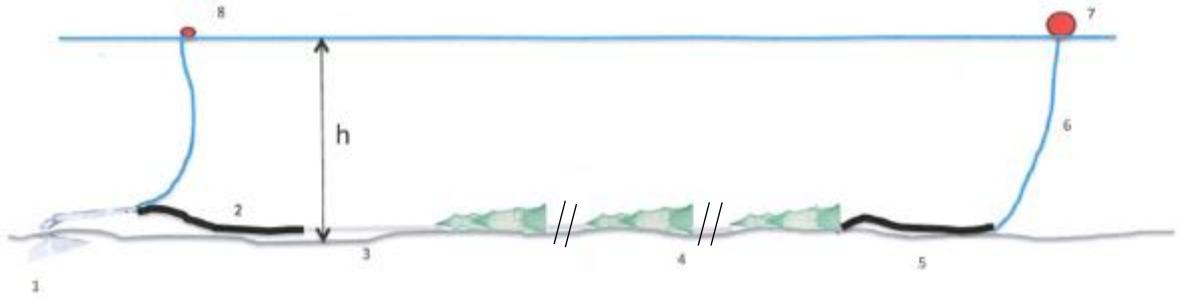


Figure 4 : Diagram of fyke nets line. h = depth (m); 1 : Anchor 16kg, 2 : chain (length = h), 3 : tail rope(length = h), 4 : fyke net (5 units) ; 5 : chain (length = h) ; 6 : head rope(length = h) ; 7 : line lifting buoy; 8 : anchor lifting buoy.

The installation of the nets was made by boat with 2 two people on board. Each time, the nets were lifted from downstream to upstream to empty the net and installed back in position after cleaning them by drifting the boat from upstream to downstream. The fish caught were stocked in basins poured with the river water. After catching, each fish was identified (species), measured (mm), and weighted (g).

Each eel caught was scanned by a Pit-tag reader, as some tagged silver eels are known to be present upstream (Action A2). Each untagged eel was tagged using Pit-Tag (12-mm HDX), by a surgery gun under anaesthesia (eugenol 10%, 0.3 ml/l). In addition to weight and length measures, the morphometric parameters (eye vertical and horizontal diameter and pectoral fin length) were recorded to determine the silver stage. Some eels were also sampled for blood and mucus by UNamur to characterize their health status. This part will be presented by UNamur in the A2 action reports.

The silvering stage was established based on the morphometric data using the Durif index (Durif et al, 2005). All eels that caught at the FIV and FV status where candidates for a tagging by surgery with an acoustic tag.

After recovering from anaesthesia, Pit-tagged eels were then restocked below the next dam upstream since the recapture of a tagged eel among other eel allows population estimation by Capture-Mark-Recapture method (CMR) described in the fishing protocol (Action A2). The eels tagged with acoustic tags were released with a different protocol in 2019 that is described in the D2 silver eel telemetry report.

II.3 Study period and catching unit effort.

A unit effort is described as the period from the moment the fyke nets are installed clean and empty into the river to the moment they are lifted back out of the water to recover the fish inside. The net was lifted once per week.

In 2019, the lines of fyke nets have been installed progressively from 26/06/19 in CHA, 10/07/19 in CHN and 17/07/19 in CHL. The fishery lasted until end of January, but from 4th December, it was not possible to lift the net for safety reason, the river discharge increasing more intensively. In CHA, the fishery was interrupted between 30/19/19 and 22/11/19 for technical reason. The fishery campaign ends the 23/01/2020. All the nets have been taken out of the water. The acoustic tagging of silver eels only started from October 2019, since the telemetry survey was waiting the end of the installation of the mitigation measures to start.

In 2020, the lines of fyke nets have been installed the 02/07/2020 on all sites. The fisheries on the 3 hydropower plants stop the 17/12/2020 before the winter discharge rising. To improve the Catch Per Unit Effort index (CPUE) we have named each net with a letter: A, B or C for the fykes nets line, and a number: 1 to 5 for the net position in the line. For each eel captured, the net ID is associate.

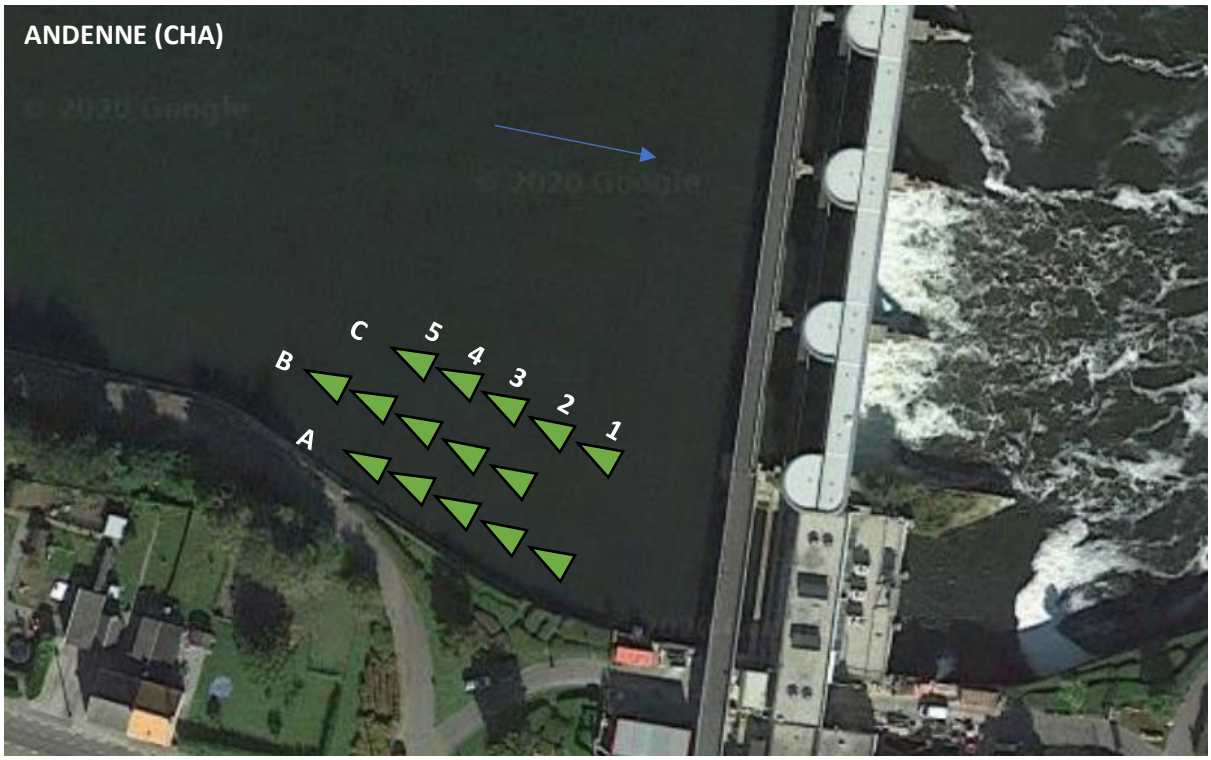


Figure 5 : Identification of nets for CPUE

No acoustic tagging has been performed in 2020 since no silver eel telemetry was planned. It was scheduled in the program to perform 3 years of silver eel fishery with only 2 years of silver eel telemetry survey.

III. Results

III.1 2019

III.1.1 Description of the eel catches distribution.

The fishery started in very low discharge conditions in July on the 3 sites, and a regular catch of silver eels was made during the summertime. The maximal catch of silver eels over all sites was observed during the first catching effort in CHA (N = 14 eels). In total over the period, 44 eels have been caught in CHA, 31 in CHN and 28 in CHL, bringing the total eel catch to 103 silver eels but some eels have been recaptured up to 2, 3 or 4 time. Only 91 different eels were really caught during these fisheries.

During the pilot study in 2018, based on the results obtained at CHA, we expected to reach a total of 69 silver eels on the 3 sites. The fishery of 2019 was consequently more efficient than expected, which is a pretty good news.

The catches were more abundant during low discharge than during high discharge, while the telemetry study tends to show that eel migration is mainly occurring during higher hydrologic conditions. The fishery does not seem to reveal a normal kinetic of eel migration but could reveal an accumulation of silver eel upstream the dams before a real trigger of the migration.

The mean length of the eels was 858 mm (min 570 mm; max 1076 mm) for a mean weight of 1.209 kg. The distribution of these eels according to their length and silvering stage (determined by Durif et al., 2005 formula) are presented in Figure 6. As shown, 54% of eel were already in the silvering stage SF IV (Figure 6). The SF IV stage is considered as pre-migratory stage. The individuals have already stopped to feed and are performing the first downstream movements and will likely start their migration within the same year. During this period, 6% of eels were already in the silvering stage SFV which is considered as the migrating stage.

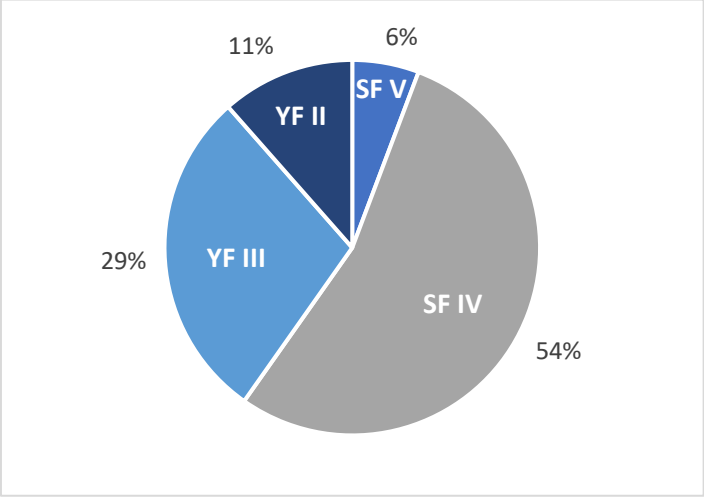


Figure 6: Distribution of the eels caught by silvering stage - 2019.

As 103 eels have been captured and recaptured on a total of 85 units efforts, the mean catching rate of the fishery is a mean of 1.21 eel/unit effort (CPUE) with 3 lines of 5 fykes on all sites. The catching rate per site varied from 1.47, 1.11 and 1.04 eel/unit effort during all the period of fisheries (03/07/2019 – 23/01/2020) at CHA, CHN and CHL, respectively.

As shown in Figure 7, the main catches have been made during the beginning of the study, under conditions of low discharge and decreasing temperature. All the captures occurred before the 04/12/2019 at CHA and CHL and 97% at CHN. At this date and without the none catch winter period; we have done 23 efforts units at CHA (CPUE = 1.91), 21 efforts units at CHN (CPUE = 1.48) and 20 efforts unit at CHL (CPUE = 1.4). During the increase of discharge in early November 2019, the nets of CHA have been removed out of the river to protect them while these of CHN and CHL could not be removed on time. Consequently, there is a long fishing period for these 2 stations during the stop of fishing effort in CHA.

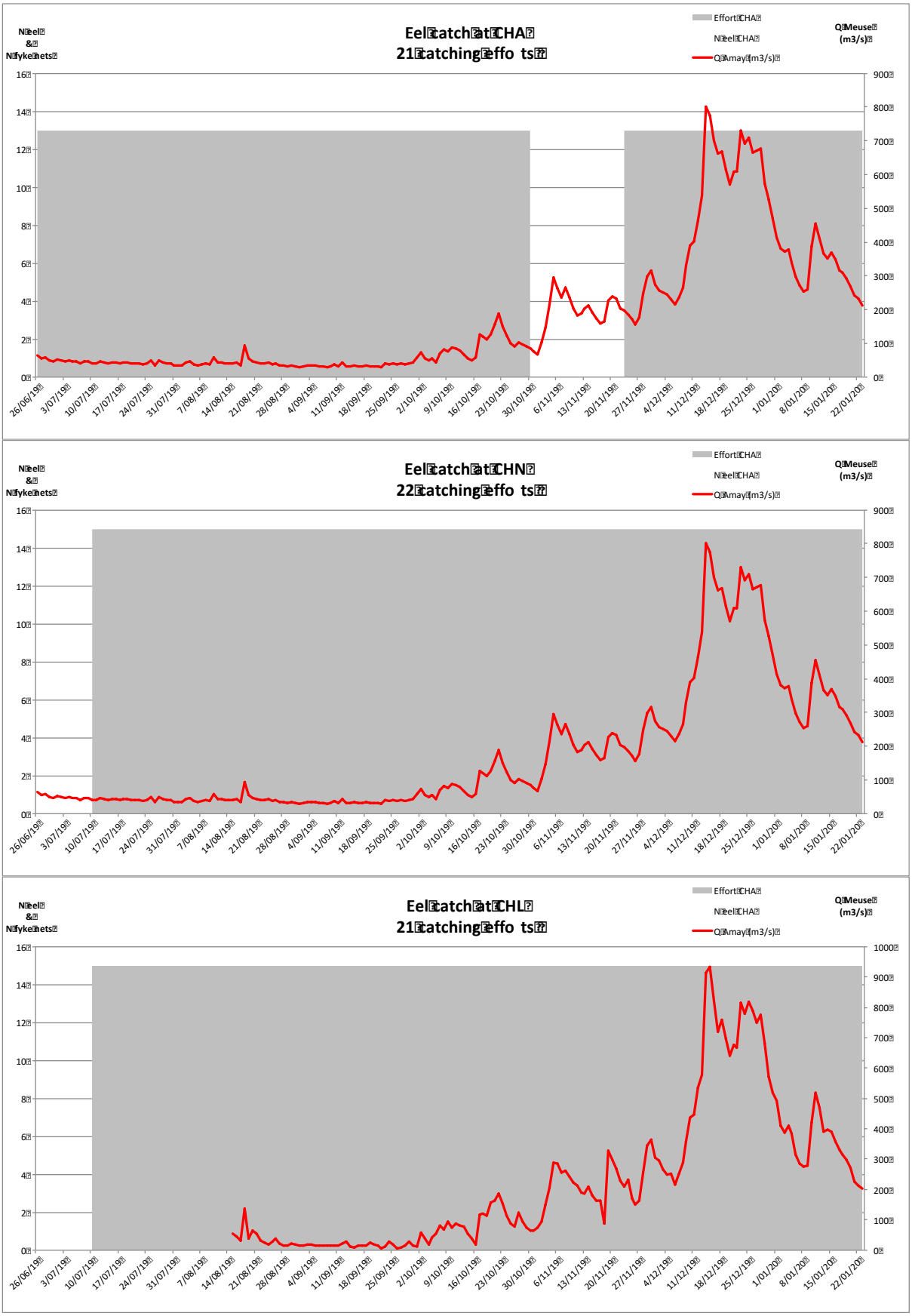


Figure 7: Unit Effort (Y = number of fyke nets used, in grey) and Number of eels (Y axis, in blue) caught during the study period (X axis) in relation with the River Meuse discharge (second Y axis, m3/s, in red) at CHA, CHN & CHL.

III.1.2 Total catches

During this fishing campaign, a total of 1606 fish and 25 crab from 14 different species has been caught (Table 1).

SPECIES	CHA	CHN	CHL	TOTAL
Anguilla anguilla*	36	28	27	91
Silurus glanis	9	22	8	39
Perca fluviatilis	18	36	69	123
Tinca tinca	0	0	17	17
Rutilus rutilus	4	15	87	106
Alburnus alburnus	1	1	2	4
Eriocher sinensis (crab)	1	7	17	25
Sander lucioperca	3	0	7	10
Abramis brama	0	0	4	4
Salmo trutta	1	0	0	1
Blicca bjoerkna	0	0	1	1
Barbus barbus	0	0	1	1
Esox lucius	0	1	0	1
Neogobius melanostomus	375	178	659	1212
TOTAL	**448**	**288**	**899**	**1635**

*Table 1: Total caught during the 2019 study period on different sites. *Number of eels without recaptured.*

The acoustic tagging period started on 1st October 2019 until the 24th January 2021. During this period, a total of 26 silver eels have been tagged and released. Consequently, since 150 silver eels were necessary to fill the survey protocol, we had to purchase silver eels from the Rhine river to complete the required sampled.

III.2 2020

III.2.1 Description of the eel catches distribution.

The fishery started in very low discharge conditions the 02/07/2020 on the 3 sites, and a regular catch of silver eels was made during the summertime. In total, 26 eels have been caught in CHA, 23 in CHN and 21 in CHL, bringing the total eel catch to 70 silver eels (Figure 8). No eel recapture has been observed during this survey, except eels caught from the 2019 fishery, that was considered in 2020 as a normal capture.

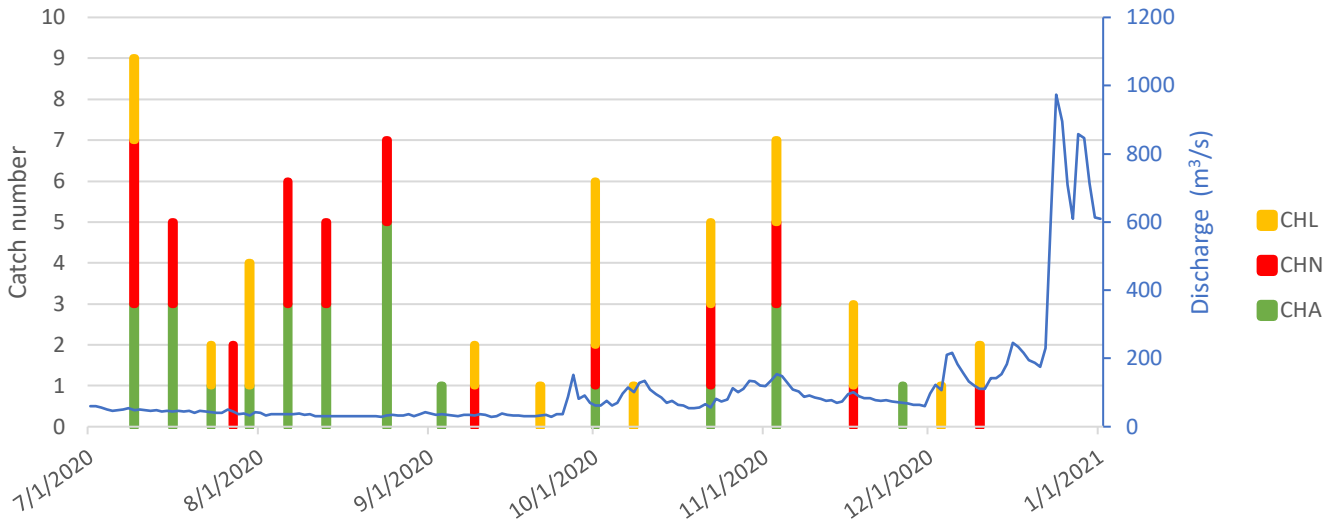


Figure 8 : Number of eels catches evolution per site over time and according to Meuse discharge.

The mean length of the eels was 874 mm (min 477 mm; max 1092 mm) for a mean weight of 1.443 kg. The distribution of these eels according to their length and silvering stage (determined by Durif et al., 2005 formula) are presented in Figure 10. As shown, 73% of eel were already in the silvering stage SF IV (Figure 9). The SF IV stage is considered as pre-migratory stage. The individuals have already stopped to feed and are performing the first downstream movements and will likely start their migration within the same year. During this period, 3% of eels were already in the silvering stage SFV which is considered as the migrating stage.

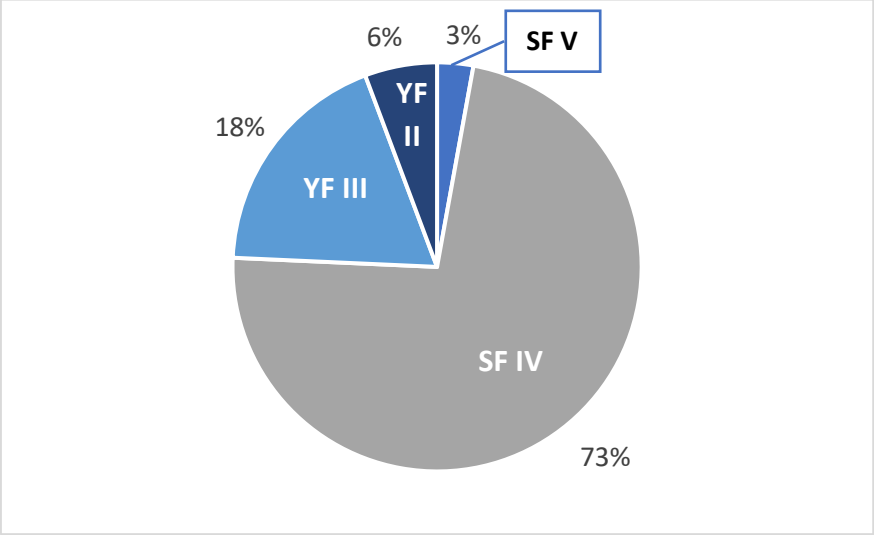


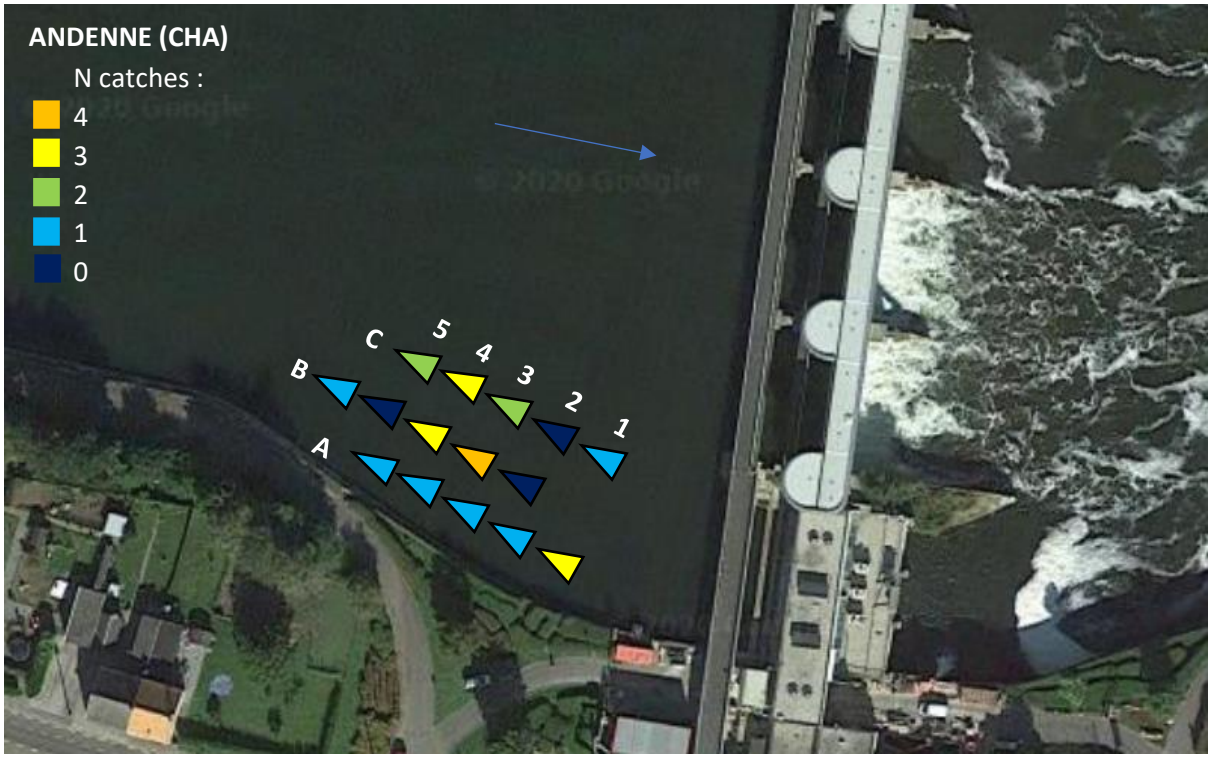
Figure 98 : Distribution of the eels caught by silvering stage - 2020.

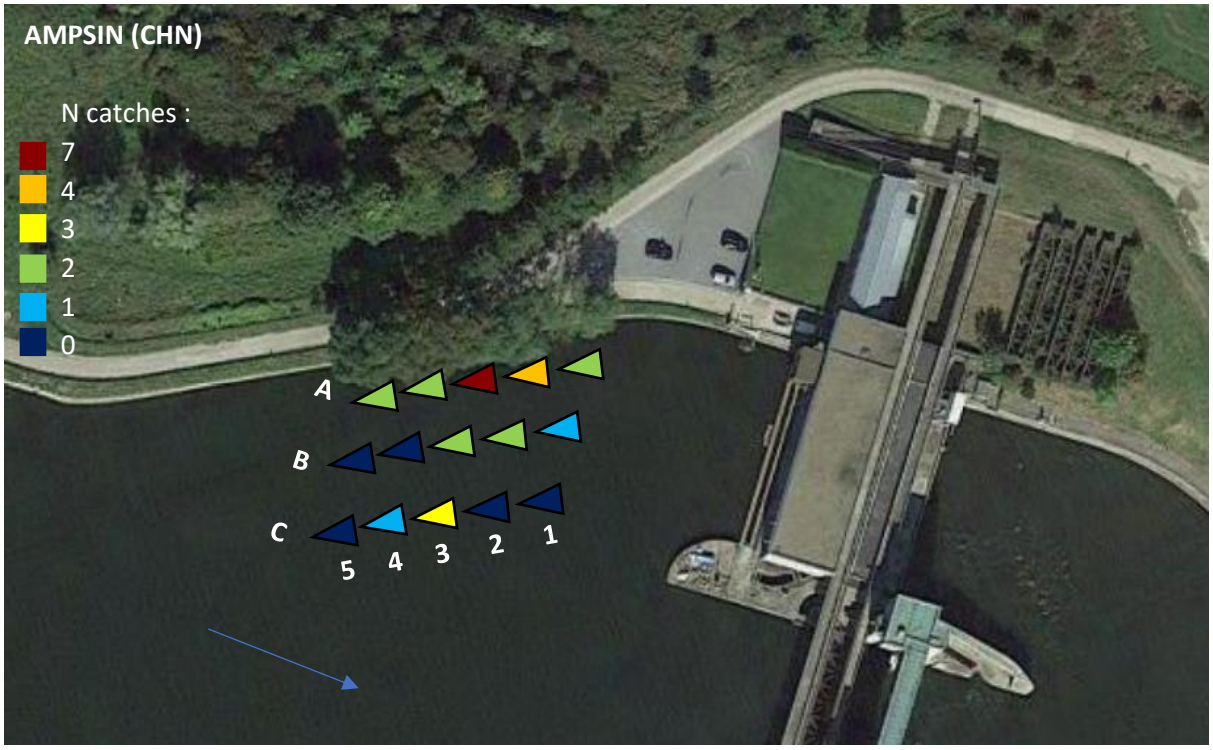
19 fisheries were realized at each site during 2020 campaign. The comparison between the CPUE of the two fishing seasons shows a decrease of 28% at CHA, 18% at CHN and 21% at CHL in 2020 (Table 2).

CPUE	2019	2020
CHA	1.91	1.37
CHN	1.48	1.21
CHL	1.40	1.11

Table 2: Catches Per Units Efforts at each fishing site during the two campaigns.

In the 2020 protocol, described in II.3, we attributed to each catch a specific net and its position in the line A-B-C, Figure 10).


ANDENNE (CHA)
N catches :
4
3
2
1
0
C
5
4
3
2
1
B
A


AMPSIN (CHN)
N catches :
7
4
3
2
1
0
A
B
C
5
4
3
2
1

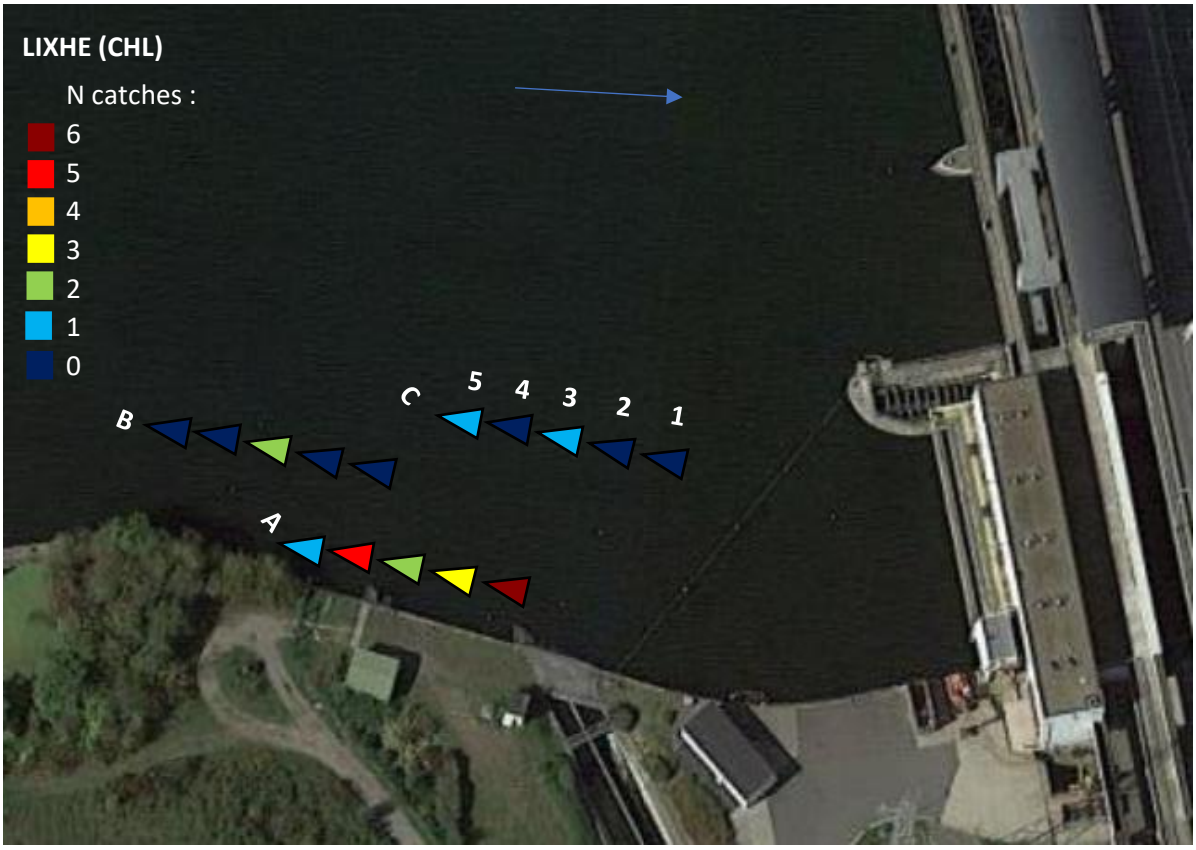


Figure 90 : positions of lines and fyke identification system on each site.

Fyke nets of line A, along the bank, were the most efficient to catch silver eels compared to line B and C. Along each line, there is a decreasing trend on lines A from the first to the 5th fyke nets (Figure 11), while middle fyke nets (2&3) were more efficient on lines B and the tail fyke nets (3-4-5) were more efficient on line C.

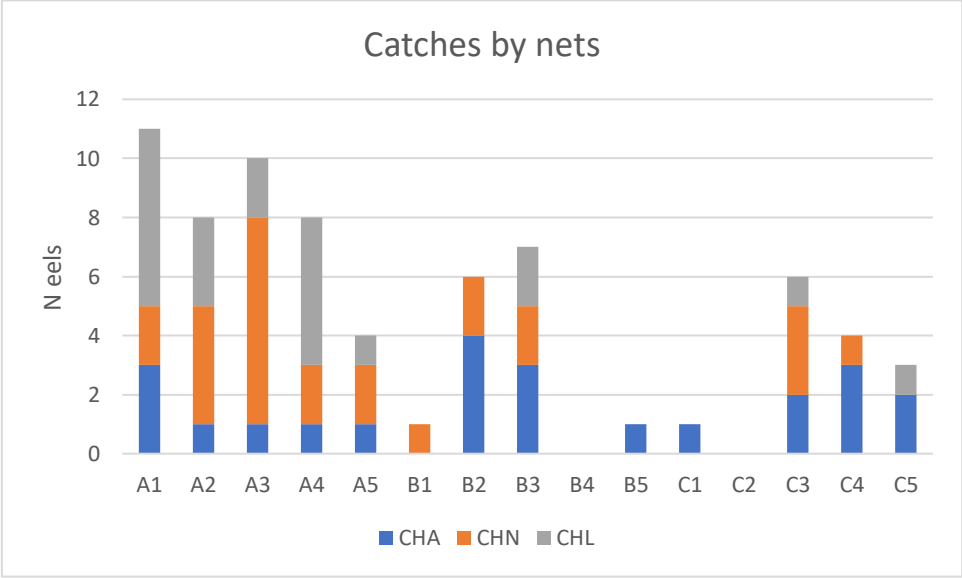


Figure 11 : Distribution of catches by fyke nets at each site

III.2.2 Total catches

During this fishing campaign, a total of 1363 fish and 48 crab from 9 different species has been caught (Table 3).

SPECIES	CHA	CHN	CHL	TOTAL
Anguilla anguilla	26	23	21	70
Perca fluviatilis	25	32	120	177
Neogobius melanostomus	509	186	405	1100
Silurus glanis	3	9	5	17
Sander lucioperca	0	0	3	3
ERIOCHEIR SINENSIS	15	24	9	48
Rutilus rutilus	0	0	14	14
Abramis brama	1	0	2	3
Alburnus alburnus	1	0	0	1
Total	**554**	**251**	**558**	**1364**

Table 3: Total caught during the 2020 study period on different sites.

IV. Feedback and recommendations

IV.1 Fishing equipment and position of the lines of fyke nets in 2019

We considered the recommended improvements from 2018 fisheries in our logistic this year. We keep the 3 lines of 5 fykes nets system a bit more upstream from the screen of hydropower plant to have less difficulties to lift them. The 2m fyke nets were easily manipulated until a discharge of 250m^3/s approximately where it was agreed with Luminus that, for safety reasons, we must not go on the boat in front of the turbines.

The new anchor system with the plough anchor was efficient, it was easier to put in place the lines and take them out at the end of the fisheries. We could not anticipate a sudden rising of discharge and did not have time to take out the nets at the end of the fishery. Consequently, they stayed in the water during the winter time. One line was probably hooked by trees with high water velocity at CHL and has never been removed. Nets at the CHN site were not significantly damaged by debris and some of CHA nets were damaged by trees, but we were able to recover them all on both sites.

IV.2 Fishing equipment and position of the lines of fyke nets in 2020

The 2020 Protocol was designed based on the experiences of 2018 and 2019, we better anticipated the rising of discharge and remove the nets the 17/12/2020 at CHN and CHL. The nets were kept at CHA to see if we were able to continue the fisheries during winter. We pull in the nets the 11/01/2021 when discharge allowed for intervention (< 300 m^3/s), no eel have been caught and the nets were either damaged or filled with debris (trash, leaves, wood...). It was decided not to maintain the fishery until conditions are more favourable.

The B line at CHL was positioned further upstream because the previous year's net line at this position could not be removed, debris accumulated on this line could have damaged the new nets.

IV.3 Recommendations for next fisheries

In 2020, the total eels' captures have decrease by more than 30% compared to 2019 and the new catches positioning system show that most eels were caught near the bank. For future studies requiring more than 50 individuals, we recommend placing all the nets as close as possible of the bank. We also consider to use wing nets in between each fyke along a line, that could guide swimming eels towards the entrance of the nets and increase the catching rate.

The next fishery is scheduled from 1st July 2022, in the framework of the last silver eel telemetry survey of the project.

V. Bibliography

Durif, C.; Dufour, S. & Elie, P. 2005. The silvering process of *Anguilla anguilla*: a new classification from the yellow resident to the silver migrating stage. *Journal of Fish Biology* **66(4)** : 1025-1043.